APPENDICES

VILLAGES OF LEIALI‘I AFFORDABLE HOUSING DRAFT ENVIRONMENTAL IMPACT STATEMENT

LAHAINA, MAUI, HAWAI‘I

TMK 4-5-21:03, 04, 05, 13, 21, 22, AND 4-5-28:70

Prepared for:

Hawaii Housing Finance & Development Corporation (HHFDC)

Prepared by:

Belt Collins Hawaii Ltd.

November 2010

APPENDICES

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November 2010

Appendix A

Community Outreach

Community Outreach included agency consultations, interviews and a request for written responses from stakeholders in 2008, and a community workshop in January 2009. This appendix includes the letter sent to stakeholders, all comments received in response to that letter, and a summary of the discussion at the community workshop.

Materials sent to stakeholders

July 9, 2008
2007.70.0500 / 08P-246

Aloha:

We are writing to you on behalf of the Hawaii Housing Finance & Development Corporation (HHFDC). HHFDC has retained Belt Collins to prepare a master plan and environmental impact statement (EIS) for an affordable housing project on 1,128 acres of state land at the Villages of Leiali‘i in Lahaina, Maui.

In recent months, HHFDC and Belt Collins have been discussing this project with government agencies, adjacent landowners, and other stakeholders. Our team has been preparing various land use alternatives based on site constraints, market trends, and infrastructure requirements such as roadway connections. At this early point in the project, we request your comments on the land use concepts being considered. Your comments will help HHFDC to select and refine its preferred concept to be presented in both the Request for Proposals to potential developers of the project, as well as the EIS preparation notice.

Two layouts are presented for your review; see attached figures. Each of these layouts incorporates a realignment of the proposed Lahaina Bypass Highway to avoid cultural resources. (The State Department of Transportation is currently evaluating several realignment options for highway.) The project would be developed in two phases, with the first phase of the project on lands makai of the bypass highway. The two Leiali‘i land use concepts have several elements in common.

- Each concept uses smart growth principles to create a walkable, bikable, active-lifestyle community.
- In addition to housing, each concept includes commercial space: to the south to serve the region, to the north to primarily serve the Leiali‘i community, and within the mixed-use areas. Each concept also includes light industrial land use adjacent to the regional commercial area.
- Each concept features mixed-use areas comprised of multifamily housing, ground-floor commercial/retail uses, and civic open space.
- Each concept includes two elementary schools (~24 acres total), neighborhood parks (~40 acres total), and a large open space area around crater reservoir.
- Each concept accommodates the potential for feasible roadway connections to adjacent lands.
- Each concept includes onsite and offsite infrastructure improvements.

Honolulu
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Boulder
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Hong Kong
Manila
Seattle
Shenzhen
Singapore

Belt Collins Hawaii Ltd.
2153 North King Street, Suite 200 ▪ Honolulu, Hawaii 96819-4554 USA
T/808 521 5361 ▪ F/808 538 7819 ▪ honolulu@beltcollins.com ▪ www.beltcollins.com

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As shown in the table below, Concepts A and B differ in terms of number of housing units and densities, with Concept B having more units and higher densities. The amount of commercial and light industrial space is the same.

	Concepts	
	A	**B**
Number of residential units:		
Single-family residential, detached	2,220	1,590
Single-family residential, attached	140	0
Multi-family residential	690	1,840
Multi-family residential in mixed use	240	480
Total	3,290	3,910
Density (dwelling units/acre):		
Single-family residential, detached	5.3	5
Single-family residential, attached	7.5	-
Multi-family residential	15	25
Total commercial/office (SF)	465,000	465,000
Total light industrial (SF)	696,000	696,000

Please send your comments by August 8, 2008, addressed to: Belt Collins Hawaii, 2153 North King Street, Suite 200, Honolulu, HI 96819, attention: Lynn Fukuhara. You may email your comments to: lfukuhara@beltcollins.com. If you have any questions, please call me at 808-521-5361 or email ssakai@beltcollins.com.

Thank you for your kokua.

Sincerely,

BELT COLLINS HAWAII LTD.

Susan A. Sakai
Vice President and Director of Planning

SAS:lf

Enclosures

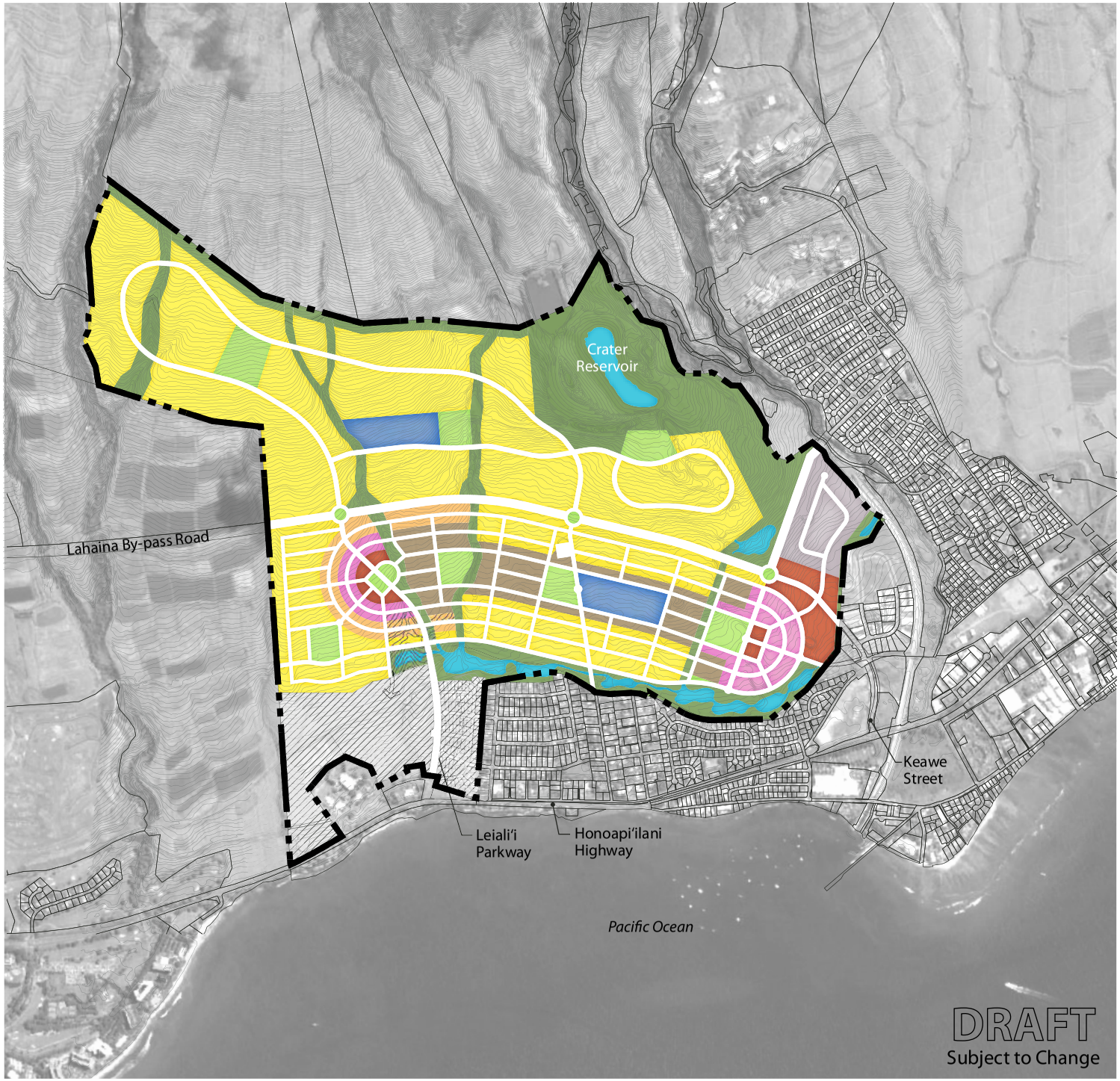

Figure 1

CONCEPT LAND USE PLAN A

Villages of Leiali'i

LEGEND

- Detached Single-Family Residential
  422.69 ac/2,220 du
- Attached Single-Family Residential
  18.73 ac/140 du
- Multi-Family Residential
  46.2 ac/ 690 du
- Open Space
  252.65 ac
- Park
  43.05 ac
- Elementary School
  24.24 ac
- Commercial
  19.6 ac/256,100 sf
- Mixed Use
  23.98 ac
  - Commercial: 208,900 sf
  - Office: 104,500 sf
  - Multi-Family Residential: 240 du
- Light Industrial
  22.78 ac/696,000 sf
- Not in Project
  96.03 ac
- Detention Ponds

Note: Lot lines shown are approximate and for illustrative purposes. Imagery is from Google Earth Pro and is approximately matched to lot lines.

NORTH

0 500 1000 1500 2000
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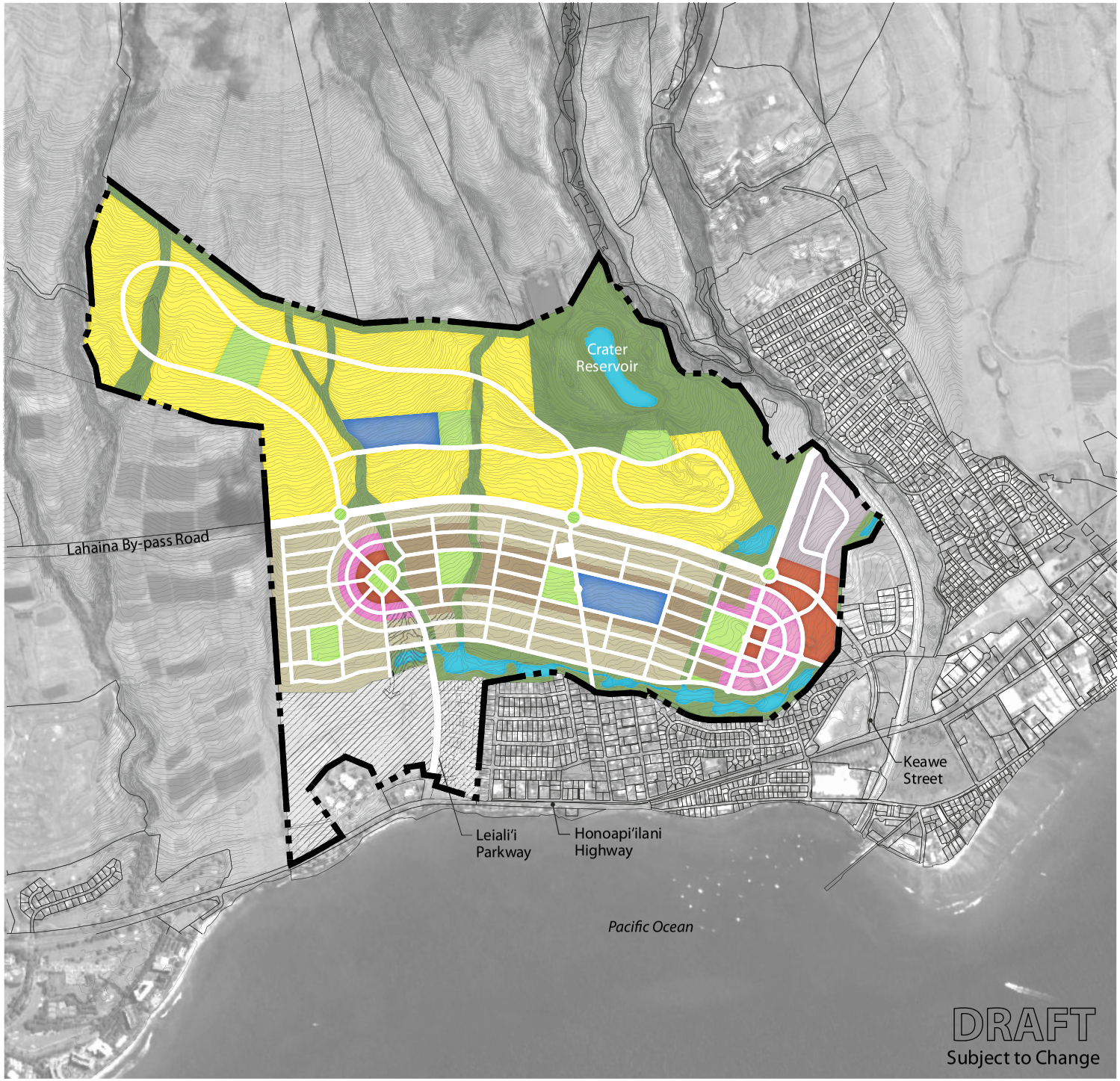

Figure 2

CONCEPT LAND USE PLAN B

Villages of Leiali'i

LEGEND

- Detached Single-Family Residential
  318.43 ac/1,590 du
- Attached Single-Family Residential
  0 ac
- Multi-Family Residential—15du/ac
  122.99 ac/1,840 du
- Multi-Family Residential—25 du/ac
  46.2 ac/1,160 du
- Open Space
  252.65 ac
- Park
  40.87 ac
- Elementary School
  24.24 ac
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Mailing List of Stakeholders Noting Who Commented

Villages of Leiali‘i
Stakeholder Mailing List

Comment Rec'd	Salutation	First	Middle	Last	Title	Company1	Company2	Company3	Address	City	State	Zip
	STATE AGENCIES											
7.31.08	Mr.	Abbey	Seth	Mayer	Director	Office of Planning	Dept. of Business, Economic Dev. & Tourism	State of Hawaii	P.O. Box 2359	Honolulu	HI	96804
	Mr.	Theodore	E.	Liu	Director		Dept. of Business, Economic Dev. & Tourism	State of Hawaii	P.O. Box 2359	Honolulu	HI	96804
	Ms.	Heidi		Meeker		Facilities Development Branch	Dept. of Education	State of Hawaii	P.O. Box 2360	Honolulu	HI	96804
8.7.08	Mr.	Duane	Y.	Kashiwai	Public Works Administrator	Office of School Facilities and Support Services	Dept. of Education	State of Hawaii	P.O. Box 2360	Honolulu	HI	96804
	Mr.	Micah	A.	Kane	Chairman		Dept. of Hawaiian Home Lands	State of Hawaii	P.O. Box 1879	Honolulu	HI	96805
	Mr.	Stewart		Matsunaga			Dept. of Hawaiian Home Lands	State of Hawaii	P.O. Box 1879	Honolulu	HI	96805
	Mr.	Larry		Sumida			Dept. of Hawaiian Home Lands	State of Hawaii	P.O. Box 1879	Honolulu	HI	96805
	Mr.	Kelvin		Sunada	Head	Environmental Planning Office	Dept. of Health	State of Hawaii	919 Ala Moana Blvd., Room 312	Honolulu	HI	96814
		Katherine	P.	Kealoha, Esq.	Director	Office of Environmental Quality Control	Dept. of Health	State of Hawaii	235 S. Beretania Street, Suite 702	Honolulu	HI	96813
	Dr.	Pua		Aiu	Administrator	State Historic Preservation Division	Dept. of Land and Natural Resources	State of Hawaii	601 Kamokila Blvd., Room 555	Kapolei	HI	96707
	Ms.	Laura	H.	Thielen	Director		Dept. of Land and Natural Resources	State of Hawaii	P.O. Box 621	Honolulu	HI	96809
8.5.08	Mr.	Morris	M.	Atta	Administrator	Land Division	Dept. of Land and Natural Resources	State of Hawaii	P.O. Box 621	Honolulu	HI	96809
	Mr.	Skippy		Hau	Aquatic Biologist	Division of Aquatic Resources - Maui	Dept. of Land and Natural Resources	State of Hawaii	130 Mahalani Street	Wailuku, Maui	HI	96793
	Mr.	Paul	J.	Conry	Administrator	Division of Forestry & Wildlife	Dept. of Land and Natural Resources	State of Hawaii	1151 Punchbowl Street, Room 325	Honolulu	HI	96813
	Mr.	Ken	C.	Kawahara, P.E.	Deputy Director	Commission on Water Resource Management	Dept. of Land and Natural Resources	State of Hawaii	P.O. Box 621	Honolulu	HI	96809
	Ms.	Charlene		Shibuya		Highways Division - Maui District	Dept. of Transportation	State of Hawaii	650 Palapala Drive	Kahului, Maui	HI	96732
	Mr.	Wayne		Kawahara		Highways Division - Planning Branch	Dept. of Transportation	State of Hawaii	869 Punchbowl Street	Honolulu	HI	96813
8.8.08		Brennon	T.	Morioka, Ph.D., P.E.	Director		Dept. of Transportation	State of Hawaii	869 Punchbowl Street	Honolulu	HI	96813
	Ms.	Karen		Seddon	Development Branch Chief		Hawaii Housing Finance & Dev. Corp.	State of Hawaii	677 Queen Street, Suite 300	Honolulu	HI	96813
	Ms.	Janice	N.	Takahashi	Interim Executive Director		Hawaii Housing Finance & Dev. Corp.	State of Hawaii	677 Queen Street, Suite 300	Honolulu	HI	96813
8.12.08	Mr.	Clyde	W.	Namu'o	Administrator		Office of Hawaiian Affairs	State of Hawaii	711 Kapiolani Blvd., Suite 500	Honolulu	HI	96813
	Ms.	Leatrice		Kauahi			Office of Hawaiian Affairs	State of Hawaii	711 Kapiolani Blvd., Suite 500	Honolulu	HI	96813
		James	E.T.	Moncur, Ph.D.	Director	Water Resources Research Center	University of Hawaii at Manoa		2540 Dole Street, Holmes Hall 283	Honolulu	HI	96822
	COUNTY OF MAUI											
	Councilmember	Jo Anne		Johnson		West Maui District	County Council	County of Maui	200 South High Street	Wailuku, Maui	HI	96793
8.6.08	Ms.	Vanessa	A.	Medeiros	Director		Dept. of Housing and Human Concerns	County of Maui	200 South High Street	Wailuku, Maui	HI	96793
7.25.08	Ms.	Tamara		Horcajo	Director		Dept. of Parks and Recreation	County of Maui	700 Hali'a Nakoa Street, Unit 2	Wailuku, Maui	HI	96793
	Mr.	Patrick		Matsui	Planner		Dept. of Parks and Recreation	County of Maui	275-D Uhu Street	Kahului, Maui	HI	96732
	Mr.	Jeff		Hunt	Director		Dept. of Planning	County of Maui	250 South High Street	Wailuku, Maui	HI	96793
	Mr.	Stan		Solamillo	Planner		Dept. of Planning	County of Maui	250 South High Street	Wailuku, Maui	HI	96793
	Mr.	John		Summers			Dept. of Planning	County of Maui	250 South High Street	Wailuku, Maui	HI	96793
	Mr.	Clayton		Yoshida			Dept. of Planning	County of Maui	250 South High Street	Wailuku, Maui	HI	96793
	Mr.	Joe		Krueger		Engineering Division	Dept. of Public Works & Environmental Mgmt.	County of Maui	200 South High Street, 4th Floor	Wailuku, Maui	HI	96793
	Mr.	Cary		Yamashita	Division Chief	Engineering Division	Dept. of Public Works & Environmental Mgmt.	County of Maui	200 South High Street, 4th Floor	Wailuku, Maui	HI	96793
	Mr.	Tracy		Takamine		Solid Waste Management	Dept. of Public Works & Environmental Mgmt.	County of Maui	200 South High Street, 4th Floor	Wailuku, Maui	HI	96793
	Mr.	Arnold		Abe		Wastewater Reclamation Division	Dept. of Public Works & Environmental Mgmt.	County of Maui	2200 Main Street, Suite 610	Wailuku, Maui	HI	96793
	Mr.	Steve		Parabicoli		Wastewater Reclamation Division	Dept. of Public Works & Environmental Mgmt.	County of Maui	2200 Main Street, Suite 610	Wailuku, Maui	HI	96793
	Mr.	Scott		Rollins		Wastewater Reclamation Division	Dept. of Public Works & Environmental Mgmt.	County of Maui	2200 Main Street, Suite 610	Wailuku, Maui	HI	96793
7.21.08	Mr.	Milton	M.	Arakawa, A.I.C.P.	Director of Public Works		Dept. of Public Works & Environmental Mgmt.	County of Maui	200 South High Street, Room 434	Wailuku, Maui	HI	96793
8.5.08	Mr.	Michael	M.	Miyamoto	Deputy Director		Dept. of Public Works & Environmental Mgmt.	County of Maui	200 South High Street, Room 434	Wailuku, Maui	HI	96793
7.16.08	Mr.	Don	A.	Medeiros	Director		Dept. of Transportation	County of Maui	200 South High Street	Wailuku, Maui	HI	96793-2155
	Mr.	Herbert		Chang	District Chief Engineer		Dept. of Water Supply	County of Maui	200 South High Street	Wailuku, Maui	HI	96793
	Mr.	Jeffrey		Eng	Director		Dept. of Water Supply	County of Maui	200 South High Street	Wailuku, Maui	HI	96793
	Mayor	Charmaine		Tavares			Office of the Mayor	County of Maui	200 South High Street	Wailuku, Maui	HI	96793
	CITIZEN GROUPS, INDIVIDUALS AND CONSULTED PARTIES											
	Mr.	Bill	D.	Mills	President		Bill Mills Development Company, Inc.		1100 Alakea Street, Suite 2200	Honolulu	HI	96813
	Ms.	Michele		Otake			Castle & Cooke Homes Hawaii, Inc.		P.O. Box 898900	Mililani	HI	96789-8900
	Mr.	Henry		Cisneros	Chairman		CityView		454 Soledad, Suite 300	San Antonio	TX	78205

Villages of Leiali‘i
Stakeholder Mailing List

Comment Rec'd	Salutation	First	Middle	Last	Title	Company1	Company2	Company3	Address	City	State	Zip
	Ms.	Tracy		Nagata	Vice President of Development - Island Group		D.R. Horton, Schuler Division		828 Fort Street Mall, 4th Floor	Honolulu	HI	96813
	Mr.	Everett	R.	Dowling	President		Dowling Company, Inc.		2005 Main Street	Wailuku, Maui	HI	96793
	Mr.	Kevin		Carney	Sr. Vice President		EAH Hawaii		841 Bishop Street, Suite 2208	Honolulu	HI	96813
	Mr.	Jon	C.	Wallenstrom	Sr. Vice President		Forest City Hawaii Residential, Inc.		5173 Nimitz Road	Honolulu	HI	96818
7.18.08		Race	A.	Randle	Development Associate		Forest City Hawaii Residential, Inc.		5173 Nimitz Road	Honolulu	HI	96818
	Ms.	Sherri		Dodson			Habitat for Humanity		P.O. Box 5034	Kahului, Maui	HI	96733
	Mr.	Roy		Katsuda	Executive Director		Hale Mahaolu (Elderly Housing)		200 Hina Avenue	Kahului, Maui	HI	96732
	Mr.	Randolph	G.	Moore	President	c/o Mr. Gary Furuta, Project Manager	Hawaii Housing Development Corp.		1177 Queen Street, Suite 1202	Honolulu	HI	96814
	Mr.	Terry		Tamble	General Manager		Hawaii Water Service Company		P.O. Box 13220	Lahaina, Maui	HI	96761
	Mr.	Lee	A.	Mansfield, P.E.	Manager		HAWAII-American Water Company		P.O. Box 25010	Honolulu	HI	96825
	Mr.	Howard		Hanzawa	Vice President		Kaanapali Land Management Corporation		275 Lahainaluna Road	Lahaina, Maui	HI	96761
	Mr.	Georgio		Calderone			Kamehameha Schools		567 South King Street, Suite 617	Honolulu	HI	96813
	Mr.	Karl		Bossert			Kapalua Land Company, Ltd.		1000 Kapalua Drive	Lahaina, Maui	HI	96761
	Mr.	Ryan		Churchill			Kapalua Land Company, Ltd.		1000 Kapalua Drive	Lahaina, Maui	HI	96761
	Mr.	David	C.	Goode	President		KSD Hawaii		8 Kiopaa Street, Suite 201	Pukalani, Maui	HI	96768
	Mr.	Theo		Morrison	Executive Director		Lahaina Bypass Now		505 Front Street, Suite 202	Lahaina, Maui	HI	96761
8.7.08							Lahaina Bypass Now		505 Front Street, Suite 202	Lahaina, Maui	HI	96761
	Mr.	Keoki		Freeland	Executive Director		Lahaina Restoration Foundation		120 Dickenson Street	Lahaina, Maui	HI	96761
	Ms.	Barbara		Allen			Lahaina-Kaanapali and Pacific Railroad		975 Limahana Place, Suite 203	Lahaina, Maui	HI	96761
	Mr.	Michael		Nakano	Principal		Lahainaluna High School		980 Lahainaluna Road	Lahaina, Maui	HI	96761
	Mr.	Michael		Rose			Maryl Group		55 Merchant Street, Suite 2900	Honolulu	HI	96813
	Ms.	Pamela		Tumpap	President		Maui Chamber of Commerce		313 Ano Street	Kahului, Maui	HI	96732
	Mr.	Wes		Nohara			Maui Land & Pineapple Company, Inc.		870 Haliimaile Road	Pukalani, Maui	HI	96768
	Ms.	Leiane		Paci			Maui Lani Partners		P.O. Box 1500	Wailuku, Maui	HI	96793
	Mr.	Mich		Hirano			Munekiyo & Hiraga, Inc.		305 High Street, Suite 104	Wailuku, Maui	HI	96793
	Mr.	Marvin		Awaya			Pacific Housing Assistance Corporation		677 Ala Moana Blvd., Suite 712	Honolulu	HI	96813-5419
	Mr.	Steve		Sakai			Ronald N.S. Ho & Associates, Inc.		2138 Algaroba Street	Honolulu	HI	96826-2714
	Mr.	Brian		Hoyle			Southwest Health Group		17207 Kuykendahl Road, Suite 210	Spring	TX	77379
	Mr.	Stanford	S.	Carr	President		Stanford Carr Development, LLC		1100 Alakea Street, 27th Floor	Honolulu	HI	96813
	Mr.	Tom		Nance			Tom Nance Water Resource Engineering		680 Ala Moana Blvd., Suite 406	Honolulu	HI	96813
	Mr.	Bruce		Tsuchida	President		Townscape, Inc.		900 Fort Street Mall, Suite 1160	Honolulu	HI	96813
8.8.08	Mr.	Jeffery	A.	Minter	President / CEO		UniDev Hawaii, LLC		1100 Alakea Street, Suite 1550	Honolulu	HI	96813
	Mr.	Charles		Jencks			Wailea 670 Associates		381 Huku Li'l Place, Suite 202	Kihei, Maui	HI	96753
	Mr.	Peter		Martin			West Maui Land Company, Inc.		33 Lono Avenue, Suite 450	Kahului, Maui	HI	96732
	Ms.	Arlene		Torricer			West Maui Land Company, Inc.		33 Lono Avenue, Suite 450	Kahului, Maui	HI	96732
8.12.08	Mr.	James		Riley	Member		Kahoma Land LLC		33 Lono Avenue, Suite 450	Kahului, Maui	HI	96732
	Mr.	Ezekiela		Kalua	Executive Director		West Maui Taxpayers Association		P.O. Box 10338	Lahaina, Maui	HI	96761
	Mr.	Joseph		Pluta	President		West Maui Taxpayers Association		P.O. Box 10338	Lahaina, Maui	HI	96761

Comment Letters

Lynn Fukuhara

From: Randle, Race [RaceRandle@forestcity.net]
Sent: Friday, July 18, 2008 10:32 AM
To: Lynn Fukuhara
Cc: Wallenstrom, Jon
Subject: Villages of Leiali'i - Lahaina Maui - Comments

Lynn,

Thank you for the opportunity to comment on the concept plan for Villages of Leiali'i. Without firsthand knowledge of the area and the community, I cannot provide much constructive comments at this time. From a cursory look, the plans look well laid out in relation to the slopes and other constraints. Pedestrian and bicycle connectivity across the detention ponds is likely in your plan and will provide great non-vehicle access to the resources of the existing community. Best of luck with your planning and EIS efforts.

Please feel free to contact us at any time and thank you again for the opportunity to comment on the planning of Villages of Leiali'i.

Mahalo,

Race A. Randle
Development Associate
Forest City Hawaii
Mobile: (808) 388-0789
Office: (808) 839-8767
racerandle@forestcity.net

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KAHOMA LAND LLC

33 Lono Avenue • Suite 450
Kahului, HI • 96732

Phone 808• 877•4202 Fax 808•877•9409

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HAWAII HOUSING FINANCE
DEVELOPMENT CORP
2008 AUG 12 P 1: 17

August 6, 2008

Ms. Susan A. Sakai, VP & Director of Planning
Belt Collins Hawaii LTD
2153 North King Street, Suite 200
Honolulu, HI 96819

Attn: Mr. Lynn Fukuhara

Re: Hawaii Housing Finance & Development Corporation (HHFDC)
Villages of Leiali`i, Concept Land Use Plans A & B
Ref: 2007.70.0500 / 08P-246; July 9, 2008

Dear Ms. Sakai,

Thank you for the opportunity to comment regarding the draft Land Use Plan Concepts for the HHFDC Villages of Leiali`i project.

Kahoma Land LLC has lands mauka of the Villages of Leali`i. We have discussed the need to have access to our mauka properties with HHFDC and DLNR officials and we are in the process of preparing an Environmental Assessment for temporary, re-locatable access easements over the Villages of Leali`i Master Plan areas to our mauka properties. We have attached a copy of your Figures 1 and 2 showing our two proposed / suggested connections (marked in red) to our mauka properties based on your conceptual roadway plans. Both accesses shown connecting to your proposed roadways are existing agricultural haul cane roads. Otherwise, at this time we have no objections or other comments regarding your revised concepts.

Thank you again for the opportunity to review and comment on your proposed conceptual plans. We look forward to speaking with you or HHFDC regarding our proposed connections or any other alternate accesses to our mauka properties that may better fit your objectives.

Sincerely,
KAHOMA LAND LLC

James Riley

James Riley, Member

Attachments

Cc: Stanley Fujimoto, HHFDC
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Figure 1

CONCEPT LAND USE PLAN A

Villages of Leiali'i

LEGEND

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NORTH

0 500 1000 1500 2000
SCALE IN FEET

BelleCollins

Figure 2

CONCEPT LAND USE PLAN B

Villages of Leiali'i

LEGEND

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NORTH

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Belt Collins

Lahaina Bypass Now

RECEIVED
2008 AUG -7 PM 1:55
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August 5, 2008

Lynn Fukuhara
Belt Collins Hawaii
2153 North King Street, Suite 200
Honolulu, Hawai'i 96819

Subject: HHFDC Villages of Leiali'i Master Plan

Dear Ms. Fukuhara:

Lahaina Bypass Now (LBN) thanks you for this opportunity to offer pre-assessment consultation on the master plan and preparation for an environmental impact statement (EIS). LBN is a community-based organization dedicated to developing transportation solutions for Maui. LBN has identified seven strategies and would like to offer comments based on those strategies.

1. Construction of the Lahaina Bypass

Both Concept Land Use Plans provide for two connections to Lahaina Bypass. LBN would like to understand how those connections are designed as the Concept Plans show a round-a-bout design. In addition, LBN would like to see a discussion on how those connections will impact the Bypass.

2. Development of a Network of Roads

LBN supports the internal grid street pattern in the Concept Plans as it incorporates smart planning principles of providing for a network of streets. A network of streets allows more choices to get from point A to point B. LBN would like to further encourage connectivity to adjacent neighborhoods. Both Concept Plans only show two connections to the adjacent neighborhoods. LBN would like to see further connections developed.

3. Improve Traffic Management

LBN would like to encourage the design of great streets where streets are designed for pedestrians **first**. One of the principles of great streets is "narrow" or pedestrian-friendly streets. Pedestrian-friendly streets promote vehicle speeds at safer speed limits by design, without the need for excessive speed bumps.

4. Increase Public Transit

Another feature of great streets is planning for public transit within the neighborhood including identifying transit routes and providing areas for bus shelters. LBN would like to encourage that the Concept Plan include public transit planning.

505 Front Street, Suite 202 • Lahaina, HI 96761
Telephone: 808-667-2516 • Fax: 808-661-2058
www.lahainabypassnow.com • info@lahainabypassnow.com

5. Encouragement of Smart Planning

As identified in the cover letter, the Concept Plan will use smart growth principles. LBN supports the intent and is looking forward to seeing these concepts further detailed, especially mixed uses and mixed income housing which hopefully includes apartment rentals.

6. Creating Walking and Biking Paths

Still another feature of great streets includes creating walking and biking paths that encourage other modes of transportation besides vehicular. LBN encourages the Concept Plan to design walking and biking paths within the neighborhoods and continuing on to adjacent neighborhoods.

7. Promotion of Telecommuting

LBN supports the availability of technology that will encourage telecommuting opportunities in residential, commercial, and light industrial areas. To the extent possible, LBN would like to support any effort in providing telecommuting opportunities within the Concept Plans.

Again, thank you for providing LBN an opportunity to comment on the pre-assessment and we look forward to reviewing the Preparation Notice for the EIS.

Mahalo,

Lahaina Bypass Now

DEPARTMENT OF
HOUSING AND HUMAN CONCERNS
COUNTY OF MAUI

CHARMAINE TAVARES
Mayor

VANESSA A. MEDEIROS
Director

LORI TSUHAKO
Deputy Director

RECEIVED
2008 AUG -6 PM 2:29
BELT COLLINS HAWAII

2200 MAIN STREET • SUITE 546 • WAILUKU, HAWAII 96793 • PHONE (808) 270-7805 • FAX (808) 270-7165
MAILING ADDRESS: 200 SOUTH HIGH STREET • WAILUKU, HAWAII 96793 • EMAIL director.hhc@mauicounty.gov

August 1, 2008

Ms. Lynn Fukuhara
Belt Collins Hawaii
2153 North King Street
Honolulu, Hawaii 96819

Dear Ms. Fukuhara:

SUBJECT: COMMENTS ON THE PROPOSED LAND USE CONCEPTS FOR THE VILLAGES OF LEIALI'I LAHAINA, MAUI, HAWAII

Thank you for the opportunity to comment on the proposed land use concepts for the Villages of Leiali'i. We are supportive of Hawaii Housing Finance & Development Corporation's (HHFDC) long-range plan for the area and advocates for the provision of long term affordable housing in West Maui.

Of the two concepts presented, we support Land Use Plan A as it provides lower density in a region that is currently congested with many multi-family type units. In determining its final plans for types of products, we ask HHFDC to consider lifespan design to accommodate the changing needs of those families who will occupy the proposed units.

Thank you.

Sincerely,

Vanessa A Medeiros

VANESSA A. MEDEIROS
Director of Housing and Human Concerns

CHARMAINE TAVARES
MAYOR

RECEIVED
2008 JUL 16 PM 1:57
BELT COLLINS HAWAII

DON A. MEDEIROS
Director
WAYNE A. BOTEILHO
Deputy Director
Telephone (808) 270-7511
Facsimile (808) 270-7505

DEPARTMENT OF TRANSPORTATION

COUNTY OF MAUI
200 South High Street
Wailuku, Hawaii, USA 96793-2155

July 11, 2008

Ms. Susan A. Sakai
BELT COLLINS HAWAII LTD.
2153 North King Street, Suite 200
Honolulu, Hawaii 96819-4554

Subject: Villages of Leiali'I in Lahaina, Maui.

Dear Ms. Sakai,

Thank you for the opportunity to comment on this project.

We would like to ask that within the overall design of the project, bus pull-ins and shelters be factored into the design. The number and location of the requested are to be determined upon final land use plan.

Please feel free to contact me if you have any questions.

Sincerely,

Don Medeiros

CHARMAINE TAVARES
Mayor

RECEIVED
2008 JUL 25 PM 1:47
BELT COLLINS HAWAII

TAMARA HORCAJO
Director

ZACHARY Z. HELM
Deputy Director

(808) 270-7230
Fax (808) 270-7934

DEPARTMENT OF PARKS & RECREATION

700 Hali'a Nakoa Street, Unit 2 , Wailuku, Hawaii 96793

July 14, 2008

Belt Collins Hawaii
Attention: Lynn Fukuhara
2153 North King Street, Suite 200
Honolulu, HI 96819

SUBJECT: Pre-EIS Submittal for Villages of Leiali'i Lahaina, Maui, Hawai'i

Dear Ms. Fukuhara:

Thank you for the opportunity to review and comment on the subject project.

The Department of Parks & Recreation would like to receive confirmation from the County of Maui Department of Housing and Human Concerns that this project meets the criteria of an affordable housing project under Section 201H-38, HRS. The exemption from Section 18.16.320, Maui County Code, will then be provided once the Maui County Council has approved the subject 201H-38 application.

In addition, we feel that in both Conceptual Plans A and B submitted, the allowance for Park locations is inadequate. For a development of this size, we would request that a single large park be provided, which includes a number of playing fields, located on a site that is topographically suited for park usage.

Please feel free to contact me or Cheryl Akiona, Capital Improvements Project Coordinator, at 270-7388 should you have any questions.

Sincerely,

Tamara Horcajo

TAMARA HORCAJO
Director

xc: Patrick Matsui, Chief of Parks Planning and Development

CHARMAINE TAVARES
Mayor

MILTON M. ARAKAWA, A.I.C.P.
Director

MICHAEL M. MIYAMOTO
Deputy Director

Telephone: (808) 270-7745
Fax: (808) 270-7975

RALPH NAGAMINE, L.S., P.E.
Development Services Administration

CARY YAMASHITA, P.E.
Engineering Division

BRIAN HASHIRO, P.E.
Highways Division

RECEIVED
2008 JUL 21 PM 8: 51
BELT COLLINS HAWAII

COUNTY OF MAUI
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
200 SOUTH HIGH STREET
WAILUKU, MAUI, HAWAII 96793

July 15, 2008

Ms. Lynn Fukuhara
Belt Collins Hawaii
2153 North King Street, Suite 200
Honolulu, Hawaii 96819

SUBJECT: VILLAGES OF LEIALI'I IN LAHAINA

Dear Ms. Fukuhara:

We received your letter dated July 9, 2008, requesting our comments regarding land use concepts being proposed for the Villages of Leiali'i project in Lahaina. We reserve comment until a more detailed document addressing both traffic and drainage issues is prepared.

Please contact Cary Yamashita at 270-7745 if you have any questions regarding this matter.

Sincerely,

MILTON M. ARAKAWA, A.I.C.P.
Director of Public Works

CY:nco(ED08-456)
S:\ENG\ALL\cary\Misc Letters\2008\villagesofleialii.wpd

CHARMAINE TAVARES
Mayor

MILTON M. ARAKAWA, A.I.C.P.
Director

MICHAEL M. MIYAMOTO
Deputy Director

Telephone: (808) 270-7845
Fax: (808) 270-7955

RALPH NAGAMINE, L.S., P.E.
Development Services Administration

CARY YAMASHITA, P.E.
Engineering Division

BRIAN HASHIRO, P.E.
Highways Division

RECEIVED
2008 AUG -5 PM 4:01
BELT COLLINS HAWAII

COUNTY OF MAUI
DEPARTMENT OF PUBLIC WORKS
200 SOUTH HIGH STREET, ROOM NO. 434
WAILUKU, MAUI, HAWAII 96793

July 29, 2008

Ms. Lynn Fukuhara
BELT COLLINS HAWAII, LTD.
2153 North King Street, Suite 200
Honolulu, Hawaii 96819

Dear Ms. Fukuhara:

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT FOR AFFORDABLE HOUSING PROJECT AT THE VILLAGES OF LEIALII; TMK: (2) 4-5-021:003, 018, 019, 020, 021, 022 (POR.)

We reviewed the subject application and have the following comments:

1. Any drainage improvements that are constructed outside of the road rights of way (that are intended for County dedication) shall be kept under private ownership and maintenance.

2. Maintain clear area along Kahoma Stream for maintenance of the Kahoma Stream Flood Control Facility. Provide area(s) for stockpiling of material removed from the Kahoma Stream debris basin within this "clear area".

Please call Michael Miyamoto at (808) 270-7845 if you have any questions regarding this letter.

Sincerely,

for MILTON M. ARAKAWA, A.I.C.P.
Director of Public Works

MMA:MMM:ls
xc: Highways Division
Engineering Division
S:\LUCA\CZM\afford_hsg_Villages_of_Leialii_eis_45021003_ls.wpd

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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2008 AUG -5 PM 1:31
BELT COLLINS HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

August 1, 2008

Belt Collins Hawaii Ltd
2153 North King Street Suite 200
Honolulu, Hawaii 96819

Attention: Ms. Lynn Fukuhara

Gentlemen:

Subject: Environmental Impact Statement for Affordable Housing project at the Village of Leiali'i in Lahaina, Maui

Thank you for the opportunity to review and comment on the subject matter. The Department of Land and Natural Resources' (DLNR), Land Division distributed or made available a copy of your report pertaining to the subject matter to DLNR Divisions for their review and comment.

Other than the comments from Division of Aquatic Resources, Division of Forestry & Wildlife, Commission on Water Resource Management, the Department of Land and Natural Resources has no other comments to offer on the subject matter. Should you have any questions, please feel free to call our office at 587-0433. Thank you.

Sincerely,

Charlene P. Unoki
for Morris M. Atta
Administrator

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

SH

LINGLE
OF HAWAII

AQUATIC RESOURCES: 1727

DIRECTOR	
COMM. FISH.	
AQ RES/ENV	
AQ REC	
PLANNER	
STAFF SVCS	
RCUH/UH	
STATISTICS	
AFRC/FED AID	
EDUCATION	
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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

July 14, 2008

MEMORANDUM

TO: DLNR Agencies:
✓ X Div. of Aquatic Resources
__ Div. of Boating & Ocean Recreation
x Engineering Division
x Div. of Forestry & Wildlife
__ Div. of State Parks
x Commission on Water Resource Management
x Office of Conservation & Coastal Lands
x Land Division – Maui District / Gavin Chun

FROM: Morris M. Atta, Administrator Charlene
SUBJECT: Environmental Impact Statement (EIS) for an Affordable Housing Project on State land at the Villages of Leiali'i
LOCATION: Lahaina, Island of Maui, Hawaii
APPLICANT: Belt Collins

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by August 1, 2008.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Darlene Nakamura at 587-0417. Thank you.

Attachments

( ) We have no objections.
( ) We have no comments.
(✓) Comments are attached.

Signed:
Date: 29 July 2008

RECEIVED
LAND DIVISION
2008 AUG -1 P 12:03
DEPT. OF LAND & NATURAL RESOURCES
STATE OF HAWAII

RECEIVED
JUL 14 2008

DIVISION OF AQUATIC RESOURCES - MAUI
DEPARTMENT OF LAND & NATURAL RESOURCES
130 Mahalani Street
Wailuku, Hawaiÿi 96793
July 28, 2008

To: Alton Miyasaka, Aquatic Biologist
Richard Sixberry, Aquatic Biologist

From: Skippy Hau, Aquatic Biologist

Subject: EIS for an Affordable Housing Project on State land at the Villages of Leiali'i.
(DAR 1727)
Due August 1, 2008 (Morris Atta)

In addition to smart growth principles, we recommend that appropriate landscaping using indigenous trees and shrubs be integrated with drainage for the development. We would also recommend porous asphalt or concrete be used whenever possible. Attention should be given to storage basins & water recharge than dependency on storm drain systems that flow directly to the ocean.

Division of Forestry & Wildlife

1151 Punchbowl Street, Rm. 325 • Honolulu, HI 96813 • (808) 587-0166 • Fax: (808) 587-0160

RECEIVED LAND DIVISION

2008 JUL 31 P 3: 26

DEPT. OF LAND & NATURAL RESOURCES STATE OF HAWAII

MEMORANDUM July 30, 2008

TO: Morris M. Atta, Administrator
Land Division

FROM: Paul J. Conry, Administrator
Division of Forestry and Wildlife

Paul J Conry

SUBJECT: Request for Comments: EIS for an Affordable Housing Project on State land at the Villages of Leiali'i, Lahaina, Maui, Hawaii by Belt Collins.

DOFAW has reviewed the subject project request for comments and provide the following for your consideration. My Maui DOFAW staff provided the following comments.

Comments provided by John Medeiros, Wildlife Biologist: This project will attract nene (an endangered bird) to the area, especially the proposed park (new nene habitat). Nene is seen in and around the crater reservoir. Additionally, the reseeding of the construction site relating to the homes and agriculture lots will potentially attract nene, game birds, pigs, and deer. New user conflicts resulting from this enormous subdivision will occur between landowners and resident wildlife that will require mitigation. Mitigating seabird's attraction to exterior lights is requested and will require review by Maui Wildlife DOFAW staff for downed seabirds. Please use the suggested recommended prescriptions to mitigate this problem in the following website:
http://www.state.hi.us/dlnr/dofaw/fbrp/shearwaterlights.htm.

Comments provided by Lance DeSilva, Protection Forester: Regarding access, at least 2 ingress/egress to the subdivision should be considered (public safety for wildland fire) and if gated entry, the appropriate public safety agency should have easy access to the subdivision. We recommend a greenbelt or firebreak be installed on the mauka section of the subdivision to prevent the potential spread of wildland fire originating from the subdivision.

Comments provided by Fern Duvall, Wildlife Biologist: Figures 1 and 2 are poor quality. There is no description of existing land zoning, TMK, or land ownership. We need additional information, if one or more homeowner or business associations are planned to apply conditions to restrict impacts,

associations will have on land use, conservation values and resources, and non-point pollution impacts by the subdivision. We recommend that pet cats reside indoors only, no feline outdoor feeding stations in covenants. How will unregulated increase in human access to mauka lands be addressed? Questions, please call John Medeiros at (808) 873-3510, Lance DeSilva at (808) 873-3980, and Fern Duvall at (808) 873-3502. Thank you for the opportunity to review this project.

Copy: John Cumming, Maui Branch Manager
John Medeiros, Maui Wildlife
Fern Duvall, Maui Wildlife
Glenn Shishido, Maui Forestry
Lance DeSilva, Maui Forestry

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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2008 JUL 28 P 3:41
DEPT. OF LAND & NATURAL RESOURCES STATE OF HAWAII

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08 JUL 15 A10:50
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

July 14, 2008

MEMORANDUM

TO: **DLNR Agencies:**
X Div. of Aquatic Resources
__Div. of Boating & Ocean Recreation
x Engineering Division
x Div. of Forestry & Wildlife
__Div. of State Parks
x Commission on Water Resource Management
x Office of Conservation & Coastal Lands
x Land Division – Maui District / Gavin Chun

FROM: Morris M. Atta, Administrator Darlene
SUBJECT: Environmental Impact Statement (EIS) for an Affordable Housing Project on State land at the Villages of Leiali'i
LOCATION: Lahaina, Island of Maui, Hawaii
APPLICANT: Belt Collins

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by August 1, 2008.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Darlene Nakamura at 587-0417. Thank you.

Attachments

( ) We have no objections.
( ) We have no comments.
(✓) Comments are attached.

Signed: Edwin T. Sakada
Date: 7/23/08

cc: Central Files

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON

MEREDITH J. CHING
JAMES A. FRAZIER
NEAL S. FUJIWARA
CHIYOME L. FUKINO, M.D.
DONNA FAY K. KIYOSAKI, P.E.
LAWRENCE H. MIIKE, M.D., J.D.

KEN C. KAWAHARA, P.E.
DEPUTY DIRECTOR

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P.O. BOX 621
HONOLULU, HAWAII 96809

July 24, 2008

REF: Leialii.AffordHsng

TO: Morris Atta, Administrator
Land Division

FROM: Ken C. Kawahara, P.E., Deputy Director
Commission on Water Resource Management

SUBJECT: Leialii (Lahaina) Affordable Housing

FILE NO.: 2007.70.0500 / 08P-246
TMK NO.: (2) 4-5-various

Thank you for the opportunity to review the subject document. The Commission on Water Resource Management (CWRM) is the agency responsible for administering the State Water Code (Code). Under the Code, all waters of the State are held in trust for the benefit of the citizens of the State, therefore, all water use is subject to legally protected water rights. CWRM strongly promotes the efficient use of Hawaii's water resources through conservation measures and appropriate resource management. For more information, please refer to the State Water Code, Chapter 174C, Hawaii Revised Statutes, and Hawaii Administrative Rules, Chapters 13-167 to 13-171. These documents are available via the Internet at http://www.hawaii.gov/dlnr/cwrm.

Our comments related to water resources are checked off below.

☒ 1. We recommend coordination with the county to incorporate this project into the county's Water Use and Development Plan. Please contact the respective Planning Department and/or Department of Water Supply for further information.

☒ 2. We recommend coordination with the Engineering Division of the State Department of Land and Natural Resources to incorporate this project into the State Water Projects Plan.

☐ 3. We recommend coordination with the Hawaii Department of Agriculture (HDOA) to incorporate the reclassification of agricultural zoned land and the redistribution of agricultural resources into the State's Agricultural Water Use and Development Plan (AWUDP). Please contact the HDOA for more information.

☒ 4. We recommend that water efficient fixtures be installed and water efficient practices implemented throughout the development to reduce the increased demand on the area's freshwater resources. Reducing the water usage of a home or building may earn credit towards Leadership in Energy and Environmental Design (LEED) certification. More information on LEED certification is available at http://www.usgbc.org/leed. A listing of fixtures certified by the EPA as having high water efficiency can be found at http://www.epa.gov/watersense/pp/index.htm.

☒ 5. We recommend the use of best management practices (BMP) for stormwater management to minimize the impact of the project to the existing area's hydrology while maintaining on-site infiltration and preventing polluted runoff from storm events. Stormwater management BMPs may earn credit toward LEED certification. More information on stormwater BMPs can be found at http://hawaii.gov/dbedt/czm/initiative/lid.php.

☒ 6. We recommend the use of alternative water sources where applicable.

☐ 7. There may be the potential for ground or surface water degradation/contamination and recommend that approvals for this project be conditioned upon a review by the State Department of Health and the developer's acceptance of any resulting requirements related to water quality.

Permits required by CWRM:
Additional information and forms are available at http://hawaii.gov/dlnr/cwrm/resources_permits.htm.

☐ 8. The proposed water supply source for the project is located in a designated water management area, and a Water Use Permit is required prior to use of water.

☐ 9. A Well Construction Permit(s) is (are) required any well construction work begins.

☐ 10. A Pump Installation Permit(s) is (are) required before ground water is developed as a source of supply for the project.

☐ 11. There is (are) well(s) located on or adjacent to this project. If wells are not planned to be used and will be affected by any new construction, they must be properly abandoned and sealed. A permit for well abandonment must be obtained.

☐ 12. Ground-water withdrawals from this project may affect streamflows, which may require an instream flow standard amendment.

☐ 13. A Stream Channel Alteration Permit(s) is (are) required before any alteration(s) can be made to the bed and/or banks of a stream channel.

☐ 14. A Stream Diversion Works Permit(s) is (are) required before any stream diversion works is (are) constructed or altered.

☐ 15. A Petition to Amend the Interim Instream Flow Standard is required for any new or expanded diversion(s) of surface water.

☒ 16. The planned source of water for this project has not been identified in this report. Therefore, we cannot determine what permits or petitions are required from our office, or whether there are potential impacts to water resources.

☒ 17. We recommend that the report identify feasible alternative non-potable water resources, including reclaimed wastewater.

☒ OTHER:

Surface water sources are subject to petitions to amend the interim Instream flow standards (IIFS) for Honokohau and Honolua Streams and potential petitions to amend the IIFS for Kanaha and Kahoma Streams, and subject to potential appurtenant rights claims.

If there are any questions, please contact Charley Ice at 587-0218.

LINDA LINGLE
GOVERNOR

PATRICIA HAMAMOTO
SUPERINTENDENT

STATE OF HAWAI'I
DEPARTMENT OF EDUCATION
P.O. BOX 2360
HONOLULU, HAWAI'I 96804

OFFICE OF SCHOOL FACILITIES AND SUPPORT SERVICES
[redacted]

RECEIVED
2008 AUG -7 PM 2:00
BELT COLLINS HAWAII

August 5, 2008

Ms. Susan A. Sakai, Vice President and Director of Planning
Belt Collins Hawaii Ltd.
2153 North King Street, Suite 200
Honolulu, Hawaii 96819-4554

Attention: Lynn Fukuhara

Dear Ms. Sakai:

Subject: Consultation on Villages of Leiali`i, Lahaina, Maui

The Department of Education (DOE) has reviewed the two concepts developed by Belt Collins and the Hawaii Housing Finance & Development corporation (HHFDC) for the Villages of Leiali`i.

The DOE has no strong preference of one concept over the other. We think that Concept B, with more multi-family residential units, will generate slightly fewer public school students than Concept A, which has more single-family units than multi-family units. The total student count could also be heavily influenced by the level of affordability in the mix of housing products it develops.

The DOE believes it will need both elementary school sites. We think a second school site in the area of Leiali`i above the Lahaina Bypass Highway is appropriate for the timing of the concentration of single family housing being proposed for the second phase of the project.

The DOE's Educational Specifications require that the length to width ratio of school campuses be no more than 2.5 to 1. The illustrations of both Concept A and Concept B appear to have long, narrow school sites. The DOE needs school campuses to be as close to a square as possible to permit more options in laying out school facilities. School sites need as much road frontage as possible so the school site as illustrated in the Phase 1, Makai area is more assuring of a workable site than Phase 2, which has only road frontage on one side of the site. The DOE is available to meet with planners as they get more definite in their planning of the school sites.

The DOE is in the process of implementing school impact fees which were established by the 2007 Legislature. The impact fee law requires the identification of impact districts where the DOE will have to build or enlarge schools to meet increasing enrollment demand. We think that it is highly likely that the Lahaina area will become a district. HHFDC can pay its school impact fees with the land set aside for the schools and it is possible that other residential projects that are too small to host a school campus will pay their impact fees in cash which could possibly be used to reimburse HHFDC.

It would be extremely helpful to DOE to know the timeframe for developing the project, as DOE makes its own long term plans for schools in the area.

The DOE believes it may be helpful if your planners were to consult with our Facilities Branch before a draft environmental statement is finalized. If you have any questions, please call Heidi Meeker of the Facilities Development Branch at 377-8301.

Sincerely yours,

Duane Y. Kashiwai
Public Works Administrator

DYK:jmb

c: CAS, Hana/Lahainaluna/Lanai/Molokai Complex Areas

LINDA LINGLE
GOVERNOR

BRENNON T. MORIOKA
DIRECTOR

Deputy Directors
MICHAEL D. FORMBY
FRANCIS PAUL KEENO
BRIAN H. SEKIGUCHI

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2008 AUG 11 PM 2:22
BELT COLLINS HAWAII

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

IN REPLY REFER TO:

STP 8.2964

August 8, 2008

Ms. Lynn Fukuhara
Belt Collins Hawaii
2153 North King Street, Suite 200
Honolulu, Hawaii 96819

Dear Ms. Fukuhara,

Subject: Early Consultation, Project Layouts
Villages of Leiali'i, Lahaina, Maui
Hawaii Housing Finance & Development Corporation

Thank you for providing the proposed land use alternatives for the subject development project.

The Department of Transportation (DOT) submits the following initial comments:

1. The proposed project will significantly impact two State highway facilities - Honoapiilani Highway and the planned Lahaina Bypass.

2. Sufficient right-of-way should be reserved for construction of six lanes of the Lahaina Bypass, as well as for turning lanes at intersections. No access will be permitted except at DOT-approved access points.

3. The DOT strongly opposes the placement of public schools next to existing or planned State highways because of the potential traffic, safety and noise concerns. The project's land use plan should include sufficient buffers to mitigate any potential noise impacts to residential uses adjacent to Honoapiilani Highway and the planned Lahaina Bypass.

4. The DOT will not allow the construction of the access road connecting to the planned T-intersection between the Lahaina Bypass and the Keawe Street Extension. The DOT will not consider a rotary design for this intersection.

5. Signalized intersections on roads which access the Lahaina Bypass should be at least 1,200 feet from build-out intersections with the Lahaina Bypass. Unsignalized intersections also require sufficient spacing. The same requirements apply to project road intersections with the proposed Keawe Street Extension. Plans for intersections with the Keawe Street Extension should be coordinated with both the DOT and the County Department of Public Works.

6. Proposals for any connections to county roads that access Honoapiilani Highway should be coordinated with both the DOT and the County Department of Public Works.

7. Drainage emanating from the project and the impacts of the drainage on State highways must be addressed in ensuing environmental documents. No additional storm water runoff will be allowed onto the State highway right-of-way.

8. Once the project's preferred layout and alternatives are selected, a traffic impact analysis report (TIAR), accompanied by a detailed project development plan, should be prepared and submitted to DOT for review and approval. The TIAR should address the local and regional traffic impacts and the proposed mitigation measures.

The DOT recommends that your firm and the Hawaii Housing Finance and Development Corporation continue discussions with the DOT Highways Division. The DOT understands that the project's development and layout are still being formulated. Request that the DOT be considered an interested party for the project's EIS process. The DOT reserves the right to provide further comments.

The DOT appreciates early consultation and preview of the alternative layouts.

Very truly yours,

Francis Paul Keeno

for BRENNON T. MORIOKA, Ph.D, P.E.
Director of Transportation

LINDA LINGLE
GOVERNOR
THEODORE E. LIU
DIRECTOR
MARK K. ANDERSON
DEPUTY DIRECTOR
ABBEY SETH MAYER
DIRECTOR
OFFICE OF PLANNING

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

OFFICE OF PLANNING

235 South Beretania Street, 6th Floor, Honolulu, Hawaii 96813
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BELT COLLINS HAWAII

Ref. No. P-12200

July 29, 2008

Ms. Susan A. Sakai
Vice President and Director of Planning
Belt Collins Hawaii Ltd.
2153 North King Street, Suite 200
Honolulu, Hawaii 96819-4554
Attention: Ms. Lynn Fukuhara

Dear Ms. Sakai:

Subject: Master Plan and Environmental Impact Statement (EIS)
Affordable Housing Project
Hawaii Housing Finance and Development Corporation (HHFDC)
Villages of Leialii, Lahaina, Maui

The State Land Use Commission (LUC) reclassified approximately 1,097.765 acres from the Agricultural District to the Urban District (TMK Nos.: 4-5-21: por. 3; 4-5-21: por. 4; 4-5-21: por. 5; 4-5-21: 9; and 4-5-14:58) at Lahaina, Maui based on a Petition by the State Housing Finance and Development Corporation (HFDC) in LUC Docket No. A89-652. The property was subject to twenty-two conditions when it was reclassified on May 18, 1990.

The current master plan for the affordable housing project will cover 1,128 acres. The difference in acreage should be explained.

The Office of Planning prefers Concept B with more units and higher densities with the understanding that the amount of commercial and light industrial space will remain the same. Each concept (A & B) will also include two elementary schools, neighborhood parks and a large open space area around the crater reservoir.

An affordable housing project of this magnitude should incorporate energy efficient design concepts as promoted by the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) programs for New Construction and its pilot program for Neighborhood Development.

Thank you for the opportunity to comment. Should you have any questions, please call the Land Use Division at (808) 587-2842.

Sincerely,

Abbey Seth Mayer
Director

c: Karen Seddon, HHFDC
Orlando Davidson, LUC
Theodore E. Liu, DBEDT

PHONE (808) 594-1888

FAX (808) 594-1865

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STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

HRD08/1040

August 6, 2008

Susan Sakai
Belt Collins Hawai'i Ltd.
2153 North King Street, Suite 200
Honolulu, Hawai'i 96819-4554

RE: Request for preliminary comments on an affordable housing project, Lahaina, Maui.

Aloha e Susan Sakai,

The Office of Hawaiian Affairs (OHA) is in receipt of the above-mentioned letter dated July 9, 2008. OHA has reviewed the invitation and offers the following comments.

OHA is unable to assess the totality of potential impacts to our beneficiaries that may result from this proposed project due to the scant information provided in the invitation to comment. OHA does understand that this invitation is preliminary and, therefore, no criticisms are generated from the lack of materials. In fact, OHA is appreciative of and excited by the invitation to help shape projects at their early stages. Therefore, we look forward to further involvement.

OHA can speak generally of an area of concern in the form of the State Historic Preservation Division site number 50-50-03-6277 and other cultural resources present in the project area. We urge that the applicant take precautions to protect such valued and important resources. Further, OHA asks that, in accordance with Section 6E-46.6, Hawaii Revised Statutes and Chapter 13-300, Hawaii Administrative Rules, if the project moves forward, and if any significant cultural deposits or human skeletal remains are encountered, work shall stop in the immediate vicinity and the State Historic Preservation Division shall be contacted.

Thank you for the opportunity to comment. If you have further questions, please contact Grant Arnold at (808) 594-0263 or e-mail him at granta@oha.org.

'O wau iho nō me ka 'oia'i'o,

Clyde W. Nāmu'o
Administrator

C: Maui CRC

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UNIDEV HAWAI'I, LLC

August 8, 2008

Belt Collins Hawaii Ltd.
2153 North King Street, Suite 200
Honolulu, Hawaii 96819-4554

Attention: Lynn Fukuhara
Subject: Villages of Leiali'i

Aloha,

Per the Belt Collins letter dated July 9, 2008, UniDev Hawaii LLC has reviewed the proposed development concepts labeled "Concept Land Use Plan A" and "Concept Land Use Plan B".

After comparing the nature and scope of the project to similar UniDev Hawaii projects, we have the following comments:

Affordability

We believe that with appropriate design and sponsor support, either Concept proposal can provide a significant number of affordable workforce dwellings to the residents of Maui County. We also believe that the affordable units produced should be required to be affordable in perpetuity.

One of the tenets of ***Affordability in Perpetuity*** is use of a modified "Land Trust" model. The sponsor (in this case HHFDC) offers the portion of the property dedicated to affordable housing to a non profit Special Purpose Entity (SPE). The SPE then secures the financing for the project utilizing a 65 to 99 year master lease term. The homebuyer purchases their home subject to the terms of a sublease on the land which provides resale restrictions and limits the amount of appreciation. These restrictions assure permanent affordability.

The development is financed and administered by the SPE. The SPE holds the master ground lease, secures financing for construction and administers all elements of the project including design, construction and operations for the entire term of the ground lease. An integral part of the modified "land trust" model are resale restrictions. Rather than the standard 10, 12 or 20 year affordable term, resale restrictions included in the sub ground lease keep the dwellings affordable for the life of the project. This provides a long term solution to the long term problem of affordable housing in Hawaii.

UniDev Hawai'i, LLC

1100 Alakea Street
Suite 1550
Honolulu, Hawaii 96813
Phone: 808.536.1110
Faxmile: 808.536.1104
www.unidevllc.com

Infrastructure
Due to the considerable cost of the off site and on site infrastructure required for this project, we believe the higher density of Concept B is a more viable approach. Even with the increased density of Concept B it is likely that some additional contribution to the *off site infrastructure* will be necessary to ensure that a significant number (70% of total) of "Affordable Workforce" dwellings can be achieved at the Villages of Leiali'i.

If HHFDC allows 25 to 30% of the proposed dwellings to be sold as fee simple, market rate homes, the market rate sales can subsidize a significant portion of the *on site infrastructure.*

Using these methods on similar projects, we have been able to achieve rental rates as low as 70% of Area Median Income (AMI) and affordable workforce home sales prices from 120% to 140% of AMI.

Walkable, Bikable, Active-Lifestyle
Any concept should include green corridor pathways to connect neighborhoods by foot traffic and/or bicycle traffic. Additionally, the proposed park areas should connect through the same common path system. This promotes a more walkable, bikable, active and transit oriented lifestyle as well as promoting a greater sense of a community.

Transit Oriented Project
Concept A or B do not appear to include dedicated Transit Areas. If the commercial and mixed use areas are to be separated by approximately 3/4 mile as shown, each center should include a transit hub with additional transit transfer points around the perimeter of the project. Most certainly there should be a transit hub on the Lahaina Bypass Road makai of the Crater Reservoir. Connecting the green areas will also allow for pedestrian access to transit areas.

Storm Water Runoff / Connectivity
Are the retention areas "fixed"? If there is the ability to place 50% of the retention basins mauka of the Bypass road there could be additional road connections to existing neighborhoods dramatically decreasing the car count on each of the proposed connectors.

Density
Concept B has a density of approximately 150% of Concept A, yet dedicated park areas remain the same size and number in both concepts. An alternative plan would provide a slightly reduced density in Concept "B" with more area dedicated to park space or perhaps an equally desirable element–several small "Community Gardens" providing open areas specifically for residents to grow produce within the community.

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UniDev HAWAI'I, LLC

Design
The "Hawaii Built Green" criteria should be incorporated into the project to provide a responsible and sustainable project.

Pre Emptions
The developer of the project should seek an "Experimental Housing" designation from the County of Maui to facilitate the planning approval / entitlement process. Certain pre emptions to county code can increase the affordability of the project through slight changes to minimum lot size requirements, street widths, height restrictions on the mixed-use components of the project (3 –5 stories), GET exemption, waived the building and permitting fees and allowance of private sitework and building inspections.

If you have any questions or if we may be of assistance, please don't hesitate to call at your convenience.

Sincerely,

Jeffery A. Minter
President/CEO

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Summary of January 2009 Meeting

Villages of Leialiʻi
Informational Meeting January 28, 2009

Summary of Presentation and Comments

Meeting Date: January 28, 2009

Meeting Time: 4:30 – 5:30 Open House, 5:30 – 6:00 Presentation, 6:00 – 7:00 Public Comments

Meeting Location: Lahaina Civic Center, Community Meeting Room

Attendance: Approximately 60 people attended, with 46 signing in. The list of those who signed in is attached. Attendees included:

- Representatives from the Mayor's Office and County agencies
- Residents of DHHL's Leialiʻi homestead
- Representative from neighboring land owners
- Reporters from the Maui News and Lahaina News
- Representatives from DHHL
- Representatives from area organizations and businesses

A Public Notice of the meeting was published in the Star Bulletin, the Honolulu Advertiser, and the Maui News on January 7 and 14, 2009. In addition, a notice was mailed directly to 73 stakeholders.

Purpose of Meeting: The purpose of this meeting was to brief the community on the revised conceptual master plan for the Villages of Leialiʻi and receive comments; in particular regarding any preference between the conceptual land use plan "A" with 3,290 residential units of "B" with 3,910 residential units.

OVERVIEW OF PRESENTATION

Upon arrival, attendees were asked to sign in and they were given a three-page handout with a summary of the two plans and a conceptual drawing of each. At sign-in, attendees were asked to indicate if they wished to testify during the comment period. The meeting format included an "open house" session that allowed attendees to review posters of the two conceptual plans and informally ask questions.

The official presentation included the background of the project, a general description of the next steps and timeline going forward, and a description of the features of the two conceptual plans. HHFDC Project Manager Stan Fujimoto presented the background and next steps and Alan Fujimori of Belt Collins Hawaii LTD described the two plans.

The following is a summary of Stan Fujimoto's presentation:

History of the Project

1. The Villages of Leialiʻi project was begun the 1980's.

2. The project site was selected in 1988 and in 1990, the EIS and Land Use Reclassification were obtained for the existing Villages of Leialiʻi master plan.

3. The Leialiʻi Parkway and Village 1A house-lot infrastructure were completed in 1994.

4. HHFDC paid for the expansion of the Lahaina Wastewater Treatment Plant for the entire Villages of Leialiʻi project and Phase 1 of a sewer and reclamation line that would eventually connect the Lahaina Wastewater Treatment Plant to the Leialiʻi project. This first phase of the line reaches about the halfway point from the Lahaina Wastewater Treatment Plant to the project site.

5. In 2005, HHFDC (HCDCH at the time) sold Villages 1A and 1B to DHHL, who retained Dowling & Co. to build the homes in Village 1A.

6. In 2007, HHFDC contracted with Belt Collins Hawaii Ltd. to completely re-do the master plan and EIS for leasehold development at Leiali'i. Belt Collins created the two master plan concepts being presented at this meeting.

Ceded Land Litigation

1. In 1994, HHFDC acquired title to 540 acres of the Villages of Leialiʻi project below the proposed Lahaina Bypass Highway. This precipitated the ceded lands litigation which suspended development at the Villages of Leiali'i.

2. The project as currently envisioned would be conveyed in leasehold but HHFDC will comply with the ultimate Supreme Court decision or legislative mandate. HHFDC's rental projects are normally conveyed in leasehold so the property can be redeveloped in the future and kept in affordable housing.

HHFDC's Next Steps

1. HHFDC plans to issue an RFP to procure a developer for the area below the proposed Lahaina Bypass Highway sometime in 2010. The specifications of the RFP will comply with whatever court decision is prevailing at that time—

    - The Hawaii Supreme Court decision of January 2008, under which land would be offered in leasehold; or
    - According to the decision of the U.S. Supreme Court.

2. The estimated schedule for completion of the first homes is 2014.

The following is a summary of Alan Fujimori's presentation:

1. The entire Villages of Leialiʻi project site is 1,128 acres. The site is organized mauka/makai of the proposed Lahaina Bypass Highway.

2. The mauka side is steeper and so it is designed for less density using single family residential units in both conceptual plans.

3. The design for the makai side of the bypass is more intense and diverse, incorporating single and multi-family residential units, civic open space, commercial areas, schools, and light industrial uses.

4. Both conceptual layouts incorporate the realignment of the proposed Lahaina Bypass Highway to avoid cultural resources.

5. The design concept is based on the Smart Growth principles for creating walkable neighborhoods using a 10 minute walking radius. The goal of the design is to cut down on the number of car trips and create an active-lifestyle community.

6. The roads are designed to provide more options to get from point to point within the community. Providing more paths to get through the development reduces the traffic on the roads.

7. The makai development in both concepts is designed around two major commercial/retail hubs and an elementary school and park. The commercial/retail hub in the southern portion of the site is intended to serve the region, while the hub in the north is geared more to the Leialiʻi community.

8. The mauka section is designed around parks and a second elementary school. Being steeper, it is not as "walkable."

9. The traffic, infrastructure, and utility demands are based on the residential numbers projected for each option.

10. The two concepts primarily differ in their emphasis on single-family versus multi-family residential units. Concept "A" calls for a total of 3,290 residential units, with 2,360 of these being single family units. Concept "B" proposes a total of 3,910 units, with 2,320 of these being multi-family units.

PUBLIC COMMENTS

A total of 13 people made comments or asked questions. None of the speakers voiced a preference for one plan over the other. The majority of those who spoke were residents of the DHHL Leialiʻi homestead (Village 1A).

The general themes of the comments made were:

- This is ceded land or crown lands and it should be developed by DHHL for 50% Hawaiians.
- This area should not be developed at all because it is sacred, there are cultural sites and burials here, and development will obstruct access to native resources and cultural practices.
- This development is too big and it will change the character of Lahaina for the worse.
- The Mayor's office supports providing land for a park above Village 1A.

Following is a summary of each comment.

1. Explain the detention ponds.

   Response: Alan Fujimori: The detention ponds are designed to collect and retain runoff from heavy rains. They will meet design standards for the run off estimated through engineering studies. The ponds will be a permanent feature to catch run off. The mauka development will have ponds that haven't been defined.

2. Norm Bezare - resident of Kaʻanapali: The first part of this development, which has been finished, has a certain type of home on it. What where the prices of those homes and will the prices of the future homes be similar? Can you say what they will cost?

   Response: The existing homes are in Village 1A and were constructed by DHHL. Stewart Matsunaga of DHHL was asked to respond. Stewart said they cost $175,000 – $290,000, however the land and infrastructure costs were not included in the sale price.

Stan added that the DHHL price will not be comparable. HHFDC will require developers to make at least 50% of the units affordable. Affordability will be based on the federal formula for 140% and below median income (MI) for Maui. The pricing will be based on a 140% MI for a family of four at the time of sale. These guidelines would have to be followed by the developer.

3. Norm Bezare: Does that mean that half of these homes will be market rate?

   Response: The cost of units will be based on what the developer proposes. HHFDC will give more points for the greater number of affordable units. The non-affordable units will be market rate units.

4. Faith Ancog - Leialiʻi resident: Are these ceded lands?

   Response: Yes. We will be abiding by whatever the U. S. Supreme Court decides. We can currently develop the lands in leasehold under the existing Hawaii Supreme Court decision.

5. Kapali Keahi - Kingdom of Hawaii representative of the Lahaina area & Leialiʻi resident: We believe that the State does not own this land and we think the land should be transferred to DHHL. However, we believe that these are not ceded lands – they are crown lands and should be given back to the Hawaiian people. This development is too big and too much and going on without any justice. The decision to develop these lands is premature. There should be some confirmation about whether these lands are going to be developed for the Hawaiian people. It should be developed for the Hawaiians because it is "our land." You should bring someone who can make a decision to this meeting.

6. Nameaaea Hoshino: Where is the water going to go to from all of these developments; especially with the bypass? What else is planned for the open space? This develop comes as a surprise and it isn't even Hawaiian homes. Who is it going to benefit? Why isn't this land going to Hawaiian Homes?

   What is going to happen to the area - to Maui - if this kind of development keeps on going? What about things like invasive species? If this is kingdom land you guys aren't even supposed to be developing it. The development cuts off access to the valleys and the waters up mauka.

7. Kailani Ross - Leialii homesteader: I don't favor either plan; the land should be given to DHHL – not sold (state agency to state agency transfer). The land should be for Hawaiians, these are ceded land and there has been much displacement of Hawaiians.

There was an act of war and Hawaiians have suffered from this – health, etc. The Hawaiian kingdom lands should be for Hawaiian people. The Hawaiian way is not to acquire things. I don't know that all of this development is progress. Give the land to DHHL so they can develop it in a true *ahupuaʻa* fashion and protect access and the natural resources.

8. Yolanda Dizon: Many years back our ancestors fought for our crown lands and that is when the development stopped. They aren't here to speak for themselves today. This is not *pololei* (correct). These are crown lands; I don't see our people benefitting from this. I think 90% will go to someone else. These won't be affordable.

   The plan says it is designed to avoid cultural resources - that is baloney. There are sites all over. This place is sacred. It appalls me that you are having these meetings. All of these meetings are a "play;" the development will go on anyway. These are broken promises. Leave our ceded lands alone. It is supposed to go to the interest of 50% Hawaiians. All of the crown lands belong to them. It is up to the 50% to make sure their descendants have these rights.

9. Alan-Dall Dizon: I stand before you as a human being, a *kanaka maoli*. My tutu is up there (indicating the project area), her name is there. This is crown land. This development is not for the *kanaka*, you take away our food source when you take away the water. No more *opae* (native shrimp). All of the food we eat will be eliminated when you take the water. Look at what happened to the Amazon.

   You are taking away the beauty of Hawaii. What is going to happen to our grand children, where will they go? On the street? Lingle does not care about the *kanaka*. You are only concerned about making money. Our children don't have jobs, I didn't ask for statehood. Hawaii won't be Hawaii if you keep developing. There won't be any forest if you keep building. If you mess with the land it will die.

10. Rod Paʻahana – Leialiʻi homesteader: I guess you guys can see we are not for this development. Will you listen to us? Has this decision been made? This is ceded land, the land is supposed to go to the Hawaiian people. The people who live next to the development don't want it. The people of Lahaina don't want it.

    We have families buried here. When you develop this land you will desecrate graves. This was the first capitol and all the chiefs lived here. The governor has to back off. Hawaiians have nowhere else to go. The ceded lands don't belong to the state or the governor. They belong to the Hawaiians. Can we get the governor here since she will be the one to make the decision? These plans were not made by us and we don't want it.

11. Mahina Martin – Mayor's office - Community Relations and Communications Director: The administration is aware that the Leialiʻi homesteaders want to be given land for a park and playground mauka of Village 1A. The county requests that HHFDC give this request earnest consideration. The administration is watching the ceded land issue and hopes that HHFDC heeds the voices of the people of Maui County.

12. Mona Stevenson: How long has this project been going on? If you are able to sell ceded land will you be selling it to developers and can they put up whatever they want, like gated communities?

    Response: This project was started on the 1980's. The selection of a developer is a competitive process. We look at the proposals from developers and select the one that provides the best benefit. If the proposal has both a gated community and the most number of affordable units it could be chosen as the best benefit. We will take the public comments into consideration.

13. Mona Stevenson: How does the revenue get distributed if this is kept as leasehold?

    Response: The developers make their money on the development. If this is leasehold, the 20% of all lease rent the developer receives other than lease rent from affordable housing goes to OHA.

14. Mona Stevenson: Have you identified the source of water?

    Response: We will be drilling wells mauka of the Villages of Leiali'i project.

15. Mona Stevenson: Will there be Hawaiian homes within the development?

    Response: There could be, we are always in discussion with DHHL.

16. Michael Young – Leialiʻi homesteader: Is the expansion of the sewer system already done?

    Response: HHFDC has already paid for the expansion but our rights to it have lapsed so we will have to apply to the County for the sewer capacity.

17. What is the timeline for this project?

    Response: Our plan was to issue an RFP next year with the first homes completed in 2014. We still need to do the off-site improvements.

18. Rod Paʻahana – Leialiʻi homesteader: Everyone here is against this but it sounds like you will still continue. What do we have to do to make this stop?

Response: I don't know, but we hear you. We will take this as part of the comments and include them in the RFP.

19. Kailani Ross – Leialiʻi homesteader: Following up on the comment by Mahina Martin regarding the park. We want to know what is being done to give us a park.

    Response: This is the first we've heard about it, we can follow up with DHHL.

20. Kailani Ross – Leialiʻi homesteader: I am concerned about wells. When you dig wells it sucks up water and we can't tell what it is doing to the water level. I oppose wells being dug anywhere.

21. Anela Rosa – Leialiʻi homesteader: What is the next step after this meeting?

    Response: HHFDC will complete the master plan. This meeting is one step in the process. We will put your comments in the master plan and the RFP. If we go forward, the developer will know what was said. The developer will propose what they think will work.

22. Anela Rosa – Leialiʻi homesteader: Will we be told who is selected for the development?

    Response: Yes we can inform you.

23. Recommendation that notices be put in the Lahaina News and that press releases are better than public notices for getting word out.

24. Daniel Ornellas – Be advised that the lands mauka of the Bypass Highway is subject to an E.O. in favor of the Department of Agriculture.

Attendance List

Villages of Leialiʻi Information Meeting

January 28, 2009

Lahaina Civic Center, Maui

	NAME	AFFILIATION
1	Mahina Martin	County of Maui - Mayor's Office
2	Donna Auwae	
3	Eve Clute	Lahaina News
4	Don Lehman	West Maui Taxpayers Association
5	Derek Kochi	Dowling Company
6	Konan Kama	Public Interest
7	Pete Martin	Kahoma Land Company LLC
8	Anela Rosa	Community
9	Michael K. Young	
10	Chad Fukunaga	Kaanapali Land Management Corporation
11	Howard Hanzawa	Kaanapali Land Management Corporation
12	Kailani Ross	Leialiʻi resident
13	Eassie Miller	Aqua Engineers
14	Claudine San Nicolas	Maui News
15	Linda Nahina	
16	Jo-Ann Ridao	County of Maui – Dept. of Housing & Human Concerns
17	June Gushi	Royal Kaanapali Golf Resort
18	Lindel Puha	
19	Stephanie Young	Roberts Hawaii School Bus
20	Arlene Torricer	Kahoma Land Company LLC
21	Norm Bezare	Self
22	Ivan Mathias	
23	P. Keahi	
24	Lillian Suter	
25	Desiree Kaiuhu	
26	Julie-Ann Cachola	DHHL
27	Mona Kapaku	DHHL
28	Faith Ancog	
29	Kapali Keahi	
30	Pili Dunn	
31	Nameaaea Hoshino	
32	Leilani Pulman	Maui Land & Pine

33	Kathleen Aoki	County of Maui – Dept. of Planning
34	Clayton Baybayan	
35	Stewart Matsunaga	DHHL
36	Mona Stevenson	
37	Yolanda Dukes	Leialiʻi homesteader
38	Yolanda Dizon	
39	Letitia Ii	
40	Haʻa	
41	Albert-Dall Dizon	Kaua Ula
42	Rod Paʻahana	Leialiʻi Homestead Association Board of Directors
43	Daniel Ornellas	DLNR
44	Maria Ornellas	DHHL
45	Jane Gordon	DHHL
46	Illegible Name	Leialiʻi homesteader

Appendix B

Botanical

Botanical Survey

of the

Villages of Leiali‘i Housing Project, Lahaina, Island of Maui

by

Art Whistler, Ph.D.
Isle Botanica
Honolulu, Hawai‘i

Report prepared for

Belt Collins Hawaii Ltd.
Honolulu, Hawai‘i

April 2008

INTRODUCTION

The Villages of Leiali‘i Housing Project site (Fig. 1) is located just mauka (inland) of Lahaina, Maui, Hawai‘i. It consists of two Phases, A and B, with approximately 1,128 acres. It comprises TMK (2) 4-5-21: 3 (most of Phase A), 4 (the northeastern part of Phase B, east of the canal), 5 (the canal), 11 (a railroad right of way), 13 (a sliver of land on the western edge of Phase A), 14 (a vacant county water tank site), 17 (a reservoir site), 18 and 19 (two parcels in the northwest corner separated from the rest of the project by DHHL land, and from each other by the railroad right of way), 21 (a sliver of land on the northwestern part of Phase A), and por. 22 (most of Phase B, extending up to Hahakea gulch in the north). Although a Master Plan of the area (PRB Hawaii 1990) included a botanical survey (Char 1989) carried out the previous year, nineteen years have passed and land uses have changed, necessitating an up-to-date botanical survey.

The gently sloping area on the west side of West Maui was formerly under sugar cane cultivation, but this was discontinued years ago. The lower (western) portion of the study site has reverted to a natural grassland vegetation dominated by alien species. The central portion of the site has been used more recently for pineapple cultivation, but this too has now been abandoned, leaving large areas still covered with dying pineapple. One area just west of the cinder cones is surrounded by remnant windbreaks and appears to have formerly been used for growing papaya. The southeast corner of the site comprises a complex of cinder cones covered with the same type of grassland as the west side, except for the nearly barren cinder walls inside the craters. Two reservoirs are found near the cinder cones.

METHODOLOGY

Before the fieldwork was carried out, a review of the literature was undertaken by the Principal Investigator (PI). The current status of any possible endangered species previously reported from the site was checked using the official database of threatened and endangered species (USFWS 2005). This list is identical to the State of Hawai‘i list of threatened and endangered plant species. In addition, information about threatened and endangered plant species found in the area was extracted from the Hawai‘i Natural Heritage Program database (Anon. 2005) of federally listed plant species (Fig. 2). Topographic maps and aerial photos were studied to determine the best access points and to locate places where native species are most likely to be found (in this case, cinder cones and gulches).

Several botanical surveys have been conducted in the area. One was conducted in almost the same area nineteen ago (Char 1989). Additionally, two earlier surveys were conducted on smaller projects in or near the current study site (Char 1986, 1988), mostly in sugar cane lands. A fourth botanical survey was carried out just north of the present project site (Char and Linney 1989).

After the literature review, a botanical field survey was done at the site by a two-person botanical team consisting of the PI (Art Whistler) and a Field Assistant (Beate Neher) from 29 January to 1 February 2008. Access was attained by a gate at the southwestern corner of the property. Most of the area could be reached by dirt roads (old cane roads) that form a network on the property, but many of these are now overgrown and impassable, even for four-wheel drive vehicles. The survey was carried out by a “walk-though” method over the highly disturbed site.

Fig. 1. The villages of Leiali‘I Housing Project site

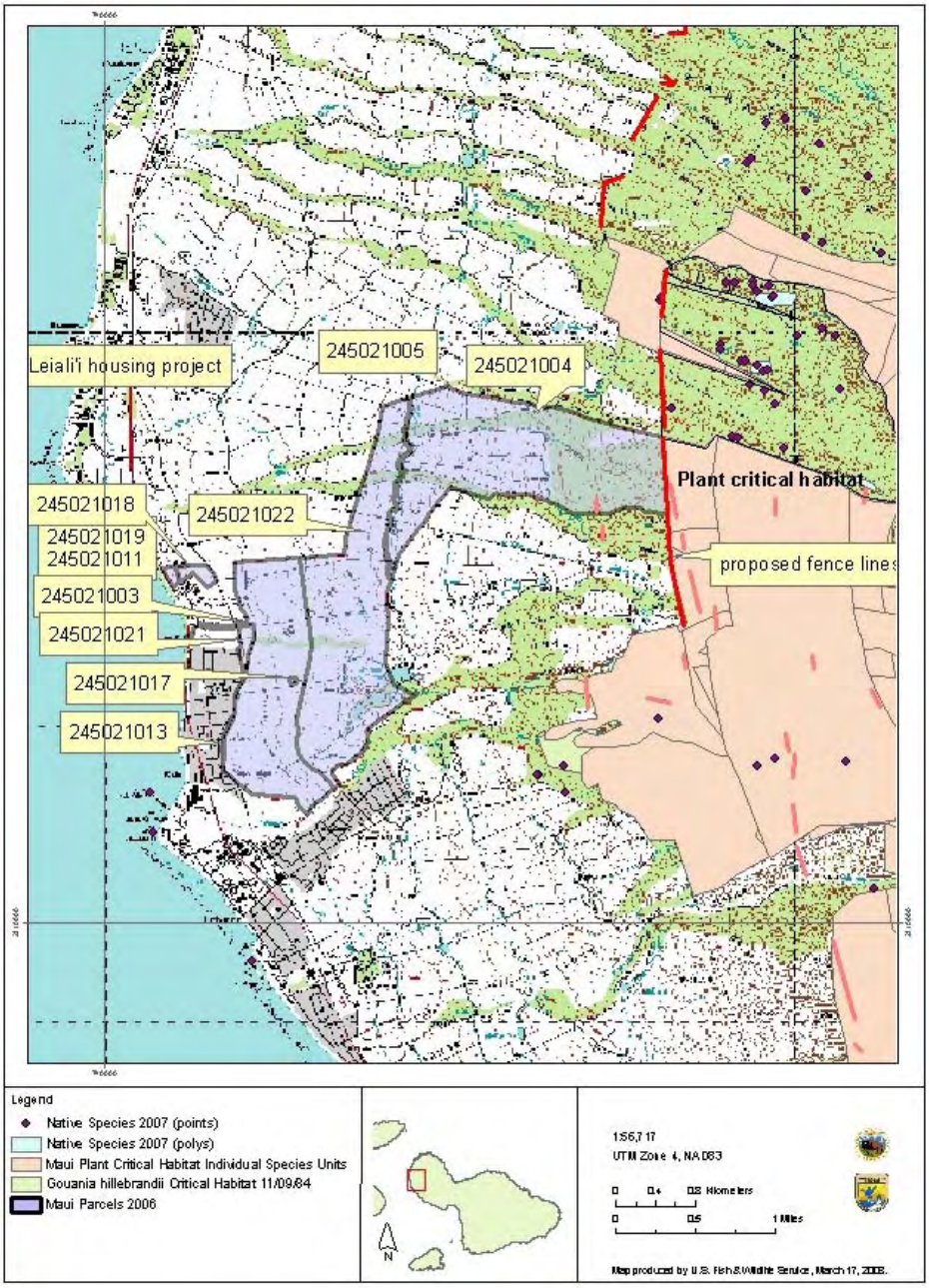

Fig. 2. Hawai‘i Natural Heritage Program map showing the absence of threatened or endangered species records in the area.

This involves walking through the site along transects and recording botanical information. Several vegetation types were recognized, and those most likely to harbor native species (e.g., gulches and cinder cones) were more intensely studied. All plant species encountered during the survey were recorded, along with an indication of their frequency. New lists were made for each vegetation type and/or day, and these were combined into a comprehensive checklist of all plants found at the study site (see Table 2). Notes were also taken on vegetation types present, indicating the dominance and frequency of the plant species found there. These were later analyzed and written up to form the vegetation section below.

Nearly all of the species encountered during the fieldwork were familiar to the field team and were identified on the site. The few that defied immediate identification were photographed and brought to the Bishop Museum, where they were promptly identified (Snow, pers. comm. 2008), except for one unknown Asteraceae weed that appears to be a new record for Hawai‘i.

THE VEGETATION

Char (1989) divided the vegetation of the area into three types: (1) Cane Fields; (2) Gulch Vegetation; and (3) Reservoir and Quarry Vegetation. Because the land use has changed for much of the area (cane fields to abandoned land and abandoned pineapple fields) over the last nineteen years, the present vegetation does not entirely fit the earlier categories. Consequently, four types of vegetation were recognized at the study site during the present survey: (1) Managed Land Vegetation; (2) Buffel Grass/Koa Haole Grassland; (3) Cinder Cone Vegetation; and (4) Riparian Vegetation.

Managed Land Vegetation

This comprises the vegetation on areas that are under periodic or frequent management, such as bulldozing, mowing, and agriculture. Several parts of the study site fit into this category: (1) old dirt sugarcane roads and tracks that cross the site; (2) a parking lot; (3) a railroad right-of-way that divides the isolated northwestern parcel; (4) bulldozed areas in and on the cinder cones; (5) areas under active individual cultivation on the western part of Phase A; (6) abandoned papaya plantations; (7) abandoned pineapple fields that comprise a large area mostly in Phase B; (8) abandoned sugarcane fields in the upland, eastern part of Phase B; and (9) canal margins. Several of these are on their way, by means of plant succession, to becoming other types of vegetation because their management has recently ceased.

The dirt tracks and sugarcane roads are mostly barren (Fig. 3), but the mostly alien, weedy species that thrive on the bare soil and sunny conditions are overrunning these, which has made many of the smaller tracks or roads impassible to vehicular traffic. Species found here include numerous sun-loving weedy species such as buffel grass (*Cenchrus ciliaris*), ‘uhaloa (*Waltheria indica*), rattle pod (*Crotalaria pallida*), hairy merremia (*Merremia aegyptia*), kaliko (*Euphorbia heterophylla*), and stink grass (*Eragrostis cilianensis*). All of these are alien species, except for the ‘uhaloa. Similar vegetation occurs on areas of exposed soil in the grasslands (Fig. 4). A parking lot (Fig. 5) in the northwest corner of the study site is currently being maintained, apparently by spraying, and is dominated by low growing weeds that are able to survive the treatment. The railroad right-of-way is also apparently maintained by spraying (Fig. 6), and only small, scattered individuals of sun-loving alien weeds, such as hairy merremia, stink grass, and creeping indigo (*Indigofera spicata*), are able to survive here. Areas where the cinder cones

have been scraped (Fig. 7) are also dominated by weedy alien species such as koa haole (*Leucaena leucocephala*), buffel grass, and orange lion's-ear (*Leonotis nepetifolia*).

Active gardens presumably tended by nearby residents are found in the western part of Phase A, where crop plants such as eggplant, snow peas, papaya, and sweet potatoes are cultivated. The abandoned papaya plantations west of the cinder cone show little sign of their former use other than a few scattered, dying papaya trees. The ground in these areas that were formerly surrounded by windbreaks, possibly of sugar cane and lemon-scented gum (*Eucalyptus citriodora*), is dominated by weedy alien species (Fig. 8), particularly orange lion's-ear (*Leonotis nepetifolia*). At least 30 other weedy species were found in these plots, the most common of which are Natal redtop (*Rhynchelytrum repens*) and buffel grass.

Abandoned pineapple fields (Fig. 9) probably comprise the second largest type of vegetation at the study site. Most of these are covered with dead and dying pineapple plants, none of which were seen to be flowering or fruiting. They are now being overgrown by alien weedy species, particularly bitter melon (*Momordica charantia*), sour grass (*Digitaria insularis*), and Natal redtop, along with lesser amounts of herbaceous weeds such as orange lion's-ear, red pualele (*Emilia fosbergii*), hairy merremia, and rattlepod. Scattered shrubs or spreading trees also occur here, especially dogtail (*Buddleja asiatica*), which often occurs in lines, probably originally becoming established in rows between pineapples. Pluchea (*Pluchea carolinensis*) and Christmas berry (*Schinus terebinthifolius*) are also occasional here.

Large areas of grassland that appear to be abandoned sugarcane fields (Fig. 10) are found above the canal in the northeastern side of Phase B. These are dominated by Guinea grass (*Panicum maximum*), with lesser amounts of weeds such as rattlepod, sour grass, hairy merremia, and pink bindweed (*Ipomoea triloba*). Buffel grass is uncommon here, probably choked out by the Guinea grass that thrives in these wetter, upslope areas. The edges of canals are also dominated by weedy species, but where water seeps into the soil, the vegetation is dominated mostly by wetland species such as Job's tears (*Coix lacryma-jobi*), Guinea grass, and primrose willow (*Ludwigia octovalvis*).

Buffel Grass/Koa Haole Grassland

This type of vegetation comprises the major type of non-managed vegetation at the site, covering nearly the entire area of Phase A. Char (1989) did not note any of this kind vegetation in her survey, because at that time the area was covered with sugarcane fields, nor did she mention the category above, Managed Land Vegetation. Although this type of grassland is common in the dry lowlands of Hawai‘i, especially in the lowlands on the dry western side of Maui, it is barely mentioned in Wagner et al. (1999) as being distinctive. This grassland appears to be mostly, as noted above, abandoned sugarcane fields, and because of the low rainfall near the coast, it is dominated by buffel grass (*Cenchrus ciliaris*). Also present throughout the area are numerous koa haole (*Leucaena leucocephala*) shrubs, which in places nearly share dominance with the buffel grass (Fig. 11). This is a fairly monotonous vegetation, with these two species being by far the dominant ones. Also present in smaller amounts are plants such as rattlepod (*Crotalaria pallida*), Natal redtop (*Rhynchelytrum repens*), hairy merremia (*Merremia aegyptia*), cow pea (*Macroptilium lathyroides*), and garden spurge (*Chamaesyce hirta*). These other species can be nearly absent when the buffel grass is dense, but where gaps occur, they are more common.

There are three minor variations of Buffel Grass/Koa Haole Grassland. Shallow gulches (Fig. 12) run downslope throughout the study area. If these were deep, they were probably not used as sugarcane fields. They are currently dominated by three species in various combinations: buffel grass; Guinea grass (*Panicum maximum*), which thrives in the relatively moister soil of the watercourses; and koa haole. This is similar to the "Gulch Vegetation" described by Char (1989), but her designation referred mostly to the much larger gulches (Hahakea and Kahoma), both of which are outside of the present study site. The second variation comprises piles of boulders (Fig. 13) that are aggregations of rocks taken out of the sugarcane fields. These are largely dominated by the same two species, buffel grass (especially where the piles have soil in them) and koa haole.

The third variation is found on the undisturbed (i.e., not graded) slopes of the cinder cones (Fig. 14). Prior to the European era, these were probably covered with a native shrubland vegetation, but decades of grazing and fires have entirely removed this, leaving a shrubby grassland dominated by alien species, the same species that are found in the lowland areas of the study site—buffel grass and koa haole. Other species common here include ʻilima (*Sida fallax*), klu (*Acacia farnesiana*), and hairy merremia, and in a few places, kiawe trees (*Prosopis pallida*).

Cinder Cone Vegetation

This is the vegetation on exposed areas of the cinder cones in the southeastern portion of Phase B (Fig. 15). It was included in the heterogeneous category "Reservoir and Quarry Vegetation" by Char (1989). The outsides of the cones are covered with Buffel Grass/Koa Haole Grassland, but the crater walls are not. Where the crater has been bulldozed, the surface is covered with a kind of open variation of grassland, with weedy species, such as Buffel grass (*Cenchrus ciliaris*), koa haole (*Leucaena leucocephala*), ʻuhaloa (*Waltheria indica*), and orange lion's-ear (*Leonotis nepetifolia*), dominating. The crater walls, which may be natural or may have been graded at one time, are dominated by a number of species, especially orange lion's-ear, Natal redtop (*Rhynchelytrum repens*), and ʻuhaloa. Nearly all the ferns recorded at the site were found in this habitat, e.g., *Nephrolepis multiflora*, *Pteris vittata*, and *Adiantum hispidulum*. The only two endemic species found at the site, *Lipochaeta lavarum* and *Doryopteris decora*, both occurred on the cinder cones. Another native species found here, aʻaliʻi (*Dodonaea viscosa*), was uncommon and virtually absent over the rest of the study site.

One area near the top of the southern cinder cone was dominated by an unusual dwarf weedy herbaceous association (Fig. 16) comprising species such as ageratum (*Ageratum conyzoides*), purple cudweed (*Gnaphalium purpureum*), rat-tail fescue (*Vulpia myuros*), ripgut grass (*Bromus diandrus*), and *Galinsoga parviflora*. These alien species are rare or absent over the rest of the study site.

Riparian Vegetation

This comprises the forest that surrounds the margins of the western reservoir. It is entirely dominated by Java plum (*Syzygium cumini*), which favors this wetland soil. Because of its dense

Table 1. Native Plants Species

	Endemic	
Doryopteris decora	----------	uncommon
Lipochaeta lavarum	----------	uncommon
	Indigenous	
Blechnum occidentale	blechnum	uncommon
Boerhavia repens	alena, nena	uncommon
Cordia subcordata	kou, cordia	cultivated
Dodonaea viscosa	‘a‘ali‘i	uncommon
Ipomoea indica	koali-‘awa	uncommon
Jacquemontia ovalifolia	pa‘u-o-Hi‘i‘aka	uncommon
Psilotum nudum	moa	uncommon
Sida fallax	‘ilima	common
Solanum americanum	black nightshade, popolo	uncommon
Waltheria indica	‘uhaloa	abundant

shade, very few plants grow on the forest floor, leaving it quite open (Fig. 17). The two reservoirs are connected by a water channel in which a large volume of water was flowing during the time of the survey. The edges of this sloping channel (almost a waterfall) are dominated by Java plum, with lesser amounts of guava (*Psidium guajava*) and Chinese banyan (*Ficus microcarpa*). A few plants accustomed to moist shady conditions are found here, including the native fern *Blechnum occidentale* and the alien species honohono (*Commelina diffusa*), oak fern (*Christella parasitica*), and Asiatic pennywort (*Centella asiatica*). The other slopes of the eastern reservoir are covered with a koa haole forest (Fig. 18) with a dense understory of grasses and herbs, mostly Guinea grass (*Panicum maximum*). The presence of the Guinea grass may possibly be accounted for by a wet soil caused by leakage from the reservoir, since buffel grass is dominant on the other, drier crater slopes.

FLORA

Char (1989) reported a total of 88 vascular plant species on almost the same site, which at that time was mostly under sugar cane cultivation. During the present survey, 155 species were recorded, nearly double the earlier number recorded in the Char survey. Only fifteen of the species found in the first survey were not encountered during the present survey, all of them cultivated plants or alien weeds. Three of the species on the earlier list were probably misidentifications.

Of the 155 plant species recorded during the present survey, only twelve are native plants—two endemic and ten indigenous species (Table 1). Indigenous plants are species that are native to a region or place, but are also found elsewhere. Endemic plants are species restricted to a single region or area, i.e., in the case of Hawai‘i, they are found only in Hawai‘i. In biodiversity terms, the endemic status is the more important of the two categories, since if a species belonging to it is endangered or threatened in Hawai‘i, it would likewise be classified globally. Indigenous species, however, can be rare in Hawai‘i, but may be common elsewhere in the

Pacific. Over 90% of the native plants in Hawai‘i are endemic, one of the highest rates in the world. The Char survey recorded only six native species—one endemic and five indigenous. All six were likewise found during the present survey. No threatened or endangered species have previously been reported in the area, as is shown on the Hawai‘i Natural Heritage Program database map (Fig. 2), and none of the twelve native species found in the present survey are threatened or endangered.

The majority of the 155 species encountered during the present survey are naturalized "alien" plants that were accidentally or intentionally introduced to Hawai‘i, but which have now become established in the islands and can spread on their own. The present survey was conducted during a fairly wet part of the year, and consequently it is unlikely that many more species, especially native species, would be found in a survey during others times of the year. One species, *Ludwigia hyssopifolia*, proved to be a new record for Hawai‘i. A list of all species found during the present survey is found in Table 2 in the Appendix.

DISCUSSION AND CONCLUSIONS

The study site has been extensively disturbed over the last two centuries, and perhaps earlier, by agriculture, grazing, quarrying, and fires. The vegetation currently present is entirely disturbed and can be divided into four types: (1) Managed Land Vegetation; (2) Buffel Grass/Koa Haole Grassland; (3) Cinder Cone Vegetation; and (4) Riparian Vegetation. None of these vegetation types is dominated by native species. The least-disturbed part of the study site comprises the cinder cones, but even these have been disturbed by quarrying activities, and are dominated by alien species. No wetlands, other than the edges of the reservoirs and irrigation canals, are found on the site, and even these are dominated by alien species and are extremely limited in extent.

The flora recorded at the study site comprises 155 vascular plant species—143 alien and twelve native species. This is a very low number of native species, which is indicative of the extensive disturbance that has occurred there. Of the twelve native species, ten are indigenous and two are endemic. None of the native species are listed as threatened or endangered. Most of them are fairly common in Hawai‘i, with *Lipochaeta lavarum* perhaps being the most uncommon of them. This member of the aster family is a variable species that is found on all the large islands south of O‘ahu, and at the site is limited to the slopes and cliffs of the cinder cones.

Because there are no threatened or endangered species present, nor are there any wetlands or other types of sensitive vegetation present, there is little of botanical interest at the site. Consequently, there would be no negative impacts to threatened or endangered, or even otherwise rare native species, or to any types of native vegetation if the proposed development is to take place.

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APPENDIX: Table 2. Checklist of vascular plant species recorded at the Leali‘i site.

The following is a checklist of vascular plants inventoried during the field studies at the proposed Leali‘i development site at Lahaina, Maui. The plants are divided into three groups, Ferns (including fern allies), Monocots, and Dicots. Within these groups, the species are presented taxonomically by family, with each family and each species in the family in alphabetical order. The taxonomy and nomenclature of the ferns follow Palmer 2003 and the flowering plants (Monocots and Dicots) follow Wagner *et al*. (1990). In most cases, common English and/or Hawaiian names listed have been taken from St. John (1973) or Porter (1972).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name, when known.
3. Biogeographic status. The following symbols are used.
   E = Endemic (found only in Hawai‘i).
   I = Indigenous (native to Hawai‘i as well as other geographic areas).
   P = Polynesian introduction (introduced to Hawai‘i by Polynesians before the advent of the Europeans).
   X = Introduced or alien (not native, introduced to Hawai‘i, either accidentally or intentionally, after the advent of the Europeans).
4. Abundance (abundant, common, locally common, occasional, uncommon, cultivated).

Species	Common Names	Status	Abundance
FERNS AND FERN ALLIES			
ADIANTACEAE (Maiden’s-hair Family)			
Adiantum hispidulum Sw.	rough maidenhair fern	X	uncommon
BLECHNACEAE (Blechnum Family)			
Blechnum occidentale L	blechnum	I	uncommon
NEPHROLEPIDACEAE (Sword Fern Family)			
Nephrolepis multiflora (Roxb.) Jarret ex Morton	hairy swordfern	X	uncommon
PSILOTACEAE (Psilotum Family)			
Psilotum nudum L.	moa	I	uncommon
PTERIDACEAE (Pteris Family)			
Doryopteris decora Wight & Arn.) Verdc.	----------	E	uncommon
Pteris vittata L.	cliff break	X	uncommon
THELYPTERIDACEAE (Downy Woodfern Family)			
Christella parasitica (L.) Leville	oak fern	X	uncommon
MONOCOTS			
AGAVACEAE (Agave Family)			
Aloe vera L.	aloe	X	uncommon
Furcraea foetida (L.) Haw.	Mauritius hemp	X	uncommon

Species	Common Names	Status	Abundance
BROMELIACEAE (Bromeliad Family)			
Ananas comosus (L.) Merr.	pineapple	X	abundant
CANNACEAE (Canna Family)			
Canna indica L.	canna	X	uncommon
COMMELINACEAE (Spiderwort Family)			
Commelina diffusa N. L. Burm.	honohono	X	uncommon
CYPERACEAE (Sedge Family)			
Cyperus rotundus L.	nutgrass	X	occasional
Kyllinga brevifolia Rottb.	kyllinga	X	uncommon
MUSACEAE (Banana Family)			
Musa x*paradisiaca* L.	banana	P	cultivated
ORCHIDACEAE (Orchid Family)			
Spathoglottis plicata Bl.	Philippine ground orchid	X	uncommon
POACEAE (Grass Family)			
Brachiaria mutica (Forssk.) Stapf	California grass	X	uncommon
Bromus diandrus Roth	ripgut grass	X	uncommon
Cenchrus ciliaris L.	buffel grass	X	abundant
Cenchrus echinatus L.	sandbur	X	uncommon
Chloris barbata (L.) Sw.	swollen fingergrass	X	common
Chloris radiata (L.) Sw.	radiate fingergrass	X	occasional
Coix lacryma-jobi L.	Job's tears	X	uncommon
Cynodon dactylon (L.) Pers.	Bermuda grass	X	uncommon
Dactyloctenium aegyptium (L.) Willd.	beach wiregrass	X	uncommon
Digitaria ciliaris (Retz.) Koeler	large crabgrass	X	uncommon
Digitaria insularis (L.) Mez ex Ekman	sour grass	X	common
Digitaria violascens Link	violet crabgrass	X	uncommon
Echinochloa crus-galli (L.) P. Beauv.	barnyard grass	X	uncommon
Eleusine indica (L.) Gaertn.	goose grass	X	occasional
Eragrostis cilianensis (All.) Link	stink grass	X	occasional
Eragrostis pectinacea (Michx.) Nees	Carolina lovegrass	X	occasional
Eragrostis tenella (L.) P. Beauv. ex Roem. & Schult.	love grass	X	uncommon
Panicum maximum Jacq.	Guinea grass	X	abundant
Paspalum conjugatum Bergius	t-grass	X	uncommon
Pennisetum purpureum Schumach.	elephant grass	X	uncommon
Rhynchelytrum repens (Willd.) C.E. Hubb.	Natal redtop	X	abundant
Saccharum officinarum L.	sugar cane	P	cultivated
Setaria verticillata (L.) P. Beauv.	bristly foxtail	X	occasional
Tragus berteronianus Schult.	Bertero goatgrass	X	occasional
Vulpia myuros (L.) C.C. Gmelin	rat-tail fescue	X	uncommon

Species	Common Names	Status	Abundance
	DICOTS		
ACANTHACEAE (Acanthus Family)			
Asystasia gangetica (L.) T. Anderson	Chinese violet	X	uncommon
Thunbergia fragrans Roxb.	white thunbergia	X	uncommon
AMARANTHACEAE (Amaranth Family)			
Alternanthera pungens Kunth	khaki weed	X	uncommon
Amaranthus spinosus L.	spiny amaranth	X	occasional
Amaranthus viridis L.	slender amaranth	X	uncommon
ANACARDIACEAE (Mango Family)			
Mangifera indica L.	mango	X	uncommon
Schinus terebinthifolius Raddi	Christmas berry	X	occasional
ANNONACEAE (Soursop Family)			
Annona cf. *muricata* L.	soursop	X	cultivated
APIACEAE (Carrot Family)			
Centella asiatica (L.) Urb.	Asiatic pennywort	X	uncommon
Ciclospermum leptophyllum (Pers.) Sprague	fir-leafed celery	X	uncommon
ARALIACEAE			
Schefflera actinophylla (Endl.) Harms	octopus tree	X	uncommon
ASCLEPIADACEAE (Milkweed Family)			
Calotropis gigantea (L.) Aiton	crown flower	X	occasional
ASTERACEAE (Sunflower Family)			
Ageratum conyzoides L.	ageratum	X	occasional
Bidens pilosa L.	beggar’s-tick	X	common
Conyza bonariensis (L.) Cronq.	hairy horseweed	X	occasional
Crassocephalum crepidioides (Benth.) S. Moore	crassocephalum	X	uncommon
Eclipta alba (L.) Hassk.	false daisy	X	uncommon
Emilia fosbergii Nicolson	red pualele, emilia	X	occasional
Galinsoga parviflora Cav.	----------	X	uncommon
Gnaphalium purpureum L .	purple cudweed	X	uncommon
Lipochaeta lavarum (Gaud.) DC.	----------	E	uncommon
Pluchea carolinensis (Jacq.) G. Don	pluchea	X	occasional
Sonchus oleraceus L.	sow thistle	X	common
Synedrella nodiflora (L.) Gaertn.	synedrella	X	uncommon
Tridax procumbens L.	coat buttons	X	common
Verbesina encelioides (Cav.) Benth. & Hook.	golden crownbeard	X	occasional
Xanthium strumarium L.	cocklebur	X	occasional
Zinnia peruviana (L.) L.	wild zinnia	X	common
Species indet.	----------	X	uncommon

Species	Common Names	Status	Abundance
BIGNONIACEAE (Bignonia Family)			
Spathodea campanulata P. Beauv.	African tulip tree	X	uncommon
BORAGINACEAE (Heliotrope Family)			
Cordia subcordata Lam.	kou, cordia	I	cultivated
Heliotropium procumbens Mill.	weedy heliotrope	X	uncommon
BRASSICACEAE (Mustard Family)			
Lepidium virginicum L.	wild peppergrass	X	uncommon
BUDDLEIACEAE (Butterfly-bush Family)			
Buddleia asiatica Lour.	dogtail, heulo'ilio	X	common
CACTACEAE (Cactus Family)			
Opuntia ficus-indica (L.) Mill.	prickly pear, panini	X	uncommon
CAPPARACEAE (Caper Family)			
Cleome gynandra L.	African spider flower	X	uncommon
CARICACEAE (Papaya Family)			
Carica papaya L.	papaya	X	cultivated
CHENOPODIACEAE (Goosefoot Family)			
Atriplex subrecta Verd.	----------	X	occasional
CLUSIACEAE (Mangosteen Family)			
Clusia rosea Jacq.	autograph tree	X	uncommon
CONVOLVULACEAE (Morning-Glory Family)			
Ipomoea alba L.	moon flower	X	locally common
Ipomoea batatas L.	sweet potato	X	cultivated
Ipomoea indica (J. Burm.) Merr.	koali-'awa	I	uncommon
Ipomoea ochracea (Lindl.) G. Don	----------	X	uncommon
Ipomoea triloba L.	pink bindweed	X	common
Jacquemontia ovalifolia (Choisy) H. Hall.	pa'u-o-Hi'i'aka	I	uncommon
Merremia aegyptia (L.) Urb.	hairy merremia	X?	abundant
CUCURBITACEAE (Gourd Family)			
Cucurbita pepo L.	pumpkin	X	cultivated
Luffa cylindrica (L.) M. Roemer	luffa	X	cultivated
Momordica charantia L.	wild bittermelon	X	common
EUPHORBIACEAE (Spurge Family)			
Chamaesyce hirta (L.) Millsp.	garden spurge	X	common
Chamaesyce hypericifolia (L.) Millsp.	graceful spurge	X	uncommon
Chamaesyce hyssopifolia (L.) Small	----------	X	uncommon
Chamaesyce thymifolia (L.) Millsp.	thyme-leafed spurge	X	uncommon
Euphorbia heterophylla L.	kaliko	X	occasional
Manihot esculenta Crantz	cassava	X	cultivated
Ricinus communis L.	castor bean	X	occasional
FABACEAE (Pea Family)			
Acacia farnesiana (L.) Willd.	klu	X	common
Albizia lebbeck (L.) Benth.	siris tree	X	occasional

Species	Common Names	Status	Abundance
FABACEAE (cont'd.)			
Canavalia cathartica Thouars	mauna-loa	X	uncommon
Chamaecrista nictitans (L.) Moench	partridge pea, lau-ki	X	common
Crotalaria incana L.	fuzzy rattlepod	X	uncommon
Crotalaria pallida Aiton	smooth rattlepod	X	common
Desmanthus pernambucanus (L.) Thellung	virgate mimosa	X	uncommon
Desmodium tortuosum (Sw.) DC.	Florida beggarweed	X	occasional
Glycine wightii (Wight & Arn.) Verdc.	----------	X	uncommon
Indigofera spicata Forssk.	creeping indigo	X	uncommon
Indigofera suffruticosa Mill.	indigo, 'iniko	X	uncommon
Leucaena leucocephala (Lam.) de Wit	koa haole	X	abundant
Macroptilium atropurpureum (DC) Urb.	wild bushbean	X	uncommon
Macroptilium lathyroides (L.) Urb.	cow pea	X	common
Pisium sativum L.	snow pea	X	cultivated
Pithecellobium dulce (Roxb.) Benth.	'opiuma, Manila tamarind	X	occasional
Prosopis pallida (Humb. & Bonpl.ex Willd.) Kunth	kiawe, mesquite	X	occasional
Senna occidentalis (L.) Link	coffee senna	X	uncommon
Senna surattensis (N.L. Burm.) H. Irwin & Barneby	kolomona	X	uncommon
Sesbania grandiflora (L.) Poiret	sessban	X	cultivated
LAMIACEAE (Mint Family)			
Leonotis nepetifolia (L.) R. Br.	orange lion's-ear	X	abundant
MALVACEAE (Mallow Family)			
Abutilon grandifolium (Willd.) Sweet	hairy abutilon	X	occasional
Malva parviflora L.	cheeseweed	X	uncommon
Malvastrum coromandelianum (L.) Garcke	false mallow	X	uncommon
Sida ciliaris L.	----------	X	uncommon
Sida fallax Walp.	'ilima	I	common
Sida rhombifolia L.	Cuba jute	X	uncommon
Sida spinosa L.	prickly sida	X	occasional
MELIACEAE (Mahogany Family)			
Melia azedarach L.	Chinaberry tree	X	uncommon
MORINGACEAE (Moringa Family)			
Moringa oleifera Lam.	horse-radish tree	X	occasional
MORACEAE (Mulberry Family)			
Ficus microcarpa L. f.	Chinese banyan	X	uncommon
MYRTACEAE (Myrtle Family)			
Eucalyptus citriodora Hook.	lemon-scented gum	X	cultivated
Melaleuca quinquenervia (Cav.) Blake	paperbark tree	X	uncommon
Psidium cattleianum Sabine	strawberry guava	X	uncommon

Species	Common Names	Status	Abundance
MYRTACEAE (cont'd.)			
Psidium guajava L.	guava	X	occasional
Syzygium cumini (L.) Skeels	Java plum	X	occasional
NYCTAGINACEAE (Four-o'-Clock Family)			
Boerhavia coccinea Mill.	----------	X	occasional
Boerhavia repens R. Br.	alena, nena	I	uncommon
ONAGRACEAE (Evening Primrose Family)			
Ludwigia hyssopifolia (G. Don) Exell	---------	X	uncommon
Ludwigia octovalvis (Jacq.) Raven	primrose willow	P?	occasional
OXALIDACEAE (Wood-Sorrel Family)			
Oxalis corniculata L.	wood sorrel	P	uncommon
Oxalis debilis Kunth	pink wood-sorrel	X	uncommon
PASSIFLORACEAE (Passionflower Family)			
Passiflora suberosa L.	----------	X	uncommon
POLYGALACEAE (Milkwort Family)			
Polygala paniculata L.	bubblegum plant	X	uncommon
POLYGONACEAE (Buckwheat Family)			
Antigonon leptopus Hook. & Arnott	Mexican creeper	X	uncommon
PORTULACACEAE (Purslane Family)			
Portulaca oleracea L.	common purslane	X	uncommon
PROTACEAE (Protea Family)			
Grevillea robusta A. Cunn. ex R. Br.	silk oak	X	uncommon
RUBIACEAE (Coffee Family)			
Richardia brasiliensis Gomes	----------	X	uncommon
SAPINDACEAE (Soapberry Family)			
Dodonaea viscosa Jacq.	'a'ali'i	I	uncommon
SOLANACEAE (Nightshade Family)			
Capsicum annum L.	green pepper	X	cultivated
Lycopersicon pimpinellifolium (Jusl.) Mill.	currant tomato	X	occasional
Nicandra physalodes (L.) Gaertn.	apple of Peru	X	occasional
Nicotiana glauca R. C. Graham	tree tobacco	X	uncommon
Solanum americanum Mill.	black nightshade, popolo	I?	uncommon
Solanum melongena L.	eggplant	X	cultivated
STERCULIACEAE (Cacao Family)			
Waltheria indica L.	'uhaloa	I	abundant
VERBENACEAE (Verbena Family)			
Lantana camara L.	lantana	X	uncommon
ZYGOPHYLLACEAE (Caltrop Family)			
Tribulus terrestris L.	puncture vine	X	uncommon

Fig. 3. Old sugarcane road being overgrown by weedy species.

Fig. 4. Clearing in grassland with invading by weedy species.

Fig. 5. Parking lot in the isolated northwest parcel dominated by weedy species.

Fig. 6. Railroad right-of-way with sparse weedy vegetation.

Fig. 7. Center of largest crater with signs of previous quarrying.

Fig. 8. Old papaya plantation now entirely overgrown with weeds.

Fig. 9. Abandoned pineapple plantation overgrown with weeds.

Fig. 10. Abandoned sugarcane land dominated by Guinea grass in eastern part of Phase B.

Fig. 11. buffel Grass/Koa Haole Grassland

Fig. 12. Gulch passing through abandoned pineapple fields.

Fig. 13. Rock pile in abandoned sugarcane land.

Fig. 14. Buffel Grass/Koa Haole Grassland on outer slopes of crater.

Fig. 15. Crater wall on the west side of the main crater.

Fig. 16. Depauperate vegetation growing on a crater rim.

Fig. 17. Java plum forest along the banks of the western reservoir.

Fig. 18. Koa haole forest with Guinea grass dominating the ground cover.

Appendix C

Fauna and Avifauna

A Survey of Avian and Terrestrial Mammalian Resources for the Villages of Leialiʻi Housing Project, Lāhainā, Island of Maui.

DRAFT

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June 9, 2008

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Introduction

The Hawai‘i Housing & Finance Development Corporation (HHFDC) is proposing to develop an affordable housing project in Lāhainā, Maui. The development has been named the Villages of Leiali‘i Housing Project, and is located on former Pioneer Mills lands west of the town of Lāhainā (Figure 1). The proposed development will be developed in two phases. The project encompass approximately 1,128-acres of land identified as TMK: (2) 4-5-21:3 (most of Phase A), 4 (the northeastern part of Phase B, east of the canal), 5 (the canal), 11 (a railroad right of way), 13 (a sliver of land on the western edge of Phase A), 14 (a vacant county water tank site), 17 (a reservoir site), 18 and 19 (two parcels in the northwest corner separated from the rest of the project by Hawaii Department of Hawaiian Homes Land (DHHL), and from each other by the railroad right of way), 21 (a sliver of land on the northwestern part of Phase A), and a portion of parcel. 22 (most of Phase B, extending up to Hahakea Gulch in the north) (Figure 1).

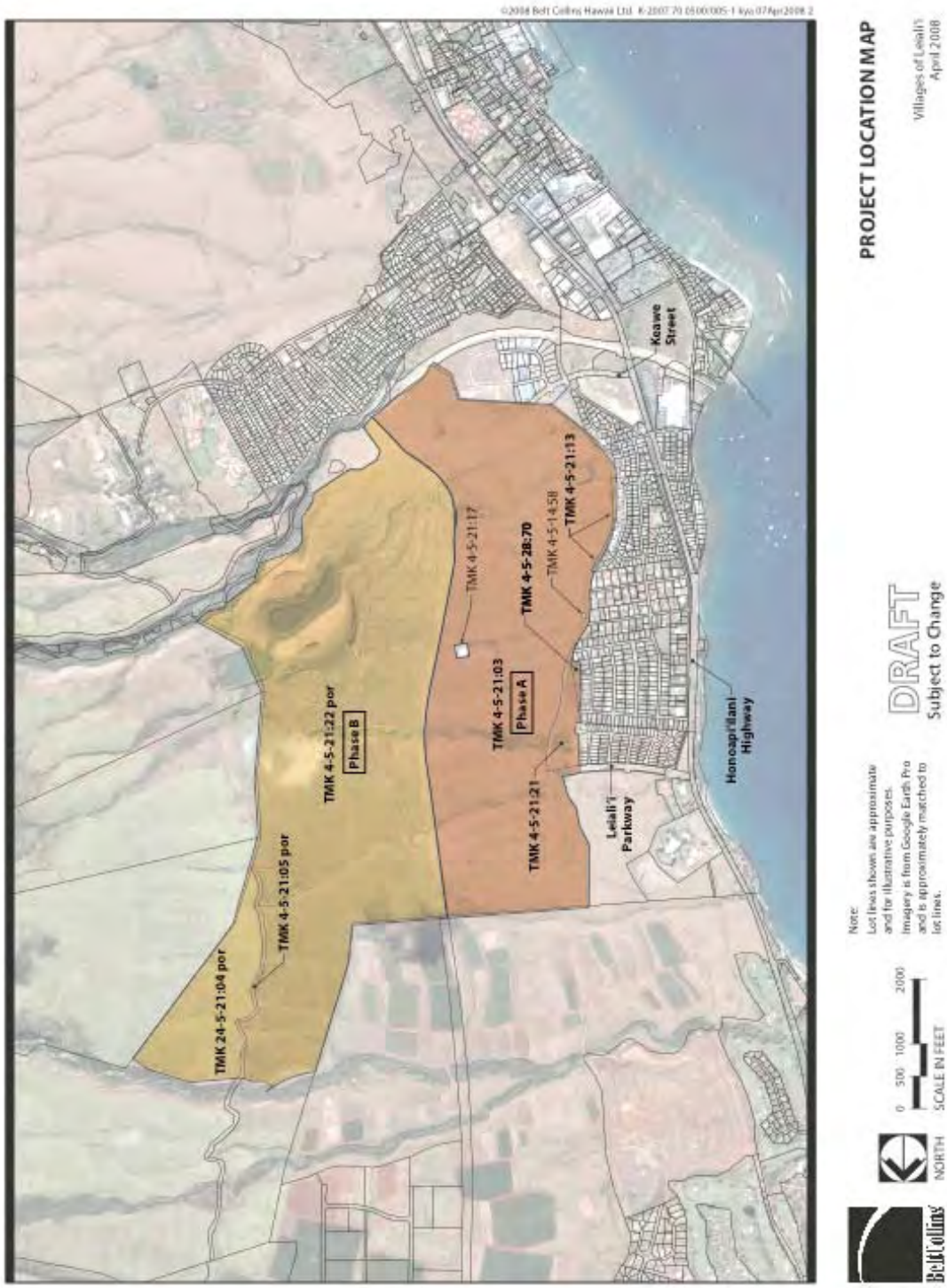
This report summarizes the findings of the avian and mammalian surveys that were conducted on the proposed development site. The primary purpose of the surveys was to determine if there were any avian or mammalian species currently listed as endangered, threatened, or proposed for listing under either the federal or the State of Hawai‘i’s endangered species programs on, or within in the immediate vicinity of the site. Federal and State of Hawai‘i listed species status follows species identified in the following referenced documents (Division of Land and Natural Resources (DLNR) 1998, Federal Register 2005, U. S. Fish & Wildlife Service (USFWS) 2005, 2008). Fieldwork was conducted by Reginald E. David between April 21 and 24, 2008.

Avian phylogenetic order and nomenclature follows *The American Ornithologists’ Union Check-list of North American Birds 7th Edition* (American Ornithologists’ Union 1998), and the 42nd through the 48th supplements to *Check-list of North American Birds* (American Ornithologists’ Union 2000; Banks et al. 2002, 2003, 2004, 2005, 2006, 2007). Mammal scientific names follow *Mammals in Hawaii* (Tomich 1986). Plant names follow *Manual of the Flowering Plants of Hawai‘i* (Wagner et al. 1990, 1999). Place names follow *Place Names of Hawaii* (Pukui et al., 1976).

Hawaiian and scientific names are italicized in the text. A glossary of technical terms and acronyms used in the document, which may be unfamiliar to the reader, are included at the end of the narrative text on page 11.

General Project and Site Description

The approximately 1,128-acres site slopes gently from the northeast corner located at approximately 850 feet (259 meters), above mean sea level (MSL), down to approximately 50-feet (15 meters) MSL in the southwest corner of the site. The parcel is bordered by existing development to the west and south, and by agricultural fields (mostly fallow) to the east and north of the site (Figure 1). The bulk of the site is comprised of former sugar cane lands, some of which were recently farmed for pineapple. Large portions of the site have reverted to ruderal weedy species commonly encountered on former sugar cane lands on Maui.


©2008 Belt Collins Hawaii Ltd. K-2007-70 0500/005-1 kyo 07Apr2008 2
TMK 24-5-21:04 por
TMK 4-5-21:05 por
TMK 4-5-21:22 por
Phase B
TMK 4-5-21:17
TMK 4-5-21:03
Phase A
TMK 4-5-28:70
TMK 4-5-14:58
TMK 4-5-21:13
TMK 4-5-21:21
Leiali'i Parkway
Honoapi'ilani Highway
Kaawa Street
PROJECT LOCATION MAP
Villages of Leiali'i
April 2008
DRAFT
Subject to Change
Note:
Lot lines shown are approximate and for illustrative purposes.
Imagery is from Google Earth Pro and is approximately matched to lot lines.
0 500 1000 2000
SCALE IN FEET
NORTH
Belt Collins

Additionally there are two reservoirs, Wahikuli, and Crater located on and adjacent to Pu‘u Laina at the southeast corner of the site.

As with most former sugar cane lands the site is crisscrossed with unimproved 4 x 4 roads which allowed for ready and complete access to the site. The site has been extensively modified by the agricultural activities that took place on the property in the past. From a native biological perspective the entire site can be considered to be extremely degraded.

Mammalian Survey Methods

With the exception of the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), or *‘ōpe‘ape‘a* as it is known locally, all terrestrial mammals currently found on the Island of Maui are alien species. Most are ubiquitous. The survey of mammals was limited to visual and auditory detection, coupled with visual observation of scat, tracks, and other animal sign. A running tally was kept of all vertebrate species observed, heard or detected by other means within the project area.

Mammalian Survey Results

Seven mammalian species were detected during the course of this survey (Table 1). All 7 species recorded are considered to be alien to the Hawaiian Islands. Numerous European house mice (*Mus musculus domesticus*), were seen within the site. I found three rat (*Rattus* sp.) skulls associated with owl pellets on the site close to Pu‘u Laina. Several dogs (*Canis f. familiaris*), three small Indian Mongooses (*Herpestes a. auropunctatus*), one cat (*Felis catus*), one pig (*Sus s. scrofa*) were seen as were several Axis deer (*Axis axis*). Scat and sign of dog, cat, pig and Axis deer were encountered in numerous locations on the site. Hawai‘i‘s sole endemic terrestrial mammalian species, the endangered Hawaiian hoary bat, was not detected during the course of this survey.

Table 1 Mammalian Species Detected, Leiali‘i Housing Project Site

Common Name	Scientific Name	ST	DT
	RODENTIA - GNAWERS		
	MURIDAE - Old World Rats & Mice		
Rat	*Rattus* sp.	A	SI
European house mouse	*Mus musculus domesticus*	A	V
	CARNIVORA – FLESH EATERS		
	CANIDAE – Wolves, Jackals & Allies		
Domestic dog	*Canis f. familiaris*	A	V, SC, SI
	VIVERRIDAE – Civets & Allies		
Small Indian mongoose	*Herpestes a. auropunctatus*	A	V, SC, SI
	FELIDAE- Cats		
House cat	*Felis catus*	A	V, SC, SI

Table 1 continued,

Common Name	Scientific Name	ST	DT
	ATRIODACTYLA – EVEN-TOED UNGULATES		
	SUICIDAE – Old World Swine		
Pig	*Sus s. scrofa*	A	V, SC, SI
	CERVIDAE – Antlered Ruminants		
Axis deer	*Axis axis*	A	V, SC, SI

Key To Table 1.

ST	Status
A	Alien Species
DT	Detection Type
V	Visual –individuals were seen
SC	Scat – Scat of this species was encountered
SI	Sign – Sign, tracks, bark rubbing, wallows, dust bath depressions etc. of this species were encountered

Avian Survey Methods

Thirty-six avian count stations were sited along linear transects running the length of the site. Count stations were placed at approximately 300-meter intervals equally spaced along these transects. Six-minute point counts were made at each of the 36 count stations. Each station was counted once. Field observations were made with the aid of Leitz 10 X 42 binoculars and by listening for vocalizations. Counts were concentrated between 07:00 a.m. and 11:00 a.m., the peak of daily bird activity. Time not spent counting was used to search the remainder of the project site for species and habitats that were not detected during count sessions.

Avian Survey Results

A total of 1,194 individual birds of 22 different species, representing 15 separate families, were recorded during station counts (Table 2). Two of the species detected, Short-eared Owl (*Asio flammeus sandwichensis*), and Black-crowned Night-Heron (*Nycticorax nycticorax hoactli*) are native species. The Short-eared Owl is a Hawaiian endemic subspecies of this near cosmopolitan raptor. Black-crowned Night-Herons are an indigenus resident breeding waterbird species. The remaining 20 species detected are all considered to be alien to the Hawaiian Islands (Table 2). No species currently listed as endangered, threatened or proposed for listing under either Federal or State of Hawai‘i endangered species statutes was recorded during the course of this survey.

Avian diversity and densities were in keeping with the location and the existing vegetation on the site. Three species, Japanese White-eye (*Zosterops japonicus*), House Finch (*Carpodacus mexicanus*), and Gray Francolin (*Francolinus pondicerianus*), accounted for slightly more than 48% of the total number of birds recorded during station counts. The most common avian species recorded was Japanese White-eye, which accounted for slightly less than 19% of the total number of individual birds recorded. An average of 33 individual birds were recorded per station count.

Table 2 Avian Species Detected, Leiali‘i Housing Project Site			
Common Name	**Scientific Name**	**ST**	**RA**
	GALLIFORMES		
	PHASIANIDAE - Pheasants & Partridges		
	Phasianinae - Pheasants & Allies		
Gray Francolin	*Francolinus pondicerianus*	A	4.19
Black Francolin	*Francolinus francolinus*	A	2.31
Red Junglefowl	*Gallus gallus*	D	0.14
Ring-necked Pheasant	*Phasianus colchicus*	A	0.53
	ODONTOPHORIDAE - New World Quail		
California Quail	*Callipepla californica*	A	0.33
	CICONIIFORMES		
	ARDEIDAE - Herons, Bitterns & Allies		
Cattle Egret	*Bubulcus ibis*	A	0.44
Black-crowned Night-Heron	*Nycticorax nycticorax hoactli*	IB	0.47
	COLUMBIFORMES		
	COLUMBIDAE - Pigeons & Doves		
Spotted Dove	*Streptopelia chinensis*	A	0.44
Zebra Dove	*Geopelia striata*	A	1.42
	STRIGIFORMES		
	STRIGIDAE - Typical Owls		
Short-eared Owl	*Asio flammeus sandwichensis*	IB	0.06
	PASSERIFORMES		
	ALAUDIDAE - Larks		
Sky Lark	*Alauda arvensis*	A	0.97
	SYLVIIDAE - Old World Warblers & Gnatcatchers		
	Sylviinae - Old World Warblers		
Japanese Bush-Warbler	*Cettia diphone*	A	0.94
	ZOSTEROPIDAE - White-eyes		
Japanese White-eye	*Zosterops japonicus*	A	6.22
	MIMIDAE - Mockingbirds & Thrashers		
Northern Mockingbird	*Mimus polyglottos*	A	1.36
	STURNIDAE - Starlings		
Common Myna	*Acridotheres tristis*	A	2.81
	EMBERIZIDAE - Emberizids		
Red-crested Cardinal	*Paroaria coronata*	A	0.22
	CARDINALIDAE - Cardinals Saltators & Allies		
Northern Cardinal	*Cardinalis cardinalis*	A	1.81

Table 2 continued,

Common Name	Scientific Name	ST	RA
	FRINGILLIDAE - Fringilline and Carduline Finches & Allies		
	Carduelinae - Carduline Finches		
House Finch	*Carpodacus mexicanus*	A	5.58
	PASSERIDAE - Old World Sparrows		
House Sparrow	*Passer domesticus*		0.89
	ESTRILDIDAE - Estrildid Finches		
	Estrildinae - Estrildine Finches		
African Silverbill	*Lonchura cantans*	A	0.69
Nutmeg Mannikin	*Lonchura punctulata*	A	0.92
Java Sparrow	*Padda oryzivora*	A	0.42

KEY TO TABLE 2

ST	Status
A	Alien Species
D	Domesticated Species – not known to be self sustaining in the wild on Maui
IB	Indigenous Resident Breeding Species
RA	Relative Abundance: Number of birds detected divided by the number of count stations (80)
I	Incidental Observation – Species seen while transiting the site, followed by the number of individuals seen

Discussion

Mammalian Resources

The findings of the mammalian survey are consistent with the location and the habitat present within the proposed project site. The mammalian survey results are similar to the results of at least one other faunal survey conducted on the subject property (Bruner 1989). Bruner encountered fewer mammalian species than did we, which is not surprising given the changes that have occurred to the habitat on the site in the intervening 19 years since he conducted his survey. All seven mammalian species detected during the course of this survey are commonly occurring alien species.

Hawaiian hoary bats were not detected during the course of this, or Bruner's survey of the site (Bruner 1989). There have been very few bats documented from the general Lāhainā area over the years. Numerous European house mice were see within the site. Additionally, we found three rat skulls in a set of highly degraded owl pellets. Bruner recorded one roof rat (*Rattus r. rattus*), on the site when he surveyed the site in 1989 (Bruner 1989). It is to be expected that the three established rat species present on the Island of Maui, Roof Rat Norway rat (*Rattus norvegicus*), and Polynesian rat (*Rattus exulans hawaiiensis*), use resources within the general project area on a seasonal basis. All of these introduced rodents are deleterious to remaining native ecosystems present in Hawai'i and the native floral and faunal species that are dependant on them for their survival.

Avian Resources

The findings of the avian survey are consistent with the location and habitat present within the proposed project site. The avian survey results are similar to the results of at least one other

faunal survey conducted on the subject property (Bruner 1989). Bruner encountered ten fewer avian species than did we, which is not surprising given the changes that have occurred to the habitat on the site in the intervening 19 years since he conducted his survey. He did record one species that I did not, namely Barn Owl (*Tyto alba*). Although, I did not detect this common alien raptor, I suspect that the owl pellets that we found were from this species. As with our survey, Japanese White-eyes were the most frequently recorded species during Bruner's survey (Bruner 1989).

All but two of the avian species detected, Short-eared Owl, and Black-crowned Night-Heron are considered to be alien to the Hawaiian Islands. No species currently listed as endangered, threatened or proposed for listing under either federal or State of Hawaii endangered species statutes was recorded during the course of this survey.

No indigenous migratory species were recorded during the course of this survey, not surprising since the surveys were conducted in late April, a time of year when almost all of the regularly occurring indigenous migratory shorebird species normally encountered in Hawai‘i are not present. It is likely that several migratory shorebird species are present on the site between late July and late April each year. The most likely species to be expected are, Pacific Golden-Plover (*Pluvialis fulva*), Ruddy Turnstone (*Arenaria interpres*), and Wandering Tattler (*Tringa incana*). All of these species are commonly encountered in Hawai‘i during the fall and winter months – all three nest in the high Arctic, and spend the winter months in lower latitudes, including Hawai‘i and the Tropical Pacific.

Although not detected during this survey both the endangered Hawaiian Petrel (*Pterodroma sandwichensis*), and the threatened endemic sub-species of the Newell's Shearwater (*Puffinus auricularis newelli*), may over-fly the project area between April and the end of November each year. Both species have been recorded flying inland south of Lāhainā and at several other locations on Maui (Cooper and Day 2003, 2004a, Day and Cooper 1999, Denis and Hamer 2007). Both of these pelagic seabird species nest high in the mountains in burrows excavated under thick vegetation, especially *uluhe* (*Dicranopteris linearis*) fern. There is no suitable nesting habitat for either of these seabirds species on, or close to the proposed development site.

The primary cause of mortality in both Hawaiian Petrels and Newell's Shearwaters is thought to be predation by alien mammalian species at the nesting colonies (USFWS 1983, Simons and Hodges 1998, Ainley et al. 2001). Collision with man-made structures is considered to be the second most significant cause of mortality of these seabird species in Hawai‘i. Nocturnally flying seabirds, especially fledglings on their way to sea in the summer and fall, can become disoriented by exterior lighting. When disoriented, seabirds often collide with manmade structures, and if they are not killed outright, the dazed or injured birds are easy targets of opportunity for feral mammals (Hadley 1961, Telfer 1979, Sincock 1981, Reed et al. 1985, Telfer et al. 1987, Cooper and Day 1998, Podolsky et al. 1998, Ainley et al. 2001, Day et al., 2003).

Potential Impacts to Protected Species

Hawaiian Petrel and Newell's Shearwater

The principal potential impact that the development of the Villages of Leiali‘i Housing Project poses to Hawaiian Petrels and Newell's Shearwaters, is the potential increased threat that birds will be downed after becoming disoriented by exterior lighting that may be required in conjunction with construction activities, or following build out with exterior lighting associated with the development. It should be noted that the development site is currently bounded on two sides by existing development.

Potential Impacts to Critical Habitat

There is no federally delineated Critical Habitat within or close to the Villages of Leiali‘i Housing Project site, thus the development of the project will not result in any impacts to federally designated Critical Habitat.

Conclusions

There is nothing unique about the project site or it's vegetation. There is abundant like habitat in, and around Lāhainā. It is not expected that the construction or operation of the proposed Villages of Leiali‘i Housing Project will result in deleterious impacts to native avian or mammalian resources present within the general project area.

Recommendation

If streetlights or other exterior lighting is installed in conjunction with this project, it is recommended that lights be shielded to reduce the potential for interactions of nocturnally flying Hawaiian Petrels and Newell's Shearwaters with external lights and man-made structures (Reed et al. 1985, Telfer et al. 1987).

Glossary:

Alien – Introduced to Hawai‘i by humans.
Crepuscular – Twilight hours.
Endangered – Listed and protected under the Endangered Species Act of 1973, as amended as an endangered species.
Endemic – Native and unique to the Hawaiian Islands
Indigenous – Native to the Hawaiian Islands, but also found elsewhere naturally.
Nocturnal – Night-time, after dark.
Pelagic – An animal that spends its life at sea – in this case seabirds that only return to land to nest and rear their young.
Ruderal – Disturbed, rocky, rubbishy areas, such as old agricultural fields and rock piles.
Threatened – Listed and protected under the ESA as a threatened species.
Volant – Flying, capable of flight, as in flying insect.

DHHL– Hawaii Department of Hawaiian Homes Lands
DLNR – Hawaii State Department of Land & Natural Resources.
DOFAW – Division of Forestry and Wildlife
ESA – Federal Endangered Species Act of 1973, as amended.
HHFDC – Hawai‘i Housing & Finance Development Corporation
USFWS – United States Fish & Wildlife Service.

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Appendix D

Environmental Phase I

PHASE I ENVIRONMENTAL SITE ASSESSMENT

Villages of Leialiʻi Phases A and B
Lahaina, Maui, Hawaiʻi

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September 2008

PHASE I ENVIRONMENTAL SITE ASSESSMENT

Villages of Leialiʻi Phases A and B
Lahaina, Maui, Hawaiʻi

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ACRONYMS

AST	aboveground storage tank
ASTM	American Society for Testing and Materials
ASTM E 1527-05	ASTM E 1527-05, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process
Belt Collins	Belt Collins Hawaii Ltd.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
CORRACTS	Corrective Action Sites
DOH	Department of Health (State of Hawai'i)
EDR	Environmental Data Resources, Inc.
ESA	Environmental Site Assessment
EPA	Environmental Protection Agency (United States)
ERNS	Emergency Response Notification System
FEMA	Federal Emergency Management Agency
HEER	Hazard Evaluation and Emergency Response (State Department of Health)
LUST	leaking underground storage tank
MECO	Maui Electric Company
msl	mean sea level
NFRAP	No Further Remedial Acton Planned (CERCLIS)
NPL	National Priorities List
PCBs	polychlorinated biphenyls
Property	Villages of Leiali'i Phases A and B
PVC	Polyvinyl chloride
RCRA	Resource Conservation and Recovery Act

RCRIS	Resource Conservation and Recovery Information System
RECs	Recognized environmental conditions
SHWB	Solid and Hazardous Waste Branch (State of Hawai'i Department of Health)
TMK	Tax Map Key
TSD	treatment, storage, and disposal (hazardous waste facilities)
UIC	Underground Injection Control
USGS	United States Geological Survey
UST	underground storage tank

EXECUTIVE SUMMARY

At the request of Hawaii Housing Finance and Development Corporation (HHFDC), Belt Collins Hawaii Ltd. (Belt Collins) has performed a Phase I Environmental Site Assessment in accordance with the Scope of Services provided in Appendix A and in general conformance with the scope and limitations of American Society of Testing and Materials (ASTM) Standard Practice E1527-05 to meet United States Environmental Protection Agency 40 Code of Federal Regulations Part 312: Standards and Practices for All Appropriate Inquiries for a portion of the Villages of Leiali'i Phase A and B, Lahaina, Maui, Hawai'i (the "Property"). Any exceptions to, or deletions from, the ASTM Practice are described in Section 1.4 of this report. This assessment has revealed no evidence of *recognized environmental conditions (RECs)* in connection with the Property except for the following:

- *One pole-mounted transformer and various substation transformers.* It is possible these transformers were installed prior to 1980 and, according to the Maui Electric Company, may contain polychlorinated biphenyls (PCBs). The transformers appear to be in poor condition with heavy rusting, posing a material threat of a release or past release of a hazardous substance.

It should be noted that the past application of herbicides is a potential source of contaminants, such as metals (especially arsenic), PCBs, organochlorine pesticides, and dioxins in the soil and groundwater. According to a State of Hawaii, Department of Agriculture report[1], the sugarcane industry was the largest single user of herbicides in Hawaii and accounted for 75 percent of total herbicide use there during the 1960s. For this reason, herbicides and pesticides are likely to be present in the soil and groundwater. However, when herbicides and pesticides are applied according to the labeled instructions, it is not considered a release and does not qualify as a REC.

The standard professional practices that Belt Collins conducted to determine if any *RECs* existed in connection with the Property included, among other things, a visual inspection of the Property, interviews with selected individuals who might have knowledge of its *RECs*, a review of readily available historical information such as aerial photographs and fire insurance maps, a drive-by inspection of accessible adjacent parcels, a review of selected environmental records that were made available to Belt Collins, and a review of a computer search of selected Federal and State environmental databases for indications of the presence of hazardous substances or petroleum products on the Property or on nearby parcels from which those substances might migrate to the Property in other than vapor form. General findings of the Property include the following:

- The Property consists of approximately 1,033 acres currently owned by HHFDC and the State of Hawai'i. Some structures associated with the former Pioneer Mill Company remain on-site, as well as irrigation features still in use. Additionally, some

[1] U. S. Environmental Protection Agency, Region 9. February 2003. Informational Flyer. *EPA to Perform Site Assessment at Pioneer Mill*. San Francisco, California.

archaeological features have been observed at the site. The Property's current use is agricultural. Historically, the Property was undeveloped.

- According to information obtained through interviews and regulatory database searches, there is no significant environmental concern on or adjacent to the Property. No known spills or chemical releases or environmental cleanups have taken place at the Property. No environmental liens have been issued against the Property, and no activity and land use limitations are in place at the Property. There is no specialized knowledge of the Property or nearby properties, and the price paid for the Property reasonably reflects the fair market value of the Property. Hazardous substances, in the form of pesticides and herbicides, have been used in their proper application on the Property. No hazardous substances or petroleum products are known to have been stored on the Property.

This report is intended for use only as the complete document. It is based upon the Scope of Services, and is subject to the Limitations and Exceptions and other restrictions, defined herein. It has been prepared for the exclusive use of HHFDC and their legal counsel. No other person or organization is entitled to rely upon any part of it without the prior written consent of Belt Collins. HHFDC or their legal counsel may release or authorize the release of all or part(s) of this report to third parties. However, if any third party uses or relies on this report without the express written permission of Belt Collins, such third party agrees that it shall indemnify and defend Belt Collins or its parent or subsidiaries from and against all claims arising out of or in conjunction with such use or reliance.

1 INTRODUCTION

This Phase I Environmental Site Assessment (ESA) evaluates the property known as Villages of Leiali'i Phases A and B located at Tax Map Keys (TMKs) 4-5-021: parcels 003, 004 (portion), 005 (portion), 013, 021, 022 (portion), and 4-5-028: parcel 070, in Lahaina, Maui, Hawai'i, hereinafter referred to as the "Property" (Figure 1). The Property consists of approximately 1,033 acres of agricultural land currently owned by Hawaii Housing Finance and Development Corporation (HHFDC) and the State of Hawai'i. This Phase I ESA has been prepared by Belt Collins Hawaii Ltd. (Belt Collins) for the sole use of HHFDC and their legal counsel as part of due diligence activities.

1.1 Purpose

The purpose of this Phase I ESA is to comply with the Environmental Protection Agency's (EPA) "All Appropriate Inquiries Final Rule," which is the first step to establishing the ability to qualify for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) liability protections. Performing a Phase I ESA in accordance with the American Society for Testing and Materials (ASTM) E 1527-05, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process (ASTM E 1527-05) satisfies the all appropriate inquiry requirement.

The objective of a Phase I ESA is to identify *recognized environmental conditions*, which are defined as the presence or likely presence of hazardous substances[2] or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, groundwater, or surface water of the property.

1.2 Scope of Services

As described in its proposal, dated April 3, 2008, Belt Collins performed the following:

- Purchased and reviewed a commercial regulatory database search report for the Property that summarizes information available on standard Federal and State government databases for indications of the presence of hazardous substances or petroleum products on the Property or on nearby parcels from which those substances might migrate to the Property in other than vapor form. The review included sites located within minimum search distances outlined in ASTM E 1527-05.
- Performed a site reconnaissance of the Property and vicinity, by vehicle and on foot, to observe existing conditions for visual and/or physical evidence indicating *recognized environmental conditions.*
- Interviewed appropriate persons associated with the Property.
- Prepared this Phase I ESA report, which contains observations and conclusions relating to the apparent environmental conditions of the Property. This report contains Belt

[2] Hazardous substances generally include those regulated as Resource Conservation and Recovery Act (RCRA) hazardous wastes, hazardous air pollutants under the Clean Air Act (CAA), imminently hazardous chemical substances under the Toxic Substances Control Act (TSCA), and toxic pollutants under the Clean Water Act (CWA), as well as those substances specifically listed in 40 Code of Federal Regulations (CFR) Part 302.

Collins' professional opinion as to whether visual and historical evidence indicates the presence of *recognized environmental conditions* in connection with the Property and defines limitations regarding this opinion.

In general, the Scope of Services has been completed in accordance with the scope and limitations of ASTM Standard Practice E1527-05, with the provision that any deletions from the ASTM Standard are discussed in Section 7. A copy of the scope of services has been included as Appendix A.

1.3 Significant Assumptions

In preparing this report, Belt Collins has relied upon certain verbal information and representations provided by government employees and others, documents provided by the Property owner and/or operator, and a computer search of government databases by a firm whose business is to provide that service. Except as discussed, Belt Collins has relied upon that information and did not attempt to independently verify its accuracy or completeness, but did not detect any inconsistency or omission of a nature that might call into question the validity of any of the provided data. To the extent that the conclusions in this report are based in whole or in part on such information, they are contingent on its validity. Belt Collins assumes no responsibility for any consequence arising from information or conditions that were concealed, withheld, misrepresented, or otherwise not fully disclosed or available to Belt Collins.

1.4 Limitations and Exceptions

Phase I ESAs are limited in scope and no Phase I ESA can wholly eliminate uncertainty regarding the potential for *recognized environmental conditions* in connection with a property.

Observations of the Property and adjoining properties[3] were limited to those areas that were readily accessible during the site reconnaissance. Conditions existed at the Property that imposed limitations on visual or physical observations of the Property, such as: areas where steepness of slope and roughness of terrain prevented visual or physical observation, areas of dense vegetation that prevented access or observation, and piles of soil and rock that prevented observation of the underlying ground.

Environmental issues or conditions that are outside the scope of the ASTM E 1527-05 practice, but which may be assessed in connection with commercial real estate, were not evaluated. For example, no sampling of building materials, air, soil, or water was performed as part of this Phase I ESA. Non-scope considerations, identified in ASTM E 1527-05, that are beyond the scope of this practice but may be considered by parties to a commercial real estate transaction include:

- asbestos-containing material,
- mold,
- radon,

[3] As defined by ASTM E 1527-05, an adjoining property is any property the border of which is contiguous or partially contiguous with that of the Property, or that would be contiguous or partially contiguous with the Property but for a street, road, or other public thoroughfare separating them.

- lead in drinking water,
- lead-based paint,
- wetlands,
- regulatory compliance,
- cultural and historic resources,
- industrial hygiene,
- health and safety,
- ecological resources,
- endangered species,
- biological agents,
- high voltage power lines,
- indoor air quality,
- vapor intrusion,
- air emissions, and
- munitions and unexploded ordnance.

Within the limitations of the agreed-upon Scope of Services, this ESA has been undertaken and performed in a professional manner, in accordance with generally accepted practices, using the degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, express or implied, is made.

1.5 User Reliance

This Phase I ESA is intended for the sole use of HHFDC (the user) and their legal counsel for the Property indicated. The scope of services performed in execution of this investigation may not be appropriate to satisfy the needs of other users, and any use or reuse of this document or the findings herein is at the sole risk of said user. This Phase I ESA shall not be relied upon by or transferred to any other party without expressed written authorization from Belt Collins.

This Phase I ESA is valid for use as part of the *all appropriate inquiry* process provided the completion date is:

- less than 180 days prior to the date of property acquisition or (for transactions not involving an acquisition) the date of the intended transaction; or
- within one year prior to the date of property acquisition or (for transactions not involving an acquisition) the date of the intended transaction, provided that interviews, searches for recorded environmental cleanup liens, reviews of government records, and site reconnaissance were conducted or updated within 180 days of the date of acquisition or intended transaction.

2 USER PROVIDED INFORMATION

Phase I ESAs should include a review of reasonably ascertainable helpful documents. The following documents for the Property were provided by the User to Belt Collins:

- PBR HAWAII. February 1990. *Lahaina Master Planned Project Final Environmental Impact Statement.*

- International Archaeological Research Institute, Inc. October 1997. *Archaeological Inventory Survey Report, Pioneer Mill Company, Ltd. Sugar Enterprise Lands, Site No. 50-50-03-4420, Villages of Leiali'i Project, Lahaina, Maui, Hawai'i.*
- International Archaeological Research Institute, Inc. December 1998. *HABS/HAER Level 2 Documentation of Irrigation Features at Villages of Leiali'i, Wahikuli Ahupua'a, Lahaina District, Maui, Hawaii (TMK: 4-5-21:3,18-20,22).*
- Munekiyo & Hiraga, Inc. January 2008. *Draft Environmental Assessment, Proposed Lahaina Wastewater Pump Station No. 1 Modifications (TMK 4-4-002:029 and 033).*
- Paul H. Rosendahl, Ph.D., Inc. (PHRI). January 3, 2008. Facsimile Memo to Stan Fujimoto from Leonard Kubo (PHRI).

3 SITE DESCRIPTION

3.1 Location and Legal Description of the Property

The Property consists of approximately 1,033 acres of land currently owned by the HHFDC and the State of Hawaii which include TMKs 4-5-021: parcels 003, 004 (portion), 005 (portion), 013, 021, 022 (portion), and 4-5-028: parcel 070, located in the Wahikuli area of Lahaina, Maui. The Property is north and east of Lahaina Town and the Kelawea subdivision and upslope of the Lahaina Civic Center and Wahikuli subdivision. For the purposes of this Phase I ESA, the Property boundaries were determined by a review of TMKs and maps provided to Belt Collins by HHFDC. A map of the Property is provided as Figure 1.

3.2 Property Infrastructure

The Property is accessed by several unpaved roads and trails. The main access point in the southwestern part of the Property is gated with several locks. No sewer, cable, or telephone infrastructure is present on the site. Overhead electricity is provided by Maui Electric Company (MECO). A series of underground pipes bring water from the higher elevations to irrigation ditches which run through the Property. Wahikuli Ditch, Reservoir Ditch, and a portion of the Honokohau Ditch run north to south across the Property. Pu'u Laina, an old volcanic cone containing the Crater Reservoir, is located in the southeast quadrant of the Property. An electrical junction station sits atop of Pu'u Laina.

Historic structures on the Property, related to former Pioneer Mill operations, include a water tank, reservoirs, generator building (hydroelectric plant) and junction points, pumps, sections of an irrigation system, bridges, roads, sugar cane fields, and an airstrip. The irrigation structures include portions of Honokohau and Wahikuli Ditches. There are booster pumps, holding ponds, a stone cistern (with stone walls and a roof), and siphon pipes associated with the irrigation ditches. The siphon pipes replaced the now rapidly deteriorating wooden flumes that were used to carry water across gulches. The valves and pipes of the existing drip irrigation hoses and

Wahikuli and Crater Reservoir are also part of the system.[4] Another walled structure built into the ground with no roof was also noted on the Property.

3.3 Topography and Drainage

Regional topography generally slopes west, towards the coast, and the topography of the Property follows this general westerly gradient. The site elevations range from approximately 40 to 120 feet above mean sea level (msl) at the Property's western (seaward) boundary to approximately 600 to 840 feet msl along the eastern (inland) boundary. While the direction of surface drainage within the Property may vary due to areas of grading and fill, surface drainage in the area appears to generally follow the topographic gradient. A 100- and 500-year flood channel, connecting to Kahoma Stream, exists adjacent to the southern boundary of the property. The channel is listed as Zone A, which according to the Federal Emergency Management Agency (FEMA), is the flood insurance rate zone that corresponds to the 1-percent annual chance floodplains that are determined in the Flood Insurance Study by approximate methods of analysis.

3.4 Subsurface Conditions

3.4.1 Geology and Soils

The Property is located on the western slope of the West Maui Mountains, which are derived from volcanic eruption of the West Maui Volcano and subsequent erosion that created the deep valleys and incisions found today. The majority of the soils at the Property are from the Lahaina Series and the Wahikuli Series. These soils are generally well drained and developed from weathered basic igneous basalt. They are described as silty clay or stony silty clay and are typically used for sugarcane and pineapple cultivation. Smaller portions of the property are designated as Rock Land (areas where exposed andesite and basalt rock covers 25 to 90 percent of the land) and Rough Broken and Stony Land (very steep stony gulches).[5]

3.4.2 Groundwater

Groundwater resources beneath the Property belong to the Honolua aquifer system and the Honokowai aquifer system of the Lahaina aquifer sector. This aquifer type is characterized as basal (fresh water in contact with seawater) and unconfined (water table is the upper surface of the saturated aquifer) and occurs in flank deposits (horizontally extensive lavas).[6] The aquifer is fresh (less than 250 milligrams per liter chloride), is listed as having a current utility for drinking water, and is identified as irreplaceable with a high vulnerability to contamination.

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[4] International Archaeological Research Institute, Inc. October 1997. Archaeological Inventory Survey Report, Pioneer Mill Company, Ltd. Sugar Enterprise Lands, Site No. 50-50-03-4420, Villages of Leiali'i Project, Lahaina, Maui, Hawaii.

[5] U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil Survey of Islands of Kauai, Oahu, Molokai, and Lanai, State of Hawaii.

[6] Mink and Lau. 1990. Aquifer Identification and Classification for Maui: Groundwater Protection Strategy for Hawai'i Technical Report No. 185.

Depth to groundwater and direction of groundwater flow beneath the Property is not definitively known. Characterization would require subsurface exploration, installation of groundwater monitoring wells, and surveys of groundwater elevations. In the Hawaiian islands, groundwater flow is generally from the mountains towards the ocean; however, localized flow direction may vary from this pattern as a result of heterogeneous subsurface conditions in the vicinity of the Property.

The majority of the Property is inland of the Department of Health (DOH) established Underground Injection Control (UIC) line (the western Property boundary is located approximately 600 to 1,200 feet seaward of the UIC line). The UIC program was established to protect the quality of underground sources of drinking water from pollution by subsurface disposal of fluids.[7] The UIC line is the boundary between non-drinking water aquifers (generally seaward of the UIC line) and underground sources of drinking water (generally inland of the UIC line).

Review of the UIC map indicates that there are no actively used supply or injection wells on the Property. The nearest drinking water wells are located approximately 2,200 and 2,500 feet east of the southeastern portion of the Property, up gradient of the Property.[8] One well listed as "other" (non-potable and non-injection) is located south of Crater Reservoir adjacent to the southeastern Property boundary, and two wells listed as "other" are located in the gulches adjacent to the northernmost Property boundary.

3.5 Current Use of the Property

The Property is zoned for agricultural use. Currently, the Property is vacant.

3.6 Current Uses of the Adjoining Properties

Adjoining property uses are as follows:

- A residential community and undeveloped land border the western boundary of the Property across an unpaved cane haul road.
- Agricultural land and Hanakea Gulch border the northern boundary of the Property.
- Agricultural land and Wahikuli Reservoir border the eastern boundary of the Property.
- An industrial/commercial area, Kahoma Stream Gulch, and a residential subdivision border the south and southwestern boundaries of the property.

4 RECORDS REVIEW

4.1 Federal and State Database Review

To obtain information concerning possible releases of hazardous substances and/or petroleum products to the ground, groundwater, or surface water at or near the Property, Belt Collins

[7] Hawaii Administrative Rules, Title 11, Chapter 23. *Underground Injection* Control. November 12, 1992.

[8] State of Hawai'i Underground Injection Control Program Map. 1984. *Island of Maui, Lahaina Quadrangle.*

reviewed appropriate Federal and State regulatory lists. This review was primarily completed through purchase and review of a commercial regulatory database search report (EDR). The EDR report, *EDR DataMap ® Area Study*, is attached as Appendix B.[9] Lists were reviewed for incidents and releases listed at the Property and at sites within ASTM-minimum search distances (Table 1).[10]

Table 1: ASTM Standard Environmental Record Sources and Minimum Search Distances

Environmental Record Sources*	ASTM Minimum Search Distances (miles)
Federal NPL	1.0
Federal CERCLIS site list	0.5
Federal CERCLIS NFRAP site list	Property and adjoining properties
Federal RCRIS CORRACTS facilities list	1.0
Federal RCRA non-CORRACTS TSD facilities list	0.5
Federal RCRA generators list	Property and adjoining properties
Federal ERNS list	Property only
State hazardous waste sites – State NPL equivalent	1.0
State hazardous waste sites – State CERCLIS equivalent	0.5
State landfill and/or solid waste disposal site lists	0.5
State LUST list	0.5
State registered UST list	Property and adjoining properties

*Acronyms are defined in the sections below.

4.1.1 Federal NPL

The National Priorities List (NPL), accessed April 30, 2008, includes sites that have the highest priority for cleanup under the United States Environmental Protection Agency (EPA) Hazard Ranking System. The EDR report identifies no NPL sites within 1.0 mile of the Property.

4.1.2 Federal CERCLIS List

The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) list, accessed April 8, 2008, identifies sites that the EPA has investigated or is currently investigating under the Federal Superfund program for potential hazardous material contamination and for possible inclusion on the NPL. The EDR report identified one site as being within 0.5 mile of the Property:

1) Pioneer Mill Company, Ltd., 380 Lahainaluna Road, Lahaina, HI. The action is listed as combined preliminary assessment/site inspection. This site is listed as No Further

[9] Environmental Data Resources (EDR). April 23, 2008. The EDR DataMap®Area Study, Villages of Leiali'i Phases A and B, Lahaina, Hawaii.

[10] ASTM E 1527-05. 2005. Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process. ASTM International, West Conshohocken.

Remedial Action Planned (NFRAP) but has not yet been reclassified as such in the CERCLIS NFRAP database.

Release of petroleum or hazardous substances from this facility would be unlikely to adversely impact the Property as the site is topographically cross-gradient from the Property.

4.1.3 Federal CERCLIS NFRAP Site List

The CERCLIS NFRAP site list, accessed December 3, 2007, includes sites that the EPA has reclassified as part of the EPA Brownfields Redevelopment Program. These former CERCLIS sites have been delisted from the CERCLIS list because a lack of significant contamination was found. The EDR report identifies no CERCLIS-NFRAP sites on the Property or adjoining properties.

4.1.4 Federal RCRIS CORRACTS Facilities List

The Resource Conservation and Recovery Information System (RCRIS) Corrective Action Sites (CORRACTS) list, accessed March 26, 2008, includes sites that are registered Resource Conservation and Recovery Act (RCRA) hazardous waste generators, transporters, or treatment/storage/disposal (TSD) facilities (including incinerators) with reported corrective action. The EDR report identifies no RCRIS CORRACTS sites within 1.0 mile of the Property.

4.1.5 Federal RCRA Non-CORRACTS TSD Facilities List

The RCRA Non-Corrective Action Sites (RCRA Non-CORRACTS) list, accessed March 6, 2008, includes sites that are registered RCRA hazardous waste TSD facilities (including incinerators). The EDR report identifies no RCRA Non-CORRACTS TSD facilities within 0.5 mile of the Property.

4.1.6 Federal RCRA Generator List

The RCRA generator list, accessed March 6, 2008, identifies facilities that are registered RCRA hazardous waste generators. The EDR report identifies no registered RCRA hazardous waste generators on the Property. The EDR report identifies one small quantity generator (SQG) on adjoining properties:

1) Pioneer Mill Company, Ltd., 380 Lahainaluna Road, Lahaina, HI. Two violations were reported: 1) used oil – generators and 2) generators – general. No additional information was reported.

Release of petroleum or hazardous substances from this facility would be unlikely to adversely impact the Property as the site is topographically cross-gradient from the Property.

4.1.7 Federal ERNS List

The Emergency Response Notification System (ERNS) list, accessed December 31, 2007, is a national database for releases of oil and hazardous substances. The ERNS represents a cooperative effort among EPA Headquarters, the Department of Transportation, the National Transportation Systems Center, the ten EPA Regions, the United States Coast Guard, and the National Response Center. The EDR report indicates no ERNS incidents for the Property.

4.1.8 State Hazardous Waste Sites – State NPL Equivalent

The State of Hawai'i does not have a NPL equivalent site list at this time; therefore, the Federal NPL is used (see Section 3.1.1).

4.1.9 State Hazardous Waste Sites (SHWS) – State CERCLIS Equivalent

The State of Hawai'i DOH Sites List, accessed April 4, 2008, was reviewed for facilities, sites, or areas in which the DOH HEER Office has an interest, has investigated, or may investigate. A hazard ranking system is used to list sites; however, inclusion of a site on this list does not necessarily mean it will be included as a Federal CERCLIS or NPL site. Three SHWS site were identified within 0.5 mile of the Property:

1) Lahaina Cannery Mall, 1221 Honoapi'ilani Highway, Lahaina, HI. A small amount of diesel fuel was detected during the excavation of a temporary monitoring well. The status is listed as having a No Further Action letter on file.
2) Pioneer Mill Company, Ltd., 380 Lahainaluna Road, Lahaina, HI. Diesel fuel over spilling was noticed during UST excavation. Approximately 25 cubic yards of soil was excavated and removed from the site. The site status is listed as ongoing.
3) Codac's Chevron Gasoline Station (Lahaina Chevron), 240 Papalaua Street, Lahaina, HI. A release of hydraulic oil was observed during removal of two hoists. The status is listed as having a No Further Action letter on file.

Release of petroleum or hazardous substances from these facilities would be unlikely to adversely impact the Property as the sites are located topographically down gradient or cross-gradient from the Property.

In addition, one orphan site, the Lahaina Waste Water Pump Station #4 (located on Ala Moana Street in Lahaina, within 0.5 miles southwest and down gradient of the Property), was listed on the SHWS. The status is listed as having a completed No Further Action letter on file. Release of petroleum or hazardous substances from this facility would be unlikely to adversely impact the Property as the site is located topographically down gradient from the Property.

4.1.10 State Landfill and/or Solid Waste Disposal Sites List

The DOH list of permitted landfills in Hawai'i, accessed May 19, 2004, is an inventory of solid waste disposal facilities or landfills. The EDR report identifies no permitted solid waste disposal sites or landfills within 0.5 mile of the Property.

4.1.11 State Leaking Underground Storage Tanks (LUST) List

The DOH LUST list, accessed June 30, 2008, is a comprehensive listing of LUSTs that have been reported to the State of Hawai'i. Four LUST sites were identified within 0.5 mile of the Property:

1) Shell Station, 711 Mill Street AKA 281 Dickenson Street, Lahaina, HI. The facility is listed as Site Cleanup Completed/No Further Action.
2) Codac's Sales & Service, 240 Papalaua Street, Lahaina, HI. The facility is listed as Site Cleanup Completed/No Further Action.
3) Mid Pac Petroleum, 243 Lahainaluna Road, Lahaina, HI. The facility is listed as LUST Cleanup Initiated; Petroleum.

4) Shell Station, 263 Lahaianluna Road, Lahaina, HI. The site is listed as LUST Cleanup Initiated: Petroleum.

Release of petroleum or hazardous substances from these facilities would be unlikely to adversely impact the Property as the sites are approximately 0.5 mile in distance and topographically cross-gradient from the Property.

4.1.12 State Registered Underground Storage Tank (UST) List

The State UST list, accessed June 30, 2008, is a comprehensive listing of USTs regulated under Subtitle I of RCRA. The EDR report identifies eight registered USTs within 0.5 mile of the Property:

1) Makila Radio Station, Front Street and Honoapi'ilani Highway, Lahaina, HI.
2) West Maui Shell, 70 Kapunakea Street, Lahaina, HI.
3) Maui Blocks, Waikapu-Off Honoapi'ilani Hwy
4) Lahainaluna High School, Lahainaluna Road, Lahaina, HI.
5) Pioneer Mill Co., Ltd, 380 Lahainaluna Road, Lahaina, HI.
6) Shell Station, 711 Mill Street AKA 281 Dickenson Street, Lahaina, HI.
7) Codac's Sales & Service, 240 Papalaua Street, Lahaina, HI.
8) Mid Pac Petroleum, 243 Lahainaluna Road, Lahaina, HI.

Release of petroleum or hazardous substances from these facilities would be unlikely to adversely impact the Property as the sites are located topographically down gradient or cross-gradient from the Property.

4.1.13 Other Sites of Interest

The **SPILLS Database**, accessed April 4, 2008, lists releases of hazardous substances to the environment that have been reported to the HEER Office since 1988. The EDR database identified three SPILLS sites within 0.5 mile of the Property:

1) Lahaina Cannery Mall, 1221 Honoapi'ilani Highway, Lahaina, HI. A small amount of diesel fuel was detected during the excavation of a temporary monitoring well. The status is listed as having a No Further Action letter on file, and the facility is listed as available for unrestricted use in the Hawaii Institutional Control database.
2) Pioneer Mill Company, Ltd., 380 Lahainaluna Road, Lahaina, HI. Diesel fuel over spilling was noticed during the UST excavation. Approximately 25 cubic yards of soil was excavated and removed from the site. The overall status of the facility is ongoing. The facility is listed as available for unrestricted use in the Hawaii Institutional Control database.
3) Codac's Chevron Gasoline Station (Lahaina Chevron), 240 Papalaua Street, Lahaina, HI. A release of hydraulic oil was observed during the removal of two hoists. The status is listed as having a No Further Action letter on file, and the facility is listed as available for unrestricted use in the Hawaii Institutional Control database.

Release of petroleum or hazardous substances from these facilities would be unlikely to adversely impact the Property as the sites are either topographically down gradient or cross-gradient from the Property.

The **Polychlorinated Biphenyls (PCB) Activity Database**, accessed December 4, 2007, indentifies generators, transporters, commercial storers and/or brokers and disposers of PCBs who are required to notify the EPA of such activities. One site was listed in the EDR database:

1) Pioneer Mill Company, Ltd., 380 Lahainaluna Road, Lahaina, HI.

The **FINDS (Facility Index System)** list accessed April 3, 2008, contains both facility information and "pointers" to other sources that contain more detail. These include RCRIS (associated with permit compliance, aerometric information, civil judicial enforcement cases, UIC, criminal enforcement actions, Federal facilities information, State environmental laws and statutes, and PCB activity systems. The FINDS database may contain references to other databases and may contain out of date records formerly associated with a site. The EDR report identifies three FINDS sites within the area of the Property:

1) Masao Aotaki, 1462 Fleming Road, Lahaina, HI.
2) Pioneer Mill Co., LTD, 380 Lahainaluna Road, Lahaina, HI.
3) Shell Station, 263 Lahainaluna Road, Lahaina, HI.

The Masao Aotaki site was listed on the FINDS system as containing other pertinent environmental activity identified at the site which identified the Hawaii UST database. The DOH UST database was reviewed and the information indicated that a UST of unknown size was located at the private residence. A letter from Inter-Island Environmental Services (IES), Inc, to the DOH UST branch, stated that the removal of one UST tank from the property would take place between January 25 and February 4, 1997. A response was submitted by DOH UST indicating the requirements for presently closing a UST tank and the final notification of the UST closure. Mr. Josh Nagashima at the DOH UST branch stated that a UST closure report had not been received from IES and that the size or contents of the tank was listed as unknown.[11] The identified residence is located to the west, down-gradient from the Property, south of Wahikuli Road (IES Letter Dated January 17, 1997 and the DOH UST letter dated February 4, 1997 are included in Appendix C).

The **FTTS (Federal Insecticide, Fungicide, and Rodenticide Act [FIFRA]/Toxic Substances Control Act [TSCA]) List**, accessed April 11, 2008, tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA, and EPCRA (Emergency Planning and Community Right-to-Know Act). HIST FTTS tracks older records that are no longer being updated. One site is listed on both databases:

1) Pioneer Mill Company, Ltd., 380 Lahainaluna Road, Lahaina, HI. Both databases indicated the same violation (disposal; environmental release, PCB item in use) for the same date (March 9, 1992). The facility was fined $5,000.

The **INST CONTROL** (Sites with institutional control), accessed, April 4, 2008, includes those sites that have been documented as voluntary remediation programs and Brownfields sites with institutional controls in place. Institutional controls are often implemented to prevent or control exposures to residual contamination at Brownfields and voluntary remediation program sites. They are designed to ensure that the post-remediation use of the affected property is

[11] Personal Communication with J.Nagashima of DOH UST Branch August 13, 2008.

compatible with the level of cleanup. The State of Hawaii DOH records the INST CONTROL sites. The EDR report identifies three sites with INST CONTROLs:

1) Lahaina Cannery Mall. 1221 Honoapi'ilani Hwy, Lahaina, HI.
2) Pioneer Mill Co. LTD. 380 Lahainaluna Road, Lahaina, HI.
3) Codac's Chevron Gasoline Station (Lahaina Chevron), 240 Papalaua Street, Lahaina, HI

All three sites have been listed available for unrestricted use by the State of Hawaii.

4.1.14 Orphan Sites

Orphan sites are those sites that are in the vicinity of the Property but are not precisely locatable from the address information in the databases.

Seventeen orphan sites were listed in the EDR database orphan summary report. Based on a review of the listed addresses, 15 of the 17 sites are located more than 0.5 mile from the Property, including the Old Pioneer Mill transformer sites. One of the sites within 0.5 miles of the Property, the Lahaina Waste Water Pump Station #4, is described under the State SHWS list in Section 4.1.9, above. The other site, Villages of Leiali'i Phase IA (adjacent to and on the west side of the Property) were on EPA's Facility Index System (FINDS) list because they held National Pollutant Discharge Elimination System (NPDES) permits. None of the orphan sites were deemed likely to have an existing release, past release, or material threat of a release of hazardous substances or petroleum products onto the Property.

4.2 Historical Use Information on the Property and Adjoining Properties

Pioneer Mill Company was established in the 1800s. Between 1885 and 1895, the company changed hands three times, but at the end of the decade, C. F. Homer and Paul Isenberg had incorporated it as the Pioneer Mill Company, Ltd. under the laws of the Hawaiian Kingdom. Pioneer's agent was H. Hackfeld & Co. In 1918, Hackfeld & Co. was succeeded by American Factors, Ltd.[12] The American Factors name was changed to Amfac Inc. in 1966; Amfac was taken over by JMB Realty Corporation in 1988 and became Amfac/JMB Hawaii Inc. and then Amfac/JMB Hawaii L.L.C. in 1998.[13]

The environmental lien search report (Appendix B) prepared for the Property dates back to 1942, and indicates the Property was owned by the Territory of Hawai'i and leased to the Pioneer Mill Company Ltd. The quarry present in the southeast part of the Property is first mentioned in 1947 with a lease to David Fleming for quarrying on Laina Hill. The tank site, garbage dump site and Honolohau Ditch are mentioned in a 1949 tax route slip. A tax map branch history sheet from 1959 discussed a cinder pit site.[14]

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[12] International Archaeological Research Institute, Inc. December 1998. HABS/HAER Level 2 Documentation of Irrigation Features at Villages of Leiali'i, Wahikuli Ahupua'a, Lahaina District, Maui, (TMK: 4-5-21:3,18-20,22).

[13] Answers.com Business and Finance. *Company History: Amfac/JMB Hawaii LLC.* <http://www.answers.com/topic/amfac-jmb-hawaii-l-l-c?cat=biz-fin> (accessed on May 12, 2008).

[14] EDR. May 5, 2008. The EDR Environmental Lien Search Report, Villages of Leialii Phases A and B, Lahaina, Hawaii.

According to the County of Maui Real Property Assessment Division Parcel History, the note to Pioneer Mill Company expired on February 24, 1994, and was reissued to HHFDC on November 4, 1994.[15] Pioneer Mill continued operations until the time of its closure in 1999.[16]

Additional historical use information for the Property and adjoining properties was obtained through review of historical topographic maps, aerial photos, environmental lien data, and a search of fire insurance maps. The results of these document reviews are presented in this section.

4.2.1 Historical Topographic Maps and Aerial Photographs

Belt Collins reviewed United States Geological Survey (USGS) topographic maps and aerial photographs for topographic, cultural, and land use changes within the area that may have affected site conditions. Table 2 presents the results of this review.

Table 2: Results of Map and Aerial Photograph Review

Date(s) and Source	Reference/Scale	Property Description
1950 University of Hawai'i at Manoa Hamilton Library - Map Collection	USGS Aerial Photograph GSMF-3-36 No Scale Black and White	**Property**: The Property appears to be agricultural land. It appears that light or unimproved roads and trails cross run throughout the Property. Pu'u Laina, an old volcanic cone containing Crater Reservoir, is visible in the southeast of the Property, as is a portion of Wahikuli Reservoir. Several irrigation ditches (Wahikuli, Reservoir, and Honokohau) run north to south across the Property. **Adjoining properties**: Adjacent properties to the north and east appear agricultural. Hanakea Gulch is visible parallel to the northeastern portion of the Property and Kahoma Stream Gulch is visible adjacent to the southern Property boundary. A small residential area (Crater Village) is located east of Wahikuli Reservoir. There is light residential and undeveloped/agricultural use land to the west. A water tank is located just inside the western Property boundary but is excluded from this assessment. A slightly denser residential area is located southwest of the Property. A pineapple cannery, mill stack and wharf are also located to the southwest. Lahaina Town is located south of the Property. It appears that a low density residential and commercial area is

[15] County of Maui Real Property Assessment Division. May 7, 2008. Maui County Parcel History (TT102) for TMK: 4-5-021-003-0000.

[16] University of Hawai'i at Manoa College of Social Science Center for Oral History. *Pioneer Mill Company: A Maui Sugar Plantation Legacy.* <http://www.oralhistory.hawaii.edu/pages/community/pioneer.html> (accessed on May 7, 2008).

Date(s) and Source	Reference/Scale	Property Description
		located southwest of the Property.
1956 University of Hawai'i at Manoa Hamilton Library - Map Collection	USGS Topographic Map Lahaina, HI Quadrangle Scale: 1:24,000	**Property:** Light duty roads and trails cross the Property. Three light duty roads cross the Property. The first road runs east to west across the center of the Property, the second runs north to south across the northeast of the Property, and the third runs north to south across part of the western side of the Property before continuing along the western Property boundary. A grid of unimproved roads runs throughout the Property. Two cisterns are located in the southwest corner of the Property. A quarry is located at Pu'u Laina. **Adjoining properties:** The area southeast of the Property consists of Lahainaluna High School, a power plant, and a low density residential area. Several cisterns are located south-southeast of the Property. A mill is shown south of the Property.
1965 University of Hawai'i at Manoa Hamilton Library - Map Collection	US Department of Agriculture Aerial Photograph EKN-1CC-81 No Scale Black and White	**Property**: No significant changes to the Property. **Adjoining properties**: The density of the residential communities west and south of the Property has increased.
1976 University of Hawai'i at Manoa Hamilton Library - Map Collection	USGS Aerial Photograph VEED00000003-180 No Scale Black and White	**Property**: No significant changes to the Property. **Adjoining properties**: A water tank is visible adjacent to the light road that crosses mid-Property. The small parcel containing the tank is not included in this assessment. Residential areas previously near Wahikuli Reservoir are no longer visible. Some commercial development is visible southwest of the Property.
1983 University of Hawai'i at Manoa Hamilton Library - Map Collection	USGS Topographic Map Lahaina, HI Quadrangle Scale: 1:24,000	**Property**: The cisterns in the southwest corner of the Property are no longer shown. **Adjoining properties**: A fire station and the Lahaina Civic and Recreation Center are shown west of the Property. Areas to the west and south continue to increase in building density. A water tank, cisterns, and a gauging station are shown to the south.
1992 University of Hawai'i at Manoa Hamilton Library - Map	USGS Topographic Map Lahaina, HI Quadrangle Scale: 1:24,000	**Property**: A borrow pit has been added south of Crater Reservoir. **Adjoining Properties**: Residential and commercial areas to the south continue to

Date(s) and Source	Reference/Scale	Property Description
Collection		expand. The cannery has been converted to a shopping mall.
2000 University of Hawai'i at Manoa Hamilton Library - Map Collection	National Oceanic and Atmospheric Administration Aerial Photograph No Scale Color	**Property**: Only a portion of the Property is visible. No significant changes are visible on the portion shown. **Adjoining properties**: A channel to the ocean (possibly a continuation of Kahoma Stream Gulch) is clearly defined with no overgrowth. Residential and commercial density continues to increase to the east and south.
2008 ©2007 Google™ Earth Pro	©2008 Tele Atlas Image ©2008 DigitalGlobe No Scale Color	**Property**: No significant changed to the Property. **Adjoining properties**: An industrial/commercial area with warehouses is visible south-southeast of the Property boundary.

Historical Summary: According to review of the historical maps, the Property land use has been agricultural. Surrounding areas, particularly to the east and south, have shown increases in residential and commercial densities. The historical maps are included as Appendix C.

4.2.2 Fire Insurance Maps

Fire insurance maps can provide information regarding past land uses and potential hazardous materials that may have been stored on a property. A search for Sanborn® Fire Insurance Maps did not identify coverage for the Property.[17] The Sanborn® map report from EDR is provided in Appendix B.

4.2.3 Environmental Lien Report

An environmental lien is described as a charge, security, or encumbrance upon title to a property to secure the payment of a cost, damage, debt, obligation, or duty arising out of response actions cleanup, or other remediation of hazardous substances or petroleum products upon a property, including (but not limited to) liens imposed pursuant to CERCLA 42 United States Code 9607(1) and similar state or local laws.[18] No environmental lien or other activity and use limitations were identified for the Property.[19] The EDR Environmental Lien Search Report is provided in Appendix B.

[17] EDR. April 22, 2008. Certified Sanborn® Map Report, Villages of Leialii Phases A and B, Lahaina, Hawaii.

[18] ASTM E 1527-05. 2005. Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process. ASTM International, West Conshohocken.

[19] EDR. May 5, 2008. The EDR Environmental Lien Search Report, Villages of Leialii Phases A and B, Lahaina, Hawaii.

5 SITE RECONNAISSANCE AND INTERVIEWS

On May 28 and 29, 2008, Belt Collins conducted a site reconnaissance of the Property to observe for visual and/or physical evidence indicating the presence of *RECs* in connection with the Property.

5.1 Methodology and Limiting Conditions

In accordance with ASTM E 1527-05, the objective of the site reconnaissance was to visually and/or physically observe conditions that may indicate the likelihood of *RECs* in connection with the Property. The site reconnaissance consisted of observing accessible portions of the Property. The site reconnaissance of the Property was performed by vehicle and on foot.

5.2 Interviews

Interview forms and questionnaires are provided in Appendix D.

5.2.1 Interview with Owner(s)

Mr. Stan S. Fujimoto, HHFDC Project Manager, listed current and historical owners and occupants of the Property and described HHFDC's use of the Property. Mr. Fujimoto provided responses to the Phase I ESA Questionnaire. He was not aware of any significant environmental concern on or near the Property, or hazardous substances or petroleum products stored or used on the Property. He was not aware of any spills or chemical releases that have taken place at the Property or of any environmental cleanups that have taken place at the Property. Mr. Fujimoto was not aware of any environmental liens against the Property or of any activity and land use limitations that are in place at the Property. He has no specialized knowledge of the Property or nearby properties, and believes that the price paid for the Property reasonably reflects the fair market value of the Property.

5.2.2 Interviews with Occupants

Mr. Larry Pacheco, land agent for the current owner and past tenant Mr. Leslie Lau, who occupied the Property from March 1989 to February 2007, provided responses to the Phase I ESA Questionnaire. Mr. Pacheco is aware of the use of fertilizers and weed control products by the previous tenant. Mr. Pacheco is not aware of any spills or releases of hazardous substances or petroleum products; environmental cleanups; pending, threatened, or past notices of violation; potential environmental hazards; environmental liens against the Property; or of any activity and land use limitations that are in place at the Property. He has no specialized knowledge of the Property or nearby properties.

Mr. Howard Hanzawa of Kaanapali Land Management provided responses to the Phase I ESA Questionnaire. Mr. Hanzawa is aware of the use of fuel for harvesting and planting equipment, and a brush fire on the Property in 2007. Mr. Hanzawa is not aware of any spills or releases of hazardous substances or petroleum products; environmental cleanups; pending, threatened, or past notices of violation; potential environmental hazards; environmental liens against the Property; or of any activity and land use limitations that are in place at the Property. He has no specialized knowledge of the Property or nearby properties.

Mr. Robbie Vorfeld of Kaanapali Land Management answered questions in a telephone interview with Belt Collins on July 22, 2008. Mr. Vorfeld was not aware of any spills or chemical

releases that have taken place at the Property or of any environmental cleanups that have taken place at the Property other than those mentioned herein.

Mr. Lenny Tehada, Coffee Farm Manager for adjacent agricultural lands, provided responses to the Phase I ESA Questionnaire. Mr. Tehada was not aware of any spills or chemical releases that have taken place at the Property or of any environmental cleanups that have taken place at the Property other than those mentioned herein.

5.2.3 Interviews with Local Government Officials

A letter was sent on April 18, 2008, from Belt Collins to the Battalion Chief's Office at the Maui County Department of Fire and Public Safety requesting information on any incident of an environmental nature on or near the Property that may have adversely impacted the soil or groundwater. However, no response to this request was received.

A written request for government records was submitted to the DOH, HEER office by Belt Collins on April 17, 2008. No records were found for the Property. However, records were reviewed for the nearby Pioneer Mill Company. For this facility, a Preliminary Assessment/Site Investigation Report (PA/SI)[20] was reviewed. The mill encompassed 40 acres and areas of concern included petroleum fuels, used oil, sugarcane pulp, wood treatment, milling operations, transformers containing PCBs, boiler facility, storage and mixing of bulk herbicides and pesticides at the mixing plant, spill relating to the herbicide/pesticide mixing. The cleanup of the mill property is complete and the property listed for unrestricted use.

5.2.4 Interviews with Others

Ms. Jessica Milbourn, MECO, indicated that transformers installed before 1980 may contain PCBs.

5.3 Site Reconnaissance of the Property

As required by ASTM E 1527-05, Belt Collins conducted the site reconnaissance to visually and/or physically observe conditions that may indicate the likelihood of *RECs* in connection with the Property. A general description of observations and findings for the Property follow, with existing or potential *RECs* identified.

The Property consists of approximately 1,033 acres of agricultural land. Some structures associated with the former Pioneer Mill Company remain onsite, as well as irrigation features still in use. Additionally, some archaeological features have been observed at the site. These observations are consistent with a review of relevant records described in Section 2.

Current Uses of the Property – The Property currently operates as agricultural land with pineapple and corn cultivation. Visual and physical evidence **did not** indicate current use, treatment, storage, disposal, or generation of hazardous substances or petroleum products on the Property. No containers of pesticides or fertilizers were observed in use. However, as the

[20] Weston Solutions, Inc. February 2004. Preliminary Assessment/Site Investigation Report, Pioneer Mill, Lahaina, Maui, Hawaii. Walnut Creek, California.

Property is currently cultivated, fertilizers and pesticides are known to be used. These items are not stored on the Property.

Past Uses of the Property – The Property has served as agricultural land since the late 1800s. The majority of the land was used for sugar cultivation with some pineapple cultivation. Visual and physical evidence **did not** indicate past use, treatment, storage, disposal, or generation of hazardous substances or petroleum products on the Property. Refer to the *Storage Tanks* section below for additional information.

- A concrete fertilizer loading station is located in the center of the Property. According to Mr. Robbie Vorfeld, the Agricultural Superintendent with Kaanapali Land Management (KLM), the loading stations has not been used since the pineapple fields were abandoned in that area.
- According to a newspaper published by Pioneer Mill in the 1970s, 9,340 acres of land were under cultivation, and 7,000 tons of fertilizer and 910 tons of chemicals to control weeds were used annually. No information about the specific chemical makeup of the fertilizer and weed control was available. In general, herbicides and pesticides application is common for agricultural land. If herbicides and pesticides are applied according to the labeled instructions, it is not considered a release and does not qualify as a *REC*.

Hazardous Substances and Petroleum Products in Connection with Identified Uses – Visual and physical evidence **did not** indicate the presence of hazardous substances or petroleum products in connection with identified uses on the Property.

Hazardous Substances and Petroleum Products Not Necessarily in Connection with Identified Uses – Visual and physical evidence **did not** indicate the presence of unidentified hazardous substances or petroleum products.

Storage Tanks – Visual and physical evidence **did** indicate the presence of ASTs, USTs, vent pipes, fill pipes, or access ways indicating USTs on the Property.

- Two empty 500-gallon polyethylene aboveground storage tanks (ASTs), one labeled ammonium nitrate, are located on the property but do not appear to be in use. According to current occupants of the Property, ammonium nitrate was added to irrigation water as a fertilizer.
- One empty rusted 300-gallon steel AST on a trailer and an adjacent steel open-topped mixing tank. According to a Kaanapali Land Management employee, the AST was used to store water and the mixing tank was most likely used for herbicide/pesticide mixing.
- Three chlorine stations, each containing one empty shed (one of which is labeled "Poison, Chlorine Gas") and six 100-gallon steel ASTs containing sand used for filtration. The stations serviced the field irrigation systems and domestic potable water. One of the stations is still in operation, although chlorine use for algae control has been discontinued.

Odors – Physical evidence **did not** indicate the presence of strong, pungent, or noxious odors.

Pools of Liquid – Visual and physical evidence **did not** indicate the presence of pools or sumps containing liquids likely to be hazardous substances or petroleum products.

Drums – Drums often hold 55 gallons of liquid, but the ASTM E 1527-05 guidance states that containers as small as 5 gallons should also be described. Visual and physical evidence **did not** indicate the presence of drums or containers of hazardous substances or petroleum products on the Property.

Unidentified Substance Containers – Visual and physical evidence **did not** indicate the presence of unidentified substance containers on the Property.

PCBs – Visual and physical evidence **did** indicate the presence of electrical or hydraulic equipment known or likely to contain PCBs on the Property.

- One rusted pole-mounted transformer located at the top of Pu'u Laina.
- Various substation transformers on bare soil associated with the former hydroelectric plant.

A MECO representative indicated that if the transformers were installed prior to 1980, they may contain PCBs. Registration and/or ownership of the transformers could not be verified. Figure 2 illustrates the approximate locations of the transformers.

Stained Soil or Pavement – Visual and physical evidence **did not** indicate the presence of stained soil or pavement on the Property.

Pits, Ponds, or Lagoons – Visual and physical evidence **did not** indicate the presence of pits, ponds, or lagoons, particularly in connection with waste disposal or waste treatment.

- Although two reservoirs are located on the Property, they are not related to waste disposal or waste treatment.

Stressed Vegetation – Visual and physical evidence **did not** indicate the presence of areas of stressed vegetation from something other than insufficient water or fire.

Solid Waste – Visual and physical evidence **did** indicate the presence of areas apparently filled or graded by non-natural causes (or containing fill of unknown origin) suggesting trash or other solid waste disposal, or mounds or depressions suggesting trash or other solid waste disposal.

- The Lahaina municipal trash dumps and domestic trash scatters[21] are described as historical structures on the Property. The latter were determined to be re-deposits for the maintenance of the Pioneer Mill cane haul road beds.

[21] International Archaeological Research Institute, Inc. October 1997. Archaeological Inventory Survey Report, Pioneer Mill Company, Ltd. Sugar Enterprise Lands, Site No. 50-50-03-4420, Villages of Leiali'i Project, Lahaina, Maui, Hawaii.

Waste Water –Visual and physical evidence **did not** indicate the presence of waste water or other liquid or any discharge into a drain, ditch, or stream on or adjacent to the Property.

Wells – Visual and physical evidence **did not** indicate the presence of potable wells on the Property.

- One well listed as "other" (non-potable and non-injection) on the UIC map is located south of Crater reservoir adjacent to the southeastern Property boundary. The well appears to be associated with Pump M – Kahoma Shaft.

Septic Systems – Visual and physical evidence **did not** indicate the presence of on-site septic systems or cesspools.

Other Items of Concern – Visual and physical evidence **did** indicate the presence of other adverse environmental impacts to the soil and groundwater due to the placement of the various transformers on the ground..

Photographs taken during the Site Reconnaissance on May 28 and 29, 2008 identifying some of the visual observations are included as Appendix E.

5.4 Site Reconnaissance Observations of the Adjoining Properties

Uses of adjoining properties are mostly agricultural land, residential communities, and commercial warehouses. The adjoining properties were visually observed from the subject Property and surrounding roadways. Observations for visual and/or physical evidence did not indicate the presence of *RECs* on adjoining properties.

The Pioneer Mill Company, listed as a Superfund Site, is located approximately 0.25-mile south of the Property in a cross-gradient direction.

6 FINDINGS, OPINIONS, AND CONCLUSIONS

6.1 Findings and Opinions

This assessment included a site reconnaissance to observe for visual and/or physical indications of *RECs* and a review of reasonably ascertainable local, state, and federal records pertaining to the Property. No subsurface explorations, sampling, or chemical analyses of air, soil, or water were performed as part of this Phase I ESA.

RECs encountered on the property include potential PCB-containing transformers. These *RECs* are further discussed in Section 6.2.

The Property consists of approximately 1,033 acres currently owned by HHFDC and the State of Hawai'i. Some structures associated with the former Pioneer Mill Company remain on-site, as well as irrigation features still in use. Additionally, some archaeological features have been observed at the site. The Property's historical and current primary use is agricultural, dating back to the late 1800s.

Information obtained through interviews and regulatory database searches did not disclose evidence of environmental concerns on or adjacent to the Property. No known spills or chemical releases or environmental cleanups have taken place at the Property. No environmental liens

have been issued against the Property, and no activity and land use limitations are in place at the Property. There is no specialized knowledge of the Property or nearby properties, and the price paid for the Property is believed to reasonably reflect the fair market value of the Property. Hazardous substances, in the form of pesticides and herbicides, have been used in their proper application on the Property. No hazardous substances or petroleum products are known to have been stored on the Property.

6.2 Conclusions

Belt Collins has performed a Phase I Environmental Site Assessment in conformance with the scope and limitations of ASTM Standard Practice E1527-05 of the Villages of Leiali'i Phases A and B located at TMKs 4-5-021: parcels 003, 004 (portion), 005 (portion), 013, 021, 022 (portion), and 4-5-028: parcel 070, in Lahaina, Maui, Hawai'i (the "Property"). Any exceptions to, or deletions from, the ASTM Practice are described in Section 1.4 of this report. This assessment has revealed no evidence of *recognized environmental conditions* in connection with the Property except for the following:

- *One pole-mounted transformer and various substation transformers located on bare soil. It is possible* these transformers were installed prior to 1980, and according to MECO, may contain PCBs*.* The transformers appear to be in poor condition with heavy rusting, posing a material threat of a release or past release of a hazardous substance (Photographs available in Appendix E).

It should be noted that the past application of herbicides is a potential source of contaminants, such as metals (especially arsenic), polychlorinated biphenyls, organochlorine pesticides, and dioxins in the soil and groundwater. According to a State of Hawai'i, Department of Agriculture report[22], sugarcane was the largest single user of herbicides in Hawai'i and accounted for 75 percent of total herbicide use there during the 1960s. For this reason, herbicides and pesticides are likely to be present in the soil and groundwater. However, when herbicides and pesticides are applied according to the labeled instructions, it is not considered a release and does not qualify as a REC.

6.3 Standard of Care

The findings presented in this Phase I ESA are professional opinions based solely upon limited visual and/or physical observations of the Property and specified vicinity and upon the interpretation by Belt Collins personnel of the available historical information and documents. This Phase I ESA is intended for the sole use of HHFDC and its subsidiaries and their legal counsel exclusively for the purposes outlined herein and for the properties indicated. Any use or reuse of this document or the findings herein is at the sole risk of said user, as the scope of services performed in execution of this investigation may not be appropriate to satisfy the needs of other users. This Phase I ESA shall not be relied upon by or transferred to any other party without expressed written authorization from Belt Collins.

---

[22] U. S. Environmental Protection Agency, Region 9. February 2003. Informational Flyer. *EPA to Perform Site Assessment at Pioneer Mill*. San Francisco, California.

In providing services for this project, Belt Collins endeavors to perform in a manner consistent with that degree of care and skill ordinarily exercised by members of the same profession currently practicing under similar circumstances. No warranty or representation, expressed or implied, is included or intended in its proposal, contracts, or reports.

7 DELETIONS/DATA GAPS

Following is a list of the data gaps and deletions from ASTM Standard Practice E1527-05 that occurred during the performance of this assessment:

- Interviews with the previous owner and other users of the of the Property
- Status of UST located at a neighboring site, 1462 Fleming Road, Lahaina, HI.

7.1 Historical Data Gaps/Data Failure

In accordance with the requirements in ASTM E1527-05, interviews should be conducted with past owners. Belt Collins was unable to interview the past owners of the Pioneer Mill Company, a user of the Property. This represents a data gap, as the information from the interview with a former Pioneer Mill employee dates back only to 1987. Additionally, portions of the Property had been leased to several other entities for use as agricultural land and quarrying. These users were also unavailable for interviews. The lack of interviews with the previous owner and users of the Property represents a data gap. Considering the historical records (aerial photographs and topographic maps); database research; and interviews with the current owner, occupants, and former Pioneer Mill employee, this data gap is not significant. The records indicate that the current and past activities on the Property have been consistent and remained unchanged throughout the development of the Property.

The lack of information in regards to the status (i.e. size, type and whether the tank has been removed) of the UST tank represents a data gap. It is not likely that the UST will adversely impact the Property from an existing release, past release, or material threat of a release of hazardous substances or petroleum products onto the Property, based upon the location of the site (down gradient and approximately 0.25 miles) from the Property. This does not represent a significant data gap.

No further historical data sources were evaluated, because: (1) they were not *reasonably ascertainable*, and/or (2) the assessor's past experience indicates that additional available sources were not likely to be sufficiently useful, accurate, or complete in terms of satisfying the historical research objectives. Based on these two criteria, the following standard historical sources were not evaluated:

Building Department Records (not applicable to the Property).

Local Street Directories.

Zoning/Land Use Records (historical data not maintained).

Other Historical Sources, including miscellaneous maps, newspaper archives, and community organizations.

7.2 Other Deletions/Data Gaps

No other deviation or data gap was identified that was deemed material to this assessment.

8 SIGNATURES AND QUALIFICATIONS OF ENVIRONMENTAL PROFESSIONALS

This Phase I Environmental Site Assessment was conducted by Ms. Lesley Matsumoto, Ms. Maura Mastriani, and Ms. Jennifer Littenberg. Ms. Matsumoto has a BS in Atmospheric Science and 20 years of environmental consulting experience including site investigations, multi-media health risk assessments, and reviews of environmental audits and Environmental Site Assessments. Ms. Mastriani has a BS degree in Environmental Science, seven years of experience, and has completed the ASTM training for Environmental Site Assessments for Commercial Real Estate. Ms. Littenberg has a BS in Chemical Engineering and over 8 years of environmental consulting experience including Environmental Phase I site assessments, Phase II site investigations and remediation, environmental audits and hazardous material and waste classification and disposal.

Appendix F provides supporting documentation of the qualifications of the environmental professionals.

We declare that, to the best of our professional knowledge and belief, we meet the definition of environmental professional as defined in §312.10 of 40 CFR 312 and we have the specific qualifications based on education, training, and experience to assess a property of the nature, history, and setting of the subject property. We have developed and performed the all appropriate inquiries in conformance with the standards and practices asset forth in 40 CFR Part 312.

BELT COLLINS HAWAII LTD.

Signed:

Lesley A. Matsumoto, Director of Environmental Consulting

9 REFERENCES

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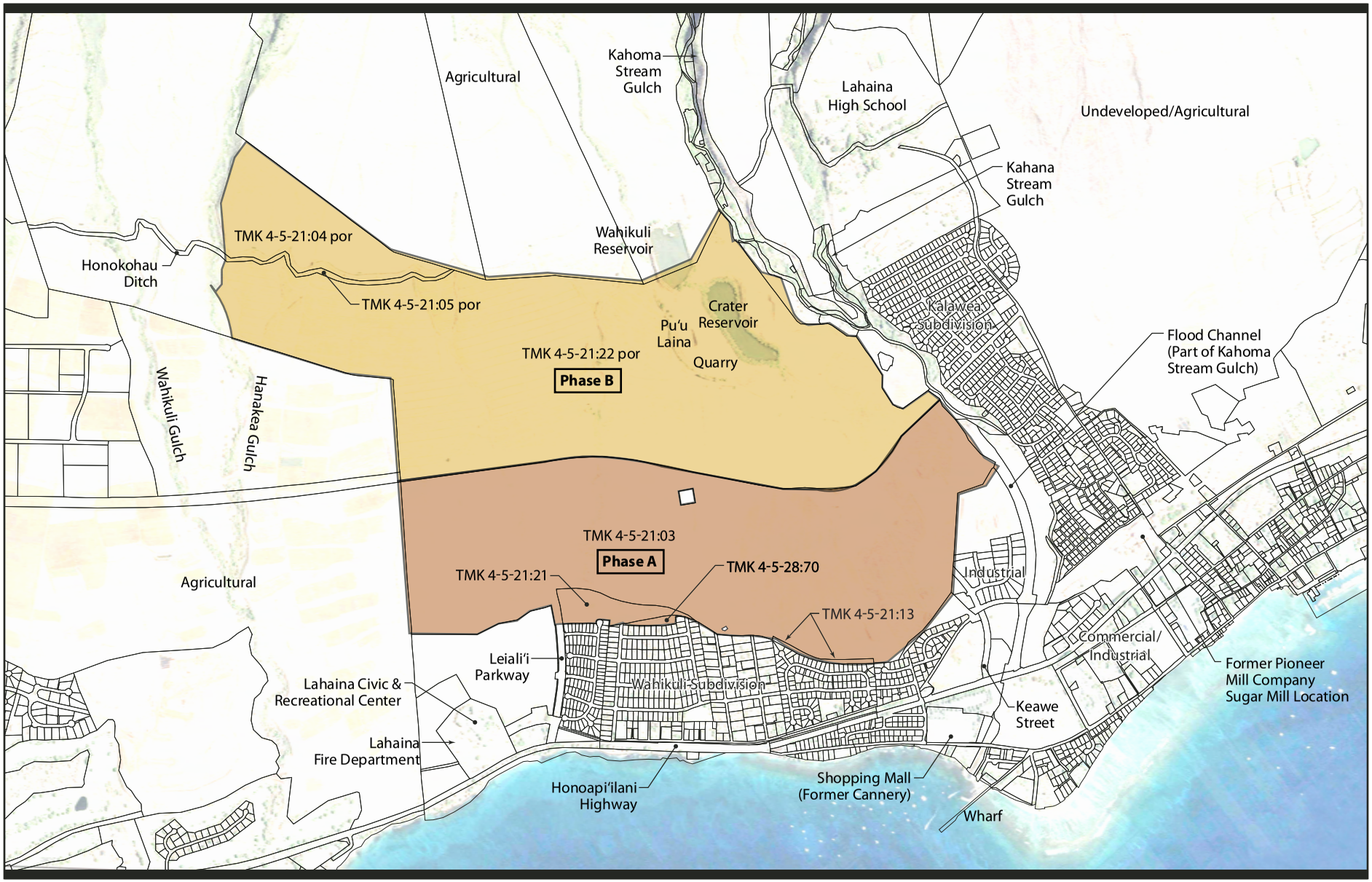
FIGURES



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Source: Imagery is from Google™ Earth Pro and is approximately matched to lot lines

BeltCollins

NORTH

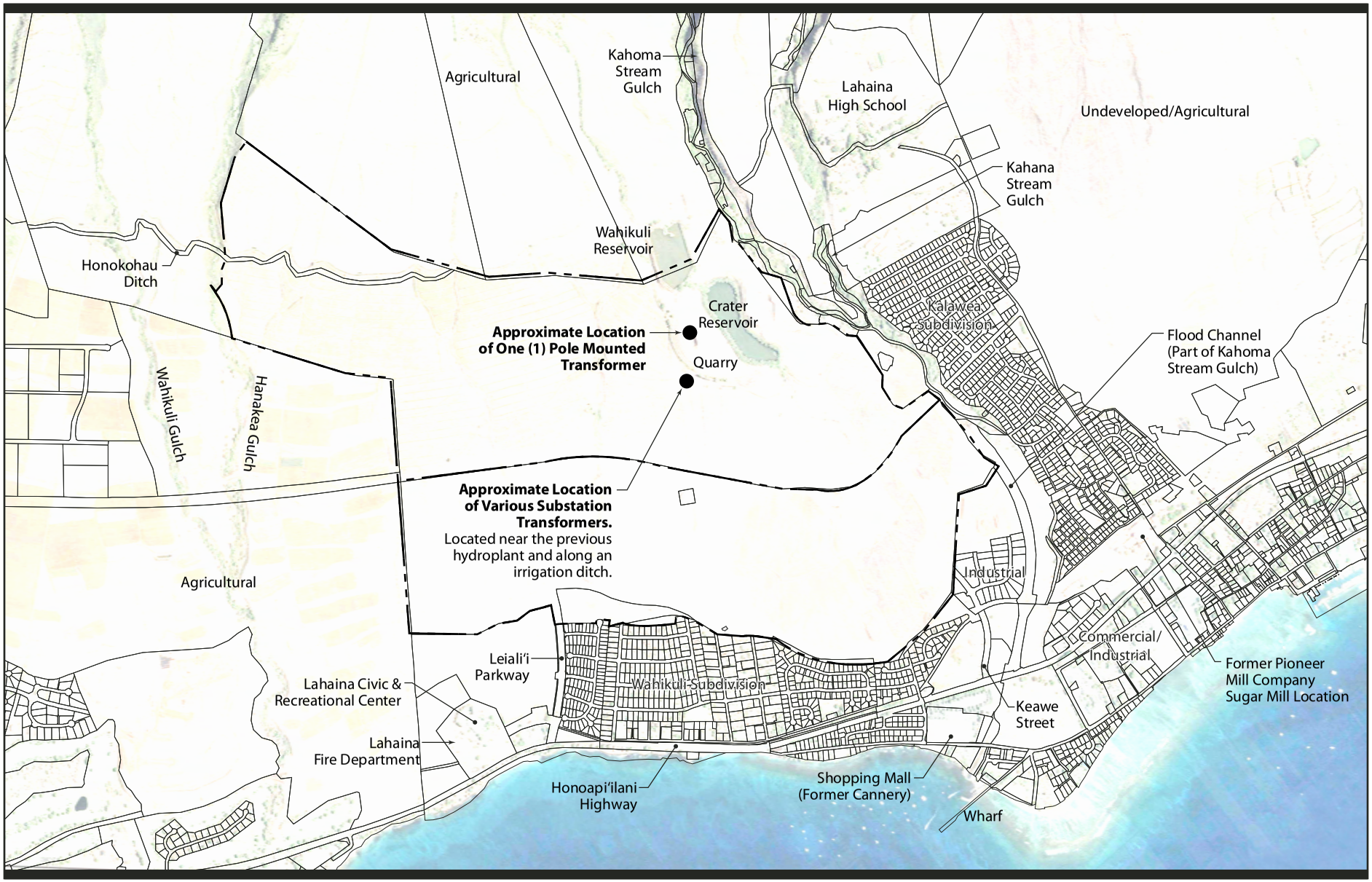
0 500 1000 2000
SCALE IN FEET

LEGEND

Property Boundaries

Figure 1
PROJECT LOCATION AND SITE VICINITY MAP
Villages of Leiali'i

September 2008



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Source: Imagery is from Google™ Earth Pro and is approximately matched to lot lines

BeltCollins

NORTH

0 500 1000 2000

SCALE IN FEET

Figure 2
LOCATION OF TRANSFORMERS
Villages of Leiali'i

September 2008

APPENDICES

APPENDIX A

SCOPE OF SERVICES

April 3, 2008
08EP-134R1

Via email to Stanley.S.Fujimoto@hawaii.gov

Mr. Stanley S. Fujimoto
Project Manager
Hawaii Housing Finance and Development Corporation
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Fujimoto:

Revised Proposal for Phase I Environmental Site Assessment
at Villages of Leiali‘i: Phase A and B
Lahaina, Maui, Hawai‘i

Belt Collins Hawaii Ltd. is pleased to submit this revised proposal to perform a Phase I Environmental Site Assessment (ESA) for the Villages of Leiali‘i: Phase A and B located in Lahaina, Maui, Hawai‘i (the "Property"). The Property encompasses approximately 1,033 acres. Refer to Attachment A for a list of the Tax Map Keys and acreage associated with the Property. This proposal is submitted in response to your request for proposal to Ms. Sue Sakai.

Honolulu
Guam
Hong Kong
Philippines
Seattle
Singapore
Thailand

We understand that this assessment would be conducted as part of due diligence activities. The purpose of the assessment, proposed scope of work, description of our qualifications, schedule, and proposed fee follow.

PURPOSE AND SCOPE OF WORK

The purpose of the Phase I ESA is to render an opinion as to whether visual or historical evidence indicates the presence of recognized environmental conditions on the Property. Recognized environmental conditions are identified by the presence or likely presence of hazardous substances or petroleum products on the Property under conditions that indicate an existing release, a past release, or a material threat of release of these substances into structures on the Property or into the ground, groundwater, or surface water of the Property. The site assessment will be completed in general accordance with American Society for Testing and Materials (ASTM) Standard E 1527-05, Standard Practice for Environmental

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Belt Collins Hawaii is an Equal Opportunity Employer

Site Assessments: Phase I Environmental Site Assessment Process and with 40 Code of Federal Regulation (CFR) Part 312, Standards and Practices for All Appropriate Inquiries. The detailed *Scope of Services* for this assessment is enclosed and a summary of the scope is provided below:

- Review history of uses on the Property to identify possible previous activities that might have led to the presence of hazardous substances or petroleum products in the ground, groundwater, or surface water at the Property. This task includes review of reasonably ascertainable[1] maps and aerial photographs pertaining to the Property.

- Purchase and review a commercial regulatory database search report for the Property that summarizes information available on standard Federal and State government databases of known or potential sources of hazardous materials or waste. The database search report will be reviewed for incidents and releases listed at locations within ASTM-minimum search distances, as outlined in ASTM Standard Practice E 1527-05.

- Perform a reconnaissance survey of the Property to identify visual evidence indicating recognized environmental conditions in connection with the Property and to confirm data provided in the commercial regulatory database.

- This proposal does not include a survey for asbestos-containing materials, lead-based paint, or other hazardous building materials.

- Make a reasonable attempt to conduct interviews with appropriate persons associated with the Property before, during, or after the reconnaissance survey. ASTM Standard Practice E1527-05 directs the environmental professional to conduct interviews with the present site manager, major property occupants, past owners, operators, and occupants, and appropriate state and/or local government officials.

- Prepare a Phase I ESA report for the Property (two hard copies will be submitted to the client). The report will provide information on historical and current uses at the Property and reconnaissance survey results, and identify activities, if documented, that may have generated recognized environmental conditions as outlined in the ASTM standard. The report will contain Belt Collins' professional opinion as to whether visual and historical evidence indicates the presence of hazardous

[1] As defined by ASTM 1527-05, reasonably ascertainable information is (1) publicly available, (2) obtainable from its source within reasonable time and cost restraints, and (3) practically reviewable. Practically reviewable information is provided by a source in a manner and from that, upon examination, yields information relevant to the property without the need for extraordinary analysis of irrelevant data.

substances or petroleum products in the ground, groundwater, or surface water on the Property and will define limitations regarding this opinion. Revisions to the report requested by the client are not made part of this scope of work.

It shall be the responsibility of Hawaii Housing Finance and Development Corporation (HHFDC) to obtain site access and any necessary right-of-entry for Belt Collins personnel, prior to our visit, and to provide information on or show Belt Collins the existing property boundaries. If access is unavailable to any portions of or persons associated with the Property, including locked structures and inaccessible terrain, our ability to complete the scope of services described herein may impose a limitation to our findings.

Additionally, in order to comply with 40 CFR Part 312, the user (HHFDC) shall provide the following:

- Information concerning environmental liens or activity use limitations recorded against the property obtained either from the review of judicial and title records, or from actual knowledge.

- Specialized knowledge or experience the user may have.

- Relationship of purchase price to fair-market value of the property if it were not contaminated.

- Commonly known or reasonably ascertainable information within the local community.

- Any obvious indicators that suggest the presence or likely presence of contamination at the property.

A Phase I ESA is a non-intrusive investigation of a property and its history. It does not include collection of samples or performance of analytical laboratory testing for the presence of contaminants. Should field observations or a review of site or regulatory history indicate evidence of the presence of hazardous substances in the ground, groundwater, or surface water, sampling and analysis may be warranted. At your request, Belt Collins can prepare an appropriate proposal outlining the cost and time frame associated with requested additional services.

QUALIFICATIONS AND EXPERIENCE

The following Belt Collins personnel would be responsible for preparing the Phase I ESA:

- Lesley Matsumoto, Principal-in-Charge. B.S., atmospheric science. Ms. Matsumoto has 19 years of environmental consulting experience including site investigations, multi-media health risk assessments, and reviews of environmental audits and Phase I ESAs.

- Maria Friedli, P.G., Project Manager. B.S., geology. Ms. Friedli has 14 years of environmental consulting experience including numerous Phase I and II ESAs, petroleum and hazardous waste investigations and remediation, and preparation of Health and Safety Plans and Quality Assurance/Quality Control Plans.

SCHEDULE AND PROPOSED FEE

Belt Collins is prepared to begin this investigation immediately following your written authorization to proceed. The report will be submitted to you within 6 to 8 weeks of the notice to proceed.

As requested, Belt Collins has provided a breakdown of costs to perform the Phase I ESA on either Phase A or Phase B (separate reports) or on both Phase A and B concurrently (one report) in the following manner:

Option 1)	Phase I ESA Report for Villages of Leiali‘i: Phase A only (≈ 451 acres)	$12,200.00
Option 2)	Phase I ESA Report for Villages of Leiali‘i: Phase B only (≈ 582 acres)	$11,950.00
Option 3)	Phase I ESA Report for Villages of Leiali‘i: Phase A and B (≈ 1,033 acres)	$16,965.00

We propose to provide services as outlined in this proposal on a fixed fee basis, inclusive of Hawaii General Excise Tax. If this proposal meets your approval, please indicate in writing which of the three options provided above you have selected and sign below and return a copy of the document to our office. Thank you for the opportunity to be of assistance. If you have any questions, please feel free to contact us.

Sincerely,

BELT COLLINS HAWAII LTD.

Maria Friedli
Project Manager

Lesley A. Matsumoto
Vice President
Director of Environmental Consulting

MF:LAM:ajk
Enclosures:
Attachment 1, Villages of Leiali‘i Tax Map Key and Acreage
Scope of Services

ACCEPTANCE:

OPTION _____

Belt Collins Hawaii Ltd. is authorized to proceed with the Scope of Services described herein.

_____	_____
NAME	COMPANY
_____	_____
TITLE	DATE

VILLAGES OF LEIALI'I
Preliminary-Subject to Revision
Attachment A

	Tax Map Key	Owner	Acreage	Total Acreage	Comments and Notes
Phase A Area					
Agricultural Field	4-5-021:003	HHFDC	435.918		
Retention Basin	4-5-021:021	HHFDC	12.195		
Remnant Parcel	4-5-021:013	State of Hawaii	1.576		
Remnant Parcel	4-5-028:070	State of Hawaii Lau, Leslie K T	1.593		
Subtotal				***451.282***	
Phase B Area					
Agricultural fields	4-5-021:portion of 022	DLNR	518.100		AutoCAD estimate
Agricultural fields	4-5-021:portion of 004	DLNR	60.400		AutoCAD estimate
Honokohau Ditch	4-5-021:portion of 005	State of Hawaii Pioneer Mil Co., Ltd	3.400		AutoCAD estimate. Portion of 6.556-ac parcel.
Subtotal				***581.900***	
TOTAL				***1,033.182***	

SCOPE OF SERVICES

Environmental Site Assessment Activities Included In the Scope of Services

The following activities constitute the Phase I Environmental Site Assessment (ESA) Scope of Services, to the extent feasible given the time, access, and other constraints of the project:

Observe accessible portions of the Property and the portions of adjacent parcels that are visible from the Property and public roads for overt causes for concern, such as the improper storage or use of petroleum products, chemicals or wastes, and the presence of tanks, oil-filled electrical equipment, stains, unusual odors, stressed vegetation, filled areas, and other indications of the potential presence of hazardous substances of regulatory concern.

Identify hazardous substances used (raw materials, operating supplies, oil-containing equipment, etc.), generated, and/or released (air emissions, wastewater discharges, etc.) on the Property in large quantities.

Describe or list each identified large aboveground storage tank (AST) or underground storage tank (UST) that is on the Property (except water tanks), and identify observed exterior tanks on adjacent parcels that may present a significant environmental risk if a release were to occur.

Interview an occupant(s) and/or representative(s) of the owner who reportedly is familiar with the history and use(s) of the Property, including any past uses of hazardous substances, and any hazardous substance incidents on it.

Identify the suppliers of water, fuels, electricity, and sewerage disposal, and any on-site source of water or waste disposal.

Review any Property records provided to the assessor(s) for indications of significant prior uses or releases of hazardous substances on the Property.

Evaluate a topographic map to ascertain the relative location of the Property with respect to adjacent parcels and regional drainage features.

Summarize information from available Sanborn® historical fire insurance maps that depict the Property about prior uses of it and adjacent parcels that may indicate potential concerns.

Examine aerial photographs that depict the Property, and are readily available for purchase from EDR® or for viewing in the vicinity of the Property at the time of the Property visit, for indications of potential concerns on or near the Property.

Honolulu
Guam
Hong Kong
Philippines
Seattle
Singapore
Thailand

Review any maps, surveys, records of ownership (e.g., Chain of Title) and use, release cleanup records, evidence of a recorded environmental lien(s) against the Property, and other written materials provided to the assessor(s), to identify relevant information and to compare them to existing conditions.

Interview appropriate local fire department and/or government personnel familiar with past utilization of the Property and/or adjacent parcels, to the extent that such interviews are authorized by the Client and can be conducted at the time of the Property visit and in the same vicinity, or by telephone.

Obtain from EDR® a computer search of existing public record environmental databases, including those specified in ASTM Standard Practice E1527-05 that routinely are readily available in a searchable format, using search radii no less than those specified in that Standard Practice, then review that report for indications of potential environmental concerns on the Property or with a significant potential to affect it.

Obtain from EDR® and review a report of a search for any federal, state, local, or tribal environmental lien(s) against the Property that is/are recorded in the place where land title records are, by law or custom, recorded for the local jurisdiction in which the Property is located.

The significance of each identified potential concern is assessed using professional judgment, considering such factors as its nature, magnitude, and known or potential impact upon the Property, and if associated with an off-site source the location of that source with respect to the Property.

Research into the history of the Property's uses includes consulting only those standard historical sources that are reasonably ascertainable and readily reviewable given the time, access, and other constraints on the project, and that in the opinion of the assessor are judged likely to yield additional useful information about such uses.

Activities Excluded From the Scope of Services

Except to the extent included within the Scope of Services as described above, the following activities are excluded from the Scope of Services:

Acquiring a compilation of recorded land title records (e.g., a Chain of Title report) covering a period back to the earlier of 1940 or the first known developed use (including agriculture) of the Property.

Extending the research into the history of a Property farther back than the earlier of 1940 or the year when it was known to have first been developed for a commercial purpose other than agriculture.

Visiting governmental agencies or inspecting their records.

Certifying the validity of information obtained from other persons or entities.

Describing the nature and location of any observed interior construction materials on the Property that, based upon EPA and OSHA guidance documents, typically may be friable presumed asbestos-containing materials (ACM).

Conducting an assessment for asbestos-containing materials (ACM), or for testing of vapor that contains or may contain a hazardous chemical, petroleum product, or constituent thereof.

Collecting or analyzing any sample of air, water, soil, flora, fauna, a building material, or any other substance, or making any representation or certification regarding its nature or quality.

Evaluating the potential for any subsurface chemical to migrate into any structure.

Identifying or listing materials suspected to be lead-based paint, biologically active (including mold or mildew), radioactive, or otherwise hazardous.

Evaluating compliance by any owner or operator with laws, regulations, ordinances, or codes.

Evaluating factors that might affect the suitability of the Property for any particular purpose or use, such as zoning and other land-use restrictions, geotechnical considerations, or the presence on or near it of wetlands or other environmentally sensitive areas, endangered species, or locations that are culturally or historically important.

Recommending measures to address any identified concern or any additional investigative procedure(s) to more accurately characterize any potential concern.

Obligations of the User as Defined in ASTM Standard Practice E1527-05

In order to qualify for one of the Landowner Liability Protections (LLPs) offered by the Small Business Liability Relief and Brownfields Revitalization Act of 2001 (the "Brownfields Amendments" to CERCLA), the User (HHFDC) is asked to provide Belt Collins with the information described below, to the extent known or available to the User, prior to the Property reconnaissance, with the understanding that failure to provide or fully disclose this information could result in a determination that "all appropriate inquiry" is complete.

The name and telephone number of an owner and/or occupant contact or representative(s) who is knowledgeable about the Property.

The reason for undertaking the ESA, and if applicable, the type of proposed transaction and why the purchase or lease price of the Property may be significantly less than that of comparable land and improvements in the area.

APPENDIX B

EDR RADIUS MAP WITH GEOCHECK® REPORT

EDR CERTIFIED SANBORN® MAP REPORT

THE EDR ENVIRONMENTAL LIEN SEARCH REPORT

Villages of Leiali I Phases A and B
Lahaina, HI 96761

Inquiry Number: 02279903.1r
August 19, 2008

EDR DataMap™ Area Study

EDR® Environmental Data Resources Inc

440 Wheelers Farms Road
Milford, CT 06461
Toll Free: 800.352.0050
www.edrnet.com

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

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EXECUTIVE SUMMARY

TARGET PROPERTY INFORMATION

ADDRESS

LAHAINA, HI 96761
LAHAINA, HI 96761

DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records within the requested search area for the following databases:

FEDERAL RECORDS

NPL	National Priority List
Proposed NPL	Proposed National Priority List Sites
Delisted NPL	National Priority List Deletions
NPL LIENS	Federal Superfund Liens
CERC-NFRAP	CERCLIS No Further Remedial Action Planned
LIENS 2	CERCLA Lien Information
CORRACTS	Corrective Action Report
RCRA-TSDF	RCRA - Transporters, Storage and Disposal
RCRA-LQG	RCRA - Large Quantity Generators
RCRA-CESQG	RCRA - Conditionally Exempt Small Quantity Generator
RCRA-NonGen	RCRA - Non Generators
US ENG CONTROLS	Engineering Controls Sites List
US INST CONTROL	Sites with Institutional Controls
ERNS	Emergency Response Notification System
HMIRS	Hazardous Materials Information Reporting System
DOT OPS	Incident and Accident Data
US CDL	Clandestine Drug Labs
US BROWNFIELDS	A Listing of Brownfields Sites
DOD	Department of Defense Sites
FUDS	Formerly Used Defense Sites
LUCIS	Land Use Control Information System
CONSENT	Superfund (CERCLA) Consent Decrees
ROD	Records Of Decision
UMTRA	Uranium Mill Tailings Sites
DEBRIS REGION 9	Torres Martinez Reservation Illegal Dump Site Locations
ODI	Open Dump Inventory
MINES	Mines Master Index File
TRIS	Toxic Chemical Release Inventory System
TSCA	Toxic Substances Control Act
SSTS	Section 7 Tracking Systems
ICIS	Integrated Compliance Information System
MLTS	Material Licensing Tracking System
RADINFO	Radiation Information Database
RAATS	RCRA Administrative Action Tracking System

STATE AND LOCAL RECORDS

SWF/LF	Permitted Landfills in the State of Hawaii

EXECUTIVE SUMMARY

VCP..... Voluntary Response Program Sites
DRYCLEANERS..... Permitted Drycleaner Facility Listing
BROWNFIELDS..... Brownfields Sites
AIRS..... List of Permitted Facilities

TRIBAL RECORDS

INDIAN RESERV..... Indian Reservations
INDIAN ODI..... Report on the Status of Open Dumps on Indian Lands
INDIAN LUST..... Leaking Underground Storage Tanks on Indian Land
INDIAN UST..... Underground Storage Tanks on Indian Land
INDIAN VCP..... Voluntary Cleanup Priority Listing

EDR PROPRIETARY RECORDS

Manufactured Gas Plants..... EDR Proprietary Manufactured Gas Plants

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were identified.

Page numbers and map identification numbers refer to the EDR Radius Map report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

Unmappable (orphan) sites are not considered in the foregoing analysis.

FEDERAL RECORDS

CERCLIS: The Comprehensive Environmental Response, Compensation and Liability Information System contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). CERCLIS contains sites which are either proposed to or on the National Priorities List (NPL) and sites which are in the screening and assessment phase for possible inclusion on the NPL.

A review of the CERCLIS list, as provided by EDR, and dated 04/08/2008 has revealed that there is 1 CERCLIS site within the searched area.

Site	Address	Map ID	Page
PIONEER NILL CO, LTD	***380 LAHAINALUNA RD***	***7***	***5***

RCRA-SQG: RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Small quantity generators (SQGs) generate between 100 kg and 1,000 kg of hazardous waste per month.

A review of the RCRA-SQG list, as provided by EDR, and dated 05/12/2008 has revealed that there is 1

RCRA-SQG site within the searched area.

Site	Address	Map ID	Page
PIONEER NILL CO, LTD	***380 LAHAINALUNA RD***	***7***	***5***

FTTS: FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA and EPCRA (Emergency Planning and Community Right-to-Know Act) over the previous five years. To maintain currency, EDR contacts the Agency on a quarterly basis.

A review of the FTTS list, as provided by EDR, and dated 04/11/2008 has revealed that there is 1 FTTS site within the searched area.

Site	Address	Map ID	Page
PIONEER NILL CO, LTD	***380 LAHAINALUNA RD***	***7***	***5***

HIST FTTS: A complete administrative case listing from the FIFRA/TSCA Tracking System (FTTS) for all ten EPA regions. The information was obtained from the National Compliance Database (NCDB). NCDB supports the implementation of FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) and TSCA (Toxic Substances Control Act). Some EPA regions are now closing out records. Because of that, and the fact that some EPA regions are not providing EPA Headquarters with updated records, it was decided to create a HIST FTTS database. It included records that may not be included in the newer FTTS database updates. This database is no longer updated.

A review of the HIST FTTS list, as provided by EDR, and dated 10/19/2006 has revealed that there is 1 HIST FTTS site within the searched area.

Site	Address	Map ID	Page
PIONEER NILL CO, LTD	***380 LAHAINALUNA RD***	***7***	***5***

PADS: The PCB Activity Database identifies generators, transporters, commercial storers and/or brokers and disposers of PCBs who are required to notify the United States Environmental Protection Agency of such activities. The source of this database is the U.S. EPA.

A review of the PADS list, as provided by EDR, and dated 12/04/2007 has revealed that there is 1 PADS site within the searched area.

Site	Address	Map ID	Page
PIONEER NILL CO, LTD	***380 LAHAINALUNA RD***	***7***	***5***

FINDS: The Facility Index System contains both facility information and "pointers" to other sources of information that contain more detail. These include: RCRIS; Permit Compliance System (PCS); Aerometric Information Retrieval System (AIRS); FATES (FIFRA [Federal Insecticide Fungicide Rodenticide Act] and TSCA Enforcement System, FTTS [FIFRA/TSCA Tracking System]; CERCLIS; DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes); Federal

Underground Injection Control (FURS); Federal Reporting Data System (FRDS); Surface Impoundments (SIA); TSCA Chemicals in Commerce Information System (CICS); PADS; RCRA-J (medical waste transporters/disposers); TRIS; and TSCA. The source of this database is the U.S. EPA/NTIS.

A review of the FINDS list, as provided by EDR, and dated 04/03/2008 has revealed that there are 3 FINDS sites within the searched area.

Site	Address	Map ID	Page
MASAO AOTAKI	1462 FLEMING RD	1	3
PIONEER NILL CO, LTD	***380 LAHAINALUNA RD***	***7***	***5***
SHELL STATION	***263 LAHAINALUNA RD***	***9***	***15***

STATE AND LOCAL RECORDS

SHWS: The State Hazardous Waste Sites records are the states' equivalent to CERCLIS. These sites may or may not already be listed on the federal CERCLIS list. Priority sites planned for cleanup using state funds (state equivalent of Superfund) are identified along with sites where cleanup will be paid for by potentially responsible parties. The data come from the Department of Health.

A review of the SHWS list, as provided by EDR, and dated 04/04/2008 has revealed that there are 3 SHWS sites within the searched area.

Site	Address	Map ID	Page
LAHAINA CANNERY MALL	***1221 HONOAPIILANI HWY***	***5***	***4***
PIONEER MILL COMPANY, LTD.	***380 LAHAINALUNA RD***	***7***	***10***
CODAC'S CHEVRON GASOLINE STATI	***240 PAPALAUA ST***	***8***	***14***

LUST: The Leaking Underground Storage Tank Incident Reports contain an inventory of reported leaking underground storage tank incidents. The data come from the Department of Health's Active Leaking Underground Storage Tank Log Listing.

A review of the LUST list, as provided by EDR, and dated 06/30/2008 has revealed that there are 4 LUST sites within the searched area.

Site	Address	Map ID	Page
SHELL STATION Facility Status: Site Cleanup Completed (NFA)	***711 MILL STAKA 281 DICK***	***8***	***11***
CODAC'S SALES & SERVICE Facility Status: Site Cleanup Completed (NFA)	***240 PAPALAUA ST***	***8***	***12***
MID PAC PETROLEUM #254680 (PR Facility Status: LUST Cleanup Initiated	***243 LAHAINALUNA RD***	***9***	***15***
SHELL STATION Facility Status: LUST Cleanup Initiated	***263 LAHAINALUNA RD***	***9***	***15***

EXECUTIVE SUMMARY

UST: The Underground Storage Tank database contains registered USTs. USTs are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA). The data come from the Department of Health's Listing of Underground Storage Tanks.

A review of the UST list, as provided by EDR, and dated 06/30/2008 has revealed that there are 8 UST sites within the searched area.

Site	Address	Map ID	Page
MAKILA RADIO STATION	FRONT ST & HONAPIILANI	2	3
WEST MAUI SHELL	70 KAPUNAKEA ST.	3	3
MAUI BLOCKS	WAIKAPU-OFF HONOAPIILAN	4	4
LAHAINALUNA HIGH SCHOOL	LAHAINALUNA RD	6	5
PIONEER MILL CO., LTD.	380 LAHAINALUNA RD	7	9
SHELL STATION	***711 MILL STAKA 281 DICK***	***8***	***11***
CODAC'S SALES & SERVICE	***240 PAPALAUA ST***	***8***	***12***
MID PAC PETROLEUM #254680 (PR	***243 LAHAINALUNA RD***	***9***	***15***

SPILLS: Releases of hazardous substances to the environment reported to the Office of Hazard Evaluation and Emergency Response since 1988.

A review of the SPILLS list, as provided by EDR, and dated 04/04/2008 has revealed that there are 3 SPILLS sites within the searched area.

Site	Address	Map ID	Page
LAHAINA CANNERY MALL	***1221 HONOAPIILANI HWY***	***5***	***4***
PIONEER MILL COMPANY, LTD.	***380 LAHAINALUNA RD***	***7***	***10***
CODAC'S CHEVRON GASOLINE STATI	***240 PAPALAUA ST***	***8***	***14***

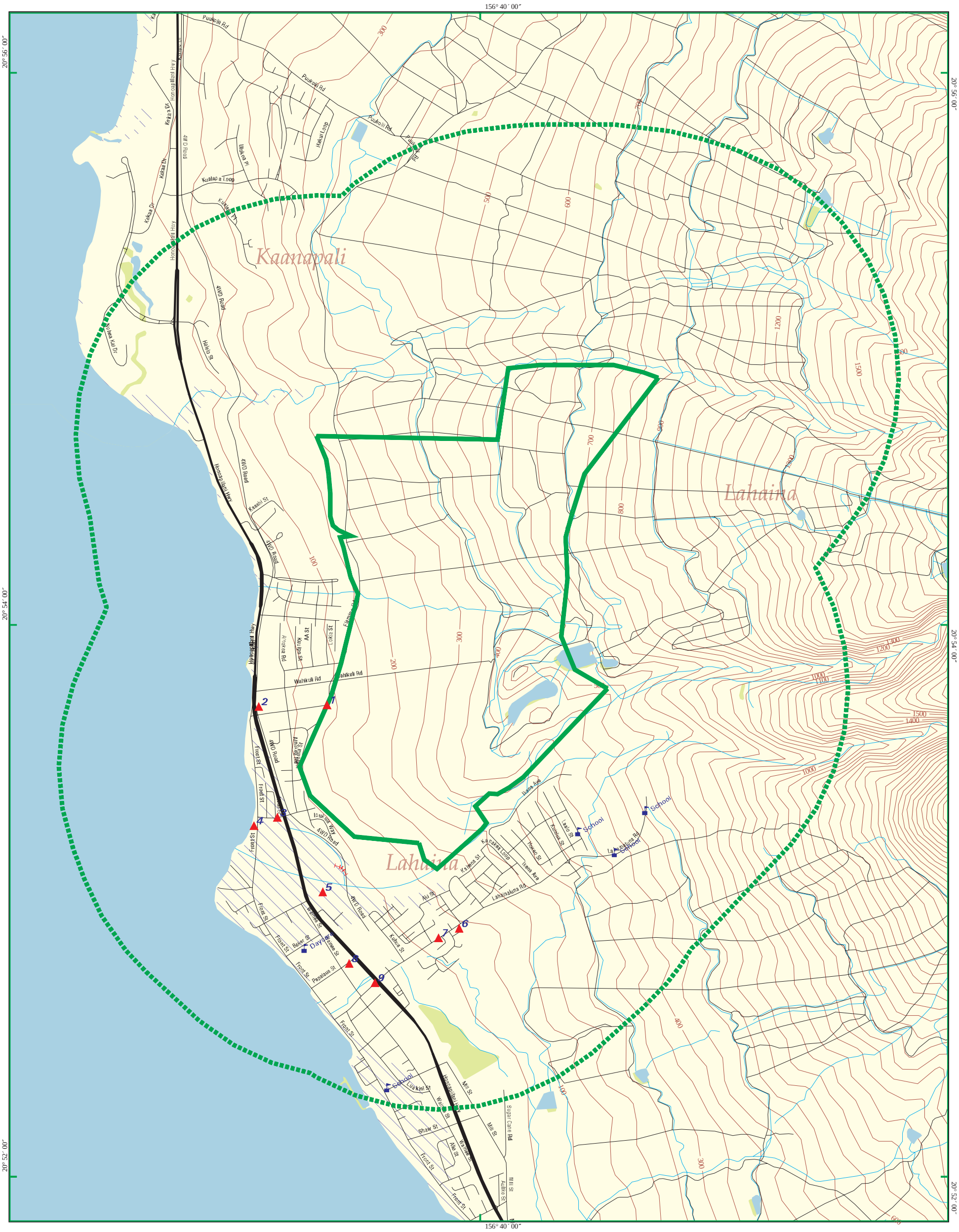
Voluntary Remediation Program and Brownfields sites with institutional controls in place.

A review of the INST CONTROL list, as provided by EDR, and dated 04/04/2008 has revealed that there are 3 INST CONTROL sites within the searched area.

Site	Address	Map ID	Page
LAHAINA CANNERY MALL	***1221 HONOAPIILANI HWY***	***5***	***4***
PIONEER MILL COMPANY, LTD.	***380 LAHAINALUNA RD***	***7***	***10***
CODAC'S CHEVRON GASOLINE STATI	***240 PAPALAUA ST***	***8***	***14***

EXECUTIVE SUMMARY

Please refer to the end of the findings report for unmapped orphan sites due to poor or inadequate address information.



EDR DataMap® - Area Study

Villages of Leiali I Phases A and B

EDR® Environmental Data Resources Inc.

- Listed Sites
- Earthquake Epicenters (Richter 5 or greater)
- Search Boundary
- Roads
- Major Roads
- Waterways
- Railroads
- Contour Lines
- Pipelines
- Powerlines
- Fault Lines
- Water
- Superfund Sites
- Federal DOD Sites
- Indian Reservations BIA
- 100-Yr Flood Zones
- National Wetland Inventory

N

0 1/4 1/2

Scale in Miles

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02279903.1r - 19 Aug 08

MAP FINDINGS SUMMARY

Database	Total Plotted
FEDERAL RECORDS	
NPL	0
Proposed NPL	0
Delisted NPL	0
NPL LIENS	0
CERCLIS	1
CERC-NFRAP	0
LIENS 2	0
CORRACTS	0
RCRA-TSDF	0
RCRA-LQG	0
RCRA-SQG	1
RCRA-CESQG	0
RCRA-NonGen	0
US ENG CONTROLS	0
US INST CONTROL	0
ERNS	0
HMIRS	0
DOT OPS	0
US CDL	0
US BROWNFIELDS	0
DOD	0
FUDS	0
LUCIS	0
CONSENT	0
ROD	0
UMTRA	0
DEBRIS REGION 9	0
ODI	0
MINES	0
TRIS	0
TSCA	0
FTTS	1
HIST FTTS	1
SSTS	0
ICIS	0
PADS	1
MLTS	0
RADINFO	0
FINDS	3
RAATS	0
STATE AND LOCAL RECORDS	
SHWS	3
SWF/LF	0
LUST	4
UST	8
SPILLS	3

MAP FINDINGS SUMMARY

Database	Total Plotted
INST CONTROL	3
VCP	0
DRYCLEANERS	0
BROWNFIELDS	0
AIRS	0
TRIBAL RECORDS	
INDIAN RESERV	0
INDIAN ODI	0
INDIAN LUST	0
INDIAN UST	0
INDIAN VCP	0
EDR PROPRIETARY RECORDS	
Manufactured Gas Plants	0

NOTES:

Sites may be listed in more than one database

Map ID Direction Distance Distance (ft.)	Site	Database(s)	EDR ID Number EPA ID Number
1	**MASAO AOTAKI** **1462 FLEMING RD** **LAHAINA, HI 96761**	**FINDS**	**1006843430** **110014049822**

FINDS:
Other Pertinent Environmental Activity Identified at Site

HI-UST (Hawaii - Underground Storage Tank). Hawaii Underground Storage Tank Program regulates underground storage tanks which store petroleum or hazardous substances and offers documents and data products for downloading.

2	**MAKILA RADIO STATION** **FRONT ST & HONAPIILANI HWY** **LAHAINA, HI 96767**	**UST**	**U003222201** **N/A**

UST:

Facility ID:	9-500559
Owner:	Hawaiian Telcom
Owner Address:	P.O. Box 2200
Ownder City,St,Zip:	Lahaina, 96767 96767
Tank ID:	M-1
Date Installed:	9/5/1996
Tank Status:	**Temporarily Out of Use**
Date Closed:	Not reported
Tank Capacity:	600
Substance:	Diesel
Tank ID:	R-1
Date Installed:	5/8/1983
Tank Status:	**Permanently Out of Use**
Date Closed:	9/4/1996
Tank Capacity:	250
Substance:	Gasoline

3	**WEST MAUI SHELL** **70 KAPUNAKEA ST.** **LAHAINA, HI 96761**	**UST**	**U003402956** **N/A**

UST:

Facility ID:	9-503501
Owner:	KAPUNAKEA PARTNERS
Owner Address:	370 Dairy Road
Ownder City,St,Zip:	Lahaina, 96761 96761
Tank ID:	3
Date Installed:	5/1/1998
Tank Status:	**Currently In Use**
Date Closed:	Not reported
Tank Capacity:	10000
Substance:	Diesel
Tank ID:	87
Date Installed:	5/1/1998

WEST MAUI SHELL (Continued) **U003402956**

Tank Status: **Currently In Use**
Date Closed: Not reported
Tank Capacity: 10000
Substance: Gasoline

Tank ID: 92
Date Installed: 5/1/1998
Tank Status: **Currently In Use**
Date Closed: Not reported
Tank Capacity: 10000
Substance: Gasoline

---

4 **MAUI BLOCKS** **UST** **U001236653**
WAIKAPU-OFF HONOAPIILANI HWY **N/A**
WAILUKU, HI 96793

UST:
Facility ID: 9-500399
Owner: MAUI BLOCKS AKA R&M SERVICE CO., INC
Owner Address: P.O. BOX 985
Ownder City,St,Zip: Wailuku, 96793 96793

Tank ID: R-1
Date Installed: 4/30/1974
Tank Status: **Permanently Out of Use**
Date Closed: 11/12/1993
Tank Capacity: 1000
Substance: Gasoline

---

5 **LAHAINA CANNERY MALL** **SHWS** **S106818664**
1221 HONOAPIILANI HWY **SPILLS** **N/A**
LAHAINA, HI 96761 **INST CONTROL**

SHWS:
File Under: Hawaii Omori Corporation
Supplement: Not reported
Restricted Use: This facility is available for unrestricted use.
Restricted Use Comm: Not reported
Ic Relied On In Remedy: Not reported
Unit: Lahaina Cannery Mall
Fed Id: Not reported
Funding: LMB
Agreement/program: State Site
Sitelist Name: Lahaina Cannery Mall
Activity Type: File Review
Assignment Date: 10/1/2007
Activity Lead: Lynn Bailey
Assignment End Date: 10/1/2007
End fill: 10/1/2007
Result fill: Status Update
Overall Status: Complete NFA Letter on File

HI SPILLS:
Island: Maui
Supplemental Loc. Text: Not reported

LAHAINA CANNERY MALL (Continued) **S106818664**

Case Number: 20031017-1200
Units: Temporary Monitoring Well Fuel Release
Substances: Diesel Oil
Less Or Greater Than: Not reported
Numerical Quantity: Not reported
Units: Not reported
Activity Type: Response
Assignment Date: 10/17/2003
Activity Lead: Terry Corpus
Assignment End Date: 11/4/2004
Result: 8
File Under: Hawaii Omori Corporation
Incident: During excavation of temporary monitoring well, small amounts of diesel fuel was detected. Well was described as being a former gas pump; well to be filled in after completion of groundwater sampling.
Initial: Not reported
Report: Contact Jeff Morrell, 808-522-0320 for further information.

HI INSTUTIONAL CONTROL:
Restricted Use: This facility is available for unrestricted use.
Comments on Restricted Use: Not reported
IC Relied on in Remedy: Not reported
File Under: Hawaii Omori Corporation

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6 **LAHAINALUNA HIGH SCHOOL** **UST** **U003155137**
LAHAINALUNA RD **N/A**
LAHAINA, HI 96761

UST:
Facility ID: 9-502971
Owner: STATE DOE
Owner Address: Not reported
Ownder City,St,Zip: Lahaina, 96761 96761

Tank ID: 1
Date Installed: Not reported
Tank Status: Permanently Out of Use
Date Closed: 4/27/1995
Tank Capacity: 500
Substance: Gasoline

---

7 **PIONEER NILL CO, LTD** **PADS** **1000312458**
380 LAHAINALUNA RD **CERCLIS** **HID009158106**
LAHAINA, HI 96761 **RCRA-SQG**
FINDS
FTTS
HIST FTTS

CERCLIS:
Site ID: 0905869
Federal Facility: Not a Federal Facility
NPL Status: Not on the NPL
Non NPL Status: NFRAP

CERCLIS Site Contact Name(s):

PIONEER NILL CO, LTD (Continued) **1000312458**

Contact Name: Eugenia Chow
Contact Tel: (415) 972-3160
Contact Title: Site Assessment Manager (SAM)

Site Description: Not reported

CERCLIS Assessment History:
Action: DISCOVERY
Date Started: Not reported
Date Completed: 07/05/2001
Priority Level: Not reported

Action: COMBINED PRELIMINARY ASSESSMENT/SITE INSPECTION
Date Started: 07/18/2002
Date Completed: 09/22/2004
Priority Level: NFRAP (No Futher Remedial Action Planned

RCRA-SQG:
Date form received by agency: 02/04/1986
Facility name: PIONEER NILL CO, LTD
Facility address: 380 LAHAINALUNA RD
LAHAINA, HI 96761
EPA ID: HID009158106
Mailing address: P O BOX 727
LAHAINA, HI 96761
Contact: CHRIS LINDLEY
Contact address: 380 LAHAINALUNA RD
LAHAINA, HI 96761
Contact country: US
Contact telephone: (808) 661-0529
Contact email: Not reported
EPA Region: 09
Land type: Facility is not located on Indian land. Additional information is not known.
Classification: Small Small Quantity Generator
Description: Handler: generates more than 100 and less than 1000 kg of hazardous waste during any calendar month and accumulates less than 6000 kg of hazardous waste at any time; or generates 100 kg or less of hazardous waste during any calendar month, and accumulates more than 1000 kg of hazardous waste at any time

Owner/Operator Summary:
Owner/operator name: AMFAC, INC
Owner/operator address: NOT REQUIRED
NOT REQUIRED, ME 99999
Owner/operator country: Not reported
Owner/operator telephone: (415) 555-1212
Legal status: Private
Owner/Operator Type: Owner
Owner/Op start date: Not reported
Owner/Op end date: Not reported

Owner/operator name: NOT REQUIRED
Owner/operator address: NOT REQUIRED
NOT REQUIRED, ME 99999
Owner/operator country: Not reported
Owner/operator telephone: (415) 555-1212

PIONEER NILL CO, LTD (Continued) **1000312458**

Legal status: Private
Owner/Operator Type: Operator
Owner/Op start date: Not reported
Owner/Op end date: Not reported

Handler Activities Summary:
U.S. importer of hazardous waste: Unknown
Mixed waste (haz. and radioactive): Unknown
Recycler of hazardous waste: No
Transporter of hazardous waste: No
Treater, storer or disposer of HW: No
Underground injection activity: No
On-site burner exemption: Unknown
Furnace exemption: Unknown
Used oil fuel burner: No
Used oil processor: No
User oil refiner: No
Used oil fuel marketer to burner: No
Used oil Specification marketer: No
Used oil transfer facility: No
Used oil transporter: No
Off-site waste receiver: Commercial status unknown

Facility Has Received Notices of Violations:
Regulation violated: F - 279.20-24
Area of violation: Used Oil - Generators
Date violation determined: 02/03/2000
Date achieved compliance: Not reported
Violation lead agency: State
Enforcement action: Not reported
Enforcement action date: Not reported
Enf. disposition status: Not reported
Enf. disp. status date: Not reported
Enforcement lead agency: Not reported
Proposed penalty amount: Not reported
Final penalty amount: Not reported
Paid penalty amount: Not reported

Regulation violated: F - 262.10-12.A
Area of violation: Generators - General
Date violation determined: 02/03/2000
Date achieved compliance: Not reported
Violation lead agency: State
Enforcement action: Not reported
Enforcement action date: Not reported
Enf. disposition status: Not reported
Enf. disp. status date: Not reported
Enforcement lead agency: Not reported
Proposed penalty amount: Not reported
Final penalty amount: Not reported
Paid penalty amount: Not reported

Evaluation Action Summary:
Evaluation date: 02/03/2000
Evaluation: FOCUSED COMPLIANCE INSPECTION
Area of violation: Used Oil - Generators

PIONEER NILL CO, LTD (Continued) **1000312458**

Date achieved compliance: Not reported
Evaluation lead agency: State

Evaluation date: 02/03/2000
Evaluation: FOCUSED COMPLIANCE INSPECTION
Area of violation: Generators - General
Date achieved compliance: Not reported
Evaluation lead agency: State

FINDS:
Other Pertinent Environmental Activity Identified at Site

Not reported

HI-UST (Hawaii - Underground Storage Tank). Hawaii Underground Storage Tank Program regulates underground storage tanks which store petroleum or hazardous substances and offers documents and data products for downloading.

NCDB (National Compliance Data Base) supports implementation of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Toxic Substances Control Act (TSCA). The system tracks inspections in regions and states with cooperative agreements, enforcement actions, and settlements.

TRIS (Toxics Release Inventory System) contains information from facilities on the amounts of over 300 listed toxic chemicals that these facilities release directly to air, water, land, or that are transported off-site.

The NEI (National Emissions Inventory) database contains information on stationary and mobile sources that emit criteria air pollutants and their precursors, as well as hazardous air pollutants (HAPs).

The HI-ECS (Hawaii Environmental Compliance Program) is the Hawaii state regulatory program relating to environmental compliance and hazardous materials that ensures that program areas and facilities are in compliance with environmental regulations

RCRAInfo is a national information system that supports the Resource Conservation and Recovery Act (RCRA) program through the tracking of events and activities related to facilities that generate, transport, and treat, store, or dispose of hazardous waste. RCRAInfo allows RCRA program staff to track the notification, permit, compliance, and corrective action activities required under RCRA.

CERCLIS (Comprehensive Environmental Response, Compensation, and Liability Information System) is the Superfund database that is used to support management in all phases of the Superfund program. The system contains information on all aspects of hazardous waste sites, including an inventory of sites, planned and actual site activities, and financial information.

FTTS:
Case Number: Not reported
Docket Number: 09-92-0010

PIONEER NILL CO, LTD (Continued) **1000312458**

Complaint Issue Date: 03/09/1992
Abatement Amount: 0.0000
Proposed Penalty: 5000.0000
Final Assessment: 0.0000
Final Order Date: 03/04/1993
Close Date: / /
Violations(s): Disposal; Environ Release, PCB Item in Use

HIST FTTS:
Case Number: Not reported
Docket Number: 09-92-0010
Complaint Issue Date: 03/09/1992
Abatement Amount: 0.0000
Proposed Penalty: 5000.0000
Final Assessment: 0.0000
Final Order Date: 03/04/1993
Close Date: / /
Violations(s): Disposal; Environ Release, PCB Item in Use

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7 **PIONEER MILL CO., LTD.** **UST** **U003541882**
380 LAHAINALUNA RD **N/A**
LAHAINA, HI 96761

UST:
Facility ID: 9-500772
Owner: PIONEER MILL CO., LTD.
Owner Address: P.O. BOX 727
Ownder City,St,Zip: Lahaina, 96761 96761

Tank ID: R-001
Date Installed: 3/12/1957
Tank Status: Permanently Out of Use
Date Closed: 5/1/1988
Tank Capacity: 1000
Substance: Gasoline

Tank ID: R-002
Date Installed: 3/12/1958
Tank Status: Permanently Out of Use
Date Closed: 5/1/1988
Tank Capacity: 1000
Substance: Kerosene

Tank ID: R-003
Date Installed: 3/12/1958
Tank Status: Permanently Out of Use
Date Closed: 5/1/1988
Tank Capacity: 1000
Substance: Other

7 PIONEER MILL COMPANY, LTD. **SHWS** **S106820070**
380 LAHAINALUNA RD **SPILLS** **N/A**
LAHAINA, HI 96761 **INST CONTROL**

SHWS:

File Under:	Pioneer Mill Co., Ltd.
Supplement:	Not reported
Restricted Use:	This facility is available for unrestricted use.
Restricted Use Comm:	Not reported
Ic Relied On In Remedy:	Not reported
Unit:	Pioneer Mill--Lahaina
Fed Id:	Not reported
Funding:	Report Ongoing
Agreement/program:	State Site Program
Sitelist Name:	Pioneer Mill--Lahaina
Activity Type:	Phase II - UST Cleanup
Assignment Date:	9/1/2007
Activity Lead:	Melody Calisay
Assignment End Date:	Not reported
End fill:	4/4/2008
Result fill:	Ongoing
Overall Status:	Ongoing EI (Environmental Interest)

HI SPILLS:

Island:	Maui
Supplemental Loc. Text:	Not reported
Case Number:	19940729-24
Units:	Pioneer Mill Co Ltd
Substances:	SEE INCIDENT DESCRIPTION
Less Or Greater Than:	Not reported
Numerical Quantity:	Not reported
Units:	Not reported
Activity Type:	Response
Assignment Date:	Not reported
Activity Lead:	Not reported
Assignment End Date:	Not reported
Result:	8
File Under:	Pioneer Mill Co., Ltd.
Incident:	EPCRA; FILE FOLDER, RE: RE-EVALUATION OF REQUIREMENTS FOR REPORTING UNDER CFR 40.Fuel overspilling noticed during UST excavation. Soil treated on site. Removal date 2/1301. Questions may be directed to John Highim, AMFAC Land Co., at 543-8929.Trailer tank fell down and lost its contents. Cause is believed to be age/rust. Spill occurred sometime yesterday a.m.
Initial:	used begas to cleanup spilled oil, and removed contaminated soils. 25 cubic yard removed. Storing waste in 4 trucks next to Cane Haul Rd. (next to Fulme Yard)Case Number changed to date input - dummy consecutive number on 02/14/2006 to facilitate export to a MS SQL back end.
Report:	Not reported

Island:	Maui
Supplemental Loc. Text:	Not reported
Case Number:	19961122-1509
Units:	Pioneer Mill Co., Ltd. Trailer Tank Failure
Substances:	used oil
Less Or Greater Than:	Not reported
Numerical Quantity:	800
Units:	Gallons
Activity Type:	Response
Assignment Date:	11/22/1996

PIONEER MILL COMPANY, LTD. (Continued) **S106820070**

Activity Lead: Terry Corpus
Assignment End Date: Not reported
Result: 8
File Under: Pioneer Mill Co., Ltd.
Incident: EPCRA; FILE FOLDER, RE: RE-EVALUATION OF REQUIREMENTS FOR REPORTING UNDER CFR 40.Fuel overspilling noticed during UST excavation. Soil treated on site. Removal date 2/1301. Questions may be directed to John Highim, AMFAC Land Co., at 543-8929.Trailer tank fell down and lost its contents. Cause is believed to be age/rust. Spill occurred sometime yesterday a.m.
Initial: used begas to cleanup spilled oil, and removed contaminated soils. 25 cubic yard removed. Storing waste in 4 trucks next to Cane Haul Rd. (next to Fulme Yard)Case Number changed to date input - dummy consecutive number on 02/14/2006 to facilitate export to a MS SQL back end.
Report: Not reported

Island: Maui
Supplemental Loc. Text: Not reported
Case Number: 20010306-1356
Units: Pioneer Mill Co. (AMFAC Land Co.)
Substances: Diesel/Bunker Fuel
Less Or Greater Than: Not reported
Numerical Quantity: Not reported
Units: Not reported
Activity Type: Response
Assignment Date: 3/6/2001
Activity Lead: Liz Galvez
Assignment End Date: Not reported
Result: 8
File Under: Pioneer Mill Co., Ltd.
Incident: EPCRA; FILE FOLDER, RE: RE-EVALUATION OF REQUIREMENTS FOR REPORTING UNDER CFR 40.Fuel overspilling noticed during UST excavation. Soil treated on site. Removal date 2/1301. Questions may be directed to John Highim, AMFAC Land Co., at 543-8929.Trailer tank fell down and lost its contents. Cause is believed to be age/rust. Spill occurred sometime yesterday a.m.
Initial: used begas to cleanup spilled oil, and removed contaminated soils. 25 cubic yard removed. Storing waste in 4 trucks next to Cane Haul Rd. (next to Fulme Yard)Case Number changed to date input - dummy consecutive number on 02/14/2006 to facilitate export to a MS SQL back end.
Report: Not reported

HI INSTUTIONAL CONTROL:
Restricted Use: This facility is available for unrestricted use.
Comments on Restricted Use: Not reported
IC Relied on in Remedy: Not reported
File Under: Pioneer Mill Co., Ltd.

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8 **SHELL STATION** **LUST** **U001236813**
711 MILL STAKA 281 DICKENSON ST **UST** **N/A**
LAHAINA, HI 96761

LUST:
Facility ID: 9-501862
Facility Status: Site Cleanup Completed (NFA)
Facility Status Date: 16-Dec-93
Release ID: 900005
Project Officer: Sheila Mackenzie

SHELL STATION (Continued) **U001236813**

UST:

Facility ID:	9-501862
Owner:	EQUILON ENTERPRISES, LLC DBA SHELL OIL PRODUCTS US
Owner Address:	2555 13TH AVE, SW
Ownder City,St,Zip:	Lahaina, 96761 96761

Tank ID:	1
Date Installed:	12/30/1988
Tank Status:	**Currently In Use**
Date Closed:	Not reported
Tank Capacity:	10000
Substance:	Gasoline

Tank ID:	2
Date Installed:	3/2/1988
Tank Status:	**Currently In Use**
Date Closed:	Not reported
Tank Capacity:	10000
Substance:	Gasoline

Tank ID:	3
Date Installed:	3/2/1988
Tank Status:	**Currently In Use**
Date Closed:	Not reported
Tank Capacity:	10000
Substance:	Gasoline

---

8 **CODAC'S SALES & SERVICE** **LUST** **U003222214**
240 PAPALAUA ST **UST** **N/A**
LAHAINA, HI 96761

LUST:

Facility ID:	9-501125
Facility Status:	Site Cleanup Completed (NFA)
Facility Status Date:	11-Jul-05
Release ID:	040038
Project Officer:	Shunsheng Fu

UST:

Facility ID:	9-501125
Owner:	CHEVRON PRODUCTS COMPANY
Owner Address:	91-480 MALAKOLE ST.
Ownder City,St,Zip:	Lahaina, 96761 96761

Tank ID:	1
Date Installed:	12/1/1985
Tank Status:	**Currently In Use**
Date Closed:	Not reported
Tank Capacity:	10000
Substance:	Gasoline

Tank ID:	2
Date Installed:	12/1/1985
Tank Status:	**Currently In Use**

CODAC'S SALES & SERVICE (Continued) **U003222214**

Date Closed: Not reported
Tank Capacity: 10000
Substance: Gasoline

Tank ID: 3
Date Installed: 11/1/1985
Tank Status: Currently In Use
Date Closed: Not reported
Tank Capacity: 10000
Substance: Gasoline

Tank ID: R-1
Date Installed: Not reported
Tank Status: Permanently Out of Use
Date Closed: 1/1/1966
Tank Capacity: Not reported
Substance: Gasoline

Tank ID: R-2
Date Installed: Not reported
Tank Status: Permanently Out of Use
Date Closed: 1/1/1966
Tank Capacity: Not reported
Substance: Gasoline

Tank ID: R-3
Date Installed: Not reported
Tank Status: Permanently Out of Use
Date Closed: 1/1/1966
Tank Capacity: Not reported
Substance: Gasoline

Tank ID: R-4A
Date Installed: Not reported
Tank Status: Permanently Out of Use
Date Closed: 1/1/1966
Tank Capacity: Not reported
Substance: Used Oil

Tank ID: R-4B
Date Installed: 12/1/1985
Tank Status: Permanently Out of Use
Date Closed: 6/18/1997
Tank Capacity: 1000
Substance: Used Oil

8 CODAC'S CHEVRON GASOLINE STATION (LAHAINA CHEVRON) **SHWS** **S106818666**
240 PAPALAUA ST **SPILLS** **N/A**
LAHAINA, HI 96761 **INST CONTROL**

SHWS:

File Under:	Lahaina Petroleum LLC
Supplement:	Codac's Chevron Facility
Restricted Use:	This facility is available for unrestricted use.
Restricted Use Comm:	Not reported
Ic Relied On In Remedy:	Not reported
Unit:	Hydraulic Hoists and Sand-and-Grease Trap Removal
Fed Id:	Not reported
Funding:	LMB
Agreement/program:	State Site
Sitelist Name:	Hydraulic Hoists and Sand-and-Grease Trap Removal
Activity Type:	File Review
Assignment Date:	10/1/2007
Activity Lead:	Lynn Bailey
Assignment End Date:	10/1/2007
End fill:	10/1/2007
Result fill:	Status Update
Overall Status:	Complete NFA Letter on File

HI SPILLS:

Island:	Maui
Supplemental Loc. Text:	Codac's Chevron Facility
Case Number:	20040719-1615
Units:	Hydraulic Hoist Removal Release
Substances:	TPH oil
Less Or Greater Than:	Not reported
Numerical Quantity:	Not reported
Units:	Not reported
Activity Type:	Response
Assignment Date:	7/19/2004
Activity Lead:	Liz Galvez
Assignment End Date:	10/28/2005
Result:	8
File Under:	Lahaina Petroleum LLC
Incident:	Release of TPH-O observed during removal of 2 hoists. Analytical result - 790 mg.kg
Initial:	Notification. Awaiting for clarification with name of station - if there has been a name change
Report:	Not reported

HI INSTUTIONAL CONTROL:

Restricted Use:	This facility is available for unrestricted use.
Comments on Restricted Use:	Not reported
IC Relied on in Remedy:	Not reported
File Under:	Lahaina Petroleum LLC

9 MID PAC PETROLEUM #254680 (PREV: ED'S UNION SERV — **LUST** — **U003222165**
243 LAHAINALUNA RD — **UST** — **N/A**
LAHAINA, HI 96761

LUST:

Facility ID:	9-500008
Facility Status:	LUST Cleanup Initiated
Facility Status Date:	26-Oct-04
Release ID:	040058
Project Officer:	Richard Takaba

UST:

Facility ID:	9-500008
Owner:	Mid Pac Petroleum LLC
Owner Address:	677 Ala Moana Blvd Suite 625
Ownder City,St,Zip:	Lahaina, 96761 96761
Tank ID:	4680-4
Date Installed:	4/15/1985
Tank Status:	**Currently In Use**
Date Closed:	Not reported
Tank Capacity:	550
Substance:	Used Oil
Tank ID:	87
Date Installed:	4/15/1985
Tank Status:	**Currently In Use**
Date Closed:	Not reported
Tank Capacity:	12000
Substance:	Gasoline
Tank ID:	92
Date Installed:	4/15/1985
Tank Status:	**Currently In Use**
Date Closed:	Not reported
Tank Capacity:	12000
Substance:	Gasoline

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9 SHELL STATION — **FINDS** — **1006843208**
263 LAHAINALUNA RD — **LUST** — **110014047414**
LAHAINA, HI 96761

FINDS:
Other Pertinent Environmental Activity Identified at Site

HI-UST (Hawaii - Underground Storage Tank). Hawaii Underground Storage Tank Program regulates underground storage tanks which store petroleum or hazardous substances and offers documents and data products for downloading.

LUST:

Facility ID:	9-500421
Facility Status:	LUST Cleanup Initiated
Facility Status Date:	22-Jan-01
Release ID:	010016
Project Officer:	Josh Nagashima

ORPHAN SUMMARY

City	EDR ID	Site Name	Site Address	Zip	Database(s)
HONOKOWAI	1009800213	HAWAIIAN CEMENT, HONOKOWAI B/P	CANE HAUL RD & PUUKOLII RD	96761	FINDS
KAANAPALI	1008173840	LANIKEHA PHASE I & PHASE II	C/O BOARD OF WATER SUPPLY	96761	FINDS
KAPALUA	U003732591	PAPILLION HAWAIIAN HELICOPTERS HELIPORT	HONOAPIILANI HIGHWAY	96761	LUST, UST
LAHAINA	1006819430	LAHAINA WASTE WATER PUMP STATION #4	ALA MOANA ST	96761	SHWS, FINDS
LAHAINA	1000244972	MAUI PINEAPPLE CO HONOLUA DIV	COR HONOAPILANI HWY/NAPILIHOU	96761	FINDS, RCRA-NonGen
LAHAINA	1010316489	ONE HOUR MARTINIZING	3350 L HONOAPIILANI RD	96761	RCRA-CESQG
LAHAINA	U003402933	LAHAINA SPS #2 (HONOAPIILANI)	2010 HONOAPIILANI HWY / KAANAPALI HWY	96761	LUST, UST
LAHAINA	U003402934	NAPILI #4 P.S.	3300 HONOAPIILANI HWY(L HONOAPIILANI HWY.MALIALANI	96761	UST
LAHAINA	U003402935	NAPILI #3 P.S. (KAEA POINT)	3300 HONOAPIILANI HWY(L HONOAPIILANI HWY / HOOHUI	96761	UST
LAHAINA	U003402936	NAPILI #2 P.S. (KAPUA)	3300 HONOAPIILANI HWY(L HONOAPIILANI HWY / AEKAI P	96761	UST
LAHAINA	U003402937	NAPILI #1 P.S. (HONOKOWA)	3300 HONOAPIILANI HWY(L HONOAPIILANI HWY / KAMEEUI	96761	UST
LAHAINA	U003541889	LAHAINA SPS#1 (HONOAPIILANI)	3300 HONOAPIILANI HWY(HONOAPIILANI HWY/HALAWAI DR)	96761	UST
LAHAINA	1008170097	HONOLUA RIDGE - PHASE I	62-3601 KAWAIHAE RD	96761	FINDS
LAHAINA	1009403737	VILLAGES OF LEIALI I, PHASE 1A	EAST OF HONOAPIILANI HIGHWAY	96761	FINDS
LAHAINA	S108859830	PUUKOLII OLD PIONEER MILL TRANSFORMERS	PUUKOLII ROAD		SHWS, SPILLS, INST CONTROL
LAHAINA	S108859841	SHAW STREET OLD PIONEER MILL TRANSFORMERS	SHAW STREET (PAST THE RECREATION CENTER)	96761	SHWS, SPILLS, INST CONTROL
LAHAINA	1010026314	MOKU ULA RESTORATION PHASE I	TMK: (2)4-6-007:001	96761	FINDS
LAHIANA	1004688774	RAILROADS OF HAWAII INC	KAANAPALI RESORT N OF PUUKOLII	96761	FINDS, RCRA-CESQG
NAPILI	U003222199	NAPILI CENTRAL OFFICE	HONOAPIILANI HWY / HUI RD EAST	96761	UST
NAPILI	1008090280	NAPILI B 5838-02	NAPILI	96761	FINDS

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

To maintain currency of the following federal and state databases, EDR contacts the appropriate governmental agency on a monthly or quarterly basis, as required.

Number of Days to Update: Provides confirmation that EDR is reporting records that have been updated within 90 days from the date the government agency made the information available to the public.

FEDERAL RECORDS

NPL: National Priority List

National Priorities List (Superfund). The NPL is a subset of CERCLIS and identifies over 1,200 sites for priority cleanup under the Superfund Program. NPL sites may encompass relatively large areas. As such, EDR provides polygon coverage for over 1,000 NPL site boundaries produced by EPA's Environmental Photographic Interpretation Center (EPIC) and regional EPA offices.

Date of Government Version: 04/30/2008
Date Data Arrived at EDR: 05/06/2008
Date Made Active in Reports: 06/09/2008
Number of Days to Update: 34

Source: EPA
Telephone: N/A
Last EDR Contact: 07/28/2008
Next Scheduled EDR Contact: 10/27/2008
Data Release Frequency: Quarterly

NPL Site Boundaries

Sources:

EPA's Environmental Photographic Interpretation Center (EPIC)
Telephone: 202-564-7333

EPA Region 1
Telephone 617-918-1143

EPA Region 6
Telephone: 214-655-6659

EPA Region 3
Telephone 215-814-5418

EPA Region 7
Telephone: 913-551-7247

EPA Region 4
Telephone 404-562-8033

EPA Region 8
Telephone: 303-312-6774

EPA Region 5
Telephone 312-886-6686

EPA Region 9
Telephone: 415-947-4246

EPA Region 10
Telephone 206-553-8665

Proposed NPL: Proposed National Priority List Sites

A site that has been proposed for listing on the National Priorities List through the issuance of a proposed rule in the Federal Register. EPA then accepts public comments on the site, responds to the comments, and places on the NPL those sites that continue to meet the requirements for listing.

Date of Government Version: 04/30/2008
Date Data Arrived at EDR: 05/06/2008
Date Made Active in Reports: 06/09/2008
Number of Days to Update: 34

Source: EPA
Telephone: N/A
Last EDR Contact: 07/28/2008
Next Scheduled EDR Contact: 10/27/2008
Data Release Frequency: Quarterly

DELISTED NPL: National Priority List Deletions

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes the criteria that the EPA uses to delete sites from the NPL. In accordance with 40 CFR 300.425.(e), sites may be deleted from the NPL where no further response is appropriate.

Date of Government Version: 04/30/2008
Date Data Arrived at EDR: 05/06/2008
Date Made Active in Reports: 06/09/2008
Number of Days to Update: 34

Source: EPA
Telephone: N/A
Last EDR Contact: 07/28/2008
Next Scheduled EDR Contact: 10/27/2008
Data Release Frequency: Quarterly

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

NPL LIENS: Federal Superfund Liens

Federal Superfund Liens. Under the authority granted the USEPA by CERCLA of 1980, the USEPA has the authority to file liens against real property in order to recover remedial action expenditures or when the property owner received notification of potential liability. USEPA compiles a listing of filed notices of Superfund Liens.

Date of Government Version: 10/15/1991
Date Data Arrived at EDR: 02/02/1994
Date Made Active in Reports: 03/30/1994
Number of Days to Update: 56

Source: EPA
Telephone: 202-564-4267
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: No Update Planned

CERCLIS: Comprehensive Environmental Response, Compensation, and Liability Information System

CERCLIS contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLIS contains sites which are either proposed to or on the National Priorities List (NPL) and sites which are in the screening and assessment phase for possible inclusion on the NPL.

Date of Government Version: 04/08/2008
Date Data Arrived at EDR: 04/25/2008
Date Made Active in Reports: 05/21/2008
Number of Days to Update: 26

Source: EPA
Telephone: 703-412-9810
Last EDR Contact: 07/22/2008
Next Scheduled EDR Contact: 09/15/2008
Data Release Frequency: Quarterly

CERCLIS-NFRAP: CERCLIS No Further Remedial Action Planned

Archived sites are sites that have been removed and archived from the inventory of CERCLIS sites. Archived status indicates that, to the best of EPA's knowledge, assessment at a site has been completed and that EPA has determined no further steps will be taken to list this site on the National Priorities List (NPL), unless information indicates this decision was not appropriate or other considerations require a recommendation for listing at a later time. This decision does not necessarily mean that there is no hazard associated with a given site; it only means that, based upon available information, the location is not judged to be a potential NPL site.

Date of Government Version: 12/03/2007
Date Data Arrived at EDR: 12/06/2007
Date Made Active in Reports: 02/20/2008
Number of Days to Update: 76

Source: EPA
Telephone: 703-412-9810
Last EDR Contact: 06/17/2008
Next Scheduled EDR Contact: 09/15/2008
Data Release Frequency: Quarterly

LIENS 2: CERCLA Lien Information

A Federal CERCLA ('Superfund') lien can exist by operation of law at any site or property at which EPA has spent Superfund monies. These monies are spent to investigate and address releases and threatened releases of contamination. CERCLIS provides information as to the identity of these sites and properties.

Date of Government Version: 06/13/2008
Date Data Arrived at EDR: 06/27/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 42

Source: Environmental Protection Agency
Telephone: 202-564-6023
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Varies

CORRACTS: Corrective Action Report

CORRACTS identifies hazardous waste handlers with RCRA corrective action activity.

Date of Government Version: 03/26/2008
Date Data Arrived at EDR: 04/02/2008
Date Made Active in Reports: 05/06/2008
Number of Days to Update: 34

Source: EPA
Telephone: 800-424-9346
Last EDR Contact: 06/02/2008
Next Scheduled EDR Contact: 09/01/2008
Data Release Frequency: Quarterly

RCRA-TSDF: RCRA - Transporters, Storage and Disposal

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Transporters are individuals or entities that move hazardous waste from the generator offsite to a facility that can recycle, treat, store, or dispose of the waste. TSDFs treat, store, or dispose of the waste.

Date of Government Version: 05/12/2008
Date Data Arrived at EDR: 06/13/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 56

Source: Environmental Protection Agency
Telephone: (415) 495-8895
Last EDR Contact: 05/21/2008
Next Scheduled EDR Contact: 08/18/2008
Data Release Frequency: Quarterly

RCRA-LQG: RCRA - Large Quantity Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Large quantity generators (LQGs) generate over 1,000 kilograms (kg) of hazardous waste, or over 1 kg of acutely hazardous waste per month.

Date of Government Version: 05/12/2008
Date Data Arrived at EDR: 06/13/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 56

Source: Environmental Protection Agency
Telephone: (415) 495-8895
Last EDR Contact: 05/21/2008
Next Scheduled EDR Contact: 08/18/2008
Data Release Frequency: Quarterly

RCRA-SQG: RCRA - Small Quantity Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Small quantity generators (SQGs) generate between 100 kg and 1,000 kg of hazardous waste per month.

Date of Government Version: 05/12/2008
Date Data Arrived at EDR: 06/13/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 56

Source: Environmental Protection Agency
Telephone: (415) 495-8895
Last EDR Contact: 05/21/2008
Next Scheduled EDR Contact: 08/18/2008
Data Release Frequency: Quarterly

RCRA-CESQG: RCRA - Conditionally Exempt Small Quantity Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Conditionally exempt small quantity generators (CESQGs) generate less than 100 kg of hazardous waste, or less than 1 kg of acutely hazardous waste per month.

Date of Government Version: 05/12/2008
Date Data Arrived at EDR: 06/13/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 56

Source: Environmental Protection Agency
Telephone: (415) 495-8895
Last EDR Contact: 05/21/2008
Next Scheduled EDR Contact: 08/18/2008
Data Release Frequency: Varies

RCRA-NonGen: RCRA - Non Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Non-Generators do not presently generate hazardous waste.

Date of Government Version: 05/12/2008
Date Data Arrived at EDR: 06/13/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 56

Source: Environmental Protection Agency
Telephone: (415) 495-8895
Last EDR Contact: 05/21/2008
Next Scheduled EDR Contact: 08/18/2008
Data Release Frequency: Varies

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

US ENG CONTROLS: Engineering Controls Sites List

A listing of sites with engineering controls in place. Engineering controls include various forms of caps, building foundations, liners, and treatment methods to create pathway elimination for regulated substances to enter environmental media or effect human health.

Date of Government Version: 04/04/2008
Date Data Arrived at EDR: 04/17/2008
Date Made Active in Reports: 05/15/2008
Number of Days to Update: 28

Source: Environmental Protection Agency
Telephone: 703-603-0695
Last EDR Contact: 06/30/2008
Next Scheduled EDR Contact: 09/29/2008
Data Release Frequency: Varies

US INST CONTROL: Sites with Institutional Controls

A listing of sites with institutional controls in place. Institutional controls include administrative measures, such as groundwater use restrictions, construction restrictions, property use restrictions, and post remediation care requirements intended to prevent exposure to contaminants remaining on site. Deed restrictions are generally required as part of the institutional controls.

Date of Government Version: 04/04/2008
Date Data Arrived at EDR: 04/17/2008
Date Made Active in Reports: 05/15/2008
Number of Days to Update: 28

Source: Environmental Protection Agency
Telephone: 703-603-0695
Last EDR Contact: 06/30/2008
Next Scheduled EDR Contact: 09/29/2008
Data Release Frequency: Varies

ERNS: Emergency Response Notification System

Emergency Response Notification System. ERNS records and stores information on reported releases of oil and hazardous substances.

Date of Government Version: 12/31/2007
Date Data Arrived at EDR: 01/23/2008
Date Made Active in Reports: 03/17/2008
Number of Days to Update: 54

Source: National Response Center, United States Coast Guard
Telephone: 202-267-2180
Last EDR Contact: 07/25/2008
Next Scheduled EDR Contact: 10/20/2008
Data Release Frequency: Annually

HMIRS: Hazardous Materials Information Reporting System

Hazardous Materials Incident Report System. HMIRS contains hazardous material spill incidents reported to DOT.

Date of Government Version: 12/31/2007
Date Data Arrived at EDR: 04/16/2008
Date Made Active in Reports: 05/15/2008
Number of Days to Update: 29

Source: U.S. Department of Transportation
Telephone: 202-366-4555
Last EDR Contact: 07/15/2008
Next Scheduled EDR Contact: 10/13/2008
Data Release Frequency: Annually

DOT OPS: Incident and Accident Data

Department of Transporation, Office of Pipeline Safety Incident and Accident data.

Date of Government Version: 05/14/2008
Date Data Arrived at EDR: 05/28/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 72

Source: Department of Transporation, Office of Pipeline Safety
Telephone: 202-366-4595
Last EDR Contact: 05/28/2008
Next Scheduled EDR Contact: 08/25/2008
Data Release Frequency: Varies

CDL: Clandestine Drug Labs

A listing of clandestine drug lab locations. The U.S. Department of Justice ("the Department") provides this web site as a public service. It contains addresses of some locations where law enforcement agencies reported they found chemicals or other items that indicated the presence of either clandestine drug laboratories or dumpsites. In most cases, the source of the entries is not the Department, and the Department has not verified the entry and does not guarantee its accuracy. Members of the public must verify the accuracy of all entries by, for example, contacting local law enforcement and local health departments.

Date of Government Version: 09/01/2007
Date Data Arrived at EDR: 12/03/2007
Date Made Active in Reports: 12/28/2007
Number of Days to Update: 25

Source: Drug Enforcement Administration
Telephone: 202-307-1000
Last EDR Contact: 06/27/2008
Next Scheduled EDR Contact: 09/22/2008
Data Release Frequency: Quarterly

US BROWNFIELDS: A Listing of Brownfields Sites

Included in the listing are brownfields properties addresses by Cooperative Agreement Recipients and brownfields properties addressed by Targeted Brownfields Assessments. Targeted Brownfields Assessments-EPA's Targeted Brownfields Assessments (TBA) program is designed to help states, tribes, and municipalities--especially those without EPA Brownfields Assessment Demonstration Pilots--minimize the uncertainties of contamination often associated with brownfields. Under the TBA program, EPA provides funding and/or technical assistance for environmental assessments at brownfields sites throughout the country. Targeted Brownfields Assessments supplement and work with other efforts under EPA's Brownfields Initiative to promote cleanup and redevelopment of brownfields. Cooperative Agreement Recipients-States, political subdivisions, territories, and Indian tribes become Brownfields Cleanup Revolving Loan Fund (BCRLF) cooperative agreement recipients when they enter into BCRLF cooperative agreements with the U.S. EPA. EPA selects BCRLF cooperative agreement recipients based on a proposal and application process. BCRLF cooperative agreement recipients must use EPA funds provided through BCRLF cooperative agreement for specified brownfields-related cleanup activities.

Date of Government Version: 04/01/2008
Date Data Arrived at EDR: 04/30/2008
Date Made Active in Reports: 05/30/2008
Number of Days to Update: 30

Source: Environmental Protection Agency
Telephone: 202-566-2777
Last EDR Contact: 07/15/2008
Next Scheduled EDR Contact: 10/13/2008
Data Release Frequency: Semi-Annually

DOD: Department of Defense Sites

This data set consists of federally owned or administered lands, administered by the Department of Defense, that have any area equal to or greater than 640 acres of the United States, Puerto Rico, and the U.S. Virgin Islands.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 11/10/2006
Date Made Active in Reports: 01/11/2007
Number of Days to Update: 62

Source: USGS
Telephone: 703-692-8801
Last EDR Contact: 08/08/2008
Next Scheduled EDR Contact: 11/03/2008
Data Release Frequency: Semi-Annually

FUDS: Formerly Used Defense Sites

The listing includes locations of Formerly Used Defense Sites properties where the US Army Corps of Engineers is actively working or will take necessary cleanup actions.

Date of Government Version: 12/31/2006
Date Data Arrived at EDR: 08/31/2007
Date Made Active in Reports: 10/11/2007
Number of Days to Update: 41

Source: U.S. Army Corps of Engineers
Telephone: 202-528-4285
Last EDR Contact: 06/30/2008
Next Scheduled EDR Contact: 09/29/2008
Data Release Frequency: Varies

LUCIS: Land Use Control Information System

LUCIS contains records of land use control information pertaining to the former Navy Base Realignment and Closure properties.

Date of Government Version: 12/09/2005
Date Data Arrived at EDR: 12/11/2006
Date Made Active in Reports: 01/11/2007
Number of Days to Update: 31

Source: Department of the Navy
Telephone: 843-820-7326
Last EDR Contact: 06/09/2008
Next Scheduled EDR Contact: 09/08/2008
Data Release Frequency: Varies

CONSENT: Superfund (CERCLA) Consent Decrees

Major legal settlements that establish responsibility and standards for cleanup at NPL (Superfund) sites. Released periodically by United States District Courts after settlement by parties to litigation matters.

Date of Government Version: 02/08/2008
Date Data Arrived at EDR: 04/25/2008
Date Made Active in Reports: 05/30/2008
Number of Days to Update: 35

Source: Department of Justice, Consent Decree Library
Telephone: Varies
Last EDR Contact: 07/21/2008
Next Scheduled EDR Contact: 10/20/2008
Data Release Frequency: Varies

ROD: Records Of Decision

Record of Decision. ROD documents mandate a permanent remedy at an NPL (Superfund) site containing technical and health information to aid in the cleanup.

Date of Government Version: 01/14/2008
Date Data Arrived at EDR: 01/22/2008
Date Made Active in Reports: 01/30/2008
Number of Days to Update: 8

Source: EPA
Telephone: 703-416-0223
Last EDR Contact: 06/30/2008
Next Scheduled EDR Contact: 09/29/2008
Data Release Frequency: Annually

UMTRA: Uranium Mill Tailings Sites

Uranium ore was mined by private companies for federal government use in national defense programs. When the mills shut down, large piles of the sand-like material (mill tailings) remain after uranium has been extracted from the ore. Levels of human exposure to radioactive materials from the piles are low; however, in some cases tailings were used as construction materials before the potential health hazards of the tailings were recognized.

Date of Government Version: 07/13/2007
Date Data Arrived at EDR: 12/03/2007
Date Made Active in Reports: 01/24/2008
Number of Days to Update: 52

Source: Department of Energy
Telephone: 505-845-0011
Last EDR Contact: 06/16/2008
Next Scheduled EDR Contact: 09/15/2008
Data Release Frequency: Varies

ODI: Open Dump Inventory

An open dump is defined as a disposal facility that does not comply with one or more of the Part 257 or Part 258 Subtitle D Criteria.

Date of Government Version: 06/30/1985
Date Data Arrived at EDR: 08/09/2004
Date Made Active in Reports: 09/17/2004
Number of Days to Update: 39

Source: Environmental Protection Agency
Telephone: 800-424-9346
Last EDR Contact: 06/09/2004
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

DEBRIS REGION 9: Torres Martinez Reservation Illegal Dump Site Locations

A listing of illegal dump sites location on the Torres Martinez Indian Reservation located in eastern Riverside County and northern Imperial County, California.

Date of Government Version: 03/25/2008
Date Data Arrived at EDR: 04/17/2008
Date Made Active in Reports: 05/15/2008
Number of Days to Update: 28

Source: EPA, Region 9
Telephone: 415-972-3336
Last EDR Contact: 06/23/2008
Next Scheduled EDR Contact: 09/22/2008
Data Release Frequency: Varies

MINES: Mines Master Index File

Contains all mine identification numbers issued for mines active or opened since 1971. The data also includes violation information.

Date of Government Version: 02/07/2008
Date Data Arrived at EDR: 03/26/2008
Date Made Active in Reports: 04/18/2008
Number of Days to Update: 23

Source: Department of Labor, Mine Safety and Health Administration
Telephone: 303-231-5959
Last EDR Contact: 06/25/2008
Next Scheduled EDR Contact: 09/22/2008
Data Release Frequency: Semi-Annually

TRIS: Toxic Chemical Release Inventory System

Toxic Release Inventory System. TRIS identifies facilities which release toxic chemicals to the air, water and land in reportable quantities under SARA Title III Section 313.

Date of Government Version: 12/31/2006
Date Data Arrived at EDR: 02/29/2008
Date Made Active in Reports: 04/18/2008
Number of Days to Update: 49

Source: EPA
Telephone: 202-566-0250
Last EDR Contact: 06/16/2008
Next Scheduled EDR Contact: 09/15/2008
Data Release Frequency: Annually

TSCA: Toxic Substances Control Act

Toxic Substances Control Act. TSCA identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site.

Date of Government Version: 12/31/2002
Date Data Arrived at EDR: 04/14/2006
Date Made Active in Reports: 05/30/2006
Number of Days to Update: 46

Source: EPA
Telephone: 202-260-5521
Last EDR Contact: 08/11/2008
Next Scheduled EDR Contact: 10/13/2008
Data Release Frequency: Every 4 Years

FTTS: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)

FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA and EPCRA (Emergency Planning and Community Right-to-Know Act). To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 04/11/2008
Date Data Arrived at EDR: 04/24/2008
Date Made Active in Reports: 05/21/2008
Number of Days to Update: 27

Source: EPA/Office of Prevention, Pesticides and Toxic Substances
Telephone: 202-566-1667
Last EDR Contact: 06/16/2008
Next Scheduled EDR Contact: 09/15/2008
Data Release Frequency: Quarterly

FTTS INSP: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)

A listing of FIFRA/TSCA Tracking System (FTTS) inspections and enforcements.

Date of Government Version: 04/11/2008
Date Data Arrived at EDR: 04/24/2008
Date Made Active in Reports: 05/21/2008
Number of Days to Update: 27

Source: EPA
Telephone: 202-566-1667
Last EDR Contact: 06/16/2008
Next Scheduled EDR Contact: 09/15/2008
Data Release Frequency: Quarterly

HIST FTTS: FIFRA/TSCA Tracking System Administrative Case Listing

A complete administrative case listing from the FIFRA/TSCA Tracking System (FTTS) for all ten EPA regions. The information was obtained from the National Compliance Database (NCDB). NCDB supports the implementation of FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) and TSCA (Toxic Substances Control Act). Some EPA regions are now closing out records. Because of that, and the fact that some EPA regions are not providing EPA Headquarters with updated records, it was decided to create a HIST FTTS database. It included records that may not be included in the newer FTTS database updates. This database is no longer updated.

Date of Government Version: 10/19/2006
Date Data Arrived at EDR: 03/01/2007
Date Made Active in Reports: 04/10/2007
Number of Days to Update: 40

Source: Environmental Protection Agency
Telephone: 202-564-2501
Last EDR Contact: 12/17/2007
Next Scheduled EDR Contact: 03/17/2008
Data Release Frequency: No Update Planned

HIST FTTS INSP: FIFRA/TSCA Tracking System Inspection & Enforcement Case Listing

A complete inspection and enforcement case listing from the FIFRA/TSCA Tracking System (FTTS) for all ten EPA regions. The information was obtained from the National Compliance Database (NCDB). NCDB supports the implementation of FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) and TSCA (Toxic Substances Control Act). Some EPA regions are now closing out records. Because of that, and the fact that some EPA regions are not providing EPA Headquarters with updated records, it was decided to create a HIST FTTS database. It included records that may not be included in the newer FTTS database updates. This database is no longer updated.

Date of Government Version: 10/19/2006
Date Data Arrived at EDR: 03/01/2007
Date Made Active in Reports: 04/10/2007
Number of Days to Update: 40

Source: Environmental Protection Agency
Telephone: 202-564-2501
Last EDR Contact: 12/17/2008
Next Scheduled EDR Contact: 03/17/2008
Data Release Frequency: No Update Planned

SSTS: Section 7 Tracking Systems

Section 7 of the Federal Insecticide, Fungicide and Rodenticide Act, as amended (92 Stat. 829) requires all registered pesticide-producing establishments to submit a report to the Environmental Protection Agency by March 1st each year. Each establishment must report the types and amounts of pesticides, active ingredients and devices being produced, and those having been produced and sold or distributed in the past year.

Date of Government Version: 12/31/2006
Date Data Arrived at EDR: 03/14/2008
Date Made Active in Reports: 04/18/2008
Number of Days to Update: 35

Source: EPA
Telephone: 202-564-4203
Last EDR Contact: 07/14/2008
Next Scheduled EDR Contact: 10/13/2008
Data Release Frequency: Annually

ICIS: Integrated Compliance Information System

The Integrated Compliance Information System (ICIS) supports the information needs of the national enforcement and compliance program as well as the unique needs of the National Pollutant Discharge Elimination System (NPDES) program.

Date of Government Version: 04/24/2008
Date Data Arrived at EDR: 06/10/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 59

Source: Environmental Protection Agency
Telephone: 202-564-5088
Last EDR Contact: 07/14/2008
Next Scheduled EDR Contact: 10/13/2008
Data Release Frequency: Quarterly

PADS: PCB Activity Database System

PCB Activity Database. PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA of such activities.

Date of Government Version: 12/04/2007
Date Data Arrived at EDR: 02/07/2008
Date Made Active in Reports: 03/17/2008
Number of Days to Update: 39

Source: EPA
Telephone: 202-566-0500
Last EDR Contact: 08/07/2008
Next Scheduled EDR Contact: 11/03/2008
Data Release Frequency: Annually

MLTS: Material Licensing Tracking System

MLTS is maintained by the Nuclear Regulatory Commission and contains a list of approximately 8,100 sites which possess or use radioactive materials and which are subject to NRC licensing requirements. To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 04/22/2008
Date Data Arrived at EDR: 05/06/2008
Date Made Active in Reports: 06/09/2008
Number of Days to Update: 34

Source: Nuclear Regulatory Commission
Telephone: 301-415-7169
Last EDR Contact: 06/30/2008
Next Scheduled EDR Contact: 09/29/2008
Data Release Frequency: Quarterly

RADINFO: Radiation Information Database

The Radiation Information Database (RADINFO) contains information about facilities that are regulated by U.S. Environmental Protection Agency (EPA) regulations for radiation and radioactivity.

Date of Government Version: 04/29/2008
Date Data Arrived at EDR: 05/01/2008
Date Made Active in Reports: 05/21/2008
Number of Days to Update: 20

Source: Environmental Protection Agency
Telephone: 202-343-9775
Last EDR Contact: 07/31/2008
Next Scheduled EDR Contact: 10/27/2008
Data Release Frequency: Quarterly

FINDS: Facility Index System/Facility Registry System

Facility Index System. FINDS contains both facility information and 'pointers' to other sources that contain more detail. EDR includes the following FINDS databases in this report: PCS (Permit Compliance System), AIRS (Aerometric Information Retrieval System), DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes), FURS (Federal Underground Injection Control), C-DOCKET (Criminal Docket System used to track criminal enforcement actions for all environmental statutes), FFIS (Federal Facilities Information System), STATE (State Environmental Laws and Statutes), and PADS (PCB Activity Data System).

Date of Government Version: 04/03/2008
Date Data Arrived at EDR: 04/08/2008
Date Made Active in Reports: 05/06/2008
Number of Days to Update: 28

Source: EPA
Telephone: (415) 947-8000
Last EDR Contact: 06/30/2008
Next Scheduled EDR Contact: 09/29/2008
Data Release Frequency: Quarterly

RAATS: RCRA Administrative Action Tracking System

RCRA Administration Action Tracking System. RAATS contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by the EPA. For administration actions after September 30, 1995, data entry in the RAATS database was discontinued. EPA will retain a copy of the database for historical records. It was necessary to terminate RAATS because a decrease in agency resources made it impossible to continue to update the information contained in the database.

Date of Government Version: 04/17/1995
Date Data Arrived at EDR: 07/03/1995
Date Made Active in Reports: 08/07/1995
Number of Days to Update: 35

Source: EPA
Telephone: 202-564-4104
Last EDR Contact: 06/02/2008
Next Scheduled EDR Contact: 09/01/2008
Data Release Frequency: No Update Planned

BRS: Biennial Reporting System

The Biennial Reporting System is a national system administered by the EPA that collects data on the generation and management of hazardous waste. BRS captures detailed data from two groups: Large Quantity Generators (LQG) and Treatment, Storage, and Disposal Facilities.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 03/06/2007
Date Made Active in Reports: 04/13/2007
Number of Days to Update: 38

Source: EPA/NTIS
Telephone: 800-424-9346
Last EDR Contact: 06/11/2008
Next Scheduled EDR Contact: 09/08/2008
Data Release Frequency: Biennially

STATE AND LOCAL RECORDS

SHWS: Sites List

Facilities, sites or areas in which the Office of Hazard Evaluation and Emergency Response has an interest, has investigated or may investigate under HRS 128D (includes CERCLIS sites).

Date of Government Version: 04/04/2008
Date Data Arrived at EDR: 06/18/2008
Date Made Active in Reports: 07/22/2008
Number of Days to Update: 34

Source: Department of Health
Telephone: 808-586-4249
Last EDR Contact: 06/18/2008
Next Scheduled EDR Contact: 09/15/2008
Data Release Frequency: Semi-Annually

SWF/LF: Permitted Landfills in the State of Hawaii

Solid Waste Facilities/Landfill Sites. SWF/LF type records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. Depending on the state, these may be active or inactive facilities or open dumps that failed to meet RCRA Subtitle D Section 4004 criteria for solid waste landfills or disposal sites.

Date of Government Version: 05/19/2004
Date Data Arrived at EDR: 05/20/2004
Date Made Active in Reports: 06/22/2004
Number of Days to Update: 33

Source: Department of Health
Telephone: 808-586-4245
Last EDR Contact: 08/04/2008
Next Scheduled EDR Contact: 10/20/2008
Data Release Frequency: Varies

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

LUST: Leaking Underground Storage Tank Database

Leaking Underground Storage Tank Incident Reports. LUST records contain an inventory of reported leaking underground storage tank incidents. Not all states maintain these records, and the information stored varies by state.

Date of Government Version: 06/30/2008
Date Data Arrived at EDR: 07/02/2008
Date Made Active in Reports: 07/22/2008
Number of Days to Update: 20

Source: Department of Health
Telephone: 808-586-4228
Last EDR Contact: 06/27/2008
Next Scheduled EDR Contact: 09/22/2008
Data Release Frequency: Semi-Annually

UST: Underground Storage Tank Database

Registered Underground Storage Tanks. UST's are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA) and must be registered with the state department responsible for administering the UST program. Available information varies by state program.

Date of Government Version: 06/30/2008
Date Data Arrived at EDR: 07/02/2008
Date Made Active in Reports: 07/24/2008
Number of Days to Update: 22

Source: Department of Health
Telephone: 808-586-4228
Last EDR Contact: 06/27/2008
Next Scheduled EDR Contact: 09/22/2008
Data Release Frequency: Semi-Annually

SPILLS: Release Notifications

Releases of hazardous substances to the environment reported to the Office of Hazard Evaluation and Emergency Response since 1988.

Date of Government Version: 04/04/2008
Date Data Arrived at EDR: 06/18/2008
Date Made Active in Reports: 07/22/2008
Number of Days to Update: 34

Source: Department of Health
Telephone: 808-586-4249
Last EDR Contact: 06/18/2008
Next Scheduled EDR Contact: 09/15/2008
Data Release Frequency: Varies

INST CONTROL: Sites with Institutional Controls

Voluntary Remediation Program and Brownfields sites with institutional controls in place.

Date of Government Version: 04/04/2008
Date Data Arrived at EDR: 06/18/2008
Date Made Active in Reports: 07/22/2008
Number of Days to Update: 34

Source: Department of Health
Telephone: 808-586-4249
Last EDR Contact: 06/18/2008
Next Scheduled EDR Contact: 09/15/2008
Data Release Frequency: Varies

VCP: Voluntary Response Program Sites

Sites participating in the Voluntary Response Program. The purpose of the VRP is to streamline the cleanup process in a way that will encourage prospective developers, lenders, and purchasers to voluntarily cleanup properties.

Date of Government Version: 04/04/2008
Date Data Arrived at EDR: 06/18/2008
Date Made Active in Reports: 07/22/2008
Number of Days to Update: 34

Source: Department of Health
Telephone: 808-586-4249
Last EDR Contact: 06/18/2008
Next Scheduled EDR Contact: 09/15/2008
Data Release Frequency: Varies

DRYCLEANERS: Permitted Drycleaner Facility Listing

A listing of permitted drycleaner facilities in the state.

Date of Government Version: 03/28/2008
Date Data Arrived at EDR: 03/28/2008
Date Made Active in Reports: 04/24/2008
Number of Days to Update: 27

Source: Department of Health
Telephone: 808-586-4200
Last EDR Contact: 07/28/2008
Next Scheduled EDR Contact: 10/27/2008
Data Release Frequency: Varies

BROWNFIELDS: Brownfields Sites
With certain legal exclusions and additions, the term 'brownfield site' means real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

Date of Government Version: 04/04/2008
Date Data Arrived at EDR: 06/18/2008
Date Made Active in Reports: 07/22/2008
Number of Days to Update: 34

Source: Department of Health
Telephone: 808-586-4249
Last EDR Contact: 06/18/2008
Next Scheduled EDR Contact: 09/15/2008
Data Release Frequency: Varies

AIRS: List of Permitted Facilities
A listing of permitted facilities in the state.

Date of Government Version: 03/28/2008
Date Data Arrived at EDR: 03/28/2008
Date Made Active in Reports: 04/24/2008
Number of Days to Update: 27

Source: Department of Health
Telephone: 808-586-4200
Last EDR Contact: 07/28/2008
Next Scheduled EDR Contact: 10/27/2008
Data Release Frequency: Varies

TRIBAL RECORDS

INDIAN RESERV: Indian Reservations
This map layer portrays Indian administered lands of the United States that have any area equal to or greater than 640 acres.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 12/08/2006
Date Made Active in Reports: 01/11/2007
Number of Days to Update: 34

Source: USGS
Telephone: 202-208-3710
Last EDR Contact: 08/08/2008
Next Scheduled EDR Contact: 11/03/2008
Data Release Frequency: Semi-Annually

INDIAN ODI: Report on the Status of Open Dumps on Indian Lands
Location of open dumps on Indian land.

Date of Government Version: 12/31/1998
Date Data Arrived at EDR: 12/03/2007
Date Made Active in Reports: 01/24/2008
Number of Days to Update: 52

Source: Environmental Protection Agency
Telephone: 703-308-8245
Last EDR Contact: 05/27/2008
Next Scheduled EDR Contact: 08/25/2008
Data Release Frequency: Varies

INDIAN LUST R10: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Alaska, Idaho, Oregon and Washington.

Date of Government Version: 05/30/2008
Date Data Arrived at EDR: 05/30/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 70

Source: EPA Region 10
Telephone: 206-553-2857
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Quarterly

INDIAN LUST R9: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Arizona, California, New Mexico and Nevada

Date of Government Version: 07/11/2008
Date Data Arrived at EDR: 07/11/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 28

Source: Environmental Protection Agency
Telephone: 415-972-3372
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Quarterly

INDIAN LUST R8: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming.

Date of Government Version: 05/28/2008
Date Data Arrived at EDR: 06/10/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 59

Source: EPA Region 8
Telephone: 303-312-6271
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Quarterly

INDIAN LUST R7: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Iowa, Kansas, and Nebraska

Date of Government Version: 03/17/2008
Date Data Arrived at EDR: 03/27/2008
Date Made Active in Reports: 05/06/2008
Number of Days to Update: 40

Source: EPA Region 7
Telephone: 913-551-7003
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Varies

INDIAN LUST R6: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in New Mexico and Oklahoma.

Date of Government Version: 06/16/2008
Date Data Arrived at EDR: 06/16/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 53

Source: EPA Region 6
Telephone: 214-665-6597
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Varies

INDIAN LUST R4: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Florida, Mississippi and North Carolina.

Date of Government Version: 03/17/2008
Date Data Arrived at EDR: 03/27/2008
Date Made Active in Reports: 05/06/2008
Number of Days to Update: 40

Source: EPA Region 4
Telephone: 404-562-8677
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Semi-Annually

INDIAN LUST R1: Leaking Underground Storage Tanks on Indian Land
A listing of leaking underground storage tank locations on Indian Land.

Date of Government Version: 03/12/2008
Date Data Arrived at EDR: 03/14/2008
Date Made Active in Reports: 03/20/2008
Number of Days to Update: 6

Source: EPA Region 1
Telephone: 617-918-1313
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Varies

INDIAN UST R1: Underground Storage Tanks on Indian Land
A listing of underground storage tank locations on Indian Land.

Date of Government Version: 03/12/2008
Date Data Arrived at EDR: 03/14/2008
Date Made Active in Reports: 03/20/2008
Number of Days to Update: 6

Source: EPA, Region 1
Telephone: 617-918-1313
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Varies

INDIAN UST R4: Underground Storage Tanks on Indian Land
No description is available for this data

Date of Government Version: 03/17/2008
Date Data Arrived at EDR: 03/27/2008
Date Made Active in Reports: 05/06/2008
Number of Days to Update: 40

Source: EPA Region 4
Telephone: 404-562-9424
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Semi-Annually

INDIAN UST R5: Underground Storage Tanks on Indian Land
No description is available for this data

Date of Government Version: 12/21/2007
Date Data Arrived at EDR: 12/21/2007
Date Made Active in Reports: 01/24/2008
Number of Days to Update: 34

Source: EPA Region 5
Telephone: 312-886-6136
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Varies

INDIAN UST R6: Underground Storage Tanks on Indian Land
No description is available for this data

Date of Government Version: 06/16/2008
Date Data Arrived at EDR: 06/16/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 53

Source: EPA Region 6
Telephone: 214-665-7591
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Semi-Annually

INDIAN UST R7: Underground Storage Tanks on Indian Land
No description is available for this data

Date of Government Version: 06/01/2007
Date Data Arrived at EDR: 06/14/2007
Date Made Active in Reports: 07/05/2007
Number of Days to Update: 21

Source: EPA Region 7
Telephone: 913-551-7003
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Varies

INDIAN UST R8: Underground Storage Tanks on Indian Land
No description is available for this data

Date of Government Version: 05/28/2008
Date Data Arrived at EDR: 06/10/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 59

Source: EPA Region 8
Telephone: 303-312-6137
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Quarterly

INDIAN UST R9: Underground Storage Tanks on Indian Land
No description is available for this data

Date of Government Version: 07/11/2008
Date Data Arrived at EDR: 07/11/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 28

Source: EPA Region 9
Telephone: 415-972-3368
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Quarterly

INDIAN UST R10: Underground Storage Tanks on Indian Land
No description is available for this data

Date of Government Version: 05/30/2008
Date Data Arrived at EDR: 06/27/2008
Date Made Active in Reports: 08/08/2008
Number of Days to Update: 42

Source: EPA Region 10
Telephone: 206-553-2857
Last EDR Contact: 08/18/2008
Next Scheduled EDR Contact: 11/17/2008
Data Release Frequency: Quarterly

INDIAN VCP R1: Voluntary Cleanup Priority Listing
A listing of voluntary cleanup priority sites located on Indian Land located in Region 1.

Date of Government Version: 04/02/2008
Date Data Arrived at EDR: 04/22/2008
Date Made Active in Reports: 05/19/2008
Number of Days to Update: 27

Source: EPA, Region 1
Telephone: 617-918-1102
Last EDR Contact: 07/21/2008
Next Scheduled EDR Contact: 10/20/2008
Data Release Frequency: Varies

INDIAN VCP R7: Voluntary Cleanup Priority Lisitng
A listing of voluntary cleanup priority sites located on Indian Land located in Region 7.

Date of Government Version: 03/20/2008
Date Data Arrived at EDR: 04/22/2008
Date Made Active in Reports: 05/19/2008
Number of Days to Update: 27

Source: EPA, Region 7
Telephone: 913-551-7365
Last EDR Contact: 07/21/2008
Next Scheduled EDR Contact: 10/20/2008
Data Release Frequency: Varies

EDR PROPRIETARY RECORDS

Manufactured Gas Plants: EDR Proprietary Manufactured Gas Plants
The EDR Proprietary Manufactured Gas Plant Database includes records of coal gas plants (manufactured gas plants) compiled by EDR's researchers. Manufactured gas sites were used in the United States from the 1800's to 1950's to produce a gas that could be distributed and used as fuel. These plants used whale oil, rosin, coal, or a mixture of coal, oil, and water that also produced a significant amount of waste. Many of the byproducts of the gas production, such as coal tar (oily waste containing volatile and non-volatile chemicals), sludges, oils and other compounds are potentially hazardous to human health and the environment. The byproduct from this process was frequently disposed of directly at the plant site and can remain or spread slowly, serving as a continuous source of soil and groundwater contamination.

Date of Government Version: N/A
Date Data Arrived at EDR: N/A
Date Made Active in Reports: N/A
Number of Days to Update: N/A

Source: EDR, Inc.
Telephone: N/A
Last EDR Contact: N/A
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

OTHER DATABASE(S)

Depending on the geographic area covered by this report, the data provided in these specialty databases may or may not be complete. For example, the existence of wetlands information data in a specific report does not mean that all wetlands in the area covered by the report are included. Moreover, the absence of any reported wetlands information does not necessarily mean that wetlands do not exist in the area covered by the report.

Sensitive Receptors: There are individuals deemed sensitive receptors due to their fragile immune systems and special sensitivity to environmental discharges. These sensitive receptors typically include the elderly, the sick, and children. While the location of all sensitive receptors cannot be determined, EDR indicates those buildings and facilities - schools, daycares, hospitals, medical centers, and nursing homes - where individuals who are sensitive receptors are likely to be located.

AHA Hospitals:
Source: American Hospital Association, Inc.
Telephone: 312-280-5991
The database includes a listing of hospitals based on the American Hospital Association's annual survey of hospitals.

Medical Centers: Provider of Services Listing
Source: Centers for Medicare & Medicaid Services
Telephone: 410-786-3000
A listing of hospitals with Medicare provider number, produced by Centers of Medicare & Medicaid Services, a federal agency within the U.S. Department of Health and Human Services.

Nursing Homes
Source: National Institutes of Health
Telephone: 301-594-6248
Information on Medicare and Medicaid certified nursing homes in the United States.

Public Schools
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on elementary and secondary public education in the United States. It is a comprehensive, annual, national statistical database of all public elementary and secondary schools and school districts, which contains data that are comparable across all states.

Private Schools
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on private school locations in the United States.

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002 and 2005 from the U.S. Fish and Wildlife Service.

STREET AND ADDRESS INFORMATION

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Certified Sanborn® Map Report

Sanborn® Library search results
Certification # BC26-4A77-9F53

Villages of Leiali I Phases A and B
Villages of Leiali I Phases A and B
Lahaina, HI 96761

Inquiry Number 2199708.2s

April 22, 2008

EDR® Environmental Data Resources Inc

The Standard in Environmental Risk Information

440 Wheelers Farms Rd
Milford, Connecticut 06461

Nationwide Customer Service

Telephone: 1-800-352-0050
Fax: 1-800-231-6802
Internet: www.edrnet.com

Certified Sanborn® Map Report

4/22/08

Site Name:
Villages of Leiali I Phases A
Villages of Leiali I Phases A
Lahaina, HI 96761

EDR Inquiry # 2199708.2s

Client Name:
Belt Collins-Hawaii
2153 North King Street
Honolulu, HI 96819

Contact: Maria Friedli

EDR® Environmental Data Resources Inc

The complete Sanborn Library collection has been searched by EDR, and fire insurance maps covering the target property location provided by Belt Collins-Hawaii were identified for the years listed below. The certified Sanborn Library search results in this report can be authenticated by visiting www.edrnet.com/sanborn and entering the certification number. Only Environmental Data Resources Inc. (EDR) is authorized to grant rights for commercial reproduction of maps by Sanborn Library LLC, the copyright holder for the collection.

Certified Sanborn Results:

Site Name: Villages of Leiali I Phases A and B
Address: Villages of Leiali I Phases A and B
City, State, Zip: Lahaina, HI 96761
Cross Street:
P.O. # NA
Project: NA
Certification # BC26-4A77-9F53

Sanborn® Library search results
Certification # BC26-4A77-9F53

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- ✔ Library of Congress
- ✔ University Publications of America
- ✔ EDR Private Collection

Total Maps: 0

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The EDR Environmental Lien Search Report

VILLAGES OF LEILALI I PHASE A & B
LAHAINA, HAWAII

Monday, May 5, 2008

Project Number: L08-02523

The Standard In Environmental Risk Management Information

440 Wheelers Farm Road
Milford, Connecticut 06460

Nationwide Customer Service

Telephone: 1-800-352-0050
Fax: 1-800-231-6802

ENVIRONMENTAL LIEN REPORT

The EDR Environmental LienSearch Report provides results from a search of available current land title records for environmental cleanup liens and other activity and use limitations, such as engineering controls and institutional controls.

A network of professional, trained researchers, following established procedures, uses client supplied property information to:

- search for parcel information and/or legal description;
- search for ownership information;
- research official land title documents recorded at jurisdictional agencies such as recorders' office, registries of deed, county clerks' offices, etc.;
- access a copy of the deed;
- search for environmental encumbering instrument(s) associated with the deed;
- provide a copy of any environmental encumbrance(s) based upon a review of key words in the instrument(s) (title, parties involved and description); and
- provide a copy of the deed or cite documents reviewed;

Thank you for your business
Please contact EDR at 1-800-352-0050
with any questions or comments

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ENVIRONMENTAL LIEN REPORT

The EDR Environmental Lien Search Report is intended to assist in the search for environmental liens filed in land title records.

TARGET PROPERTY INFORMATION

ADDRESS

Villages of Leilali I Phase A & B
Lahaina, Hawaii

RESEARCH SOURCE

Source: Maui County Assessor
State of Hawaii Bureau of Conveyances

DEED INFORMATION

Records were researched at the County of Maui Assessor's Office and the Hawaii Bureau of Conveyances back to 1940. Based on our research, the State/Territory of Hawaii has owned the property in it's entirety since at least 1940.

LEGAL DESCRIPTION

All that certain piece or parcel of land bearing Tax Key Designation Number 4-5-021-003; 4-5-021-004; 4-5-021-005; 4-5-021-013; 4-5-021-021; 4-5-021-022; and 4-5-028-070, situated and lying in the City of Lahaina, Maui County, State of Hawaii

Assessor's Parcel Number(s): 4-5-021-003; 4-5-021-004; 4-5-021-005; 4-5-021-013; 4-5-021-021; 4-5-021-022; and 4-5-028-070

ENVIRONMENTAL LIEN

Environmental Lien: Found ☐ Not Found ☒

OTHER ACTIVITY AND USE LIMITATIONS (AULs)

Other AULs: Found ☐ Not Found ☒

SOURCE: [illegible] LOCATION:

BY: [illegible] DATE: 3/17/43

ZONE	SEC.	PLAT	PARCEL
4	5	71	3

1942

Route Slip

Change of area.
Checked with C. Brown of P.M.Co. Ltd.

TAX MAPS
TAX OFFICE
PLACING
ROUTE SLIP
SKETCH
ADJOINING PARCELS
F.B. LEDGER
RETURN PLAT

FORMER KEY				CHANGE	FINAL DATA AS SHOWN ON TAX MAPS AS OF 3/17/43						
ZONE	SEC.	PLAT	PARCEL		ZONE	SEC.	PLAT	PARCEL	AREA	OWNER	INT.
				Area	4	5	71	3	1243.163	Terr. of Hawaii	
										(Pioneer Mill Co. Ltd)	
										For G.L. 2305	

SOURCE	LOCATION	ZONE	SEC.	PLAT	PARCEL
Land Office	Wahikuli, Lahaina, Maui	4	5	21	3

BY Kerr DATE 8/8/47

208 PARTIAL SURRENDER 1943
General Lease #2305

Date: 6/5/43
C S F No 9866

Pioneer Mill Co. to Territory of Hawaii

See M-3
4-5-14-1 etc

TAX MAPS	
TAX OFFICE	
TRACING	
ROUTE SLIP	
ENTRY	
ADJOINING PARCELS	
T.P.B.	LEDGER
RETURN	

Partial release from above lease of the following land:

ADDITION TO WAHIKULI HOUSE LOTS TRACT

Being por of Gov (Crown) land Area 11.40 Acres

1243.16 ac.
less 11.40 ac
1231.76 ac.

Note:

The annual rental has been reduced $74.10 from $8541.00 to $8466.90

Note: LLG.
4-5-21-per. 3 dropped into 4-5-14-44 to 57 incl.

FORMER KEY ZONE	SEC.	PLAT	PARCEL	CHANGE	FINAL DATA AS SHOWN ON TAX MAPS AS OF 7/1/23 ZONE	SEC.	PLAT	PARCEL	AREA	OWNER	INT.
				area	4	5	21	3	1231.76 ac.	Territory of Hawaii (Pioneer Mill Co., Ltd.) lessee	
										por. G.L. 2305	
		21		new parcels	4	5	14	44 to 57		(SEE PAGE 2)	

SOURCE Land Office | LOCATION

BY L.L.G. DATE 12/2/42

1943

ZONE	SEC	PLAT	PARCEL
4	5	21	3

TMB #524 '43 ✓

TAX MAPS	
TAX OFFICE	
	✓
TRACING	
ROUTE-SLIP	
	✓
SKETCH	
	✓
ADJOINING PARCELS	
	✓
F.S.	LEDGER
RETURN	PLATE

FOR FURTHER REFERENCE, SEE

Z. 4 S. 5 P. 14 P. 58 ✓

Sur. G.L. NO. 2305

DATED 8/27/43 REC.

LIBER. PAGE

1231.76 ac

lcs .065 ac. or 2834 to 4-5-14-58

1231.69(5)

1231.70 ac.

FORMER KEY				CHANGE	FINAL DATA AS SHOWN ON TAX MAPS AS OF 12/3/43						
ZONE	SEC.	PLAT	PARCEL		ZONE	SEC.	PLAT	PARCEL	AREA	OWNER	INT.
				Area etc.	4	5	21	3	1231.70 ac.	Terr. of Hawaii	
										(Pioneer Mill Co. Ltd.) le	
										Per G.L. 2305	

SOURCE	LOCATION	ZONE	SEC.	PLAT	PARCEL
BY HM DATE 6/1/44		4	5	21	3 & 4

See O.S.F. 7351-7352

TABULATION OF G L 2305 & G L L 2409

1944

Original area of G L 2305 -- 1815.685 Ac

Deductions:

Gr. 11073 -- 1.58 ac
Ess. Lots -- 11.40 ac
Res. -- 0.06 ac
13.04 Ac

1815.685 ac
less 13.040 ac
1802.645 Ac as of 6/1/44

parcel 3 -- 1147.812 ac
parcel 4 -- 654.833 ac
1802.645 ac

Area of G L L 2409 -- 102.755 ac.

105.315 ac
less 5.556 ac -- (par. 5)
99.759 ac
plus 2.996 ac -- (R/R)
102.755 ac

parcel 3 -- 88.038 ac
parcel 4 -- 14.717 ac
102.755 ac

TAX MAPS	
New	Mined
TAX OFFICE	
New	Mined
TRACING	
ROUTE SLIP	
SKETCH	
ADJOINING PARCELS	
F.S.	LEDGER
RETURN	PLATE

FORMER KEY				CHANGE	FINAL DATA AS SHOWN ON TAX MAPS AS OF 6/1/44						
ZONE	SEC.	PLAT	PARCEL		ZONE	SEC.	PLAT	PARCEL	AREA	OWNER	INT.
				area	4	5	21	3	1236.85 ac		
								4	669.55 ac		

SOURCE 5/31/44 LOCATION

BY PM DATE 5/31/44

263

ZONE	SEC.	PLAT	PARCEL
4	5	21	3

ROUTE SLIP 1944

The area of this parcel has been changed from 1231.70 Ac to 1235.85 ac

4-5-12-4 has been dropped into this parcel

Carry as:

Territory of Hawaii
1235.85 ac
(Pioneer Mill Co. Ltd)-le
Per G L 2305 - (1147.812 ac)
Per G LL 2409 - (88.038 ac)

TAX MAPS
TAX OFFICE
TRACING
ROUTE SLIP
SUPER
ADJOINING PARCELS
F.B. LEDGER
RETURN PLATE

FORMER KEY				CHANGE	FINAL DATA AS SHOWN ON TAX MAPS AS OF 5/31/44						
ZONE	SEC.	PLAT	PARCEL		ZONE	SEC.	PLAT	PARCEL	AREA	OWNER	INT.
4				area & Status	4	5	21	3	1235.85 ac	Territory of Hawaii	
										(Pioneer Mill Co. Ltd)-le	
										Per G L 2305 & G L L 2409	

SOURCE	Land Office	LOCATION	Laina Hill Wahikuli
BY	AY	DATE	9/17/47

726

1947

ZONE	SEC.	PLAT	PARCEL
4	3	21	3

Dated: June 26, 1947 REVOCABLE LICENSE NO. 267
Effective: April 1, 1947

Territory of Hawaii to David T Fleming

TAX MAPS	
	✓
TAX OFFICE	
	✓
TRACING	
	✓
ROUTE SLIP	
	✓
SKETCH	
	✓
ADJOINING PARCELS	
	✓
F.B.	LEDGER
RETURN	PLATE

License to enter the black sand pit for quarrying on Laina Hill in the Government land of Wahikuli, Lahaina, and to quarry and take therefrom such quantities of black sand or cinders necessary for the manufacturing of hollow tile and such other products as may be manufactured from black sand or cinders.

The licensee shall pay the sum of 15 cents per cubic yard for sand or cinders taken under said authority of this license, and all payment be made quarterly.

KEYED ONLY Key 4-5-62
NO CHANGE

FORMER KEY				CHANGE	FINAL DATA AS SHOWN ON TAX MAPS AS OF						
ZONE	SEC.	PLAT	PARCEL		ZONE	SEC.	PLAT	PARCEL	AREA	OWNER	INT.

BY: ART DATE: 7/8/49 TIME NO. 535

LOCATION

1949

TAX KEY: 4-5-21-3

EXTENSION OF TIME
G. L. NO. 2506

Territory of Hawaii with Pioneer Mill Co., Ltd.

MAUI

Extended 1 year from April 7, 1949 to April 6, 1950

Per of Government Lands of Wahikuli & Kapunakea, Lahaina

AREA 1815.69 ac

4-5-21-3
4-5-21-por. 6

MAPS	
OFFICE	
TRACING	
NEW PRINTS	
T.M.K.	
T.D.	
L.E.	LEDGER
RETURN	PLATE

FINAL DATA AS SHOWN ON TAX MAPS AS OF

FORMER TAX KEY	CHANGE	TAX KEY	AREA

KEYED ONLY
NO CHANGE

TERRITORY OF HAWAII
TAX COMMISSIONER

SOURCE	LOCATION	DIVISION
JHH DATE 2/24/50 TAX NO. M 61'49	1/1 ROUTE SLIP √1949	TAX KEY 4 5 21 3

Parcel 4-5-21-3 area as shown on Tax Maps 1235.85 ac

Area of parcel 4-5-21-3 revised and reduced by 0.578 ac to correspond to revised area as shown by C S F 10822.

Parcel 4-5-21-3 old area 1235.85 ac
Less 0.578 ac
1235.272 ac

Parcel 4-5-21-3 revised area 1235.272 ac

Area notation:
Parcel 4-5-21-3 (revised) 1235.272 ac
Parcel 4-5-21-4 669.55 ac
1904.822 ac 1904.822 ac

Area as per C S F 10822 1961.414 ac
Gross area
Less Wahikuli House lots & roads 45.571 ac
Tank site 0.065
Garbage Dump site 4.40
For Honokohau ditch 6.556
56.592 56.592

TAX MAPS	
JHH	
TAX OFFICE	
TRACING	
M	
DRAWING	
TYPE	

FORMER TAX KEY	CHANGE	TAX KEY	AREA	NAME
		FINAL OR A AS SHOWN ON TAX MAPS ALSO	1904.822 ac	1904.822 ac
				2/24/50
	area	4 5 21 3	1235.272 ac	Territory of Hawaii (Pioneer Mill Co. Ltd.) - 1s

SOURCE:	LOC. & TITLE: Wahikuli, Lahaina		DIV. 4 5 21 3
BY: DATE:	DEED. ETC.:	TMB NO.	
BY: pdk DATE: 12/2/59			

NO.	GRANTOR, ETC.	AREA OF PARCEL	GRANTEE ETC.
1.	As shown on tax map	1235.272ac.	State of Hawaii
	(Lease Expires 4/6/65)		(Pioneer Mill Co., Ltd.)-le
			G.L.-#3296
2.	TMB: M-55 '59 (4521-3) pdk 12/2/59		
	R/S: Cinder Pit Site situate at Laina Mill	1235.272ac	do
	as shown on CSF-13201, dated 11/16/59		
	Cinder Pit Area (36.04 ac.) Laina Trig.		
	Station (0.12 ac.) other area (1199.112ac)		
	1 9 6 0		
3.	TMB: M-36'60:2/2 (4521-3) pdk 7/27/60		
	R/S: As shown on CSF-12937, PARCEL 4	1235.272 ac.	do
	containing an area of 247184 □' or 5.675 ac.		
	is to be withdrawn for HONOPILIANI		
	HIGHWAY (FAP.No.S-0380(1) PARCEL 31n4521-7.		
4.	TMB M-22'64 RSY/pl 1/14/65		
	R/S: Por of 4521-3 sub'd into 1187.943Ac	do	do
	& 5.502 Ac. as per CSF N 14332 dtd		
	June 23, 1964.		
	Other sub-areas: OK		
	F/D: 4521-3, sub'd		
5.	TMB 457'65(4521-3 & 4)DL/ay 5/21/65		
	Expiration of GL 3296: Pioneer Mill Co	1035.272 Ac.	State of Hawaii
	To: State of Hawaii Expired 4/6/65.		

(Continued)

NOTE: LAST AREA & GRANTEE FINAL DATA AS SHOWN ON TAX MAPS.

TAX MAPS BRANCH HISTORY SHEET

DATE: 7/ /65

LOCATION: Lahaina, Maui

TITLE:

DIV. Z	DIV. S	DIV. PLAT	DIV. PAR
4	5	21	3

NO.	GRANTOR, ETC.	AREA OF PARCEL	GRANTEE, ETC.
5	As shown on Tax Maps	1235.272 Ac.	State of Hawaii
6	TMB M-49'65 HN/ay 7/27/65		
	R/S: From 4521-8(3), 4.40 Ac	1166.239 Ac.	do
	New Area 4521-3 = 1239.672 Ac		
	To: 4521-8(Pickup) 19.649 Ac		
	To: New Plats 4-5-27 & 28 and assigned		
	parcel numbers = 42.423 Ac.		
	Dropped into Roads (Wahikuli Homes Lots,		
	4th Series) 5.686 Ac.		
	Dropped into Honoapiilani Highway=5.675 Ac.		
	F/D: 4521-3; Area & bdry		
	Carry the following sub-areas:		
	(1124.577 Ac)		
	(5.502 Ac)		
	(0.120 Ac)		
	(36.040 Ac)		
7	~~TMB M-89'65 1/2~~ DL 10/13/65		
	~~R/S: To 4-5-21-9 (1) 5.502 ac~~	1160.737 ac.	State of Hawaii
	~~F/D: 4-5-21-3, Area~~		
8	TMB 1208'68 (4521-3, 4) DL/jo 5/28/68		
	Rev. Prmt No. S-4122: State of Hawaii	1160.737 Ac.	do
	Bg: 4/7/66 Mo-$2185. Purpose: Sugar Cane		(Amfac Properties)
	Cultivation & Pasture Improvement: None		per Rev. Prmt S-4122
	(Note: Refer to G.L. 3296)		
	CONTINUED		

NOTE: INFORMATION ON THIS SHEET IS SUBJECT TO CHANGE

TAXATION DIVISION

STATE OF HAWAII PROPERTY

FORM F-10 HISTORY SHEET

222

STATE OF HAWAII DEPARTMENT OF TAXATION PROPERTY ASSESSMENT DIVISION MAPS-TMK SECTION

FORM 2-10 TRUST SHEET

TAX MAPS BRANCH HISTORY SHEET

DATE: 5/9/69	DIV. Z	S	PLAT	PAR
LOCATION: Lahaina, Maui				
TITLE:	4	5	21	3

NO.	Page 3 GRANTOR, ETC.	AREA OF PARCEL	GRANTEE, ETC.
9	TMB 1347'69 (4521-3,4) RK/jo 5/9/69		
	Canc Rev. Permit No. S-4122: Pioneer Mill	1160.737	State of Hawaii
	Co. Date: 2/24/69. Info rec'd fr L/O,	Ac	
	5/2/69.		
10	TMB 1865'69(4521-3)RK/sy 6/27/69		
	To: 4521-8(2), 11.286 Ac	1149.451 Ac	State of Hawaii
	Gen. Lease No. S-4229: State of Hawaii		(Pioneer Mill Company, Ltd)Le
	Term: 25 yrs commencing 2/25/69 to		Por G.L. S-4229
	2/24/1994 Ann Rental:$36,000		
	Purpose: Cultivation of Sugar Cane		
	Info per Conveyance Tax Certificate filed		
	6/6/69.		
	F/D: 4521-3; Area, bdry, G.L. S-4229 issued		
	(4521-3 & 4)		
11	TMB M-603, 604'69-70, 1/7 WD/yc 3/24/70		
	R/S: To 4521-10(new), 12.5 Ac. Fl.	1134.700 Ac	do
	To 4521-11(new), 2.251 Ac		
	F/D: 4521-3; Area & bdry		
12	TMB M-88,89,90,91'77 JT/ak 5/5/77		
	R/S: Fr 4521-10(2) 12.5 ac.	1122.693 Ac	do
	New area 1147.200 ac cons & por resubd per		
	CSF 17900 & 17991 & maps by County of Maui-		
	Dept of Public Works 3/4/76.		
	To: 4521-10(2) 24.507 ac.		
	F/D: Area & bdry, lease area reduced		

CONTINUED

NOTE: INFORMATION ON THIS SHEET IS SUBJECT TO CHANGE

STATE OF HAWAII DEPARTMENT OF TAXATION
PROPERTY ASSESSMENT DIVISION
TAX MAPS BRANCH

FORM P-10 HISTORY SHEET

TAX MAPS BRANCH HISTORY SHEET

DATE:

LOCATION: Lahaina, Maui

TITLE:

DIV. Z	S	PLAT	PAR
4	5	21	3

NO.	PAGE 4 GRANTOR, ETC.	AREA OF PARCEL	GRANTEE, ETC.
12	As shown on tax maps	1122.693 Ac	State of Hawaii
			(Pioneer Mill Co Ltd)Le
			Por G.L. S-4229
13	TMB 9015'83 JF/lm 1/12/84		
	R/S: Partial Surrender of Land:	1121.775 Ac	do
	0.918 Ac. dropped into 4521-17		
	F/D: Area		

NOTE: INFORMATION ON THIS SHEET IS SUBJECT TO CHANGE

LOCATION: LP HUNT

DATE: 3/1/40

SECOND DIVISION			
ZONE	SEC.	PLAT	PARCEL
4	5	21	04

1939

11272

Change of Area
Checked with P. McCoy

J. H. LEASE

CHANGE			FINAL DATA AS SHOWN ON TAX MAPS AS OF 3/7/40						
PLAT	PARCEL		ZONE	SEC.	PLAT	PARCEL	AREA	OWNER	IN
			4	5	21	04	669.55	J. H.	
								CPMC 4-12	

ZONE	SEC.	PLAT	PARCEL
4	5	21	4

SOURCE: | LOCATION:

BY: DATE: 6/1/44

262

ROUTE SLIP 1944

The status of this parcel has been changed.

Carry as:

Territory of Hawaii
669.55 ac
(Pioneer Mill Co. Ltd)-le
Por G L 2305 -- (654.833 ac)
Por G LL 2409 - (14.717 ac)

TAX MAPS
TAX OFFICE
TRACING
ROUTE SLIP
BRANCH
ADJOINING PARCELS
ADDRESS
PLATE

NOTE: A portion of G L L 2409 is in this parcel, the remainder of this Li. is accounted for in parcel 3 of this plat

FORMER KEY ZONE	SEC.	PLAT	PARCEL	CHANGE	FINAL DATA AS SHOWN ON TAX MAPS AS OF 6/1/44 ZONE	SEC.	PLAT	PARCEL	AREA	OWNER	INT.
				status	4	5	21	4	669.55 ac	Territory of Hawaii (Pioneer Mill Co. Ltd)-le Por G L 2305 & G L L 2409	

SOURCE

BY AMT DATE 7/8/49 TMB NO 536

LOCATION 1949

DIVISION

TAX KEY 4571 2

EXTENSION OF TIME
G. L. NO. 2409

Territory of Hawaii to Pioneer Mill Co., Ltd.

MAUI

Extended 1 year from April 7, 1949 to April 6, 1950

Right of way for Plantation utilities on Government land at Wahikuli, and Kapunakea, Lahaina

AREA 102.76 ac

TAX MAPS	
TAX OFFICE	
TRACING	
NEW PRINTS	
TMB	
T.O	
F.B.	LEDGER
RETURN	PLATE

TERRITORY OF HAWAII
TAX COMMISSIONER

FINAL DATA AS SHOWN ON TAX MAPS AS OF 7/8/49

FORMER TAX KEY	CHANGE	TAX KEY	AREA	OWNER
				KEYED ONLY NO CHANGE

SOURCE: OSF- 1822	TITLE: Mahinahi, Lahaina			DIV. 4 5 21 6
	por.G.L.-3296			
BY: DATE:	DEED, ETC.	TMK NO.		
BY: pdk DATE: 7/27/69				

GRANTOR, ETC.	AREA OF PARCEL	GRANTEE, ETC.
ole shown on tax map	669.55 ac	State of Hawaii
G.L.-#3296 dated 9/11/49 Term: 15 yrs.		(Pioneer Mill Co.,Ltd.)-le
Rent:$6985.85 Ann. Expiration:4/7/80		por.G.L.-#3296
(other key:4521-3) Ref. TMK G.L. 1904.822ac		
TMK 457'65(4521-3 & 4)DL/sy 5/21/65		
Expiration of GL 3296: Pioneer Mill Co	669.55 Ac	State of Hawaii
to: State of Hawaii Expired 4/6/65		
TMB 1208'68 (4521-3,4) DL/jo 5/28/68		
Rev/ Prmt No. S-4122: State of Haw	669.55 Ac	do
Eff: 4/7/66 No-$2185. Purpose: Sugar Cane		(Amfac Properties)
Cultivation & Pasture Improvement: None		per Rev. Prmt S-4122
(Note: Refer to G.L. 3296)		
TMB 1347'69 (4521-3,4) RK/jo 5/9/69		
Canc Rev Permit No. S-4122: Pioneer Mill	do	State of Hawaii
Co. Date:-2/24/69. Info per L/O, rec'd		
5/2/69.		
TMB 1865'69(4521-3 etc)RK/sy 6/27/69		
Gen. Lease No. S-4229: State of Hawaii	669.55 Ac	State of Hawaii
Term: 25 yrs bg 2/25/69 to 2/24/1994		(Pioneer Mill Co Ltd)Le
Ann Rental:$36,000. Purpose: Cultivation		Por G.L. S-4229
of Sugar Cane. Info per Conveyance Tax		
Certificate filed 6/6/69.		
P/D: 4521-4; G.L. S-4229 issued		
	NOTE: LAST AREA & GRANTEE FINAL DATA AS SHOWN ON TAX MAPS	

SOURCE	LOCATION
BY	DATE

SECOND DIVISION			
ZONE	SEC.	PLAT	PARCEL
4	5	21	05

1940

3/2

Map shows Honokohau R/W and addressograph plate carries this as T.H. - P.M.Co. Ltd returns same as under Lease from T.H.

Por. Lr L.L. 7639

FORMER KEY				CHANGE	FINAL DATA AS SHOWN ON TAX MAPS AS OF 6/29/20						
ZONE	SEC.	PLAT	PARCEL		ZONE	SEC.	PLAT	PARCEL	AREA	OWNER	INT.
				owner	4	5	21	5	6.56 ac	Terr. of Hawaii	
										(P.M.Co. Ltd.) - lc	

SOURCE: [illegible] LOCATION:

BY: [illegible] DATE: 4/16/42

1942

ZONE	SEC.	PLAT	PARCEL
4	5	21	5

TAX MAPS

TAX OFFICE

TRACING

ROUTE SLIP

SKETCH

ADJOINING PARCELS

LEDGER

G.L. 39

PLATE

FOR FURTHER REFERENCE, SEE

4 B. 3 P. 01 P. 7 etc.

G.L. NO. L-2639

DATED 4/2/40 REC.

LIBER PAGE

TMB # 752 '42

FORMER KEY				CHANGE	FINAL DATA AS SHOWN ON TAX MAPS AS OF 4/16/42						
ZONE	SEC.	PLAT	PARCEL		ZONE	SEC.	PLAT	PARCEL	AREA	OWNER	INT.
				Erase No	4	5	21	5	6.56 Ac.	Territory of Hawaii	
										(Pioneer Mill Co. Ltd.)	
										per G.L. # L-2639	

SOURCE:	LOC. & TITLE: Wahikuli, Maui	1962	DIV.
BY: DATE:	DEED, ETC.:	TMB NO.	4 5 21 5
BY: DATE:			

NO.	GRANTOR, ETC.	AREA OF PARCEL	GRANTEE, ETC
1.	As shown on Tax Maps	6.56 Ac	State of Hawaii (Pioneer Mill Co Ltd) Le G L 2639
2.	TMB 493'62(4402-12 etc) PK/sy 10/19/62 Rev Permit S-3132: State of Hawaii Date: 7/21/60 To: Pioneer Mill Co Ltd. Note: G L 2639 expired 7/21/60. F/D: 4521-5; Status	6.56 Ac	State of Hawaii [Pioneer Mill Co Ltd)Lic Por Rev Prmt S-3132
3.	TMB 675'64(4402-12 etc)DL/sy 11/9/64 State of Hawaii GL S-3835 To: Pioneer Mill Co. Fr 6/2/64 to 6/1/84 Easement for transmission & irrigation waters of gov't land. Info received from L/O 7/17/64. F/D: 4521-5; Rev Prmt S-3132 Out, Lease (Tax Keys: 4402-12,13,14; 4405-35; 4407-10; 4407-9; 4521-5; 4618-11)	6.56 Ac	State of Hawaii (Pioneer Mill Co Ltd)-Le Por G.L. S-3835
4	R/S: Expiration G.L. No S-3835, Pioneer Mill Co Ltd Expiration Date 6/1/84 TK No 4402-12 etc F/D: Le-out	do	To: State of Hawaii

NOTE: LAST AREA & GRANTEE FINAL DATA AS SHOWN ON TAX MAPS.

TERRITORY OF HAWAII TAX COMMISSIONER STATION MAPS BUREAU

TAX MAPS BRANCH HISTORY SHEET

DATE: 6/30/71

LOCATION: Wahikuli

TITLE: Govt. Land

DIV. Z	DIV. S	DIV. PLAT	DIV. PAR
4	5	21	13

NO.	GRANTOR, ETC.	AREA OF PARCEL	GRANTEE, ETC.
1	TMB 4151'70-71 WD/en 6/30/71		
	R/S: From 4521-8(4) (1.576 Ac), New	1.576 Ac	State of Hawaii

(NOTE) INFORMATION ON THIS SHEET IS SUBJECT TO CHANGE

STATE OF HAWAII PROPERTY ASSESSMENT DIVISION TAX MAPS HISTORY SHEET

SOURCE:	LOT TITLE: Lahaina, Maui		DIV.
BY: D Lake DATE: 5/19/65	DEED, ETC.:	TMB NO.	4 5 21 8
BY: DATE:			

NO.	GRANTOR, ETC.	AREA OF PARCEL	GRANTEE, ETC.
1	As Shown on Tax Maps	4.40 ac	Territory of Hawaii
			(County of Maui)
			Exec. Order 1342
			LAINA DUMP SITE
2	TMB M-21'65 DL 5/19/65		
	R/S: By Exec. Order 2185 dated April 9,	4.40 ac	State of Hawaii
	1965, Exec. Order 1342 is hereby cancelled		
	and no longer in force and effect		
3.	TMB M-49'65 HN/sy 7/27/65		
	R/S: 4.40 Ac To 4521-3(6)	Nil	Dropped
	F/D: 4521-8; Dropped		
			4 5 21 8
			(Pickup)
1	TMB M-49'65 HN/sy 7/27/65		
	R/S: From 4521-3(6), Pickup, 19.649 Ac	19.649 Ac	State of Hawaii
2	TMB 1865'69(4521-3 etc)RK/sy 6/27/69		
	From: 4521-3(10), 11.286 Ac	30.935 Ac	do
	F/D: 4521-8; Area, bdry.		
3.	TMB M-603, 604'69-70, 6/7 (1/7, 4521-3)		
	WD/yc 3/24/70		
	R/S: To 4521-12(new), 1.323 Ac	29.612 Ac	do
	F/D: 4521-8; Area & bdry		
		(Cont)	

NOTE: LAST AREA & GRANTEE FINAL DATA AS SHOWN ON TAX MAPS.

STATE OF HAWAII DEPARTMENT OF TAXATION
PROPERTY ASSESSMENT DIVISION
TAX MAPS BRANCH

TAX MAPS BRANCH HISTORY SHEET

DATE: 6/30/71
LOCATION: Lahaina
TITLE:

DIV. Z	S	PLAT	PAR
4	5	21	8

NO.	Page 2 GRANTOR, ETC.	AREA OF PARCEL	GRANTEE, ETC.
3	As shown on tax maps	29.612 Ac	State of Hawaii
4	TMB 4151'70-71 WD/en 6/30/71		
	R/S: To: 4521-13 (1.576 Ac), New	28.036 Ac	To: County of Maui
	L P Grant No. S-14875: State of Hawaii		Gr S-14875
	Date: 1/7/71 Info rec'd fr L/O 6/28/71		
	F/D: 4521-8: Area, des, ownership & status		
5	TMB 4147'70-71(4512-19 etc)WD/en 6/30/71	28.217 Ac	County of Maui
	From 4512-19(3)(0.439 Ac or 19,103#, Lt 19-A)		
	To: 4512-19(3)(0.258 Ac or 11,243#,Lot 8-B)		
	Exch/D: Pioneer Mill Co Ltd To: County of		
	Maui Bk 7625 p 411 SCT$1.00 Cons: Exchange		
	5/3/71 6/24/71 DES		
	F/D: 4521-8: Area, des & bdry: Lots 8-A		
	(27.778 Ac) & 19-A (0.439 Ac)		
6.	TMB M-31'71-72,1/2 wd 8/13/71		
	R/S:Parcel 4521-8 28.217 Ac. subd into	NONE	DROPPED
	Lots 1 to 137, designation of Esmts A to		
	G, E-1 to E-24 incl. per FP 1208 WAHIKULI		
	TERRACE SUBD, & dropped into new plat &		
	assigned new keys 4530-1 to 137.		
	F/D: 4521-8; dropped.		

NOTE: INFORMATION ON THIS SHEET IS SUBJECT TO CHANGE

TAX MAPS BRANCH HISTORY SHEET

		Z	B	PLAT	DIV. PAR
DATE: 9/14/72					
LOCATION: Wahikuli, Lahaina					
TITLE REMNANT "B" WAHIKULI HOUSE LOTS - 5th Series HSS Plat 1006-B		4	5	28	70

NO.	GRANTOR, ETC.	AREA OF PARCEL	GRANTEE, ETC.
1.	TMP M-31'72-73 CS/sy 9/14/72	69,092	
	R/S: From 4528-37(2), New		State of Hawaii
2.	Rev Pmt S-5397: St of HI 5/27/77 $5.65 fr	do	do
	5/27/77 to 5/31/77: $35 mo fr 6/1/77		To: (James Kahahane) Rev Pmt S-5397
	Purpose: agriculture Source: L/O 6/22/77		
3.	Canc Rev Pmt S-5397: James Kahahane 6/30/78	do	State of Hawaii
	Source: L/O 5/9/78		
4.	Rev Pmt S-5559: St of HI eff 7/1/78 $5 mo	do	do
	Use: agriculture Source: L/O 8/8/79		To: (Shigero Hamachi) Le Rev Pmt S-5559
5	Canc Rev Pmt S-5559: Shigero Hamachi	do	State of Hawaii
	eff 7/1/78 Cancelled as of 6/30/79		
6	Rev PMT S-5713: DLNR to Francis Y Tanaka	do	do
	eff 7/15/79 $10 mo fr 8/1/79 Use: agriculture		To: (Francis Y Tanaka) Le Rev Pmt S-5713

NOTE: INFORMATION ON THIS SHEET IS SUBJECT TO CHANGE

STATE OF HAWAII DEPARTMENT OF TAXATION PROPERTY ASSESSMENT MAPS BRANCH

FORM P-40 HISTORY SHEET

TAX MAPS BRANCH HISTORY SHEET

DATE: 7/7/65

LOCATION:

TITLE:

Z	S	PLAT	PAR
4	5	28	37

DIV.

NO.	GRANTOR, ETC.	AREA OF PARCEL	GRANTEE, ETC.
1	TMK M-49'65 HH/ay 7/27/65		
2	B/St: From 4521-3 (6) New	16.741 ac	State of Hawaii
3	TMK M-31'72-73 GS/ay 9/14/72		
4	B/St: Par 4528-37. Area revised from	10,309 ⊕	do
5	16.741 Ac. To 729,119 ⊕ or 16.738 Ac. and		
6	Sub'd into Lots 22 to 72 i nl., Road Lots		
7	C, D & E & Remnant B & C of "WAHIKULI HOUSE		
8	LOTS - 5th Series," per HSS Plat 1006-B		
9	dated February, 1972.		
10	Lots 22 to 38 incl., 40 to 72 incl &		
11	Remnants B & C (614,216 ⊕) assigned new		
12	parcel numbers 4528-18 to 24, 38 to 80.		
13	Road Lots C, D & E (100,594 ⊕) dropped		
14	into Road.		
15	P/n: 4528-37: Area, desc & Bdry, Lot 39	do	do
16	SSA No. S-5359: State of Hawaii		(Stanley K Honda &wf Roberta C
17	Cons:$17,000.00 Date: 6/7/73		T/E)
18	Info per Conveyance Tax Cert filed 7/16/73.		SSA No. 5359
19	L.P Grant S-15434: St of HI 4/14/78	do	To: Stanley K Honda &wf
20	Info per Conveyance Tax Cert filed 4/24/78		Roberta C -T/E
			Gr S-15434

NOTE: INFORMATION ON THIS SHEET IS SUBJECT TO CHANGE

APPENDIX C

TOPOGRAPHIC MAPS, AERIAL PHOTOGRAPHS AND OTHER HISTORICAL DATA

UNITED STATES GEOLOGICAL SURVEY
AERIAL PHOTOGRAPHS
LAHAINA QUADRANGLE: 1950, 1965, 1976

&

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION AERIAL PHOTOGRAPH: 2000

&

2007 Google™ Earth Pro AERIAL PHOTOGRAPH: 2008

N

1950

1950_AB1MF0000000003_36_a.jpg

N 1965

1965_EKN1CC_81.jpg

1976

1976_AB1VEED00000003_180_a.jpg

2000

2000_2147.tif

2008

←Z-

STATE OF HAWAII DEPARTMENT OF HELATH
UNDERGROUND STORAGE TANK (UST)
INFORMATION ON FILE FOR: MASAO AOTAKI RESCIDENCE

LINDA LINGLE
GOVERNOR OF HAWAII

CHIYOME L. FUKINO, M.D
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
ENVIRONMENTAL MANAGEMENT DIVISION
SOLID AND HAZARDOUS WASTE BRANCH
919 ALA MOANA BLVD., #212
HONOLULU, HAWAII 96814

In reply, please refer to:
EMD.SHWB

Telephone No. (808) 586-4226
Facsimile No. (808) 586-7509

FACSIMILE REQUEST AND COVER SHEET
(Use Black or Blue Ink Only)

DATE: 8/13/08 No. of pages (Incl. cover sheet) 4

TO: Jennifer Littenberg

Office/Phone/Mail Stop: 521-5361 / 538-7819

FROM: Josh Nagaoshima

Office/Phone/Mail Stop: see above

SUBJECT/MESSAGE: Letters Regarding Masao Aotaki UST

Please send a return fax for receipt confirmation. Thank you!

SIGNATURE OF SENDER: [signature]

NOTE: If this transmittal was incomplete or illegible, please call the sender's office.

Rev. 11/95

INTER-ISLAND ENVIRONMENTAL SERVICES INC.

JAN 27

SC

G-503271

UD221RK

January 17, 1997

Section Manager
State of Hawaii
Department of Health
Solid and Hazardous Waste Branch
UST Section
919 Ala Moana Blvd., Suite 212
Honolulu, Hawaii 96813

Subject: *Intent to Permanently Close UST*

Dear Sir:

InterIsland Environmental Services, Inc. (IIES) will remove one UST from a private residence in Lahaina, Maui. The property address is 1462 Fleming Road. The tank does not seem to be registered, as far as we can tell. An elderly gentleman and his wife live in the house and their family has requested that the UST be removed during their absence from January 25 to February 4, 1997. This timing is not within the 30-day window you require, however, we ask that you consider the special circumstances.

Please call me at (808) 946-9423 and let me know your decision.

Sincerely,

AH Campbell

Arlene H. Campbell
Project Manager

1/31/97 Arlene
1) used code for contacting business
2) send to:
Masao Aofaki
1462 Flemings Rd
Lahaina Maui 96761

1661 Ala Moana Blvd. • Honolulu, HI 96815 • Oahu Tel (808) 946-9423 • Fax (808) 955-5287
Kauai Office (808) 245-3366 • Fax (808) 246-1054
Contractor's License #ABC-19787

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

LAWRENCE MIIKE
DIRECTOR OF HEALTH

Missing File
12/12/97
3/2/98

STATE OF HAWAII
DEPARTMENT OF HEALTH
ENVIRONMENTAL MANAGEMENT DIVISION
SOLID AND HAZARDOUS WASTE BRANCH
919 ALA MOANA BLVD., #212
HONOLULU, HAWAII 96814

In reply, please refer to:
EMD/SHW

February 18, 1997

U0221RK
Facility ID: 9-503271

Mr. Masao Aotaki
1462 Fleming Road
Lahaina, Maui, Hawaii 96791

Dear Mr. Aotaki:

Subject: Intent to Permanently Close Underground Storage Tank

This is in response to a report dated January 17, 1997, to the Department of Health (DOH) Underground Storage Tank Section notifying us of your intent to permanently close one underground storage tank (UST) from a private residence at 1462 Fleming Road, Lahaina, Maui, Hawaii.

The U.S. Environmental Protection Agency's final regulations on USTs became effective on December 22, 1988 and are set forth in Title 40 of the **Code of Federal Regulations** (40 CFR) Part 280 (see Enclosure A). These federal UST regulations include, among other things, specific requirements that UST owners and operators must meet when closing their UST system (refer to 40 CFR Part 280 Subpart G of Enclosure A). In addition, DOH is providing additional guidance on UST closure (see Enclosure B).

In particular, you should note that owners and operators are required to measure for the presence of a release where contamination is most likely to be present at the UST site before completing UST closure. If an UST release is discovered, owners and operators must report the discovery of the release to DOH within 24 hours and immediately begin release response actions in accordance with the federal UST regulations (40 CFR Part 280 Subpart F) and DOH guidelines.

Finally, upon completion of UST closure, an amended "Notification for Underground Stystorage Tanks" form (EPA Form 7530-1, 9/89) reflecting the closure of the UST

system should be submitted to DOH within 30 days. For each permanently closed UST, Part X of the notification form should be completed in its entirety. A copy of the notification form is found in Enclosure C.

Should you have any questions regarding the UST closure, please contact our Underground Storage Tank Section at (808) 586-4226.

Sincerely,

ROXANNE KWAN
Underground Storage Tank Section

RK:alk

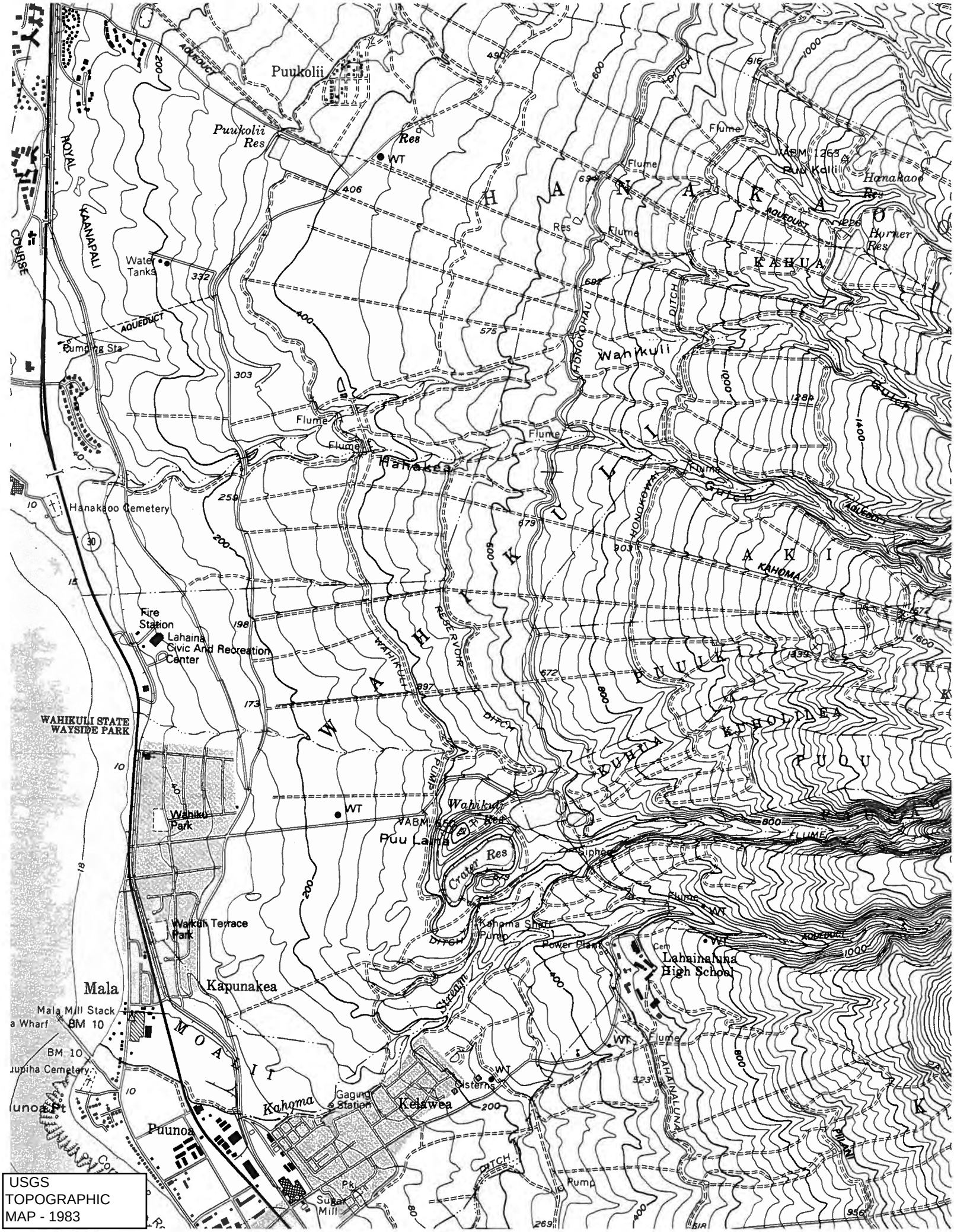
Enclosures

c: Maui County Fire Department

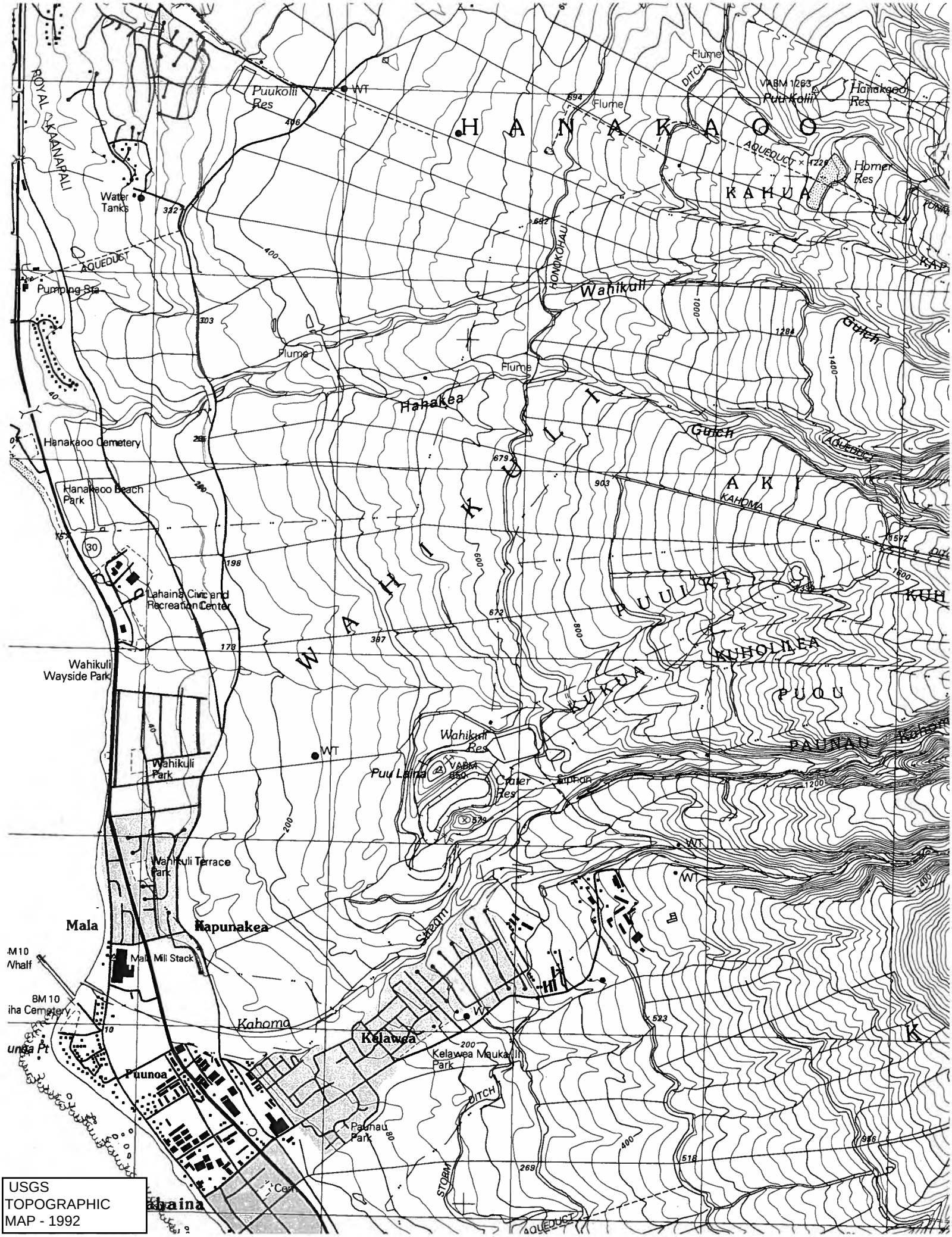
UNITED STATES GEOLOGICAL SURVEY
TOPOGRAPHIC MAPS

LAHAINA QUADRANGLE: 1956, 1983, 1992

USGS
TOPOGRAPHIC
MAP - 1956



USGS TOPOGRAPHIC MAP - 1983



USGS
TOPOGRAPHIC
MAP - 1992

APPENDIX D

INTERVIEW FORMS AND QUESTIONNAIRES

Phase I ESA – Property Occupant Interview Form

Property: TMK(2) 4-5-028:070 & 4-5-021:022 (POR)

Date of Interview: ~~VILLAGE OF LEAHI~~ 7/9/08 Type of Interview: ___ in person ___ by telephone IN WRITING

Name and Title of Person Interviewed: LANNY TIHADA - COFFEE FARM MANAGER

Occupancy/Property Use of Person Interviewed: NEIGHBORING LANDS

Area or Percent of Property Occupied: N/A Duration of This Occupancy/ Use: ___

Interviewer Name and Title: ___

Ask interviewee to be as specific as possible, and to answer in good faith and to the extent of their knowledge.

1.0 What activities has your occupancy involved?

RAISING/GROWING SUGAR CANE

2.0 What *hazardous substances* (HS) or *petroleum products* (PP) has your organization used (may include fuels, paints and solvents, hydraulic fluid, pesticides, cleaning chemicals, etc.), and how were wastes and empty containers disposed?

EQUIPMENT USING FUEL ON PROPERTY, BUT FUELING & SERVICING WAS DONE OFF THE PROPERTY AT THE PMCo MELLYARD.

3.0 Do you know of, or have records of any fire, accident, spill, or other release of HS or PP on, from, or near the *property*?

BRUSH FIRES IN 2007

4.0 Do you know or have records of any pending, threatened, or past administrative proceeding, notice of violation, or litigation relevant to HS or PP that involves the *property*?

NO

5.0 Do you know of any potential environmental hazard/condition on the *property*, or on a nearby parcel?

NO

6.0 Who are other current or past occupants?

STATE OF HAWAII IS THE CURRENT OWNER

Phase I ESA – User Questionnaire

Property: TMK(2) 4-5-028:070 & 4-5-021:022 (POR)

Address: Villages of Leiali'i Phase A & B

In order to qualify for one of the Landowner Liability Protections (LLPs) offered by the Small Business Liability Relief and Brownfields Revitalization Act of 2001 (the "*Brownfields Amendments*" to CERCLA), the *user* must provide the following information (if available) to the *environmental professional* who conducts a Phase I Environmental Site Assessment (ESA). Failure to provide this information could result in a determination that "*all appropriate inquiry*" is not complete.

Note: All terms in *italics* have the meanings defined in ASTM Standard Practice E1527-05.

1.0 Environmental cleanup liens that are filed or recorded against the *property* (40 CFR 312.25).

Are you aware of any environmental cleanup lien against the *property* that has been filed or recorded under federal, tribal, state or local law?
Yes___ No_✓_ If yes, describe it and identify where recorded:

2.0 Activity and land use limitations that are in place on the *property* or that have been filed or recorded in a registry (40 CFR 312.26).

Are you aware of any Activity and Use Limitation, such as an *engineering control*, land use restriction or *institutional control* that is in place at the *property* and/or has been filed or recorded in a registry under federal, tribal, state or local law?
Yes___ No_✓_ If yes, describe it and identify where recorded:

3.0 Specialized knowledge or experience of the person seeking to qualify for the LLPs (40 CFR 312.28).

As the *user* of this *ESA* do you have any specialized knowledge or experience related to the *property* or nearby properties? For example, are you involved in the same line of business as the current or former *occupants* of the *property* or an adjoining *property* so that you would have specialized knowledge of the chemicals and processes used by this type of business?
Yes___ No_✓_ If yes, describe:

4.0 Relationship of the purchase price to the fair market value of the *property* if it were not contaminated (40 CFR 312.29).

Do you believe that the purchase price being paid for this *property* reasonably reflects the fair market value of the *property*?
Yes___ No___ If no, discuss why not. If you conclude that there is a difference, have you considered whether the lower purchase price is because contamination is known or believed to be present at the *property*?

N.A.

5.0 Commonly known or *reasonably ascertainable* information about the *property* (40 CFR 312.30).

Are you aware of commonly known or *reasonably ascertainable* information about the *property* that would help the *environmental professional* to identify conditions indicative of releases or threatened releases? As a *user* of the ESA report:

(a) Do you know any of the past uses of the *property*?
Yes ✓ No___ If yes, describe:

The properties were planted in sugar cane up to ten years ago.

(b) Do you know of specific chemicals that are or formerly were present on the *property*?
Yes___ No ✓ If yes, which chemicals and when:

(c) Do you know of spills or other chemical releases that have taken place on or near the *property*?
Yes___ No ✓ If yes, describe each:

(d) Do you know of any environmental cleanup(s) that has taken place on or adjacent to the *property*?
Yes___ No_✓_ If yes, describe each:

6.0 The degree of obviousness of the presence or likely presence of contamination at the *property*, and the ability to detect the contamination by appropriate investigation (40 CFR 312.31).

As the *user* of this ESA, based on your knowledge and experience related to the *property*, are there any *obvious* indicators that point to the presence or likely presence of contamination at the *property*?
Yes___ No_✓_ If yes, describe each:

7.0 Additional Information.

In addition, certain information that may not be required should, if available, be provided to the *environmental professional* conducting an ESA. This information is intended to assist the *environmental professional*, but is not necessarily required to qualify for one of the LLPs. The information includes:

(a) The reason(s) why the Phase I ESA has been requested:
Per request of Belt Collins.

(b) The type of *property* (commercial, retail, warehouse, etc.) and type of *property* transaction, for example a sale, purchase, exchange, etc.:
Undeveloped ag lands. Transaction unknown.

(c) A complete and correct address for the *property*. A map, survey, or other document showing *property* location and boundaries is helpful. (Note: A *property* may have more than one address, or an address range; if so, please indicate all known addresses that are associated with the *property*.)

Map is attached

Please attach a copy of a site map to this questionnaire or provide at site visit (if available).

(d) Names and addresses of all parties who expect to rely on the Phase I ESA report:

State of Hawaii Housing Finance Development Corp.

(e) Identification of a contact(s) for a *property* visit, and how the contact(s) can be reached:

(f) Any other knowledge or experience with the *property*, or documents related to it, that may be pertinent to the *environmental professional*, such as copies of prior ESA reports, cleanup records, other documents or correspondence, etc. concerning the *property* and its environmental condition. (Please provide/attach a list of any available documents, and provide copies of them or arrange a time and place for the *environmental professional* to review them.)

N/A.

Completed by:

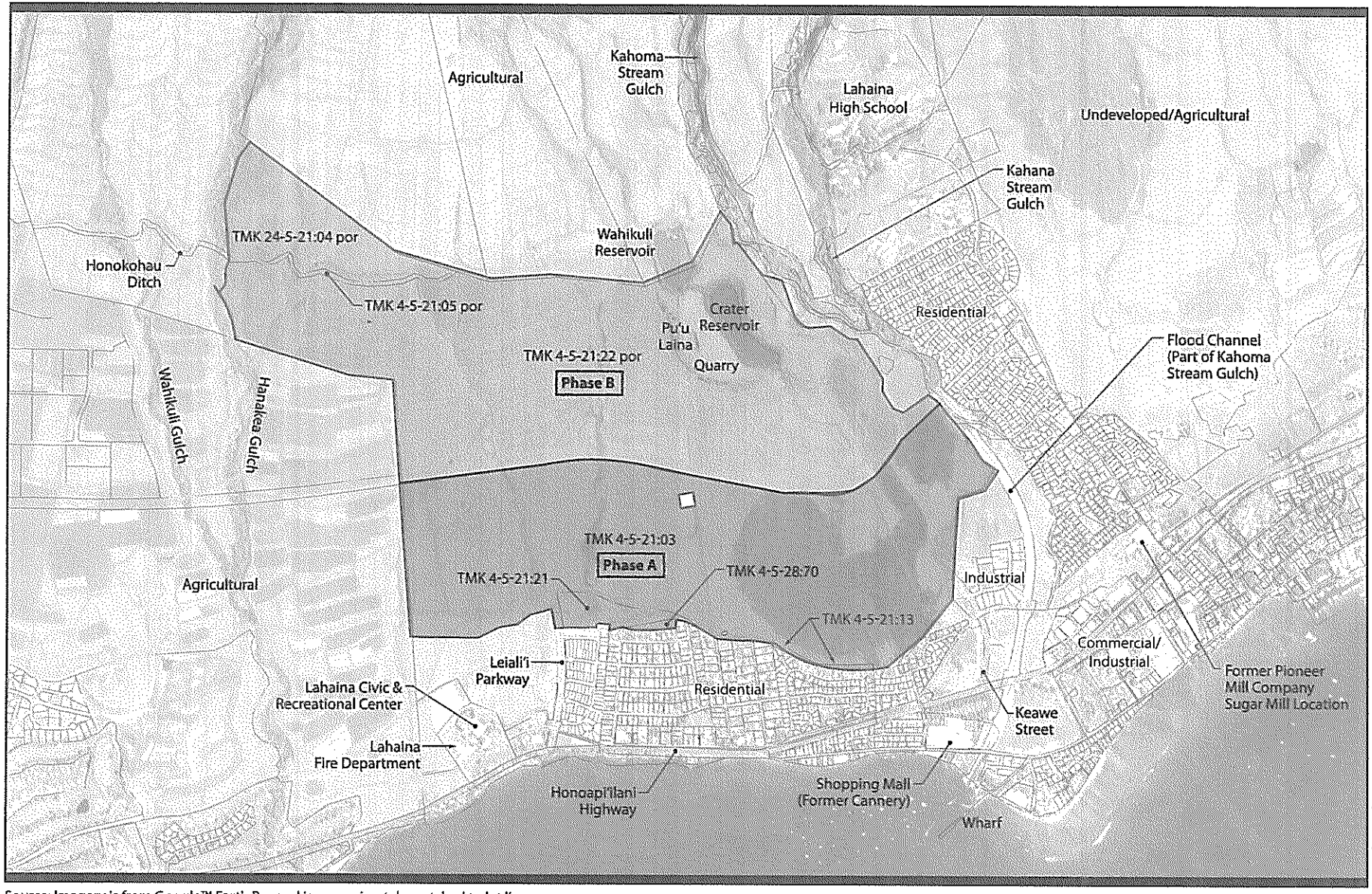
Howard Hazama
Signature

7/9/08
Date

Howard Hazama
Printed Name

Vice President
Title

Kaanapali Land Management Corp.
Pioneer Mill Co.



Source: Imagery is from Google™ Earth Pro and is approximately matched to lot lines

©2008 Belt Collins Hawaii Ltd. K-2007.70.0500/010-1 kya 13May2008 2

BeltCollins

NORTH

0 500 1000 2000
SCALE IN FEET

LEGEND

Property Boundaries.

Figure 1
PROJECT LOCATION AND SITE VICINITY MAP
Villages of Leiali'i

May 2008

Phase I ESA – Owners and Occupants Interview Form

Property: TMK(2) 4-5-028:070 & 4-5-021:022 (POR)

Name & Title of Person Interviewed: Howard Hanzawa

Interview Date: 7/9/08 ___ in person ___ by telephone ✓ in writing (attach questionnaire)

Ask the interviewee to be as specific as possible, and to answer in good faith and to the extent of their knowledge.

NOTE: Residential occupants do not need to be interviewed. If the *property* has fewer than five current occupants, a reasonable attempt must be made to interview a representative of each. If there are more than five, a reasonable attempt must be made to interview all major occupants and those others whose operations are likely to indicate an environmental concern. Many interviewees have no obligation to answer questions. If an answer is incomplete, or a question not answered, note this on the form. The *user* has an obligation to answer.

How is the person interviewed related to the *property*?

___ Current Owner (since _____)

___ Former Owner (from _____ to _____)

___ Key Site Manager, Title: _____

___ Occupant/Tenant: Name of Entity: Pioneer Mill Co.

Period of occupancy: ? to 1999

A. Basic Information – All Interviewees

1.0 What current and past activities/uses has your occupancy involved?

Planting & raising Sugar Cane

2.0 What *hazardous substances* (HS) or *petroleum products* (PP) has your organization used (may include fuels, paints and solvents, hydraulic fluid, pesticides, cleaning chemicals, etc.), and how were wastes and empty containers disposed?

Harvesting & planting equipment did require fuel. However equipment based land was not on the property.

3.0 Do you know of, or have records of any fire, accident, spill, or other release of a HS or PP on, from, or near the *property*?

There was a brush fire in the summer of 2007 on the property.

4.0 Are you aware of any pending, threatened, or past notice of violation, litigation, or administrative proceeding relevant to *hazardous substances* or *petroleum products* in, on or from the *property*?

No

5.0 To the best of your knowledge, what are the current and past uses of adjacent parcels?

The lower neighboring properties are existing residential. Other adjacent properties are open lands which may have been in sugar cane in the past.

6.0 Do you know of any potential environmental hazard/condition on the *property*, or on a nearby parcel?

No

7.0 Who are other current or past owners or occupants?

Current owner is State of Hawaii.

8.0 What is the source of your drinking water?

Parcels do not have a potable water system.

For a tenant, the interview can be ended at this point.

B. Detailed Information – Owner, Key site Manager, or ESA User

1.0 Documents: If the interviewee is the *property owner*, *key site manager*, or *user*, they must be asked if the following documents exist, and, if so, whether copies can and will be provided to the *environmental professional* within reasonable time and cost constraints:

		Exists	To Be Provided
1.	Environmental Site Assessment Reports	Yes__No✓	Yes__No__
2.	Environmental Audit Reports	Yes__No✓	Yes__No__
3.	Environmental Permits	Yes__No✓	Yes__No__
	a. Solid waste disposal	Yes__No✓	Yes__No__
	b. Hazardous waste disposal	Yes__No✓	Yes__No__
	c. Wastewater	Yes__No✓	Yes__No__
	d. NPDES	Yes__No✓	Yes__No__
	e. Air	Yes__No✓	Yes__No__
4.	Storage Tanks	Yes__No✓	Yes__No__
	a. Registrations for Underground Storage Tanks	Yes__No✓	Yes__No__
	b. Registrations for Aboveground Storage Tanks	Yes__No✓	Yes__No__
5.	Material Safety Data Sheets	Yes__No✓	Yes__No__
6.	Community Right-to-Know Documents	Yes__No✓	Yes__No__
7.	Safety Plans	Yes__No✓	Yes__No__
	a. Preparedness and Prevention	Yes__No✓	Yes__No__
	b. Spill Prevention; Countermeasures and Control	Yes__No✓	Yes__No__
	c. Storm Water Pollution Prevention	Yes__No✓	Yes__No__
	d. Waste Minimization/Pollution Prevention	Yes__No✓	Yes__No__
	e. Process Safety Management	Yes__No✓	Yes__No__
	f. Chemical Hygiene (occupational exposures to hazardous chemicals in laboratories)	Yes__No✓	Yes__No__
	g. Hazard Communication Standard (HCS)	Yes__No✓	Yes__No__
	h. Occupational Exposure to Bloodborne Pathogens	Yes__No✓	Yes__No__
8.	Reports regarding hydrogeologic conditions on the *property* or in the surrounding area.	Yes__No✓	Yes__No__
9.	Notices from any government agency relating to past or current violations of environmental laws with respect to the *property* or relating to environmental liens encumbering the *property*.	Yes__No✓	Yes__No__
10.	Hazardous waste generator notices or reports.	Yes__No✓	Yes__No__
11.	Geotechnical studies.	Yes__No✓	Yes__No__

2.0. What *hazardous substances* or *petroleum products* are or in the past were used, treated, stored, or disposed of, on the *property*?

PRESENT*

Chemical	Amount	Container Type	Storage Conditions

PAST*

Chemical	Amount	Container Type	Storage Conditions

* Attach sheet if additional space is needed

3.0 What is the sewage disposal system for the *property*? Describe any septic system or cesspool.

N/A

4.0 Describe any aboveground or underground storage tanks, or vent pipes, fill pipes, or access ways?

N/A

5.0 Have you ever noticed any strong, pungent, or noxious odors on or near the *property*?

No

6.0 Have you ever noticed standing surface water, or pools or sumps, containing liquids likely to be *hazardous substances* or *petroleum products*?

No

7.0 Have you ever seen drums or other containers of oils or chemicals on the *property* (other than yours)? If yes, to the best of your knowledge what was in them, and were there any leaks or spills?

No

8.0 Are you aware of any electrical or hydraulic equipment known, or likely to, contain PCBs?

No

9.0 What is the means of heating and cooling the buildings (include all fuel sources)?

NA

10.0 Have you ever noticed any stains or corrosion on floors, walls, or ceilings?

NA

11.0 Are you aware of any floor drains or sumps? If yes, where and what is nearby?

NA

12.0 Are there any pits, ponds, or lagoons on the *property*? If yes, what were/are they used for?

There is a water reservoir & irrigation ditches on the property. They are part of an agricultural irrigation system.

13.0 Have you ever noticed stained soil or pavement?

No

14.0 Have you ever noticed areas of stressed vegetation (except due to weather or lack of water)?

No

15.0 Are you aware of any buried trash or other waste (areas that are apparently filled or graded by non-natural causes, or filled by fill of unknown origin, or mounds or depressions suggesting disposal)?

No

16.0 Is waste water (including storm water) or any other liquid discharged into a drain, ditch or stream on or adjacent to the *property*?

Storm water on the property flows into the irrigation ditches.

17.0 Are there any water wells or monitoring wells on the *property*? Yes If yes, please describe.

There is an old irrigation water well below the Crater Lake reservoir.

Phase I ESA – Owners and Occupants Interview Form

Property: Villages of Leiali'i, Phases A and B

Name & Title of Person Interviewed: Stan S. Fujimoto, HHFDC Project Manager

Interview Date: April 24, 2008 ___ in person ___ by telephone _X_ in writing (attach questionnaire)

Ask the interviewee to be as specific as possible, and to answer in good faith and to the extent of their knowledge.

NOTE: Residential occupants do not need to be interviewed. If the *property* has fewer than five current occupants, a reasonable attempt must be made to interview a representative of each. If there are more than five, a reasonable attempt must be made to interview all major occupants and those others whose operations are likely to indicate an environmental concern. Many interviewees have no obligation to answer questions. If an answer is incomplete, or a question not answered, note this on the form. The *user* has an obligation to answer.

How is the person interviewed related to the *property*?

___ Current Owner (since _____)

___ Former Owner (from _____ to _____)

_X_ Key Site Manager, Title: Project Manager

___ Occupant/Tenant: Name of Entity: _____

Period of occupancy: HHFDC took title to Phase A in November 1994. Phase B is owned by DLNR, however, HHFDC is the master developer of the Villages of Leiali'i, which includes Phase B.

A. Basic Information – All Interviewees

1.0 What current and past activities/uses has your occupancy involved?

Development of Phase 1A into 104 single-family houselots.

2.0 What *hazardous substances* (HS) or *petroleum products* (PP) has your organization used (may include fuels, paints and solvents, hydraulic fluid, pesticides, cleaning chemicals, etc.), and how were wastes and empty containers disposed?

None.

3.0 Do you know of, or have records of any fire, accident, spill, or other release of a HS or PP on, from, or near the *property*?

No.

4.0 Are you aware of any pending, threatened, or past notice of violation, litigation, or administrative proceeding relevant to *hazardous substances* or *petroleum products* in, on or from the *property*?

No.

5.0 To the best of your knowledge, what are the current and past uses of adjacent parcels?

Vacant land mauka (east); Kahoma Stream to the south; residential subdivisions and civic center To the makai (west); and vacant land to the north formerly in sugar cane cultivation.

6.0 Do you know of any potential environmental hazard/condition on the *property*, or on a nearby parcel?

No.

7.0 Who are other current or past owners or occupants?

Department of Land and Natural Resources (DLNR), Kaanapali Land Management Corp., Maui Land and Pine, Pioneer Mill Company, Ltd.

8.0 What is the source of your drinking water?

N/A – vacant land.

For a tenant, the interview can be ended at this point.

B. Detailed Information – Owner, Key site Manager, or ESA User

1.0 Documents: If the interviewee is the *property owner*, *key site manager*, or *user*, they must be asked if the following documents exist, and, if so, whether copies can and will be provided to the *environmental professional* within reasonable time and cost constraints:

	Exists	To Be Provided
1. Environmental Site Assessment Reports	Yes__No_X_	Yes__No__
2. Environmental Audit Reports	Yes__No_X_	Yes__No__
3. Environmental Permits	Yes_X_No__	Yes__No__
a. Solid waste disposal	Yes__No_X_	Yes__No__
b. Hazardous waste disposal	Yes__No_X_	Yes__No__
c. Wastewater	Yes__No_X_	Yes__No__
d. NPDES	Yes_X_No__	Yes_X_No__
e. Air	Yes__No_X_	Yes__No__
4. Storage Tanks	Yes__No_X_	Yes__No__
a. Registrations for Underground Storage Tanks	Yes__No_X_	Yes__No__
b. Registrations for Aboveground Storage Tanks	Yes__No_X_	Yes__No__
5. Material Safety Data Sheets	Yes__No_X_	Yes__No__
6. Community Right-to-Know Documents	Yes__No_X_	Yes__No__
7. Safety Plans	Yes__No_X_	Yes__No__
a. Preparedness and Prevention	Yes__No_X_	Yes__No__
b. Spill Prevention; Countermeasures and Control	Yes__No_X_	Yes__No__
c. Storm Water Pollution Prevention	Yes__No_X_	Yes__No__
d. Waste Minimization/Pollution Prevention	Yes__No_X_	Yes__No__
e. Process Safety Management	Yes__No_X_	Yes__No__
f. Chemical Hygiene (occupational exposures to hazardous chemicals in laboratories)	Yes__No_X_	Yes__No__
g. Hazard Communication Standard (HCS)	Yes__No_X_	Yes__No__
h. Occupational Exposure to Bloodborne Pathogens	Yes__No_X_	Yes__No__
8. Reports regarding hydrogeologic conditions on the *property* or in the surrounding area.	Yes__No_X_	Yes__No__
9. Notices from any government agency relating to past or current violations of environmental laws with respect to the *property* or relating to environmental liens encumbering the *property*.	Yes__No_X_	Yes__No__
10. Hazardous waste generator notices or reports.	Yes__No_X_	Yes__No__
11. Geotechnical studies.	Yes_X_No__	Yes__No_X*_

*Geotechnical studies already on file with Belt Collins Hawaii Ltd.

2.0. What *hazardous substances* or *petroleum products* are or in the past were used, treated, stored, or disposed of, on the *property*?

PRESENT*

Chemical	Amount	Container Type	Storage Conditions
Not known			

PAST*

Chemical	Amount	Container Type	Storage Conditions

* Attach sheet if additional space is needed

3.0 What is the sewage disposal system for the *property*? Describe any septic system or cesspool.

N/A – vacant land.

4.0 Describe any aboveground or underground storage tanks, or vent pipes, fill pipes, or access ways?

Not known.

5.0 Have you ever noticed any strong, pungent, or noxious odors on or near the *property*?

No.

6.0 Have you ever noticed standing surface water, or pools or sumps, containing liquids likely to be *hazardous substances* or *petroleum products*?

No.

7.0 Have you ever seen drums or other containers of oils or chemicals on the *property* (other than yours)? If yes, to the best of your knowledge what was in them, and were there any leaks or spills?

No.

8.0 Are you aware of any electrical or hydraulic equipment known, or likely to, contain PCBs?

No.

9.0 What is the means of heating and cooling the buildings (include all fuel sources)?
N/A – vacant land.

10.0 Have you ever noticed any stains or corrosion on floors, walls, or ceilings?
N/A.

11.0 Are you aware of any floor drains or sumps? If yes, where and what is nearby?
N/A.

12.0 Are there any pits, ponds, or lagoons on the *property*? If yes, what were/are they used for?
Yes. Wahikuli and Crater Reservoirs used for irrigation by off-site user, Kaanapali Land Management Corp.; Temporary retention basin mauka of Village 1A.

13.0 Have you ever noticed stained soil or pavement?
No.

14.0 Have you ever noticed areas of stressed vegetation (except due to weather or lack of water)?
No.

15.0 Are you aware of any buried trash or other waste (areas that are apparently filled or graded by non-natural causes, or filled by fill of unknown origin, or mounds or depressions suggesting disposal)?
No.

16.0 Is waste water (including storm water) or any other liquid discharged into a drain, ditch or stream on or adjacent to the *property*?

Honokohau and Wahikuli Return Ditches collect storm waters and discharge into Wahikuli And Crater Reservoirs. Temporary retention basin mauka of Village 1A.

17.0 Are there any water wells or monitoring wells on the *property*? _____ If yes, please describe.

Non-potable irrigation well on TMK (2) 4-5-21: 21 (well no. 5440-01).

Phase I ESA – User Questionnaire

Property: Villages of Leiali'i, Phases A and B

Address: Lahaina, Maui, Hawaii

In order to qualify for one of the Landowner Liability Protections (LLPs) offered by the Small Business Liability Relief and Brownfields Revitalization Act of 2001 (the "*Brownfields Amendments*" to CERCLA), the *user* must provide the following information (if available) to the *environmental professional* who conducts a Phase I Environmental Site Assessment (ESA). Failure to provide this information could result in a determination that "*all appropriate inquiry*" is not complete.

Note: All terms in *italics* have the meanings defined in ASTM Standard Practice E1527-05.

1.0 Environmental cleanup liens that are filed or recorded against the *property* (40 CFR 312.25).

Are you aware of any environmental cleanup lien against the *property* that has been filed or recorded under federal, tribal, state or local law?
Yes___ No_X__ If yes, describe it and identify where recorded:

2.0 Activity and land use limitations that are in place on the *property* or that have been filed or recorded in a registry (40 CFR 312.26).

Are you aware of any Activity and Use Limitation, such as an *engineering control*, land use restriction or *institutional control* that is in place at the *property* and/or has been filed or recorded in a registry under federal, tribal, state or local law?
Yes___ No_X__ If yes, describe it and identify where recorded:

3.0 Specialized knowledge or experience of the person seeking to qualify for the LLPs (40 CFR 312.28).

As the *user* of this *ESA* do you have any specialized knowledge or experience related to the *property* or nearby properties? For example, are you involved in the same line of business as the current or former *occupants* of the *property* or an adjoining *property* so that you would have specialized knowledge of the chemicals and processes used by this type of business?
Yes___ No_X__ If yes, describe:

4.0 Relationship of the purchase price to the fair market value of the *property* if it were not contaminated (40 CFR 312.29).

Do you believe that the purchase price being paid for this *property* reasonably reflects the fair market value of the *property*?
Yes_X__ No___ If no, discuss why not. If you conclude that there is a difference, have you considered whether the lower purchase price is because contamination is known or believed to be present at the *property*?

5.0 Commonly known or *reasonably ascertainable* information about the *property* (40 CFR 312.30).

Are you aware of commonly known or *reasonably ascertainable* information about the *property* that would help the *environmental professional* to identify conditions indicative of releases or threatened releases? As a *user* of the ESA report:

(a) Do you know any of the past uses of the *property*?
Yes_X__ No___ If yes, describe:
Sugar cane cultivation by Pioneer Mill Company, Ltd.

(b) Do you know of specific chemicals that are or formerly were present on the *property*?
Yes___ No_X__ If yes, which chemicals and when:

(c) Do you know of spills or other chemical releases that have taken place on or near the *property*?
Yes___ No_X__ If yes, describe each:

(d) Do you know of any environmental cleanup(s) that has taken place on or adjacent to the *property*?
Yes___ No_X__ If yes, describe each:

6.0 The degree of obviousness of the presence or likely presence of contamination at the *property*, and the ability to detect the contamination by appropriate investigation (40 CFR 312.31).

As the *user* of this ESA, based on your knowledge and experience related to the *property*, are there any *obvious* indicators that point to the presence or likely presence of contamination at the *property*?
Yes___ No_X__ If yes, describe each:

7.0 Additional Information.

In addition, certain information that may not be required should, if available, be provided to the *environmental professional* conducting an ESA. This information is intended to assist the *environmental professional*, but is not necessarily required to qualify for one of the LLPs. The information includes:

(a) The reason(s) why the Phase I ESA has been requested:
Investigate and document general available information concerning the property.

(b) The type of *property* (commercial, retail, warehouse, etc.) and type of *property* transaction, for example a sale, purchase, exchange, etc.:
Vacant land. Potential future sale or development.

(c) A complete and correct address for the *property*. A map, survey, or other document showing *property* location and boundaries is helpful. (Note: A *property* may have more than one address, or an address range; if so, please indicate all known addresses that are associated with the *property*.)

Phase A – TMK (2) 4-5—21: 3, 13, 21; 4-5-21: 70.

Phase B – TMK (2) 4-5-21: portions of 4, 5 and 22.

Please attach a copy of a site map to this questionnaire or provide at site visit (if available).

(d) Names and addresses of all parties who expect to rely on the Phase I ESA report:

Not known. Future buyers, lessees, or developers of the property.

(e) Identification of a contact(s) for a *property* visit, and how the contact(s) can be reached:

Coordinate entry with Lanny Tihada and Kathleen of Kaanapali Land Management Corp. at 661-9652

To install HHFDC lock at Keawe St. entry to haul cane road. BCH has keys to HHFDC lock. All entries

To the property to be coordinated with Lanny of KLMC at 661-9652.

(f) Any other knowledge or experience with the *property*, or documents related to it, that may be pertinent to the *environmental professional*, such as copies of prior ESA reports, cleanup records, other documents or correspondence, etc. concerning the *property* and its environmental condition. (Please provide/attach a list of any available documents, and provide copies of them or arrange a time and place for the *environmental professional* to review them.)

See attached information list dated April 24, 2008.

Completed by:

Stan S. Fujimoto

Signature

April 24, 2008

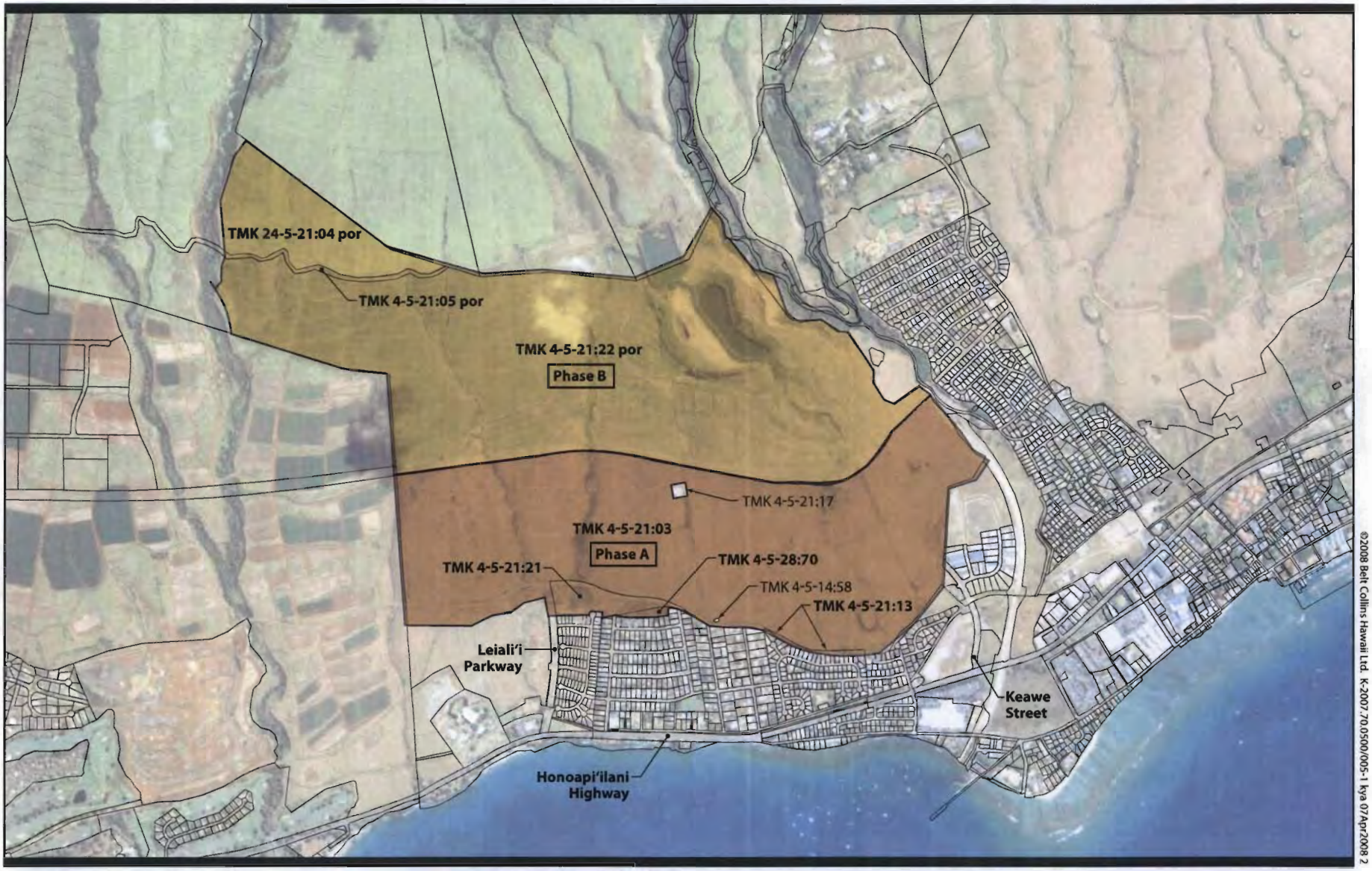
Date

Stan S. Fujimoto

Printed Name

HHFDC Project Manager

Title



©2008 Belt Collins Hawaii Ltd. K-2007.70.0500/005-1 kya 07Apr2008 2

BeltCollins

NORTH

0 500 1000 2000
SCALE IN FEET

Note:
Lot lines shown are approximate and for illustrative purposes.
Imagery is from Google Earth Pro and is approximately matched to lot lines.

DRAFT
Subject to Change

PROJECT LOCATION MAP

Villages of Leiali'i
April 2008

4/24/08

VILLAGES OF LEIALI'I – PHASES A & B
Phase I ESA – User Questionnaire

Question #7.0(f)

1) The following information was obtained from Kaanapali Land Management Corp. (Robert Vorfeld) and refers to Belt Collins Hawaii Ltd.'s (BCH) photos obtained from field trips to the project site in early 2008:

   a) BCH photo 2610: rain gauge; can be moved.

   b) BCH photo 2615: Filter station for irrigation water still in operation.

   c) BCH photo 2522: Second filter station not active.

   d) BCH photo 2614: Fertilizer loading station abandoned by Maui Land & Pine.

   e) Photo of shed with "poison gas" sign used to house chlorine gas for algae control in drip irrigation tubes. The shed contains nothing now.

2) Copies of the following geotechnical studies were turned over, and are on file at BCH:

   a) Soils Investigation, Offsite Improvements, Lahaina Planned Community (May 2, 1991)

   b) Soils Investigation, Village I, Phase 1A, Lahaina Planned Community (May 6, 1991)

   c) Soils Investigation, Village I, Phase 1B, Lahaina Planned Community (September 27, 1991)

3) Copies of the following archaeological studies were turned over, and are on file at BCH:

   a) Archaeological Inventory Survey Report, Pioneer Mill Company, Ltd. Sugar Enterprise Lands, Site No. 50-50-03-4420, Villages of Leiali'i Project (October 1997)

   b) HABS/HAER Level 2 Documentation of Irrigation Features at Villages of Leiali'i (December 1998)

4) A copy of the following NPDES application will be provided to BCH:

a) Notice of Intent – Form C Permit Application, Villages of Leiali'i, Retention Basin Cleanout and Security Fence Installation (July 2007)

RECEIVED
JUN 21 2 19 PM '91

SOILS INVESTIGATION

OFFSITE IMPROVEMENTS

LAHAINA PLANNED COMMUNITY PROJECT

LAHAINA, MAUI, HAWAII

for

HOUSING FINANCE & DEVELOPMENT CORPORATION

W.O. 90-2044
May 2, 1991

EH

ERNEST K. HIRATA & ASSOCIATES, INC.

RECEIVED
H.F.D.C.
MAY 7 12 03 PM '91

SOILS INVESTIGATION

LAHAINA PLANNED COMMUNITY PROJECT

VILLAGE I, PHASE IA

AND OFFSITE SEWER LINE

LAHAINA, MAUI, HAWAII

for

HOUSING FINANCE & DEVELOPMENT CORPORATION

W.O. 90-2044.2
May 6, 1991

EH

ERNEST K. HIRATA & ASSOCIATES, INC.

RECEIVED
H.F.D.C.
SEP 30 4 17 PM '91

SOILS INVESTIGATION

LAHAINA PLANNED COMMUNITY PROJECT

VILLAGE I - PHASE IB

LAHAINA, MAUI, HAWAII

for

HOUSING FINANCE & DEVELOPMENT CORPORATION

W.O. 90-2044.3
September 27, 1991

ERNEST K. HIRATA & ASSOCIATES, INC.

Soils and Foundation Engineering

Archaeological Inventory Survey Report
Pioneer Mill Company, Ltd. Sugar Enterprise Lands, Site No. 50-50-03-4420, Villages of Leiali'i Project, Lahaina, Maui, Hawai'i

RECEIVED
H.F.D.C.
Oct 16 1 53 PM '97

Conrad "Mac" Goodwin, Ph.D.
Spencer Leineweber, FAIA

prepared for

Housing Finance and Development Corporation
Department of Budget and Finance
677 Queen Street, #300
Honolulu, Hawai'i 96813

International Archaeological Research Institute, Inc.
949 McCully Street, Suite 5
Honolulu, Hawai'i 96826

October 1997

HABS/HAER LEVEL 2 DOCUMENTATION OF IRRIGATION FEATURES AT VILLAGES OF LEIALII, WAHIKULI *AHUPUA'A*, LAHAINA DISTRICT, MAUI (TMK: 4-5-21:3, 18-20,22)

by

Spencer Leineweber, FAIA

Spencer Architects
1820 University Ave.
Honolulu, Hawai'i 96822

Prepared for

Housing Community Development Corporation of Hawaii
677 Queen St., Suite 300
Honolulu, Hawai'i 96813

International Archaeological Research Institute, Inc.
949 McCully St., Suite 5
Honolulu, Hawai'i 96826

December 1998

State of Hawaii
Department of Health
Clean Water Branch
Notice of Intent – Form C Permit Application

Villages of Leiali'i
Retention Basin Cleanout and Security Fence Installation
Lahaina, Maui, Hawaii

Prepared for

State of Hawaii
Department of Business, Economic Development, and Tourism
Hawaii Housing Finance and Development Corporation

Prepared by

Shimabukuro, Endo & Yoshizaki, Inc.
dba SEY Engineers

July 2007

Phase I ESA – Owners and Occupants Interview Form

Property: TMK: (2) 4-5-028:070 / 1.586 Acres

Name & Title of Person Interviewed: Form completed by Land Agent Larry Pacheco
Interview Date: _____ ___ in person ___ by telephone X in writing (attach questionnaire)

Ask the interviewee to be as specific as possible, and to answer in good faith and to the extent of their knowledge.

NOTE: Residential occupants do not need to be interviewed. If the *property* has fewer than five current occupants, a reasonable attempt must be made to interview a representative of each. If there are more than five, a reasonable attempt must be made to interview all major occupants and those others whose operations are likely to indicate an environmental concern. Many interviewees have no obligation to answer questions. If an answer is incomplete, or a question not answered, note this on the form. The *user* has an obligation to answer.

How is the person interviewed related to the *property*?

X Current Owner (since _____)

___ Former Owner (from _____ to _____)

x Key Site Manager, Title: Larry Pacheco, Land Agent

X Occupant/Tenant: Name of Entity: Last Tenant- Leslie Lau (Revocable Permit 6620)

Period of occupancy: March 1, 1989 through February 13, 2007.

A. Basic Information – All Interviewees

1.0 What current and past activities/uses has your occupancy involved?

The subject parcel was previously used for Agricultural Purposes via a Month to Month Revocable Permit.

2.0 What *hazardous substances* (HS) or *petroleum products* (PP) has your organization used (may include fuels, paints and solvents, hydraulic fluid, pesticides, cleaning chemicals, etc.), and how were wastes and empty containers disposed?

The last tenant utilized fertilizers and weed control products.

3.0 Do you know of, or have records of any fire, accident, spill, or other release of a HS or PP on, from, or near the *property*?

None

4.0 Are you aware of any pending, threatened, or past notice of violation, litigation, or administrative proceeding relevant to *hazardous substances* or *petroleum products* in, on or from the *property*?

No

5.0 To the best of your knowledge, what are the current and past uses of adjacent parcels?

There is a residential subdivision below and agricultural parcels above the subject parcel. Refer to the attached Topographical photo.

6.0 Do you know of any potential environmental hazard/condition on the *property*, or on a nearby parcel?

No

7.0 Who are other current or past owners or occupants?

The most recent Tenant- Mr. Leslie Lau (Month to Month Revocable Permit # 6620)

Period: 3/1/89 to 2/13/07

8.0 What is the source of your drinking water?

Unknown

For a tenant, the interview can be ended at this point.

B. Detailed Information – Owner, Key site Manager, or ESA User

1.0 Documents: If the interviewee is the *property owner*, *key site manager*, or *user*, they must be asked if the following documents exist, and, if so, whether copies can and will be provided to the *environmental professional* within reasonable time and cost constraints:

		Exists	To Be Provided
1.	Environmental Site Assessment Reports	Yes__No x	Yes__No__
2.	Environmental Audit Reports	Yes__No x	Yes__No__
3.	Environmental Permits	Yes__No x	Yes__No__
	a. Solid waste disposal	Yes__No x	Yes__No__
	b. Hazardous waste disposal	Yes__No x	Yes__No__
	c. Wastewater	Yes__No x	Yes__No__
	d. NPDES	Yes__No x	Yes__No__
	e. Air	Yes__No x	Yes__No__
4.	Storage Tanks	Yes__No x	Yes__No__
	a. Registrations for Underground Storage Tanks	Yes__No x	Yes__No__
	b. Registrations for Aboveground Storage Tanks	Yes__No x	Yes__No__
5.	Material Safety Data Sheets	Yes__No x	Yes__No__
6.	Community Right-to-Know Documents	Yes__No x	Yes__No__
7.	Safety Plans	Yes__No x	Yes__No__
	a. Preparedness and Prevention	Yes__No x	Yes__No__
	b. Spill Prevention; Countermeasures and Control	Yes__No x	Yes__No__
	c. Storm Water Pollution Prevention	Yes__No x	Yes__No__
	d. Waste Minimization/Pollution Prevention	Yes__No x	Yes__No__
	e. Process Safety Management	Yes__No x	Yes__No__
	f. Chemical Hygiene (occupational exposures to hazardous chemicals in laboratories)	Yes__No x	Yes__No__
	g. Hazard Communication Standard (HCS)	Yes__No x	Yes__No__
	h. Occupational Exposure to Bloodborne Pathogens	Yes__No x	Yes__No__
8.	Reports regarding hydrogeologic conditions on the *property* or in the surrounding area.	Yes__No x	Yes__No__
9.	Notices from any government agency relating to past or current violations of environmental laws with respect to the *property* or relating to environmental liens encumbering the *property*.	Yes__No x	Yes__No__
10.	Hazardous waste generator notices or reports.	Yes__No x	Yes__No__
11.	Geotechnical studies.	Yes__No x	Yes__No__

2.0. What *hazardous substances* or *petroleum products* are or in the past were used, treated, stored, or disposed of, on the *property*? None

PRESENT*

Chemical	Amount	Container Type	Storage Conditions

PAST*

Chemical	Amount	Container Type	Storage Conditions

* Attach sheet if additional space is needed

3.0 What is the sewage disposal system for the *property*? Describe any septic system or cesspool.

None

4.0 Describe any aboveground or underground storage tanks, or vent pipes, fill pipes, or access ways?

None

5.0 Have you ever noticed any strong, pungent, or noxious odors on or near the *property*?

No

6.0 Have you ever noticed standing surface water, or pools or sumps, containing liquids likely to be *hazardous substances* or *petroleum products*?

No

7.0 Have you ever seen drums or other containers of oils or chemicals on the *property* (other than yours)? If yes, to the best of your knowledge what was in them, and were there any leaks or spills?

No

8.0 Are you aware of any electrical or hydraulic equipment known, or likely to, contain PCBs?

No

9.0 What is the means of heating and cooling the buildings (include all fuel sources)?
None, there are no buildings or structures on site.

10.0 Have you ever noticed any stains or corrosion on floors, walls, or ceilings?
NA No building on property. Vacant.

11.0 Are you aware of any floor drains or sumps? If yes, where and what is nearby?
NA No building on property. Vacant.

12.0 Are there any pits, ponds, or lagoons on the *property*? If yes, what were/are they used for?
No

13.0 Have you ever noticed stained soil or pavement?
No

14.0 Have you ever noticed areas of stressed vegetation (except due to weather or lack of water)?
No

15.0 Are you aware of any buried trash or other waste (areas that are apparently filled or graded by non-natural causes, or filled by fill of unknown origin, or mounds or depressions suggesting disposal)?
No

16.0 Is waste water (including storm water) or any other liquid discharged into a drain, ditch or stream on or adjacent to the *property*?

No

17.0 Are there any water wells or monitoring wells on the *property*? **No** If yes, please describe.

Phase I ESA – User Questionnaire

Property: TMK: (2) 4-5-028:070

Address: Wahikuli House Lots, 5th Series, Wahikuli, Lahaina, Maui Hawaii

In order to qualify for one of the Landowner Liability Protections (LLPs) offered by the Small Business Liability Relief and Brownfields Revitalization Act of 2001 (the "*Brownfields Amendments*" to CERCLA), the *user* must provide the following information (if available) to the *environmental professional* who conducts a Phase I Environmental Site Assessment (ESA). Failure to provide this information could result in a determination that "*all appropriate inquiry*" is not complete.

Note: All terms in *italics* have the meanings defined in ASTM Standard Practice E1527-05.

1.0 Environmental cleanup liens that are filed or recorded against the *property* (40 CFR 312.25).

Are you aware of any environmental cleanup lien against the *property* that has been filed or recorded under federal, tribal, state or local law?
Yes___ No X If yes, describe it and identify where recorded:

2.0 Activity and land use limitations that are in place on the *property* or that have been filed or recorded in a registry (40 CFR 312.26).

Are you aware of any Activity and Use Limitation, such as an *engineering control*, land use restriction or *institutional control* that is in place at the *property* and/or has been filed or recorded in a registry under federal, tribal, state or local law?
Yes___ No x If yes, describe it and identify where recorded:

3.0 Specialized knowledge or experience of the person seeking to qualify for the LLPs (40 CFR 312.28).

As the *user* of this *ESA* do you have any specialized knowledge or experience related to the *property* or nearby properties? For example, are you involved in the same line of business as the current or former *occupants* of the *property* or an adjoining *property* so that you would have specialized knowledge of the chemicals and processes used by this type of business?
Yes___ No x If yes, describe:
The only chemicals that I am aware of which were used on the subject parcel are fertilizers and weed control products.

4.0 Relationship of the purchase price to the fair market value of the *property* if it were not contaminated (40 CFR 312.29).

Do you believe that the purchase price being paid for this *property* reasonably reflects the fair market value of the *property*?
Yes___ No___ If no, discuss why not. If you conclude that there is a difference, have you considered whether the lower purchase price is because contamination is known or believed to be present at the *property*?

State property. Not for sale.

5.0 Commonly known or *reasonably ascertainable* information about the *property* (40 CFR 312.30).

Are you aware of commonly known or *reasonably ascertainable* information about the *property* that would help the *environmental professional* to identify conditions indicative of releases or threatened releases? As a *user* of the ESA report:

(a) Do you know any of the past uses of the *property*?
Yes x No___ If yes, describe:
The subject parcel was utilized for agricultural purposes under a Month to Month Revocable Permit to Mr. Leslie Lau from 3/1/89 to 2/13/07.

(b) Do you know of specific chemicals that are or formerly were present on the *property*?
Yes X No___ If yes, which chemicals and when:
Miscellaneous fertilizers and weed control (Round Up)

(c) Do you know of spills or other chemical releases that have taken place on or near the *property*?
Yes___ No X If yes, describe each:

(d) Do you know of any environmental cleanup(s) that has taken place on or adjacent to the *property*?
Yes___ No X If yes, describe each:

6.0 The degree of obviousness of the presence or likely presence of contamination at the *property*, and the ability to detect the contamination by appropriate investigation (40 CFR 312.31).

As the *user* of this ESA, based on your knowledge and experience related to the *property*, are there any *obvious* indicators that point to the presence or likely presence of contamination at the *property*?
Yes___ No X If yes, describe each:

7.0 Additional Information.

In addition, certain information that may not be required should, if available, be provided to the *environmental professional* conducting an ESA. This information is intended to assist the *environmental professional*, but is not necessarily required to qualify for one of the LLPs. The information includes:

(a) The reason(s) why the Phase I ESA has been requested:

Not applicable.

(b) The type of *property* (commercial, retail, warehouse, etc.) and type of *property* transaction, for example a sale, purchase, exchange, etc.:

The subject property was formerly utilized on a Month to Month basis via a Revocable Permit with Tenant Leslie Lau for agricultural purposes.

(c) A complete and correct address for the *property*. A map, survey, or other document showing *property* location and boundaries is helpful. (Note: A *property* may have more than one address, or an address range; if so, please indicate all known addresses that are associated with the *property*.)

TMK: (2) 4-5-028:070, Wahikuli House Lots, 5th Series, Wahikuli, Lahaina, Maui, Hawaii.

Please attach a copy of a site map to this questionnaire or provide at site visit (if available).

(d) Names and addresses of all parties who expect to rely on the Phase I ESA report:

Unknown

(e) Identification of a contact(s) for a *property* visit, and how the contact(s) can be reached:

Land Agent Larry Pacheco , Phone: 808-984-8103

(f) Any other knowledge or experience with the *property*, or documents related to it, that may be pertinent to the *environmental professional*, such as copies of prior ESA reports, cleanup records, other documents or correspondence, etc. concerning the *property* and its environmental condition. (Please provide/attach a list of any available documents, and provide copies of them or arrange a time and place for the *environmental professional* to review them.)

Completed by:

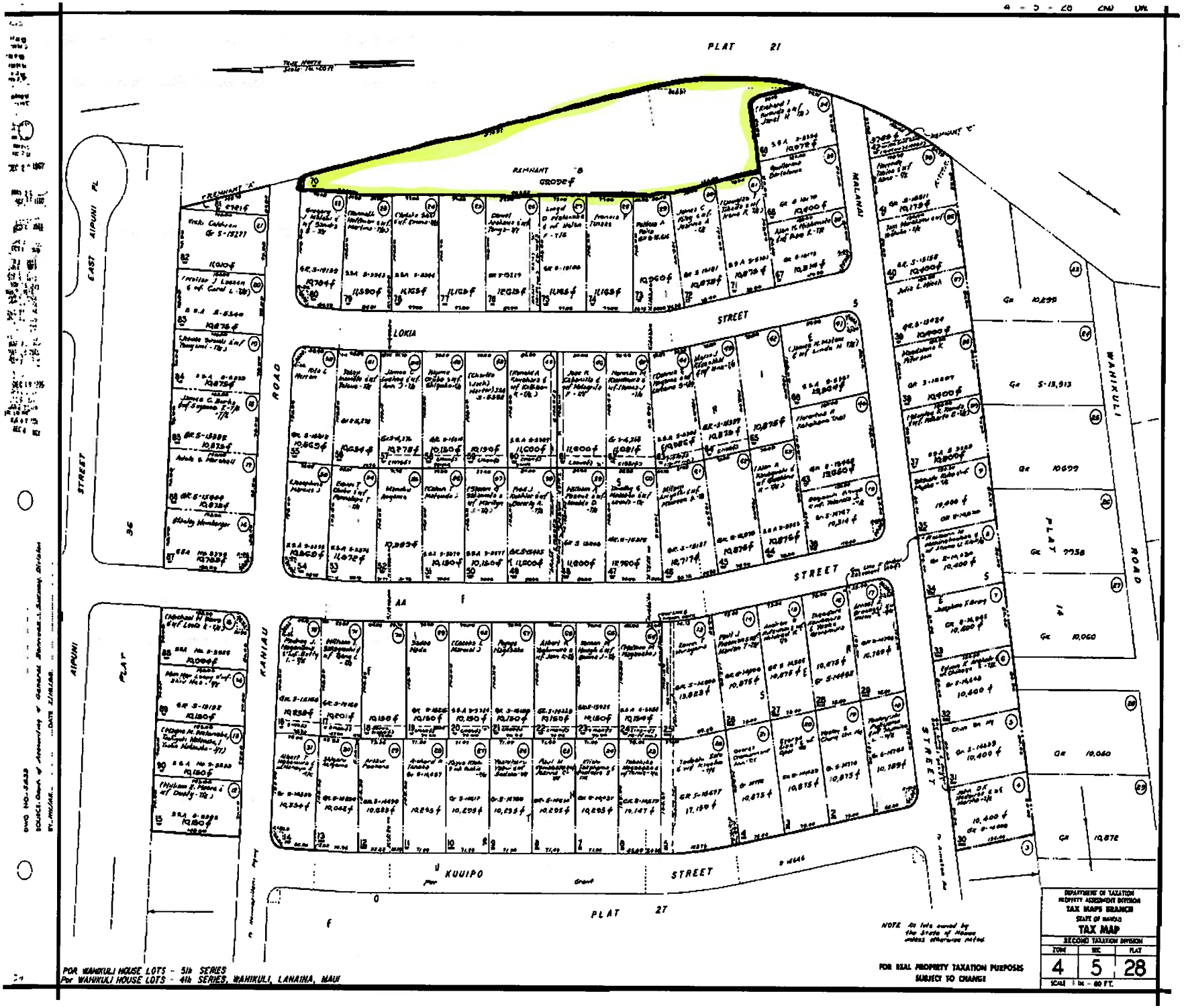
Signature

4/22/08
Date

Larry Pacheco
Printed Name

Land Agent
Title

Subject Parcel
TMK: (2) 4-5-028:070


PLAT 21
REMNANT "B"
REMNANT "A"
REMNANT "C"
GROVE
LOKIA
STREET
MALANAI
WAHIKULI
ROAD
EAST AIPUNI PL
AIPUNI
KAHIAU
KUUIPO
PLAT 27
PLAT 28
PLAT 36
NOTE: All lots owned by the State of Hawaii unless otherwise noted
FOR REAL PROPERTY TAXATION PURPOSES SUBJECT TO CHANGE
DEPARTMENT OF TAXATION
PROPERTY ASSESSMENT DIVISION
TAX MAPS BRANCH
STATE OF HAWAII
TAX MAP
SECOND TAXATION DIVISION
ZONE 4
SEC 5
PLAT 28
SCALE 1 IN. = 60 FT.
For WAHIKULI HOUSE LOTS - 5th SERIES
For WAHIKULI HOUSE LOTS - 4th SERIES, WAHIKULI, LAHAINA, MAUI

APPENDIX E

PHOTOGRAPHS

One pole mounted transformer located at the top of Pu'u Laina

One empty rusted steel opened top mixing tank

One empty rusted 300-gallon AST

Three pole mounted transformers belonging to MECO

Two empty 500-gallon polyethylene ASTs

Six 100-gallon steel AST containing sand for filtration.

Various unidentified transformers located at the former generating station above the reservoir.

APPENDIX F

QUALIFICATIONS OF ENVIRONMENTAL PROFESSIONALS

PHASE I ENVIRONMENTAL SITE ASSESSMENTS/ALL APPROPRIATE INQUIRIES, AND ENVIRONMENTAL BASELINE SURVEYS

INTRODUCTION

Belt Collins environmental staff performs Phase I Environmental Site Assessments (ESAs)/All Appropriate Inquiries and Environmental Baseline Surveys. Phase I ESAs/All Appropriate Inquiries are completed in accordance with the American Society for Testing and Materials (ASTM) Standard E 1527, which is consistent with 40 CFR Part 312 requirements of EPA's Final Rule on All Appropriate Inquiries. Environmental Baseline Surveys (EBSs) for federal and state governments are conducted in a similar manner as Phase I ESAs, with an expanded analysis that includes specific agency requirements.

The scope of service for each of these processes will vary, but generally include: a review of property history (through available maps, aerial photographs, previous environmental reports, and agency records); a reconnaissance survey of the property and vicinity to observe existing conditions for visual evidence of release of hazardous materials, which include interviews with current and previous owner, operators, and occupants; reviews of federal and state government databases for known or potential sources of hazardous materials or waste within ASTM-specified search distances; and the preparation of a report describing observations and conclusions relating to the apparent environmental conditions.

RELEVANT EXPERIENCE

A brief list of clients and associated Phase I ESAs and EBSs are provided below.

Confidential Client (2007) Phase I ESA for 678 acres of agricultural land in Kahuku on Oahu.

Confidential Client (2007) Phase I ESA for 360 acres of ranch and maintenance yard land in Hokukano on the Island of Hawaii.

Confidential Client (2007) Phase I ESA for 23 acres of former nursery and slaughterhouse land in Ewa Beach on Oahu.

Confidential Client (2007) Phase I ESA for 290 acres of undeveloped land in Honalo on the Island of Hawaii.

Confidential Client (2007) Phase I ESA for 20 acres of industrial land in Barbers Point on Oahu.

Confidential Client (2006) Phase I ESA for 11,000 square feet of commercial land in Honolulu on Oahu.

Confidential Client (2006) Phase I ESA for 1,400 acres of resort and golf course land in Kahuku and 230 acres of wooded land in Laie on Oahu.

Confidential Client (2006) Phase I ESA for 6 acres of vacant land in the North Kona District of the Island of Hawaii.

Confidential Client (2006) Phase I ESA for 227 acres of ranch land in Hanalei Valley on Kauai.

Confidential Client (2006) Phase I ESA for 5 acres of commercial land on the Kohala Coast of the Island of Hawaii.

Confidential Client (2006) Phase I ESA for 13,000 square feet of hotel/resort land in Waikiki, on Oahu.

Confidential Client (2006) Phase I ESA for 37 acres of school property in Manoa Valley, on Oahu.

Confidential Client (2006) Phase I ESA for 17 acres of vacant land on the South Kohala District of the Island of Hawaii.

Confidential Client (2006) Phase I ESA for 0.5 acres of industrial land in the Airport Industrial Area of Honolulu, on Oahu.

Confidential Client (2005) Phase I ESA for 2,000 acres of agricultural land in Kealia, on Kauai.

Confidential Client (2005) Phase I ESA for 741 acres of agricultural land in the North Kohala District, on the Island of Hawaii.

Confidential Client (2005) Phase I ESA for 700 acres of resort land and golf courses in the North Kona District, on the Island of Hawaii.

Confidential Client (2004) Phase I ESA for commercial shopping center and service station on Oahu.

Confidential Client (2004) Phase I ESA for 2.7 acres of former agricultural land on the North Shore of Oahu.

Confidential Client (2004) Phase I ESA of 29.7 acres of coastal land in the South Kohala district, on the Island of Hawaii.

Confidential Client (2003) Phase I ESA for an industrial facility and associated easements in the Campbell Industrial Park on Oahu.

Confidential Client (2003) Phase I ESA for vacant land on the Island of Hawaii.

Confidential Client (2003) Phase I ESA update for property in Kahului on Maui.

U.S. Army Corps of Engineers (2003) Environmental Baseline Survey for 23,000 acres on the Island of Hawaii.

Confidential Client (2003) Phase I ESA for commercial building site in Honolulu on Oahu.

U.S. Army Corps of Engineers (2002) Environmental Baseline Survey for 1,400 acres in the Wahiawa area of Oahu.

Confidential Client (2001) Phase I ESA for a Maui Property and Transaction Screen for Five Properties on Molokai and the Island of Hawaii.

Hawaii Army National Guard (1999) EBS for a portion of Naval Air Station Barbers Point and a Phase II EBS (2001), which included soil sampling, Oahu.

Appendix E

Archaeology and Cultural Impact

Report 2692-031908

Archaeological Survey and Cultural Impact Assessment Villages of Leiali'i (Phases A and B) Master Planning Project

Land of Wahikuli, Lahaina District
Island of Maui

PHRI
Paul H. Rosendahl, Ph.D., Inc.
Archaeological • Historical • Cultural Resource Management Studies & Services

Report 2692-031908

Archaeological Survey and Cultural Impact Assessment Villages of Leiali'i (Phases A and B) Master Planning Project

Land of Wahikuli, Lahaina District, Island of Maui (TMK:4-5-021:003,por.004,018-021,por.022;4-5-036:001-111)

BY

Alan B. Corbin, M.A. • Supervisory Archaeologist
Paul H. Rosendahl, Ph.D. • Principal Archaeologist

PREPARED FOR

State of Hawai'i
c/o Belt Collins Hawaii, Ltd.
2153 North King Street, Suite 200
Honolulu, Hawai'i 96819-4554

MAY 2008

PHRI **Paul H. Rosendahl, Ph.D., Inc.**
Archaeological · Historical · Cultural Resource Management Studies & Services

HAWAII: 224 Waianuenue Avenue • Hilo, Hawaii 96720 • (808) 969-1763 • GUAM: P.O. Box 23305 • G.M.F., Guam 96921 • (671) 472-3117

SUMMARY

At the request of Sue Sakai, Vice President and Director of Planning, Belt Collins Hawaii, Inc., for their client, the State of Hawai'i Housing Finance and Development Corporation, Paul H. Rosendahl, Ph.D., Inc. (PHRI) recently conducted an archaeological survey and prepared a cultural impact assessment (CIA) in connection with land use planning for the initial phase of the Villages of Leiali'i residential project in the Land of Wahikuli, Lahaina District, on the northwest side of the Island of Maui. The project area consists of approximately 468 acres immediately seaward of the proposed Lahaina By-Pass Highway (TMK:4-5-021:003,por.004,018-021,por022;4-5-036:001-111). The objective of the field survey was to relocate specified archaeological sites within the project area. The overall purpose of the survey and CIA study was to satisfy the historic preservation requirements of the Department of Land and Natural Resources – State Historic Preservation Division (DLNR-SHPD), and the County of Maui.

During the field survey five archaeological sites were re-located, and the sites were reviewed against earlier descriptions and drawings made during the archaeological inventory survey of the area conducted in 1989.

One of the goals of the CIA was to assess the probable number and significance of known or suspected cultural properties, features, practices, or beliefs within or associated with the specific project area. The CIA study indicates that cultural properties are relatively few in the general area due to the widespread use of the land for historic sugarcane cultivation. Concerning traditional cultural properties, as defined in this document, no specific physical entities or features with definable boundaries, such as a specific location within the current project site, has been identified.

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INTRODUCTION

BACKGROUND

At the request of Sue Sakai, Vice President and Director of Planning, Belt Collins Hawaii, Inc., for their client, the State of Hawai'i Housing Finance and Development Corporation, Paul H. Rosendahl, Ph.D., Inc. (PHRI) recently conducted an archaeological survey and prepared a cultural impact assessment (CIA) in connection with land use planning for the initial phase of the Villages of Leiali'i residential project in the Land of Wahikuli, Lahaina District, on the northwest side of the Island of Maui. The project area consists of approximately 468 acres immediately seaward of the proposed Lahaina By-Pass Highway (TMK:4-5-021:003,por.004,018-021,por022;4-5-036:001-111). The objective of the field survey was to relocate specified archaeological sites within the project area. Subsequently a few other archaeological sites located in the adjacent Phase B area (approximately 632 acres) were added to the original project scope (*Figure 1* shows entire Lahaina Master Planned Project Site). The overall purpose of the survey and CIA study was to satisfy the historic preservation requirements of the Hawai'i State Historic Preservation Division (SHPD), and the County of Maui.

PURPOSE, OBJECTIVES, SCOPE OF WORK

Archaeological Survey

The basic purpose of the archaeological survey was to relocate previously identified significant sites; upgrade, as necessary, site documentation, and assist professional land surveyors with the accurate plotting of all significant sites, and to comply with appropriate historic preservation requirements of the SHPD and the Maui County Planning Department in connection with any subsequent development planning and permit applications.

In 1989, PHRI conducted an archaeological inventory survey of the current project area as part of an archaeological inventory survey of the c. 1,200 acre Lahaina Master Planned Project (Jensen 1989). The specific objectives of the survey were four-fold: (a) to identify all potentially significant archaeological remains present within the corridor study area; (b) to collect information sufficient to evaluate and document the potential significance of all identified remains; (c) to evaluate the potential impacts of any proposed development upon any identified significant remains; and (d) to recommend appropriate measures that would mitigate any adverse impacts upon identified significant remains. The 1989 PHRI report – including findings, site significance evaluations, and general mitigation treatment recommendations – was subsequently accepted by the State, and incorporated into the State Land Use Commission decision and order (Docket No. A89-652) in 1990.

Based on (a) project specifications provided by Sue Sakai of Belt Collins Hawaii, (b) prior PHRI work within the current project area, and (c) our familiarity with both the general project area and the current regulatory review requirements of the SHPD and the Maui County Planning Department, the following tasks were determined to constitute an adequate scope of work for the current project:

1. Conduct (a) appropriate archaeological and historical documentary background review and research; and (b) identification of and consultation with appropriate local informants and agency staff;

2. Conduct informal (non-taped) interviews with identified knowledgeable informants;

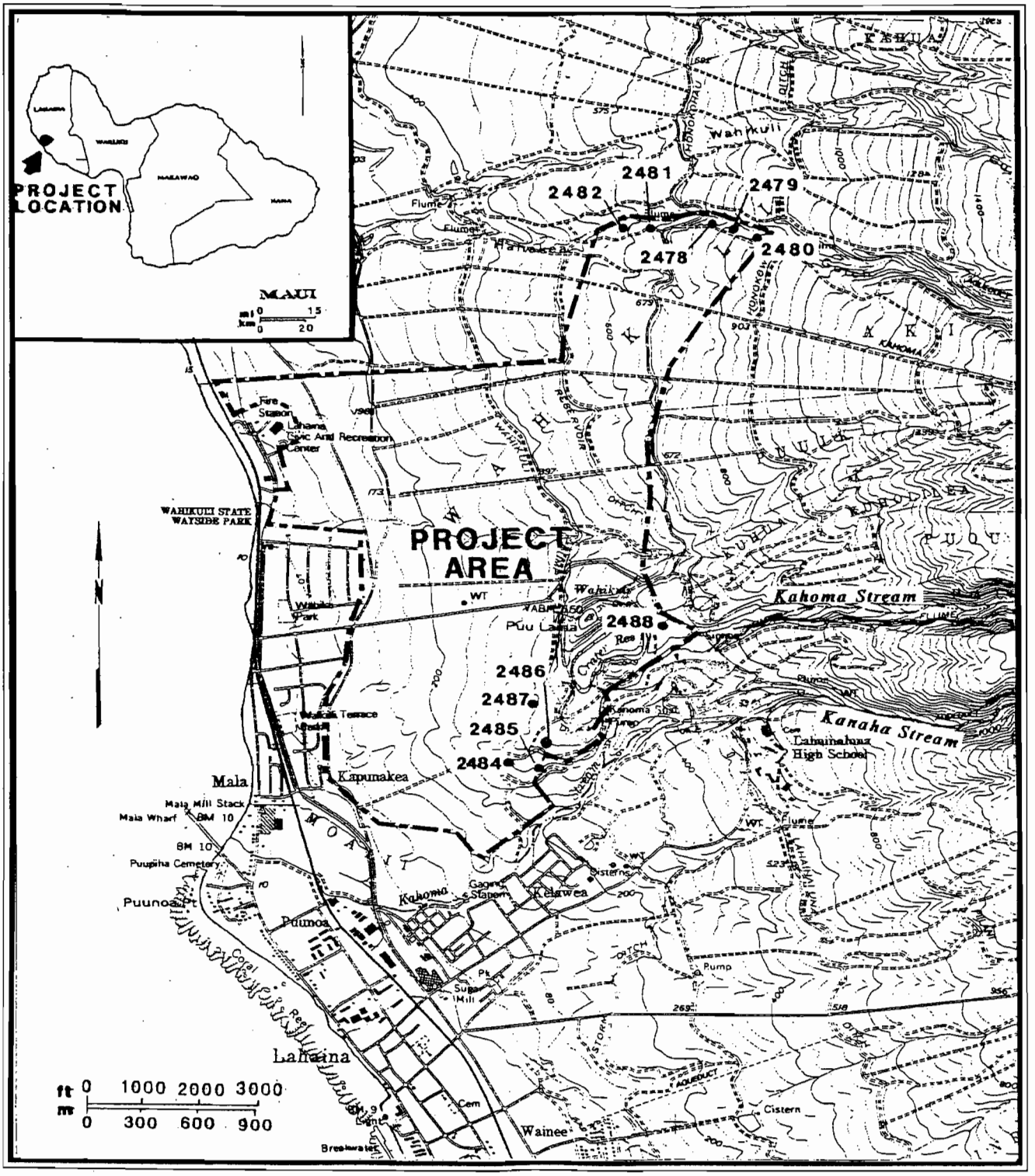

Figure 1. Project Area and Site Locations

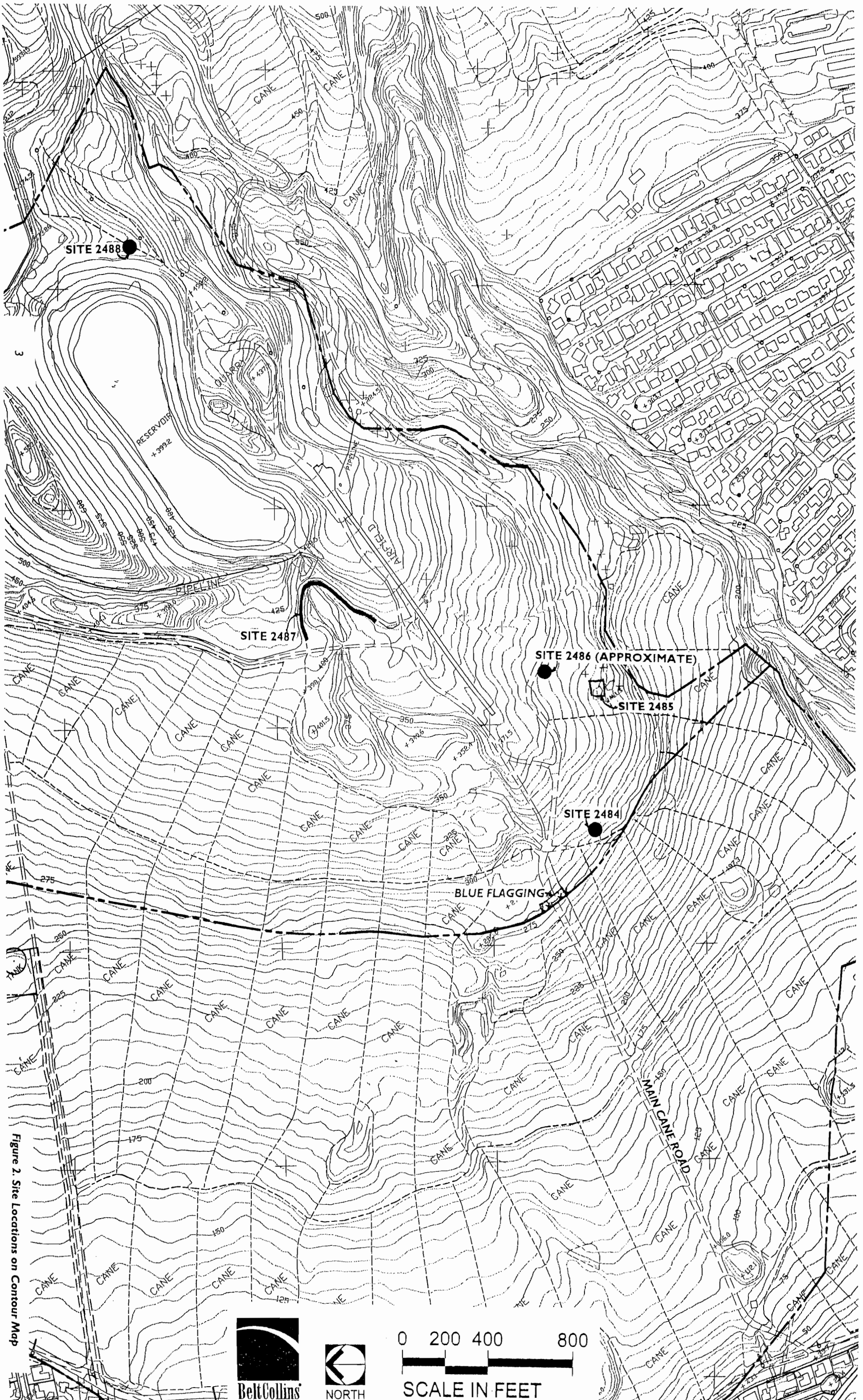

Figure 2. Site Locations on Contour Map

3. Mobilization – including field work preparations, field crew travel, and demobilization;

4. Conduct fieldwork – identify and upgrade documentation for all significant sites;

5. Conduct fieldwork – assist professional land surveyors in the accurate locational plotting of all significant sites;

6. Conduct post-field analyses of fieldwork and other research data;

7. Prepare appropriate draft and final reports – including general significance assessments and recommended general mitigation treatments, as appropriate, for all potentially significant sites and features; and

8. Coordination and consultation with client, client representatives, local informants, agency staff, etc.

Cultural Impact Assessment

The basic purpose of the cultural impact assessment study (*Appendix A*) was to comply with the requirements of Chapter 343 (Haw. Rev. Stat.), as amended by H.B. No.2895 H.D. 1 of the Hawai'i State Legislature (2000) and approved by the Governor as Act 50 on April 26, 2000, and which among other things requires that environmental assessments (EA) and environmental impact statements (EIS) identify and assess the potential effects of any proposed project upon the "...cultural practices of the community and State..." *Chapter 343 (Haw.Rev.Stat.)* was amended by the State legislature because of the perceived need to assure that the environmental review process explicitly addressed the potential effects of any proposed project upon "... Hawai'i's culture, and traditional and customary rights." Guidelines previously prepared and adopted by the State Office of Environmental Quality Control (OEQC) (1997) provide compliance guidance. Both *Act 50* and the OEQC *Guidelines for Assessing Cultural Impacts* mandate consideration of all the different groups comprising the multi-ethnic community of Hawaii.

The specific objectives of the cultural impact assessment study were to determine the following: (a) if the project area is currently being accessed by native Hawaiian cultural practitioners, or individuals of any other cultural groups, for any traditional and customary cultural uses; (b) if the proposed project would have any adverse impacts upon any identified current native Hawaiian or other cultural group uses of the area; and (c) what measures might be proposed to mitigate any adverse impacts the proposed project might have upon any identified current native Hawaiian or other cultural group uses of the area.

PROJECT AREA DESCRIPTION

The overall Villages of Leiali'i Master Planning project area consists of approximately 1,100 acres in the Land of Wahikuli (*Figure 1*). The project area is bounded on the west by Wahiku and Waikuli Terrace Parks and by Lahaina Civic and Recreation Center property, on the north by the Wahikuli *ahupua'a* boundary line, and around the east and south perimeters by (approximately) Kahoma Stream. While a portion of Hahakea Gulch defines the northeast margin of the project area, and segments of the high ground above Kahoma Stream define the southern margins of the parcel, the remainder of the land is dissected by only a single gulch which descends westward to the Pacific Ocean from the lower reaches of the West Maui Mountains.

Virtually all of the project area has been intensively cultivated for sugarcane and pineapple. Most of the cultural features currently visible on the surface of the parcel relate to this essentially modern agricultural activity, and include graded access and major cane haul roads, major and minor irrigation ditches, irrigation reservoirs and small ponds, and a short section of the historic Pioneer Mill Railroad Route. That both historic and contemporary cultivation have involved deep plowing and extensive surface modifications and substantial disturbance to subsurface deposits is attested by the presence of massive field clearing debris piles, particularly within the southwestern portion of the project area. According to Foote et al. (1972: Sheet 93), the project area incorporates at least two major soil classifications, including Pulehu silt loam and Ewa silty clay loam (Foote et al. 1972:29, 116). Annual rainfall in the project area is estimated to be about 15-20 inches (Armstrong 1973:56). The available water supply, combined with the deep rich soils, was more than adequate to support dense stands of native vegetation in early historic and prehistoric times. However, the extensive agricultural activities within the area have resulted in removal of virtually all of this cover and its replacement with sugarcane (*Saccharum officinarum*). Small pockets of relatively undisturbed terrain containing stands of native and introduced species comprise only about 10-12% of the project area and occur primarily restricted to the steep-sided, non-arable gulches associated with Kahoma Stream, Hahakea Gulch, and the unnamed gulch dissecting the approximate center of the project area.

FIELD METHODS

The archaeological field survey took place on February 5 and 6, 2008, by PHRI Supervisory Archaeologist Alan B. Corbin, M.A., assisted by Leonard Kubo, in capacity of Field Technician. The initial stage of site re-location involved the study of previously compiled site inventory maps, overall project maps, and site descriptions in order to determine the probable locations of sites that had been previously identified during the inventory stage. In the field, if the site was not found at its probable location, a further methodology was employed. Using office-compiled distance and bearing from known points in the landscape, compass and tape were used in the field to estimate the sites's probable location. The employed methodologies were sufficient to relocate all sites. All relocated sites were flagged with blue flagging in a line-of-sight manner.

FINDINGS

Prior to the field survey, in discussions with Belt Collins Hawaii, it was decided that five sites would be relocated (2484, 2485, 2488, 2487, and 2488). All of these sites were located in the south to southeast portion of the project area (*Figure 1*). The remaining sites in the project area were located in the far northeast portion, near gulch areas that would not be developed. During the field survey, the five archaeological sites were re-identified and re-located (*Figures 1 and 2*). In addition, the sites were reviewed against their earlier descriptions and drawings (the sites had been initially identified and recorded during the course of an archaeological survey conducted in 1989; [Jensen 1989]). The sites were found to be adequately recorded during the initial Jensen (1989) survey; no additional recording was done. Later, the identified sites were located using GPS technology.

CURRENT HISTORIC PRESERVATION STATUS

The sites relocated during the current project, and other sites in the overall Lahaina master Planned project, were initially identified during the earlier Jensen (1989) inventory survey. The SHPD approved the survey in 1990, as evidenced in a letter dated March 6, 1990, to the State of Hawaii, Department of Land and Natural Resources, from Joseph Conant, Executive Director, Housing Finance and Development Corporation. This letter states that the final EIS (in which Jensen 1989 was included), has been accepted by the Governor.

The current status of all archaeological sites in the project area is given below.

Site 2478

Site 2478 is recommended for further data recovery (Jensen 1989) and will be included in a future data recovery plan to be written. During the current project it was not flagged due to its location in a gulch area that would not be affected by the current development. The site has been assessed as significant for information content (Criterion D).

Site 2479

Site 2479 is recommended for further data recovery (Jensen 1989) and will be included in a future data recovery plan to be written. During the current project it was not flagged due to its location in a gulch area that would not be affected by the current development. The site has been assessed as significant for information content (Criterion D).

Site 2480

Site 2479 is recommended for further data recovery (Jensen 1989) and will be included in a future data recovery plan to be written. During the current project it was not flagged due to its location in a gulch area that would not be affected by the current development. The site has been assessed as significant for information content (Criterion D) and as an excellent example of a site type (Criterion C). The site is recommended for preservation with some level of interpretive development, pending the results of the data recovery work. If the data recovery work indicates the site needs to be preserved, the site will be included in a site preservation plan yet to be written.

Site 2481

Site 2479 is recommended for further data recovery (Jensen 1989) and will be included in a future data recovery plan to be written. During the current project it was not flagged due to its location in a gulch area that would not be affected by the current development. The site has been assessed as significant for information content (Criterion D).

Site 2482

Site 2482 is recommended for further data recovery (Jensen 1989) and will be included in a future data recovery plan to be written. During the current project it was not flagged due to its location in a gulch area that would not be affected by the current development. The site has been assessed as significant for information content (Criterion D).

Site 2484

Site 2484 was recommended for further data recovery in Jensen (1989). At least a portion of the site is in the Lahaina Bypass Road corridor, which runs between Phases A and B (*Figure 1*). Under work for the Department of Transportation the site is currently undergoing data recovery work by the archaeological consulting firm Cultural Surveys Hawaii. The site was assessed by Jensen (1989) as significant under Criterion D (information content).

Site 2485

Site 2485 was recommended for further data recovery (Jensen 1989) and will be included in a data recovery plan yet to be written. Its significance category is D (important for information content). It is also recommended for preservation with some level of interpretive development, pending the results of the data recovery work. If the data recovery work indicates the site needs to be preserved, the site will be included in a site preservation plan yet to be written.

Site 2486

Site 2486 was recommended for further data recovery (Jensen 1989) and will be included in a data recovery plan yet to be written. It is recommended that the site undergo burial testing to determine presence/absence of human skeletal remains. If human skeleton remains are found at the site, or at any other site in the project area, a burial treatment plan for the project area will have to be prepared and implemented. This plan will be prepared in consultation with the SHPD and the Maui Island Burial Council, and requires the final approval of these two agencies. The plan will include a search for lineal and cultural descendents, detailed descriptions of each burial, and burial treatments, including preservation buffers and possible structural protection measures.

Site 2487

Site 2487 has been recommended for no further archaeological work (Jensen 1989). Its significance category is D (important for information content).

Site 2488

Site 2488 was recommended for further data recovery (Jensen 1989) and will be included in a data recovery plan yet to be written. Its significance category is D (important for information content). It is recommended for preservation with some level of interpretive development recommended pending the results of the data recovery work. If the data recovery work indicates the site needs to be preserved, the site will be included in a site preservation plan yet to be written.

Table 1. Summary of General Significance Assessments and Recommended General Treatments

SIHP Site Number	Formal Site Type	Functional Interpretation	Significance Category					General Recommendations			
			A	B	C	D	E	FDC	NFW	PID	PAI
SITES RELOCATED											
2484	Enclosure/L-shape	Poss. habitation	-	-	-	+	-	+	-	-	-
2485	Enclosure	Habitation	-	-	+	+	-	+	-	+	-
2486	Cairn/Marker/Mounds	Poss. graves/grave markers	+	-	+	+	+	+	-	*	*
2487	Access Road	Agriculture	-	-	-	+	-	-	+	-	-
2488	Enclosure	Habitation	-	-	+	+	-	+	-	*	-
OTHER SITES IN/NEAR GULCHES/STREAMS											
2478	Terrace	Agriculture	-	-	-	+	-	+	-	-	-
2479	Terrace	Agriculture	-	-	-	+	-	+	-	-	-
2480	Enclosures (2)	Habitation	-	-	+	+	-	+	-	*	-
2481	Terrace (2)	Agriculture	-	-	-	+	-	+	-	-	-
2482	Terrace	Agriculture	-	-	-	+	-	+	-	-	-

General Significance Categories

A = Important for historical contribution to significant events and/or broad patterns of history
B = Important for association with the lives of important individuals in history
C = Excellent example of site type at local, region, island, state, or national level
D = Important for information content
E = Culturally significant
* = Provisional assessment; definite assessment pending further data collection
(e.g., detailed recordings, testing features for presence/absence of skeletal remains)

Recommended General Treatments:

FDC = Further data collection necessary (detailed recording, surface collections, and limited excavations, and possibly subsequent data recovery/mitigation excavations)
NFW = No further work of any kind necessary, sufficient data collected, no preservation potential
PID = Preservation with some level of interpretive development recommended (including appropriate related data recovery work)
PAI = Preservation "as is" with no further work (and possible inclusion into landscaping), or possibly minimal further data collection necessary

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APPENDIX A:
CULTURAL IMPACT ASSESSMENT STUDY

PURPOSE, BACKGROUND, AND OBJECTIVES

The purpose of this cultural impact assessment is to comply with the requirements of *Chapter 343 (Haw. Rev. Stat.),* as amended by H.B. No.2895 H.D. 1 of the Hawai'i State Legislature (2000) and approved by the Governor as *Act 50* on April 26, 2000, and which among other things requires that environmental assessments (EA) and environmental impact statements (EIS) identify and assess the potential effects of any proposed project upon the "...cultural practices of the community and State...." *Chapter 343 (Haw.Rev.Stat.)* was amended by the State legislature because of the perceived need to assure that the environmental review process explicitly addressed the potential effects of any proposed project upon "...Hawai'i's culture, and traditional and customary rights." Guidelines previously prepared and adopted by the State Office of Environmental Quality Control (OEQC 1997) provide compliance guidance. Both *Act 50* and the OEQC *Guidelines for Assessing Cultural Impacts* mandate consideration of all the different groups comprising the multi-ethnic community of Hawai'i. This inclusiveness, however, is generally understated, and the emphasis – as indicated by a background review (see below) of the cultural impact assessment issue, and the intent and evolution of both the legislative action and the guidelines – is clearly meant to be primarily upon aspects of Native Hawaiian culture – particularly traditional and customary access and use rights.

Cultural resources include a broad range of often overlapping categories of cultural items – places, behaviors, values, beliefs, objects, records, stories, and so on. A traditional cultural property ("TCP") is one specific type of cultural resource that falls within the purview of the historic preservation review process. A "TCP" is a historic property or place that is important because it possesses "traditional cultural significance":

> "Traditional" in this context refers to those beliefs, customs, and practices of a living community of people that have been passed down through the generations, usually orally or through practice. The traditional cultural significance of a historic property, then, is significance derived from the role the property plays in a community's historically rooted beliefs, customs, and practices....
>
> A traditional cultural property, then, can be defined generally as one that is...[important/significant]...because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community (Parker and King 1990:1).

In addition, it is important to realize that sometimes a traditional cultural property may not have a visible physical manifestation:

> Although many traditional cultural properties have physical manifestations that anyone walking across the surface of the earth can see, others do not have this kind of visibility, and more important, the meaning, the historical importance of most traditional cultural properties can only be evaluated in terms of the oral history of the community (Sebastian 1993:22).

There are at least two significant differences that distinguish traditional cultural properties as a subset within the larger sphere of cultural resources. First, while cultural resources such as practices and beliefs may be spatially associated with general types of geographical areas, such as the exposed lava lands of the Keahole Point area, a traditional cultural property is a specific physical entity or feature with a definable boundary, such as a specific location within the current project site. Second, while cultural resources such as practices and beliefs can include general cultural behaviors such as the gathering of various natural resources for general subsistence, industrial, or ceremonial uses, a traditional cultural property is a specific place or feature directly associated with specific behaviors the continuity of which over time, in either actual practice or remembrance, can be demonstrated.

Based on these two significant distinctions, it is possible to suggest three types of practitioner claims relating to cultural practices, beliefs, and features that are likely to be encountered in the course of conducting a cultural impact assessment study. These claims can be referred to as (a) traditional cultural property claims, (b) traditional and customary cultural practice claims, and (c) contemporary or neo-traditional cultural practice claims.

Traditional cultural property claims would be those which lie within the purview of the current historic preservation review process (DLNR 2001a,b); that is, they are claims involving the traditional practices and beliefs of a local ethnic community or members of that community that (a) are associated with a definable physical property (an entity such as a site, building, structure, object, or district), (b) are founded in the history of the local community, (c) contribute to the maintenance of the cultural identity of the community, and (d) demonstrate a historical continuity of practice or belief up to the present – through either actual practice or historical documentation. Furthermore, to qualify as a legitimate traditional cultural property within the historic preservation context, a potential traditional cultural property must be able to demonstrate its historical significance in terms of established evaluation criteria, such as those of the National Register of Historic Places and/or the Hawai'i Register of Historic Places.

Traditional and customary cultural practice claims would be those native Hawaiian claims which lie within the purview of Article XII, Section 7, of the Hawai'i State Constitution ("Traditional and Customary Rights"), and various other state laws and court rulings, particularly as reaffirmed in 1995 by the Hawai'i State Supreme Court in the decision commonly referred to as the "PASH decision," and as further clarified more recently in its 1998 decision in State of Hawai'i v. Alapa'i Hanapi and its 2000 decision in Ka Pa'akai o Ka 'Aina et al. v. Land Use Commission, State of Hawai'i et al. The notable points of the decisions in PASH and in Hanapi can be summarized as follows: (a) the reasonable exercise of ancient Hawaiian usage is entitled to protection under Article XII, Section 7 of the Hawai'i State Constitution; and (b) those persons claiming their conduct is constitutionally protected must prove that they are a native Hawaiian as defined in PASH, that the claimed right is constitutionally protected as a traditional or customary native Hawaiian practice, and that the exercise of the right is occurring on undeveloped or less than fully developed property. Ka Pa'akai generally reaffirms the same points as in the PASH and Hanapi decisions and, in addition, (a) indicates the explicit responsibility of the regulatory agency involved in any application review to arrive at affirmative and substantive conclusions regarding potential impacts upon traditional and customary native Hawaiian cultural practices and resources, and (b) suggests an "analytical framework" for the identification of and potential impacts upon any such cultural practices and resources. Traditional native Hawaiian cultural practices can be categorized as two general types: (a) practices with active behaviors involving both observable activities with material results and their inherent values or beliefs; and (b) practices with more passive behaviors that seek to produce nonmaterial results. The former type of behaviors – practices with active behaviors, for example, would involve practices like the gathering and collecting of different animal and plant resources for various purposes, such as subsistence, medicinal, adornment, social, and ceremonial possibly other uses. Uses such as these usually have associated beliefs and values (both explicit and implicit) relating to a pervasive general theme that flows throughout traditional native Hawaiian culture and binds it together. To native Hawaiians, the natural elements of the physical environment – the land, sea, water, winds, rains, plants, and animals, and their various embodied

spiritual aspects – comprise the very foundation of all cultural life and activity – subsistence, social, and ceremonial; to native Hawaiians, the relationship with these natural elements is one of family and kinship. The latter type of behaviors – practices with more passive behaviors – involves more experiential activities focused on "communing with nature"; that is, behaviors relating to spiritual communication and interaction that reaffirm and reinforce familial and kinship relationships with the natural environment.

While traditional cultural property claims, as defined above, would certainly fall within the general domain of traditional and customary cultural practice claims, not all traditional and customary cultural practice claims would necessarily qualify as traditional cultural property claims. Traditional and customary cultural practice claims subsume a broad range of cultural practices and beliefs associated with a general geographical area or region, rather than a clearly definable property or site – for example, the gathering of marine resources from along a section of shoreline for traditional subsistence or ceremonial purposes, in contrast to the gathering of a specific marine resource species for a specific use by current generation members of a family that had obtained the same resource from the same recognized site for several generations.

Contemporary, or "neo-traditional", cultural practice claims overlap with neither traditional property claims nor traditional and customary practice claims. Contemporary cultural practice claims would be those made by cultural practitioners relating to current practices or beliefs for which no clear specific historical basis in traditional culture can be clearly established or demonstrated; for example, the conducting of ritual ceremonies of uncertain authenticity at sites or features for which no such prior use can be demonstrated.

The specific purpose of the present cultural impact assessment study is to assess the potential impacts of the proposed project upon the cultural resources – the practices, features and/or beliefs – of native Hawaiians or any other ethnic group that might be associated with project area. To accomplish this purpose, several specific objectives were established:

1. Identify any native Hawaiian or other ethnic group cultural practices currently being conducted by individual cultural practitioners or groups;

2. Collect sufficient information so as to define the general nature, location, and authenticity of any identified cultural practices;

3. Assess the potential impacts of the proposed project upon identified cultural practices; and

4. Recommend appropriate mitigation measures for any potentially adverse impacts upon identified cultural practices.

Thus, the overall goal or objective of the present cultural impact assessment study was to identify any native Hawaiian or other cultural practices currently being conducted within or immediately adjacent to present project area that might potentially be in some manner constrained, restricted, prohibited, or eliminated if the proposed project were to be approved. The types of practices to be identified would be inclusive; that is, claims for all three types of practices – traditional cultural property, traditional and customary cultural practices, and contemporary cultural practices – would be identified and considered. More specifically, the objectives of the cultural impact assessment were to determine the following: (a) if the project area is currently being accessed by native Hawaiian cultural practitioners for any traditional and customary cultural uses; (b) if the proposed project would have any adverse impacts upon any identified current native Hawaii cultural uses of the area; and (c) what measures might be proposed to mitigate any adverse impacts the proposed project might have upon any identified current native Hawaiian uses of the area.

CULTURAL IMPACT ASSESSMENT AND OEQC GUIDELINES

To understand the cultural impact assessment issue, particularly as it is addressed by the present study, a summary review of the intent and evolution of the OEQC guidelines is necessary. The guidelines evolved out of what are commonly referred to as "PASH/Kohanaiki" issues – issues relating to native Hawaiian traditional and customary access and land use rights as they were reasserted by a State Supreme Court decision in August 1995 and further clarified in its 1998 decision in State v. Hanapi – and the need for appropriate means to address these issues within the State environmental impact review process. For a good discussion of the issues and options involved, the "Report on Native Hawaiian Traditional and Customary Practices Following the Opinion of the Supreme Court of the State of Hawai'i in Public Access Shoreline Hawai'i v. Hawai'i County Planning Commission" prepared by the PASH/Kohanaiki Study Group (1998) should be consulted.

Initial attempts to address various issues relating to native Hawaiian traditional and customary access and land use rights within the framework of the State environmental impact review process were made in the form of proposed changes to the State EIS law as contained in Chapter 343 (HRS). These attempts to require a formal cultural impact assessment failed to pass the State legislature in 1996 and 1997.

A subsequent, second attempt to address various issues relating to native Hawaiian traditional and customary access and land use rights was made in the form of proposed changes in the "Administrative Rules" for compliance with Chapter 343 (DOH Title 11, Chapter 200). This attempt to require an explicitly defined cultural impact assessment also failed, as the governor declined to approve the proposed amendments.

The third attempt to address various issues relating to native Hawaiian traditional and customary access and land use rights within the State environmental impact review process resulted in the current OEQC "Guidelines for Assessing Cultural Impacts" (OEQC 1997). Draft guidelines were initially issued for public review and comment on September 8, 1997. The Environmental Council formally adopted the guidelines in their final form on November 19, 1997.

The relationship of the OEQC guidelines to the State Supreme Court "PASH decision" was clearly stated on the front page of the September 8, 1997 issue of the OEQC bulletin, *"The Environmental Notice,"* when the draft guidelines were first issued for public review and comment:

> For years, a controversy has simmered over developer's responsibility to perform a "Cultural Impa/ct Study" prior to building a project. The recent Supreme Court "PASH" decision reaffirmed the state's duty to protect the gathering rights of native Hawaiians. In light of these events, the Environmental Council has drafted a guidance document to provide clarity on when and how to assess a project's impacts on the cultural practices of host communities.

It should be noted that the guidelines for cultural impact assessment are meant to include consideration of all the different groups comprising the multi-ethnic community of Hawai'i; however, this inclusiveness is generally understated, and the clear emphasis is meant to be upon aspects of native Hawaiian culture.

More than 20 letters were received by OEQC in response to the publication of the draft guidelines, and relevant comments were said to have been incorporated into a final version of the guidelines (OEQC n.d.). The Environmental Council formally adopted the final guidelines (OEQC 1997) on November 19, 1997.

The final guidelines are virtually identical to the draft guidelines initially published on September 8, 1997, and the degree to which any of the received comments on the draft guidelines were considered prior to issuance of the final guidelines is uncertain. In fact, the overall process through which the guidelines were prepared and adopted brings out several important questions relating to such topics as (a) the source or basis utilized for the content of the guidelines, (b) the background and qualifications of the preparer(s) of the guidelines, (c) the criteria to be used for the adequacy of cultural impact assessment studies prepared in response to the guidelines, and (d) the legal question of how compliance can be required when the standards are guidelines.

According to the Chair's Report contained in *The 1997 Annual Report of the Environmental Council*, the Cultural Impacts Committee drafted the guidelines:

> The Committee drafted guidelines recommending a methodology to assess the impact of proposed actions on cultural resources, including Native Hawaiian cultural resources, values, and beliefs. The guidelines also specify the contents of a cultural impact assessment.
>
> To prepare the Guidelines, the Committee reviewed public testimony and solicited input from interested parties. Expertise from the DLNR's Historic Preservation Division as well as Federal regulations governing the "Protection of Historic Properties" were used to model the draft guidelines.
>
> The draft cultural impact guidelines were published for review and comment in the Sept. 8 *Environmental Notice*, and over 20 letters were received. Relevant comments were incorporated into a final draft version of the guidelines, which were adopted as a policy document by the Environmental Council on November 19, 1997 (OEQC n.d.:5).

Direct inquiries to OEQC (Gary Gill, then-Director) and SHPD (Dr. Holly McEldowney, then-Staff Specialist in the History and Culture Branch) provided additional background information relating to the formulation of the cultural impact assessment guidelines. The principal author or compiler of the guidelines was Arnold Lum, Esq., a member of the Environmental Council's Cultural Impacts Committee. Mr. Lum was also a staff attorney at the Native Hawaiian Legal Corporation. OEQC staff also assisted in the preparation of the guidelines. Several internal drafts were prepared, reviewed, and revised. Preparation of the guidelines relied to some degree upon National Register Bulletin No. 38, *Guidelines for Evaluating and Documenting Traditional Cultural Properties* (Parker and King 1990) for basic content information. Other sources, including the SHPD draft rules for conducting ethnographic surveys and dealing with traditional cultural properties (DLNR n.d.), were consulted; in fact, a copy of the SHPD draft rules was provided to OEQC and the Cultural Impacts Committee by then-SHPD Administrator, Dr. Don Hibbard. Professional staff in the SHPD-History and Culture Branch took part in the preparation and review of the guidelines. Certainly the inclusion of such professional anthropological and historical expertise in the preparation of the guidelines was appropriate; however, much of the professional advice on the extent to which detailed expectations – regarding study scope, content, methodology, documentation, and impact assessment – should be explicitly addressed in the guidelines was apparently discounted.

The most recent attempt to address various issues relating to native Hawaiian traditional and customary access and land use rights within the State environmental impact review process resulted in the amendment to *Chapter 343 (Haw.Rev.Stat.),* as amended by H.B. No.2895, H.D.1 of the Hawai'i State Legislature (2000) and approved by the Governor as *Act 50* on April 26, 2000. While no specific administrative rules for the implementation of this amendment have been adopted, it is generally accepted that the *Guidelines* previously prepared and adopted by the State Office of Environmental Quality Control (OEQC 1997) are meant to provide general compliance guidance.

The OEQC *Guidelines* consist of three basic sections. The first section is an introduction which notes the various statutory and other bases for addressing potential impacts upon cultural resources within the context of the environmental assessment review process, and "...encourages preparers of environmental assessments and environmental impact statements to analyze the impact of a proposed action on cultural practices and features associated with the project area" (OEQC 1997:1). The second section of the guidelines discusses methodological considerations for conducting cultural impact assessments, and presents a recommended six-step protocol to be followed by the assessment preparers. The third section of the guidelines outlines eleven topics or "matters" that a cultural assessment should address; these topics basically represent the desired content and organization of a cultural impact assessment report.

As "guidelines," the OEQC Guidelines would seem to have neither the specific statutory authority of law, nor the regulatory authority of administrative rules. As guidelines, they can be regarded as providing general guidance; that is, they represent general suggestions and recommendations as to how to approach the assessment of potential cultural impacts. The guidelines provide little or no guidance relative to many important questions, perhaps the most significant of which would be the following:

1. How would project-specific determinations be made as to whether or not a cultural impact assessment study might even be necessary or appropriate – given the specific nature and location of a proposed project;

2. If a cultural impact assessment study is to be conducted, how does one determine what constitutes an appropriate project-specific level of effort – that is, the general scope of work or objectives for the study, and the specific tasks or activities required to accomplish successfully the scope of work or objectives;

3. What criteria are to be used for determining the credibility and reliability of potential cultural information sources (generally referred to as "informants" or "knowledgeable individuals");

4. If specific cultural practices, beliefs, or features are definitely identified as being associated with a project area, what criteria are to be applied for evaluating (a) the descriptive adequacy and (b) the cultural authenticity of the identified practices, beliefs, or features;

5. If specific culturally authentic practices, beliefs, or features are definitely identified as being associated with a project area, what criteria are to be used for assessing the nature and extent of potential impacts of a proposed project on the identified practices, beliefs, or features – that is, "no effect," "no adverse effect," or "adverse effect;"

6. If a project is determined to have potentially adverse impacts upon specific identified culturally authentic practices, beliefs, or features, what criteria are to be used for evaluating the adequacy and appropriateness of alternative potential mitigation actions;

7. Within the purview of what regulatory office or agency would the review and acceptance or rejection of a completed cultural impact assessment study legitimately fall; and

8. What standards or criteria are to be used to evaluate the overa/ll adequacy or acceptability of a completed cultural impact assessment study?

Consideration of these questions, and their implications, has direct relevance to the present cultural impact assessment study. These implications relate most importantly to (a) the level of study effort believed appropriate for the project-specific context, and (b) the rationale adopted for both the study overall, as well as for the identification and evaluation of any identified cultural practice claims, the assessment of potential project-specific impacts, and the formulation of any specific recommendations for further study or other mitigation actions.

BASIC GUIDANCE DOCUMENTS

Several references are available to serve as basic guidance documents for carrying out cultural impact assessment studies of various scopes and intensities. The principal sources are the following:

1. The OEQC Guidelines for Assessing Cultural Impacts (OEQC 1997);

2. The Native Hawaiian Rights Handbook (MacKenzie 1991), and more specifically the discussions of traditional and customary rights contained in the two chapters on access rights (Lucas 1991a) and gathering rights (Lucas 1991b);

3. The Report on Native Hawaiian Traditional and Customary Practices Following the Opinion of the Supreme Court of the State of Hawai'i in Public Access Shoreline Hawaii v. Hawai'i County Planning Commission prepared by the PASH/Kohanaiki Study Group (1998);

4. The text of several relevant decisions of the Hawai'i Supreme Court, including the decision commonly referred to as the "PASH decision" (1995), and the more recent decisions in State of Hawai'i v. Alapa'i Hanapi (1998) and Ka Pa'akai o Ka 'Aina et al. v. Land Use Commission, State of Hawai'i et al. (2000);

5. The federal regulations of the Advisory Council on Historic Preservation for the National Register of Historic Places (CFR 1981) and the Protection of Historic Properties (CFR 1986);

6. National Register Bulletin No. 38, Guidelines for Evaluating and Documenting Traditional Cultural Properties (Parker and King 1990); and

7. Recently approved versions of the State Historic Preservation Division (SHPD) administrative rules (effective December 11, 2003), including Chapter 275: Rules Governing Procedures for Historic Preservation Review for Governmental Projects Covered Under Sections 6E-7 and 6E-8, HRS (DLNR 2002a), and Chapter 284: Rules Governing Procedures for Historic Preservation Review to Comment on Chapter 6E-42, HRS, Projects (2002b), as well as an earlier draft Chapter 284--Rules Governing Procedures for Ethnographic Inventory Surveys, Treatment of Traditional Cultural Properties, and Historical Data Recovery (DLNR n.d.).

While the general nature and content of the first four referenced sources are self-explanatory, further comment should be made regarding the final three items. In the absence of any formally adopted administrative rule specifically addressing the treatment of traditional cultural properties, SHPD currently utilizes National Register Bulletin No. 38, *Guidelines for Evaluating and Documenting Traditional Cultural Properties* (Parker and King 1990), as its principal source of guidance for reviewing and

evaluating the adequacy and acceptability of traditional cultural property study reports prepared in connection with various permit applications for which SHPD regulatory review is required. Bulletin No. 38 provides detailed guidance for the assessment of traditional cultural properties within the framework of the National Register significance criteria evaluation process (NPS 1990).

The SHPD draft administrative rule relating to ethnographic surveys and traditional cultural properties (DLNR n.d.) has existed in finalized draft version since at least early 1997; however, it has never been circulated openly, much less formally provided for public review, comment, and eventual adoption by the Department of Land and Natural Resources. This situation is unfortunate because the draft rule goes well beyond National Register Bulletin No. 38 in providing detailed guidance for conducting traditional cultural property studies, and more specifically for dealing with the identification, evaluation, and documentation of native Hawaiian traditional cultural properties and their associated cultural practices and beliefs.

In the absence of any formally adopted administrative rule specifically addressing the treatment of traditional cultural properties, SHPD can also be said to basically follow the federal regulations of the Advisory Council on Historic Preservation for guidance in the evaluation of significance – as contained in Section 60.4 ("Criteria for evaluation") of the "National Register of Historic Places" (CFR 1981), and for guidance in the assessment of potential effects – as contained in Section 800.9 ("Criteria of effect and adverse effect") of the "Protection of Historic Properties" (CFR 1986).

HISTORICAL DOCUMENTARY RESEARCH

The *ahupua'a* of Wahikuli, literally translated as "noisy place," has always been in the shadow of its neighbor to the south, Lahaina. As a result, relatively little historical information on Wahikuli is available. However, considerable information on Lahaina is presented here; from this one can surmise what life must have been like in Wahikuli.

Inez Ashdown (personal notes) claims that Lahaina was originally *Laha'aina*, literally meaning "land [of] prophesy," deriving from the ancient *ali'i* prophets who made their predictions there. Another interpretation of the name is "cruel sun"; as noted by Albert Pierce Taylor, "[a] thin-haired chief who lived at Kauaula Valley, while going to and fro without a hat, felt annoyed at the effects of the scorching rays of the sun. He looked up and gazed into the heavens and cursed at the sun thus: 'He keu hoi keia o kala haina!' ('What an unmerciful sun!')" (Taylor 1928:36). Another old variant name for Lahaina, attributed to a number of sources, is *Lele* (literally, "jump"). According to Ashdown, "The surf of U-o at Lele was even more important to *ali' i*...than others such as Ka-lehua-wehe at Waikiki" (personal notes).

Traditional References and Legends

Kamakau recounts details of a burial site north of the project area. His description suggests that people from Wahikuli were buried there:

> Waiuli.. .is a deep pit where the corpses of the common people were thrown (he lua meki ho'olei kupapa'u ia no na maka'ainana). It is directly mauka of Honokohau, Honolua, and Honokahua, and for those from Lahaina to Kahakuloa, it was the common burial place (ho'oilina kupapa'u). The body of anyone from those places who had died on Molokai was brought back to that place. (Kamakau 1964:39)

Here are two legends associated with the Lahaina area, the first from Kamakau, and the second from Beckwith:

> This is the main reason why the people of Maui worshipped sharks—in order to be saved from being eaten by a shark when they went fishing. At...Lahaina...a fisherman was in danger of being devoured by a shark when he went out fishing with a dip net ('upena 'aki'iki'i), or fishing for octopus with a lure (lawai'a lu'uhe'e), or setting traps for hinalea fish (ho'olu'ulu'u hinalea), or diving with a scoop net...or whichever kind of fishing a man would be doing alone. It would be better to stay ashore, but the fisherman craves fish to eat, and so might be devoured by a shark. Hence the people of that island worshiped sharks. Most of the people of that land do not eat shark even to this day; those who do are malihini—the kama'aina are afraid to eat shark (Kamakau 1964:78).
>
> There was a famous mo'o (lizard) goddess named Kihawahine who lived at Lahaina. A chiefess who worshipped her there died and was given the name Kihawahine. The one-time chiefess became confused with the more ancient mo'o to whom she was dedicated. Kihawahine was one of the deities venerated by Kamehameha the Great, who set her image in a heiau. Presumably the image was in the form of a giant reptile. The image was dressed "in deep saffron, yellow or light yellow on a

> patterned tapa cloth" (yellow was the color identified with mo'o; the patterned tapa perhaps suggestive of the patterns on a lizard skin). "In her name [Kamehameha] carried his conquest over the islands.... Ulumaheihei Hoapili, who later became an active friend of the missionaries and a leader in establishing the Christian church, was her keeper (kahu)" (Beckwith 1940:125-126).

Fornander (1917-19) describes nearby Kekaa in a reference that also mentions Wahikuli:

> Kekaa was the capital of Maui when Kakaalaneo was reigning over West Maui....Many houses were constructed and people cultivated a great deal of potatoes, bananas, sugar cane, and things of a like nature. I have been told that the country from Kekaa to Hahakea and Wahikuli—that country now covered by cactus, in a northwesterly direction from Lahaina—was all cultivated. This chief (Kakaalaneo) also planted breadfruit and kukui trees down at Lahaina. Some of these trees southwest of the Lahaina fort, were called the bread fruit of Kauheana (Fornander, vol. 5:540-541).

Additional Historic References

Menzies, a naturalist and surgeon on board H*MS Discovery* during Captain George Vancouver's 1793 tour, made these observations of the Lahaina coast and the village:

> ...[We] soon entered the verge of the woods where we observed the rugged banks of a large rivulet that came out of the chasm cultivated and watered with great neatness and industry. Even the shelving cliffs of rock were planted with esculent roots, banked in and watered by aqueducts from the rivulet with as much art as if their level had been taken by the most ingenious engineer....
>
> March 17...to see the village of Lahaina, which we found scattered along shore on a low tract of land that was neatly divided into little fields and laid out in the highest state of cultivation and improvement by being planted in the most regulated manner with the different esculent roots and useful vegetables of the country, and watered at pleasure by aqueducts that ran here and there along the banks intersecting the fields, and in this manner branching through the greatest part of the plantation (Menzies1920:105,112).

J. Arago, who visited Hawaii with Captain Louis de Freycinet in 1819, was impressed with the area as well:

> The environs of Lahaina are like a garden. It would be difficult to find a soil more fertile, or a people who can turn it to greater advantage...various sorts of vegetables and plants...amongst which we distinguish the Caribee-cabbage, named here taro; double rows of banana, bread-fruit, cocoa-nut, palma-christi, and the paper-mulberry trees...
>
> The space cultivated by the natives of Lahaina is about three leagues [9 miles] in length, and one in its greatest breadth. Beyond this all is dry and barren; everything recalls the image of desolation (*In* Handy and Handy 1972).

Reverend C. S. Stewart visited Hawaii twice, first as a missionary in 1823 assigned to the station at Lahaina, then as Chaplain of the U.S. Frigate Vincennes. His diary entry for May 31, 1823 reads:

> The settlement is far more beautiful than any place we have yet seen on the Islands. The entire district stretching nearly three miles along the seaside, is covered with luxuriant groves, not only of the cocoanut, the only tree we have before seen except on the tops of the mountains, but also of the breadfruit and of the kou...while the banana plant, kapa and sugar-cane are abundant, and extend almost to the beach, on which a fine surf constantly rolls (Taylor 1928:42).

Another Stewart entry reads:

> ...The breadfruit trees stand as thickly as those of a regularly planted orchard, and beneath them are kalo patches and fishponds, 20 or 30 yards square, filled with stagnant water, and interspersed with kapa trees, groves of banana, rows of the sugar cane, and bunches of the potato and melon... .It scarcely ever rains, not oftener, we are told, than half a dozen times during the year, and the land is watered entirely by conducting streams, which rush from the mountains, by artificial courses, on every plantation. Each farmer has a right, established by custom, to the water every fifth day (Taylor1928:43).

The *Pacific Commercial Advertiser* (February 12, 1857) devoted itself to the port of Lahaina. The following excerpt reports on the population as well as the agriculture:

> ...Fruits are generally abundant. The grape seems to luxuriate in the rich soil, and the sunny, clear weather of Lahaina.... Figs, bananas and melons are produced in abundance, and pumpkins enough for all New England to make pies for a general Thanksgiving....
>
> In tiding through [a] "Tropic road"...we counted twenty varieties of trees and shrubs growing by the road side, and presenting within a mile's ride, as fine specimens of tropical productions as any similar drive to be found on the Islands.
>
> The population of Lahaina is estimated at fifteen hundred, the foreign part of which will not probably exceed one to two hundred. The causes that have been at work depopulating the islands have likewise tended to reduce the numbers here. "Years ago there was a hut under every breadfruit tree," was the statement of an old man who has seen the four Kamehamehas as the rulers of the land. So far as local diseases, we are singularly free. The climate is unequaled; the mild, sea breezes temper the heat of the day, and the cool breeze of the night makes sleeping a luxury to be enjoyed.

The *Maui News* (2-3-1926) provided the following narrative of a 1926 trip on horseback, in an article entitled "Historic Lahaina":

> The road during the rest of the journey to Lahaina [rider is departing the Honokohau area, north of Wahikuli] is first-class. For a great part of the way the traveler can indulge in a brisk canter whenever he chooses. It skirts the sea beach very closely, running, in some places, within eight or ten feet of high water mark. Beyond this part, all the way into Lahaina, it lies further from the sea, but is equally good for riding.

> ...The large number of mango, breadfruit, tamarind, and other trees, with innumerable bananas, which are growing in all parts of the town and around it, give the place a most picturesque appearance. The luxuriance with which these trees grow here I have not seen equalled at any other place in the Kingdom. Mr. Turton's sugar plantation also is quite near to the town. Sugarcane is planted here wherever land can be obtained, a proof how rich the soil is....It [Lahaina] has suffered from the advance of other places, and also, in common with all the formerly populous parts of the Kingdom, from the lamentable depopulation, which is the most striking feature in the history of the islands since they became known to European nations. It has, I believe, experienced of late some revival, but its prospects are by no means so good as those of many other Hawaiian towns, which, under the influence of what is now the staple industry of the Kingdom, sugar growing, are making rapid strides in advance. - *George Cummings, clerk in the Office of the County Auditor.*

Handy concludes there was "continuous cultivation on the coastal region along the northwest coast" of Maui, and goes on to describe it further:

> On the south side of western Maui the flat coastal plain all the way from Kihei and Maalaea to Honokahua, in old Hawaiian times, must have supported many fishing settlements and isolated fishermen's houses, where sweet potatoes were grown in the sandy soil or red lepo near the shore. For fishing, this coast is the most favorable on Maui, and, although a considerable amount of taro was grown, I think it is reasonable to suppose that the large fishing population which presumably inhabited this leeward coast ate more sweet potatoes than taro with their fish. Almost no sweet potatoes are planted in this section now, however, which is partly due to the displacement of Hawaiians by Orientals on the industrialized sugar and pineapple plantations (Handy 1940:159).
>
> Lahaina District was a favorable place for the high chiefs of Maui and their entourage for a number of reasons: the abundance of food from both land and sea; its equable climate and its attractiveness as a place of residence; it had probably the largest concentration of population, with its adjoining areas of habitation; easy communication with the other heavily populated areas of eastern and northeastern West Maui and with the people living on the western, southwestern and southern slope of Haleakala; and its propinquity to Lanai and Molokai... All this area, like that around and above Lahaina, is now sugar-cane land....Lahaina's main taro lands, on the lower slopes running up to the west side of Pu'u Kukui, were watered by two large streams, Kanaha and Kahoma, which run far back into deep valleys whose sides were too precipitous for terracing (Handy et al. 1972:492).

A survey of Maui archaeological sites was conducted by Winslow Walker in 1929. He lists one site for Wahikuli Ahupua'a.

> Halulukoakoa Heiau, Mala Region
>
> *Location:* S.E. corner of a cocoanut grove at Mala, just north of Kapunakea Camp. It lies in the ahupuaa of Wahikuli according to Thrum.

Description: A large heiau for human sacrifice of which but few fragments of walls remain. There is some coral to be found in their construction, but most of the stone has been removed for rock ballast on the railroad. The site has been further cleared and levelled to make a playground, and what remains has been used for a dump of debris of every kind, and the whole is heavily overgrown with kiawe bushes.

Remarks: Informant J. Kahahana is said to know of some legends connected with this heiau (Walker 1929:114).

Land Commission Awards

Testimony given in support of Land Commission Awards (LCA) is often used to shed light on land uses for a particular area. The *Indices to Land Commission Awards* lists only two awards for the *ahupua'a* of Wahikuli: LCA 477-F to P. Keliipio for 1 acre, 2 rods, 3 rods; and LCA7724 to Poholapu for 12 acres. Keliipio's parcel is listed as a house lot alongside Kaanapali Road and Chandler's land (Alexander map Aug. 20, 1851). Poholapu's parcel, which was bounded by Kahoma Stream on the Olowalu side, was cultivated in taro (Hawaii State Archives, Native Testimony). A large percentage of Wahikuli was Crown Land. The Index of Kamehameha Deeds shows that 2,194 acres were leased from Kamehameha III to Kamehameha V on March 1, 1854 for the amount of $250 per annum (State Survey Office, personal communication). Kamehameha V had title of the ahupua'a of Hanakao'o, the northern neighbor of Wahikuli, and tried his hand at sugar cultivation. A 1913 map by W. E. Wall (Reg. #2569) depicts another LCA, #5483:2 to Kaeo, as well as Grant 1891 to D. Baldwin. The map also reveals that 14,797 acres were devoted to cane land, and 221 acres to pasture land. This cane cultivation was under the management of Pioneer Mill Company.

Pioneer Mill Company

Some of the earliest sugar enterprises in Hawaii took place in Lahaina. In 1849 Judge A.W. Parsons operated a Lahaina sugar mill. The mill, along with 1,000 acres of land, was later sold to O. H. Gulick at auction. Henry Dickenson, a Lahaina storeowner, began a plantation in 1859, and the success of his Lahaina Sugar Company encouraged the establishment the following year of a second plantation, Pioneer Mill Company. Lahaina Sugar Company was founded by three partners: James Campbell, a carpenter who later became Hawai'i's first millionaire, Henry Turton, and James Dunbar. The company was founded on lands deeded to them by Benjamin Pittman. In 1863, Lahaina Sugar Company went bankrupt and was sold to Pioneer Mill Company (HRHP Site Form 50-03-1598, and Conde 1973:252). A few years later, a plantation formed in 1870 by Lot Kamehameha and other investors, was bought by Pioneer Mill Company (HRHP Site Form 50-03-1598). The firm of Walker & Allen appears to have been the plantation agency in the early years, but in 1877 H. Hackfeld replaced them as agents (Conde 1973:252). An 1883 evaluation of plantations represented by H. Hackfeld lists Pioneer Mill Company assets at $500,000 (Simpich 1974).

Pioneer Mill's main railroad line extended north from the mill, which is several blocks from the center of Lahaina Village, to a point north of the town of Puukolii in Hanakaoo, five miles distant and, at the north end, about 350 feet above the sea (Conde 1975:169). The *Pacific Commercial Advertiser* reported on the construction of the railway on Oct. 23, 1882:

> Turton's railroad to Kaanapali is making rapid progress. The grading is finished for over two miles out from the mill, and the track is laid on same for nearly the whole distance. Mr. Johnstone, the civil and every other kind of engineer, has management of the whole thing, and is making things hum along the route — he expects to be hauling cane [to] Kaanapali by January next...
>
> Formerly the cane was brought to Lahaina at the rate of twenty cart loads a day — the carts would come into Lahaina in the morning and return in the afternoon to load up for the next day's trip. It took from six to eight bullocks to a cart, a driver for each team, and a luna to go back and forth with them. Now however, 120 loads will be hauled by steam in a day and it will require but the engineer, and say two trainmen on the cars — the wear and tear and loss of cattle and mules on the Kaanapali route was more than running expenses and wear and tear on the railroad will be.

The *Hawaiian Gazette* added to this on November 29, 1882:

> Mr. Turton's railroad to Honokowai has made good progress; the grading is now substantially completed and three miles of track are laid. About one mile has been heavy grading along a rocky tract, where a large amount of dynamite has been used. The whole length of the permanent track is four and one half miles; width of track 31 inches, steel rails. There will be some 5000 feet more movable track in addition. One and one quarter miles of railway will be laid from the mill to the south end of Lahaina. The whole cost of the railway and other plant will not exceed $30,000. This will dispense with about $20,000 invested in carts and teams, heretofore employed in conveying cane to the mill.

Pioneer Mill Company reorganized in 1900. The prospectus for the change is interesting, as it designates the land areas comprising the plantation property:

> Lahaina - 1,000 acres of land on the flat and outside of small kuleanas, the land is fee simple.
>
> Launiupoko - 2,900 acres of fee simple land, lying between Lahaina and Olowalu.
>
> Wahikuli - A tract of Government land of 5,000 acres, under lease for eighteen years, lies between Lahaina and Kaanapali.
>
> Kaanapali - Some 3,600 acres at various levels, fee simple land, beyond Wahikuli. (The area also comprises streams at Kahumu, Lahainaluna, Kawaulu and Launiupoko.)

The extent of sugar cultivation is noted in the *Hawaii Sugar Manual*:

> The cane fields of the estate have a sea frontage of ten miles, and while cultivated to 1 1/2 miles average depth in some sections raising of cane is followed so far back as two and one half miles as the farthest reach up the slopes of the West Maui mountains.
>
> The bulk of the crop is raised on lands that range from 10 feet to 700 feet elevation above sea level; the highest being cultivated at 1500 feet (*In* Conde 1973:254).

Beginning in 1929, the company's Annual Report lists equipment retirements, signalling the decline of the railroad. The 1933 report lists "Railroads & Bridges— 1,020 linear feet of 26 lb. rail, acquired in 1920 was retired in 1933." The 1934 report notes "1 Velocipede track-car, acquired 1921, retired 1934." Starting in 1943, the company experimented with loading harvested cane into trucks using grab loaders. The 1946 report reveals that by that year, serious consideration was being given to abandoning the railroad and harvesting exclusively by trucks. The final rail report appeared in 1953: "Change in operation—...All cane will be hauled by truck on a time shift basis...All railroad tracks were taken up, sorted and subsequently sold to a mainland buyer. Most of the railroad equipment was sold to various purchasers. The mill yard was graded, dressed with cinders and a direct cane dumping arrangement was built." (Conde 1973:254).

An article in the *Maui News* reports that a large number of ties were purchased by ranchers for use as fence posts, and that portable track iron, all of the old rails, and old rail switches, frogs, fishplates angle bars and spikes were sold to the Purdy Company of San Francisco.

The rennaissance of the railway began when A.W. McKelvey received capital from Taylor A. "Tap" Pryor to construct the "Lahaina, Kaanapali & Railroad" in 1968. The new railway began several blocks from the center of Lahaina, north of Pioneer Mill, on the old railroad grade, alongside cane haul dirt roads. New tracks were laid, and a trestle was built at the cost of $15,000 near the golf course to offer a panoramic view of Kaanapali. In 1973 the operation was sold to Willis B. Kylè who hired R.D. Ranger to run the line (Conde 1975:169).

Wahikuli State Wayside Park, *makai* of the project area, is described in *The Beaches of Maui County*:

> Wahikuli means "noisy place" and is an alternate name of the ahupua'a of Mala which includes this park. Wahikuli State Wayside Park is one of the most popular beach parks in West Maui. It is usually crowded with picnickers, swimmers, and sunbathers, especially on weekends and holidays. Wahikuli's popularity is undoubtedly due to its size, its good swimming conditions, its excellent facilities, and its proximity to Lahaina....Almost the entire shoreline is lined with a retaining wall composed of large boulders (Clark 1989:60).

PREVIOUS ARCHAEOLOGICAL WORK

General Vicinity

Although formal archaeological survey work was initiated relatively early on Maui (e.g., Emory 1921; Walker 1929), the island's prehistoric resources remains much less intensively studied than the resources for either Hawaii Island or Oahu. Emory's early work on Maui involved an inventory of archaeological sites located in Haleakala Crater, and is not directly relevant to the present project area. Winslow Walker's Bishop Museum-commissioned study involved a partial assessment and inventory of larger sites and *heiau* around the island. Immediately southwest of the present project area, Walker references information from Thrum concerning several *heiau* remnants (Walker's Sites 7, 8, 9, and 10). However, all of these features had been completely, or nearly completely destroyed by the time that Walker conducted his survey fieldwork (n.d.). Walker had also identified a *heiau* site (Walker's Site 11) immediately west of the present project area and to the north of Mala Wharf, which he described as a "large heiau for human sacrifice..." Again, however, by 1930 only a "...few fragments of walls remain[ed]." Walker identified no additional sites either along the coast or inland for a distance of at least two miles north of the northern perimeter of the present project area. Walker does not even mention the existence of the Alaloa ("Long Road") through the project area. Although major segments of this putative 16th century alignment remain intact around the island, according to Handy and Handy (1972:490-491) "...it was formerly clearly visible across the West Maui golf links, but was obliterated in the Lahaina area and beyond by the cultivation of cane and pineapple."

Maui archaeology was largely ignored during the 1950s, at a time when research being undertaken elsewhere was establishing important local and regional artifact chronologies and frameworks for categorizing major Hawaiian site-types. Some productive research was undertaken on East Maui during the 1960s (Soehren 1963, Pearson 1970), and Chapman's intensive settlement pattern survey and excavation work in Kahikinui contained island-wide implications for prehistoric patterns of settlement and land use (Chapman and Kirch 1979). In West Maui, a small brick building called the "birth place" of King Kamehameha I, located near the center of the Lahaina National Landmark, was evaluated, stabilized, and prepared for public display during the mid-1960s (Frederickson and Frederickson 1965). For the most part, however, relatively little research was undertaken within West Maui during this period.

During the succeeding decade and through the 1980s, West Maui finally began to receive increased attention, as the pace of urbanization and resort development demanded intensive contracted survey and excavation projects, a number of which have been undertaken within the immediate project vicinity. Proposed flood control improvements for Kahoma Stream, portions of which mark the eastern and southern perimeter of the present project area, had been conducted on the south side of the stream during the 1970s (Connolly 1974, Hommon 1973, Ahlo and Morgenstein 1980). Development of the nearby Mala Wharf Boat Launch Ramp had likewise been accompanied by several archaeological studies, including those by Sinoto (1975), Davis (1974), and Hammatt (1978). The latter projects identified numerous human burials, principally historic period in age, in the sand berm situated inland of the Mala Wharf and immediately west of the southernmost portion of the present project area. Also identified south of Kahoma Stream was an historic earth oven, or *imu*, and a ditch which Hammatt (1978) believed may have connected the well-documented Alamihi Fishpond to Kahoma Stream to the north (cf. Joerger and Kaschko 1979).

Additional subsurface reconnaissance surveys were undertaken within the immediate vicinity of the Alamihi Fishpond and Mala Wharf by PHRI. One of these projects was undertaken in January of 1988 and involved excavation of 19 backhoe trenches, recording of stratigraphic information, and evaluating

subsurface components for the presence of cultural materials and features. The program yielded a total of 33 glass bottles, 24 of which were dated to the period just prior to and immediately following the turn of the century (Haun 1988:16). In addition, volcanic glass and radiocarbon age determinations samples yielded evidence of prehistoric use and occupation of the area between AD 1260 and 1640 (Haun 1988:17). The extensive disturbance documented in the backhoe trench profiles did not warrant preservation of specific cultural features or artifact concentrations, although monitoring was recommended as appropriate in view of the potential for encountering additional *in situ* cultural materials during construction. A second similar but smaller-scale project was conducted by PHRI in March of 1988, involving a small commercial lot located immediately south of Mala Wharf Road and within the general vicinity of the south side of Alamihi Fishpond. Based on the negative findings of both the background documentary research and the subsurface reconnaissance testing (eight backhoe trenches were excavated), provisional archaeological clearance for the proposed future development of the lot was recommended (Jensen 1988).

A thorough review of present project area maps and site locational information for the several previously identified resources at and around the mouth of Kahoma Stream, as discussed above, indicates that none of these previously recorded sites or features is located within the present project area, nor will any be affected by the proposed undertaking as presently planned. Further inland, additional cultural resources have been relocated along Kahoma Stream outside and in the vicinity of the southeast corner of the present project area. Originally recorded in April of 1974, SIHP Site 1203, known as the Kahoma Complex and consisting of 38 petroglyphs and a rockshelter, was relocated by Barrera in conjunction with his literature search and field survey of Alternative C of the proposed Honoapiilani Highway realignment between Lahaina and Honokawai (Barrera 1989:9). In reexamining this previously recorded site, Barrera also discovered additional agricultural features, including at least three terraces and a possible irrigation ditch on the alluvial floodplain on the south side of Kahoma Stream. On the basis of his conclusion that the site likely retains potentially significant information value, Barrera recommended that project effects be further evaluated in the event that direct impacts cannot be avoided. Following submission of Barrera's report, the State Historic Preservation Office concluded that basic identification and evaluation of the resource (Step 1 of the 106 Process compliance) had not been adequately completed.

Immediately southeast of the project area, at Wainee Village near Lahaina, Hommon surveyed several hundred acres; no intact cultural resources were encountered (Hommon 1982).

North of the present project area, and during the early 1970s, Kirch documented intermittent marine exploitation at several small sites at Hawea Point for the period postdating c. AD 1500 (Kirch 1973b). During this same period, the Archaeological Research Center of Hawaii (ARCH) undertook intensive survey of several hundred acres in conjunction with proposed realignment of the Honoapiilani Highway corridor through Kaanapali, between Honokawai and Alaeloa (Griffin and Lovelace 1977). Only four sites were encountered, including walls and a small midden deposit. The latter feature was further evaluated and eventually yielded radiocarbon dates confirming occupation for several centuries prior to western contact.

During his survey of the North Beach Mauka and South Beach Mauka project areas (involving c. 240 acres), Hommon identified only three sites, including a single agricultural complex and two short wall segments. Hommon's findings, and the earlier work by Griffin and Lovelace, clearly highlighted the extensive surface disturbance to which much of West Maui has been subjected by both resort development as well as historic and contemporary agricultural activities. Despite these findings, however, monitoring of construction work along the beachfront at the site of the Kaanapali Ali'i Condominiums did confirm the presence of prehistoric burials (Dobyns and Allen-Wheeler 1982), a discovery which later resulted in similar recommendations for other such coastal development areas.

Besides the work by Kirch, Hommon, Dobyns and Allen-Wheeler, and Griffin and Lovelace (cited above), additional studies have been undertaken north of Lahaina and the present project area. Immediately northwest of the present parcel. PHRI conducted surface reconnaissance survey of the Sheraton Maui Master Plan Site in the Lands of Honokawai and Hanakaoo, Lahaina District. The archaeological team discovered virtually all of the project area to be fully developed with hotel structures, parking lots, driveways, and landscaping. The only unaltered portions of the project area were the barren coastal flats and the exposed faces of the old cinder cone at the point. No surface indications of cultural material were encountered during the examination of these areas, and conditional archaeological clearance was recommended for additional development of the Sheraton property at this location (Rosendahl, M.L.K. 1986).

In 1986, Barrera (1986) conducted an archaeological reconnaissance survey of the North Beach project area in conjunction with additional proposed developments at Kaanapali. No surface structures were identified during the survey, which concluded with a recommendation for subsurface reconnaissance of the sand dune area (Barrera 1986:3-4) in view of the previous findings by Dobyns and Allen-Wheeler (1982). The recommended dune reconnaissance (subsurface coring) was undertaken the succeeding year by PHRI (PHRI Project 321; Rosendahl 1987), but failed to identify any subsurface prehistoric cultural deposits or human skeletal remains. Fragments of glass and metal were present in approximately 20% of the cores, although most of this material was recovered from upper strata and was determined to be of recent vintage. The generally negative findings were interpreted as evidence that there had been little to no prehistoric use of the area, or that such evidence was simply no longer present. The subsurface coring of the dune did result in the identification of a single surface feature, consisting of an L-shaped wall without associated cultural deposits. Based on these findings, archaeological clearance was recommended for the proposed Kaanapali Resort expansions on the condition that initial ground disturbing activities along the shoreline be accompanied by archaeological monitoring. A monitoring plan was subsequently prepared and approved by the DLNRHSS/SHPO and the Army Corps of Engineers (PHRI Project 345; Rosendahl 1987).

Still further north, a proposal by the U.S. Department of Agriculture, Soil Conservation Service to establish a desilting basin at Kahana was accompanied by a program of subsurface archaeological reconnaissance (PHRI Project 128; Walker and Rosendahl 1985). The program was undertaken in order to evaluate possible subsurface accumulations of cultural material at several previously recorded prehistoric sites (Kaschko 1974). Detailed recording and test excavations had already been undertaken at several of these sites by the Bishop Museum (Komori 1983), whose findings suggested the possibility that additional significant cultural material may remain buried within the vicinity, and that this material reflected historic-era cattle ranching operations in the area. The PHRI evaluation suggested, on the other hand, that the project area sites represent an inland portion of the agricultural component of the traditional Hawaiian land use system, with historic period re-use of the area following initial displacement of Native Hawaiians which accompanied the introduction of commercial sugar cane and pineapple cultivation (Walker and Rosendahl 1985:22).

At the Kapalua Hotel Development Site, in the Land of Honokahua, Lahaina District, situated at Honokahua Bay, evidence of prehistoric burials was first recorded by Kirch in 1973 during a reconnaissance survey for Kapalua Resort (Kirch 1973a). The burial site was subsequently listed with five other prehistoric sites within the Honokahua Archaeological District (Site 1342). In early 1986, vegetation grubbing associated with initial clearing for access roads required for engineering studies exposed five areas of disturbed skeletal material. Subsurface survey conducted in the spring of 1986 documented intensive use of the area as a cemetery, as well as previously unrecorded cultural features (including buried midden) within the project area (Donham 1986). Following additional surface and subsurface evaluations, mitigation data recovery fieldwork was initiated in March of 1987 and continued more or less uninterrupted through late December of 1988. Interim reports (Donham 1989) document a complex, multi-component burial site with indications of initial use of at least some project area features as early as AD 600 (Donham 1989).

In 1992, PHRI conducted an archaeological inventory survey of the c. 7.0 mile long proposed Lahaina Bypass Section, Modified Corridor Alignment, of the Honoapiilani Highway Realignment Project, situated in the Lands of Honokowai, Hanakaoo, Wahikuli, Panaewa, Kuia, Halakaa, Puehuehunui, Pahoa, Polanui, and Launiupoko, Lahaina District, Island of Maui. During the survey, four archaeological sites consisting of 28 component features were identified within or adjacent to the study corridor. Of the four sites, three had been identified and recorded in conjunction with previous inventory survey projects in the area (SIHP Site 2484; Jensen 1989), and Sites 2489 and 2490 (Hommon 1982). The remaining site was newly identified (Site 2847). Ranging in physical condition from poor to excellent, the identified sites included single as well as multiple components, and displayed a range of feature types, including possible habitation terraces, walled enclosures, agricultural terraces, a possible burial, possible boundary walls, and a possible burial mound. Tentatively identified functional types included habitation, transportation, possible water storage, agriculture, and ceremonial/religious activities in conjunction with burial practices (Jensen 1991). In addition to the above four sites, six additional sites were located close to but outside of the Area of Potential Effect (APE). Five of the sites were previously recorded by PHRI in conjunction with either the HFDC or North/South Beach Mauka Projects (Jensen 1989); the remaining site appears to have been identified in conjunction with a 1990 survey of the first proposed alignment for the present road realignment project (the site was tagged in the field as "ACH, 10-17-90") (Jensen 1991). Of the four sites within or adjacent to the APE, all were assessed as significant for information content. Further work was recommended for all of the sites in order to fully preserve the information potential represented. One of the sites (Site 2489) was thought to possibly contain one or more burials, indicating potential cultural value (Jensen 1991).

Finally, in 1993, PHRI conducted an archaeological inventory survey of the proposed Lahaina Bypass Highway New Connector Roads project, situated in the Lands of Hanakao'o and Paunau, Lahaina District. The project area comprised two 300 ft-wide corridors (the proposed Kaanapali Connector Road and the proposed Dickenson Street Connector Road). The survey included a pedestrian field survey and backhoe trenching. No significant cultural materials were identified during the fieldwork; it was judged the negative findings were attributed primarily to the extensive disturbance to which all of the project area has been subjected (Jensen 1994).

Current Project Area

The initial archaeological work conducted in the current project area was William Barrera's 1988 reconnaissance survey of Alternative C of the Honoapi'ilani Highway. Alternative C crosses Kahoma Stream downhill of from Crater reservoir and continues across the property. Barrera found no sites along the proposed route (Barrera 1988).

In 1989, Jensen conducted an archaeological inventory survey of the current project area, plus a small section appended to the southeast. Jensen identified twelve archaeological sites within the project area and two sites adjacent to the northeast corner of the property. PHRI assessed nine sites in the project area as significant. The sites include agricultural terraces, walled enclosures, and a complex of cairn/marker mounds. Data recovery was recommended for five sites, and four sites were recommended for preservation in place. One site, a historical agricultural access road, was assessed as having no significance, and no further work was recommended (Jensen 1989). Jensen did not evaluate the historic period archaeological features associated with the Pioneer Mill sugar plantation in his report. In 1994, the State Historic Preservation Division (SHPD) generally concurred with the Jensen recommendations, but requested further historical research for the Pioneer Mill features in the project area.

In 1991, Jensen conducted an archaeological inventory survey along the Honoapiilani Highway Corridor C realignment (Jensen 1991). This was a follow-up survey, after Barrera's 1988 reconnaissance. No new sites were found.

Archaeological Consultants of Hawaii recently investigated a small portion of the property adjacent to the north and east sides of the Lahaina Civic Center (Kennedy and Denham 1992). Only debris from clearing cane fields, and the Lahaina Sugar Cane railroad track, were identified. No new archaeological features were found.

In January 1997 IARII conducted an archaeological and architectural inventory survey of the project area (Goodwin and Leineweber (1997). This project had been as requested by the SHPD, primarily to further document the Pioneer Mill features in the project area (see Jensen 1989, above). The work included documentary research, a field survey, and informant interviews. The mill structures identified by IARII included a water tank, reservoirs, irrigation system parts, bridges, roads, sugar cane fields, and an airstrip. The irrigation structures were parts of Honokohau and Wahikuli ditches, which were associated with holding ponds, a stone cistern, pipes, and wooden flumes. The project recommend Historic Architectural Building Survey (HABS), and Historic American Engineering Record (HAER) Level 2 recording for irrigation structures within the area of anticipated impacts. Additional recording for other significant structures were not deemed necessary as they had been adequately documented in Goodwin and Leineweber report. The HABS/HAER recording was later completed by Leineweber (Leineweber 1998); following documentation preservation of the features and other features at the project area were not deemed necessary.

Collectively, the various studies discussed above document the presence within West Maui of a variety of significant and potentially significant prehistoric and historic-era cultural resources. Previous archaeological work has documented that much of the land located to the north of Lahaina has been extensively disturbed by historic and contemporary cane and pineapple cultivation. As a consequence of this disturbance, archaeological surveys of even relatively large parcels have occasionally failed to identify any resources at all. In the current project area it is estimated that nearly 90% has been subjected to intensive agricultural (primarily sugarcane) development.

Recently, the archaeological consulting firm Cultural Surveys Hawaii, while conducting data recovery work within the Lahaina Bypass Road corridor, located adjacent to the current project area, identified a new archaeological site within the project area. The site comprises an extensive historic terracing system used for early sugar cane cultivation. Cultural Surveys Hawaii, in consultation with the SHPD, has documented the site and in the near future will issue a report on its findings.

CONCLUSION

Present Study Scope and Methodology

The scope of work and methodology for the current project is based on the general assumption that the level of study effort appropriate in any project-specific context should involve the consideration of several factors, the most relevant of which are the following: (a) the probable number and significance of known or suspected cultural properties, features, practices, or beliefs within or associated with the specific project area; (b) the potential number of individuals (potential informants) with cultural knowledge of the specific project area; (c) the availability of historical and cultural information on the specific project area or immediately adjacent lands; (d) the physical size, configuration, and natural and human modification history of the specific project area; and (e) the potential effects of the project on known or expected cultural properties, features, practices, or beliefs within or related to the specific project area.

Consideration of these factors within the specific nature and context of the proposed project, it was thought that the most appropriate level of study for an adequate assessment of potential cultural impacts would be a limited assessment study. Based on the location, size, number and quality of sites, this study assumes that (a) potential cultural impact assessment issues would be moderate, (b) the results of the archaeological survey conducted for the project would confirm both the limited number and scope of cultural resources within or related to the project area, and (c) in the instance that any legitimate cultural impact assessment issues should arise during the environmental review period, they could be addressed adequately within the framework of the review process (i.e., from Draft to Final Environmental Impact Statement).

Consideration of these factors within the specific nature and context of the proposed project indicated that the relatively greater levels of study effort that can be characterized as identification or documentation studies would be inappropriate and excessive. The distinctive characteristics of an identification study are that it would be restricted to (a) the identification of native Hawaiian or other ethnic group cultural practices, beliefs, properties, features, or exploitable natural resources associated with and/or present within or related to the specific project area that are currently being conducted by and/or known to individual cultural practitioners or groups, and (b) the collection of information reasonably sufficient so as to define the general nature, location, and likely authenticity of identified cultural claims. An identification study would not involve the considerably greater level of study effort – both calendar months and hours of labor – needed to carry out a full documentation study. The distinctive characteristics of the latter, which would commonly be referred to as a full ethnographic or oral history study, would be (a) the collection of detailed information regarding identified native Hawaiian or other ethnic group cultural practices by means of formal oral history interviews which are usually tape recorded and transcribed, and (b) the analysis and synthesis of all collected data – from interviews, as well as relevant historical documentary and archival research – within the general cultural-historical context of traditional native Hawaiian or other ethnic group culture and the defined specific geographical area of a specific project.

The overall rationale guiding the present limited assessment study has been that the level of study effort should be commensurate with the potential of the proposed project for making any adverse impacts upon any native Hawaiian or other ethnic group cultural practices currently conducted by cultural practitioners within the project area. The study presented in this report is believed to constitute a reasonable approach for the assessment of potential cultural impacts within this specific project area.

Thus, the overall goal or objective of the present cultural impact assessment study was to identify any native Hawaiian or other cultural practices currently being conducted within or immediately adjacent to present project area that might potentially be in some manner constrained, restricted, prohibited, or eliminated if the proposed project were to be approved. The types of practices to be identified would be inclusive; that is, claims for all three types of practices – traditional cultural property, traditional and customary cultural practices, and contemporary cultural practices – would be identified and considered. More specifically, the objectives of the cultural impact assessment were to determine the following: (a) if the project area is currently being accessed by native Hawaiian cultural practitioners for any traditional and customary cultural uses; (b) if the proposed project would have any adverse impacts upon any identified current native Hawaii cultural uses of the area; and (c) what measures might be proposed to mitigate any adverse impacts the proposed project might have upon any identified current native Hawaiian uses of the area.

Prehistoric Land Use

In general, very little is known about the prehistory of Wahikuli. In prehistoric times it is likely that people grew taro and other suited crops in the gulches present, including Kahoma Stream gulch. Fornander (1917-19:vol.5:540-541) in a reference notes Wahikuli was "all cultivated." Commonly, irrigated terrace systems were present along stream courses. What crops were grown would likely have been traded with those who lived at the coast. According to Hussy (1997), in the Lahaina area, this tradition of exchange continued well into the 20th century in some Hawaiian families. Edward Hussey was an irrigation supervisor for Pioneer Mill. He notes that his grandmother, born and raised in the hills above Lahainaluna High School, often traded her taro and other foods she raised for fish from people who lived along the coast (Hussy 1997).

Most knowledge of prehistoric times in Wahikuli comes from the archaeological projects conducted in the general vicinity over the past decades. Oral history (Klieger at al. 1995) and the archaeology indicate that prior to Western contact Hawaiian were living in Lahaina and to the north (Kennedy and Denham 1992). In the immediate project area archaeologists have found evidence of extended pre-contact occupation, as well as post contact use along the Mala Wharf beach front, around the mouth of Kahoma Stream (Ahlo and Morgenstein 1980, Davis 1974, Hammatt 1978, Haun 1988, Jensen 1988, Joerger and Kaschko 1979, and Sinoto 1975). Winslow Walker in 1929, in his survey of Hawaiian sites, listed one *heiau* in Wahikuli (Halulukoakoa, in the Mala region), of which only remnants existed at that time. He notes that it was a large *heiau* for human sacrifice. The presence of such a structure hints at the importance of Wahikuli in prehistoric times. Uphill from the streamflood plain Jensen (1989) found three terraces and enclosure sites, and a probable graveyard . These may also reflect the pattern of long-term land use by Hawaiian along or near Kahoma Stream. Jensen (1989) also reported a similar system of five terraces and enclosure along Hahakea Gulch. These sites are possible prehistoric. Numerous human burials, and the Alamihi Fishpond, and numerous historic and prehistoric artifacts have been found in the Lahaina vicinity. The burials are post contact (Burgett and Spear 1994; Kennedy and Denham 1992). From the mouth of Kahoma Stream disconnected terraces and related shelter and storage area have been identified (Barrera 1988, Conolly 1974, Jensen 1989, 1991). These sites may have once been joined forming an extensive agricultural system from the coast to the highlands (Goodwin and Leineweber 1997). It is presumed these sites are prehistoric, although there is no direct evidence.

Collectively, the various studies document the presence within West Maui of a variety of significant prehistoric and historic-era cultural resources. However, only a single prehistoric site, containing habitation

and agricultural features as well as petroglyphs, has been recorded near the present project area (SIHP Site 1203, the "Kahoma Complex"). On the other hand, previous archaeological work has documented that much of the land located to the north of Lahaina has been extensively disturbed by historic and contemporary cane and pineapple cultivation. As a consequence of this disturbance, archaeological surveys of even relatively large parcels have occasionally failed to identify any resources at all. In light of the fact that nearly 90% of the current project area has been subjected to intensive agricultural development, it is not surprising there are few intact prehistoric properties within the area.

Historic Land Use

Land Commission Award testimonies indicate there were two awards in Wahikuli. One of the awards was for a houselot of once acre and does not mention land use other than for residence. The other was for 12 acres and was on Kahoma Stream. This parcel was cultivated in taro. Land records show Wahikuli was Crown Land and that thousands of acres were devoted to growing sugar cane under the management of Pioneer Mill Company.

In fact, Pioneer Mill Company was one of the earliest sugar enterprises in Hawaii. It began in 1860; by 1883, an evaluation of plantations by H. Hackfeld lists Pioneer Mill Company assets at $500,000 (Simpich 1974).

Pioneer Mill Company reorganized in 1900. The prospectus for the reorganization designates Wahikuli as a tract of Government land of 5,000 acres, under lease by the company for eighteen years. The *Hawaii Sugar Manual* notes the extent of cultivation in the general vicinity:

> The cane fields of the estate have a sea frontage of ten miles, and while cultivated to 1 1/2 miles average depth in some sections raising of cane is followed so far back as two and one half miles as the farthest reach up the slopes of the West Maui mountains (Conde 1973:254).

Beginning in 1929, the company's Annual Report lists equipment retirements, signaling the decline of the railroad. By 1946, the annual report reveals that serious consideration was being given to abandoning the railroad and harvesting exclusively by trucks. By 1953 all cane was hauled by trucks.

Concluding Comments

One of the goals of a CIA is to assess the probable number and significance of known or suspected cultural properties, features, practices, or beliefs within or associated with the specific project area. The documentary and informant information available relevant to the project area and presented herein clearly indicates that cultural properties are relatively few in the general area due to the widespread use of the land for historic sugarcane cultivation. The somewhat few cultural resources that have been identified have been documented in various studies, primarily in archaeological reports for the vicinity. The documentary information provided only a very limited amount of information on cultural practices or beliefs, and what information is available is general in content. Concerning traditional cultural properties, as defined in this document, no specific physical entities or features with definable boundaries, such as a specific location within the current project site, has been identified; second, while cultural resources such as practices and beliefs can include general cultural behaviors, no specific places or features directly associated with specific behaviors, the continuity of which over time, in either actual practice or remembrance, can be demonstrated, have been identified.

In assessing the potential number of informants with cultural knowledge of the specific project area, commonly, and most sensibly, one seeks out those who have worked or lived on or near the land, or are otherwise associated with the land. In the current situation, we have a large parcel of land that has been associated with historic sugarcane development over a very long period of time, specifically, from 1860 (Goodwin and Leineweber 1997:3). This generally means that there has been very little use of the land for traditional cultural purposes since that period, and that knowledge of land use since that time would generally be limited to that concerning sugar cane operations. As mentioned, informant information on the historic period is provided adequately in Goodwin and Leineweber 1997). The only land in the project area that has not been subjected to sugar cane cultivation are areas within or adjacent to gulches. As the documentary evidence in this report suggests, cultural use of these areas for early cultivation must have certainly taken place; however, it is highly unlikely that further informant research would yield specific information on use of these gulches.

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APPENDIX B: SHPD APPROVAL LETTER

89-653/90-813

JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
Keith W. Ahue
MANABU TAGOMORI
RUSSELL N. FUKUMOTO

AQUACULTURE DEVELOPMENT PROGRAM
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CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE HISTORIC PRESERVATION
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

RECEIVED
'90 JAN 30 A11:36
OFC. OF ENVIRONMENTAL QUALITY CONTROL

January 25, 1990

Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, #104
Honolulu, Hawaii 96813

Dear Mr. Miura:

SUBJECT: Historic preservation review of the Draft EIS for the Lahaina Master Planned Project
Wahikuli, Lahaina, Maui
TMK 4-5-21:3, 4, 5, & 9

Thank you for the opportunity to review this document and we offer the following comments:

Chapter I, Introduction and Summary, indicates the presence of one potentially significant archaeological site which "could be retained as is and incorporated into a major, open space, passive park (p. I-6)." This is not consistent with the description of the affected environment in Chapter IV. This statement should be revised to reflect the actual number of significant sites.

The identified historic sites, assessment of significance, and mitigation measures are addressed in Chapter IV.4, Historical and Archaeological Resources. Page IV-34 states that an archaeological inventory survey was conducted and the results of the survey are included in this document's Appendix H. This section of the chapter summarizes the report.

A total of 12 sites with 44 component features were identified (one previously identified and 11 new ones). It appears that the survey has been adequate and that all sites have been identified. On page IV-36 is a map showing the archaeological site/feature locations; however, it does not show sites 2483 and 1203. In the final EIS, this figure should be revised to include the location of these sites.

A summary of the site numbers, respective general significance assessments and recommended general treatments, is shown in a table (Table IV-2) on p. IV-37. Based on this table and discussion on page IV-35, all 12 sites are significant under single or multiple criteria. Six are assessed as significant solely for their information content, five are significant for information content and as good examples of site types and one is assessed significant for its information content and cultural value. We concur with these significance assessments. (Line 2 of paragraph 2, p. IV-35 should be revised as: "Five of the remaining six of the total 12 sites are assessed as significant for information content and as being good examples of site types." This statement would be consistent with the

table.) One site assessed as significant only for its information content was determined as "no longer significant" because adequate information has been collected. Thus, there are only 11 significant sites within the project area.

This document indicates that the project will impact all significant historic sites with the exception of site 2486, a potential burial site, which is located in an area not subject to development. Table IV-2 recommends further data collection for the 11 significant sites. In addition, subsequent data recovery work might be required for the 5 sites significant only for their information content. For the 5 sites that are also significant as good examples of site types, preservation with interpretation is recommended. Preservation "as is" is recommended for the one site that is potentially culturally significant. P. IV-38 indicates that recommended archaeological investigations, as shown in Table IV-2, would be performed by the applicant and that preservation or partial preservation and extensive salvage work (data recovery) recommended for any sites would also be conducted. We concur with these recommended treatments and, with their performance by the applicant, the proposed project will have "no adverse effect" on significant historic sites. However, we would like to point out that these are only general mitigation commitments and a detailed mitigation plan should be prepared and submitted to our office for approval prior to additional archaeological work on these sites.

Our last comments concern Appendix H. It is difficult to read due to the reduction of the original pages and poor reproduction. Also, page 12 under the Description of Field Methodology, states that a limited subsurface testing was conducted. However, the findings do not include the results of the testing. Although we believe that adequate information on the sites have been included in the report to assess their significance, the report should be revised to include the results of the analyses and interpretation of the cultural materials recovered from the subsurface testing. The revised report should be included in the final EIS and a copy should also be submitted to our office.

Should you have any questions, please feel free to contact Ms. Annie Griffin, Staff Archaeologist, at 548-6408.

Sincerely,

DON HIBBARD, Director
Historic Preservation Program

DRAFT

March 6, 1990

State of Hawaii
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Attention: Don Hibbard, Director,
Historic Preservation Program

Subject: Lahaina Master Planned Project
Draft Environmental Impact Statement

Dear Mr. Hibbard:

Thank you for your Memorandum of January 25, 1990 to Dr. Marvin T. Miura, Director, Office of Environmental Quality Control, regarding the subject project and Draft Environmental Impact Statement (EIS). Unfortunately we did not receive your Memorandum until after publication of the Final EIS. However, the following is provided in response to your Memorandum and a copy of this response has been forwarded to the State Office of Environmental Quality Control.

All of your comments on the subject Draft EIS have been addressed in our letter of ???? to Mr. William Paty, Chairman and Director, Department of Land and Natural Resources, in response to the departmental letter regarding the subject project.

The following responses, regarding your concerns are included in our response letter:

Historic Sites

As noted above, the Final EIS has been printed, submitted to OEQC and accepted by the Governor. As such, no further corrections to the document are possible. However, we have corrected many of the inconsistencies found in the Draft EIS. The wording in Chapter I, page I-6 regarding the one site that could be retained and incorporated into a major, open space passive park, was intended to refer to the one site of significance that our consulting archaeologist recommended for preservation as is. The other sites found within the project boundaries were recommended for further data collection only and that work will proceed prior to any construction activities.

As shown on Figure 1 of Appendix H (Archaeological Inventory Survey Lahaina Master Planned Project Site), sites 1203 and 2483 are outside the proposed Lahaina Master Planned Project site boundaries. Only those sites found within the project boundaries were included on Figure IV-10 in Chapter IV of the Draft EIS.

With regard to mitigation, our consulting archaeologist, Paul H. Rosendahl, Inc., will be submitting to you, on our behalf, a detailed mitigation plan for approval prior to additional archaeological work on the sites as well as prior to any construction activities that might affect the sites. As noted previously, because your Memorandum was not received until after publication of the Final EIS, we will not be able to include the mitigation plan in the Final EIS.

Thank you for your comments and participation in the Draft EIS review process. As noted previously, a copy of this response will be forwarded to OEQC.

Sincerely,

Joseph Conant
Executive Director

cc: Dr. Marvin Miura
Office of Environmental Quality Control

Appendix F

Road System

HHFDC Leialii
Off-Site Road System Costs

OFF-SITE ROAD SYSTEM

Item No.	Estimated Quantity	Description	Unit Price	Total
Keawe Street				
1- 1	4.0	Acres, Clearing and Grubbing	$ 5,000	$ 20,000
1- 2	1	Lump Sum, Water Pollution and Erosion Control Measures	$ 60,000	$ 60,000
1- 3	16,700	Sq. Ft., Demolish/Remove AC Pavement (Shoulder)	$ 1.70	$ 28,390
1- 4	18,000	Cu. Yds., Embankment	$ 38.00	$ 684,000
1- 5	0.60	Acres, Earthwork	$ 47,916	$ 28,750
1- 6	4.0	Acres, Grading	$ 29,200	$ 116,800
1- 7	56,100	Sq. Ft., AC Pavement for Roadways (2.5" AC / 5" BC / 8" SBC)	$ 6.20	$ 347,820
1- 8	6,800	Sq. Ft., AC Pavement for Shoulders	$ 6.20	$ 42,160
1- 9	2,200	Lin. Ft., Concrete Curb and Gutter	$ 34.00	$ 74,800
1- 10	13,500	Sq. Ft., Concrete Sidewalk with Base Course	$ 12.00	$ 162,000
1- 11	2	Each, Centerline Monuments	$ 980	$ 1,960
1- 12	1	Lump Sum, Striping and Marking	$ 32,000	$ 32,000
1- 13	8	Each, Sign, Post and Footing	$ 550	$ 4,400
1- 14	8	Each, Catch Basin	$ 35,000	$ 280,000
1- 15	700	Lin. Ft., 24-inch Drain Line	$ 200	$ 140,000
1- 16	460	Lin. Ft., 36-inch Drain Line	$ 316	$ 145,360
1- 17	1,160	Lin. Ft., 12-inch Water Line	$ 140	$ 162,400
1- 18	5	Each, Fire Hydrant	$ 5,000	$ 25,000
1- 19	3	Each, 12-inch Gate Valve and Box	$ 5,000	$ 15,000
1- 20	3	Each, Air Relief Valve and Box	$ 2,300	$ 6,900
1- 21	2	Each Cleanout and Manhole	$ 1,500	$ 3,000
1- 22	1	Each, Connection to Existing Water Line, Testing and Chlorination	$ 7,800	$ 7,800
1- 23	240	Lin. Ft., 18" Reclaimed Water Line	$ 338	$ 81,120
1- 24	1	Each, 18-inch Butterfly Valve and Box	$ 10,000	$ 10,000
1- 25	1	Each, Air Relief Valve and Box	$ 2,300	$ 2,300
1- 26	240	Lin. Ft., 8" Sewer Line	$ 266	$ 63,840
1- 27	2	Each, Sewer Manhole	$ 15,000	$ 30,000
1- 28	240	Lin. Ft., 18" Sewer Force Main	$ 338	$ 81,120
1- 29	1	Each, Air Relief Valve and Box	$ 18,600	$ 18,600
1- 30	1,000	Lin. Ft., Street Lights	$ 130	$ 130,000
1- 31	1	Lump Sum, Traffic Control	$ 110,000	$ 110,000
1- 32	1	Lump Sum, Construction Surveys	$ 50,000	$ 50,000
1- 33	1	Lump Sum, Mobilization/Demobilization	$ 500,000	$ 500,000
		Subtotal for Keawe Street Intersection		$ 3,465,520
		Contingency (20%)		$ 693,104
		Subtotal		$ 4,158,624
		Design and Construction Services (15%)		$ 623,794
		Total		$ 4,782,417
		SAY		**$ 4,783,000**

Note: Cost is 2009 dollars.

HHFDC Leialii
Off-Site Road System Costs

OFF-SITE ROAD SYSTEM

Item No.	Estimated Quantity	Description	Unit Price	Total
60' Keawe Street Connector Road - 700 LF with 3 - 5' x 2.67' RCBC				
1- 1	1.3	Acres, Clearing and Grubbing	$ 5,000	$ 6,500
1- 2	1	Lump Sum, Water Pollution and Erosion Control Measures	$ 19,500	$ 19,500
1- 3	840	Sq. Ft., Demolish/Remove Concrete Sidewalk	$ 2.50	$ 2,100
1- 4	140	Lin. Ft., Demolish/Remove Concrete Curb and Gutter	$ 9.00	$ 1,260
1- 5	1	Each, Demolish/Remove Catch Basin	$ 4,000	$ 4,000
1- 6	1	Each, Demolish/Remove Fire Hydrant	$ 2,000	$ 2,000
1- 7	1.3	Acres, Earthwork	$ 47,916	$ 62,291
1- 8	1.3	Acres, Grading	$ 29,200	$ 37,960
1- 9	33,600	Sq. Ft., AC Pavement for Roadways (2.5" AC / 5" BC / 8" SBC)	$ 6.20	$ 208,320
1- 10	1,400	Lin. Ft., Concrete Curb and Gutter	$ 34.00	$ 47,600
1- 11	7,000	Sq. Ft., Concrete Sidewalk with Base Course	$ 12.00	$ 84,000
1- 12	2	Each, Centerline Monuments	$ 980	$ 1,960
1- 13	1	Lump Sum, Striping and Marking	$ 10,000	$ 10,000
1- 14	4	Each, Sign, Post and Footing	$ 550	$ 2,200
1- 15	4	Each, Catch Basin	$ 35,000	$ 140,000
1- 16	700	Lin. Ft., 3 - 5' x 2.67' Reinforced Concrete Box Culvert	$ 3,400	$ 2,380,000
1- 17	80	Lin. Ft., 24-inch Drain Line	$ 200	$ 16,000
1- 18	1	Each, Fire Hydrant (Relocation)	$ 5,000	$ 5,000
1- 19	700	Lin. Ft., Reclaimed Water System	$ 153.53	$ 107,471
1- 20	700	Lin. Ft., Electrical System	$ 350	$ 245,000
1- 21	700	Lin. Ft., Landscaping	$ 50.08	$ 35,056
1- 22	1	Lump Sum, Traffic Control	$ 30,000	$ 30,000
1- 23	700	Lin. Ft., Construction Surveys, Testing, Field Office	$ 210	$ 147,000
		Subtotal for Keawe Street Connector Road		$ 3,595,218
		Contingency (20%)		$ 719,044
		Subtotal		$ 4,314,261
		Design and Construction Services (15%)		$ 647,139
		Total		$ 4,961,401
		SAY		**$ 4,962,000**

Notes: Cost is 2009 dollars.
Reinforced Concrete Box Culvert is an extension to an existing box culvert into the site.

HHFDC Leialii
Off-Site Road System Costs

OFF-SITE ROAD SYSTEM

Item No.	Estimated Quantity	Description	Unit Price	Total
Honoapiilani Highway and Leialii Parkway Intersection				
1- 1	2.2	Acres, Clearing and Grubbing	$ 5,000	$ 11,000
1- 2	1	Lump Sum, Water Pollution and Erosion Control Measures	$ 33,000	$ 33,000
1- 3	22,700	Sq. Ft., Demolish/Remove AC Pavement	$ 1.70	$ 38,590
1- 4	2,900	Sq. Ft., Demolish/Remove Concrete Sidewalk	$ 2.50	$ 7,250
1- 5	900	Lin. Ft., Demolish/Remove Concrete Curb and Gutter	$ 9.00	$ 8,100
1- 6	320	Lin. Ft., Demolish/Remove Concrete Curb	$ 5.30	$ 1,696
1- 7	2	Each, Demolish/Remove Catch Basin/Inlet	$ 4,000	$ 8,000
1- 8	1	Each, Demolish/Remove Fire Hydrant	$ 2,000	$ 2,000
1- 9	1	Each, Demolish/Remove Light Standard	$ 2,000	$ 2,000
1- 10	2.2	Acres, Earthwork	$ 47,916	$ 105,415
1- 11	2.2	Acres, Grading	$ 29,200	$ 64,240
1- 12	72,700	Sq. Ft., AC Pavement (4" AC / 8" BC / 12" SBC)	$ 9.80	$ 712,460
1- 13	1,220	Lin. Ft., Concrete Curb and Gutter	$ 34	$ 41,480
1- 14	500	Lin. Ft., Concrete Curb	$ 31	$ 15,500
1- 15	8,500	Sq. Ft., Concrete Sidewalk with Base Course	$ 12	$ 102,000
1- 16	300	Lin. Ft., Retaining Wall	$ 450	$ 135,000
1- 17	3	Each, Centerline Monuments	$ 980	$ 2,940
1- 18	1	Lump Sum, Striping and Marking	$ 70,000	$ 70,000
1- 19	15	Each, Sign, Post and Footing	$ 550	$ 8,250
1- 20	4	Each, Catch Basin	$ 35,000	$ 140,000
1- 21	2	Each, Drain Inlets	$ 20,000	$ 40,000
1- 22	170	Lin. Ft., 24-inch Drain Line	$ 200	$ 34,000
1- 23	320	Lin. Ft., 36-inch Drain Line	$ 316	$ 101,120
1- 24	110	Lin. Ft., 48-inch Drain Line	$ 459	$ 50,490
1- 25	1	Each, Fire Hydrant	$ 5,000	$ 5,000
1- 26	1,000	Linear Feet, Traffic Signals and Street Lighting	$ 500	$ 500,000
1- 27	1	Lump Sum, Kaanapali Railroad Crossing gates and lights	$ 200,000	$ 200,000
1- 28	1	Lump Sum, Kaanapali Railroad Crossing gates and lights	$ 200,000	$ 200,000
1- 29	1	Lump Sum, Entry Walls and Signs	$ 255,000	$ 255,000
1- 30	20	Each, Coconut Trees	$ 2,000	$ 40,000
1- 31	20	Each, Bougainvillea, 15 gal	$ 75	$ 1,500
1- 32	41	Each, Bougainvillea, 3 gal	$ 20	$ 820
1- 33	6,275	Sq. Ft., akia	$ 5	$ 31,375
1- 34	600	Each, Naupaka	$ 10	$ 6,000
1- 35	450	Lin. Ft., Concrete Brick Header	$ 3	$ 1,350
1- 36	0.23	Acre, Soil Preparation	$ 10,900	$ 2,502
1- 37	10,000	Sq. Ft., Irrigation	$ 2.5	$ 25,000
1- 38	1	Lump Sum, Construction Surveys	$ 100,000	$ 100,000
1- 39	1	Lump Sum, Mobilization/Demobilization	$ 770,000	$ 770,000
		Subtotal for Intersection		$ 3,873,078
		Contingency (20%)		$ 774,616
		Subtotal		$ 4,647,694
		Design and Construction Services (15%)		$ 697,154
		Total		$ 5,344,848
		SAY		**$ 5,345,000**

HHFDC Leialii
Off-Site Road System Costs

Item No.	Estimated Quantity	Description	Unit Price	Total

Honoapiilani Highway and Leialii Parkway Intersection

Notes: Demolish and existing Leialii Parkway from Honoapiilani Highway to 4-lane Leialii Parkway, approximately 100 LF of Civic Center Road, plus approximately 250 LF of mauka half of Civic Center Road and driveways to Lahaina Post Office and park.
Construct improvements per "Offsite Roadway Improvements Plan" by Warren S. Unemori SMA Requirements, including additional right turn lane on Honoapiilani Highway.
Cost is 2009 dollars.

HHFDC Leialii
Off-Site Road System Costs

OFF-SITE ROAD SYSTEM

Item No.	Estimated Quantity	Description		Unit Price		Total
Honoapiilani Highway and Leialii Parkway Intersection - Post Office Improvements						
1- 1	1.3	Acres, Clearing and Grubbing	$	5,000	$	6,500
1- 2	1	Lump Sum, Water Pollution and Erosion Control Measures	$	19,500	$	19,500
1- 3	550	Sq. Ft., Demolish/Remove Concrete Sidewalk	$	2.50	$	1,375
1- 4	90	Lin. Ft., Demolish/Remove Concrete Curb and Gutter	$	9.00	$	810
1- 5	1.3	Acres, Earthwork	$	47,916	$	62,291
1- 6	1.3	Acres, Grading	$	29,200	$	37,960
1- 7	17,000	Sq. Ft., AC Pavement	$	4.50	$	76,500
1- 8	900	Lin. Ft., Concrete Curb	$	31.00	$	27,900
1- 9	1,620	Sq. Ft., Concrete Sidewalk with Base Course	$	12.00	$	19,440
1- 10	500	Lin. Ft., Fence	$	100.00	$	50,000
1- 11	1	Lump Sum, Striping and Marking	$	3,000.00	$	3,000
1- 12	4	Each, Sign, Post and Footing	$	550.00	$	2,200
1- 13	1	Lump Sum, Construction Surveys	$	7,000.00	$	7,000
1- 14	1	Lump Sum, Mobilization/Demobilization	$	100,000.00	$	100,000
		Subtotal for Post Office			$	414,476
		Contingency (20%)			$	82,895
		Subtotal			$	497,371
		Design and Construction Services (15%)			$	74,606
		Total			$	571,977
		SAY			**$**	**572,000**

Notes: Construct improvements per "Offsite Roadway Improvements Plan"
by Warren S. Unemori SMA Requirements.
Cost is 2009 dollars.

HHFDC Leialii
On-Site Road System Costs

ON-SITE ROADS

Item No.	Estimated Quantity	Description	Unit Price	Total
Concept Land Use Plan One and Two				
On-Site Roads - Phase A				
1- 1	3,300	Lin. Ft., 70' Right-of-Way Roads	$ 2,680.00	$ 8,844,000
1- 2	11,920	Lin. Ft., 60' Right-of-Way Roads	$ 2,450.00	$ 29,204,000
1- 3	63,330	Lin. Ft., 50' Right-of-Way Roads	$ 2,340.00	$ 148,192,200
		Subtotal for On-Site Roads		$ 186,240,200
		Contingency (20%)		$ 37,248,040
		Subtotal		$ 223,488,240
		Design and Construction Services (15%)		$ 33,523,236
		Total		$ 257,011,476
		SAY		**$ 257,012,000**
On-Site Roads - Phase B				
1- 1	21,170	Lin. Ft., 70' Right-of-Way Roads	$ 2,680.00	$ 56,735,600
1- 2		Lin. Ft., 60' Right-of-Way Roads	$ 2,450.00	$ 0
1- 3	1,500	Lin. Ft., 50' Right-of-Way Roads	$ 2,340.00	$ 3,510,000
		Subtotal for On-Site Roads		$ 60,245,600
		Contingency (20%)		$ 12,049,120
		Subtotal		$ 72,294,720
		Design and Construction Services (15%)		$ 10,844,208
		Total		$ 83,138,928
		SAY		**$ 83,139,000**
		TOTAL		**$ 340,151,000**

Notes: Cost is 2009 dollars
Future Lahaina Bypass Highway is 7,200 Linear feet, but not included in estimate.

HHFDC Leialii
On-Site Road System Costs

Item No.	Estimated Quantity	Description	Unit Price	Total
Concept Land Use Plan Three				
On-Site Roads - Phase A				
1- 1	0	Lin. Ft., 70' Right-of-Way Roads	$ 2,680.00	$ 0
1- 2	11,020	Lin. Ft., 60' Right-of-Way Roads	$ 2,450.00	$ 26,999,000
1- 3	66,640	Lin. Ft., 50' Right-of-Way Roads	$ 2,340.00	$ 155,937,600
		Subtotal for On-Site Roads		$ 182,936,600
		Contingency (20%)		$ 36,587,320
		Subtotal		$ 219,523,920
		Design and Construction Services (15%)		$ 32,928,588
		Total		$ 252,452,508
		SAY		**$ 252,453,000**
On-Site Roads - Phase B				
1- 1	0	Lin. Ft., 70' Right-of-Way Roads	$ 2,680.00	$ 0
1- 2	12,620	Lin. Ft., 60' Right-of-Way Roads	$ 2,450.00	$ 30,919,000
1- 3	15,500	Lin. Ft., 50' Right-of-Way Roads	$ 2,340.00	$ 36,270,000
		Subtotal for On-Site Roads		$ 67,189,000
		Contingency (20%)		$ 13,437,800
		Subtotal		$ 80,626,800
		Design and Construction Services (15%)		$ 12,094,020
		Total		$ 92,720,820
		SAY		**$ 92,721,000**
		TOTAL		**$ 345,174,000**

Notes: Cost is 2009 dollars
Future Lahaina Bypass Highway is 7,200 Linear feet, but not included in estimate.

HHFDC Leialii
On-Site Road System Costs

Item No.	Estimated Quantity	Description		Unit Price		Total
70' Right-of-Way Roads						
2- 1	1	Lin. Ft., Clearing and Grubbing	$	10.33	$	10.33
2- 2	1	Lin. Ft., Erosion Control Measures	$	30.99	$	30.99
2- 3	1	Lin. Ft., Roadway Excavation/Embankment	$	228.00	$	228.00
2- 4	1	Lin. Ft., Roadway Pavement	$	310.00	$	310.00
2- 5	1	Lin. Ft., Concrete Curb and Gutter	$	68.00	$	68.00
2- 6	1	Lin. Ft., Concrete Sidewalk	$	120.00	$	120.00
2- 7	1	Lin. Ft., Signing, Striping and Marking	$	9.20	$	9.20
2- 8	1	Lin. Ft., Catch Basin with Sediment Trap	$	140.00	$	140.00
2- 9	1	Lin. Ft., Drain Lines	$	400.00	$	400.00
2- 10	1	Lin. Ft., Sewer System	$	316.00	$	316.00
2- 11	1	Lin. Ft., Water System	$	175.53	$	175.53
2- 12	1	Lin. Ft., Reclaimed Water System	$	153.53	$	153.53
2- 13	1	Lin. Ft., Construction Surveys, Testing, Field Office	$	210.00	$	210.00
2- 14	1	Lin. Ft., Electrical System	$	450.00	$	450.00
2- 15	1	Lin. Ft., Landscaping	$	50.08	$	50.08
		Subtotal			$	2,671.67
		SAY			**$**	**2,680.00**
60' Right-of-Way Roads						
3- 1	1	Lin. Ft., Clearing and Grubbing	$	9.18	$	9.18
3- 2	1	Lin. Ft., Erosion Control Measures	$	27.55	$	27.55
3- 3	1	Lin. Ft., Roadway Excavation/Embankment	$	171.00	$	171.00
3- 4	1	Lin. Ft., Roadway Pavement	$	248.00	$	248.00
3- 5	1	Lin. Ft., Concrete Curb and Gutter	$	68.00	$	68.00
3- 6	1	Lin. Ft., Concrete Sidewalk	$	120.00	$	120.00
3- 7	1	Lin. Ft., Signing, Striping and Marking	$	9.20	$	9.20
3- 8	1	Lin. Ft., Catch Basin with Sediment Trap	$	140.00	$	140.00
3- 9	1	Lin. Ft., Drain Lines	$	400.00	$	400.00
3- 10	1	Lin. Ft., Sewer System	$	316.00	$	316.00
3- 11	1	Lin. Ft., Water System	$	175.53	$	175.53
3- 12	1	Lin. Ft., Reclaimed Water System	$	153.53	$	153.53
3- 13	1	Lin. Ft., Construction Surveys, Testing, Field Office	$	210.00	$	210.00
3- 14	1	Lin. Ft., Electrical System	$	350.00	$	350.00
3- 15	1	Lin. Ft., Landscaping	$	50.08	$	50.08
		Subtotal			$	2,448.08
		SAY			**$**	**2,450.00**

HHFDC Leialii
On-Site Road System Costs

Item No.	Estimated Quantity	Description		Unit Price		Total
50' Right-of-Way Roads						
4- 1	1	Lin. Ft., Clearing and Grubbing	$	8.03	$	8.03
4- 2	1	Lin. Ft., Erosion Control Measures	$	24.10	$	24.10
4- 3	1	Lin. Ft., Roadway Excavation/Embankment	$	121.60	$	121.60
4- 4	1	Lin. Ft., Roadway Pavement	$	186.00	$	186.00
4- 5	1	Lin. Ft., Concrete Curb and Gutter	$	68.00	$	68.00
4- 6	1	Lin. Ft., Concrete Sidewalk	$	120.00	$	120.00
4- 7	1	Lin. Ft., Signing, Striping and Marking	$	9.20	$	9.20
4- 8	1	Lin. Ft., Catch Basin with Sediment Trap	$	140.00	$	140.00
4- 9	1	Lin. Ft., Drain Lines	$	400.00	$	400.00
4- 10	1	Lin. Ft., Sewer System	$	316.00	$	316.00
4- 11	1	Lin. Ft., Water System	$	175.53	$	175.53
4- 12	1	Lin. Ft., Reclaimed Water System	$	153.53	$	153.53
4- 13	1	Lin. Ft., Construction Surveys, Testing, Field Office	$	210.00	$	210.00
4- 14	1	Lin. Ft., Electrical System	$	350.00	$	350.00
4- 15	1	Lin. Ft., Landscaping	$	50.08	$	50.08
		Subtotal			$	2,332.09
		SAY			**$**	**2,340.00**

Cost Parameters:

1	Clearing and Grubbing	$	5,000.00	Acre
2	Erosion Control Measures	$	15,000.00	Acre
3	Roadway Excavation/Embankment	$	38.00	CY
4	Roadway Pavement	$	6.20	SF
5	Concrete Curb and Gutter	$	34.00	LF
6	Concrete Sidewalk (5-feet wide, each side)	$	12.00	SF
7	Signs (1 per 250 feet)	$	550.00	EA
	Striping and Marking	$	7.00	LF
8	Catch Basins with sediment trap (2 per 500 feet)	$	35,000.00	EA
9	Drain Line ($316/LF for 36" + $94/LF for 24" laterals)	$	400.00	LF
10	Sewer Line (8")	$	266.00	LF
	Sewer Manhole (1 per 300 feet)	$	15,000.00	EA
11	Water Line (12")	$	140.00	LF
	Fire Hydrants (1 per 250 feet)	$	5,000.00	EA
	Gate Valve and Box (1 per 500 feet)	$	5,000.00	EA
	Air Relief Valves and Box (1 per 1500 feet)	$	2,300.00	EA
	Testing and Chlorination	$	4.00	LF
12	Reclaimed Water Line (12")	$	140.00	LF
	Gate Valves and Box (1 per 500 feet)	$	5,000.00	EA
	Air Relief Valves and Box (1 per 1500 feet)	$	2,300.00	EA
	Testing	$	2.00	LF
13	Construction Surveys, Testing and Field Office	$	210.00	LF
14	Electrical System (MECo, HTCo, Oceanic, Lighting, Cabling)			
	50 or 60-foot right-of-way	$	350.00	LF
	70-foot right-of-way	$	450.00	LF
15	Landscaping			
	Irrigation System	$	4.00	LF
	4" Thick Topsoil ($35/CY)	$	0.43	SF
	Grass	$	1.00	SF
	Trees (25 gallon) (2 per 40 feet)	$	750.00	EA

Appendix G

Drainage

DRAINAGE REPORT FOR VILLAGES OF LEIALI‘I MASTER PLAN

LAHAINA, MAUI, HAWAI‘I
TAX MAP KEY 4-5-28: 70
TAX MAP KEY 4-5-21: 03, 13, 21, AND PORTIONS OF 04, 05, 22

Prepared for
HAWAII HOUSING FINANCE & DEVELOPMENT CORPORATION
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

Prepared by
BELT COLLINS HAWAII LTD.
2153 North King Street, Suite 200
Honolulu, Hawai‘i 96819

October 2009

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APPENDICES

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Appendix C Design of Drainage Improvements
Appendix D Construction Cost Estimates

EXECUTIVE SUMMARY

The findings from this drainage study reported herein may be summarized by the following statements:

- The proposed affordable housing project would generate excess runoff from on-site areas that would be converted from inactive agricultural farmlands to urban development with more impervious land area.

- The proposed culvert improvements at Honoapiʻilani Highway baseline station 24+00, which was part of the original Villages of Leialiʻi project, would be required under this drainage master plan.

- Drainage improvements for post-development conditions-including a cutoff ditch along the mauka border of the project site, detention basins, and on-site culverts-are required for each of the three land use concepts. A diversion channel would be required for Land Use Concept One and Land Use Concept Two.

- All detention basins are designed to temporarily store runoff generated by the 100-year, 24-hour design storm for post-development conditions. Runoff discharging from the detention basins would be limited to pre-development runoff quantities or capacities of downstream outlet structures.

- A majority of the mauka off-site runoff would be captured by the cutoff ditch and routed to Crater Reservoir, where storm water would be temporarily stored. Runoff would discharge from Crater Reservoir to an on-site detention basin, before discharging to Kahoma Stream. Required improvements to Crater Reservoir would include an outlet drain pipe and an emergency spillway.

- A magnitude of construction costs was determined for the drainage improvements proposed for each land use concept. The construction costs related to material, labor, and overhead reflect projected costs in the year 2009. The cost estimates for the drainage improvements provided in this report do not include the costs for the roadway drainage system, which have already been factored in the roadway infrastructure cost estimates.

- Total construction costs for the drainage improvements proposed for Land Use Concept One and Land Use Concept Two are estimated at $85.6 million for Phase A and $14.8 million for Phase B. Total construction costs for the drainage improvements proposed for Land Use Concept Three are estimated at approximately $79.6 million for Phase A and $15.2 million for Phase B.

- The preliminary drainage improvements proposed in this study are part of the master-planning process; they are based on reasonable assumptions and do not reflect precise engineering design analyses. Further, the cost estimates provided in this report are based

on the preliminary drainage systems and should be only accepted as probable magnitudes of construction costs.

1 INTRODUCTION

1.1 Purpose

This drainage report assesses the impact that the Villages of Leiali‘i affordable housing development project would have on storm-water runoff. The specific objectives of this drainage study are to recommend a preliminary drainage system for each of the three land use concepts of the master-planned subdivision and provide an opinion of probable construction costs for each of these drainage systems.

The drainage systems are designed to meet the following objectives:

- Capture and convey on-site and off-site runoff through the project site.
- Protect adjacent and downstream properties by limiting runoff that would leave the project site to values that can be safely conveyed to the ocean through proposed drainage structures downstream of the development.
- Maintain post-development runoff discharging to Hahakea Gulch at or below pre-development levels.
- Maintain post-development runoff discharging to Kahoma Stream at or below design levels.
- Provide water quality detention treatment for runoff discharging from the development.

1.2 Site Description

The proposed Villages of Leiali‘i development is located in the town of Lahaina on the island of Maui (see Figure 1). The site lies to the mauka or east side of the existing Wahikuli Subdivision and the Department of Hawaiian Home Lands (DHHL) Village 1 Phase 1 Subdivision (see Figure 2).

The project site is approximately 1,030 acres and is described as Tax Map Key (TMK) 4-5-28:70 and TMK 4-5-21: 03, 13, 21, and portions of 04, 05 and 22. Land within the development area is predominantly comprised of inactive agricultural land previously used for sugar cane production. The site varies in elevation from approximately 50 feet mean sea level (MSL) to 855 feet MSL. The proposed Lahaina Bypass Highway bisects the site, with the Phase A area makai and the Phase B area mauka of the proposed highway.

1.3 Drainage Concept and Report Format

The basis of design for the drainage improvements in this report is to meet the requirements of Title MC-15, Chapter 4, *Rules for the Design of Storm Drainage Facilities in the County of Maui*, dated July 1995. The drainage rules require adequate drainage outlets or drainage systems to dispose of additional storm runoff from a new development that could result in adverse

impacts off site. This study proposes detention basins to capture post-development runoff from on-site drainage areas and discharge the stored runoff to the ocean at rates that are capable of being safely conveyed by proposed outlet structures, based on a 100-year, 24-hour design storm.[1] At other discharge points, post-development runoff captured by on-site detention basins would be released at rates that match or are below pre-development levels.

Section 2 of this report describes the existing drainage system. Section 3 describes the methods used to quantify the runoff generated from the existing site and the runoff that would be generated by the proposed development. Section 4 describes the existing off-site and on-site drainage basins and provides runoff quantities for each basin. Section 5 describes the proposed drainage system. Section 6 describes the on-site drainage basins for each land use concept after the development has been completed, and provides runoff values for each basin. Section 7 describes post-development runoff conditions with the drainage improvements implemented. Section 8 provides an estimate of the construction costs associated with the various drainage improvements.

Supporting documentation including exhibits and all pertinent calculations and analyses can be found at the end of this report.

[1] "Safely" means not increasing theoretical existing hydraulic water levels for the applicable design storm(s) for upstream and downstream areas relative to the project site.

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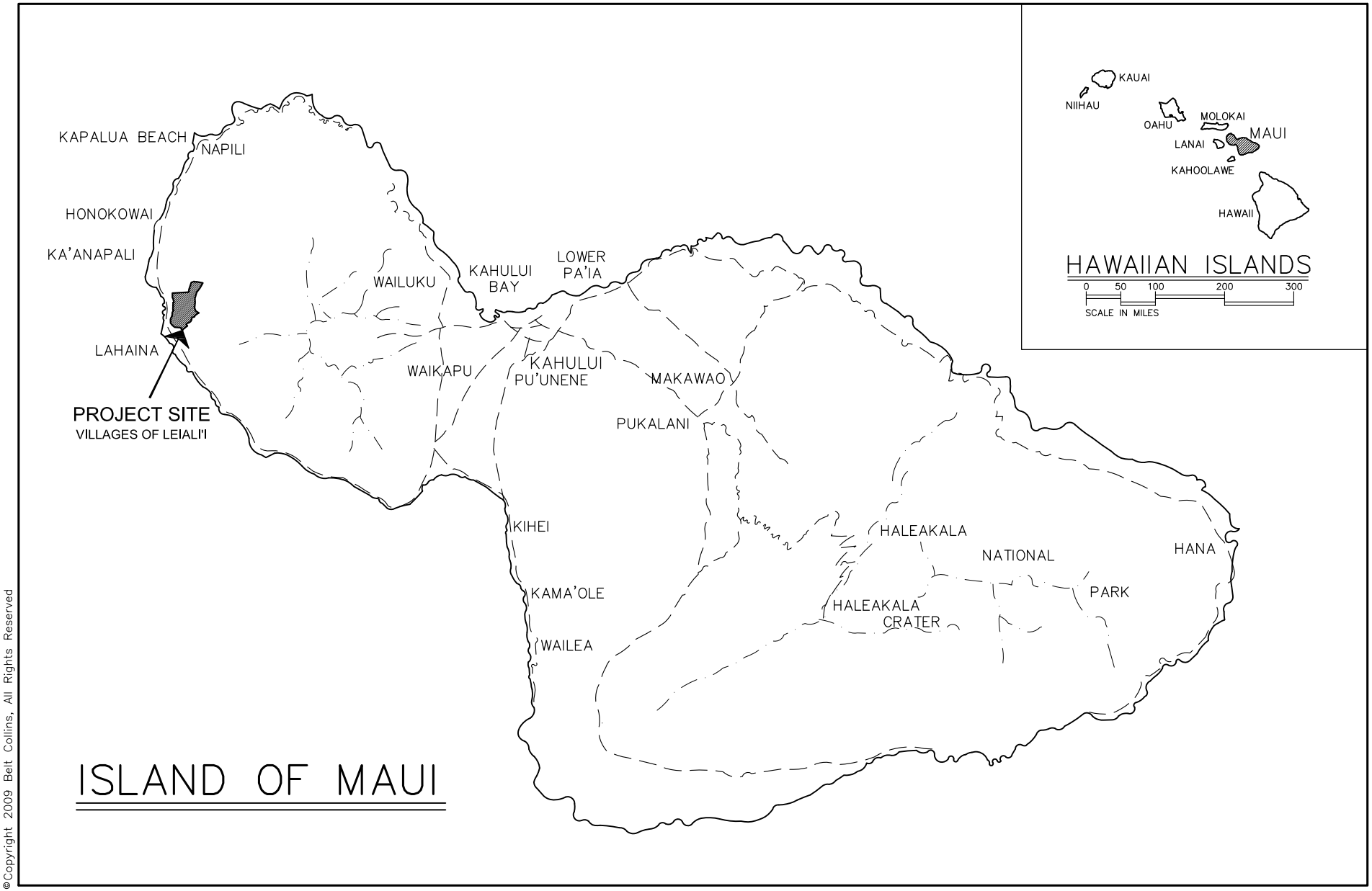

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BELT COLLINS

NORTH

0 1.5 3 6
SCALE IN MILES

Figure 1
LOCATION MAP

VILLAGES OF LEIALI'I MASTER PLAN
DRAINAGE REPORT
HAWAII HOUSING FINANCE & DEVELOPMENT CORPORATION
OCTOBER 2009
PAGE 5

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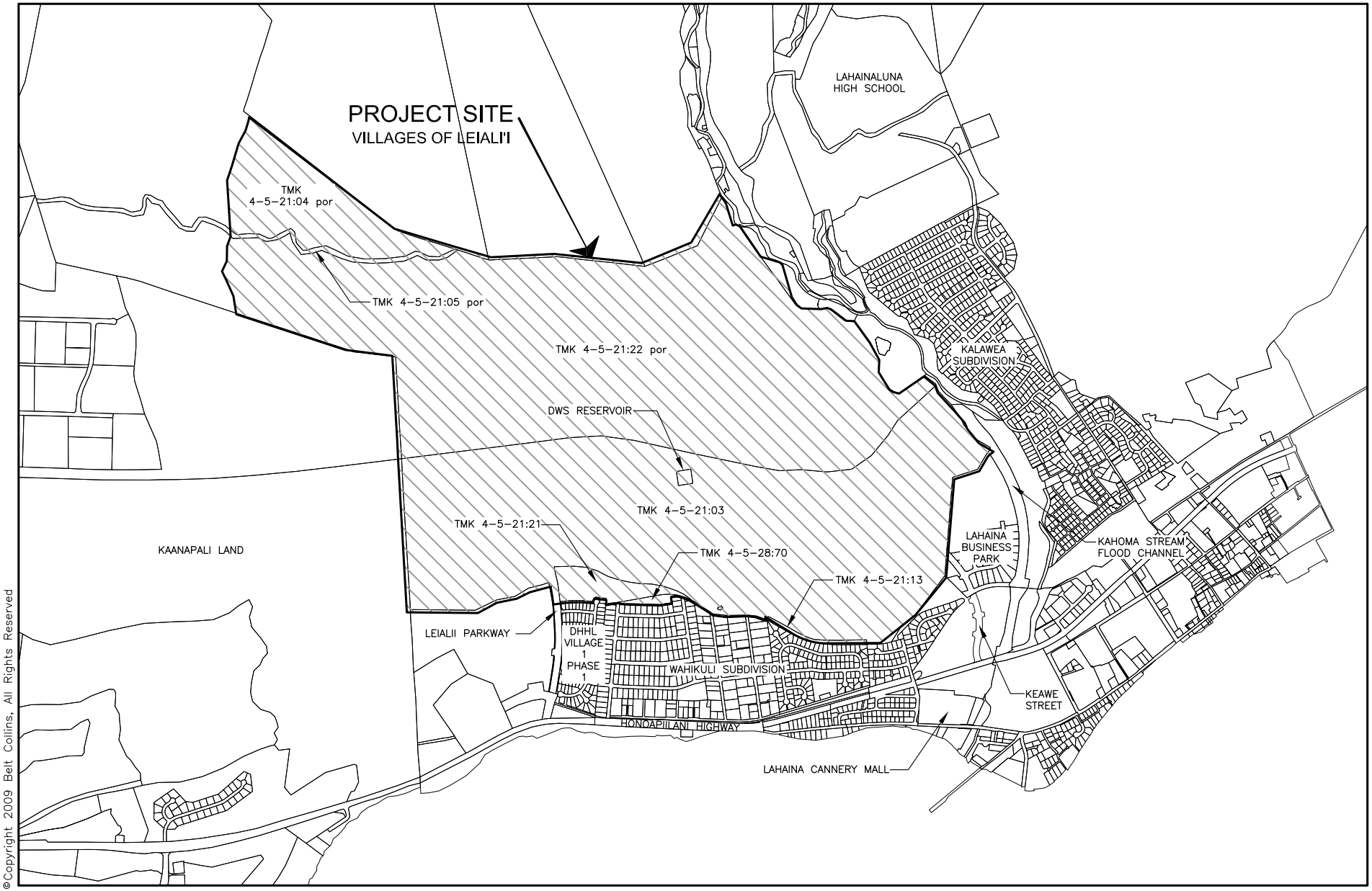

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NORTH

0 500 1000 2000
SCALE IN FEET

Figure 2
VICINITY MAP

VILLAGES OF LEIALI'I MASTER PLAN
DRAINAGE REPORT
HAWAII HOUSING FINANCE & DEVELOPMENT CORPORATION
OCTOBER 2009
PAGE 6

2 EXISTING DRAINAGE SYSTEM

The existing drainage system consists of the detention basin east of DHHL Village 1 Phase 1, three 48-inch-diameter culverts at Honoapiʻilani Highway baseline station 24+00, one 48-inch reinforced concrete pipe (RCP) culvert at Honoapiʻilani Highway baseline station 42+00, and a triple-reinforced concrete box culvert (RCBC) with 5' x 2.67' cells through Keawe Street to Kahoma Stream (see Figure 3). The existing detention basin, part of the Village 1 Phase 1 project, was designed for a 100-year, 6-hour design storm and drainage area of 171 acres.[2] Discharge from the detention basin to the three 48-inch RCP culverts at baseline station 24+00 was also based on those design criteria. The existing triple-RCBC was designed for a peak discharge rate of 230 cubic feet per second (cfs), based on a 100-year storm and drainage area of 220 acres.[3]

As part of the original Villages of Leialiʻi project, two culvert improvements were proposed at Honoapiʻilani Highway baseline station 24+00 and 42+00. These drainage improvements are subject to the Special Management Area (SMA) Use Permit and Shoreline Setback Variance (SSV), which were held in abeyance by the County of Maui, Department of Planning in May of 2000. HHFDC requested holding the two permits in abeyance in order to resolve land title issues facing the project.

Under the original Leialiʻi project, the three existing 48-inch RCP culverts at Honoapiʻilani Highway baseline station 24+00 would be supplemented with a fourth 48-inch diameter culvert and connected to an existing upstream drainage junction structure with four 48-inch diameter culverts. An existing open concrete rubble masonry (CRM) drainage channel connecting the three existing 48-inch RCP culverts to the upstream junction structure would be filled. The additional 48-inch diameter culvert would increase the system's capacity from 210 cfs to 430 cfs. The existing 48-inch RCP culvert at Honoapiʻilani Highway baseline station 42+00 would be replaced with a 7' x 9' RCBC with new headwalls and upstream channel improvements. The box culvert would increase the system's capacity from 108 cfs to 1,093 cfs.[4]

---

[2] *Drainage and Soil Erosion Control Report for Lahaina Master-Planned Community, Village 1 – Phase 1-A.* Prepared by Warren S. Unemori Engineering, Inc. June, 1991.

[3] *Drainage and Soil Erosion Control Study for Hawaii Omori Mauka Subdivision*. Prepared by R. T. Tanaka Engineers, Inc. Revised January, 1998.

[4] *Final Environmental Assessment – Offsite Drainage and Roadway Improvements, Villages of Leialiʻi Master Planned Project.* Prepared by PBR Hawaii. November, 1995.

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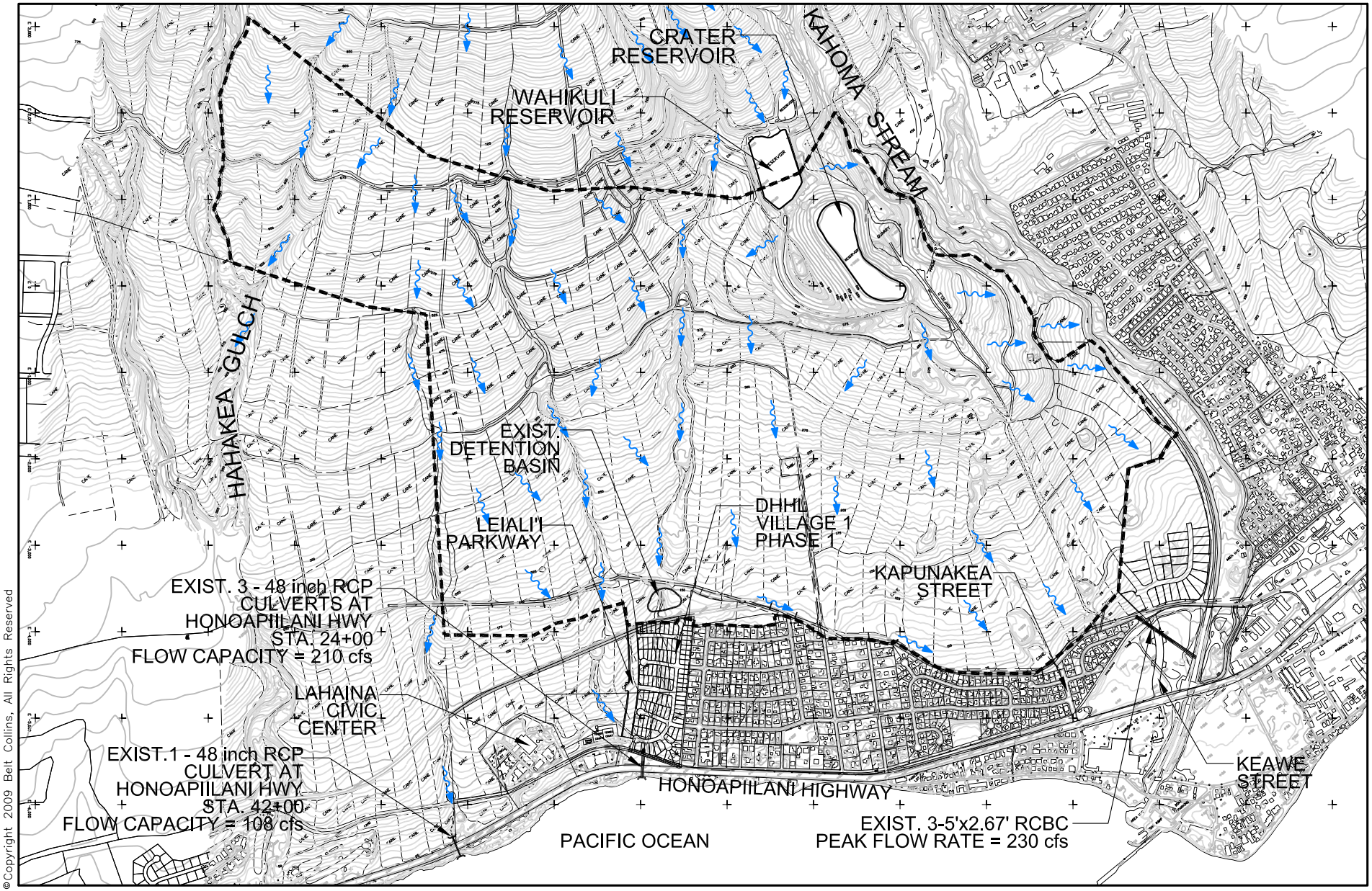

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NORTH

0 400 800 1600
SCALE IN FEET

LEGEND:

PROJECT BOUNDARY

FLOW DIRECTION

Figure 3
EXISTING DRAINAGE SYSTEM

VILLAGES OF LEIALI'I MASTER PLAN
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OCTOBER 2009
PAGE 8

3 METHODOLOGY

In accordance with Title MC-15, Chapter 4, *Rules for the Design of Storm Drainage Facilities in the County of Maui* (1995), a 100-year (recurrence interval), 24-hour (storm duration) design storm, and the Natural Resources Conservation Service's (NRCS) hydrograph method should be used to compute the runoff for drainage areas greater than 100 acres. All runoff quantities for existing and post-development drainage basins were consistently evaluated with this design storm and NRCS TR-55, Urban Hydrology for Small Watersheds, methodologies.

The computer program HydroCAD (HydroCAD Software Solutions LLC, 2009) was used to generate all runoff values and determine required detention volumes, based on TR-55 methodologies. TR-55 considers such factors as ground cover (amount of impervious area), soil characteristics, hydraulic parameters that affect flow travel time, and the longest flow travel paths with respect to time based on existing or proposed conditions. For a map of the hydrologic soil groups (HSG) encountered in this study, refer to Exhibit 1 of Appendix A. TR-55 also includes four regional 24-hour rainfall distributions (I, IA, II, and III) for the United States, of which Hawaii is classified as Type I.

All of the ground cover for existing conditions is assumed to be sugarcane farmland with limited cover and contoured crop rows. The CNs for sugarcane with limited cover and contoured crop rows are 75, 82, and 86 for HSGs B, C, and D, respectively (NRCS, 2004). Soils categorized by HSG A do not occur in the project site or in contributing off-site drainage areas. Assuming full capacity, reservoirs utilized a CN of 98. All pertinent hydrologic calculations for existing off-site and on-site runoff are provided in Appendix B, Table 1 and Table 2, respectively. Land cover for post-development off-site drainage basins is not expected to change.

Table 2-2a - *Runoff Curve Numbers for Urban Areas* of TR-55 was referenced to determine the weighted average CNs for post-development drainage basins. A list of the various planned land uses and their corresponding cover types from Table 2-2a has been provided for each concept in Table 3 through Table 5 of Appendix B.

The post-development drainage analysis assumed existing topography to estimate overland flow. The drain lines in each drainage basin were uniformly sized for existing on-site peak runoff rates to determine the travel time in closed conduits.

Although on-site and off-site drainage basins are part of larger, combined drainage areas, when separated, the basins are treated independently such that the flow travel path does not have to be continuous (with the exception of Drainage Basin E1 and Drainage Basin B1). In HydroCAD, the time of concentration was determined by taking the longest flow path. The Soil Conservation Survey's (now NRCS) CN Method was used to determine sheet and shallow concentrated flow travel times for each drainage basin. To determine the runoff travel time in open channels, this study assumes an average channel cross-section and constant flow depth of five feet per drainageway.

Runoff values generated from post-development conditions are based on each of the three land use alternatives proposed in the Villages of Leiali‘i master plan. Land Use Concept One and Land Use Concept Two have the same layout with different densities of single-family and multi-family development but utilize identical roadway layouts. Land Use Concept Three has a different layout for both the roadways and proposed land uses. Therefore, the curve numbers and times of concentration are similar for Land Use Concept One and Land Use Concept Two, but different for Land Use Concept Three.

The same on-site drainage basins defined for existing conditions were used to generate runoff quantities for each land use concept under post-development conditions. However, post-development drainage basins were subdivided to determine the tributary areas for on-site culverts and the diversion channel, and their subsequent designs. Off-site drainage basins for post-development conditions are consistent with existing conditions.

4 EXISTING CONDITION RUNOFF

4.1 Existing Runoff Conditions

Existing runoff mauka of and through the currently undeveloped project site generally sheet flows and is captured and routed through natural channels in the mauka-to-makai direction. One major and three minor natural drainageways cross through the Leiali`i project site in an east-to-west (mauka-to-makai) direction. Kahoma Stream and Hahakea Gulch border the project site on the south and north sides, respectively.

The mauka end of the major drainageway is located north of Wahikuli reservoir and meanders to the existing on-site detention basin east of the DHHL Village 1 Phase 1 Subdivision. From the detention basin, rainfall-runoff is conveyed through DHHL Village 1 Phase 1 in a 78-inch drain line and through Leiali`i Parkway in a 48-inch drain line. Both drain lines converge makai of DHHL Village 1 Phase 1 in a junction structure. The junction structure discharges into an open CRM drainage channel mauka of Honoapi`ilani Highway. Three 48-inch diameter RCP culverts at Honoapi`ilani Highway baseline station 24+00 convey drainage from the open CRM channel under Honoapi`ilani Highway and discharge to the ocean at Wahikuli Beach Park.

The minor drainageway along the south side of the site is not well defined. It starts makai of Crater reservoir and meanders through the site toward Kapunakea Street. The makai end of the drainageway is not well defined. The cane haul road along the makai boundary of the site directs runoff toward Keawe Street. Runoff reaching Keawe Street is captured in the catch basins along the road and discharges into Kahoma Stream through an existing triple-RCBC with 5’ x 2.67’ cells.

The second minor drainageway is located north of the major drainageway. This minor drainageway originates near the middle of the mauka boundary and traverses in a makai and south direction, towards the tennis courts at the Lahaina Civic Center. At the tennis courts, runoff is captured and conveyed into the Leiali`i Parkway roadway drainage system, conveyed to the junction structure and to the ocean via the three 48-inch culverts at Honoapi`ilani Highway baseline station 24+00.

The third minor drainageway is located along the north side of the site and discharges into Hahakea Gulch.

4.2 Existing Off-Site Drainage Basins

The two off-site drainage basins located mauka of the project site comprise an area of approximately 683 acres (for off-site and on-site drainage basin delineations, see Figure 4). The off-site drainage basins are designated as Drainage Basin E1 and Drainage Basin E2.

Runoff generated by the two existing off-site drainage basins generally sheet flows towards on-site drainage basins. Runoff from the major drainageway that flows through on-site Drainage Basin B5 originates in Drainage Basin E2. Runoff from Drainage Basin E1 and a portion of Drainage Basin E2 (depicted as Drainage Sub-Basin E2A on Figure 4) sheet flows towards

Drainage Basin B1, where it collects in an existing drainageway before discharging to Hahakea Gulch. Runoff from a majority of Drainage Basin E2 flows towards Drainage Basin B2, Drainage Basin B4, Drainage Basin B5, Drainage Basin B6, and Wahikuli Reservoir. Water that is captured by Wahikuli Reservoir either spills into Crater Reservoir below or is transported to farms and the Pu‘ukoli Reservoir north of the project site via an irrigation ditch.

Table 1 summarizes the runoff quantities for each off-site drainage basin under existing conditions (refer also to Figure 4).

Table 1 – Off-Site Drainage Flow

Existing Off-Site Drainage Basin	Area	Peak Runoff Rate, Q_{100}	Runoff Volume
	(acres)	(cfs)	(ac-ft)
E1	78	260	45.0
E2	605	1,448	359.5
Sub-Basin E2A	66	218	37.7

4.3 Existing On-Site Drainage Basins

The eight on-site basins for existing conditions are designated as Drainage Basin B1 through Drainage Basin B8.

As mentioned in Section 4.2, Drainage Basin B1 discharges into Hahakea Gulch.

Drainage Basin B2 contributes runoff to the minor drainageway south of Hahakea Gulch, which originates just makai of Drainage Basin B2 and meanders through the project site in Drainage Basin B3. This channel discharges runoff into the existing 48-inch RCP culvert along Honoapi‘ilani Highway baseline station 42+00.

Runoff from Drainage Basin B4 flows into the minor drainageway located north of the major drainageway. After leaving Drainage Basin B4, the drainageway eventually discharges runoff into the Leiali‘i Parkway drainage system and into a junction structure makai of the DHHL Village 1 Phase 1 Subdivision. Runoff entering this junction structure discharges to the ocean through the three existing 48-inch RCP culverts at Honoapi‘ilani Highway baseline station 24+00.

Drainage Basin B5 is tributary to the major drainageway, located north of Wahikuli Reservoir, which drains to the existing detention basin located at the makai end of Drainage Basin B5. The detention basin discharges flow from two outlets: a 78-inch drain line that passes through the Village 1 Phase 1 Subdivision and a 48-inch drain line that runs along Leiali‘i Parkway. Both drain lines converge in the same junction structure before discharging into the three 48-inch RCP culverts along Honoapi‘ilani Highway baseline station 24+00.

The mauka boundary of Drainage Basin B6 traverses Wahikuli Reservoir. Runoff from Wahikuli Reservoir spills over to Crater Reservoir. There have been no reported discharges from Crater Reservoir. Runoff from Drainage Basin B6 is conveyed through the less well-

defined drainageway that runs along the south border of the basin. As a conservative approach, the hydrologic analysis assumes that the two reservoirs are at capacity during the storm's occurrence and runoff essentially sheet flows over the water surface. Runoff is either captured by the minor drainageway or sheet flows through Drainage Basin B6 towards the makai boundary of the basin, where an existing cane haul road runs roughly parallel to the boundary. The cane haul road directs flow from this basin towards Keawe Street, where a triple-RCBC (3 - 5'x 2.67' cells) running under the road discharges into Kahoma Stream.

Runoff generated by Drainage Basin B7 sheet flows into Kahoma Stream along the south border of the basin.

Runoff from Drainage Basin B8 sheet flows towards Lahaina Business Park, where an existing diversion channel along the easterly and northerly boundaries of the property intercepts runoff and routes it to Kahoma Stream via an existing drainage system in Keawe Street.

Runoff quantities generated by Drainage Basin B1 and Drainage Basin B7 for the 100-year, 24-hour design storm were estimated for existing conditions as part of the process to determine the necessary storage volume for Detention Basin 1 and Detention Basin 4, respectively. The runoff volume is defined as the product of the runoff depth, Q, in feet, and the drainage basin area in acres. Table 2 summarizes the runoff quantities generated by each on-site drainage basin under existing conditions (refer also to Figure 4).

Table 2 – Pre-Development On-Site Drainage Flow

Existing On-site Drainage Basin	Area	Peak Runoff Rate, Q_{100}	Runoff Volume
	(acres)	(cfs)	(ac-ft)
B1	102	339	58.7
B2	30	124	16.9
B3	10	49	5.9
B4	218	727	125.1
B5	161	651	95.5
B6	384	862	224.1
B7	53	251	31.2
B8	63	202	36.4

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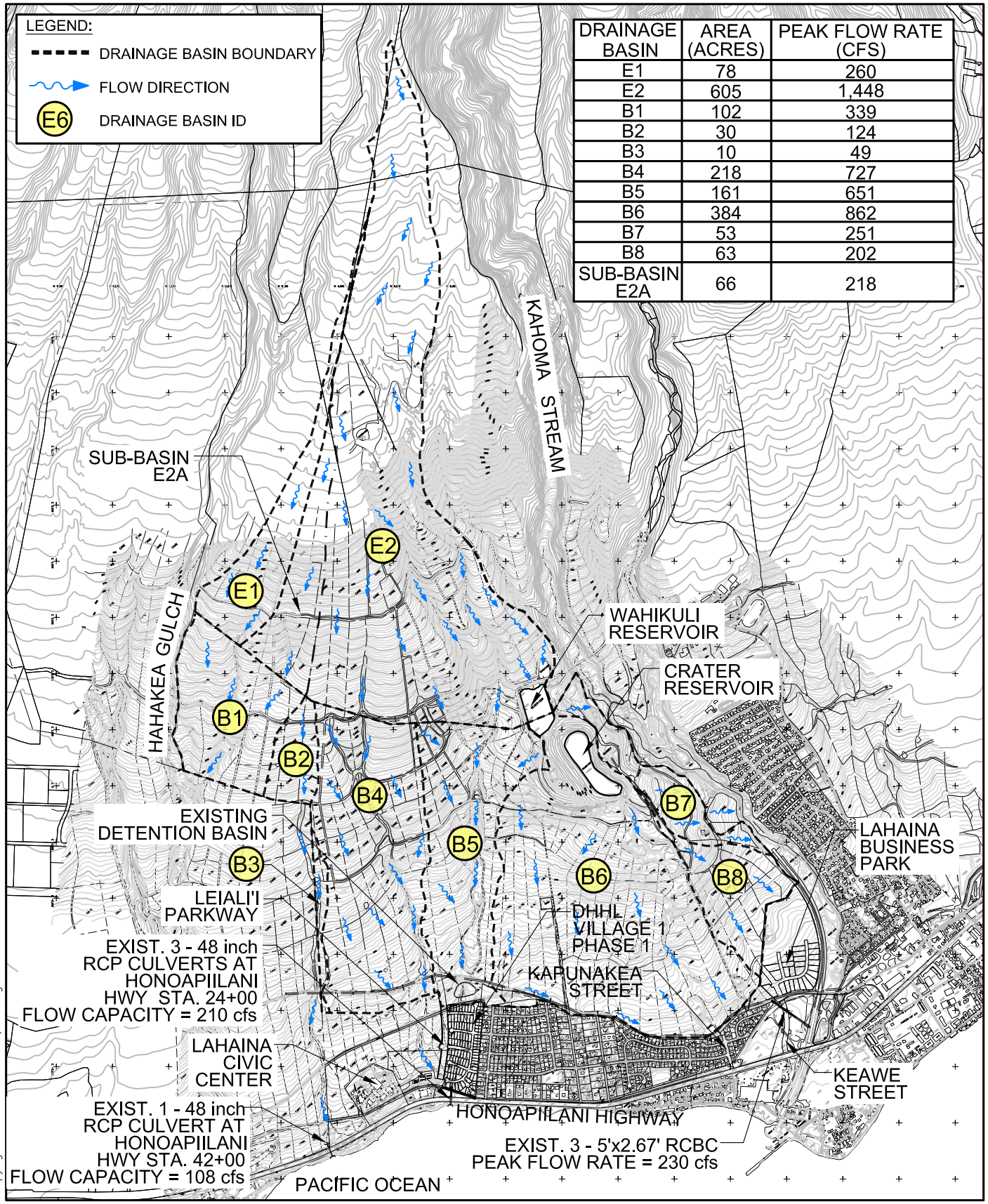

DRAINAGE BASIN	AREA (ACRES)	PEAK FLOW RATE (CFS)
E1	78	260
E2	605	1,448
B1	102	339
B2	30	124
B3	10	49
B4	218	727
B5	161	651
B6	384	862
B7	53	251
B8	63	202
SUB-BASIN E2A	66	218

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Figure 4
EXISTING CONDITION DRAINAGE BASINS

5 PROPOSED DRAINAGE SYSTEM

Completion of the previously proposed culvert improvements at Honoapi‘ilani Highway baseline station 24+00 that was intended to be a part of the original Villages of Leiali‘i project would be required for this proposed drainage system. A new SMA Use Permit and SSV would be required to construct the culvert improvements. Downstream drainage improvements, not part of the original Leiali‘i project, would also include an approximately 700-foot extension of the existing triple-RCBC (3 – 5’ x 2.67’ cells) into the project site. The triple box culvert would discharge to Kahoma Stream at its existing peak discharge rate of 230 cfs.

Storm water runoff generated on site would be collected in existing drainageways and new swales, ditches, gutters, inlets, and catch basins, and routed through drain pipes before flowing to detention basins. Runoff generated by Drainage Basin E1 and Drainage Basin B1 would be detained in Detention Basin 1 before discharging to Hahakea Gulch (see Figure 5 and Figure 6). Runoff generated by Drainage Basin B2 through Drainage Basin B5 would be detained in Detention Basin 2 and discharge to the ocean via the proposed four 48-inch RCP culverts at Honoapi‘ilani Highway baseline station 24+00. Runoff generated by Drainage Basin B6 and Drainage Basin B8 would be detained in Detention Basin 3 and leave the project site through the triple 5’ x 2.67’ box culvert extending from the project site to Keawe Street. Detention Basin 4 would detain excess runoff from Drainage Basin B7.

Detention basins would serve to do one or more of the following: provide water quality detention treatment for development runoff; reduce post-development runoff leaving the project site to pre-development values; and/or reduce post-development runoff discharging from the development to rates that are capable of being conveyed by downstream drainage structures.

A majority of the runoff generated from off-site drainage areas up-gradient of the project site would be collected in a cutoff ditch traversing most of the mauka border of the project site for about 6,860 feet. This cutoff ditch would be a grouted rubble pavement (GRP)-lined open trapezoidal channel with bottom width varying from 10 feet to 35 feet, design flow depth with freeboard ranging from 3.7 feet to 5 feet, and side slopes of 3 horizontal to 1 vertical. Approximately 840 feet of the cutoff ditch at the north end (Cutoff Ditch-North) would collect runoff from Drainage Basin E1 and flow it through the development in the minor drainageway that discharges to Hahakea Gulch. Storm water flowing through the development in existing drainageways would be conveyed through 96-inch diameter RCP culverts beneath the proposed roadways.

The other 6,020 feet of cutoff ditch (Cutoff Ditch-South and Cutoff Ditch-Crater Reservoir) would route off-site runoff from Drainage Basin E2 to Crater Reservoir, where storm water would be temporarily stored before discharging to Detention Basin 3 through a 24-inch diameter drain line. An emergency spillway would be constructed in Crater Reservoir to allow overflow to Kahoma Stream. The GRP-lined emergency spillway would be approximately 370 feet in length, have a bottom width of 35 feet, design flow depth with freeboard of 5 feet, and side slopes of 3 horizontal to 1 vertical.

For Land Use Concept One and Land Use Concept Two, a diversion channel is proposed along approximately one third of the proposed Lahaina Bypass Highway. It would collect runoff from a portion of Phase B and direct it towards the makai detention basins via a 48-inch diameter drain line and a 72-inch diameter drain line. The diversion channel would not be required for Land Use Concept Three because that portion of Phase B runoff would be conveyed to the makai detention basins through a drainageway along the south end of Phase A. The diversion channel would be an open trapezoidal channel lined with permanent erosion control matting and vegetation. The channel would consist of an approximately 965-foot long north portion and an approximately 2,005-foot long south portion, with bottom widths ranging from 5 to 10 feet, design flow depths with freeboard varying from 4 to 4.9 feet, and side slopes of 3 horizontal to 1 vertical.

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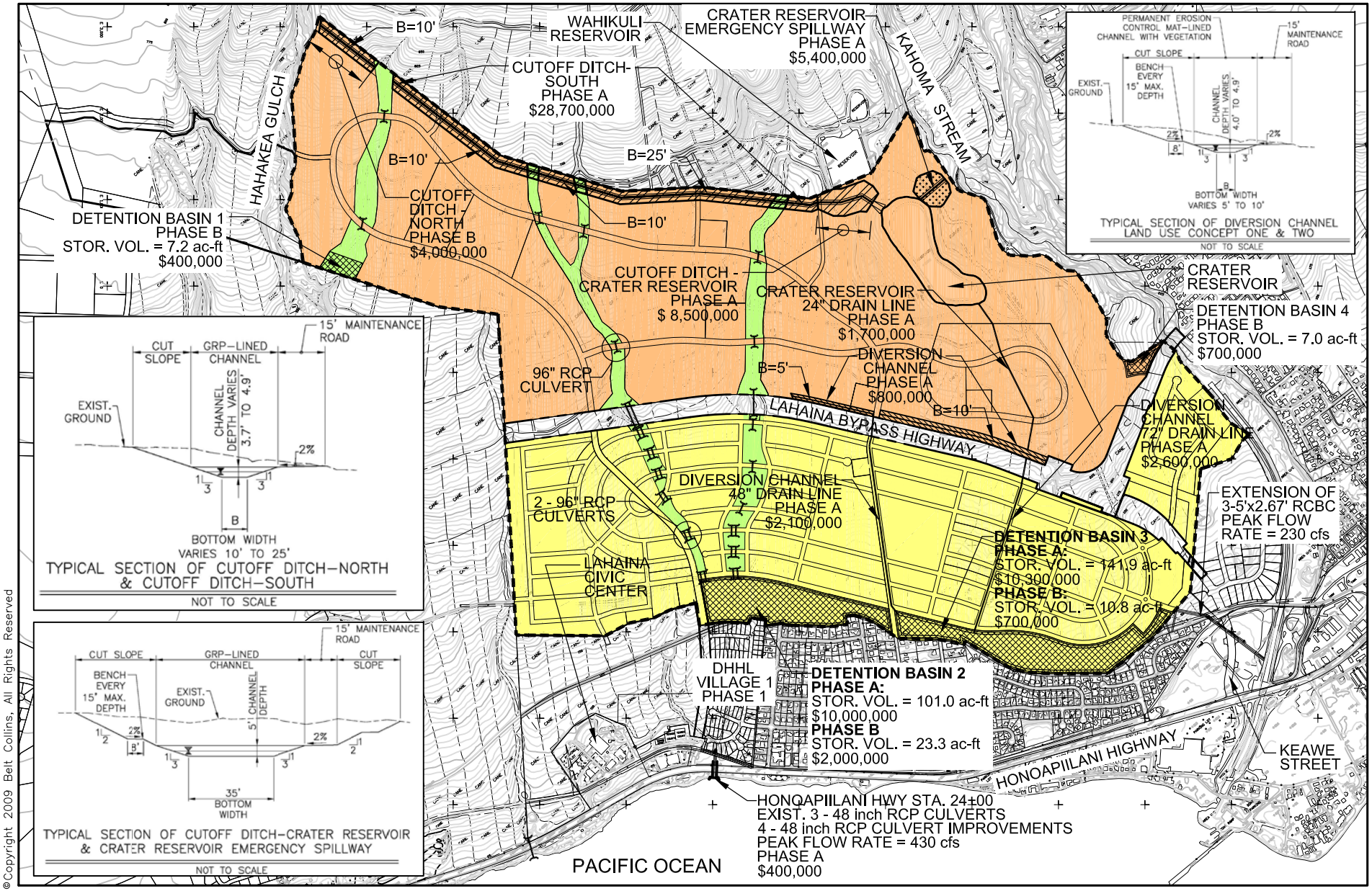

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LEGEND

- Project Boundary
- Phase A
- Phase B
- Culvert

(Estimated Cost for Phase A On-Site Culverts = $15,100,000)
(Estimated Cost for Phase B On-Site Culverts = $7,000,000)

Figure 5
PROPOSED DRAINAGE SYSTEM
LAND USE CONCEPT ONE AND LAND USE CONCEPT TWO

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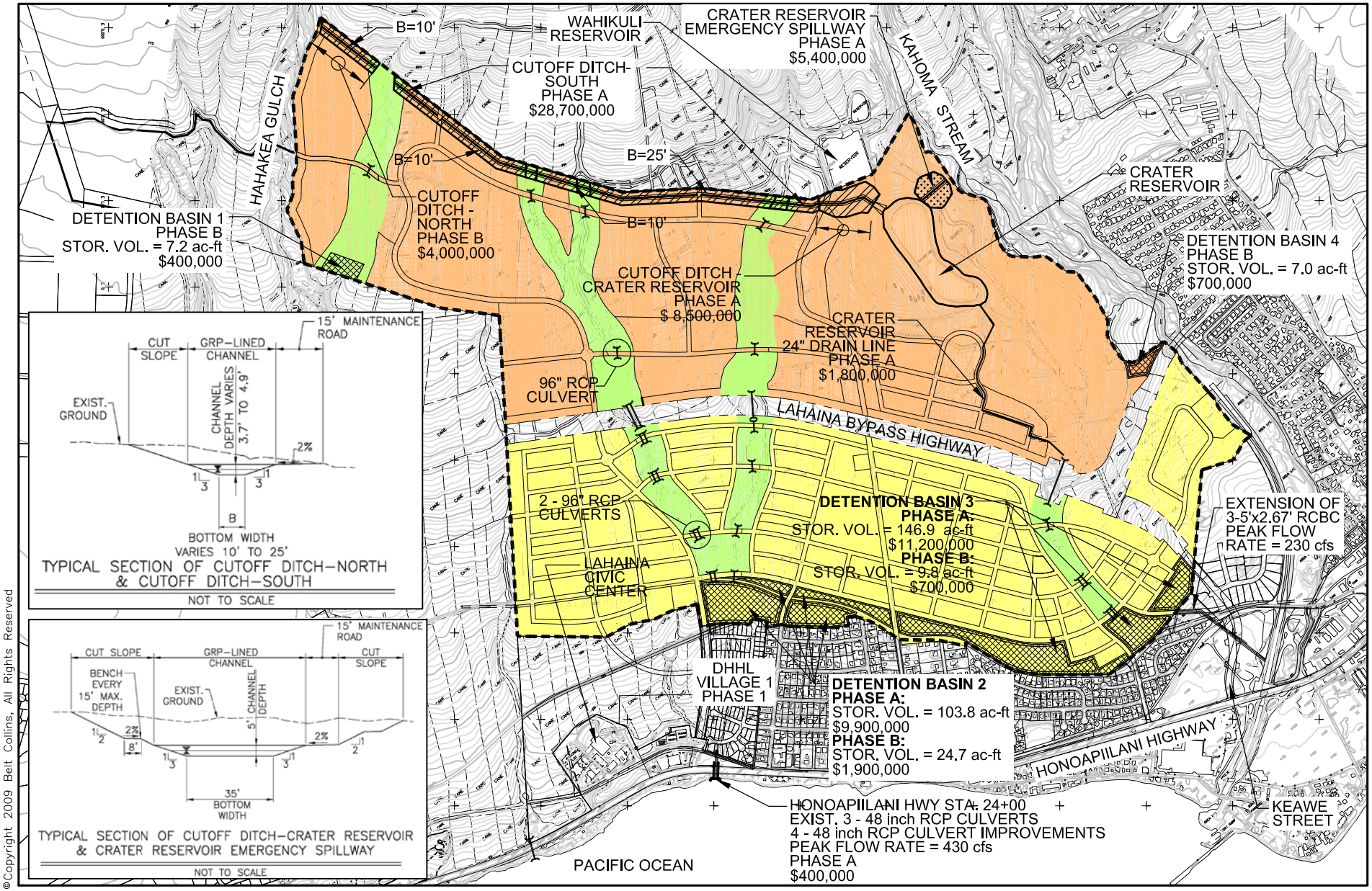

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LEGEND

Project Boundary

Phase A

Phase B

Culvert

(Estimated Cost for Phase A On-Site Culverts = $13,700,000)
(Estimated Cost for Phase B On-Site Culverts = $7,500,000)

Figure 6
PROPOSED DRAINAGE SYSTEM
LAND USE CONCEPT THREE
VILLAGES OF LEIALI'I MASTER PLAN
DRAINAGE REPORT
HAWAII HOUSING FINANCE & DEVELOPMENT CORPORATION
OCTOBER 2009

6 POST-DEVELOPMENT DRAINAGE BASINS

The proposed development would increase storm runoff due to an increase in impervious land area and general decrease in the time of concentration. The following subsections summarize important runoff characteristics for post-development drainage basins in each land use concept. All pertinent hydrologic calculations for on-site post-development runoff are provided in Appendix B, Table 3 through Table 5, and the results are also displayed in Figure 7 and Figure 8, and Exhibit 2 and Exhibit 3 of Appendix A.

6.1 Summary of Land Use Concept One Drainage Basins

Detention Basin 1 would temporarily detain runoff from Drainage Basin B1, in addition to runoff generated by off-site Drainage Basin E1. The combined post-development runoff from these two drainage basins would be less than the pre-development runoff flowing to Hahakea Gulch, which also includes runoff from a portion of Drainage Basin E2 (depicted as Sub-Basin E2A on Figure 4).[5] The runoff generated by Drainage Sub-Basin E2A would be captured by the proposed cutoff ditch and routed to Crater Reservoir. Therefore, the purpose of Detention Basin 1 would be to provide water quality detention treatment for runoff generated by Drainage Basin B1.

Runoff from Drainage Basin B2 through Drainage Basin B5 is routed towards Detention Basin 2, located at the makai end of Drainage Basin B5.

Detention Basin 3, located along the makai boundary of Drainage Basin B6, would detain all runoff generated by this drainage basin and Drainage Basin B8.

Detention Basin 4 would temporarily store post-development runoff from Drainage Basin 7 and limit runoff discharging to Kahoma Stream from this drainage area to its pre-development peak discharge rate of 251 cfs (see Table 2 of Section 4.3 or Figure 4).

Calculating runoff volumes and peak runoff rates generated by the entire 100-year, 24-hour design storm for post-development drainage basins is necessary to determine the storage volumes for Detention Basin 2 through Detention Basin 4. The City and County of Honolulu Storm Drainage Rules was used to determine the water quality detention volume (WQDV) for Detention Basin 1 (see Table 8 of Appendix C). The storage volumes of Detention Basin 2 through Detention Basin 4 are greater than the WQDVs required by the City and County of Honolulu Storm Drainage Rules. The peak runoff rates from post-development conditions are used to size the on-site roadway culverts and the diversion channel. Table 3 summarizes the runoff quantities generated by each on-site drainage basin subject to post-development conditions (also see Figure 7).

[5] Existing peak discharge from Drainage Basin E1, Drainage Sub-Basin E2A, and Drainage Basin B1 to Hahakea Gulch would be 816 cfs, based on a combined drainage area of 246.6 acres (see Table 1 and Table 2 of Appendix B). Developed peak discharge from Drainage Basin E1 and Drainage Basin B1 to Hahakea Gulch would be 655 cfs, based on a combined drainage area of 180.9 acres (see Table 1 and Table 3 of Appendix B).

Table 3 – Concept One and Concept Two On-Site Flow and Runoff Volume

Developed On-site Drainage Basin	Area	Peak Runoff Rate, Q_{100}	Runoff Volume
	(acres)	(cfs)	(ac-ft)
B1	102	395	68.5
B2	30	191	20.7
B3	10	57	7.3
B4	218	1,426	152.9
B5	161	964	112.6
B6	384	1,658	268.9
B7	53	296	34.0
B8	63	430	45.8

6.2 Summary of Land Use Concept Two Drainage Basins

Planned land uses for Land Use Concept Two are very similar to Land Use Concept One. The minor difference between the two concepts is that some of the Phase A lots designated as single-family residential in Land Use Concept One are designated as multi-family residential in Land Use Concept Two. The CNs used for all types of residential land uses are uniform throughout this study. Runoff is routed through similar travel paths because roadway layouts and their drainage systems would be similar for both land use concepts. Hence, post-development runoff quantities and all proposed drainage improvements are identical for both concepts.

6.3 Summary of Land Use Concept Three Drainage Basins

Runoff from Land Use Concept Three drainage basins would be directed to similar detention basin locations as Land Use Concept One and Land Use Concept Two. However, roadway layouts, lot layouts, and planned land uses in Land Use Concept Three differ from the other two concepts. Different lot layouts and land uses would impact runoff factors and thereby alter post-development runoff quantities and detention basin sizing. Alternate roadway alignments and lot layouts would impact travel times and tributary areas and thereby alter the location and sizing of on-site culverts.

Consistent with Land Use Concept One and Land Use Concept Two, Detention Basin 1 in Land Use Concept Three would be sized for water quality.

Table 4 summarizes the runoff quantities generated by each post-development drainage basin in Land Use Concept Three (also see Figure 8).

Table 4 – Concept Three On-Site Flow and Runoff Volume

Developed On-site Drainage Basin	Area	Peak Runoff Rate, Q_{100}	Runoff Volume
	(acres)	(cfs)	(ac-ft)
B1	102	395	68.5
B2	30	176	20.4
B3	10	63	6.9
B4	218	1,405	150.6
B5	161	901	110.9
B6	384	1,419	268.9
B7	53	296	34.0
B8	63	347	45.1

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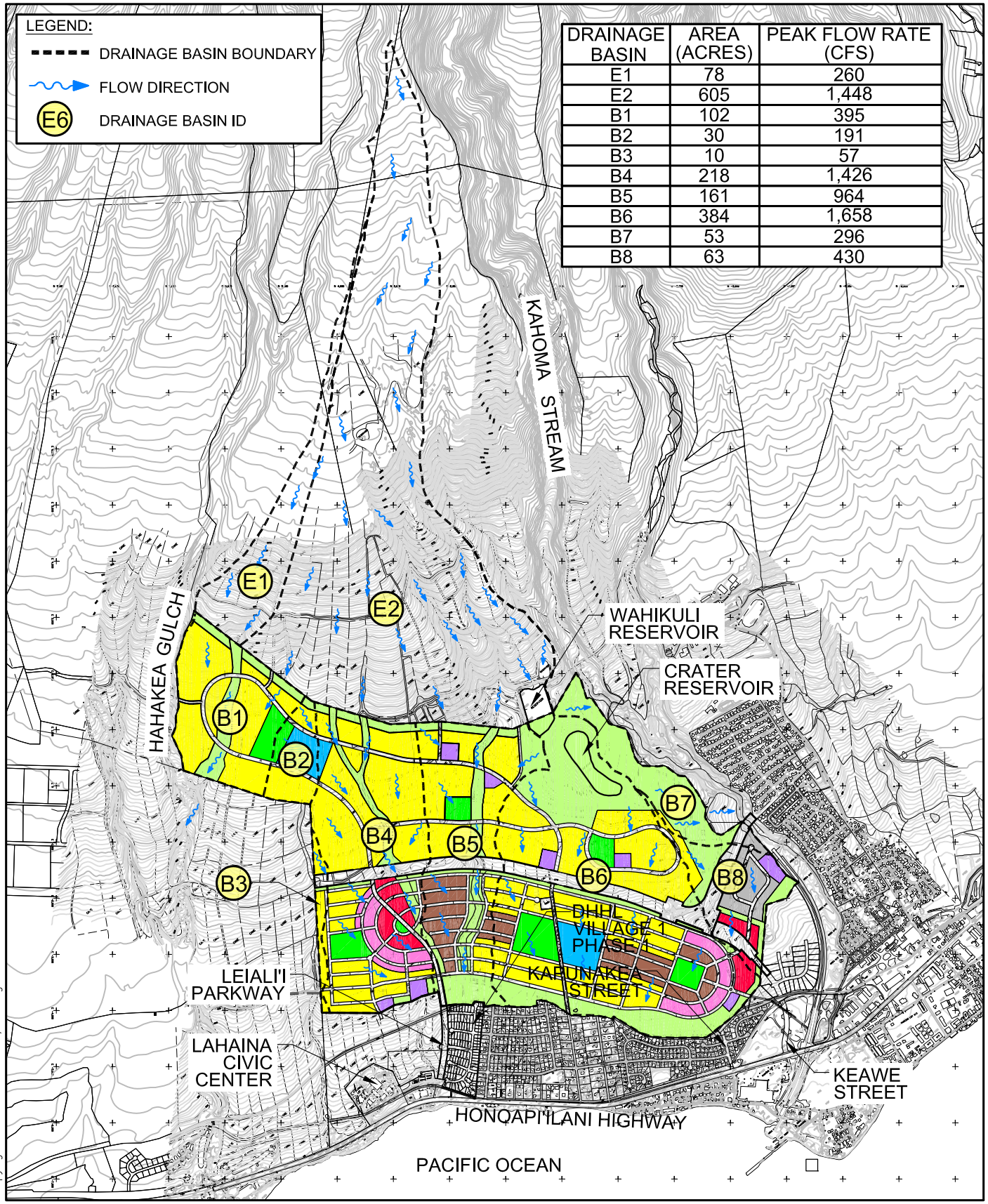

DRAINAGE BASIN	AREA (ACRES)	PEAK FLOW RATE (CFS)
E1	78	260
E2	605	1,448
B1	102	395
B2	30	191
B3	10	57
B4	218	1,426
B5	161	964
B6	384	1,658
B7	53	296
B8	63	430

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Figure 7
POST-DEVELOPMENT DRAINAGE BASINS
LAND USE CONCEPT ONE AND LAND USE CONCEPT TWO

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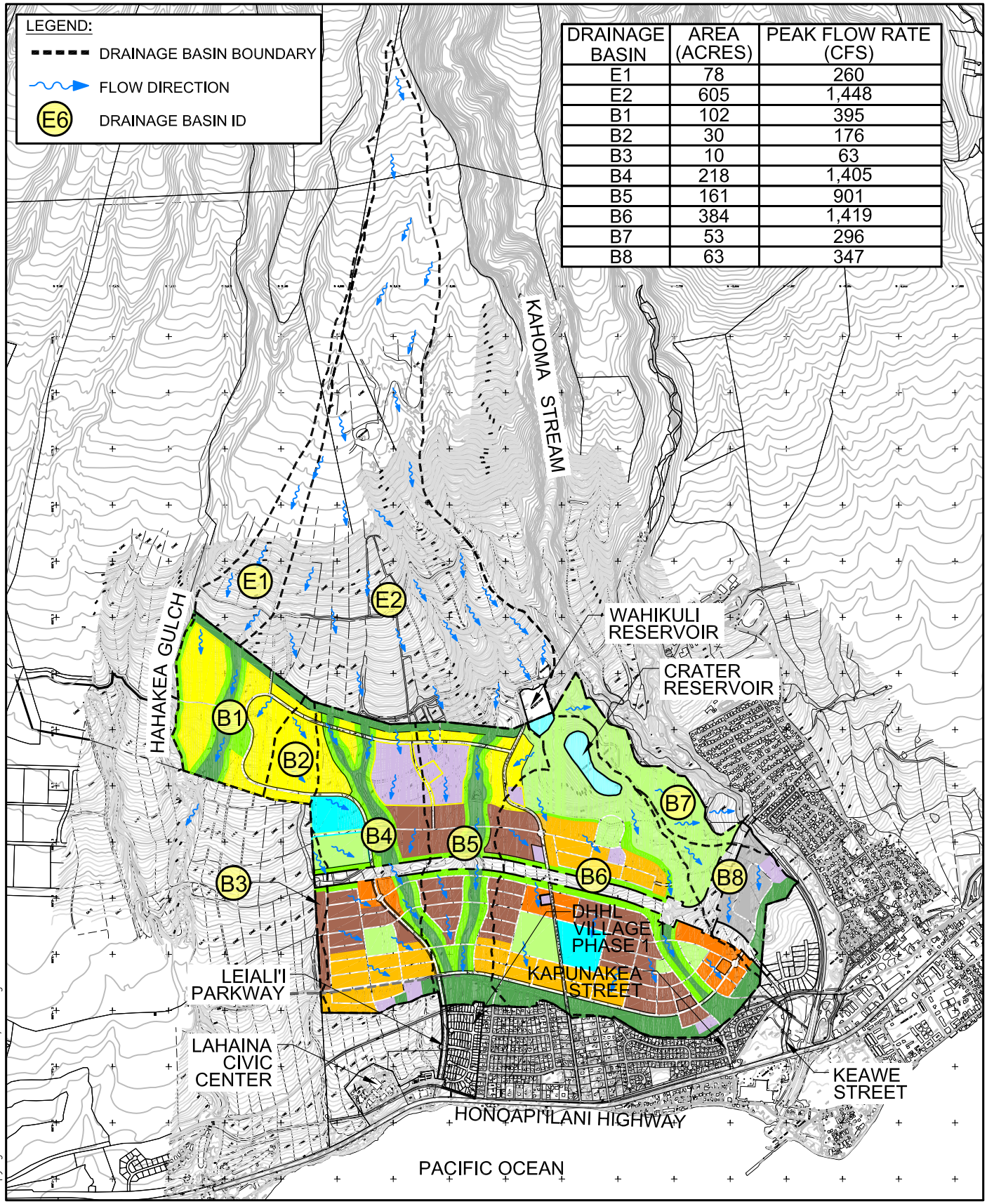

DRAINAGE BASIN	AREA (ACRES)	PEAK FLOW RATE (CFS)
E1	78	260
E2	605	1,448
B1	102	395
B2	30	176
B3	10	63
B4	218	1,405
B5	161	901
B6	384	1,419
B7	53	296
B8	63	347

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Figure 8
POST-DEVELOPMENT DRAINAGE BASINS
LAND USE CONCEPT THREE

7 POST-DEVELOPMENT RUNOFF CONDITIONS WITH DRAINAGE IMPROVEMENTS

This drainage analysis assumes that runoff produced by the 100-year, 24-hour design storm for post-development conditions would be detained on-site in detention basins and Crater Reservoir. The shapes and locations of the detention basins are prototypical at this master-planning phase. The detention basins depicted in Figure 5 and Figure 6 merely demonstrate that a sufficient amount of open space is available to construct the detention basins. Detention basins could be placed anywhere appropriate throughout the site.

One main objective of this drainage study is to demonstrate that there is sufficient open land area to detain post-development runoff on-site. Detention volumes are controlled by the capacities of downstream drainage structures or pre-development runoff quantities. Therefore, this drainage analysis requires that runoff produced by the development and off-site areas would not adversely affect down-gradient and adjacent properties. Aside from the previously proposed culvert improvements at Honoapiʻilani Highway baseline station 24+00 and the extension of the triple-RCBC from the project site to Kahoma Stream, no additional off-site drainage improvements are proposed.

This section explains the rationale used to size the detention basins, cutoff ditch, Crater Reservoir improvements, diversion channel, and on-site roadway crossings. An explanation of the opinion of probable construction costs for each land use concept is provided in Section 8.

7.1 Detention Basins

A total of four detention basins are proposed for the drainage system to reduce post-development runoff generated by the drainage basins. The first detention basin, depicted as Detention Basin 1 on Figure 5 and Figure 6, would provide water quality detention treatment for runoff generated by Drainage Basin B1. Detention Basin 2 would temporarily store runoff generated by Drainage Basin B2 through Drainage Basin B5. Runoff detained in Detention Basin 2 would discharge to the proposed four 48-inch RCP culverts at Honoapi'ilani Highway baseline station 24+00 via the 78-inch drain line running through DHHL Village 1 Phase 1 and the 48-inch drain line running through Leialiʻi Parkway. Runoff captured by Detention Basin 3 would include contributions from Drainage Basin B6 and Drainage Basin B8 and discharge to Kahoma Stream via the proposed triple-RCBC (5' x 2.67' cells) extending from the project site. Detention Basin 4 would capture excess runoff generated by Drainage Basin B7.

Table 5 lists the post-development drainage basins and the corresponding detention basins that would detain runoff from each drainage basin. This table is consistent for all three land use concepts.

Table 5 – Summary of Proposed Detention Basins

Drainage Basin	Corresponding Detention Basin
B1	Detention Basin 1
B2	Detention Basin 2
B3	Detention Basin 2
B4	Detention Basin 2
B5	Detention Basin 2
B6	Detention Basin 3
B7	Detention Basin 4
B8	Detention Basin 3

Aside from Detention Basin 1, the required storage volumes for all detention basins were calculated in HydroCAD. HydroCAD determines the required water storage volume of a detention basin by considering how much runoff is being detained (runoff volume), the rate at which runoff is being captured (inflow hydrograph), the maximum allowable discharge (peak outflow rate), and the configuration of the detention basin. The runoff volume is equal to the entire amount of runoff generated by tributary drainage basins from the 100-year, 24-hour design storm under post-development conditions. The design inflow hydrograph is generated by estimating the runoff produced by tributary drainage basins from a 100-year, 24-hour design storm over the duration of the runoff process, and the peak outflow rate is determined by the capacity of the proposed outlet structure at Honoapiʻilani Highway baseline station 24+00 (Detention Basin 2) or the existing flow rates to Kahoma Stream (Detention Basin 3 and Detention Basin 4).

The storage volumes shown on Figure 5 and Figure 6 (STOR. VOL.) are only the required water storage volumes; they do not include a 1-foot freeboard allowance or excavation quantities of the existing slope. Detention Basin 1 would be constructed by erecting a 15-foot high (at its maximum) wall structure within the existing drainageway in Drainage Basin B1. Detention Basin 2 through Detention Basin 4 are irregular in shape, have side slopes of 2 horizontal to 1 vertical, and include a freeboard allowance of one foot above the water surface. For a summary of the factors used to design the detention basins, refer to the following Table 6 or Table 7 in Appendix C. The required WQDVs for each detention basin are provided in Table 8 of Appendix C.

Table 6 – Design Criteria for Proposed Detention Basins

Detention Basin	Tributary Drainage Basins	Total Existing Peak Discharge (Inflow) Rate, Qi	Total Developed Peak Discharge (Inflow) Rate, Qi	Total Developed Runoff Volume, Vr	Peak Outflow Rate, Qo	Required Storage Volume, Vs
		(cfs)	(cfs)	(ac-ft)	(cfs)	(ac-ft)
Land Use Concept One and Two						
*1	E1, B1	816	655	113.5	655	7.2
2	B2 to B5	1,487	2,602	293.4	**348	124.3
3	B6, B8	982	1,780	314.7	***210	152.6
4	B7	251	296	34.0	251	7.0
Land Use Concept Three						
*1	E1, B1	816	655	113.5	655	7.2
2	B2 to B5	1,487	2,471	288.8	**346	128.5
3	B6, B8	982	1,592	314.0	***209	156.7
4	B7	251	296	34.0	251	7.0

**Detention Basin 1 is only sized for water quality as post-development runoff would be less than existing runoff due to the proposed cutoff ditch re-routing flow from Sub-Basin E2A to Crater Reservoir (see Section 6.1 for details).*
***Capacity of the 4 – 48" RCP culverts would be 430 cfs. However, 80 cfs of that capacity would be required for DHHL Village 1 Phase 1 (Warren S. Unemori Engineering, Inc, 1991).*
****Existing runoff to Kahoma Stream via the triple-RCBC (5'x2.67' cells) is 230 cfs, but 20 cfs would be reserved for runoff discharging from Crater Reservoir and flowing through Detention Basin 3.*

Table 7 summarizes the dimensions of Detention Basin 2 through Detention Basin 4.

Table 7 – Proposed Detention Basin Configurations

Detention Basin	Depth (with 1-foot freeboard)	Basin Volume (with 1-foot freeboard)	*Total Excavation
	(ft)	(ac-ft)	(ac-ft)
Land Use Concept One and Land Use Concept Two			
2	8.4	142.2	474.6
3	9.7	171.8	447.2
4	8.4	8.2	19.6
Land Use Concept Three			
2	11.5	143.1	420.2
3	10.4	176.5	451.9
4	8.4	8.2	19.6

**The total excavation volume includes the detention basin volume with a 1-foot freeboard and excavation of the existing slope.*

The actual number of detention basins and their shapes and locations could differ from those shown on Figure 5 and Figure 6. Erosion control measures, such as grassing and/or erosion control matting, should be incorporated to minimize the potential for sediment accumulation

within the detention basins. A fence should also be constructed around the perimeter of the detention basins for public safety.

7.2 Cutoff Ditch

The cutoff ditch is divided into two main sections: a north section (Cutoff Ditch-North) and a south section (Cutoff Ditch-South and Cutoff Ditch-Crater Reservoir). Cutoff Ditch-North would convey runoff from Drainage Basin E1 to the existing drainageway flowing to Hahakea Gulch. Cutoff Ditch-South would capture runoff from Drainage Basin E2 and convey the runoff to the Crater Reservoir section of the cutoff ditch and to Crater Reservoir. Cutoff Ditch-Crater Reservoir would cut through Wahikuli Reservoir, which would dry out because the irrigation ditch which feeds the reservoir would be taken out of use by the proposed development.

Cut slopes of 3 horizontal to 1 vertical for excavation depths less than 15 feet and 2 horizontal to 1 vertical for excavation depths greater than 15 feet, 8-foot benches every 15 feet in depth, and a 15-foot maintenance access road are considered in the design. The channel depths of the ditch segments include the design flow depths and freeboards in accordance with Section 15-04-06(b)(2)(A) of the *Rules for the Design of Storm Drainage Facilities in the County of Maui* (1995).

The computer program FlowMaster (Bentley Systems, Inc., 2008) was used to determine the flow conditions in the cutoff ditch. This program was used to solve for the normal depths of flow and flow velocity by considering the channel roughness coefficient, slope, geometry, peak discharge rate, and open channel hydraulic theory.

All three land use concepts would contain the same cutoff ditch design because off-site drainage conditions are the same for each concept. The design of the cutoff ditch is summarized in Table 9 and Table 10 of Appendix C. Cross sections for each channel segment are provided in Figure 1 through Figure 4 of each table. A summary of the cutoff ditch dimensions is provided in Table 8 below.

Table 8 – Proposed Cutoff Ditch Channel Configuration

Portion	Discharge Point	Channel Length	Channel Depth (with freeboard)	Channel Bottom Width
		(ft)	(ft)	(ft)
Cutoff Ditch-North				
	Drainage Basin B1, Hahakea Gulch	840	3.7	10
Cutoff Ditch-South				
1	Crater Reservoir	2,215	3.9	10
2	Crater Reservoir	550	4.1	10
3	Crater Reservoir	2,575	4.9	25
Cutoff Ditch-Crater Reservoir				
	Crater Reservoir	680	5	35

7.3 Crater Reservoir Improvements

Crater Reservoir would serve as a detention basin for off-site drainage basin E2. The available storage in Crater Reservoir was determined from its existing water surface at 399.2 feet and lowest elevation at approximately 428.5 feet. The available storage volume includes a freeboard of approximately 2.5 feet, which resulted in a maximum water surface elevation of 426 feet and corresponding storage volume of approximately 334 acre-feet. Considering the inflow to Crater Reservoir from off-site drainage areas and the available storage, the outflow rate was estimated in HydroCAD to be roughly 20 cfs.

Improvements to Crater Reservoir would include a 24-inch diameter drain pipe that would eventually discharge runoff to Detention Basin 3 and an emergency spillway that would outlet to Kahoma Stream. For Land Use Concept One and Land Use Concept Two, the 24-inch diameter drain pipe would terminate at the proposed diversion channel mauka of the proposed Lahaina Bypass Highway and for Land Use Concept Three, the 24-inch diameter drain pipe would terminate at a culvert inlet mauka of the highway. The emergency spillway is sized to convey the peak inflow rate and its dimensions are identical to the Crater Reservoir section of the cutoff ditch (see Table 11 of Appendix C for details and channel sections).

7.4 Diversion Channel

A diversion channel is proposed for Land Use Concept One and Land Use Concept Two to route post-development runoff from a portion of Drainage Basin B6 mauka of the proposed Lahaina Bypass Highway to Detention Basin 3 because there is no drainageway in this developed drainage basin (a drainageway would exist for Land Use Concept Three). The diversion channel would consist of an approximately 965-foot north portion that would route runoff from approximately 10 percent of Drainage Basin B6 to Detention Basin 3 via a 48-inch diameter drain line. It would also include an approximately 2,005-foot south portion that would collect runoff from approximately 30 percent of Drainage Basin B6 and route it to Detention Basin 3 via a 72-inch diameter drain line. The 24-inch diameter drain line from Crater Reservoir would discharge runoff to the 72-inch diameter drain line, which is sized to convey runoff from both the 24-inch diameter Crater Reservoir drain line and the south portion of the diversion channel.

FlowMaster was also used to determine the flow conditions in the diversion channel.

Cut slopes of 2 horizontal to 1 vertical, 8-foot benches every 15 feet in depth, and a 15-foot maintenance access road are considered in the design of the diversion channel. A description of the factors used to design the diversion channel and typical sections of the open channel are provided in Appendix C, Table 12. Details of its dimensions are presented in Table 9.

Table 9 – Proposed Diversion Channel Configuration

Land Use Concept One and Land Use Concept Two			
Open Channel			
Portion	Length	Depth (with freeboard)	Bottom Width
-	(ft)	(ft)	(ft)
North	965	4.0	5
South	2,005	4.9	10
Drain Lines (flow rates consider 1.5 bulking factor)			
Portion	Length	Flow Rate	Diameter
-	(ft)	(cfs)	(in)
North	2,370	236	48
South	2,170	761	72

7.5 On-Site Roadway Crossings

Existing drainageways traversing the project site are preserved in each of the development concepts. Culvert structures are proposed as roadway crossings but bridge structures with equivalent conveyances may be used where appropriate. Culvert locations are determined by the proposed roadway layouts and their channel crossings. Land Use Concepts One and Two include identical culvert locations and designs.

The culvert design flows were estimated by first determining the cumulative percentages of drainage basin areas discharging to each culvert location. The percentages of tributary basin areas were then multiplied by the basins' peak runoff rates and the products summed. A bulking factor of 1.5 was then applied to the flow rates to size the culverts. As a conservative approach, the culvert analysis assumes outlet control. Based on outlet control, peak flow rate from the 100-year, 24-hour design storm, and the existing slope traversing the culvert, the number of 96-inch RCP culverts was determined for each crossing.

For a summary of the calculations involved in estimating the design flow rates and number of 96-inch barrels, refer to Appendix C, Table 13 and Table 14, respectively. Table 10 below provides the total number of 96-inch culverts required for each land use concept.

Table 10 – Culvert Quantities for Land Use Concepts

Land Use Concept	Number of Required 96-inch RCP Culverts
One and Two	31
Three	27

8 COST ESTIMATE FOR CONSTRUCTION OF DRAINAGE IMPROVEMENTS

An opinion of probable construction costs is provided in this drainage study for each land use concept. Construction costs related to the cutoff ditch, Honoapiʻilani Highway culvert improvements, and Crater Reservoir improvements are consistent for each land use concept. All construction costs for drainage improvements included in Land Use Concept One and Land Use Concept Two are identical. The cost estimates for the preliminary drainage systems are based on 2009 dollars. The construction costs for the roadway drainage system have already been factored in the cost estimates for the proposed roadway infrastructure. Drainage costs for Land Use Concept One and Land Use Concept Two, and Land Use Concept Three are broken down in Figure 5 and Figure 6, respectively.

The construction costs are separated into the drainage improvements required by Phase A and Phase B of the Villages of Leialiʻi project. All costs for the Crater Reservoir improvements, Honoapiʻilani Highway culvert improvements, and diversion channel (for Land Use Concept One and Land Use Concept Two) are included in Phase A. Phase B includes the costs of the roadway crossings mauka of the Lahaina Bypass Highway, a portion of the cutoff ditch (Cutoff Ditch-North) that would drain to Hahakea Gulch, Detention Basin 1 and Detention Basin 4, and a portion of Detention Basin 2 and Detention Basin 3 costs based on percentages of total storage volumes required for Phase B.

Detention basin construction costs were based on excavation quantities, interconnection between detention basins separated by roadways, weir structures, wall structures, vegetation, 6-foot-high fencing along the perimeter, and outlet structures. Excavation quantities included the total volume of the detention basins (including a 1-foot freeboard allowance) and the existing slopes above the top surface of the detention basins.

In order to determine the Phase A and Phase B costs for Detention Basin 2 and Detention Basin 3, the required storage volumes for Phase A were determined for tributary on-site drainage basins by considering developed land cover makai of the proposed Lahaina Bypass Highway and existing ground cover mauka of the highway. The proportion of the Phase A storage volume over the total storage volume for each detention basin was then multiplied by the total excavation, fence, and vegetation costs. These costs were then added to any costs related to outlet structures and interconnections between basins and the total Phase A detention basin costs determined. Phase B detention basin costs were determined by multiplying the proportion of the storage volume required by Phase B over the total required storage volume for each detention basin by the total excavation, fence, and vegetation costs. The entire costs for Detention Basin 1 and Detention Basin 4 are included in Phase B. The magnitude of construction costs for the detention basins is separated by item in Table 15 of Appendix D.

Construction costs were estimated for the cutoff ditch by considering excavation quantities for the ditch channel (includes channel design flow depth and freeboard) and existing slope, the GRP lining for the channel and outlet, and slope protection (combination of Hydromulch and North American Green SC-150 temporary erosion control matting) for the ditch cut slopes. The

magnitudes of construction costs for the north and south sections, and Crater Reservoir section of the cutoff ditch are broken down in Appendix D, Table 16 and Table 17, respectively.

Construction costs for the Crater Reservoir improvements consider the length of micro-tunneled and non-tunneled 24" RCP drain pipe, outlet structures, and number of manholes for the pipe system. The emergency spillway construction costs include excavation quantities for the open channel and existing slope, the GRP lining for the channel, a spillway structure, and slope protection (combination of Hydromulch and North American Green SC-150 temporary erosion control matting) for the spillway cut slopes. See Table 18 of Appendix D for details of the construction costs for the Crater Reservoir improvements.

Construction costs were estimated for the diversion channel by considering length of 48" and 72" RCP drain line, headwall and discharge aprons at the ends of the drain lines, number of manholes for each drain line, excavation quantities for the open channel and existing slope, permanent erosion control mat lining (combination of North American Green P550 permanent erosion control matting and grass with Hydromulch) for the channel, and slope protection (combination of Hydromulch and North American Green SC-150 temporary erosion control matting) for the diversion channel cut slopes. The magnitudes of construction costs for the diversion channel are broken down in Appendix D, Table 19.

The construction cost estimate for the on-site roadway culverts considers the earthwork quantities, length of 96-inch RCP culvert, and the headwall and discharge aprons at the culvert ends. The magnitude of construction costs for the on-site culverts is summarized in Table 20 of Appendix D.

The construction cost estimate for the off-site culvert improvements at Honoapiʻilani Highway baseline station 24+00 considers the length of the additional 48-inch RCP culvert crossing the highway and upstream channel improvements, which include four 48-inch diameter culverts, a new inlet structure, and filling the existing open channel. The construction cost for the extension of the triple-RCBC to Kahoma Stream is included in the cost estimate for the roadway infrastructure. The magnitude of construction costs for the off-site Honoapiʻilani Highway culvert improvements is summarized in Table 21 of Appendix D.

The drainage improvements required by each development phase are summarized in Table 11 and the total construction cost estimates for the drainage improvements are summarized in Table 12. In 2009 dollars, the magnitude of construction costs for Land Use Concept One and Land Use Concept Two preliminary drainage improvements would be approximately $85.6 million for Phase A and $14.8 million for Phase B. The magnitude of construction costs for Land Use Concept Three preliminary drainage improvements would be approximately $79.6 million for Phase A and $15.2 million for Phase B.

Table 11 – Summary of Drainage System Improvements

Land Use Concept	Phase A	Phase B
One and Two	• Cutoff Ditch-South, 5,340 linear feet • Cutoff Ditch-Crater Reservoir, 680 linear feet • Crater Reservoir Emergency Spillway, 370 linear feet • Crater Reservoir 24-inch Drain Line, 1,900 linear feet • Diversion Channel, 2,970 linear feet • Diversion Channel 48-inch Drain Line, 2,370 linear feet • Diversion Channel 72-inch Drain Line, 2,170 linear feet • Detention Basin 2, 101.0 Acre-ft • Detention Basin 3, 141.9 Acre-ft • 96” RCP Culverts, 3,420 linear feet • 4-48” RCP Culvert Improvements at Honoapiilani Highway, Station 24+00	• Cutoff Ditch-North, 840 linear feet • Detention Basin 1, 7.2 Acre-ft • Detention Basin 2, 23.3 Acre-ft • Detention Basin 3, 10.8 Acre-ft • Detention Basin 4, 7.0 Acre-ft • 96” RCP Culverts, 840 linear feet
Three	• Cutoff Ditch-South, 5,340 linear feet • Cutoff Ditch-Crater Reservoir, 680 linear feet • Crater Reservoir Emergency Spillway, 370 linear feet • Crater Reservoir 24” Drain Line, 2,610 linear feet • Detention Basin 2, 103.8 Acre-ft • Detention Basin 3, 146.9 Acre-ft • 96” RCP Culverts, 3,390 linear feet • 4-48” RCP Culvert Improvements at Honoapiilani Highway, Station 24+00	• Cutoff Ditch-North, 840 linear feet • Detention Basin 1, 7.2 Acre-ft • Detention Basin 2, 24.7 Acre-ft • Detention Basin 3, 9.8 Acre-ft • Detention Basin 4, 7.0 Acre-ft • 96” RCP Culverts, 720 linear feet

Table 12 – Summary of Drainage Infrastructure Costs

Estimated Costs for Phase A							
Land Use Concept	Detention Basins	Cutoff Ditch	Crater Reservoir Improvements	On-Site Culverts	Diversion Channel	Honoapi‘ilani Highway Culvert Improvements	Total
One & Two	$20,300,000	$37,200,000	$7,100,000	$15,100,000	$5,500,000	$400,000	$85,600,000
Three	$21,100,000	$37,200,000	$7,200,000	$13,700,000	$0	$400,000	$79,600,000
Estimated Costs for Phase B							
Land Use Concept	Detention Basins	Cutoff Ditch	Crater Reservoir Improvements	On-Site Culverts	Diversion Channel	Honoapi‘ilani Highway Culvert Improvements	Total
One & Two	$3,800,000	$4,000,000	$0	$7,000,000	$0	$0	$14,800,000
Three	$3,700,000	$4,000,000	$0	$7,500,000	$0	$0	$15,200,000
Total Estimated Costs							
Land Use Concept	Detention Basins	Cutoff Ditch	Crater Reservoir Improvements	On-Site Culverts	Diversion Channel	Honoapi‘ilani Highway Culvert Improvements	Grand Total
One & Two	$24,100,000	$41,200,000	$7,100,000	$22,100,000	$5,500,000	$400,000	$100,400,000
Three	$24,800,000	$41,200,000	$7,200,000	$21,200,000	$0	$400,000	$94,800,000

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APPENDICES

APPENDIX A

Exhibits

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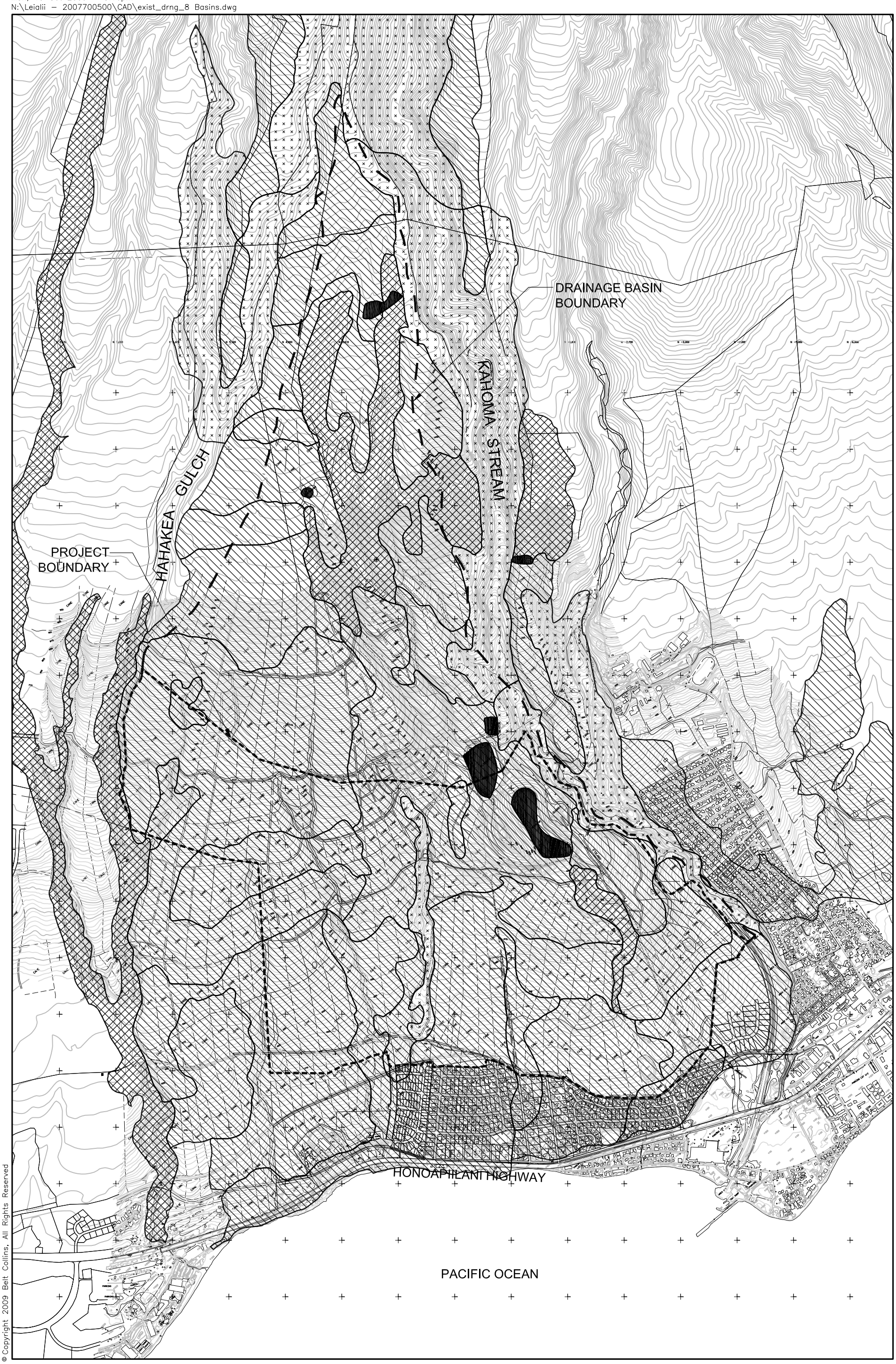

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BELT COLLINS

NORTH

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SCALE IN FEET

LEGEND:

- HYDROLOGIC SOIL GROUP B
- HYDROLOGIC SOIL GROUP C
- HYDROLOGIC SOIL GROUP D
- RESERVOIR

EXHIBIT 1
SOILS MAP

VILLAGES OF LEIALI'I MASTER PLAN
DRAINAGE REPORT
HAWAII HOUSING FINANCE & DEVELOPMENT CORPORATION
OCTOBER 2009

Tue, 20 Oct 2009 – 3:47pm
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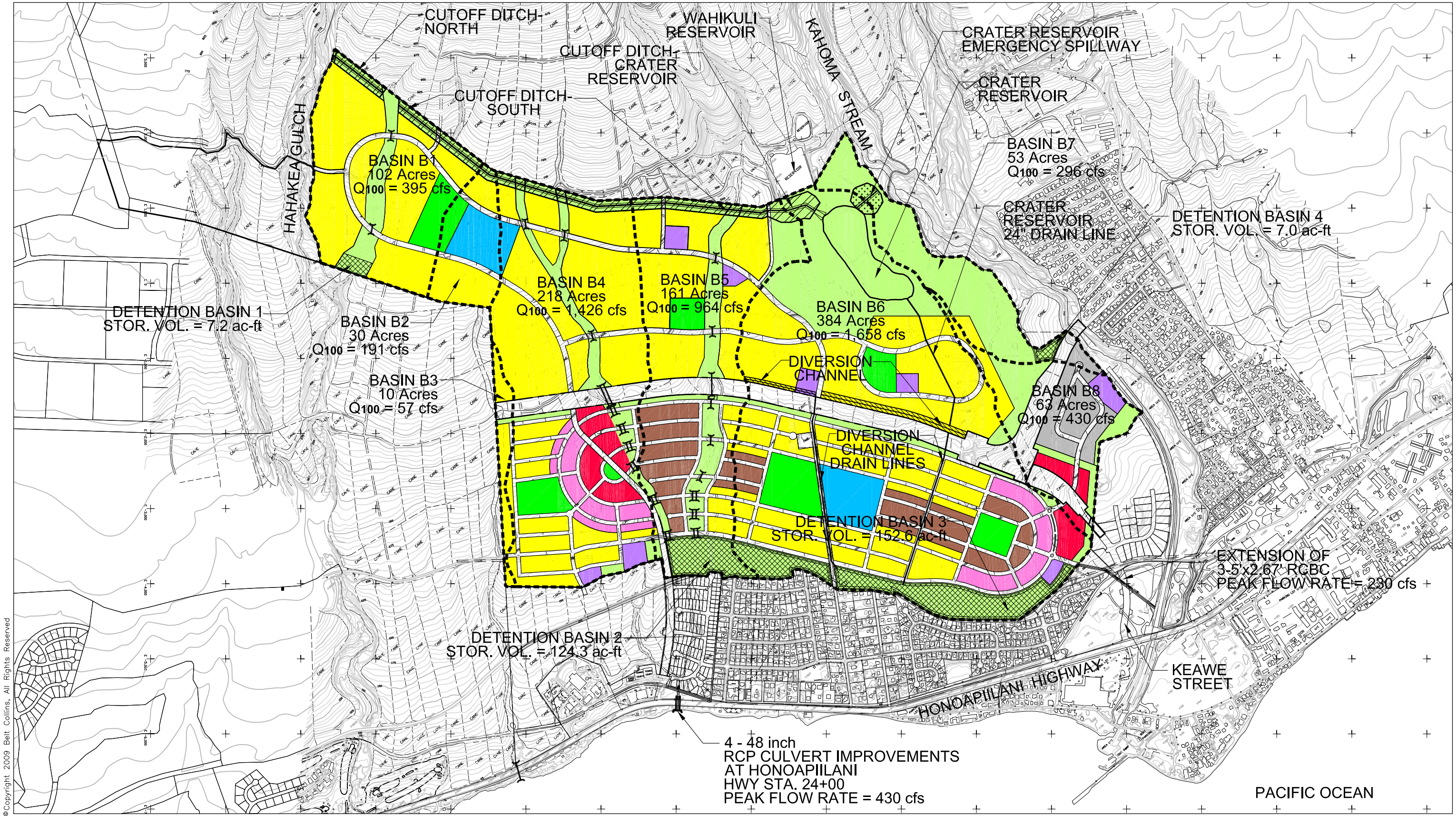

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BELT COLLINS

NORTH

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SCALE IN FEET

LEGEND:

- DRAINAGE BASIN BOUNDARY
- CUTOFF DITCH
- APPROXIMATE LOCATION OF DETENTION BASIN
- CULVERT

EXHIBIT 2
POST-DEVELOPMENT RUNOFF CONDITIONS
LAND USE CONCEPT ONE AND LAND USE CONCEPT TWO

VILLAGES OF LEIALI'I MASTER PLAN
DRAINAGE REPORT
HAWAII HOUSING FINANCE & DEVELOPMENT CORPORATION
OCTOBER 2009

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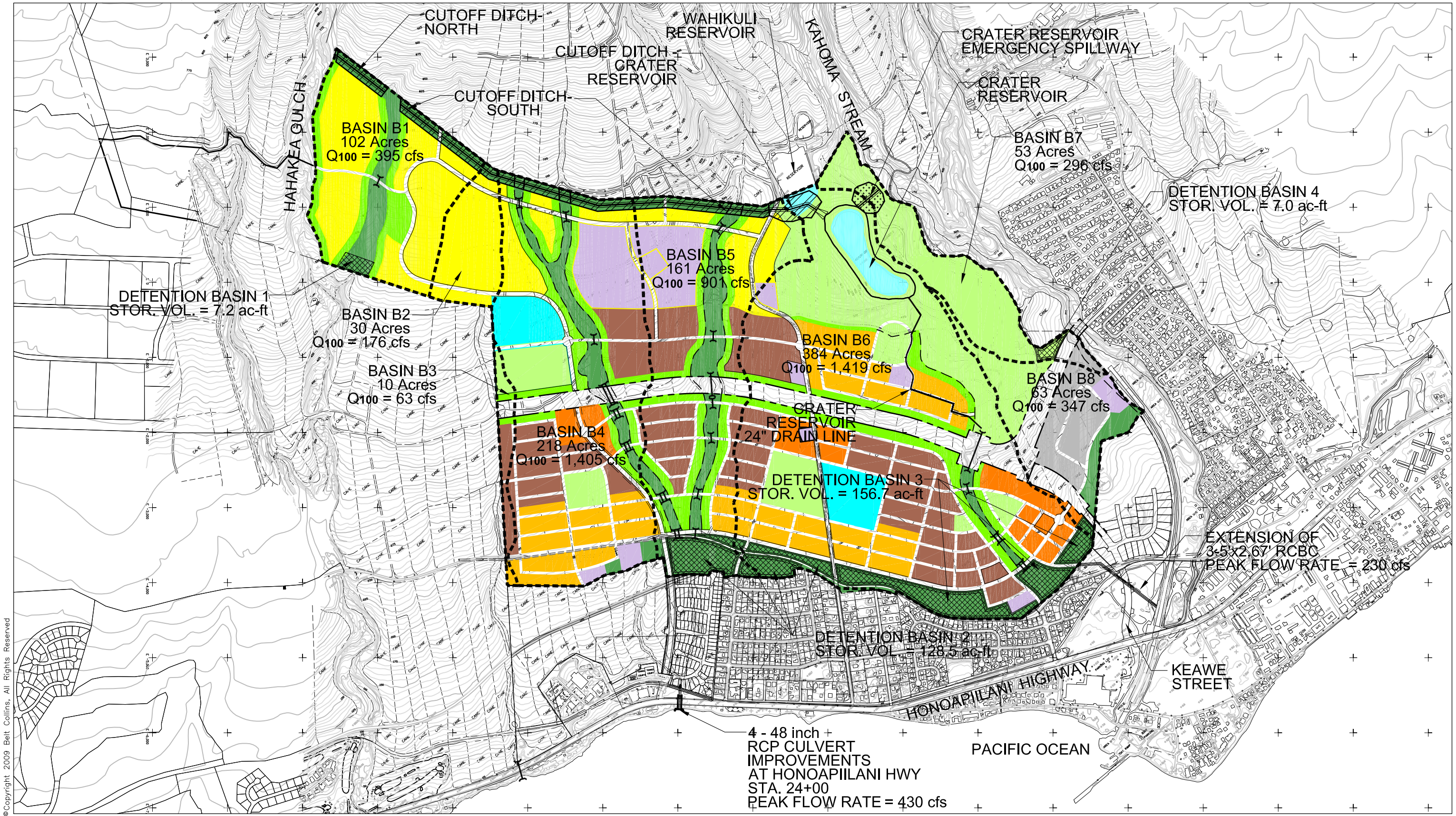

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BELT COLLINS

NORTH

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SCALE IN FEET

LEGEND:

- DRAINAGE BASIN BOUNDARY
- CUTOFF DITCH
- APPROXIMATE LOCATION OF STORAGE BASIN
- CULVERT

EXHIBIT 3
POST-DEVELOPMENT RUNOFF CONDITIONS
LAND USE CONCEPT THREE

VILLAGES OF LEIALI'I MASTER PLAN
DRAINAGE REPORT
HAWAII HOUSING FINANCE & DEVELOPMENT CORPORATION
OCTOBER 2009

APPENDIX B

Hydrologic Analysis

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PROJECT:	Villages of Lealii
CLIENT:	Hawaii Housing Finance Development Corp
DATE:	10-Oct-09
BY:	adc

Table 1: Peak Discharge Calculations for Existing Off-Site Runoff

Precipitation Summary

Frequency (yr)	2	100	[1]Source: *Rainfall Frequency Atlas of the Hawaiian Islands* (U.S. Department of Commerce, Weather Bureau)
24-hr Rainfall (inch)[1]	4	10	(Figure 51 - 2-yr., 24-hr. rainfall & Figure 56 - 100-yr., 24-hr. rainfall)

Summary of Drainage Basins

Drainage Basin	Area (sf)	Area (acres)	Area (sq mi)	*Q (in)	*T_c (min)	*Q_p (cfs)	*Runoff Volume (ac-ft)
E1	3,418,934	78.49	0.12	6.88	28.4	259.8	44.983
E2	26,337,891	604.63	0.94	7.14	53.3	1,448.3	359.539
Total Off-Site Area	29,756,825	683.12	1.07				
Sub-Basin E2-A	2,862,344	65.71	0.10	6.88	28.4	217.5	37.658

*Q, Tc, Qp, Runoff Volume solved in HydroCAD using SCS TR-20 method and SCS UH

Runoff Curve Number (Table 9-4[2])

Drainage Basin	Surface Description	Hydrologic Soil Group	A	B	C	D	Reserv.	check	Comp.
		Curve Number	65	75	82	86	98	total	CN
E1	limited cover, contoured	% of Total Basin Area	0%	100%	0%	0%	0%	100%	75
E2	limited cover, contoured	% of Total Basin Area	0%	80%	16%	2%	2%	100%	77
Sub-Basin E2-A	limited cover, contoured	% of Total Basin Area	0%	100%	0%	0%	0%	100%	75

[2]Source: Table 9-4. Runoff curve numbers, tentative estimates for sugarcane hydrologic soil-cover complexes in Hawaii. *Hydrologic Soil-Cover Complexes, National Engineering Handbook.*

Time of Concentration

Basin	E1	E2	E2-A
**Shallow Concentrated Flow			
1. Travel Length (ft)	3,417	9,253	3,417
2. Average Slope of Drainage Basin (ft/ft)	0.14	0.15	0.14
3. Velocity (ft/s)	2.16	2.89	2.16
4. Travel Time (min)	26.4	53.3	26.4
Channel Flow	***		***
1. Cross Section Area, a (sf)	155.02		155.02
2. Wetted Perimeter, Pw (ft)	57.54		57.54
3. Hydraulic Radius, r (ft)	2.69		2.69
4. Manning's Roughness Coefficient, n (Table 5-6[3])	0.035		0.035
5. Flow Length, L (ft)	3,052		3,052
6. Watercourse slope, S (ft/ft)	0.10		0.10
7. Velocity (ft/s)	26.01		26.01
8. Travel time (min)	2.0		2.0
Total Watershed time of travel, T_c (min)	28.4	53.3	28.4

** Shallow concentrated flow and channel flow solved in HydroCAD using LAG/CN Method and Open Channel Flow Theory, respectively

*** Assume Yn = 5 ft. and average channel cross-section

[3]Source: Table 5-6. Values of the Roughness Coefficient n. *Open-Channel Hydraulics* (Chow, 1959).

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PROJECT:	Villages of Lealii
CLIENT:	Hawaii Housing Finance Development Corp
DATE:	10-Oct-09
BY:	adc

Table 2: Peak Discharge Calculations for Existing On-Site Runoff

Precipitation Summary

Frequency (yr)	2	100	[1]Source: *Rainfall Frequency Atlas of the Hawaiian Islands* (U.S. Department of Commerce, Weather Bureau)
24-hr Rainfall (inch)[1]	4	10	(Figure 51 - 2-yr., 24-hr. rainfall & Figure 56 - 100-yr., 24-hr. rainfall)

Runoff Summary

Drainage Basin	Area (sf)	Area (acres)	Area (sq mi)	*Q (in)	*T_c (min)	*Q_p (cfs)	*Runoff Volume (ac-ft)
B1	4,459,529	102.38	0.16	6.88	28.4	338.9	58.674
B2	1,285,708	29.52	0.05	6.88	17.7	123.7	16.918
B3	451,709	10.37	0.02	6.88	13.1	49.0	5.943
B4	9,507,072	218.25	0.34	6.88	28.0	727.3	125.079
B5	6,998,729	160.67	0.25	7.14	20.6	651.0	95.541
B6	16,720,964	383.86	0.60	7.01	57.6	862.2	224.131
B7	2,288,733	52.54	0.08	7.14	14.1	250.9	31.243
B8	2,764,833	63.47	0.10	6.88	30.5	201.9	36.375
Totals	44,477,277	1,021.06	1.60				

*Q, Tc, Qp, Runoff Volume solved in HydroCAD using SCS TR-20 method and SCS UH

Runoff Curve Number (Table 9-4[2])

Drainage Basin	Surface Description	Hydrologic Soil Group / Curve Number	A 65	B 75	C 82	D 86	Reserv. 98	check total	Comp. CN
B1	limited cover, contoured	% of Total Basin Area	0%	99%	1%	0%	0%	100%	75
B2	limited cover, contoured	% of Total Basin Area	0%	100%	0%	0%	0%	100%	75
B3	limited cover, contoured	% of Total Basin Area	0%	100%	0%	0%	0%	100%	75
B4	limited cover, contoured	% of Total Basin Area	0%	100%	0%	0%	0%	100%	75
B5	limited cover, contoured	% of Total Basin Area	0%	85%	0%	15%	0%	100%	77
B6	limited cover, contoured	% of Total Basin Area	0%	92%	5%	0%	3%	100%	76
B7	limited cover, contoured	% of Total Basin Area	0%	81%	0%	19%	0%	100%	77
B8	limited cover, contoured	% of Total Basin Area	0%	100%	0%	0%	0%	100%	75

[2]Source: Table 9-4. Runoff curve numbers, tentative estimates for sugarcane hydrologic soil-cover complexes in Hawaii. *Hydrologic Soil-Cover Complexes, National Engineering Handbook* .

Time of Concentration

Basin	B1	B2	B3	B4	B5	B6	B7	B8
**Shallow Concentrated Flow								
1. Travel Length (ft)	3,417	1,785	1,097	3,152	2,409	6,635	1,440	3,325
2. Average Slope of Drainage Basin (ft/ft)	0.14	0.11	0.10	0.12	0.15	0.08	0.11	0.10
3. Velocity (ft/s)	0.22	1.68	1.46	1.97	2.21	1.92	1.71	1.82
4. Travel Time (min)	26.4	17.7	12.6	26.7	18.2	57.6	14.1	30.5
Channel Flow	***		***	***	***			
1. Cross Section Area, a (sf)	155.02		345.36	228.10	228.57			
2. Wetted Perimeter, Pw (ft)	57.54		129.02	78.16	91.98			
3. Hydraulic Radius, r (ft)	2.69		2.68	2.92	2.48			
4. Manning's Roughness Coefficient, n (Table 5-6[3])	0.035		0.035	0.035	0.035			
5. Flow Length, L (ft)	3,052		667	1,764	2,532			
6. Watercourse slope, S (ft/ft)	0.10		0.09	0.07	0.05			
7. Velocity (ft/s)	26.01		24.56	22.93	17.42			
8. Travel time (min)	2.0		0.5	1.3	2.4			
Total Watershed time of travel, T_c (min)	28.4	17.7	13.1	28.0	20.6	57.6	14.1	30.5

** Shallow concentrated flow and channel flow solved in HydroCAD using LAG/CN Method and Open Channel Flow Theory, respectively

*** Assume Yn = 5 ft. and average channel cross-section

[3]Source: Table 5-6. Values of the Roughness Coefficient n. *Open-Channel Hydraulics* (Chow, 1959).

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PROJECT:	Villages of Lealii
CLIENT:	Hawaii Housing Finance Development Corp
DATE:	10-Aug-09
BY:	adc

Table 3: Peak Discharge Calculations for Land Use Concept One Drainage Basins

Precipitation Summary

Frequency (yr)	2	100	[1]Source: *Rainfall Frequency Atlas of the Hawaiian Islands* (U.S. Department of Commerce, Weather Bureau)
24-hr Rainfall (inch)[1]	4	10	(Figure 51 - 2-yr., 24-hr. rainfall & Figure 56 - 100-yr., 24-hr. rainfall)

Summary of Drainage Basins

Drainage Basin	Area (sf)	Area (acres)	Area (sq mi)	*Q (in)	*T_c (min)	*Q_p (cfs)	*Runoff Volume (ac-ft)
B1	4,459,529	102.38	0.16	8.03	28.4	395.0	68.502
B2	1,285,708	29.52	0.05	8.41	7.9	191.3	20.680
B3	451,709	10.37	0.02	8.41	14.2	57.2	7.264
B4	9,507,072	218.25	0.34	8.41	7.4	1,425.9	152.890
B5	6,998,729	160.67	0.25	8.41	10.9	964.0	112.554
B6	16,720,964	383.86	0.60	8.41	24.6	1,657.7	268.905
B7	2,288,733	52.54	0.08	7.78	10.8	296.4	34.045
B8	2,764,833	63.47	0.10	8.66	6.8	429.6	45.782
Totals	44,477,277	1,021.06	1.60				

*Q, Tc, Qp, Runoff Volume solved in HydroCAD using SCS TR-20 method and SCS UH

Runoff Curve Number

Drainage Basin	Surface Description	Residential (1/8 acre or less)[2]			Open Space (Poor Condition)[2]			Open Space (Fair Condition)[2]			Commercial and Business[2]			Industrial[2]			Mixed Use (see table below)			Paved[2]	Reservoir	check total	Comp. CN
	Hydrologic Soil Group	B	C	D	B	C	D	B	C	D	B	C	D	B	C	D	B	C	D	-	-		
	Curve Number	85	90	92	79	86	89	69	79	84	92	94	95	88	91	93	87	91	93	98	98		
B1	% of Total Basin Area	69%	1%	0%	16%	0%	0%	7%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	0%	100%	84
B2	% of Total Basin Area	47%	0%	0%	2%	0%	0%	11%	0%	0%	33%	0%	0%	0%	0%	0%	0%	0%	0%	8%	0%	100%	87
B3	% of Total Basin Area	81%	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	16%	0%	100%	87
B4	% of Total Basin Area	55%	0%	0%	10%	0%	0%	3%	0%	0%	7%	0%	0%	0%	0%	0%	5%	0%	0%	20%	0%	100%	87
B5	% of Total Basin Area	45%	0%	4%	21%	0%	7%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	21%	0%	100%	87
B6	% of Total Basin Area	35%	4%	0%	22%	0%	0%	6%	0%	0%	4%	0%	0%	0%	0%	0%	3%	0%	0%	22%	3%	100%	87
B7	% of Total Basin Area	4%	0%	0%	73%	0%	17%	0%	0%	0%	0%	0%	0%	2%	0%	2%	0%	0%	0%	3%	0%	100%	82
B8	% of Total Basin Area	7%	0%	0%	25%	0%	0%	0%	0%	0%	8%	0%	0%	24%	0%	0%	0%	0%	0%	35%	0%	100%	89

[2]Source: Table 2-2a. Runoff curve numbers for urban areas. NRCS TR-55, Urban Hydrology for Small Watersheds

Time of Concentration

Basin	B1	B2	B3	B4	B5	B6	B7	B8
**Shallow Concentrated Flow								
1. Travel Length (ft)	3,417	824	1,809	610	1,483	2,739	1,294	804
2. Average Slope of Drainage Basin (ft/ft)	0.14	0.08	0.08	0.12	0.15	0.07	0.12	0.13
3. Velocity (ft/s)	2.16	1.81	2.12	2.09	2.79	2.15	2.04	2.48
4. Travel Time (min)	26.4	7.6	14.2	4.9	8.9	21.2	10.6	5.4
Channel Flow	***	***		****	****	***	***	***
1. Cross Section Area, a (sf)	155.02	7.13		221.50	403.78	35.00	10.88	9.04
2. Wetted Perimeter, Pw (ft)	57.54	6.89		78.16	108.43	15.52	8.41	7.72
3. Hydraulic Radius, r (ft)	2.69	1.03		2.83	3.72	2.26	1.29	1.17
4. Manning's Roughness Coefficient, n (Table 5-6[3])	0.035	0.015		0.035	0.035	0.015	0.015	0.015
5. Flow Length, L (ft)	3,052	337		3,972	2,954	7,048	267	2,506
6. Watercourse slope, S (ft/ft)	0.10	0.04		0.10	0.06	0.04	0.05	0.07
7. Velocity (ft/s)	26.01	20.19		26.88	24.99	34.10	26.35	29.08
8. Travel time (min)	2.0	0.3		2.5	2.0	3.4	0.2	1.4
Total Watershed time of travel, T_c (min)	28.4	7.9	14.2	7.4	10.9	24.6	10.8	6.8

** Shallow concentrated flow and channel flow solved in HydroCAD using LAG/CN Method and Open Channel Flow Theory, respectively
*** Pipe flow based on existing on-site peak flow rate
**** Assume Yn = 5 ft. and average channel cross-section
[3]Source: Table 5-6. Values of the Roughness Coefficient n. *Open-Channel Hydraulics* (Chow, 1959).

Description of Developed Curve Numbers

Land Use	Cover Type (Table 2-2a)	
Detached SFR	Residential (1/8 acre or less)	5 du/ac --> convervative approach
Attached SFR	Residential (1/8 acre or less)	10 du/ac
MFR (15 du/ac)	Residential (1/8 acre or less)	
MFR (20du/ac)	Residential (1/8 acre or less)	
Open Space	Open Space (Poor Condition)	
Park	Open Space (Fair Condition)	
Elementary School	Commercial and Business	
Commercial	Commercial and Business	
Mixed Use	See Below	
Light Industrial	Industrial	
Infrastructure/Roads	Paved Lots/Paved Roads	

Average Land Usage (%) of Mixed Use

Concept	Comm.	Office	MFR	Ave. Lot Size
1	**20.0%**	**10.0%**	**70.0%**	**10 du/ac**
2	20.0%	10.0%	70.0%	10 du/ac
3	33.3%	16.7%	50.0%	60 du/ac

Concept	Comm.	Office	MFR
1	20.0%	10.0%	70.0%

Compostite CN for Mixed Use

Soil	Com. CN	Office CN	MFR CN	Composite CN
HSG B	92	92	85	87
HSG C	94	94	90	91
HSG D	95	95	92	93

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PROJECT:	Villages of Leali'i
CLIENT:	Hawaii Housing Finance Development Corp
DATE:	10-Aug-09
BY:	adc

Table 4: Peak Discharge Calculations for Land Use Concept Two Drainage Basins

Precipitation Summary

Frequency (yr)	2	100	[1]Source: *Rainfall Frequency Atlas of the Hawaiian Islands* (U.S. Department of Commerce, Weather Bureau)
24-hr Rainfall (inch)[1]	4	10	(Figure 51 - 2-yr., 24-hr. rainfall & Figure 56 - 100-yr., 24-hr. rainfall)

Summary of Drainage Basins

Drainage Basin	Area (sf)	Area (acres)	Area (sq mi)	*Q (in)	*T_c (min)	*Q_p (cfs)	*Runoff Volume (ac-ft)
B1	4,459,529	102.38	0.16	8.03	28.4	395.0	68.502
B2	1,285,708	29.52	0.05	8.41	7.9	191.3	20.680
B3	451,709	10.37	0.02	8.41	14.2	57.2	7.264
B4	9,507,072	218.25	0.34	8.41	7.4	1,425.9	152.890
B5	6,998,729	160.67	0.25	8.41	10.9	964.0	112.554
B6	16,720,964	383.86	0.60	8.41	24.6	1,657.7	268.905
B7	2,288,733	52.54	0.08	7.78	10.8	296.4	34.045
B8	2,764,833	63.47	0.10	8.66	6.8	429.6	45.782
Total	44,477,277	1,021.06	1.60				

*Q, Tc, Qp, Runoff Volume solved in HydroCAD using SCS TR-20 method and SCS UH

Runoff Curve Number

Drainage Basin	Surface Description / Hydrologic Soil Group / Curve Number	Residential (1/8 acre or less)[2] B	C	D	Open Space (Poor Condition)[2] B	C	D	Open Space (Fair Condition)[2] B	C	D	Commercial and Business[2] B	C	D	Industrial[2] B	C	D	Mixed Use (see table below) B	C	D	Paved[2] -	Reservoir -	check total	Comp. CN
	Curve Number	85	90	92	79	86	89	69	79	84	92	94	95	88	91	93	87	91	93	98	98		
B1	% of Total Basin Area	69%	1%	0%	16%	0%	0%	7%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	0%	100%	84
B2	% of Total Basin Area	47%	0%	0%	2%	0%	0%	11%	0%	0%	33%	0%	0%	0%	0%	0%	0%	0%	0%	8%	0%	100%	87
B3	% of Total Basin Area	81%	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	16%	0%	100%	87
B4	% of Total Basin Area	55%	0%	0%	10%	0%	0%	3%	0%	0%	7%	0%	0%	0%	0%	0%	5%	0%	0%	20%	0%	100%	87
B5	% of Total Basin Area	45%	0%	4%	21%	0%	7%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	21%	0%	100%	87
B6	% of Total Basin Area	35%	4%	0%	22%	0%	0%	6%	0%	0%	4%	0%	0%	0%	0%	0%	3%	0%	0%	22%	3%	100%	87
B7	% of Total Basin Area	4%	0%	0%	73%	0%	17%	0%	0%	0%	0%	0%	0%	2%	0%	2%	0%	0%	0%	3%	0%	100%	82
B8	% of Total Basin Area	7%	0%	0%	25%	0%	0%	0%	0%	0%	8%	0%	0%	24%	0%	0%	0%	0%	0%	35%	0%	100%	89

[2]Source: Table 2-2a. Runoff curve numbers for urban areas. NRCS TR-55, Urban Hydrology for Small Watersheds

Time of Concentration

Basin	B1	B2	B3	B4	B5	B6	B7	B8
**Shallow Concentrated Flow								
1. Travel Length (ft)	3,417	824	1,809	610	1,483	2,739	1,294	804
2. Average Slope of Drainage Basin (ft/ft)	0.14	0.08	0.08	0.12	0.15	0.07	0.12	0.13
3. Velocity (ft/s)	2.16	1.81	2.12	2.09	2.79	2.15	2.04	2.48
4. Travel Time (min)	26.4	7.6	14.2	4.9	8.9	21.2	10.6	5.4
Channel Flow	***	***		****	****	***	***	***
1. Cross Section Area, a (sf)	155.02	7.13		221.50	403.78	35.00	10.88	9.04
2. Wetted Perimeter, Pw (ft)	57.54	6.89		78.16	108.43	15.52	8.41	7.72
3. Hydraulic Radius, r (ft)	2.69	1.03		2.83	3.72	2.26	1.29	1.17
4. Manning's Roughness Coefficient, n (Table 5-6[3])	0.035	0.015		0.035	0.035	0.015	0.015	0.015
5. Flow Length, L (ft)	3,052	337		3,972	2,954	7,048	267	2,506
6. Watercourse slope, S (ft/ft)	0.10	0.04		0.10	0.06	0.04	0.05	0.07
7. Velocity (ft/s)	26.01	20.19		26.88	24.99	34.10	26.35	29.08
8. Travel time (min)	2.0	0.3		2.5	2.0	3.4	0.2	1.4
Total Watershed time of travel, T_c (min)	28.4	7.9	14.2	7.4	10.9	24.6	10.8	6.8

** Shallow concentrated flow and channel flow solved in HydroCAD using LAG/CN Method and Open Channel Flow Theory, respectively
*** Pipe flow based on existing on-site peak flow rate
**** Assume Yn = 5 ft. and average channel cross-section
[3]Source: Table 5-6. Values of the Roughness Coefficient n. *Open-Channel Hydraulics* (Chow, 1959).

Description of Developed Curve Numbers

Land Use	Cover Type (Table 2-2a)	
Detached SFR	Residential (1/8 acre or less)	5 du/ac --> convervative approach
Attached SFR	Residential (1/8 acre or less)	10 du/ac
MFR (15 du/ac)	Residential (1/8 acre or less)	
MFR (20du/ac)	Residential (1/8 acre or less)	
Open Space	Open Space (Poor Condition)	
Park	Open Space (Fair Condition)	
Elementary School	Commercial and Business	
Commercial	Commercial and Business	
Mixed Use	See Below	
Light Industrial	Industrial	
Infrastructure/Roads	Paved Lots/Paved Roads	

Average Land Usage (%) of Mixed Use

Concept	Comm.	Office	MFR	Ave. Lot Size
1	20.0%	10.0%	70.0%	10 du/ac
2	**20.0%**	**10.0%**	**70.0%**	**10 du/ac**
3	33.3%	16.7%	50.0%	60 du/ac

Concept	Comm.	Office	MFR
2	20.0%	10.0%	70.0%

Compostite CN for Mixed Use

Soil	Com. CN	Office CN	MFR CN	Composite CN
HSG B	92	92	85	87
HSG C	94	94	90	91
HSG D	95	95	92	93

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PROJECT:	Villages of Lealii
CLIENT:	Hawaii Housing Finance Development Corp
DATE:	11-Aug-09
BY:	adc

Table 5: Peak Discharge Calculations for Land Use Concept Three Drainage Basins

Precipitation Summary

Frequency (yr)	2	100	[1]Source: *Rainfall Frequency Atlas of the Hawaiian Islands* (U.S. Department of Commerce, Weather Bureau)
24-hr Rainfall (inch)[1]	4	10	(Figure 51 - 2-yr., 24-hr. rainfall & Figure 56 - 100-yr., 24-hr. rainfall)

Summary of Drainage Basins

Drainage Basin	Area (sf)	Area (acres)	Area (sq mi)	*Q (in)	*T_c (min)	*Q_p (cfs)	*Runoff Volume (ac-ft)
B1	4,459,529	102.38	0.16	8.03	28.4	395.0	68.502
B2	1,285,708	29.52	0.05	8.28	10.7	176.1	20.371
B3	451,709	10.37	0.02	8.03	9.0	63.1	6.938
B4	9,507,072	218.25	0.34	8.28	7.7	1,404.9	150.610
B5	6,998,729	160.67	0.25	8.28	13.1	901.4	110.875
B6	16,720,964	383.86	0.60	8.41	33.0	1,419.0	268.905
B7	2,288,733	52.54	0.08	7.78	10.8	296.4	34.045
B8	2,764,833	63.47	0.10	8.53	15.0	346.7	45.123
Totals	44,477,277	1,021.06	1.60				

*Q, Tc, Qp, Runoff Volume solved in HydroCAD using SCS TR-20 method and SCS UH

Runoff Curve Number

Drainage Basin	Surface Description	Residential (1/8 acre or less)[2]			Open Space (Poor Condition)[2]			Open Space (Fair Condition)[2]			Commercial and Business[2]			Industrial[2]			Mixed Use (see table below)			Paved[2]	Reservoir	check total	Comp. CN
	Hydrologic Soil Group	B	C	D	B	C	D	B	C	D	B	C	D	B	C	D	B	C	D	-	-		
	Curve Number	85	90	92	79	86	89	69	79	84	92	94	95	88	91	93	89	92	94	98	98		
B1	% of Total Basin Area	60%	0%	0%	34%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	5%	0%	100%	84
B2	% of Total Basin Area	92%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	0%	100%	86
B3	% of Total Basin Area	54%	0%	0%	10%	0%	0%	19%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	17%	0%	100%	84
B4	% of Total Basin Area	33%	0%	0%	21%	0%	0%	7%	0%	0%	6%	0%	0%	9%	0%	0%	3%	0%	0%	21%	0%	100%	86
B5	% of Total Basin Area	27%	0%	2%	31%	0%	10%	0%	0%	0%	0%	0%	0%	10%	0%	0%	0%	0%	0%	19%	0%	100%	86
B6	% of Total Basin Area	27%	0%	0%	28%	5%	0%	5%	0%	0%	5%	0%	0%	0%	0%	0%	4%	0%	0%	24%	3%	100%	87
B7	% of Total Basin Area	0%	0%	0%	76%	0%	17%	0%	0%	0%	0%	0%	0%	2%	0%	2%	0%	0%	0%	3%	0%	100%	82
B8	% of Total Basin Area	0%	0%	0%	34%	0%	0%	0%	0%	0%	2%	0%	0%	31%	0%	0%	0%	0%	0%	33%	0%	100%	88

[2]Source: Table 2-2a. Runoff curve numbers for urban areas.

Time of Concentration

Basin	B1	B2	B3	B4	B5	B6	B7	B8
**Shallow Concentrated Flow								
1. Travel Length (ft)	3,417	1,447	954	769	1,797	4,491	1,294	2,097
2. Average Slope of Drainage Basin (ft/ft)	0.14	0.11	0.09	0.13	0.14	0.07	0.12	0.10
3. Velocity (ft/s)	2.16	2.29	1.78	2.19	2.70	2.38	2.04	2.53
4. Travel Time (min)	26.4	10.5	9.0	5.8	11.1	31.5	10.6	13.8
Channel Flow	***	***		****	****	***	***	***
1. Cross Section Area, a (sf)	155.02	8.91		221.50	403.78	777.86	10.88	8.50
2. Wetted Perimeter, Pw (ft)	57.54	7.65		78.16	108.43	226.28	8.41	7.42
3. Hydraulic Radius, r (ft)	2.69	1.16		2.83	3.72	3.44	1.29	1.15
4. Manning's Roughness Coefficient, n (Table 5-6[3])	0.035	0.015		0.035	0.035	0.035	0.015	0.015
5. Flow Length, L (ft)	3,052	206		2,941	2,954	2,597	267	2,152
6. Watercourse slope, S (ft/ft)	0.10	0.02		0.09	0.06	0.09	0.05	0.08
7. Velocity (ft/s)	26.01	15.43		25.50	24.99	29.01	26.35	30.73
8. Travel time (min)	2.0	0.2		1.9	2.0	1.5	0.2	1.2
Total Watershed time of travel, T_c (min)	28.4	10.7	9.0	7.7	13.1	33.0	10.8	15.0

** Shallow concentrated flow and channel flow solved in HydroCAD using LAG/CN Method and Open Channel Flow Theory, respectively
*** Pipe flow based on existing on-site peak flow rate
**** Assume Yn = 5 ft. and average channel cross-section
[3]Source: Table 5-6. Values of the Roughness Coefficient n. *Open-Channel Hydraulics* (Chow, 1959).

Description of Developed Curve Numbers

Land Use	Cover Type (Table 2-2a)	
Detached SFR	Residential (1/8 acre or less)	5 du/ac --> convervative approach
Attached SFR	Residential (1/8 acre or less)	10 du/ac
MFR (15 du/ac)	Residential (1/8 acre or less)	
MFR (20du/ac)	Residential (1/8 acre or less)	
Open Space	Open Space (Poor Condition)	
Park	Open Space (Fair Condition)	
Elementary School	Commercial and Business	
Commercial	Commercial and Business	
Mixed Use	See Below	
Light Industrial	Industrial	
Infrastructure/Roads	Paved Lots/Paved Roads	

Average Land Usage (%) of Mixed Use

Concept	Comm.	Office	MFR	Ave. Lot Size
1	20.0%	10.0%	70.0%	10 du/ac
2	20.0%	10.0%	70.0%	10 du/ac
3	**33.3%**	**16.7%**	**50.0%**	**60 du/ac**

Concept	Comm.	Office	MFR
3	33.3%	16.7%	50.0%

Compostite CN for Mixed Use

Soil	Com. CN	Office CN	MFR CN	Composite CN
HSG B	92	92	85	89
HSG C	94	94	90	92
HSG D	95	95	92	94

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PROJECT: Villages of Lealii
CLIENT: Hawaii Housing Finance Development Corp
DATE: 10-Aug-09
BY: adc

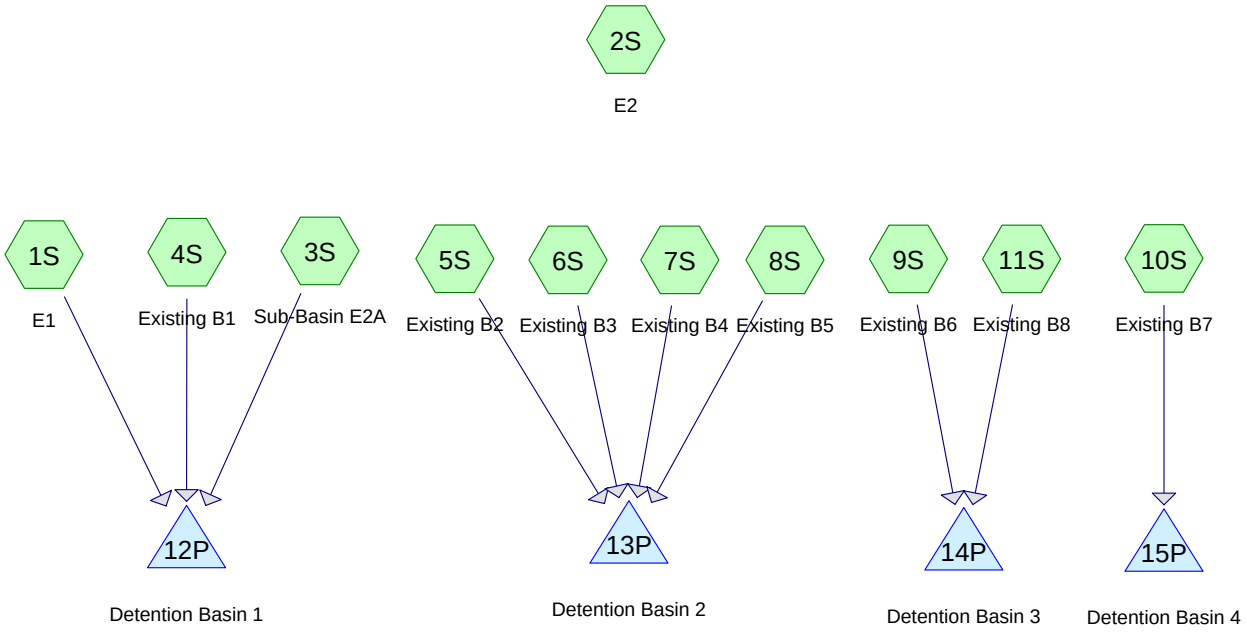
Table 6: Summary of Net Runoff Volumes and Net Peak Discharge Rates

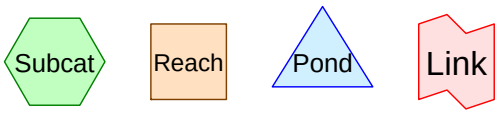
Summary of Net Runoff Volumes

	Concept 1			Concept 2			Concept 3		
Drainage Basin	Existing Runoff Volume (acre-feet)	Developed Runoff Volume (acre-feet)	Net Runoff Volume (acre-feet)	Existing Runoff Volume (acre-feet)	Developed Runoff Volume (acre-feet)	Net Runoff Volume (acre-feet)	Existing Runoff Volume (acre-feet)	Developed Runoff Volume (acre-feet)	Net Runoff Volume (acre-feet)
B1	58.674	68.502	9.828	58.674	68.502	9.828	58.674	68.502	9.828
B2	16.918	20.680	3.762	16.918	20.680	3.762	16.918	20.371	3.453
B3	5.943	7.264	1.321	5.943	7.264	1.321	5.943	6.938	0.995
B4	125.079	152.890	27.811	125.079	152.890	27.811	125.079	150.610	25.531
B5	95.541	112.554	17.013	95.541	112.554	17.013	95.541	110.875	15.334
B6	224.131	268.905	44.774	224.131	268.905	44.774	224.131	268.905	44.774
B7	31.243	34.045	2.802	31.243	34.045	2.802	31.243	34.045	2.802
B8	36.375	45.782	9.407	36.375	45.782	9.407	36.375	45.123	8.748
Totals	593.904	710.622	116.718	593.904	710.622	116.718	593.904	705.369	111.465

Summary of Net Peak Discharge Rates

	Concept 1			Concept 2			Concept 3		
Drainage Basin	Existing Peak Discharge Rate (cfs)	Developed Peak Discharge Rate (cfs)	Net Peak Discharge Rate (cfs)	Existing Peak Discharge Rate (cfs)	Developed Peak Discharge Rate (cfs)	Net Peak Discharge Rate (cfs)	Existing Peak Discharge Rate (cfs)	Developed Peak Discharge Rate (cfs)	Net Peak Discharge Rate (cfs)
B1	338.9	395.0	56.1	338.9	395.0	56.1	338.9	395.0	56.1
B2	123.7	191.3	67.6	123.7	191.3	67.6	123.7	176.1	52.4
B3	49.0	57.2	8.2	49.0	57.2	8.2	49.0	63.1	14.2
B4	727.3	1,425.9	698.6	727.3	1,425.9	698.6	727.3	1,404.9	677.6
B5	651.0	964.0	313.0	651.0	964.0	313.0	651.0	901.4	250.4
B6	862.2	1,657.7	795.5	862.2	1,657.7	795.5	862.2	1,419.0	556.8
B7	250.9	296.4	45.5	250.9	296.4	45.5	250.9	296.4	45.5
B8	201.9	429.6	227.7	201.9	429.6	227.7	201.9	346.7	144.8
Totals	3,204.9	5,417.1	2,212.2	3,204.9	5,417.1	2,212.2	3,204.9	5,002.6	1,797.7





Drainage Diagram for Existing Basins
Prepared by Belt Collins Hawaii, Printed 10/19/2009
HydroCAD® 9.00 s/n 06009 © 2009 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
568.190	75	(1S, 3S, 4S, 5S, 6S, 7S, 11S)
383.860	76	(9S)
817.840	77	(2S, 8S, 10S)
1,769.890		**TOTAL AREA**

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: E1 Runoff Area=78.490 ac 0.00% Impervious Runoff Depth=6.88"
Flow Length=6,469' Tc=28.4 min CN=75 Runoff=259.82 cfs 44.983 af

Subcatchment 2S: E2 Runoff Area=604.630 ac 0.00% Impervious Runoff Depth=7.14"
Flow Length=9,253' Slope=0.1500 '/' Tc=53.3 min CN=77 Runoff=1,448.25 cfs 359.539 af

Subcatchment 3S: Sub-Basin E2A Runoff Area=65.710 ac 0.00% Impervious Runoff Depth=6.88"
Flow Length=6,469' Tc=28.4 min CN=75 Runoff=217.52 cfs 37.658 af

Subcatchment 4S: Existing B1 Runoff Area=102.380 ac 0.00% Impervious Runoff Depth=6.88"
Flow Length=6,469' Tc=28.4 min CN=75 Runoff=338.90 cfs 58.674 af

Subcatchment 5S: Existing B2 Runoff Area=29.520 ac 0.00% Impervious Runoff Depth=6.88"
Flow Length=1,785' Slope=0.1100 '/' Tc=17.7 min CN=75 Runoff=123.68 cfs 16.918 af

Subcatchment 6S: Existing B3 Runoff Area=10.370 ac 0.00% Impervious Runoff Depth=6.88"
Flow Length=1,764' Tc=13.1 min CN=75 Runoff=48.96 cfs 5.943 af

Subcatchment 7S: Existing B4 Runoff Area=218.250 ac 0.00% Impervious Runoff Depth=6.88"
Flow Length=4,916' Tc=28.0 min CN=75 Runoff=727.30 cfs 125.079 af

Subcatchment 8S: Existing B5 Runoff Area=160.670 ac 0.00% Impervious Runoff Depth=7.14"
Flow Length=4,941' Tc=20.6 min CN=77 Runoff=651.02 cfs 95.541 af

Subcatchment 9S: Existing B6 Runoff Area=383.860 ac 0.00% Impervious Runoff Depth=7.01"
Flow Length=6,635' Slope=0.0800 '/' Tc=57.6 min CN=76 Runoff=862.19 cfs 224.131 af

Subcatchment 10S: Existing B7 Runoff Area=52.540 ac 0.00% Impervious Runoff Depth=7.14"
Flow Length=1,440' Slope=0.1100 '/' Tc=14.1 min CN=77 Runoff=250.92 cfs 31.243 af

Subcatchment 11S: Existing B8 Runoff Area=63.470 ac 0.00% Impervious Runoff Depth=6.88"
Flow Length=3,325' Slope=0.1000 '/' Tc=30.5 min CN=75 Runoff=201.93 cfs 36.375 af

Pond 12P: Detention Basin 1 Inflow=816.24 cfs 141.315 af
Primary=816.24 cfs 141.315 af

Pond 13P: Detention Basin 2 Inflow=1,486.94 cfs 243.481 af
Primary=1,486.94 cfs 243.481 af

Pond 14P: Detention Basin 3 Inflow=981.69 cfs 260.505 af
Primary=981.69 cfs 260.505 af

Pond 15P: Detention Basin 4 Inflow=250.92 cfs 31.243 af
Primary=250.92 cfs 31.243 af

Total Runoff Area = 1,769.890 ac Runoff Volume = 1,036.083 af Average Runoff Depth = 7.02"
100.00% Pervious = 1,769.890 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: E1

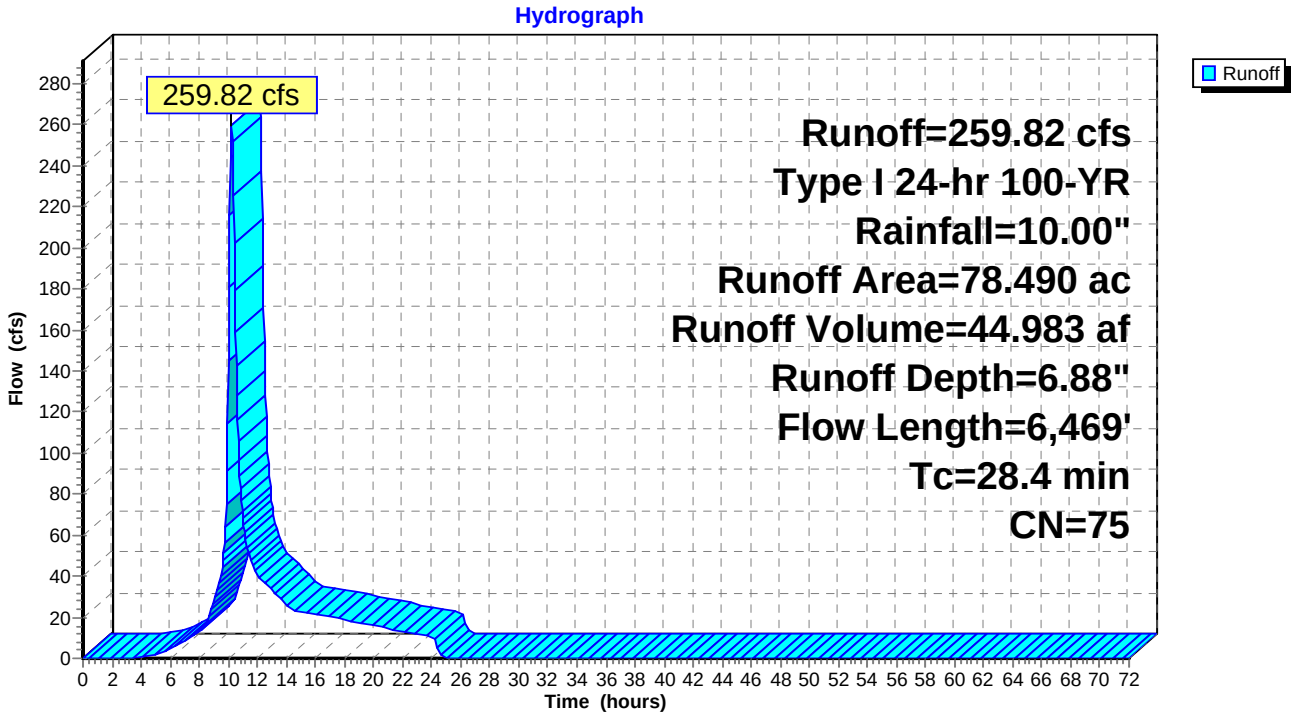
Runoff = 259.82 cfs @ 10.22 hrs, Volume= 44.983 af, Depth= 6.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	78.490	75	
	78.490		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.4	3,417	0.1400	2.16		**Lag/CN Method,**
2.0	3,052	0.1000	26.01	4,030.80	**Channel Flow,** Area= 155.0 sf Perim= 57.5' r= 2.70' n= 0.035
28.4	6,469	Total			

Subcatchment 1S: E1



Summary for Subcatchment 2S: E2

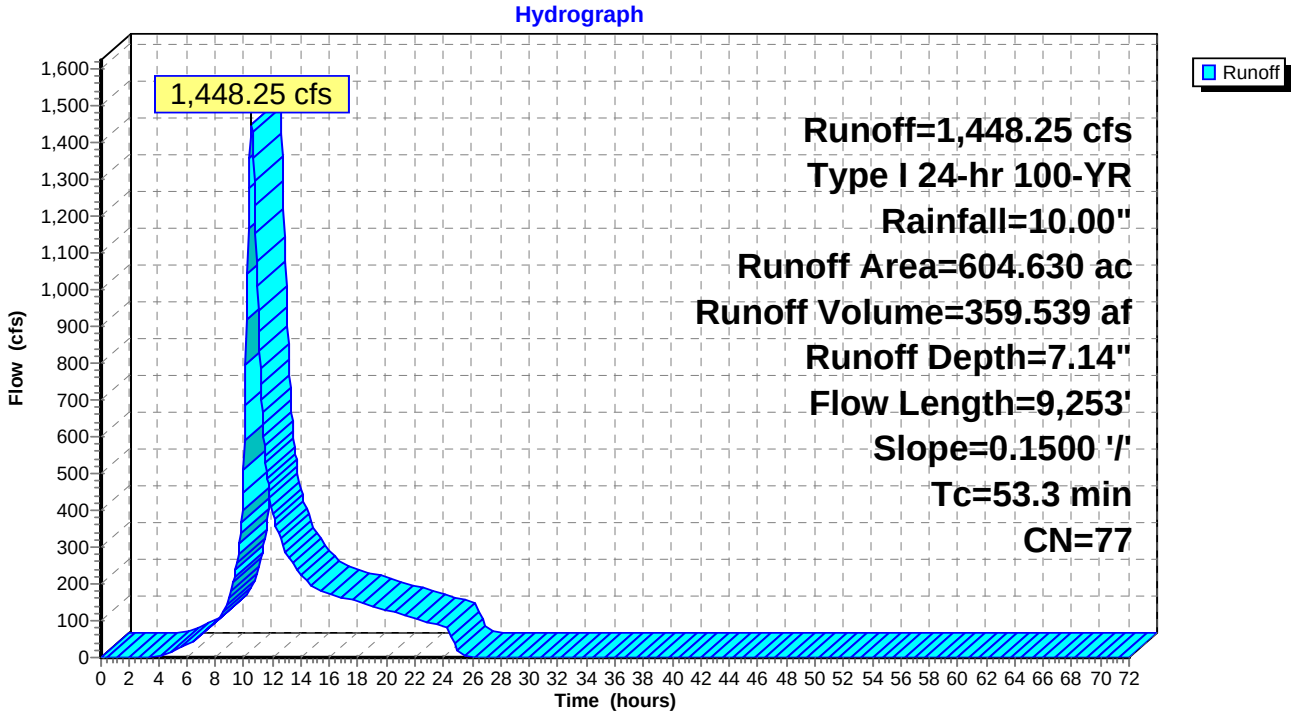
Runoff = 1,448.25 cfs @ 10.54 hrs, Volume= 359.539 af, Depth= 7.14"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	604.630	77	
	604.630		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
53.3	9,253	0.1500	2.89		**Lag/CN Method,**

Subcatchment 2S: E2



Summary for Subcatchment 3S: Sub-Basin E2A

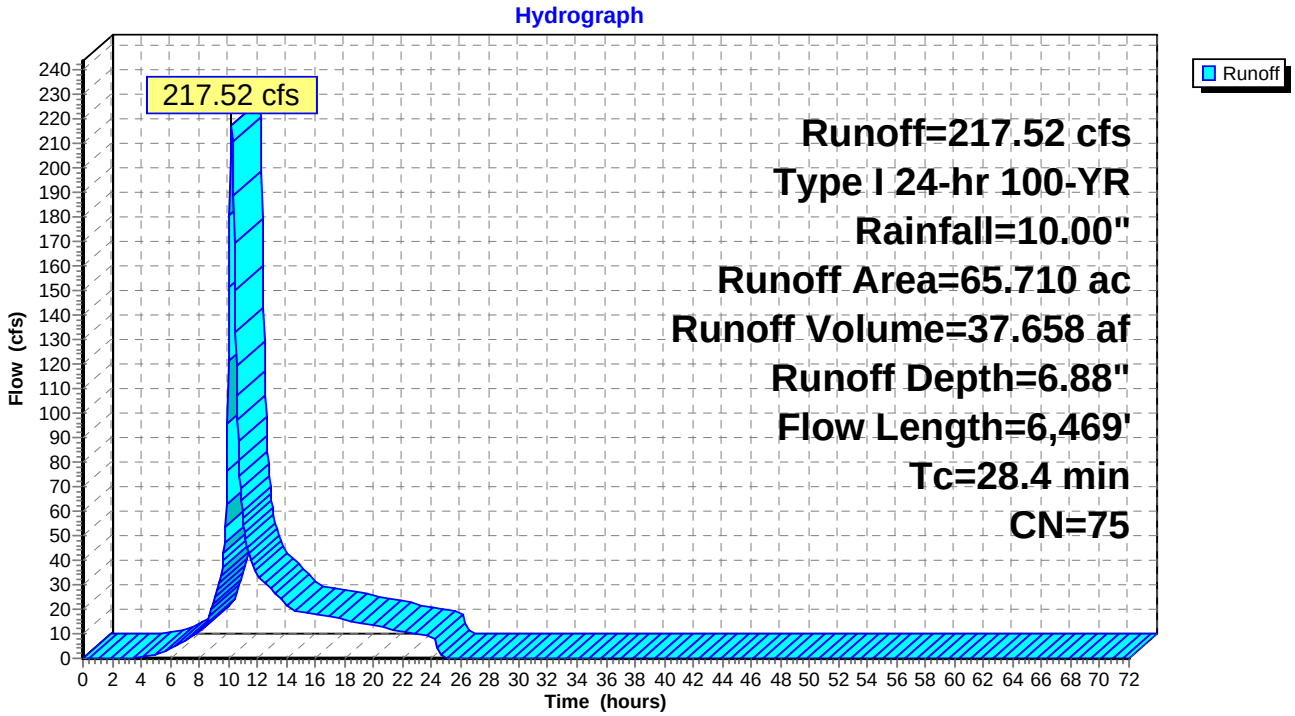
Runoff = 217.52 cfs @ 10.22 hrs, Volume= 37.658 af, Depth= 6.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	65.710	75	
	65.710		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.4	3,417	0.1400	2.16		**Lag/CN Method,**
2.0	3,052	0.1000	26.01	4,030.80	**Channel Flow,** Area= 155.0 sf Perim= 57.5' r= 2.70' n= 0.035
28.4	6,469	Total			

Subcatchment 3S: Sub-Basin E2A



Summary for Subcatchment 4S: Existing B1

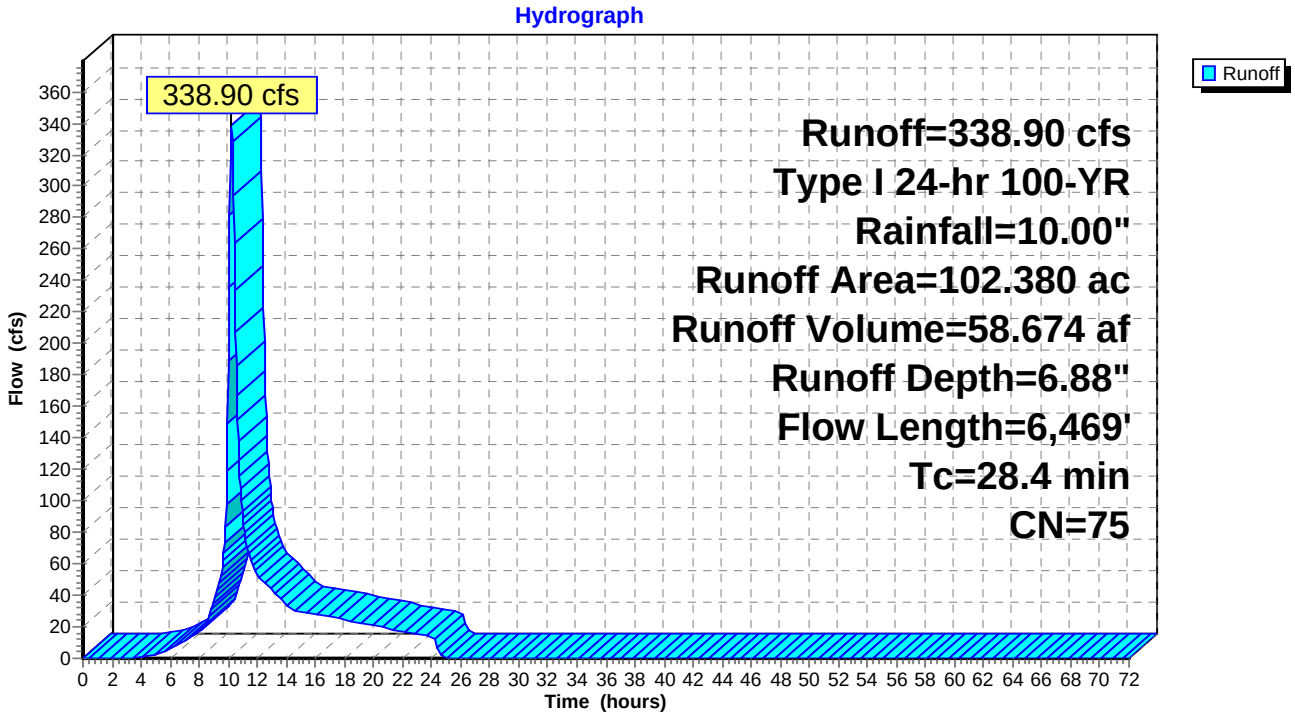
Runoff = 338.90 cfs @ 10.22 hrs, Volume= 58.674 af, Depth= 6.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	102.380	75	
	102.380		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.4	3,417	0.1400	2.16		**Lag/CN Method,**
2.0	3,052	0.1000	26.01	4,030.80	**Channel Flow,** Area= 155.0 sf Perim= 57.5' r= 2.70' n= 0.035
28.4	6,469	Total			

Subcatchment 4S: Existing B1



Summary for Subcatchment 5S: Existing B2

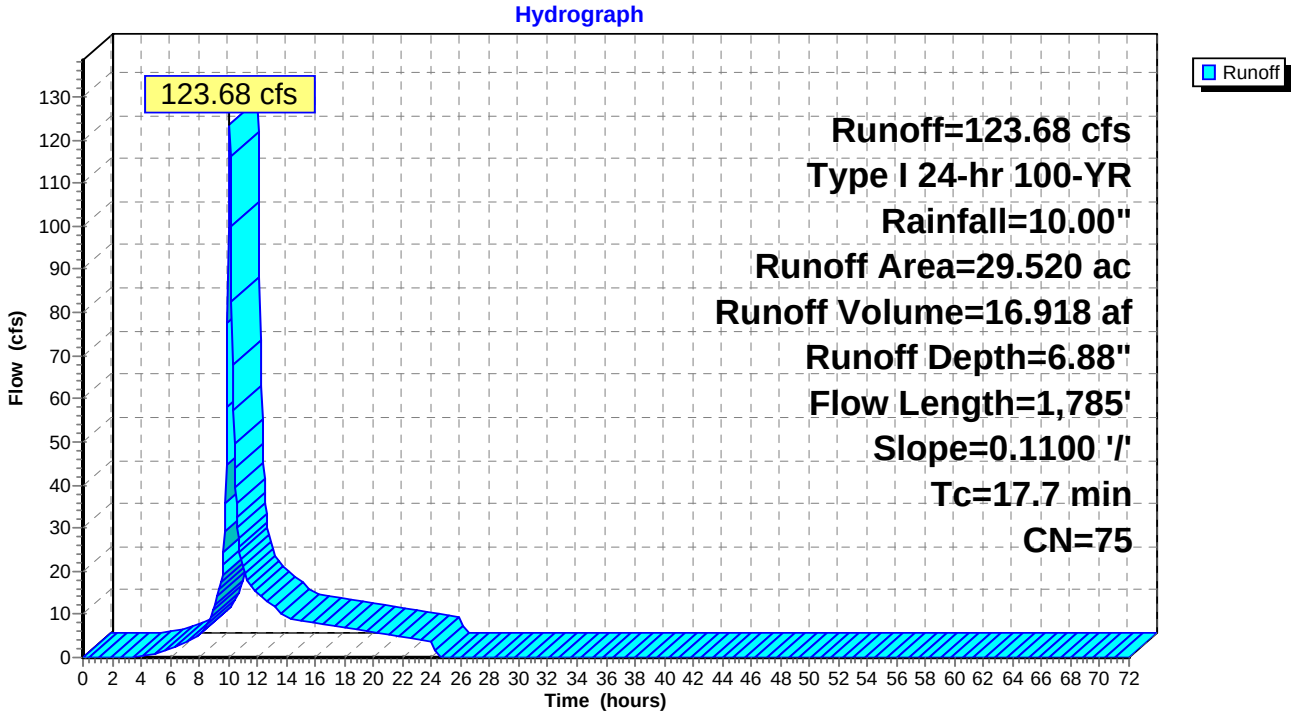
Runoff = 123.68 cfs @ 10.10 hrs, Volume= 16.918 af, Depth= 6.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	29.520	75	
	29.520		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.7	1,785	0.1100	1.68		**Lag/CN Method,**

Subcatchment 5S: Existing B2



Summary for Subcatchment 6S: Existing B3

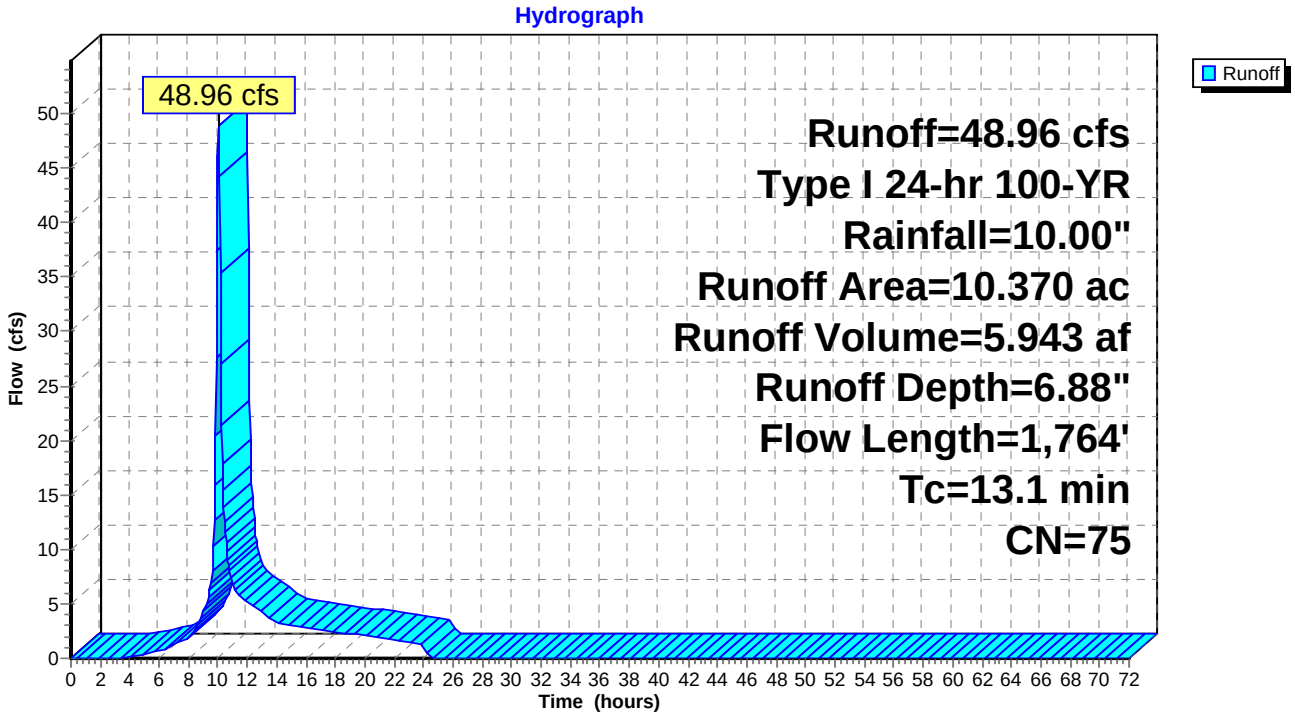
Runoff = 48.96 cfs @ 10.04 hrs, Volume= 5.943 af, Depth= 6.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	10.370	75	
	10.370		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.6	1,097	0.1000	1.46		**Lag/CN Method,**
0.5	667	0.0900	24.56	8,483.00	**Channel Flow,** Area= 345.4 sf Perim= 129.0' r= 2.68' n= 0.035
13.1	1,764	Total			

Subcatchment 6S: Existing B3



Summary for Subcatchment 7S: Existing B4

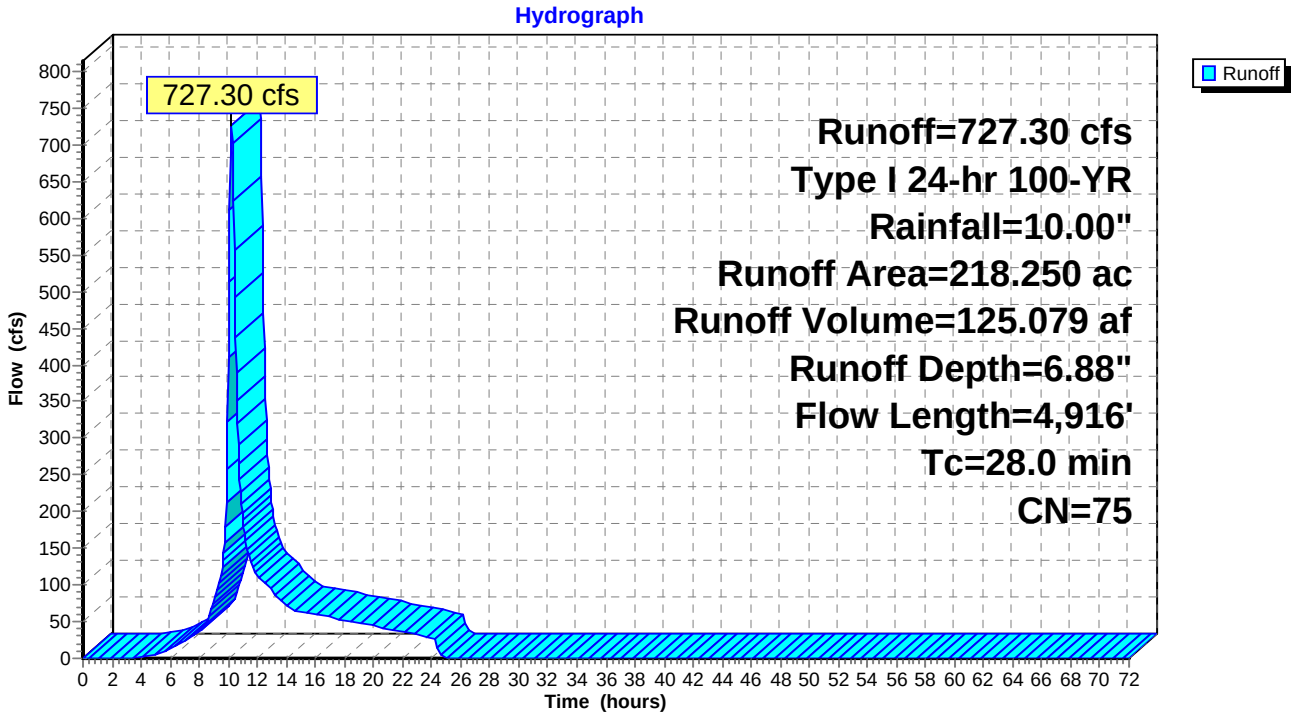
Runoff = 727.30 cfs @ 10.22 hrs, Volume= 125.079 af, Depth= 6.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	218.250	75	
	218.250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.7	3,152	0.1200	1.97		**Lag/CN Method,**
1.3	1,764	0.0700	22.93	5,230.83	**Channel Flow,** Area= 228.1 sf Perim= 78.2' r= 2.92' n= 0.035
28.0	4,916	Total			

Subcatchment 7S: Existing B4



Summary for Subcatchment 8S: Existing B5

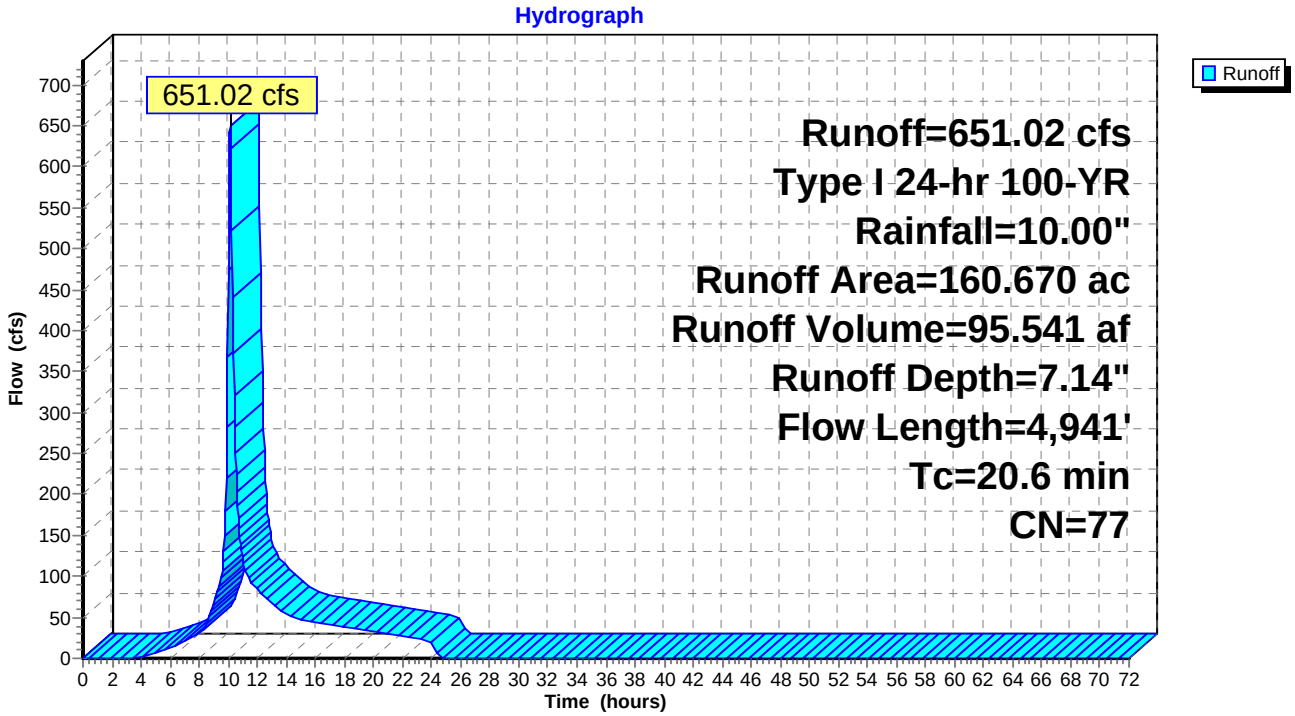
Runoff = 651.02 cfs @ 10.13 hrs, Volume= 95.541 af, Depth= 7.14"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	160.670	77	
	160.670		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.2	2,409	0.1500	2.21		**Lag/CN Method,**
2.4	2,532	0.0500	17.42	3,981.42	**Channel Flow,** Area= 228.6 sf Perim= 92.0' r= 2.48' n= 0.035
20.6	4,941	Total			

Subcatchment 8S: Existing B5



Summary for Subcatchment 9S: Existing B6

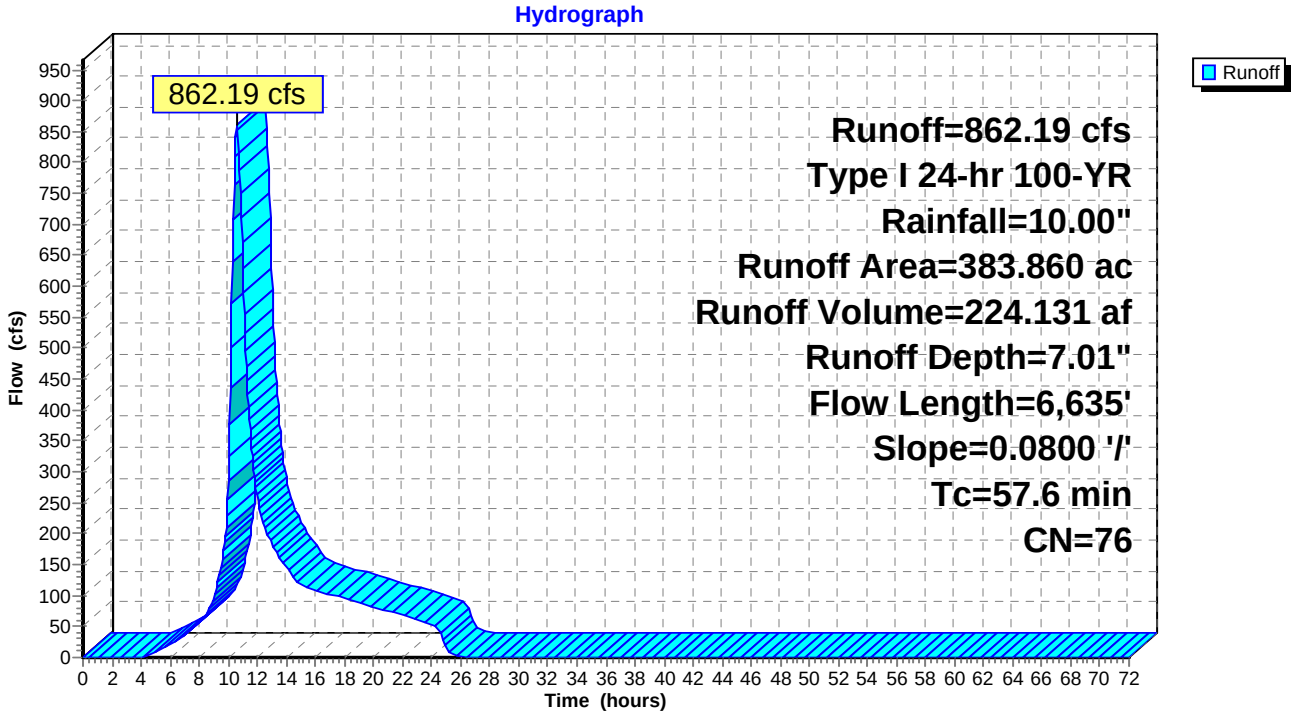
Runoff = 862.19 cfs @ 10.59 hrs, Volume= 224.131 af, Depth= 7.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	383.860	76	
	383.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
57.6	6,635	0.0800	1.92		**Lag/CN Method,**

Subcatchment 9S: Existing B6



Summary for Subcatchment 10S: Existing B7

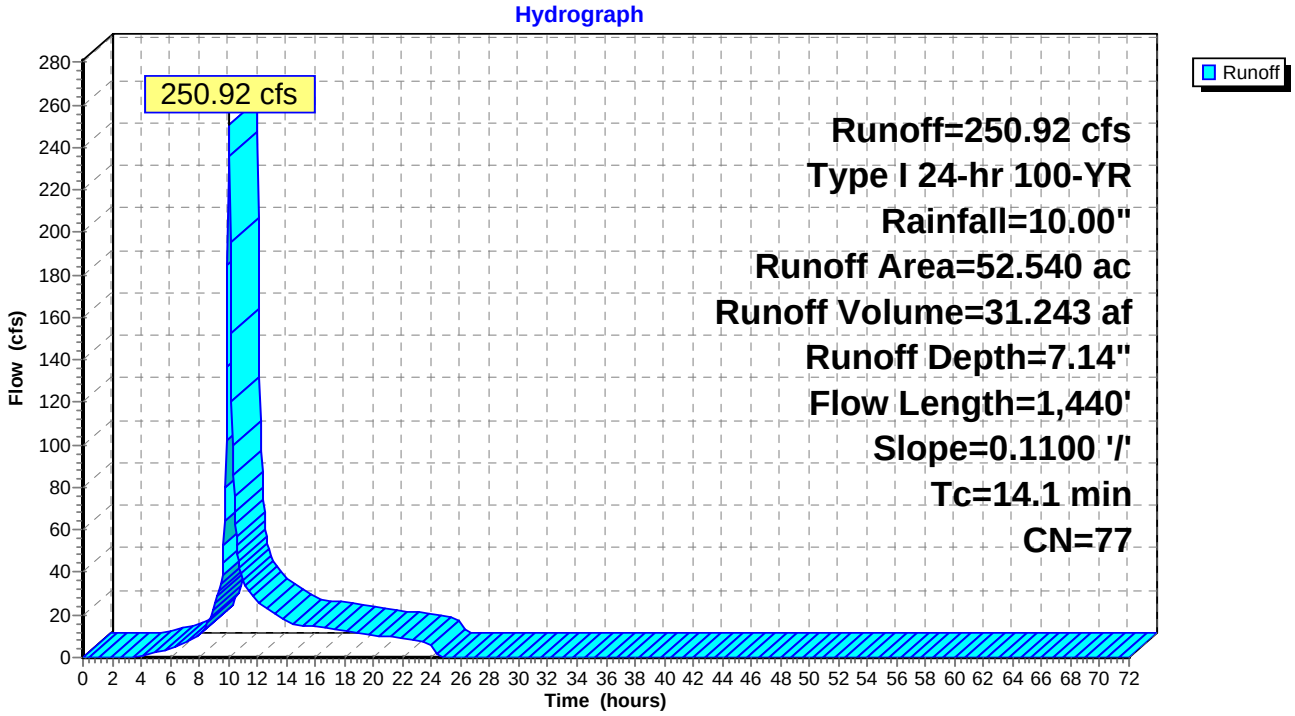
Runoff = 250.92 cfs @ 10.05 hrs, Volume= 31.243 af, Depth= 7.14"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	52.540	77	
	52.540		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.1	1,440	0.1100	1.71		**Lag/CN Method, Sheet Flow**

Subcatchment 10S: Existing B7



Summary for Subcatchment 11S: Existing B8

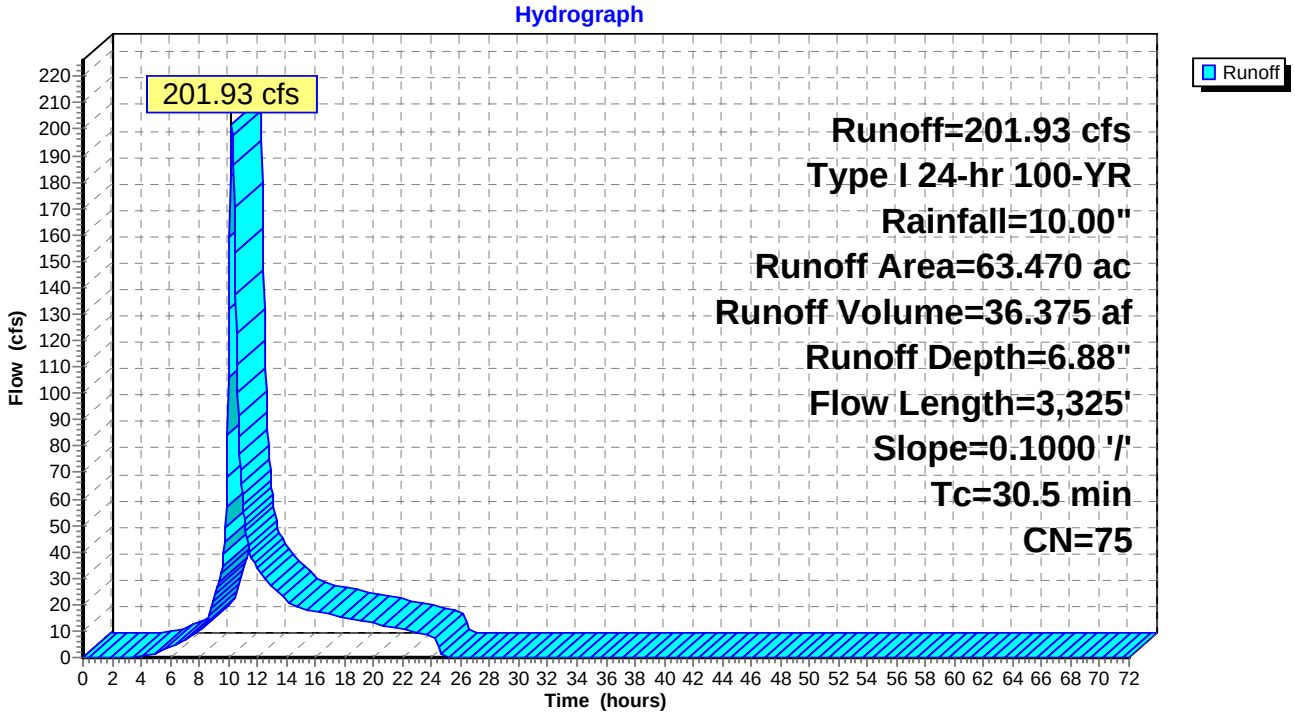
Runoff = 201.93 cfs @ 10.25 hrs, Volume= 36.375 af, Depth= 6.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	63.470	75	
	63.470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
30.5	3,325	0.1000	1.82		**Lag/CN Method,**

Subcatchment 11S: Existing B8



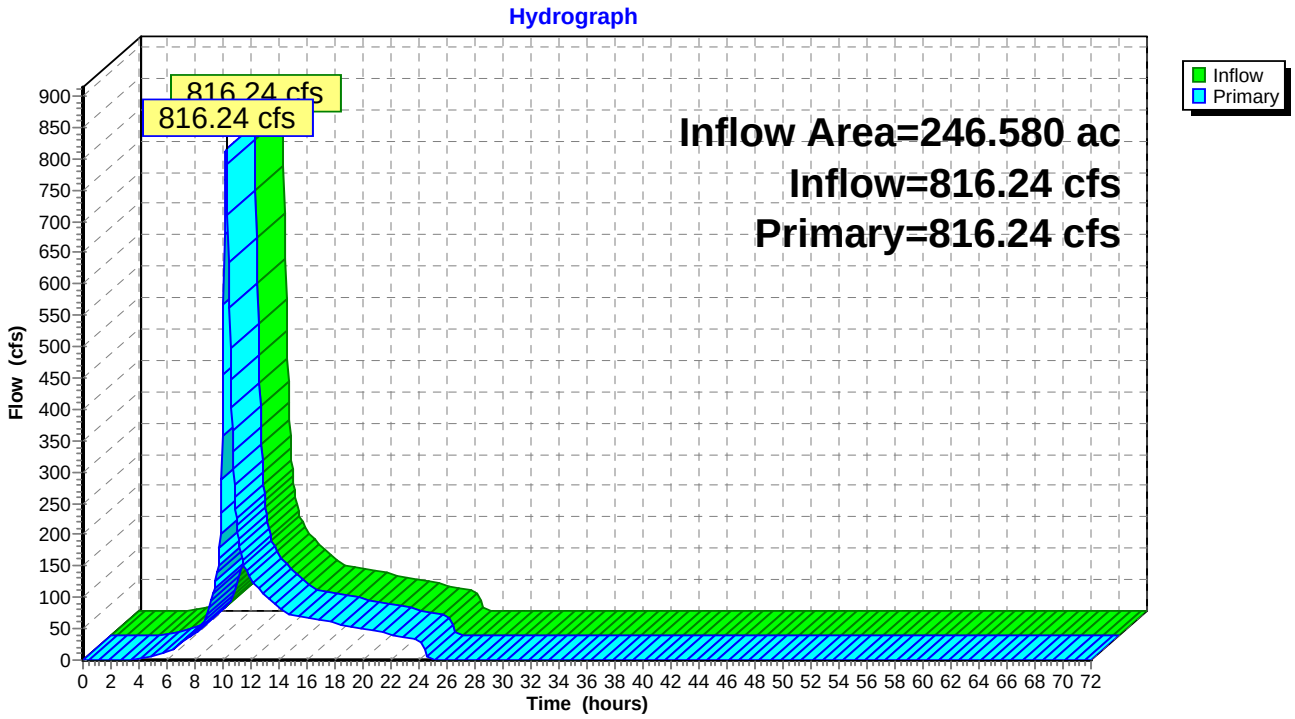
Summary for Pond 12P: Detention Basin 1

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 246.580 ac, 0.00% Impervious, Inflow Depth = 6.88" for 100-YR event
Inflow = 816.24 cfs @ 10.22 hrs, Volume= 141.315 af
Primary = 816.24 cfs @ 10.22 hrs, Volume= 141.315 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond 12P: Detention Basin 1



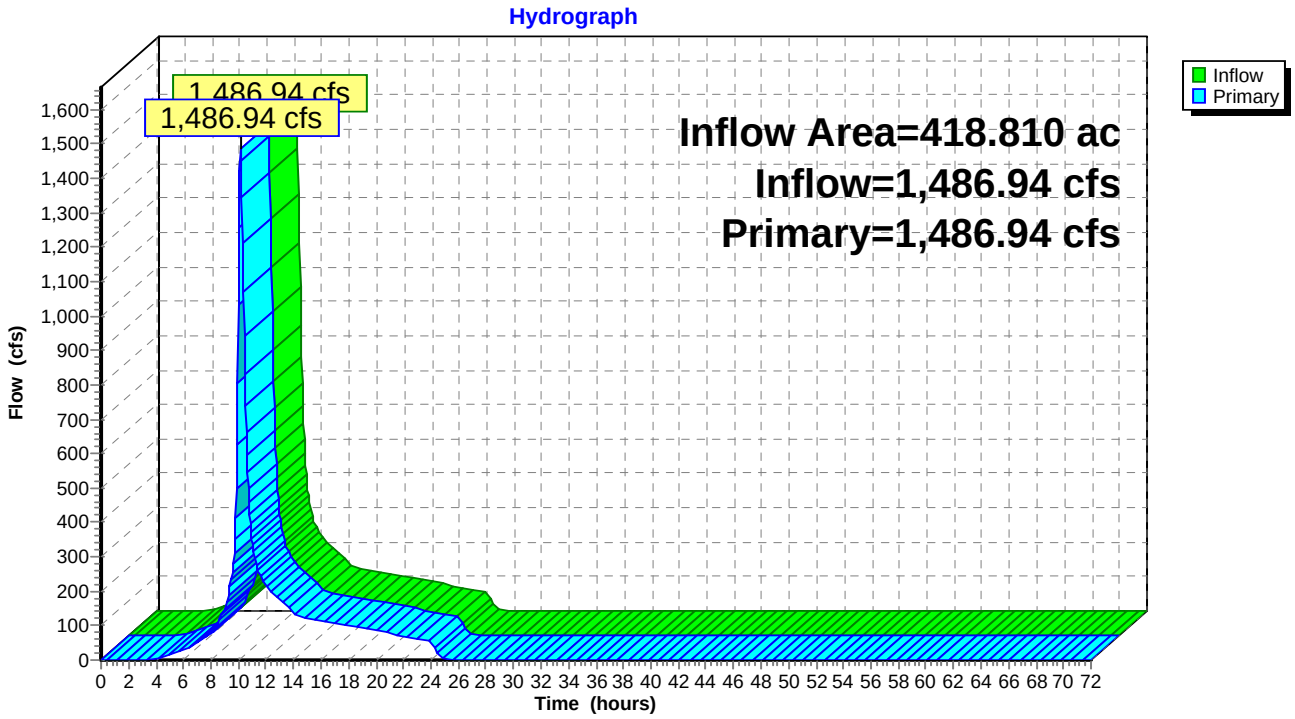
Summary for Pond 13P: Detention Basin 2

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 418.810 ac, 0.00% Impervious, Inflow Depth = 6.98" for 100-YR event
Inflow = 1,486.94 cfs @ 10.16 hrs, Volume= 243.481 af
Primary = 1,486.94 cfs @ 10.16 hrs, Volume= 243.481 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond 13P: Detention Basin 2



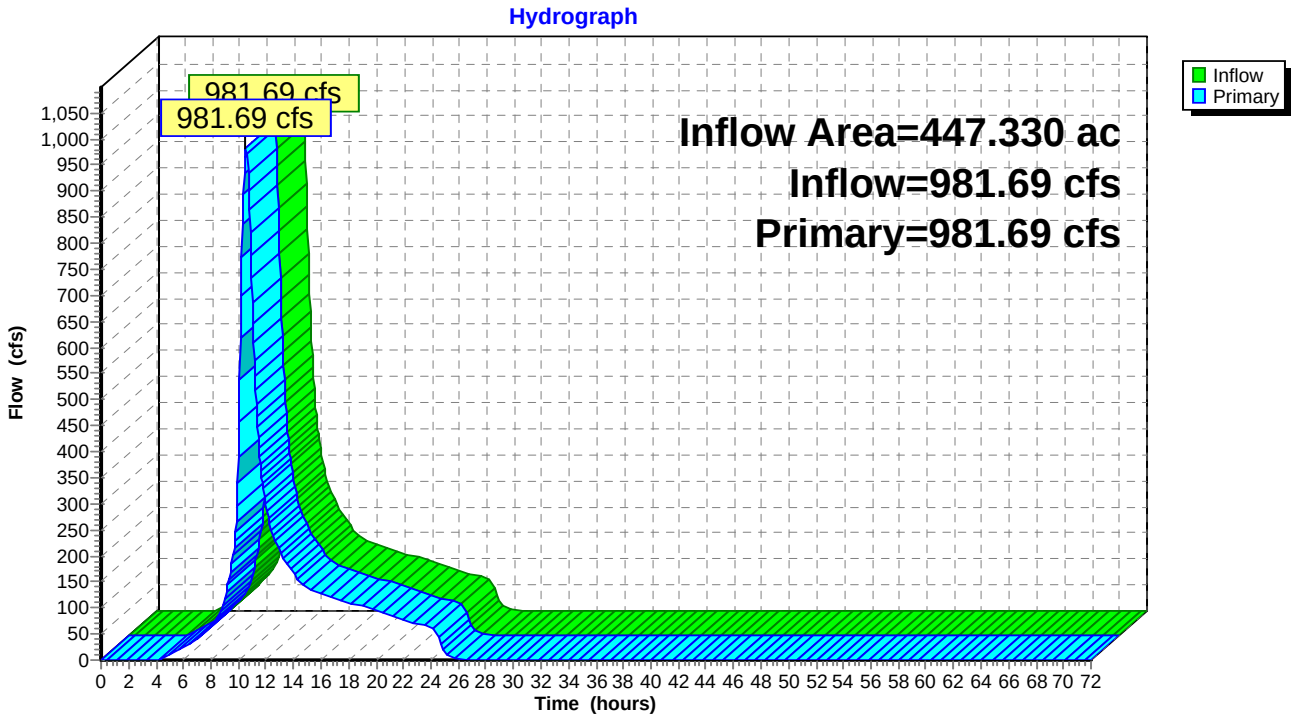
Summary for Pond 14P: Detention Basin 3

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 447.330 ac, 0.00% Impervious, Inflow Depth = 6.99" for 100-YR event
Inflow = 981.69 cfs @ 10.54 hrs, Volume= 260.505 af
Primary = 981.69 cfs @ 10.54 hrs, Volume= 260.505 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond 14P: Detention Basin 3



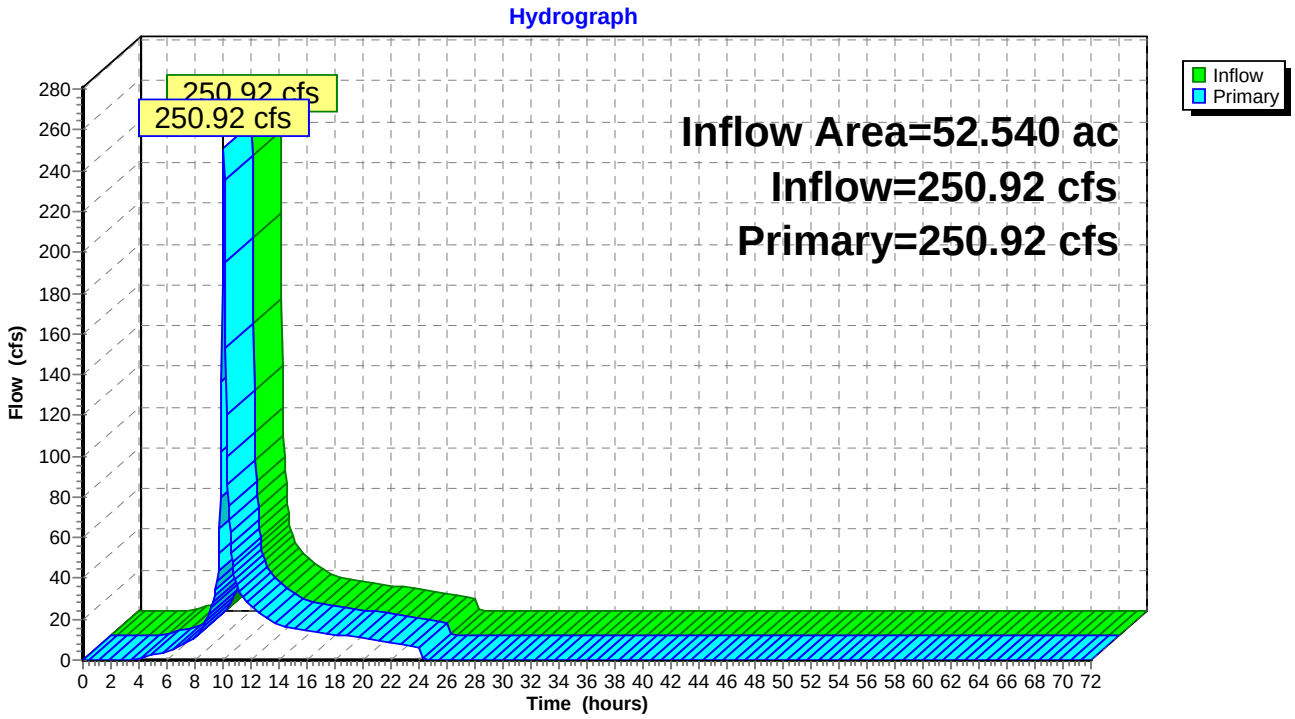
Summary for Pond 15P: Detention Basin 4

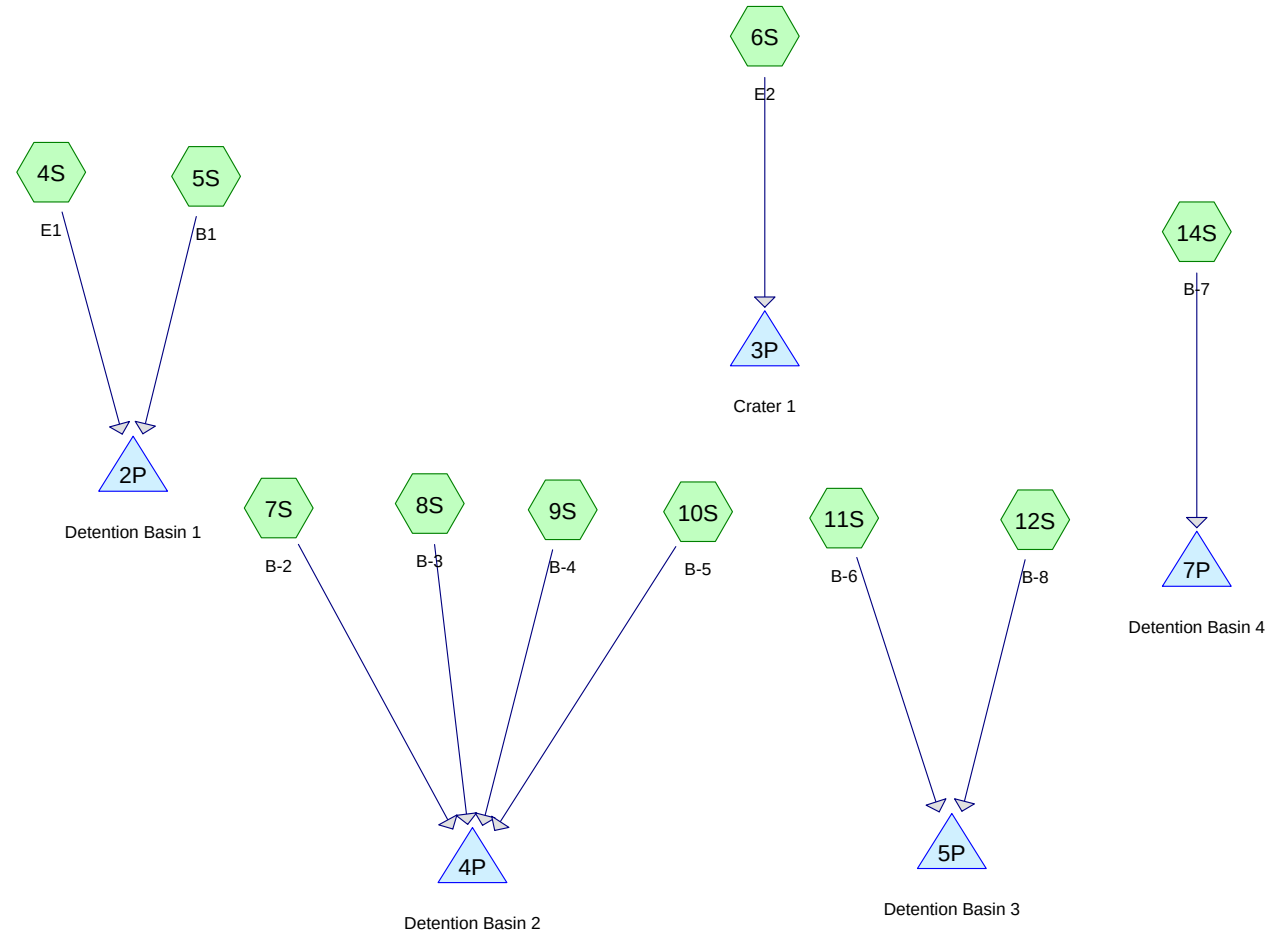
[40] Hint: Not Described (Outflow=Inflow)

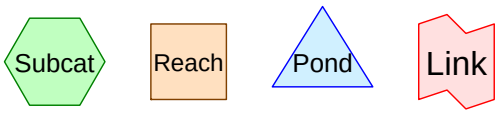
Inflow Area = 52.540 ac, 0.00% Impervious, Inflow Depth = 7.14" for 100-YR event
Inflow = 250.92 cfs @ 10.05 hrs, Volume= 31.243 af
Primary = 250.92 cfs @ 10.05 hrs, Volume= 31.243 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond 15P: Detention Basin 4







Drainage Diagram for Land Use Concept One & Two
Prepared by Belt Collins Hawaii, Printed 10/17/2009
HydroCAD® 9.00 s/n 06009 © 2009 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
78.490	75	(4S)
604.630	77	(6S)
52.540	82	(14S)
102.380	84	(5S)
802.670	87	(7S, 8S, 9S, 10S, 11S)
63.470	89	(12S)
1,704.180		**TOTAL AREA**

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 4S: E1 Runoff Area=78.490 ac 0.00% Impervious Runoff Depth=6.88"
Flow Length=6,469' Tc=28.4 min CN=75 Runoff=259.82 cfs 44.983 af

Subcatchment 5S: B1 Runoff Area=102.380 ac 0.00% Impervious Runoff Depth=8.03"
Tc=28.4 min CN=84 Runoff=395.01 cfs 68.502 af

Subcatchment 6S: E2 Runoff Area=604.630 ac 0.00% Impervious Runoff Depth=7.14"
Flow Length=9,253' Slope=0.1500 '/' Tc=53.3 min CN=77 Runoff=1,448.25 cfs 359.539 af

Subcatchment 7S: B-2 Runoff Area=29.520 ac 0.00% Impervious Runoff Depth=8.41"
Flow Length=1,161' Tc=7.9 min CN=87 Runoff=191.29 cfs 20.680 af

Subcatchment 8S: B-3 Runoff Area=10.370 ac 0.00% Impervious Runoff Depth=8.41"
Flow Length=1,809' Slope=0.0800 '/' Tc=14.2 min CN=87 Runoff=57.20 cfs 7.264 af

Subcatchment 9S: B-4 Runoff Area=218.250 ac 0.00% Impervious Runoff Depth=8.41"
Flow Length=4,582' Tc=7.4 min CN=87 Runoff=1,425.86 cfs 152.890 af

Subcatchment 10S: B-5 Runoff Area=160.670 ac 0.00% Impervious Runoff Depth=8.41"
Flow Length=4,437' Tc=10.9 min CN=87 Runoff=963.99 cfs 112.554 af

Subcatchment 11S: B-6 Runoff Area=383.860 ac 0.00% Impervious Runoff Depth=8.41"
Flow Length=9,787' Tc=24.6 min CN=87 Runoff=1,657.74 cfs 268.905 af

Subcatchment 12S: B-8 Runoff Area=63.470 ac 0.00% Impervious Runoff Depth=8.66"
Flow Length=3,310' Tc=6.8 min CN=89 Runoff=429.63 cfs 45.782 af

Subcatchment 14S: B-7 Runoff Area=52.540 ac 0.00% Impervious Runoff Depth=7.78"
Flow Length=1,561' Tc=10.8 min CN=82 Runoff=296.43 cfs 34.045 af

Pond 2P: Detention Basin 1 Inflow=654.79 cfs 113.484 af
Primary=654.79 cfs 113.484 af

Pond 3P: Crater 1 Peak Elev=425.99' Storage=333.785 af Inflow=1,448.25 cfs 359.539 af
Primary=19.71 cfs 99.631 af Secondary=0.00 cfs 0.000 af Outflow=19.71 cfs 99.631 af

Pond 4P: Detention Basin 2 Peak Elev=122.41' Storage=124.310 af Inflow=2,602.45 cfs 293.388 af
Outflow=348.17 cfs 281.689 af

Pond 5P: Detention Basin 3 Peak Elev=62.71' Storage=152.630 af Inflow=1,779.98 cfs 314.687 af
101.0" x 24.0" Box Culvert n=0.013 L=1,165.0' S=0.0295 '/' Outflow=209.76 cfs 297.285 af

Pond 7P: Detention Basin 4 Peak Elev=232.36' Storage=7.044 af Inflow=296.43 cfs 34.045 af
Outflow=250.87 cfs 29.557 af

Total Runoff Area = 1,704.180 ac Runoff Volume = 1,115.144 af Average Runoff Depth = 7.85"
100.00% Pervious = 1,704.180 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 4S: E1

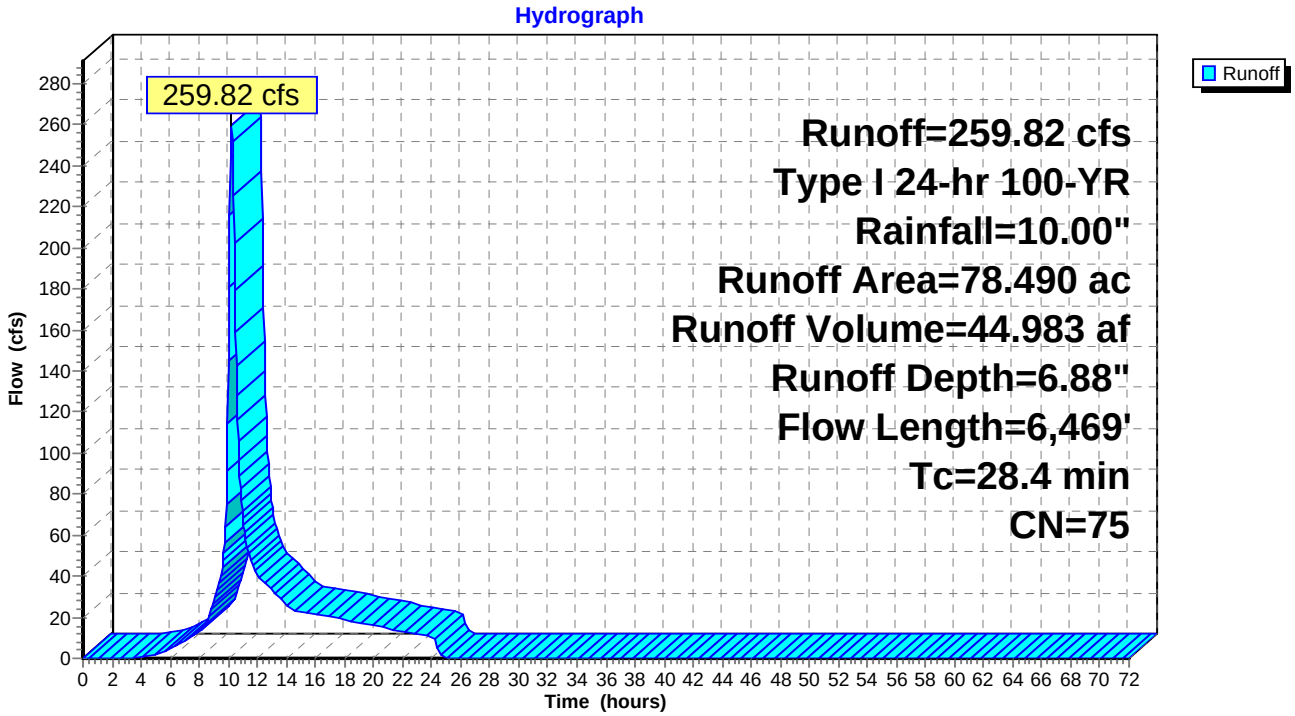
Runoff = 259.82 cfs @ 10.22 hrs, Volume= 44.983 af, Depth= 6.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	78.490	75	
	78.490		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.4	3,417	0.1400	2.16		**Lag/CN Method,**
2.0	3,052	0.1000	26.01	4,030.80	**Channel Flow,** Area= 155.0 sf Perim= 57.5' r= 2.70' n= 0.035
28.4	6,469	Total			

Subcatchment 4S: E1



Summary for Subcatchment 5S: B1

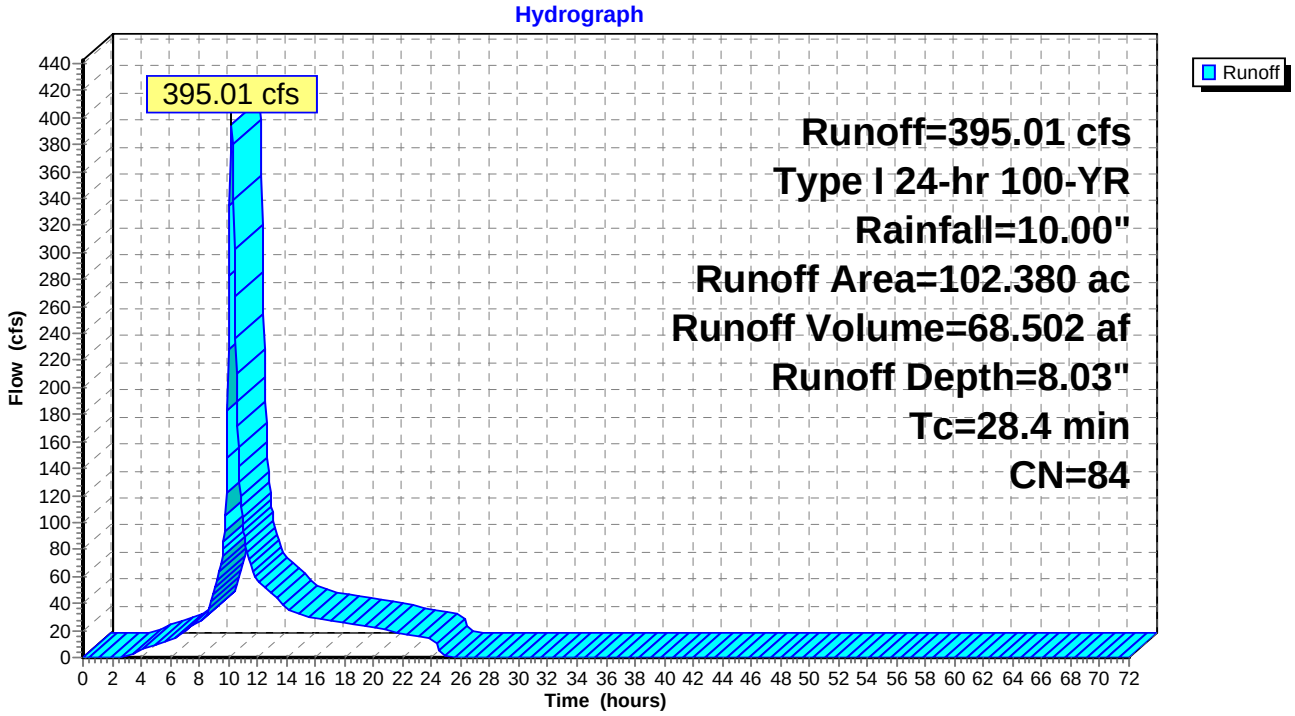
Runoff = 395.01 cfs @ 10.22 hrs, Volume= 68.502 af, Depth= 8.03"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	102.380	84	
	102.380		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.4					**Direct Entry, Basin E1, B1, E2A Tc**

Subcatchment 5S: B1



Summary for Subcatchment 6S: E2

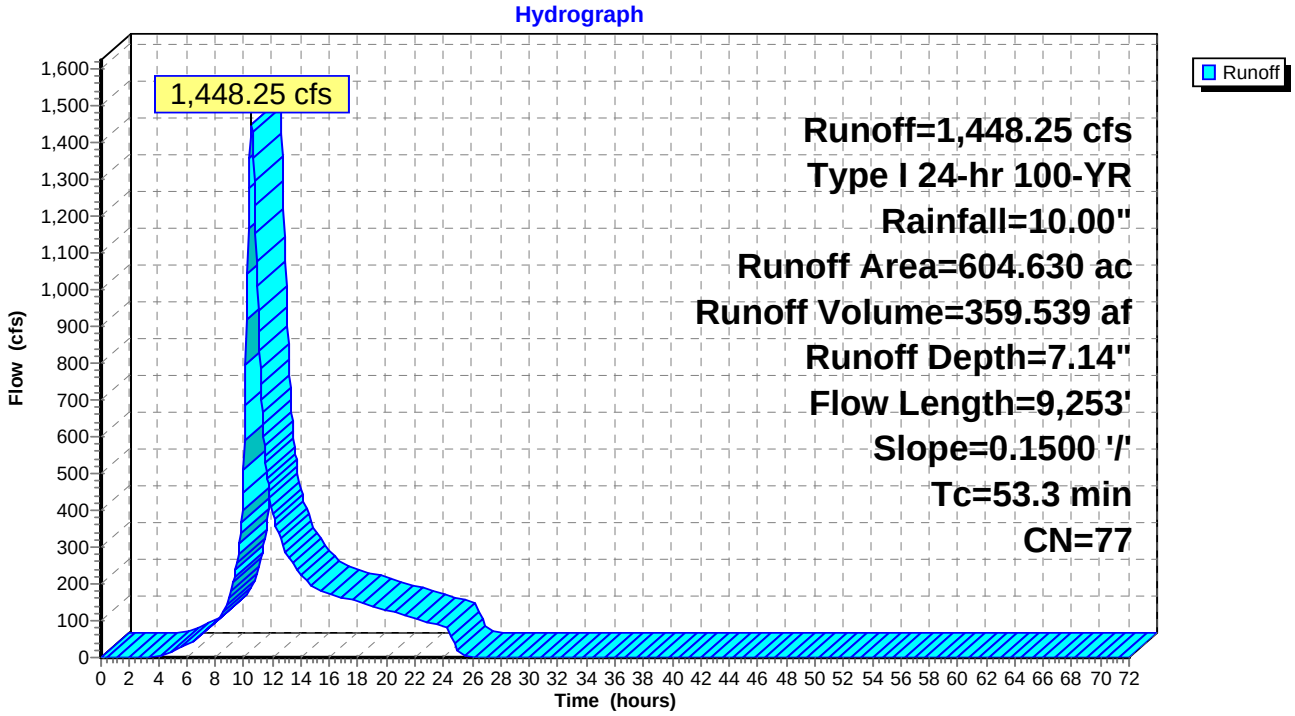
Runoff = 1,448.25 cfs @ 10.54 hrs, Volume= 359.539 af, Depth= 7.14"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	604.630	77	
	604.630		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
53.3	9,253	0.1500	2.89		**Lag/CN Method,**

Subcatchment 6S: E2



Summary for Subcatchment 7S: B-2

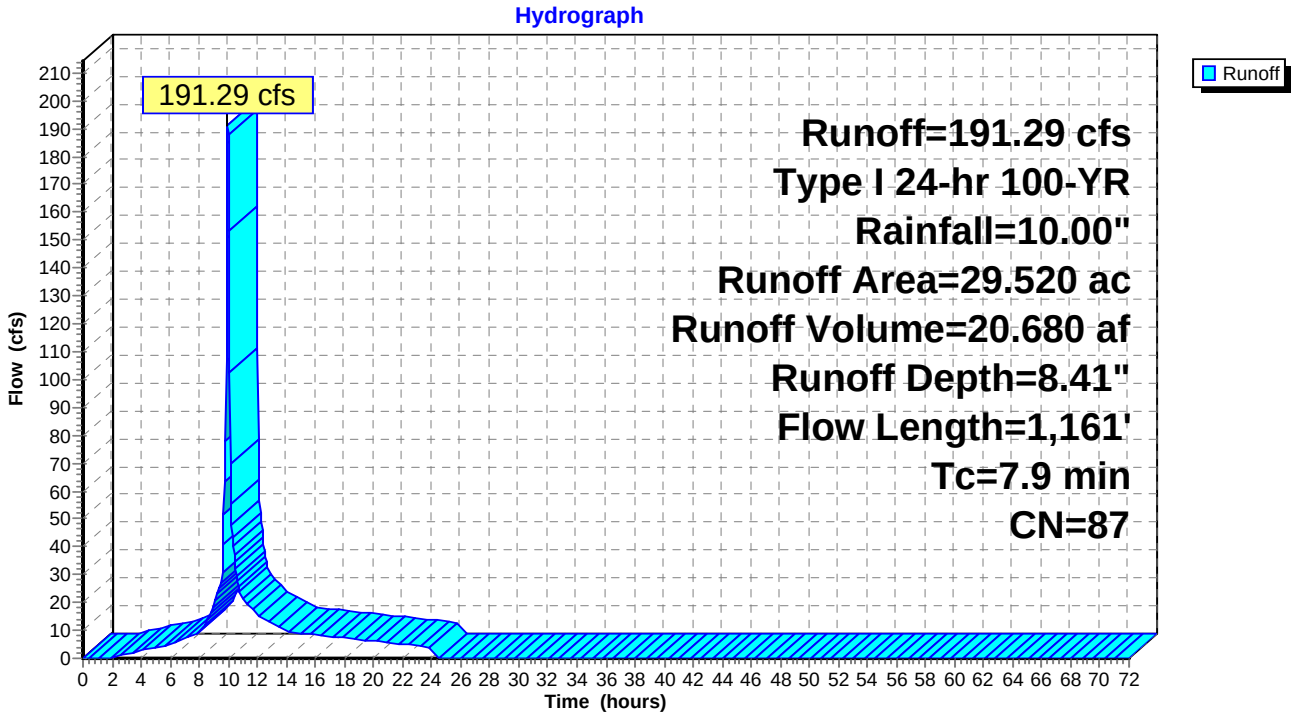
Runoff = 191.29 cfs @ 9.98 hrs, Volume= 20.680 af, Depth= 8.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	29.520	87	
	29.520		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	824	0.0800	1.81		**Lag/CN Method, B-2**
0.3	337	0.0400	20.19	143.38	**Channel Flow, B-2 Channel Flow**
					Area= 7.1 sf Perim= 6.9' r= 1.03' n= 0.015
7.9	1,161	Total			

Subcatchment 7S: B-2



Summary for Subcatchment 8S: B-3

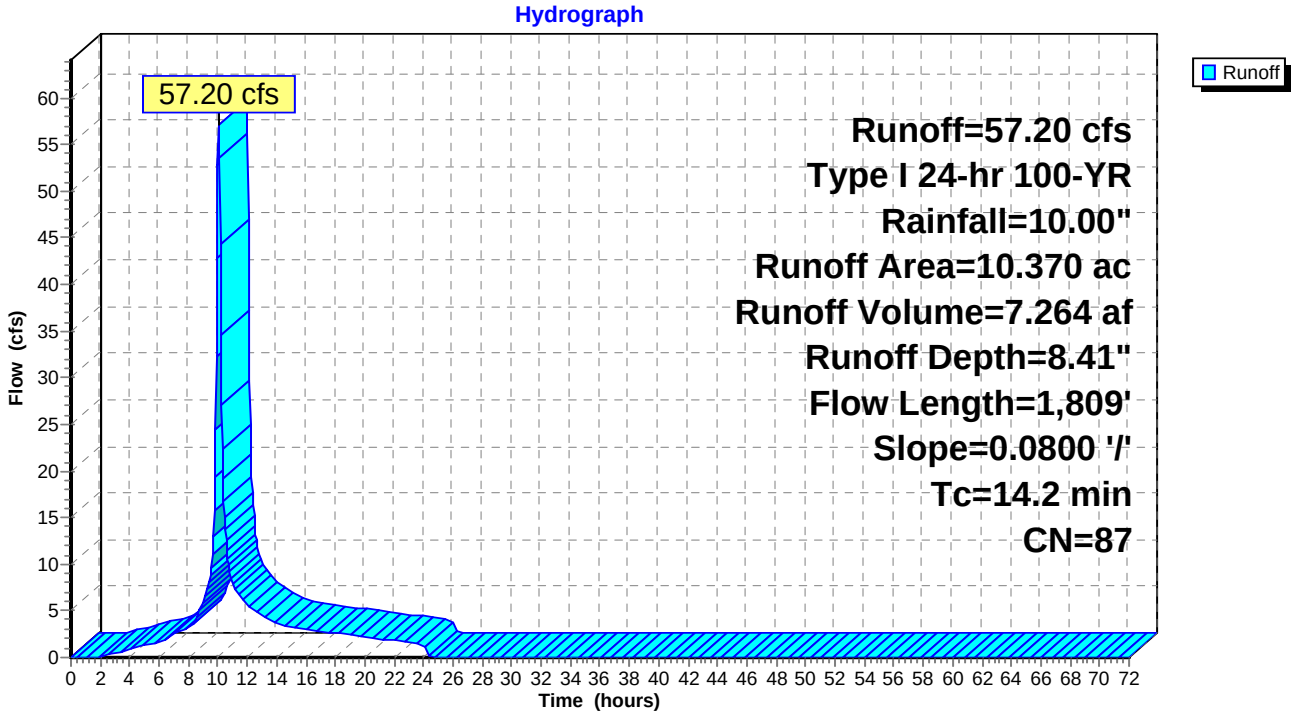
Runoff = 57.20 cfs @ 10.05 hrs, Volume= 7.264 af, Depth= 8.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	10.370	87	
	10.370		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.2	1,809	0.0800	2.12		**Lag/CN Method, B-3**

Subcatchment 8S: B-3



Summary for Subcatchment 9S: B-4

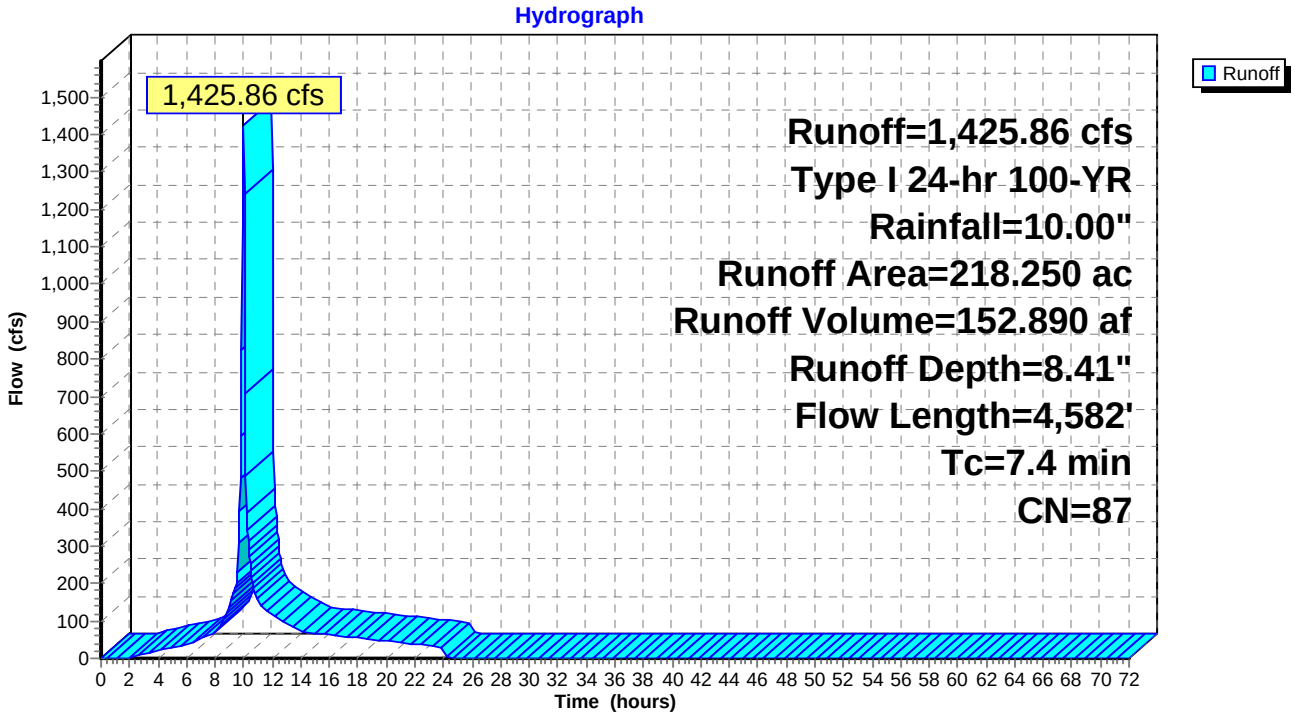
Runoff = 1,425.86 cfs @ 9.97 hrs, Volume= 152.890 af, Depth= 8.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	218.250	87	
	218.250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.9	610	0.1200	2.09		**Lag/CN Method,**
2.5	3,972	0.1000	26.88	5,953.46	**Channel Flow,** Area= 221.5 sf Perim= 78.2' r= 2.83' n= 0.035
7.4	4,582	Total			

Subcatchment 9S: B-4



Summary for Subcatchment 10S: B-5

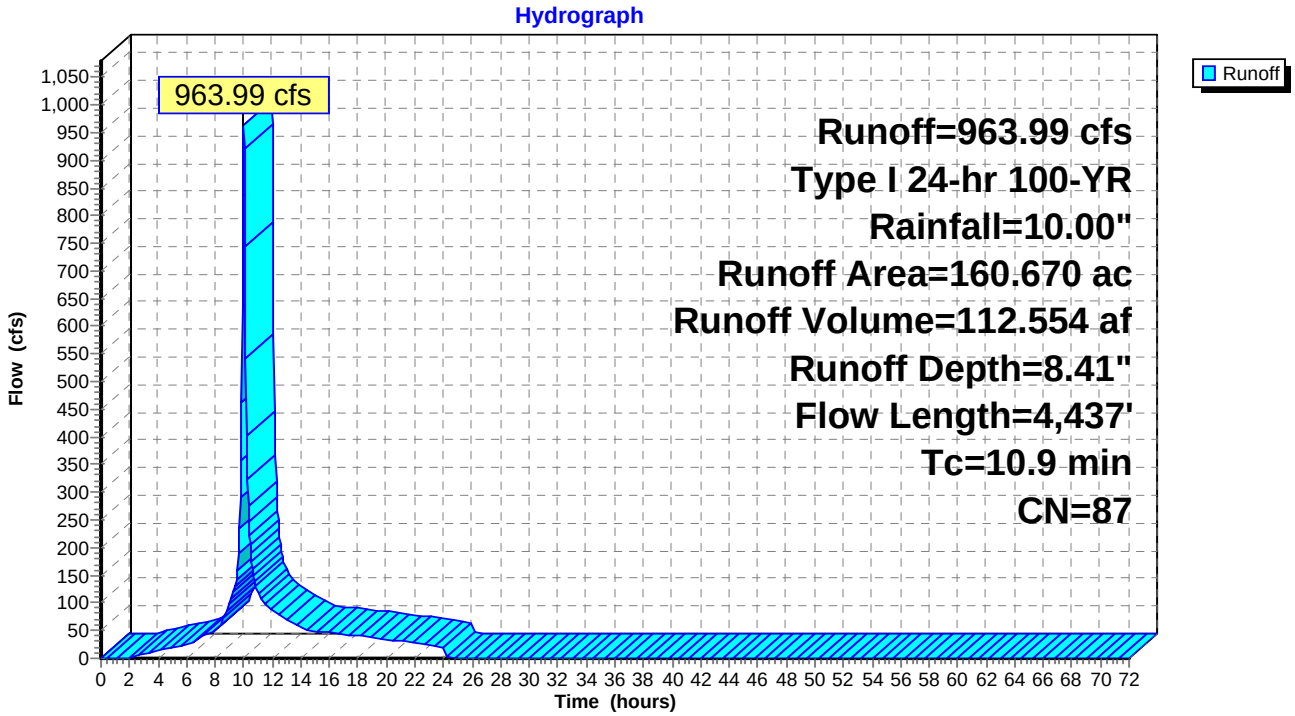
Runoff = 963.99 cfs @ 10.01 hrs, Volume= 112.554 af, Depth= 8.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	160.670	87	
	160.670		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.9	1,483	0.1500	2.79		**Lag/CN Method,**
2.0	2,954	0.0600	24.99	10,091.38	**Channel Flow,** Area= 403.8 sf Perim= 108.4' r= 3.73' n= 0.035
10.9	4,437	Total			

Subcatchment 10S: B-5



Summary for Subcatchment 11S: B-6

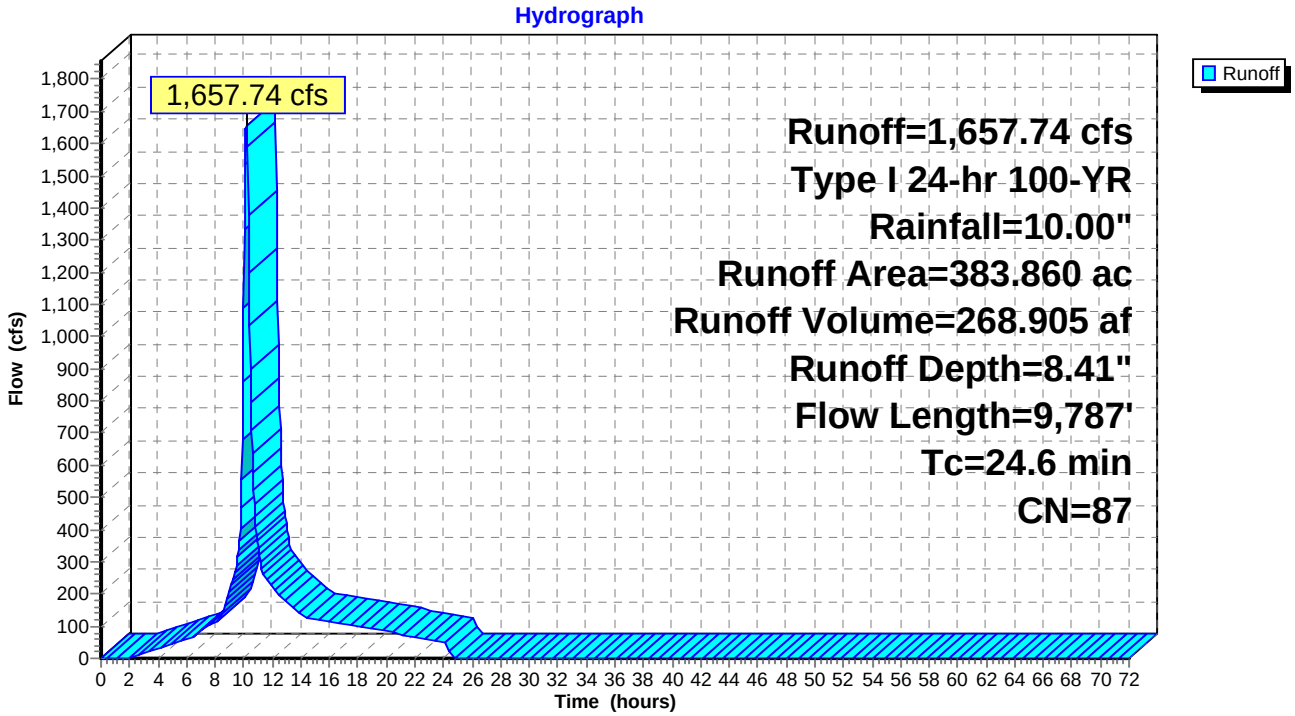
Runoff = 1,657.74 cfs @ 10.17 hrs, Volume= 268.905 af, Depth= 8.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	383.860	87	
	383.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.2	2,739	0.0700	2.15		**Lag/CN Method,**
3.4	7,048	0.0400	34.10	1,193.58	**Channel Flow,** Area= 35.0 sf Perim= 15.5' r= 2.26' n= 0.015
24.6	9,787	Total			

Subcatchment 11S: B-6



Summary for Subcatchment 12S: B-8

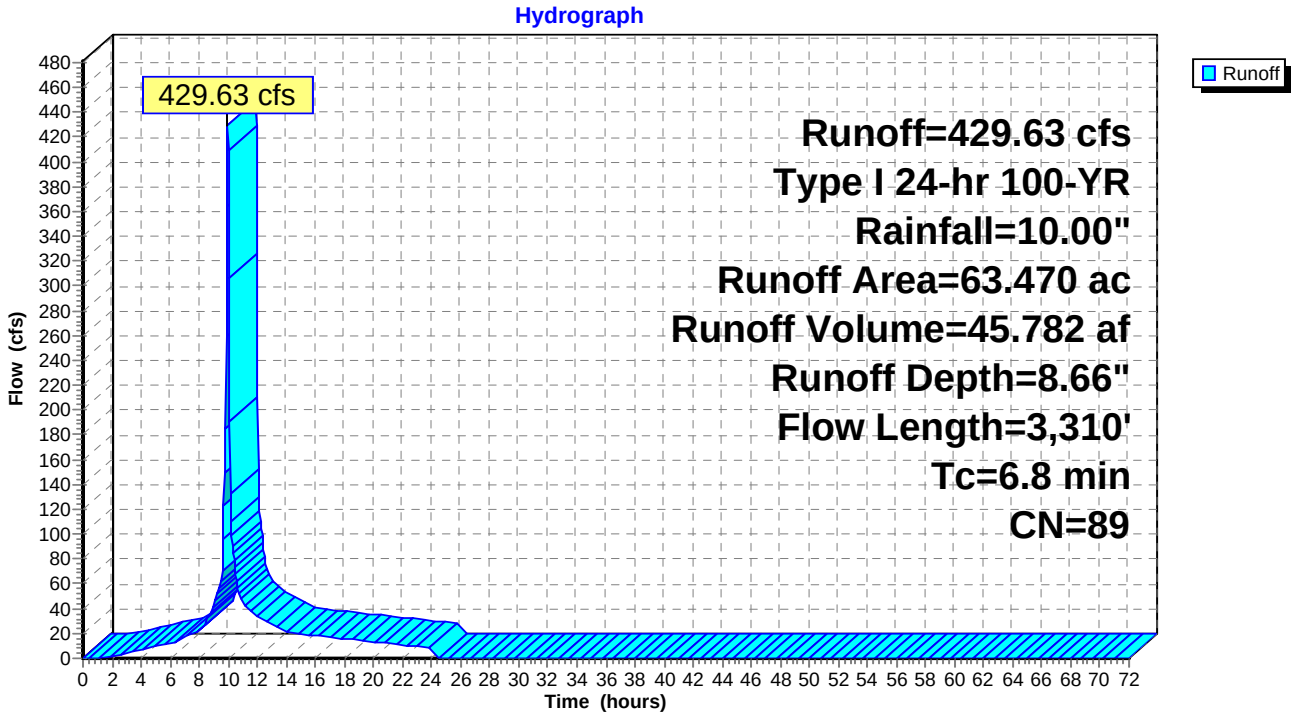
Runoff = 429.63 cfs @ 9.96 hrs, Volume= 45.782 af, Depth= 8.66"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	63.470	89	
	63.470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	804	0.1300	2.48		**Lag/CN Method,**
1.4	2,506	0.0700	29.08	261.75	**Channel Flow,** Area= 9.0 sf Perim= 7.7' r= 1.17' n= 0.015
6.8	3,310	Total			

Subcatchment 12S: B-8



Summary for Subcatchment 14S: B-7

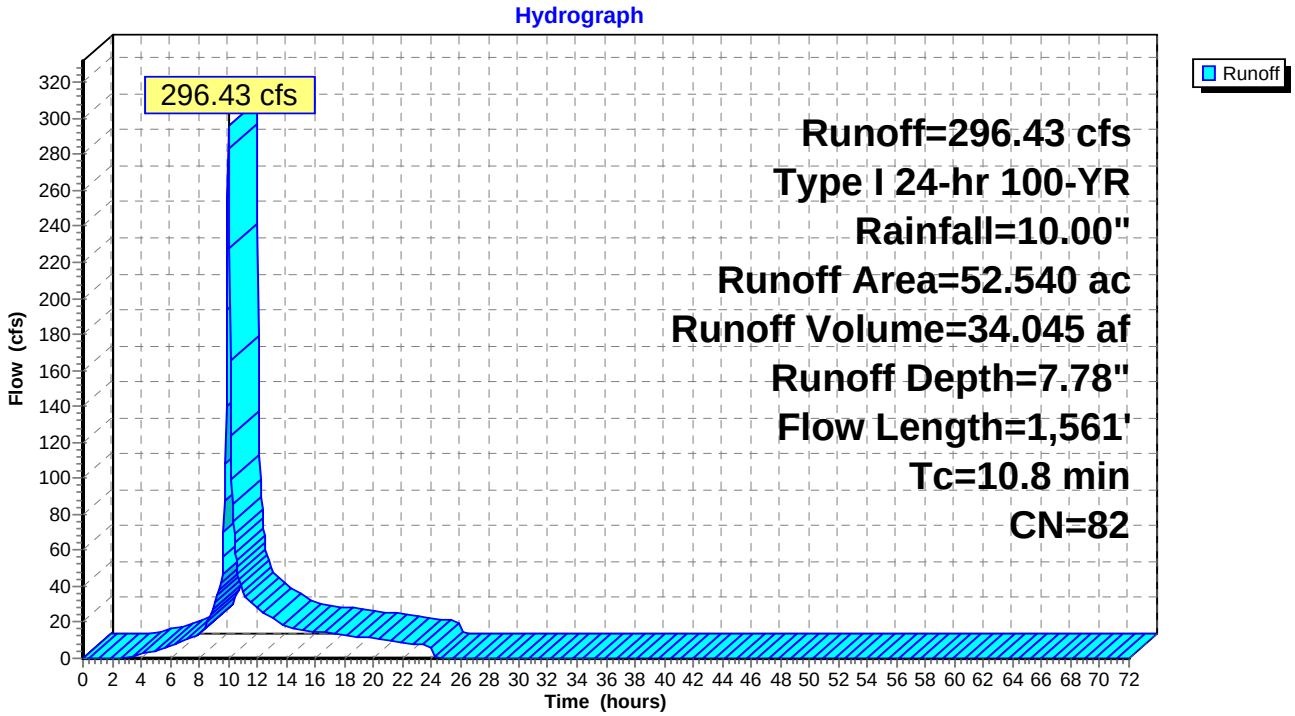
Runoff = 296.43 cfs @ 10.01 hrs, Volume= 34.045 af, Depth= 7.78"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	52.540	82	
	52.540		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	1,294	0.1200	2.04		**Lag/CN Method,**
0.2	267	0.0500	26.35	287.26	**Channel Flow,** Area= 10.9 sf Perim= 8.4' r= 1.30' n= 0.015
10.8	1,561	Total			

Subcatchment 14S: B-7



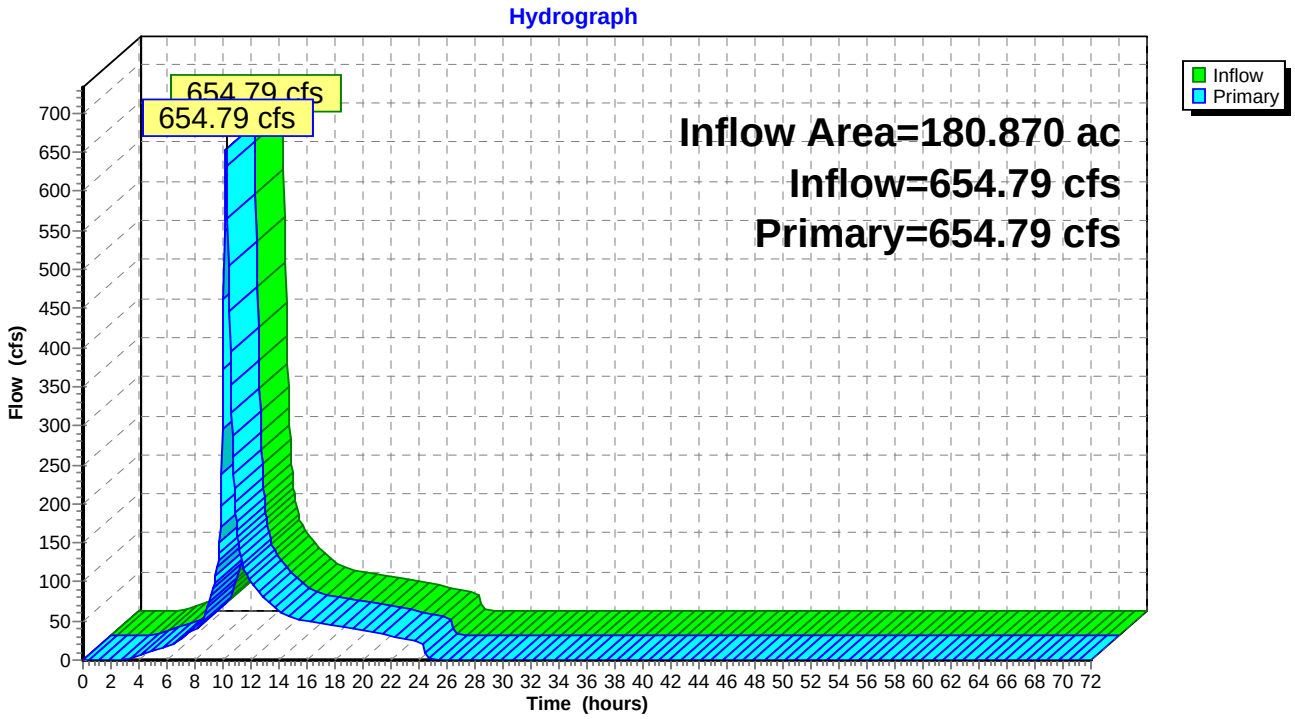
Summary for Pond 2P: Detention Basin 1

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 180.870 ac, 0.00% Impervious, Inflow Depth = 7.53" for 100-YR event
Inflow = 654.79 cfs @ 10.22 hrs, Volume= 113.484 af
Primary = 654.79 cfs @ 10.22 hrs, Volume= 113.484 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond 2P: Detention Basin 1



Summary for Pond 3P: Crater 1

Inflow Area = 604.630 ac, 0.00% Impervious, Inflow Depth = 7.14" for 100-YR event
Inflow = 1,448.25 cfs @ 10.54 hrs, Volume= 359.539 af
Outflow = 19.71 cfs @ 25.01 hrs, Volume= 99.631 af, Atten= 99%, Lag= 868.2 min
Primary = 19.71 cfs @ 25.01 hrs, Volume= 99.631 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 425.99' @ 25.01 hrs Surf.Area= 15.302 ac Storage= 333.785 af

Plug-Flow detention time= 1,852.0 min calculated for 99.631 af (28% of inflow)
Center-of-Mass det. time= 1,615.3 min (2,422.1 - 806.8)

Volume	Invert	Avail.Storage	Storage Description
#1	399.20'	372.576 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

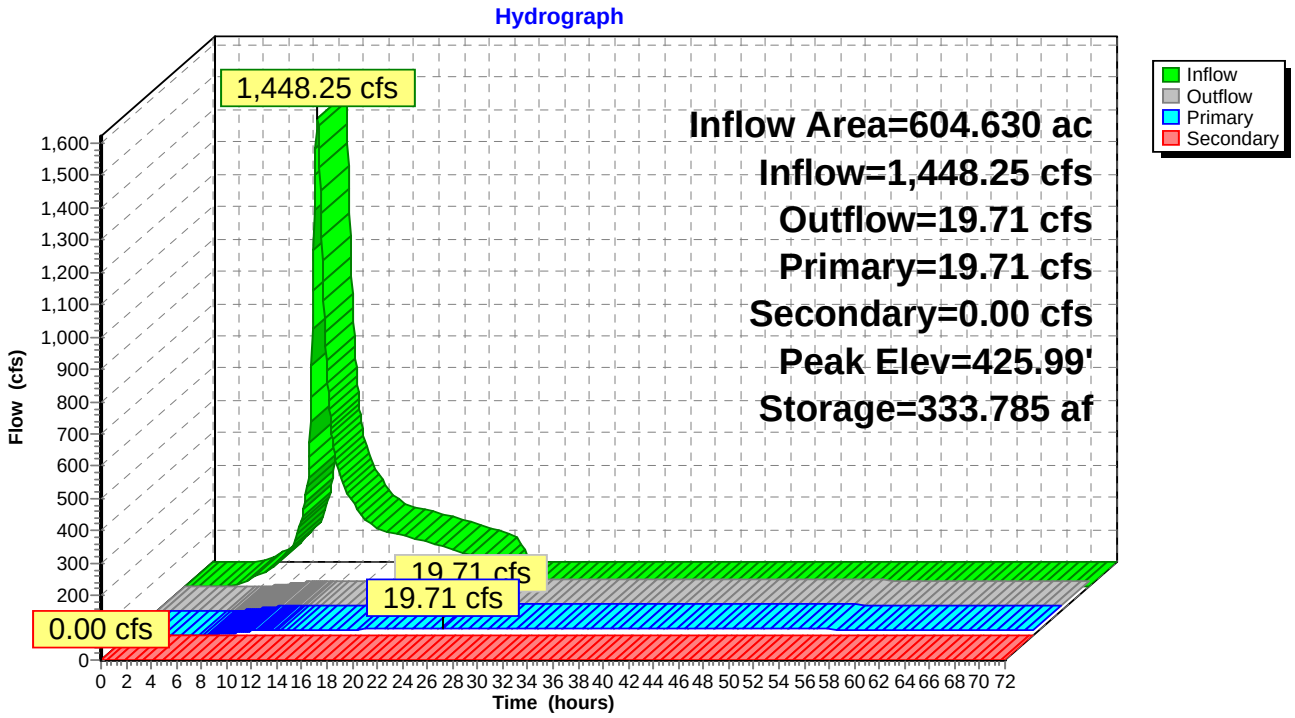
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
399.20	9.615	0.000	0.000
426.20	15.346	336.974	336.974
428.50	15.613	35.603	372.576

Device	Routing	Invert	Outlet Devices
#1	Secondary	428.50'	**40.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	399.20'	**18.0" Round Culvert** L= 1,200.0' RCP, square edge headwall, Ke= 0.500 Outlet Invert= 379.20' S= 0.0167 '/' Cc= 0.900 n= 0.013 Concrete pipe, straight & clean

Primary OutFlow Max=19.71 cfs @ 25.01 hrs HW=425.99' (Free Discharge)
└**2=Culvert** (Barrel Controls 19.71 cfs @ 11.15 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=399.20' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Crater 1



Summary for Pond 4P: Detention Basin 2

Inflow Area = 418.810 ac, 0.00% Impervious, Inflow Depth = 8.41" for 100-YR event
Inflow = 2,602.45 cfs @ 9.99 hrs, Volume= 293.388 af
Outflow = 348.17 cfs @ 10.76 hrs, Volume= 281.689 af, Atten= 87%, Lag= 46.5 min
Primary = 348.17 cfs @ 10.76 hrs, Volume= 281.689 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 122.41' @ 10.76 hrs Surf.Area= 17.680 ac Storage= 124.310 af

Plug-Flow detention time= 367.4 min calculated for 281.493 af (96% of inflow)
Center-of-Mass det. time= 342.5 min (1,076.0 - 733.5)

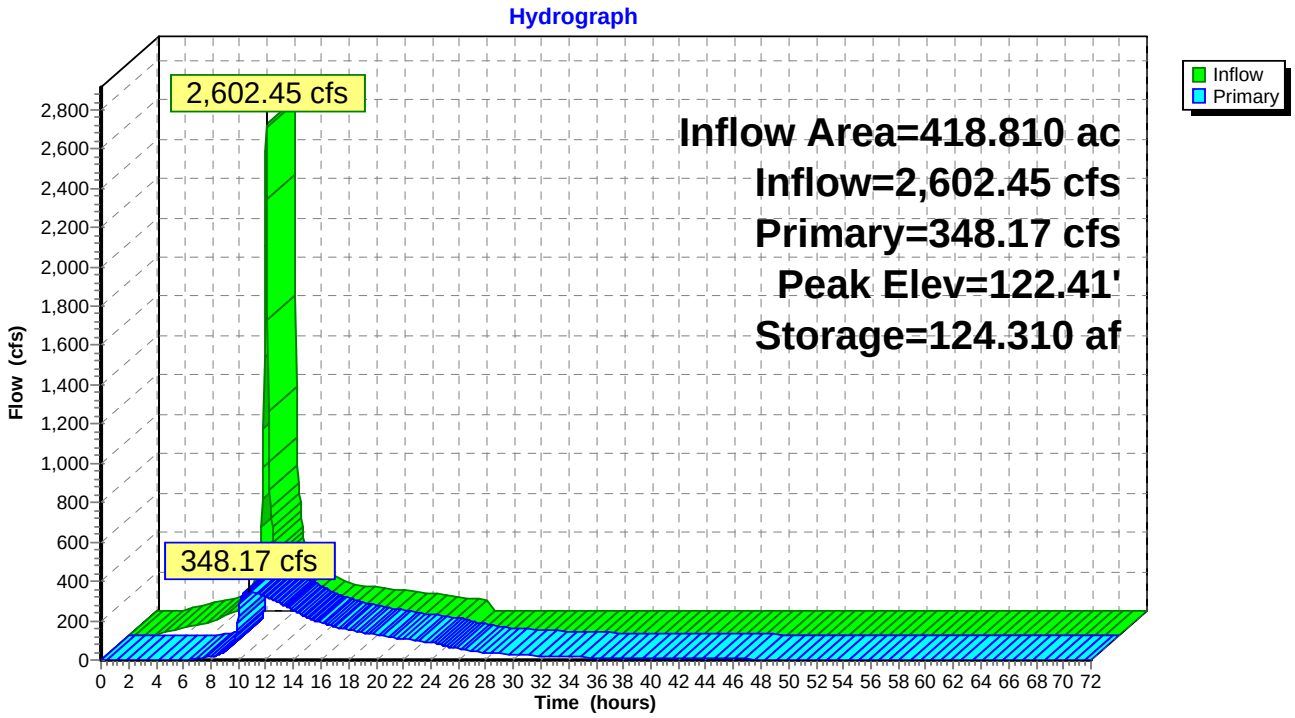
Volume	Invert	Avail.Storage	Storage Description
#1	115.00'	170.983 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
115.00	15.894	0.000	0.000
119.00	16.852	65.492	65.492
123.00	17.824	69.352	134.844
125.00	18.315	36.139	170.983

Device	Routing	Invert	Outlet Devices
#1	Primary	119.59'	**48.0" Round 48" Culvert** L= 1,700.0' RCP, square edge headwall, Ke= 0.500 Outlet Invert= 24.00' S= 0.0562 '/' Cc= 0.900 n= 0.013 Concrete pipe, straight & clean
#2	Primary	115.40'	**75.5" Round 78" Culvert** L= 1,720.0' RCP, square edge headwall, Ke= 0.500 Outlet Invert= 15.56' S= 0.0580 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=348.15 cfs @ 10.76 hrs HW=122.41' (Free Discharge)
└─**1=48" Culvert** (Inlet Controls 54.03 cfs @ 5.71 fps)
└─**2=78" Culvert** (Inlet Controls 294.13 cfs @ 9.46 fps)

Pond 4P: Detention Basin 2



Summary for Pond 5P: Detention Basin 3

Inflow Area = 447.330 ac, 0.00% Impervious, Inflow Depth = 8.44" for 100-YR event
Inflow = 1,779.98 cfs @ 10.16 hrs, Volume= 314.687 af
Outflow = 209.76 cfs @ 12.84 hrs, Volume= 297.285 af, Atten= 88%, Lag= 161.1 min
Primary = 209.76 cfs @ 12.84 hrs, Volume= 297.285 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 62.71' @ 12.84 hrs Surf.Area= 18.980 ac Storage= 152.630 af

Plug-Flow detention time= 473.8 min calculated for 297.285 af (94% of inflow)
Center-of-Mass det. time= 437.5 min (1,182.1 - 744.6)

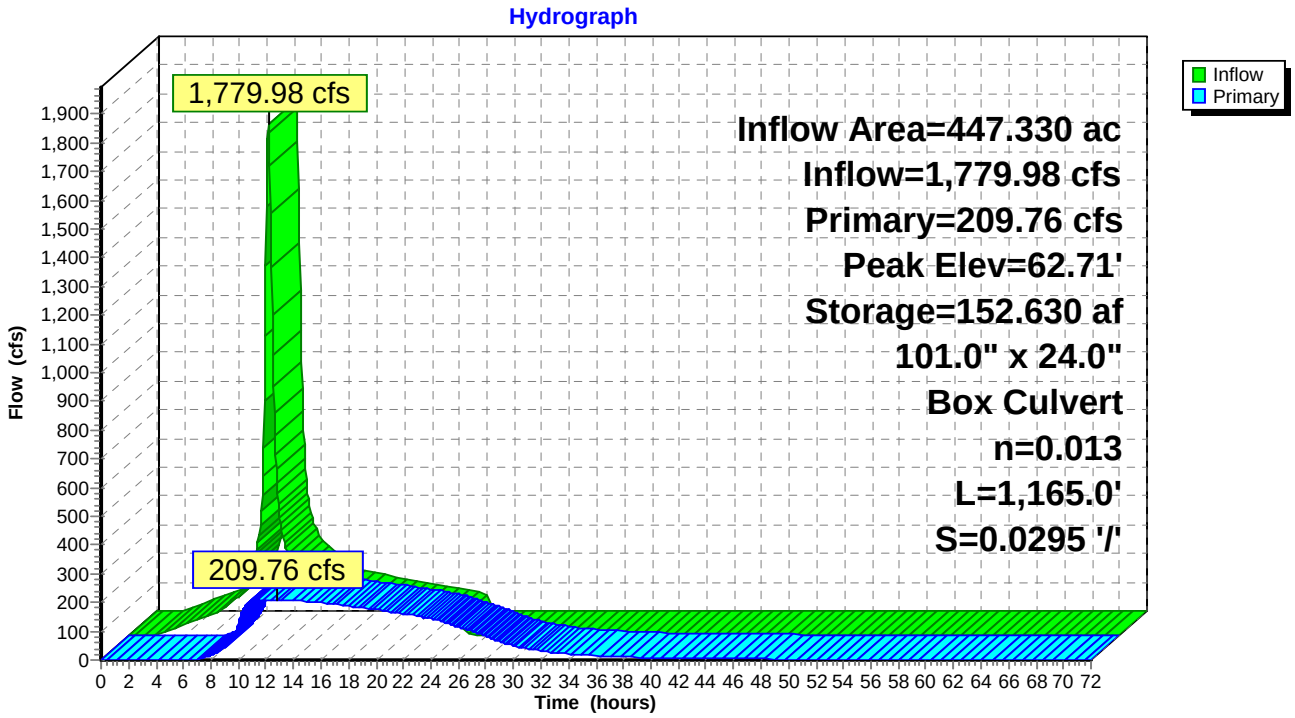
Volume	Invert	Avail.Storage	Storage Description
#1	54.00'	196.976 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
54.00	16.066	0.000	0.000
63.00	19.077	158.144	158.144
65.00	19.755	38.832	196.976

Device	Routing	Invert	Outlet Devices
#1	Primary	55.00'	**101.0" W x 24.0" H Box Culvert** L= 1,165.0' RCP, square edge headwall, Ke= 0.500 Outlet Invert= 20.65' S= 0.0295 '/' Cc= 0.900 n= 0.013 Concrete pipe, straight & clean

Primary OutFlow Max=209.76 cfs @ 12.84 hrs HW=62.71' (Free Discharge)
└─**1=Culvert** (Inlet Controls 209.76 cfs @ 12.46 fps)

Pond 5P: Detention Basin 3



Summary for Pond 7P: Detention Basin 4

Inflow Area = 52.540 ac, 0.00% Impervious, Inflow Depth = 7.78" for 100-YR event
Inflow = 296.43 cfs @ 10.01 hrs, Volume= 34.045 af
Outflow = 250.87 cfs @ 10.08 hrs, Volume= 29.557 af, Atten= 15%, Lag= 4.2 min
Primary = 250.87 cfs @ 10.08 hrs, Volume= 29.557 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 232.36' @ 10.08 hrs Surf.Area= 1.144 ac Storage= 7.044 af

Plug-Flow detention time= 139.2 min calculated for 29.557 af (87% of inflow)
Center-of-Mass det. time= 61.6 min (813.5 - 751.9)

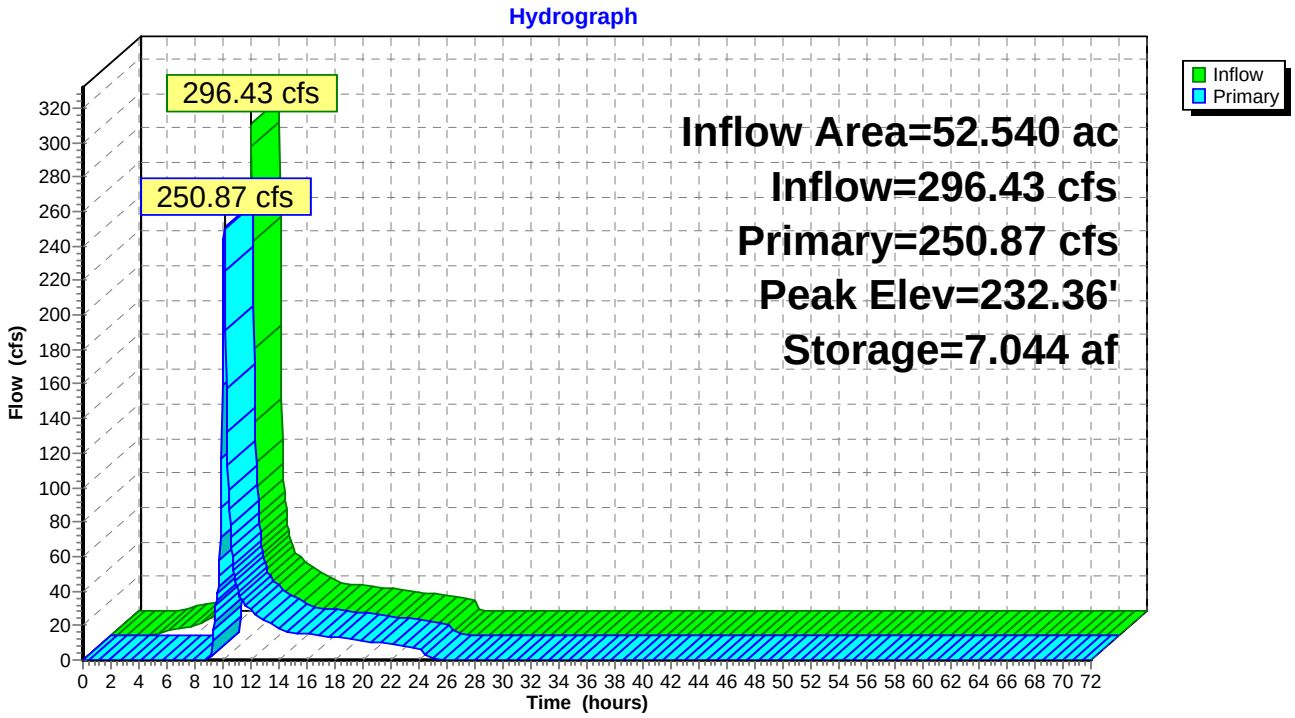
Volume	Invert	Avail.Storage	Storage Description
#1	225.00'	10.256 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

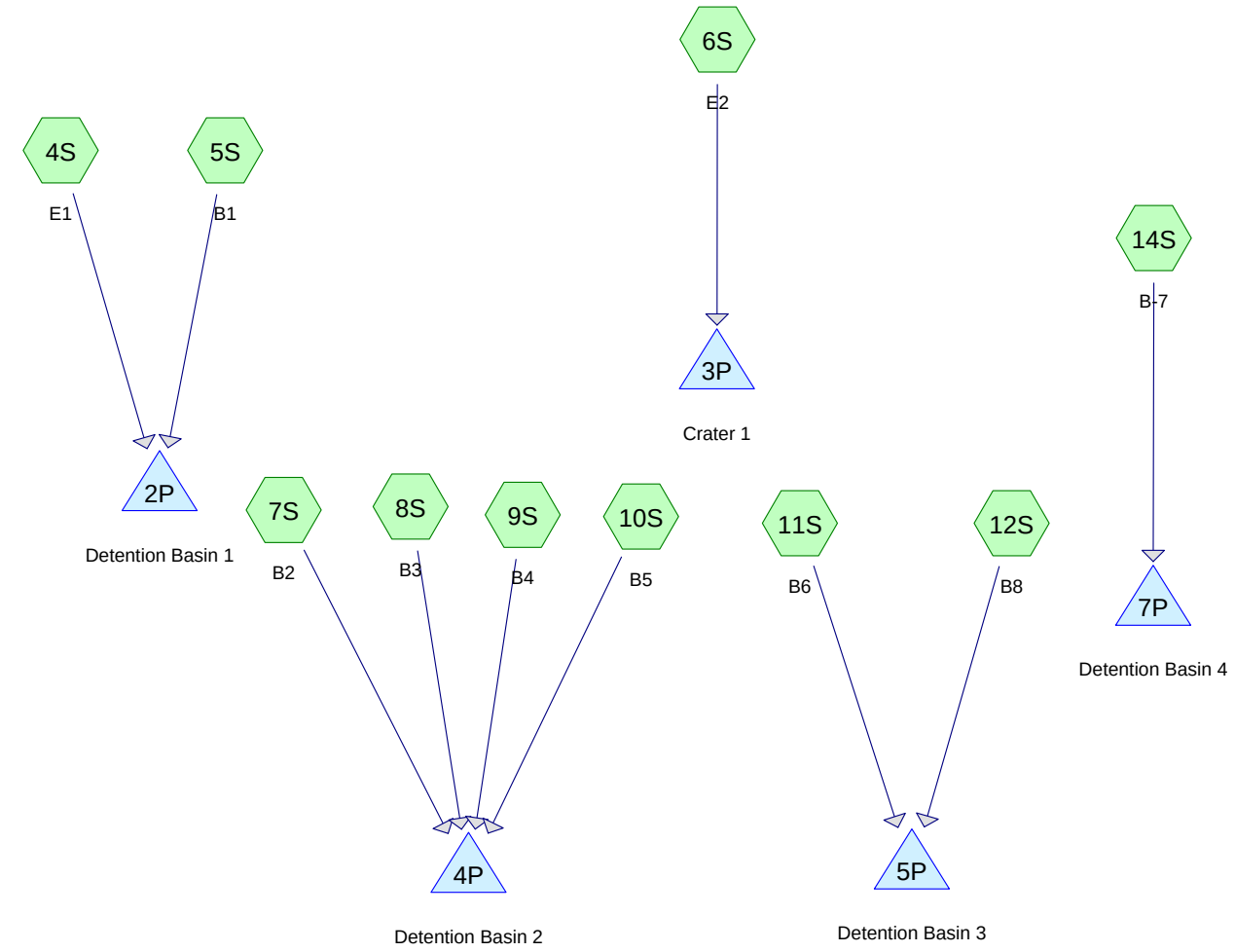
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
225.00	0.771	0.000	0.000
233.00	1.176	7.788	7.788
235.00	1.292	2.468	10.256

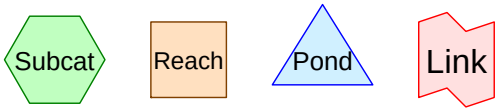
Device	Routing	Invert	Outlet Devices
#1	Primary	230.00'	**26.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=247.69 cfs @ 10.08 hrs HW=232.34' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 247.69 cfs @ 4.07 fps)

Pond 7P: Detention Basin 4







Drainage Diagram for Land Use Concept Three
Prepared by Belt Collins Hawaii, Printed 10/17/2009
HydroCAD® 9.00 s/n 06009 © 2009 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
78.490	75	(4S)
604.630	77	(6S)
52.540	82	(14S)
112.750	84	(5S, 8S)
408.440	86	(7S, 9S, 10S)
383.860	87	(11S)
63.470	88	(12S)
1,704.180		**TOTAL AREA**

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 4S: E1 Runoff Area=78.490 ac 0.00% Impervious Runoff Depth=6.88"
Flow Length=6,469' Tc=28.4 min CN=75 Runoff=259.82 cfs 44.983 af

Subcatchment 5S: B1 Runoff Area=102.380 ac 0.00% Impervious Runoff Depth=8.03"
Tc=28.4 min CN=84 Runoff=395.01 cfs 68.502 af

Subcatchment 6S: E2 Runoff Area=604.630 ac 0.00% Impervious Runoff Depth=7.14"
Flow Length=9,253' Slope=0.1500 '/' Tc=53.3 min CN=77 Runoff=1,448.25 cfs 359.539 af

Subcatchment 7S: B2 Runoff Area=29.520 ac 0.00% Impervious Runoff Depth=8.28"
Flow Length=1,653' Tc=10.7 min CN=86 Runoff=176.07 cfs 20.371 af

Subcatchment 8S: B3 Runoff Area=10.370 ac 0.00% Impervious Runoff Depth=8.03"
Flow Length=954' Slope=0.0900 '/' Tc=9.0 min CN=84 Runoff=63.11 cfs 6.938 af

Subcatchment 9S: B4 Runoff Area=218.250 ac 0.00% Impervious Runoff Depth=8.28"
Flow Length=3,710' Tc=7.7 min CN=86 Runoff=1,404.92 cfs 150.610 af

Subcatchment 10S: B5 Runoff Area=160.670 ac 0.00% Impervious Runoff Depth=8.28"
Flow Length=4,751' Tc=13.1 min CN=86 Runoff=901.37 cfs 110.875 af

Subcatchment 11S: B6 Runoff Area=383.860 ac 0.00% Impervious Runoff Depth=8.41"
Flow Length=7,088' Tc=33.0 min CN=87 Runoff=1,419.03 cfs 268.905 af

Subcatchment 12S: B8 Runoff Area=63.470 ac 0.00% Impervious Runoff Depth=8.53"
Flow Length=4,249' Tc=15.0 min CN=88 Runoff=346.65 cfs 45.123 af

Subcatchment 14S: B-7 Runoff Area=52.540 ac 0.00% Impervious Runoff Depth=7.78"
Flow Length=1,561' Tc=10.8 min CN=82 Runoff=296.43 cfs 34.045 af

Pond 2P: Detention Basin 1 Inflow=654.79 cfs 113.484 af
Primary=654.79 cfs 113.484 af

Pond 3P: Crater 1 Peak Elev=425.99' Storage=333.785 af Inflow=1,448.25 cfs 359.539 af
Primary=19.71 cfs 99.631 af Secondary=0.00 cfs 0.000 af Outflow=19.71 cfs 99.631 af

Pond 4P: Detention Basin 2 Peak Elev=122.51' Storage=128.451 af Inflow=2,471.35 cfs 288.796 af
Outflow=345.92 cfs 248.759 af

Pond 5P: Detention Basin 3 Peak Elev=62.43' Storage=156.743 af Inflow=1,591.50 cfs 314.028 af
103.0" x 24.0" Box Culvert n=0.013 L=1,165.0' S=0.0295 '/' Outflow=209.42 cfs 283.097 af

Pond 7P: Detention Basin 4 Peak Elev=232.36' Storage=7.044 af Inflow=296.43 cfs 34.045 af
Outflow=250.87 cfs 29.557 af

Total Runoff Area = 1,704.180 ac Runoff Volume = 1,109.892 af Average Runoff Depth = 7.82"
100.00% Pervious = 1,704.180 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 4S: E1

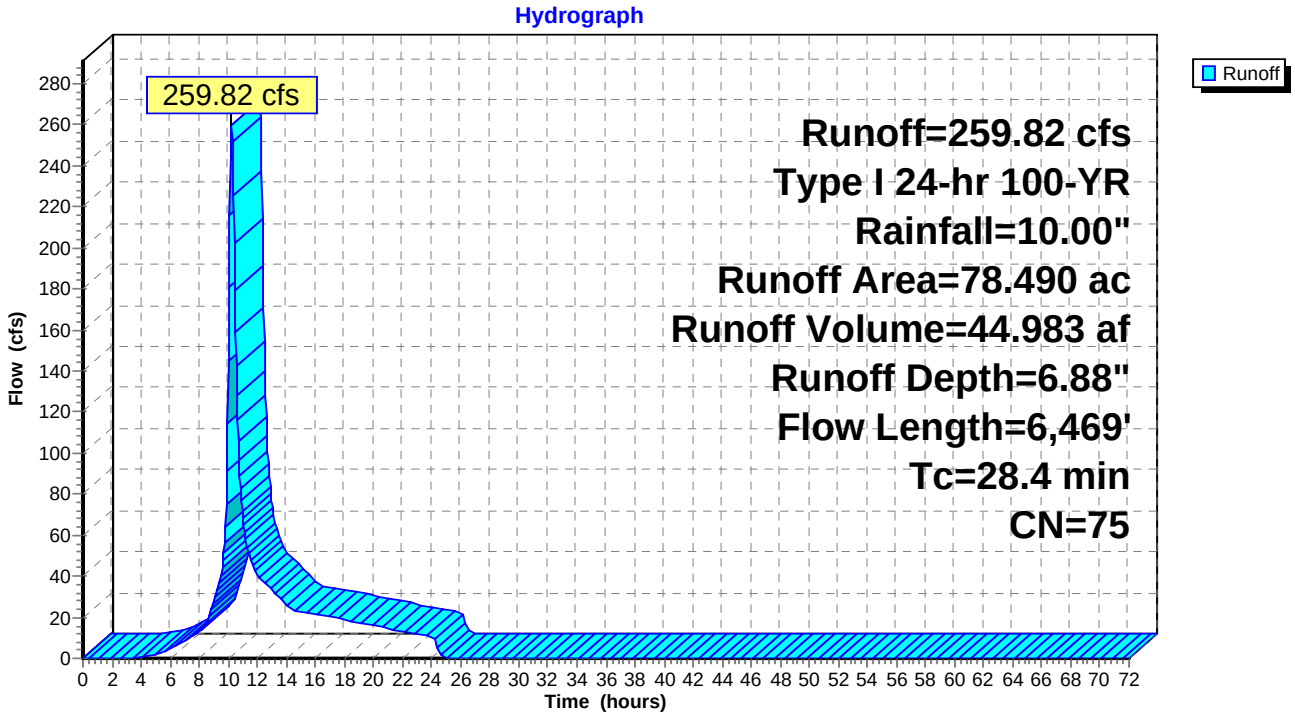
Runoff = 259.82 cfs @ 10.22 hrs, Volume= 44.983 af, Depth= 6.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	78.490	75	
	78.490		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.4	3,417	0.1400	2.16		**Lag/CN Method,**
2.0	3,052	0.1000	26.01	4,030.80	**Channel Flow,** Area= 155.0 sf Perim= 57.5' r= 2.70' n= 0.035
28.4	6,469	Total			

Subcatchment 4S: E1



Summary for Subcatchment 5S: B1

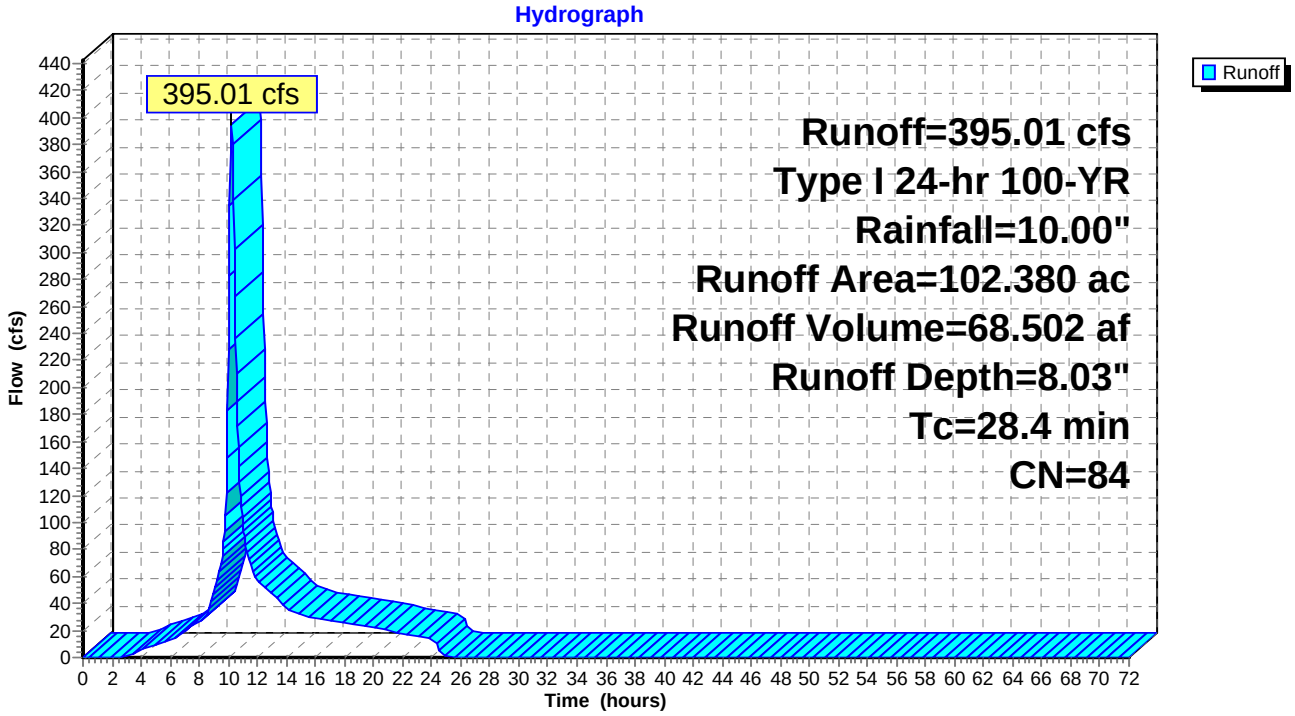
Runoff = 395.01 cfs @ 10.22 hrs, Volume= 68.502 af, Depth= 8.03"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	102.380	84	
	102.380		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.4					**Direct Entry, Basin E1, B1, E2A Tc**

Subcatchment 5S: B1



Summary for Subcatchment 6S: E2

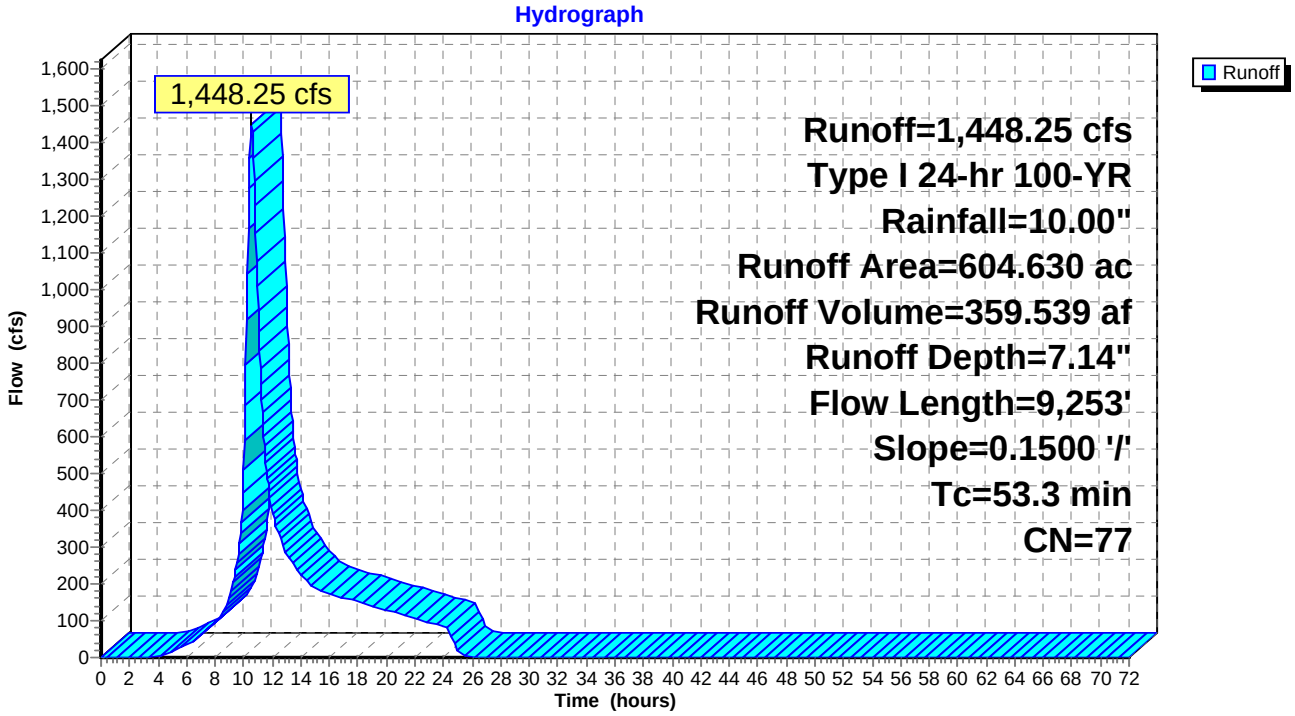
Runoff = 1,448.25 cfs @ 10.54 hrs, Volume= 359.539 af, Depth= 7.14"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	604.630	77	
	604.630		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
53.3	9,253	0.1500	2.89		**Lag/CN Method,**

Subcatchment 6S: E2



Summary for Subcatchment 7S: B2

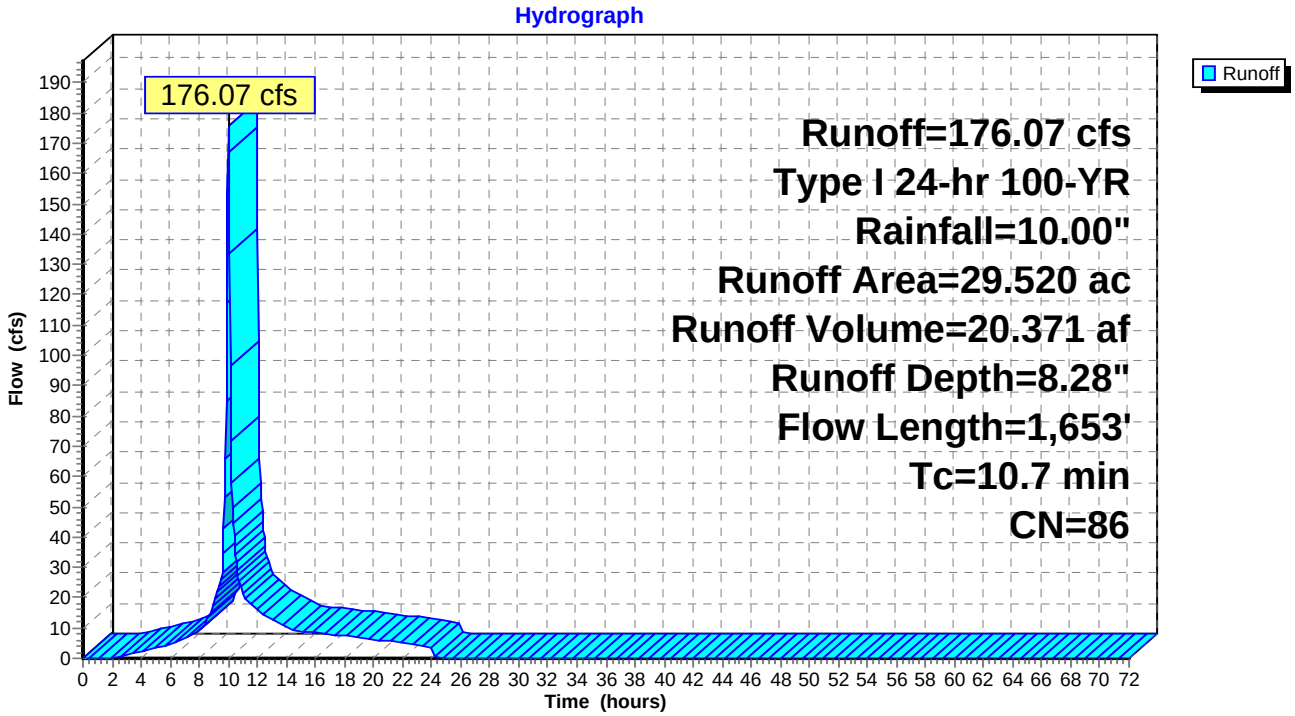
Runoff = 176.07 cfs @ 10.01 hrs, Volume= 20.371 af, Depth= 8.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	29.520	86	
	29.520		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	1,447	0.1100	2.29		**Lag/CN Method, B-2**
0.2	206	0.0200	15.43	137.33	**Channel Flow, B-2 Channel Flow**
					Area= 8.9 sf Perim= 7.7' r= 1.16' n= 0.015
10.7	1,653	Total			

Subcatchment 7S: B2



Summary for Subcatchment 8S: B3

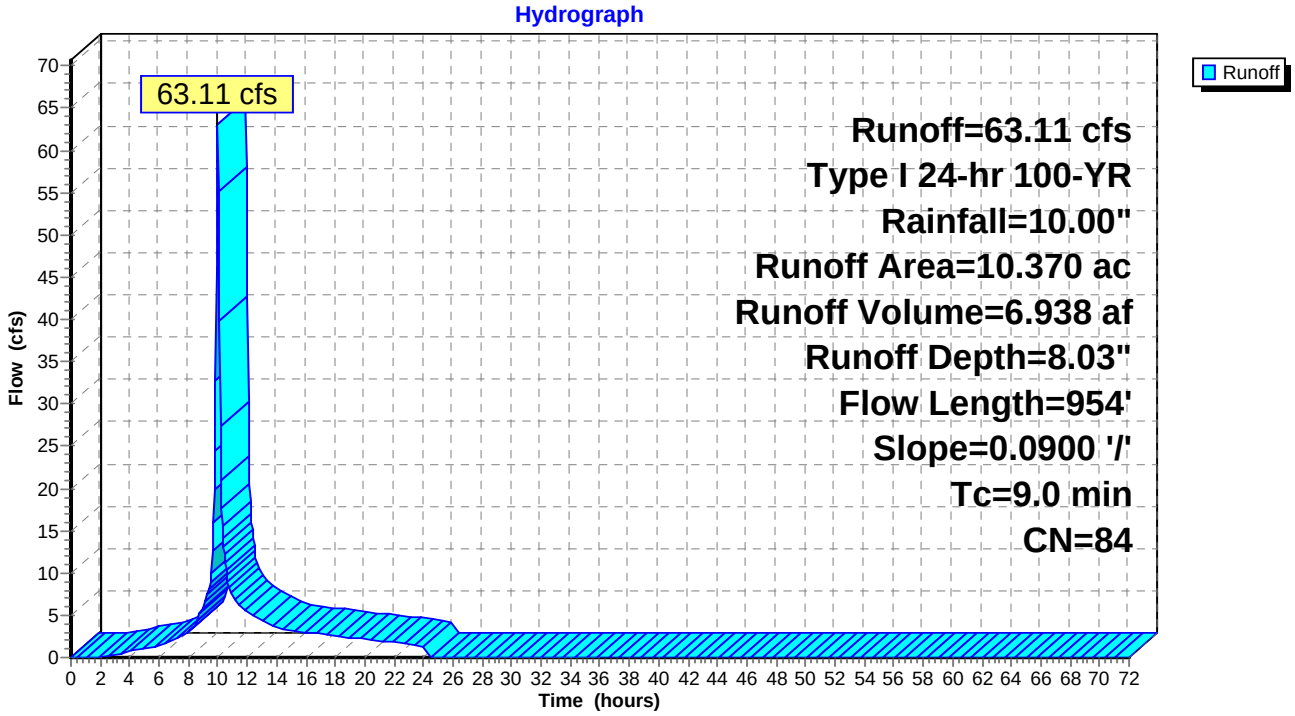
Runoff = 63.11 cfs @ 9.99 hrs, Volume= 6.938 af, Depth= 8.03"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	10.370	84	
	10.370		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	954	0.0900	1.78		**Lag/CN Method, B-3**

Subcatchment 8S: B3



Summary for Subcatchment 9S: B4

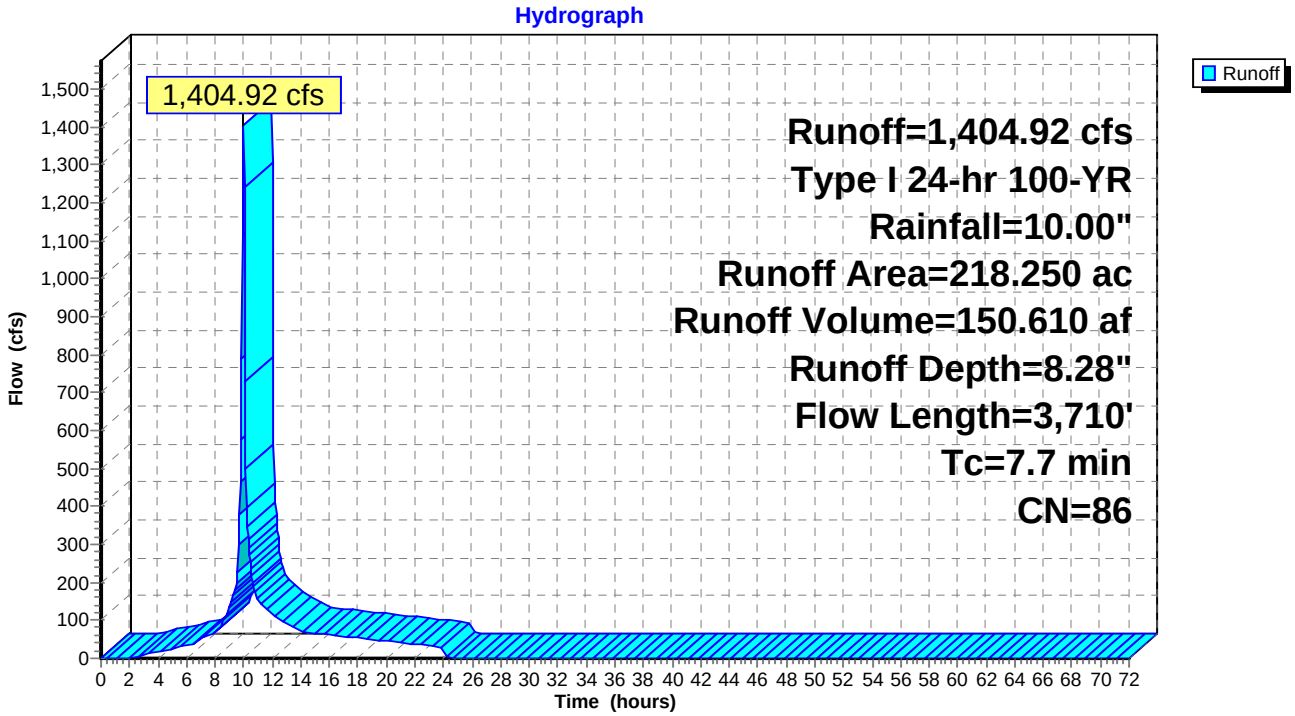
Runoff = 1,404.92 cfs @ 9.98 hrs, Volume= 150.610 af, Depth= 8.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	218.250	86	
	218.250		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	769	0.1300	2.19		**Lag/CN Method,**
1.9	2,941	0.0900	25.50	5,647.94	**Channel Flow,** Area= 221.5 sf Perim= 78.2' r= 2.83' n= 0.035
7.7	3,710	Total			

Subcatchment 9S: B4



Summary for Subcatchment 10S: B5

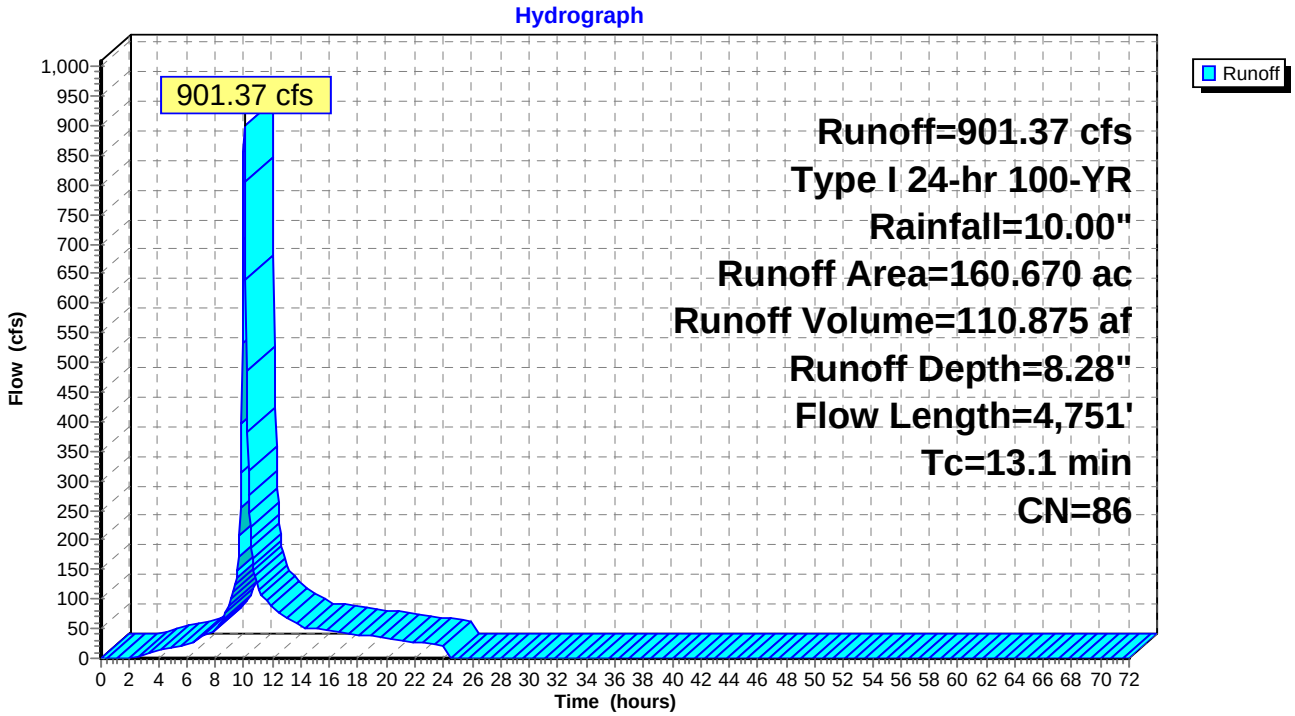
Runoff = 901.37 cfs @ 10.04 hrs, Volume= 110.875 af, Depth= 8.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	160.670	86	
	160.670		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.1	1,797	0.1400	2.70		**Lag/CN Method,**
2.0	2,954	0.0600	24.99	10,091.38	**Channel Flow,** Area= 403.8 sf Perim= 108.4' r= 3.73' n= 0.035
13.1	4,751	Total			

Subcatchment 10S: B5



Summary for Subcatchment 11S: B6

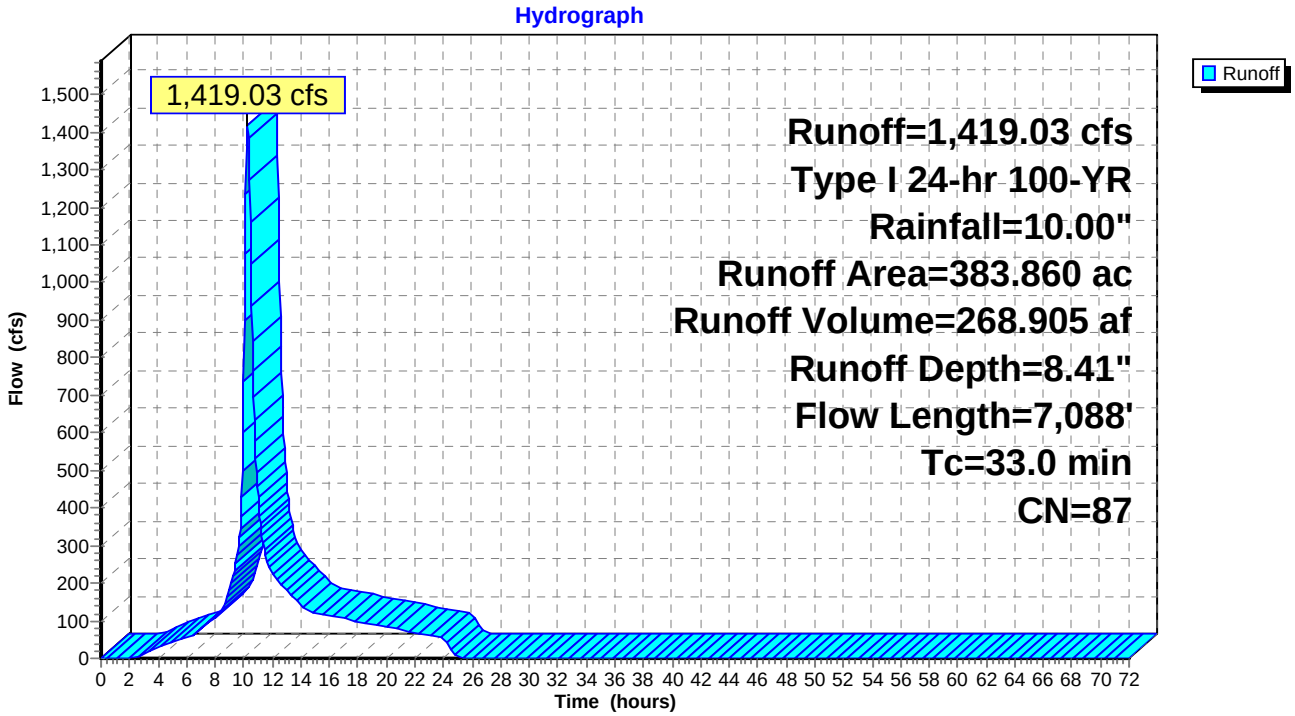
Runoff = 1,419.03 cfs @ 10.27 hrs, Volume= 268.905 af, Depth= 8.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	383.860	87	
	383.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
31.5	4,491	0.0700	2.38		**Lag/CN Method,**
1.5	2,597	0.0900	29.01	22,567.77	**Channel Flow,** Area= 777.9 sf Perim= 226.3' r= 3.44' n= 0.035
33.0	7,088	Total			

Subcatchment 11S: B6



Summary for Subcatchment 12S: B8

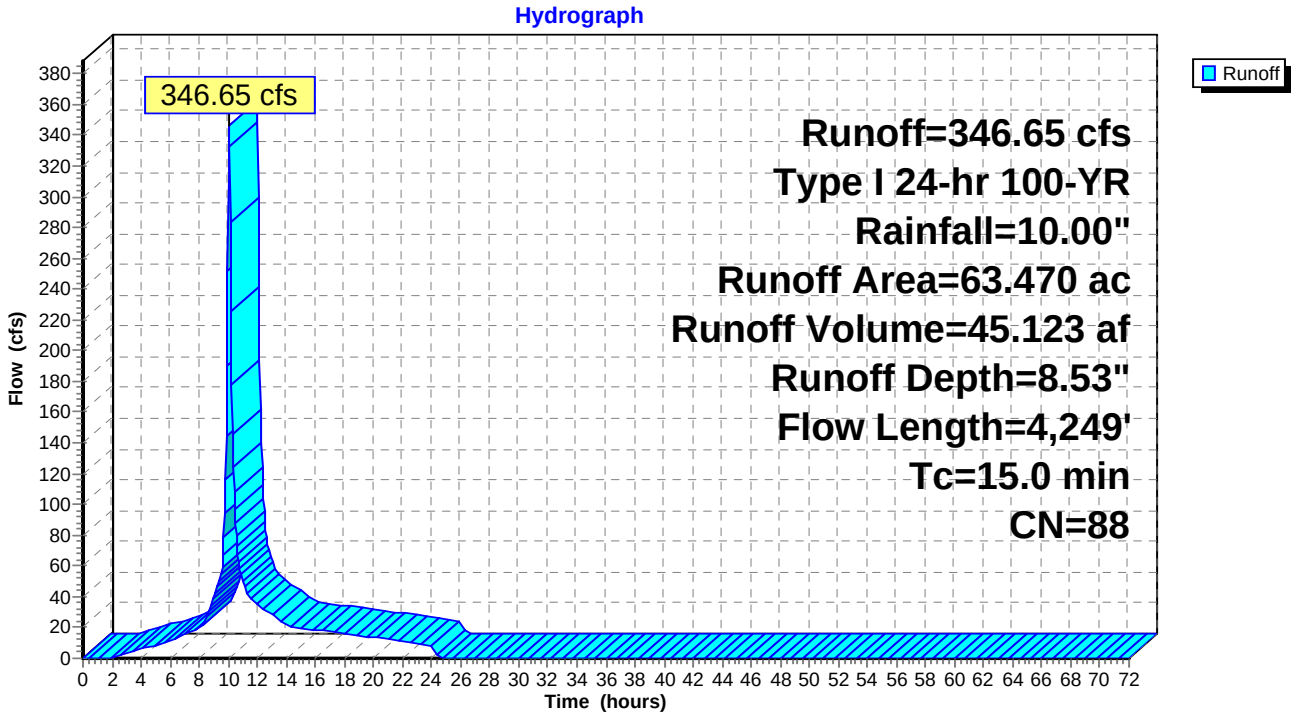
Runoff = 346.65 cfs @ 10.06 hrs, Volume= 45.123 af, Depth= 8.53"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	63.470	88	
	63.470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.8	2,097	0.1000	2.53		**Lag/CN Method,**
1.2	2,152	0.0800	30.73	261.23	**Channel Flow,** Area= 8.5 sf Perim= 7.4' r= 1.15' n= 0.015
15.0	4,249	Total			

Subcatchment 12S: B8



Summary for Subcatchment 14S: B-7

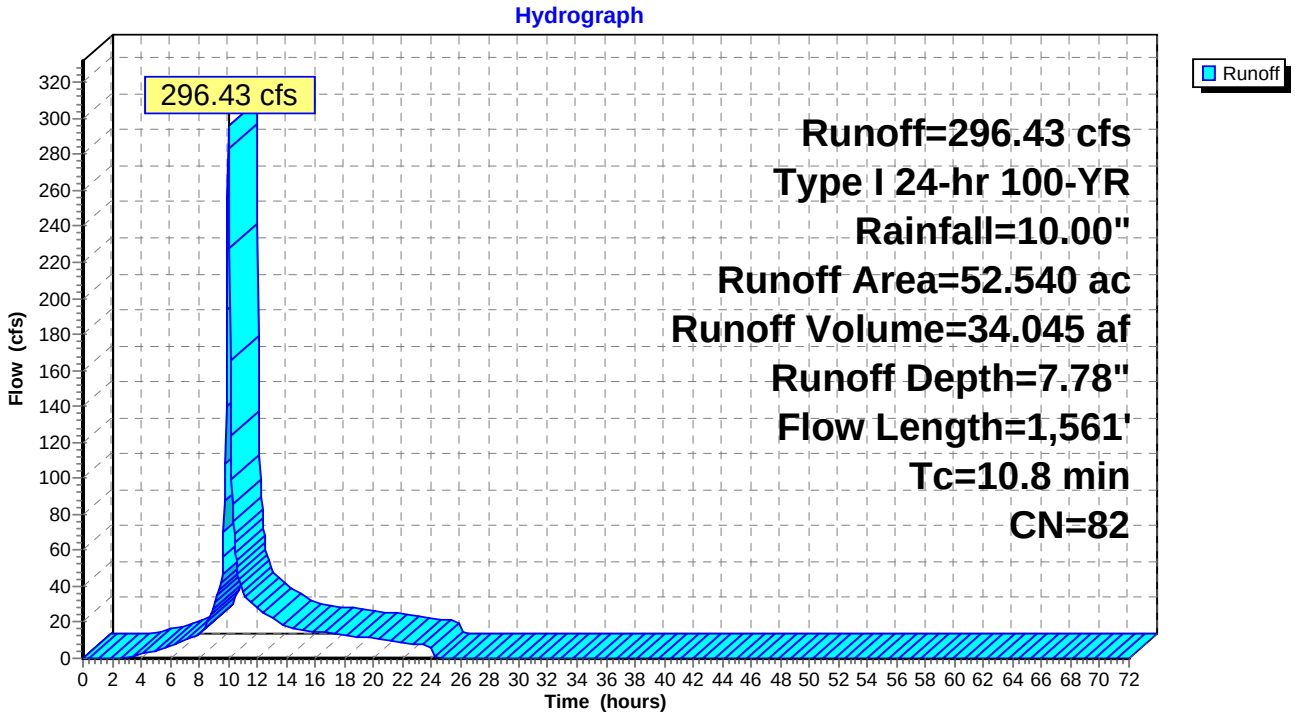
Runoff = 296.43 cfs @ 10.01 hrs, Volume= 34.045 af, Depth= 7.78"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type I 24-hr 100-YR Rainfall=10.00"

	Area (ac)	CN	Description
*	52.540	82	
	52.540		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	1,294	0.1200	2.04		**Lag/CN Method,**
0.2	267	0.0500	26.35	287.26	**Channel Flow,** Area= 10.9 sf Perim= 8.4' r= 1.30' n= 0.015
10.8	1,561	Total			

Subcatchment 14S: B-7



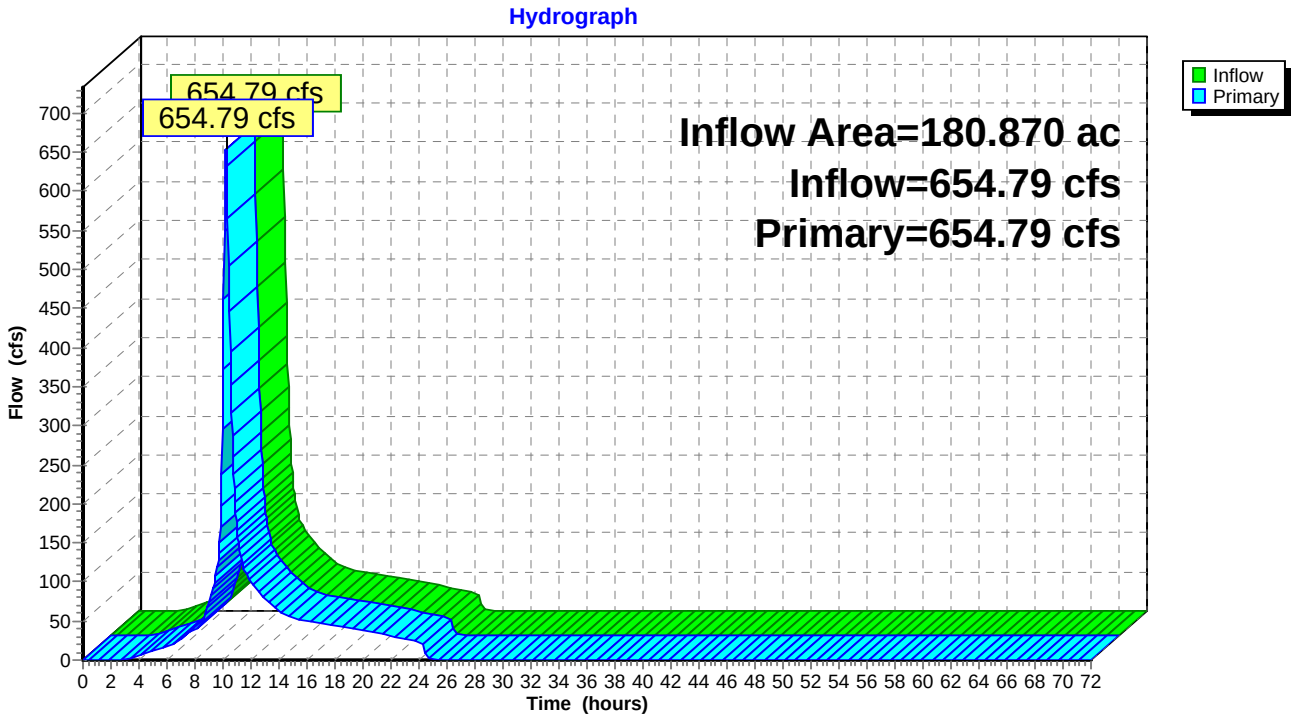
Summary for Pond 2P: Detention Basin 1

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 180.870 ac, 0.00% Impervious, Inflow Depth = 7.53" for 100-YR event
Inflow = 654.79 cfs @ 10.22 hrs, Volume= 113.484 af
Primary = 654.79 cfs @ 10.22 hrs, Volume= 113.484 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Pond 2P: Detention Basin 1



Summary for Pond 3P: Crater 1

Inflow Area = 604.630 ac, 0.00% Impervious, Inflow Depth = 7.14" for 100-YR event
Inflow = 1,448.25 cfs @ 10.54 hrs, Volume= 359.539 af
Outflow = 19.71 cfs @ 25.01 hrs, Volume= 99.631 af, Atten= 99%, Lag= 868.2 min
Primary = 19.71 cfs @ 25.01 hrs, Volume= 99.631 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 425.99' @ 25.01 hrs Surf.Area= 15.302 ac Storage= 333.785 af

Plug-Flow detention time= 1,852.0 min calculated for 99.631 af (28% of inflow)
Center-of-Mass det. time= 1,615.3 min (2,422.1 - 806.8)

Volume	Invert	Avail.Storage	Storage Description
#1	399.20'	372.576 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

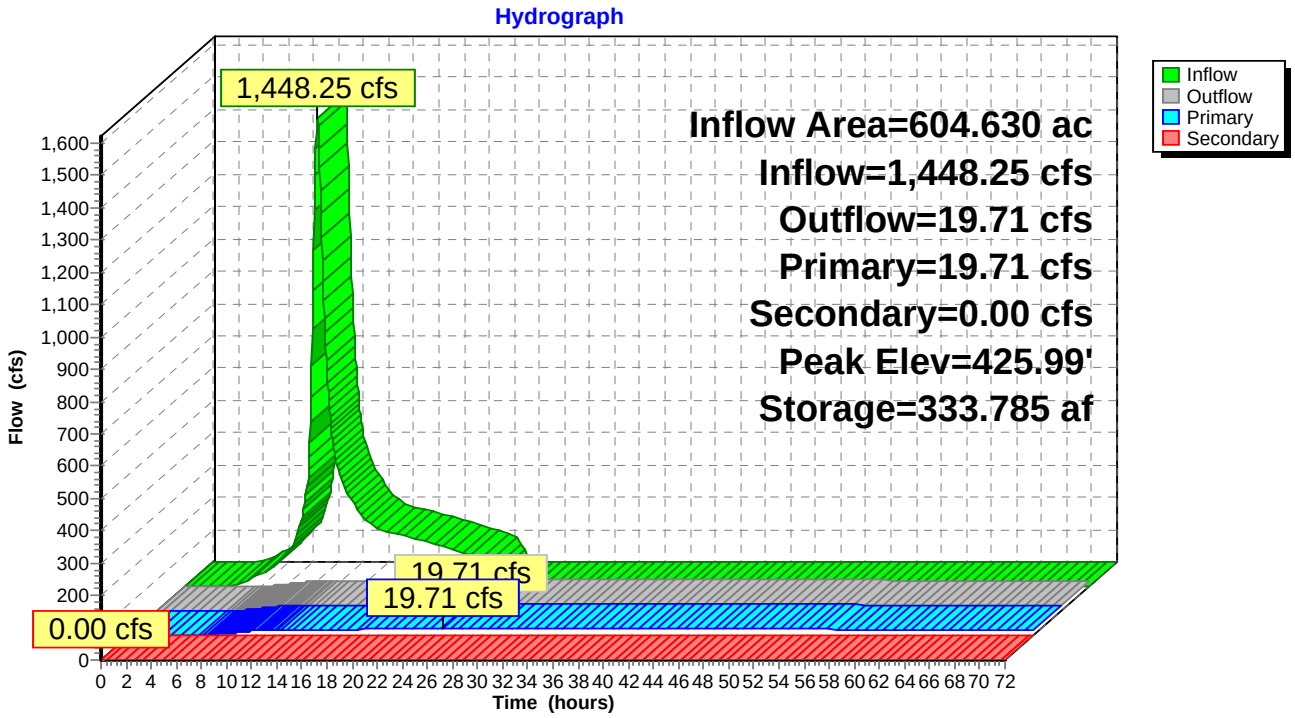
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
399.20	9.615	0.000	0.000
426.20	15.346	336.974	336.974
428.50	15.613	35.603	372.576

Device	Routing	Invert	Outlet Devices
#1	Secondary	428.50'	**40.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	399.20'	**18.0" Round Culvert** L= 1,200.0' RCP, square edge headwall, Ke= 0.500 Outlet Invert= 379.20' S= 0.0167 '/' Cc= 0.900 n= 0.013 Concrete pipe, straight & clean

Primary OutFlow Max=19.71 cfs @ 25.01 hrs HW=425.99' (Free Discharge)
└**2=Culvert** (Barrel Controls 19.71 cfs @ 11.15 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=399.20' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Crater 1



Summary for Pond 4P: Detention Basin 2

Inflow Area = 418.810 ac, 0.00% Impervious, Inflow Depth = 8.27" for 100-YR event
Inflow = 2,471.35 cfs @ 10.00 hrs, Volume= 288.796 af
Outflow = 345.92 cfs @ 10.78 hrs, Volume= 248.759 af, Atten= 86%, Lag= 47.2 min
Primary = 345.92 cfs @ 10.78 hrs, Volume= 248.759 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 122.51' @ 10.78 hrs Surf.Area= 14.151 ac Storage= 128.451 af

Plug-Flow detention time= 385.0 min calculated for 248.759 af (86% of inflow)
Center-of-Mass det. time= 303.4 min (1,041.5 - 738.1)

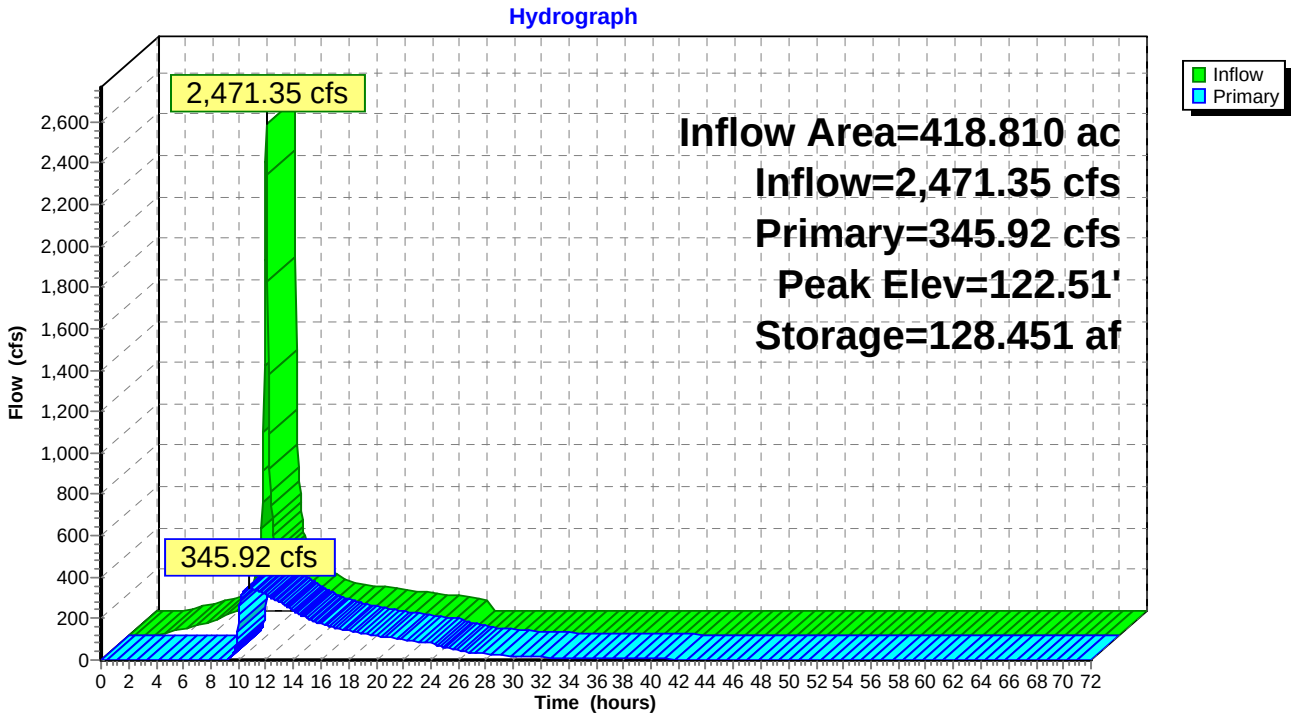
Volume	Invert	Avail.Storage	Storage Description
#1	112.00'	164.842 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
112.00	10.327	0.000	0.000
119.00	12.833	81.060	81.060
123.00	14.334	54.334	135.394
125.00	15.114	29.448	164.842

Device	Routing	Invert	Outlet Devices
#1	Primary	119.59'	**48.0" Round 48" Culvert** L= 1,700.0' RCP, square edge headwall, Ke= 0.500 Outlet Invert= 24.00' S= 0.0562 '/' Cc= 0.900 n= 0.013 Concrete pipe, straight & clean
#2	Primary	115.40'	**74.0" Round 78" Culvert** L= 1,720.0' RCP, square edge headwall, Ke= 0.500 Outlet Invert= 15.56' S= 0.0580 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=345.90 cfs @ 10.78 hrs HW=122.51' (Free Discharge)
└─**1=48" Culvert** (Inlet Controls 57.25 cfs @ 5.82 fps)
└─**2=78" Culvert** (Inlet Controls 288.65 cfs @ 9.66 fps)

Pond 4P: Detention Basin 2



Summary for Pond 5P: Detention Basin 3

Inflow Area = 447.330 ac, 0.00% Impervious, Inflow Depth = 8.42" for 100-YR event
Inflow = 1,591.50 cfs @ 10.24 hrs, Volume= 314.028 af
Outflow = 209.42 cfs @ 12.98 hrs, Volume= 283.097 af, Atten= 87%, Lag= 164.6 min
Primary = 209.42 cfs @ 12.98 hrs, Volume= 283.097 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 62.43' @ 12.98 hrs Surf.Area= 18.681 ac Storage= 156.743 af

Plug-Flow detention time= 485.5 min calculated for 282.901 af (90% of inflow)
Center-of-Mass det. time= 426.2 min (1,179.1 - 752.9)

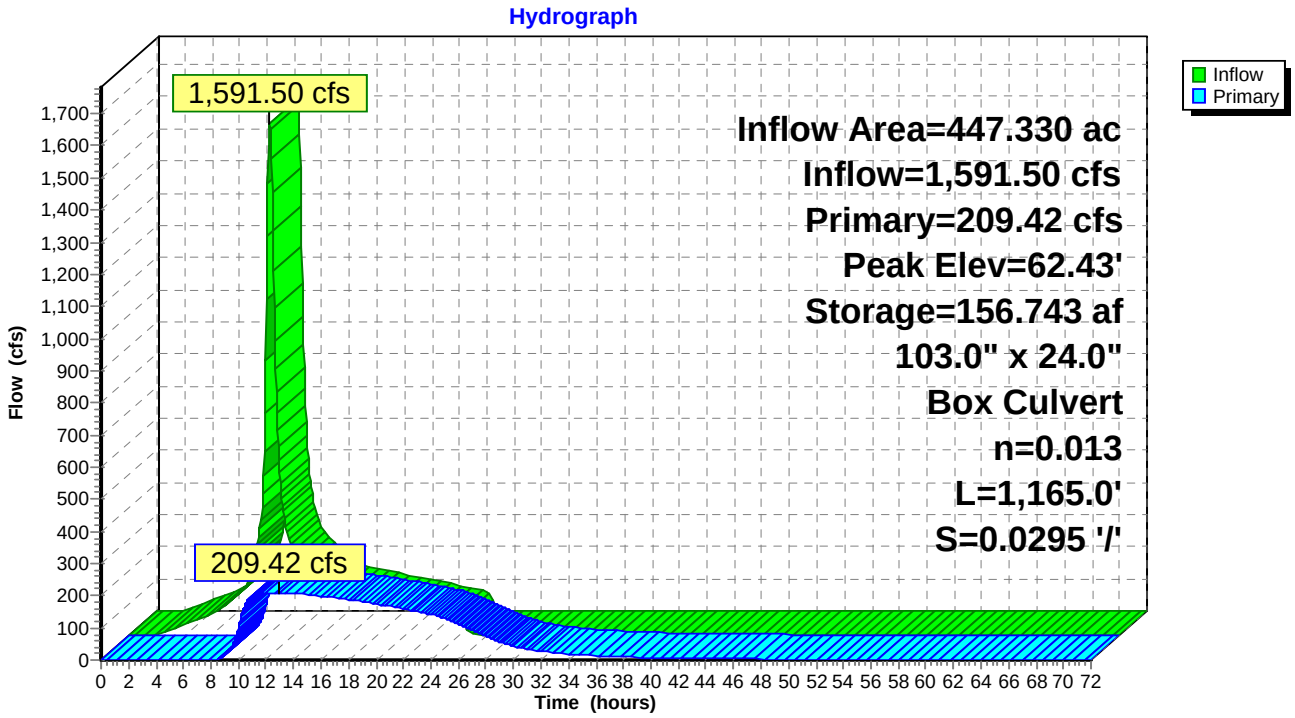
Volume	Invert	Avail.Storage	Storage Description
#1	53.00'	206.185 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
53.00	14.588	0.000	0.000
58.00	16.724	78.280	78.280
63.00	18.932	89.140	167.420
65.00	19.833	38.765	206.185

Device	Routing	Invert	Outlet Devices
#1	Primary	55.00'	**103.0" W x 24.0" H Box Culvert** L= 1,165.0' RCP, square edge headwall, Ke= 0.500 Outlet Invert= 20.65' S= 0.0295 '/' Cc= 0.900 n= 0.013 Concrete pipe, straight & clean

Primary OutFlow Max=209.42 cfs @ 12.98 hrs HW=62.43' (Free Discharge)
└─**1=Culvert** (Inlet Controls 209.42 cfs @ 12.20 fps)

Pond 5P: Detention Basin 3



Summary for Pond 7P: Detention Basin 4

Inflow Area = 52.540 ac, 0.00% Impervious, Inflow Depth = 7.78" for 100-YR event
Inflow = 296.43 cfs @ 10.01 hrs, Volume= 34.045 af
Outflow = 250.87 cfs @ 10.08 hrs, Volume= 29.557 af, Atten= 15%, Lag= 4.2 min
Primary = 250.87 cfs @ 10.08 hrs, Volume= 29.557 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 232.36' @ 10.08 hrs Surf.Area= 1.144 ac Storage= 7.044 af

Plug-Flow detention time= 139.2 min calculated for 29.557 af (87% of inflow)
Center-of-Mass det. time= 61.6 min (813.5 - 751.9)

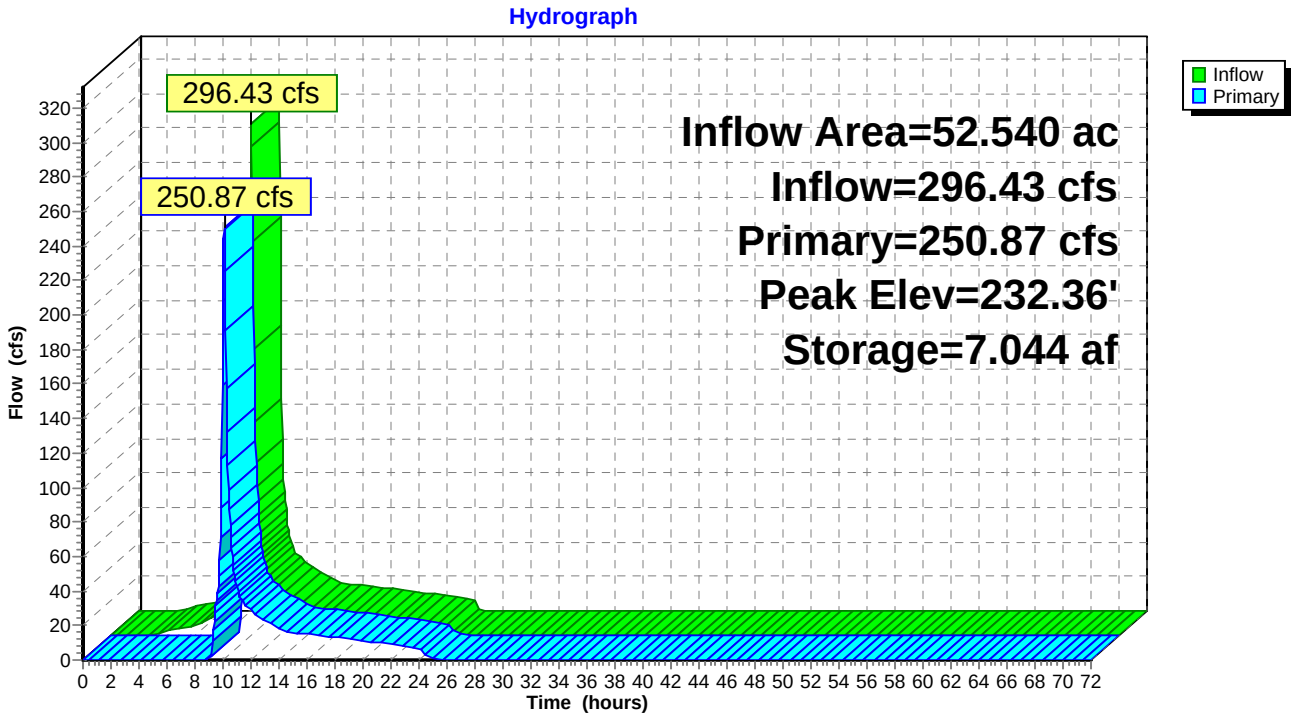
Volume	Invert	Avail.Storage	Storage Description
#1	225.00'	10.256 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
225.00	0.771	0.000	0.000
233.00	1.176	7.788	7.788
235.00	1.292	2.468	10.256

Device	Routing	Invert	Outlet Devices
#1	Primary	230.00'	**26.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=247.69 cfs @ 10.08 hrs HW=232.34' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 247.69 cfs @ 4.07 fps)

Pond 7P: Detention Basin 4



APPENDIX C

Design of Drainage Improvements

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PROJECT: Villages of Lealii
CLIENT: Hawaii Housing Finance Development Corp
DATE: 12-Oct-09
BY: adc

Table 7: Detention Basin Design Calculations

Detention Basin Storage Volumes, Concept One & Concept Two

	On-Site Basin	B1	B2	B3	B4	B5	B6	B7	B8	E1	E2	E2-A				
	Basin Area (acre)	102.38	29.52	10.37	218.25	160.67	383.86	52.54	63.47	78.49	604.63	65.71	*Peak Discharge (Inflow) Rate Qi	Cumulative Developed Runoff, Vr	**Peak Outflow Rate Qo	***Required Storage Volume Vs
	Existing Runoff Volume (ac-ft)	58.674	16.918	5.943	125.079	95.541	224.131	31.243	36.375	44.983	359.539	37.658				
	Developed Runoff Volume (ac-ft)	68.502	20.680	7.264	152.890	112.554	268.905	34.045	45.782	44.983	359.539	37.658				
Detention Basin	Developed Peak Flow Rate (cfs)	395.0	191.3	57.2	1,425.9	964.0	1,657.7	296.4	429.6	259.8	1,448.3	217.5	(cfs)	(ac-ft)	(cfs)	(ac-ft)
Crater Reservoir	% of Total Basin Area	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	1,448.3	359.539	20	333.785
1	% of Total Basin Area	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	654.8	113.485	655	7.167
2	% of Total Basin Area	0.0%	100.0%	100.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2,602.5	293.388	348	124.310
3	% of Total Basin Area	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	0.0%	1,780.0	314.687	210	152.630
4	% of Total Basin Area	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	296.4	34.045	251	7.044

*Cumulative inflow rates solved in HydroCAD. Values consider time-routing effects of tributary drainage basins

** Peak outflow rates determined by Crater Reservoir available storage, existing peak discharge rate for Detention Basin 1 & 4, allowable flow conveyance of downstream structures for Detention Basin 2 & 3.
*** Storage volumes, water depth, and water surface area solved in HydroCAD
**** Includes excavation of existing slope with approximate average slope of 8%
Additional Notes: Aside from Detention Basin 1, detention basins have 2:1 (H:V) side slopes
Detention Basin 1: Runoff to Hahakea Gulch reduced by cutoff ditch (runoff from Sub-Basin E2A re-routed to Crater Reservoir) - storage only needed for water quality.

Detention Basin Design, Concept One & Concept Two

					Includes Freeboard					
Detention Basin	Bottom Area	***Water Depth	***Water Surface Area	Freeboard	Detention Basin Depth	Detention Basin Top Area	Detention Basin Ave. Top Width	Detention Basin Ave. Top Length	***Detention Basin Volume	****Total Excavation
	(acre)	(ft)	(acre)	(ft)	(ft)	(acre)	(ft)	(ft)	(ac-ft)	(ac-ft)
Crater	9.615	Elev. 426.0	15.302	2.50	Elev. 428.5	15.613	-	-	372.576	-
1	-	-	-	-	-	-	-	-	-	-
2	15.894	7.41	17.680	1.00	8.41	17.925	390	2,000	142.207	474.620
3	16.066	8.71	18.980	1.00	9.71	19.318	300	2,800	171.791	447.162
4	0.771	7.36	1.144	1.00	8.36	1.196	200	260	8.222	19.587
								Total Excavation Volume (ac-ft) =		941.369
								Total Excavation Volume (yd³) =		1,518,742

Detention Basin Storage Volumes, Concept Three

	On-Site Basin	B1	B2	B3	B4	B5	B6	B7	B8	E1	E2	E2-A				
	Basin Area (acre)	102.38	29.52	10.37	218.25	160.67	383.86	52.54	63.47	78.49	604.63	65.71	*Peak Discharge (Inflow) Rate Qi	Cumulative Developed Runoff, Vr	**Peak Outflow Rate Qo	***Required Storage Volume Vs
	Existing Runoff Volume (ac-ft)	58.674	16.918	5.943	125.079	95.541	224.131	31.243	36.375	44.983	359.539	37.658				
	Developed Runoff Volume (ac-ft)	68.502	20.371	6.938	150.610	110.875	268.905	34.045	45.123	44.983	359.539	37.658				
Detention Basin	Developed Peak Flow Rate (cfs)	395.0	176.1	63.1	1,404.9	901.4	1,419.0	296.4	346.7	259.8	1,448.3	217.5	(cfs)	(ac-ft)	(cfs)	(ac-ft)
Crater Reservoir	% of Total Basin Area	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	1,448.3	359.539	20	333.785
1	% of Total Basin Area	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	654.8	113.485	655	7.167
2	% of Total Basin Area	0.0%	100.0%	100.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2,471.4	288.794	346	128.451
3	% of Total Basin Area	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	0.0%	1,591.5	314.028	209	156.743
4	% of Total Basin Area	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	296.4	34.045	251	7.044

*Cumulative inflow rates solved in HydroCAD. Values consider time-routing effects of tributary drainage basins

** Peak outflow rates determined by Crater Reservoir available storage, existing peak discharge rate for Detention Basin 1 & 4, allowable flow conveyance of downstream structures for Detention Basin 2 & 3.
*** Storage volumes, water depth, and water surface area solved in HydroCAD
**** Includes excavation of existing slope with approximate average slope of 8%
Additional Notes: Aside from Detention Basin 1, detention basins have 2:1 (H:V) side slopes
Detention Basin 1: Runoff to Hahakea Gulch reduced by cutoff ditch (runoff from Sub-Basin E2A re-routed to Crater Reservoir) - storage only needed for water quality.

Detention Basin Design, Concept Three

					Includes Freeboard					
Detention Basin	Bottom Area	***Water Depth	***Water Surface Area	Freeboard	Detention Basin Depth	Detention Basin Top Area	Detention Basin Ave. Top Width	Detention Basin Ave. Top Length	***Detention Basin Volume	****Total Excavation
	(acre)	(ft)	(acre)	(ft)	(ft)	(acre)	(ft)	(ft)	(ac-ft)	(ac-ft)
Crater	9.615	Elev. 426.0	15.302	2.50	Elev. 428.5	15.613	-	-	372.576	-
1	-	-	-	-	-	-	-	-	-	-
2	10.327	10.51	14.151	1.00	11.51	14.531	400	1,585	143.055	420.176
3	14.588	9.43	18.681	1.00	10.43	19.265	300	2,800	176.544	451.916
4	0.771	7.36	1.144	1.00	8.36	1.196	200	260	8.222	19.587
								Total Excavation Volume (ac-ft) =		891.679
								Total Excavation Volume (yd³) =		1,438,575

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PROJECT: Villages of Lealii
CLIENT: Hawaii Housing Finance Development Corp
DATE: 3-Oct-09
BY: adc

Table 8: Water Quality Detention Volumes

Land Use Concept One and Two

Detention Basin	Drainage Basin	B1	B2	B3	B4	B5	B6	B7	B8	Cumulative Area	Weighted CN	Runoff Coefficient, C	[1]Water Quality Design Volume	Water Quality Design Volume	Storage Volume
	Area (acre)	102.38	29.52	10.37	218.25	160.67	383.86	52.54	63.47						
	CN	84	87	87	87	87	87	82	89	(acre)	-	-	(ft^3)	(ac-ft)	(ac-ft)
1	% of drainage basin	100%	0%	0%	0%	0%	0%	0%	0%	102.38	84	0.84	312,177	7.167	0.000
2	% of drainage basin	0%	100%	100%	100%	100%	0%	0%	0%	418.81	87	0.87	1,322,644	30.364	124.310
3	% of drainage basin	0%	0%	0%	0%	0%	100%	0%	100%	447.33	87	0.87	1,412,713	32.431	152.630
4	% of drainage basin	0%	0%	0%	0%	0%	0%	100%	0%	52.54	82	0.82	156,391	3.590	7.044

Land Use Concept Three

Detention Basin	Drainage Basin	B1	B2	B3	B4	B5	B6	B7	B8	Cumulative Area	Weighted CN	Runoff Coefficient, C	Water Quality Design Volume	Water Quality Design Volume	Storage Volume
	Area (acre)	102.38	29.52	10.37	218.25	160.67	383.86	52.54	63.47						
	CN	84	86	84	86	86	87	82	88	(acre)	-	-	(ft^3)	(ac-ft)	(ac-ft)
1	% of drainage basin	100%	0%	0%	0%	0%	0%	0%	0%	102.38	84	0.84	312,177	7.167	0.000
2	% of drainage basin	0%	100%	100%	100%	100%	0%	0%	0%	418.81	86	0.86	1,307,441	30.015	128.451
3	% of drainage basin	0%	0%	0%	0%	0%	100%	0%	100%	447.33	87	0.87	1,412,713	32.431	156.743
4	% of drainage basin	0%	0%	0%	0%	0%	0%	100%	0%	52.54	82	0.82	156,391	3.590	7.044

[1]Source: Section 1-5.1.C of Rules Relating to Storm Drainage Standards. City and County of Honolulu, Department of Planning and Permitting. January, 2000.

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PROJECT: Villages of Leilii
CLIENT: Hawaii Housing Finance Development Corp
DATE: 30-Sep-09
BY: adc

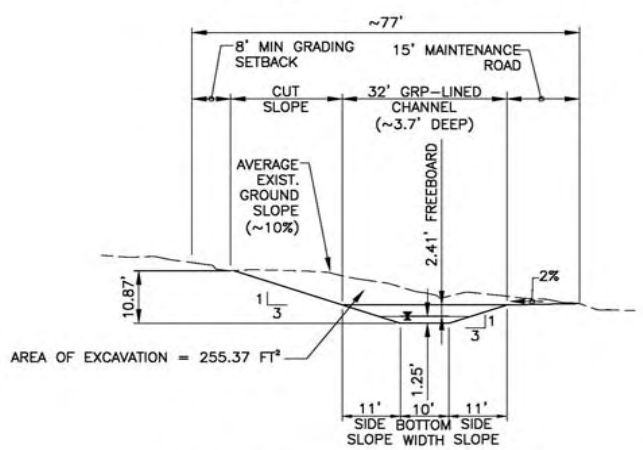
Table 9: Cutoff Ditch-North & Cutoff Ditch-South Design Calculations for Land Use Concept One through Land Use Concept Three

Portion	Off-Site Basin Basin Area (acre) Peak Flow (cfs)	E1 78.49 259.8	E2 604.63 1,448.3	Tributary Qp* (cfs)	n^1	Channel Slope** (ft/ft)	Bottom Width (ft)	Left Side Slope H:V (ft/ft)	Right Side Slope H:V (ft/ft)	Velocity*** (ft/s)	Flow Depth*** (ft)	Freeboard[2] (cfs)	Channel Depth (ft)	Said Channel Depth (ft)	Top Width (ft)	Channel Length (ft)	****Area of Excavation (ft^2)	Excavation Volume (yd^3)
Cutoff Ditch-North																		
-	% of Total Basin Area	100.0%	0.0%	259.8	0.025	0.067	10.0	3.0	3.0	15.04	1.25	2.41	3.66	3.70	32.2	840	255.37	7,945
															Cutoff Ditch-North Total Excavation Volume (yd^3) =			7,945
Cutoff Ditch-South																		
1	% of Total Basin Area	0.0%	18.3%	264.5	0.025	0.038	10.0	3.0	3.0	12.40	1.48	2.35	3.83	3.90	33.4	2,217	270.64	22,223
2	% of Total Basin Area	0.0%	24.7%	358.1	0.025	0.051	10.0	3.0	3.0	14.98	1.61	2.44	4.05	4.10	34.6	552	343.28	7,018
3	% of Total Basin Area	0.0%	94.2%	1,363.7	0.025	0.049	25.0	3.0	3.0	19.39	2.22	2.63	4.85	4.90	54.4	2,575	802.65	76,549
															Cutoff Ditch-South Total Excavation Volume (yd^3) =			105,790

* Tributary Qp: Sum of products of percentage of basin area and peak flow
** Channel Slope: Average slope of existing ground along centerline of proposed ditch
*** Velocity and Flow Depth solved in FlowMaster
**** Excavation Area: See Figures 1-4 below.
[1]Source: Title MC-15 (Department of Public Works and Waste Management, County of Maui), Subtitle 01, Chapter 4, Section 15-04-06(b)(2)(B)
[2]Source: Title MC-15 (Department of Public Works and Waste Management, County of Maui), Subtitle 01, Chapter 4, Section 15-04-06(b)(2)(A)

Additional Notes:
3:1 side slopes for maintenance reasons
Velocity not to exceed 20 ft/s for GRP-lined channels
If velocity< 20 ft/s, bottom width designed such that flow depth<2 ft, per 5-ft interval, and then increased 5 ft as a conservative approac
minimum bottom width = 10 ft

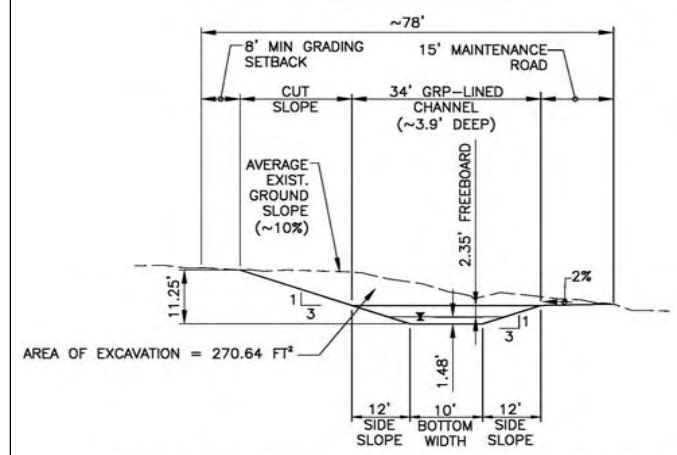
FIGURE 1



CUTOFF DITCH–NORTH

NOT TO SCALE

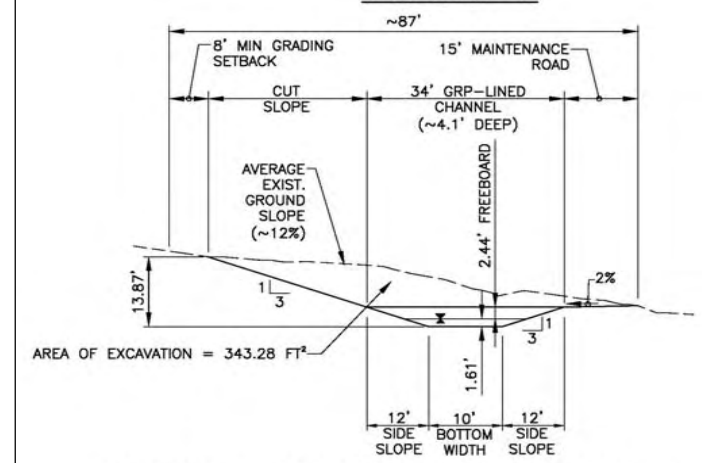
FIGURE 2



CUTOFF DITCH–SOUTH, PORTION 1

NOT TO SCALE

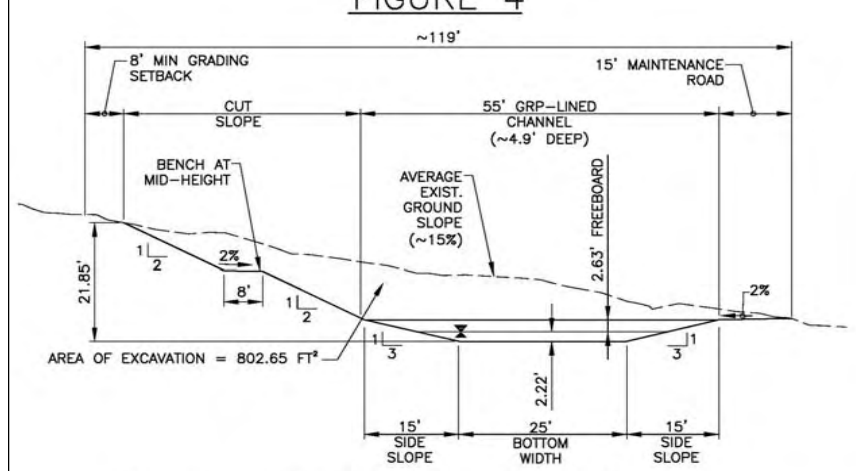
FIGURE 3



CUTOFF DITCH–SOUTH, PORTION 2

NOT TO SCALE

FIGURE 4



CUTOFF DITCH–SOUTH, PORTION 3

NOT TO SCALE

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PROJECT: Villages of Lealii
CLIENT: Hawaii Housing Finance Development Corp
DATE: 30-Sep-09
BY: adc

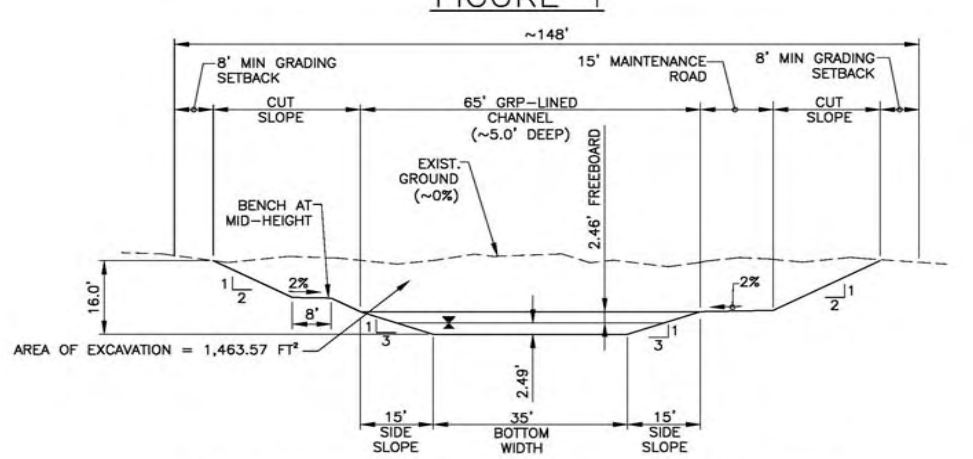
Table 10: Cutoff Ditch-Crater Reservoir Design Calculations for Land Use Concept One through Land Use Concept Three

	*E2 Qp	n[1]	Channel Slope	Bottom Width	Left Side Slope	Right Side Slope	Velocity***	Flow Depth***	Freeboard[2]	Channel Depth	Said Channel Depth	Top Width	Channel Length	****Area of Excavation	Excavation Volume
Portion	(cfs)		(ft/ft)	(ft)	H:V	H:V	(ft/s)	(ft)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft^2)	(yd^3)
1	1,448.3	0.025	0.020	35.0	3.0	3.0	13.71	2.49	2.46	4.95	5.00	65.0	185	1,463.57	10,028
2	1,448.3	0.025	0.020	35.0	3.0	3.0	13.71	2.49	2.46	4.95	5.00	65.0	85	8,302.40	26,137
3	1,448.3	0.025	0.020	35.0	3.0	3.0	13.71	2.49	2.46	4.95	5.00	65.0	305	9,498.40	107,297
4	1,448.3	0.025	0.020	35.0	3.0	3.0	13.71	2.49	2.46	4.95	5.00	65.0	100	5,322.98	19,715
													Total Excavation Volume (yd^3) =		163,177

*Qp solved in HydroCAD.
** Velocity and Flow Depth solved in FlowMaster
*** Excavation Area: See Figures 1-4 below.
[1]Source: Title MC-15 (Department of Public Works and Waste Management, County of Maui), Subtitle 01, Chapter 4, Section 15-04-06(b)(2)(B)
[2]Source: Title MC-15 (Department of Public Works and Waste Management, County of Maui), Subtitle 01, Chapter 4, Section 15-04-06(b)(2)(A)

Additional Notes:
3:1 side slopes for maintenance reasons
Velocity not to exceed 20 ft/s for GRP-lined channels

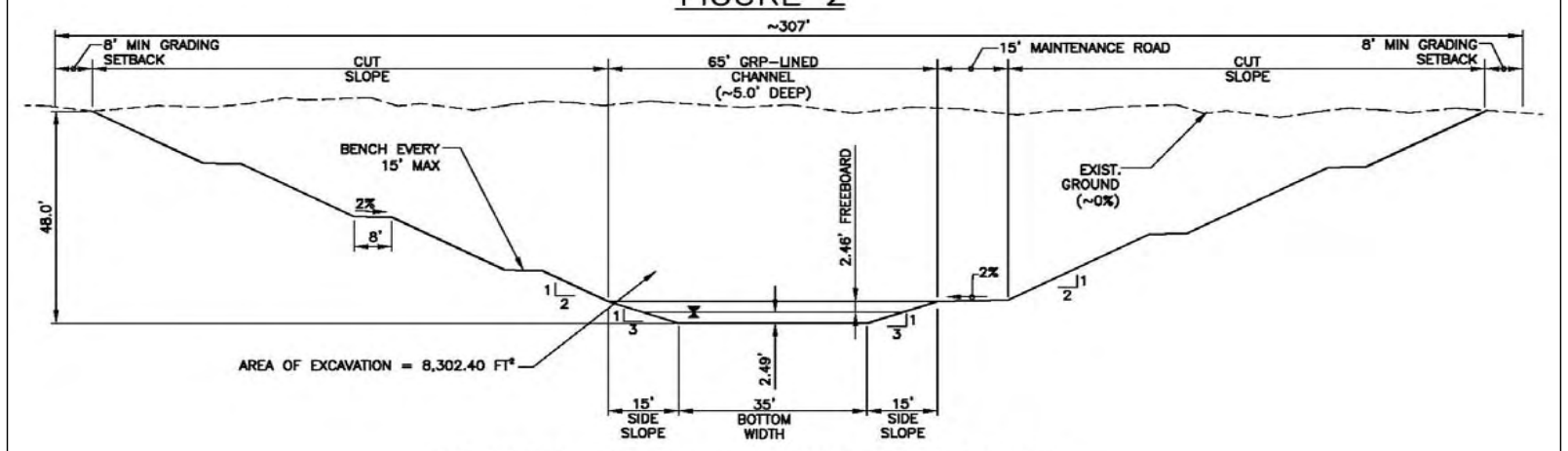
FIGURE 1



CUTOFF DITCH-CRATER RESERVOIR
PORTION 1 (531' to 550')

NOT TO SCALE

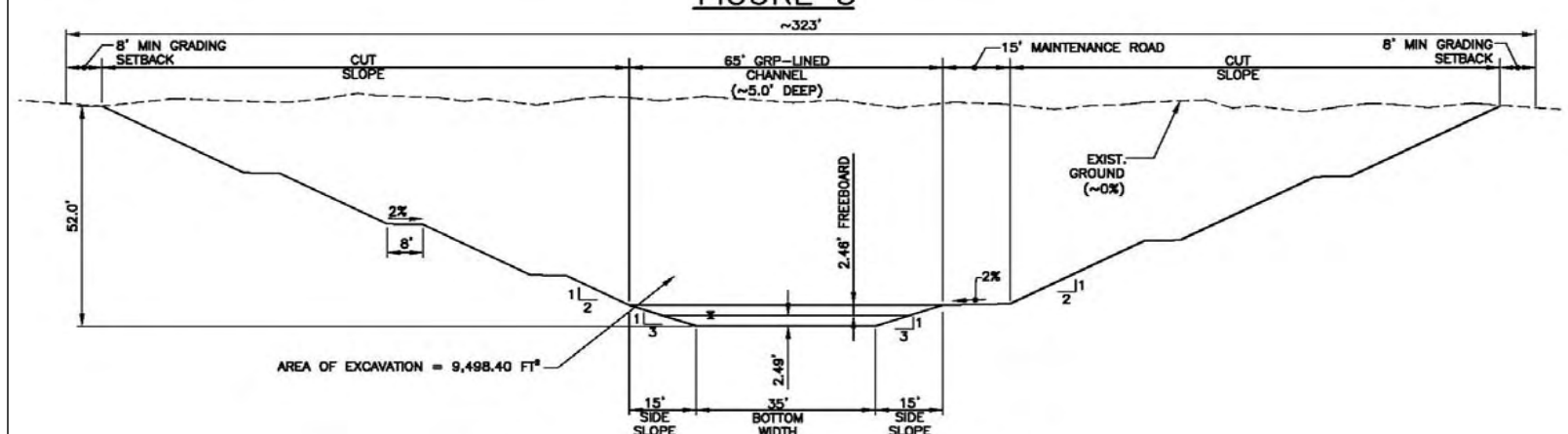
FIGURE 2



CUTOFF DITCH-CRATER RESERVOIR
PORTION 2 (550' to 574')

NOT TO SCALE

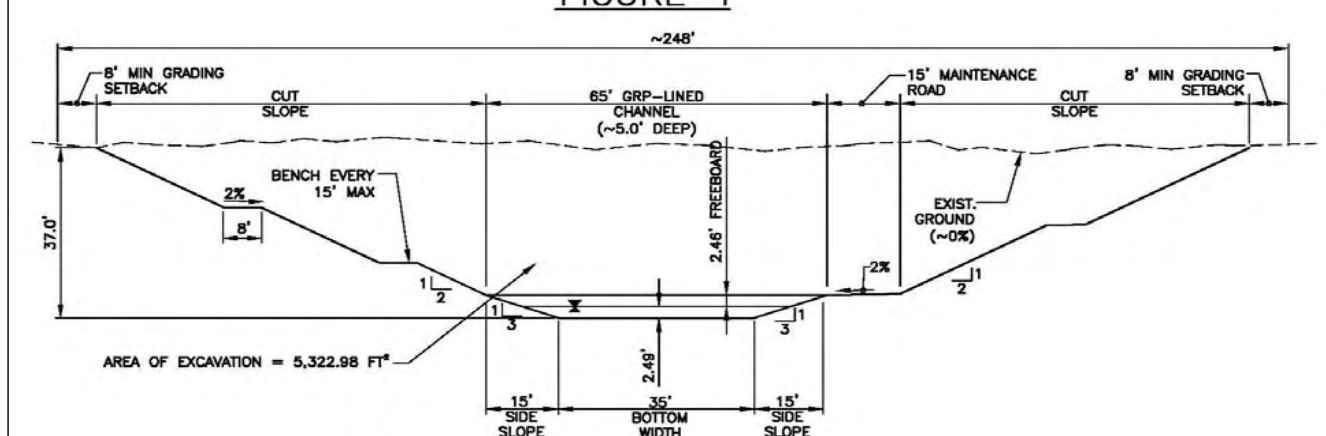
FIGURE 3



CUTOFF DITCH-CRATER RESERVOIR
PORTION 3 (THROUGH RESERVOIR)

NOT TO SCALE

FIGURE 4



CUTOFF DITCH-CRATER RESERVOIR
PORTION 4 (574' to 517')

NOT TO SCALE

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PROJECT: Villages of Lealii
CLIENT: Hawaii Housing Finance Development Corp
DATE: 3-Oct-09
BY: adc

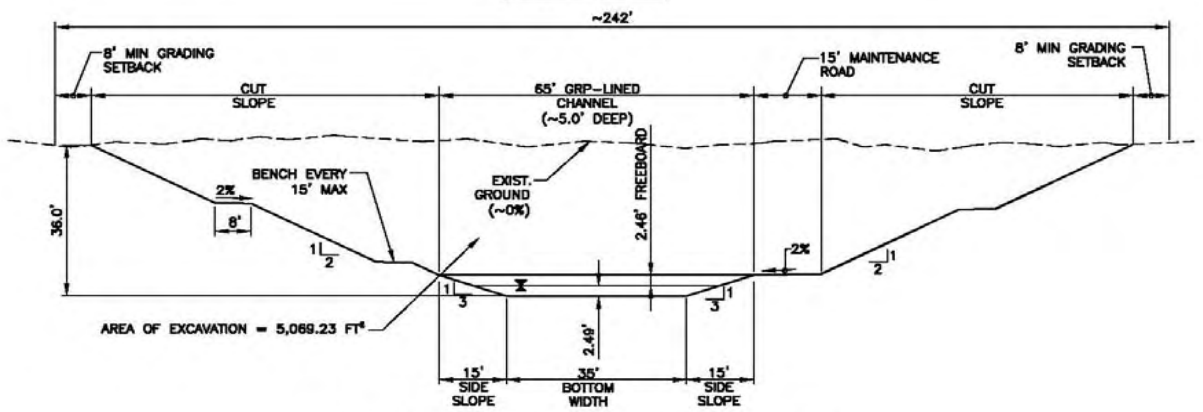
Table 11: Crater Reservoir Emergency Spillway Design Calculations for Land Use Concept One through Land Use Concept Three

	*Qp	n[1]	Channel Slope	Bottom Width	Left Side Slope	Right Side Slope	Velocity***	Flow Depth***	Freeboard[2]	Channel Depth	Said Channel Depth	Top Width	Channel Length	****Area of Excavation	Excavation Volume
Portion	(cfs)		(ft/ft)	(ft)	H:V (ft/ft)	H:V (ft/ft)	(ft/s)	(ft)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft^2)	(yd^3)
1	1,448.3	0.025	0.020	35.0	3.0	3.0	13.71	2.49	2.46	4.95	5.00	65.0	128	5,069.23	24,032
2	1,448.3	0.025	0.020	35.0	3.0	3.0	13.71	2.49	2.46	4.95	5.00	65.0	46	16,482.84	28,082
3	1,448.3	0.025	0.020	35.0	3.0	3.0	13.71	2.49	2.46	4.95	5.00	65.0	150	9,406.48	52,258
4	1,448.3	0.025	0.020	35.0	3.0	3.0	13.71	2.49	2.46	4.95	5.00	65.0	47	1,241.84	2,162
													Total Excavation Volume (yd^3) =		106,534

*Qp matches design inflow
** Velocity and Flow Depth solved in FlowMaster
*** Excavation Area: See Figures 1-4 below.
[1]Source: Title MC-15 (Department of Public Works and Waste Management, County of Maui), Subtitle 01, Chapter 4, Section 15-04-06(b)(2)(B)
[2]Source: Title MC-15 (Department of Public Works and Waste Management, County of Maui), Subtitle 01, Chapter 4, Section 15-04-06(b)(2)(A)

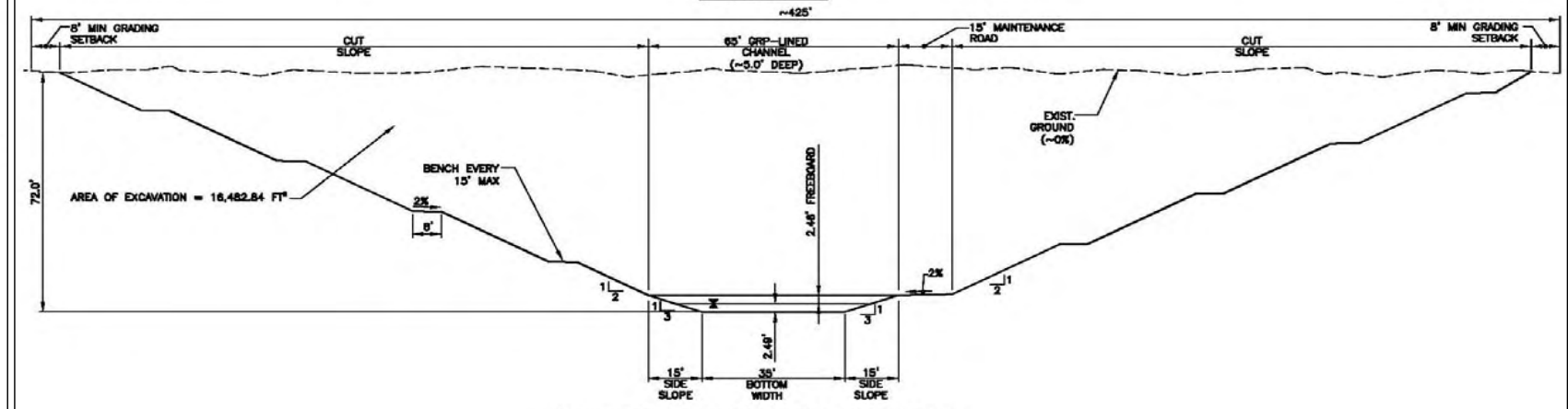
Additional Notes:
3:1 side slopes for maintenance reasons
Velocity not to exceed 20 ft/s for GRP-lined channels

FIGURE 1



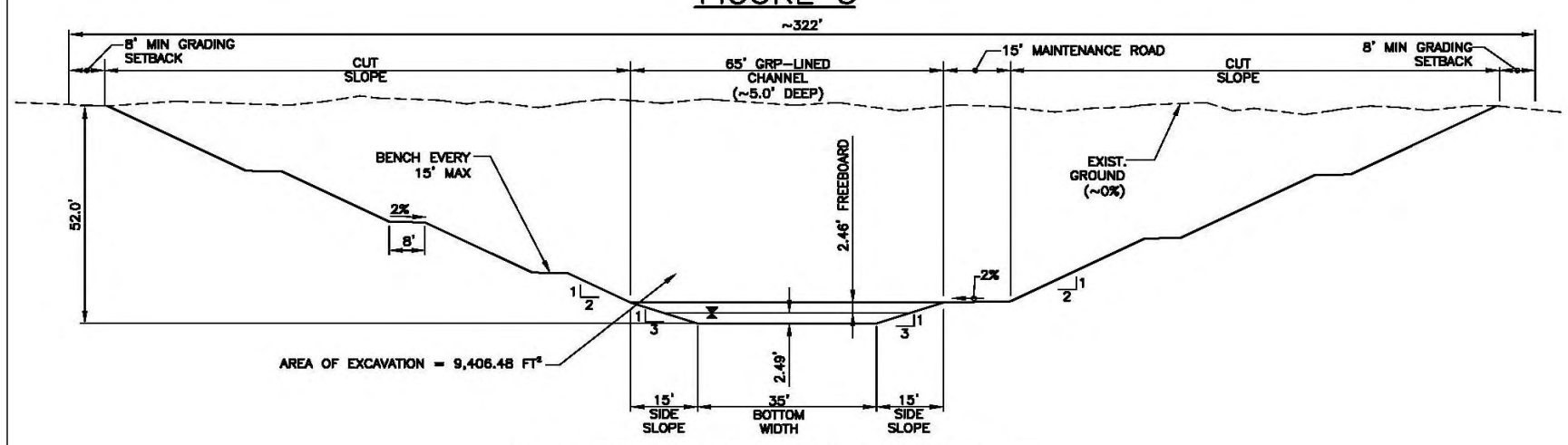
CRATER EMERGENCY SPILLWAY
PORTION 1 (526' to 595')
NOT TO SCALE

FIGURE 2



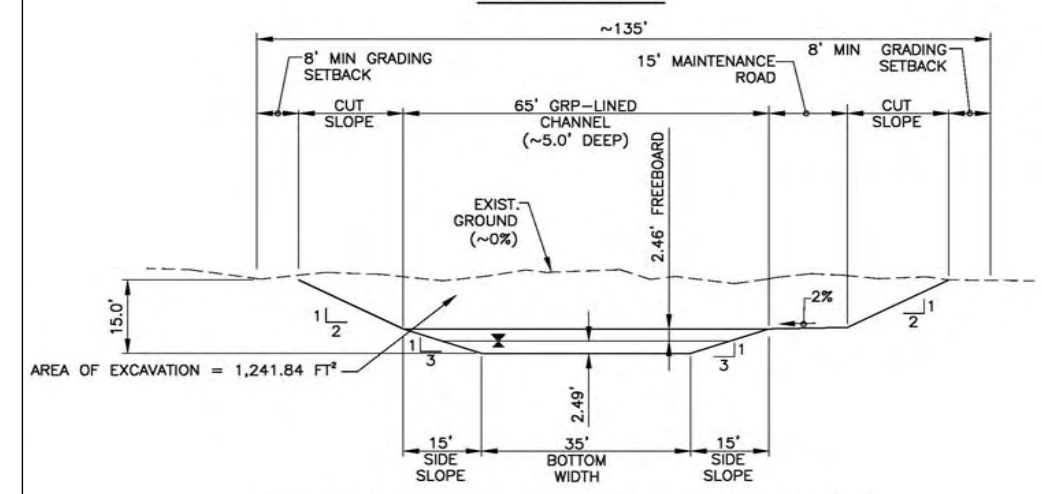
CRATER EMERGENCY SPILLWAY
PORTION 2 (THROUGH RIDGE)
NOT TO SCALE

FIGURE 3



CRATER EMERGENCY SPILLWAY
PORTION 3 (495' TO 450')
NOT TO SCALE

FIGURE 4



CRATER EMERGENCY SPILLWAY
PORTION 4 (450' to 419')
NOT TO SCALE

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PROJECT:	Villages of Leilii
CLIENT:	Hawaii Housing Finance Development Corp
DATE:	12-Oct-09
BY:	adc

Table 12: Diversion Channel Design Calculations for Land Use Concept One & Land Use Concept Two

	Drainage Basin	B6	Peak Discharge Rate	n	Channel Slope*	Bottom Width	Left Side Slope	Right Side Slope	Velocity**	Flow Depth**	Freeboard[1]	Channel Depth	Said Channel Depth	Top Width	Channel Length	***Area of Excavation	Excavation Volume
	Basin Area (acre)	383.86															
Channel Segment	Peak Flow (cfs)	1,657.7	(cfs)	-	(ft/ft)	(ft)	H:V	H:V	(ft/s)	(ft)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft^2)	(yd^3)
North	% of Total Basin Area	9.5%	157.3	0.025	0.020	5.0	3.0	3.0	8.97	1.72	2.27	3.99	4.00	29.0	966	173.74	6,216
South	% of Total Basin Area	29.4%	487.0	0.025	0.017	10.0	3.0	3.0	11.15	2.50	2.38	4.88	4.90	39.4	2,007	476.63	35,429
															Total Excavation Volume (yd^3) =		41,646

* Channel Slope: Average slope of existing ground along centerline of proposed ditch
** Velocity and Flow Depth solved in FlowMaster
*** Excavation Area: See Figure 1 & Figure 2 below
[1]Source: Title MC-15 (Department of Public Works and Waste Management, County of Maui), Subtitle 01, Chapter 4, Section 15-04-06(b)(2)(A)

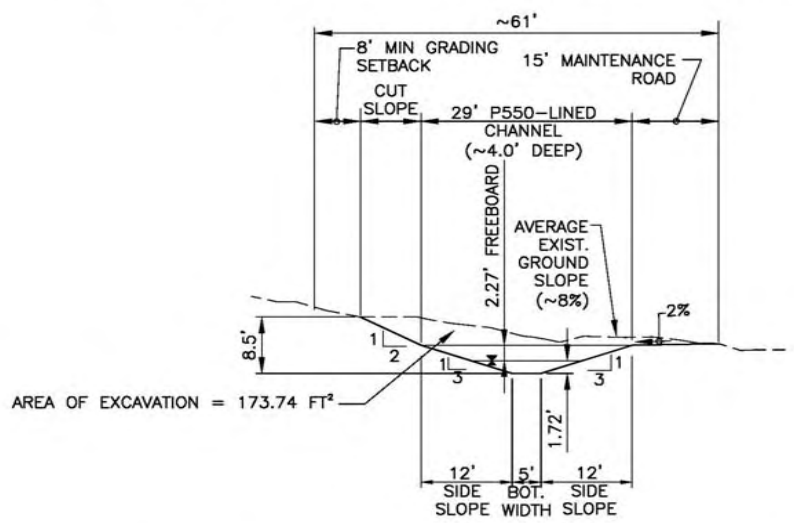
Additional Notes:
3:1 (H:V) channel side slopes for maintenance reasons
Velocity not to exceed 25 ft/s for vegetated P550-lined channels

Culverts Connecting Diversion Channel

Qp	Qp Design*	Slope	Culvert Diameter	Pipe Capacity	No. of Barrels
(cfs)	(cfs)	(ft/ft)	(in)	-	-
157.3	236.0	0.060	48	305	1
507.0	760.5	0.070	72	971	1

*Includes 1.5 bulking factor.
Flow rate for 72" pipe includes 20 cfs from Crater Reservoir drain line

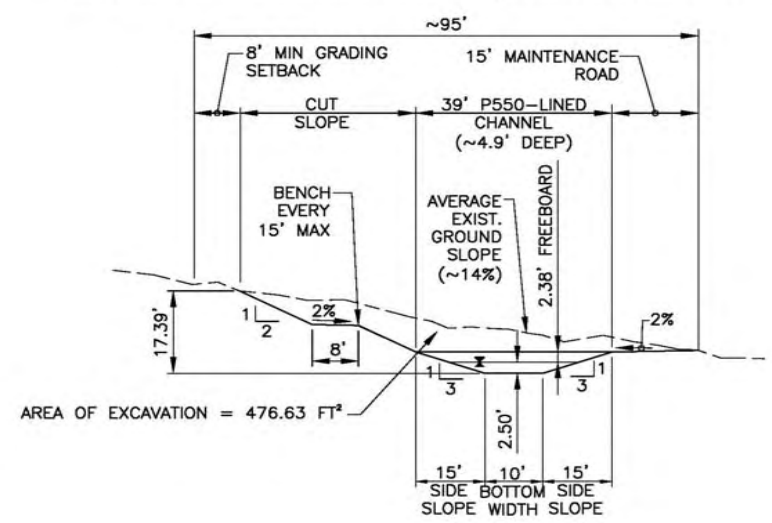
FIGURE 1 – Concept One and Two



DIVERSION CHANNEL – NORTH

NOT TO SCALE

FIGURE 2 – Concept One and Two



DIVERSION CHANNEL – SOUTH

NOT TO SCALE

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PROJECT: Villages of Leialii
CLIENT: Hawaii Housing Finance Development Corp
DATE: 18-Aug-09
BY: rmm

Table 13: Design Flow Rates for On-Site Culverts

Concept 1 and Concept 2

	Gulch 1			Gulch 2			Gulch 3			Gulch 4		
	Basin	Fraction	Qp (cfs)	Basin	Fraction	Qp (cfs)	Basin	Fraction	Qp (cfs)	Basin	Fraction	Qp (cfs)
Offsite*	E1	100.0%	259.8									
Level 1 rd (highest)	B1	10.0%	39.5	B1	7.0%	27.7	B4	3.0%	42.8	B4	3.0%	42.8
				B2	15.0%	28.7				B5	20.0%	192.8
				B4	2.0%	28.5						
Cumulative Qp			299.3			84.9			42.8			235.6
Level 2 rd	B1	55.0%	217.3	B1	15.0%	59.3	Gulch 3 merges into Gulch 2			B5	30.0%	289.2
				B2	50.0%	95.7						
				B4	30.0%	427.8						
Cumulative Qp			516.6			667.7						524.8
Bypass road	Gulch 1 drains offsite			B1	10.0%	39.5				B5	30.0%	289.2
				B4	20.0%	285.2						
Cumulative Qp						992.4						814.0
Level 4 rd				B4	3.0%	42.8				B5	1.0%	9.6
Cumulative Qp						1035.2						823.6
Level 5 rd				B4	5.0%	71.3						
Cumulative Qp						1106.5						
Level 6 rd				B4	6.0%	85.6				B5	4.0%	38.6
Cumulative Qp						1192.1						862.2
Level 7 rd				B4	6.0%	85.6						
Cumulative Qp						1277.7						
Level 8 rd				B4						B5	4.0%	38.6
Cumulative Qp												900.8
Level 9 rd				B4	7.0%	99.8				B5	4.0%	38.6
Cumulative Qp						1377.5						939.4
Level 10 rd										B5	4.0%	38.6
Cumulative Qp												978.0
Level 11 rd (lowest)				B4	8.0%	114.1				B5	3.0%	28.9
Cumulative Qp						1491.6						1006.9
				Check B4 % <100%		93.0%				Check B5% <100%		100.0%

* Runoff values from Appendix B
Predevelopment basins adjusted to match post-development roadway configuration.

Concept 3

	Gulch 1			Gulch 2			Gulch 3			Gulch 4			B6 Gulch		
	Basin	Fraction	Qp (cfs)	Basin	Fraction	Qp (cfs)	Basin	Fraction	Qp (cfs)	Basin	Fraction	Qp (cfs)	Basin	Fraction	Qp (cfs)
Offsite*	E1	100.0%	259.8												
Level 1 rd (highest)				B1	5.0%	19.8	B4	3.0%	42.1	B4	3.0%	42.1			
				B2	8.0%	14.1				B5	10.0%	90.1			
				B4	2.0%	28.1									
Cumulative Qp						62.0			42.1			132.2			
Level 2 rd	B1	30.0%	118.5				Outlet 3 merges into Outlet 2								
Cumulative Qp			378.3												
Level 3 rd	Outlet 1 drains offsite			B1	25.0%	98.8				B5	35.0%	315.5			
				B2	80.0%	140.9									
				B4	35.0%	491.7									
Cumulative Qp						793.4						447.7			
Bypass road				B4	10.0%	140.5				B5	10.0%	90.1	B6	38.9%	552.0
Cumulative Qp						933.9						537.8			552.0
Level 5 rd				B4	2.0%	28.1				B5	2.0%	18.0			
Cumulative Qp						962.0						555.8			
Level 7 rd				B4	8.0%	112.4				B5	8.0%	72.1	B6	10.0%	141.9
Cumulative Qp						1074.4						627.9			693.9
Level 10 rd				B4	15.0%	210.7				B5	12.0%	108.2	B6	20.0%	283.8
				B5	8.0%	72.1									
Cumulative Qp						1285.1						736.1			977.7
Level 12 rd (lowest)				B4	10.0%	140.5				B5	5.0%	45.1	B6	15.0%	212.9
				B5	5.0%	45.1									
Cumulative Qp						1425.6						781.2			1190.6
			Check B4 % <100%		88.0%					Check B5% <100%		87.0%	Check B6% <100%		83.9%

* Runoff values from Appendix B
Predevelopment basins adjusted to match post-development roadway configuration.

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PROJECT: Villages of Lealii
CLIENT: Hawaii Housing Finance Development Corp
DATE: 18-Aug-09
BY: rmm

Table 14: Number of 96-Inch RCP Culverts Required per Crossing

Concept 1 and Concept 2

Road	Gulch	Qp (cfs)	Qp Design*	Slope	D96 cap	No. of D96
1	1	299.3	449.0	0.100	1600	1
	2	84.9	127.4	0.125	1800	1
	3	235.6	353.4	0.143	1900	1
	4	42.8	64.2	0.100	1600	1
2	1	516.6	774.9	0.100	1600	1
	2	667.7	1001.6	0.125	1800	1
	4	524.8	787.2	0.100	1600	1
Bypass	2	992.4	1488.6	0.070	1300	2
	4	814.0	1221.0	0.080	1400	1
4	2	1035.2	1552.8	0.090	1500	2
	4	823.6	1235.4	0.080	1400	1
5	2	1106.5	1659.8	0.090	1500	2
6	2	1192.1	1788.2	0.090	1500	2
	4	862.2	1293.3	0.080	1400	1
7	2	1277.7	1916.6	0.090	1500	2
8	4	900.8	1351.2	0.080	1400	1
9	2	1377.5	2066.3	0.090	1500	2
	4	939.4	1409.1	0.080	1400	2
10	4	978.0	1467.0	0.080	1400	2
11	2	1491.6	2237.4	0.070	1300	2
	4	1006.9	1510.4	0.080	1400	2
*Qp x 1.5 debris bulking factor					Sum D96	31

Concept 3

Road	Gulch	Qp (cfs)	Qp Design*	Slope	D96 cap	No. of D96
1	2	62.0	93.0	0.125	1800	1
	3	42.1	63.2	0.143	1900	1
	4	132.2	198.3	0.100	1600	1
2	1	378.3	567.5	0.100	1600	1
3	2	793.4	1190.1	0.100	1600	1
	4	447.7	671.6	0.100	1600	1
Bypass	2	933.9	1400.9	0.070	1300	2
	4	537.8	806.7	0.080	1400	1
	B6	552.0	828.0	0.080	1400	1
5	2	962.0	1443.0	0.080	1400	2
	4	555.8	833.7	0.080	1400	1
7	2	1074.4	1611.6	0.090	1500	2
	4	627.9	941.9	0.080	1400	1
	B6	693.9	1040.9	0.080	1400	1
10	2	1285.1	1927.7	0.080	1400	2
	4	736.1	1104.2	0.080	1400	1
	B6	977.7	1466.6	0.080	1400	2
12	2	1425.6	2138.4	0.080	1400	2
	4	781.2	1171.8	0.080	1400	1
	B6	1190.6	1785.9	0.080	1400	2
*Qp x 1.5 debris bulking factor					Sum D96	27

APPENDIX D

Construction Cost Estimates

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PROJECT: Villages of Lealii
CLIENT: Hawaii Housing Finance Development Corp
DATE: 12-Oct-09
BY: adc

Table 15: Detention Basin Cost Estimate

Land Use Concepts One & Two					Grass Quantities, Land Use Concept One & Two			
Item Description	Unit	*Estimated Quantity	Unit Price	Total	Detention Basin	Perimeter at Mid-Height	Unit Length	Area
Excavation	C.Y.	1,518,742	$12.00	$18,224,908	-	(ft)	(ft)	(ft²)
Outlet Structure	EA.	3	$500,000.00	$1,500,000	2	5,259	18.81	791,240
Weir Structure	L.F.	30	$3,820.00	$114,600	3	7,296	21.71	858,247
Grass with Hydromulch	S.F.	1,703,672	$0.35	$596,285	4	1,102	18.69	54,185
6'-High Fence	L.F.	14,137	$80.00	$1,130,960		Total Grassed Area (ft²) =		1,703,672
**Wall	C.Y.	730	$500.00	$365,000				
		Subtotal Less Contingency		$21,931,754				
			10% Contingency	$2,193,175				
			Total	$24,124,929				
			Say	$24,100,000				

Land Use Concept Three					Grass Quantities, Land Use Concept Three			
Item Description	Unit	*Estimated Quantity	Unit Price	Total	Detention Basin	Perimeter at Mid-Height	Unit Length	Area
Excavation	C.Y.	1,438,575	$12.00	$17,262,897	-	(ft)	(ft)	(ft²)
Outlet Structure	EA.	3	$500,000.00	$1,500,000	2	7,829	25.74	651,340
Weir Structure	L.F.	30	$3,820.00	$114,600	3	9,499	23.32	856,991
Grass with Hydromulch	S.F.	1,562,516	$0.35	$546,881	4	1,102	18.69	54,185
6'-High Fence	L.F.	19,951	$80.00	$1,596,080		Total Grassed Area (ft²) =		1,562,516
Interconnection Between Detention Basins	EA.	5	$240,000.00	$1,200,000				
**Wall	C.Y.	730	$500.00	$365,000				
		Subtotal Less Contingency		$22,585,458				
			10% Contingency	$2,258,546				
			Total	$24,844,004				
			Say	$24,800,000				

* See Table 7, Appendix C for excavation quantities.
** Wall around Detention Basin 1 includes a 3-ft thickness and 2-ft burial depth
*** See Table 18, Appendix D for Crater Reservoir Improvements Cost

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PROJECT: Villages of Lealii
CLIENT: Hawaii Housing Finance Development Corp
DATE: 30-Sep-09
BY: adc

Table 16: Cutoff Ditch-North & Cutoff Ditch-South Cost Estimate for Land Use Concepts One through Three

Cutoff Ditch - North					Cutoff Ditch - South				
Item Description	Unit	*Estimated Quantity	Unit Price	Total	Item Description	Unit	*Estimated Quantity	Unit Price	Total
Excavation	C.Y.	7,945	$12.00	$95,338	Excavation	C.Y.	105,790	$12.00	$1,269,477
GRP Channel Lining	S.F.	28,057	$102.00	$2,861,814	GRP Channel Lining	S.F.	240,863	$102.00	$24,568,026
**Slope Protection for Areas Above Freeboard	S.F.	31,646	$1.10	$34,810	**Slope Protection for Areas Above Freeboard	S.F.	266,939	$1.10	$293,633
Outlet Structure	E.A.	1	$600,000.00	$600,000	Outlet Structure	E.A.	0	$600,000.00	$0
			Subtotal Less Contingency	$3,591,962				Subtotal Less Contingency	$26,131,136
			10% Contingency	$359,196				10% Contingency	$2,613,114
			Total	$3,951,159				Total	$28,744,250
			Say	$4,000,000				Say	$28,700,000

* See Table 9, Appendix C for excavation quantities. See table below for GRP lining and slope protection quantities.
** Slope Protection: Hydromulch with Geotextile Fabric (SC-150)

Quantity Estimates for Cutoff Ditch - North & Cutoff Ditch-South

	Channel Length	Channel Unit Width	Channel Coverage Area	Height of Slope Protection	Top Width of Slope Protection	Unit Width of Slope Protection	Area of Slope Protection
Portion	(ft)	(ft)	(ft²)	(ft)	(ft)	(ft)	(ft²)
Cutoff Ditch-North							
-	840	33.4	28,057	7.17	21.51	37.7	31,646
Cutoff Ditch-North Total Area, GRP Lining (ft²) =			28,057	Cutoff Ditch-North Total Area, Slope Protection (ft²) =			31,646
Cutoff Ditch-South							
1	2,217	34.7	76,854	7.35	22.05	38.2	84,784
2	552	35.9	19,834	9.77	29.31	45.9	25,334
3	2,575	56.0	144,175	16.95	33.9	60.9	156,821
Cutoff Ditch-South Total Area, GRP Lining (ft²) =			240,863	Cutoff Ditch-South Total Area, Slope Protection (ft²) =			266,939

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DATE: 3-Oct-09
BY: adc

Table 17: Cutoff Ditch-Crater Reservoir Cost Estimate for Land Use Concepts One through Three

Cutoff Ditch - Crater Reservoir Section				
Item Description	Unit	*Estimated Quantity	Unit Price	Total
Excavation	C.Y.	163,177	$12.00	$1,958,122
Channel GRP-Lining	S.F.	44,970	$102.00	$4,586,940
**Slope Protection for Areas Above Freeboard	S.F.	133,470	$1.10	$146,817
Outlet GRP-Lining	S.F.	10,575	$102.00	$1,078,650
		Subtotal Less Contingency		$7,770,529
			10% Contingency	$777,053
			Total	$8,547,582
			Say	$8,500,000

* See Table 10, Appendix C for excavation quantities. See table below for GRP lining and slope protection quantities.
** Slope Protection: Hydromulch with Geotextile Fabric (SC-150)

Quantity Estimates for Cutoff Ditch - Crater Reservoir Section

Portion	Channel Length (ft)	unit width of channel (ft)	coverage area of channel (ft²)	height of slope protection (ft)	top width of slope protection (ft)	unit width of slope protection (ft)	area of slope protection (ft²)
1	185	66.6	12,325	11.00	22	72.2	13,356
2	85	66.6	5,663	43.00	86	247.3	21,021
3	305	66.6	20,320	47.00	94	265.2	80,883
4	100	66.6	6,662	32.00	64	182.1	18,211
	Total Area, GRP Lining (ft²) =		44,970		Total Area, Slope Protection (ft²) =		133,470

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CLIENT: Hawaii Housing Finance Development Corp
DATE: 3-Oct-09
BY: adc

Table 18: Crater Reservoir Improvements Cost Estimate

Land Use Concepts One and Two					Land Use Concept Three				
Crater Reservoir Emergency Spillway					Crater Reservoir Emergency Spillway				
Item Description	Unit	*Estimated Quantity	Unit Price	Total	Item Description	Unit	*Estimated Quantity	Unit Price	Total
Excavation	C.Y.	106,534	$12.00	$1,278,405	Excavation	C.Y.	106,534	$12.00	$1,278,405
Channel GRP-Lining	S.F.	24,717	$102.00	$2,521,134	Channel GRP-Lining	S.F.	24,717	$102.00	$2,521,134
**Slope Protection for Areas Above Freeboard	S.F.	82,740	$1.10	$91,014	**Slope Protection for Areas Above Freeboard	S.F.	82,740	$1.10	$91,014
Spillway Structure	E.A.	1	$1,000,000.00	$1,000,000	Spillway Structure	E.A.	1	$1,000,000.00	$1,000,000
		Subtotal Less Contingency		$4,890,553			Subtotal Less Contingency		$4,890,553
			10% Contingency	$489,055				10% Contingency	$489,055
			Total	$5,379,608				Total	$5,379,608
			Say	$5,400,000				Say	$5,400,000
Crater Reservoir Drain Line					Crater Reservoir Drain Line				
Item Description	Unit	*Estimated Quantity	Unit Price	Total	Item Description	Unit	*Estimated Quantity	Unit Price	Total
Drilled 24" RCP	L.F.	275	$500.00	$137,500	Drilled 24" RCP	L.F.	275	$500.00	$137,500
24" RCP	L.F.	1,620	$200.00	$324,000	24" RCP	L.F.	2,330	$200.00	$466,000
Standard Manhole	E.A.	8	$5,000.00	$40,000	Standard Manhole	E.A.	11	$5,000.00	$55,000
Outlet Structure	E.A.	2	$500,000.00	$1,000,000	Outlet Structure	E.A.	2	$500,000.00	$1,000,000
		Subtotal Less Contingency		$1,501,500			Subtotal Less Contingency		$1,658,500
			10% Contingency	$150,150				10% Contingency	$165,850
			Total	$1,651,650				Total	$1,824,350
			Say	$1,700,000				Say	$1,800,000
Total for Crater Reservoir Drainage Improvements, Concept One & Two				$7,100,000	Total for Crater Reservoir Drainage Improvements, Concept Three				$7,200,000

* See Table 11, Appendix C for excavation quantities. See table below for GRP lining and slope protection quantities.
** Slope Protection: Hydromulch with Geotextile Fabric (SC-150)

Quantity Estimates for Crater Reservoir Emergency Spillway, Land Use Concept One through Three

Portion	Channel Length (ft)	unit width of channel (ft)	coverage area of channel (ft²)	height of slope protection (ft)	top width of slope protection (ft)	unit width of slope protection (ft)	area of slope protection (ft²)
1	128	66.6	8,528	31.00	62	177.6	22,737
2	46	66.6	3,065	67.00	134	378.6	17,417
3	150	66.6	9,993	47.00	94	265.2	39,779
4	47	66.6	3,131	10.00	20	59.7	2,807
	Total Area, GRP Lining (ft²) =		24,717		Total Area, Slope Protection (ft²) =		82,740

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PROJECT: Villages of Lealii
CLIENT: Hawaii Housing Finance Development Corp
DATE: 13-Oct-09
BY: adc

Table 19: Diversion Channel Cost Estimate for Land Use Concepts One and Two

Item Description	Unit	*Estimated Quantity	**Unit Price	Total
Diversion Channel				
Excavation	C.Y.	41,646	$12.00	$499,746
**P550 Channel Lining	L.F.	18,879	$5.30	$100,059
***Slope Protection for Areas Above Freeboard	S.F.	126,469	$1.10	$139,115
Diversion Channel Drain Lines to Detention Basin 3				
48" RCP Pipe	L.F.	2,372	$400.00	$948,800
72" RCP Pipe	L.F.	2,170	$600.00	$1,302,000
Custom Manhole	E.A.	10	$20,000.00	$200,000
Headwall+Discharge Apron	EA.	4	$450,000.00	$1,800,000
			Subtotal Less Contingency	$4,989,720
			10% Contingency	$498,972
			Total	$5,488,692
			Say	$5,500,000

* See Table 12, Appendix C for excavation quantities. See table below for P550- lining and slope protection quantities.
**P550 permanent erosion control matting includes grass with hydromulch
***Slope Protection: Hydromulch with Geotextile Fabric (SC-150)

Quantity Estimates for Diversion Channel

Channel Segment	Channel Length (ft)	unit width of channel (ft)	Number of 6.5' - Wide P550 Matting Rolls -	height of slope protection (ft)	top width of slope protection (ft)	unit width of slope protection (ft)	area of slope protection (ft²)
North	966	30.3	5	4.50	9	25.1	24,210
South	2,007	41.0	7	12.50	25	51.0	102,258
	Total Length, P550 Lining (ft) =		18,879		Total Area, Slope Protection (ft²) =		126,469

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PROJECT: Villages of Lealii
CLIENT: Hawaii Housing Fin Dev Corp
DATE: 18-Aug-09
BY: rmm

	Unit Costs			
	Embank/CY	D96/EA*	Byp D96/Ea*	Wall/SF**
2009	$12.00	$240,000	$600,000	$100.00

Table 20: On-Site Culverts Cost Estimate

Concept One and Concept Two

Road	Gulch	Top Width	Depth (ft)	Embank (CY)	No. of D96	Earthwork ($)	Pipe ($)	Headwall** + disch apron($)	Total $
1	1	100	10	356	1	$4,270	$240,000	$350,000	$594,270
	2	100	12	349	1	$4,190	$240,000	$420,000	$664,190
	3	100	15	337	1	$4,040	$240,000	$525,000	$769,040
	4	150	20	570	1	$6,840	$240,000	$900,000	$1,146,840
2	1	250	30	1126	1	$13,510	$240,000	$1,950,000	$2,203,510
	2	150	10	578	1	$6,940	$240,000	$450,000	$696,940
	4	200	12	808	1	$9,700	$240,000	$660,000	$909,700
Bypass	2	200	12	2112	2	$25,340	$1,200,000	$660,000	$1,885,340
	4	300	25	3241	1	$38,890	$600,000	$1,875,000	$2,513,890
4	2	200	10	800	2	$9,600	$480,000	$550,000	$1,039,600
	4	200	10	800	1	$9,600	$240,000	$550,000	$799,600
5	2	200	10	800	2	$9,600	$480,000	$550,000	$1,039,600
6	2	200	10	800	2	$9,600	$480,000	$550,000	$1,039,600
	4	250	10	1022	1	$12,260	$240,000	$650,000	$902,260
7	2	100	10	356	2	$4,270	$480,000	$350,000	$834,270
8	4	200	10	800	1	$9,600	$240,000	$550,000	$799,600
9	2	100	6	365	2	$4,380	$480,000	$210,000	$694,380
	4	200	10	800	2	$9,600	$480,000	$550,000	$1,039,600
10	4	150	10	578	2	$6,940	$480,000	$450,000	$936,940
11	2	100	6	365	2	$4,380	$480,000	$210,000	$694,380
	4	150	10	578	2	$6,940	$480,000	$450,000	$936,940
				Total Pipes	31		Total Cost		**$22,100,000**

*Assumes 120' length, except 300' for Bypass Highway. Unit cost extrap from 6/08 Kapolei Bus Pk est of $1340/LF for 84" RCP.
**Headwall area = (top width + 25' wingwalls each side + 25' floor) x depth, discharge apron area = headwall area.

Concept Three

	Road	Gulch	Width (ft)	Depth (ft)	Embank (CY)	No. of D96	Earthwork ($)	Pipe ($)	Headwall** + disch apron($)	Total $
	1	2	200	15	819	1	$9,830	$240,000	$825,000	$1,074,830
		3	250	15	1059	1	$12,710	$240,000	$975,000	$1,227,710
		4	250	10	1022	1	$12,260	$240,000	$650,000	$902,260
	2	1	300	25	1389	1	$16,670	$240,000	$1,875,000	$2,131,670
	3	2	250	15	1059	1	$12,710	$240,000	$975,000	$1,227,710
		4	250	10	1022	1	$12,260	$240,000	$650,000	$902,260
	Bypass	2	250	10	2726	2	$32,710	$1,200,000	$650,000	$1,882,710
300' wide		4	200	10	2133	1	$25,600	$600,000	$550,000	$1,175,600
450' wide		B6	200	6	3258	1	$39,100	$900,000	$330,000	$1,269,100
	5	2	250	10	1022	2	$12,260	$480,000	$650,000	$1,142,260
		4	200	10	800	1	$9,600	$240,000	$550,000	$799,600
	7	2	200	10	800	2	$9,600	$480,000	$550,000	$1,039,600
		4	250	10	1022	1	$12,260	$240,000	$650,000	$902,260
		B6	200	10	800	1	$9,600	$240,000	$550,000	$799,600
	10	2	200	6	780	2	$9,360	$480,000	$330,000	$819,360
		4	200	10	800	1	$9,600	$240,000	$550,000	$799,600
		B6	150	6	572	2	$6,860	$480,000	$270,000	$756,860
	12	2	150	6	572	2	$6,860	$480,000	$270,000	$756,860
		4	200	10	800	1	$9,600	$240,000	$550,000	$799,600
		B6	200	6	780	2	$9,360	$480,000	$330,000	$819,360
					Total Pipes	27		Total Cost		**$21,200,000**

*Assumes 120' length, except 300' for Bypass Highway. Unit cost extrap from 6/08 Kapolei Bus Pk est of $1340/LF for 84" RCP.
*B6 Bypass Highway Culvert is 450'
**Headwall area = (top width + 25' wingwalls each side + 25' floor) x depth, discharge apron area = headwall area.

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PROJECT: Villages of Lealii
CLIENT: Hawaii Housing Finance Development Corp
DATE: 26-Sep-09
BY: adc

Table 21: Honoapi'ilani Highway Culvert Improvements Cost Estimate

Additional 48" RCP Culvert at Honoapiilani Highway Sta. 24+00 and Upstream Channel Modifications

Item Description	Unit	Estimated Quantity	Unit Price	Item Total
48" RCP Culvert	L.F.	500	$400	$200,000
Inlet Structure	E.A.	1	$150,000	$150,000
Fill Open CRM Channel	E.A.	1	$20,000	$20,000
			Subtotal Less Contingency	$370,000
			10% Contingency	$37,000
			Total	$407,000
			Say	$400,000

BELT COLLINS

MEMORANDUM

TO:	FROM:
Mr. Stan Fujimoto	Belt Collins Hawaii Ltd.
COMPANY:	DATE:
Hawaii Housing Finance and Development Corporation	August 17, 2010
SUBJECT:	JOB NUMBER/REFERENCE NUMBER:
Villages of Leiali‘i – Drainage Discharge to Mauka Storage Basins in Lieu of Crater Reservoir	2007.70.0500

The purpose of this supplemental study is to determine the land area required to store storm water runoff generated off-site within the Villages of Leiali‘i development in lieu of Crater Reservoir. This study shows storage alternatives for Land Use Concept Three, but could be applied to Land Use Concepts One and Two. According to the Master Plan (December 2009), Crater Reservoir is used to store 334 acre-feet of storm water runoff from the lands upslope of the development.

The main objective is to minimize the land area required to store the storm water runoff. To minimize the impact on the development, the use of storage basins classified as dams was avoided. Pursuant to Hawaii Administrative Rules, Title 13, Subtitle 7, Chapter 190, dams are classified as being 25 feet more in height, from the lowest elevation to a maximum water storage elevation, or having an impounding capacity at maximum water storage elevation of 50 acre-feet or more.

The storage basins were designed with a maximum storage elevation of 24 feet and a maximum impounding capacity of 49 acre-feet. A freeboard allowance, typically one foot, is required for storage basin design. Fencing would be installed along the perimeter of the storage basins for safety purposes. A portion of runoff in the drainage channel would be diverted to a storage basin by an impoundment constructed in the drainage channel, and an open channel would convey runoff to the basin. The basins would include an overflow spillway and a low-flow drain pipe that would control return of runoff to the drainage channels. The side slopes of the storage basins would be lined with grouted rubble paving at an angle of 1 horizontal to 1 vertical to minimize the footprint. For storage basins on the same side of a drainage channel, the minimum vertical spacing should be approximately 50 feet, from the bottom of one basin to the bottom of an adjacent basin.

Two storage alternatives have been proposed. Storage Alternative 2 includes three basins that would each function together with portions of the cutoff ditch along the mauka property line. The two storage plans proposed in this study are conceptual – the shapes and locations of the basins could be adjusted to fit the overall land use plan. The cutoff ditch along the mauka property line would be required to capture and convey runoff to the natural drainage channels and, subsequently, to divert runoff to the storage basins. The storage alternatives are summarized below:

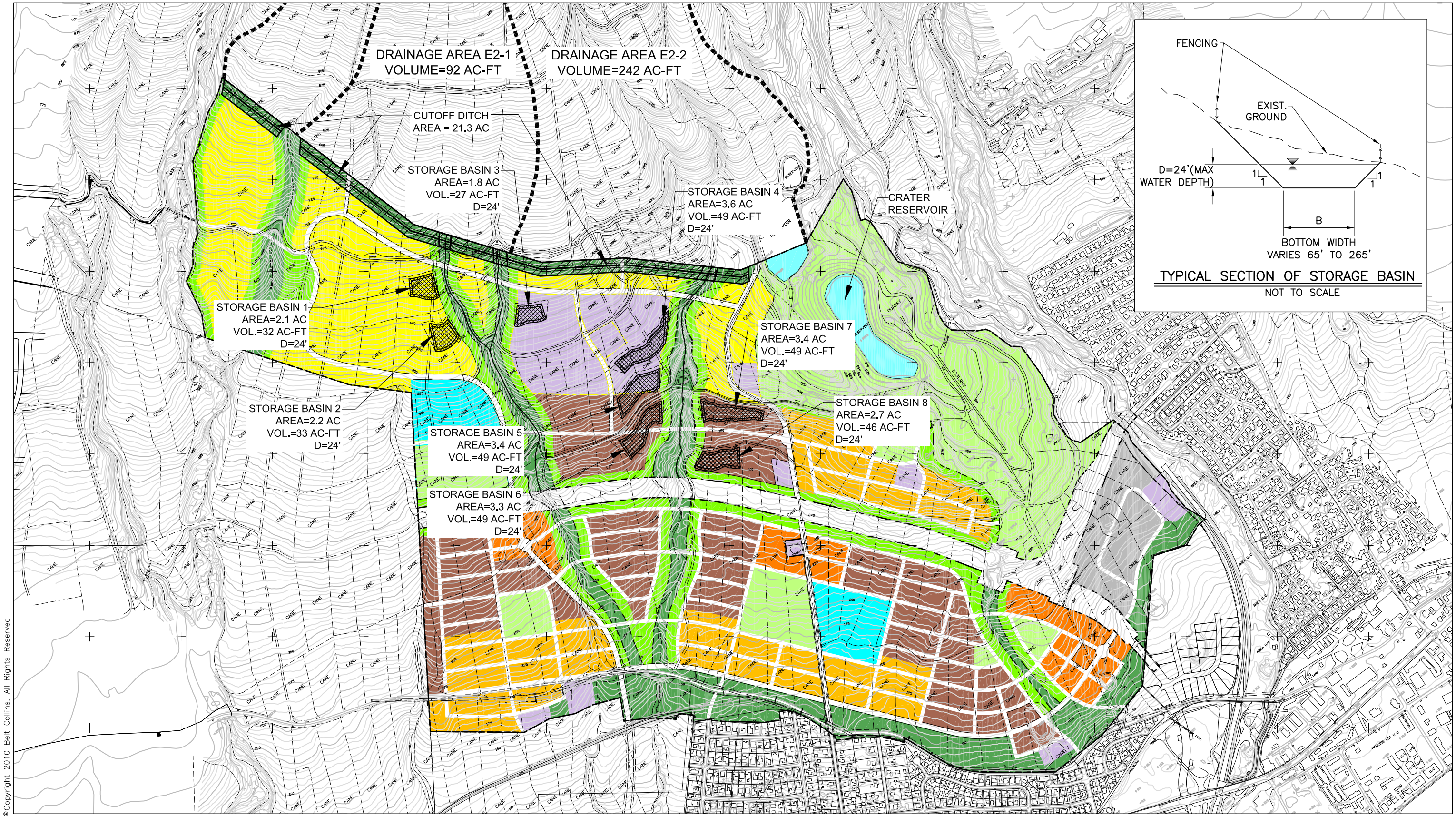
<u>Storage Alternative 1</u>

- Number of storage basins = 8
- Storage basin land area = 22.5 acres
- Cutoff ditch land area = 21.3 acres
- Total (storage basin and cutoff ditch) land area = 43.8 acres

Storage Alternative 2

- Number of basins = 8
- Storage basin land area = 24.8 acres
- Cutoff ditch land area = 14.4 acres
- Total (storage basin and cutoff ditch) land area = 39.2 acres

Tue, 17 Aug 2010 – 8:06am
N:\Leialii – 2007700500\No Crater Supplemental Study\CAD\Figures\FIGURE – Alternative 1.dwg



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NORTH

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SCALE IN FEET

TOTAL STORAGE BASIN VOLUME = 334 ACRE-FEET
STORAGE BASIN LAND AREA = 22.5 ACRES
CUTOFF DITCH LAND AREA = 21.3 ACRES
TOTAL (STORAGE BASIN AND CUTOFF DITCH) LAND AREA = 43.8 ACRES

NOTE: Storage Alternative 1 is conceptual - shapes and locations of basins are subject to change.

STORAGE ALTERNATIVE 1
Land Use Concept Three

VILLAGES OF LEIALI'I
STORAGE ALTERNATIVES TO CRATER RESERVOIR
HAWAII HOUSING FINANCE & DEVELOPMENT CORPORATION
AUGUST 2010

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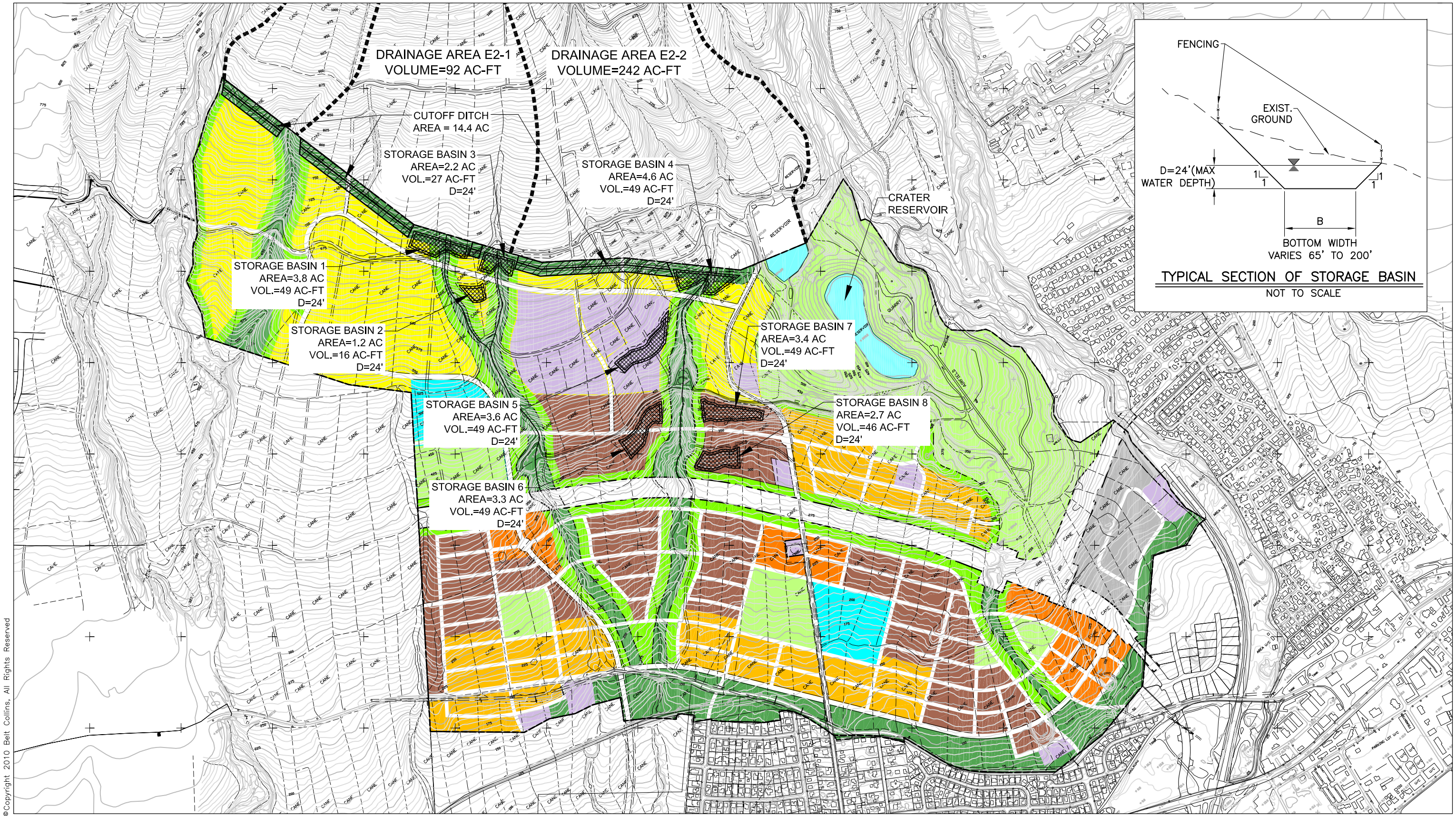

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BELT COLLINS

NORTH

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SCALE IN FEET

TOTAL STORAGE BASIN VOLUME = 334 ACRE-FEET
STORAGE BASIN LAND AREA = 24.8 ACRES
CUTOFF DITCH LAND AREA = 14.4 ACRES
TOTAL (STORAGE BASIN AND CUTOFF DITCH) LAND AREA = 39.2 ACRES

NOTE: Storage Alternative 2 is conceptual - shapes and locations of basins are subject to change.

STORAGE ALTERNATIVE 2
Land Use Concept Three

VILLAGES OF LEIALI'I
STORAGE ALTERNATIVES TO CRATER RESERVOIR
HAWAII HOUSING FINANCE & DEVELOPMENT CORPORATION
AUGUST 2010

Appendix H

Water

PROJECT:	Villages of Leialii	JOB NO:	2007.70.0500
CLIENT:	HHFDC	DATE:	30-Aug-10
SUBJECT:	Water Availability and Demand	BY:	A. Kato
FILE:	Availability and Demand Sept 14 2009.xls]Private Water		

PRIVATE WATER SYSTEM (Honolulu Board of Water Supply Standards)

Maximum Available Water (MGD)

Based on 24-hour pumping time to meet maximum day demand.

Well 1 =	300	GPM	Existing
Well 2 =	450	GPM	Existing
Well 3 =	550	GPM	
Well 4 =	550	GPM	
Well 5 =	550	GPM	
Well 6 =	550	GPM	(one well standby)
Total =	2,400	GPM	(one well standby)
	3,456,000	GPD	
	3.456	MGD	<== Total Available

LAND USE	NO. UNITS	UNIT	GPD/UNIT	GPD
Concept One				
Phase A				
SF Residential	613	du	500	306,500
MF Residential	788	du	400	315,200
Retail	449,100	SF	0.12	53,892
Office	101,900	SF	0.12	12,228
Industrial	17.20	Acres	4,000	68,800
School	12.01	Acres	4,000	48,040
Park	24.39	Acres	4,000	97,560
Subtotal Phase A				902,220
Phase B				
SF Residential	1,522	du	500	761,000
MF Residential	0	du	400	0
Retail	0	SF	0.12	0
Office	0	SF	0.12	0
Industrial	0	Acres	4,000	0
School	12.01	Acres	4,000	48,040
Park	19.58	Acres	4,000	78,320
Subtotal Phase B				887,360
Total Phase A and B				1,789,580

Average Day Demand (MGD) =	1.790	
Maximum Day Demand (MGD) =	2.684	OK, below total available

PROJECT:	Villages of Leialii	JOB NO:	2007.70.0500
CLIENT:	HHFDC	DATE:	30-Aug-10
SUBJECT:	Water Availability and Demand	BY:	A. Kato
FILE:	Availability and Demand Sept 14 2009.xls]Private Water		

LAND USE	NO. UNITS	UNIT	GPD/UNIT	GPD
Concept Two				
Phase A				
SF Residential	0	du	500	0
MF Residential	2,521	du	400	1,008,400
Retail	449,100	SF	0.12	53,892
Office	101,900	SF	0.12	12,228
Industrial	17.20	Acres	4,000	68,800
School	12.01	Acres	4,000	48,040
Park	24.39	Acres	4,000	97,560
Subtotal Phase A				1,288,920
Phase B				
SF Residential	1,522	du	500	761,000
MF Residential	0	du	400	0
Retail	0	SF	0.12	0
Office	0	SF	0.12	0
Industrial	0	Acres	4,000	0
School	12.01	Acres	4,000	48,040
Park	19.58	Acres	4,000	78,320
Subtotal Phase B				887,360
Total Phase A and B				2,176,280
Average Day Demand (MGD) =				2.176
Maximum Day Demand (MGD) =				3.264

OK, below total available

LAND USE	NO. UNITS	UNIT	GPD/UNIT	GPD
Concept Three				
Phase A				
SF Residential	532	du	500	266,000
MF Residential	2,069	du	400	827,600
Retail	452,700	SF	0.12	54,324
Office	143,300	SF	0.12	17,196
Industrial	21.81	Acres	4,000	87,240
School	12.01	Acres	4,000	48,040
Park	20.52	Acres	4,000	82,080
Subtotal Phase A				1,382,480
Phase B				
SF Residential	854	du	500	427,000
MF Residential	650	du	400	260,000
Retail	0	SF	0.12	0
Office	0	SF	0.12	0
Industrial	0	Acres	4,000	0
School	12.58	Acres	4,000	50,320
Park	17.46	Acres	4,000	69,840
Subtotal Phase B				807,160
Total Phase A and B				2,189,640
Average Day Demand (MGD) =				2.190
Maximum Day Demand (MGD) =				3.284

OK, below total available

PROJECT:	Villages of Leialii	JOB NO:	2007.70.0500
CLIENT:	HHFDC	DATE:	30-Aug-10
SUBJECT:	Water Availability and Demand	BY:	A. Kato
FILE:	Availability and Demand Sept 14 2009.xls]Private Water		

DWS WATER SYSTEM (Maui Department of Water Supply Standards)

Maximum Available Water (MGD)

DWS allocated pumping rate = 400 GPM for the area

45% Pumping Capacity for each well (DWS Policy)

75% Development Allocation / 25% DWS Allocation (DWS Development Allocation Agreement)

Well Production:

Well 1 =	300	GPM	Existing
Well 2 =	400	GPM	Existing
Well 3 =	400	GPM	
Well 4 =	400	GPM	
Well 5 =	400	GPM	
Well 6 =	400	GPM	(one well standby)
Total =	1,900	GPM	(one well standby)
	2,736,000	GPD	
	1,231,200	GPD	45% Capacity
	923,400	GPD	75% Allocation
	0.9234	MGD	<== Total Available

LAND USE	NO. UNITS	UNIT	GPD/UNIT	GPD
Concept One				
Phase A				
SF Residential	613	du	600	367,800
MF Residential	788	du	560	441,280
Retail	449,100	SF	0.14	62,874
Office	101,900	SF	0.14	14,266
Industrial	17.20	Acres	6,000	103,200
School	12.01	Acres	1,700	20,417
Park	24.39	Acres	1,700	41,463
Subtotal Phase A				1,051,300
Phase B				
SF Residential	1,522	du	600	913,200
MF Residential	0	du	560	0
Retail	0	SF	0.14	0
Office	0	SF	0.14	0
Industrial	0	Acres	6,000	0
School	12.01	Acres	1,700	20,417
Park	19.58	Acres	1,700	33,286
Subtotal Phase B				966,903
Total Phase A and B				2,018,203

Average Day Demand (MGD) =	2.018	
Maximum Day Demand (MGD) =	3.027	Exceeds Total Available

PROJECT:	Villages of Leialii	JOB NO:	2007.70.0500
CLIENT:	HHFDC	DATE:	30-Aug-10
SUBJECT:	Water Availability and Demand	BY:	A. Kato
FILE:	Availability and Demand Sept 14 2009.xls]Private Water		

LAND USE	NO. UNITS	UNIT	GPD/UNIT	GPD
Concept Two				
Phase A				
SF Residential	0	du	600	0
MF Residential	2,521	du	560	1,411,760
Retail	449,100	SF	0.14	62,874
Office	101,900	SF	0.14	14,266
Industrial	17.20	Acres	6,000	103,200
School	12.01	Acres	1,700	20,417
Park	24.39	Acres	1,700	41,463
Subtotal Phase A				1,653,980
Phase B				
SF Residential	1,522	du	600	913,200
MF Residential	0	du	560	0
Retail	0	SF	0.14	0
Office	0	SF	0.14	0
Industrial	0	Acres	6,000	0
School	12.01	Acres	1,700	20,417
Park	19.58	Acres	1,700	33,286
Subtotal Phase B				966,903
Total Phase A and B				2,620,883
Average Day Demand (MGD) =				2.621
Maximum Day Demand (MGD) =				3.931 Exceeds Total Available

LAND USE	NO. UNITS	UNIT	GPD/UNIT	GPD
Concept Three				
Phase A				
SF Residential	532	du	600	319,200
MF Residential	2,069	du	560	1,158,640
Retail	452,700	SF	0.14	63,378
Office	143,300	SF	0.14	20,062
Industrial	21.81	Acres	6,000	130,860
School	12.01	Acres	1,700	20,417
Park	20.52	Acres	1,700	34,884
Subtotal Phase A				1,747,441
Phase B				
SF Residential	854	du	600	512,400
MF Residential	650	du	560	364,000
Retail	0	SF	0.14	0
Office	0	SF	0.14	0
Industrial	0	Acres	6,000	0
School	12.58	Acres	1,700	21,386
Park	17.46	Acres	1,700	29,682
Subtotal Phase B				927,468
Total Phase A and B				2,674,909
Average Day Demand (MGD) =				2.675
Maximum Day Demand (MGD) =				4.012 Exceeds Total Available

Conceptual Offsite Water Master Plan for the Villages of Lealii in Lahaina, Maui

Prepared for:

Belt Collins Hawaii
2153 North King Street - Suite 200
Honolulu, Hawaii 96819

Prepared by:

Tom Nance Water Resource Engineering
680 Ala Moana Boulevard - Suite 406
Honolulu, Hawaii 96813

August 2009

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D Cost Estimate for the Offsite Water System Infrastructure for Concept Land Use Plan Two

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Introduction

This report presents a conceptual offsite water master plan for the Villages of Lealii to be located in Lahaina, Maui. It identifies the main components of required water system infrastructure, including wells, storage reservoirs, and transmission mains. Belt Collins Hawaii has developed three alternative concept land use plans (Figures 1, 2, and 3). The water system infrastructure presented herein have been created to meet the supply requirements of these plans.

Private Water System Versus a System Dedicated to the Maui County Department of Water Supply

The project's water system could be privately owned and operated or it could be constructed to Maui County Department of Water Supply (DWS) standards and dedicated to that agency. For the size and location of the project, a private water system has compelling advantages. These advantages are as follows:

- Due to differing design standards for use rate criteria, supply requirements for a private system would be 13 to 23 percent less than a DWS-dedicated system.
- The number of wells required for a private system would be less than two-thirds of the number of wells required for a DWS system.
- All of the water developed by wells for a private system would be allocated to the project. If it were a DWS-dedicated system, 25 percent of the well supply would have to be allocated to DWS' for its use elsewhere in Lahaina.
- A private water system provides greater flexibility in the choice of materials of construction. The biggest advantage in this regard would be the use of steel storage tanks rather than the concrete tanks that would be required for a DWS-dedicated system.

Groundwater resources and available sites for supply wells in the area of the project are limited. From this perspective, meeting all of the requirements for well development for a DWS-dedicated system is simply not practical. As such, the master plan presented herein is based on providing the required infrastructure for a private system.

Projected Water Supply Requirements

Tables 1, 2, and 3 present the projected water supply requirements for the three alternative conceptual land use plans prepared by Belt Collins Hawaii. Each set of projected supply requirements is divided into Phases A and B. Phase A would encompass all of the area makai of the proposed Lahaina Bypass Road and would be the initial area to be developed. Phase B, the project area mauka of the Bypass Road, would be developed at a future time.

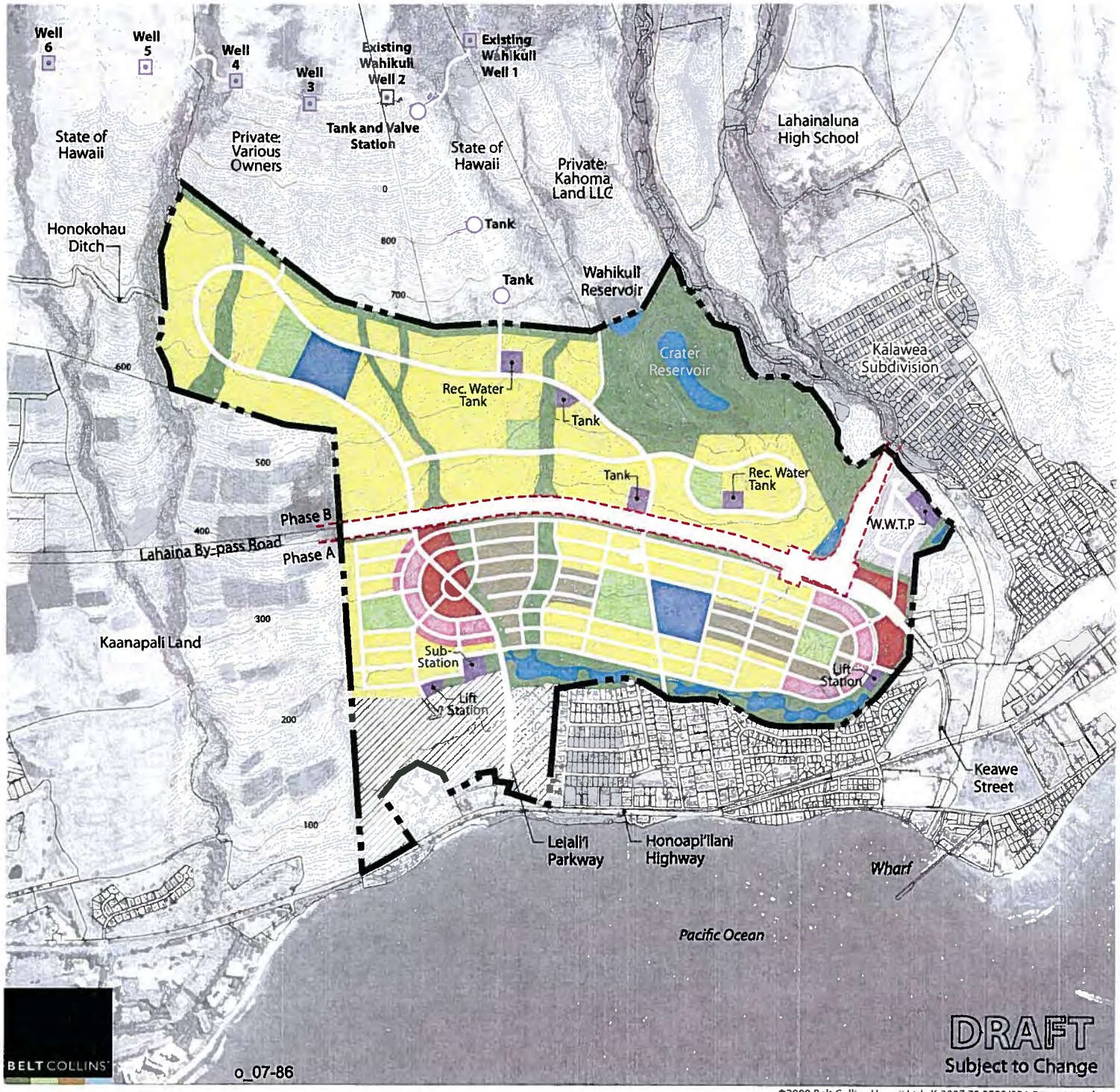

Figure 1
CONCEPT LAND USE PLAN ONE

Villages of Leialiʻi

LEGEND

- Detached Single-Family Residential
  Phase A: 101.47 ac/ 624 du
  Phase B: 306.00 ac/ 1,529 du
- Multi-Family Residential
  Phase A: 41.52 ac/ 614 du
- Open Space
  Phase A: 78.11 ac
  Phase B: 179.84 ac
- Park
  Phase A: 24.39 ac
  Phase B: 19.58 ac
- Elementary School
  Phase A: 12.01 ac
  Phase B: 12.01 ac
- Commercial
  Phase A: 20.75 ac/ 245,200 sf
- Mixed Use
  Phase A: 23.40 ac
  Commercial: 203,900 sf
  Office: 101,900
  Multi-Family Residential: 163
- Light Industrial
  Phase A: 17.20 ac/ 524,500 sf
- Infrastructure
  Phase A: 7.67 ac
  Phase B: 7.47 ac
- Not in Project
  96.02 ac
- Detention Ponds
- Phase Boundary

Note: Lot lines shown are approximate and for illustrative purposes. Imagery is from Google Earth Pro and is approximately matched to lot lines.

NORTH

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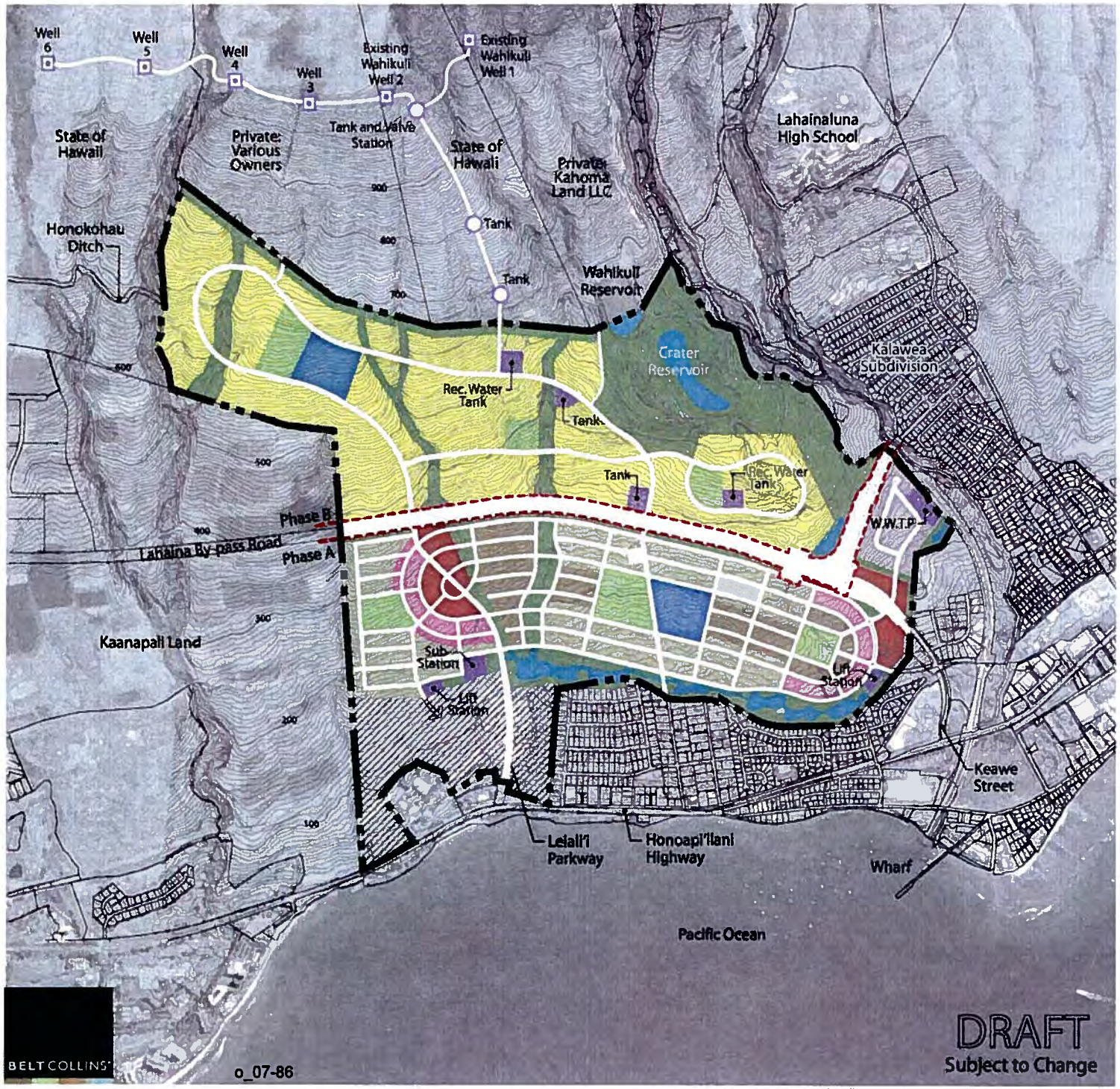
Figure 2

CONCEPT LAND USE PLAN TWO

Villages of Leiali'i



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LEGEND

- Detached Single-Family Residential
  Phase B: 306.00 ac/ 1,529 du
- Multi-Family Residential - 15 du/ac
  Phase A: 101.47 ac/ 1,524 du
- Multi-Family Residential - 20 du/ac
  Phase A: 41.51 ac/ 834 du
- Open Space
  Phase A: 78.11 ac
  Phase B: 179.84 ac
- Park
  Phase A: 24.39 ac
  Phase B: 19.58 ac
- Elementary School
  Phase A: 12.01 ac
  Phase B: 12.01 ac
- Commercial
  Phase A: 20.75 ac/ 245,200 sf
- Mixed Use
  Phase A: 23.40 ac
  Commercial: 203,900 sf
  Office: 101,900 sf
  Multi-Family Residential: 163 du
- Light Industrial
  Phase A: 17.20 ac/ 524,500 sf
- Infrastructure
  Phase A: 7.67 ac
  Phase B: 7.47 ac
- Not in Project
  96.02 ac
- Detention Ponds
- Phase Boundary

Note: Lot lines shown are approximate and for illustrative purposes. Imagery is from Google Earth Pro and is approximately matched to lot lines.

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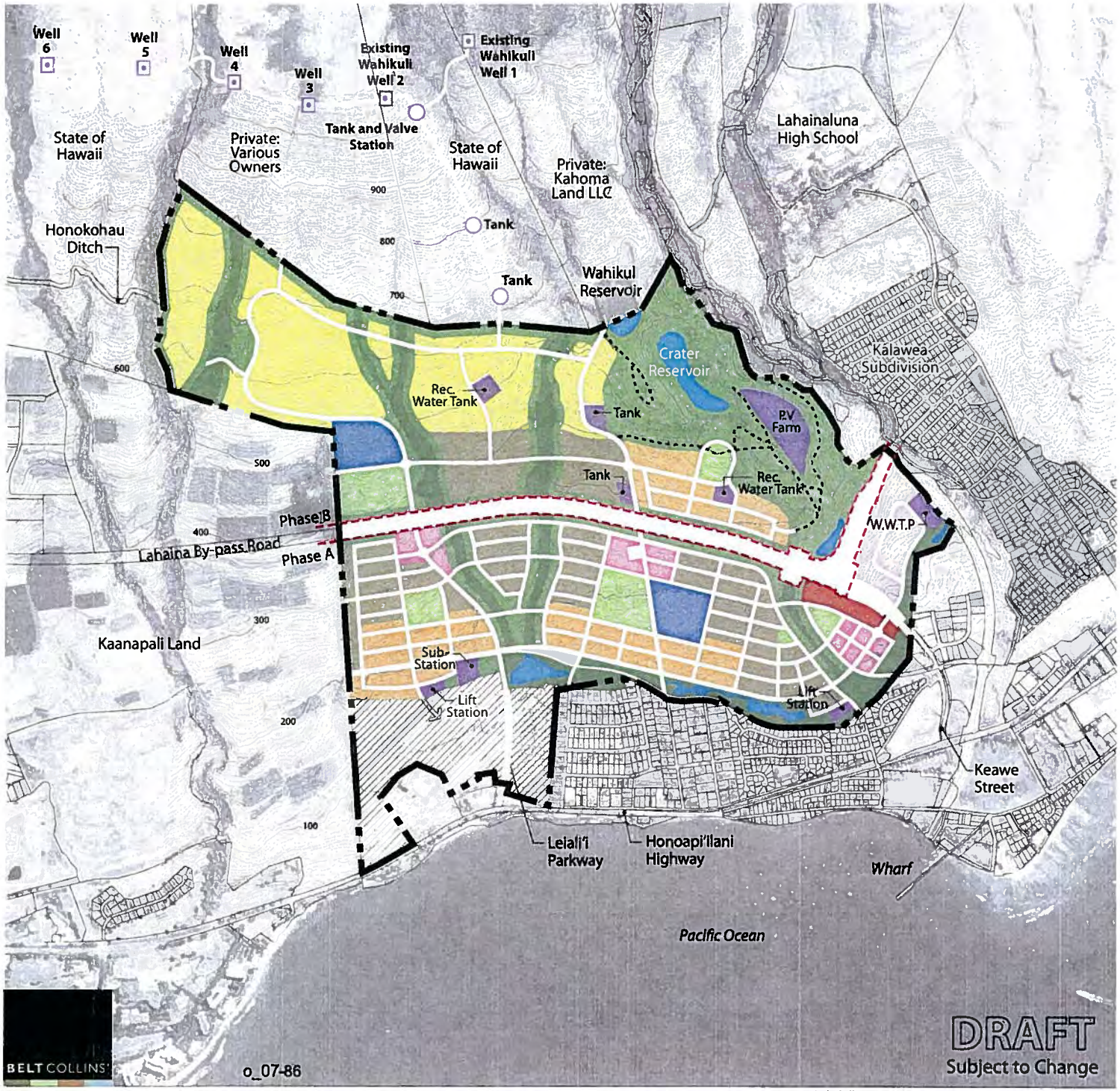

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Figure 3

CONCEPT LAND USE PLAN THREE

Villages of Leialiʻi

LEGEND

- Detached Single-Family Residential
  Phase B: 166.00 ac/ 830 du
- Attached Single-Family Residential
  Phase A: 50.68 ac/ 508 du
  Phase B: 17.83 ac/ 179 du
- Multi-Family Residential - 20 du/ac
  Phase A: 72.61 ac/ 1,530 du
  Phase B: 36.15 ac/ 687 du
- Open Space
  Phase A: 103.81 ac
  Phase B: 260.96 ac
- Park
  Phase A: 20.52 ac
  Phase B: 17.46 ac
- Elementary School
  Phase A: 12.01 ac
  Phase B: 12.58 ac
- Commercial
  Phase A: 7.62 ac/ 165,800 sf
- Mixed Use
  Phase A: 19.74 ac
  Commercial: 286,700 sf
  Office: 143,300 sf
  Multi-Family Residential: 592 du
- Light Industrial
  Phase A: 21.81 ac/ 607,700 sf
- Infrastructure
  Phase A: 7.67 ac
  Phase B: 18.71 ac
- Not in Project
  96.02 ac
- Detention Ponds
- Phase Boundary

Note: Lot lines shown are approximate and for illustrative purposes. Imagery is from Google Earth Pro and is approximately matched to lot lines.

NORTH

0 500 1000 1500 2000
SCALE IN FEET

Table 1

Water Supply Requirements for Concept Land Use Plan One of the Villages at Lealii by Phase Areas and Using Maui County DWS and Recommended Private System Use Rate Criteria

Land Use	Unit	No. of Units	Maui DWS Use Rate Criteria		Recommended Private System Use Rate Criteria	
			GPD / Unit	Average GPD	GPD per Unit	GPD
Phase A						
• SF Residential	Res. Unit	624	600	374,400	500	312,000
• MF Residential	Res. Unit	777	560	435,120	400	310,800
• Retail	Sq. Ft.	449,100	140 / 1,000	62,874	120 / 1,000	53,892
• Office	Sq. Ft.	101,900	140 / 1,000	14,266	120 / 1,000	12,228
• Industrial	Acres	17.20	6,000	103,200	4,000	68,800
• School	Acres	12.01	1,700	20,417	4,000	48,040
• Park	Acres	24.39	1,700	41,463	4,000	97,560
Total for Phase A				1,051,740		903,320
Phase B						
• SF Residential	Res. Unit	1,529	600	917,400	500	764,500
• School	Acres	12.01	1,700	20,417	4,000	48,040
• Park	Acres	19.58	1,700	33,286	4,000	78,320
Total for Phase B				971,103		890,860
Total for Both Phases				2,022,843		1,794,180

Table 2

Water Supply Requirements for Concept Land Use Plan Two of the Villages at Lealii by Phase Areas and Using Maui County DWS and Recommended Private System Use Rate Criteria

Land Use	Unit	No. of Units	Maui DWS Use Rate Criteria		Recommended Private System Use Rate Criteria	
			GPD / Unit	Average GPD	GPD per Unit	GPD
Phase A						
• MF Residential	Res. Unit	2,521	560	1,411,760	400	1,008,400
• Retail	Sq. Ft.	449,100	140 / 1,000	62,874	120 / 1,000	53,892
• Office	Sq. Ft.	101,900	140 / 1,000	14,266	120 / 1,000	12,228
• Industrial	Acres	17.20	6,000	103,200	4,000	68,800
• School	Acres	12.01	1,700	20,417	4,000	48,040
• Park	Acres	24.39	1,700	41,463	4,000	97,560
Total for Phase A				1,653,980		1,288,920
Phase B						
• SF Residential	Res. Unit	1,529	600	917,400	500	764,500
• School	Acres	12.01	1,700	20,417	4,000	48,040
• Park	Acres	19.58	1,700	33,286	4,000	78,320
Total for Phase B				971,103		890,860
Total for Both Phases				2,625,083		2,179,780

Table 3

Water Supply Requirements for Concept Land Use Plan Three of the Villages at Lealii by Phase Areas and Using Maui County DWS and Recommended Private System Use Rate Criteria

Land Use	Unit	No. of Units	Maui DWS Use Rate Criteria		Recommended Private System Use Rate Criteria	
			GPD / Unit	Average GPD	GPD per Unit	GPD
Phase A						
• SF Residential	Res. Unit	508	600	304,800	500	254,000
• MF Residential	Res. Unit	2,122	560	1,188,320	400	848,800
• Retail	Sq. Ft.	452,500	140 / 1,000	63,350	120 / 1,000	54,300
• Office	Sq. Ft.	143,300	140 / 1,000	20,062	120 / 1,000	17,196
• Industrial	Acres	21.81	6,000	130,860	4,000	87,240
• School	Acres	12.01	1,700	20,417	4,000	48,040
• Park	Acres	20.52	1,700	34,884	4,000	82,080
Total for Phase A				1,762,693		1,391,656
Phase B						
• SF Residential	Res. Unit	1,009	600	605,400	500	504,500
• MF Residential	Res. Unit	687	560	384,720	400	274,800
• School	Acres	12.58	1,700	21,386	4,000	50,320
• Park	Acres	17.46	1,700	29,682	4,000	69,840
Total for Phase B				1,041,188		899,460
Total for Both Phases				2,803,881		2,291,116

The projected supply requirements on the three tables also contrast the differences between a private system's requirements and the requirements for a DWS-dedicated system. These differences range from 13 percent (Concept Land Use Plan One) to 23 percent (Concept Land Use Plan Three). On top of these differences, an additional 25 percent of well pumping capacity would be required for a DWS-dedicated system.

Required Well Development

Design Standards. Two county municipal departments of water supply, Honolulu and Maui, require the well pumping capacity (exclusive of standby) to be equal to the maximum day supply with an operating time of 16 hours. The other two, Kauai and Hawaii, allow an operating time of 24 hours. All four define the maximum day amount as 1.5 times the average day. For the Honolulu and Maui criteria, well pumping capacity would need to be 2.25 times the average day supply, plus one more well for standby. For Kauai and Hawaii, that capacity would need to be 1.5 times the average plus one standby well. Virtually all private water systems in Hawaii follow the 24-hour pumping day criterion.

If the wells draw water from high level groundwater or a very robust basal lens, the development cost difference between the 16- and 24-hour design criteria would actually be relatively modest: the same number of wells would be developed; the well casing diameter would only be a size larger; and bigger well pumps and motors would be installed. The cost difference might be on the order of 20 percent. But where groundwater occurs in a thin basal lens, well pump capacities must be limited to avoid salinity intrusion. In this situation, the cost difference between the 16- and 24-hour design standards is substantial -- 50 percent more wells and at least 50 percent more costs. Land availability for the additional well sites can also be a critical issue.

Wells for the Villages of Lealii will tap a thin basal lens with long-term salinity intrusion concerns, an aspect emphatically demonstrated by the experience of the nearby Kaanapali water system wells. Further, land availability and avoiding conflict with the Kaanapali system wells to the north also impose geographic constraints. For these reasons, it is recommended that well pumping capacity be based on meeting projected maximum day use with an operating time of 24 hours with one additional well for standby. It is simply not practical in this location to create a system on providing the maximum day supply in a 16-hour pumping day.

Supply Potential of the Existing Wahikuli Wells. Two wells, known as Wahikuli 1 and 2, were drilled, cased, and pump tested in the early 1990s as sources for the project. Appendices A and B provide evaluations of their potential supply. Although both tap basal groundwater, that occurrence in these locations is clearly influenced by subsurface geologic structures which impede the free flow of groundwater through the parent volcanic rock. This effect is more evident in Well 1 than Well 2. These subsurface geologic structures are almost certainly dikes, as numerous dike exposures have been

mapped for much of the length of the nearby Kahoma Stream valley. Because of this, recommended pump capacities for these wells are modest: 300 GPM (0.432 MGD) for Well 1; and 450 GPM (0.648 MGD) for Well 2.

Locations and Expectable Capacities of New Wells. Analyses were made of the rainfall recharge on the upgradient watershed and the potential groundwater supply assuming that new wells will be arrayed from south to north along the 1040-foot contour. In the vicinity of Wahikuli Wells 1 and 2, the developable groundwater supply is estimated to be 2.0 MGD per mile. Progressing to the north, that developable supply is somewhat greater due to a slightly larger contributing watershed and somewhat higher rainfall. Together with the selected well pump capacity, this developable supply sets the appropriate lateral spacing between wells. Based on the foregoing and the favorable results of the recently completed Kaanapali P-3 well (State No. 5539-03) to the north, well sites and capacities should be selected as follows:

- All new wells should be located approximately along the 1040-foot contour and exclusively to the north of Wahikuli Well 2. A well south of Wahikuli Well 1 is likely to have a yield no greater and probably less than the 300 GPM recommended for Well 1. Also, there is insufficient lateral space to put a new well between Wells 1 and 2.

- For planning purposes, new well capacities of 550 GPM (ie. more than Wahikuli Well 2) are reasonable to anticipate.

- Desirable lateral spacing for the new wells is about 1200 feet.

- Assuming that (1) Wahikuli Wells 1 and 2 are of 300 and 400 GPM capacity, (2) all of the new wells are of 550 GPM capacity, and (3) that a standby well for redundant/back up capacity is required at all stages of development, then the numbers of new wells required for the three concept land use plans would be as tallied on Table 4 and summarized below.

Summary of Required New Well Development*

Development Phase	Concept Land Use Plan One	Concept Land Use Plan Two	Concept Land Use Plan Three
A	2	2	3
Full Build Out	3	4	4

* Assumes use of Wahikuli Wells 1 and 2 in Phase A and that all new wells will have 550 GPM capacity.

Table 4

Summary of Required New Well Development for Concept Land Use Plans One, Two, and Three Based on the Recommended Private Water System Use Rate Criteria

Concept Land Use Plan One

Parameter	Phase A	Full Build-Out
Ultimate Supply Required : Average (MGD)	0.903	1.794
: Max. Day (MGD)	1.355	2.691
Required "Safe" Well Pumping Capacity, Exclusive of Standby (GPM)	940	1870
Supply Provided by Wahikuli Wells 1 and 2 (GPM)	750	750
Minimum Supply to be Provided by New Wells Exclusive of Standby (GPM)	190	1120
Required Number of New Wells (Including Standby)	2 @ 550 GPM	3 @ 550 GPM

Concept Land Use Plan Two

Parameter	Phase A	Full Build-Out
Ultimate Supply Required : Average (MGD)	1.289	2.180
: Max. Day (MGD)	1.934	3.270
Required "Safe" Well Pumping Capacity, Exclusive of Standby (GPM)	1343	2270
Supply Provided by Wahikuli Wells 1 and 2 (GPM)	750	750
Minimum Supply to be Provided by New Wells Exclusive of Standby (GPM)	593	1520
Required Number of New Wells (Including Standby)	2 @ 550 GPM	4 @ 550 GPM

Concept Land Use Plan Three

Parameter	Phase A	Full Build-Out
Ultimate Supply Required : Average (MGD)	1.392	2.291
: Max. Day (MGD)	2.088	3.436
Required "Safe" Well Pumping Capacity, Exclusive of Standby (GPM)	1450	2385
Supply Provided by Wahikuli Wells 1 and 2 (GPM)	750	750
Minimum Supply to be Provided by New Wells Exclusive of Standby (GPM)	700	1635
Required Number of New Wells (Including Standby)	3 @ 550 GPM	4 @ 550 GPM

Delineation of Service Pressure Zones

The project site extends over a relatively wide range of elevations, from 80 to 840 feet. This will require the water system to be comprised of five service pressure zones, each established by a storage tank. The recommended delineation of these pressure zones is listed below and it is identical for all three land use plans. Required supply in each service zone is presented in Tables 5, 6, and 7. Reservoir storage volume requirements for each zone would be as follows:

Tank Spillway Elevation (Feet MSL)	Approximate Range of Elevations Served (Feet MSL)	Reservoir Storage (MG)*		
		Concept Land Use Plan One	Concept Land Use Plan Two	Concept Land Use Plan Three
325	80 to 215	0.5	1.0	1.0
470	215 to 360	1.0	1.0	1.0
630	360 to 520	0.5	0.5	0.5
790	520 to 680	0.5	0.5	0.5
950	680 to 840	0.5	0.5	0.5
Total		3.0	3.5	3.5

* Based on the private water system use rate criteria. Storage in the 950 zone is based on system operating criteria. All others are determined by the maximum day criterion with surplus amounts in upper zones applicable to storage in lower zones.

Estimated Water System Development Costs

Estimated design and construction costs for the water system described above are presented in detail in Appendices C, D, and E and in summary form on Tables 8, 9, and 10. These totals are also presented below.

Total Estimated Design and Construction Costs for Water System Infrastructure

Development Stage	Concept Land Use Plan One	Concept Land Use Plan Two	Concept Land Use Plan Three
Phase A	$ 19,560,500	$ 20,176,000	$ 23,562,000
Phase B	6,893,500	10,063,300	6,758,000
Total for Both Phases	$ 26,454,000	$ 30,239,300	$ 30,320,000

Table 5

Water Supply Requirements for Concept Land Use Plan One
of the Villages of Lealii by Service Pressure Zone

Service Pressure Zone by Tank Spillway Elevation (Feet)	Land Use	Unit	No. of Units	Required Average Supply	
				GPD per Unit	Amount
325	SF Residential	Res. Unit	321	500	160,500
	MF Residential	Res. Unit	429	400	171,600
	Retail and Office	Sq. Ft.	332,600	120 / 1,000	39,912
	Industrial	Acres	17.20	4,000	68,800
	Park	Acres	16.98	4,000	67,920
	School	Acres	12.01	4,000	48,040
Total for 325 Zone					556,772
470	SF Residential	Res. Unit	594	500	297,000
	MF Residential	Res. Unit	348	400	139,200
	Retail and Office	Sq. Ft.	268,400	120 / 1,000	26,208
	Park	Acres	12.45	4,000	49,800
Total for 470 Zone					512,208
630	SF Residential	Res. Unit	590	500	295,000
	Park	Acres	4.43	4,000	17,720
Total for 630 Zone					312,720
790	SF Residential	Res. Unit	509	500	254,500
	School	Acres	12.01	4,000	48,040
	Park	Acres	10.11	4,000	40,440
Total for 790 Zone					342,980
950	SF Residential	Res. Unit	139	500	69,500
Grand Total					1,794,180

Table 6

Water Supply Requirements for Concept Land Use Plan Two
of the Villages of Lealii by Service Pressure Zone

Service Pressure Zone by Tank Spillway Elevation (Feet)	Land Use	Unit	No. of Units	Required Average Supply	
				GPD per Unit	Amount
325	MF Residential	Res. Unit	1,300	400	520,000
	Retail and Office	Sq. Ft.	332,600	120 / 1,000	39,912
	Industrial	Acres	17.20	4000	68,800
	Park	Acres	16.98	4000	67,920
	School	Acres	12.01	4000	48,040
Total for 325 Zone					744,672
470	SF Residential	Res. Unit	291	500	145,500
	MF Residential	Res. Unit	1,221	400	488,400
	Retail and Office	Sq. Ft.	218,400	120 / 1,000	26,208
	Park	Acres	12.45	4000	49,800
Total for 470 Zone					709,908
630	SF Residential	Res. Unit	590	500	295,000
	Park	Acres	443	4000	17,720
Total for 630 Zone					312,720
790	SF Residential	Res. Unit	509	500	254,500
	School	Acres	12.01	4000	48,040
	Park	Acres	10.11	4000	40,440
Total for 790 Zone					342,980
950	SF Residential	Res. Unit	139	500	69,500
Grand Total					2,179,780

Table 7

Water Supply Requirements for Concept Land Use Plan Three
of the Villages of Lealii by Service Pressure Zone

Service Pressure Zone by Tank Spillway Elevation (Feet)	Land Use	Unit	No. of Units	Required Average Supply	
				GPD per Unit	Amount
325	SF Residential	Res. Unit	348	500	174,000
	MF Residential	Res. Unit	960	400	384,000
	Retail and Office	Sq. Ft.	380,600	120 / 1,000	45,672
	Industrial	Acres	21.81	4,000	87,240
	Park	Acres	15.15	4,000	60,600
	School	Acres	12.01	4,000	48,040
Total for 325 Zone					799,552
470	SF Residential	Res. Unit	312	500	156,000
	MF Residential	Res. Unit	1203	400	481,200
	Retail and Office	Sq. Ft.	215,200	120 / 1,000	25,824
	Park	Acres	7.01	4,000	28,040
Total for 470 Zone					691,064
630	SF Residential	Res. Unit	227	500	113,500
	MF Residential	Res. Unit	646	400	258,400
	School	Acres	10.15	4,000	40,600
	Park	Acres	12.92	4,000	51,680
Total for 630 Zone					464,180
790	SF Residential	Res. Unit	509	500	254,500
	School	Acres	2.43	4,000	9,720
	Park	Acres	2.90	4,000	11,600
Total for 790 Zone					275,820
950	SF Residential	Res. Unit	121	500	60,500
Grand Total					2,291,116

Table 8

Cost Estimate Summary for Concept Land Use Plan One

Phase A	
• Outfit Wahikuli Well 1	$ 1,222,000
• Outfit Wahikuli Well 2	1,296,000
• Drill, Case, and Pump Test Wahikuli Well 3	1,135,000
• Drill, Case, and Pump Test Wahikuli Well 4	1,135,000
• Outfit Wahikuli Well 3	1,346,000
• Outfit Wahikuli Well 4	1,346,000
• Transmission Pipelines, Wells to 325-Foot Reservoir	3,862,250
• Chlorination System at 950-Foot Tank	295,000
• Storage Reservoirs	
▪ 0.5 MG at 950 Feet	1,281,250
▪ 1.0 MG at 470 Feet	1,789,750
▪ 0.5 MG at 325 Feet	1,281,250
• PRV Stations at Sites of 790- and 630-Foot Reservoirs	175,000
Total for Construction	$ 16,164,500
Engineering Design and Construction Management	1,779,000
Contingency	1,617,000
Budget Total for Phase A	$ 19,560,500
Phase B	
• Drill, Case, and Pump Test Wahikuli Well 5	$ 1,135,000
• Outfit Wahikuli Well 5	1,346,000
• Well Transmission Pipelines	653,000
• Storage Reservoirs	
▪ 0.5 MG at 790 Feet	1,281,250
▪ 0.5 MG at 630 Feet	1,281,250
Total for Construction	$ 5,696,500
Engineering Design and Construction Management	627,000
Contingency	570,000
Budget Total for Phase B	$ 6,893,500

Table 9

Cost Estimate Summary for Concept Land Use Plan Two

Phase A	
• Outfit Wahikuli Well 1	$ 1,222,000
• Outfit Wahikuli Well 2	1,296,000
• Drill, Case, and Pump Test Wahikuli Well 3	1,135,000
• Drill, Case, and Pump Test Wahikuli Well 4	1,135,000
• Outfit Wahikuli Well 3	1,346,000
• Outfit Wahikuli Well 4	1,346,000
• Transmission Pipelines, Wells to 325-Foot Reservoir	3,862,250
• Chlorination Building and System at 950-Foot Reservoir	295,000
• Storage Reservoirs	
▪ 0.5 MG at 950 Feet	1,281,250
▪ 1.0 MG at 470 Feet	1,789,750
▪ 1.0 MG at 325 Feet	1,789,750
• PRV Stations at Sites of 790- and 630-Foot Reservoirs	175,000
Total for Construction	$ 16,673,000
Engineering Design and Construction Management	1,835,000
Contingency	1,668,000
Budget Total for Phase A	$ 20,176,000
Phase B	
• Drill, Case, and Pump Test Wahikuli Well 5	$ 1,135,000
• Drill, Case, and Pump Test Wahikuli Well 6	1,135,000
• Outfit Wahikuli Well 5	1,346,000
• Outfit Wahikuli Well 6	1,346,000
• Well Transmission Pipelines	790,800
• Storage Reservoirs	
▪ 0.5 MG at 790 Feet	1,281,250
▪ 0.5 MG at 630 Feet	1,281,250
Total for Construction	$ 8,315,300
Engineering Design and Construction Management	916,000
Contingency	832,000
Budget Total for Phase B	$ 10,063,300

Table 10

Cost Estimate Summary for Concept Land Use Plan Three

Phase A	
• Outfit Wahikuli Well 1	$ 1,222,000
• Outfit Wahikuli Well 2	1,296,000
• Drill, Case, and Pump Test Wahikuli Well 3	1,135,000
• Drill, Case, and Pump Test Wahikuli Well 4	1,135,000
• Drill, Case, and Pump Test Wahikuli Well 5	1,135,000
• Outfit Wahikuli Well 3	1,346,000
• Outfit Wahikuli Well 4	1,346,000
• Outfit Wahikuli Well 5	1,346,000
• Transmission Pipelines, Wells to 325-Foot Reservoir	4,179,250
• Chlorination Building and System at 950-Foot Reservoir	295,000
• Storage Reservoirs	
▪ 0.5 MG at 950 Feet	1,281,250
▪ 1.0 MG at 470 Feet	1,789,750
▪ 1.0 MG at 325 Feet	1,789,750
• PRV Stations at Sites of 790- and 630-Foot Reservoirs	175,000
Total for Construction	$ 19,471,000
Engineering Design and Construction Management	2,143,000
Contingency	1,948,000
Budget Total for Phase A	$ 23,562,000
Phase B	
• Drill, Case, and Pump Test Wahikuli Well 6	$ 1,135,000
• Outfit Wahikuli Well 6	1,346,000
• Well Transmission Pipelines	540,500
• Storage Reservoirs	
▪ 0.5 MG at 790 Feet	1,281,250
▪ 0.5 MG at 630 Feet	1,281,250
Total for Construction	$ 5,584,000
Engineering Design and Construction Management	615,000
Contingency	559,000
Budget Total for Phase B	$ 6,758,000

Appendix

A. Evaluation of the Pump Test Results of Wahikuli Well 1, State No. 5439-01

B. Evaluation of the Pump Test Results of Wahikuli Well 2, State No. 5439-02

C. Cost Estimate for the Offsite Water System Infrastructure for Concept Land Use Plan One

D. Cost Estimate for the Offsite Water System Infrastructure for Concept Land Use Plan Two

E. Cost Estimate for the Offsite Water System Infrastructure for Concept Land Use Plan Three

Appendix A

Evaluation of the Pump Test Results of Wahikuli Well 1, State No. 5439-01

TNWRE
Tom Nance Water
Resource Engineering

Email: akato@beltcollins.com

Original ☑ will ☐ will not be mailed to you.

May 20, 2008
08-122 (07-86)

MEMORANDUM

TO: Alan Kato and BCH

FROM: Tom Nance

SUBJECT: Evaluation of the Pump Test Results of Wahikuli Well 1, State No. 5439-01

This memo and its attachments will summarize the pump test data and my interpretations of it for Wahikuli Well 1, State No. 5439-01. The well was constructed to State Department of Land and Natural Resources (DLNR) standards and the pump test was run by Mitch Ouye at DLNR, so I am confident that construction methods were satisfactory and that the pump test data are reliable.

Pump Tests

The initial pump test was run on March 30 to 31, 1992. It was interrupted and then finally stopped due to equipment malfunction. The final pump test was run after the malfunction was corrected from March 31 to April 3, 1992. The initial test did provide the hydraulic performance data presented below and illustrated on Figure 1.

Step-Drawdown Data

Pumping Rate (GPM)	Drawdown (Feet)
327	4.40
502	7.55
675	12.20

Fitted Curve

$S = AQ^2 + BQ$

where:
S = Drawdown in Feet
Q = Pumping Rate in GPM
A = 1.326×10^{-5}
B = 8.874×10^{-3}
r^2 = 0.967

These initial test data established the following several quite anomalous results:

- Based on the well's static water level of 6.6 feet (MSL), the expectation was that it tapped basal groundwater. However, the response to pumping was not typical for basal groundwater. There was a time-dependent component of drawdown and recovery indicative of drawing water from a small compartment created by unknown subsurface geology. Two and a half hours after pumping was stopped, the recovered water level was still 2.6 feet below the initial static level (refer to Figure 2).

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- Chlorides were anomalously low (about 12 MG/L) and not sensitive to pumping. As with the time-dependent drawdown and recovery, this suggests that water was drawn from a compartment.

- Drawdown was relatively high. At 675 GPM, for example, it was 12.2 feet.

The second pump test was started on March 31st before full recovery from the first test was achieved. It was run for 70 hours at a reasonably constant 700 GPM rate. Results of this test (on Figure 3) show far more definitely the time-dependent, compartmentalized groundwater response: drawdown continued to increase throughout the test; a stable drawdown level was never achieved; recovery was slow; and after six hours, the recovered water level was still 6.55 feet below the original static level.

Time-dependent drawdown and recovery are more appropriately evaluated on a semi-log plot such as Figure 4. This shows that a clear boundary effect occurred about 1000 minutes into the 4200-minute test, resulting a substantial steepening of the drawdown rate. Recovery is plotted from right to left on the graph (the X-axis is the time since pumping started divided by the time since pumping stopped). It typically duplicates the drawdown curve, offset above it by the turbulent component of drawdown. Measuring water levels by slow-responding airline may be the reason the "duplication" of the recovery curve is a bit off.

Water Quality

Despite the well's substantial drawdown, there was no salinity increase at any time during the two pump tests (chlorides were consistently about 12 MG/L). Complete drinking water analyses were done by Montgomery Laboratories (Sample No. 930121033) on a January 19, 1993 sample, some nine months after the contractor's pump test and apparently using a pump installed by the Department of Water Supply (DWS) for the sampling. Results showed the water to be of excellent quality.

Issues and Recommendations

1. DWS has an unwritten (and for some situations, questionable) policy of not allowing the well's drawdown to drop below mean sea level. In this instance, such a policy would limit the capacity of the permanent pump to less than 450 GPM. I have no information on the capacity of the pump now installed in the well, but it is highly unlikely that it is salvageable after more than a decade of not being run. Plans completed by Unemori called for a 400 GPM submersible pump to be used.

2. I believe this well has a long-term useable safe capacity, but that capacity is probably in the range of 300 GPM. A pump test at that rate would need to be conducted to confirm that. Pumping for a minimum of seven days and possibly longer would be needed. At the end of that time, resampling for DOH drinking water certification could be done.

3. Assuming the intention is to dedicate this system to DWS, agreements with that agency should be obtained before undertaking a costly pump test.

Attachments

Figure 1. March 30, 1992 Step Test Performance of Wahikuli Well 1 (5439-01)

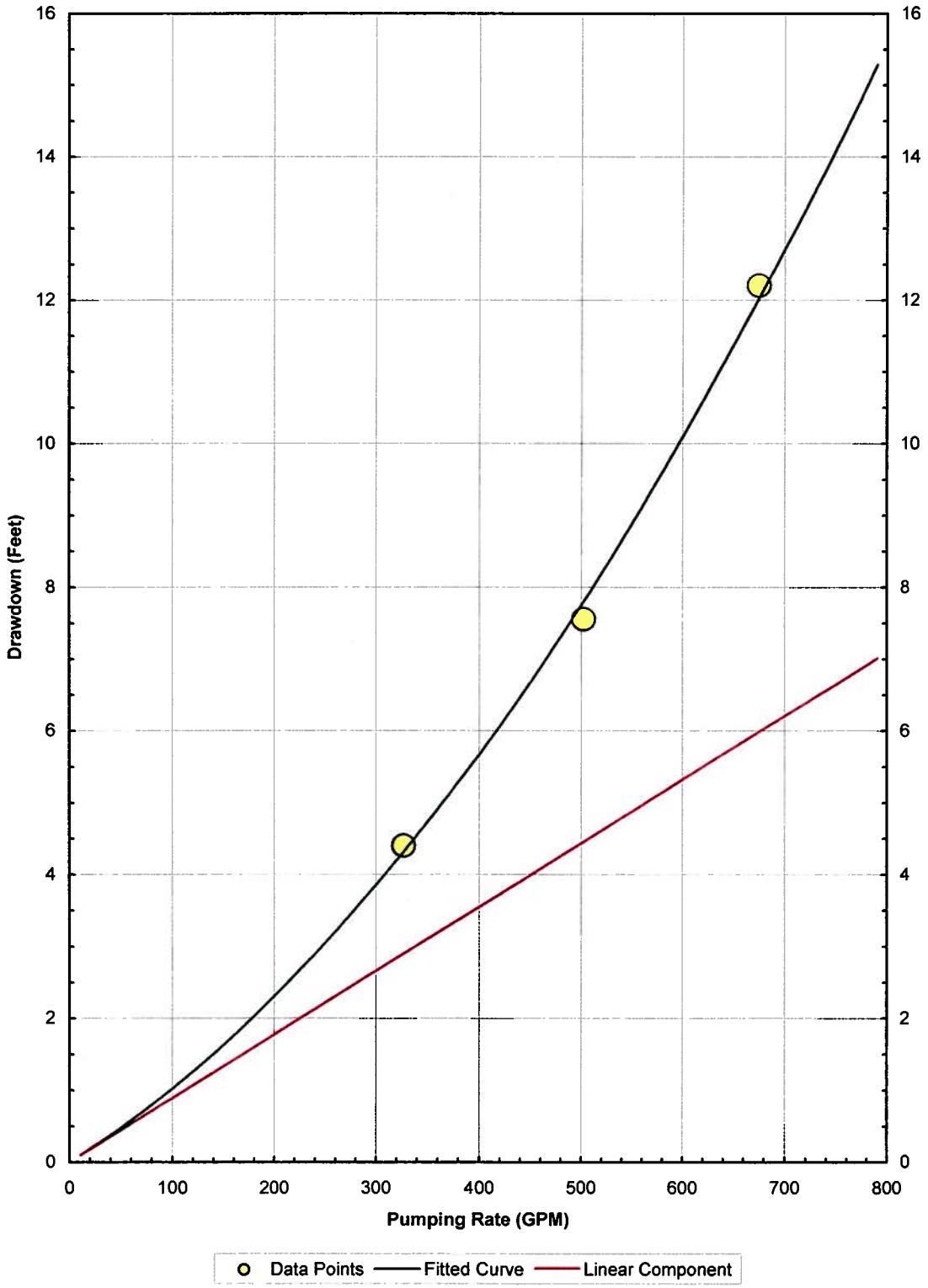


Figure 2. Linear Plot of the First Pump Test of Wahikuli Well 1, March 30 to 31, 1992

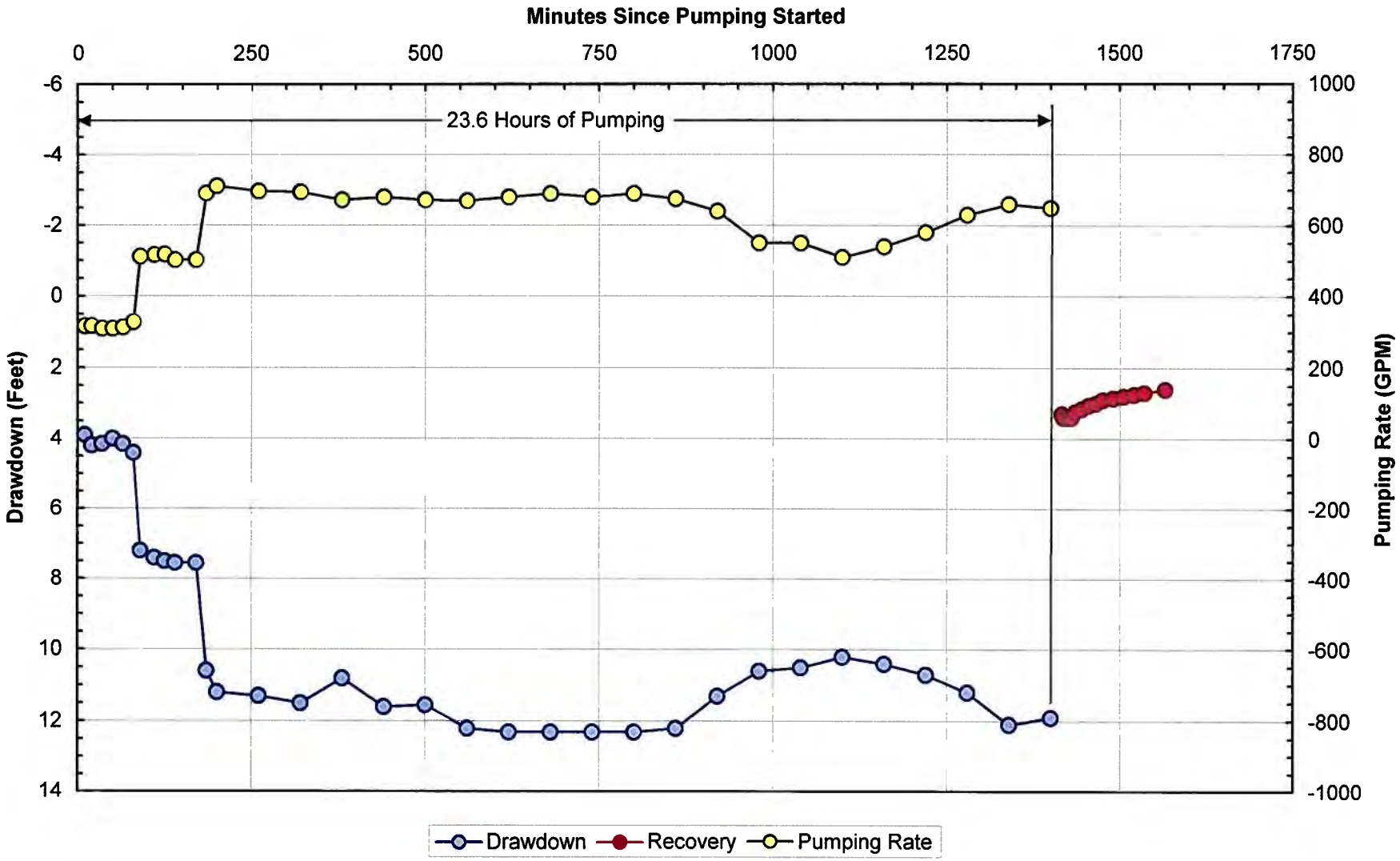


Figure 3. Linear Plot of the Second Pump Test of Wahikuli Well 1, March 31 to April 3, 1992

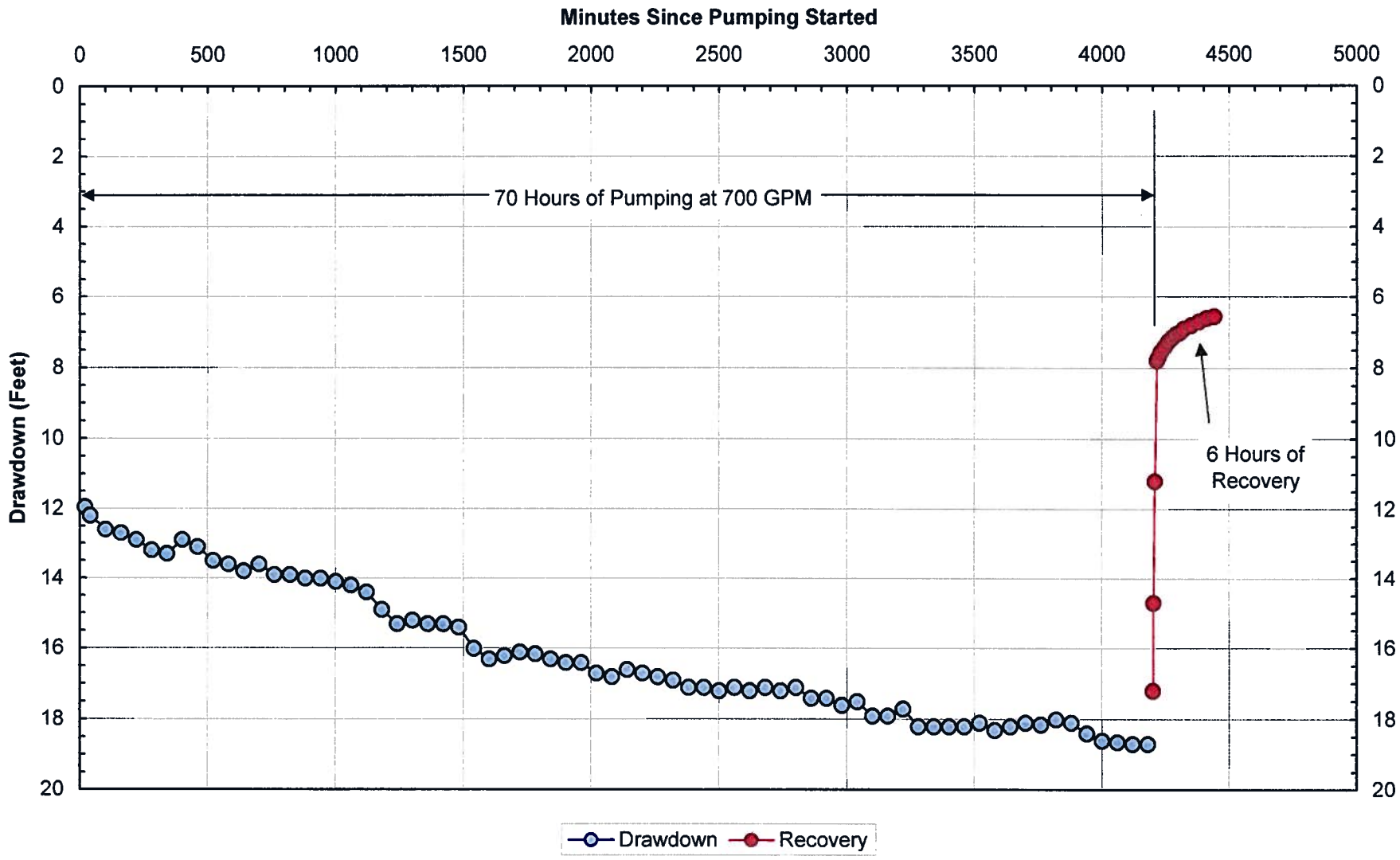
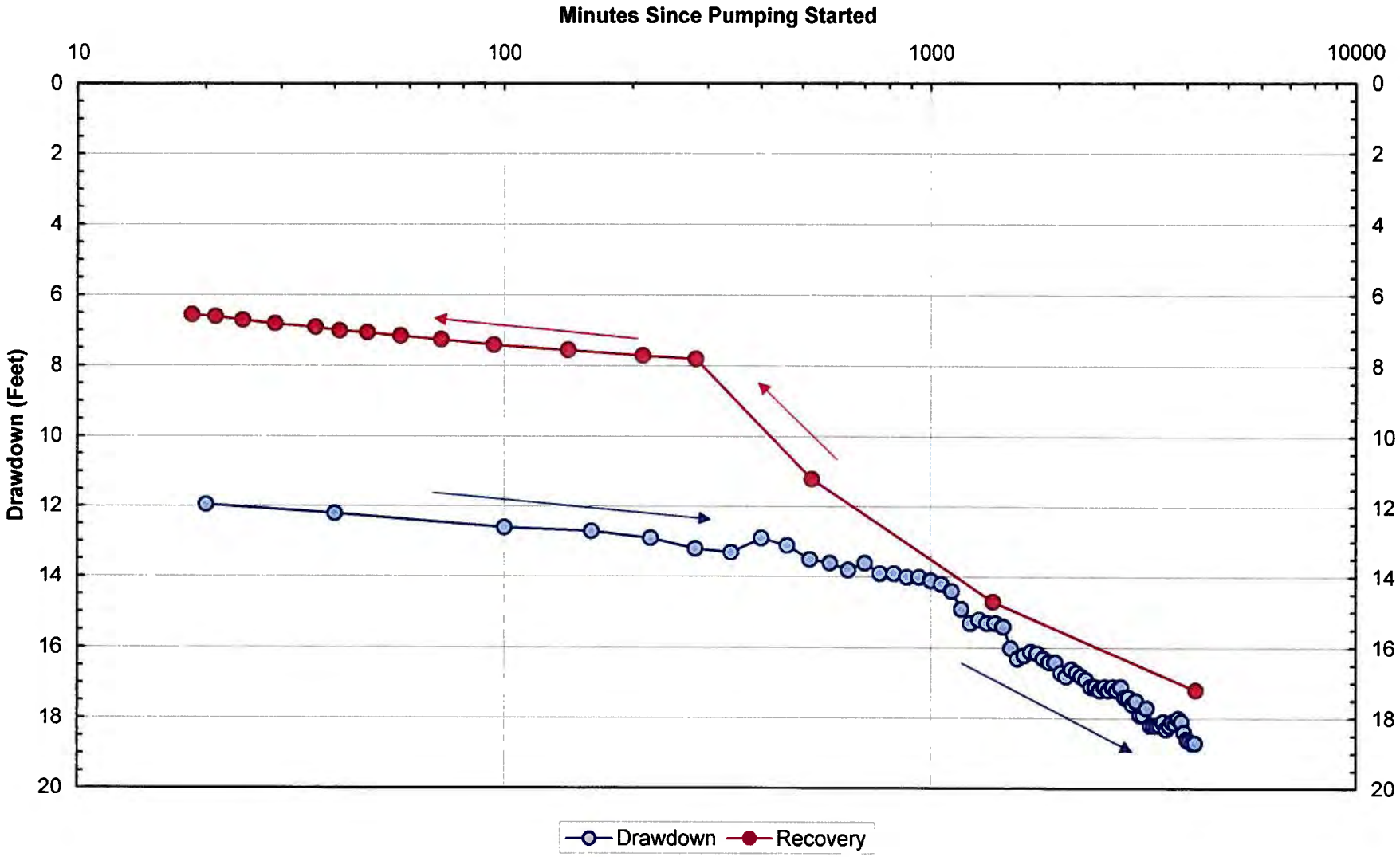


Figure 4. Semi-Log Plot of the Second Pump Test of Wahikuli Well 1, March 30 to April 3, 1992



Appendix B

Evaluation of the Pump Test Results of
Wahikuli Well 2, State No. 5439-02

TNWRE
Tom Nance Water
Resource Engineering

No. of pages: 5
Email: akato@beltcollins.com

Original ☑ will ☐ will not be mailed to you.

May 27, 2008
08-133 (07-86)

MEMORANDUM

TO: Alan Kato - BCH

FROM: Tom Nance

SUBJECT: Evaluation of the Pump Test Results of Wahikuli Well 2, State No. 5439-02

This memo and its attachments summarize the results and my interpretations of the pump test of Wahikuli Well 2, State No. 5439-02. This well was constructed by Water Resources International, Inc. (No. 1 was done by Paul Frandsen). As with Well 1, the pump test was run by Mitch Ouye of the State Department of Land and Natural Resources.

Pump Tests

Two pump tests were run, a step-drawdown test on June 25, 1993 and then a 120-hour constant rate test from June 28 to July 3, 1993. Their results are described below.

Step-Drawdown Pump Test. The step-drawdown test defined the well's very substantial hydraulic capacity, a consequence of the highly permeable lavas the well penetrates (refer to the tally below and Figure 1). Drawdown was only 2.3 feet at 1000 GPM, for example. Well 2's capacity is far greater than Well 1 which, at a drawdown of 2.3 feet, would only be producing about 200 GPM.

Step-Drawdown Data

Pumping Rate (GPM)	Drawdown (Feet)
394	0.60
617	1.20
750	1.50
1014	2.30

Fitted Curve

$S = AQ^2 + BQ$

where:
S = Drawdown in Feet
Q = Pumping Rate in GPM
A = 1.157×10^{-6}
B = 1.131×10^{-3}
r^2 = 0.946

Constant Rate Pump Test. The five-day constant rate pump test was run at an average of 1016 GPM (Figure 2). Two key indicators of the well's long-term performance were demonstrated. First, there was a time-dependent component of the well's drawdown and recovery with an obvious boundary effect.

This is not like the typical response of basal groundwater in a formation as permeable as shown by the step-test results. The semi-log plot on Figure 3 best illustrates this. Second, although chlorides were quite low (between 20 and 30 MG/L), they steadily increased throughout the five-day test (Figure 2).

Conclusions and Recommendations

1. The boundary effect which manifested itself as a steepening of the drawdown curve 120 minutes into the constant rate test was caused by an unknown subsurface feature. It undoubtedly contributed to the exceptionally low salinity of the pumped water.

2. Continuously increasing chlorides during the constant rate test demonstrated that the test's 1000 GPM rate clearly exceeded the well's long term yield.

3. In view of the pump test results and the size of the upgradient contributing watershed, I would limit the installed pump capacity to 450 GPM.

4. I could not find any laboratory analyses of regulated drinking water constituents and I suspect no such sampling was ever done. Certification of the well by DOH-SDWB will require installation of a pump, sampling, and laboratory analyses of the samples.

Attachments

Figure 1. June 25, 1993 Step Test Performance of Wahikuli Well 2 (5439-02)

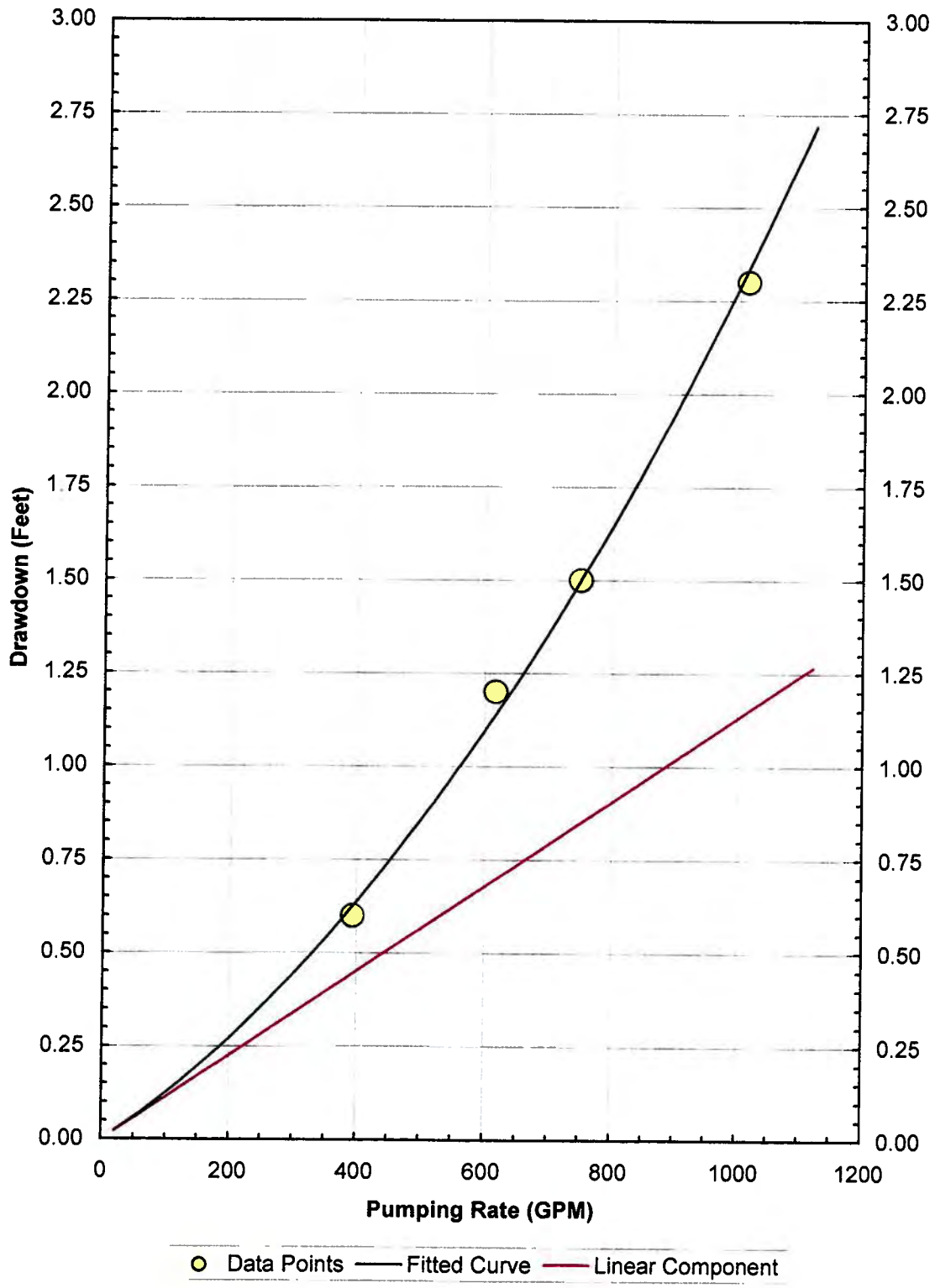


Figure 2. Chlorides During the 1000 GPM Constant Rate Pump Test of Wahikuli Well 2 (State No. 5439-02)

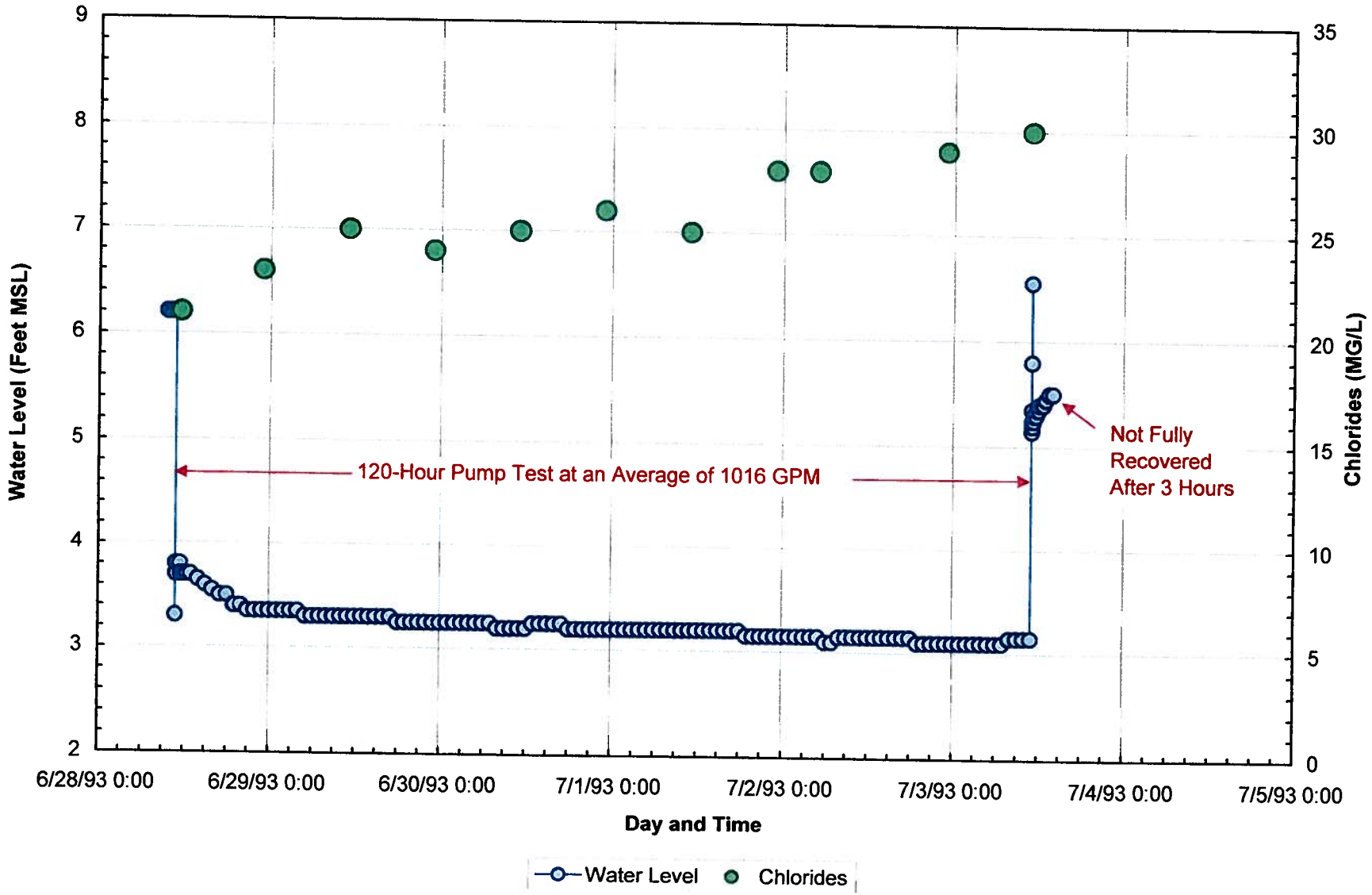
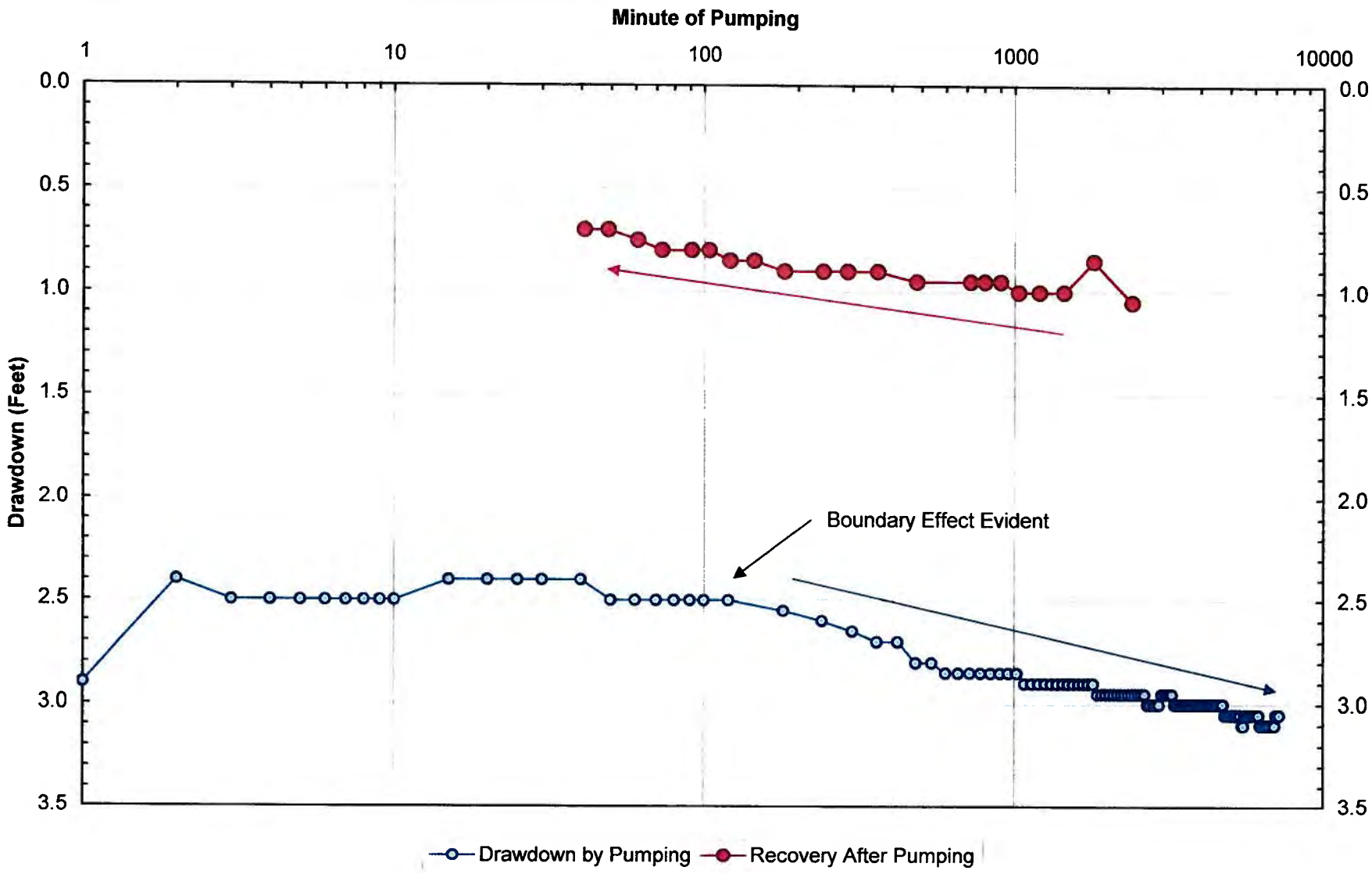


Figure 3. Drawdown and Recovery During the Constant Rate Pump Test of Wahikuli Well 2



Appendix C

Cost Estimate for the
Offsite Water System Infrastructure for
Concept Land Use Plan One

Villages at Leialii - Plan 1 - Phase A - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Outfit Wahikuli Well No. 1					
Well Site Earthwork	1,000	CY	40	40,000	
Site Paving	2,000	SY	30	60,000	
Site Fencing		LS		30,000	
Site Drainage System		LS		40,000	
8" DI Pipe, Class 52	100	LF	110	11,000	
Pipe Valves and Fittings		LS		5,000	
Testing and Chlorination		LS		6,000	
Submersible Pump (300 GPM, 125 HP)		LS		300,000	
Pump Discharge Piping		LS		60,000	
Pump Control Building		LS		120,000	
Control Building Mechanical		LS		40,000	
Erosion and Dust Control		LS		10,000	
Construction Survey		LS		5,000	
Pump and Building Electrical		LS		50,000	
Transformer Pad and Ducts		LS		25,000	
Metering, Motor Control Center, and SCADA System		LS		400,000	
MECO Facility Charge for Service		LS		20,000	
Total					$1,222,000
Outfit Wahikuli Well No. 2					
Well Site Earthwork	1,000	CY	40	40,000	
Site Paving	2,000	SY	30	60,000	
Site Fencing		LS		30,000	
Site Drainage System		LS		40,000	
8" DI Pipe, Class 52	100	LF	100	10,000	
Pipe Valves and Fittings		LS		5,000	
Testing and Chlorination		LS		6,000	
Submersible Pump (450 GPM, 200 HP)		LS		350,000	
Pump Discharge Piping		LS		60,000	
Pump Control Building		LS		120,000	
Control Building Mechanical		LS		40,000	
Erosion and Dust Control		LS		10,000	
Construction Survey		LS		5,000	
Pump and Building Electrical		LS		50,000	
Transformer Pad and Ducts		LS		25,000	
Metering, Motor Control Center, and SCADA System		LS		425,000	
MECO Facility Charge for Service		LS		20,000	
Total					$1,296,000
Drill, Case, and Pump Test Wahikuli Well No. 3					
Mob-Demob		LS		100,000	
Drill 12-Inch Pilot Hole	1,100	LF	250 #	275,000	
Ream Pilot Hole to 25 Inches	1,100	LF	300	330,000	
18" Solid Casing	1,040	LF	200	208,000	
18" Perforated Casing	60	LF	275	16,500	
Furnishing and Installing Grout	900	LF	95	85,500	
Pilot Hole Pump Test		LS		15,000	
Well Development and Test Pumping		LS		90,000	
Well Chlorination,Video, and Plumbness-Align Test		LS		15,000	
Total					$1,135,000

Villages at Leialii - Plan 1 - Phase A - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Construct Well No. 4 (Same Cost Well No. 3)					$1,135,000
Outfit Wahikuli Well No. 3					
Well Site Earthwork	1,000	CY	40	40,000	
Site Paving	2,000	SY	30	60,000	
Site Fencing		LS		30,000	
Site Drainage System		LS		40,000	
8" DI Pipe, Class 52	100	LF	100	10,000	
Pipe Valves and Fittings		LS		5,000	
Testing and Chlorination		LS		6,000	
Submersible Pump (550 GPM, 250 HP)		LS		375,000	
Pump Discharge Piping		LS		60,000	
Pump Control Building		LS		120,000	
Control Building Mechanical		LS		40,000	
Erosion and Dust Control		LS		10,000	
Construction Survey		LS		5,000	
Pump and Building Electrical		LS		50,000	
Transformer Pad and Ducts		LS		25,000	
Metering, Motor Control Center, and SCADA System		LS		450,000	
MECO Facility Charge for Service		LS		20,000	
Total					$1,346,000
Outfit Wahikuli Well No. 4 (Same Cost as No. 3)					$1,346,000
Well Transmission Line Well Sites to 0.5 MG 325' Tank					
6" DI Pipe, Class 52	950	LF	80	76,000	
12" DI Pipe, Class 52	1,150	LF	120	138,000	
16" DI Pipe, Class 52	9,350	LF	165	1,542,750	
6" GV w/VB	2	EA	3,000	6,000	
12" GV w/VB	3	EA	5,000	15,000	
16" GV w/VB	5	EA	6,000	30,000	
DI Fittings		LS		125,000	
Pressure Sustaining Station for Wells	1	EA	100,000	100,000	
Access Road Earthwork	11,450	LF	50	572,500	
Access Road Paving	11,450	LF	60	687,000	
Road Drainage		LS		125,000	
Erosion and Dust Control		LS		50,000	
Construction Survey		LS		20,000	
Testing and Chlorination		LS		75,000	
MECO Facility Charge (OH Service)		LS		300,000	
Total					$3,862,250

Villages at Leialii - Plan 1 - Phase A - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Chlorination System Building at 0.5 MG (950') Tank Site					
Pump Control Building		LS		70,000	
Control Building Mechanical		LS		60,000	
Chlorination System		LS		60,000	
Building Electrical		LS		20,000	
Chlorination Electrical - SCADA System		LS		75,000	
MECO Facility Charge for Service		LS		10,000	
Total					$295,000
0.50 MG (950') Tank					
Site Earthwork for Tank and Access Road	3,500	CY	25	87,500	
Access Road Paving	800	SY	70	56,000	
Drainage System and Swale		LS		60,000	
Site Fencing		LS		25,000	
16" DI Pipe, class 52	150	LF	165	24,750	
12" DI Pipe, class 52	150	LF	120	18,000	
Pipe Valves and Fittings		LS		50,000	
Pipe Testing and Chlorination		LS		15,000	
0.50 MG Steel Tank with Concrete Floor		LS		750,000	
Tank Flow Control Station		LS		80,000	
Erosion and Dust Control		LS		15,000	
Construction Survey		LS		10,000	
Tank SCADA system in Electrical Enclosure		LS		80,000	
MECO Facility Charge for Service		LS		10,000	
Total					$1,281,250
Construct 0.5 MG (325') Tank (Same Cost as First Tank)					$1,281,250
1.0 MG (470') Tank					
Site Earthwork for Tank and Access Road	4,000	CY	25	100,000	
Access Road Paving	1,000	SY	70	70,000	
Drainage System and Swale		LS		75,000	
Site Fencing		LS		30,000	
16" DI Pipe, class 52	150	LF	165	24,750	
12" DI Pipe, class 52	150	LF	120	18,000	
Pipe Valves and Fittings		LS		60,000	
Pipe Testing and Chlorination		LS		17,000	
1.0 MG Steel Tank with Concrete Floor		LS		1,200,000	
Tank Flow Control Station		LS		80,000	
Erosion and Dust Control		LS		15,000	
Construction Survey		LS		10,000	
Tank SCADA System in Electrical Enclosure		LS		80,000	
MECO Facility Charge for Service		LS		10,000	
Total					$1,789,750

Villages at Leialii - Plan 1 - Phase A - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Pressure Reducing Station (790') Tank Site					
Site Work		LS		20,000	
Site Fencing		LS		7,500	
PRV Station		LS		60,000	
Total					$87,500
Construct PRV (630') Tank Site (Same Cost as First PRV)					$87,500
Total for Construction					**$16,164,500**
Engineering Design (8%)					**1,294,000**
Construction Management (3%)					**485,000**
Contingency (10%)					**1,617,000**
Total Cost for Offsite Potable Water System Improvements Plan 1 - Phase A					**$19,560,500**

Villages at Leialii - Plan 1 - Phase B - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Drill, Case, and Pump Test Wahikuli Well No. 5					
Mob-Demob		LS		100,000	
Drill 12-Inch Pilot Hole	1,100	LF	250	275,000	
Ream Pilot Hole to 25 Inches	1,100	LF	300	330,000	
18" Solid Casing	1,040	LF	200	208,000	
18" Perforated Casing	60	LF	275	16,500	
Furnishing and Installing Grout	900	LF	95	85,500	
Pilot Hole Pump Test		LS		15,000	
Well Development and Test Pumping		LS		90,000	
Well Chlorination,Video, and Plumbness-Align Test		LS		15,000	
Total					$1,135,000
Outfit Wahikuli Well No. 5					
Well Site Earthwork	1,000	CY	40	40,000	
Site Paving	2,000	SY	30	60,000	
Site Fencing		LS		30,000	
Site Drainage System		LS		40,000	
8" DI Pipe, Class 52	100	LF	100	10,000	
Pipe Valves and Fittings		LS		5,000	
Testing and Chlorination		LS		6,000	
Submersible Pump (550 GPM, 250 HP)		LS		375,000	
Pump Discharge Piping		LS		60,000	
Pump Control Building		LS		120,000	
Control Building Mechanical		LS		40,000	
Erosion and Dust Control		LS		10,000	
Construction Survey		LS		5,000	
Pump and Building Electrical		LS		50,000	
Transformer Pad and Ducts		LS		25,000	
Metering, Motor Control Center, and SCADA System		LS		450,000	
MECO Facility Charge for Service		LS		20,000	
Total					$1,346,000
Well Transmission Line					
12" DI Pipe, Class 52	1,600	LF	120	192,000	
12" GV w/VB	2	EA	5,000	10,000	
DI Fittings		LS		125,000	
Access Road Earthwork	1,600	LF	50	80,000	
Access Road Paving	1,600	LF	60	96,000	
Ford Crossing		LS		50,000	
Road Drainage		LS		20,000	
Erosion and Dust Control		LS		10,000	
Construction Survey		LS		5,000	
Testing and Chlorination		LS		15,000	
MECO Facility Charge (OH Service)		LS		50,000	
Total					$653,000

Villages at Leialii - Plan 1 - Phase B - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
0.50 MG (790') Tank					
Site Earthwork for Tank and Access Road	3,500	CY	25	87,500	
Access Road Paving	800	SY	70	56,000	
Drainage System and Swale		LS		60,000	
Site Fencing		LS		25,000	
16" DI Pipe, class 52	150	LF	165	24,750	
12" DI Pipe, class 52	150	LF	120	18,000	
Pipe Valves and Fittings		LS		50,000	
Pipe Testing and Chlorination		LS		15,000	
0.50 MG Steel Tank With Concrete Floor		LS		750,000	
Tank Flow Control Station		LS		80,000	
Erosion and Dust Control		LS		15,000	
Construction Survey		LS		10,000	
Tank SCADA System in Electrical Enclosure		LS		80,000	
MECO Facility Charge for Service		LS		10,000	
Total					$1,281,250
Construct 0.5 MG (630') Tank (Same Cost as 0.50 MG Tank)					$1,281,250
Total for Construction					**$5,696,500**
Engineering Design (8%)					**456,000**
Construction Management (3%)					**171,000**
Contingency (10%)					**570,000**
Total Cost for Offsite Potable Water System Improvements Plan 1 - Phase B					**$6,893,500**

Appendix D

Cost Estimate for the
Offsite Water System Infrastructure for
Concept Land Use Plan Two

Villages at Leialii - Plan 2 - Phase A - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Outfit Wahikuli Well No. 1					
Well Site Earthwork	1,000	CY	40	40,000	
Site Paving	2,000	SY	30	60,000	
Site Fencing		LS		30,000	
Site Drainage System		LS		40,000	
8" DI Pipe, Class 52	100	LF	110	11,000	
Pipe Valves and Fittings		LS		5,000	
Testing and Chlorination		LS		6,000	
Submersible Pump (300 GPM, 125 HP)		LS		300,000	
Pump Discharge Piping		LS		60,000	
Pump Control Building		LS		120,000	
Control Building Mechanical		LS		40,000	
Erosion and Dust Control		LS		10,000	
Construction Survey		LS		5,000	
Pump and Building Electrical		LS		50,000	
Transformer Pad and Ducts		LS		25,000	
Metering, Motor Control Center, and SCADA System		LS		400,000	
MECO Facility Charge for Service		LS		20,000	
Total					$1,222,000
Outfit Wahikuli Well No. 2					
Well Site Earthwork	1,000	CY	40	40,000	
Site Paving	2,000	SY	30	60,000	
Site Fencing		LS		30,000	
Site Drainage System		LS		40,000	
8" DI Pipe, Class 52	100	LF	100	10,000	
Pipe Valves and Fittings		LS		5,000	
Testing and Chlorination		LS		6,000	
Submersible Pump (450 GPM, 200 HP)		LS		350,000	
Pump Discharge Piping		LS		60,000	
Pump Control Building		LS		120,000	
Control Building Mechanical		LS		40,000	
Erosion and Dust Control		LS		10,000	
Construction Survey		LS		5,000	
Pump and Building Electrical		LS		50,000	
Transformer Pad and Ducts		LS		25,000	
Metering, Motor Control Center, and SCADA System		LS		425,000	
MECO Facility Charge for Service		LS		20,000	
Total					$1,296,000
Drill, Case, and Pump Test Wahikuli Well No. 3					
Mob-Demob		LS		100,000	
Drill 12-Inch Pilot Hole	1,100	LF	250	275,000	
Ream Pilot Hole to 25 Inches	1,100	LF	300	330,000	
18" Solid Casing	1,040	LF	200	208,000	
18" Perforated Casing	60	LF	275	16,500	
Furnishing and Installing Grout	900	LF	95	85,500	
Pilot Hole Pump Test		LS		15,000	
Well Development and Test Pumping		LS		90,000	
Well Chlorination,Video, and Plumbness-Align Test		LS		15,000	
Total					$1,135,000

Villages at Leialii - Plan 2 - Phase A - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Construct Well No. 4 (Same Cost Well No. 3)					$1,135,000
Outfit Wahikuli Well No. 3					
Well Site Earthwork	1,000	CY	40	40,000	
Site Paving	2,000	SY	30	60,000	
Site Fencing		LS		30,000	
Site Drainage System		LS		40,000	
8" DI Pipe, Class 52	100	LF	100	10,000	
Pipe Valves and Fittings		LS		5,000	
Testing and Chlorination		LS		6,000	
Submersible Pump (550 GPM, 250 HP)		LS		375,000	
Pump Discharge Piping		LS		60,000	
Pump Control Building		LS		120,000	
Control Building Mechanical		LS		40,000	
Erosion and Dust Control		LS		10,000	
Construction Survey		LS		5,000	
Pump and Building Electrical		LS		50,000	
Transformer Pad and Ducts		LS		25,000	
Metering, Motor Control Center, and SCADA System		LS		450,000	
MECO Facility Charge for Service		LS		20,000	
Total					$1,346,000
Outfit Waikuli Well No. 4 (Same Cost as No. 3)					$1,346,000
Well Transmission Line Well Sites to 0.5 MG 325' Tank					
6" DI Pipe, Class 52	950	LF	80	76,000	
12" DI Pipe, Class 52	1,150	LF	120	138,000	
16" DI Pipe, Class 52	9,350	LF	165	1,542,750	
6" GV w/VB	2	EA	3,000	6,000	
12" GV w/VB	3	EA	5,000	15,000	
16" GV w/VB	5	EA	6,000	30,000	
DI Fittings		LS		125,000	
Pressure Sustaining Station for Wells	1	EA	100,000	100,000	
Access Road Earthwork	11,450	LF	50	572,500	
Access Road Paving	11,450	LF	60	687,000	
Road Drainage		LS		125,000	
Erosion and Dust Control		LS		50,000	
Construction Survey		LS		20,000	
Testing and Chlorination		LS		75,000	
MECO Facility Charge (OH Service)		LS		300,000	
Total					$3,862,250

Villages at Leialii - Plan 2 - Phase A - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Chlorination System Building at 0.5 MG (950') Tank Site					
Pump Control Building		LS		70,000	
Control Building Mechanical		LS		60,000	
Chlorination System		LS		60,000	
Building Electrical		LS		20,000	
Chlorination Electrical - SCADA System		LS		75,000	
MECO Facility Charge for Service		LS		10,000	
Total					$295,000
0.50 MG (950') Tank					
Site Earthwork for Tank and Access Road	3,500	CY	25	87,500	
Access Road Paving	800	SY	70	56,000	
Drainage System and Swale		LS		60,000	
Site Fencing		LS		25,000	
16" DI Pipe, Class 52	150	LF	165	24,750	
12" DI Pipe, Class 52	150	LF	120	18,000	
Pipe Valves and Fittings		LS		50,000	
Pipe Testing and Chlorination		LS		15,000	
0.50 MG Steel Tank with Concrete Floor		LS		750,000	
Tank Flow Control Station		LS		80,000	
Erosion and Dust Control		LS		15,000	
Construction Survey		LS		10,000	
Tank SCADA System in Electrical Enclosure		LS		80,000	
MECO Facility Charge for Service		LS		10,000	
Total					$1,281,250
1.0 MG (470') Tank					
Site Earthwork for Tank and Access Road	4,000	CY	25	100,000	
Access Road Paving	1,000	SY	70	70,000	
Drainage System and Swale		LS		75,000	
Site Fencing		LS		30,000	
16" DI Pipe, Class 52	150	LF	165	24,750	
12" DI Pipe, Class 52	150	LF	120	18,000	
Pipe Valves and Fittings		LS		60,000	
Pipe Testing and Chlorination		LS		17,000	
1.0 MG Steel Tank with Concrete Floor		LS		1,200,000	
Tank Flow Control Station		LS		80,000	
Erosion and Dust Control		LS		15,000	
Construction Survey		LS		10,000	
Tank SCADA System in Electrical Enclosure		LS		80,000	
MECO Facility Charge for Service		LS		10,000	
Total					$1,789,750
Construct 1.0 MG (325') Tank (Same Cost as First Tank)					$1,789,750

Villages at Leialii - Plan 2 - Phase A - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Pressure Reducing Station (790') Tank Site					
Site Work		LS		20,000	
Site Fencing		LS		7,500	
PRV Station		LS		60,000	
Total					$87,500
Construct PRV (630') Tank Site (Same Cost as First PRV)					$87,500
Total for Construction					**$16,673,000**
Engineering Design (8%)					**1,334,000**
Construction Management (3%)					**501,000**
Contingency (10%)					**1,668,000**
Total Cost for Offsite Potable Water System Improvements Plan 2 - Phase A					**$20,176,000**

Villages at Leialii - Plan 2 - Phase B - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Drill, Case, and Pump Test Wahikuli Well No. 5					
Mob-Demob		LS		100,000	
Drill 12-Inch Pilot Hole	1,100	LF	250	275,000	
Ream Pilot Hole to 25 Inches	1,100	LF	300	330,000	
18" Solid Casing	1,040	LF	200	208,000	
18" Perforated Casing	60	LF	275	16,500	
Furnishing & installing grout	900	LF	95	85,500	
Pilot Hole Pump Test		LS		15,000	
Well Development and Test Pumping		LS		90,000	
Well Chlorination,Video, and Plumbness-Align Test		LS		15,000	
Total					$1,135,000
Construct Wahikuli Well No. 6 (Same Cost as Well No. 5)					$1,135,000
Outfit Waikuli Well No. 5					
Well Site Earthwork	1,000	CY	40	40,000	
Site Paving	2,000	SY	30	60,000	
Site Fencing		LS		30,000	
Site Drainage System		LS		40,000	
8" DI Pipe, Class 52	100	LF	100	10,000	
Pipe Valves and Fittings		LS		5,000	
Testing and Chlorination		LS		6,000	
Submersible Pump (550 GPM, 250 HP)		LS		375,000	
Pump Discharge Piping		LS		60,000	
Pump Control Building		LS		120,000	
Control Building Mechanical		LS		40,000	
Erosion and Dust Control		LS		10,000	
Construction Survey		LS		5,000	
Pump & Building Electrical		LS		50,000	
Transformer Pad and Ducts		LS		25,000	
Metering, Motor Control Center, and SCADA System		LS		450,000	
MECO Facility Charge for Service		LS		20,000	
Total					$1,346,000
Outfit Wahikuli Well No. 6 (Same Cost as Well No. 5)					$1,346,000
Well Transmission Line					
12" DI Pipe, Class 52	1,960	LF	120	235,200	
12" GV w/VB	3	EA	5,000	15,000	
DI Fittings		LS		125,000	
Access Road Earthwork	1,960	LF	50	98,000	
Access Road Paving	1,960	LF	60	117,600	
Ford Crossing		LS		50,000	
Road Drainage		LS		40,000	
Erosion and Dust Control		LS		15,000	
Construction Survey		LS		5,000	
Testing and Chlorination		LS		20,000	
MECO Facility Charge (OH Service)		LS		70,000	
Total					$790,800

Villages at Leialii - Plan 2 - Phase B - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
0.50 MG (790') Tank					
Site Earthwork for Tank and Access Road	3,500	CY	25	87,500	
Access Road Paving	800	SY	70	56,000	
Drainage System and Swale		LS		60,000	
Site Fencing		LS		25,000	
16" DI Pipe, class 52	150	LF	165	24,750	
12" DI Pipe, class 52	150	LF	120	18,000	
Pipe Valves & Fittings		LS		50,000	
Pipe Testing and Chlorination		LS		15,000	
0.50 MG Steel Tank with Concrete Floor		LS		750,000	
Tank Flow Control Station		LS		80,000	
Erosion and Dust Control		LS		15,000	
Construction Survey		LS		10,000	
Tank SCADA system in Electrical Enclosure		LS		80,000	
MECO Facility Charge for Service		LS		10,000	
Total					$1,281,250
Construct 0.5 MG (630') Tank (Same Cost as 0.50 MG Tank)					$1,281,250
Total for Construction					**$8,315,300**
Engineering Design (8%)					**666,000**
Construction Management (3%)					**250,000**
Contingency (10%)					**832,000**
Total Cost for Offsite Potable Water System Improvements Plan 2 - Phase B					**$10,063,300**

Appendix E

Cost Estimate for the Offsite Water System Infrastructure for Concept Land Use Plan Three

Villages at Leialii - Plan 3 - Phase A - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Outfit Wahikuli Well No. 1					
Well Site Earthwork	1,000	CY	40	40,000	
Site Paving	2,000	SY	30	60,000	
Site Fencing		LS		30,000	
Site Drainage System		LS		40,000	
8" DI Pipe, Class 52	100	LF	110	11,000	
Pipe Valves and Fittings		LS		5,000	
Testing and Chlorination		LS		6,000	
Submersible Pump (300 GPM, 125 HP)		LS		300,000	
Pump Discharge Piping		LS		60,000	
Pump Control Building		LS		120,000	
Control Building Mechanical		LS		40,000	
Erosion and Dust Control		LS		10,000	
Construction Survey		LS		5,000	
Pump and Building Electrical		LS		50,000	
Transformer Pad and Ducts		LS		25,000	
Metering, Motor Control Center, and SCADA System		LS		400,000	
MECO Facility Charge for Service		LS		20,000	
Total					$1,222,000
Outfit Wahikuli Well No. 2					
Well Site Earthwork	1,000	CY	40	40,000	
Site Paving	2,000	SY	30	60,000	
Site Fencing		LS		30,000	
Site Drainage System		LS		40,000	
8" DI Pipe, Class 52	100	LF	100	10,000	
Pipe Valves and Fittings		LS		5,000	
Testing and Chlorination		LS		6,000	
Submersible Pump (450 GPM, 200 HP)		LS		350,000	
Pump Discharge Piping		LS		60,000	
Pump Control Building		LS		120,000	
Control Building Mechanical		LS		40,000	
Erosion and Dust Control		LS		10,000	
Construction Survey		LS		5,000	
Pump and Building Electrical		LS		50,000	
Transformer Pad and Ducts		LS		25,000	
Metering, Motor Control Center, and SCADA System		LS		425,000	
MECO Facility Charge for Service		LS		20,000	
Total					$1,296,000
Drill, Case, and Pump Test Wahikuli Well No. 3					
Mob-Demob		LS		100,000	
Drill 12-Inch Pilot Hole	1,100	LF	250	275,000	
Ream Pilot Hole to 25 Inches	1,100	LF	300	330,000	
18" Solid Casing	1,040	LF	200	208,000	
18" Perforated Casing	60	LF	275	16,500	
Furnishing and Installing Grout	900	LF	95	85,500	
Pilot Hole Pump Test		LS		15,000	
Well Development and Test Pumping		LS		90,000	
Well Chlorination,Video, and Plumbness-Align Test		LS		15,000	
Total					$1,135,000

Villages at Leialii - Plan 3 - Phase A - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Construct Well Nos. 4 and 5 (Same Cost Well No. 3)					$2,270,000
Outfit Wahikuli Well No. 3					
Well Site Earthwork	1,000	CY	40	40,000	
Site Paving	2,000	SY	30	60,000	
Site Fencing		LS		30,000	
Site Drainage System		LS		40,000	
8" DI Pipe, Class 52	100	LF	100	10,000	
Pipe Valves and Fittings		LS		5,000	
Testing and Chlorination		LS		6,000	
Submersible Pump (550 GPM, 250 HP)		LS		375,000	
Pump Discharge Piping		LS		60,000	
Pump Control Building		LS		120,000	
Control Building Mechanical		LS		40,000	
Erosion and Dust Control		LS		10,000	
Construction Survey		LS		5,000	
Pump and Building Electrical		LS		50,000	
Transformer Pad and Ducts		LS		25,000	
Metering, Motor Control Center, and SCADA System		LS		450,000	
MECO Facility Charge for Service		LS		20,000	
Total					$1,346,000
Outfit Wahikuli Well Nos. 4 and 5 (Same Cost as No. 3)					$2,692,000
Well Transmission Line Well Sites to 0.5 MG 325' Tank					
6" DI Pipe, Class 52	950	LF	80	76,000	
12" DI Pipe, Class 52	2,750	LF	120	330,000	
16" DI Pipe, Class 52	9,350	LF	165	1,542,750	
6" GV w/VB	2	EA	3,000	6,000	
12" GV w/VB	3	EA	5,000	15,000	
16" GV w/VB	5	EA	6,000	30,000	
DI Fittings		LS		140,000	
Pressure Sustaining Station for Wells	1	EA	100,000	100,000	
Access Road Earthwork	11,450	LF	50	572,500	
Access Road Paving	11,450	LF	60	687,000	
Ford Crossing		LS		50,000	
Road Drainage		LS		140,000	
Erosion and Dust Control		LS		50,000	
Construction Survey		LS		20,000	
Testing and Chlorination		LS		80,000	
MECO Facility Charge (OH Service)		LS		340,000	
Total					$4,179,250

Villages at Leialii - Plan 3 - Phase A - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Chlorination System Building at 0.5 MG (950') Tank Site					
Pump Control Building		LS		70,000	
Control Building Mechanical		LS		60,000	
Chlorination System		LS		60,000	
Building Electrical		LS		20,000	
Chlorination Electrical - SCADA System		LS		75,000	
MECO Facility Charge for Service		LS		10,000	
Total					$295,000
0.50 MG (950') Tank					
Site Earthwork for Tank and Access Road	3,500	CY	25	87,500	
Access Road Paving	800	SY	70	56,000	
Drainage System and Swale		LS		60,000	
Site Fencing		LS		25,000	
16" DI Pipe, Class 52	150	LF	165	24,750	
12" DI Pipe, Class 52	150	LF	120	18,000	
Pipe Valves and Fittings		LS		50,000	
Pipe Testing and Chlorination		LS		15,000	
0.50 MG Steel Tank with Concrete Floor		LS		750,000	
Tank Flow Control Station		LS		80,000	
Erosion and Dust Control		LS		15,000	
Construction Survey		LS		10,000	
Tank SCADA system in Electrical Enclosure		LS		80,000	
MECO Facility Charge for Service		LS		10,000	
Total					$1,281,250
1.0 MG (470') Tank					
Site Earthwork for Tank and Access Road	4,000	CY	25	100,000	
Access Road Paving	1,000	SY	70	70,000	
Drainage System and Swale		LS		75,000	
Site Fencing		LS		30,000	
16" DI Pipe, Class 52	150	LF	165	24,750	
12" DI Pipe, Class 52	150	LF	120	18,000	
Pipe Valves and Fittings		LS		60,000	
Pipe Testing and Chlorination		LS		17,000	
1.0 MG Steel Tank With Concrete Floor		LS		1,200,000	
Tank Flow Control Station		LS		80,000	
Erosion and Dust Control		LS		15,000	
Construction Survey		LS		10,000	
Tank SCADA System in Electrical Enclosure		LS		80,000	
MECO Facility Charge for Service		LS		10,000	
Total					$1,789,750
Construct 1.0 MG (325') Tank (Same Cost as First Tank)					$1,789,750

Villages at Leialii - Plan 3 - Phase A - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Pressure Reducing Station (790') Tank Site					
Site Work		LS		20,000	
Site Fencing		LS		7,500	
PRV Station		LS		60,000	
Total					$87,500
Construct PRV (630') Tank Site (Same Cost as First PRV)					$87,500
Total for Construction					**$19,471,000**
Engineering Design (8%)					**1,558,000**
Construction Management (3%)					**585,000**
Contingency (10%)					**1,948,000**
Total Cost for Offsite Potable Water System Improvements Plan 3 - Phase A					**$23,562,000**

Villages at Leialii - Plan 3 - Phase B - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Drill, Case, and Pump Test Wahikuli Well No. 6					
Mob-Demob		LS		100,000	
Drill 12-Inch Pilot Hole	1,100	LF	250	275,000	
Ream Pilot Hole to 25 Inches	1,100	LF	300	330,000	
18" Solid Casing	1,040	LF	200	208,000	
18" Perforated Casing	60	LF	275	16,500	
Furnishing and Installing Grout	900	LF	95	85,500	
Pilot Hole Pump Test		LS		15,000	
Well Development and Test Pumping		LS		90,000	
Well Chlorination,Video, and Plumbness-Align Test		LS		15,000	
Total					$1,135,000
Outfit Wahikuli Well No. 6					
Well Site Earthwork	1,000	CY	40	40,000	
Site Paving	2,000	SY	30	60,000	
Site Fencing		LS		30,000	
Site Drainage System		LS		40,000	
8" DI Pipe, Class 52	100	LF	100	10,000	
Pipe Valves and Fittings		LS		5,000	
Testing and Chlorination		LS		6,000	
Submersible Pump (550 GPM, 250 HP)		LS		375,000	
Pump Discharge Piping		LS		60,000	
Pump Control Building		LS		120,000	
Control Building Mechanical		LS		40,000	
Erosion and Dust Control		LS		10,000	
Construction Survey		LS		5,000	
Pump and Building Electrical		LS		50,000	
Transformer Pad and Ducts		LS		25,000	
Metering, Motor Control Center, and SCADA System		LS		450,000	
MECO Facility Charge for Service		LS		20,000	
Total					$1,346,000

Villages at Leialii - Plan 3 - Phase B - Cost Estimate

Item Description	Quantity	Unit	Unit Price	Amount	Total
Well Transmission Line					
12" DI Pipe, Class 52	1,350	LF	120	162,000	
12" GV w/VB	2	EA	5,000	10,000	
DI Fittings		LS		125,000	
Access Road Earthwork	1,350	LF	50	67,500	
Access Road Paving	1,350	LF	60	81,000	
Road Drainage		LS		25,000	
Erosion and Dust Control		LS		10,000	
Construction Survey		LS		5,000	
Testing and Chlorination		LS		15,000	
MECO Facility Charge (OH Service)		LS		40,000	
Total					$540,500
0.50 MG (790') Tank					
Site Earthwork for Tank and Access Road	3,500	CY	25	87,500	
Access Road Paving	800	SY	70	56,000	
Drainage System and Swale		LS		60,000	
Site Fencing		LS		25,000	
16" DI Pipe, Class 52	150	LF	165	24,750	
12" DI Pipe, Class 52	150	LF	120	18,000	
Pipe Valves and Fittings		LS		50,000	
Pipe Testing and Chlorination		LS		15,000	
0.50 MG Steel Tank With Concrete Floor		LS		750,000	
Tank Flow Control Station		LS		80,000	
Erosion and Dust Control		LS		15,000	
Construction Survey		LS		10,000	
Tank SCADA System in Electrical Enclosure		LS		80,000	
MECO Facility Charge for Service		LS		10,000	
Total					$1,281,250
Construct 0.5 MG (630') Tank (Same Cost as 0.50 MG Tank)					$1,281,250
Total for Construction					**$5,584,000**
Engineering Design (8%)					**447,000**
Construction Management (3%)					**168,000**
Contingency (10%)					**559,000**
Total Cost for Offsite Potable Water System Improvements Plan 3 - Phase B					**$6,758,000**

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January 4, 2010
10-001 (09-57)

MEMORANDUM

To: Sue Sakai - Belt Collins Hawaii
Stan Fujimoto - HHFDC

From: Tom Nance

Subject: Assessment of Blackhawk's TDEM Results in the Area Inland of the Villages of Lealii Project

Introduction

Blackhawk Division of Zapata Incorporated recently completed Time Domain Electro-Magnetic (TDEM) surveys on the land upslope from HHFDC's proposed Villages of Lealii project. Blackhawk's TDEM results are presented in its November 2009 report. The objective of this geophysical work was identify where the groundwater changes from the basal mode to what is commonly referred to as "high level". Basal groundwater is fresh water floating on saltwater at depth. If well pump capacities in wells tapping basal groundwater are not appropriately limited, rising salinity in response to pumping is likely to occur. High level groundwater occurs where there are low permeability subsurface features which impede and/or control groundwater movement. In almost all cases, wells which tap high level groundwater are not subject to salinity intrusion and, in contrast to a basal well, can develop a larger fraction of the groundwater flow without adverse water quality consequences.

This memo and its attachments provide an interpretation of the TDEM results delineating and high level groundwater and the consequences for well development for the Villages of Lealii project.

TDEM Results

Figure 1 shows the location of the six TDEM survey sites ("loop"). These are color-coded light green if saltwater was detected below sea level (indicating basal groundwater) and blue if saltwater was not detected at any depth (suggesting the possibility of high level groundwater. Also shown on this figure are:

- Existing wells which tap basal groundwater. These include: the two Wahikuli wells (Well Nos. 5439-01 and -02) which were drilled in the early 1990s to supply the HHFDC project; Well Nos. 5539-01, -02, and -03 (also known as P-1, P-2, and P-3) which supply the private Kaanapali Water System; and Honokowai Well B (No. 5638-03).

- Inland existing wells and horizontal development tunnels which tap high level groundwater. These are: Well Nos. 5437-02 in Kahoma Valley; and Well Nos. 5537-01, 5537-02, and 5637-05 in Honokowai Valley; and

- The sites of four additional wells that would be needed for the HHFDC project if drilled in locations which would tap basal groundwater (labeled 3, 4, 5, and 6 on Figure 1).

The fact that saltwater was not detected in the four inland TDEM loops (L2, L3, L4, and L6) infers, but does not guarantee that basal groundwater will not be encountered at these locations. These results could be the distortion effects of subsurface features which do not create high level groundwater conditions. It is possible, for example, that there are a number of east-west trending dikes which do not effectively create high level groundwater but are in sufficient numbers to "hide" the presence of saltwater at depth.

Interpretation of Groundwater Conditions

Figure 2 presents my interpretation of groundwater conditions based on the TDEM results, information from existing wells, and known geologic conditions including the mapping of intrusive dikes (the red line strikes in the upper reaches of Kahoma and Honokowai Valleys on Figure 2). There are essentially three zones to consider, each delineated by the dashed green lines on Figure 2:

- Within the band between the 1000-, 1100-foot elevation contours, developable potable quality groundwater occurs in the basal mode. Well pump capacities should not exceed 550 GPM and spacing between wells should be at least 1200 feet, both criteria necessary to avoid salinity intrusion.

- Based exclusively on the TDEM results, drilling for high level groundwater could be undertaken within the band between the 1600- and 1700-foot elevation contour. Although a TDEM Loops L2 and L3 suggest that wells might be successful at even lower elevations (about 1450 feet), the risk of missing high level groundwater increases at progressively lower elevations.

- Development tunnels, one drilled well, and exposures of dikes in Honokowai and Kahoma Valleys all indicate that drilling further inland at elevations of about 3000 feet would virtually guarantee encountering high level groundwater.

Pragmatic Aspects of the Development of High Level Groundwater

The pursuit of high level groundwater at greater distance inland rather than basal groundwater at about 1050-foot elevation would only make sense if rising salinity in the basal wells is a concern and/or developing high level groundwater would be less costly. Previous recommendations for the basal wells to limit capacity to 550 GPM and to space wells 1200 feet apart were made to address salinity concerns. However, stable salinity at a pumping rate of 550 GPM can not be assured. For example, this was not achieved in either of the two existing Wahikuli wells (their recommended capacities are just 300 and 450 GPM) and is not guaranteed in the proposed four new basal wells along the 1050-foot corridor. Results of the three nearest Kaanapali Water Company wells (Nos. P-1, P-2, and P-3) are instructive. The P-2 and P-3 wells are among the best of the six wells the water company operates. They are able to sustain 550 GPM at very acceptable salinity levels. However, the P-1 well, located in the middle of these three, is one of the poorest performing wells, with spikes of chlorides above 400 MG/L after just a few hours of pumping. This could happen in one or more of the four basal wells the project requires.

With regard to cost, the deeper high level groundwater wells will obviously be more expensive. In order for this to make economic sense, tapping high level groundwater must reduce the required number of wells. This possibility is addressed in the next several paragraphs.

Well Dimensions and Pump Horsepower. Basal wells arrayed along the 1050-foot contour and sized to provide 550 GPM would provide the following advantages:

- At the 1050-foot depth to water, required pump horsepower would be 200.
- At the 1050-foot depth, line shaft vertical turbine pumps (with enclosed tubes) could be used. These will have longer useful lives and slightly better efficiency than the submersible pumps and motors that would have to be used for greater depths.
- Casing size, dictated by pump diameter, could be 14-inch.

For wells designed to tap high level groundwater at 1450- or 1700-foot elevations, four-pole (1760 RPM) submersible pumps and motors would be used. In this case, motor diameter would dictate well casing diameter:

Motor Horsepower	Motor Diameter (Inches)	Well Casing Diameter (Inches)	Maximum GPM at 1450-Foot Elevation	Maximum GPM at 1700-Foot Elevation
200	14	16	410	350
300	14	16	615	525
400	17	19	820	700
500	17	19	1030	880
600	17	19	1235	1055
700	18	20	1440	1230
800	18	20	1645	1410

Notes:
1. Values use of four-pole motors with 2300 or 4000 volts.
2. Well design would use the solid casing as a shroud for the motor to assure proper motor cooling.
3. Maximum flowrate calculations assume 78% pump efficiency, 50 feet of friction loss, and drawdown to mean sea level.

Required Number of Wells. Using the projected supply requirements for Land Use Concepts One, Two, and Three in my August 2009 report, and assuming that the existing two Wahikuli wells will be outfitted with 300 and 450 GPM pumps, respectively, Table 1 presents the required number of new wells for three scenarios: (1) 550 GPM wells at 1050-foot elevation as presented in my August 2009 report; (2) wells at 1450-foot elevation tapping high level groundwater; and (3) wells at 1700-foot elevation tapping high level groundwater. This tally demonstrates that within the practical pumping limits at the depths required to tap high level groundwater, the project would need one less well than if it proceeded with development of 550 GPM basal wells at 1050-foot elevation. As the high level wells would be deeper, have larger boreholes and casing diameters, and require longer transmission and power lines to their locations, doing one less well is not likely to produce a savings. In addition, the greater pumping lifts will result is higher operating costs. In other words, inland wells tapping high level groundwater could not be developed and operated at less cost than basal wells.

Conclusions and Recommendations

1. The TDEM method distinguishes between areas of basal groundwater and high level groundwater by the detection (or lack thereof) of a highly conductive stratum at depth below sea level. The conductive stratum is taken to be seawater saturated volcanics beneath a basal lens. If such a stratum is not detected, the TDEM results suggest that high level groundwater may exist below the TDEM loop.

2. Blackhawk's TDEM results, due to the lack of a conductive layer at depth, infer that high level groundwater may exist beneath land as low as 1450-foot elevation. This result is not guaranteed, as there are other possible subsurface features which could mask the presence of saltwater at depth.

3. Wells tapping high level groundwater offer two distinct advantages over basal wells in the Kaanapali area (1) water of very low and stable salinity is virtually assured; and (2) pumping capacities are almost certain to be considerably greater than the 550 GPM maximum expectable rate for a basal well.

4. Within the practical limits of motor horsepower, developing high level wells would reduce the required number of new wells for the Villages of Lealii by one. Since high level wells will be more expensive to develop (deeper, larger casing diameter, larger pump equipment, greater transmission distance), developing one less well will not reduce total well development costs.

5. Based on past results, avoiding the uncertainty of salinity and/or yield of basal wells in the Kaanapali area makes a compelling case to pursue high level groundwater. A test borehole at about 1660-foot elevation inland of TDEM Loop L2 and on the south side of the plateau between the Hahakea and Wahikuli Gulches is recommended. The test hole should be a minimum of 12 inches in diameter so that pumping at useful (150± GPM) rates in the open hole would be possible. The drilling contract could be phased so that if high level groundwater is encountered, the borehole could be reamed, cased, and converted to a production well.

Attachments

Table 1

Comparisons of the Required Numbers of New Wells

Parameter	Land Use Concept Plan		
	One	Two	Three
Required Maximum Day Supply (MGD)	2.691	3.270	3.437
Supply Provided by Wahikuli Wells 1 and 2 (MGD)	1.020	1.020	1.020
Required Supply by New Well Development : MGD	1.611	2.190	2.357
: GPM	1119	1520	1637
Required Numbers of New Wells, Including One as Standby			
• 550 GPM Wells Tapping Basal Groundwater	3	4	4
• 750 to 825 GPM Wells Tapping High Level Groundwater	3	3	3
• 1050 GPM Wells Tapping High Level Groundwater	3	3	3
• 1400 GPM Wells Tapping High Level Groundwater	2	3	3*

* Would require 800 horsepower motor not considered to be a practical application.

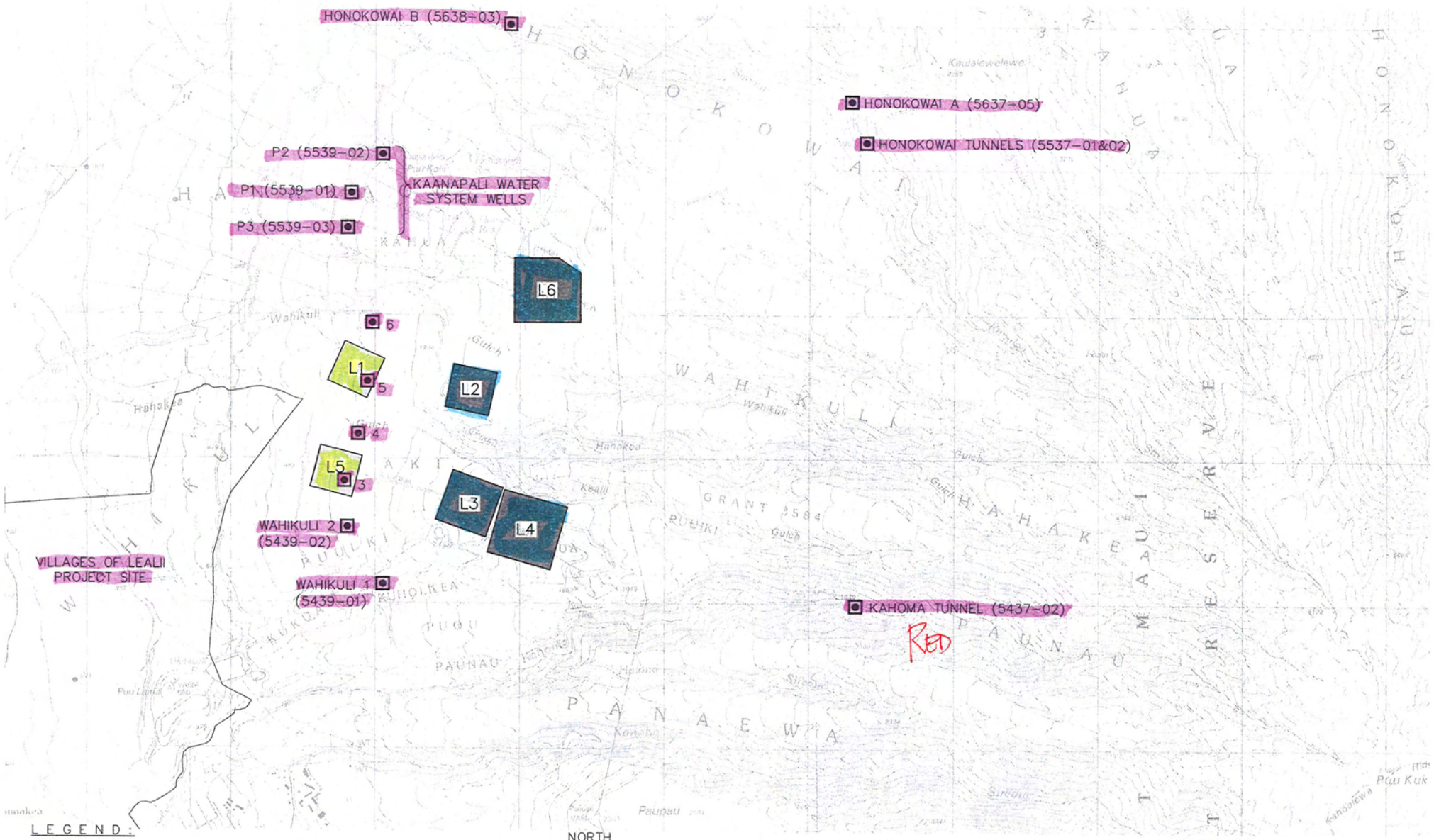

FIGURE 1
BLACKHAWK'S TDEM LOOP
LOCATIONS AND INTERPRETED RESULTS

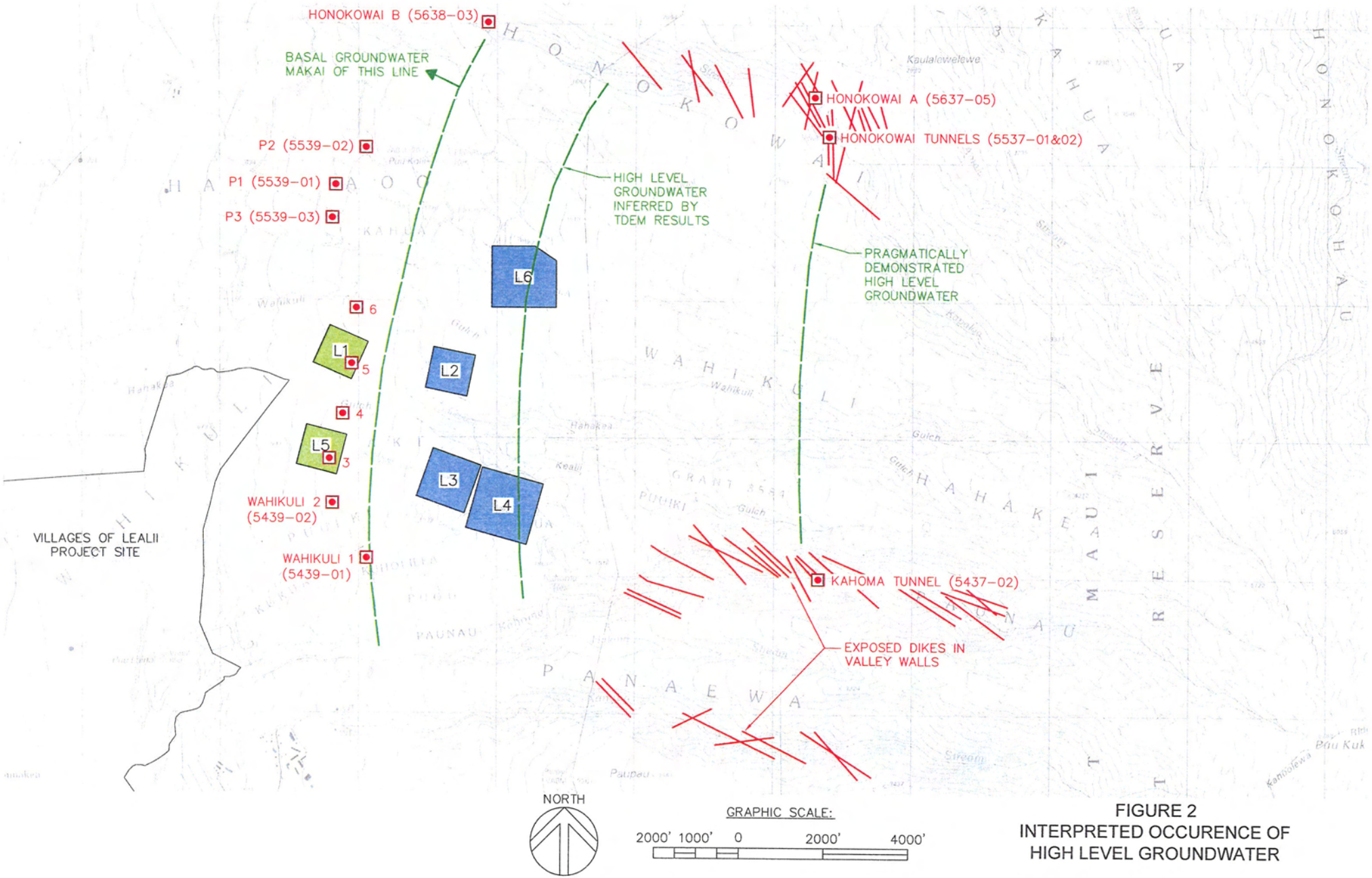

FIGURE 2
INTERPRETED OCCURENCE OF
HIGH LEVEL GROUNDWATER

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July 22, 2010
10-160 | 10-06

MEMORANDUM

To: Stan Fujimoto - HHFDC
Alan Kato - Belt Collins

From: Tom Nance

Subject: Possible Use of Development Tunnel 20A (State Well No. 5537-01) for the Villages of Lealii Project

This memo summarizes available information on the water development tunnel in Honokowai Valley known as Tunnel 20A and also identified as state well number 5537-01. The objective is to evaluate the tunnel as a potential source of potable supply for HHFDC's Villages of Lealii project. The available sources of information on the tunnel are quite limited:

- Tabulated information in Stearns and MacDonald (1942) based on a field survey by Gordan MacDonald.
- A description in Hatton (1976) based on field observations by Bert Hatton.
- My observations on a July 21, 2010 site visit.

The date of the tunnel's construction is not known. Its outlet is on the south side of Kapaloa Stream (one of two tributaries to Honokowai Stream) at about 1700-foot elevation and about 500 feet upstream of a diversion dam on the stream. According to Gordan MacDonald, the tunnel is about 1250 feet long and cuts 18 dikes, meaning that it develops high level groundwater from a number of dike compartments. As reported in Stearns and MacDonald (1942), its flow is about 2.0 MGD. Hatton (1976) repeats this figure, describing the flowrate as "fairly steady". There are the remnants of a Parshall flume which was used at one time to measure flowrate at the tunnel's entrance, but it was apparently already out of service at the time of Bert Hatton's 1976 field survey. No records of the Parshall flume's data are known to exist.

As observed on July 21, 2010, the tunnel's discharge through the remnants of the Parshall flume's 2-foot wide throat was estimated to be 800± 100 GPM or about 1.1 to 1.2 MGD. This low flowrate is consistent with the extended dry period being experienced state-wide and with observations and measurements in West Maui that I've made in the past three weeks in Honokohau to the north and Olowalu to the south.

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Use of the tunnel source for the Villages of Lealii project is judged to be infeasible in comparison to the alternative of drilling wells for the following reasons:

- The source is the main irrigation supply for Kaanapali Coffee. This farming venture could not survive without it.

- Honokowai Valley is exceptionally narrow and steep sided, with valley walls that are 1000 feet high at the site of the tunnel. Construction equipment and supplies would need to be airlifted in (precariously) by helicopter.

- To convert the tunnel to potable use, its tunnel outlet would need to be bulkheaded. This work would also include stream channel improvements to assure that the stream's storm flowrates would not inundate the bulkheaded outlet.

- Conveyance of the tunnel's water to the Villages of Lealii project might consider two alternatives, neither of which are considered to be cost effective in comparison the alternative of drilled wells in easier to access locations:

  (1) Install a pipeline in the existing 1.6-mile long tunnel which outlets at 1550-foot elevation in an unnamed gulch above Horner Reservoir. The State Department of Health would require this pipeline to be hung from the tunnel's soffit so that it is always above the streamflow being conveyed in the tunnel.

  (2) Install a road and pipeline along the route of the trail into the tunnel. In this case, there would be two stream crossings enroute to the stream's diversion dam, more stream crossings from the dam to the tunnel, and pumping would be required.

In summary, the cost and environmental consequences of using this source for potable supply for the Villages of Lealii project in comparison to the alternative drilled wells in easier to access locations are simply prohibitive.

References Cited:

Hatton, B.L. 1976. Hydromania, A Pioneer Mill Company Water Source Primer. Manuscript Report prepared by Bert Hatton, Civil Engineer for Pioneer Mill Company.

Stearns, H.T. and G.A. MacDonald. 1942. Geology and Ground-Water Resources of the Island of Maui, Hawaii. Bulletin 7, Division of Hydrography, Territory of Hawaii.

Appendix I

Wastewater and Reclaimed Water

SEWER MASTER PLAN

FOR THE

VILLAGES OF LEIALI`I

Prepared for

Hawaii Housing Finance & Development Corporation
677 Queen Street, Suite 300
Honolulu, Hawai`i 96813

Prepared by

BELT COLLINS HAWAII LTD.
2153 North King Street, Suite 200
Honolulu, Hawai'i 96819

September 2009 (Revised October 2010)

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1.0 INTRODUCTION

The purpose of this sewer master plan is to provide preliminary sewer and sewer reclamation requirements for the Villages of Leiali`i project in Lahaina, Maui, Hawaii. See Figure 1: Project Location Map. The Villages of Leiali`i is a master planned community that is primarily for affordable housing, up to 140% of the median family income. The total Villages of Leiali`i project site, excluding the Department of Hawaiian Home Lands (DHHL) Villages 1A and 1B, consists of approximately 1,033 acres located at Tax Map Key numbers: 4-5-021: 3, 13, 21, and portions of 4, 5 and 22, and 4-5-028: 70. The first phase of the development, Phase A, consists of the makai half of the project, below the proposed Lahaina Bypass Highway. Phase A is approximately 416 acres, consisting of Tax Map Key numbers: 4-5-021: 3, 13 and 21, and 4-5-028: 70. The second phase, Phase B, located above the proposed Lahaina Bypass Highway, consists of approximately 561 acres. Phase B Tax Map Key numbers are 4-5-021: portions of 4, 5 and 22. The proposed Lahaina Bypass Highway and Keawe Street within the Leiali`i project boundary consists of approximately 56 acres.

The sewer master plan is to support the environmental impact statement (EIS) for the project and provide information to potential developers for the Request for Proposals (RFP) for the site.

2.0 MASTER PLAN CONCEPT

The proposed Villages of Leiali`i project is a master planned community developed by the State Hawaii Housing Finance and Development Corporation (HHFDC). The site is located mauka of the Lahaina Civic Center and Wahikuli subdivision, and north of the Kelawea subdivision and Kahoma Stream. The Civic Center site contains a police station, post office, fire station, health center, gym, District Courts, meeting rooms, and tennis courts.

Three alternative land use concepts have been developed for the Leiali`i project, each consisting of single family housing units, multi-family housing units, commercial/office areas, mixed use areas, industrial areas, schools, and parks. The three concepts, representing varying housing types and densities, have several elements in common, particularly between Concept One and Concept Two:

- All concepts include two schools (~12 acres each), neighborhood parks, and detention ponds incorporated within natural open space areas.
- All concepts include on-site and off-site infrastructure improvements.
- Concept One and Concept Two include the same amount of commercial, office, and light industrial space, as well as schools and parks.
- The physical layouts for Concept One and Concept Two are identical in terms of roadways and blocks. The differences are in housing types and densities.
- Phase B for Concept One and Concept Two are identical.

Concept One, representing the lowest density of the three concepts, has a total of approximately 2,923 housing units that primarily consist of single-family housing. Concept One also includes 551,000 SF of commercial and office space, 524,500 SF of light industrial space, and 43.97 acres of park. See Figure 2.

Concept Two has a higher density than Concept One, with a total of approximately 4,043 residential units and the same amount of commercial, office, light industrial, and park space as Concept One. Residential units within Phase A of Concept Two consist entirely of multi-family housing units. See Figure 3.

Concept Three represents the highest density alternative and a layout that incorporates LEED Neighborhood Development criteria to increase the potential for a sustainable community. Concept Three includes 4,105 residential units, 596,000 SF commercial and office space, 665,100 SF of light industrial space, and 37.98 acres of park. See Figure 4.

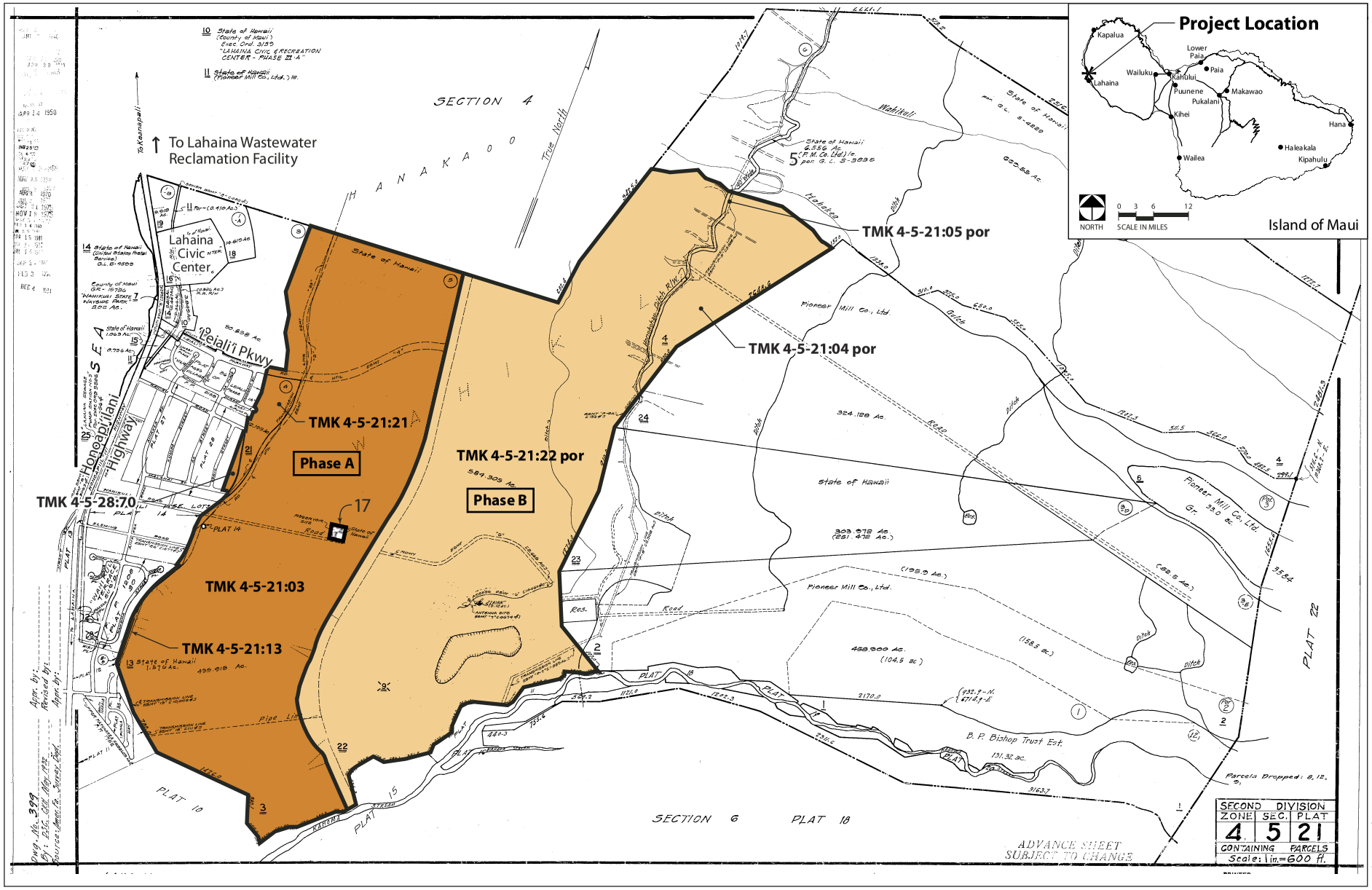

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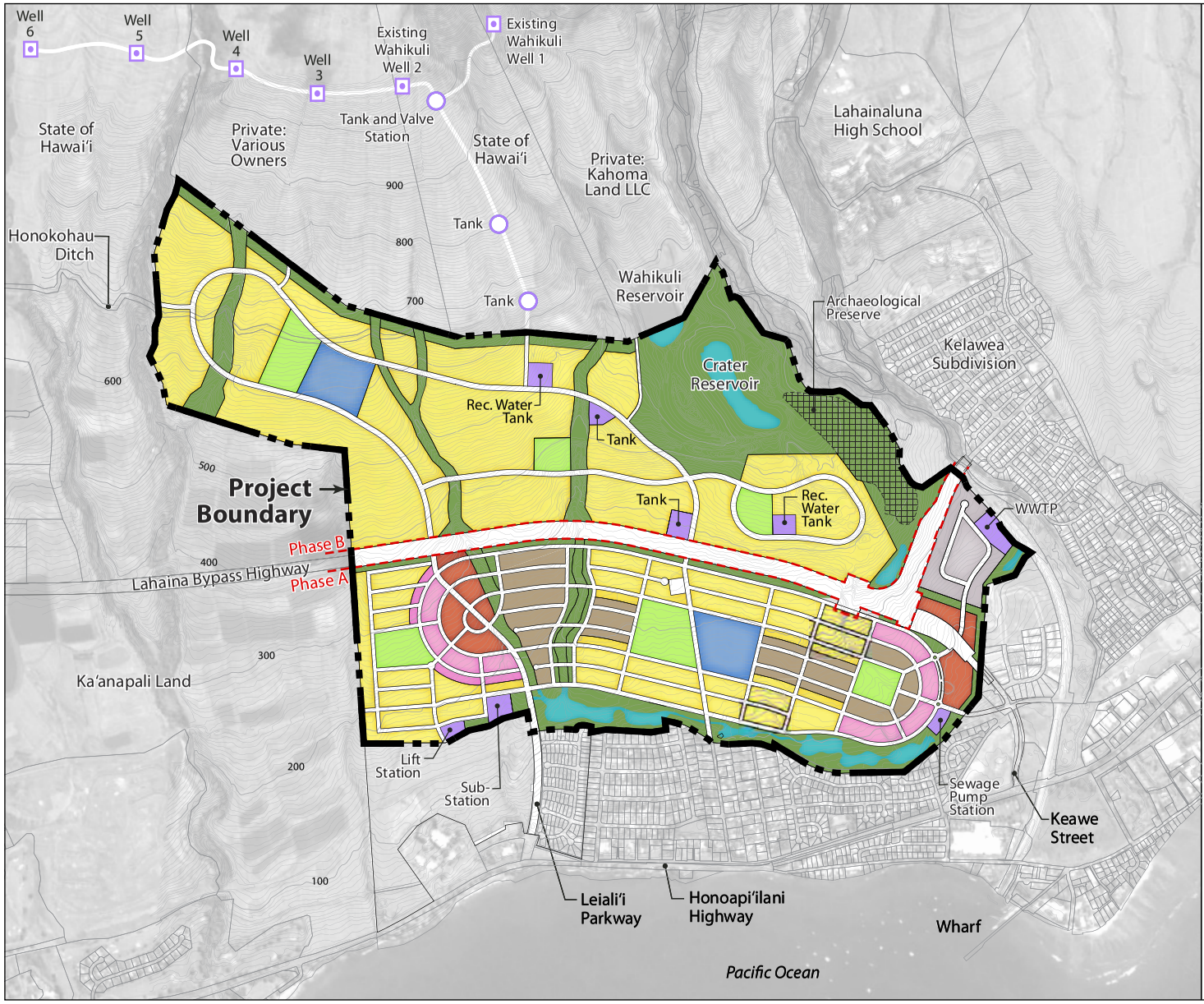
Figure 1
PROJECT LOCATION MAP

Sewer System Master Plan
Villages of Leialiʻi
September 2009



LEGEND

- Detached Single-Family Residential
  Phase A: 101.47 ac/ 613 du
  Phase B: 304.57 ac/ 1,522 du
- Multi-Family Residential - 15 du/ac
  Phase A: 41.52 ac/ 625 du
- Open Space
  Phase A: 78.11 ac
  Phase B: 180.77 ac
- Park
  Phase A: 24.39 ac
  Phase B: 19.58 ac
- Elementary School
  Phase A: 12.01 ac
  Phase B: 12.01 ac
- Commercial
  Phase A: 20.75 ac/ 245,200 sf
- Mixed Use
  Phase A: 23.40 ac
  Commercial: 203,900 sf
  Office: 101,900 sf
  Multi-Family Residential: 163 du
- Light Industrial
  Phase A: 17.20 ac/ 524,500 sf
- Infrastructure
  Phase A: 7.67 ac
  Phase B: 7.47 ac
- Detention Ponds
- Phase Boundary

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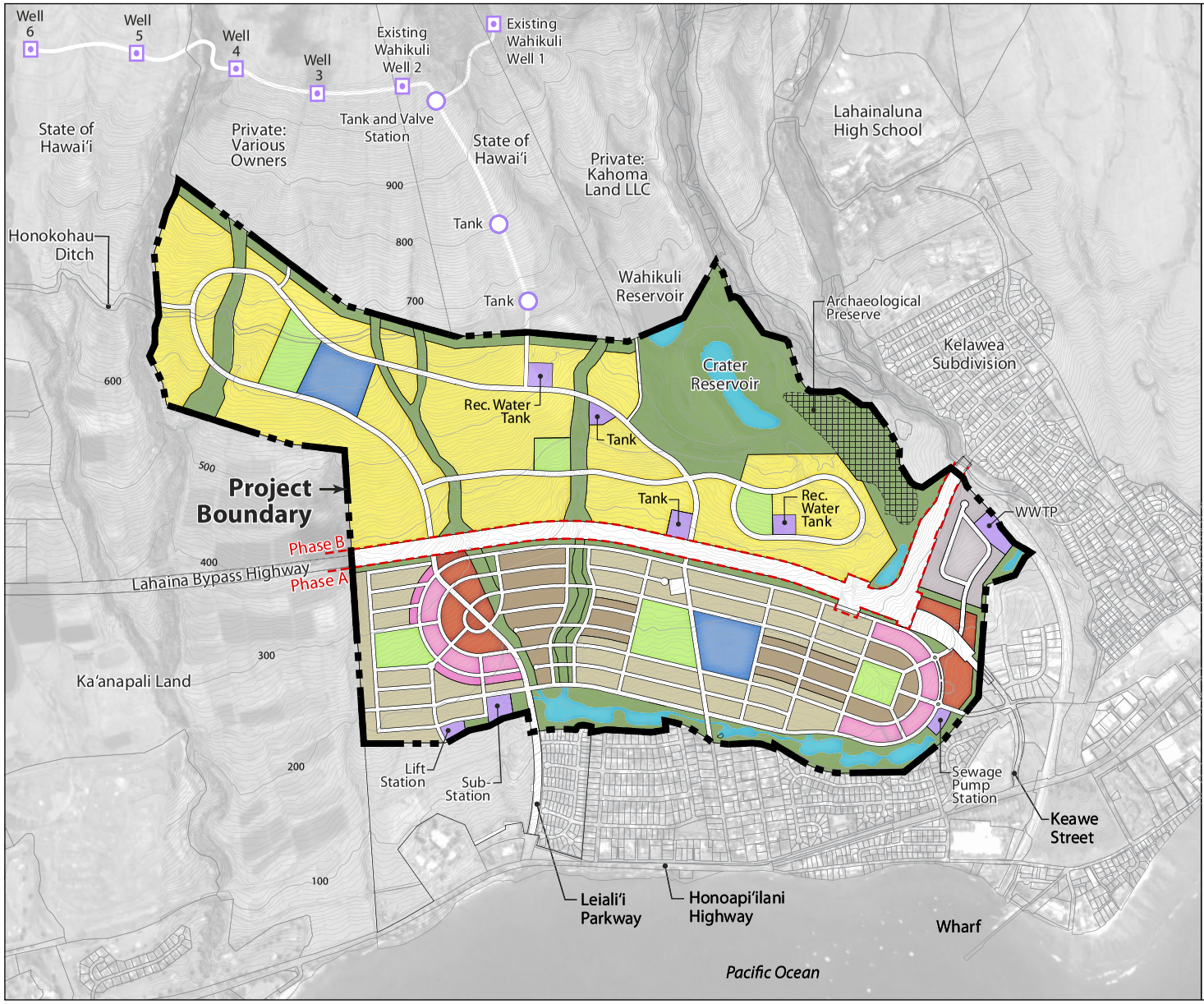
Note: Lot lines shown are approximate and for illustrative purposes. Imagery is from Google Earth Pro and is approximately matched to lot lines.

Figure 2
CONCEPT LAND USE PLAN—ONE

Sewer System Master Plan
Villages of Leiali'i
September 2009



LEGEND

- Detached Single-Family Residential
  Phase B: 304.57 ac/ 1,522 du
- Multi-Family Residential - 15 du/ac
  Phase A: 101.47 ac/ 1,524 du
- Multi-Family Residential - 20 du/ac
  Phase A: 41.52 ac/ 834 du
- Open Space
  Phase A: 78.11 ac
  Phase B: 180.77 ac
- Park
  Phase A: 24.39 ac
  Phase B: 19.58 ac
- Elementary School
  Phase A: 12.01 ac
  Phase B: 12.01 ac
- Commercial
  Phase A: 20.75 ac/ 245,200 sf
- Mixed Use
  Phase A: 23.40 ac
  Commercial: 203,900 sf
  Office: 101,900 sf
  Multi-Family Residential: 163 du
- Light Industrial
  Phase A: 17.20 ac/ 524,500 sf
- Infrastructure
  Phase A: 7.67 ac
  Phase B: 7.47 ac
- Detention Ponds
- Phase Boundary

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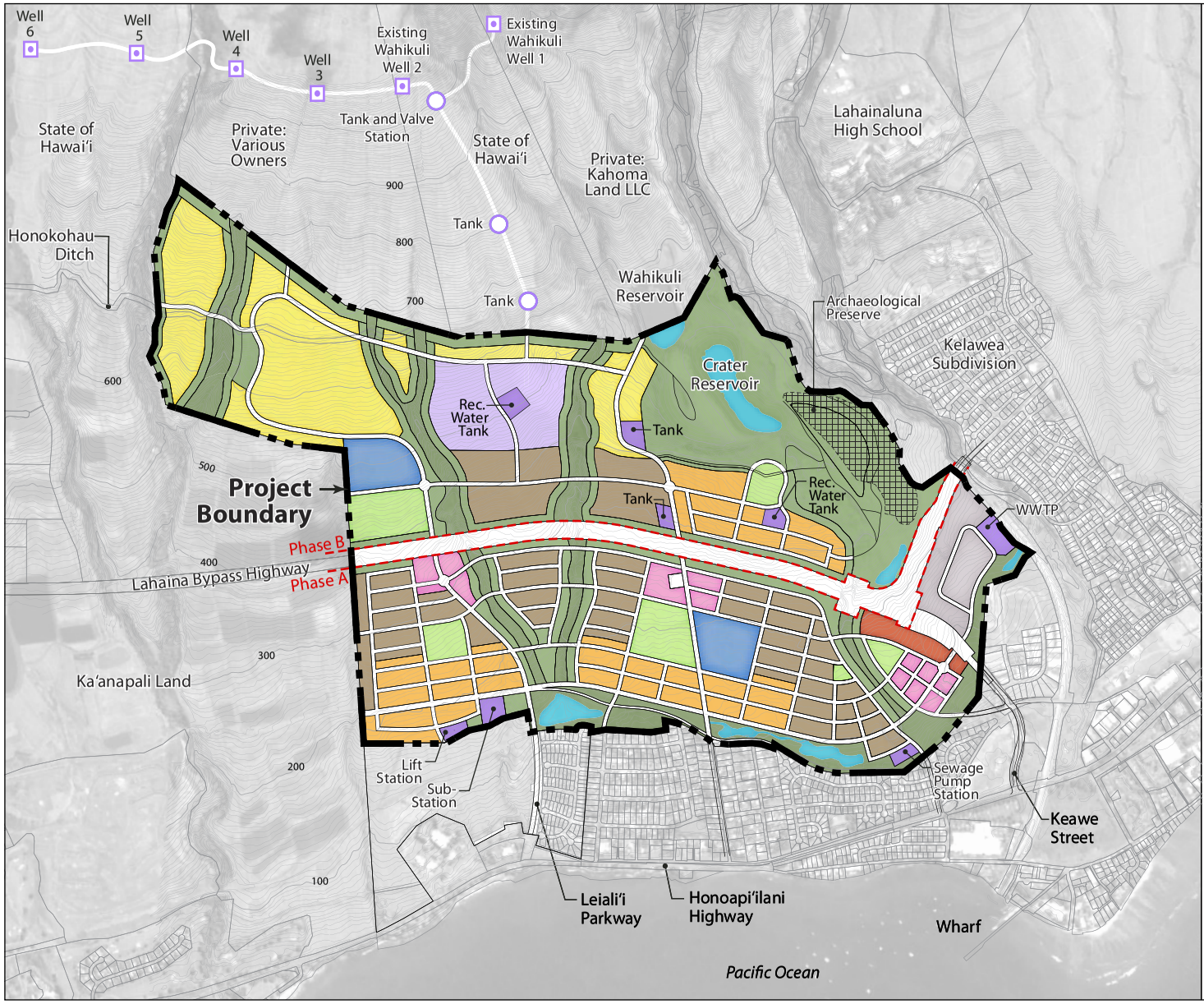
Figure 3
CONCEPT LAND USE PLAN—TWO

Sewer System Master Plan
Villages of Leiali'i
September 2009



LEGEND

- Detached Single-Family Residential
  Phase B: 121.56 ac/ 607 du
- Attached Single-Family Residential
  Phase A: 53.07 ac/ 532 du
  Phase B: 24.63 ac/ 247 du
- Multi-Family Residential—18 & 20 du/ac
  Phase A: 80.92 ac/ 1,477 du
  Phase B: 36.15 ac/ 650 du
- Open Space
  Phase A: 103.81 ac
  Phase B: 267.44 ac
- Park
  Phase A: 20.52 ac
  Phase B: 17.46 ac
- Elementary School
  Phase A: 12.01 ac
  Phase B: 12.58 ac
- Commercial
  Phase A: 7.62 ac/ 166,000 sf
- Mixed Use
  Phase A: 19.74 ac
  Commercial: 286,700 sf
  Office: 143,300 sf
  Multi-Family Residential: 592 du
- Light Industrial
  Phase A: 21.81 ac/ 665,100 sf
- Infrastructure
  Phase A: 7.67 ac
  Phase B: 6.84 ac
- Photovoltaic Farm
  Phase B: 37.29 ac
- Detention Ponds
- Phase Boundary

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SCALE IN FEET

Note: Lot lines shown are approximate and for illustrative purposes. Imagery is from Google Earth Pro and is approximately matched to lot lines.

Figure 4
CONCEPT LAND USE PLAN—THREE

Sewer System Master Plan
Villages of Leiali'i
September 2009

3.0 EXISTING INFRASTRUCTURE

The County of Maui Department of Environmental Management owns and operates the wastewater system from the Leiali`i project site to the County's Lahaina Wastewater Reclamation Facility (WWRF). The existing wastewater transmission system between the project site and the WWRF consists of three (3) wastewater pumping stations (WWPS), sewer force mains and gravity transmission lines along Honoapi`ilani Highway. There is a reclaimed water line which extends from the Lahaina WWRF to the Royal Ka`anapali Golf Course. See Figure 5: Existing Infrastructure Map.

3.1 SANITARY SEWER SYSTEM

Wastewater from the lands makai of the project site and Lahaina town flow to Lahaina No. 3 WWPS and is pumped through a 20-inch force main north along Honoapi`ilani Highway to Lahaina No. 2 WWPS. Approximately 2,260 feet south of Lahaina No. 2 WWPS, the 20-inch force main discharges into a manhole, which conveys the wastewater by gravity in a 27-inch line to Lahaina No. 2 WWPS.

From Lahaina No. 2 WWPS, wastewater is pumped in a 20-inch force main north along Honoapi`ilani Highway to Lahaina No. 1 WWPS. Approximately 6,380 feet south of Lahaina No. 1 WWPS, the 20-inch force main discharges into a manhole, which conveys the wastewater by gravity in a 24-inch, 30-inch, and 36-inch line to Lahaina No. 1 WWPS.

From Lahaina No. 1 WWPS, wastewater is pumped by a 20-inch force main to the Lahaina WWRF. The County is currently working on a project to upgrade Lahaina No. 1 WWPS and install a new 30-inch force main to the Lahaina WWRF. Improvements to the WWPS and the force main were begun in 2008 and scheduled for completion in mid-2010.

3.2 LAHAINA WASTEWATER RECLAMATION FACILITY

At the Lahaina WWRF, located at TMK: 4-4-02: 29, wastewater is treated for reuse or disposal. The Lahaina WWRF has an operating capacity of about 6.5 million gallons per day (MGD). Currently the facility is treating about 5.4 MGD of wastewater. About 1.2 MGD of wastewater is treated to R-1 water, which is recycled water that has been oxidized, filtered and exposed to a disinfection process. The R-1 water is used to irrigate the Royal Ka`anapali golf course, landscape areas along Honoapi`ilani Highway and the landscape median of Ka`anapali Parkway. The remaining 4.2 MGD of treated effluent is disposed into four (4) injections wells within the WWRF. The County is allowed to dispose of 6.7 MGD of treated effluent via injection wells per its Environmental Protection Agency (EPA) permit. The County is working on a potential project to upgrade the WWRF to operate at a capacity of about 9.0 MGD.

Entities which have reserved capacity at the Lahaina WWRF include:

- Kapalua – a couple hundred thousand gallons per day
- Amfac – 1.0 MGD
- Department of Hawaiian Home Lands, Villages 1A and 1B – 125,000 gallons per day

HHFDC reserved capacity agreement at the Lahaina WWRF with the County of Maui expired. Currently projects are allowed to connect to the WWRF without an assessment fee, as long as there is capacity at the WWRF. The County of Maui Wastewater Reclamation Division (WRD) prefers to distribute R-1 water to locations that are closer to the WWRF in order to limit costs associated with pumping the water. WRD anticipates that there is potential for a significant demand for R-1 water with the development of lands that are closer to the WWRF in the next 10 to 15 years.

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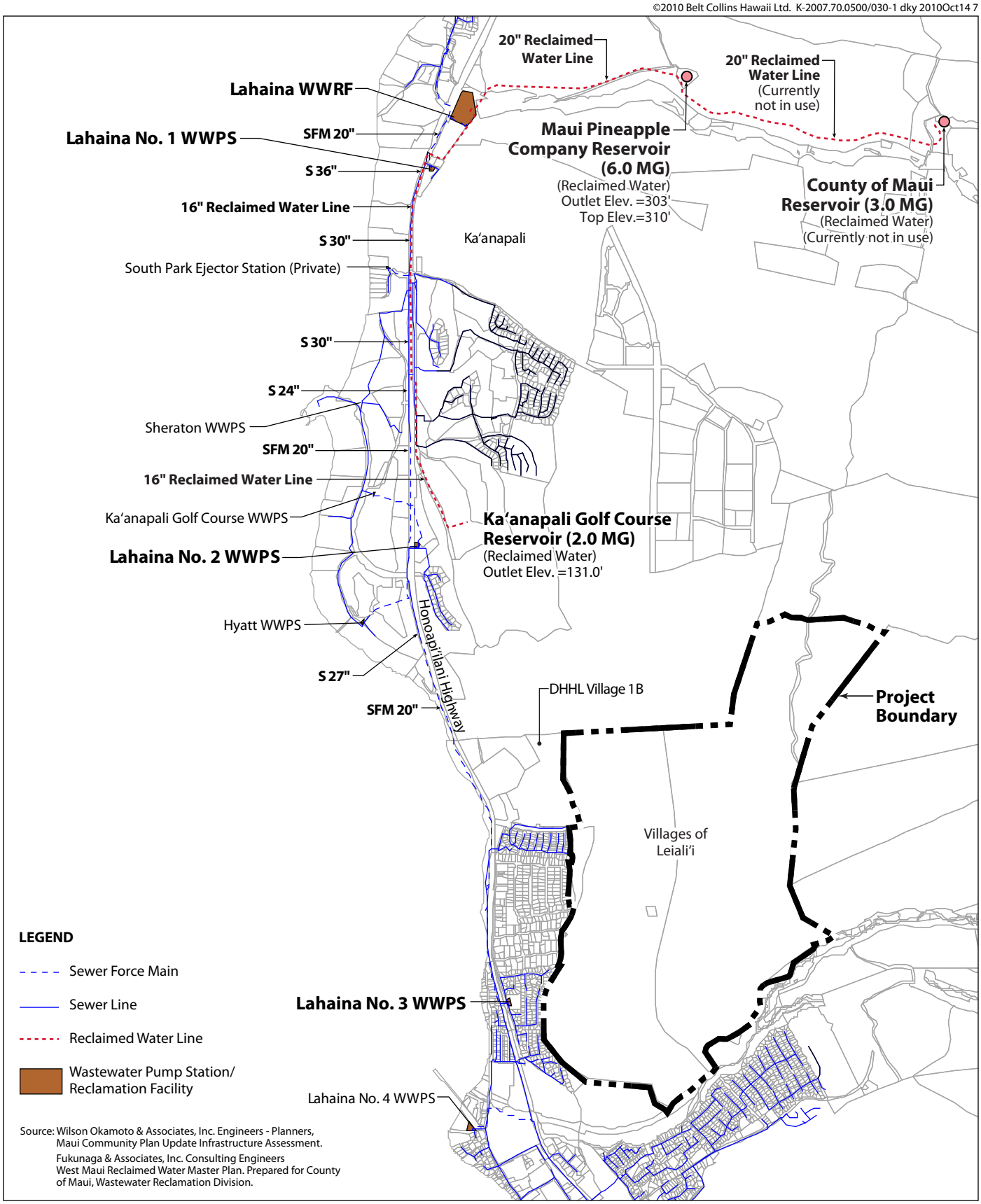

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Figure 5
EXISTING INFRASTRUCTURE MAP

Sewer System Master Plan
Villages of Leiali'i
September 2010

3.3 RECLAIMED WATER SYSTEM

An existing 16-inch reclaimed water line extends south from the Lahaina WWRF along Honoapi`ilani Highway, approximately 8,000 linear feet, to Kualapa Loop. From Kualapa Loop, the 16-inch reclaimed water line traverses along the old cane haul road, approximately 2,000 linear feet, to the 2.0 million gallon Royal Ka`anapali golf course reservoir.

An existing 20-inch reclaimed water line extends approximately 5,500 linear feet east from the Lahaina WWRF to the 6.0 million gallon Maui Pineapple Company reservoir, and continues approximately 6,100 linear feet east to the 3.0 million gallon County reservoir. The portion of the system from the Maui Pineapple Company reservoir up to and including the 3.0 million gallon County reservoir is currently not in use, as pumping to the County reservoir is too costly. The Maui Pineapple Company reservoir does not rely on supply from the Lahaina WWRF, but the WWRF occasionally exercises the pumps to the reservoir for maintenance purposes.

The 16-inch system and 20-inch system are independent of one another. However, the County plans to connect the two systems, install a 200' elevation, 1.0 million gallon reservoir connected to the existing 20-inch line, replace the pumps for the Maui Pineapple Company reservoir at the WWRF with ones designed to pump to the proposed 1.0 million gallon reservoir, and install a pressure sustaining valve at the golf course reservoir. The improvements would provide continuous pressurized service to the reclaimed water system, enabling surrounding developments to connect to and utilize the R-1 system.

4.0 SEWER SYSTEM DESIGN

Sewer system design options include off-site sewer treatment at the Lahaina WWRF, or on-site sewer treatment at a wastewater treatment plant (WWTP) located on the Villages of Leiali`i site.

Off-site sewer treatment would include gravity sewer lines to the Lahaina WWRF. The sewer system with off-site treatment would be constructed to County standards and dedicated to the WRD for operation and maintenance.

On-site sewer treatment would include construction of a WWTP for on-site reuse of treated reclaimed water and injection wells for backup disposal. The on- site WWTP would produce R-1 water (significant reduction in viral and bacterial pathogens), and include spare equipment parts and multiple modular paths for the disinfection system in lieu of an offline, redundant disinfection system. A private entity would operate the on-site WWTP. Currently, the WRD would not accept a small on-site WWTP due to the differences in technology of treatment plants of this size and the County's treatment plant. The County does not have the expertise to operate the on-site WWTP technology. It may be a possibility in the future if the County's technology changes, but further coordination would be required. The injection wells would be located on the sewage pump station site, located makai of the UIC line.

The sewer lines would be sized using the projected flows from the proposed development, and analyzed according to the County sewer design criteria. The gravity sewers would be designed to carry design peak flow without surcharging. The off-site sewer system would have a minimum pipe size of 18 inches and maximum pipe size of 21 inches. The on-site sewer system would have a minimum pipe size of 8 inches and maximum pipe size of 18 inches. The design criteria and analyses for the proposed system are presented in Appendix A.

4.1 DESIGN CRITERIA

Wastewater flows from the Villages of Leiali`i were developed using the County of Maui's wastewater flow standards. A residential occupancy density of 4 persons per unit and sewer flow of 350 gallons/unit per

day was used for single family units and multi-family duplexes. A residential density of 2.5 persons per unit and sewer flow of 255 gallons/unit per day was used for multi-family apartments and low rise (2 or 3 story structure) units. A population of 550 students was used for each elementary school, which would need to be verified by the Department of Education. Sewer flows from schools were computed using 15 gallons/capita per day (gpcd). A residential population equivalent was developed using the County standards of 1 person per 200 square feet (SF) of floor area, 1 person per 500 SF of floor area, and 100 persons per 5 acres with a sewer flow of 20 gpcd, 25 gpcd, and 10 gpcd for commercial, industrial, and parks, respectively. Mixed use developments consisting of commercial, office, and multi-family residential units utilized the sewer flows for each development type.

The existing and proposed sewer systems were analyzed based on peak flows. The peak flows were determined by applying Babbitt's maximum flow factor in accordance with the County standards. Dry and wet weather infiltration/inflow was included in the analyses based on all sewer lines being above the normal groundwater table.

4.2 POPULATION PROJECTIONS AND SERVICE AREA

The three alternative land use concepts for the development utilized varying housing types and densities. Housing densities ranging from five to six units per acre were identified for detached single-family housing, ten units per acre for attached single-family housing, seven units per acre for multi-family housing within mixed use parcels for Concept One and Concept Two, thirty units per acre for multi-family housing within mixed use parcels for Concept Three, and fifteen, eighteen, or twenty units per acre for multi-family housing. The two schools and parks were assigned flows based on the projected number of users. For commercial and industrial developments, floor area was used to obtain equivalent population densities, applying 1 person per 200 SF, and 1 person per 500 SF, respectively.

The projected sewer flows from the proposed alternative land use concepts are presented in Table 1.

Table 1 – Sewer Flow

Description		Design Average Flow (GPD)	Design Peak Flow (GPD)
Concept One	Phase A	556,262	2,346,859
	Phase B	580,014	2,482,638
	Total	**1,136,276**	**4,292,592**
Concept Two	Phase A	793,030	2,986,519
	Phase B	580,014	2,482,638
	Total	**1,373,044**	**4,862,060**
Concept Three	Phase A	881,860	3,156,881
	Phase B	506,093	2,172,018
	Total	**1,387,953**	**4,748,386**

4.3 SEWER ALIGNMENTS

The sewers would be constructed within the roadways wherever it is possible. In areas where no roads are planned, sewer easements would be required. For off-site sewer treatment, Hawaii Housing Finance & Development Corporation (HHFDC) would obtain an easement for the sewer line from the Villages of Leiali`i project site to the Honoapi`ilani Highway. The Wastewater Reclamation Division (WRD) typically does not accept easements, but they would consider an easement with a 12-foot paved access road.

The Leiali`i project site can be divided into two sewer areas, east sewer and west sewer, based on the areas that can be serviced by gravity sewer lines. The east sewer area, encompassing the majority of the site, discharges by gravity to a sewage pump station located on the southwest corner of the site. The west sewer area, approximately 13.5 acres in the northwest corner of the site, would require a lift station to convey wastewater to a trunk sewer to the sewage pump station. The west sewer area is located at lower elevation than the trunk sewer. For Concept Three, the southwest sewer area is a three-acre area on the south end of the site located at lower elevation than the gravity sewer main. Service to the southwest sewer area would require a lift station, maximum 30-feet depth gravity sewer lines in the roadway, or a sewer branch and service road located west of the sewer area and crossing the drainage way to the sewage pump station. See Figure 6 for on-site sewer system for Concepts One and Two, and Figure 7 for Concept Three on-site sewer system.

Four sewer line crossings of the Lahaina Bypass Highway for the Phase B area would require easements, which require coordination with the State Department of Transportation. Two of the sewer line crossings do not align with proposed Phase B roadway crossings of the Lahaina Bypass Highway, so paved service roads would be required to the Lahaina Bypass Highway

For the off-site treatment option, the wastewater flow from the east sewer area would be pumped from the sewage pump station to Leiali‘i Parkway, where it would flow by gravity through the DHHL Village 1B site, along the old cane haul road to Honoapi`ilani Highway, and eventually the Lahaina WWRF. Wastewater from the west sewer area would flow through an 8-inch gravity sewer line through the DHHL Village 1B site, connecting to the gravity main from the east sewer area. The gravity sewer lines would require easements through the DHHL Village 1B site. See Figure 8: Off-Site Sewer System. The off-site gravity sewer line from the DHHL Village 1B site to the existing sewer on Honoapi`ilani Highway was designed in the *Villages of Leiali`i Offsite Sewer System* project (1994), but the sewer system was not constructed. In order to accommodate the projected flows from the Leiali`i project, the design should be revised to provide the new 21-inch sewer line with a minimum 0.0025 ft/ft slope for Concept One, and minimum 0.0032 ft/ft slope for Concept Two and Concept Three.

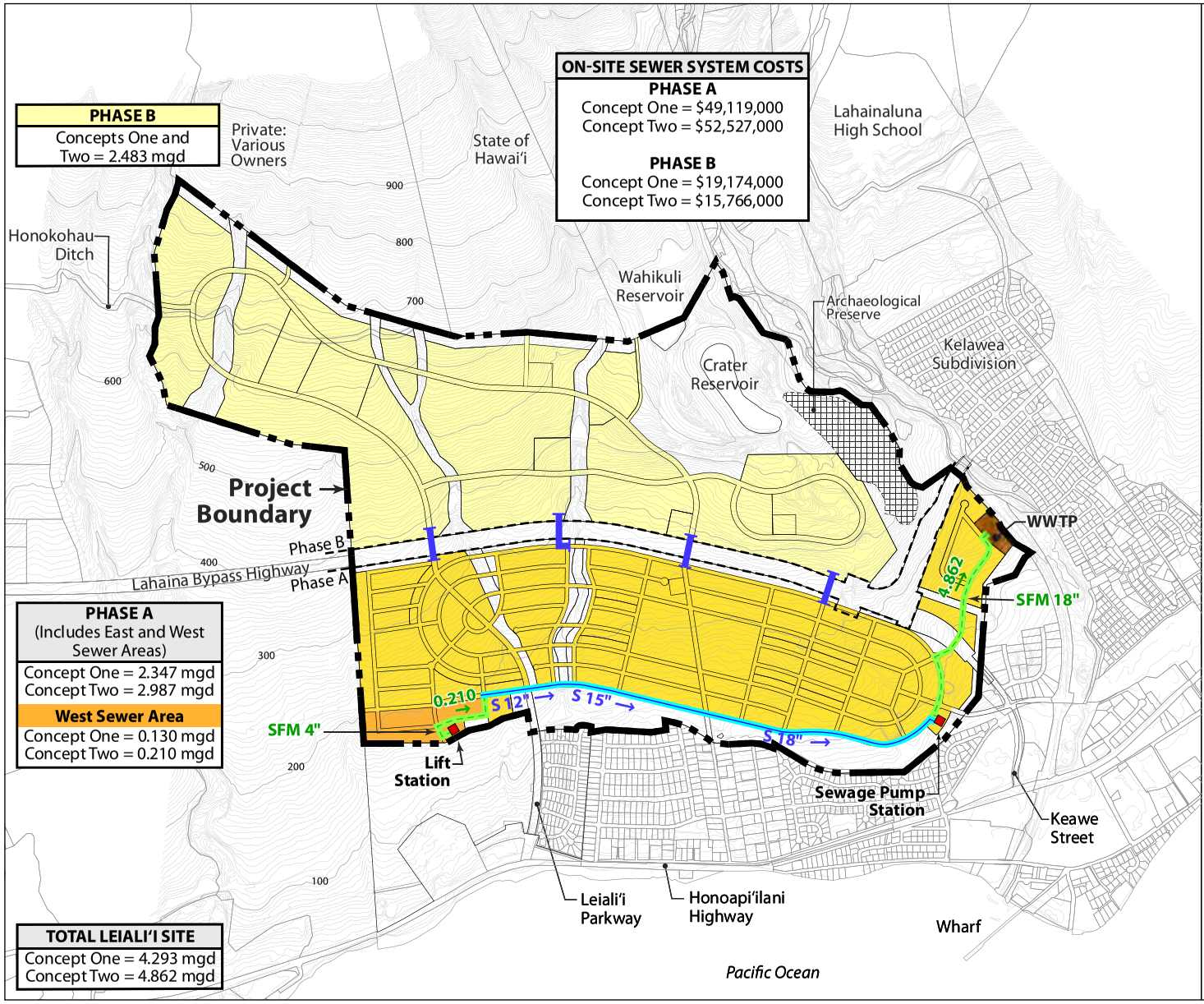
For the on-site treatment option, the wastewater flow would be pumped from the sewage pump station to the on-site WWTP located on the southeast corner of the site, as shown in Figures 6 and 7.

5.0 RECLAIMED WATER SYSTEM DESIGN

Reclaimed water can only be used for multi-family areas, commercial areas, mixed use areas, industrial areas, schools, parks, and roads where a master association or entity can oversee the use. Reclaimed water cannot be used for single-family lots, unless landscape areas are maintained by a master association.

The Villages of Leiali`i could utilize all of the available reclaimed water that would be processed from the wastewater generated from the site by irrigating the developed areas (except single-family housing), in addition to the open space/drainage areas on-site. The Lahaina Civic Center could also be considered if excess reclaimed water were available.

With the off-site sewer treatment option, reclaimed water would be gravity fed to the Leiali`i site from the proposed 1.0 million gallon reservoir mauka of the Lahaina WWRF. Improvements to the off-site



LEGEND

- Phase A—East Sewer Area
- Phase A—West Sewer Area
- Phase B—East Sewer Area
- SFM 18" Sewer Force Main
- S 18" Trunk Sewer Line
- 4.862 Sewer Flow (mgd) for Concept Two
- Sewer Line Crossing for Phase B
- Wastewater Treatment Plant (WWTP)
- Sewage Pump Station/ Lift Station
- PHASE A 2.347 Design Peak Flow (mgd) from Sewer Area

Notes:

1. Costs are in 2009 dollars and do not include roadway infrastructure costs.
2. On-Site Sewer System costs for Phase A include the trunk sewer line, sewer force mains, lift station, sewage pump station and WWTP (equipped to serve Phase A). Phase B costs include WWTP improvement to add service to Phase B.

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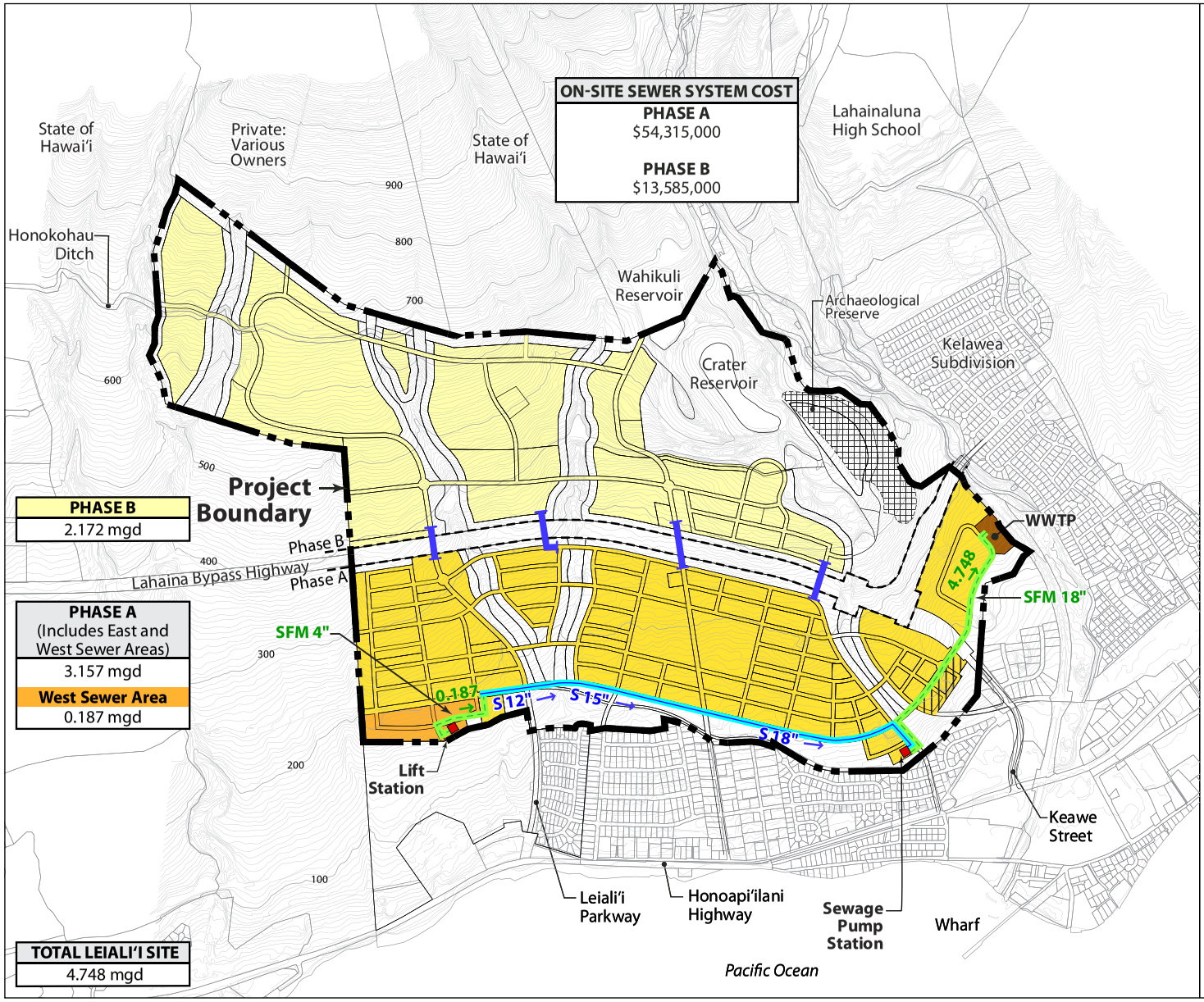
Note: Lot lines shown are approximate and for illustrative purposes.

Figure 6
ON-SITE SEWER SYSTEM CONCEPTS ONE AND TWO

Sewer System Master Plan
Villages of Leiali'i
September 2009



LEGEND

- Phase A—East Sewer Area
- Phase A—Southwest Sewer Area
- Phase A—West Sewer Area
- Phase B—East Sewer Area
- SFM 18" — Sewer Force Main
- S 18" — Trunk Sewer Line
- 4.862 — Sewer Flow (mgd)
- Sewer Line Crossing for Phase B
- Wastewater Treatment Plant (WWTP)
- Sewage Pump Station/ Lift Station
- PHASE A 3.157 — Design Peak Flow (mgd) from Sewer Area

Notes:

1. Costs are in 2009 dollars and do not include roadway infrastructure costs.
2. On-Site Sewer System cost for Phase A includes the trunk sewer line, sewer force mains, lift station, sewage pump station and WWTP (equipped to serve Phase A). Phase B cost includes WWTP improvement to add service to Phase B.

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Note: Lot lines shown are approximate and for illustrative purposes.

Figure 7
ON-SITE SEWER SYSTEM CONCEPT THREE

Sewer System Master Plan
Villages of Leiali'i
September 2009

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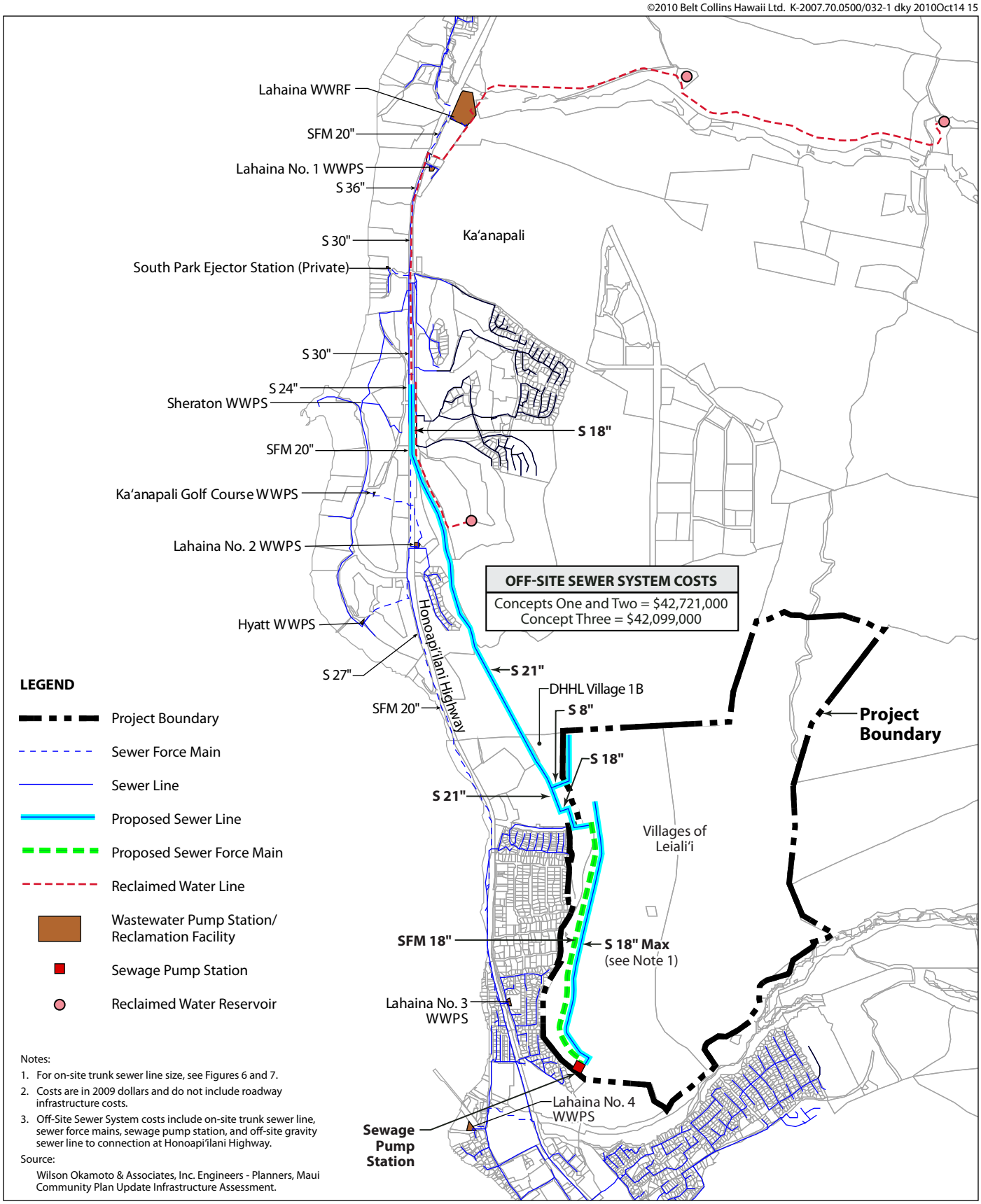

Notes:

1. For on-site trunk sewer line size, see Figures 6 and 7.
2. Costs are in 2009 dollars and do not include roadway infrastructure costs.
3. Off-Site Sewer System costs include on-site trunk sewer line, sewer force mains, sewage pump station, and off-site gravity sewer line to connection at Honoapi'ilani Highway.

Source:

Wilson Okamoto & Associates, Inc. Engineers - Planners, Maui Community Plan Update Infrastructure Assessment.

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0 1000 2000 3000

SCALE IN FEET

Figure 8

OFF-SITE SEWER SYSTEM

Sewer System Master Plan
Villages of Leiali'i
September 2010

reclaimed water system would be required. The reclaimed water system with off-site treatment would be constructed to County standards and dedicated to the WRD for operation and maintenance.

With on-site treatment, reclaimed water would be supplied from the on-site WWTP. The reclaimed water system from the on-site WWTP would be operated and maintained by a private entity.

5.1 DESIGN CRITERIA

The landscape irrigation demand was developed using landscape area percentages of comparable developments and projected landscape water requirements. See Table 2 for landscape area percentages. Landscape water requirement of 1.42 inches per week, based on LEED criteria for water efficient landscaping, was used to calculate irrigation demand. See Appendix B for calculations.

Table 2 – Landscape Area Percentages

Development Type	Percentage of Landscape Area
Multi-Family	58%
Mixed Use	23%
Retail	23%
Industrial	7%
School	58%
Park	78%
Roads	9%
Open Space / Drainage Area	100%

Irrigation demand was analyzed to accommodate phasing of the Leiali`i project and utilize all of the available reclaimed water from the wastewater treatment process. The amount of available reclaimed water was projected by reducing the design average wastewater flow to 90 percent. This is based on an estimated 90-percent development occupancy, which accounts for such events as homeowners not at home, school enrollments below capacity, vacant lots, etc. Irrigation of open space / drainage areas was used to consume excess reclaimed water beyond that which would be utilized for the developed areas. Table 3 presents irrigation demand.

Table 3 – Irrigation Demand

Concept	Phase A (GPD)	Phase B (GPD)	Total (GPD)
One	840,678	181,970	1,022,648
Two	1,095,191	140,549	1,235,739
Three	1,071,793	177,365	1,249,157

Irrigation demand for Phase A would include service to portions of Keawe Street and the Lahaina Bypass Highway within the Leiali`i project boundary. However, Phase A for Concept Two would not have sufficient reclaimed water supply to service the Lahaina Bypass Highway, so irrigation of the Bypass Highway would require completion of Phase B, or a supplement from the potable water system.

The Villages of Leiali`i project site extends from about 50-feet to 840-feet elevation and would be divided into three pressure zones: two gravity service pressure zones (50’ to 215’-elevation, and 215’ to 380’-elevation) and one pumped service pressure zone (380’ to 840’-elevation). Reservoir tank(s) would

supply each of the gravity service pressure zones. The 215' to 380'-elevation pressure zone would service portions of Phase A and Phase B, so two reservoir tanks were included at the reservoir site to accommodate phasing of the project. Transmission of reclaimed water to the reservoir tanks would be via booster pump stations. The area in Phase B that lies above the gravity service pressure zones (380'-elevation) would be serviced by pump station from the higher-elevation reservoir tank site. Location of the reservoir sites and delineation of the pressure zones are shown on Figure 9 (Concepts One and Two) and Figure 10 (Concept Three). Table 4 summarizes the pressure service zones and reclaimed water reservoir tank data.

Table 4 – Reclaimed Water Reservoir Tank Summary

Tank Spillway Elevation (Feet MSL)	Pressure Zone Service Elevation Range (Feet MSL)	Reservoir Tank Capacity (MG)		
		Concept One	Concept Two	Concept Three
360	50 to 215	0.7	0.9	0.7
525	215 to 380	0.7*	0.8*	1.0*
	380 to 840**			
Total		1.4	1.7	1.7

* Denotes total reservoir tank capacity for two equal-sized tanks.
** Denotes pumped service to range indicated.

For Concepts One and Two, the area irrigated with reclaimed water within Phase B located above the gravity service pressure zones is relatively small. The majority of Concepts One and Two Phase B area above the gravity service pressure zone is single-family housing. For Concept Three, the area irrigated with reclaimed water would be significantly larger than Concepts One and Two due to multi-family housing located above the 380' elevation. A park, located west of the Crater Reservoir and above the 380' elevation, also increases the irrigation pumping requirement for Concept Three.

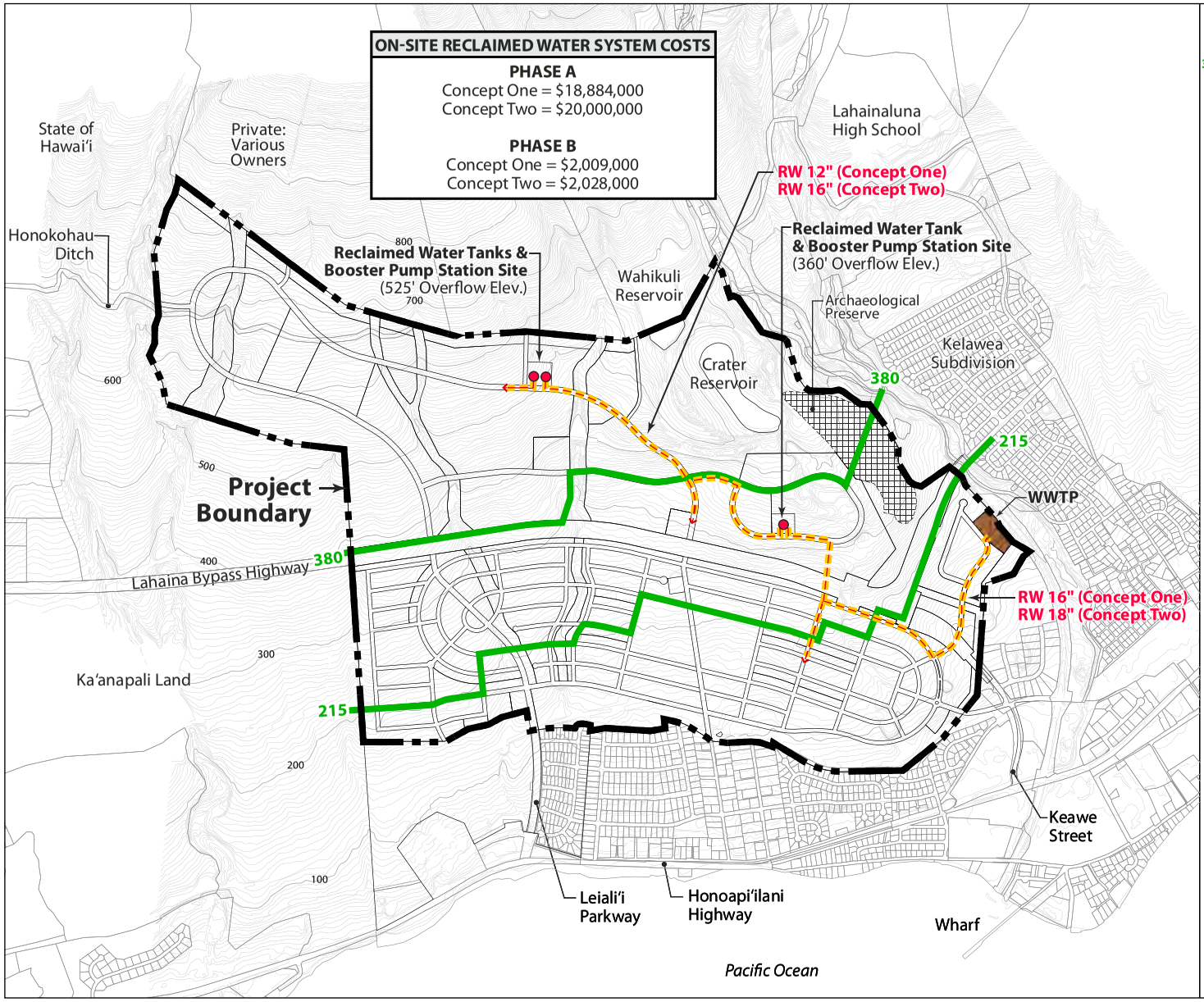
The reclaimed water system was designed to provide a minimum pressure of 55 psi and maximum pressure of 150 psi. Portions of the system that exceed 100 psi would need a pressure reducing valve at each branch. The tanks for reclaimed water on the project site can be covered or an above ground tank. The reservoir tanks were sized to accommodate the design average wastewater flow for Phase A and full build-out (Phase B) of the project site, and provide minimum three feet of freeboard. Appendix B shows reclaimed water system calculations.

5.2 RECLAIMED WATER ALIGNMENTS

The reclaimed water lines would be constructed within the roadways wherever it is possible. In areas where no roads are planned, sewer easements and access roads would be required.

The on-site reclaimed water system would consist of one reservoir tank with 360' overflow elevation and two equal-sized reservoir tanks with 525' overflow elevation. The 360' tank and one 525' tank would be constructed with Phase A; the second 525' tank would be constructed upon full build-out. A booster pump station would be located at each tank site. The booster pump at the 360' tank site would supply the 525' tank with reclaimed water; booster pump at the 525' tank site would provide pressure service to the areas in Phase B located above the service pressure zones.

The transmission mains that supply reclaimed water to the tanks would also be utilized for distribution throughout the site. The reclaimed water mains would use the same easement as the sewer lines to cross the Lahaina Bypass Highway. The reclaimed water line that would supply the 360' tank does not align with a proposed Phase B roadway. The required paved service road for the reclaimed water line



LEGEND

380 380 Delineation of Service Pressure Zones

RW16" Reclaimed Water Line

Wastewater Treatment Plant

Reclaimed Water Reservoir Tank

Notes:

1. Costs are in 2009 dollars and do not include roadway infrastructure costs.
2. On-Site Reclaimed Water System costs for Phase A include reclaimed water lines from WWTP to 525' reclaimed water tank, booster pump station at WWTP, 360' reclaimed water tank and associated booster pump station, and one (1) 525' reclaimed water tank. Phase B costs include the second 525' reclaimed water tank and associated booster pump station.

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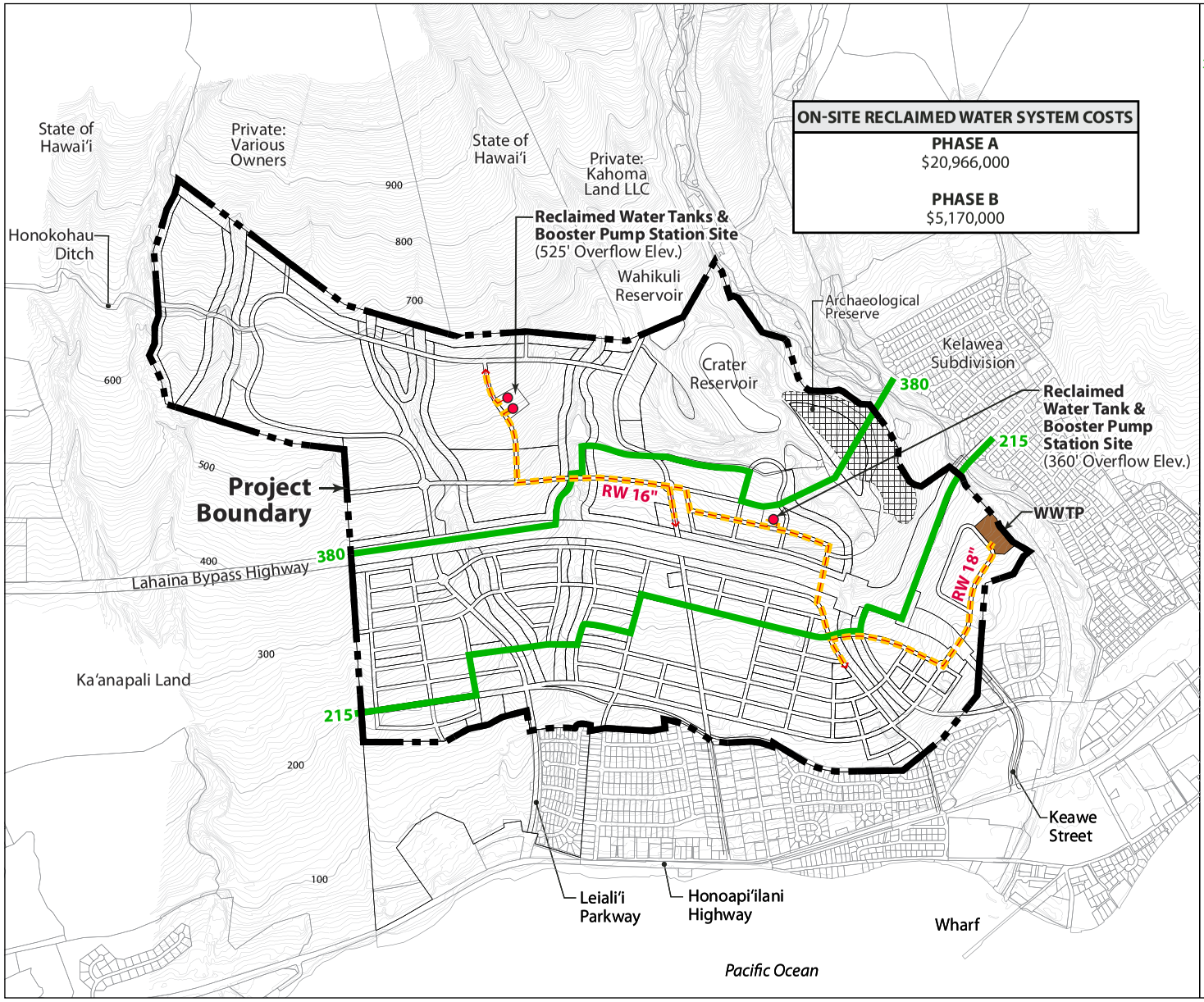
NORTH

0 500 1000 2000
SCALE IN FEET

Note: Lot lines shown are approximate and for illustrative purposes.

Figure 9
ON-SITE RECLAIMED WATER SYSTEM CONCEPTS ONE AND TWO

Sewer System Master Plan
Villages of Leiali'i
September 2009



ON-SITE RECLAIMED WATER SYSTEM COSTS

PHASE A	$20,966,000
PHASE B	$5,170,000

LEGEND

380 — 380 Delineation of Service Pressure Zones

RW16" Reclaimed Water Line

Wastewater Treatment Plant (WWTP)

Reclaimed Water Reservoir Tank

Notes:

1. Costs are in 2009 dollars and do not include roadway infrastructure costs.
2. On-Site Reclaimed Water System cost for Phase A includes reclaimed water lines from WWTP to 525' reclaimed water tank, booster pump station at WWTP, 360' reclaimed water tank and associated booster pump station, and one (1) 525' reclaimed water tank. Phase B cost includes the second 525' reclaimed water tank and associated booster pump station.

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SCALE IN FEET

Note: Lot lines shown are approximate and for illustrative purposes.

Figure 10
ON-SITE RECLAIMED WATER SYSTEM CONCEPT THREE

Sewer System Master Plan
Villages of Leiali'i
September 2009

intersecting with the Lahaina Bypass Highway could be shared with the sewer line service road. The easements need to be coordinated with the State Department of Transportation.

For the off-site sewer treatment option, the off-site reclaimed water service would require 21,300 feet of a new 16-inch reclaimed water line. The new reclaimed water line would connect to the existing 20-inch reclaimed water line approximately 1,700 feet mauka of the Lahaina WWRF, then parallel the existing 20-inch line to the Lahaina WWRF, the existing 16-inch reclaimed water line from the Lahaina WWRF to the Ka`anapali Golf Course Reservoir, and the proposed sewer line along the old cane haul road through the DHHL Village 1B site. See Figure 11: Off-Site Reclaimed Water System. The reclaimed water line between the DHHL Village 1B site and Honoapi`ilani Highway was also designed in the *Villages of Leiali`i Offsite Sewer System* project, but not constructed. The reclaimed water line would use the same easement as the sewer line through the DHHL Village 1B site. The portion of the new reclaimed water line mauka of the Lahaina WWRF would utilize the existing easement for the existing 20-inch line within DHHL property. Easement for approximately 500 feet of the new reclaimed water line between the WWRF and DHHL property would need to be coordinated with Ka`anapali Land Management Corp. An upgrade to the Lahaina WWRF effluent pump station, a new 2.0 MG storage reservoir at the Lahaina WWRF, and a new reclaimed booster pump station would also be required, as indicated in the *West Maui Reclaimed Water Master Plan*. The *West Maui Reclaimed Water Master Plan* locates the new booster pump station at the Lahaina Civic Center and indicates 230' elevation for the reclaimed water reservoir at the Villages of Leiali`i. Preliminary analysis determined that the booster pump station could be located at the north-makai end of DHHL Village 1B. The booster pump station, located on a site of approximately 0.16 acres, would need to provide for additional lift to the 360' reservoir tank. Engineering analysis of the final configuration will be needed to ensure compatibility between the on-site and off-site reclaimed water systems.

For the on-site sewer treatment option, the on-site WWTP would supply reclaimed water to the reservoir tanks, as shown in Figures 9 and 10. A booster pump station at the WWTP would pump reclaimed water to the 360' reservoir tank.

6.0 ESTIMATED INFRASTRUCTURE COSTS

The major infrastructure requirements for the sewer and reclaimed water system for the on-site and off-site treatment options discussed above are summarized in Tables 5 and 7. The order-of-magnitude costs for the sewer and reclaimed water system construction are detailed in Appendix C and summarized in Tables 6 and 8. The on-site system costs are for a private system. The sewer lines and reclaimed water lines along the roads are not included in the tables. All costs are in 2009 dollars.

Table 5 – Off-Site and On-Site Sewer System Infrastructure

Description	Off-Site Sewer System (County System)	On-Site Sewer System (Private System)
Concepts One, Two, and Three	Phase A • On-site sewer lines o Trunk sewer line to sewage pump station o Force main from sewage pump station to Leiali'i Parkway o Trunk sewer line from Leiali'i Parkway to north-makai corner of DHHL site o Gravity sewer line from west sewer area trunk sewer line in DHHL site • On-site sewage pump station • Off-site gravity sewer lines from north-makai corner of DHHL site to existing sewer on Honoapi`ilani Highway	Phase A • Sewer lines o Force main from lift station to trunk sewer line o Trunk sewer line to sewage pump station o Force main from sewage pump station to WWTP • Lift station • Sewage pump station • WWTP (equipped to serve Phase A) • Injection wells
	Phase B • None	Phase B • WWTP improvement (add equipment to service Phase B) • Injection wells

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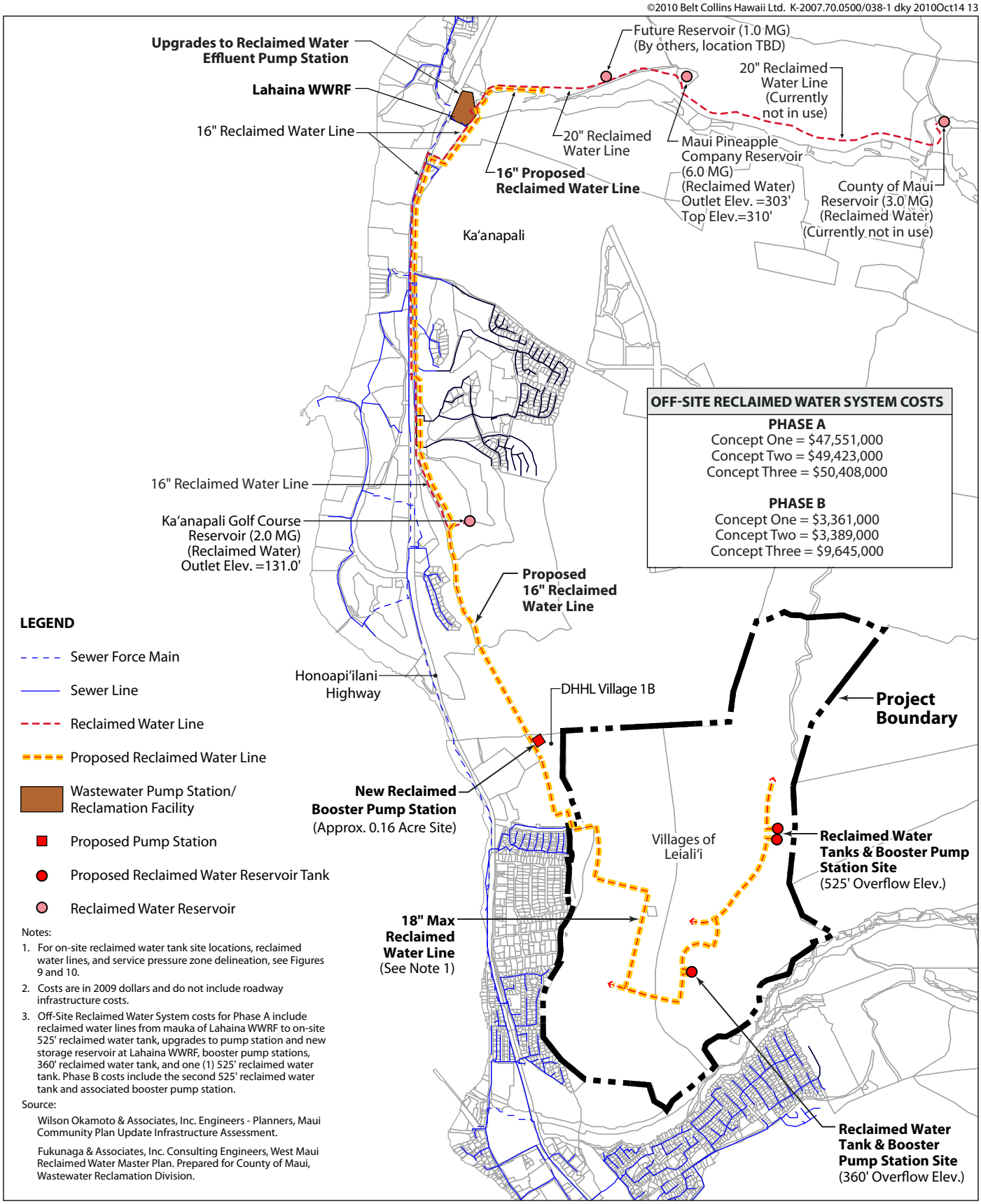

Notes:

1. For on-site reclaimed water tank site locations, reclaimed water lines, and service pressure zone delineation, see Figures 9 and 10.
2. Costs are in 2009 dollars and do not include roadway infrastructure costs.
3. Off-Site Reclaimed Water System costs for Phase A include reclaimed water lines from mauka of Lahaina WWRF to on-site 525' reclaimed water tank, upgrades to pump station and new storage reservoir at Lahaina WWRF, booster pump stations, 360' reclaimed water tank, and one (1) 525' reclaimed water tank. Phase B costs include the second 525' reclaimed water tank and associated booster pump station.

Source:

Wilson Okamoto & Associates, Inc. Engineers - Planners, Maui Community Plan Update Infrastructure Assessment.

Fukunaga & Associates, Inc. Consulting Engineers, West Maui Reclaimed Water Master Plan. Prepared for County of Maui, Wastewater Reclamation Division.

BELT COLLINS

NORTH

0 1000 2000 3000
SCALE IN FEET

Figure 11
OFF-SITE RECLAIMED WATER SYSTEM

Sewer System Master Plan
Villages of Leiali'i
September 2010

Table 6 – Off-Site and On-Site Sewer System Costs

Description		Off-Site Sewer (County System)	On-Site Sewer (Private System)
Concept One	Phase A	$ 42,721,000	$ 49,119,000
	Phase B	$ -	$ 19,174,000
	Total	**$ 42,721,000**	**$ 68,293,000**
Concept Two	Phase A	$ 42,721,000	$ 52,527,000
	Phase B	$ -	$ 15,766,000
	Total	**$ 42,721,000**	**$ 68,293,000**
Concept Three	Phase A	$ 42,099,000	$ 54,315,000
	Phase B	$ -	$ 13,585,000
	Total	**$ 42,099,000**	**$ 67,900,000**

Costs for the off-site sewer system for Concept Three are less than Concepts One and Two due to shorter trunk sewer line and less earthwork for the Sewage Pump Station. The Sewage Pump Station site for Concept Three is located northwest on a flatter site than Concepts One and Two.

Cost differences among the concepts for the on-site sewer system are due to the phased construction of the equipment at the WWTP. More of the WWTP will be built during Phase A sequentially from Concept One to Concept Three. The total WWTP cost for each concept is the same. Total costs for Concept Three are less than Concepts One and Two due to less earthwork for the Sewage Pump Station.

Table 7 – Off-Site and On-Site Reclaimed Water System Infrastructure

Description	Off-Site Reclaimed Water System (County System)	On-Site Reclaimed Water System (Private System)
Concept One	Phase A • On-site transmission lines o From Leiali'i Parkway to 360' reservoir o From 360' reservoir to 525' reservoir • On-site reservoirs o 0.685 MG 360' elevation o 0.355 MG 525' elevation • On-site booster pump stations o 360' reservoir site • Off-site transmission lines from 20-inch line mauka of Lahaina WWRF to Leiali'i Parkway • Upgrade WWRF effluent pump station • 2.0 MG storage reservoir at WWRF • Off-site booster pump station	Phase A • Transmission lines o From WWTP to 360' reservoir o From 360' reservoir to 525' reservoir • Reservoirs o 0.685 MG 360' elevation o 0.355 MG 525' elevation • Booster pump stations o WWTP site o 360' reservoir site

Table 7 (continued)

Description	Off-Site Reclaimed Water System (County System)	On-Site Reclaimed Water System (Private System)
Concept One (continued)	Phase B • On-site reservoirs o 0.355 MG 525' elevation • On-site booster pump station o 525' reservoir site	Phase B • Reservoirs o 0.355 MG 525' elevation • Booster pump station o 525' reservoir site
Concept Two	Phase A • On-site transmission lines o From Leiali'i Parkway to 360' reservoir o From 360' reservoir to 525' reservoir • On-site reservoirs o 0.859 MG 360' elevation o 0.395 MG 525' elevation • On-site booster pump stations o 360' reservoir site • Off-site transmission lines from 20-inch line mauka of Lahaina WWRF to Leiali'i Parkway • Upgrade WWRF effluent pump station • 2.0 MG storage reservoir at WWRF • Off-site booster pump station	Phase A • Transmission lines o From WWTP to 360' reservoir o From 360' reservoir to 525' reservoir • Reservoirs o 0.859 MG 360' elevation o 0.395 MG 525' elevation • Booster pump stations o WWTP site o 360' reservoir site
	Phase B • On-site reservoirs o 0.395 MG 525' elevation • On-site booster pump station o 525' reservoir site	Phase B • Reservoirs o 0.395 MG 525' elevation • Booster pump station o 525' reservoir site
Concept Three	Phase A • On-site transmission lines o From Leiali'i Parkway to 360' reservoir o From 360' reservoir to 525' reservoir • On-site reservoirs o 0.741 MG 360' elevation o 0.483 MG 525' elevation • On-site booster pump stations o 360' reservoir site • Off-site transmission lines from 20-inch line mauka of Lahaina WWRF to Leiali'i Parkway • Upgrade WWRF effluent pump station • 2.0 MG storage reservoir at WWRF • Off-site booster pump station	Phase A • Transmission lines o From WWTP to 360' reservoir o From 360' reservoir to 525' reservoir • Reservoirs o 0.741 MG 360' elevation o 0.483 MG 525' elevation • Booster pump stations o WWTP site o 360' reservoir site
	Phase B • On-site reservoirs o 0.483 MG 525' elevation • On-site booster pump station o 525' reservoir site	Phase B • Reservoirs o 0.483 MG 525' elevation • Booster pump station o 525' reservoir site

Table 8 – Off-Site and On-Site Reclaimed Water System Costs

Description		Off-Site Reclaimed Water (County System)	On-Site Reclaimed Water (Private System)
Concept One	Phase A	$ 47,551,000	$ 18,884,000
	Phase B	$ 3,361,000	$ 2,009,000
	Total	**$ 50,912,000**	**$ 20,893,000**
Concept Two	Phase A	$ 49,423,000	$ 20,000,000
	Phase B	$ 3,389,000	$ 2,028,000
	Total	**$ 52,812,000**	**$ 22,028,000**
Concept Three	Phase A	$ 50,408,000	$ 20,966,000
	Phase B	$ 9,645,000	$ 5,170,000
	Total	**$ 60,053,000**	**$ 26,136,000**

Cost differences among the concepts are due to pipe and reservoir tank sizes. The higher cost for Concept Three is due to a larger booster pump required to service a larger area and additional transmission lines and service roads between the reservoir tank sites.

7.0 SUMMARY

The sewer master plan layout for the Villages of Leiali`i includes off-site and on-site treatment options for the sewer and reclaimed water systems that will serve the Villages of Leiali`i community. The sewer and reclaimed water systems for off-site treatment would be a system dedicated to the County of Maui for operation and maintenance. The sewer and reclaimed water systems for on-site treatment would be a privately run system.

For the off-site treatment option, it is necessary for Hawaii Housing Finance and Development Corporation (HHFDC) to coordinate with the County to ensure that the required plant capacity is available at the time of the community's development and to address further upgrades to the Lahaina WWRF and Lahaina No. 1 WWPS. Wastewater from the Leiali`i site would be pumped off-site to a new 21-inch and 18-inch gravity sewer line through the DHHL Village 1B site, along the old cane haul road to Honoapi`ilani Highway, and eventually the Lahaina WWRF. A new 16-inch reclaimed water line, running parallel to the sewer line, would transfer R-1 water to the Villages of Leiali`i from the 20-inch reclaimed water line mauka of the Lahaina WWRF. Upgrade effluent pump station and a new 2.0 MG storage reservoir at the Lahaina WWRF, and a new off-site reclaimed booster pump station in DHHL Village 1B would be required.

For the on-site treatment option, a WWTP, injection wells, and a lift station would be constructed on-site. The on-site WWTP would produce R-1 water and pump the water to the reservoir tanks.

The on-site sewer system for both the off-site and on-site treatment options includes gravity lines to a sewage pump station. The reclaimed water system includes two reservoir tank sites, each with a booster pump station.

8.0 REFERENCES

1. County of Maui, Wastewater Reclamation Division. Wastewater Flow Standards. February 2, 2006.

2. Fukunaga and Associates, Inc., *Lahaina-Kaanapali Gravity Sewer Replacement Phase 2A* (As-built plans). February 1997. Prepared for County of Maui, Department of Public Works and Environmental Management.

3. Fukunaga and Associates, Inc., Letter Report*, Lahaina Kaanapali Wastewater Reclamation Project – Phase 1 Feasibility Study*. July 24, 2008. Addressed to Intrawest Placemaking.

4. Fukunaga and Associates, Inc., *West Maui Reclaimed Water Master Plan*. March 2004. Prepared for County of Maui, Department of Public Works and Environmental Management, Wastewater Reclamation Division.

5. Munekiyo & Hiraga, Inc, *Draft Environmental Assessment Proposed Lahaina Wastewater Pump Station No. 1 Modifications (TMK 4-4-002:029 and 033)*. January 2008.

6. R.M. Towill Corporation, *Sewerage Master Plan for County of Maui*. October 1971.

7. Warren S. Unemori Engineering, Inc., *Construction Plans for Villages of Leiali`i Offsite Sewer System*. March 1994. Prepared for Hawaii Housing Finance and Development Corporation.

APPENDIX A – SEWER CALCULATIONS

Appendix – Sewer System

Criteria

The sewer system criteria for the HHFDC Villages of Leiali`i follow the County of Maui, Department of Environmental Management, Wastewater Reclamation Division criteria as shown below:

1. Quantity of Wastewater:

Residence, subdivision =	350 gallons per unit per day
Apartment/Condo =	255 gallons per unit per day
Office =	20 gallons per capita per day
Industrial Shop =	25 gallons per capita per day
School, elementary =	15 gallons per capita per day
Parks =	10 gallons per capita per day

Land Use	Densities
Residential	4 persons per unit
Apartment/Condo	2.5 persons per unit
Office	1 per 200 square feet of floor area
Industrial	1 per 500 square feet of floor area
Parks	20 capita per acre

2. Pipeline sizing:

   a. Size pipes to convey the design peak flow.
   b. Minimum size of pipe is 8-inches for mains in roadway areas.
   c. Minimum velocity in the sewer line flowing full is 2.0 feet per second.
   d. Maximum velocity in the sewer line flowing full is 10 feet per second.
   e. Minimum and maximum slopes for sewer lines flowing full:

Pipe Diameter	Minimum Slope	Maximum Slope
8”	0.00444	0.1110
10”	0.00331	0.0827
12”	0.00259	0.0648
15”	0.00192	0.0479
18”	0.00160	0.0377
21”	0.00092	0.0231
24”	0.00077	0.0193
27”	0.00066	0.0165
30”	0.00057	0.0143

3. Manhole Spacing:

   a. 350 feet – pipes up to and including 30 inches in diameter in street areas.
   b. 250 feet – pipes up to and including 18 inches in diameter in easement areas.
   c. 350 feet – pipes larger than 18 inches and up to and including 30 inches in diameter in easement areas.

4. Drop Manholes:

A drop manhole or shallow drop manhole should be provided where a sewer enters a manhole at a height of 18 inches or more above the manhole invert.

5. Wastewater Treatment Plant Capacity:

The wastewater treatment plant capacity is based on the design average flow from the development.

County of Maui
Wastewater Reclamation Division

2200 Main Street Suite 610 ● Wailuku, HI 96793 ● (808) 270-7417 ● 270-7425 fax

Wastewater Flow Standards

The following wastewater flow contributions are to be utilized for projecting wastewater flows for the following types of uses, unless other supporting data is provided to show differently.

Type of use	Unit	Contribution (Gal/Unit/Day)
Apartment/Condo	Unit	255
Bar	Seat	15
Church, large	Seat	6
Church, small	Seat	4
Cottage or Ohana (600 S.F. max)	Unit	180
Day-care Center	Child	10
Factory	Employee	30
Golf Clubhouse	Golf Rounds	25
Hotel, resort with laundry	Room	350
Hotel, average with laundry	Room	300
Hotel, average without laundry	Room	250
Hospital	Bed	200
Industrial Shop	Employee	25
Laundry (coin operated)	Machine	300
Office	Employee	20
Residence, subdivision	Home	350
Restaurant, average	Seat	80
Restaurant, fast food	Seat	100
Rest Home	Patient	100
Retail Store	Employee	15
School, elementary	Student	15
School, high	Student	25
Storage, w/ offices	Employee	15
Storage w/ offices and showers	Employee	30
Store Customer bathroom usage	Use	5
Theater	Seat	5

The following standards will be used as necessary to compute the number of units required to make wastewater calculations:

Residential Occupancy	4 persons per unit
Apartment/Condo Occupancy	2.5 persons per unit
Hotel Occupancy	2.25 persons per unit
Hotel Employees	1 per hotel room
Office Employees	1 per 200 square feet of floor area
Retail Warehouse Employees	1 per 350 square feet of floor area
Storage/ Industrial Employees	1 per 500 square feet of floor area

Average Wastewater Flow: The average wastewater flow is the sum of the applicable wastewater flows listed above.

Maximum Wastewater Flow: The maximum wastewater flow is obtained by multiplying the average flow by a flow factor. The flow factor shall be obtained utilizing the Babbit formula or other rationale method.

Dry Weather Infiltration/Inflow: The following rates shall be used in the design of wastewater transmission lines:

a. 35 gpcd* - Wastewater lines laid below the normal ground water table.

b. 5 gpcd - Wastewater lines laid above the normal ground water table.

* gpcd = Gallons per Capita Day

Wet Weather Infiltration/Inflow: The following rates shall be used in the design of wastewater transmission lines:

a 2,750 gad* - Wastewater lines laid below the normal ground water table.

b. 1,250 gad - Wastewater lines laid above the normal ground water table.

* gad = Gallons per Acre per Day

Design Average Flow: The design average flow is the sum of the average wastewater flow and the applicable dry weather infiltration/inflow rate.

Design Maximum Flow: The design maximum flow is the sum of the maximum flow and the applicable dry weather infiltration/inflow rate.

Design Peak Flow: The design peak flow of wastewater is the sum of design maximum flow and the wet weather infiltration/inflow

BeltCollins

MEETING SUMMARY

PROJECT:	BCH JOB NUMBER:
Villages of Leiali`i	2007.70.0500/08E-023
MEETING LOCATION:	DATE AND TIME:
County of Maui Wastewater Reclamation Division	January 18, 2008 9:40 – 10:10 am
SUBJECT:	ATTENDEES:
Project Introduction and Data Gathering	Mr. Scott Rollins – WRD Mr. Arnold Abe - WRD Mr. Stanley Fujimoto – HHFDC Mr. Alan Kato - BCH

The meeting with Mr. Scott Rollins and Mr. Arnold Abe of the Wastewater Reclamation Division (WRD) was held to discuss the Leiali`i project which is being developed by the State Hawaii Housing Finance and Development Corporation (HHFDC). The Leiali`i site consists of approximately 1,100 acres, of which HHFDC is proceeding with development of 468 acres, owned by HHFDC, below the Lahaina By-Pass Highway. The remaining portion, above the Lahaina By-Pass is owned by the State Department of Land and Natural Resources.

- Mr. Stanley Fujimoto is the project manager with HHFDC.
- Mr. Alan Kato is the civil engineering consultant with Belt Collins Hawaii Ltd (BCH), who has been retained by HHFDC to prepare a master plan and EIS for the project.
- BCH is planning for the entire Leiali`i site, although the Request for Proposal (RFP) from developers will be only for the 468 acres below the Lahaina By-Pass Highway.
- The Lahaina Wastewater Reclamation Facility (LWRF) has a paper capacity of 9.0 MGD and an actual capacity of 6.5 MGD. Currently the facility is operating at about 5.0 to 5.1 MGD.
- The HHFDC reserved capacity at the LWRF agreement with the County has expired.
- The County is working on a potential project to upgrade the LWRF to operate at a capacity of 9.0 MGD.
- Kapalua has reserved a couple hundred-thousand gallons per day capacity at the LWRF and Amfac has reserved 1.0 MGD capacity at the LWRF. WRD is reserving 125,000 gpd for DHHL's Villages 1A and 1B projects, since they requested for capacity before HHFDC's LWRF agreement lapsed.

Honolulu
Bangkok
Guam
Hong Kong
Manila
Seattle
Shenzhen
Singapore

- There currently is no assessment fee to connect to the LWRF – projects are allowed to connect to the facility as long as there is capacity.

- Previously the project proposed to connect to the existing sewer system along Kapunakea Street with an added 12" sewer line in Honoapiilani Highway. WRD can check to see if there is capacity in the system at this location for the project.

- The previous agreement that the project had to take reclaimed water from the LWRF has expired. But WRD anticipates that the County Council will require the project take reclaimed water from the LWRF.

- The LWRF discharges R-1 water.

- Based on costs, the project could consider placing a treatment plant on site and use the reclaimed water on site.

- HHFDC is in the process of obtaining an easement for the sewer line from the Leiali`i project site to Honoapiilani Highway. WRD typically do not accept easements, however they would consider an easement with a paved access road, 12-feet wide.

- A project to build a sewer line from the end of the easement to the LWRF was previously designed. WRD to determine whether the project was built and determine if additional improvements are required at the SPS #1 site.

- WRD is considering pumping from SPS No. 3 to the gravity line from the Leiali`i project site to the LWRF.

- If the sewer line is routed through DHHL's 1B project, WRD indicated that the homes mauka of the sewer line may have to connect to the sewer line due to insufficient capacity in the sewer system makai of 1B.

- WRD indicated that a sewer line built within the Special Management Area is exempt because the improvements are underground or less than 4 feet above ground, as long as it is not inside the shoreline setback.

- WRD will provide BCH the Maui standards for sewer flow generation.

- A tank for reclaimed water on the Leiali`i project site can be either covered or an above ground tank.

- WRD has no standards for service zones.

- Reclaimed water can only be used for multi-family areas, schools and parks, where a master association or entity can oversee the use. Reclaimed water cannot be used for single family lots.

Alan Kato

From: Scott Rollins [Scott.Rollins@co.maui.hi.us]
Sent: Friday, January 18, 2008 2:21 PM
To: Alan Kato
Cc: Arnold Abe; Steve Parabicoli
Subject: Lahaina Reclaimed Water Master Plan

Attachments: R1 master plan Ph3.pdf

R1 master plan Ph3.pdf (2 MB)

Alan,
As a follow up to our meeting regarding the Village of Lealii I have attached an exhibit from our 2004 Reclaimed Water Master Plan. Our Phase III construction noted the Villages of Lealii would use 1.8 mgd of R-1 per day. Our preliminary plan and estimate showed the requirements for this phase were:

12,000 ft. of 16" line ($6M),
Upgrade to the plant pump station ($4.3M), New booster pump station ($2.5M) near the Civic Center and 2.0 mgd reservior at Lealii ($3.2M).

Of course all of this would need to be reviewed based on the demand from the new master plan, but it is a start. Please contact us should you have additional questions. Mr. Steve Parabicoli is our Reuse Coordinator and will be best equipped to assist you. He can be reached at steve.parabicoli@co,maui.hi.us or 270-7426.

Scott R. Rollins, CE-VI
Department of Environmental Management
Wastewater Reclamation Division
2200 Main Street, Suite 610
Wailuku, HI 96793

Phone: (808) 270-7427
Fax: (808) 270-7425
E-mail: scott.rollins@co.maui.hi.us

Alan Kato

From: Scott Rollins [Scott.Rollins@co.maui.hi.us]
Sent: Wednesday, January 30, 2008 9:26 AM
To: Alan Kato
Subject: Re: FW: Maui County Wastewater Flow Standards

Alan,

Sorry for the delay in responding. In regards to your questions:

1) yes this would be the category. The exception is duplexes where we would probably use the 350 per unit figure.
2) and 3) I think those are reasonable (and probably conservative) estimates at this point.
4) We don't have any numbers but your suggestion seems reasonable. The 15 gpd seems high for discharge, I think 10 would be better.
5) yes only use the areas that will be developed with lots that have sewer service.

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>>> "Alan Kato" <akato@beltcollins.com> Saturday, January 19, 2008 5:41 PM >>>
Scott:

I was in the process of updating my spreadsheet to reflect the Maui flow standards and a number of questions seemed to pop up. See the attached spreadsheet. Questions include:

1) For multi-family units (probably low rise - 2 or 3 story structures), does this fall into the apartment/condo category? 2.5 persons/unit and 255 gallons/unit/day

2) For commercial, what factor can we use for converting the acres to the persons? Would 140 capita/acre be acceptable?

3) For industrial, what factor can we use for converting the acres to persons? Would 100 capita/acre be acceptable?

4) Do you have any numbers for parks? Will 100 person/5 acres and 15 gallons/day/capita be acceptable?

The above numbers are what we utilized for HHFDC's Kona project.

5) For the total area used to compute the wet weather

infiltration/inflow, can we deduct out the drainageways, archaeological preserves, natural preserves (if we cut out the area surrounding Wahikuli and Crater reservoirs), and any water and reclaimed water reservoir sites?

Alan Kato
Belt Collins Hawaii Ltd.

-----Original Message-----
From: Scott Rollins [mailto:Scott.Rollins@co.maui.hi.us]
Sent: Friday, January 18, 2008 11:02 AM
To: Alan Kato
Subject: Maui County Wastewater Flow Standards

Alan,

it was nice meeting you today. Attached are the flow Standards use by Maui County. Please contact us if you have any questions.

Scott

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Alan Kato

From: Steve Parabicoli [Steve.Parabicoli@co.maui.hi.us]
Sent: Thursday, April 03, 2008 7:21 AM
To: Alan Kato
Cc: Arnold Abe; Scott Rollins; Stanley.S.Fujimoto@hawaii.gov
Subject: Re: Villages of Leialii and Reclaimed Water

Alan,

Here are the answers to your questions:

1) Generally, daily R-1 water use is calcuated by multiplying the number of acres to be irrigated by 6,000 gallons per acre/day. However in the case of the Villages of Leiali, it is my understanding that the orginal agreement called for the Villages to use a volume of R-1 water that equalled the volume of sewage that was produced. In this case, the figure was 1.8 mgd.

2) No design has been conducted. The figure Scott sent you came from our West Maui Reclaimed Water Master Plan that was was prepared in 2004. I believe the siting was selected to minimize additional pumping requirements to higher elevations. Its possible that the Villages might have to boost the R-1 water to a higher elevation at their expense.

3) Again, pumping to higher elevations will greatly increase pumping costs. But as mentioned in #2 above, no design has been completed nor will it be in the near future as the County as placed a low priority on funding expansions to our R-1 water systems. Any expansions to the County's R-1 systems will have to be privately funded.

4) Thats right, nothing has been completed. Currenlty, developers are considering making some improvements to our system that will allow them to access the R-1 water. These proposed improvements will essentially allow us to pressurize our existing 16" line and our existing 20" line by connecting the two lines and by installing a storage tank off of the 20" line. Additional UV disinfection will also be required.

5) The items listed are what is required with the possible addtion of another UV disinfection channel The existing 16" line does not have adequate capacity to meet the projected R-1 water demand thus a parallel line would need to be installed. The plant pump station upgrade is dependent on if the developers listed in #4 above actually make the improvements to our system. If so, we will be using a different set of existing pumps that are capable of pumping to a higher elevation. An engineering analysis will be required to determine if these pumps are suitable to deliver R-1 water out to the Villages.

Please feel free to call me if you require additional information.

Steve Parabicoli
Water Recycling Program Coordinator
County of Maui
Department of Environmental Management
Wastewater Reclamation Division
One Main Plaza
2200 Main Street, Suite 610
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steve.parabicoli@co.maui.hi.us

>>> "Alan Kato" <akato@beltcollins.com> 4/2/2008 2:58 PM >>>
Steve:

Thank you for your response yesterday. After looking through my information, I had more questions:

1) Scott Rollins previously indicated that the Leialii project would use 1.8 mgd of R-1 water per day. Is there a criteria to determine how much R-1 water is used by a development? If so, can you advise what is
the criteria. We are looking at different development scenarios for
the site, so wanted to figure out how to determine how this impacts the
R-1 water useage.

2) The new reclaimed booster pump station - 1, adjacent to the Civic Center Site may not work with the proposed alignment of the reclaimed waterline adjacent to the sewer line from the Leialii project. The sewer line from the Leialii project is routed mauka of the Civic Center Site, tieing in near the Kaanapali Golf Course Reservoir location. Do you know the siting criteria for the reclaimed booster pump? Based on an elevation and/or length from the treatment plant? Or was it sited based on an open area at the Civic Center site.

3) The reclaimed water reservoir at the Villages of Leialii is shown at elevation 230. At this elevation service out to the Villages of Leialii would have to be by pump. Would it be better, or can the reservoir be sited at a higher elevation, so the tank can gravity feed R-1 water to the Villages of Leialii? Can it be set higher at elevations 300 or 730? (i.e. - are there service zones established?)

4) Your previous e-mail stated that no improvements have been made to the reclaimed water system. Does this mean that none of the Phase 1 work has been completed?

5) If no work has been undertaken for a reclaimed water system, can you advise what work would be required to get reclaimed water to the Villages of Leialii project site. Previously, Scott indicated the following work items were required:
* 12,000 feet of 16" line ($6M)
* Upgrade Plant Pump Station ($4.3M)
* New Booster Pump Station ($2.5M) near the Civic Center
* 2.0 MG Reservoir at Leialii ($3.2M)

If no work was previously done, does that mean there additional:
* Upgrades to the Plant Pump Station
* Additional _____ Linear footage required of the 16" reclaimed water line

I was planning on stopping into your office to get the as-built plans for the sewer line in Honoapiilani Highway from Arnold (Arnold - DSA didn't have the drawings.), when we had the preliminary development concepts for the Villages of Leialii further developed. However, DOT is reviewing realigning the Lahaina By-Pass Highway through the project, which is impacting the design of the preliminary concepts. Hopefully, we'll have some concepts developed for you, Scott and Arnold to review and comment on shortly.

<<20080118 Lahaina Reclaimed Water Email R1 master plan Ph3.pdf>>

Alan Kato
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MEETING SUMMARY

PROJECT:	BCH JOB NUMBER:
Villages of Leiali`i	2007.70.0500 / 08E-185
MEETING LOCATION:	DATE AND TIME:
County of Maui Wastewater Reclamation Division	April 21, 2008 9:00 – 10:00 am
SUBJECT:	ATTENDEES:
Project Data Gathering	Mr. Steve Parabicoli - WWRD Mr. Scott Rollins – WWRD Mr. Arnold Abe - WWRD Mr. Stanley Fujimoto – HHFDC Mr. Alan Kato - BCH

The meeting with Mr. Steve Parabicoli, Mr. Scott Rollins and Mr. Arnold Abe of the Wastewater Reclamation Division (WWRD) was held to obtain more information on the existing sewer and reclaimed water systems which can be used to service the HHFDC Leiali`i project.

- The expired agreement for the upgrades to the Lahaina Wastewater Reclamation Facility (WWRF) between WWRD and HHFDC required the Leiali`i project to take back 1.8 million gallons per day (MGD) of reclaimed water. However, since the agreement has expired, this may not be applicable. The project should consider taking back the amount of wastewater it generates in R-1 water.

- The WWRF treats a maximum of 2.0 MGD of wastewater to R-1. The limitation on R-1 production is because the plant only has one UV channel. Currently up to 1.8 MGD is utilized. There is approximately 200,000 gallons per day excess R-1 that is being produced by the WWRF. The WWRF treats an average of about 1.2 MGD of wastewater to R-1.

- Currently the WWRF has one UV channel for disinfection of wastewater to R-1 water. The WWRF has room for three UV channels. A group of developers are considering paying for upgrades for a second UV channel to generate more R-1 water for use.

- There are two pump systems, which pump R-1 water from the WWRF. A low pressure system pumps to the Kaanapali Golf Course Reservoir. A high pressure system pumps to the mauka 300' elevation reclaimed reservoir. WWRD is considering combining both systems into a single pump system at the WWRF, which can service the 300' elevation reservoir. The connection of the two systems will be funded by area developers.

- The $4.3 million upgrade to the plant pump station may not be required if the two reclaimed water systems are combined.

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- The 230' elevation reclaimed reservoir shown in the Master Plan is not existing, however, there are some reclaimed water irrigation lines in the area.

- WWRD takes no exception to aligning the reclaimed water line with the offsite sewer system, which traverses from mauka of the Lahaina Civic Center to the Kaanapali Golf Course Reservoir reclaimed water line and to Honoapiilani Highway.

- WWRD takes no exception to placing the tank at a higher elevation, such as 300'. However, a new booster pump ($2.5 million) may still be required. Engineering analysis of the final configuration will need to be completed to insure compatibility with the balance of the system.

- WWRD does not have any set standards for reclaimed water tanks, however, preference is above grade tank, either stainless steel or concrete. If 2.0 MG of storage is required, the preference is to have two 1.0 MG tanks constructed. Having two tanks allows one to be taken out for servicing. WWRD is not sure what type of tank was included in the $3.2 million cost in the Master Plan.

- WWRD provided HHFDC with a copy of the "Agreement for HFDC's Participation in County of Maui's Lahaina-Kaanapali Gravity Sewer Replacement Project".

- The Lahaina-Kaanapali Gravity Sewer Replacement Phase 2A and Kaanapali Effluent Reuse Line Phase 3 have been constructed and portion of the plans were provided to BCH on CD.

- WWRD suggested that the project consider an on-site treatment plant to treat the sewer to R-1 water and reuse it on site. The County may consider accepting on-site treatment plants, if several individual on-site treatment plants are turned over. Other area developments are considering on-site treatment plants. (Honuaula in Wailea was conditioned to build its own package plant for 1,400 units, Peleluhua in Lahaina will probably be required to do the same. The County's position is to have most larger projects build their own facilities as it would be more cost effective.)

- An on-site treatment plant requires approximately 5 to 10 acres of land.

- An on-site treatment plant requires storage capacity and/or an injection well, located below the UIC line, as a backup for disposal when inflow is greater than reuse demand or water quality is not suitable for reuse. The Department of Health would determine the requirements.

- An on-site treatment plant may require public utilities commission (PUC) approval.

- WWRD provided BCH a CD of the West Maui Reclaimed Water Master Plan.

- The existing 16" reclaimed water line in Honoapiilani Highway may not have the capacity to serve the Villages of Leiali`i with R-1 water. Existing and near future use may exceed the capacity of the 16" line. A dual 16" line may be required to service the area, as called for in the West Maui Reclaimed Water Master Plan.

- HHFDC has paid for a share of the existing 16" reclaimed water line construction. WWRD will look at how the second 16" reclaimed water line should get funded.

Carolyn Ancheta

From: Steve Parabicoli [Steve.Parabicoli@co.maui.hi.us]
Sent: Friday, June 12, 2009 1:29 PM
To: Carolyn Ancheta
Subject: Re: Villages of Leialii - Reclaimed Water

Hi Carolyn,

Here are the answers:

1) We will be receiving the first phase of funding from one of the developers this coming fiscal year. These funds will be used to upgrade and add more UV disinfection as well as to design an elevated R-1 water storage tank w/associated infrastructure improvements. It will take about 2 years to design and construct the UV. The next phase will be funded by more developers however due to the economy, their projects are on hold so we don't know exactly when we receive their contributions. Once received, we intend to construct the R-1 storage tank.

2) The West Maui Master Plan correctly lists the requirements you mention. A tank will still be needed by the Villages along with the booster station and of course all the pipe lines. The system that is being developed now will only allow properties in the near vicinity to the Lahaina WWRF to utilize the R-1 water. FYI, we have no plans at this time to fund these improvements. We have suggested to your company that it would be better for the project to construct its own wastewater plant and reuse the recycled water.

3) No. Those plans are not going to happen.

Please contact me if you have any questions.

Steve Parabicoli
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County of Maui
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>>> "Carolyn Ancheta" <cancheta@beltcollins.com> 6/12/2009 10:10 AM >>>
Steve,

I am working with Alan Kato on the proposed Villages of Leialii affordable housing project.

According to the 2004 West Maui Reclaimed Water Master Plan, Phase 3 improvements -- upgrade to WWRF pump station, new booster pump station (near Civic Center), 2.0 MG reservoir at Leialii, and 12,000-feet of 16" water line -- would be required to serve the Villages of Leialii site. However, in April 2008 you indicated no improvements had been made to the system, and developers were considering making other improvements to the system that would affect the Phase 3 improvements (please see attached email, #4-5).

I have a few follow-up questions:

1) What is the status of the improvements that were to be funded by the developers?

2) What improvements need to be completed to serve the Villages of

Leialii site? If the developers are connecting the 16" and 20" lines and adding UV disinfection, are just the new booster pump station (located mauka of the Civic Center) and ~16,000-feet of 16" water line (7,000-feet parallel to existing segment in Honoapiilani Highway and 9,000-feet from Honoapiilani Highway through Cane Haul Road to Leialii site) required to get reclaimed water to the Leialii site? Preliminary calculations indicate that the reclaimed water reservoir for the lower service pressure zone of the Villages of Leialii site will have overflow elevation of ~360'. We are considering using a breaker tank and pump to get the reclaimed water from the maximum elevation that the Lahaina WWRF can serve (230' based on the master plan, but possibly higher with improved pump system funded by developers?) to the lowest reclaimed water reservoir on-site.

3) We had noted previously that the WRD is considering pumping from the Lahaina No. 3 WWPS to the gravity sewer line at the Villages of Leiali`i site to the Lahaina WWRF. If the sewer line is routed through the Department of Hawaiian Home Lands' (DHHL) 1B community, you indicated that homes mauka of the sewer line may have to connect to this sewer line due to insufficient capacity in the sewer system makai of the 1B community. Is this still under consideration?

Thank you,

Carolyn Ancheta, PE | Civil Engineer
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M E M O R A N D U M

TO:	FROM:
File	Carolyn Ancheta
COMPANY:	DATE: September 17, 2009 9:45 am
SUBJECT: Villages of Leiali'i	JOB NUMBER/REFERENCE NUMBER: 2007.70.0500

RE: PHONE CONVERSATION

BCH (Carolyn Ancheta) contacted Mr. Scott Rollins, County of Maui Wastewater Reclamation Division (Phone: 270-7417) regarding on-site wastewater treatment plants (WWTP) for Leiali'i.

Mr. Rollins provided the following information:

- In order for the County to accept an on-site WWTP, it would need to be discussed with the Director.
- Typically, smaller WWTPs are contracted with the homeowner's association to be privately owned and maintained.
- Currently, the County would not accept an on-site WWTP. Smaller WWTPs utilize different technology than the County's plant, so they do not have the expertise to operate on-site WWTPs.
- Mr. Rollins is 90% sure that the County would not accept an on-site WWTP. Perhaps in the future if County technology changes, they might consider it. However, a lot of discussion and coordination would be required.

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PROJECT: Villages of Leialii
JOB NO: 2007700500
CLIENT: HHFDC
DATE: 22-Sep-09
SUBJECT: Estimate of Sewer Flows
BY: C. Ancheta
FILE: P:\Projects\Leialii_2007700500\Reports\Consultant Reports\Civil\Sewer Information\[Wastewater Flow Calculations.xls]West Sewer Area - Conc3

Summary of Sewer Flows

Description		Raw Average Flow (gpd)	Design Average Flow (gpd)	Design Peak Flow (gpd)
Concept One	Phase A	509,943	556,262	2,346,859
	Phase B	544,866	580,014	2,482,638
	Total	**1,054,809**	**1,136,276**	**4,292,592**
Concept Two	Phase A	737,308	793,030	2,986,519
	Phase B	544,866	580,014	2,482,638
	Total	**1,282,174**	**1,373,044**	**4,862,060**
Concept Three	Phase A	819,004	881,860	3,156,881
	Phase B	476,392	506,093	2,172,018
	Total	**1,295,396**	**1,387,953**	**4,748,386**

Hawaii Housing Finance and Development Corporation — August 18, 2009
Villages of Leialii — Prepared by: Belt Collins Hawaii Ltd.

Sewer Flows - Leialii - Phase A, Concept One

Single Family Residential =	4	persons/unit	350	gallons/unit
Multi-family Residential =	2.5	persons/unit	255	gallons/unit
Commercial/Office =	200	SF/capita	20	gallons/capita
Industrial =	500	SF/capita	25	gallons/capita
Schools (Elementary) =	550	students	15	gallons/student
Parks =	20	persons/acre	10	gallons/capita

Development	Units	capita/unit	capita	sewer flow (gallons/day)	average flow (gallons)
Single Family	613	4	2,452	350	214,550
Multi-Family	788	2.5	1,970	255	200,940
Commercial/Office	551,000	200	2,755	20	55,100
Industrial	524,500	500	1,049	25	26,225
Schools	1	550	550	15	8,250
Parks	24.39	20	488	10	4,878
Total			9,264		509,943

Total Area:	339.16	acres	
Average Wastewater Flow:	509,943	gallons/day	A
Flow Factor:	3.68	(Babbit)	B
Maximum Wastewater Flow:	1,876,590	gallons/day	C = A x B
Dry Weather Infiltration/Inflow:	46,319	gallons/day	D = 5 gpcd x capita
Design Average Flow:	556,262	gallons/day	E = A + D
Design Maximum Flow:	1,922,909	gallons/day	F = C + D
Wet Weather Infiltration/Inflow:	423,950	gallons/day	G = 1250 gad x acres
Design Peak Flow:	2,346,859	gallons/day	H = F + G

Hawaii Housing Finance and Development Corporation — August 18, 2009
Villages of Leialii — Prepared by: Belt Collins Hawaii Ltd.

Sewer Flows - Leialii - Phase A, Concept Two

Single Family Residential =	4	persons/unit	350	gallons/unit
Multi-family Residential =	2.5	persons/unit	255	gallons/unit
Commercial/Office =	200	SF/capita	20	gallons/capita
Industrial =	500	SF/capita	25	gallons/capita
Schools (Elementary) =	550	students	15	gallons/student
Parks =	20	persons/acre	10	gallons/capita

Development	Units	capita/unit	capita	sewer flow (gallons/day)	average flow (gallons)
Single Family	0	4	0	350	0
Multi-Family	2,521	2.5	6,303	255	642,855
Commercial/Office	551,000	200	2,755	20	55,100
Industrial	524,500	500	1,049	25	26,225
Schools	1	550	550	15	8,250
Parks	24.39	20	488	10	4,878
Total			11,144		737,308

Total Area:	339.16	acres	
Average Wastewater Flow:	737,308	gallons/day	A
Flow Factor:	3.40	(Babbit)	B
Maximum Wastewater Flow:	2,506,847	gallons/day	C = A x B
Dry Weather Infiltration/Inflow:	55,722	gallons/day	D = 5 gpcd x capita
Design Average Flow:	793,030	gallons/day	E = A + D
Design Maximum Flow:	2,562,569	gallons/day	F = C + D
Wet Weather Infiltration/Inflow:	423,950	gallons/day	G = 1250 gad x acres
Design Peak Flow:	2,986,519	gallons/day	H = F + G

Hawaii Housing Finance and Development Corporation — August 18, 2009
Villages of Leialii — Prepared by: Belt Collins Hawaii Ltd.

Sewer Flows - Leialii - Phase B

Single Family Residential =	4	persons/unit	350	gallons/unit
Multi-family Residential =	2.5	persons/unit	255	gallons/unit
Commercial/Office =	200	SF/capita	20	gallons/capita
Industrial =	500	SF/capita	25	gallons/capita
Schools (Elementary) =	550	students	15	gallons/student
Parks =	20	persons/acre	10	gallons/capita

Development	Units	capita/unit	capita	sewer flow (gallons/day)	average flow (gallons)
Single Family	1,522	4	6,088	350	532,700
Multi-Family	0	2.5	0	255	0
Commercial/Office	0	200	0	20	0
Industrial	0	500	0	25	0
Schools	1	550	550	15	8,250
Parks	19.58	20	392	10	3,916
Total			7,030		544,866

Total Area:	380.06	acres	
Average Wastewater Flow:	544,866	gallons/day	A
Flow Factor:	3.62	(Babbit)	B
Maximum Wastewater Flow:	1,972,415	gallons/day	C = A x B
Dry Weather Infiltration/Inflow:	35,148	gallons/day	D = 5 gpcd x capita
Design Average Flow:	580,014	gallons/day	E = A + D
Design Maximum Flow:	2,007,563	gallons/day	F = C + D
Wet Weather Infiltration/Inflow:	475,075	gallons/day	G = 1250 gad x acres
Design Peak Flow:	2,482,638	gallons/day	H = F + G

Hawaii Housing Finance and Development Corporation — August 18, 2009
Villages of Leialii — Prepared by: Belt Collins Hawaii Ltd.

Sewer Flows - Leialii - Total (Concept One)

Single Family Residential =	4	persons/unit	350	gallons/unit
Multi-family Residential =	2.5	persons/unit	255	gallons/unit
Commercial/Office =	200	SF/capita	20	gallons/capita
Industrial =	500	SF/capita	25	gallons/capita
Schools (Elementary) =	550	students	15	gallons/student
Parks =	20	persons/acre	10	gallons/capita

Development	Units	capita/unit	capita	sewer flow (gallons/day)	average flow (gallons)
Single Family	2,135	4	8,540	350	747,250
Multi-Family	788	2.5	1,970	255	200,940
Commercial/Office	551,000	200	2,755	20	55,100
Industrial	524,500	500	1,049	25	26,225
Schools	2	550	1,100	15	16,500
Parks	43.97	20	879	10	8,794
Total			16,293		1,054,809

Total Area:	719.22	acres	
Average Wastewater Flow:	1,054,809	gallons/day	A
Flow Factor:	3.14	(Babbit)	B
Maximum Wastewater Flow:	3,312,100	gallons/day	C = A x B
Dry Weather Infiltration/Inflow:	81,467	gallons/day	D = 5 gpcd x capita
Design Average Flow:	1,136,276	gallons/day	E = A + D
Design Maximum Flow:	3,393,567	gallons/day	F = C + D
Wet Weather Infiltration/Inflow:	899,025	gallons/day	G = 1250 gad x acres
Design Peak Flow:	4,292,592	gallons/day	H = F + G

Hawaii Housing Finance and Development Corporation — August 18, 2009
Villages of Leialii — Prepared by: Belt Collins Hawaii Ltd.

Sewer Flows - Leialii - Total (Concept Two)

Single Family Residential =	4	persons/unit	350	gallons/unit
Multi-family Residential =	2.5	persons/unit	255	gallons/unit
Commercial/Office =	200	SF/capita	20	gallons/capita
Industrial =	500	SF/capita	25	gallons/capita
Schools (Elementary) =	550	students	15	gallons/student
Parks =	20	persons/acre	10	gallons/capita

Development	Units	capita/unit	capita	sewer flow (gallons/day)	average flow (gallons)
Single Family	1,522	4	6,088	350	532,700
Multi-Family	2,521	2.5	6,303	255	642,855
Commercial/Office	551,000	200	2,755	20	55,100
Industrial	524,500	500	1,049	25	26,225
Schools	2	550	1,100	15	16,500
Parks	43.97	20	879	10	8,794
Total			18,174		1,282,174

Total Area:	719.22	acres	
Average Wastewater Flow:	1,282,174	gallons/day	A
Flow Factor:	3.02	(Babbit)	B
Maximum Wastewater Flow:	3,872,165	gallons/day	C = A x B
Dry Weather Infiltration/Inflow:	90,870	gallons/day	D = 5 gpcd x capita
Design Average Flow:	1,373,044	gallons/day	E = A + D
Design Maximum Flow:	3,963,035	gallons/day	F = C + D
Wet Weather Infiltration/Inflow:	899,025	gallons/day	G = 1250 gad x acres
Design Peak Flow:	4,862,060	gallons/day	H = F + G

Hawaii Housing Finance and Development Corporation September 9, 2009
Villages of Leialii Prepared by: Belt Collins Hawaii Ltd.

Sewer Flows - Leialii - Phase A, Concept Three

Single Family Residential =	4	persons/unit	350	gallons/unit
Multi-family Residential =	2.5	persons/unit	255	gallons/unit
Commercial/Office =	200	SF/capita	20	gallons/capita
Industrial =	500	SF/capita	25	gallons/capita
Schools (Elementary) =	550	students	15	gallons/student
Parks =	20	persons/acre	10	gallons/capita

Development	Units	capita/unit	capita	sewer flow (gallons/day)	average flow (gallons)
Single Family	532	4	2,128	350	186,200
Multi-Family	2,069	2.5	5,173	255	527,595
Commercial/Office	596,000	200	2,980	20	59,600
Industrial	665,100	500	1,330	25	33,255
Schools	1	550	550	15	8,250
Parks	20.52	20	410	10	4,104
Total			12,571		819,004

Total Area:	313.05	acres	
Average Wastewater Flow:	819,004	gallons/day	A
Flow Factor:	3.30	(Babbit)	B
Maximum Wastewater Flow:	2,702,713	gallons/day	C = A x B
Dry Weather Infiltration/Inflow:	62,856	gallons/day	D = 5 gpcd x capita
Design Average Flow:	881,860	gallons/day	E = A + D
Design Maximum Flow:	2,765,569	gallons/day	F = C + D
Wet Weather Infiltration/Inflow:	391,313	gallons/day	G = 1250 gad x acres
Design Peak Flow:	3,156,881	gallons/day	H = F + G

Hawaii Housing Finance and Development Corporation September 9, 2009
Villages of Leialii Prepared by: Belt Collins Hawaii Ltd.

Sewer Flows - Leialii - Phase B, Concept Three

Single Family Residential =	4	persons/unit	350	gallons/unit
Multi-family Residential =	2.5	persons/unit	255	gallons/unit
Commercial/Office =	200	SF/capita	20	gallons/capita
Industrial =	500	SF/capita	25	gallons/capita
Schools (Elementary) =	550	students	15	gallons/student
Parks =	20	persons/acre	10	gallons/capita

Development	Units	capita/unit	capita	sewer flow (gallons/day)	average flow (gallons)
Single Family	854	4	3,416	350	298,900
Multi-Family	650	2.5	1,625	255	165,750
Commercial/Office	0	200	0	20	0
Industrial	0	500	0	25	0
Schools	1	550	550	15	8,250
Parks	17.46	20	349	10	3,492
Total			5,940		476,392

Total Area:	292.30	acres	
Average Wastewater Flow:	476,392	gallons/day	A
Flow Factor:	3.73	(Babbit)	B
Maximum Wastewater Flow:	1,776,942	gallons/day	C = A x B
Dry Weather Infiltration/Inflow:	29,701	gallons/day	D = 5 gpcd x capita
Design Average Flow:	506,093	gallons/day	E = A + D
Design Maximum Flow:	1,806,643	gallons/day	F = C + D
Wet Weather Infiltration/Inflow:	365,375	gallons/day	G = 1250 gad x acres
Design Peak Flow:	2,172,018	gallons/day	H = F + G

Hawaii Housing Finance and Development Corporation September 9, 2009
Villages of Leialii Prepared by: Belt Collins Hawaii Ltd.

Sewer Flows - Leialii - Total (Concept Three)

Single Family Residential =	4	persons/unit	350	gallons/unit
Multi-family Residential =	2.5	persons/unit	255	gallons/unit
Commercial/Office =	200	SF/capita	20	gallons/capita
Industrial =	500	SF/capita	25	gallons/capita
Schools (Elementary) =	550	students	15	gallons/student
Parks =	20	persons/acre	10	gallons/capita

Development	Units	capita/unit	capita	sewer flow (gallons/day)	average flow (gallons)
Single Family	1,386	4	5,544	350	485,100
Multi-Family	2,719	2.5	6,798	255	693,345
Commercial/Office	596,000	200	2,980	20	59,600
Industrial	665,100	500	1,330	25	33,255
Schools	2	550	1,100	15	16,500
Parks	37.98	20	760	10	7,596
Total			18,511		1,295,396

Total Area:	605.35	acres	
Average Wastewater Flow:	1,295,396	gallons/day	A
Flow Factor:	3.01	(Babbit)	B
Maximum Wastewater Flow:	3,899,142	gallons/day	C = A x B
Dry Weather Infiltration/Inflow:	92,557	gallons/day	D = 5 gpcd x capita
Design Average Flow:	1,387,953	gallons/day	E = A + D
Design Maximum Flow:	3,991,698	gallons/day	F = C + D
Wet Weather Infiltration/Inflow:	756,688	gallons/day	G = 1250 gad x acres
Design Peak Flow:	4,748,386	gallons/day	H = F + G

Hawaii Housing Finance and Development Corporation August 18, 2009
Villages of Leialii Prepared by: Belt Collins Hawaii Ltd.

Sewer Flows - Leialii - West Sewer Area, Concept One

Single Family Residential =	4	persons/unit	350	gallons/unit
Multi-family Residential =	2.5	persons/unit	255	gallons/unit
Commercial/Office =	200	SF/capita	20	gallons/capita
Industrial =	500	SF/capita	25	gallons/capita
Schools (Elementary) =	550	students	15	gallons/student
Parks =	20	persons/acre	10	gallons/capita

Development	Units	capita/unit	capita	sewer flow (gallons/day)	average flow (gallons)
Single Family	64	4	256	350	22,400
Multi-Family	0	2.5	0	255	0
Commercial/Office	0	200	0	20	0
Industrial	0	500	0	25	0
Schools	0	550	0	15	0
Parks	0.00	20	0	10	0
Total			256		22,400

Total Area:	13.57	acres	
Average Wastewater Flow:	22,400	gallons/day	A
Flow Factor:	5.00	(Babbit)	B
Maximum Wastewater Flow:	112,000	gallons/day	C = A x B
Dry Weather Infiltration/Inflow:	1,280	gallons/day	D = 5 gpcd x capita
Design Average Flow:	23,680	gallons/day	E = A + D
Design Maximum Flow:	113,280	gallons/day	F = C + D
Wet Weather Infiltration/Inflow:	16,958	gallons/day	G = 1250 gad x acres
Design Peak Flow:	130,238	gallons/day	H = F + G

Hawaii Housing Finance and Development Corporation August 18, 2009
Villages of Leialii Prepared by: Belt Collins Hawaii Ltd.

Sewer Flows - Leialii - West Sewer Area, Concept Two

Single Family Residential =	4	persons/unit	350	gallons/unit
Multi-family Residential =	2.5	persons/unit	255	gallons/unit
Commercial/Office =	200	SF/capita	20	gallons/capita
Industrial =	500	SF/capita	25	gallons/capita
Schools (Elementary) =	550	students	15	gallons/student
Parks =	20	persons/acre	10	gallons/capita

Development	Units	capita/unit	capita	sewer flow (gallons/day)	average flow (gallons)
Single Family	0	4	0	350	0
Multi-Family	150	2.5	375	255	38,250
Commercial/Office	0	200	0	20	0
Industrial	0	500	0	25	0
Schools	0	550	0	15	0
Parks	0.00	20	0	10	0
Total			375		38,250

Total Area:	13.57	acres	
Average Wastewater Flow:	38,250	gallons/day	A
Flow Factor:	5.00	(Babbit)	B
Maximum Wastewater Flow:	191,250	gallons/day	C = A x B
Dry Weather Infiltration/Inflow:	1,875	gallons/day	D = 5 gpcd x capita
Design Average Flow:	40,125	gallons/day	E = A + D
Design Maximum Flow:	193,125	gallons/day	F = C + D
Wet Weather Infiltration/Inflow:	16,958	gallons/day	G = 1250 gad x acres
Design Peak Flow:	210,083	gallons/day	H = F + G

Hawaii Housing Finance and Development Corporation August 18, 2009
Villages of Leialii Prepared by: Belt Collins Hawaii Ltd.

Sewer Flows - Leialii - West Sewer Area, Concept Three

Single Family Residential =	4	persons/unit	350	gallons/unit
Multi-family Residential =	2.5	persons/unit	255	gallons/unit
Commercial/Office =	200	SF/capita	20	gallons/capita
Industrial =	500	SF/capita	25	gallons/capita
Schools (Elementary) =	550	students	15	gallons/student
Parks =	20	persons/acre	10	gallons/capita

Development	Units	capita/unit	capita	sewer flow (gallons/day)	average flow (gallons)
Single Family	96	4	384	350	33,600
Multi-Family	0	2.5	0	255	0
Commercial/Office	0	200	0	20	0
Industrial	0	500	0	25	0
Schools	0	550	0	15	0
Parks	0.00	20	0	10	0
Total			384		33,600

Total Area:	13.33	acres	
Average Wastewater Flow:	33,600	gallons/day	A
Flow Factor:	5.00	(Babbit)	B
Maximum Wastewater Flow:	168,000	gallons/day	C = A x B
Dry Weather Infiltration/Inflow:	1,920	gallons/day	D = 5 gpcd x capita
Design Average Flow:	35,520	gallons/day	E = A + D
Design Maximum Flow:	169,920	gallons/day	F = C + D
Wet Weather Infiltration/Inflow:	16,661	gallons/day	G = 1250 gad x acres
Design Peak Flow:	186,581	gallons/day	H = F + G

COMPUTATION OF WASTEWATER FLOW

TRIBUTARY AREA	SMH	TRIBUTARY AREA (ACRE) INC.	TRIBUTARY AREA (ACRE) TOTAL	POPULATION INC.	POPULATION TOTAL	WASTEWATER FLOW COMPUTATIONS: AVE DAY (gpcd)	INC. AVE. FLOW (MGD)	AVE. WWATER (MGD)	MAX FLOW FACT.	MAX FLOW (MGD)	DRY WEAT INF/INFL (MGD)	DESIGN AVE. FLOW (MGD)	DESIGN MAX. FLOW (MGD)	WET WEAT INF/INF (MGD)	DESIGN PEAK FLOW (MGD)	PIPE DESIGN: PIPE DIA. (IN.)	N	LENGTH (LF)	SLOPE (FT/FT)	MAX CAP. (MGD)	FULL FLOW VEL. (FPS)	DESGN DEPTH (IN)	DESGN VEL. (FPS)	EXCESS CAP. (%)	REMARKS
OFF-SITE SEWER SYSTEM (Concept One)																									
Single Family		2,135		4	8,540	350	0.74725																		
Multi-Family		788		2.5	1,970	255	0.20094																		
Commercial/Office		551,000		200	2,755	20	0.0551																		
Industrial		524,500		500	1,049	25	0.026225																		
Schools		2		550	1,100	15	0.0165																		
Parks		43.97		20	879	10	0.008794																		
SUBTOTAL	SMH A-35	719.22	719.22		16,293		1.0548	1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	159	0.0032	5.400	3.23	14.9	3.63	20.5%	
	SMH A-34		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	321	0.0032	5.400	3.23	14.9	3.63	20.5%	
	SMH A-33		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	231	0.0032	5.400	3.23	14.9	3.63	20.5%	
	SMH A-32		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	340	0.0025	4.773	2.85	16.6	3.25	10.1%	Revise orig design slope from 0.0022 ft/ft
	SMH A-31		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	340	0.0025	4.773	2.85	16.6	3.25	10.1%	
	SMH A-30		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	350	0.0025	4.773	2.85	16.6	3.25	10.1%	
	SMH A-29		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	310	0.0025	4.773	2.85	16.6	3.25	10.1%	
	SMH A-28		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	328	0.0025	4.773	2.85	16.6	3.25	10.1%	
	SMH A-27		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	240	0.0041	6.113	3.66	13.6	4.02	29.8%	Revise orig design slope from 0.0046 ft/ft to make up elev diff from upstream segments
	SMH A-26		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	242	0.0046	6.475	3.87	13.1	4.21	33.7%	
	SMH A-25		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	300	0.0066	7.756	4.64	11.7	4.84	44.7%	
	SMH A-24		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	130	0.0033	5.484	3.28	14.8	3.68	21.7%	
	SMH A-23		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	330	0.0033	5.484	3.28	14.8	3.68	21.7%	
	SMH A-22		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	300	0.0033	5.484	3.28	14.8	3.68	21.7%	
	SMH A-21		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	350	0.0033	5.484	3.28	14.8	3.68	21.7%	
	SMH A-20		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	265	0.0033	5.484	3.28	14.8	3.68	21.7%	
	SMH A-19		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	280	0.0053	6.950	4.16	12.5	4.45	38.2%	
	SMH A-18		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	350	0.0053	6.950	4.16	12.5	4.45	38.2%	
	SMH A-17		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	350	0.0053	6.950	4.16	12.5	4.45	38.2%	
	SMH A-16		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	300	0.0051	6.818	4.08	12.7	4.38	37.0%	
	SMH A-15		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	235	0.0032	5.400	3.23	14.9	3.63	20.5%	
	SMH A-14		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	300	0.0050	6.751	4.04	12.7	4.35	36.4%	
	SMH A-13		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	300	0.0055	7.080	4.23	12.4	4.51	39.4%	
	SMH A-12		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	340	0.0060	7.395	4.42	12.0	4.67	42.0%	
	SMH A-11		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	285	0.0096	9.354	5.59	10.4	5.58	54.1%	
	SMH A-10		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	175	0.0114	10.193	6.10	9.9	5.95	57.9%	

COMPUTATION OF WASTEWATER FLOW

TRIBUTARY AREA	SMH	TRIBUTARY AREA (ACRE) INC.	TRIBUTARY AREA (ACRE) TOTAL	POPULATION INC.	POPULATION TOTAL	WASTEWATER FLOW COMPUTATIONS: AVE DAY (gpcd)	INC. AVE. FLOW (MGD)	AVE. WWATER (MGD)	MAX FLOW FACT.	MAX FLOW (MGD)	DRY WEAT INF/INFL (MGD)	DESIGN AVE. FLOW (MGD)	DESIGN MAX. FLOW (MGD)	WET WEAT INF/INF (MGD)	DESIGN PEAK FLOW (MGD)	PIPE DESIGN: PIPE DIA. (IN.)	N	LENGTH (LF)	SLOPE (FT/FT)	MAX CAP. (MGD)	FULL FLOW VEL. (FPS)	DESGN DEPTH (IN)	DESGN VEL. (FPS)	EXCESS CAP. (%)	REMARKS
	SMH A-9		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	180	0.0050	6.751	4.04	12.7	4.35	36.4%	
	SMH A-8		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	21	0.015	95	0.0051	6.818	4.08	12.7	4.38	37.0%	
	SMH A-7		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	18	0.015	288	0.0093	6.103	4.97	11.7	5.46	29.7%	
	SMH A-6		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	18	0.015	212	0.0218	9.345	7.61	8.9	7.58	54.1%	
	SMH A-5		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	18	0.015	350	0.0182	8.538	6.95	9.4	7.09	49.7%	
	SMH A-4		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	18	0.015	350	0.0100	6.329	5.15	11.4	5.62	32.2%	
	SMH A-3		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	18	0.015	300	0.0154	7.854	6.39	9.9	6.65	45.3%	
	SMH A-2		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	18	0.015	217	0.0391	12.515	10.19	7.6	9.42	65.7%	
	SMH A-1		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	18	0.015	28.44	0.0352	11.874	9.67	7.8	9.06	63.8%	Shallow Drop
LAHAINA-KAANAPALI GRAVITY SEWER																									
	SMH 41-B		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	24	0.015	50	0.0120	14.931	6.84	9.2	6.03	71.3%	
	SMH 41		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	24	0.015	350	0.0083	12.418	5.69	10.1	5.27	65.4%	
	SMH 42		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	30	0.015	350	0.0054	18.160	5.32	10.3	4.44	76.4%	
	SMH 43		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	30	0.015	347	0.0057	18.658	5.47	10.2	4.53	77.0%	
	SMH 44		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	30	0.015	350	0.0080	22.104	6.48	9.3	5.12	80.6%	
	SMH 45		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	30	0.015	305.5	0.0057	18.658	5.47	10.2	4.53	77.0%	
	SMH 46		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	30	0.015	345.5	0.0080	22.104	6.48	9.3	5.12	80.6%	
	SMH 47		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	30	0.015	280.83	0.0031	13.760	4.03	12.0	3.63	68.8%	
	SMH 48		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	30	0.015	338	0.0042	16.016	4.69	11.0	4.06	73.2%	
	SMH 49		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	30	0.015	350	0.0182	33.340	9.77	7.5	6.87	87.1%	
	SMH 50		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	30	0.015	255	0.0199	34.862	10.22	7.4	7.09	87.7%	
	SMH 51		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	30	0.015	336	0.0172	32.411	9.50	7.7	6.73	86.8%	
	SMH 52		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	30	0.015	319	0.0038	15.234	4.46	11.3	3.91	71.8%	
	SMH 53		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	30	0.015	272	0.0035	14.620	4.28	11.6	3.80	70.6%	
	SMH 54		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	36	0.015	227	0.0014	15.036	3.06	13.7	2.69	71.5%	
	SMH 55		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	36	0.015	331.59	0.0017	16.569	3.37	13.0	2.89	74.1%	
	SMH 56		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	36	0.015	236.41	0.0012	13.921	2.83	14.3	2.54	69.2%	
	SMH 57		719.22		16,293			1.0548	3.14	3.3121	0.0815	1.1363	3.3936	0.8990	4.2926	36	0.015	69.71	0.0007	10.632	2.16	16.6	2.09	59.6%	
	SMH 58																								

COMPUTATION OF WASTEWATER FLOW

TRIBUTARY AREA	SMH	TRIBUTARY AREA (ACRE) INC.	TRIBUTARY AREA (ACRE) TOTAL	POPULATION INC.	POPULATION TOTAL	WASTEWATER FLOW COMPUTATIONS: AVE DAY (gpcd)	INC. AVE. FLOW (MGD)	AVE. WWATER (MGD)	MAX FLOW FACT.	MAX FLOW (MGD)	DRY WEAT INF/INFL (MGD)	DESIGN AVE. FLOW (MGD)	DESIGN MAX. FLOW (MGD)	WET WEAT INF/INF (MGD)	DESIGN PEAK FLOW (MGD)	PIPE DESIGN: PIPE DIA. (IN.)	N	LENGTH (LF)	SLOPE (FT/FT)	MAX CAP. (MGD)	FULL FLOW VEL. (FPS)	DESGN DEPTH (IN)	DESGN VEL. (FPS)	EXCESS CAP. (%)	REMARKS
OFF-SITE SEWER SYSTEM (Concept Two)																									
Single Family		1,522		4	6,088	350	0.5327																		
Multi-Family		2,521		2.5	6,303	255	0.642855																		
Commercial/Office		551,000		200	2,755	20	0.0551																		
Industrial		524,500		500	1,049	25	0.026225																		
Schools		2		550	1,100	15	0.0165																		
Parks		43.97		20	879	10	0.008794																		
SUBTOTAL	SMH A-35	719.22	719.22		18,174		1.2822	1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	159	0.0032	5.400	3.23	16.6	3.68	10.0%	
	SMH A-34		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	321	0.0032	5.400	3.23	16.6	3.68	10.0%	
	SMH A-33		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	231	0.0032	5.400	3.23	16.6	3.68	10.0%	
	SMH A-32		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	340	0.0032	5.400	3.23	16.6	3.68	10.0%	Revise orig design slope from 0.0022 ft/ft
	SMH A-31		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	340	0.0032	5.400	3.23	16.6	3.68	10.0%	Revise orig design slope from 0.0025 ft/ft
	SMH A-30		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	350	0.0032	5.400	3.23	16.6	3.68	10.0%	Revise orig design slope from 0.0025 ft/ft
	SMH A-29		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	310	0.0032	5.400	3.23	16.6	3.68	10.0%	Revise orig design slope from 0.0025 ft/ft
	SMH A-28		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	328	0.0032	5.400	3.23	16.6	3.68	10.0%	Revise orig design slope from 0.0025 ft/ft
	SMH A-27		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	240	0.0032	5.400	3.23	16.6	3.68	10.0%	Revise orig design slope from 0.0046 ft/ft to make up elev diff from upstream segments
	SMH A-26		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	242	0.0032	5.400	3.23	16.6	3.68	10.0%	Revise orig design slope from 0.0046 ft/ft to make up elev diff from upstream segments
	SMH A-25		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	300	0.0046	6.475	3.87	14.3	4.31	24.9%	Revise orig design slope from 0.0066 ft/ft to make up elev diff from upstream segments
	SMH A-24		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	130	0.0033	5.484	3.28	16.4	3.73	11.3%	
	SMH A-23		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	330	0.0033	5.484	3.28	16.4	3.73	11.3%	
	SMH A-22		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	300	0.0033	5.484	3.28	16.4	3.73	11.3%	
	SMH A-21		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	350	0.0033	5.484	3.28	16.4	3.73	11.3%	
	SMH A-20		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	265	0.0033	5.484	3.28	16.4	3.73	11.3%	
	SMH A-19		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	280	0.0053	6.950	4.16	13.6	4.56	30.0%	
	SMH A-18		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	350	0.0053	6.950	4.16	13.6	4.56	30.0%	
	SMH A-17		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	350	0.0053	6.950	4.16	13.6	4.56	30.0%	
	SMH A-16		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	300	0.0051	6.818	4.08	13.8	4.49	28.7%	
	SMH A-15		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	235	0.0032	5.400	3.23	16.6	3.68	10.0%	
	SMH A-14		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	300	0.0050	6.751	4.04	13.9	4.46	28.0%	
	SMH A-13		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	300	0.0055	7.080	4.23	13.4	4.63	31.3%	
	SMH A-12		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	340	0.0060	7.395	4.42	13.0	4.80	34.3%	
	SMH A-11		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	285	0.0096	9.354	5.59	11.2	5.75	48.0%	

COMPUTATION OF WASTEWATER FLOW

TRIBUTARY AREA	SMH	TRIBUTARY AREA (ACRE) INC.	TRIBUTARY AREA (ACRE) TOTAL	POPULATION INC.	POPULATION TOTAL	WASTEWATER FLOW COMPUTATIONS: AVE DAY (gpcd)	INC. AVE. FLOW (MGD)	AVE. WWATER (MGD)	MAX FLOW FACT.	MAX FLOW (MGD)	DRY WEAT INF/INFL (MGD)	DESIGN AVE. FLOW (MGD)	DESIGN MAX. FLOW (MGD)	WET WEAT INF/INF (MGD)	DESIGN PEAK FLOW (MGD)	PIPE DESIGN: PIPE DIA. (IN.)	N	LENGTH (LF)	SLOPE (FT/FT)	MAX CAP. (MGD)	FULL FLOW VEL. (FPS)	DESGN DEPTH (IN)	DESGN VEL. (FPS)	EXCESS CAP. (%)	REMARKS
	SMH A-10		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	175	0.0114	10.193	6.10	10.7	6.14	52.3%	
	SMH A-9		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	180	0.0050	6.751	4.04	13.9	4.46	28.0%	
	SMH A-8		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	21	0.015	95	0.0051	6.818	4.08	13.8	4.49	28.7%	
	SMH A-7		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	18	0.015	288	0.0093	6.103	4.97	12.8	5.58	20.3%	
	SMH A-6		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	18	0.015	212	0.0218	9.345	7.61	9.6	7.82	48.0%	
	SMH A-5		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	18	0.015	350	0.0182	8.538	6.95	10.2	7.30	43.1%	
	SMH A-4		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	18	0.015	350	0.0100	6.329	5.15	12.5	5.76	23.2%	
	SMH A-3		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	18	0.015	300	0.0154	7.854	6.39	10.7	6.84	38.1%	
	SMH A-2		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	18	0.015	217	0.0391	12.515	10.19	8.1	9.73	61.1%	
	SMH A-1		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	18	0.015	28.44	0.0352	11.874	9.67	8.4	9.36	59.1%	Shallow Drop
LAHAINA-KAANAPALI GRAVITY SEWER																									
	SMH 41-B		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	24	0.015	50	0.0120	14.931	6.84	9.8	6.23	67.4%	
	SMH 41		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	24	0.015	350	0.0083	12.418	5.69	10.9	5.44	60.8%	
	SMH 42		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	30	0.015	350	0.0054	18.160	5.32	11.0	4.60	73.2%	
	SMH 43		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	30	0.015	347	0.0057	18.658	5.47	10.9	4.69	73.9%	
	SMH 44		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	30	0.015	350	0.0080	22.104	6.48	9.9	5.30	78.0%	
	SMH 45		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	30	0.015	305.5	0.0057	18.658	5.47	10.9	4.69	73.9%	
	SMH 46		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	30	0.015	345.5	0.0080	22.104	6.48	9.9	5.30	78.0%	
	SMH 47		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	30	0.015	280.83	0.0031	13.760	4.03	12.8	3.76	64.7%	
	SMH 48		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	30	0.015	338	0.0042	16.016	4.69	11.8	4.20	69.6%	
	SMH 49		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	30	0.015	350	0.0182	33.340	9.77	8.0	7.12	85.4%	
	SMH 50		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	30	0.015	255	0.0199	34.862	10.22	7.9	7.35	86.1%	
	SMH 51		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	30	0.015	336	0.0172	32.411	9.50	8.1	6.98	85.0%	
	SMH 52		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	30	0.015	319	0.0038	15.234	4.46	12.1	4.05	68.1%	
	SMH 53		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	30	0.015	272	0.0035	14.620	4.28	12.4	3.93	66.7%	
	SMH 54		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	36	0.015	227	0.0014	15.036	3.06	14.7	2.78	67.7%	
	SMH 55		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	36	0.015	331.59	0.0017	16.569	3.37	13.9	2.99	70.7%	
	SMH 56		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	36	0.015	236.41	0.0012	13.921	2.83	15.3	2.63	65.1%	
	SMH 57		719.22		18,174			1.2822	3.02	3.8722	0.0909	1.3730	3.9630	0.8990	4.8621	36	0.015	69.71	0.0007	10.632	2.16	17.8	2.15	54.3%	
	SMH 58																								

COMPUTATION OF WASTEWATER FLOW

TRIBUTARY AREA	SMH	TRIBUTARY AREA (ACRE) INC.	TRIBUTARY AREA (ACRE) TOTAL	POPULATION INC.	POPULATION TOTAL	WASTEWATER FLOW COMPUTATIONS: AVE DAY (gpcd)	INC. AVE. FLOW (MGD)	AVE. WWATER (MGD)	MAX FLOW FACT.	MAX FLOW (MGD)	DRY WEAT INF/INFL (MGD)	DESIGN AVE. FLOW (MGD)	DESIGN MAX. FLOW (MGD)	WET WEAT INF/INF (MGD)	DESIGN PEAK FLOW (MGD)	PIPE DESIGN: PIPE DIA. (IN.)	N	LENGTH (LF)	SLOPE (FT/FT)	MAX CAP. (MGD)	FULL FLOW VEL. (FPS)	DESGN DEPTH (IN)	DESGN VEL. (FPS)	EXCESS CAP. (%)	REMARKS
OFF-SITE SEWER SYSTEM (Concept Three)																									
Single Family		1,386		4	5,544	350	0.4851																		
Multi-Family		2,719		2.5	6,798	255	0.693345																		
Commercial/Office		596,000		200	2,980	20	0.0596																		
Industrial		665,100		500	1,330	25	0.033255																		
Schools		2		550	1,100	15	0.0165																		
Parks		37.98		20	760	10	0.007596																		
SUBTOTAL	SMH A-35	605.35	605.35		18,511		1.2954	1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	159	0.0032	5.400	3.23	16.3	3.67	12.1%	
	SMH A-34		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	321	0.0032	5.400	3.23	16.3	3.67	12.1%	
	SMH A-33		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	231	0.0032	5.400	3.23	16.3	3.67	12.1%	
	SMH A-32		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	340	0.0032	5.400	3.23	16.3	3.67	12.1%	Revise orig design slope from 0.0022 ft/ft
	SMH A-31		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	340	0.0032	5.400	3.23	16.3	3.67	12.1%	Revise orig design slope from 0.0025 ft/ft
	SMH A-30		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	350	0.0032	5.400	3.23	16.3	3.67	12.1%	Revise orig design slope from 0.0025 ft/ft
	SMH A-29		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	310	0.0032	5.400	3.23	16.3	3.67	12.1%	Revise orig design slope from 0.0025 ft/ft
	SMH A-28		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	328	0.0032	5.400	3.23	16.3	3.67	12.1%	Revise orig design slope from 0.0025 ft/ft
	SMH A-27		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	240	0.0032	5.400	3.23	16.3	3.67	12.1%	Revise orig design slope from 0.0046 ft/ft to make up elev diff from upstream segments
	SMH A-26		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	242	0.0032	5.400	3.23	16.3	3.67	12.1%	Revise orig design slope from 0.0046 ft/ft to make up elev diff from upstream segments
	SMH A-25		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	300	0.0046	6.475	3.87	14.1	4.29	26.7%	Revise orig design slope from 0.0066 ft/ft to make up elev diff from upstream segments
	SMH A-24		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	130	0.0033	5.484	3.28	16.0	3.73	13.4%	
	SMH A-23		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	330	0.0033	5.484	3.28	16.0	3.73	13.4%	
	SMH A-22		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	300	0.0033	5.484	3.28	16.0	3.73	13.4%	
	SMH A-21		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	350	0.0033	5.484	3.28	16.0	3.73	13.4%	
	SMH A-20		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	265	0.0033	5.484	3.28	16.0	3.73	13.4%	
	SMH A-19		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	280	0.0053	6.950	4.16	13.4	4.54	31.7%	
	SMH A-18		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	350	0.0053	6.950	4.16	13.4	4.54	31.7%	
	SMH A-17		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	350	0.0053	6.950	4.16	13.4	4.54	31.7%	
	SMH A-16		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	300	0.0051	6.818	4.08	13.6	4.47	30.4%	
	SMH A-15		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	235	0.0032	5.400	3.23	16.3	3.67	12.1%	
	SMH A-14		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	300	0.0050	6.751	4.04	13.7	4.44	29.7%	
	SMH A-13		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	300	0.0055	7.080	4.23	13.2	4.61	32.9%	
	SMH A-12		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	340	0.0060	7.395	4.42	12.8	4.77	35.8%	
	SMH A-11		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	285	0.0096	9.354	5.59	11.1	5.72	49.2%	

COMPUTATION OF WASTEWATER FLOW

TRIBUTARY AREA	SMH	TRIBUTARY AREA (ACRE) INC.	TRIBUTARY AREA (ACRE) TOTAL	POPULATION INC.	POPULATION TOTAL	WASTEWATER FLOW COMPUTATIONS: AVE DAY (gpcd)	INC. AVE. FLOW (MGD)	AVE. WWATER (MGD)	MAX FLOW FACT.	MAX FLOW (MGD)	DRY WEAT INF/INFL (MGD)	DESIGN AVE. FLOW (MGD)	DESIGN MAX. FLOW (MGD)	WET WEAT INF/INF (MGD)	DESIGN PEAK FLOW (MGD)	PIPE DESIGN: PIPE DIA. (IN.)	N	LENGTH (LF)	SLOPE (FT/FT)	MAX CAP. (MGD)	FULL FLOW VEL. (FPS)	DESGN DEPTH (IN)	DESGN VEL. (FPS)	EXCESS CAP. (%)	REMARKS
	SMH A-10		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	175	0.0114	10.193	6.10	10.5	6.10	53.4%	
	SMH A-9		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	180	0.0050	6.751	4.04	13.7	4.44	29.7%	
	SMH A-8		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	21	0.015	95	0.0051	6.818	4.08	13.6	4.47	30.4%	
	SMH A-7		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	18	0.015	288	0.0093	6.103	4.97	12.6	5.56	22.2%	
	SMH A-6		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	18	0.015	212	0.0218	9.345	7.61	9.5	7.78	49.2%	
	SMH A-5		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	18	0.015	350	0.0182	8.538	6.95	10.0	7.26	44.4%	
	SMH A-4		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	18	0.015	350	0.0100	6.329	5.15	12.3	5.73	25.0%	
	SMH A-3		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	18	0.015	300	0.0154	7.854	6.39	10.6	6.81	39.5%	
	SMH A-2		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	18	0.015	217	0.0391	12.515	10.19	8.0	9.67	62.1%	
	SMH A-1		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	18	0.015	28.44	0.0352	11.874	9.67	8.2	9.30	60.0%	Shallow Drop
LAHAINA-KAANAPALI GRAVITY SEWER																									
	SMH 41-B		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	24	0.015	50	0.0120	14.931	6.84	9.7	6.19	68.2%	
	SMH 41		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	24	0.015	350	0.0083	12.418	5.69	10.7	5.41	61.8%	
	SMH 42		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	30	0.015	350	0.0054	18.160	5.32	10.9	4.57	73.9%	
	SMH 43		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	30	0.015	347	0.0057	18.658	5.47	10.7	4.66	74.6%	
	SMH 44		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	30	0.015	350	0.0080	22.104	6.48	9.8	5.27	78.5%	
	SMH 45		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	30	0.015	305.5	0.0057	18.658	5.47	10.7	4.66	74.6%	
	SMH 46		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	30	0.015	345.5	0.0080	22.104	6.48	9.8	5.27	78.5%	
	SMH 47		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	30	0.015	280.83	0.0031	13.760	4.03	12.7	3.73	65.5%	
	SMH 48		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	30	0.015	338	0.0042	16.016	4.69	11.6	4.17	70.4%	
	SMH 49		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	30	0.015	350	0.0182	33.340	9.77	7.9	7.07	85.8%	
	SMH 50		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	30	0.015	255	0.0199	34.862	10.22	7.8	7.30	86.4%	
	SMH 51		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	30	0.015	336	0.0172	32.411	9.50	8.1	6.93	85.3%	
	SMH 52		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	30	0.015	319	0.0038	15.234	4.46	12.0	4.02	68.8%	
	SMH 53		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	30	0.015	272	0.0035	14.620	4.28	12.2	3.90	67.5%	
	SMH 54		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	36	0.015	227	0.0014	15.036	3.06	14.5	2.77	68.4%	
	SMH 55		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	36	0.015	331.59	0.0017	16.569	3.37	13.7	2.97	71.3%	
	SMH 56		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	36	0.015	236.41	0.0012	13.921	2.83	15.1	2.61	65.9%	
	SMH 57		605.35		18,511			1.2954	3.01	3.8991	0.0926	1.3880	3.9917	0.7567	4.7484	36	0.015	69.71	0.0007	10.632	2.16	17.6	2.14	55.3%	
	SMH 58																								

APPENDIX B – RECLAIMED WATER CALCULATIONS

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PROJECT:	Villages of Leialii	JOB NO:	2007.70.0500
CLIENT:	HHFDC	DATE:	22-Sep-09
SUBJECT:	Estimate of Landscape Areas	BY:	C. Ancheta
FILE:	P:\Projects\Leialii_2007700500\Reports\Consultant Reports\Civil\Sewer Information\[Landscape Area (		

Estimate Landscape Areas for Reclaimed Water Irrigation based on Runoff Coefficient, C
Use Runoff Coefficient, C, from *Rules for the Design of Storm Drainage Facilities in the County of Maui*, Department of Public Works, dated July 1995.

Development Type	Runoff Coefficent, C	Calculated Percentage of Landscape Areas	Comparable Area
Business			
Downtown Areas	0.95	0%	
Neighborhood Areas	0.70	35%	23%
Residential			
Multi-units, Attached	0.75	28%	58%
Industrial			
Light areas	0.80	21%	7%
Heavy areas	0.90	7%	
Parks	0.25	97%	78%
Streets	0.95	0%	
Roofs	0.95	0%	
Lawns			
Sandy Soil, avg. 2-7%	0.15		
Sandy Soil, steep, 7%	0.20		
Heavy Soil, avg. 2-7%	0.22		
Heavy Soil, steep, 7%	0.35		
Average for Lawns	0.23		

Development Type Runoff Coefficient = (Hardstand Area x Runoff Coefficent) + (Lawn Area x Runoff Coefficient)

Example Calculations: Multi-Family Residential
0.75 = ([1-A] x 0.95) + (A x 0.23)
0.75 = 0.95 - 0.95A + 0.23A
A = 0.28 or 28% of the Multifamily Residential Area is in Landscape

Percentage of Landscape Areas of comparable developments.

Multi-Family:	Lailani in Kona (13.8 du/acre) = 63%	Honokowai Kauhale (17.8 du/acre) = 45%
	Project is 15 du/acres = 58% (extrapolated)	**<-- Use Comparable 58%**
School:	Kamalii Elementary School in Kihei = 58%	**<-- Use Comparable 58%**
Park:	Tavares Community Center and Park (w/o Comm Center) = 78%	**<-- Use Comparable 78%**
Industrial:	Lahaina Business Park = 7%	**<-- Use Comparable 7%**
Commercial:	Honokowai Marketplace = 23%	**<-- Use Comparable 23%**
Road:	Based on County Code Average with 5' paved sidewalk =	**9%**

Notes:
HHFDC Lailani in Kona is 200 units on 14.5 acres = 13.8 units/acre
HHFDC Honokowai Kauhale in Lahaina is 184 units on 10.329 acres = 17.8 units/acre
Kamalii Elementary School is 12.014 acres
Roads is based on County Code Average of Road Right-of-way - (Pavement Width + Curb + 2 x (5' walk))
No comparable type development for Mixed Use, use Commercial Comparable = **23%**

PROJECT:	Villages of Leialii	JOB NO:	2007700500
CLIENT:	HHFDC	DATE:	18-Mar-09
SUBJECT:	Landscape Water Requirements	BY:	A. Kato
FILE:	P:\Projects\Leialii_2007700500\Reports\Consultant Reports\Civil\Sewer Information\[Landscape		

TWA [gallons] = (Area [sf] x (ETL [in] / IE)) x CE x 0.6233 gal/sf/in (See Reference 1)

TWA = Total Water Applied [gallons]
Area = Irrigated Area [square feet]
ETL = Evapotranspiration Rate [inches]
IE = Irrigation Efficiency = 0.625 for Sprinkler
CE = Controller Efficiency =1.0

ETL = ETo x KL (See Reference 1)

ETL = Evapotranspiration Rate [inches]
ETo = Evapotranspiration Rate for Region
= 0.20 inches/day for Lahaina (See Reference 2)
KL = Landscape Coefficient Avg. Mixed Trees, Shrubs
= Ks x Kd x Kmc Groundcover & Turfgrass
Ks = Species Factor = 0.6
Kd = Density Factor = 1.05
Kmc = Microclimate Factor = 1.0
= 0.6 x 1.05 x 1.0
= 0.63

ETL = 0.20 inches x 0.63
= 0.126 inches

For 1 acre area, daily Total Water Applied

TWA = (43,560 sf x (0.126 / 0.625)) x 1.0 x 0.6233 gal/sf/in
= 5,473 gallons per acre
= **5,500 gallons per acre** 1.42 in/week

References:
1. LEED for New Construction Version 2.2, WE Credit 1, page 123
2. www.rainbird.com/ETManager

Table 1. Select the "low," "average," or "high" value for each parameter as appropriate for your design. Any variance from these recommended values should be explained in the credit narrative.

Calculate the Landscape Coefficient (K_L) by multiplying the three area characteristics as shown in **Equation 1**.

Determine the reference evapotranspiration rate (ET_0) for your region. The **evapotranspiration rate** is a measurement of the total amount of water needed to grow a certain reference plant (such as grass or alfalfa) expressed in millimeters or inches. The Resources section provides a link to ET data. The ET_0 for July is used in the LEED calculation because this is typically the month with the greatest evapotranspiration effects and, therefore, the greatest irrigation demands.

Calculate your project-specific evapotranspiration rate (ET_L) for each landscape area by multiplying the (ET_0) by your KL, as shown in **Equation 2**.

Determine your **Irrigation Efficiency** (IE) by listing the type of irrigation used for each landscape area and the corresponding efficiency. **Table 2** lists irrigation efficiencies for different irrigation systems.

Determine, if applicable, the Controller Efficiency (CE). CE is the percent reduction in water use from any weather-based controllers or moisture sensor-based systems. This number must be supported by either manufacturer documentation or detailed calculations by the landscape designer.

Determine, if applicable, the volume of reuse water (captured rainwater, recycled graywater, or treated wastewater) available in the month of July. Reuse water volumes may depend on rainfall volume/frequency, building-generated graywater/wastewater, and on-site storage capacity. On-site reuse systems should be modeled to predict volumes generated on a monthly basis as well as optimal storage capacity. For captured rainwater calculations, project teams may use either the collected rainwater total for July based on historical average precipitation, or the historical data for each month in order to model collection and reuse throughout the year. The latter method allows the project team to determine what volume of water is expected to be in the storage cistern at the beginning of July and add it to the expected rainwater volume collected during the month. This approach also allows the project team to determine the optimal size of the rainwater cistern.

Table 2: Irrigation Types

Irrigation Type	IE
Sprinkler	0.625
Drip	0.90

Table 1: Landscape Factors

Vegetation Type	Species Factor (k_s)			Density Factor (k_d)			Microclimate Factor (k_{mc})		
	low	average	high	low	average	high	low	average	high
Trees	0.2	0.5	0.9	0.5	1.0	1.3	0.5	1.0	1.4
Shrubs	0.2	0.5	0.7	0.5	1.0	1.1	0.5	1.0	1.3
Groundcovers	0.2	0.5	0.7	0.5	1.0	1.1	0.5	1.0	1.2
Mixed: trees, shrubs, groundcovers	0.2	0.5	0.9	0.6	1.1	1.3	0.5	1.0	1.4
Turfgrass	0.6	0.7	0.8	0.6	1.0	1.0	0.8	1.0	1.2

Equation 2

$$ET_L\,[in] = ET_0 \times K_L$$

ISI HAWAII
Water Solutions

Rain Bird® ET Manager™

Weather Reach Signal Provider Information

A Weather Reach Signal Provider (WRSP) broadcasts a wireless weather signal used by ET Managers to automatically control the frequency of watering. The information on this sheet, provided by the WRSP, contains essential settings that need to be programmed in the ET Manager for proper operation:

Signal Provider Code - The code consists of 10 numbers labeled A through J. The code is unique to each WRSP.

Weather Region – The Weather Region number represents a weather station managed by the Weather Reach Signal Provider. Choose a weather region that corresponds to the weather station closest to the location of the ET Manager.

Elevation - The ET Manager uses elevation to calculate ET. The weather station elevation is provided as a reference. ET Manager location elevation must be programmed to calculate ET.

Historical ET – The ET Manager uses average daily ET for each month only as a back up to real-time ET. The Average Daily Historical ET values are provided as a reference.

Weather Reach Signal Provider Information
ISI Hawaii Water Solutions

Contact: Ken Ota
Email: ken.ota@isihawaii.com
Website: http://www.isihawaii.com

Phone: 808-871-5459

Address: 368 Lehuakona St.
Kahului, HI 96732

Signal Provider Code

A: 64	D: 95	G: 35
B: 255	E: 11	H: 10
C: 89	F: 216	I: 140
		J: 66

ISI Hawaii Water Solutions offers Weather Reach Signal Service at no annual cost. Contact ISI Hawaii Water Solutions for a copy of the Service Agreement. Email or Fax in the completed Service Agreement prior to installing the ET Manager. After installing the ET-Manager and programming the ISI Hawaii Water Solutions signal provider code, complete the weather signal test described in the Installation Guide. The attention light will be on and the attention message on the display will read, "No Signal Service". Contact ISI Hawaii Water Solutions and they will send a wireless command to activate the ET Manager. Once Water Management activates the ET Manager; the "No Signal Service" message will disappear.

Weather Regions

Weather Region 1 – Kahili Golf Course

Location: Honoapiilani Hwy
City: Wailuku, Hawaii
Elevation: 220 Feet

Average Daily Historical ET

Jan: 0.11″	May: 0.17″	Sep: 0.18″
Feb: 0.14″	Jun: 0.20″	Oct: 0.15″
Mar: 0.14″	Jul: 0.19″	Nov: 0.13″
Apr: 0.17″	Aug: 0.19″	Dec: 0.11″

Weather Region 2 – Keopuolani Park

Location: Keopuolani Park Drive
City: Wailuku, Hawaii
Elevation: 120 Feet

Average Daily Historical ET

Jan: 0.11″	May: 0.17″	Sep: 0.18″
Feb: 0.14″	Jun: 0.20″	Oct: 0.15″
Mar: 0.14″	Jul: 0.19″	Nov: 0.13″
Apr: 0.17″	Aug: 0.19″	Dec: 0.11″

Weather Region 3 – Sheraton Maui HI

Location: Kannapali Parkway
City: Lahaina, Hawaii
Elevation: 10 Feet

Average Daily Historical ET

Jan: 0.11″	May: 0.17″	Sep: 0.18″
Feb: 0.14″	Jun: 0.20″	Oct: 0.15″
Mar: 0.14″	Jul: 0.20″	Nov: 0.13″
Apr: 0.16″	Aug: 0.19″	Dec: 0.13″

Weather Region 4 – King Kamehameha GC

Location: Honoapiilani Hwy
City: Wailuku, Hawaii
Elevation: 200 Feet

Average Daily Historical ET

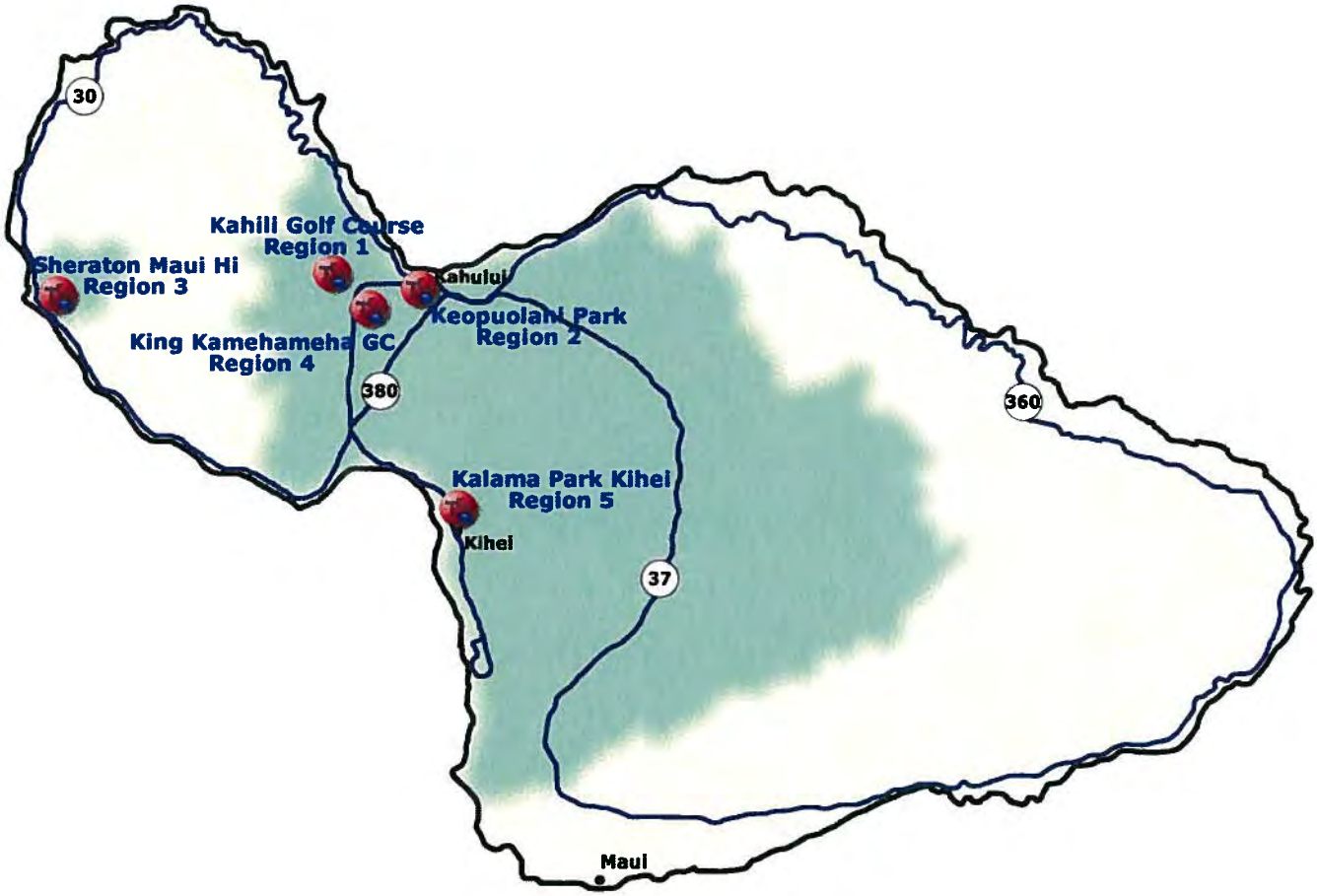
Jan: 0.11″	May: 0.17″	Sep: 0.18″
Feb: 0.14″	Jun: 0.20″	Oct: 0.15″
Mar: 0.14″	Jul: 0.19″	Nov: 0.13″
Apr: 0.17″	Aug: 0.19″	Dec: 0.10″

Weather Region 5 – Kalama Park Kihei

Location: Kalama Kihei Park
City: Kihei, Hawaii
Elevation: 10 Feet

Average Daily Historical ET

Jan: 0.11″	May: 0.18″	Sep: 0.18″
Feb: 0.14″	Jun: 0.20″	Oct: 0.15″
Mar: 0.14″	Jul: 0.20″	Nov: 0.13″
Apr: 0.18″	Aug: 0.20″	Dec: 0.11″



Because of the nature of radio transmission, strength of signal varies depending upon location.

Step three: Determining irrigation requirements

To answer the questions "How much water has to be applied to the plant material?" and "How often and how long does the system need to run?," a number of factors need to be examined.

The local climate is one of the main factors that influences how much water is needed to maintain good plant growth. The plant water requirement includes the water lost by evaporation into the atmosphere from the soil and soil surface, and by transpiration, which is the amount of water used by the plant. The combination of these is **evapotranspiration (ET).**

ET_0 stands for **reference evapotranspiration**, which is the maximum average rate of water use for plants in a given climate. Reference evapotranspiration is multiplied by a crop coefficient to obtain the ET rate for a specific plant or turf. Although it is a rough guide to water requirements and not geared to a specific plant, the table below and in the Technical Data section of this manual will help establish a ball park figure for your project. At the design stage, the designer wants to provide an irrigation system that can meet peak season (summer time) ET rates.

In the table, note the factors that affect the water use rate for a given climate type. The three categories of "Cool," "Warm" and "Hot" indicate that temperature has an influence on water use. The hotter the climate, the more water loss is expected. Other major factors are humidity and wind speed. If the air is humid, evaporation will be lower as compared to a climate with the same average temperature but drier air.

Climate PET

Climate	Inches (millimeters) Daily
Cool Humid	.10 to .15 in (3 to 4 mm)
Cool Dry	.15 to .20 in (4 to 5 mm)
Warm Humid	.15 to .20 in (4 to 5 mm)
Warm Dry	.20 to .25 in (5 to 6 mm)
Hot Humid	.25 to .30 in (6 to 8 mm)
Hot Dry	.30 to .45 in (8 to 11 mm) "worst case"

Cool = under 70° F (21° C) as an average midsummer high
Warm = between 70° and 90° F (21° and 32° C) as midsummer highs
Hot = over 90° F (32°C)
Humid = over 50% as average midsummer relative humidity [dry = under 50%]

In the table, a "Cool Humid" climate has an ET range in inches (millimeters) of water required per day of .10 to .15 in (3 to 4 mm). At the upper end of the scale, a "Hot Dry" climate produces a requirement of .30 to .45 in (8 to 11 mm) per day. These figures are rough estimates for these types of climates for an average midsummer day.

To help determine in which climate your project is located, consult the notes on "Hot," "Warm," or "Cool" that are listed below the PET table. Also listed are the humidity ranges that establish the "Humid" and "Dry" classifications. An irrigation system should always be designed to adequately water the project in the "worst case" condition. This is usually midsummer when the average daily temperature is at or near its highest for the growing season or when humidity is averaging its lowest percentages. Of course, a combination of these extremes produces the greatest water requirement. When you have determined the climate type for the area where your project is located, use the highest number, the "worst case" condition listed at the top of the ET range for that climate type, as the requirement for your project.

We will be discussing the precipitation rate of sprinklers later in the design process. Choosing sprinklers to match the irrigation requirement is a critical consideration for the designer. Later in this manual, we will also consider matching the scheduling of automatic irrigation controls to both the sprinkler precipitation rate and the system irrigation requirement.

The soil type on the project site is a factor in determining how fast and how often water can be applied to the plant material.

Soil type

Soil absorbs and holds water in much the same way as a sponge. A given texture and volume of soil will hold a given amount of moisture. The intake rate of the soil will influence the precipitation rate and type of sprinkler that can be utilized. The ability of soil to hold moisture, and the amount of moisture it can hold, will greatly affect the irrigation operational schedule.

Soil is made up of sand, silt and clay particles. The percentage of each of these three particles is what determines the actual soil texture. Because the percentage of any one of these three particles can differ, there is virtually an unlimited number of soil types possible.

The simplest way to determine the soil type is to place a moistened soil sample in your hand and squeeze. Take the sample from a representative part of the site, and from approximately the same depth to which you will be watering. In other words, if you want to water to a depth of 6 in (15 cm), dig down 6 in (15 cm) to take your soil sample.

PROJECT: Villages of Leialii JOB NO: 2007700500
CLIENT: HHFDC DATE: 22-Sep-09
SUBJECT: Estimate of Reclaimed Water Volumes BY: C. Ancheta
FILE: P:\Projects\Leialii_2007700500\Reports\Consultant Reports\Civil\Sewer Information\[Reclaimed Water Calculations.xls]Tank summary (2)

Estimate Reclaimed Water Irrigation Demand (Concept One)

Acreage Yield

Service Pressure Zone	Description	MF	Landscape 58%	Mixed Use	Landscape 23%	Retail	Landscape 23%	Industrial	Landscape 7%	Schools	Landscape 58%	Parks	Landscape 78%	ROW ESMTS[3]	Landscape 9%	Drainage Areas[4]	Landscape 100%
50' to 215' Elevation	Subtotal Phase A	21.63	12.55	14.40	3.31	9.13	2.10	17.20	1.20	12.01	6.97	16.98	13.24	54.56	4.91	56.84	56.84
	Total	21.63	12.55	14.40	3.31	9.13	2.10	17.20	1.20	12.01	6.97	16.98	13.24	54.56	4.91	56.84	56.84
215' to 380' Elevation	Subtotal Phase A	19.89	11.54	9.00	2.07	11.62	2.67	-	-	-	-	7.41	5.78	90.85	8.18	21.27	21.27
(& Pump Phase B)[8]	Subtotal Phase B	-	-	-	-	-	-	-	-	12.01	6.97	19.58	15.27	36.43	3.28	7.52	7.52
	Total	19.89	11.54	9.00	2.07	11.62	2.67	-	-	12.01	6.97	26.99	21.05	127.28	11.46	28.79	28.79
Grand Total		41.52	24.08	23.40	5.38	20.75	4.77	17.20	1.20	24.02	13.93	43.97	34.30	181.84	16.37	85.63	85.63

Irrigation Demand Criteria[5] = 1.42 inches/week
Reclaimed Water Supply Criteria[6] = 90% development occupancy (for design average wastewater flow)

Service Pressure Zone	Description	Landscape Area (AC)	Irrigation Demand[5] (gal/day)	Design Average Wastewater Flow[7] (gal)	Reclaimed Water Supply[6] (gal)	Available Reclaimed Water[4] (gal)
50' to 215' Elevation	Subtotal Phase A	101.12	556,984	250,318	225,286	(331,698)
	Total	101.12	556,984	250,318	225,286	(331,698)
215' to 380' Elevation	Subtotal Phase A	51.51	283,694	305,944	275,350	(8,345)
(& Pump Phase B)[8]	Subtotal Phase B	33.04	181,970	580,014	522,013	340,043
	Total	84.54	465,664	885,958	797,362	331,698
Grand Total		185.66	1,022,648	1,136,276	1,022,648	0

	Irrigation Demand[5] (gal/day)	Design Average Wastewater Flow[7] (gal)	Reclaimed Water Supply[6] (gal)	Available Reclaimed Water[4] (gal)
Phase A	840,678	556,262	500,636	(340,043)
Phase B	181,970	580,014	522,013	340,043
Total	1,022,648	1,136,276	1,022,648	0

← Zero Net Reclaimed Water for Entire Site

Notes:
1. Reclaimed water for irrigation not used in SFR.
2. Landscape area percentages determined from comparable area developments. See Estimate of Landscape Areas.
3. ROW ESMTS includes areas of the Lahaina By-pass Highway and Keawe Street that are within the Leialii site.
4. Total open space drainage area for Phase A is 78.11 acres. The amount of irrigated drainage area required to provide zero net reclaimed water for Phase A would be reduced to 16.37 acres. The amount of irrigated drainage area required to provide zero net reclaimed water for the total site would be 85.63 acres, or an additional 7.52 acres in Phase B.
5. Irrigation demand criteria determined from landscape water requirements. See Landscape Water Requirements.
6. Reclaimed water supply is calculated by reducing the design average wastewater flow based on an estimated development occupancy of 90%. The estimated development occupancy considers homeowners not at home, school enrollments that are below capacity, vacant lots, etc. For wastewater flow calculations, see Sewer Flows.
7. Remainder of Phase B that is not within pressure service zone for 525' tank (above 380' elevation) to be serviced via pump station.

BELTCOLLINS

PROJECT: Villages of Leialii | JOB NO: 2007700500
CLIENT: HHFDC | DATE: 22-Sep-09
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FILE: P:\Projects\Leialii_2007700500\Reports\Consultant Reports\Civil\Sewer Information\[Reclaimed Water Calculations.xls]Tank summary (2)

CHECK SCENARIOS FOR SIZING OF TANKS - PHASE A ONLY
Estimate Reclaimed Water Irrigation Demand (Concept One)

Service Pressure Zone	Description	MF	Landscape 58%	Mixed Use	Landscape 23%	Retail	Landscape 23%	Industrial	Landscape 7%	Schools	Landscape 58%	Parks	Landscape 78%	ROW ESMTS[3]	Landscape 9%	Drainage Areas[4]	Landscape 100%
		Acreage Yield															
50' to 215' Elevation	Subtotal Phase A	21.63	12.55	14.40	3.31	9.13	2.10	17.20	1.20	12.01	6.97	16.98	13.24	54.56	4.91	16.37	16.37
	Total	21.63	12.55	14.40	3.31	9.13	2.10	17.20	1.20	12.01	6.97	16.98	13.24	54.56	4.91	16.37	16.37
215' to 380' Elevation (& Pump Phase B)[8]	Subtotal Phase A	19.89	11.54	9.00	2.07	11.62	2.67	-	-	-	-	7.41	5.78	90.85	8.18	-	-
	Subtotal Phase B	-	-	-	-	-	-	-	-	12.01	6.97	19.58	15.27	36.43	3.28	-	-
	Total	19.89	11.54	9.00	2.07	11.62	2.67	-	-	12.01	6.97	26.99	21.05	127.28	11.46	-	-
Grand Total		41.52	24.08	23.40	5.38	20.75	4.77	17.20	1.20	24.02	13.93	43.97	34.30	181.84	16.37	16.37	16.37

Irrigation Demand Criteria[5] = 1.42 inches/week
Reclaimed Water Supply Criteria[6] = 90% development occupancy (for design average wastewater flow)

Service Pressure Zone	Description	Landscape Area (AC)	Irrigation Demand[5] (gal/day)	Design Average Wastewater Flow[7] (gal)	Reclaimed Water Supply[6] (gal)	Available Reclaimed Water[4] (gal)
50' to 215' Elevation	Subtotal Phase A	60.66	334,098	371,220	334,098	0
	Total	60.66	334,098	371,220	334,098	0
215' to 380' Elevation (& Pump Phase B)[8]	Subtotal Phase A	30.24	166,538	185,042	166,538	0
	Subtotal Phase B	25.52	140,549	580,014	522,013	381,464
	Total	55.75	307,087	765,056	688,551	381,464
Grand Total		116.41	641,184	1,136,276	1,022,648	381,464

	Irrigation Demand[5] (gal/day)	Design Average Wastewater Flow[7] (gal)	Reclaimed Water Supply[6] (gal)	Available Reclaimed Water[4] (gal)
Phase A	500,636	556,262	500,636	0
Phase B	140,549	580,014	522,013	381,464
Total	641,184	1,136,276	1,022,648	381,464

← Zero Net Reclaimed Water for Phase A

Notes:
1. Reclaimed water for irrigation not used in SFR.
2. Landscape area percentages determined from comparable area developments. See Estimate of Landscape Areas.
3. ROW ESMTS includes areas of the Lahaina By-pass Highway and Keawe Street that are within the Leialii site.
4. Total open space drainage area for Phase A is 78.11 acres. The amount of irrigated drainage area required to provide zero net reclaimed water for Phase A would be reduced to 16.37 acres. The amount of irrigated drainage area required to provide zero net reclaimed water for the total site would be 85.63 acres, or an additional 7.52 acres in Phase B.
5. Irrigation demand criteria determined from landscape water requirements. See Landscape Water Requirements.
6. Reclaimed water supply is calculated by reducing the design average wastewater flow based on an estimated development occupancy of 90%. The estimated development occupancy considers homeowners not at home, school enrollments that are below capacity, vacant lots, etc. For wastewater flow calculations, see Sewer Flows.
7. Remainder of Phase B that is not within pressure service zone for 525' tank (above 380' elevation) to be serviced via pump station.

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Estimate Reclaimed Water Irrigation Demand (Concept Two)

Acreage Yield

Service Pressure Zone	Description	MF	Landscape 58%	Mixed Use	Landscape 23%	Retail	Landscape 23%	Industrial	Landscape 7%	Schools	Landscape 58%	Parks	Landscape 78%	ROW ESMTS[3]	Landscape 9%	Drainage Areas[4]	Landscape 100%
50' to 215' Elevation	Subtotal Phase A	70.92	41.13	14.40	3.31	9.13	2.10	17.20	1.20	12.01	6.97	16.98	13.24	54.56	4.91	56.84	56.84
	Total	70.92	41.13	14.40	3.31	9.13	2.10	17.20	1.20	12.01	6.97	16.98	13.24	54.56	4.91	56.84	56.84
215' to 380' Elevation	Subtotal Phase A	72.07	41.80	9.00	2.07	11.62	2.67	-	-	-	-	7.41	5.78	90.85	8.18	8.62	8.62
(& Pump Phase B)[8]	Subtotal Phase B	-	-	-	-	-	-	-	-	12.01	6.97	19.58	15.27	36.43	3.28	-	-
	Total	72.07	41.80	9.00	2.07	11.62	2.67	-	-	12.01	6.97	26.99	21.05	127.28	11.46	8.62	8.62
Grand Total		142.99	82.93	23.40	5.38	20.75	4.77	17.20	1.20	24.02	13.93	43.97	34.30	181.84	16.37	65.46	65.46

Irrigation Demand Criteria[5] = 1.42 inches/week
Reclaimed Water Supply Criteria[6] = 90% development occupancy (for design average wastewater flow)

Service Pressure Zone	Description	Landscape Area (AC)	Irrigation Demand[5] (gal/day)	Design Average Wastewater Flow[7] (gal)	Reclaimed Water Supply[6] (gal)	Available Reclaimed Water[4] (gal)
50' to 215' Elevation	Subtotal Phase A	129.71	714,449	396,515	356,863	(357,586)
	Total	129.71	714,449	396,515	356,863	(357,586)
215' to 380' Elevation	Subtotal Phase A	69.12	380,741	396,515	356,863	(23,878)
(& Pump Phase B)[8]	Subtotal Phase B	25.52	140,549	580,014	522,013	381,464
	Total	94.64	521,290	976,529	878,876	357,586
Grand Total		224.35	1,235,739	1,373,044	1,235,739	0

	Irrigation Demand[5] (gal/day)	Design Average Wastewater Flow[7] (gal)	Reclaimed Water Supply[6] (gal)	Available Reclaimed Water[4] (gal)
Phase A	1,095,191	793,030	713,727	(381,464)
Phase B	140,549	580,014	522,013	381,464
Total	1,235,739	1,373,044	1,235,739	0

← Zero Net Reclaimed Water for Entire Site

Notes:
1. Reclaimed water for irrigation not used in SFR.
2. Landscape area percentages determined from comparable area developments. See Estimate of Landscape Areas.
3. ROW ESMTS includes areas of the Lahaina By-pass Highway and Keawe Street that are within the Leialii site. Also see Note 4 below.
4. Total open space drainage area for Phase A is 78.11 acres. Even if no drainage area is irrigated, the amount of irrigation demand for the remainder land uses exceeds the available reclaimed water supply for Phase A. If irrigation for the Lahaina By-pass Highway is not included, there is sufficient reclaimed water supply for Phase A (i.e. irrigation of the Lahaina By-pass Highway would be dependent on additional reclaimed water supply from Phase B). The amount of irrigated drainage area required to provide zero net reclaimed water for the total site would be 65.46 acres.
5. Irrigation demand criteria determined from landscape water requirements. See Landscape Water Requirements.
6. Reclaimed water supply is calculated by reducing the design average wastewater flow based on an estimated development occupancy of 90%. The estimated development occupancy considers homeowners not at home, school enrollments that are below capacity, vacant lots, etc. For wastewater flow calculations, see Sewer Flows.

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CHECK SCENARIOS FOR SIZING OF TANKS - PHASE A ONLY
Estimate Reclaimed Water Irrigation Demand (Concept Two)

Acreage Yield

Service Pressure Zone	Description	MF	Landscape 58%	Mixed Use	Landscape 23%	Retail	Landscape 23%	Industrial	Landscape 7%	Schools	Landscape 58%	Parks	Landscape 78%	ROW ESMTS[3]	Landscape 9%	Drainage Areas[4]	Landscape 100%
50' to 215' Elevation	Subtotal Phase A	70.92	41.13	14.40	3.31	9.13	2.10	17.20	1.20	12.01	6.97	16.98	13.24	54.56	4.91	-	-
	Total	70.92	41.13	14.40	3.31	9.13	2.10	17.20	1.20	12.01	6.97	16.98	13.24	54.56	4.91	-	-
215' to 380' Elevation	Subtotal Phase A	72.07	41.80	9.00	2.07	11.62	2.67	-	-	-	-	7.41	5.78	90.85	8.18	-	-
(& Pump Phase B)[8]	Subtotal Phase B	-	-	-	-	-	-	-	-	12.01	6.97	19.58	15.27	36.43	3.28		-
	Total	72.07	41.80	9.00	2.07	11.62	2.67	-	-	12.01	6.97	26.99	21.05	127.28	11.46	-	-
Grand Total		142.99	82.93	23.40	5.38	20.75	4.77	17.20	1.20	24.02	13.93	43.97	34.30	181.84	16.37	-	-

Irrigation Demand Criteria[5] = 1.42 inches/week
Reclaimed Water Supply Criteria[6] = 90% development occupancy (for design average wastewater flow)

Service Pressure Zone	Description	Landscape Area (AC)	Irrigation Demand[5] (gal/day)	Design Average Wastewater Flow[7] (gal)	Reclaimed Water Supply[6] (gal)	Available Reclaimed Water[4] (gal)
50' to 215' Elevation	Subtotal Phase A	72.87	401,371	793,030	713,727	312,355
	Total	72.87	401,371	793,030	713,727	312,355
215' to 380' Elevation	Subtotal Phase A	60.50	333,236	0	0	(333,236)
(& Pump Phase B)[8]	Subtotal Phase B	25.52	140,549	580,014	522,013	381,464
	Total	86.02	473,785	580,014	522,013	48,228
Grand Total		158.89	875,156	1,373,044	1,235,739	360,583

	Irrigation Demand[5] (gal/day)	Design Average Wastewater Flow[7] (gal)	Reclaimed Water Supply[6] (gal)	Available Reclaimed Water[4] (gal)
Phase A	734,608	793,030	713,727	(20,881)
Phase B	140,549	580,014	522,013	381,464
Total	875,156	1,373,044	1,235,739	360,583

← Irrigation Demand Exceeds Reclaimed Water Supply for Phase A

Notes:
1. Reclaimed water for irrigation not used in SFR.
2. Landscape area percentages determined from comparable area developments. See Estimate of Landscape Areas.
3. ROW ESMTS includes areas of the Lahaina By-pass Highway and Keawe Street that are within the Leialii site. Also see Note 4 below.
4. Total open space drainage area for Phase A is 78.11 acres. Even if no drainage area is irrigated, the amount of irrigation demand for the remainder land uses exceeds the available reclaimed water supply for Phase A. If irrigation for the Lahaina By-pass Highway is not included, there is sufficient reclaimed water supply for Phase A (i.e. irrigation of the Lahaina By-pass Highway would be dependent on additional reclaimed water supply from Phase B). The amount of irrigated drainage area required to provide zero net reclaimed water for the total site would be 65.46 acres.
5. Irrigation demand criteria determined from landscape water requirements. See Landscape Water Requirements.
6. Reclaimed water supply is calculated by reducing the design average wastewater flow based on an estimated development occupancy of 90%. The estimated development occupancy considers homeowners not at home, school enrollments that are below capacity, vacant lots, etc. For wastewater flow calculations, see Sewer Flows.

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CHECK SCENARIOS FOR SIZING OF TANKS - PHASE A ONLY
Estimate Reclaimed Water Irrigation Demand (Concept Two)

Service Pressure Zone	Description	MF	Landscape 58%	Mixed Use	Landscape 23%	Retail	Landscape 23%	Industrial	Landscape 7%	Schools	Landscape 58%	Parks	Landscape 78%	ROW ESMTS[3]	Landscape 9%	Drainage Areas[4]	Landscape 100%
		Acreage Yield															
50' to 215' Elevation	Subtotal Phase A	70.92	41.13	14.40	3.31	9.13	2.10	17.20	1.20	12.01	6.97	16.98	13.24	54.56	4.91	-	-
	Total	70.92	41.13	14.40	3.31	9.13	2.10	17.20	1.20	12.01	6.97	16.98	13.24	54.56	4.91	-	-
215' to 380' Elevation	Subtotal Phase A	72.07	41.80	9.00	2.07	11.62	2.67	-	-	-	-	7.41	5.78	40.63	3.66	-	-
(& Pump Phase B)[8]	Subtotal Phase B	-	-	-	-	-	-	-	-	12.01	6.97	19.58	15.27	36.43	3.28		-
	Total	72.07	41.80	9.00	2.07	11.62	2.67	-	-	12.01	6.97	26.99	21.05	77.06	6.94	-	-
Grand Total		142.99	82.93	23.40	5.38	20.75	4.77	17.20	1.20	24.02	13.93	43.97	34.30	131.62	11.85	-	-

Irrigation Demand Criteria[5] = 1.42 inches/week
Reclaimed Water Supply Criteria[6] = 90% development occupancy (for design average wastewater flow)

Service Pressure Zone	Description	Landscape Area (AC)	Irrigation Demand[5] (gal/day)	Design Average Wastewater Flow[7] (gal)	Reclaimed Water Supply[6] (gal)	Available Reclaimed Water[4] (gal)
50' to 215' Elevation	Subtotal Phase A	72.87	401,371	445,968	401,371	0
	Total	72.87	401,371	445,968	401,371	0
215' to 380' Elevation	Subtotal Phase A	55.98	308,341	347,061	312,355	4,014
(& Pump Phase B)[8]	Subtotal Phase B	25.52	140,549	580,014	522,013	381,464
	Total	81.50	448,889	927,075	834,368	385,478
Grand Total		154.37	850,261	1,373,044	1,235,739	385,478

	Irrigation Demand[5] (gal/day)	Design Average Wastewater Flow[7] (gal)	Reclaimed Water Supply[6] (gal)	Available Reclaimed Water[4] (gal)
Phase A	709,712	793,030	713,727	4,014
Phase B	140,549	580,014	522,013	381,464
Total	850,261	1,373,044	1,235,739	385,478

← Sufficient Reclaimed Water Supply for Phase A (if irrigation for the Lahaina By-pass Highway is not included)

Notes:
1. Reclaimed water for irrigation not used in SFR.
2. Landscape area percentages determined from comparable area developments. See Estimate of Landscape Areas.
3. ROW ESMTS includes areas of Keawe Street that are within the Leialii site. Also see Note 4 below.
4. Total open space drainage area for Phase A is 78.11 acres. Even if no drainage area is irrigated, the amount of irrigation demand for the remainder land uses exceeds the available reclaimed water supply for Phase A. If irrigation for the Lahaina By-pass Highway is not included, there is sufficient reclaimed water supply for Phase A (i.e. irrigation of the Lahaina By-pass Highway would be dependent on additional reclaimed water supply from Phase B). The amount of irrigated drainage area required to provide zero net reclaimed water for the total site would be 65.46 acres.
5. Irrigation demand criteria determined from landscape water requirements. See Landscape Water Requirements.
6. Reclaimed water supply is calculated by reducing the design average wastewater flow based on an estimated development occupancy of 90%. The estimated development occupancy considers homeowners not at home, school enrollments that are below capacity, vacant lots, etc. For wastewater flow calculations, see Sewer Flows.

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CLIENT:	HHFDC	DATE:	22-Sep-09
SUBJECT:	Estimate of Reclaimed Water Volumes	BY:	C. Ancheta
FILE:	P:\Projects\Leialii_2007700500\Reports\Consultant Reports\Civil\Sewer Information\[Reclaimed Water Calculations.xls]Tank summary (2)		

Estimate Reclaimed Water Irrigation Demand (Concept Three)

Service Pressure Zone	Description	MF	Landscape 58%	Mixed Use	Landscape 23%	Retail	Landscape 23%	Industrial	Landscape 7%	Schools	Landscape 58%	Parks	Landscape 78%	ROW ESMTS[3]	Landscape 9%	Drainage Areas[4]	Landscape 100%
		Acreage Yield															
50' to 215' Elevation	Subtotal Phase A	25.88	15.01	6.21	1.43	7.62	1.75	21.81	1.53	12.01	6.97	15.15	11.82	53.79	4.84	68.17	68.17
	Total	25.88	15.01	6.21	1.43	7.62	1.75	21.81	1.53	12.01	6.97	15.15	11.82	53.79	4.84	68.17	68.17
215' to 380' Elevation	Subtotal Phase A	55.04	31.92	13.53	3.11	-	-	-	-	-	-	5.37	4.19	91.23	8.21	35.64	35.64
(& Pump Phase B)[8]	Subtotal Phase B	36.15	20.97	-	-	-	-	-	-	12.58	7.30	17.46	13.62	35.79	3.22	8.06	8.06
	Total	91.19	52.89	13.53	3.11	-	-	-	-	12.58	7.30	22.83	17.81	127.02	11.43	43.70	43.70
Grand Total		117.07	67.90	19.74	4.54	7.62	1.75	21.81	1.53	24.59	14.26	37.98	29.62	180.81	16.27	111.87	111.87

Irrigation Demand Criteria[5] = 1.42 inches/week

Reclaimed Water Supply Criteria[6] = 90% development occupancy (for design average wastewater flow)

Service Pressure Zone	Description	Landscape Area (AC)	Irrigation Demand[5] (gal/day)	Design Average Wastewater Flow[7] (gal)	Reclaimed Water Supply[6] (gal)	Available Reclaimed Water[4] (gal)
50' to 215' Elevation	Subtotal Phase A	111.51	614,212	440,930	396,837	(217,375)
	Total	111.51	614,212	440,930	396,837	(217,375)
215' to 380' Elevation	Subtotal Phase A	83.07	457,581	440,930	396,837	(60,744)
(& Pump Phase B)[8]	Subtotal Phase B	32.20	177,365	506,093	455,484	278,119
	Total	115.28	634,945	947,023	852,320	217,375
Grand Total		226.79	1,249,157	1,387,953	1,249,157	0

	Irrigation Demand[5] (gal/day)	Design Average Wastewater Flow[7] (gal)	Reclaimed Water Supply[6] (gal)	Available Reclaimed Water[4] (gal)
Phase A	1,071,793	881,860	793,674	(278,119)
Phase B	177,365	506,093	455,484	278,119
Total	1,249,157	1,387,953	1,249,157	0

← Zero Net Reclaimed Water for Entire Site

Notes:

1. Reclaimed water for irrigation not used in SFR.
2. Landscape area percentages determined from comparable area developments. See Estimate of Landscape Areas.
3. ROW ESMTS includes areas of the Lahaina By-pass Highway and Keawe Street that are within the Leialii site.
4. Total open space drainage area for Phase A is 103.81 acres. The amount of irrigated drainage area required to provide zero net reclaimed water for Phase A would be reduced to 53.32 acres. The amount of irrigated drainage area required to provide zero net reclaimed water for the total site would be 123.18 acres, or an additional 19.37 acres in Phase B.
5. Irrigation demand criteria determined from landscape water requirements. See Landscape Water Requirements.
6. Reclaimed water supply is calculated by reducing the design average wastewater flow based on an estimated development occupancy of 90%. The estimated development occupancy considers homeowners not at home, school enrollments that are below capacity, vacant lots, etc. For wastewater flow calculations, see Sewer Flows.
7. Remainder of Phase B that is not within pressure service zone for 525' tank (above 380' elevation) to be serviced via pump station.

PROJECT: Villages of Leialii JOB NO: 2007700500
CLIENT: HHFDC DATE: 22-Sep-09
SUBJECT: Estimate of Reclaimed Water Volumes BY: C. Ancheta
FILE: P:\Projects\Leialii_2007700500\Reports\Consultant Reports\Civil\Sewer Information\[Reclaimed Water Calculations.xls]Tank summary (2)

CHECK SCENARIOS FOR SIZING OF TANKS - PHASE A ONLY
Estimate Reclaimed Water Irrigation Demand (Concept Three)

Service Pressure Zone	Description	MF	Landscape 58%	Mixed Use	Landscape 23%	Retail	Landscape 23%	Industrial	Landscape 7%	Schools	Landscape 58%	Parks	Landscape 78%	ROW ESMTS[3]	Landscape 9%	Drainage Areas[4]	Landscape 100%
		Acreage Yield															
50' to 215' Elevation	Subtotal Phase A	25.88	15.01	6.21	1.43	7.62	1.75	21.81	1.53	12.01	6.97	15.15	11.82	53.79	4.84	53.32	53.32
	Total	25.88	15.01	6.21	1.43	7.62	1.75	21.81	1.53	12.01	6.97	15.15	11.82	53.79	4.84	53.32	53.32
215' to 380' Elevation	Subtotal Phase A	55.04	31.92	13.53	3.11	-	-	-	-	-	-	5.37	4.19	91.23	8.21	-	-
(& Pump Phase B)[8]	Subtotal Phase B	36.15	20.97	-	-	-	-	-	-	12.58	7.30	17.46	13.62	35.79	3.22	-	-
	Total	91.19	52.89	13.53	3.11	-	-	-	-	12.58	7.30	22.83	17.81	127.02	11.43	-	-
Grand Total		117.07	67.90	19.74	4.54	7.62	1.75	21.81	1.53	24.59	14.26	37.98	29.62	180.81	16.27	53.32	53.32

Irrigation Demand Criteria[5] = 1.42 inches/week
Reclaimed Water Supply Criteria[6] = 90% development occupancy (for design average wastewater flow)

Service Pressure Zone	Description	Landscape Area (AC)	Irrigation Demand[5] (gal/day)	Design Average Wastewater Flow[7] (gal)	Reclaimed Water Supply[6] (gal)	Available Reclaimed Water[4] (gal)
50' to 215' Elevation	Subtotal Phase A	96.66	532,400	591,556	532,400	0
	Total	96.66	532,400	591,556	532,400	0
215' to 380' Elevation	Subtotal Phase A	47.43	261,273	290,304	261,273	0
(& Pump Phase B)[8]	Subtotal Phase B	24.14	132,944	506,093	455,484	322,540
	Total	71.57	394,218	796,397	716,757	322,540
Grand Total		168.23	926,618	1,387,953	1,249,157	322,540

	Irrigation Demand[5] (gal/day)	Design Average Wastewater Flow[7] (gal)	Reclaimed Water Supply[6] (gal)	Available Reclaimed Water[4] (gal)
Phase A	793,674	881,860	793,674	0
Phase B	132,944	506,093	455,484	322,540
Total	926,618	1,387,953	1,249,157	322,540

← Zero Net Reclaimed Water for Phase A

Notes:
1. Reclaimed water for irrigation not used in SFR.
2. Landscape area percentages determined from comparable area developments. See Estimate of Landscape Areas.
3. ROW ESMTS includes areas of the Lahaina By-pass Highway and Keawe Street that are within the Leialii site.
4. Total open space drainage area for Phase A is 103.81 acres. The amount of irrigated drainage area required to provide zero net reclaimed water for Phase A would be reduced to 53.32 acres. The amount of irrigated drainage area required to provide zero net reclaimed water for the total site would be 123.18 acres, or an additional 19.37 acres in Phase B.
5. Irrigation demand criteria determined from landscape water requirements. See Landscape Water Requirements.
6. Reclaimed water supply is calculated by reducing the design average wastewater flow based on an estimated development occupancy of 90%. The estimated development occupancy considers homeowners not at home, school enrollments that are below capacity, vacant lots, etc. For wastewater flow calculations, see Sewer Flows.
7. Remainder of Phase B that is not within pressure service zone for 525' tank (above 380' elevation) to be serviced via pump station.

PROJECT: Villages of Leialii JOB NO: 2007700500
CLIENT: HHFDC DATE: 22-Sep-09
SUBJECT: Estimate of Irrigation Demand BY: C. Ancheta
FILE: P:\Projects\Leialii_2007700500\Reports\Consultant Reports\Civil\Sewer Information\[Reclaimed Water Calculations.xls]Tank summary (2)

Estimate Irrigation (Reclaimed Water) Peak Demand for Pump Station Design for Pumped Service to Portions of Phase B (Concept One)

	School			Parks			ROW			Drainage Areas[2]			Total[6]	
Service Area Description	Area (ac)	Daily Demand[4] (gal/day)	Peak Flow[5] (gpm)	Area (ac)	Daily Demand[4] (gal/day)	Peak Flow[5] (gpm)	Area (ac)	Daily Demand[4] (gal/day)	Peak Flow[5] (gpm)	Area (ac)	Daily Demand[4] (gal/day)	Peak Flow[5] (gpm)	Peak Flow (gpm)	Peak Flow (cfs)
Phase BA Landscape	6.97	38,368	53.29	7.89	43,435	72.39	1.23	6,762	18.78	-	-	-	144.46	0.32
Phase BB Landscape	0.00	0	0.00	3.46	19,033	31.72	0.72	3,991	11.08	-	-	-	42.81	0.10
Phase BC Landscape	0.00	0	0.00	0.00	0	0.00	0.46	2,557	7.10	2.26	12,442	20.74	27.84	0.06
Total	6.97	38,368	53.29	11.34	62,468	104.11	2.42	13,310	36.97	2.26	12,442	20.74	215.11	0.48

	School	Parks	ROW	Drainage Areas
Daily duration of irrigation system use[5]	12 hrs	10 hrs	6 hrs	10 hrs

Irrigation Demand Criteria[4] = 1.42 inches/week

Drainage area in Phase B below 380' zone = 10.52 AC
Available drainage area in Phase B below 380[3] = 5.26 AC ← Drainage area w/in pump station service area = 7.52 - 5.26 = 2.26 AC

Notes:
1. Estimated pump station service area for areas above 380' pressure zone (gravity): Phase BA, Phase BB, and 35% of ROW in Phase BC.
2. Drainage area is the estimated amount of irrigated open space drainage area above 380' pressure zone that is required to provide zero net reclaimed water for the total site. The amount of irrigated drainage area required to provide zero net reclaimed water for the total site would be 85.63 acres, or an additional 7.52 acres in Phase B. Drainage area within the pump station service are is calculated as 7.52 acres less the available drainage area in Phase B below the 380' pressure zone.
3. Assume 50% of open space drainage area in Phase B below 380' zone is accessible for irrigation.
4. Daily irrigation demand derived from landscape water requirements. See Landscape Water Requirements.
5. Peak flow based on delivering daily demand at daily duration of irrigation system use indicated for each land use category.
6. Total peak flow assumes overlap of irrigation system durations for Schools, Parks, and ROW.

PROJECT:	Villages of Leialii	JOB NO:	2007700500
CLIENT:	HHFDC	DATE:	22-Sep-09
SUBJECT:	Estimate of Irrigation Demand	BY:	C. Ancheta
FILE:	P:\Projects\Leialii_2007700500\Reports\Consultant Reports\Civil\Sewer Information\[Reclaimed Water Calculations.xls]Tank summary (2)		

Estimate Irrigation (Reclaimed Water) Peak Demand for Pump Station Design for Pumped Service to Portions of Phase B (Concept Two)

	School			Parks			ROW			Total[4]	
Service Area Description	Area (ac)	Daily Demand[2] (gal/day)	Peak Flow[3] (gpm)	Area (ac)	Daily Demand[2] (gal/day)	Peak Flow[3] (gpm)	Area (ac)	Daily Demand[2] (gal/day)	Peak Flow[3] (gpm)	Peak Flow (gpm)	Peak Flow (cfs)
Phase BA Landscape	6.97	38,368	53.29	7.89	43,435	72.39	1.23	6,762	18.78	144.46	0.32
Phase BB Landscape	0.00	0	0.00	3.46	19,033	31.72	0.72	3,991	11.08	42.81	0.10
Phase BC Landscape	0.00	0	0.00	0.00	0	0.00	0.46	2,557	7.10	7.10	0.02
Total	6.97	38,368	53.29	11.34	62,468	104.11	2.42	13,310	36.97	194.37	0.43

	School	Parks	ROW
Daily duration of irrigation system use[3]	12 hrs	10 hrs	6 hrs

Irrigation Demand Criteria[2] = 1.42 inches/week

Notes:
1. Estimated pump station service area for areas above 380' pressure zone (gravity): Phase BA, Phase BB, and 35% of ROW in Phase BC.
2. Daily irrigation demand derived from landscape water requirements. See Landscape Water Requirements.
3. Peak flow based on delivering daily demand at daily duration of irrigation system use indicated for each land use category.
4. Total peak flow assumes overlap of irrigation system durations for Schools, Parks, and ROW.

PROJECT: Villages of Leialii JOB NO: 2007700500
CLIENT: HHFDC DATE: #######
SUBJECT: Estimate of Irrigation Demand BY: C. Ancheta
FILE: P:\Projects\Leialii_2007700500\Reports\Consultant Reports\Civil\Sewer Information\[Reclaimed Water Calculations.xls]Tank summary (2)

Estimate Irrigation (Reclaimed Water) Peak Demand for Pump Station Design for Pumped Service to Portions of Phase B (Concept Thre

	MF			School			Parks			ROW			Drainage Areas[2]			Total[6]	
Service Area Description	Area (ac)	Daily Demand[4] (gal/day)	Peak Flow[5] (gpm)	Area (ac)	Daily Demand[4] (gal/day)	Peak Flow[5] (gpm)	Area (ac)	Daily Demand[4] (gal/day)	Peak Flow[5] (gpm)	Area (ac)	Daily Demand[4] (gal/day)	Peak Flow[5] (gpm)	Area (ac)	Daily Demand[4] (gal/day)	Peak Flow[5] (gpm)	Peak Flow (gpm)	Peak Flow (cfs)
Phase BA Landscape	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.10	575	1.60	-	-	-	1.60	0.00
Phase BB Landscape	0.00	0	0.00	7.30	40,189	55.82	10.09	55,551	92.58	1.06	5,850	16.25	-	-	-	164.65	0.37
Phase BC Landscape	12.29	67,695	798.67	0.00	0	0.00	0.00	0	0.00	0.66	3,658	10.16	-	-	-	808.83	1.80
Phase BD Landscape	0.00	0	0.00	0.00	0	0.00	3.53	19,462	32.44	0.49	2,681	7.45	0.00	0	0.00	39.88	0.09
Total	12.29	67,695	798.67	7.30	40,189	55.82	13.62	75,013	125.02	2.32	12,764	35.45	0.00	0	0.00	1014.96	2.26

	MF	School	Parks	ROW	Drainage Areas
Daily duration of irrigation system use[5]	0.2 hr / acre lot	12 hrs	10 hrs	6 hrs	10 hrs

Irrigation Demand Criteria[4] = 1.42 inches/week

Drainage area in Phase B below 380' zone = 36.91 AC
Available drainage area in Phase B below 380'[3] = 18.45 AC ← Drainage area w/in pump station service area = 19.37 - 18.45 = 0.92 AC

Notes:
1. Estimated pump station service area for areas above 380' pressure zone (gravity): Phase BA, Phase BB, Phase BC, and 35% of ROW in Phase BD.
2. Drainage area is the estimated amount of irrigated open space drainage area above 380' pressure zone that is required to provide zero net reclaimed water for the total site. The amount of irrigated drainage area required to provide zero net reclaimed water for the total site would be 123.18 acres, or an additional 19.37 acres in Phase B. Drainage area within the pump station service area is calculated as 19.37 acres less the available drainage area in Phase B below 380' pressure zone.
3. Assume 50% of open space drainage area in Phase B below 380' zone is accessible for irrigation.
4. Daily irrigation demand derived from landscape water requirements. See Landscape Water Requirements.
5. Peak flow based on delivering daily demand at daily duration of irrigation system use indicated for each land use category.
6. Total peak flow assumes overlap of irrigation system durations for MF, Schools, Parks, and ROW.

PROJECT:	Villages of Leialii	JOB NO:	2007700500
CLIENT:	HHFDC	DATE:	22-Sep-09
SUBJECT:	Estimate of Reclaimed Water Volumes	BY:	C. Ancheta
FILE:	P:\Projects\Leialii_2007700500\Reports\Consultant Reports\Civil\Sewer Information\[Reclaimed Water Calculations.xls]Tank summary (2)		

Estimate Reclaimed Water Tank Elevation (Concept One)

Landscape Irrigation Criteria: Minimum pressure = 55 psi
Maximum pressure (w/out PRV) = 100 psi
Ultimate maximum pressure = 150 psi

Est. Tank Spillway Elevation = (Max elev in service area) + [(Minimum pressure) / (62.4 pcf) * (12 in/ft)^2] + [(Length of pipe) * (s)]
Check pressure at minimum elevation in service area = [(Tank spillway elev) - (Min elev in service area) - [(Length of pipe) * (s)]] * (62.4 pcf) / (12 in/ft)^2

<u>380' to 215' Elevation Pressure Zone</u>

Use:
Pipe diameter = 12 in
Q (estimated) = 789 gpm (Average Daily Flow) → s = 0.00266 ft/ft

Max elevation in service area = 380 Length of pipe = 8,000 ft
Min elevation in service area = 215 Length of pipe = 6,300 ft
Est. Tank Spillway Elevation = 528 → **Use Tank Spillway Elevation = 525**
Check pressure at maximum elevation in service area = 53.612
Check pressure at minimum elevation in service area = 127.0715 ← > 100 psi. Use PRV at each branch.

<u>215' to 50' Elevation Pressure Zone</u>

Use:
Pipe diameter = 16 in
Q (estimated) = 1,578 gpm (2x Average Daily Flow) → s = 0.00236 ft/ft

Max elevation in service area = 215 Length of pipe = 8,900 ft
Min elevation in service area = 50 Length of pipe = 4,500 ft
Est. Tank Spillway Elevation = 363 → **Use Tank Spillway Elevation = 360**
Check pressure at maximum elevation in service area = 53.7316
Check pressure at minimum elevation in service area = 129.7313 ← > 100 psi. Use PRV at each branch.

PROJECT:	Villages of Leialii	JOB NO:	2007700500
CLIENT:	HHFDC	DATE:	22-Sep-09
SUBJECT:	Estimate of Reclaimed Water Volumes	BY:	C. Ancheta
FILE:	P:\Projects\Leialii_2007700500\Reports\Consultant Reports\Civil\Sewer Information\[Reclaimed Water Calculations.xls]Tank summary (2)		

Estimate Reclaimed Water Tank Elevation (Concept Two)

Landscape Irrigation Criteria: Minimum pressure = 55 psi
Maximum pressure (w/out PRV) = 100 psi

Est. Tank Spillway Elevation = (Max elev in service area) + [(Minimum pressure) / (62.4 pcf) * (12 in/ft)^2] + [(Length of pipe) * (s)]
Check pressure at minimum elevation in service area = [(Tank spillway elev) - (Min elev in service area) - [(Length of pipe) * (s)]] * (62.4 pcf) / (12 in/ft)^2

<u>380' to 215' Elevation Pressure Zone</u>

Use:
Pipe diameter = 16 in
Q (estimated) = 954 gpm (Average Daily Flow) → s = 0.00093 ft/ft

Max elevation in service area = 380 Length of pipe = 8,000 ft
Min elevation in service area = 215 Length of pipe = 6,300 ft
Est. Tank Spillway Elevation = 514 → **Use Tank Spillway Elevation = 525**
Check pressure at maximum elevation in service area = 59.60933
Check pressure at minimum elevation in service area = 131.7944 ← > 100 psi. Use PRV at each branch.

<u>215' to 50' Elevation Pressure Zone</u>

Use:
Pipe diameter = 18 in
Q (estimated) = 1,907 gpm (2x Average Daily Flow) → s = 0.00189 ft/ft

Max elevation in service area = 215 Length of pipe = 8,900 ft
Min elevation in service area = 50 Length of pipe = 4,500 ft
Est. Tank Spillway Elevation = 359 → **Use Tank Spillway Elevation = 360**
Check pressure at maximum elevation in service area = 55.54423
Check pressure at minimum elevation in service area = 130.6478 ← > 100 psi. Use PRV at each branch.

PROJECT:	Villages of Leialii	JOB NO:	2007700500
CLIENT:	HHFDC	DATE:	22-Sep-09
SUBJECT:	Estimate of Reclaimed Water Volumes	BY:	C. Ancheta
FILE:	P:\Projects\Leialii_2007700500\Reports\Consultant Reports\Civil\Sewer Information\[Reclaimed Water Calculations.xls]Tank summary (2)		

Estimate Reclaimed Water Tank Elevation (Concept Three)

Landscape Irrigation Criteria: Minimum pressure = 55 psi
Maximum pressure (w/out PRV) = 100 psi

Est. Tank Spillway Elevation = (Max elev in service area) + [(Minimum pressure) / (62.4 pcf) * (12 in/ft)^2] + [(Length of pipe) * (s)]
Check pressure at minimum elevation in service area = [(Tank spillway elev) - (Min elev in service area) - [(Length of pipe) * (s)]] * (62.4 pcf) / (12 in/ft)^2

<u>380' to 215' Elevation Pressure Zone</u>

Use:
Pipe diameter = 16 in
Q (estimated) = 1060 gpm (1.1x Average Daily Flow) → s = 0.00115 ft/ft

Max elevation in service area = 380 Length of pipe = 8,400 ft
Min elevation in service area = 215 Length of pipe = 6,000 ft
Est. Tank Spillway Elevation = 517 → **Use Tank Spillway Elevation = 525**
Check pressure at maximum elevation in service area = 58.64733
Check pressure at minimum elevation in service area = 131.3433 ← > 100 psi. Use PRV at each branch.

<u>215' to 50' Elevation Pressure Zone</u>

Use:
Pipe diameter = 18 in
Q (estimated) = 1,928 gpm (2x Average Daily Flow) → s = 0.00193 ft/ft

Max elevation in service area = 215 Length of pipe = 9,100 ft
Min elevation in service area = 50 Length of pipe = 4,100 ft
Est. Tank Spillway Elevation = 359 → **Use Tank Spillway Elevation = 360**
Check pressure at maximum elevation in service area = 55.2227
Check pressure at minimum elevation in service area = 130.9044 ← > 100 psi. Use PRV at each branch.

PROJECT:	Villages of Leialii	JOB NO:	2007700500
CLIENT:	HHFDC	DATE:	22-Sep-09
SUBJECT:	Reclaimed Water Tanks	BY:	C. Ancheta
FILE:	P:\Projects\Leialii_2007700500\Reports\Consultant Reports\Civil\Sewer Information\[Reclaimed Water Calculations.xls]Tank summary (2)		

Reclaimed Water Tank Summary

Concept One		Calculated Tank Size (gal)	AquaStore Tank Model Diameter (ft)	AquaStore Tank Model Sidewall Height (ft)	Nominal Tank Capacity (gal)	Storage Depth (ft)	Freeboard (ft)	Budget Cost[1]
525' Tank	Phase A	290,000	50	24	355,000	19.61	4.39	$658,000
	Phase B	290,000	50	24	355,000	19.61	4.39	$658,000
	Total Site	580,000	70	24	685,000	20.32	3.68	$889,995
360' Tank	Phase A	375,000	56	24	438,000	20.55	3.45	$686,841
		185,000	39	24	214,000	20.75	3.25	$498,446
	Total Site	560,000	70	24	685,000	19.62	4.38	$889,995

Concept Two		Calculated Tank Size (gal)	AquaStore Tank Model Diameter (ft)	AquaStore Tank Model Sidewall Height (ft)	Nominal Tank Capacity (gal)	Storage Depth (ft)	Freeboard (ft)	Budget Cost[1]
525' Tank	Phase A	330,000	53	24	395,000	20.05	3.95	$672,290
	Phase B	330,000	53	24	395,000	20.05	3.95	$672,290
	Total Site	660,000	76	24	799,000	19.82	4.18	$984,831
360' Tank	Phase A	450,000	62	24	530,000	20.38	3.62	$753,988
		265,000	48	24	316,000	20.13	3.87	$637,738
	Total Site	715,000	78	24	859,000	19.98	4.02	$1,000,983

Concept Three		Calculated Tank Size (gal)	AquaStore Tank Model Diameter (ft)	AquaStore Tank Model Sidewall Height (ft)	Nominal Tank Capacity (gal)	Storage Depth (ft)	Freeboard (ft)	Budget Cost[1]
525' Tank	Phase A	390,000	59	24	483,000	19.38	4.62	$694,781
	Phase B	390,000	59	24	483,000	19.38	4.62	$694,781
	Total Site	780,000	84	24	986,000	18.99	5.01	$1,125,000
360' Tank	Phase A	595,000	73	24	741,000	19.27	4.73	$937,000
		20,000	14	24	27,000	17.78	6.22	-
	Total Site	615,000	73	24	741,000	19.92	4.08	$937,000

Notes:

1. Budget cost from M & M Tanks, Inc. for Aquastore Glass-Fused Water Tank. See estimate from Steve Gabriel, dated 5/28/09, for cost exclusions.

APPENDIX C – SEWER AND RECLAIMED WATER SYSTEMS COSTS

PROJECT: Villages of Leialii
CLIENT: HHFDC
SUBJECT: System Costs
FILE: P:\Projects\Leialii_2007700500\Reports\Consultant Reports\Civil\Sewer Information\Cost Estimates\[Leialii Offsite Reclaimed Water System Probable Construction Costs_2010 October.xls]One-A

JOB NO: 2007700500
DATE: 8-Oct-10
BY: C. Ancheta

Summary of Sewer and Reclaimed Water System Infrastructure Costs

Description		Off-Site Sewer	On-Site Sewer	Off-Site Reclaimed Water	On-Site Reclaimed Water	Total Off-Site Treatment	Total On-Site Treatment
Concept One	Phase A	$ 42,721,000	$ 49,119,000	$ 47,551,000	$ 18,884,000	$ 90,272,000	$ 68,003,000
	Phase B	$ -	$ 19,174,000	$ 3,361,000	$ 2,009,000	$ 3,361,000	$ 21,183,000
	Total	**$ 42,721,000**	**$ 68,293,000**	**$ 50,912,000**	**$ 20,893,000**	**$ 93,633,000**	**$ 89,186,000**
Concept Two	Phase A	$ 42,721,000	$ 52,527,000	$ 49,423,000	$ 20,000,000	$ 92,144,000	$ 72,527,000
	Phase B	$ -	$ 15,766,000	$ 3,389,000	$ 2,028,000	$ 3,389,000	$ 17,794,000
	Total	**$ 42,721,000**	**$ 68,293,000**	**$ 52,812,000**	**$ 22,028,000**	**$ 95,533,000**	**$ 90,321,000**
Concept Three	Phase A	$ 42,099,000	$ 54,315,000	$ 50,408,000	$ 20,966,000	$ 92,507,000	$ 75,281,000
	Phase B	$ -	$ 13,585,000	$ 9,645,000	$ 5,170,000	$ 9,645,000	$ 18,755,000
	Total	**$ 42,099,000**	**$ 67,900,000**	**$ 60,053,000**	**$ 26,136,000**	**$ 102,152,000**	**$ 94,036,000**

Villages of Leiali'i Opinion of Probable Construction Cost - Off-site Sewer System Concepts One and Two

	Quant	Units	Unit cost	Line Cost
SITE WORK				
Mobilization / Demobilization	1	LS	180,000	$180,000
Traffic Control	1	LS	120,000	$120,000
Construction Surveys	1	LS	140,000	$140,000
Erosion Control	1	LS	40,000	$40,000
Cut and patch road	10,500	SY	120	$1,260,000
Subtotal, Site Work				**$1,740,000**
SANITARY SEWER SYSTEM				
On-site System				
Earthwork	17,000	CY	45	$765,000
Clearing and grading	1.2	AC	20,000	$24,000
Drainage system	1	LS	115,000	$115,000
Chain link fence	1,000	LF	50	$50,000
AC Pavement	600	SY	75	$45,000
8" sewer pipe	1,400	LF	160	$224,000
12" sewer pipe	950	LF	220	$209,000
15" sewer pipe	2,450	LF	270	$661,500
18" sewer pipe	3,150	LF	320	$1,008,000
21" sewer pipe	3,100	LF	360	$1,116,000
18" pressure sewer pipe	5,900	LF	230	$1,357,000
Miscellaneous fittings	1	LS	90,000	$90,000
Sewer manhole	43	EA	11,000	$473,000
Sewage pump station	1	LS	20,000,000	$20,000,000
Air relief valve assembly and manhole	2	EA	15,000	$30,000
Gravity sewer line testing	11,050	LF	2	$22,100
Pressure sewer line testing	5,900	LF	2.5	$14,750
Subtotal, On-site System				$26,204,350
Sewer Line from Leiali'i Site to Honoapi'ilani Highway STA 124+10.43				
Connection to existing	1	LS	8,000	$8,000
21" vitrified clay or HDPE sewer pipe	7,726	LF	270	$2,086,020
18" vitrified clay or HDPE sewer pipe	1,746	LF	255	$445,230
8" PVC sewer pipe	60	LF	155	$9,300
Miscellaneous fittings	1	LS	80,000	$80,000
Sewer manhole, 6' to 9.9' deep	25	EA	7,000	$175,000
Sewer manhole, 10' to 14.9' deep	7	EA	9,000	$63,000
Sewer manhole, 15' to 20' deep	1	EA	13,000	$13,000
Sewer shallow drop manhole, 10' deep	1	EA	11,000	$11,000
Sewer shallow drop manhole, 18' deep	1	EA	16,000	$16,000
Air relief valve assembly and manhole	3	EA	15,000	$45,000
Reinforced concrete jacket	85	LF	500	$42,500
Gravity sewer line testing	9,532	LF	2.00	$19,064
Subtotal, Leiali'i to Honoapi'ilani Hwy Sta 124+10.43				$3,013,114
Subtotal, Sanitary Sewer System				**$29,217,464**

SUBTOTAL	**$30,957,464**
CONTINGENCY (20%)	$6,191,493
CONSTRUCTION TOTAL	$37,148,957
DESIGN AND CONSTRUCTION SERVICES (15%)	$5,572,344
TOTAL	$42,721,300
SAY	**$42,721,000**

Notes:
1. Costs are in 2009 dollars and include piping sewer flows from gravity trunk sewer through offsite gravity lines to Honoapi'ilani Highway (that eventually flow to Lahaina WWRF). Costs are for County-dedicated system.
2. Offsite gravity sewer lines are based on Construction Plans for Villages of Leiali'i Offsite Sewer System (to Honoapi'ilani Highway STA 124+30.43).
3. Mobilization/demobilization, traffic control, construction surveys, and erosion control for on-site systems are not included, as measures for these items will be included with the main site.
4. Earthwork quantities include earthwork operations for the pump station site only. Assume excess excavated material will be used elsewhere onsite, so no cost associated with the removal.

Villages of Leiali'i Opinion of Probable Construction Cost - Off-site Sewer System Concept Three

	Quant	Units	Unit cost	Line Cost
SITE WORK				
Mobilization / Demobilization	1	LS	180,000	$180,000
Traffic Control	1	LS	120,000	$120,000
Construction Surveys	1	LS	140,000	$140,000
Erosion Control	1	LS	40,000	$40,000
Cut and patch road	10,500	SY	120	$1,260,000
Subtotal, Site Work				**$1,740,000**
SANITARY SEWER SYSTEM				
On-site System				
Earthwork	10,600	CY	45	$477,000
Clearing and grading	1.2	AC	20,000	$24,000
Drainage system	1	LS	220,000	$220,000
Chain link fence	1,000	LF	50	$50,000
AC Pavement	600	SY	75	$45,000
8" sewer pipe	1,400	LF	160	$224,000
12" sewer pipe	1,300	LF	220	$286,000
15" sewer pipe	2,100	LF	270	$567,000
18" sewer pipe	2,650	LF	320	$848,000
21" sewer pipe	3,100	LF	360	$1,116,000
18" pressure sewer pipe	5,450	LF	230	$1,253,500
Miscellaneous fittings	1	LS	90,000	$90,000
Sewer manhole	43	EA	11,000	$473,000
Sewage pump station	1	LS	20,000,000	$20,000,000
Air relief valve assembly and manhole	3	EA	15,000	$45,000
Gravity sewer line testing	10,550	LF	2	$21,100
Pressure sewer line testing	5,450	LF	2.5	$13,625
Subtotal, On-site System				$25,753,225
Sewer Line from Leiali'i Site to Honoapi'ilani Highway STA 124+10.43				
Connection to existing	1	LS	8,000	$8,000
21" vitrified clay or HDPE sewer pipe	7,726	LF	270	$2,086,020
18" vitrified clay or HDPE sewer pipe	1,746	LF	255	$445,230
8" PVC sewer pipe	60	LF	155	$9,300
Miscellaneous fittings	1	LS	80,000	$80,000
Sewer manhole, 6' to 9.9' deep	25	EA	7,000	$175,000
Sewer manhole, 10' to 14.9' deep	7	EA	9,000	$63,000
Sewer manhole, 15' to 20' deep	1	EA	13,000	$13,000
Sewer shallow drop manhole, 10' deep	1	EA	11,000	$11,000
Sewer shallow drop manhole, 18' deep	1	EA	16,000	$16,000
Air relief valve assembly and manhole	3	EA	15,000	$45,000
Reinforced concrete jacket	85	LF	500	$42,500
Gravity sewer line testing	9,532	LF	2.00	$19,064
Subtotal, Leiali'i to Honoapi'ilani Hwy Sta 124+10.43				$3,013,114
Subtotal, Sanitary Sewer System				**$28,766,339**

SUBTOTAL	**$30,506,339**
CONTINGENCY (20%)	$6,101,268
CONSTRUCTION TOTAL	$36,607,607
DESIGN AND CONSTRUCTION SERVICES (15%)	$5,491,141
TOTAL	$42,098,748
SAY	**$42,099,000**

Notes:
1. Costs are in 2009 dollars and include piping sewer flows from gravity trunk sewer through offsite gravity lines to Honoapi'ilani Highway (that eventually flow to Lahaina WWRF). Costs are for County-dedicated system.
2. Offsite gravity sewer lines are based on Construction Plans for Villages of Leiali'i Offsite Sewer System (to Honoapi'ilani Highway STA 124+30.43).
3. Mobilization/demobilization, traffic control, construction surveys, and erosion control for on-site systems are not included, as measures for these items will be included with the main site.
4. Earthwork quantities include earthwork operations for the pump station site only. Assume excess excavated material will be used elsewhere onsite, so no cost associated with the removal.

Prepared by Belt Collins Hawaii Ltd.
For Hawaii Housing Finance and Development Corporation

Villages of Leiali'i Opinion of Probable Construction Cost - On-site Sewer System
Concept One - Phase A

	Quant	Units	Unit cost	Line Cost
SITE WORK				
Earthwork	35,000	CY	45	$1,575,000
Clearing and grading	5.4	AC	20,000	$107,600
Drainage system	1	LS	450,000	$450,000
Chain link fence	3,400	LF	50	$170,000
AC Pavement	4,000	SY	75	$300,000
Subtotal, Site Work				**$2,602,600**
SANITARY SEWER SYSTEM				
12" sewer pipe	950	LF	220	$209,000
15" sewer pipe	2,450	LF	270	$661,500
18" sewer pipe	3,150	LF	320	$1,008,000
4" pressure sewer pipe	1,300	LF	135	$175,500
18" pressure sewer pipe	3,100	LF	230	$713,000
Miscellaneous fittings	1	LS	40,000	$40,000
Sewer manhole	25	EA	11,000	$275,000
Lift station (northwest of site)	1	LS	500,000	$500,000
Sewage pump station	1	LS	10,000,000	$10,000,000
Wastewater Treatment Plant (WWTP)	1	LS	18,730,000	$18,730,000
Injection Wells	2	EA	312,250	$624,500
Air relief valve assembly and manhole	2	EA	15,000	$30,000
Gravity sewer line testing	6,550	LF	2	$13,100
Pressure sewer line testing	4,400	LF	2.50	$11,000
Subtotal, Sanitary Sewer System				**$32,990,600**
SUBTOTAL				**$35,593,200**
CONTINGENCY (20%)				$7,118,640
CONSTRUCTION TOTAL				$42,711,840
DESIGN AND CONSTRUCTION SERVICES (15%)				$6,406,776
TOTAL				$49,118,616
SAY				**$49,119,000**

Notes:
1. Costs are in 2009 dollars and include piping sewer flows from lift station to gravity main and from sewage pump station to onsite WWTP. Costs are for system operated by private entity.
2. Mobilization/demobilization, traffic control, construction surveys, and erosion control are not included, as measures for these items will be included with the main site.
3. Earthwork quantities include earthwork operations for the WWTP and pump station sites only.
   Assume excess excavated material will be used elsewhere onsite, so no cost associated with the removal.

Prepared by Belt Collins Hawaii Ltd.
For Hawaii Housing Finance and Development Corporation

Villages of Leiali'i Opinion of Probable Construction Cost - On-site Sewer System Concept One - Phase B

	Quant	Units	Unit cost	Line Cost
SANITARY SEWER SYSTEM				
Wastewater Treatment Plant (WWTP)	1	LS	13,270,000	$13,270,000
Injection Wells	2	EA	312,250	$624,500
Subtotal, Sanitary Sewer System				**$13,894,500**
SUBTOTAL				**$13,894,500**
CONTINGENCY (20%)				$2,778,900
CONSTRUCTION TOTAL				$16,673,400
DESIGN AND CONSTRUCTION SERVICES (15%)				$2,501,010
TOTAL				$19,174,410
SAY				**$19,174,000**

Notes:
1. Costs are in 2009 dollars and include improvements to WWTP to add equipment to service Phase B. Costs are for system operated by private entity.
2. Mobilization/demobilization, traffic control, construction surveys, and erosion control are not included, as measures for these items will be included with the main site.
3. Site work for the WWTP included in Phase A.

Prepared by Belt Collins Hawaii Ltd.
For Hawaii Housing Finance and Development Corporation

Villages of Leiali'i Opinion of Probable Construction Cost - On-site Sewer System
Concept Two - Phase A

	Quant	Units	Unit cost	Line Cost
SITE WORK				
Earthwork	35,000	CY	45	$1,575,000
Clearing and grading	5.4	AC	20,000	$107,600
Drainage system	1	LS	450,000	$450,000
Chain link fence	3,400	LF	50	$170,000
AC Pavement	4,000	SY	75	$300,000
Subtotal, Site Work				**$2,602,600**
SANITARY SEWER SYSTEM				
12" sewer pipe	950	LF	220	$209,000
15" sewer pipe	2,450	LF	270	$661,500
18" sewer pipe	3,150	LF	320	$1,008,000
4" pressure sewer pipe	1,300	LF	135	$175,500
18" pressure sewer pipe	3,100	LF	230	$713,000
Miscellaneous fittings	1	LS	40,000	$40,000
Sewer manhole	25	EA	11,000	$275,000
Lift station (northwest of site)	1	LS	500,000	$500,000
Sewage pump station	1	LS	10,000,000	$10,000,000
Wastewater Treatment Plant (WWTP)	1	LS	21,200,000	$21,200,000
Injection Wells	2	EA	312,250	$624,500
Air relief valve assembly and manhole	2	EA	15,000	$30,000
Gravity sewer line testing	6,550	LF	2	$13,100
Pressure sewer line testing	4,400	LF	2.50	$11,000
Subtotal, Sanitary Sewer System				**$35,460,600**
SUBTOTAL				**$38,063,200**
CONTINGENCY (20%)				$7,612,640
CONSTRUCTION TOTAL				$45,675,840
DESIGN AND CONSTRUCTION SERVICES (15%)				$6,851,376
TOTAL				$52,527,216
SAY				**$52,527,000**

Notes:
1. Costs are in 2009 dollars and include piping sewer flows from lift station to gravity main and from sewage pump station to onsite WWTP. Costs are for system operated by private entity.
2. Mobilization/demobilization, traffic control, construction surveys, and erosion control are not included, as measures for these items will be included with the main site.
3. Earthwork quantities include earthwork operations for the WWTP and pump station sites only.
   Assume excess excavated material will be used elsewhere onsite, so no cost associated with the removal.

Prepared by Belt Collins Hawaii Ltd.
For Hawaii Housing Finance and Development Corporation

Villages of Leiali'i Opinion of Probable Construction Cost - On-site Sewer System Concept Two - Phase B

	Quant	Units	Unit cost	Line Cost
SANITARY SEWER SYSTEM				
Wastewater Treatment Plant (WWTP)	1	LS	10,800,000	$10,800,000
Injection Wells	2	EA	312,250	$624,500
Subtotal, Sanitary Sewer System				**$11,424,500**
SUBTOTAL				**$11,424,500**
CONTINGENCY (20%)				$2,284,900
CONSTRUCTION TOTAL				$13,709,400
DESIGN AND CONSTRUCTION SERVICES (15%)				$2,056,410
TOTAL				$15,765,810
SAY				**$15,766,000**

Notes:
1. Costs are in 2009 dollars and include improvements to WWTP to add equipment to service Phase B. Costs are for system operated by private entity.
2. Mobilization/demobilization, traffic control, construction surveys, and erosion control are not included, as measures for these items will be included with the main site.
3. Site work for the WWTP included in Phase A.

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Prepared by Belt Collins Hawaii Ltd.
For Hawaii Housing Finance and Development Corporation

Villages of Leiali'i Opinion of Probable Construction Cost - On-site Sewer System
Concept Three - Phase A

	Quant	Units	Unit cost	Line Cost
SITE WORK				
Earthwork	29,500	CY	45	$1,327,500
Clearing and grading	5.4	AC	20,000	$107,600
Drainage system	1	LS	450,000	$450,000
Chain link fence	3,600	LF	50	$180,000
AC Pavement	4,000	SY	75	$300,000
Subtotal, Site Work				**$2,365,100**
SANITARY SEWER SYSTEM				
12" sewer pipe	1,300	LF	220	$286,000
15" sewer pipe	2,100	LF	270	$567,000
18" sewer pipe	2,650	LF	320	$848,000
4" pressure sewer pipe	1,200	LF	135	$162,000
18" pressure sewer pipe	3,700	LF	230	$851,000
Miscellaneous fittings	1	LS	42,000	$42,000
Sewer manhole	24	EA	11,000	$264,000
Lift station (northwest of site)	1	LS	500,000	$500,000
Sewage pump station	1	LS	10,000,000	$10,000,000
Wastewater Treatment Plant (WWTP)	1	LS	22,780,000	$22,780,000
Injection Wells	2	EA	312,250	$624,500
Air relief valve assembly and manhole	3	EA	15,000	$45,000
Gravity sewer line testing	6,050	LF	2	$12,100
Pressure sewer line testing	4,900	LF	2.50	$12,250
Subtotal, Sanitary Sewer System				**$36,993,850**
SUBTOTAL				**$39,358,950**
CONTINGENCY (20%)				$7,871,790
CONSTRUCTION TOTAL				$47,230,740
DESIGN AND CONSTRUCTION SERVICES (15%)				$7,084,611
TOTAL				$54,315,351
SAY				**$54,315,000**

Notes:
1. Costs are in 2009 dollars and include piping sewer flows from lift station to gravity main and from sewage pump station to onsite WWTP. Costs are for system operated by private entity.
2. Mobilization/demobilization, traffic control, construction surveys, and erosion control are not included, as measures for these items will be included with the main site.
3. Earthwork quantities include earthwork operations for the WWTP and pump station sites only.
   Assume excess excavated material will be used elsewhere onsite, so no cost associated with the removal.

Prepared by Belt Collins Hawaii Ltd.
For Hawaii Housing Finance and Development Corporation

Villages of Leiali'i Opinion of Probable Construction Cost - On-site Sewer System Concept Three - Phase B

	Quant	Units	Unit cost	Line Cost
SANITARY SEWER SYSTEM				
Wastewater Treatment Plant (WWTP)	1	LS	9,220,000	$9,220,000
Injection Wells	2	EA	312,250	$624,500
Subtotal, Sanitary Sewer System				**$9,844,500**
SUBTOTAL				**$9,844,500**
CONTINGENCY (20%)				$1,968,900
CONSTRUCTION TOTAL				$11,813,400
DESIGN AND CONSTRUCTION SERVICES (15%)				$1,772,010
TOTAL				$13,585,410
SAY				**$13,585,000**

Notes:
1. Costs are in 2009 dollars and include improvements to WWTP to add equipment to service Phase B. Costs are for system operated by private entity.
2. Mobilization/demobilization, traffic control, construction surveys, and erosion control are not included, as measures for these items will be included with the main site.
3. Site work for the WWTP included in Phase A.

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Villages of Leiali'i Opinion of Probable Construction Cost - Off-site Reclaimed Water System Concept One - Phase A

	Quant	Units	Unit cost	Line Cost
SITE WORK				
Mobilization / Demobilization	1	LS	210,000	$210,000
Traffic Control	1	LS	150,000	$150,000
Construction Surveys	1	LS	200,000	$200,000
Erosion Control	1	LS	75,000	$75,000
Cut and patch road	16,000	SY	120	$1,920,000
Subtotal, Site Work				**$2,555,000**
WATER RECLAMATION SYSTEM				
On-site System				
Earthwork	29,000	CY	45	$1,305,000
Clearing and grading	5.6	AC	20,000	$112,000
Drainage system and temporary outfall	1	LS	350,000	$350,000
Chain link fence	3,250	LF	50	$162,500
AC Pavement	3,800	SY	75	$285,000
12" DI pressure sewer pipe	4,500	LF	200	$900,000
16" DI pressure sewer pipe	6,800	LF	220	$1,496,000
Miscellaneous fittings	1	LS	110,000	$110,000
12" Gate valve and valve box	5	EA	5,000	$25,000
16" Butterfly valve and manhole	7	EA	8,000	$56,000
Air relief valve assembly and manhole	4	EA	5,000	$20,000
Pressure reducing valve assembly and box	6	EA	12,000	$72,000
0.685 MG Reservoir tank	1	EA	1,202,000	$1,202,000
0.355 MG Reservoir tank	1	EA	888,000	$888,000
Booster pump station (360' tank to 525' tanks)	1	LS	4,000,000	$4,000,000
Reclamation line testing	11,300	LF	2.5	$28,250
Subtotal, On-site System				$11,011,750
Reclamation Line from Leiali'i Site to Honoapi'ilani Highway STA 124+10.43				
Connection to existing	1	LS	8,000	$8,000
20" HDPE (or 16" DI) pressure sewer pipe	12,600	LF	260	$3,276,000
Miscellaneous fittings	1	LS	95,000	$95,000
20" Butterfly valve and manhole	7	EA	12,000	$84,000
Air relief valve assembly and manhole	2	EA	5,000	$10,000
Reinforced concrete jacket	75	LF	500	$37,500
Reclamation line testing	12,600	LF	2.50	$31,500
Subtotal, Leiali'i to Honoapi'ilani Hwy Sta 124+10.43				$3,542,000
Reclamation Line from Honoapi'ilani Highway STA 124+10.43 to 20" Line mauka of Lahaina Wastewater Reclamation Facility (WWRF)				
Connection to existing	1	LS	20,000	$20,000
20" HDPE (or 16" DI) pressure sewer pipe	8,700	LF	260	$2,262,000
Miscellaneous fittings	1	LS	75,000	$75,000
20" Butterfly valve and manhole	6	EA	12,000	$72,000
Air relief valve assembly and manhole	1	EA	5,000	$5,000
Blowoff assembly and manhole	1	EA	3,000	$3,000
Reinforced concrete jacket	140	LF	500	$70,000
Reclamation line testing	8,700	LF	2.50	$21,750
Subtotal, Honoapi'ilani Hwy Sta 124+10.43 to mauka of Lahaina WWRF				$2,528,750

Improvements to Existing Reclaimed Water System			
Upgrade to Reclaimed Water Effluent Pump Station at Lahaina WWRF	1 LS	5,070,000	$5,070,000
New 2.0 MG Storage Reservoir at Lahaina WWRF	1 LS	3,750,000	$3,750,000
Reclaimed Booster Pump Station - 1	1 LS	6,000,000	$6,000,000
Subtotal, County Reclaimed Water System			$14,820,000
Subtotal, Water Reclamation System			**$31,902,500**
SUBTOTAL			**$34,457,500**
CONTINGENCY (20%)			$6,891,500
CONSTRUCTION TOTAL			$41,349,000
DESIGN AND CONSTRUCTION SERVICES (15%)			$6,202,350
TOTAL			$47,551,350
SAY			**$47,551,000**

Notes:
1. Costs are in 2009 dollars and include piping reclaimed water through offsite pressure lines from mauka of the Lahaina WWRF to the onsite reservoir tanks. Costs are for County-dedicated system.
2. Offsite reclaimed water lines are based on Construction Plans for Villages of Leiali'i Offsite Sewer System (to Honoapi'ilani Highway STA 124+10.43). Reclaimed water lines are also based on providing a separate line similar to that shown in Lahaina-Kaanapali Gravity Sewer Replacement Phase 2A (from Honoapi'ilani Highway STA 124+10.43 to Lahaina WWRF) and parallel to the existing 20" line mauka of the WWRF toward the proposed 1MG reservoir.
3. Excavation quantities include earthwork operations for the onsite reservoir tank sites only. Assume excess excavated material will be used elsewhere onsite, so no cost associated with the removal.
4. Mobilization/demobilization, traffic control, construction surveys, and erosion control for on-site systems are not included, as measures for these items will be included with the main site.
5. Improvements to Existing Reclaimed Water System costs based on West Maui Reclaimed Water Master Plan (2004) with additional 20%.
6. Reservoir tanks are Techstore stainless steel tanks.

Villages of Leiali'i Opinion of Probable Construction Cost - Off-site Reclaimed Water System Concept One - Phase B

	Quant	Units	Unit cost	Line Cost
WATER RECLAMATION SYSTEM				
On-site System				
Drainage System	1	LS	25,000	$25,000
AC Pavement	300	SY	75	$22,500
0.355 MG Reservoir tank	1	EA	888,000	$888,000
Booster pump station (525' tanks to serve part Ph B)	1	LS	1,500,000	$1,500,000
Subtotal, On-site System				**$2,435,500**
SUBTOTAL				**$2,435,500**
CONTINGENCY (20%)				$487,100
CONSTRUCTION TOTAL				$2,922,600
DESIGN AND CONSTRUCTION SERVICES (15%)				$438,390
TOTAL				$3,360,990
SAY				**$3,361,000**

Notes:
1. Costs are in 2009 dollars and include booster pump station and reservoir tank to service mauka areas of Phase B located above the gravity service pressure zones. Costs are for County-dedicated system.
2. Mobilization/demobilization, traffic control, construction surveys, and erosion control are not included, as measures for these items will be included with the main site.
3. Earthwork operations for the reservoir tank site included in Phase A.
4. Pump station for water reclamation system irrigation service to school, parks, roads, and drainage areas in Phase BA and Phase BB, and 35% of roads in Phase BC. Distribution force main from pump station to service Phase B are not included, as these items will be included with the on-site road infrastructure costs.

Villages of Leiali'i Opinion of Probable Construction Cost - Off-site Reclaimed Water System Concept Two - Phase A

	Quant	Units	Unit cost	Line Cost
SITE WORK				
Mobilization / Demobilization	1	LS	210,000	$210,000
Traffic Control	1	LS	150,000	$150,000
Construction Surveys	1	LS	200,000	$200,000
Erosion Control	1	LS	75,000	$75,000
Trench and patch road	16,000	SY	120	$1,920,000
Subtotal, Site Work				**$2,555,000**
WATER RECLAMATION SYSTEM				
On-site System				
Earthwork	29,000	CY	45	$1,305,000
Clearing and grading	5.6	AC	20,000	$112,000
Drainage system and temporary outfall	1	LS	350,000	$350,000
Chain link fence	3,250	LF	50	$162,500
AC Pavement	3,800	SY	75	$285,000
16" DI pressure sewer pipe	4,500	LF	220	$990,000
18" DI pressure sewer pipe	6,800	LF	230	$1,564,000
Miscellaneous fittings	1	LS	110,000	$110,000
16" Butterfly valve and manhole	5	EA	8,000	$40,000
18" Butterfly valve and manhole	7	EA	10,000	$70,000
Air relief valve assembly and manhole	4	EA	5,000	$20,000
Pressure reducing valve assembly and box	6	EA	12,000	$72,000
0.859 MG Reservoir tank	1	EA	1,351,000	$1,351,000
0.395 MG Reservoir tank	1	EA	908,000	$908,000
Booster pump station (360' tank to 525' tanks)	1	LS	5,000,000	$5,000,000
Reclamation line testing	11,300	LF	2.5	$28,250
Subtotal, On-site System				$12,367,750
Reclamation Line from Leiali'i Site to Honoapi'ilani Highway STA 124+10.43				
Connection to existing	1	LS	8,000	$8,000
20" HDPE (or 16" DI) pressure sewer pipe	12,600	LF	260	$3,276,000
Miscellaneous fittings	1	LS	95,000	$95,000
20" Butterfly valve and manhole	7	EA	12,000	$84,000
Air relief valve assembly and manhole	2	EA	5,000	$10,000
Reinforced concrete jacket	75	LF	500	$37,500
Reclamation line testing	12,600	LF	3	$31,500
Subtotal, Leiali'i to Honoapi'ilani Hwy Sta 124+10.43				$3,542,000
Reclamation Line from Honoapi'ilani Highway STA 124+10.43 to 20" Line mauka of Lahaina Wastewater Reclamation Facility (WWRF)				
Connection to existing	1	LS	20,000	$20,000
20" HDPE (or 16" DI) pressure sewer pipe	8,700	LF	260	$2,262,000
Miscellaneous fittings	1	LS	75,000	$75,000
20" Butterfly valve and manhole	6	EA	12,000	$72,000
Air relief valve assembly and manhole	1	EA	5,000	$5,000
Blowoff assembly and manhole	1	EA	3,000	$3,000
Reinforced concrete jacket	140	LF	500	$70,000
Reclamation line testing	8,700	LF	3	$21,750
Subtotal, Honoapi'ilani Hwy Sta 124+10.43 to Lahaina WWRF				$2,528,750

Improvements to Existing Reclaimed Water System			
Upgrade to Reclaimed Water Effluent Pump Station at Lahaina WWRF	1 LS	5,070,000	$5,070,000
New 2.0 MG Storage Reservoir at Lahaina WWRF	1 LS	3,750,000	$3,750,000
Reclaimed Booster Pump Station - 1	1 LS	6,000,000	$6,000,000
Subtotal, County Reclaimed Water System			$14,820,000
Subtotal, Water Reclamation System			**$33,258,500**
SUBTOTAL			**$35,813,500**
CONTINGENCY (20%)			$7,162,700
CONSTRUCTION TOTAL			$42,976,200
DESIGN AND CONSTRUCTION SERVICES (15%)			$6,446,430
TOTAL			$49,422,630
SAY			**$49,423,000**

Notes:
1. Costs are in 2009 dollars and include piping reclaimed water through offsite pressure lines from mauka of the Lahaina WWRF to the onsite reservoir tanks. Costs are for County-dedicated system.
2. Offsite reclaimed water lines are based on Construction Plans for Villages of Leiali'i Offsite Sewer System (to Honoapi'ilani Highway STA 124+10.43). Reclaimed water lines are also based on providing a separate line similar to that shown in Lahaina-Kaanapali Gravity Sewer Replacement Phase 2A (from Honoapi'ilani Highway STA 124+10.43 to Lahaina WWRF) and parallel to the existing 20" line mauka of the WWRF toward the proposed 1MG reservoir.
3. Excavation quantities include earthwork operations for the onsite reservoir tank sites only. Assume excess excavated material will be used elsewhere onsite, so no cost associated with the removal.
4. Mobilization/demobilization, traffic control, construction surveys, and erosion control for on-site systems are not included, as measures for these items will be included with the main site.
5. Improvements to Existing Reclaimed Water System costs based on West Maui Reclaimed Water Master Plan (2004) with additional 20%.
6. Reservoir tanks are Techstore stainless steel tanks.

Villages of Leiali'i Opinion of Probable Construction Cost - Off-site Reclaimed Water System Concept Two - Phase B

	Quant	Units	Unit cost	Line Cost
WATER RECLAMATION SYSTEM				
On-site System				
Drainage System	1	LS	25,000	$25,000
AC Pavement	300	SY	75	$22,500
0.395 MG Reservoir tank	1	EA	908,000	$908,000
Booster pump station (525' tanks to serve part Ph B)	1	LS	1,500,000	$1,500,000
Subtotal, On-site System				**$2,455,500**
SUBTOTAL				**$2,455,500**
CONTINGENCY (20%)				$491,100
CONSTRUCTION TOTAL				$2,946,600
DESIGN AND CONSTRUCTION SERVICES (15%)				$441,990
TOTAL				$3,388,590
SAY				**$3,389,000**

Notes:
1. Costs are in 2009 dollars and include booster pump station and reservoir tank to service mauka areas of Phase B located above the gravity service pressure zones. Costs are for County-dedicated system.
2. Mobilization/demobilization, traffic control, construction surveys, and erosion control are not included, as measures for these items will be included with the main site.
3. Earthwork operations for the reservoir tank site included in Phase A.
4. Pump station for water reclamation system irrigation service to school, parks, roads, and drainage areas in Phase BA and Phase BB, and 35% of roads in Phase BC. Distribution force main from pump station to service Phase B are not included, as these items will be included with the on-site road infrastructure costs.

Villages of Leiali'i Opinion of Probable Construction Cost - Off-site Reclaimed Water System Concept Three - Phase A

	Quant	Units	Unit cost	Line Cost
SITE WORK				
Mobilization / Demobilization	1	LS	210,000	$210,000
Traffic Control	1	LS	150,000	$150,000
Construction Surveys	1	LS	200,000	$200,000
Erosion Control	1	LS	75,000	$75,000
Trench and patch road	16,000	SY	120	$1,920,000
Subtotal, Site Work				**$2,555,000**
WATER RECLAMATION SYSTEM				
On-site System				
Earthwork	28,500	CY	45	$1,282,500
Clearing and grading	6.4	AC	20,000	$127,600
Drainage system and temporary outfall	1	LS	360,000	$360,000
Chain link fence	3,200	LF	50	$160,000
AC Pavement	7,450	SY	75	$558,750
16" DI pressure sewer pipe	4,800	LF	220	$1,056,000
18" DI pressure sewer pipe	7,700	LF	230	$1,771,000
Miscellaneous fittings	1	LS	120,000	$120,000
16" Butterfly valve and manhole	5	EA	8,000	$40,000
18" Butterfly valve and manhole	8	EA	10,000	$80,000
Air relief valve assembly and manhole	4	EA	5,000	$20,000
Pressure reducing valve assembly and box	6	EA	12,000	$72,000
0.741 MG Reservoir tank	1	EA	1,265,000	$1,265,000
0.483 MG Reservoir tank	1	EA	938,000	$938,000
Booster pump station (360' tank to 525' tanks)	1	LS	5,200,000	$5,200,000
Reclamation line testing	12,500	LF	3	$31,250
Subtotal, On-site System				$13,082,100
Reclamation Line from Leiali'i Site to Honoapi'ilani Highway STA 124+10.43				
Connection to existing	1	LS	8,000	$8,000
20" HDPE (or 16" DI) pressure sewer pipe	12,600	LF	260	$3,276,000
Miscellaneous fittings	1	LS	95,000	$95,000
20" Butterfly valve and manhole	7	EA	12,000	$84,000
Air relief valve assembly and manhole	2	EA	5,000	$10,000
Reinforced concrete jacket	75	LF	500	$37,500
Reclamation line testing	12,600	LF	2.50	$31,500
Subtotal, Leiali'i to Honoapi'ilani Hwy Sta 124+10.43				$3,542,000
Reclamation Line from Honoapi'ilani Highway STA 124+10.43 to 20" Line mauka of Lahaina Wastewater Reclamation Facility (WWRF)				
Connection to existing	1	LS	20,000	$20,000
20" HDPE (or 16" DI) pressure sewer pipe	8,700	LF	260	$2,262,000
Miscellaneous fittings	1	LS	75,000	$75,000
20" Butterfly valve and manhole	6	EA	12,000	$72,000
Air relief valve assembly and manhole	1	EA	5,000	$5,000
Blowoff assembly and manhole	1	EA	3,000	$3,000
Reinforced concrete jacket	140	LF	500	$70,000
Reclamation line testing	8,700	LF	2.50	$21,750
Subtotal, Honoapi'ilani Hwy Sta 124+10.43 to Lahaina WWRF				$2,528,750

Improvements to Existing Reclaimed Water System			
Upgrade to Reclaimed Water Effluent Pump Station at Lahaina WWRF	1 LS	5,070,000	$5,070,000
New 2.0 MG Storage Reservoir at Lahaina WWRF	1 LS	3,750,000	$3,750,000
Reclaimed Booster Pump Station - 1	1 LS	6,000,000	$6,000,000
Subtotal, County Reclaimed Water System			$14,820,000
Subtotal, Water Reclamation System			**$33,972,850**
SUBTOTAL			**$36,527,850**
CONTINGENCY (20%)			$7,305,570
CONSTRUCTION TOTAL			$43,833,420
DESIGN AND CONSTRUCTION SERVICES (15%)			$6,575,013
TOTAL			$50,408,433
SAY			**$50,408,000**

Notes:
1. Costs are in 2009 dollars and include piping reclaimed water through offsite pressure lines from mauka of the Lahaina WWRF to the onsite reservoir tanks. Costs are for County-dedicated system.
2. Offsite reclaimed water lines are based on Construction Plans for Villages of Leiali'i Offsite Sewer System (to Honoapi'ilani Highway STA 124+10.43). Reclaimed water lines are also based on providing a separate line similar to that shown in Lahaina-Kaanapali Gravity Sewer Replacement Phase 2A (from Honoapi'ilani Highway STA 124+10.43 to Lahaina WWRF) and parallel to the existing 20" line mauka of the WWRF toward the proposed 1MG reservoir.
3. Excavation quantities include earthwork operations for the onsite reservoir tank sites only. Assume excess excavated material will be used elsewhere onsite, so no cost associated with the removal.
4. Mobilization/demobilization, traffic control, construction surveys, and erosion control for on-site systems are not included, as measures for these items will be included with the main site.
5. Improvements to Existing Reclaimed Water System costs based on West Maui Reclaimed Water Master Plan (2004) with additional 20%.
6. Reservoir tanks are Techstore stainless steel tanks.

Villages of Leiali'i Opinion of Probable Construction Cost - Off-site Reclaimed Water System Concept Three - Phase B

	Quant	Units	Unit cost	Line Cost
WATER RECLAMATION SYSTEM				
On-site System				
Drainage System	1	LS	25,000	$25,000
AC Pavement	350	SY	75	$26,250
0.483 MG Reservoir tank	1	EA	938,000	$938,000
Booster pump station (525' tanks to serve part Ph B)	1	LS	6,000,000	$6,000,000
Subtotal, On-site System				**$6,989,250**
SUBTOTAL				**$6,989,250**
CONTINGENCY (20%)				$1,397,850
CONSTRUCTION TOTAL				$8,387,100
DESIGN AND CONSTRUCTION SERVICES (15%)				$1,258,065
TOTAL				$9,645,165
SAY				**$9,645,000**

Notes:
1. Costs are in 2009 dollars and include booster pump station and reservoir tank to service mauka areas of Phase B located above the gravity service pressure zones. Costs are for County-dedicated system.
2. Mobilization/demobilization, traffic control, construction surveys, and erosion control are not included, as measures for these items will be included with the main site.
3. Earthwork operations for the reservoir tank site included in Phase A.
4. Pump station for water reclamation system irrigation service to school, parks, roads, and drainage areas in Phase BA and Phase BB, and 35% of roads in Phase BC. Distribution force main from pump station to service Phase B are not included, as these items will be included with the on-site road infrastructure costs.

Prepared by Belt Collins Hawaii Ltd.
For Hawaii Housing Finance and Development Corporation

Villages of Leiali'i Opinion of Probable Construction Cost - On-site Reclaimed Water System Concept One - Phase A

	Quant	Units	Unit cost	Line Cost
SITE WORK				
Earthwork	20,000	CY	45	$900,000
Clearing and grading	4.4	AC	20,000	$88,000
Drainage system and temporary outfall	1	LS	200,000	$200,000
Chain link fence	2,300	LF	50	$115,000
AC Pavement	3,200	SY	75	$240,000
Subtotal, Site Work				**$1,543,000**
WATER RECLAMATION SYSTEM				
12" DI pressure sewer pipe	4,500	LF	200	$900,000
16" DI pressure sewer pipe	6,400	LF	220	$1,408,000
Miscellaneous fittings	1	LS	85,000	$85,000
12" Gate valve and valve box	5	EA	5,000	$25,000
16" Butterfly valve and manhole	7	EA	8,000	$56,000
Air relief valve assembly and manhole	4	EA	5,000	$20,000
Pressure reducing valve assembly and box	6	EA	12,000	$72,000
0.685 MG Reservoir tank	1	EA	890,000	$890,000
0.355 MG Reservoir tank	1	EA	658,000	$658,000
Booster pump station (WWTF to 360' tank)	1	LS	6,000,000	$6,000,000
Booster pump station (360' tank to 525' tanks)	1	LS	2,000,000	$2,000,000
Reclamation line testing	10,900	LF	2.50	$27,250
Subtotal, Water Reclamation System				**$12,141,250**
SUBTOTAL				$13,684,250
CONTINGENCY (20%)				$2,736,850
CONSTRUCTION TOTAL				$16,421,100
DESIGN AND CONSTRUCTION SERVICES (15%)				$2,463,165
TOTAL				$18,884,265
SAY				**$18,884,000**

Notes:
1. Costs are in 2009 dollars and include piping reclaimed water from onsite WWTP to onsite reservoir tanks. Costs are for system operated by private entity.
2. Mobilization/demobilization, traffic control, construction surveys, and erosion control are not included, as measures for these items will be included with the main site.
3. Earthwork quantities include earthwork operations for the reservoir tank sites only. Assume excess material will be used elsewhere onsite, so no cost associated with the removal.
4. Cost for the access road to the 525' tank is included in the off-site water system cost, as the 525' tank can utilize the the same access road as the potable water tanks.
5. Reservoir tanks are Aquastore glass-fused to steel tanks.

Prepared by Belt Collins Hawaii Ltd.
For Hawaii Housing Finance and Development Corporation

Villages of Leiali'i Opinion of Probable Construction Cost - On-site Reclaimed Water System Concept One - Phase B

	Quant	Units	Unit cost	Line Cost
SITE WORK				
Drainage System	1	LS	25,000	$25,000
AC Pavement	300	SY	75	$22,500
Subtotal, Site Work				**$47,500**
WATER RECLAMATION SYSTEM				
0.355 MG Reservoir tank	1	EA	658,000	$658,000
Booster pump station (525' tanks to serve part Ph B)	1	LS	750,000	$750,000
Subtotal, Water Reclamation System				**$1,408,000**
SUBTOTAL				$1,455,500
CONTINGENCY (20%)				$291,100
CONSTRUCTION TOTAL				$1,746,600
DESIGN AND CONSTRUCTION SERVICES (15%)				$261,990
TOTAL				$2,008,590
SAY				**$2,009,000**

Notes:
1. Costs are in 2009 dollars and include booster pump station and reservoir tank to service mauka areas of Phase B located above the gravity service pressure zones. Costs are for system operated by private entity.
2. Mobilization/demobilization, traffic control, construction surveys, and erosion control are not included, as measures for these items will be included with the main site.
3. Earthwork operations for the reservoir tank site included in Phase A.
4. Pump station for water reclamation system irrigation service to school, parks, roads, and drainage areas in Phase BA and Phase BB, and 35% of roads in Phase BC. Distribution force main from pump station to service Phase B are not included, as these items will be included with the on-site road infrastructure costs.

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Prepared by Belt Collins Hawaii Ltd.
For Hawaii Housing Finance and Development Corporation

Villages of Leiali'i Opinion of Probable Construction Cost - On-site Reclaimed Water System Concept Two - Phase A

	Quant	Units	Unit cost	Line Cost
SITE WORK				
Earthwork	20,000	CY	45	$900,000
Clearing and grading	4.4	AC	20,000	$88,000
Drainage system and temporary outfall	1	LS	200,000	$200,000
Chain link fence	2,300	LF	50	$115,000
AC Pavement	3,200	SY	75	$240,000
Subtotal, Site Work				**$1,543,000**
WATER RECLAMATION SYSTEM				
16" DI pressure sewer pipe	4,500	LF	220	$990,000
18" DI pressure sewer pipe	6,400	LF	230	$1,472,000
Miscellaneous fittings	1	LS	85,000	$85,000
16" Butterfly valve and manhole	5	EA	8,000	$40,000
18" Butterfly valve and manhole	7	EA	10,000	$70,000
Air relief valve assembly and manhole	4	EA	5,000	$20,000
Pressure reducing valve assembly and box	6	EA	12,000	$72,000
0.859 MG Reservoir tank	1	EA	1,001,000	$1,001,000
0.395 MG Reservoir tank	1	EA	672,300	$672,300
Booster pump station (WWTF to 360' tank)	1	LS	6,000,000	$6,000,000
Booster pump station (360' tank to 525' tanks)	1	LS	2,500,000	$2,500,000
Reclamation line testing	10,900	LF	2.50	$27,250
Subtotal, Water Reclamation System				**$12,949,550**
SUBTOTAL				$14,492,550
CONTINGENCY (20%)				$2,898,510
CONSTRUCTION TOTAL				$17,391,060
DESIGN AND CONSTRUCTION SERVICES (15%)				$2,608,659
TOTAL				$19,999,719
SAY				**$20,000,000**

Notes:
1. Costs are in 2009 dollars and include piping reclaimed water from onsite WWTP to onsite reservoir tanks. Costs are for system operated by private entity.
2. Mobilization/demobilization, traffic control, construction surveys, and erosion control are not included, as measures for these items will be included with the main site.
3. Earthwork quantities include earthwork operations for the reservoir tank sites only. Assume excess material will be used elsewhere onsite, so no cost associated with the removal.
4. Cost for the access road to the 525' tank is included in the off-site water system cost, as the 525' tank can utilize the the same access road as the potable water tanks.
5. Reservoir tanks are Aquastore glass-fused to steel tanks.

Prepared by Belt Collins Hawaii Ltd.
For Hawaii Housing Finance and Development Corporation

Villages of Leiali'i Opinion of Probable Construction Cost - On-site Reclaimed Water System Concept Two - Phase B

	Quant	Units	Unit cost	Line Cost
SITE WORK				
Drainage System	1	LS	25,000	$25,000
AC Pavement	300	SY	75	$22,500
Subtotal, Site Work				**$47,500**
WATER RECLAMATION SYSTEM				
0.395 MG Reservoir tank	1	EA	672,300	$672,300
Booster pump station (525' tanks to serve part Ph B)	1	LS	750,000	$750,000
Subtotal, Water Reclamation System				**$1,422,300**
SUBTOTAL				$1,469,800
CONTINGENCY (20%)				$293,960
CONSTRUCTION TOTAL				$1,763,760
DESIGN AND CONSTRUCTION SERVICES (15%)				$264,564
TOTAL				$2,028,324
SAY				**$2,028,000**

Notes:
1. Costs are in 2009 dollars and include booster pump station and reservoir tank to service mauka areas of Phase B located above the gravity service pressure zones. Costs are for system operated by private entity.
2. Mobilization/demobilization, traffic control, construction surveys, and erosion control are not included, as measures for these items will be included with the main site.
3. Earthwork operations for the reservoir tank site included in Phase A.
4. Pump station for water reclamation system irrigation service to school, parks, roads, and drainage areas in Phase BA and Phase BB, and 35% of roads in Phase BC. Distribution force main from pump station to service Phase B are not included, as these items will be included with the on-site road utility costs.

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Prepared by Belt Collins Hawaii Ltd.
For Hawaii Housing Finance and Development Corporation

Villages of Leiali'i Opinion of Probable Construction Cost - On-site Reclaimed Water System Concept Three - Phase A

	Quant	Units	Unit cost	Line Cost
SITE WORK				
Earthwork	20,000	CY	45	$900,000
Clearing and grading	5.2	AC	20,000	$103,600
Drainage system and temporary outfall	1	LS	220,000	$220,000
Chain link fence	2,200	LF	50	$110,000
AC Pavement	6,850	SY	75	$513,750
Subtotal, Site Work				**$1,847,350**
WATER RECLAMATION SYSTEM				
16" DI pressure sewer pipe	4,800	LF	220	$1,056,000
18" DI pressure sewer pipe	7,500	LF	230	$1,725,000
Miscellaneous fittings	1	LS	90,000	$90,000
16" Butterfly valve and manhole	5	EA	8,000	$40,000
18" Butterfly valve and manhole	8	EA	10,000	$80,000
Air relief valve assembly and manhole	4	EA	5,000	$20,000
Pressure reducing valve assembly and box	6	EA	12,000	$72,000
0.741 MG Reservoir tank	1	EA	937,000	$937,000
0.483 MG Reservoir tank	1	EA	694,800	$694,800
Booster pump station (WWTF to 360' tank)	1	LS	6,000,000	$6,000,000
Booster pump station (360' tank to 525' tanks)	1	LS	2,600,000	$2,600,000
Reclamation line testing	12,300	LF	2.50	$30,750
Subtotal, Water Reclamation System				**$13,345,550**
SUBTOTAL				$15,192,900
CONTINGENCY (20%)				$3,038,580
CONSTRUCTION TOTAL				$18,231,480
DESIGN AND CONSTRUCTION SERVICES (15%)				$2,734,722
TOTAL				$20,966,202
SAY				**$20,966,000**

Notes:
1. Costs are in 2009 dollars and include piping reclaimed water from onsite WWTP to onsite reservoir tanks. Costs are for system operated by private entity.
2. Mobilization/demobilization, traffic control, construction surveys, and erosion control are not included, as measures for these items will be included with the main site.
3. Earthwork quantities include earthwork operations for the reservoir tank sites only. Assume excess material will be used elsewhere onsite, so no cost associated with the removal.
4. Reservoir tanks are Aquastore glass-fused to steel tanks.

Prepared by Belt Collins Hawaii Ltd.
For Hawaii Housing Finance and Development Corporation

Villages of Leiali'i Opinion of Probable Construction Cost - On-site Reclaimed Water System Concept Three - Phase B

	Quant	Units	Unit cost	Line Cost
SITE WORK				
Drainage System	1	LS	25,000	$25,000
AC Pavement	350	SY	75	$26,250
Subtotal, Site Work				**$51,250**
WATER RECLAMATION SYSTEM				
0.483 MG Reservoir tank	1	EA	694,800	$694,800
Booster pump station (525' tanks to serve part Ph B)	1	LS	3,000,000	$3,000,000
Subtotal, Water Reclamation System				**$3,694,800**
SUBTOTAL				$3,746,050
CONTINGENCY (20%)				$749,210
CONSTRUCTION TOTAL				$4,495,260
DESIGN AND CONSTRUCTION SERVICES (15%)				$674,289
TOTAL				$5,169,549
SAY				**$5,170,000**

Notes:
1. Costs are in 2009 dollars and include booster pump station and reservoir tank to service mauka areas of Phase B located above the gravity service pressure zones. Costs are for system operated by private entity.
2. Mobilization/demobilization, traffic control, construction surveys, and erosion control are not included, as measures for these items will be included with the main site.
3. Earthwork operations for the reservoir tank site included in Phase A.
4. Pump station for water reclamation system irrigation service to school, parks, roads, and drainage areas in Phase BA Phase BB, Phase BC, and 35% of roads in Phase BD. Distribution force main from pump station to service Phase B are not included, as these items will be included with the on-site road utility costs.

Appendix J

Solid Waste

SOLID WASTE MANAGEMENT PLAN

FOR THE

VILLAGES OF LEIALI‘I

Prepared for

Hawaii Housing Finance & Development Corporation
677 Queen Street, Suite 300
Honolulu, Hawai`i 96813

Prepared by

BELT COLLINS HAWAII LTD.
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This work was prepared by me or under my supervision.
Expiration Date of License: April 30, 2012

July 2010

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1. INTRODUCTION

The purpose of this report is to develop a solid waste management plan (SWMP) for the Villages of Leialiʻi affordable housing project. The SWMP will:

- Identify land use for the three preliminary development plan concepts and present the anticipated project development timeline.
- Calculate quantities and compositions of solid waste generated during the construction and occupancy phases of the project.
- Calculate quantities and compositions of solid waste diverted during the construction and occupancy phases of the project.
- Compare quantities of diverted and landfilled waste.
- Assess impact of landfilled waste on County of Maui landfill.

The Villages of Leialiʻi will be located on approximately 1,033 acres of land located at Tax Map Key Nos. (2) 4-5-021: 003, 013, 021, portions of 004, 005 and 022; and (2) 4-5-028: 070 in Lahaina, Maui, Hawaiʻi (Figure 1 – Project Location Map). The project site is located mauka of Lahaina town, the Lahaina Civic Center and Wahikuli subdivision, and north of the Kelawea subdivision and Lahainaluna High School (Figure 2 – Area Map).

The proposed Villages of Leialiʻi is a master planned community of 2,923 to 4,105 dwelling units (single family and multi-family residences), 551,000 to 596,000 square feet of commercial/office space, 524,500 to 665,100 square feet of light industrial space, two elementary school facilities (550 students and 70 faculty and staff with 8,700 square feet of buildings, each, for a total of 17,400 square feet of buildings), neighborhood parks, archaeological preserves, natural preserves, open space and associated infrastructure.

Three preliminary development plan concepts with varying dwelling unit densities and the projected timeline are summarized in Tables 1-1A, 1-1B and 1-1C.

TABLE 1-1A: PRELIMINARY DEVELOPMENT PLAN – CONCEPT ONE

Year [2]	Land Use [1]					
	Residential Units (multifamily / single family)	Retail / Office (SF)	Industrial (Acres)	School (Acres)	Park (Acres)	PV Farm (Acres)
Phase A						
2016	100 / 100		4.30			
2017	100 / 100				4.39	
2018	100 / 100					
2019	100 / 100					
2020	100 / 100		4.30		10.00	
2021	100 / 100					
2022	188 / 13	78,600		12.01		
2023		78,600				
2024		78,600	4.30			
2025		78,600				
2026		78,600				

TABLE 1-1A: PRELIMINARY DEVELOPMENT PLAN – CONCEPT ONE *(CONTINUED)*

Year [2]	Land Use [1]					
	Residential Units (multifamily / single family)	Retail / Office (SF)	Industrial (Acres)	School (Acres)	Park (Acres)	PV Farm (Acres)
2027		78,600				
2028		79,400	4.30		10.00	
Subtotal	1,401	551,000	17.20	12.01	24.39	0
Phase B						
2029	0 / 200					
2030	0 / 200				10.00	
2031	0 / 200					
2032	0 / 200					
2033	0 / 200					
2034	0 / 200					
2035	0 / 200					
2036	0 / 122			12.01	9.58	
Subtotal	1,522	0	0	12.01	19.58	0
Total	**2,923**	**551,000**	**17.20**	**24.02**	**43.97**	**0**

Note:
1. Land use development quantities of residential dwelling units, retail/office building square footage, and industrial, school, and park land areas from Villages of Leiali‘i Affordable Housing Master Plan.
2. Project phasing timeline from Hawaii Housing Finance & Development Corporation.

TABLE 1-1B: PRELIMINARY DEVELOPMENT PLAN – CONCEPT TWO

Year [2]	Land Use [1]					
	Residential Units (multifamily / single family)	Retail / Office (SF)	Industrial (Acres)	School (Acres)	Park (Acres)	PV Farm (Acres)
Phase A						
2016	200 / 0		4.30			
2017	200 / 0				4.39	
2018	200 / 0					
2019	200 / 0					
2020	200 / 0		4.30		10.00	
2021	200 / 0					
2022	200 / 0	78,600		12.01		
2023	200 / 0	78,600				
2024	200 / 0	78,600	4.30			
2025	200 / 0	78,600				
2026	200 / 0	78,600				
2027	200 / 0	78,600				
2028	121 / 0	79,400	4.30		10.00	
Subtotal	2,521	551,000	17.20	12.01	24.39	0

TABLE 1-1B: PRELIMINARY DEVELOPMENT PLAN – CONCEPT TWO (*continued*)

Year [2]	Land Use [1]					
	Residential Units (multifamily / single family)	Retail / Office (SF)	Industrial (Acres)	School (Acres)	Park (Acres)	PV Farm (Acres)
Phase B						
2029	0 / 200					
2030	0 / 200				10.00	
2031	0 / 200					
2032	0 / 200					
2033	0 / 200					
2034	0 / 200					
2035	0 / 200					
2036	0 / 122			12.01	9.58	
Subtotal	1,522	0	0	12.01	19.58	0
Total	**4,043**	**551,000**	**17.20**	**24.02**	**43.97**	**0**

Note:
1. Land use development quantities of residential dwelling units, retail/office building square footage, and industrial, school, and park land areas from Villages of Leiali‘i Affordable Housing Master Plan.
2. Project phasing timeline from Hawaii Housing Finance & Development Corporation.

TABLE 1-1C: PRELIMINARY DEVELOPMENT PLAN – CONCEPT THREE

Year [2]	Land Use [1]					
	Residential Units (multifamily / single family)	Retail / Office (SF)	Industrial (Acres)	School (Acres)	Park (Acres)	PV Farm (Acres)
Phase A						
2016	100 / 100		4.30			
2017	100 / 100				10.00	
2018	100 / 100					
2019	100 / 100					
2020	100 / 100		4.30			
2021	168 / 32					
2022	200 / 0	85,200		12.01	10.88	
2023	200 / 0	85,200				
2024	200 / 0	85,200	4.30			
2025	200 / 0	85,200				
2026	200 / 0	85,200				
2027	200 / 0	85,200				
2028	201 / 0	84,800	8.92			
Subtotal	2,601	596,000	21.82	12.01	20.88	0

TABLE 1-1C: PRELIMINARY DEVELOPMENT PLAN – CONCEPT THREE (*continued)*

Year [2]	Land Use [1]					
	Residential Units (multifamily / single family)	Retail / Office (SF)	Industrial (Acres)	School (Acres)	Park (Acres)	PV Farm (Acres)
Phase B						
2029	100 / 100					
2030	100 / 100				10.00	10.00
2031	100 / 100					
2032	100 / 100					
2033	100 / 100					10.00
2034	100 / 100					
2035	50 / 150					
2036	0 / 104			12.58	7.46	17.29
Subtotal	1,504	0	0	12.58	17.46	37.29
Total	**4,105**	**596,000**	**21.82**	**24.59**	**38.34**	**37.29**

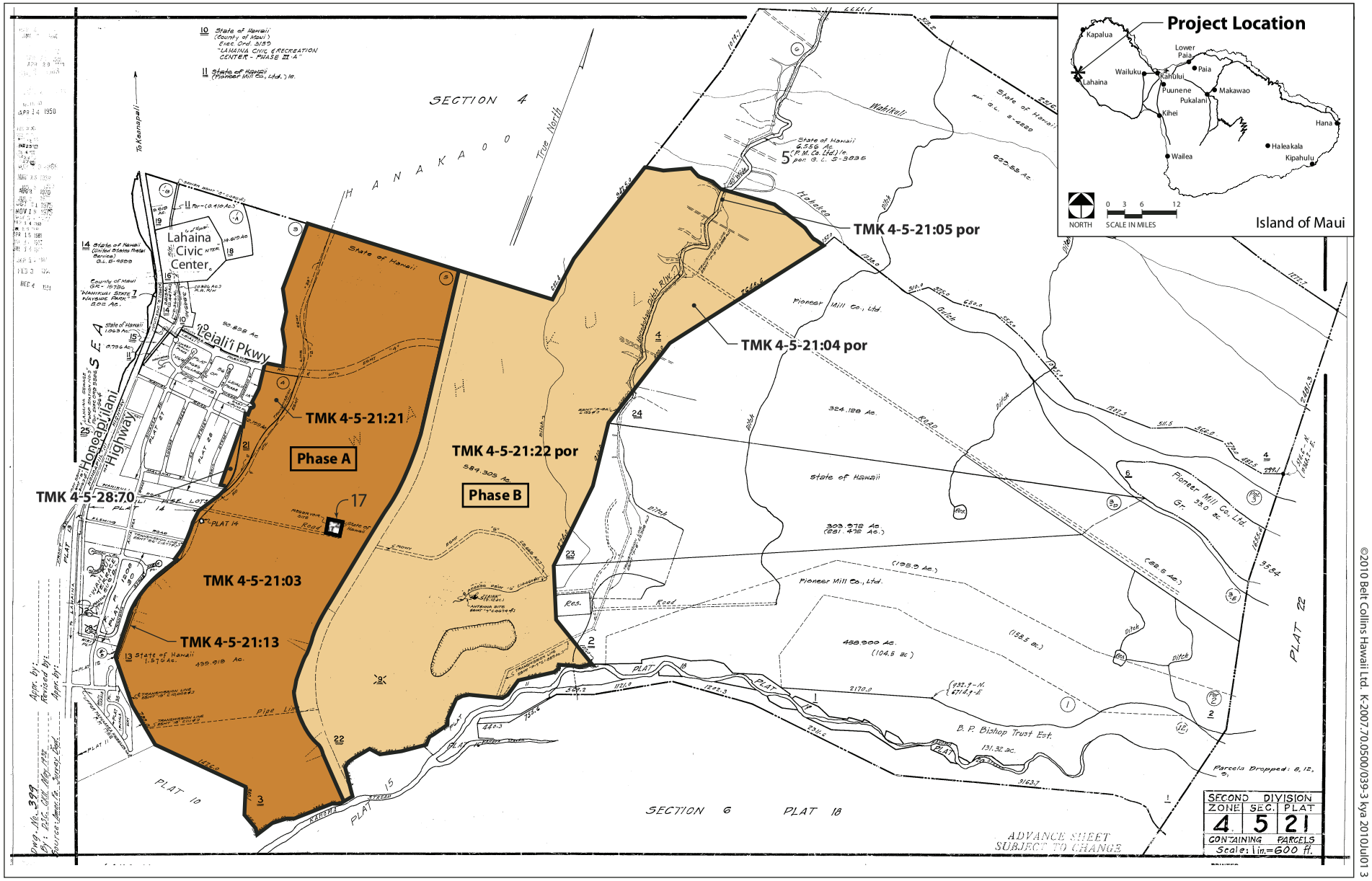
Note:
1. Land use development quantities of residential dwelling units, retail/office building square footage, and industrial, school, park, and photovoltaic (PV) farm land areas from Villages of Leiali'i Affordable Housing Master Plan.
2. Project phasing timeline from Hawaii Housing Finance & Development Corporation.

The concepts include a variety of residential units, including detached single-family, attached single-family, multifamily residential and multifamily residential in mixed used. Table 1-2 provides a breakdown of the units and densities.

TABLE 1-2: ALTERNATIVE DEVELOPMENT PLAN CONCEPTS

	Alternative Concepts		
	One	**Two**	**Three**
Residential Units [1]			
Single-family, detached	2,135	1,522	607
Single-family, attached	0	0	779
Multifamily	625	2,358	2,127
Multifamily in mixed use	163	163	592
Total	**2,923**	**4,043**	**4,105**
Commercial/Office [1]	**551,000 SF**	**551,000 SF**	**596,000 SF**
Light Industrial [1]	**524,500 SF**	**524,500 SF**	**665,100 SF**
School [2]	**17,400 SF**	**17,400 SF**	**17,400 SF**

Note:
1. Land use development quantities of residential dwelling units, and commercial/office and light industrial building square footage from Villages of Leiali'i Affordable Housing Master Plan.
2. Each alternative development plan concept contains two elementary schools, with approximately 8,700 square feet of buildings for each school, for a total of 17,400 square feet of buildings.



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BELT COLLINS

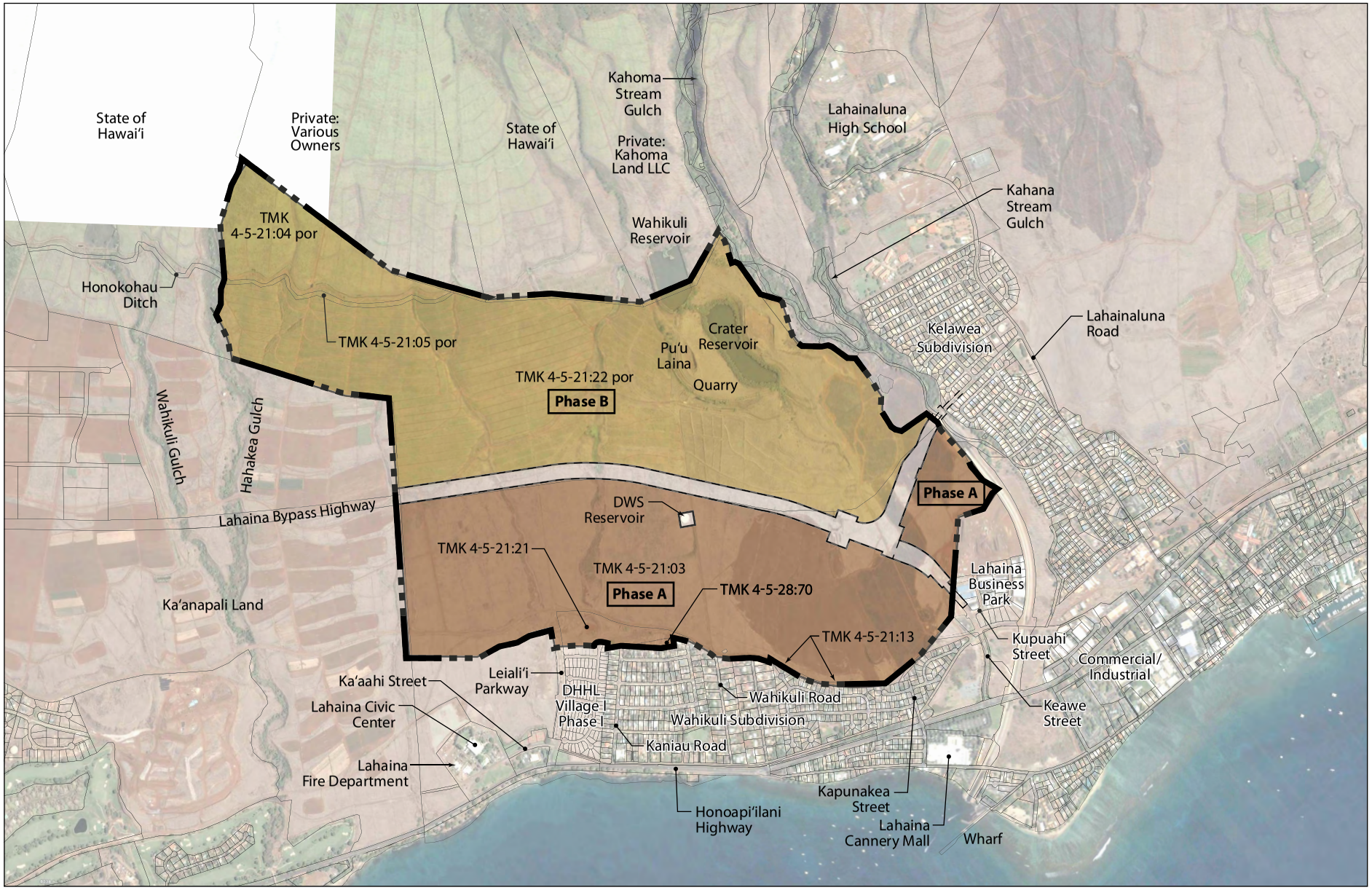
NORTH

0 500 1000 2000

SCALE IN FEET

Figure 1
PROJECT LOCATION MAP

Solid Waste Management Plan
Villages of Leialiʻi
July 2010



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BELT COLLINS

NORTH

0 500 1000 2000
SCALE IN FEET

LEGEND

Property Boundaries

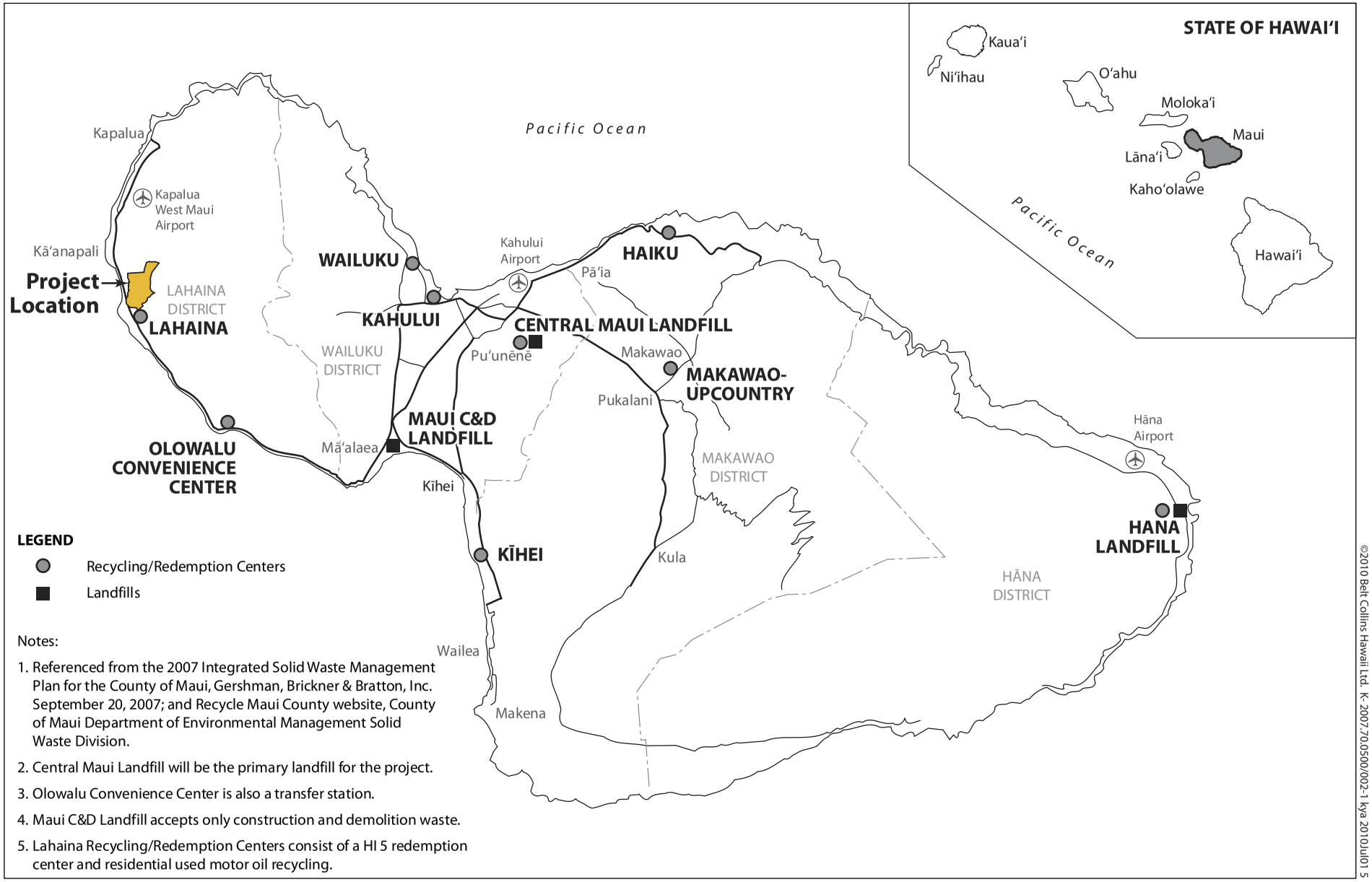
Source: Imagery is from Google™ Earth Pro and is approximately matched to lot lines.

Figure 2
AREA MAP

Solid Waste Management Plan
Villages of Leiali'i
July 2010

This report addresses reduction and recycling of solid wastes generated during the Villages of Leiali‘i construction and occupancy. Occupancy waste collection will involve a centralized system, where recyclables and wastes from residences, commercial/office buildings, light industrial facilities, schools, parks, and wastewater treatment plant (WWTP) will be collected and taken directly to recycling centers or other licensed solid waste facilities. Waste that is not recycled will be taken directly to the closest landfill, which is the Central Maui Landfill and is managed by the County. The shortest driving distance from the proposed development to the Central Maui Landfill is approximately 27 miles (See Figure 3 – Public Facilities - Landfills and Recycling/Redemption Centers). Waste collection from single-family residences would likely be provided by the County. Wastes from all other land use facilities and recyclables from all land use facilities would be collected by one or more private contractors or by individuals.

Arrangements for construction waste recycling and disposal would be formalized once the planned development’s construction scheduled is finalized. Likewise, arrangements for operations waste recycling and disposal would be formalized when the planned development is constructed and occupied.



Notes:

1. Referenced from the 2007 Integrated Solid Waste Management Plan for the County of Maui, Gershman, Brickner & Bratton, Inc. September 20, 2007; and Recycle Maui County website, County of Maui Department of Environmental Management Solid Waste Division.
2. Central Maui Landfill will be the primary landfill for the project.
3. Olowalu Convenience Center is also a transfer station.
4. Maui C&D Landfill accepts only construction and demolition waste.
5. Lahaina Recycling/Redemption Centers consist of a HI 5 redemption center and residential used motor oil recycling.

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BELT COLLINS

NORTH

0 2 4 6
SCALE IN MILES

Figure 3
PUBLIC FACILITIES
LANDFILLS AND RECYCLING/REDEMPTION CENTERS

Solid Waste Management Plan
Villages of Leiali'i
July 2010

2. SOLID WASTE GENERATION

According to the Maui County Code, which references the Hawaii Revised Statutes, solid waste is defined as "garbage, refuse and other discarded solid materials, including solid waste materials resulting from industrial and commercial operations, and from community activities." If not properly managed, solid waste can have serious negative effects on the environment which could potentially lead to various public health problems. The County of Maui therefore requires solid waste to be removed from any building or premise and disposed of at an approved solid waste disposal facility.

Quantities of solid waste were estimated for both construction and occupancy phases of the planned development. The "construction phase" of development is anticipated to begin in 2012 and be complete in 2036. The "occupancy phase" of development refers to the time at which the facilities have been constructed and are open for use. The construction and occupancy phases are expected to overlap, as construction of later portions of the Villages of Leialiʻi project would continue while earlier portions are completed and occupied.

2.1 CONSTRUCTION PHASE

The construction of the proposed project is anticipated to start in 2012 and continue until 2036. Projected building floor areas were used to estimate the amount of solid waste generated during construction with the following criteria (summarized in Table 2-1):

- Range of 400 to 1,500 square feet of building floor area for multifamily residential units (per Hawaii Housing Finance & Development Corporation).
    - Use average of 1,000 square feet for each multifamily residential unit.
- Range of 1,000 to 2,000 square feet of building floor area for single-family residential units (per Hawaii Housing Finance & Development Corporation).
    - Use average of 1,500 square feet for each single-family residential unit.
- 551,000 square feet (Concepts One and Two) and 596,000 square feet (Concept Three) of building floor area for commercial / office (per Villages of Leialiʻi Affordable Housing Master Plan).
- 524,500 square feet (Concepts One and Two) and 665,100 square feet (Concept Three) of building floor area for light industrial (per Villages of Leialiʻi Affordable Housing Master Plan).
- 8,700 square feet of building floor area for each school.
    - Total of 17,400 square feet for two schools.
- 500 square feet of building floor area for each park with greater than two acres of land area. (Park land areas per Villages of Leialiʻi Affordable Housing Master Plan).
    - Building area for each park consists of one comfort station.
    - Six park comfort stations for Concepts One and Two, for a total of 3,000 square feet of building floor area.
    - Five park comfort stations for Concept Three, for a total of 2,500 square feet of building floor area.
- Building floor area for onsite infrastructure facilities (WWTP, sewage pump station, reclaimed and potable water tanks, and photovoltaic (PV) farm) includes estimated footprint of process equipment, pumps, and tanks.
    - Use 1.5 acres – or half of WWTP site area – for building floor area for WWTP. (WWTP site area per Villages of Leialiʻi Affordable Housing Master Plan).

- Use 10,000 square feet for building floor area for sewage pump station.
- Use approximate tank footprint (per Villages of Leiali‘i Affordable Housing Master Plan) for reclaimed and potable water tanks. Total for reclaimed and potable water ranges from 20,400 to 26,700 square feet of building floor area.

- PV farm for Concept Three consists of a building and PV panels.
  - Use 5,000 square feet of building to house the PV equipment that is sensitive to the environment.
  - Use 18.65 acres – or half of PV farm site area – for PV panel area for PV farm. (PV farm site area per Villages of Leiali‘i Affordable Housing Master Plan).
- Solid waste generation rate of 3.0 to 5.2 pounds (lbs) of construction waste per square foot (ft^2) of building floor area for construction activity within all land uses except PV farm panels. (Solid waste generation rate per HABiT).
- Estimated solid waste generation rate of 0.15 pounds per square foot – or 5 percent of the minimum range for HABiT building construction waste – for PV farm panels.

TABLE 2-1: BUILDING FLOOR AREA

Building	Area (ft^2)
Multifamily [1]	1,000
Single-family [1]	1,500
Commercial/Office [2]	551,000 (Concepts One and Two) 596,000 (Concept Three)
Light Industrial [2]	524,500 (Concepts One and Two) 665,100 (Concept Three)
School [3]	17,400
Parks [4]	3,000 (Concepts One and Two) 2,500 (Concept Three)
Infrastructure [5]	95,800 (Concept One) 101,600 (Concept Two) 102,100 (Concept Three)
PV Farm (Building) [6]	5,000
PV Farm (Panels) [6]	18.65 acres

Note:
1. Range of residential building floor areas from Hawaii Housing Finance & Development Corporation. Average value of the range is shown.
2. Land use development quantities of commercial/office and light industrial building square footage from Villages of Leiali‘i Affordable Housing Master Plan.
3. Building square footage of 8,700 sf for each school. Two schools are included.
4. Estimate of 500 sf per comfort station from Alan Fujimori, Belt Collins Hawaii, Ltd., and confirmed tentatively with County Department of Parks and Recreation. One comfort station at each of six parks in Concepts One and Two and five parks in Concept Three.
5. Building floor area represents estimated footprint of process equipment (from Leland Lee, Belt Collins Hawaii, Ltd.) and tanks (from Villages of Leiali‘i Affordable Housing Master Plan).
6. Estimate of building square footage for sensitive PV equipment from Ronald NS Ho and Associates. Estimate of area for PV farm panels is half of PV farm site area (from Villages of Leiali‘i Affordable Housing Master Plan).

Table 2-2 presents the anticipated amount of solid waste generated during the construction phase for the development plan concepts.

TABLE 2-2: CONSTRUCTION WASTE GENERATION PROJECTIONS

Year	Construction Waste (tons/year) [1]		
	Concept One	Concept Two	Concept Three
2012	70 – 121	74 – 129	74 – 129
2013	70 – 121	74 – 129	74 – 129
2014	286 – 495	248 – 430	286 – 495
2015	474 – 822	399 – 692	474 – 822
2016	375 – 650	300 – 520	376 – 651
2017	375 – 650	300 – 520	375 – 650
2018	474 – 822	399 – 692	473 – 820
2019	473 – 820	398 – 690	448 – 776
2020	409 – 708	365 – 633	383 – 664
2021	280 – 485	424 – 736	434 – 753
2022	216 – 375	516 – 895	526 – 912
2023	216 – 375	516 – 895	526 – 912
2024	118 – 204	418 – 724	428 – 742
2025	120 – 207	420 – 728	430 – 746
2026	219 – 380	460 – 798	635 – 1100
2027	383 – 664	474 – 821	606 – 1050
2028	451 – 781	451 – 781	384 – 662
2029	451 – 781	451 – 781	383 – 661
2030	450 – 780	450 – 780	375 – 650
2031	450 – 780	450 – 780	379 – 654
2032	450 – 780	450 – 780	379 – 654
2033	450 – 780	450 – 780	394 – 683
2034	370 – 641	370 – 641	338 – 580
2035	144 – 249	144 – 249	131 – 221
2036	0	0	0

Note:
1. All calculations are based on (3.0 lbs/ft^2) x (area of buildings constructed/year) to (5.2 lbs/ft^2) x (area of buildings constructed/year) per HABiT. Pounds were multiplied by 5 x 10^{-4} (or 1/2000) to convert to tons.
General Note:
See Appendix A for supporting calculations.

Shown in Table 2-3 is an estimate of the components of construction waste for buildings based upon its typical composition. Since buildings only comprise a percentage of the construction waste generation for infrastructure facilities, the estimate of the components of construction waste was revised for infrastructure construction (including PV farm panels) and is presented in Table 2-3A. Tables 2-4A, 2-4B and 2-4C are estimates of the construction waste for the development plan concepts. The composition of construction waste is an estimate, as the waste composition would vary according to the material selected for construction (See Appendix A for supporting calculations).

TABLE 2-3: CONSTRUCTION WASTE COMPOSITION

Waste Type	Percent of of Total Waste [1]	100 Percent of Total Waste [2]
Wood	40.4-43.3	41.9
Drywall	23.1-33.3	28.2
Cardboard	3.3-9.6	6.5
Metal	0.7-2.5	1.6
Other [3]	16.7-25.0	21.9
Total	84.2-113.7	100

Notes:
1. Percent of total waste derived from range of waste composition per square foot of building floor space from HABiT.
2. Converted "Percent of Total Waste" to 100 percent by taking the average of the range.
3. Composed of plastics, shingles, ceramic, etc.
General Note:
Calculations based on annual waste generated. See Appendix A for supporting calculations.

TABLE 2-3A: INFRASTRUCTURE CONSTRUCTION WASTE COMPOSITION

Waste Type	Percent of Total Waste [1]
Wood [2]	25.0
Drywall [3]	2.0
Cardboard [4]	11.0
Metal [5]	25.0
Other [4]	37.0
Total	100

Notes:
1. Estimated percentages based on comparisons between typical building construction (from HABiT) and infrastructure construction.
2. Wood reduced from 41.9 percent for typical building because the material selected for infrastructure building would not be wood.
3. Drywall reduced from 28.2 percent for typical building because only a small portion of infrastructure construction (e.g. WWTP labs and offices) would include drywall.
4. Cardboard and Other waste types increased proportionately to typical building values with remaining waste composition percentage.
5. Metal increased from 1.6 percent for typical building to account for additional pipe work and mechanical duct work associated with treatment process.

TABLE 2-4A: CONSTRUCTION WASTE COMPOSITION – CONCEPT ONE

Year	Construction Waste Type (tons/year) [1]					
	Wood	Drywall	Cardboard	Metal	Other [2]	Total
2012	18 – 30	1 – 2	8 – 13	18 – 30	26 – 45	70 – 121
2013	18 – 30	1 – 2	8 – 13	18 – 30	26 – 45	70 – 121
2014	120 – 208	81 – 140	19 – 32	5 – 8	63 – 109	286 – 495
2015	199 – 344	134 – 232	31 – 53	8 – 13	104 – 180	474 – 822
2016	157 – 272	106 – 183	24 – 42	6 – 10	82 – 142	375 – 650
2017	157 – 272	106 – 183	24 – 42	6 – 10	82 – 142	375 – 650
2018	199 – 344	134 – 232	31 – 53	8 – 13	104 – 180	474 – 822
2019	198 – 344	133 – 231	31 – 53	8 – 13	104 – 180	473 – 820
2020	171 – 297	115 – 200	27 – 46	7 – 11	89 – 155	409 – 708
2021	117 – 203	79 – 137	18 – 32	4 – 8	61 – 106	280 – 485
2022	91 – 157	61 – 106	14 – 24	3 – 6	47 – 82	216 – 375
2023	91 – 157	61 – 106	14 – 24	3 – 6	47 – 82	216 – 375
2024	49 – 86	33 – 58	8 – 13	2 – 3	26 – 45	118 – 204
2025	50 – 86	33 – 58	8 – 14	2 – 4	26 – 46	120 – 207
2026	92 – 159	61 – 106	14 – 25	4 – 7	48 – 84	219 – 380
2027	160 – 278	108 – 187	25 – 43	6 – 11	84 – 145	383 – 664
2028	189 – 327	127 – 220	29 – 51	7 – 13	99 – 171	451 – 781
2029	189 – 327	127 – 220	29 – 51	7 – 13	99 – 171	451 – 781
2030	189 – 327	127 – 220	29 – 51	7 – 12	99 – 171	450 – 780
2031	189 – 327	127 – 220	29 – 51	7 – 12	99 – 171	450 – 780
2032	189 – 327	127 – 220	29 – 51	7 – 12	99 – 171	450 – 780
2033	189 – 327	127 – 220	29 – 51	7 – 12	99 – 171	450 – 780
2034	155 – 268	104 – 181	24 – 42	6 – 10	81 – 140	370 – 641
2035	60 – 104	41 – 70	9 – 16	2 – 4	31 – 55	144 – 249
2036	0	0	0	0	0	0

Notes:
1. *See Appendix A for supporting calculations.*
2. *Other waste type composed of plastics, shingles, ceramic, etc.*

TABLE 2-4B: CONSTRUCTION WASTE COMPOSITION – CONCEPT TWO

Year	Construction Waste Type (tons/year) [1]					
	Wood	Drywall	Cardboard	Metal	Other [2]	Total
2012	19 – 32	1 – 3	8 – 14	19 – 32	27 – 48	74 – 129
2013	19 – 32	1 – 3	8 – 14	19 – 32	27 – 48	74 – 129
2014	104 – 180	70 – 121	16 – 28	4 – 7	54 – 94	248 – 430
2015	167 – 290	113 – 195	26 – 45	6 – 11	87 – 151	399 – 692
2016	126 – 218	85 – 147	20 – 34	5 – 8	66 – 114	300 – 520
2017	126 – 218	85 – 147	20 – 34	5 – 8	66 – 114	300 – 520
2018	167 – 290	113 – 195	26 – 45	6 – 11	87 – 151	399 – 692
2019	167 – 289	112 – 195	26 – 45	6 – 11	87 – 151	398 – 690
2020	153 – 265	103 – 179	24 – 41	6 – 10	80 – 139	365 – 633
2021	178 – 308	120 – 207	28 – 48	7 – 12	93 – 161	424 – 736
2022	216 – 375	146 – 252	34 – 58	8 – 14	113 – 196	516 – 895
2023	216 – 375	146 – 252	34 – 58	8 – 14	113 – 196	516 – 895
2024	175 – 304	118 – 204	27 – 47	7 – 12	92 – 159	418 – 724
2025	176 – 304	118 – 204	27 – 47	7 – 12	92 – 160	420 – 728
2026	193 – 334	129 – 224	30 – 52	8 – 14	101 – 175	460 – 798
2027	198 – 344	134 – 232	31 – 53	8 – 13	104 – 180	474 – 821
2028	189 – 327	127 – 220	29 – 51	7 – 13	99 – 171	451 – 781
2029	189 – 327	127 – 220	29 – 51	7 – 13	99 – 171	451 – 781
2030	189 – 327	127 – 220	29 – 51	7 – 12	99 – 171	450 – 780
2031	189 – 327	127 – 220	29 – 51	7 – 12	99 – 171	450 – 780
2032	189 – 327	127 – 220	29 – 51	7 – 12	99 – 171	450 – 780
2033	189 – 327	127 – 220	29 – 51	7 – 12	99 – 171	450 – 780
2034	155 – 268	104 – 181	24 – 42	6 – 10	81 – 140	370 – 641
2035	60 – 104	41 – 70	9 – 16	2 – 4	31 – 55	144 – 249
2036	0	0	0	0	0	0

Notes:
1. *See Appendix A for supporting calculations.*
2. *Other waste type composed of plastics, shingles, ceramic, etc.*

TABLE 2-4C: CONSTRUCTION WASTE COMPOSITION – CONCEPT THREE

Year	Construction Waste Type (tons/year) [1]					
	Wood	Drywall	Cardboard	Metal	Other [2]	Total
2012	19 – 32	1 – 3	8 – 14	19 – 32	27 – 48	74 – 129
2013	19 – 32	1 – 3	8 – 14	19 – 32	27 – 48	74 – 129
2014	120 – 208	81 – 140	19 – 32	5 – 8	63 – 108	286 – 495
2015	199 – 344	134 – 232	31 – 53	8 – 13	104 – 180	474 – 822
2016	157 – 273	106 – 184	24 – 42	6 – 10	82 – 143	376 – 651
2017	157 – 272	106 – 183	24 – 42	6 – 10	82 – 142	375 – 650
2018	198 – 344	133 – 231	31 – 53	8 – 13	104 – 180	473 – 820
2019	188 – 325	126 – 219	29 – 50	7 – 12	98 – 170	448 – 776
2020	161 – 278	108 – 187	25 – 43	6 – 11	84 – 145	383 – 664
2021	182 – 315	122 – 212	28 – 49	7 – 12	95 – 165	434 – 753
2022	220 – 382	148 – 257	34 – 59	8 – 15	115 – 200	526 – 912
2023	220 – 382	148 – 257	34 – 59	8 – 15	115 – 200	526 – 912
2024	179 – 311	121 – 209	28 – 48	7 – 12	94 – 162	428 – 742
2025	180 – 312	121 – 209	28 – 49	7 – 13	95 – 164	430 – 746
2026	265 – 460	178 – 309	41 – 72	11 – 19	139 – 242	635 – 1,100
2027	254 – 440	171 – 296	39 – 68	10 – 17	133 – 230	606 – 1,050
2028	160 – 277	107 – 186	25 – 43	7 – 12	85 – 146	384 – 662
2029	160 – 276	107 – 185	25 – 43	7 – 12	84 – 145	383 – 661
2030	157 – 272	106 – 183	24 – 42	6 – 10	82 – 142	375 – 650
2031	158 – 273	106 – 183	25 – 43	7 – 11	84 – 144	379 – 654
2032	158 – 273	106 – 183	25 – 43	7 – 11	84 – 144	379 – 654
2033	165 – 286	111 – 192	26 – 44	6 – 11	86 – 149	394 – 683
2034	140 – 242	93 – 162	22 – 38	7 – 11	75 – 128	338 – 580
2035	54 – 91	35 – 61	9 – 15	4 – 5	30 – 50	131 – 221
2036	0	0	0	0	0	0

Notes:
1. *See Appendix A for supporting calculations.*
2. *Other waste type composed of plastics, shingles, ceramic, etc.*

2.2 OCCUPANCY PHASE

The Villages of Leiali‘i project is anticipated to begin its occupancy phase in 2016 and increase continuously until full occupancy is achieved in 2036. During the occupancy phase, solid waste quantities are a function of population and number of residential households. Therefore, the population and households during the occupancy phase were estimated based upon the following considerations (summarized in Table 2-5):

- One household per single-family or multifamily residential unit.
    - Solid waste generation rate of 2.3 tons per household per year or 12.6 pounds per household per day (per County Integrated Solid Waste Management Plan).
- 551,000 square feet (Concepts One and Two) and 596,000 square feet (Concept Three) of commercial / office (per Villages of Leiali‘i Affordable Housing Master Plan).
    - 200 square feet / employee for office (per County Wastewater Reclamation Division)
    - 551,000 square feet daily population = 2,755 persons
    - 596,000 square feet daily population = 2,980 persons
    - Solid waste generation rate of 1.58 tons per employee per year or 8.66 pounds per employee per day (per County Integrated Solid Waste Management Plan).
- 524,500 square feet (Concepts One and Two) and 665,100 square feet (Concept Three) of light industrial (per Villages of Leiali‘i Affordable Housing Master Plan).
    - 500 square feet / employee for industrial (per County Wastewater Reclamation Division)
    - 524,500 square feet daily population = 1,049 persons
    - 665,100 square feet daily population = 1,330 persons
- 620 students, faculty and staff for each school facility
    - Students, faculty and staff are at the school only 49% of the year
    - Daily population for each school = 304 persons
- 43.97 acres (Concepts One and Two) and 38.34 acres (Concept Three) of parks (per Villages of Leiali‘i Affordable Housing Master Plan).
    - 20 persons / acre (per Sewer Master Plan for the Villages of Leiali‘i)
    - 43.97 acre daily population = 879 persons
    - 38.34 acre daily population = 767 persons
- Two employees for WWTP
- Solid waste generation rate of 14.3 pounds per person per day (per County Integrated Solid Waste Management Plan) for light industrial, schools, parks, and WWTP.

TABLE 2-5: LAND USE POPULATION

Land Use	Population
Multifamily [1]	788 households (Concept One) 2,521 households (Concept Two) 2,719 households (Concept Three)
Single-family [1]	2,135 households (Concept One) 1,522 households (Concept Two) 1,386 households (Concept Three)
Commercial/Office [2]	2,755 (Concepts One and Two) 2,980 (Concept Three)
Light Industrial [2]	1,049 (Concepts One and Two) 1,330 (Concept Three)
School [3]	608
Parks [4]	879 (Concepts One and Two) 767 (Concept Three)
WWTP [6]	2

Note:
1. Land use development quantities of number of households (or residential units) from Villages of Leiali'i Affordable Housing Master Plan.
2. Population for commercial/office and light industrial derived from building square footage (from Villages of Leiali'i Affordable Housing Master Plan) and square footage per capita (from County Wastewater Reclamation Division).
3. Population for each school derived from total of 620. Two schools are included.
4. Population for parks derived from land area (from Villages of Leiali'i Affordable Housing Master Plan) and capita per land area (from Sewer Master Plan for the Villages of Leiali'i).
5. Estimate of WWTP employees from Leland Lee, Belt Collins Hawaii, Ltd.

Shown in Tables 2-6A, 2-6B or 2-6C are population estimates as well as the anticipated amount of solid waste generated during the operations phase for Development Concepts One, Two or Three, respectively.

TABLE 2-6A: HOUSEHOLDS, POPULATIONS AND WASTE GENERATION RATES – CONCEPT ONE

Year	Number of Households	Average Daily Population	Daily Waste Generated (lbs/day) [1]	Annual Waste Generated (tons/year) [2]
2016	200	264	6,299	1,150
2017	400	352	10,075	1,839
2018	600	352	12,596	2,299
2019	800	352	15,117	2,759
2020	1,000	814	24,247	4,425
2021	1,200	814	26,768	4,885
2022	1,401	1,511	37,051	6,762
2023	1,401	1,904	40,453	7,383
2024	1,401	2,560	47,606	8,688
2025	1,401	2,953	51,008	9,309
2026	1,401	3,346	54,410	9,930
2027	1,401	3,739	57,813	10,551
2028	1,401	4,598	67,860	12,384
2029	1,601	4,598	70,381	12,844
2030	1,801	4,798	75,761	13,826
2031	2,001	4,798	78,282	14,286
2032	2,201	4,798	80,802	14,746
2033	2,401	4,798	83,323	15,206
2034	2,601	4,798	85,843	15,666
2035	2,801	4,798	88,364	16,126
2036 and Beyond	2,923	5,293	96,988	17,700

Notes:

1. Calculation based on (12.6 lbs./household/day) x (total number of households) + (8.66 lbs./employee/day) x (total commercial employees) + (14.3 lbs./person/day) x (total average per day population [all other land uses]). See Appendix A for supporting calculations.

2. Calculation based on (daily waste generation) x (365 days) x (1/2000 tons/lb.). See Appendix A for supporting calculations.

TABLE 2-6B: HOUSEHOLDS, POPULATIONS AND WASTE GENERATION RATES – CONCEPT TWO

Year	Number of Households	Average Daily Population	Daily Waste Generated (lbs/day) [1]	Annual Waste Generated (tons/year) [2]
2016	200	264	6,299	1,150
2017	400	352	10,075	1,839
2018	600	352	12,596	2,299
2019	800	352	15,117	2,759
2020	1,000	814	24,247	4,425
2021	1,200	814	26,768	4,885
2022	1,400	1,511	37,038	6,759
2023	1,600	1,904	42,961	7,840
2024	1,800	2,560	52,634	9,606
2025	2,000	2,953	58,557	10,687
2026	2,200	3,346	64,480	11,768
2027	2,400	3,739	70,403	12,849
2028	2,521	4,598	81,975	14,960
2029	2,721	4,598	84,496	15,420
2030	2,921	4,798	89,876	16,402
2031	3,121	4,798	92,397	16,862
2032	3,321	4,798	94,917	17,322
2033	3,521	4,798	97,438	17,782
2034	3,721	4,798	99,958	18,242
2035	3,921	4,798	102,479	18,702
2036 and Beyond	4,043	5,293	111,104	20,276

Notes:
1. Calculation based on (12.6 lbs./household/day) x (total number of households) + (8.66 lbs./employee/day) x (total commercial employees) + (14.3 lbs./person/day) x (total average per day population [all other land uses]). See Appendix A for supporting calculations.
2. Calculation based on (daily waste generation) x (365 days) x (1/2000 tons/lb.). See Appendix A for supporting calculations.

TABLE 2-6C: HOUSEHOLDS, POPULATIONS AND WASTE GENERATION RATES – CONCEPT THREE

Year	Number of Households	Average Daily Population	Daily Waste Generated (lbs/day) [1]	Annual Waste Generated (tons/year) [2]
2016	200	264	6,298	1,149
2017	400	464	11,678	2,131
2018	600	464	14,199	2,591
2019	800	464	16,719	3,051
2020	1,000	726	22,988	4,195
2021	1,200	726	25,509	4,655
2022	1,400	1,674	39,177	7,150
2023	1,600	2,100	45,385	8,283
2024	1,800	2,788	55,342	10,100
2025	2,000	3,214	61,551	11,233
2026	2,200	3,640	67,760	12,366
2027	2,400	4,066	73,968	13,499
2028	2,601	5,034	87,949	16,051
2029	2,801	5,034	90,469	16,511
2030	3,001	5,234	95,850	17,493
2031	3,201	5,234	98,370	17,953
2032	3,401	5,234	100,891	18,413
2033	3,601	5,234	103,411	18,873
2034	3,801	5,234	105,932	19,333
2035	4,001	5,234	108,452	19,793
2036 and Beyond	4,105	5,687	116,244	21,214

Notes:
1. Calculation based on (12.6 lbs./household/day) x (total number of households) + (8.66 lbs./employee/day) x (total commercial employees) + (14.3 lbs./person/day) x (total average per day population [all other land uses]). See Appendix A for supporting calculations.
2. Calculation based on (daily waste generation) x (365 days) x (1/2000 tons/lb.). See Appendix A for supporting calculations.

The composition of wastes generated during the occupancy phase of the Villages of Leiali‘i project is based upon the 2009 County Integrated Solid Waste Management Plan, which references the 1994 County Integrated Solid Waste Management Plan. Table 2-7 includes waste composition proportions and Tables 2-8A, 2-8B or 2-8C provide a yearly breakdown of the waste composition anticipated at the Villages of Leiali‘i project for Development Concepts One, Two or Three, respectively. Management of these wastes is discussed in the following section.

Sewage sludge from the WWTP process is estimated roughly at 8,000 wet pounds per day for Concept One and 10,000 wet pounds per day for Concepts Two and Three under full occupancy. (See Appendix A for calculation). Sewage sludge is included in the “Other Organic” percentage in Table 2-7, and listed individually in Tables 2-8A, 2-8B and 2-8C. The estimated quantities of sewage sludge amount to an average of 8.6 percent of total occupancy solid waste for the project under full occupancy.

TABLE 2-7: OCCUPANCY WASTE COMPOSITION

Waste Type	Percent of Total Waste[1]
Paper	30.0
Yard Waste	13.1
Plastic	8.0
Other Organic	26.9
Metals	7.0
Glass	4.0
Rubber	1.0
Household Hazardous Waste	1.0
Other Waste	9.0
Total	**100.0**

Notes:

1. 2009 and 1994 County of Maui Integrated Solid Waste Management Plan; personal communication, Mr. Tracy Takamine, Division Chief, County of Maui Department of Environmental Management, Solid Waste Division.

TABLE 2-8A: OCCUPANCY WASTE COMPOSITION – CONCEPT ONE

Year	Occupancy Waste (tons/year) [1]										
	Paper	Yard	Plastic	Sewage Sludge	Other Organic	Metals	Glass	Rubber	Household Hazardous Waste	Other Waste	Total
2016	345	151	92	95	214	80	46	11	11	103	**1,150**
2017	552	241	147	152	343	129	74	18	18	165	**1,839**
2018	690	302	184	190	428	161	92	23	23	207	**2,299**
2019	828	362	221	228	514	193	110	28	28	248	**2,759**
2020	1,328	581	354	365	824	310	177	44	44	398	**4,425**
2021	1,466	641	391	403	910	342	195	49	49	440	**4,885**
2022	2,029	887	541	558	1,260	473	270	68	68	609	**6,762**
2023	2,215	969	591	609	1,376	517	295	74	74	664	**7,383**
2024	2,606	1,140	695	717	1,619	608	348	87	87	782	**8,688**
2025	2,793	1,221	745	768	1,734	652	372	93	93	838	**9,309**
2026	2,979	1,303	794	819	1,850	695	397	99	99	894	**9,930**
2027	3,165	1,384	844	870	1,966	739	422	106	106	950	**10,551**
2028	3,715	1,625	991	1,022	2,307	867	495	124	124	1,115	**12,384**
2029	3,853	1,685	1,028	1,059	2,393	899	514	128	128	1,156	**12,844**
2030	4,148	1,814	1,106	1,140	2,576	968	553	138	138	1,244	**13,826**
2031	4,286	1,874	1,143	1,178	2,662	1,000	571	143	143	1,286	**14,286**
2032	4,424	1,935	1,180	1,216	2,747	1,032	590	147	147	1,327	**14,746**
2033	4,562	1,995	1,217	1,254	2,833	1,064	608	152	152	1,369	**15,206**
2034	4,700	2,055	1,253	1,292	2,919	1,097	627	157	157	1,410	**15,666**
2035	4,838	2,116	1,290	1,330	3,005	1,129	645	161	161	1,451	**16,126**
2036	5,310	2,322	1,416	1,460	3,298	1,239	708	177	177	1,593	**17,700**

Notes:
1. *Calculation based on ("Annual Waste Generated" from Table 2-6A) x ("Percent of Total Waste" from Table 2-7).*

TABLE 2-8B: OCCUPANCY WASTE COMPOSITION – CONCEPT TWO

Year	Occupancy Waste (tons/year) [1]										
	Paper	Yard	Plastic	Sewage Sludge	Other Organic	Metals	Glass	Rubber	Household Hazardous Waste	Other Waste	Total
2016	345	151	92	103	206	80	46	11	11	103	**1,150**
2017	552	241	147	165	329	129	74	18	18	165	**1,839**
2018	690	302	184	207	411	161	92	23	23	207	**2,299**
2019	828	362	221	248	493	193	110	28	28	248	**2,759**
2020	1,328	581	354	398	791	310	177	44	44	398	**4,425**
2021	1,466	641	391	440	873	342	195	49	49	440	**4,885**
2022	2,028	887	541	608	1,209	473	270	68	68	608	**6,759**
2023	2,352	1,029	627	706	1,402	549	314	78	78	706	**7,840**
2024	2,882	1,260	768	865	1,717	672	384	96	96	865	**9,606**
2025	3,206	1,402	855	962	1,911	748	427	107	107	962	**10,687**
2026	3,530	1,544	941	1,059	2,104	824	471	118	118	1,059	**11,768**
2027	3,855	1,686	1,028	1,156	2,297	899	514	128	128	1,156	**12,849**
2028	4,488	1,963	1,197	1,347	2,675	1,047	598	150	150	1,346	**14,960**
2029	4,626	2,023	1,234	1,388	2,757	1,079	617	154	154	1,388	**15,420**
2030	4,921	2,152	1,312	1,476	2,933	1,148	656	164	164	1,476	**16,402**
2031	5,059	2,212	1,349	1,518	3,015	1,180	674	169	169	1,518	**16,862**
2032	5,197	2,273	1,386	1,559	3,097	1,213	693	173	173	1,559	**17,322**
2033	5,335	2,333	1,423	1,601	3,179	1,245	711	178	178	1,600	**17,782**
2034	5,473	2,393	1,459	1,642	3,262	1,277	730	182	182	1,642	**18,242**
2035	5,611	2,454	1,496	1,683	3,344	1,309	748	187	187	1,683	**18,702**
2036	6,083	2,660	1,622	1,825	3,625	1,419	811	203	203	1,825	**20,276**

Notes:
1. *Calculation based on ("Annual Waste Generated" from Table 2-6B) x ("Percent of Total Waste" from Table 2-7).*

TABLE 2-8C: OCCUPANCY WASTE COMPOSITION – CONCEPT THREE

Year	Occupancy Waste (tons/year) [1]										
	Paper	Yard	Plastic	Sewage Sludge	Other Organic	Metals	Glass	Rubber	Household Hazardous Waste	Other Waste	Total
2016	345	151	92	99	210	80	46	11	11	103	**1,149**
2017	639	280	171	183	390	149	85	21	21	192	**2,131**
2018	777	340	207	223	474	181	104	26	26	233	**2,591**
2019	915	400	244	262	558	214	122	31	31	275	**3,051**
2020	1,259	550	336	361	767	294	168	42	42	378	**4,195**
2021	1,397	611	372	400	851	326	186	47	47	419	**4,655**
2022	2,145	938	572	615	1,307	500	286	71	71	643	**7,150**
2023	2,485	1,087	663	713	1,514	580	331	83	83	745	**8,283**
2024	3,030	1,325	808	869	1,846	707	404	101	101	909	**10,100**
2025	3,370	1,474	899	966	2,053	786	449	112	112	1,011	**11,233**
2026	3,710	1,622	989	1,064	2,260	866	495	124	124	1,113	**12,366**
2027	4,050	1,771	1,080	1,161	2,467	945	540	135	135	1,215	**13,499**
2028	4,815	2,106	1,284	1,381	2,934	1,124	642	161	161	1,445	**16,051**
2029	4,953	2,166	1,321	1,420	3,018	1,156	660	165	165	1,486	**16,511**
2030	5,248	2,295	1,399	1,505	3,197	1,224	700	175	175	1,574	**17,493**
2031	5,386	2,355	1,436	1,544	3,281	1,257	718	180	180	1,616	**17,953**
2032	5,524	2,416	1,473	1,584	3,365	1,289	737	184	184	1,657	**18,413**
2033	5,662	2,476	1,510	1,624	3,449	1,321	755	189	189	1,699	**18,873**
2034	5,800	2,536	1,547	1,663	3,533	1,353	773	193	193	1,740	**19,333**
2035	5,938	2,597	1,583	1,703	3,618	1,385	792	198	198	1,781	**19,793**
2036	6,364	2,783	1,697	1,825	3,877	1,485	849	212	212	1,909	**21,214**

Notes:
1. *Calculation based on ("Annual Waste Generated" from Table 2-6C) x ("Percent of Total Waste" from Table 2-7).*

3. SOLID WASTE MANAGEMENT

Emphasis for the management of solid wastes generated by the Villages of Leialiʻi project would be placed on waste diversion and recycling. Solid wastes would be managed in conformance with the applicable Department of Health and County requirements. The landfill nearest to the Villages of Leialiʻi project is the Central Maui Landfill at Puʻunene. Since the County of Maui provides waste collection services only for single-family residential waste, recycle and disposal of occupancy wastes generated by all other sources and of construction wastes would be hauled by private contractors or individuals. Recyclables and wastes would be managed in a centralized system or by private individuals, and hauled directly to recycling centers, transfer stations and the landfill.

All waste should avoid contact with water as best as possible. Waste that comes into contact with water before being hauled to the landfill may result in leachate (liquid produced when water percolates through

any permeable material) at the landfill. Leachate could contaminate both ground and surface water, which may lead to various environmental and health problems as well as the degradation of local amenities. It can best be managed by daily covering of all waste to minimize the amount of water percolation.

3.1 CONSTRUCTION PHASE

As shown in Table 2-2, approximately 70 – 822 tons/year, 74 – 895 tons/year or 74 – 1,100 tons/year of construction waste would be generated for Development Concepts One, Two or Three, respectively, during the construction of the Villages of Leiali‘i Affordable Housing project from 2012 to 2035.

The primary method of reducing (or mitigating) the amount of construction waste to be hauled offsite would be recycling. The following items or materials would be recycled to the extent practicable: green waste (processed and used on site), wood waste (processed with green waste when practical, depending on type of wood and ability to chip, and used on site), cardboard (recycled off site), and metals (recycled off site). The remaining categories of wastes (i.e., drywall, other) may be recycled if a local recycling vendor is available. Otherwise, these non-recyclable wastes would be hauled to the landfill. The construction waste composition that may be diverted or recycled is shown in Table 3-1 and Tables 3-2A, 3-2B or 3-2C provide a yearly breakdown of the waste composition for Development Concepts One, Two or Three, respectively. According to the estimated waste composition information, approximately 43 – 411 tons/year, 46 – 447 tons/year or 46 – 550 tons/year of construction wastes could be recycled for Development Concepts One, Two or Three, respectively. The remaining 50% would likely be hauled to the landfill.

TABLE 3-1: WASTE COMPOSITION

DIVERTED OR RECYCLED CONSTRUCTION WASTE

Waste Type	Percent of Total Waste[1]	100 Percent of Total Waste[2]
Wood	40.4-43.3	41.9
Cardboard	3.3-9.6	6.5
Metal	0.7-2.5	1.6
Total	44.4-55.4	49.9

Notes:
1. Percent of total waste derived from range of waste composition per square foot of building floor space from HABiT.
2. Converted “Percent of Total Waste” to 100 percent by taking the average of the range.

TABLE 3-2A: DIVERTED OR RECYCLED CONSTRUCTION WASTE COMPOSITION – CONCEPT ONE

Year	Diverted or Recycled Construction Waste (tons/year) [1]			
	Wood	Cardboard	Metal	Total
2012	18 – 30	8 – 13	18 – 30	**43 – 74**
2013	18 – 30	8 – 13	18 – 30	**43 – 74**
2014	120 – 208	19 – 32	5 – 8	**143 – 248**
2015	199 – 344	31 – 53	8 – 13	**237 – 411**
2016	157 – 272	24 – 42	6 – 10	**188 – 325**
2017	157 – 272	24 – 42	6 – 10	**188 – 325**
2018	199 – 344	31 – 53	8 – 13	**237 – 411**
2019	198 – 344	31 – 53	8 – 13	**237 – 410**
2020	171 – 297	27 – 46	7 – 11	**204 – 354**
2021	117 – 203	18 – 32	4 – 8	**140 – 243**
2022	91 – 157	14 – 24	3 – 6	**108 – 187**
2023	91 – 157	14 – 24	3 – 6	**108 – 187**
2024	49 – 86	8 – 13	2 – 3	**59 – 102**
2025	50 – 86	8 – 14	2 – 4	**60 – 104**
2026	92 – 159	14 – 25	4 – 7	**110 – 190**
2027	160 – 278	25 – 43	6 – 11	**191 – 332**
2028	189 – 327	29 – 51	7 – 13	**225 – 391**
2029	189 – 327	29 – 51	7 – 13	**225 – 391**
2030	189 – 327	29 – 51	7 – 12	**225 – 390**
2031	189 – 327	29 – 51	7 – 12	**225 – 390**
2032	189 – 327	29 – 51	7 – 12	**225 – 390**
2033	189 – 327	29 – 51	7 – 12	**225 – 390**
2034	155 – 268	24 – 42	6 – 10	**185 – 320**
2035	60 – 104	9 – 16	2 – 4	**72 – 125**
2036	0	0	0	**0**

Notes:
1. See Table 2-4A and Appendix A for supporting calculations.

TABLE 3-2B: DIVERTED OR RECYCLED CONSTRUCTION WASTE COMPOSITION – CONCEPT TWO

Year	Diverted or Recycled Construction Waste (tons/year) [1]			
	Wood	Cardboard	Metal	Total
2012	19 – 32	8 – 14	19 – 32	**45 – 79**
2013	19 – 32	8 – 14	19 – 32	**45 – 79**
2014	104 – 180	16 – 28	4 – 7	**124 – 215**
2015	167 – 290	26 – 45	6 – 11	**200 – 346**
2016	126 – 218	20 – 34	5 – 8	**150 – 260**
2017	126 – 218	20 – 34	5 – 8	**150 – 260**
2018	167 – 290	26 – 45	6 – 11	**200 – 346**
2019	167 – 289	26 – 45	6 – 11	**199 – 345**
2020	153 – 265	24 – 41	6 – 10	**183 – 317**
2021	178 – 308	28 – 48	7 – 12	**212 – 368**
2022	216 – 375	34 – 58	8 – 14	**258 – 447**
2023	216 – 375	34 – 58	8 – 14	**258 – 447**
2024	175 – 304	27 – 47	7 – 12	**209 – 362**
2025	176 – 304	27 – 47	7 – 12	**210 – 364**
2026	193 – 334	30 – 52	8 – 14	**230 – 399**
2027	198 – 344	31 – 53	8 – 13	**237 – 410**
2028	189 – 327	29 – 51	7 – 13	**225 – 391**
2029	189 – 327	29 – 51	7 – 13	**225 – 391**
2030	189 – 327	29 – 51	7 – 12	**225 – 390**
2031	189 – 327	29 – 51	7 – 12	**225 – 390**
2032	189 – 327	29 – 51	7 – 12	**225 – 390**
2033	189 – 327	29 – 51	7 – 12	**225 – 390**
2034	155 – 268	24 – 42	6 – 10	**185 – 320**
2035	60 – 104	9 – 16	2 – 4	**72 – 125**
2036	0	0	0	**0**

Notes:
1. See Table 2-4B and Appendix A for supporting calculations.

TABLE 3-2C: DIVERTED OR RECYCLED CONSTRUCTION WASTE COMPOSITION – CONCEPT THREE

Year	Diverted or Recycled Construction Waste (tons/year) [1]			
	Wood	Cardboard	Metal	Total
2012	19 – 32	8 – 14	19 – 32	**45 – 78**
2013	19 – 32	8 – 14	19 – 32	**45 – 78**
2014	120 – 208	19 – 32	5 – 8	**143 – 248**
2015	199 – 344	31 – 53	8 – 13	**237 – 411**
2016	157 – 273	24 – 42	6 – 10	**188 – 326**
2017	157 – 272	24 – 42	6 – 10	**188 – 325**
2018	198 – 344	31 – 53	8 – 13	**237 – 410**
2019	188 – 325	29 – 50	7 – 12	**224 – 388**
2020	161 – 278	25 – 43	6 – 11	**192 – 332**
2021	182 – 315	28 – 49	7 – 12	**217 – 376**
2022	220 – 382	34 – 59	8 – 15	**263 – 456**
2023	220 – 382	34 – 59	8 – 15	**263 – 456**
2024	179 – 311	28 – 48	7 – 12	**214 – 371**
2025	180 – 312	28 – 49	7 – 13	**215 – 373**
2026	265 – 460	41 – 72	11 – 19	**318 – 550**
2027	254 – 440	39 – 68	10 – 17	**303 – 525**
2028	160 – 277	25 – 43	7 – 12	**192 – 331**
2029	160 – 276	25 – 43	7 – 12	**191 – 330**
2030	157 – 272	24 – 42	6 – 10	**188 – 325**
2031	158 – 273	25 – 43	7 – 11	**190 – 327**
2032	158 – 273	25 – 43	7 – 11	**190 – 327**
2033	165 – 286	26 – 44	6 – 11	**197 – 341**
2034	140 – 242	22 – 38	7 – 11	**169 – 290**
2035	54 – 91	9 – 15	4 – 5	**65 – 111**
2036	0	0	0	**0**

Notes:
1. See Table 2-4C and Appendix A for supporting calculations.

3.2 OCCUPANCY PHASE

The primary method of reducing (or mitigating) the amount of occupancy waste to be hauled offsite is recycling. To the extent practicable, the planned development would arrange for green waste (e.g., yard waste) generated during grounds keeping be collected and processed for use as soil amendment on the site. Wastes that cannot be incorporated into green waste processing on site would be minimized, and recycled or hauled to the landfill as appropriate. Future arrangements for recycling collection (aluminum, paper, newspaper, glass, and plastic containers) in building areas, and waste hauling for the remainder of waste that is not readily recyclable, would be made. The wastes associated with commercial / office activities would also be recycled (likely to include cardboard, paper, glass, and plastic containers). Specialized materials associated with grounds keeping (e.g., pesticides and fertilizers) would be used according to accepted practices (i.e., pesticide rinsate would be used as product, and fertilizer would be used up or incorporated into green waste processing at the site). Specialized materials associated with maintenance and industrial activities (e.g., motor oil and solvents) would be recycled when possible or disposed according to accepted practices for the County of Maui. Sewage sludge from the WWTP could be processed into compost at the Central Maui Landfill, similarly to the sludge processed from the Lahaina Wastewater Reclamation Facility. EKO Compost, which is contracted with the County to produce compost from green waste and sewage sludge, can accommodate an additional 8 wet tons per day, or 2,920 tons per year, of sludge, as long as it meets Federal EPA Part 503 Biosolids Rule (Mr. Tracy Takamine, County of Maui Department of Environmental Management, Solid Waste Division Chief).

The anticipated recycled waste composition for the occupancy is shown in Table 3-3 and Tables 3-4A, 3-4B or 3-4C provide a yearly breakdown of the recycled waste for the development concepts, One, Two or Three, respectively. Maui County's diversion rate is approximately 30.6 percent (County Integrated Solid Waste Management Plan 2009). Based on the Villages of Leiali'i Affordable Housing project having a diversion rate equivalent to that measured by Maui County, 5,416 tons, 6,205 tons or 6,492 tons of the total occupancy waste would be diverted or recycled for Development Concepts One, Two or Three, respectively. All other organic and inorganic categories of waste would likely be hauled to the landfill. Contracts with private recyclers and waste haulers would be developed to achieve these ends. In addition, green waste would be processed and used on site as soil amendment to the extent practical. Processing of green waste may involve chipping and passive composting of organic waste, resulting in soil amendment for use at the Villages of Leiali'i Affordable Housing project.

TABLE 3-3: WASTE COMPOSITION

DIVERTED OR RECYCLED OCCUPANCY WASTE

Waste Type	Percent of Total Waste[1]
Paper	30.0
Yard Waste	13.1
Plastic	8.0
Sewage Sludge [2]	8.6
Metals	7.0
Glass	4.0
Total Recyclable	**70.7**
Total Diverted Waste	**30.6**

Notes:

1. 2009 and 1994 County of Maui Integrated Solid Waste Management Plan; personal communication, Mr. Tracy Takamine, Division Chief, County of Maui Department of Environmental Management, Solid Waste Division.

2. See Appendix A for sludge calculation.

TABLE 3-4A: DIVERTED OR RECYCLED OCCUPANCY WASTE COMPOSITION – CONCEPT ONE

Year	Occupancy Waste (tons/year) [1]							
	Paper	Yard	Plastic	Sewage Sludge	Metals	Glass	Total Recyclable	Total Diverted Waste [2]
2016	345	151	92	95	80	46	809	**352**
2017	552	241	147	152	129	74	1,294	**563**
2018	690	302	184	190	161	92	1,618	**703**
2019	828	362	221	228	193	110	1,941	**844**
2020	1,328	581	354	365	310	177	3,114	**1,354**
2021	1,466	641	391	403	342	195	3,438	**1,495**
2022	2,029	887	541	558	473	270	4,758	**2,069**
2023	2,215	969	591	609	517	295	5,195	**2,259**
2024	2,606	1,140	695	717	608	348	6,114	**2,659**
2025	2,793	1,221	745	768	652	372	6,551	**2,849**
2026	2,979	1,303	794	819	695	397	6,988	**3,039**
2027	3,165	1,384	844	870	739	422	7,424	**3,229**
2028	3,715	1,625	991	1,022	867	495	8,715	**3,790**
2029	3,853	1,685	1,028	1,059	899	514	9,038	**3,930**
2030	4,148	1,814	1,106	1,140	968	553	9,729	**4,231**
2031	4,286	1,874	1,143	1,178	1,000	571	10,053	**4,372**
2032	4,424	1,935	1,180	1,216	1,032	590	10,377	**4,512**
2033	4,562	1,995	1,217	1,254	1,064	608	10,700	**4,653**
2034	4,700	2,055	1,253	1,292	1,097	627	11,024	**4,794**
2035	4,838	2,116	1,290	1,330	1,129	645	11,348	**4,935**
2036	5,310	2,322	1,416	1,460	1,239	708	12,455	**5,416**

Notes:

1. *Occupancy waste type (paper, yard, plastic, sewage sludge, metals and glass) are referenced from Table 2-8A.*
2. *Calculation based on (annual waste generated from Table 2-6A) x (30.6 percent diversion rate*).

TABLE 3-4B: DIVERTED OR RECYCLED OCCUPANCY WASTE COMPOSITION – CONCEPT TWO

Year	Occupancy Waste (tons/year) [1]							
	Paper	Yard	Plastic	Sewage Sludge	Metals	Glass	Total Recyclable	Total Diverted Waste [2]
2016	345	151	92	103	80	46	809	**352**
2017	552	241	147	165	129	74	1,294	**563**
2018	690	302	184	207	161	92	1,618	**703**
2019	828	362	221	248	193	110	1,941	**844**
2020	1,328	581	354	398	310	177	3,114	**1,354**
2021	1,466	641	391	440	342	195	3,438	**1,495**
2022	2,028	887	541	608	473	270	4,756	**2,068**
2023	2,352	1,029	627	706	549	314	5,517	**2,399**
2024	2,882	1,260	768	865	672	384	6,759	**2,939**
2025	3,206	1,402	855	962	748	427	7,520	**3,270**
2026	3,530	1,544	941	1,059	824	471	8,281	**3,601**
2027	3,855	1,686	1,028	1,156	899	514	9,041	**3,932**
2028	4,488	1,963	1,197	1,347	1,047	598	10,527	**4,578**
2029	4,626	2,023	1,234	1,388	1,079	617	10,851	**4,719**
2030	4,921	2,152	1,312	1,476	1,148	656	11,542	**5,019**
2031	5,059	2,212	1,349	1,518	1,180	674	11,866	**5,160**
2032	5,197	2,273	1,386	1,559	1,213	693	12,189	**5,301**
2033	5,335	2,333	1,423	1,601	1,245	711	12,513	**5,441**
2034	5,473	2,393	1,459	1,642	1,277	730	12,837	**5,582**
2035	5,611	2,454	1,496	1,683	1,309	748	13,161	**5,723**
2036	6,083	2,660	1,622	1,825	1,419	811	14,268	**6,205**

Notes:

1. *Occupancy waste type (paper, yard, plastic, sewage sludge, metals and glass) are referenced from Table 2-8B.*
2. *Calculation based on (annual waste generated from Table 2-6B) x (30.6 percent diversion rate*).

TABLE 3-4C: DIVERTED OR RECYCLED OCCUPANCY WASTE COMPOSITION – CONCEPT THREE

Year	Occupancy Waste (tons/year) [1]							
	Paper	Yard	Plastic	Sewage Sludge	Metals	Glass	Total Recyclable	Total Diverted Waste [2]
2016	345	151	92	99	80	46	809	**352**
2017	639	280	171	183	149	85	1,500	**652**
2018	777	340	207	223	181	104	1,823	**793**
2019	915	400	244	262	214	122	2,147	**934**
2020	1,259	550	336	361	294	168	2,952	**1,284**
2021	1,397	611	372	400	326	186	3,276	**1,425**
2022	2,145	938	572	615	500	286	5,031	**2,188**
2023	2,485	1,087	663	713	580	331	5,828	**2,535**
2024	3,030	1,325	808	869	707	404	7,107	**3,091**
2025	3,370	1,474	899	966	786	449	7,905	**3,437**
2026	3,710	1,622	989	1,064	866	495	8,702	**3,784**
2027	4,050	1,771	1,080	1,161	945	540	9,499	**4,131**
2028	4,815	2,106	1,284	1,381	1,124	642	11,295	**4,911**
2029	4,953	2,166	1,321	1,420	1,156	660	11,618	**5,052**
2030	5,248	2,295	1,399	1,505	1,224	700	12,309	**5,353**
2031	5,386	2,355	1,436	1,544	1,257	718	12,633	**5,493**
2032	5,524	2,416	1,473	1,584	1,289	737	12,957	**5,634**
2033	5,662	2,476	1,510	1,624	1,321	755	13,280	**5,775**
2034	5,800	2,536	1,547	1,663	1,353	773	13,604	**5,916**
2035	5,938	2,597	1,583	1,703	1,385	792	13,928	**6,057**
2036	6,364	2,783	1,697	1,825	1,485	849	14,928	**6,492**

Notes:

1. *Occupancy waste type (paper, yard, plastic, sewage sludge, metals and glass) are referenced from Table 2-8C.*
2. *Calculation based on (annual waste generated from Table 2-6C) x (30.6 percent diversion rate*).

4. SUMMARY

Based on the estimated waste generation rates for construction and occupancy at the Villages of Leiali‘i Affordable Housing project and the solid waste management plans for waste diversion through minimization and recycling of materials, estimated waste diversion and landfilling generation are shown in Tables 4-1A, 4-1B or 4-1C for Development Concepts One, Two, or Three, respectively.

TABLE 4-1A: SUMMARY OF WASTE DIVERTED AND LANDFILLED – CONCEPT ONE

Year	Construction Waste				Occupancy Waste				Total Diverted Waste (tons/yr)	Total Landfilled Waste (tons/yr)
	Diverted		Landfilled		Diverted		Landfilled			
	Waste[1] (tons/yr)	# Trucks per week[2]	Waste[3] (tons/yr)	# Trucks per week[2]	Waste[4] (tons/yr)	# Trucks per week[2]	Waste[5] (tons/yr)	# Trucks per week[2]		
2012	43 – 74	0.1–0.1	27–47	0.1–0.1	0	0	0	0	**43–74**	**27–47**
2013	43 – 74	0.1–0.1	27–47	0.1–0.1	0	0	0	0	**43–74**	**27–47**
2014	143 – 248	0.3–0.5	143–248	0.3–0.5	0	0	0	0	**143–248**	**143–248**
2015	237 – 411	0.5–0.8	237–411	0.5–0.8	0	0	0	0	**237–411**	**237–411**
2016	188 – 325	0.4–0.6	188–325	0.4–0.6	352	0.7	798	1.5	**539–677**	**985–1,123**
2017	188 – 325	0.4–0.6	188–325	0.4–0.6	563	1.1	1,276	2.5	**750–888**	**1,464–1,601**
2018	237 – 411	0.5–0.8	237–411	0.5–0.8	703	1.4	1,595	3.1	**940–1,114**	**1,832–2,006**
2019	237 – 410	0.5–0.8	237–410	0.5–0.8	844	1.6	1,915	3.7	**1,081–1,254**	**2,151–2,325**
2020	204 – 354	0.4–0.7	204–354	0.4–0.7	1,354	2.6	3,071	5.9	**1,558–1,708**	**3,275–3,425**
2021	140 – 243	0.3–0.5	140–243	0.3–0.5	1,495	2.9	3,390	6.5	**1,635–1,738**	**3,530–3,633**
2022	108 – 187	0.2–0.4	108–187	0.2–0.4	2,069	4.0	4,693	9.0	**2,177–2,256**	**4,801–4,880**
2023	108 – 187	0.2–0.4	108–187	0.2–0.4	2,259	4.3	5,124	9.9	**2,367–2,447**	**5,232–5,311**
2024	59 – 102	0.1–0.2	59–102	0.1–0.2	2,659	5.1	6,029	11.6	**2,717–2,761**	**6,088–6,132**
2025	60 – 104	0.1–0.2	60–103	0.1–0.2	2,849	5.5	6,460	12.4	**2,909–2,953**	**6,520–6,564**
2026	110 – 190	0.2–0.4	109–190	0.2–0.4	3,039	5.8	6,891	13.3	**3,148–3,229**	**7,001–7,081**
2027	191 – 332	0.4–0.6	191–332	0.4–0.6	3,229	6.2	7,322	14.1	**3,420–3,560**	**7,514–7,654**
2028	225 – 391	0.4–0.8	225–391	0.4–0.8	3,790	7.3	8,595	16.5	**4,015–4,180**	**8,820–8,985**
2029	225 – 391	0.4–0.8	225–391	0.4–0.8	3,930	7.6	8,914	17.1	**4,156–4,321**	**9,139–9,305**
2030	225 – 390	0.4–0.8	225–390	0.4–0.8	4,231	8.1	9,596	18.5	**4,456–4,621**	**9,821–9,986**
2031	225 – 390	0.4–0.8	225–390	0.4–0.8	4,372	8.4	9,915	19.1	**4,597–4,762**	**10,140–10,305**
2032	225 – 390	0.4–0.8	225–390	0.4–0.8	4,512	8.7	10,234	19.7	**4,737–4,902**	**10,459–10,624**
2033	225 – 390	0.4–0.8	225–390	0.4–0.8	4,653	8.9	10,553	20.3	**4,878–5,043**	**10,778–10,943**

TABLE 4-1A: SUMMARY OF WASTE DIVERTED AND LANDFILLED – CONCEPT ONE *(CONTINUED)*

Year	Construction Waste				Occupancy Waste				Total Diverted Waste (tons/yr)	Total Landfilled Waste (tons/yr)
	Diverted		Landfilled		Diverted		Landfilled			
	Waste[1] (tons/yr)	# Trucks per week[2]	Waste[3] (tons/yr)	# Trucks per week[2]	Waste[4] (tons/yr)	# Trucks per week[2]	Waste[5] (tons/yr)	# Trucks per week[2]		
2034	185 – 320	0.4–0.6	185–320	0.4–0.6	4,794	9.2	10,872	20.9	**4,979–5,114**	**11,057–11,193**
2035	72 – 125	0.1–0.2	72–125	0.1–0.2	4,935	9.5	11,192	21.5	**5,007–5,059**	**11,264–11,316**
2036 +	0	0	0	0	5,416	10.4	12,284	23.6	**5,416**	**12,284**

Notes:
1. *Diverted waste (tons/year) is waste that would be recycled. Values from total diverted construction waste (Table 3-2A).*
2. *Calculation based on 10-ton capacity for trucks that pick up waste.*
3. *Calculation based on total construction waste (Table 2-4A) – total diverted construction waste (Table 3-2A).*
4. *Diverted waste is waste that would be recycled. Values from total diverted occupancy waste (Table 3-4A).*
5. *Calculation based on total occupancy waste (Table 2-8A) – total diverted occupancy waste (Table 3-4A).*

General Note:
See Appendix A for supporting calculations.

TABLE 4-1B: SUMMARY OF WASTE DIVERTED AND LANDFILLED – CONCEPT TWO

Year	Construction Waste				Occupancy Waste				Total Diverted Waste (tons/yr)	Total Landfilled Waste (tons/yr)
	Diverted		Landfilled		Diverted		Landfilled			
	Waste[1] (tons/yr)	# Trucks per week[2]	Waste[3] (tons/yr)	# Trucks per week[2]	Waste[4] (tons/yr)	# Trucks per week[2]	Waste[5] (tons/yr)	# Trucks per week[2]		
2012	45 – 79	0.1–0.2	29–50	0.1–0.1	0	0	0	0	**45–79**	**29–50**
2013	45 – 79	0.1–0.2	29–50	0.1–0.1	0	0	0	0	**45–79**	**29–50**
2014	124 – 215	0.2–0.4	124–215	0.2–0.4	0	0	0	0	**124–215**	**124–215**
2015	200 – 346	0.4–0.7	200–346	0.4–0.7	0	0	0	0	**200–346**	**200–346**
2016	150 – 260	0.3–0.5	150–260	0.3–0.5	352	0.7	798	1.5	**502–612**	**948–1,058**
2017	150 – 260	0.3–0.5	150–260	0.3–0.5	563	1.1	1,276	2.5	**713–823**	**1,426–1,536**
2018	200 – 346	0.4–0.7	200–346	0.4–0.7	703	1.4	1,595	3.1	**903–1,049**	**1,795–1,941**
2019	199 – 345	0.4–0.7	199–345	0.4–0.7	844	1.6	1,915	3.7	**1,043–1,189**	**2,114–2,260**
2020	183 – 317	0.4–0.6	183–317	0.4–0.6	1,354	2.6	3,071	5.9	**1,537–1,671**	**3,254–3,388**
2021	212 – 368	0.4–0.7	212–368	0.4–0.7	1,495	2.9	3,390	6.5	**1,707–1,863**	**3,602–3,758**
2022	258 – 447	0.5–0.9	258–447	0.5–0.9	2,068	4.0	4,691	9.0	**2,327–2,516**	**4,949–5,138**
2023	258 – 447	0.5–0.9	258–447	0.5–0.9	2,399	4.6	5,441	10.5	**2,657–2,847**	**5,699–5,889**

TABLE 4-1B: SUMMARY OF WASTE DIVERTED AND LANDFILLED – CONCEPT TWO *(CONTINUED)*

Year	Construction Waste				Occupancy Waste				Total Diverted Waste (tons/yr)	Total Landfilled Waste (tons/yr)
	Diverted		Landfilled		Diverted		Landfilled			
	Waste[1] (tons/yr)	# Trucks per week[2]	Waste[3] (tons/yr)	# Trucks per week[2]	Waste[4] (tons/yr)	# Trucks per week[2]	Waste[5] (tons/yr)	# Trucks per week[2]		
2024	209 – 362	0.4–0.7	209–362	0.4–0.7	2,939	5.7	6,666	12.8	**3,148–3,302**	**6,875–7,029**
2025	210 – 364	0.4–0.7	210–364	0.4–0.7	3,270	6.3	7,417	14.3	**3,480–3,634**	**7,626–7,780**
2026	230 – 399	0.4–0.8	230–399	0.4–0.8	3,601	6.9	8,167	15.7	**3,831–4,000**	**8,397–8,565**
2027	237 – 410	0.5–0.8	237–410	0.5–0.8	3,932	7.6	8,917	17.1	**4,168–4,342**	**9,154–9,327**
2028	225 – 391	0.4–0.8	225–391	0.4–0.8	4,578	8.8	10,383	20.0	**4,803–4,969**	**10,608–10,773**
2029	225 – 391	0.4–0.8	225–391	0.4–0.8	4,719	9.1	10,702	20.6	**4,944–5,109**	**10,927–11,092**
2030	225 – 390	0.4–0.8	225–390	0.4–0.8	5,019	9.7	11,383	21.9	**5,244–5,409**	**11,608–11,773**
2031	225 – 390	0.4–0.8	225–390	0.4–0.8	5,160	9.9	11,703	22.5	**5,385–5,550**	**11,928–12,093**
2032	225 – 390	0.4–0.8	225–390	0.4–0.8	5,301	10.2	12,022	23.1	**5,526–5,691**	**12,247–12,412**
2033	225 – 390	0.4–0.8	225–390	0.4–0.8	5,441	10.5	12,341	23.7	**5,666–5,831**	**12,566–12,731**
2034	185 – 320	0.4–0.6	185–320	0.4–0.6	5,582	10.7	12,660	24.3	**5,767–5,902**	**12,845–12,980**
2035	72 – 125	0.1–0.2	72–125	0.1–0.2	5,723	11.0	12,979	25.0	**5,795–5,848**	**13,051–13,104**
2036 +	0	0	0	0	6,205	11.9	14,072	27.1	**6,205**	**14,072**

Notes*:*

1. *Diverted waste (tons/year) is waste that would be recycled. Values from total diverted construction waste (Table 3-2B).*
2. *Calculation based on 10-ton capacity for trucks that pick up waste.*
3. *Calculation based on total construction waste (Table 2-4B) – total diverted construction waste (Table 3-2B).*
4. *Diverted waste is waste that would be recycled. Values from total diverted occupancy waste (Table 3-4B).*
5. *Calculation based on total occupancy waste (Table 2-8B) – total diverted occupancy waste (Table 3-4B).*

General Note*:*

See Appendix A for supporting calculations.

TABLE 4-1C: SUMMARY OF WASTE DIVERTED AND LANDFILLED – CONCEPT THREE

Year	Construction Waste				Occupancy Waste				Total Diverted Waste (tons/yr)	Total Landfilled Waste (tons/yr)
	Diverted		Landfilled		Diverted		Landfilled			
	Waste[1] (tons/yr)	# Trucks per week[2]	Waste[3] (tons/yr)	# Trucks per week[2]	Waste[4] (tons/yr)	# Trucks per week[2]	Waste[5] (tons/yr)	# Trucks per week[2]		
2012	45 – 78	0.1–0.2	29–50	0.1–0.1	0	0	0	0	**45–78**	**29–50**
2013	45 – 78	0.1–0.2	29–50	0.1–0.1	0	0	0	0	**45–78**	**29–50**
2014	143 – 248	0.3–0.5	143–248	0.3–0.5	0	0	0	0	**143–248**	**143–248**
2015	237 – 411	0.5–0.8	237–411	0.5–0.8	0	0	0	0	**237–411**	**237–411**
2016	188 – 326	0.4–0.6	188–326	0.4–0.6	352	0.7	798	1.5	**540–677**	**986–1,123**
2017	188 – 325	0.4–0.6	188–325	0.4–0.6	652	1.3	1,479	2.8	**840–977**	**1,667–1,804**
2018	237 – 410	0.5–0.8	237–410	0.5–0.8	793	1.5	1,798	3.5	**1,030–1,203**	**2,035–2,209**
2019	224 – 388	0.4–0.7	224–388	0.4–0.7	934	1.8	2,118	4.1	**1,158–1,322**	**2,341–2,506**
2020	192 – 332	0.4–0.6	192–332	0.4–0.6	1,284	2.5	2,912	5.6	**1,475–1,616**	**3,103–3,244**
2021	217 – 376	0.4–0.7	217–376	0.4–0.7	1,425	2.7	3,231	6.2	**1,642–1,801**	**3,448–3,607**
2022	263 – 456	0.5–0.9	263–456	0.5–0.9	2,188	4.2	4,962	9.5	**2,451–2,644**	**5,225–5,418**
2023	263 – 456	0.5–0.9	263–456	0.5–0.9	2,535	4.9	5,748	11.1	**2,798–2,990**	**6,011–6,204**
2024	214 – 371	0.4–0.7	214–371	0.4–0.7	3,091	5.9	7,009	13.5	**3,305–3,461**	**7,223–7,380**
2025	215 – 373	0.4–0.7	215–372	0.4–0.7	3,437	6.6	7,796	15.0	**3,653–3,811**	**8,011–8,168**
2026	318 – 550	0.6–1.1	317–549	0.6–1.1	3,784	7.3	8,582	16.5	**4,102–4,334**	**8,899–9,132**
2027	303 – 525	0.6–1.0	303–525	0.6–1.0	4,131	7.9	9,368	18.0	**4,434–4,656**	**9,671–9,893**
2028	192 – 331	0.4–0.6	192–331	0.4–0.6	4,911	9.4	11,139	21.4	**5,103–5,242**	**11,331–11,470**
2029	191 – 330	0.4–0.6	191–330	0.4–0.6	5,052	9.7	11,458	22.0	**5,244–5,383**	**11,650–11,789**
2030	188 – 325	0.4–0.6	188–325	0.4–0.6	5,353	10.3	12,140	23.3	**5,540–5,678**	**12,327–12,465**
2031	190 – 327	0.4–0.6	190–327	0.4–0.6	5,493	10.6	12,459	24.0	**5,683–5,821**	**12,649–12,786**
2032	190 – 327	0.4–0.6	190–327	0.4–0.6	5,634	10.8	12,778	24.6	**5,824–5,961**	**12,968–13,105**
2033	197 – 341	0.4–0.7	197–341	0.4–0.7	5,775	11.1	13,098	25.2	**5,972–6,116**	**13,294–13,439**
2034	169 – 290	0.3–0.6	169–290	0.3–0.6	5,916	11.4	13,417	25.8	**6,085–6,206**	**13,586–13,707**
2035	65 – 111	0.1–0.2	65–111	0.1–0.2	6,057	11.6	13,736	26.4	**6,122–6,167**	**13,801–13,847**
2036+	0	0	0	0	6,492	12.5	14,723	28.3	**6,492**	**14,723**

Notes:

1. *Diverted waste (tons/year) is waste that would be recycled. Values from total diverted construction waste (Table 3-2C).*
2. *Calculation based on 10-ton capacity for trucks that pick up waste.*
3. *Calculation based on total construction waste (Table 2-4C) – total diverted construction waste (Table 3-2C).*
4. *Diverted waste is waste that would be recycled. Values from total diverted occupancy waste (Table 3-4C).*
5. *Calculation based on total occupancy waste (Table 2-8C) – total diverted occupancy waste (Table 3-4C).*

General Note:

See Appendix A for supporting calculations.

Trucks would most likely be used to haul construction and occupancy waste to either a local recycling vendor, for diverted waste, or to the Central Maui Landfill, for landfilled waste. For construction waste, the number of trucks is expected to be on an on-call basis, meaning that less than one truck per week to about three trucks per week would be required for both diverted and landfilled waste. For occupancy waste, the number of trucks is expected to be a set schedule varying from about three to 41 trucks per week for both diverted and landfilled waste. The truck route to the Central Maui Landfill would most likely be from the project down Leialiʻi Parkway or Keawe Street, along Honoapiʻilani Highway, Kuihelani Highway, and Hana Highway to Pulehu Road. The truck route to the local recycling vendor (anticipated to be in Kahului) would most likely be from the project down Leialiʻi Parkway or Keawe Street to Honoapiʻilani Highway, Kuihelani Highway, and Hana Highway into town, or from Honoapiʻilani Highway to N. Kihei Road, Piʻilani Highway, and Mokulele Highway into the Central Maui Baseyard.

According to the 2009 County Integrated Solid Waste Management Plan, approximately 199,500 tons of waste was deposited at the Central Maui Landfill in 2006. Using this quantity of waste, the annual percent waste increase to the Central Maui Landfill from the Villages of Leialiʻi Affordable Housing project were estimated in Table 4-2. The project's full build-out annual occupancy landfill waste percentage of the annual Central Maui Landfill waste would be estimated to be 6.16%, 7.05% or 7.38% for Development Concepts One, Two or Three, respectively. The County estimates that Central Maui Landfill has adequate capacity to accommodate the project's projected quantity of waste.

TABLE 4-2: VILLAGES OF LEIALIʻI AFFORDABLE HOUSING PROJECT WASTE GENERATION IMPACT ON CENTRAL MAUI LANDFILL

Year	Percent Annual Waste Increase to Landfill[1]		
	Concept A	Concept B	Concept C
2012	0.01 – 0.02	0.01 – 0.03	0.01 – 0.03
2013	0.01 – 0.02	0.01 – 0.03	0.01 – 0.03
2014	0.07 – 0.12	0.06 – 0.11	0.07 – 0.12
2015	0.12 – 0.21	0.10 – 0.17	0.12 – 0.21
2016	0.49 – 0.56	0.48 – 0.53	0.49 – 0.56
2017	0.73 – 0.80	0.71 – 0.77	0.84 – 0.90
2018	0.92 – 1.01	0.90 – 0.97	1.02 – 1.11
2019	1.08 – 1.17	1.06 – 1.13	1.17 – 1.26
2020	1.64 – 1.72	1.63 – 1.70	1.56 – 1.63
2021	1.77 – 1.82	1.81 – 1.88	1.73 – 1.81
2022	2.41 – 2.45	2.48 – 2.58	2.62 – 2.72
2023	2.62 – 2.66	2.86 – 2.95	3.01 – 3.11
2024	3.05 – 3.07	3.45 – 3.52	3.62 – 3.70
2025	3.27 – 3.29	3.82 – 3.90	4.02 – 4.09
2026	3.51 – 3.55	4.21 – 4.29	4.46 – 4.58
2027	3.77 – 3.84	4.59 – 4.68	4.85 – 4.96
2028	4.42 – 4.50	5.32 – 5.40	5.68 – 5.75
2029	4.58 – 4.66	5.48 – 5.56	5.84 – 5.91
2030	4.92 – 5.01	5.82 – 5.90	6.18 – 6.25
2031	5.08 – 5.17	5.98 – 6.06	6.34 – 6.41
2032	5.24 – 5.33	6.14 – 6.22	6.50 – 6.57
2033	5.40 – 5.49	6.30 – 6.38	6.66 – 6.74
2034	5.54 – 5.61	6.44 – 6.51	6.81 – 6.87
2035	5.65 – 5.67	6.54 – 6.57	6.92 – 6.94
2036	6.16	7.05	7.38

Notes:
1. Calculation based on [(total Landfilled Waste from Tables 4-1A, 4-1B or 4-1C) / (199,500 tons/year)] x 100 percent.

It should be noted that the objectives for waste diversion for both construction and operations at the Villages of Leialiʻi Affordable Housing project are based upon the assumption that private companies in the vicinity of the development can be contracted to either directly recycle materials on the island of Maui or to economically ship materials to recycling markets elsewhere in Hawaiʻi, the U.S. mainland, or international countries. If recycling vendors are not immediately available for all materials intended to be recycled, some of these materials may be hauled to the landfill.

5. REFERENCES

1. County of Maui, Department of Environmental Management, Solid Waste Division. February 17, 2009. Integrated Solid Waste Management Plan. Prepared by Gershman, Brinckner & Bratton, Inc., Fairfax, Virginia.

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3. County of Maui, Department of Environmental Management, Solid Waste Division. Recycle Maui County website. April 2010. http://www.co.maui.hi.us/index.aspx?NID=742

4. County of Maui, Wastewater Reclamation Division. Wastewater Flow Standards. February 2, 2006.

5. Hawai‘i Advanced Building Technologies Training Program (HABiT). June 2000. Guide to Resource-Efficient Building in Hawai‘i - HABiT. Developed by Kathleen O'Brien of O'Brien & Company, WA. Managed by Alan Ewell, Integrated Architecture and Gail Suzuki-Jones, Clean Hawai‘i Center, HI. Funded by U.S. Department of Energy through Hawai‘i Department of Business, Economic Development and Tourism.

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7. Hawai‘i Housing Finance & Development Corporation. December 2009. Villages of Leiali‘i Affordable Housing Master Plan. Prepared by Belt Collins Hawaii Ltd.

8. Personal Communication, Mr. Tracy Takamine, Division Chief, County of Maui, Department of Environmental Management, Solid Waste Division, April 23, 2010.

9. Telephone Conversation Summary, Ms. Elaine Baker, Engineer, County of Maui, Department of Environmental Management, Solid Waste Division, May 14, 2010.

.

APPENDIX A – CALCULATIONS

Construction Waste Generation - Concept One

Year	Building Type	Number	Building Area (sf)	Construction Waste (tons/year)	
2012	Infrastructure (WWTP, SPS, tanks)		46,702	70	min.
				121	max.
2013	Infrastructure (WWTP, SPS, tanks)		46,702	70	min.
				121	max.
2014	Multifamily	50	50,000	286	min.
	Single Family	50	75,000	495	max.
	Industrial		65,563		
2015	Multifamily	100	100,000	474	min.
	Single Family	100	150,000	822	max.
	Industrial		65,563		
	Park		500		
2016	Multifamily	100	100,000	375	min.
	Single Family	100	150,000	650	max.
	Park		0		
2017	Multifamily	100	100,000	375	min.
	Single Family	100	150,000	650	max.
2018	Multifamily	100	100,000	474	min.
	Single Family	100	150,000	822	max.
	Industrial		65,563		
	Park		500		
2019	Multifamily	100	100,000	473	min.
	Single Family	100	150,000	820	max.
	Industrial		65,563		
	Park		0		
2020	Multifamily	144	144,000	409	min.
	Single Family	56.5	84,750	708	max.
	Commercial/Retail		39,300		
	School		4,350		
2021	Multifamily	94	94,000	280	min.
	Single Family	6.5	9,750	485	max.
	Commercial/Retail		78,600		
	School		4,350		
2022	Commercial/Retail		78,600	216	min.
	Industrial		65,563	375	max.
2023	Commercial/Retail		78,600	216	min.
	Industrial		65,563	375	max.
2024	Commercial/Retail		78,600	118	min.
				204	max.
2025	Commercial/Retail		78,600	120	min.
	Infrastructure (tanks)		1,182	207	max.
2026	Commercial/Retail		79,000	219	min.
	Industrial		65,563	380	max.
	Infrastructure (tanks)		1,182		
	Park		500		
2027	Single Family	100	150,000	383	min.
	Commercial/Retail		39,700	664	max.
	Industrial		65,563		
	Park		0		
2028	Single Family	200	300,000	451	min.
	Park		500	781	max.
2029	Single Family	200	300,000	451	min.
	Park		500	781	max.
2030	Single Family	200	300,000	450	min.
				780	max.
2031	Single Family	200	300,000	450	min.
				780	max.
2032	Single Family	200	300,000	450	min.
				780	max.
2033	Single Family	200	300,000	450	min.
				780	max.
2034	Single Family	161	241,500	370	min.
	School		4,350	641	max.
	Park		500		
2035	Single Family	61	91,500	144	min.
	School		4,350	249	max.
	Park		0		
2036					

Multifamily	1000	square feet	
Single Family	1500	square feet	
Construction Waste	3	lbs / ft^2	min.
Construction Waste	5.2	lbs / ft^2	max.

Notes:

1. All calculations are based on (3.0 lbs/ft^2) x (area of building) x (number of buildings constructed/year). Pounds were multiplied by 5 x 10^{-4} (or 1/2000) to convert to tons.

2. Two-year buildout for each development.

3. Of the total residential units to be completed for each development year (~200), assume 50% to be single-family and 50% to be multifamily until single-family is built out.

4. For parks, the building area represents comfort stations. Assume comfort stations to be built within the first year of park development. For the Phase B parks to be completed by year 2030, assume two comfort stations will be built, one during each development year.

5. For infrastructure, assume 1.5 acres for WWTP and 10,000 SF for SPS (building, process equipment, and tanks). Use approximate tank footprint for potable and reclaimed water tanks. Only on-site tanks are included.

Construction Waste Generation - Concept Two

Year	Building Type	Number	Building Area (sf)	Construction Waste (tons/year)	
2012	Infrastructure (WWTP, SPS, tanks)		49,505	74	min.
				129	max.
2013	Infrastructure (WWTP, SPS, tanks)		49,505	74	min.
				129	max.
2014	Multifamily	100	100,000	248	min.
	Industrial		65,563	430	max.
2015	Multifamily	200	200,000	399	min.
	Industrial		65,563	692	max.
	Park		500		
2016	Multifamily	200	200,000	300	min.
	Park		0	520	max.
2017	Multifamily	200	200,000	300	min.
				520	max.
2018	Multifamily	200	200,000	399	min.
	Industrial		65,563	692	max.
	Park		500		
2019	Multifamily	200	200,000	398	min.
	Industrial		65,563	690	max.
	Park		0		
2020	Multifamily	200	200,000	365	min.
	Commercial/Retail		39,300	633	max.
	School		4,350		
2021	Multifamily	200	200,000	424	min.
	Commercial/Retail		78,600	736	max.
	School		4,350		
2022	Multifamily	200	200,000	516	min.
	Commercial/Retail		78,600	895	max.
	Industrial		65,563		
2023	Multifamily	200	200,000	516	min.
	Commercial/Retail		78,600	895	max.
	Industrial		65,563		
2024	Multifamily	200	200,000	418	min.
	Commercial/Retail		78,600	724	max.
2025	Multifamily	200	200,000	420	min.
	Commercial/Retail		78,600	728	max.
	Infrastructure (tanks)		1,303		
2026	Multifamily	160.5	160,500	460	min.
	Commercial/Retail		79,000	798	max.
	Industrial		65,563		
	Infrastructure (tanks)		1,303		
	Park		500		
2027	Single Family	100	150,000	474	min.
	Multifamily	60.5	60,500	821	max.
	Commercial/Retail		39,700		
	Industrial		65,563		
	Park		0		
2028	Single Family	200	300,000	451	min.
	Park		500	781	max.
2029	Single Family	200	300,000	451	min.
	Park		500	781	max.
2030	Single Family	200	300,000	450	min.
				780	max.
2031	Single Family	200	300,000	450	min.
				780	max.
2032	Single Family	200	300,000	450	min.
				780	max.
2033	Single Family	200	300,000	450	min.
				780	max.

2034	Single Family	161	241,500	370	min.
	School		4,350	641	max.
	Park		500		
2035	Single Family	61	91,500	144	min.
	School		4,350	249	max.
	Park		0		
2036					

Multifamily	1000	square feet	
Single Family	1500	square feet	
Construction Waste	3	lbs / ft^2	min.
Construction Waste	5.2	lbs / ft^2	max.

Notes:

1. All calculations are based on (3.0 lbs/ft^2) x (area of building) x (number of buildings constructed/year). Pounds were multiplied by 5 x 10^{-4} (or 1/2000) to convert to tons.

2. Two-year buildout for each development.

3. For parks, the building area represents comfort stations. Assume comfort stations to be built within the first year of park development. For the Phase B parks to be completed by year 2030, assume two comfort stations will be built, one during each development year.

4. For infrastructure, assume 1.5 acres for WWTP and 10,000 SF for SPS (building, process equipment, and tanks). Use approximate tank footprint for potable and reclaimed water tanks. Only on-site tanks are included.

Construction Waste Generation - Concept Three

Year	Building Type	Number	Building Area (sf)	Construction Waste (tons/year)	
2012	Infrastructure (WWTP, SPS, tanks)		49,472	74	min.
				129	max.
2013	Infrastructure (WWTP, SPS, tanks)		49,472	74	min.
				129	max.
2014	Multifamily	50	50,000	286	min.
	Single Family	50	75,000	495	max.
	Industrial		65,535		
2015	Multifamily	100	100,000	474	min.
	Single Family	100	150,000	822	max.
	Industrial		65,535		
	Park		500		
2016	Multifamily	100	100,000	376	min.
	Single Family	100	150,000	651	max.
	Park		500		
2017	Multifamily	100	100,000	375	min.
	Single Family	100	150,000	650	max.
2018	Multifamily	100	100,000	473	min.
	Single Family	100	150,000	820	max.
	Industrial		65,535		
2019	Multifamily	134	134,000	448	min.
	Single Family	66	99,000	776	max.
	Industrial		65,535		
2020	Multifamily	184	184,000	383	min.
	Single Family	16	24,000	664	max.
	Commercial/Retail		42,600		
	School		4,350		
	Park		500		
2021	Multifamily	200	200,000	434	min.
	Commercial/Retail		85,200	753	max.
	School		4,350		
	Park		0		
2022	Multifamily	200	200,000	526	min.
	Commercial/Retail		85,200	912	max.
	Industrial		65,535		
2023	Multifamily	200	200,000	526	min.
	Commercial/Retail		85,200	912	max.
	Industrial		65,535		
2024	Multifamily	200	200,000	428	min.
	Commercial/Retail		85,200	742	max.
2025	Multifamily	200	200,000	430	min.
	Commercial/Retail		85,200	746	max.
	Infrastructure (tanks)		1,567		
2026	Multifamily	200.5	200,500	635	min.
	Commercial/Retail		85,000	1,100	max.
	Industrial		135,946		
	Infrastructure (tanks)		1,567		
2027	Multifamily	150.5	150,500	606	min.
	Single Family	50	75,000	1,050	max.
	Commercial/Retail		42,400		
	Industrial		135,946		

2028	Multifamily	100	100,000	384	min.
	Single Family	100	150,000	662	max.
	Park		500		
	PV Farm (Bldg)		2,500		
	PV Farm	2.5	54,450		
2029	Multifamily	100	100,000	383	min.
	Single Family	100	150,000	661	max.
	Park		0		
	PV Farm (Bldg)		2,500		
	PV Farm	2.5	54,450		
2030	Multifamily	100	100,000	375	min.
	Single Family	100	150,000	650	max.
2031	Multifamily	100	100,000	379	min.
	Single Family	100	150,000	654	max.
	PV Farm	2.5	54,450		
2032	Multifamily	100	100,000	379	min.
	Single Family	100	150,000	654	max.
	PV Farm	2.5	54,450		
2033	Multifamily	75	75,000	394	min.
	Single Family	125	187,500	683	max.
2034	Multifamily	25	25,000	338	min.
	Single Family	127	190,500	580	max.
	School		4,350		
	Park		500		
	PV Farm	4.3225	94,144		
2035	Single Family	52	78,000	131	min.
	School		4,350	221	max.
	Park		0		
	PV Farm	4.3225	94,144		
2036					

Multifamily	1000	square feet	
Single Family	1500	square feet	
PV Farm Panels	50%	total site area	
Construction Waste	3	lbs / ft^2	min.
Construction Waste	5.2	lbs / ft^2	max.
PV Farm Panels Construction Waste	0.15	lbs / ft^2 =	5% of min. Bldg Construction Waste

Notes:

1. All calculations are based on (3.0 lbs/ft^2) x (area of building) x (number of buildings constructed/year). Pounds were multiplied by 5 x 10^{-4} (or 1/2000) to convert to tons.

2. Two-year buildout for each development.

3. Of the total residential units to be completed for each development year (~200), assume 50% to be single-family and 50% to be multifamily until single-family is built out in Phase A and multifamily is built out in Phase B.

4. For parks, the building area represents comfort stations. Assume comfort stations to be built within the first year of park development. For the Phase A parks to be completed by year 2017, assume two comfort stations will be built, one during each development year.

5. For infrastructure, assume 1.5 acres for WWTP and 10,000 SF for SPS (building, process equipment, and tanks). Use approximate tank footprint for potable and reclaimed water tanks. Only on-site tanks are included.

6. For PV farm, assume PV panels constitute 50% of the total site area and 5,000 SF building required to house equipment that is sensitive to the environment. Construction of the building will take place with the first phase of development of the PV farm.

Infrastructure Construction Waste Composition

Waste Type

Wood = 25% (estimated)

Metal = 25% (estimated)

Drywall = (WWTP "building") x (10% lab/office) x (28.2% drywall [HABiT]) / (Total Infrastructure)
= (1.5 Ac) x (43,560 sf/Ac) x (0.10) x (0.282) / (93,404 sf)
= 2.0%

Cardboard = (HABiT cardboard %) / (HABiT cardboard % + HABiT other %) x (100 - wood % - metal % - drywall %)
= (0.065) / (0.065 + 0.219) x (1.00 - 0.25 - 0.25 - 0.02)
= 11.0%

Other = (HABiT other %) / (HABiT cardboard % + HABiT other %) x (100 - wood % - metal % - drywall %)
= (0.219) / (0.065 + 0.219) x (1.00 - 0.25 - 0.25 - 0.02)
= 37.0%

Notes:

1. Estimated percentages are based on comparisons between typical building construction (from HABiT) and infrastructure construction.

2. Wood reduced from 41.9 percent for typical building to 25 percent because material selected for infrastructure building would not be wood.

3. Metal increased from 1.6 percent for typical building to 25 percent to account for additional pipe work and mechanical duct work associated with treatment process.

4. Drywall reduced from 28.2 percent for typical building to 2 percent because only a small portion of infrastructure construction (e.g. WWTP labs and offices) would include drywall.

5. Cardboard and Other waste types increased proportionately to typical building values with remaining waste composition percentage.

Construction Waste Composition - Concept One

Year	Construction Waste (tons/year)	Wood (tons/year)	Drywall (tons/year)	Cardboard (tons/year)	Metal (tons/year)	Other (tons/year)
2012	70	18	1	8	18	26
	121	30	2	13	30	45
2013	70	18	1	8	18	26
	121	30	2	13	30	45
2014	286	120	81	19	5	63
	495	208	140	32	8	109
2015	474	199	134	31	8	104
	822	344	232	53	13	180
2016	375	157	106	24	6	82
	650	272	183	42	10	142
2017	375	157	106	24	6	82
	650	272	183	42	10	142
2018	474	199	134	31	8	104
	822	344	232	53	13	180
2019	473	198	133	31	8	104
	820	344	231	53	13	180
2020	409	171	115	27	7	89
	708	297	200	46	11	155
2021	280	117	79	18	4	61
	485	203	137	32	8	106
2022	216	91	61	14	3	47
	375	157	106	24	6	82
2023	216	91	61	14	3	47
	375	157	106	24	6	82
2024	118	49	33	8	2	26
	204	86	58	13	3	45
2025	120	50	33	8	2	26
	207	86	58	14	4	46
2026	219	92	61	14	4	48
	380	159	106	25	7	84
2027	383	160	108	25	6	84
	664	278	187	43	11	145
2028	451	189	127	29	7	99
	781	327	220	51	13	171
2029	451	189	127	29	7	99
	781	327	220	51	13	171
2030	450	189	127	29	7	99
	780	327	220	51	12	171
2031	450	189	127	29	7	99
	780	327	220	51	12	171
2032	450	189	127	29	7	99
	780	327	220	51	12	171
2033	450	189	127	29	7	99
	780	327	220	51	12	171
2034	370	155	104	24	6	81
	641	268	181	42	10	140
2035	144	60	41	9	2	31
	249	104	70	16	4	55
2036						

	Wood	Drywall	Cardboard	Metal	Other
Waste Composition:	41.9%	28.2%	6.5%	1.6%	21.9%
Infrastructure (WWTP, SPS, tanks) Waste Composition:	25.0%	2.0%	11.0%	25.0%	37.0%

Construction Waste Composition - Concept Two

Year	Construction Waste (tons/year)	Wood (tons/year)	Drywall (tons/year)	Cardboard (tons/year)	Metal (tons/year)	Other (tons/year)
2012	74	19	1	8	19	27
	129	32	3	14	32	48
2013	74	19	1	8	19	27
	129	32	3	14	32	48
2014	248	104	70	16	4	54
	430	180	121	28	7	94
2015	399	167	113	26	6	87
	692	290	195	45	11	151
2016	300	126	85	20	5	66
	520	218	147	34	8	114
2017	300	126	85	20	5	66
	520	218	147	34	8	114
2018	399	167	113	26	6	87
	692	290	195	45	11	151
2019	398	167	112	26	6	87
	690	289	195	45	11	151
2020	365	153	103	24	6	80
	633	265	179	41	10	139
2021	424	178	120	28	7	93
	736	308	207	48	12	161
2022	516	216	146	34	8	113
	895	375	252	58	14	196
2023	516	216	146	34	8	113
	895	375	252	58	14	196
2024	418	175	118	27	7	92
	724	304	204	47	12	159
2025	420	176	118	27	7	92
	728	304	204	47	12	160
2026	460	193	129	30	8	101
	798	334	224	52	14	175
2027	474	198	134	31	8	104
	821	344	232	53	13	180
2028	451	189	127	29	7	99
	781	327	220	51	13	171
2029	451	189	127	29	7	99
	781	327	220	51	13	171
2030	450	189	127	29	7	99
	780	327	220	51	12	171
2031	450	189	127	29	7	99
	780	327	220	51	12	171
2032	450	189	127	29	7	99
	780	327	220	51	12	171
2033	450	189	127	29	7	99
	780	327	220	51	12	171
2034	370	155	104	24	6	81
	641	268	181	42	10	140
2035	144	60	41	9	2	31
	249	104	70	16	4	55
2036						

	Wood	Drywall	Cardboard	Metal	Other
Waste Composition:	41.9%	28.2%	6.5%	1.6%	21.9%
Infrastructure (WWTP, SPS, tanks) Waste Composition:	25.0%	2.0%	11.0%	25.0%	37.0%

Construction Waste Composition - Concept Three

Year	Construction Waste (tons/year)	Wood (tons/year)	Drywall (tons/year)	Cardboard (tons/year)	Metal (tons/year)	Other (tons/year)
2012	74	19	1	8	19	27
	129	32	3	14	32	48
2013	74	19	1	8	19	27
	129	32	3	14	32	48
2014	286	120	81	19	5	63
	495	208	140	32	8	108
2015	474	199	134	31	8	104
	822	344	232	53	13	180
2016	376	157	106	24	6	82
	651	273	184	42	10	143
2017	375	157	106	24	6	82
	650	272	183	42	10	142
2018	473	198	133	31	8	104
	820	344	231	53	13	180
2019	448	188	126	29	7	98
	776	325	219	50	12	170
2020	383	161	108	25	6	84
	664	278	187	43	11	145
2021	434	182	122	28	7	95
	753	315	212	49	12	165
2022	526	220	148	34	8	115
	912	382	257	59	15	200
2023	526	220	148	34	8	115
	912	382	257	59	15	200
2024	428	179	121	28	7	94
	742	311	209	48	12	162
2025	430	180	121	28	7	95
	746	312	209	49	13	164
2026	635	265	178	41	11	139
	1,100	460	309	72	19	241
2027	606	254	171	39	10	133
	1,050	440	296	68	17	230
2028	384	160	107	25	7	85
	662	277	186	43	12	146
2029	383	160	107	25	7	84
	661	276	185	43	12	145
2030	375	157	106	24	6	82
	650	272	183	42	10	142
2031	379	158	106	25	7	84
	654	273	183	43	11	144
2032	379	158	106	25	7	84
	654	273	183	43	11	144
2033	394	165	111	26	6	86
	683	286	192	44	11	149
2034	338	140	93	22	7	75
	580	242	162	38	11	128
2035	131	54	35	9	4	30
	221	91	61	15	5	50
2036						

	Wood	Drywall	Cardboard	Metal	Other
Waste Composition:	41.9%	28.2%	6.5%	1.6%	21.9%
Infrastructure (WWTP, SPS, tanks, PV farm) Waste Composition:	25.0%	2.0%	11.0%	25.0%	37.0%

Occupancy Waste Generation - Concept One

Year	Building Type	Number	Population	Waste Generated	
				Daily (lbs/day)	Annual (tons/yr)
2016	Multifamily	100		1,260	1,150
	Single Family	100		1,260	
	Industrial	131,125	262	3,750	
	WWTP staff	2	2	29	
	Total		264	6,299	
2017	Multifamily	200		2,521	1,839
	Single Family	200		2,521	
	Industrial	131,125	262	3,750	
	WWTP staff	2	2	29	
	Park	4.39	88	1,256	
	Total		352	10,075	
2018	Multifamily	300		3,781	2,299
	Single Family	300		3,781	
	Industrial	131,125	262	3,750	
	WWTP staff	2	2	29	
	Park	4.39	88	1,256	
	Total		352	12,596	
2019	Multifamily	400		5,041	2,759
	Single Family	400		5,041	
	Industrial	131,125	262	3,750	
	WWTP staff	2	2	29	
	Park	4.39	88	1,256	
	Total		352	15,117	
2020	Multifamily	500		6,301	4,425
	Single Family	500		6,301	
	Industrial	262,250	525	7,500	
	WWTP staff	2	2	29	
	Park	14.39	288	4,116	
	Total		814	24,247	
2021	Multifamily	600		7,562	4,885
	Single Family	600		7,562	
	Industrial	262,250	525	7,500	
	WWTP staff	2	2	29	
	Park	14.39	288	4,116	
	Total		814	26,768	
2022	Multifamily	788		9,931	6,762
	Single Family	613		7,725	
	School	1	304	4,347	
	Commercial/Retail	78,600	393	3,402	
	Industrial	262,250	525	7,500	
	WWTP staff	2	2	29	
	Park	14.39	288	4,116	
	Total		1,511	37,051	
2023	Multifamily	788		9,931	7,383
	Single Family	613		7,725	
	School	1	304	4,347	
	Commercial/Retail	157,200	786	6,805	
	Industrial	262,250	525	7,500	
	WWTP staff	2	2	29	
	Park	14.39	288	4,116	
	Total		1,904	40,453	
2024	Multifamily	788		9,931	8,688
	Single Family	613		7,725	
	School	1	304	4,347	
	Commercial/Retail	235,800	1,179	10,207	
	Industrial	393,375	787	11,251	
	WWTP staff	2	2	29	
	Park	14.39	288	4,116	
	Total		2,560	47,606	
2025	Multifamily	788		9,931	9,309
	Single Family	613		7,725	
	School	1	304	4,347	
	Commercial/Retail	314,400	1,572	13,610	
	Industrial	393,375	787	11,251	
	WWTP staff	2	2	29	
	Park	14.39	288	4,116	
	Total		2,953	51,008	

2026	Multifamily	788		9,931	9,930
	Single Family	613		7,725	
	School	1	304	4,347	
	Commercial/Retail	393,000	1,965	17,012	
	Industrial	393,375	787	11,251	
	WWTP staff	2	2	29	
	Park	14.39	288	4,116	
	Total		3,346	54,410	
2027	Multifamily	788		9,931	10,551
	Single Family	613		7,725	
	School	1	304	4,347	
	Commercial/Retail	471,600	2,358	20,414	
	Industrial	393,375	787	11,251	
	WWTP staff	2	2	29	
	Park	14.39	288	4,116	
	Total		3,739	57,813	
2028	Multifamily	788		9,931	12,384
	Single Family	613		7,725	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP staff	2	2	29	
	Park	24.39	488	6,976	
	Total		4,598	67,860	
2029	Multifamily	788		9,931	12,844
	Single Family	813		10,246	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP staff	2	2	29	
	Park	24.39	488	6,976	
	Total		4,598	70,381	
2030	Multifamily	788		9,931	13,826
	Single Family	1,013		12,767	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP staff	2	2	29	
	Park	34.39	688	9,836	
	Total		4,798	75,761	
2031	Multifamily	788		9,931	14,286
	Single Family	1,213		15,287	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP staff	2	2	29	
	Park	34.39	688	9,836	
	Total		4,798	78,282	
2032	Multifamily	788		9,931	14,746
	Single Family	1,413		17,808	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP staff	2	2	29	
	Park	34.39	688	9,836	
	Total		4,798	80,802	
2033	Multifamily	788		9,931	15,206
	Single Family	1,613		20,328	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP staff	2	2	29	
	Park	34.39	688	9,836	
	Total		4,798	83,323	
2034	Multifamily	788		9,931	15,666
	Single Family	1,813		22,849	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP staff	2	2	29	
	Park	34.39	688	9,836	
	Total		4,798	85,843	

2035	Multifamily	788		9,931	16,126
	Single Family	2,013		25,369	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP staff	2	2	29	
	Park	34.39	688	9,836	
	Total		4,798	88,364	
2036	Multifamily	788		9,931	17,700
	Single Family	2,135		26,907	
	School	2	608	8,694	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP staff	2	2	29	
	Park	43.97	879	12,575	
	Total		5,293	96,988	

Multifamily	2.3	ton / household / year =	12.603	lbs / household / day
Single Family	2.3	ton / household / year =	12.603	lbs / household / day
School	304	persons = 620 students/faculty/staff at the school for 49% of the day		
Commercial/Retail	1.58	ton / employee / year =	8.658	lbs / employee / day
	0.005	employee / sf = 200 sf / employee (per County WWRD)		
Light Industrial	0.002	persons / sf = 500 sf / employee (per County WWRD)		
WWTP	2	full-time employees		
Parks	20	persons / acre		
Waste Generation	14.3	lbs/person/day		

Occupancy Waste Generation - Concept Two

Year	Building Type	Number	Population	Waste Generated	
				Daily (lbs/day)	Annual (tons/yr)
2016	Multifamily	200		2,521	1,150
	Single Family	0		0	
	Industrial	131,125	262	3,750	
	WWTP	2	2	29	
	Total		264	6,299	
2017	Multifamily	400		5,041	1,839
	Single Family	0		0	
	Industrial	131,125	262	3,750	
	WWTP	2	2	29	
	Park	4.39	88	1,256	
	Total		352	10,075	
2018	Multifamily	600		7,562	2,299
	Single Family	0		0	
	Industrial	131,125	262	3,750	
	WWTP	2	2	29	
	Park	4.39	88	1,256	
	Total		352	12,596	
2019	Multifamily	800		10,082	2,759
	Single Family	0		0	
	Industrial	131,125	262	3,750	
	WWTP	2	2	29	
	Park	4.39	88	1,256	
	Total		352	15,117	
2020	Multifamily	1,000		12,603	4,425
	Single Family	0		0	
	Industrial	262,250	525	7,500	
	WWTP	2	2	29	
	Park	14.39	288	4,116	
	Total		814	24,247	
2021	Multifamily	1,200		15,123	4,885
	Single Family	0		0	
	Industrial	262,250	525	7,500	
	WWTP	2	2	29	
	Park	14.39	288	4,116	
	Total		814	26,768	
2022	Multifamily	1,400		17,644	6,759
	Single Family	0		0	
	School	1	304	4,347	
	Commercial/Retail	78,600	393	3,402	
	Industrial	262,250	525	7,500	
	WWTP	2	2	29	
	Park	14.39	288	4,116	
	Total		1,511	37,038	

2023	Multifamily	1,600		20,164	7,840
	Single Family	0		0	
	School	1	304	4,347	
	Commercial/Retail	157,200	786	6,805	
	Industrial	262,250	525	7,500	
	WWTP	2	2	29	
	Park	14.39	288	4,116	
	Total		1,904	42,961	
2024	Multifamily	1,800		22,685	9,606
	Single Family	0		0	
	School	1	304	4,347	
	Commercial/Retail	235,800	1,179	10,207	
	Industrial	393,375	787	11,251	
	WWTP	2	2	29	
	Park	14.39	288	4,116	
	Total		2,560	52,634	
2025	Multifamily	2,000		25,205	10,687
	Single Family	0		0	
	School	1	304	4,347	
	Commercial/Retail	314,400	1,572	13,610	
	Industrial	393,375	787	11,251	
	WWTP	2	2	29	
	Park	14.39	288	4,116	
	Total		2,953	58,557	
2026	Multifamily	2,200		27,726	11,768
	Single Family	0		0	
	School	1	304	4,347	
	Commercial/Retail	393,000	1,965	17,012	
	Industrial	393,375	787	11,251	
	WWTP	2	2	29	
	Park	14.39	288	4,116	
	Total		3,346	64,480	
2027	Multifamily	2,400		30,247	12,849
	Single Family	0		0	
	School	1	304	4,347	
	Commercial/Retail	471,600	2,358	20,414	
	Industrial	393,375	787	11,251	
	WWTP	2	2	29	
	Park	14.39	288	4,116	
	Total		3,739	70,403	
2028	Multifamily	2,521		31,772	14,960
	Single Family	0		0	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP	2	2	29	
	Park	24.39	488	6,976	
	Total		4,598	81,975	
2029	Multifamily	2,521		31,772	15,420
	Single Family	200		2,521	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP	2	2	29	
	Park	24.39	488	6,976	
	Total		4,598	84,496	
2030	Multifamily	2,521		31,772	16,402
	Single Family	400		5,041	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP	2	2	29	
	Park	34.39	688	9,836	
	Total		4,798	89,876	
2031	Multifamily	2,521		31,772	16,862
	Single Family	600		7,562	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP	2	2	29	
	Park	34.39	688	9,836	
	Total		4,798	92,397	

2032	Multifamily	2,521		31,772	17,322
	Single Family	800		10,082	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP	2	2	29	
	Park	34.39	688	9,836	
	Total		4,798	94,917	
2033	Multifamily	2,521		31,772	17,782
	Single Family	1,000		12,603	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP	2	2	29	
	Park	34.39	688	9,836	
	Total		4,798	97,438	
2034	Multifamily	2,521		31,772	18,242
	Single Family	1,200		15,123	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP	2	2	29	
	Park	34.39	688	9,836	
	Total		4,798	99,958	
2035	Multifamily	2,521		31,772	18,702
	Single Family	1,400		17,644	
	School	1	304	4,347	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP	2	2	29	
	Park	34.39	688	9,836	
	Total		4,798	102,479	
2036	Multifamily	2,521		31,772	20,276
	Single Family	1,522		19,181	
	School	2	608	8,694	
	Commercial/Retail	551,000	2,755	23,852	
	Industrial	524,500	1,049	15,001	
	WWTP	2	2	29	
	Park	43.97	879	12,575	
	Total		5,293	111,104	

Multifamily	2.3	ton / household / year =	12.603	lbs / household / day
Single Family	2.3	ton / household / year =	12.603	lbs / household / day
School	304	persons = 620 students/faculty/staff at the school for 49% of the day		
Commercial/Retail	1.58	ton / employee / year =	8.658	lbs / employee / day
	0.005	employee / sf		
Light Industrial	0.002	persons / sf = 500 sf / employee (per County WWRD)		
WWTP	2	full-time employees		
Parks	20	persons / acre		
Waste Generation	14.3	lbs/person/day		

Occupancy Waste Generation - Concept Three

Year	Building Type	Number	Population	Waste Generated	
				Daily (lbs/day)	Annual (tons/yr)
2016	Multifamily	100		1,260	1,149
	Single Family	100		1,260	
	Industrial	131,069	262	3,749	
	WWTP	2	2	29	
	Total		264	6,298	
2017	Multifamily	200		2,521	2,131
	Single Family	200		2,521	
	Industrial	131,069	262	3,749	
	WWTP	2	2	29	
	Park	10	200	2,860	
	Total		464	11,678	
2018	Multifamily	300		3,781	2,591
	Single Family	300		3,781	
	Industrial	131,069	262	3,749	
	WWTP	2	2	29	
	Park	10	200	2,860	
	Total		464	14,199	

2019	Multifamily	400		5,041	3,051
	Single Family	400		5,041	
	Industrial	131,069	262	3,749	
	WWTP	2	2	29	
	Park	10	200	2,860	
	Total		464	16,719	
2020	Multifamily	500		6,301	4,195
	Single Family	500		6,301	
	Industrial	262,138	524	7,497	
	WWTP	2	2	29	
	Park	10	200	2,860	
	Total		726	22,988	
2021	Multifamily	668		8,419	4,655
	Single Family	532		6,705	
	Industrial	262,138	524	7,497	
	WWTP	2	2	29	
	Park	10	200	2,860	
	Total		726	25,509	
2022	Multifamily	868		10,939	7,150
	Single Family	532		6,705	
	School	1	304	4,347	
	Commercial/Retail	85,200	426	3,688	
	Industrial	262,138	524	7,497	
	WWTP	2	2	29	
	Park	20.88	418	5,972	
	Total		1,674	39,177	
2023	Multifamily	1,068		13,460	8,283
	Single Family	532		6,705	
	School	1	304	4,347	
	Commercial/Retail	170,400	852	7,376	
	Industrial	262,138	524	7,497	
	WWTP	2	2	29	
	Park	20.88	418	5,972	
	Total		2,100	45,385	
2024	Multifamily	1,268		15,980	10,100
	Single Family	532		6,705	
	School	1	304	4,347	
	Commercial/Retail	255,600	1,278	11,064	
	Industrial	393,208	786	11,246	
	WWTP	2	2	29	
	Park	20.88	418	5,972	
	Total		2,788	55,342	
2025	Multifamily	1,468		18,501	11,233
	Single Family	532		6,705	
	School	1	304	4,347	
	Commercial/Retail	340,800	1,704	14,752	
	Industrial	393,208	786	11,246	
	WWTP	2	2	29	
	Park	20.88	418	5,972	
	Total		3,214	61,551	
2026	Multifamily	1,668		21,021	12,366
	Single Family	532		6,705	
	School	1	304	4,347	
	Commercial/Retail	426,000	2,130	18,441	
	Industrial	393,208	786	11,246	
	WWTP	2	2	29	
	Park	20.88	418	5,972	
	Total		3,640	67,760	
2027	Multifamily	1,868		23,542	13,499
	Single Family	532		6,705	
	School	1	304	4,347	
	Commercial/Retail	511,200	2,556	22,129	
	Industrial	393,208	786	11,246	
	WWTP	2	2	29	
	Park	20.88	418	5,972	
	Total		4,066	73,968	
2028	Multifamily	2,069		26,075	16,051
	Single Family	532		6,705	
	School	1	304	4,347	
	Commercial/Retail	596,000	2,980	25,799	
	Industrial	665,100	1,330	19,022	
	WWTP	2	2	29	
	Park	20.88	418	5,972	
	Total		5,034	87,949	

2029	Multifamily	2,169		27,335	16,511
	Single Family	632		7,965	
	School	1	304	4,347	
	Commercial/Retail	596,000	2,980	25,799	
	Industrial	665,100	1,330	19,022	
	WWTP	2	2	29	
	Park	20.88	418	5,972	
	Total		5,034	90,469	
2030	Multifamily	2,269		28,596	17,493
	Single Family	732		9,225	
	School	1	304	4,347	
	Commercial/Retail	596,000	2,980	25,799	
	Industrial	665,100	1,330	19,022	
	WWTP	2	2	29	
	Park	30.88	618	8,832	
	Total		5,234	95,850	
2031	Multifamily	2,369		29,856	17,953
	Single Family	832		10,485	
	School	1	304	4,347	
	Commercial/Retail	596,000	2,980	25,799	
	Industrial	665,100	1,330	19,022	
	WWTP	2	2	29	
	Park	30.88	618	8,832	
	Total		5,234	98,370	
2032	Multifamily	2,469		31,116	18,413
	Single Family	932		11,746	
	School	1	304	4,347	
	Commercial/Retail	596,000	2,980	25,799	
	Industrial	665,100	1,330	19,022	
	WWTP	2	2	29	
	Park	30.88	618	8,832	
	Total		5,234	100,891	
2033	Multifamily	2,569		32,376	18,873
	Single Family	1,032		13,006	
	School	1	304	4,347	
	Commercial/Retail	596,000	2,980	25,799	
	Industrial	665,100	1,330	19,022	
	WWTP	2	2	29	
	Park	30.88	618	8,832	
	Total		5,234	103,411	
2034	Multifamily	2,669		33,637	19,333
	Single Family	1,132		14,266	
	School	1	304	4,347	
	Commercial/Retail	596,000	2,980	25,799	
	Industrial	665,100	1,330	19,022	
	WWTP	2	2	29	
	Park	30.88	618	8,832	
	Total		5,234	105,932	
2035	Multifamily	2,719		34,267	19,793
	Single Family	1,282		16,157	
	School	1	304	4,347	
	Commercial/Retail	596,000	2,980	25,799	
	Industrial	665,100	1,330	19,022	
	WWTP	2	2	29	
	Park	30.88	618	8,832	
	Total		5,234	108,452	
2036	Multifamily	2,719		34,267	21,214
	Single Family	1,386		17,467	
	School	2	608	8,694	
	Commercial/Retail	596,000	2,980	25,799	
	Industrial	665,100	1,330	19,022	
	WWTP	2	2	29	
	Park	38.34	767	10,965	
	Total		5,687	116,244	

Multifamily	2.3	ton / household / year =	12.603	lbs / household / day
Single Family	2.3	ton / household / year =	12.603	lbs / household / day
School	304	persons = 620 students/faculty/staff at the school for 49% of the day		
Commercial/Retail	1.58	ton / employee / year =	8.658	lbs / employee / day
	0.005	employee / sf		
Light Industrial	0.002	persons / sf = 500 sf / employee (per County WWRD)		
WWTP	2	full-time employees		
Parks	20	persons / acre		
Waste Generation	14.3	lbs/person/day		

Occupancy Waste Composition - Concept One

Year	Occupancy Waste (tons/year)										
	Paper	Yard	Plastic	Sewage Sludge	Other Organic	Metals	Glass	Rubber	Household Hazardous Waste	Other Waste	Total
2016	345	151	92	95	214	80	46	11	11	103	1,150
2017	552	241	147	152	343	129	74	18	18	165	1,839
2018	690	302	184	190	428	161	92	23	23	207	2,299
2019	828	362	221	228	514	193	110	28	28	248	2,759
2020	1,328	581	354	365	824	310	177	44	44	398	4,425
2021	1,466	641	391	403	910	342	195	49	49	440	4,885
2022	2,029	887	541	558	1,260	473	270	68	68	609	6,762
2023	2,215	969	591	609	1,376	517	295	74	74	664	7,383
2024	2,606	1,140	695	717	1,619	608	348	87	87	782	8,688
2025	2,793	1,221	745	768	1,734	652	372	93	93	838	9,309
2026	2,979	1,303	794	819	1,850	695	397	99	99	894	9,930
2027	3,165	1,384	844	870	1,966	739	422	106	106	950	10,551
2028	3,715	1,625	991	1,022	2,307	867	495	124	124	1,115	12,384
2029	3,853	1,685	1,028	1,059	2,393	899	514	128	128	1,156	12,844
2030	4,148	1,814	1,106	1,140	2,576	968	553	138	138	1,244	13,826
2031	4,286	1,874	1,143	1,178	2,662	1,000	571	143	143	1,286	14,286
2032	4,424	1,935	1,180	1,216	2,747	1,032	590	147	147	1,327	14,746
2033	4,562	1,995	1,217	1,254	2,833	1,064	608	152	152	1,369	15,206
2034	4,700	2,055	1,253	1,292	2,919	1,097	627	157	157	1,410	15,666
2035	4,838	2,116	1,290	1,330	3,005	1,129	645	161	161	1,451	16,126
2036	5,310	2,322	1,416	1,460	3,298	1,239	708	177	177	1,593	17,700
Waste Composition	30.0%	13.1%	8.0%		26.9%	7.0%	4.0%	1.0%	1.0%	9.0%	100.0%

Occupancy Waste Composition - Concept Two

Year	Occupancy Waste (tons/year)										
	Paper	Yard	Plastic	Sewage Sludge	Other Organic	Metals	Glass	Rubber	Household Hazardous Waste	Other Waste	Total
2016	345	151	92	103	206	80	46	11	11	103	1,150
2017	552	241	147	165	329	129	74	18	18	165	1,839
2018	690	302	184	207	411	161	92	23	23	207	2,299
2019	828	362	221	248	493	193	110	28	28	248	2,759
2020	1,328	581	354	398	791	310	177	44	44	398	4,425
2021	1,466	641	391	440	873	342	195	49	49	440	4,885
2022	2,028	887	541	608	1,209	473	270	68	68	608	6,759
2023	2,352	1,029	627	706	1,402	549	314	78	78	706	7,840
2024	2,882	1,260	768	865	1,717	672	384	96	96	865	9,606
2025	3,206	1,402	855	962	1,911	748	427	107	107	962	10,687
2026	3,530	1,544	941	1,059	2,104	824	471	118	118	1,059	11,768
2027	3,855	1,686	1,028	1,156	2,297	899	514	128	128	1,156	12,849
2028	4,488	1,963	1,197	1,347	2,675	1,047	598	150	150	1,346	14,960
2029	4,626	2,023	1,234	1,388	2,757	1,079	617	154	154	1,388	15,420
2030	4,921	2,152	1,312	1,476	2,933	1,148	656	164	164	1,476	16,402
2031	5,059	2,212	1,349	1,518	3,015	1,180	674	169	169	1,518	16,862
2032	5,197	2,273	1,386	1,559	3,097	1,213	693	173	173	1,559	17,322
2033	5,335	2,333	1,423	1,601	3,179	1,245	711	178	178	1,600	17,782
2034	5,473	2,393	1,459	1,642	3,262	1,277	730	182	182	1,642	18,242
2035	5,611	2,454	1,496	1,683	3,344	1,309	748	187	187	1,683	18,702
2036	6,083	2,660	1,622	1,825	3,625	1,419	811	203	203	1,825	20,276
Waste Composition	30.0%	13.1%	8.0%		26.9%	7.0%	4.0%	1.0%	1.0%	9.0%	100.0%

Occupancy Waste Composition - Three

Year	Occupancy Waste (tons/year)										
	Paper	Yard	Plastic	Sewage Sludge	Other Organic	Metals	Glass	Rubber	Household Hazardous Waste	Other Waste	Total
2016	345	151	92	99	210	80	46	11	11	103	1,149
2017	639	280	171	183	390	149	85	21	21	192	2,131
2018	777	340	207	223	474	181	104	26	26	233	2,591
2019	915	400	244	262	558	214	122	31	31	275	3,051
2020	1,259	550	336	361	767	294	168	42	42	378	4,195
2021	1,397	611	372	400	851	326	186	47	47	419	4,655
2022	2,145	938	572	615	1,307	500	286	71	71	643	7,150
2023	2,485	1,087	663	713	1,514	580	331	83	83	745	8,283
2024	3,030	1,325	808	869	1,846	707	404	101	101	909	10,100
2025	3,370	1,474	899	966	2,053	786	449	112	112	1,011	11,233
2026	3,710	1,622	989	1,064	2,260	866	495	124	124	1,113	12,366
2027	4,050	1,771	1,080	1,161	2,467	945	540	135	135	1,215	13,499
2028	4,815	2,106	1,284	1,381	2,934	1,124	642	161	161	1,445	16,051
2029	4,953	2,166	1,321	1,420	3,018	1,156	660	165	165	1,486	16,511
2030	5,248	2,295	1,399	1,505	3,197	1,224	700	175	175	1,574	17,493
2031	5,386	2,355	1,436	1,544	3,281	1,257	718	180	180	1,616	17,953
2032	5,524	2,416	1,473	1,584	3,365	1,289	737	184	184	1,657	18,413
2033	5,662	2,476	1,510	1,624	3,449	1,321	755	189	189	1,699	18,873
2034	5,800	2,536	1,547	1,663	3,533	1,353	773	193	193	1,740	19,333
2035	5,938	2,597	1,583	1,703	3,618	1,385	792	198	198	1,781	19,793
2036	6,364	2,783	1,697	1,825	3,877	1,485	849	212	212	1,909	21,214
Waste Composition	30.0%	13.1%	8.0%		26.9%	7.0%	4.0%	1.0%	1.0%	9.0%	100.0%

Construction Waste - Diverted or Recycled - Concept One

Year	Construction Waste (tons/year)	Wood (tons/year)	Cardboard (tons/year)	Metal (tons/year)	Total (tons/year)
2012	70	18	8	18	43
	121	30	13	30	74
2013	70	18	8	18	43
	121	30	13	30	74
2014	286	120	19	5	143
	495	208	32	8	248
2015	474	199	31	8	237
	822	344	53	13	411
2016	375	157	24	6	188
	650	272	42	10	325
2017	375	157	24	6	188
	650	272	42	10	325
2018	474	199	31	8	237
	822	344	53	13	411
2019	473	198	31	8	237
	820	344	53	13	410
2020	409	171	27	7	204
	708	297	46	11	354
2021	280	117	18	4	140
	485	203	32	8	243
2022	216	91	14	3	108
	375	157	24	6	187
2023	216	91	14	3	108
	375	157	24	6	187
2024	118	49	8	2	59
	204	86	13	3	102
2025	120	50	8	2	60
	207	86	14	4	104
2026	219	92	14	4	110
	380	159	25	7	190
2027	383	160	25	6	191
	664	278	43	11	332
2028	451	189	29	7	225
	781	327	51	13	391
2029	451	189	29	7	225
	781	327	51	13	391
2030	450	189	29	7	225
	780	327	51	12	390
2031	450	189	29	7	225
	780	327	51	12	390
2032	450	189	29	7	225
	780	327	51	12	390
2033	450	189	29	7	225
	780	327	51	12	390
2034	370	155	24	6	185
	641	268	42	10	320
2035	144	60	9	2	72
	249	104	16	4	125
2036					

	Wood	Cardboard	Metal
Waste Composition:	41.9%	6.5%	1.6%
Infrastructure (WWTP, SPS, tanks)			
Waste Composition:	25.0%	11.0%	25.0%

Construction Waste - Diverted or Recycled - Concept Two

Year	Construction Waste (tons/year)	Wood (tons/year)	Cardboard (tons/year)	Metal (tons/year)	Total (tons/year)
2012	74	19	8	19	45
	129	32	14	32	79
2013	74	19	8	19	45
	129	32	14	32	79
2014	248	104	16	4	124
	430	180	28	7	215
2015	399	167	26	6	200
	692	290	45	11	346
2016	300	126	20	5	150
	520	218	34	8	260
2017	300	126	20	5	150
	520	218	34	8	260
2018	399	167	26	6	200
	692	290	45	11	346
2019	398	167	26	6	199
	690	289	45	11	345
2020	365	153	24	6	183
	633	265	41	10	317
2021	424	178	28	7	212
	736	308	48	12	368
2022	516	216	34	8	258
	895	375	58	14	447
2023	516	216	34	8	258
	895	375	58	14	447
2024	418	175	27	7	209
	724	304	47	12	362
2025	420	176	27	7	210
	728	304	47	12	364
2026	460	193	30	8	230
	798	334	52	14	399
2027	474	198	31	8	237
	821	344	53	13	410
2028	451	189	29	7	225
	781	327	51	13	391
2029	451	189	29	7	225
	781	327	51	13	391
2030	450	189	29	7	225
	780	327	51	12	390
2031	450	189	29	7	225
	780	327	51	12	390
2032	450	189	29	7	225
	780	327	51	12	390
2033	450	189	29	7	225
	780	327	51	12	390
2034	370	155	24	6	185
	641	268	42	10	320
2035	144	60	9	2	72
	249	104	16	4	125
2036					

	Wood	Cardboard	Metal
Waste Composition:	41.9%	6.5%	1.6%
Infrastructure (WWTP, SPS, tanks) Waste Composition:	25.0%	11.0%	25.0%

Construction Waste - Diverted or Recycled - Concept Three

Year	Construction Waste (tons/year)	Wood (tons/year)	Cardboard (tons/year)	Metal (tons/year)	Total (tons/year)
2012	74	19	8	19	45
	129	32	14	32	78
2013	74	19	8	19	45
	129	32	14	32	78
2014	286	120	19	5	143
	495	208	32	8	248
2015	474	199	31	8	237
	822	344	53	13	411
2016	376	157	24	6	188
	651	273	42	10	326
2017	375	157	24	6	188
	650	272	42	10	325
2018	473	198	31	8	237
	820	344	53	13	410
2019	448	188	29	7	224
	776	325	50	12	388
2020	383	161	25	6	192
	664	278	43	11	332
2021	434	182	28	7	217
	753	315	49	12	376
2022	526	220	34	8	263
	912	382	59	15	456
2023	526	220	34	8	263
	912	382	59	15	456
2024	428	179	28	7	214
	742	311	48	12	371
2025	430	180	28	7	215
	746	312	49	13	373
2026	635	265	41	11	318
	1,100	460	72	19	550
2027	606	254	39	10	303
	1,050	440	68	17	525
2028	384	161	25	6	192
	662	277	43	11	331
2029	383	160	25	6	191
	661	277	43	11	330
2030	375	157	24	6	188
	650	272	42	10	325
2031	379	159	25	6	190
	654	274	43	10	327
2032	379	159	25	6	190
	654	274	43	10	327
2033	394	165	26	6	197
	683	286	44	11	341
2034	338	141	22	5	169
	580	243	38	9	290
2035	131	55	8	2	65
	221	93	14	4	111
2036					

	Wood	Cardboard	Metal
Waste Composition:	41.9%	6.5%	1.6%
Infrastructure (WWTP, SPS, tanks) Waste Composition:	25.0%	11.0%	25.0%

Occupancy Waste Composition - Diverted or Recycled - Concept One

Year	Occupancy Waste (tons/year)								
	Paper	Yard	Plastic	Sewage Sludge	Metals	Glass	Total Recyclable	Total Diverted	Total Waste
2016	345	151	92	95	80	46	809	352	1,150
2017	552	241	147	152	129	74	1,294	563	1,839
2018	690	302	184	190	161	92	1,618	703	2,299
2019	828	362	221	228	193	110	1,941	844	2,759
2020	1,328	581	354	365	310	177	3,114	1,354	4,425
2021	1,466	641	391	403	342	195	3,438	1,495	4,885
2022	2,029	887	541	558	473	270	4,758	2,069	6,762
2023	2,215	969	591	609	517	295	5,195	2,259	7,383
2024	2,606	1,140	695	717	608	348	6,114	2,659	8,688
2025	2,793	1,221	745	768	652	372	6,551	2,849	9,309
2026	2,979	1,303	794	819	695	397	6,988	3,039	9,930
2027	3,165	1,384	844	870	739	422	7,424	3,229	10,551
2028	3,715	1,625	991	1,022	867	495	8,715	3,790	12,384
2029	3,853	1,685	1,028	1,059	899	514	9,038	3,930	12,844
2030	4,148	1,814	1,106	1,140	968	553	9,729	4,231	13,826
2031	4,286	1,874	1,143	1,178	1,000	571	10,053	4,372	14,286
2032	4,424	1,935	1,180	1,216	1,032	590	10,377	4,512	14,746
2033	4,562	1,995	1,217	1,254	1,064	608	10,700	4,653	15,206
2034	4,700	2,055	1,253	1,292	1,097	627	11,024	4,794	15,666
2035	4,838	2,116	1,290	1,330	1,129	645	11,348	4,935	16,126
2036	5,310	2,322	1,416	1,460	1,239	708	12,455	5,416	17,700
Waste Composition	30.0%	13.1%	8.0%	8.2%	7.0%	4.0%	70.4%	30.6%	

Occupancy Waste Composition - Diverted or Recycled - Concept Two

Year	Occupancy Waste (tons/year)								
	Paper	Yard	Plastic	Sewage Sludge	Metals	Glass	Total Recyclable	Total Diverted	Total Waste
2016	345	151	92	103	80	46	809	352	1,150
2017	552	241	147	165	129	74	1,294	563	1,839
2018	690	302	184	207	161	92	1,618	703	2,299
2019	828	362	221	248	193	110	1,941	844	2,759
2020	1,328	581	354	398	310	177	3,114	1,354	4,425
2021	1,466	641	391	440	342	195	3,438	1,495	4,885
2022	2,028	887	541	608	473	270	4,756	2,068	6,759
2023	2,352	1,029	627	706	549	314	5,517	2,399	7,840
2024	2,882	1,260	768	865	672	384	6,759	2,939	9,606
2025	3,206	1,402	855	962	748	427	7,520	3,270	10,687
2026	3,530	1,544	941	1,059	824	471	8,281	3,601	11,768
2027	3,855	1,686	1,028	1,156	899	514	9,041	3,932	12,849
2028	4,488	1,963	1,197	1,347	1,047	598	10,527	4,578	14,960
2029	4,626	2,023	1,234	1,388	1,079	617	10,851	4,719	15,420
2030	4,921	2,152	1,312	1,476	1,148	656	11,542	5,019	16,402
2031	5,059	2,212	1,349	1,518	1,180	674	11,866	5,160	16,862
2032	5,197	2,273	1,386	1,559	1,213	693	12,189	5,301	17,322
2033	5,335	2,333	1,423	1,601	1,245	711	12,513	5,441	17,782
2034	5,473	2,393	1,459	1,642	1,277	730	12,837	5,582	18,242
2035	5,611	2,454	1,496	1,683	1,309	748	13,161	5,723	18,702
2036	6,083	2,660	1,622	1,825	1,419	811	14,268	6,205	20,276
Waste Composition	30.0%	13.1%	8.0%	9.0%	7.0%	4.0%	71.1%	30.6%	

Occupancy Waste Composition - Diverted or Recycled - Concept Three

Year	Occupancy Waste (tons/year)								
	Paper	Yard	Plastic	Sewage Sludge	Metals	Glass	Total Recyclable	Total Diverted	Total Waste
2016	345	151	92	99	80	46	809	352	1,149
2017	639	280	171	183	149	85	1,500	652	2,131
2018	777	340	207	223	181	104	1,823	793	2,591
2019	915	400	244	262	214	122	2,147	934	3,051
2020	1,259	550	336	361	294	168	2,952	1,284	4,195
2021	1,397	611	372	400	326	186	3,276	1,425	4,655
2022	2,145	938	572	615	500	286	5,031	2,188	7,150
2023	2,485	1,087	663	713	580	331	5,828	2,535	8,283
2024	3,030	1,325	808	869	707	404	7,107	3,091	10,100
2025	3,370	1,474	899	966	786	449	7,905	3,437	11,233
2026	3,710	1,622	989	1,064	866	495	8,702	3,784	12,366
2027	4,050	1,771	1,080	1,161	945	540	9,499	4,131	13,499
2028	4,815	2,106	1,284	1,381	1,124	642	11,295	4,911	16,051
2029	4,953	2,166	1,321	1,420	1,156	660	11,618	5,052	16,511
2030	5,248	2,295	1,399	1,505	1,224	700	12,309	5,353	17,493
2031	5,386	2,355	1,436	1,544	1,257	718	12,633	5,493	17,953
2032	5,524	2,416	1,473	1,584	1,289	737	12,957	5,634	18,413
2033	5,662	2,476	1,510	1,624	1,321	755	13,280	5,775	18,873
2034	5,800	2,536	1,547	1,663	1,353	773	13,604	5,916	19,333
2035	5,938	2,597	1,583	1,703	1,385	792	13,928	6,057	19,793
2036	6,364	2,783	1,697	1,825	1,485	849	14,928	6,492	21,214
Waste Composition	30.0%	13.1%	8.0%	8.6%	7.0%	4.0%	70.7%	30.6%	

Summary of Waste Diverted and Landfilled - Concept One

Year	Construction Waste				Occupancy Waste				Total Diverted Waste (tons/year)	Total Landfilled Waste (tons/yr)
	Diverted		Landfilled		Diverted		Landfilled			
	Waste (tons/yr)	# Trucks per week	Waste (tons/yr)	# Trucks per week	Waste (tons/yr)	# Trucks per week	Waste (tons/yr)	# Trucks per week		
2012	43	0.1	27	0.1	0	0.0	0	0.0	43	27
	74	0.1	47	0.1					74	47
2013	43	0.1	27	0.1	0	0.0	0	0.0	43	27
	74	0.1	47	0.1					74	47
2014	143	0.3	143	0.3	0	0.0	0	0.0	143	143
	248	0.5	248	0.5					248	248
2015	237	0.5	237	0.5	0	0.0	0	0.0	237	237
	411	0.8	411	0.8					411	411
2016	188	0.4	188	0.4	352	0.7	798	1.5	539	985
	325	0.6	325	0.6					677	1,123
2017	188	0.4	188	0.4	563	1.1	1,276	2.5	750	1,464
	325	0.6	325	0.6					888	1,601
2018	237	0.5	237	0.5	703	1.4	1,595	3.1	940	1,832
	411	0.8	411	0.8					1,114	2,006
2019	237	0.5	237	0.5	844	1.6	1,915	3.7	1,081	2,151
	410	0.8	410	0.8					1,254	2,325
2020	204	0.4	204	0.4	1,354	2.6	3,071	5.9	1,558	3,275
	354	0.7	354	0.7					1,708	3,425
2021	140	0.3	140	0.3	1,495	2.9	3,390	6.5	1,635	3,530
	243	0.5	243	0.5					1,738	3,633
2022	108	0.2	108	0.2	2,069	4.0	4,693	9.0	2,177	4,801
	187	0.4	187	0.4					2,256	4,880
2023	108	0.2	108	0.2	2,259	4.3	5,124	9.9	2,367	5,232
	187	0.4	187	0.4					2,447	5,311
2024	59	0.1	59	0.1	2,659	5.1	6,029	11.6	2,717	6,088
	102	0.2	102	0.2					2,761	6,132
2025	60	0.1	60	0.1	2,849	5.5	6,460	12.4	2,909	6,520
	104	0.2	103	0.2					2,953	6,564
2026	110	0.2	109	0.2	3,039	5.8	6,891	13.3	3,148	7,001
	190	0.4	190	0.4					3,229	7,081
2027	191	0.4	191	0.4	3,229	6.2	7,322	14.1	3,420	7,514
	332	0.6	332	0.6					3,560	7,654
2028	225	0.4	225	0.4	3,790	7.3	8,595	16.5	4,015	8,820
	391	0.8	391	0.8					4,180	8,985
2029	225	0.4	225	0.4	3,930	7.6	8,914	17.1	4,156	9,139
	391	0.8	391	0.8					4,321	9,305
2030	225	0.4	225	0.4	4,231	8.1	9,596	18.5	4,456	9,821
	390	0.8	390	0.8					4,621	9,986
2031	225	0.4	225	0.4	4,372	8.4	9,915	19.1	4,597	10,140
	390	0.8	390	0.8					4,762	10,305
2032	225	0.4	225	0.4	4,512	8.7	10,234	19.7	4,737	10,459
	390	0.8	390	0.8					4,902	10,624
2033	225	0.4	225	0.4	4,653	8.9	10,553	20.3	4,878	10,778
	390	0.8	390	0.8					5,043	10,943
2034	185	0.4	185	0.4	4,794	9.2	10,872	20.9	4,979	11,057
	320	0.6	320	0.6					5,114	11,193
2035	72	0.1	72	0.1	4,935	9.5	11,192	21.5	5,007	11,264
	125	0.2	125	0.2					5,059	11,316
2036	0	0.0	0	0.0	5,416	10.4	12,284	23.6	5,416	12,284
	0	0.0	0	0.0					5,416	12,284

Construction Truck Volume: 20'x8'x7' (LxWxH) = 41.5 CY (Max Load is 10 tons)

Operations Bin Volume: 72"x43"x45" (LxWxH) = 3 CY Use Truck Capacity: 10 tons / truck

Summary of Waste Diverted and Landfilled - Concept Two

Year	Construction Waste				Occupancy Waste				Total Diverted Waste (tons/year)	Total Landfilled Waste (tons/yr)
	Diverted		Landfilled		Diverted		Landfilled			
	Waste (tons/yr)	# Trucks per week	Waste (tons/yr)	# Trucks per week	Waste (tons/yr)	# Trucks per week	Waste (tons/yr)	# Trucks per week		
2012	45	0.1	29	0.1	0	0.0	0	0.0	45	29
	79	0.2	50	0.1					79	50
2013	45	0.1	29	0.1	0	0.0	0	0.0	45	29
	79	0.2	50	0.1					79	50
2014	124	0.2	124	0.2	0	0.0	0	0.0	124	124
	215	0.4	215	0.4					215	215
2015	200	0.4	200	0.4	0	0.0	0	0.0	200	200
	346	0.7	346	0.7					346	346
2016	150	0.3	150	0.3	352	0.7	798	1.5	502	948
	260	0.5	260	0.5					612	1,058
2017	150	0.3	150	0.3	563	1.1	1,276	2.5	713	1,426
	260	0.5	260	0.5					823	1,536
2018	200	0.4	200	0.4	703	1.4	1,595	3.1	903	1,795
	346	0.7	346	0.7					1,049	1,941
2019	199	0.4	199	0.4	844	1.6	1,915	3.7	1,043	2,114
	345	0.7	345	0.7					1,189	2,260
2020	183	0.4	183	0.4	1,354	2.6	3,071	5.9	1,537	3,254
	317	0.6	317	0.6					1,671	3,388
2021	212	0.4	212	0.4	1,495	2.9	3,390	6.5	1,707	3,602
	368	0.7	368	0.7					1,863	3,758
2022	258	0.5	258	0.5	2,068	4.0	4,691	9.0	2,327	4,949
	447	0.9	447	0.9					2,516	5,138
2023	258	0.5	258	0.5	2,399	4.6	5,441	10.5	2,657	5,699
	447	0.9	447	0.9					2,847	5,889
2024	209	0.4	209	0.4	2,939	5.7	6,666	12.8	3,148	6,875
	362	0.7	362	0.7					3,302	7,029
2025	210	0.4	210	0.4	3,270	6.3	7,417	14.3	3,480	7,626
	364	0.7	364	0.7					3,634	7,780
2026	230	0.4	230	0.4	3,601	6.9	8,167	15.7	3,831	8,397
	399	0.8	399	0.8					4,000	8,565
2027	237	0.5	237	0.5	3,932	7.6	8,917	17.1	4,168	9,154
	410	0.8	410	0.8					4,342	9,327
2028	225	0.4	225	0.4	4,578	8.8	10,383	20.0	4,803	10,608
	391	0.8	391	0.8					4,969	10,773
2029	225	0.4	225	0.4	4,719	9.1	10,702	20.6	4,944	10,927
	391	0.8	391	0.8					5,109	11,092
2030	225	0.4	225	0.4	5,019	9.7	11,383	21.9	5,244	11,608
	390	0.8	390	0.8					5,409	11,773
2031	225	0.4	225	0.4	5,160	9.9	11,703	22.5	5,385	11,928
	390	0.8	390	0.8					5,550	12,093
2032	225	0.4	225	0.4	5,301	10.2	12,022	23.1	5,526	12,247
	390	0.8	390	0.8					5,691	12,412
2033	225	0.4	225	0.4	5,441	10.5	12,341	23.7	5,666	12,566
	390	0.8	390	0.8					5,831	12,731
2034	185	0.4	185	0.4	5,582	10.7	12,660	24.3	5,767	12,845
	320	0.6	320	0.6					5,902	12,980
2035	72	0.1	72	0.1	5,723	11.0	12,979	25.0	5,795	13,051
	125	0.2	125	0.2					5,848	13,104
2036	0	0.0	0	0.0	6,205	11.9	14,072	27.1	6,205	14,072
	0	0.0	0	0.0					6,205	14,072

Construction Truck Volume: 20'x8'x7' (LxWxH) = 41.5 CY (Max Load is 10 tons)

Operations Bin Volume: 72"x43"x45" (LxWxH) = 3 CY Use Truck Capacity: 10 tons / truck

Summary of Waste Diverted and Landfilled - Concept Three

Year	Construction Waste				Occupancy Waste				Total Diverted Waste (tons/year)	Total Landfilled Waste (tons/yr)
	Diverted		Landfilled		Diverted		Landfilled			
	Waste (tons/yr)	# Trucks per week	Waste (tons/yr)	# Trucks per week	Waste (tons/yr)	# Trucks per week	Waste (tons/yr)	# Trucks per week		
2012	45	0.1	29	0.1	0	0.0	0	0.0	45	29
	78	0.2	50	0.1					78	50
2013	45	0.1	29	0.1	0	0.0	0	0.0	45	29
	78	0.2	50	0.1					78	50
2014	143	0.3	143	0.3	0	0.0	0	0.0	143	143
	248	0.5	248	0.5					248	248
2015	237	0.5	237	0.5	0	0.0	0	0.0	237	237
	411	0.8	411	0.8					411	411
2016	188	0.4	188	0.4	352	0.7	798	1.5	540	986
	326	0.6	326	0.6					677	1,123
2017	188	0.4	188	0.4	652	1.3	1,479	2.8	840	1,667
	325	0.6	325	0.6					977	1,804
2018	237	0.5	237	0.5	793	1.5	1,798	3.5	1,030	2,035
	410	0.8	410	0.8					1,203	2,209
2019	224	0.4	224	0.4	934	1.8	2,118	4.1	1,158	2,341
	388	0.7	388	0.7					1,322	2,506
2020	192	0.4	192	0.4	1,284	2.5	2,912	5.6	1,475	3,103
	332	0.6	332	0.6					1,616	3,244
2021	217	0.4	217	0.4	1,425	2.7	3,231	6.2	1,642	3,448
	376	0.7	376	0.7					1,801	3,607
2022	263	0.5	263	0.5	2,188	4.2	4,962	9.5	2,451	5,225
	456	0.9	456	0.9					2,644	5,418
2023	263	0.5	263	0.5	2,535	4.9	5,748	11.1	2,798	6,011
	456	0.9	456	0.9					2,990	6,204
2024	214	0.4	214	0.4	3,091	5.9	7,009	13.5	3,305	7,223
	371	0.7	371	0.7					3,461	7,380
2025	215	0.4	215	0.4	3,437	6.6	7,796	15.0	3,653	8,011
	373	0.7	372	0.7					3,811	8,168
2026	318	0.6	317	0.6	3,784	7.3	8,582	16.5	4,102	8,899
	550	1.1	549	1.1					4,334	9,132
2027	303	0.6	303	0.6	4,131	7.9	9,368	18.0	4,434	9,671
	525	1.0	525	1.0					4,656	9,893
2028	192	0.4	192	0.4	4,911	9.4	11,139	21.4	5,103	11,331
	331	0.6	331	0.6					5,242	11,470
2029	191	0.4	191	0.4	5,052	9.7	11,458	22.0	5,244	11,650
	330	0.6	330	0.6					5,383	11,789
2030	188	0.4	188	0.4	5,353	10.3	12,140	23.3	5,540	12,327
	325	0.6	325	0.6					5,678	12,465
2031	190	0.4	190	0.4	5,493	10.6	12,459	24.0	5,683	12,649
	327	0.6	327	0.6					5,821	12,786
2032	190	0.4	190	0.4	5,634	10.8	12,778	24.6	5,824	12,968
	327	0.6	327	0.6					5,961	13,105
2033	197	0.4	197	0.4	5,775	11.1	13,098	25.2	5,972	13,294
	341	0.7	341	0.7					6,116	13,439
2034	169	0.3	169	0.3	5,916	11.4	13,417	25.8	6,085	13,586
	290	0.6	290	0.6					6,206	13,707
2035	65	0.1	65	0.1	6,057	11.6	13,736	26.4	6,122	13,801
	111	0.2	111	0.2					6,167	13,847
2036	0	0.0	0	0.0	6,492	12.5	14,723	28.3	6,492	14,723
	0	0.0	0	0.0					6,492	14,723

Construction Truck Volume: 20'x8'x7' (LxWxH) = 41.5 CY (Max Load is 10 tons)

Operations Bin Volume: 72"x43"x45" (LxWxH) = 3 CY Use Truck Capacity: 10 tons / truck

Summary of Waste Diverted and Landfilled - Concept One

Year	Construction Waste		Occupancy Waste		Total Diverted Waste (tons/year)	Total Landfilled Waste (tons/yr)	Percent Annual Waste Increase to Landfill
	Diverted Waste (tons/yr)	Landfilled Waste (tons/yr)	Diverted Waste (tons/yr)	Landfilled Waste (tons/yr)			
2012	43	27	0	0	43	27	0.01%
	74	47			74	47	0.02%
2013	43	27	0	0	43	27	0.01%
	74	47			74	47	0.02%
2014	143	143	0	0	143	143	0.07%
	248	248			248	248	0.12%
2015	237	237	0	0	237	237	0.12%
	411	411			411	411	0.21%
2016	188	188	352	798	539	985	0.49%
	325	325			677	1,123	0.56%
2017	188	188	563	1,276	750	1,464	0.73%
	325	325			888	1,601	0.80%
2018	237	237	703	1,595	940	1,832	0.92%
	411	411			1,114	2,006	1.01%
2019	237	237	844	1,915	1,081	2,151	1.08%
	410	410			1,254	2,325	1.17%
2020	204	204	1,354	3,071	1,558	3,275	1.64%
	354	354			1,708	3,425	1.72%
2021	140	140	1,495	3,390	1,635	3,530	1.77%
	243	243			1,738	3,633	1.82%
2022	108	108	2,069	4,693	2,177	4,801	2.41%
	187	187			2,256	4,880	2.45%
2023	108	108	2,259	5,124	2,367	5,232	2.62%
	187	187			2,447	5,311	2.66%
2024	59	59	2,659	6,029	2,717	6,088	3.05%
	102	102			2,761	6,132	3.07%
2025	60	60	2,849	6,460	2,909	6,520	3.27%
	104	103			2,953	6,564	3.29%
2026	110	109	3,039	6,891	3,148	7,001	3.51%
	190	190			3,229	7,081	3.55%
2027	191	191	3,229	7,322	3,420	7,514	3.77%
	332	332			3,560	7,654	3.84%
2028	225	225	3,790	8,595	4,015	8,820	4.42%
	391	391			4,180	8,985	4.50%
2029	225	225	3,930	8,914	4,156	9,139	4.58%
	391	391			4,321	9,305	4.66%
2030	225	225	4,231	9,596	4,456	9,821	4.92%
	390	390			4,621	9,986	5.01%
2031	225	225	4,372	9,915	4,597	10,140	5.08%
	390	390			4,762	10,305	5.17%
2032	225	225	4,512	10,234	4,737	10,459	5.24%
	390	390			4,902	10,624	5.33%
2033	225	225	4,653	10,553	4,878	10,778	5.40%
	390	390			5,043	10,943	5.49%
2034	185	185	4,794	10,872	4,979	11,057	5.54%
	320	320			5,114	11,193	5.61%
2035	72	72	4,935	11,192	5,007	11,264	5.65%
	125	125			5,059	11,316	5.67%
2036	0	0	5,416	12,284	5,416	12,284	6.16%
	0	0			5,416	12,284	6.16%

Operations Use Truck Capacity: 10 tons / truck

Percent Increase to Landfill Based on 199,500 tons of waste disposed at Central Maui Landfill in year 2006

Summary of Waste Diverted and Landfilled - Concept Two

Year	Construction Waste		Occupancy Waste		Total Diverted Waste (tons/year)	Total Landfilled Waste (tons/yr)	Percent Annual Waste Increase to Landfill
	Diverted Waste (tons/yr)	Landfilled Waste (tons/yr)	Diverted Waste (tons/yr)	Landfilled Waste (tons/yr)			
2012	45	29	0	0	45	29	0.01%
	79	50			79	50	0.03%
2013	45	29	0	0	45	29	0.01%
	79	50			79	50	0.03%
2014	124	124	0	0	124	124	0.06%
	215	215			215	215	0.11%
2015	200	200	0	0	200	200	0.10%
	346	346			346	346	0.17%
2016	150	150	352	798	502	948	0.48%
	260	260			612	1,058	0.53%
2017	150	150	563	1,276	713	1,426	0.71%
	260	260			823	1,536	0.77%
2018	200	200	703	1,595	903	1,795	0.90%
	346	346			1,049	1,941	0.97%
2019	199	199	844	1,915	1,043	2,114	1.06%
	345	345			1,189	2,260	1.13%
2020	183	183	1,354	3,071	1,537	3,254	1.63%
	317	317			1,671	3,388	1.70%
2021	212	212	1,495	3,390	1,707	3,602	1.81%
	368	368			1,863	3,758	1.88%
2022	258	258	2,068	4,691	2,327	4,949	2.48%
	447	447			2,516	5,138	2.58%
2023	258	258	2,399	5,441	2,657	5,699	2.86%
	447	447			2,847	5,889	2.95%
2024	209	209	2,939	6,666	3,148	6,875	3.45%
	362	362			3,302	7,029	3.52%
2025	210	210	3,270	7,417	3,480	7,626	3.82%
	364	364			3,634	7,780	3.90%
2026	230	230	3,601	8,167	3,831	8,397	4.21%
	399	399			4,000	8,565	4.29%
2027	237	237	3,932	8,917	4,168	9,154	4.59%
	410	410			4,342	9,327	4.68%
2028	225	225	4,578	10,383	4,803	10,608	5.32%
	391	391			4,969	10,773	5.40%
2029	225	225	4,719	10,702	4,944	10,927	5.48%
	391	391			5,109	11,092	5.56%
2030	225	225	5,019	11,383	5,244	11,608	5.82%
	390	390			5,409	11,773	5.90%
2031	225	225	5,160	11,703	5,385	11,928	5.98%
	390	390			5,550	12,093	6.06%
2032	225	225	5,301	12,022	5,526	12,247	6.14%
	390	390			5,691	12,412	6.22%
2033	225	225	5,441	12,341	5,666	12,566	6.30%
	390	390			5,831	12,731	6.38%
2034	185	185	5,582	12,660	5,767	12,845	6.44%
	320	320			5,902	12,980	6.51%
2035	72	72	5,723	12,979	5,795	13,051	6.54%
	125	125			5,848	13,104	6.57%
2036	0	0	6,205	14,072	6,205	14,072	7.05%
	0	0			6,205	14,072	7.05%

Operations Use Truck Capacity: 10 tons / truck

Percent Increase to Landfill Based on 199,500 tons of waste disposed at Central Maui Landfill in year 2006

Summary of Waste Diverted and Landfilled - Concept Three

Year	Construction Waste		Occupancy Waste		Total Diverted Waste (tons/year)	Total Landfilled Waste (tons/yr)	Percent Annual Waste Increase to Landfill
	Diverted Waste (tons/yr)	Landfilled Waste (tons/yr)	Diverted Waste (tons/yr)	Landfilled Waste (tons/yr)			
2012	45	29	0	0	45	29	0.01%
	78	50			78	50	0.03%
2013	45	29	0	0	45	29	0.01%
	78	50			78	50	0.03%
2014	143	143	0	0	143	143	0.07%
	248	248			248	248	0.12%
2015	237	237	0	0	237	237	0.12%
	411	411			411	411	0.21%
2016	188	188	352	798	540	986	0.49%
	326	326			677	1,123	0.56%
2017	188	188	652	1,479	840	1,667	0.84%
	325	325			977	1,804	0.90%
2018	237	237	793	1,798	1,030	2,035	1.02%
	410	410			1,203	2,209	1.11%
2019	224	224	934	2,118	1,158	2,341	1.17%
	388	388			1,322	2,506	1.26%
2020	192	192	1,284	2,912	1,475	3,103	1.56%
	332	332			1,616	3,244	1.63%
2021	217	217	1,425	3,231	1,642	3,448	1.73%
	376	376			1,801	3,607	1.81%
2022	263	263	2,188	4,962	2,451	5,225	2.62%
	456	456			2,644	5,418	2.72%
2023	263	263	2,535	5,748	2,798	6,011	3.01%
	456	456			2,990	6,204	3.11%
2024	214	214	3,091	7,009	3,305	7,223	3.62%
	371	371			3,461	7,380	3.70%
2025	215	215	3,437	7,796	3,653	8,011	4.02%
	373	372			3,811	8,168	4.09%
2026	318	317	3,784	8,582	4,102	8,899	4.46%
	550	549			4,334	9,132	4.58%
2027	303	303	4,131	9,368	4,434	9,671	4.85%
	525	525			4,656	9,893	4.96%
2028	192	192	4,911	11,139	5,103	11,331	5.68%
	331	331			5,242	11,470	5.75%
2029	191	191	5,052	11,458	5,244	11,650	5.84%
	330	330			5,383	11,789	5.91%
2030	188	188	5,353	12,140	5,540	12,327	6.18%
	325	325			5,678	12,465	6.25%
2031	190	190	5,493	12,459	5,683	12,649	6.34%
	327	327			5,821	12,786	6.41%
2032	190	190	5,634	12,778	5,824	12,968	6.50%
	327	327			5,961	13,105	6.57%
2033	197	197	5,775	13,098	5,972	13,294	6.66%
	341	341			6,116	13,439	6.74%
2034	169	169	5,916	13,417	6,085	13,586	6.81%
	290	290			6,206	13,707	6.87%
2035	65	65	6,057	13,736	6,122	13,801	6.92%
	111	111			6,167	13,847	6.94%
2036	0	0	6,492	14,723	6,492	14,723	7.38%
	0	0			6,492	14,723	7.38%

Operations Use Truck Capacity: 10 tons / truck

Percent Increase to Landfill Based on 199,500 tons of waste disposed at Central Maui Landfill in year 2006

Leialii WWTP - Bioreactor Sludge Production											
Concept One											
7/6/2010											
Average flow, Q, gpd					1,140,000						
Influent BOD, mg/L					500						
Influent soluble BOD, mg/L					350	(assume 70 % BOD is soluble)					
Effluent BOD, mg/L					10						
Effluent soluble BOD, S_e, mg/L					7	(assume 70 % BOD is soluble)					
Bioreactor Tanks											
	Total liquid volume, V_{tank}, gal				1122750						
	Total liquid volume, V_{tank}, cf				150000						
	Hydraulic detention time (remove USBF Clarifier), t_h, hr @ ADF				24	V/Q	12 hours minimum preferred				
	MCRT (remove USBF Clarifier), days @ ADF				15	3-15 days for conventional, 20-30 days for extended (M&E)					
		MLSS in aeration tank, mg/L			3000						
	If:	MLVSS in aeration tank, X, mg/L			2100	$\frac{1}{\quad}$	$\frac{Y(S_o - S_e)}{\quad}$		(assume 70% volatile)		
		Sludge yield, Y, lb cells/lb BOD			0.7	Typical:	0.6	(WEF and ASCE, 1991, p-530, warmer climates)			
		Endogenous decay, kd, 1/day			0.05	Typical:	0.06	(WEF and ASCE, 1991, p-530)			
Aerobic Digesters											
	WAS MLSS, Xr, mg/L				3000	(from bioreactor or MBR tanks)					
	WAS to digesters, SS, lb/day				1855	using $MCRT = \frac{V_{tank} X}{Q_w X_{WAS}}$					
	or WAS to digesters, SS, lb/day (use higher of the two values)				2283	using Px = (So - Se)Q*8.34*Yo					
	Sludge digester solids reduction, %				35						
	Digester output, dry solids, lb/day				1484						
	Dewatered dry solids weight of total sludge weight, %				18						
	Wet sludge output, lb/day				8243						

Leialii WWTP - Bioreactor Sludge Production											
Concept Two											
7/6/2010											
Average flow, Q, gpd					1,380,000						
Influent BOD, mg/L					500						
Influent soluble BOD, mg/L					350	(assume 70 % BOD is soluble)					
Effluent BOD, mg/L					10						
Effluent soluble BOD, S_e, mg/L					7	(assume 70 % BOD is soluble)					
Bioreactor Tanks											
	Total liquid volume, V_{tank}, gal				1122750						
	Total liquid volume, V_{tank}, cf				150000						
	Hydraulic detention time (remove USBF Clarifier), t_h, hr @ ADF				20	V/Q	12 hours minimum preferred				
	MCRT (remove USBF Clarifier), days @ ADF				11	3-15 days for conventional, 20-30 days for extended (M&E)					
		MLSS in aeration tank, mg/L			3000						
	If:	MLVSS in aeration tank, X, mg/L			2100	$\frac{1}{}$	$\frac{Y(S_o - S_e)}{}$		(assume 70% volatile)		
		Sludge yield, Y, lb cells/lb BOD			0.7	Typical:	0.6	(WEF and ASCE, 1991, p-530, warmer climates)			
		Endogenous decay, kd, 1/day			0.05	Typical:	0.06	(WEF and ASCE, 1991, p-530)			
Aerobic Digesters											
	WAS MLSS, Xr, mg/L				3000	(from bioreactor or MBR tanks)					
	WAS to digesters, SS, lb/day				2541	using $MCRT = \frac{V_{tank} X}{Q_w X_{WAS}}$					
	or WAS to digesters, SS, lb/day (use higher of the two values)				2763	using Px = (So - Se)Q*8.34*Yo					
	Sludge digester solids reduction, %				35						
	Digester output, dry solids, lb/day				1796						
	Dewatered dry solids weight of total sludge weight, %				18						
	Wet sludge output, lb/day				9979						

Leialii WWTP - Bioreactor Sludge Production											
Concept Three											
7/6/2010											
Average flow, Q, gpd					1,390,000						
Influent BOD, mg/L					500						
Influent soluble BOD, mg/L					350	(assume 70 % BOD is soluble)					
Effluent BOD, mg/L					10						
Effluent soluble BOD, S_e, mg/L					7	(assume 70 % BOD is soluble)					
Bioreactor Tanks											
	Total liquid volume, V_{tank}, gal				1122750						
	Total liquid volume, V_{tank}, cf				150000						
	Hydraulic detention time (remove USBF Clarifier), t_h, hr @ ADF				19	V/Q	12 hours minimum preferred				
	MCRT (remove USBF Clarifier), days @ ADF				11	3-15 days for conventional, 20-30 days for extended (M&E)					
		MLSS in aeration tank, mg/L			3000						
	If:	MLVSS in aeration tank, X, mg/L			2100	$\frac{1}{}$	$\frac{Y(S_o - S_e)}{}$		(assume 70% volatile)		
		Sludge yield, Y, lb cells/lb BOD			0.7	Typical:	0.6	(WEF and ASCE, 1991, p-530, warmer climates)			
		Endogenous decay, kd, 1/day			0.05	Typical:	0.06	(WEF and ASCE, 1991, p-530)			
Aerobic Digesters											
	WAS MLSS, Xr, mg/L				3000	(from bioreactor or MBR tanks)					
	WAS to digesters, SS, lb/day				2570	using $MCRT = \frac{V_{tank} X}{Q_w X_{WAS}}$					
	or WAS to digesters, SS, lb/day (use higher of the two values)				2783	using Px = (So - Se)Q*8.34*Yo					
	Sludge digester solids reduction, %				35						
	Digester output, dry solids, lb/day				1809						
	Dewatered dry solids weight of total sludge weight, %				18						
	Wet sludge output, lb/day				10051						

APPENDIX B – CORRESPONDENCES

Carolyn Ancheta

From: Tracy Takamine [Tracy.Takamine@co.maui.hi.us]
Sent: Friday, April 23, 2010 1:36 PM
To: Carolyn Ancheta
Subject: RE: Villages of Leiali'i - Solid Waste Standards
Attachments: Villages at Leilani.doc

Answers to your questions.

>>> "Carolyn Ancheta" <cancheta@beltcollins.com> 4/22/2010 2:02 PM >>>
Tracy,

Just checking on the status of the other comments. Do you have an estimate on when you will be receiving them all?

Thank you,
Carolyn

-----Original Message-----
From: Tracy Takamine [mailto:Tracy.Takamine@co.maui.hi.us]
Sent: Wednesday, April 07, 2010 11:18 AM
To: Carolyn Ancheta; Elaine Baker
Cc: Alan Kato; Hana Steel
Subject: RE: Villages of Leiali'i - Solid Waste Standards

Carolyn,

Elaine sent you this prematurely, this is not all the comments we have, only hers. I am still consolidating comments and will send them all to you.

>>> "Carolyn Ancheta" <cancheta@beltcollins.com> 4/7/2010 11:08 AM >>>
Elaine,

Thank you for your response.

2) Please clarify, should we use the Honolulu figure of 10.2 lbs. per person per day, or the State figure of 5.8 lbs. per person per day?

Do you have any comments for 5) and 6)?

Thank you,
Carolyn

-----Original Message-----
From: Elaine Baker [mailto:Elaine.Baker@co.maui.hi.us]
Sent: Wednesday, April 07, 2010 10:54 AM
To: Carolyn Ancheta
Cc: Hana Steel; Tracy Takamine
Subject: Re: Villages of Leiali'i - Solid Waste Standards

1) Be consistent with other County criteria, such as Wastewater's ratios, so use them.
2) 14.8 lbs. per person per day of waste generation does seem high especially for all land uses; use the Honolulu figure of 5._ lbs. per

person per day otherwise all waste generation numbers will be skewed.
3) No sludge can go to Central Landfill; re: sludge, call Rubens Fonseca at 870-5910 for info, and yes, he does take sludge from private sources in Pukulani and Kanaapali.

>>> "Carolyn Ancheta" <cancheta@beltcollins.com> 3/11/2010 4:47 PM >>>

Tracy,

As mentioned briefly, I am working on the solid waste management plan for the Villages of Leiali'i, a master planned community by HHFDC that is primarily for affordable housing. The site is located on approximately 1,033 acres that will include single family and multi-family residences, commercial/office space, light industrial, two elementary schools, neighborhood parks, archaeological preserves, open space, and associated infrastructure.

Calculations in the project's solid waste management plan will be based on criteria presented in the County's Integrated Solid Waste Management Plan (ISWMP), dated February 17, 2009. I wanted to confirm the criteria and have a few questions:

1. Table 2-7 of the ISWMP provides residential waste generation rate of 2.3 ton per household per year and commercial generation rate of 1.58 tons per employee per year. For commercial, would it be acceptable to use 1 employee per 200 square feet of floor area (from County Wastewater Reclamation Division's flow standards) to determine the number of employees?

2. Please confirm the waste generation rate of 14.3 pounds per person per day, as indicated on page 2-12 of the ISWMP, could be applied to the remainder land uses: parks, schools, light industrial (see item 3 below), and wastewater treatment plant employees. The rate seems a little high compared to Honolulu. Honolulu's ISWMP indicates 10.2 pounds per person per day, while the State ISWMP indicates 5.8 pounds per person per day for the state and 4.4 pounds per person per day average for the nation.

3. For schools and parks, we propose to apply the waste generation rate of 14.3 pounds per person per day to an estimated daily population for each land use.

a. For schools, would it be acceptable to use 49% (180 instruction days / 365 days per year) of the school population?

b. For parks, would it be acceptable to use 20 persons per acre (from the sewer master plan for the project)?

c. For light industrial, would it be acceptable to use 1 employee per 500 square feet of floor area (from County Wastewater Reclamation Division's flow standards) to determine number of employees?

4. A private on-site wastewater treatment facility is proposed for the project. According to the ISWMP, sludge from the Lahaina Wastewater Reclamation Facility is processed into compost at the Central Maui Landfill.

a. Could sludge from the on-site wastewater treatment facility also be processed into compost at the Central Maui Landfill?

b. If so, does the composting facility have a finite capacity to receive sludge? How much sludge beyond that which the Wastewater Reclamation Division produces can the composting facility receive?

c. If not, could the sludge be disposed in the Central Maui Landfill?

5. Waste composition:

a. Would it be acceptable to use the 1994 data, Figure 2-3 of the ISWMP for County- and commercial-hauled? Please confirm our understanding that the Villages of Leiali'i refuse would be collected by the County. The types of waste and rates are as follows:

Waste Type

Percent of Total Waste

Paper

30

Organics

40

Plastic

8

Metals

7

Glass

4

Rubber

1

Other Waste

9

Household Hazardous Waste

1

Total

100

b. If we use the data above, could we use 9% of total waste for yard waste?

Yard waste is not detailed. Honolulu's Waste Characterization Study indicates 8.7% yard waste, equivalent to 22.9% of total organic waste (8.7% / [8.7% green waste + 4.5% wood waste + 24.8% other organics]). We would recommend applying the 22.9% to the composition of organics from the 1994 data. Estimated yard waste would be 9% (.229 x 40).

c. For light industrial, would it be acceptable to use the same waste composition types and percentages as discussed in items "a" and "b" above?

6. Please confirm the diversion rate of 30.6% for diverted or recyclable material (paper, yard waste, plastic, metals, and glass) as indicated in the ISWMP page 2-10. Can the same diversion rate be applied to light industrial?

Thank you very much for your time and assistance.

If you have any questions or require any additional information, please contact our office.

Thank you,

Carolyn Ancheta, PE, LEED AP | Civil Engineer
Belt Collins Hawaii Ltd.
2153 North King Street, Suite 200 | Honolulu, HI 96819-4554 USA
T: 808.521.5361 | F: 808.538.7819 | www.beltcollins.com

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[Attachment to email dated Friday, April 23, 2010 1:36 PM: Villages at Leilani.doc]

Tracy,

As mentioned briefly, I am working on the solid waste management plan for the Villages of Leiali'i, a master planned community by HHFDC that is primarily for affordable housing. The site is located on approximately 1,033 acres that will include single family and multi-family residences, commercial/office space, light industrial, two elementary schools, neighborhood parks, archaeological preserves, open space, and associated infrastructure.

Calculations in the project's solid waste management plan will be based on criteria presented in the County's Integrated Solid Waste Management Plan (ISWMP), dated February 17, 2009. I wanted to confirm the criteria and have a few questions:

1. Table 2-7 of the ISWMP provides residential waste generation rate of 2.3 ton per household per year and commercial generation rate of 1.58 tons per employee per year. For commercial, would it be acceptable to use 1 employee per 200 square feet of floor area (from County Wastewater Reclamation Division's flow standards) to determine the number of employees?

Yes.

2. Please confirm the waste generation rate of 14.3 pounds per person per day, as indicated on page 2-12 of the ISWMP, could be applied to the remainder land uses: parks, schools, light industrial (see item 3 below), and wastewater treatment plant employees. The rate seems a little high compared to Honolulu. Honolulu's ISWMP indicates 10.2 pounds per person per day, while the State ISWMP indicates 5.8 pounds per person per day for the state and 4.4 pounds per person per day average for the nation.

Confirmed 14.3 ppp.

3. For schools and parks, we propose to apply the waste generation rate of 14.3 pounds per person per day to an estimated daily population for each land use.

a. For schools, would it be acceptable to use 49% (180 instruction days / 365 days per year) of the school population? **No comment.**

b. For parks, would it be acceptable to use 20 persons per acre (from the sewer master plan for the project)? **No comment.**

c. For light industrial, would it be acceptable to use 1 employee per 500 square feet of floor area (from County Wastewater Reclamation Division's flow standards) to determine number of employees? **No comment.**

4. A private on-site wastewater treatment facility is proposed for

the project. According to the ISWMP, sludge from the Lahaina Wastewater Reclamation Facility is processed into compost at the Central Maui Landfill.

a. Could sludge from the on-site wastewater treatment facility also be processed into compost at the Central Maui Landfill?

According to EKO Compost, yes, as long as it meets Federal EPA Part 503 Biosolids Rules Standards.

b. If so, does the composting facility have a finite capacity to receive sludge? How much sludge beyond that which the Wastewater Reclamation Division produces can the composting facility receive?

According to EKO Compost, their State Department of Health (DOH) Solid Waste permit allows them to receive up to 68 wet tons of biosolids per day. In 2009 they averaged 59.5 wet tpd. Therefore, they can still accommodate an additional 8 wet tpd.

c. If not, could the sludge be disposed in the Central Maui Landfill?

NO.

5. Waste composition:

a. Would it be acceptable to use the 1994 data, Figure 2-3 of the ISWMP for County- and commercial-hauled?

Yes, the percentages may be used, but the amount of household refuse picked up by County crews is now. For FY 2009.

Please confirm our understanding that the Villages of Leiali'i refuse would be collected by the County. The types of waste and rates are as follows:

We need to know more details as to number of houses and when they expect to come on line. At the current time we do not have the staff or trucks to increase refuse pick up for this large a subdivision.

Waste Type	Percent of Total Waste
Paper	30
Organics	40
Plastic	8
Metals	7
Glass	4
Rubber	1
Other Waste	9
Household Hazardous Waste	1
Total	100

b. If we use the data above, could we use 9% of total waste for yard waste?

NO.
Yard waste is not detailed. Honolulu's Waste Characterization Study indicates 8.7% yard waste, equivalent to 22.9% of total organic waste (8.7% / [8.7% green waste + 4.5% wood waste + 24.8% other organics]). We would recommend applying the 22.9% to the composition of organics from the 1994 data. Estimated yard waste would be 9% (.229 x 40).

No. Please use 32.8%, which is a combination of Large Yard Waste (1,032 tpy) and Leaves and Grass (5,611 tpy) in Maui's 1994 study.

c. For light industrial, would it be acceptable to use the same waste composition types and percentages as discussed in items "a" and "b" above?

We have no comment on and leave it up to the consultant.

6. Please confirm the diversion rate of 30.6% for diverted or recyclable material (paper, yard waste, plastic, metals, and glass) as indicated in the ISWMP page 2-10. Can the same diversion rate be applied to light industrial?

Confirmed.

Thank you very much for your time and assistance.

If you have any questions or require any additional information, please contact our office.

Thank you,

Carolyn Ancheta, PE, LEED AP | Civil Engineer
Belt Collins Hawaii Ltd.
2153 North King Street, Suite 200 | Honolulu, HI 96819-4554 USA
T: 808.521.5361 | F: 808.538.7819 | www.beltcollins.com

Carolyn Ancheta

From: Carolyn Ancheta
Sent: Monday, May 17, 2010 10:30 AM
To: 'Tracy Takamine'
Cc: 'Elaine Baker'; 'Stanley.S.Fujimoto@hawaii.gov'; Alan Kato
Subject: Villages of Leiali'i - Landfill Capacity
Attachments: 20100514 Memorandum Telcon with Elaine Baker.pdf

Tracy,

Attached, please find a summary of the telephone conversation that I had with Ms. Elaine Baker of your office. Although the ISWMP indicates that the Central Maui Landfill will be full by the year 2026, Elaine has informed me that the landfill will have adequate capacity to accommodate the Villages of Leialiʻi development. Please note that we will continue to use the 30.6% diversion rate (that was previously confirmed with you) rather than 60% as suggested by Elaine. Without a confirmed timeline for the 60% diversion, it is more conservative to use 30.6% at this time.

If you have any questions or require any additional information, please contact our office.

Thank you,

Carolyn Ancheta, PE, LEED AP | Civil Engineer
Belt Collins Hawaii Ltd.
2153 North King Street, Suite 200 | Honolulu, HI 96819-4554 USA
T: 808.521.5361 | F: 808.538.7819 | www.beltcollins.com

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BELT COLLINS

TELEPHONE CONVERSATION SUMMARY

PROJECT:	BCH JOB NUMBER:
Villages of Leiali‘i	2007.70.0500
PARTICIPANTS:	**DATE AND TIME:**
Ms. Elaine Baker, County of Maui Department of Environmental Management, Solid Waste Division Ms. Carolyn Ancheta, BCH	May 14, 2010 1:45pm
SUBJECT:	
Central Maui Landfill and ISWMP	

Ms. Carolyn Ancheta of Belt Collins Hawaii Ltd (BCH) contacted Ms. Elaine Baker of the County Solid Waste Division regarding the Integrated Solid Waste Management Plan (ISWMP) and the capacity of the Central Maui Landfill.

Ms. Baker provided the following information:

- Central Maui Landfill has ample capacity: 16 years [to fill Phases IV through VI] as indicated in the ISWMP plus a minimum of 90 acres of open space.
    - Landfill occupancy follows the Ameron quarry operation, and the landfill has been filling at a much slower rate than Ameron has been blasting.
- Central Maui Landfill’s capacity in the present and future should be able to accommodate the new Leiali‘i development.
- The County has hired another consultant, R.W. Beck, to review the Scenario III recommendations in the ISWMP.
- The Scenario III recommendations do not adequately reflect the County’s current plans.
    - Currently, the County will not develop its own Material Recovery Facility (MRF) as indicated in the ISWMP.
        - The County has service contracts with Maui Disposal to utilize their MRF.
        - The County has no curbside recycling program and may not implement a program due to budget constraints.
    - The County is looking into the feasibility of a waste-to-energy facility, but it would not be operational by 2014 as indicated in the ISWMP.
- In order to project the Leiali‘i development’s waste disposal requirement, consider using 60% diversion rate to correspond to the diversion rate of Scenario III.

Appendix K

Socio-Economic

DRAFT

SOCO-ECONOMIC IMPACT ASSESSMENT OF THE VILLAGES OF LEIALI‘I WORKFORCE HOUSING PROJECT

BELT COLLINS HAWAII LTD.

August 2010

1 INTRODUCTION

This report is being written in conjunction with the Draft Environmental Impact Statement (EIS) of the Villages of Leialiʻi Affordable Housing Project, proposed by the Hawaii Housing Finance & Development Corporation (HHFDC).[1] The project being assessed occupies up to 1,013 acres. It is located in West Maui, just north of the Kelawea subdivisions and east of the Wahikuli subdivision and Department of Hawaiian Home Lands (DHHL) Leialiʻi project area.

All discussion of the project in this report follows the description of three Concept Plans in the Draft EIS. Plan descriptions and location maps are included in the Draft EIS and not repeated here.

1.1 Study Areas

The HHFDC Leialiʻi project is planned as a response to the islandwide need for housing and the desire to reduce congestion on regional highways as residents travel long distances between home and work. Future residents of Leialiʻi are likely to come from West Maui and the rest of the Maui Market Area.[2] (Currently, residents working in West Maui live in neighborhoods throughout the Maui Market Area.) Figure 1-1 shows the Community Plan areas for Maui. Figure 1-2 identifies some of the major urbanized areas on Maui. The boundaries enclose Census Designated Places, for which decennial Census information is available.

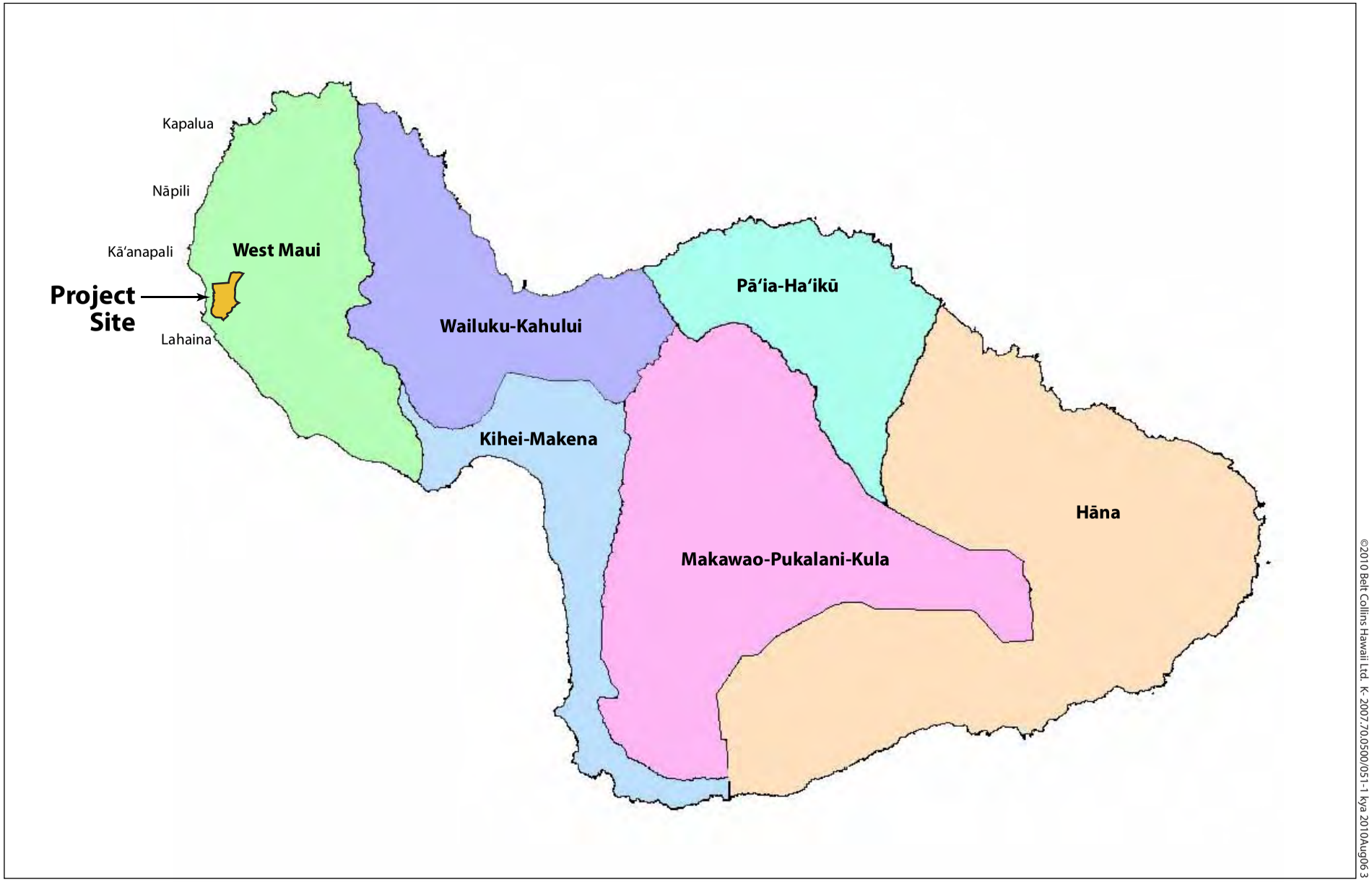
1.2 Types of Impact

Socio-economic impacts include both immediate and secondary or cumulative impacts. For example, the impact analysis includes estimates of the number of jobs, created on-site, but also deals with associated job creation throughout the county and state and with impacts on the island labor market. Social impacts are often produced through interaction between new populations or activities and ones in nearby areas, including likely new developments nearby. These impacts are cumulative.

The impact analysis moves from quantifiable impacts to more qualitative ones. It deals with the more clearly quantifiable demographic and economic impacts first, and social impacts later. The account of economic impacts relies on Input-Output Modeling by the State Department

[1] The Housing Finance and Development Corporation proposed developing a Lahaina Master-Planned Community on the site. Since that proposal was held up by litigation, part of the site was transferred to the State Department of Hawaiian Homelands. Village 1A has been built; DHHL also has the site for Village 1B for development. In this report, that part of the original Lahaina Master Planned Community is termed DHHL Leialiʻi, which the project under consideration is discussed as "the Villages of Leialiʻi" or "Leialiʻi."

[2] Maui County recognizes six Community Plan areas on Maui: Lahaina (or West Maui), Kīhei-Mākena (or South Maui); Wailuku-Kahului (or Central Maui), Makawao-Pukalani-Kula (or Upcountry), Pāʻia-Haʻikū, and Hāna. In recent decades, new development in all of these areas except Hāna has interested and attracted residents from other areas. The five Community Plan areas of Maui, excluding Hāna, are termed the Maui Market Area in this report. (The three other islands of Maui County -- Molokaʻi, Lānaʻi and Kahoʻolawe – are each treated as a separate Community Plan area. The island of Maui home to more than 90 percent of the County's population, jobs and visitors, so information about the County can be used to describe the island-level impact area.)



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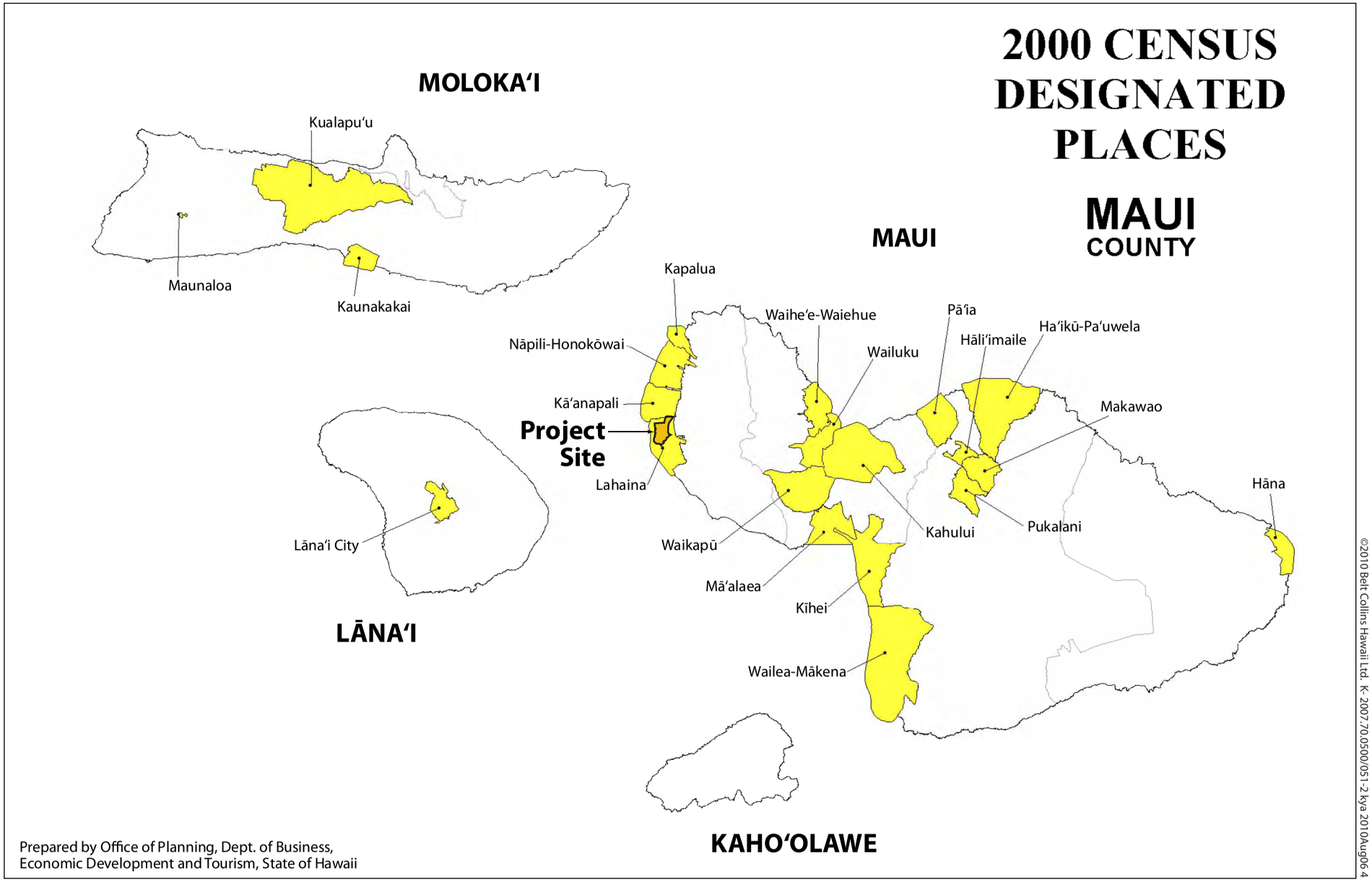
NORTH

0 2 4 6
SCALE IN MILES

Figure 1-1
COMMUNITY PLAN AREAS AND MAUI MARKET AREA

Villages of Leialiʻi
August 2010



BELT COLLINS

NORTH

0 5 10
SCALE IN MILES

Figure 1-2
CENSUS DESIGNATED PLACES ON MAUI

Villages of Leiali'i
August 2010

of Business, Economic Development and Tourism (DBEDT).[3] Input-Output Models trace the relationships among industries in a regional economy and are used to estimate the results of new capital flows. Impacts may be direct (created directly by a new project or activity), indirect (due to spending in the regional economy by firms involved in the direct activity), or induced (due to spending by workers in firms involved in direct or indirect activity). Direct investment in, for example, construction of a building results in purchase of materials from local supplier firms (indirect impact) and eventually spending by both the job-site workers and employees of supplier firms (induced impact).

2 EXISTING SOCIO-ECONOMIC CONDITIONS

2.1 Historical Background

In the first half of the 19th century, Lahaina was a leading port and often the seat of government for Hawaiʻi. The export of crops became increasingly important for Maui, and West Maui became a sugar-producing region starting in the 1840s. By the early 20th century, Kahului emerged as a more important port for Maui, serving the large plantation areas of Central Maui.

World War II saw a sudden population spurt as large areas on Maui were used to mobilize and train troops for the Pacific war. After the war, Maui's population declined. Many residents emigrated to Oʻahu for urban jobs. (The same trend occurred throughout Hawaiʻi.) Population growth returned when tourism led to new jobs in Maui resorts. As Table 2-1 shows, the population and visitor industry grew rapidly until 1990. After that year, the local population continued to grow, but visitor numbers increased much more slowly. The number of jobs grew consistently, in part because Maui changed from a single-industry island, dependent first on agriculture and then on tourism, to a more diverse economy with a wide range of commercial goods and services locally available.

West Maui has most of the county's visitor units and a large share of Maui jobs. The regional population, however, is still less than 15 percent of the county total, so much of the workforce must commute daily via the one highway linking the region to Central and South Maui.

[3] DBEDT, *The Hawaii Inter-County Input-Output Study: 2005 Benchmark Report.* Honolulu, HI, 2009. Posted at http://hawaii.gov/dbedt/info/economic/data_reports/2005_Intercounty_I-O/.

Table 2-1: Resident Population, Visitor Count and Jobs, Maui County and West Maui, 1970 - 2008

	1970	1980	1990	2000	2008 (1)
Maui County					
Resident population	46,156	70,991	101,709	128,873	143,691
Wage and Salary Jobs	20,320	30,950	50,850	62,400	72,850
Unemployment rate	7.0%	5.1%	4.2%	3.7%	4.5%
Average Visitor Census	3,645	15,363	39,500	43,854	44,433
Visitor units	2,743	9,701	18,285	18,270	19,055
Hotel occupancy rate (2)	67%	66%	69%	80%	68%
West Maui					
Resident population	5,524	10,284	14,574	17,967	19,122
share of county	12%	14%	14%	14%	13%
Visitor units	1,826	5,357	9,285	9,759	10,453
share of county	67%	55%	51%	53%	55%
Hotel occupancy rate (2)	67%	76%	73%	80%	68%

Notes:

(1) County estimates for 2008 from State reports and the US Census; West Maui estimates derived from County forecast model and County- or island-level information.

(2) Recent rates are for the island of Maui, not the County or region.

2.2 Population and Housing

2.2.1 Population

Census data from 2000 show that West Maui combines several distinct communities (see Table 2-2).[4] Lahaina had slightly more than half the region's resident population, and the Nāpili-Honokōwai area contained more than a third of the region's residents. Kāʻanapali and Kapalua had very small resident populations. The median age in these two resort communities was much higher, while Lahaina and Nāpili residents tended to be about the same age as residents of the county as a whole.

Since Census respondents can identify with more than one "race," this information does not point to neatly separated groups. Still, Lahaina clearly had fewer Whites and more Asians than the other communities. More current information on ethnicity comes from school records. Table 2-3 shows that the ethnic distribution of young people in West Maui is similar to that of the rest of Maui. However, Hawaiians form a slightly smaller share of the West Maui population. Table 2-4 shows that most of West Maui's people were born outside Hawaiʻi. In Lahaina, nearly half

[4] Much of the West Maui region – from Puamana to the northern edge of the region -- is within the four CDPs shown in Table 2-2. The remainder consists of the Olowalu and Ukumehame areas south of Lahaina.

the population was from Hawaiʻi and 28 percent were foreign-born. In the other Census Designated Places (CDPs), persons born in other states predominate.

Lahaina residents had large households in 2000, averaging 3.5 persons per household, compared to the other West Maui communities and the county as a whole.

More recent county data show population growth, an aging population, and a continuing trend towards smaller household sizes. Census data for smaller areas will not be available until 2011.

Table 2-2: Demographic Characteristics, 2000 and 2008

	2008 ACS	2000 Census					
	Maui County	Maui County	West Maui Community Plan Area	Lahaina CDP	Ka'anapali CDP	Napilil-Honokowai CDP	Kapalua CDP
Total Population	143,641	128,094	17,967	9,118	1,375	6,788	467
Age							
Under age 5	6.7%	6.7%	6.8%	6.1%	5.0%	8.0%	8.4%
Age 5 to 17	15.8%	18.8%	15.3%	16.7%	11.3%	14.8%	9.2%
Age 18 to 64	65.3%	63.0%	63.4%	65.3%	67.9%	71.0%	65.7%
Age 65 and over	12.2%	11.4%	10.2%	11.9%	15.9%	6.2%	16.7%
Median Age (years)	38.1	36.8	36.1	36.0	44.8	34.8	41.7
Race (alone or in combination)							
White	49.5%	37.6%	43.3%	30.5%	79.7%	53.8%	57.9%
Black or African American	0.4%	0.8%	0.9%	0.6%	1.2%	1.1%	0.5%
American Indian and Alaska Native	0.2%	1.6%	1.6%	1.6%	0.4%	1.8%	0.0%
Asian	34.8%	36.7%	34.2%	45.9%	10.3%	23.8%	18.2%
Native Hawaiian and Other Pacific Islander	13.2%	19.8%	15.5%	17.7%	3.9%	13.5%	20.5%
Some other race	1.8%	3.5%	4.6%	3.7%	4.5%	6.0%	2.8%
Hispanic or Latino	9.7%	8.6%	8.6%	7.1%	10.5%	10.7%	3.4%
Households							
Total households	48,950	43,507	6,031	2,599	537	2,629	186
Family households (families)	67.3%	68.7%	62.8%	67.7%	70.9%	55.9%	71.5%
With own children under 18 years (% of Total)	29.7%	33.0%	27.1%	27.6%	20.5%	28.3%	25.3%
Average household size (persons)	2.86	2.91	2.98	3.5	2.56	2.58	2.51

Note: CDP = Census Designated Place.

Sources: US Census, 2000 Census and American Community Survey (downloaded using American FactFinder, at www.census.gov).

Table 2-3: Ethnicity of Public School Students, 2008

	Lahainaluna High	Lahaina Intermediate	Princess Nahienaena Elementary	Kamehameha III Elementary	Combined: Lahainaluna Complex Area		Comparison: Rest of MMA High Schools (Baldwin, Maui, Kekaulike)	
Filipino	317	248	285	81	931	31%	1,343	29%
Hawaiian/Part-Hawaiian	184	124	133	99	540	18%	1,130	25%
White	195	107	23	150	475	16%	726	16%
Hispanic	81	90	92	123	386	13%	153	3%
Japanese	21	16	19	13	69	2%	418	9%
Samoan	6	8	7	13	34	1%	28	1%
Portuguese	13	4	4	2	23	1%	154	3%
Black	8	5	3	6	22	1%	27	1%
Indo-Chinese	5	1	4	7	17	1%	10	0%
Native American	7	6	3	1	17	1%	28	1%
Chinese	3	-	5	6	14	0%	40	1%
Korean	3	-	1	2	6	0%	30	1%
Other	106	89	78	214	487	16%	490	11%

Sources: School Status and Improvement Reports for Maui schools, 2008-2009, posted at http://arch.k12.hi.us/school/ssir/2009/maui.html.

Table 2-4: Geographic Mobility, 2000 and 2008

	2008 ACS	2000 Census					
	Maui County	Maui County	West Maui Community Plan Area	Lahaina CDP	Ka'anapali CDP	Napilil-Honokowai CDP	Kapalua CDP
RESIDENCE 5 YEARS AGO							
Population 5 year and over	134,065	119,675	16,872	8,602	1,323	6,213	374
Same house	NA	55.8%	49.9%	63.2%	34.4%	33.9%	44.4%
Same county	NA	26.2%	27.0%	21.7%	24.3%	35.5%	23.8%
Hawaii, different county	NA	4.2%	3.5%	4.3%	3.1%	3.0%	0.0%
Different state	NA	10.9%	15.7%	8.1%	33.2%	22.2%	31.8%
Abroad	NA	2.9%	3.7%	2.7%	5.1%	5.0%	0.0%
PLACE OF BIRTH							
Total population	143,641	128,094	18,009	9,118	1,375	6,788	467
Born in United States	80.6%	83.5%	75.8%	71.9%	88.7%	76.4%	90.0%
Hawaii	49.1%	54.4%	37.4%	49.8%	15.4%	24.2%	29.2%
Different state	31.5%	27.9%	36.3%	20.3%	72.7%	49.7%	60.8%
Born in Puerto Rico, U.S. Island areas,	2.0%	1.2%	2.0%	0.8%	5.7%	1.5%	7.7%
Foreign born	17.3%	16.5%	24.2%	28.1%	11.3%	23.6%	10.0%

Note: NA = Not Available.

Sources: US Census, 2000 Census and American Community Survey (downloaded using American FactFinder, at www.census.gov).

2.2.2 Housing

A quarter of Maui County's housing stock and more than 40 percent of housing in West Maui did not house residents in 2000. (See Table 2-5.) While the Census categorizes these units as "vacant," they may be actually rented to vacationers, reserved by owners as a second home, or both. Demand in the housing market hence comes from residents, investors, and non-residents. As a result, average prices do not reflect residents' ability to pay for housing.

Most resident households are owner-occupied. Renters accounted for more than 40 percent of households in 2000 in Maui County, but a smaller share in the Kāʻanapali and Kapalua resort areas. A large share of households, both renters and homeowners, paid more than a third of their income for housing in 2000. County data for 2008 suggest that even more residents are now paying high housing costs.

While the population has been growing slowly over recent decades, housing production is far more variable. Figure 2-1 shows that housing construction hit a peak on Maui when major resorts were developed in the 1970s; recent high-volume years reach only half that level. During recessionary periods, construction has declined further. Figure 2-2 shows that sales volumes follow similar trends. Sales prices show a long-term trend toward increasing value (in Figure 2-3). In the current recession, median single family home prices have dropped to about the level of the condominium average.

Mean or median prices mask great variation in prices and sales volumes in different communities on Maui. Recent compilations show:

- West Maui accounts for 30 percent of housing sales, largely of condominiums.
- Median prices for single family homes in West Maui are far higher than for the county as a whole.
- Condominium prices in Lahaina and Nāpili are lower than the county median, while prices in Kāʻanapali and Kapalua are far higher.
- No Maui Market Area (MMA) region has single-family housing at prices well below the county median. Only in Central Maui and South Maui are condos available at prices well below the MMA and county medians.

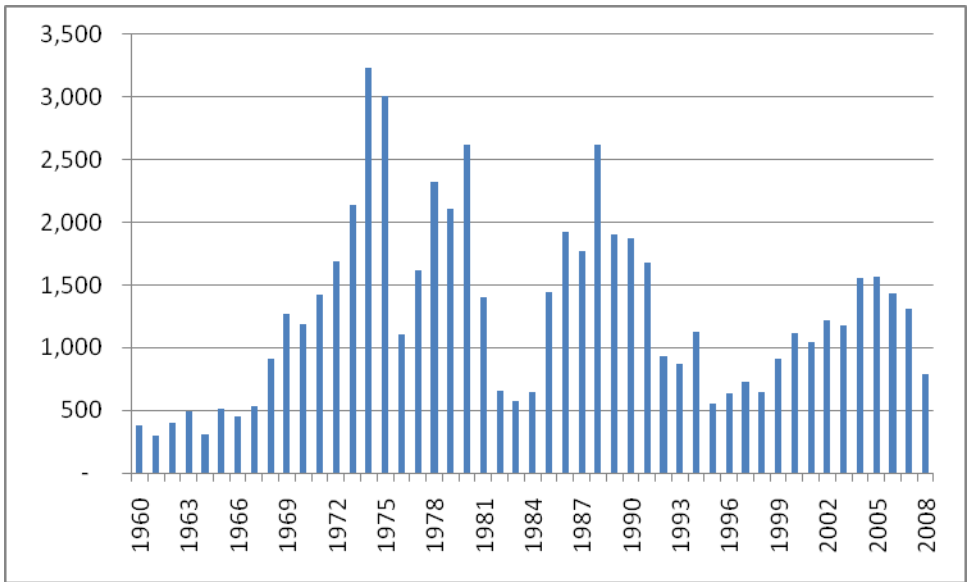
Over time, average housing prices tend to rise above the level that most residents can afford. At that point, market volume drops and prices stall or decline. With increasing prosperity, residents' ability to buy improves, housing prices seem more affordable, and greater demand encourages higher prices. This cycle can be seen in Figure 2-4.

Table 2-5: Housing Characteristics, 2000 and 2008

	2008 ACS	2000 Census					
	Maui County	Maui County	West Maui Community Plan Area	Lahaina CDP	Ka'anapali CDP	Napilil-Honokowai CDP	Kapalua CDP
Total housing units	66,224	56,377	10,431	3,027	1,775	4,681	831
Occupied housing units	73.9%	77.2%	57.8%	85.9%	30.3%	56.2%	22.4%
Vacant housing units	26.1%	22.8%	42.2%	14.1%	69.7%	43.8%	77.6%
Housing Tenure							
Occupied housing units	48,950	43,507	6,031	2,599	537	2,629	186
Owner-occupied	57.5%	57.6%	51.4%	53.6%	77.5%	42.9%	64.5%
Renter-occupied	42.5%	42.4%	48.6%	46.4%	22.5%	57.1%	35.5%
Average household size, owner-occupied units	3.12	3.13	3.36	4.05	2.58	2.92	2.35
Average household size, renter-occupied units	2.52	2.62	2.57	2.87	2.48	2.32	2.8
Average household size, all units	2.86	2.91	2.98	3.5	2.56	2.58	2.51
Crowding (Occupants per room)'							
Households	48,950	43,507	6,062	2,631	550	2,624	169
Mild (1.0-1.5 persons/room)	9.0%	4.5%	4.5%	8.8%	0.4%	1.1%	5.9%
Severe (1.51 or more persons/room)	2.3%	3%	2.2%	3%	0%	1%	0%
Home ownership costs, as % of income							
Households for which costs computed	27,875	19,953	2,226	1,331	190	631	49
30-34.9% of income	8.5%	7.3%	4.9%	4.4%	4.2%	6.7%	0.0%
35% or more	36.2%	24.1%	29.4%	22.8%	40.0%	38.5%	36.7%
Gross rent as % of income							
Households for which costs computed	18,831	5,822	621	445	42	106	21
30-34.9% of income	11.3%	8.0%	7.7%	5.5%	11.2%	9.5%	0.0%
35% or more	44.6%	31.9%	30.9%	26.5%	32.8%	33.7%	42.0%

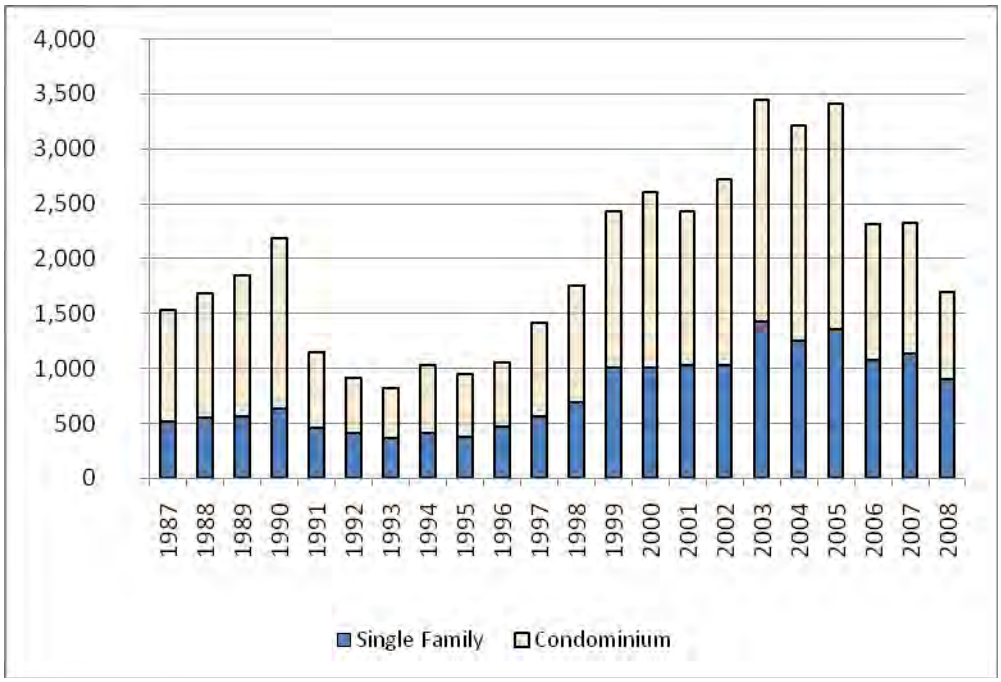
Sources: US Census, 2000 Census and American Community Survey (downloaded using American FactFinder, at www.census.gov)

Figure 2-1: New Housing Units Built Annually, Maui County



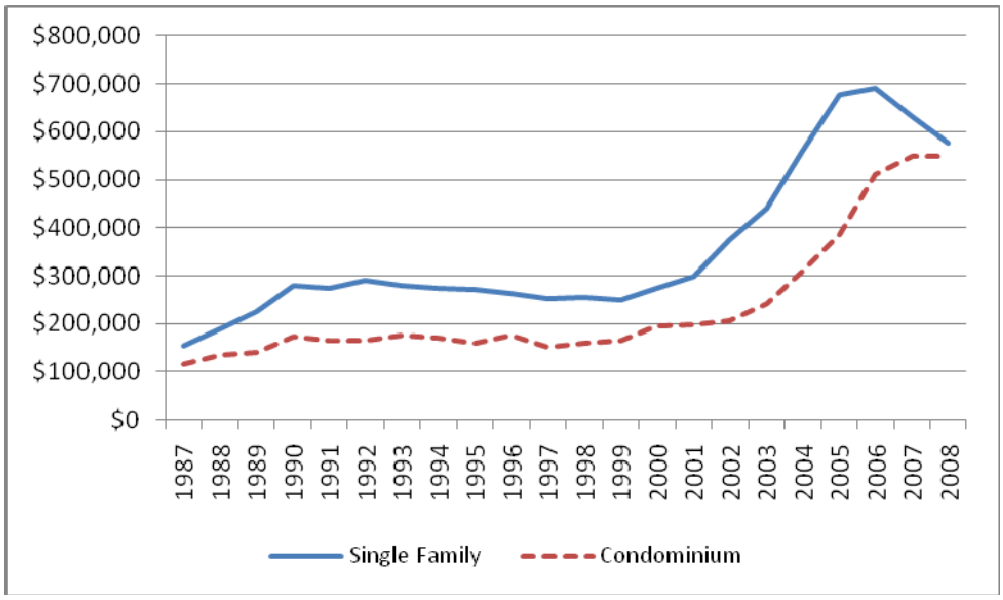
Source: DBEDT. State of Hawaii Data Book 2008.

Figure 2-2: Annual Sales Volume, Maui County, 1987-2008



Source: DBEDT. State of Hawaii Data Book 2008.

Figure 2-3: Average Annual Sales Prices, Maui County, 1987-2008



Source: DBEDT. State of Hawaii Data Book 2008.

Table 2-6: Housing Sales by Region, 2009

Community Plan Area / Realtors' Region	Sales Volume SF	Sales Volume Condo	Share of All MMA Sales	Median Price SF	Median Price Condo	Median as Share of County Median SF	Median as Share of County Median Condo
West Maui			30%				
Kaanapali	14	193		$1,447,500	$975,000	291%	217%
Kapalua	5	20		$2,325,000	$784,500	467%	174%
Lahaina	31	55		$650,000	$399,000	130%	89%
Napili/Kahana/Honokawai	24	96		$755,000	$367,500	152%	82%
Olowalu	1	NL		$3,750,000	NL	753%	
South Maui			34%				
Kihei	124	257		$481,325	$305,000	97%	68%
Maalaea	NL	28		NL	$350,500		78%
Maui Meadows	12	NL		$687,500	NL	138%	
Wailea/Makena	18	71		$1,525,000	$1,315,000	306%	292%
Central Maui + Pāʻia-Haʻikū			25%				
Central	242	77		$471,250	$190,000	95%	42%
Haiku	35	NL		$600,000	NL	120%	
Kahukuloa	2	NL		$890,850	NL	179%	
Sprecklesville/Paia/Kuau	21	0		$469,000	$0	94%	
Upcountry			10%				
Kula/Ulupalakua/Kanaio	50	NL		$592,500	NL	119%	
Makawao/Olinda/Haliimaile	36	0		$432,500	$0	87%	
Pukalani	56	11		$471,500	$459,000	95%	102%
Maui Market Area Subtotal	671	808					
Maui County Summary	693	824		$498,106	$450,000	100%	100%

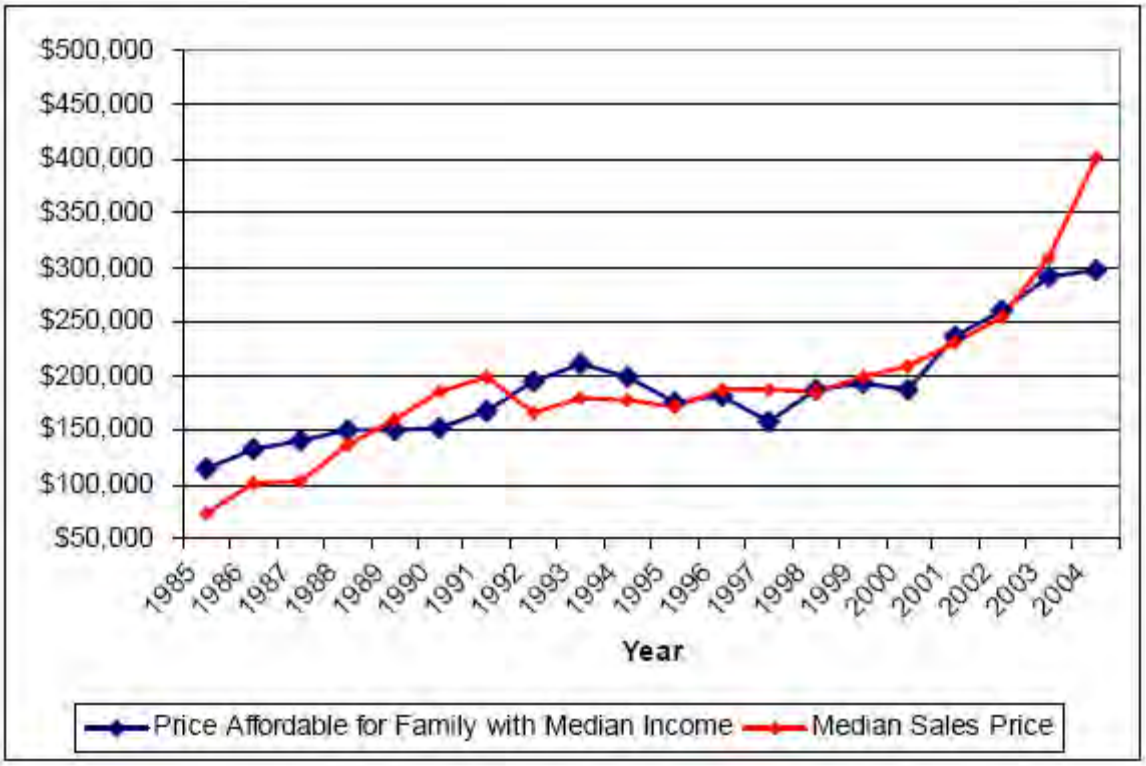
Notes:

Year-to-date sales information, through 12/31/2009. Note that median prices may vary greatly in regions with small annual sales volume. County listings also include Hāna, Molokaʻi, and Lānaʻi. Central Maui and Pāʻia-Haʻikū are combined because one Realtors' area runs across the boundary between them.

NL = region not listed (for single family or for condominium sales).

Source: Realtors Association of Maui, posted at http://www.ramaui.com/content/4921d233da006/Market_Statistics.html.

Figure 2-4: Affordability of Housing on the Market, island of Maui, 1985 to 2004



Note: Affordable price computed based on current median income and mortgage rates.

Source: Adapted and updated, from SMS Research, Affordable Housing Policies and Hawaii's For-Sale Housing Markets. Prepared for Land Use Research Foundation of Hawaii. Honolulu, HI. 2005.

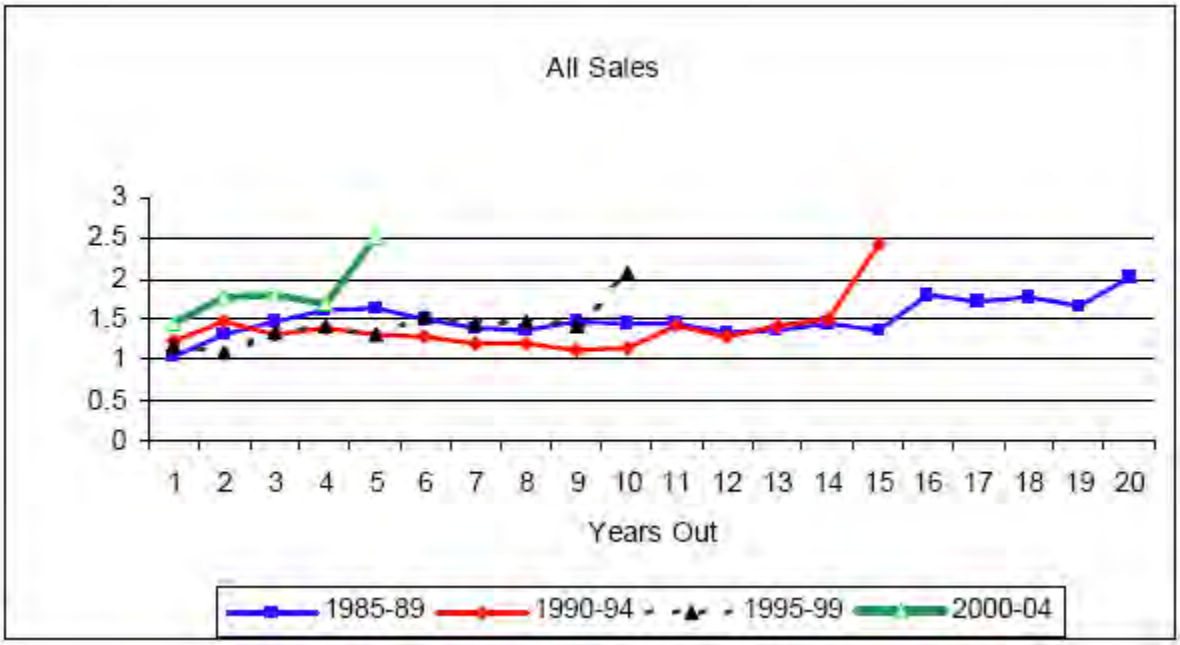
The 2005 study used real property data on housing sales over time to track changes in the affordability of housing produced on each of the major islands. It went further, to analyze changes in the value of homes resold over time. In that study, housing sales prices were converted to shares of the price affordable to median-income households in the year of the sale. The price of a house that sold for the median affordable price, just under $200,000 in 1992, would then be expressed as 1.00. If it resold for $300,000 in 2004, that price would also be expressed as 1.00, since that was the 100 percent affordable price for that year. The study showed:

- New homes provided about 29 percent of the housing sold annually from 1985 through 2003, although the new housing share of the market declined after 1992.
- A good deal of year-to-year change occurred in the distribution of new homes produced on Maui, in terms of affordability level, but most of the *new* units sold for prices affordable to families earning 120 percent of the county median household income or less.

- Housing produced at all affordability levels and in the market as a whole tended to increase in value (i.e., price relative to income), not just price. Housing held or gained in value when it was *resold*. That trend accelerated in the last years of the study period.

The gain in housing value suggests that residents pay increasing shares of their incomes for homes and/or that those homes are being sold to non-residents. It is evident in data from Maui and Kauaʻi, and much weaker or absent in data from Oʻahu and Hawaiʻi County.

Figure 2-5: Affordability of Resale Housing over Time, Maui



Source: SMS Research, *Affordable Housing Policies and Hawaii's For-Sale Housing Markets.* Prepared for Land Use Research Foundation of Hawaii. Honolulu, HI. 2005.

Non-residents own or occupy a large share of Maui's housing; moreover, they account for most housing sales. Table 2-7 shows that current owners of most of the housing sold in the MMA from 2000 through 2009 live off-island. The non-resident share is slightly higher in West Maui (64 percent) than in the MMA as a whole (61 percent).

Table 2-7: Location of Current Owner, Dwellings Sold from 2000 through 2009

	Units sold 2000 to 2009	Current Owner Location -- Maui Island	Rest of Hawaii	Outside Hawaii
Maui Market Area				
Leasehold	717	159	54	504
All units	20,840	8,170	4,596	8,074
Leasehold share	3.4%	1.9%	1.2%	6.2%
West Maui				
Leasehold	482	109	14	359
All units	5,571	2,033	164	3,374
Leasehold share	8.7%	5.4%	8.5%	10.6%

Notes: Data are from Real Property Tax files, selecting properties sold from 2000 through 2009, with dwellings. Sales of multiple parcels or portions excluded. Counts are of parcels sold; in some cases, more than one dwelling is found on a parcel.

Source: Hawaii Information Service, Inc. data downloaded in April 2010 by Belt Collins Hawaii Ltd.

Leasehold housing is separated out in Table 2-7 because land in the Villages of Leialiʻi project will likely be leased, not transferred in fee simple. The table shows that leasehold units are a small fraction of the Maui market. An analysis of owner-occupant housing identified only 816 owner-occupied leasehold units in all of Maui County in 2008, accounting for only 3.2 percent of all units in that class.[5]

Development of homes on land leased through a community land trust has been discussed in Hawaiʻi as a tool to encourage development of housing at prices affordable to workforce families. The 2006 housing survey found a large share of potential homebuyers to be open to the concept of a "sustainable lease" that could be passed on to heirs: 20.6 percent of Maui County respondents said they would *prefer* it to other forms of tenure, but 29 percent still wanted to buy a home in fee simple. Respondents open to leasehold tenure were apt to rent, have moderate incomes, and have high shelter-to-income ratios.

In that survey, respondents showed a strong preference for single-family homes but many were willing to consider multifamily housing, as shown in Table 2-8. Respondents expressed a strong interest in moving Upcountry; otherwise, preferences tended to mirror available housing stock.

[5] DBEDT, *Hawaii State Databook 2008*, Table 21.15.

Table 2-8: Housing Size and Tenure Preferences, 2006 Survey

	Want to buy		All who expect to move	
	Number	Percentage	Number	Percentage
Preferred type				
Single family	8,979	83%	14,174	69%
Condominium	309	3%	383	2%
Apartment	858	8%	1,662	8%
Other	220	2%	980	5%
No preference	423	4%	3,204	16%
Would take condo if SF too expensive?				
Yes	3,945	44%	7,465	53%
Not sure	207	2%	305	2%
No	4,828	54%	6,436	45%
Smallest number of bedrooms acceptable				
Studio	1,711	16%	3,420	19%
1	4,764	44%	9,290	51%
2	3,807	35%	4,561	25%
3	354	3%	629	3%
4	153	1%	153	1%

Source: SMS Research, 2006.

Table 2-9: Regional Location Preferences for Maui County Residents, 2006

	Number	Percentage
Hāna	689	2.2%
Upcountry	9,273	29.7%
Central Maui	6,197	19.9%
Pāʻia-Haikū	2,399	7.7%
South Maui	5,516	17.7%
West Maui	4,442	14.2%
Maui, anywhere	1,274	4.1%
Molokaʻi	1,085	3.5%
Lānaʻi	312	1.0%
Preferences	31,187	100.0%
Respondents	17,972	

Note: Multiple responses were allowed. Total "will move": 19,584. Total from Maui County expressing some preference (including locations on other islands): 17,972. All these figures are based on a survey sample and weighted to estimate preferences for the County population as a whole.

Source: SMS Research, 2006.

Private developers, the County, HHFDC, and DHHL have made a concerted effort to bring new units to market on Maui at prices affordable to working families. The new production has been concentrated in Central Maui. In West Maui, new projects aimed at resident markets have served delimited groups – Native Hawaiians and the elderly – not the larger population.

2.3 Economy

Maui's economy is greatly dependent on tourism. It has diversified in recent decades. Ventures such as the Maui High Performance Computing Center have encouraged new industries. With overall economic growth, stores, business services, and government services for Maui are increasingly found on Maui, not on Oʻahu. Maui jobcounts grew consistently through the 1990s, as shown in Figure 2-6. Unemployment increased after 2007, on Maui as elsewhere, but remains moderate. (As of April 2010, unemployment on Maui was estimated at 8.2 percent, well above the State figure [6.3 percent] but also well below the national figure [9.5 percent].)[6]

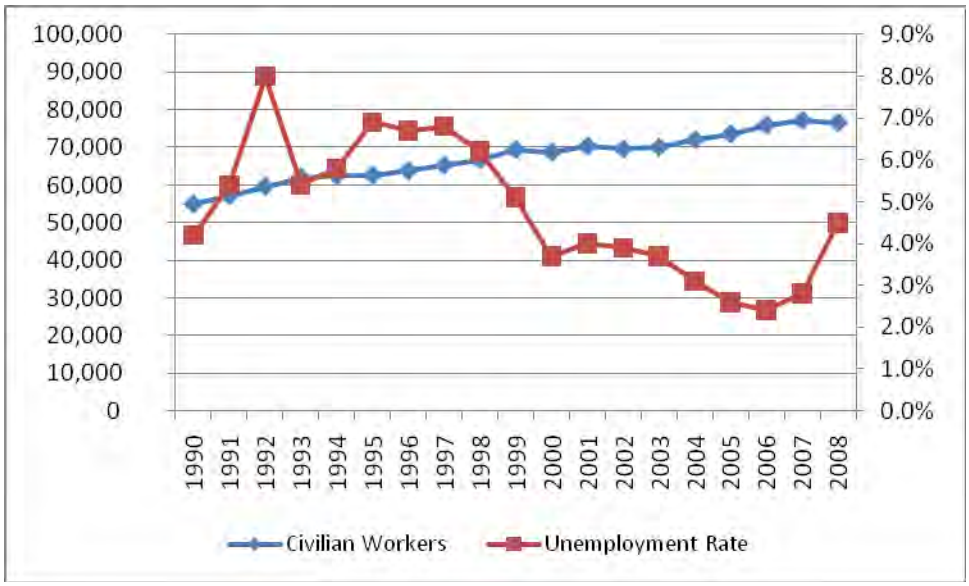
[6] Rates are not seasonally adjusted. Local Area Unemployment Statistics posted by Hawaii State Department of Labor and Industrial Relations at http://www.hiwi.org/article.asp?ARTICLEID=463&PAGEID=94&SUBID.

Table 2-10: Maui Job Count by Major Industries: 1990, 2000 and 2009

	1990	2000	2009
Total Jobcount	47,950	58,850	63,800
Share of Jobs in Major Industries			
Agriculture	4.5%	3.1%	2.6%
Construction	6.5%	4.9%	5.2%
Accommodations and Food Service	29.6%	29.4%	26.7%
Retail	13.6%	13.6%	13.6%
Finance, Insurance	5.0%	4.4%	3.8%
Professional and business Services	6.3%	8.2%	9.3%
Government	10.8%	12.1%	13.9%

Source: Jobcount by industry data (CES series) posted by Hawaiʻi State Department of Labor and Industrial Relations at http://www.hiwi.org/article.asp?PAGEID=94&SUBID=&ARTICLEID=515&SEGMENTID=0

Figure 2-6: Civilian Workers and Unemployment Rate, Maui



Jobs are concentrated in Central Maui and the West and South Maui resort areas. While West Maui provided some 16,500 jobs in 2007, its civilian labor force was smaller. The 2000 Census showed that unemployment was also lower in West Maui than the county as a whole. (See Table 2-12.) Labor force participation was high in the Nāpili CDP and low in the resort areas.

Residents' incomes were, on average, higher than for the county as a whole in 2000 (as shown in Table 2-13). Only Kāʻanapali residents had appreciably higher average incomes. Again, poverty rates in West Maui were lower than for the county as a whole, but extremely low only in Kāʻanapali.

Table 2-11: Location of Jobs, Maui 2007

	Jobs, 2007	Share of Maui Jobs
West Maui	16,541	26%
South Maui	13,233	21%
Central Maui	27,469	44%
Upcountry	3,668	6%
Pāʻia-Haʻikū	1,701	3%
Hāna	521	1%

Source: US Census, County Business Patterns, 2007 (zip code tabulations compiled and analyzed by Belt Collins Hawaii). Posted at http://www.census.gov/econ/cbp/index.html

2.4 Commuting

Workers in West Maui mostly drove alone to work in 2000, and spent about the same time commuting as others in the county. Lahaina residents averaged a shorter commute time. From 2000 to 2008, the countywide average commute time did not change. The share of workers who do not commute appears to have grown. (See Table 2-14.)

Commuting is usually analyzed from the point of view of the worker. It can also be seen as characterizing communities. In West Maui, Lahaina stands out in that about half its workforce actually lives in the community (as shown in Table 2-15). It had the highest resident worker share of any major CDP on Maui in 2000.

Table 2-12: Labor Force, 2000 and 2008

	2008 ACS	2000 Census					
	Maui County	Maui County	West Maui Community Plan Area	Lahaina CDP	Ka'anapali CDP	Napilil-Honokowai CDP	Kapalua CDP
Population 16 years and over	114,966	99,326	14,448	7,300	1,181	5,344	335
In labor force	70.0%	66.8%	69.7%	66.9%	56.1%	78.0%	52.8%
Civilian labor force	69.5%	66.7%	69.6%	66.9%	55.9%	78.0%	52.8%
Employed	66.2%	63.4%	66.7%	63.9%	54.3%	75.3%	49.3%
Unemployed	3.3%	3.3%	3.0%	2.9%	1.6%	2.7%	3.6%
Armed Forces	0.5%	0.1%	0.0%	0.0%	0.2%	0.0%	0.0%
Not in labor force	30.0%	33.2%	30.3%	33.1%	43.9%	22.0%	47.2%
Civilian labor force	79,898	66,219	10,063	4,882	660	4,169	177
Percent Unemployed	4.7%	5.0%	4.3%	4.4%	2.9%	3.5%	6.8%
Females 16 years and over	56,434	49,878	6,890	3,425	563	2,598	158
In labor force	63.8%	62.1%	65.11%	62.7%	51.2%	72.4%	46.8%

Sources: US Census, 2000 Census and American Community Survey (downloaded using American FactFinder, at www.census.gov)

Table 2-13: Income Characteristics

	2008 ACS	2000 Census					
	Maui County	Maui County	West Maui Community Plan Area	Lahaina CDP	Ka'anapali CDP	Napilil-Honokowai CDP	Kapalua CDP
Household Income							
Total households	48,950	43,563	6,062	2,528	613	2,635	186
Less than $25,000	15.3%	23.0%	21.1%	21.9%	10.1%	22.5%	19.9%
$25,000 to $49,999	19.7%	27.5%	24.0%	24.5%	19.7%	25.2%	17.2%
$50,000 to $74,999	20.2%	22.2%	22.2%	23.5%	18.6%	22.2%	21.5%
$75,000 to $99,999	15.7%	11.8%	13.1%	10.5%	13.5%	15.3%	7.0%
$100,000 to $149,999	19.2%	9.8%	11.8%	13.1%	16.2%	9.8%	10.2%
$150,000 to $199,999	5.5%	2.8%	4.1%	4.1%	9.0%	2.8%	7.5%
$200,000 or more	4.5%	2.9%	3.7%	2.5%	12.9%	2.1%	16.7%
Median household income (dollars)	$67,619	$49,489	$53,356	$52,984	$79,288	$51,030	$57,292
Share of population below poverty level							
Total population	8.1%	10.5%	8.4%	7.8%	2.7%	9.5%	7.2%
Persons under 18 (% of this group)	9.4%	3.2%	1.9%	1.8%	0.0%	2.2%	1.0%
Persons 65 and over (% of group)	5.3%	0.9%	0.6%	1.0%	0.0%	0.1%	0.0%

Sources: US Census, 2000 Census and American Community Survey (downloaded using American FactFinder, at www.census.gov)

Table 2-14: Commuting Patterns, Maui County and West Maui

	2008 ACS	2000 Census					
	Maui County	Maui County	West Maui Community Plan Area	Lahaina CDP	Ka'anapali CDP	Napilil-Honokowai CDP	Kapalua CDP
Workers 16 years and over	72,941	61,262	9,413	4,562	615	3,941	158
Car, truck, or van -- drove alone	69.3%	71.1%	70.1%	68.0%	77.7%	71.0%	72.2%
Car, truck, or van -- carpooled	15.5%	17.2%	13.9%	14.4%	6.7%	14.4%	23.4%
Public transportation	2.7%	0.8%	2.1%	2.4%	0.7%	1.7%	1.9%
Walked	2.5%	2.8%	4.9%	5.9%	4.7%	4.0%	1.3%
Other means	2.6%	3.2%	6.0%	7.5%	2.6%	5.4%	0.0%
Worked at home	7.4%	4.9%	3.0%	1.8%	7.6%	3.5%	1.3%
Mean travel time to work (minutes)	21.1	21.7	15.7	13.9	18.3	16.6	20.7

Notes: ACS = American Community Survey. CDP = Census Designated Place.
Sources: U.S. Census, 2008 single-year American Community Survey results and 2000 Census Summary File 3 data (available through www.census.gov)

Table 2-15: Commuters as Share of Population, Maui CDPs, 2000

Census Designated Place on Maui Island	Total resident population	Total workers working in the place	Total workers living in the place	Estimated daytime population	Daytime population change due to commuting		Workers who lived and worked in the same place	
					Number	%	Number	%
	[1]	[2]	[3]	[4] = [1]+[2]-[3]	[5] = [4]-[1]	[6] = [5]/[1]*100	[7]	[8] = [7]/[3]*100
Haiku-Pauwela CDP	6,578	1,139	3,071	4,646	-1,932	-29.4	652	21.2
Kaanapali CDP	1,375	2,844	615	3,604	2,229	162.1	154	25.0
Kahului CDP	20,146	12,992	8,203	24,935	4,789	23.8	3,496	42.6
Kihei CDP	16,749	6,117	8,819	14,047	-2,702	-16.1	2,878	32.6
Lahaina CDP	9,118	6,568	4,562	11,124	2,006	22.0	2,256	49.5
Makawao CDP	6,327	1,356	3,252	4,431	-1,896	-30.0	492	15.1
Napili-Honokowai CDP	6,788	890	3,941	3,737	-3,051	-44.9	465	11.8
Pukalani CDP	7,380	1,119	3,812	4,687	-2,693	-36.5	486	12.7
Waihee-Waiehu CDP	7,310	238	3,392	4,156	-3,154	-43.1	112	3.3
Wailea-Makena CDP	5,671	4,441	3,176	6,936	1,265	22.3	990	31.2
Wailuku CDP	12,296	8,271	5,602	14,965	2,669	21.7	1,901	33.9

Note: Based on data for places with either 2,500 workers living in the place or 2,500 workers working in the place. West Maui CDPs are shown in boldface.
Source: US Census 2000, compiled and posted by DBEDT (http://hawaii.gov/dbedt/info/census/Folder.2005-10-3.2927/DaytimePop)

2.5 Quality of Life

Information on quality of life for residents is available from studies of children and young people reported by high school catchment areas. Table 2-16 compares data for the Lahainaluna complex area (i.e., West Maui) with data for the Maui Department of Education (DOE) district and the state as a whole.

Table 2-16: Quality of Life Indicators for West Maui

	West Maui	Maui County	State of Hawaii
Children's Wellbeing			
K - 8 students with health insurance	88.4%	86.8%	90.3%
Child abuse rate per 1000 children	4.5	10	11.1
Children ages 0-5 living in poverty	13.5%	17.4%	15.4%
Children ages 0-5 with all parents in the labor force	59.4%	65.6%	61.8%
Children ages 3-5 enrolled in nursery school, preschool, or kindergarten	55.6%	70.5%	72.7%
Risk and Involvement, Adolescents			
Adolescents reporting unsafe neighborhoods	44.2%	37.3%	43.9%
Adolescents lacking close neighborhood ties	38.0%	37.5%	38.6%
Adolescents reporting close family ties	40.7%	48.7%	46.2%
Parents report checking child's homework and other public school involvement	59.1%	64.1%	63.2%
Adolescents reporting poor parental supervision	58.4%	48.0%	46.3%
Parents feeling positive about students' safety	64.2%	63.9%	66.8%
Adolescents reporting exposure to illicit drug use in their school and community	14.9%	18.3%	14.5%
Adolescents reporting a lack of interest in school	54.2%	47.6%	45.3%
Teachers			
Teachers with 5+ years at their school	54.7%	63.6%	66.4%
Teachers with advanced degrees	16.5%	19.2%	19.1%
Teachers reporting a safe school environment	60.4%	68.2%	68.2%

Source: Center on the Family, University of Hawaiʻi at Mānoa. Downloaded from School Community Profiles for Lahainaluna Complex. Table is based on 2000 or 2001 data. Posted at http://uhfamily.hawaii.edu/Cof_Data/profiles/profiles.asp

The views compiled by the Center on the Family show West Maui to be relatively safe for children. An unusual finding is the percentage of children ages 3 to 5 not enrolled in preschool or similar settings. Next, both adolescents and their parents are apt to find their community and the school setting less safe. Parental involvement in adolescents' lives appears slightly less than the

average. These differences between West Maui data and the county and state averages cannot be judged to be significant without several years' data.

2.6 Issues and Concerns

2.6.1 Concerns of the Island Community

Over the last decade, Maui County residents have participated in a series of discussions and polls designed to identify broad community values. These have helped to formulate the new Countywide Policy Plan (passed by County Council in 2010). Five major themes emerged from the Focus Maui Nui process. The project's director found that community concerns voiced in 2003 still are important.[7] When asked if "progress" is occurring, respondents varied, with over 30 percent seeing improvement and about 20 percent seeing a decline on key issues (in Table 2-17). With most respondents seeing no change or change for the worse on all topics, it appears that most residents still see the need for action on these issues – education, environmental protection, infrastructure (including housing), economic development, and local culture.

2.6.2 Issues Arising in West Maui

West Maui residents have long been concerned with their dependence on a single highway connection to the rest of Maui. Residents must travel far and long to reach islandwide services, notably health services at Maui Memorial Hospital. The road is sometimes blocked due to an accident, brush fire, or high winds, isolating residents and visitors. Plans for a relocated highway and emergency access alternatives have been explored. However, West Maui is likely to continue to be at risk of isolation for the foreseeable future.

Congestion on the highway in and around Lahaina has been a longstanding problem. It has been addressed in part by widening projects, in part by the Lahaina Bypass, now beginning construction. When all segments of the bypass are completed, people traveling to Kapalua and Kāʻanapali will be able to avoid Lahaina roadways, and residents from communities north of Lahaina will have a quicker route to the public schools located at the top of Lahainaluna Road.

Considerable effort has gone into planning for a West Maui Hospital and Medical Center. After a lengthy review, it has received a Certificate of Need from the State Health Planning and Development Agency. The new facility is proposed to be situated on land in Kāʻanapali near the Lahaina Civic Center.

At a meeting devoted to the draft *Maui Island Plan*, many residents underlined the need for housing for workers near the major employment sites. Others expressed concern about the scale of development being proposed, asking whether the region's roads and schools could handle additional demand.[8]

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[7] Alexa Betts Basinger, in Loomis, I. "Residents See some Progress, Poll Shows." *Maui News,* April 9, 2010. Posted at http://www.mauinews.com/page/content.detail/id/530324.html?nav=10.

[8] I. Loomis, "Pulelehua, Olowalu Projects get Attention: Maui Planning Commission Takes up the Maui Island Plan." *Maui News,* August 6, 2009. Posted at http://www.mauinews.com/page/content.detail/id/521933.html.

Table 2-17: Responses in 2009 to Focus Maui Nui Survey Questions

	Making progress	No Change	Getting worse	Don't know
Education				
Providing quality child care and development programs for all children	38%	22%	20%	19%
Preparing our young people for real-world, workforce challenges	37%	28%	22%	13%
Increasing community participation in decision-making about education	35%	30%	20%	16%
Environment				
Decreasing dependence on fossil fuels	47%	29%	12%	12%
Developing policies that will support responsible environmental behavior	49%	30%	10%	11%
Maintaining high ocean and air quality and preserving coastal lands	43%	31%	16%	10%
Improving infrastructure				
Developing housing and transit solutions	45%	27%	19%	9%
Increasing inventory of affordable, sustainable housing solutions	31%	35%	22%	11%
Assuring capacity of our airports, harbors and highways to meet our needs	31%	37%	19%	12%
Economic development				
Creating strategies that diversify the economy with living-wage pay	22%	36%	28%	14%
Expanding sustainable agricultural opportunities	33%	33%	19%	14%
Increasing health, wellness, sci and tech employment	39%	30%	16%	15%
Culture and human needs				
Supporting community efforts to perpetuate local culture and tradition	54%	28%	9%	9%
Preserving small towns	37%	33%	20%	10%
Addressing the elimination of substance and alcohol abuse	38%	31%	20%	10%

Note: Percentages combine data from face-to-face and on-line surveys. The only information provided about demographics was that this draws on "over 1,500 individual voices, from all areas of our county, ranging in age from 7 to 88, and representing 15 ethnicities."

Source: Download from Focus Maui Nui website (http://www.focusmauinui.com/pdf/2009FMNStateoftheCommunityReport.pdf).

2.6.3 Issues with Regard to the Villages of Leialiʻi Project

When the Villages of Leialiʻi Project was first proposed in 1990, many people came to public meetings to testify to the need for workforce housing in West Maui. Maui lacked suitable housing located near employment centers priced at levels that working families can afford. Since that time, only DHHL has succeeded in building a major housing project in the region. Private developers have proposed projects at Pulelehua in Napili, at Kāʻanapali, at Waineʻe, and in Olowalu. Of these, only the Pulelehua project and the Puʻukoliʻi component of Kāʻanapali 2020 have obtained major land use permits. (The original Villages of Leialiʻi project gained "Act 15" approval, much as Puʻukoliʻi did, but HHFDC recognizes that changes in the project plans make a new EIS and permit applications appropriate.)

When plans for the Lahaina Master Planned Community project were originally presented, the reaction voiced most strongly in West Maui was that it had long been needed.

HHFDC held a public meeting in January 2009 to hear community reactions to the preliminary concept plans. Most of the discussion focused on the status of the Leialiʻi property as ceded or Crown land; some speakers viewed the land as solely for Native Hawaiians.[9] This was in the same period as the State Legislature's deliberations leading to Act 176. A related concern was voiced that Native Hawaiian burials may have been located throughout the property, since Lahaina was an extensive urban area before the plantation period.

Other issues raised at the meeting included:

- Affordability of housing: What would the project housing cost? How much of it would be priced below market rates?
- Water for new development: Where would it come from? Would the project cut off access to upland water resources? Would wells for the project affect the water table?
- Park space for the DHHL Villages of Leialiʻi: DHHL had not included any park space in the Village 1A development, and residents hoped that the State would provide such space.

Since the meeting, conversations with a few local residents have indicated that:

- The need for housing for the West Maui workforce remains unmet.
- Some believe that "local" Maui families will only want single-family homes and will not move to Leialiʻi to live in townhomes or the like.
- Some suspect that upland single-family lots will go to non-residents, so the project will not greatly benefit Maui residents.
- The proposed development is large in relation to existing Lahaina neighborhoods. Some residents are unhappy with a major expansion of Lahaina, given limited infrastructure and public facilities. Residents of subdivisions makai of the project site want assurance that the project will not create drainage problems for them.

[9] C. San Nicolas, "Hawaiians Speak out against Plans for Villages of Leialiʻi." *Maui News*, January 30, 2009. Posted at http://www.mauinews.com/page/content.detail/id/514278.html.

2.7 Emerging Trends and Proposals for New Development

Table 2.18 presents the most recent State projections for Maui County. (These are long-term projections, and are not intended to capture year to year variations.)

Table 2-18: Projected Demographic and Economic Trends, Maui County, to 2035

	State of Hawaiʻi	Maui County	County as % of State	Annual Rate of Change, Maui
Resident Population				
2007	1,277,356	141,523	11.1%	
2015	1,367,795	158,043	11.6%	1.4%
2020	1,432,538	169,066	11.8%	1.4%
2025	1,492,253	179,404	12.0%	1.2%
2030	1,547,460	189,300	12.2%	1.1%
2035	1,598,675	198,727	12.4%	1.0%
Wage and Salary Jobs				
2007	661,112	76,730	11.6%	
2015	701,990	81,810	11.7%	0.8%
2020	736,370	86,670	11.8%	1.2%
2025	769,790	91,390	11.9%	1.1%
2030	802,240	95,870	12.0%	1.0%
2035	834,090	100,180	12.0%	0.9%
Personal Income (2000 $ mil)				
2007	40,260	4,073	10.1%	
2015	45,190	4,640	10.3%	1.6%
2020	48,990	5,080	10.4%	1.8%
2025	53,080	5,550	10.5%	1.8%
2030	57,460	6,040	10.5%	1.7%
2035	62,130	6,560	10.6%	1.7%

Source: DBEDT revised 2035 projections, posted at http://hawaii.gov/dbedt/info/economic/data_reports/2035Long RangeSeries/

The projection is for slow economic growth. Personal income is expected to rise, but so is the population, and Maui's share of the state population. As a result, the projection is for very little or no growth in per capita income for Maui County residents.

The Maui County Planning Department has allocated earlier State projections to Community Plan areas. Regional population projections depend on the availability of land on which new development has been proposed and permitted by State and County agencies. The projections published in 2006 showed housing demand islandwide as about 1,380 units annually. Of those, some 260 to 310 housing units annually are projected for West Maui.[10]

The major new infrastructure projects affecting West Maui are the Lahaina Bypass Highway, now under construction, and the proposed West Maui Hospital and Medical Center. These will meet major community needs. Other projects being planned or designed include flood diversion works protecting the south side of Lahaina and expansion of the fire station at Lahaina Civic Center.

Future developments may already have land use entitlements or gain presumptive status through the community planning process. In the past, major developments have been identified as Project Districts.[11] More recently, County planners have sorted proposed developments according to each project's permits, with projects having all their major State and County land use permits grouped as "Planned/Committed," projects with some permits as "Planned/Designated," and projects without such permits as "Proposed." These are shown in Table 2-19. In West Maui, the first grouping consists of DHHL projects and ones aimed at visitor and second home markets. The latter two categories include the major projects developed by HHFDC, Kāʻanapali Land Management Corporation (KLMC), and Maui Land and Pine (ML&P) for a wider range of households, including workforce and market housing.

In the current planning process, focus has shifted from developers' proposals for their land to the Planning Department's judgment that some areas would be more appropriate for development given "Smart Growth" criteria. Table 2-20 shows the projects included in "Planned Growth Areas" in the draft *Maui Island Plan.* While the list in the plan is not authoritative at this point, the distribution of growth areas among the Community Plan areas indicates that major new development is anticipated for West Maui. The West Maui projects in the draft *Maui Island Plan* include parts of Pulelehua, the Villages of Leialiʻi, and the Waineʻe project.

Should all the projects mentioned here actually be developed in the next decades, West Maui would see major growth in housing both for vacationers and for residents. However, major challenges to such development can be noted:

- To gain permits, developers of the "Planned/Designated" and "Proposed" projects (listed in Table 2-19) would need to show that these projects will serve residents.
- Private developers face significant hurdles in gaining capital for new projects, whether for the visitor or the resident market.

[10] Maui County Planning Department, *Socio-Economic Report*, 2006. Exhibit R-11. Housing demand includes both resident and non-resident demand.

[11] The Project Districts recognized in the *West Maui Community Plan* as of 1996 were (1) Kapalua, (2) Kapalua Mauka, (3) Kaʻanapali-North Beach, and (4) the Weinberg property next to Kahoma Stream. The Plan also recognizes the Puʻukoliʻi and Villages of Leialiʻi master planned communities as affordable housing projects.

- Both KLMC and ML&P have plans for a mix of projects in which housing sold or rented at controlled rates would meet the developer's workforce housing obligations. Workforce housing is not likely to be financially attractive to these developers unless development of vacation units can be done at the same time. The likelihood of investment in new Maui resort development is at this time very uncertain.

Table 2-19: Proposed Major Developments in West Maui

	SF	MF	Hotel or Time Share
Planned/Committed Projects			
Honokowai (DHHL)	1,250		
Honolua Ridge	50		
Hyatt Regency Maui Time Shares			131
Intrawest Honua Kai		730	
Kaʻanapali Coffee Farms	67		
Kaʻanapali Ocean Resort Villas			516
Kaʻanapali Residences	18		
Kapalua Bay Visitor Accommodation		155	155
Kapalua Mauka Residential	690		
Kapalua Project District 1	60		1,050
Kapalua Village Residential	20		
Lanikeha Kaʻanapali	132		
Marriott Maui Ocean Club Sequel Towers			148
Ha Hale o Wainee Phase 2		26	
Pailolo Place		42	
Sunstone	5		
Villages of Lealiʻi 1B (DHHL)	253		
Villas at Royal Lahaina			455
West Maui Breakers		90	
West Maui Village		158	
Subtotal	*2,545*	*1,201*	*2,455*
Planned/Designated			
Kaʻanapali Ocean Resort Villas SVC Pacific			390
Kaʻanapali Lower North Honokowai	275	330	
Leialiʻi HHFDC Community	4,000		
Puʻukoliʻi Villages	292	648	
	4,567	*978*	*390*
Proposed			
Kaʻanapali Lower East Honokowai	225		
Kaʻanapali Lower South Honokowai	410	630	
Kahoma Lots	300		
Kahoma Resident Housing	70	25	
Napilihau Mauka Residences	10		
Pineapple Ridge	24		
Pulelehua	533	349	
Waineʻe Residential Community	560	540	
	2,132	*1,544*	-
Total	9,244	3,723	2,845

Notes: Planned/Committed projects have all or nearly all land use permits needed to proceed with construction; Planned/Designated projects may lack zoning or Community Plan designation. Proposed projects may have no

permits. Inclusion of a project on this list does not indicate Planning Department support. The Planning Department is updating its lists, and has included the "Planned Growth Areas" shown in the next table in developing projections of what will or will not be built in the next few years. (Some, but not all, of the Planned Growth Areas in West Maui are in the above table. Planned Growth Areas may not yet have land use permits.)

Source: West Maui Development Projects maps (as of July 1, 2009) posted by Maui County Planning Department at http://www.co.maui.hi.us/DocumentView.aspx?DID=8335 and http://www.co.maui.hi.us/DocumentView.aspx?DID=8334.

Table 2-20: Distributions of Planned Growth Areas by Community Plan Area, Draft *Maui Island Plan*

	Dwelling Units		Commercial Space	
	Number	*Share*	*Square Feet (1)*	*Share*
West Maui	3,591	35%	240,000	41%
South Maui	1,500	15%	100,000	17%
Central Maui	4,227	41%	180,000	31%
Upcountry	731	7%	40,000	7%
Pāʻia-Haʻikū	207	2%	20,000	3%
Hāna	0	0%	0	0%
	10,256	100%	580,000	100%

Notes: Some 800 homes in the Leialiʻi project are included in the West Maui unit count. While no units are shown for Hāna, a longstanding proposal for up to 200 resident agricultural lots would likely be supported by the County, if steps are taken to realize the plan.

(1) The draft *Maui Island Plan* identifies the number of dwelling units in Planned Growth Areas and whether commercial space in these areas would be "neighborhood serving," "convenience shopping," or "convenience shopping: region serving." To estimate the commercial areas that could be built, these have been assumed here to average:

Neighborhood	20,000	square feet Gross Leasable Area
Convenience	40,000	square feet Gross Leasable Area
Convenience: Regional	100,000	square feet Gross Leasable Area

While there is much uncertainty concerning current proposals, the draft *Maui Island Plan*'s Directed Growth Strategy shows that housing demand is strong. Its Table 8-1 shows demand for 34,637 housing units over a 25-year period – on average, 1,386 units a year. From 1999 through 2008, new housing unit production on Maui averaged 908 units per year. [12] With likely demand at more than 150 percent of historic rates of production, continuing growth in the housing stock is expected.

[12] County of Maui Planning Department, *DRAFT Maui Island Plan.* December 2009. The total of new housing units needed includes some 23,483 units in projects with entitlement. Production of housing units from analysis of real property data downloaded from Hawaii Information Service, Inc. by Belt Collins Hawaii.

3 DEMOGRAPHIC AND ECONOMIC IMPACTS

3.1 Population

Table 3-1 shows the estimated housing development of the project for sample years and for project buildout (following the schedule in the Draft EIS). The number of occupants will depend on household size and the share of units that are occupied at any given time.

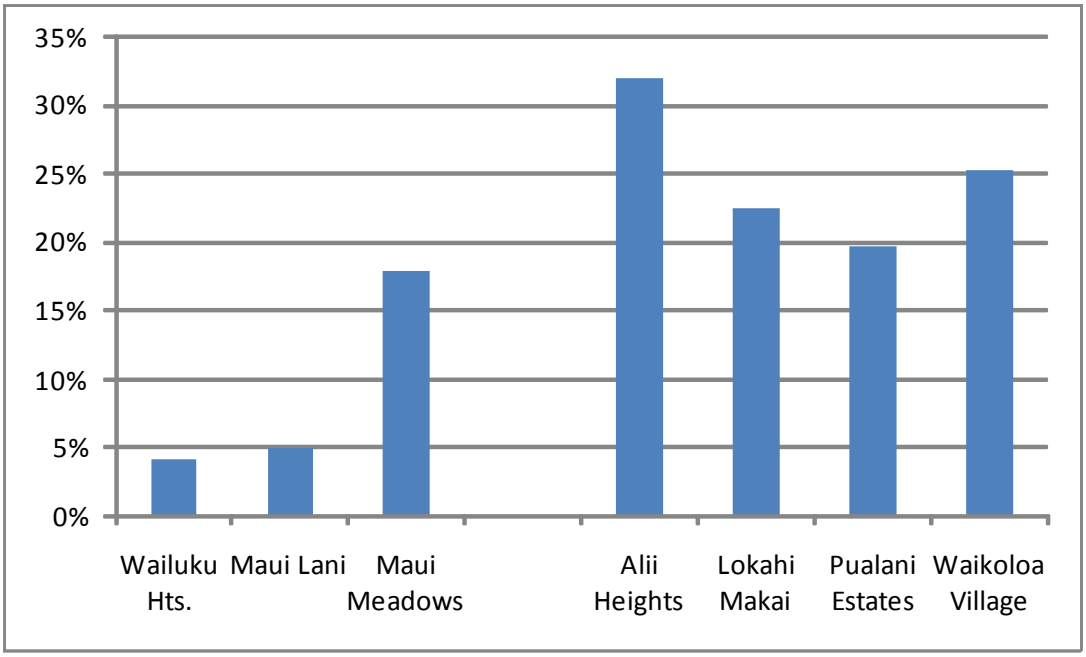
Table 3-1: Housing Development at the Villages of Leialiʻi Project

	2020	2025	2030	2035	Buildout
Housing Units Built					
CONCEPT ONE					
Phase A					
SF	500	613	613	613	613
MF	500	788	788	788	788
Phase B					
SF			400	1,400	1,522
MF					
CONCEPT TWO					
Phase A					
SF	-	-	-	-	-
MF	1,000	2,000	2,521	2,521	2,521
Phase B					
SF			400	1,400	1,522
MF					
CONCEPT THREE					
Phase A					
SF	500	532	532	532	532
MF	500	1,468	2,069	2,069	2,069
Phase B					
SF			300	750	854
MF			300	650	650

Leases on affordable units will go to owner-occupants, and owner-occupants will have a preference in buying market units. The West Maui workforce currently lives throughout the Maui Market Area. Consequently, the project is likely to attract residents from all parts of the MMA.

Since buyers of market units do not have to be owner-occupants, some could be from outside Hawaiʻi. Data from selected subdivisions (in Figure 3-1) indicate that (a) non-residents are present even in newer Central Maui subdivisions, and (b) they constitute a significant part of the owners of West Hawaiʻi subdivisions that are designed and marketed above all to the resident market. (Waikoloa Village is included as an older area, marketed both to residents and offshore buyers. Its offshore share of owners is lower than that of Aliʻi Heights, an upscale single-family area in Kailua-Kona.)

Figure 3.1: Share of Homes in Selected Maui and West Hawai‘i Subdivisions Owned Out-of-State



Note: Analysis includes all built dwellings. “Out-of-state owners” are identified from the address to which property tax bills are currently sent.

Source: Hawaii Information Service data, downloaded by Belt Collins in May 2010.

In light of both Census data for West Maui (in Table 2-4) and the comparative data in Figure 3-1, it is reasonable to expect that as many as 20 percent of the market units in the Leiali‘i project would in time be owned by out-of-state owners. If held for vacation use, these units would be occupied only for part of the year. Allowing for a mix of second homes, sublets, and informal family uses, these units can be estimated to be occupied approximately 30 percent of the time. Table 3-2 shows the estimated population living on-site.

Table 3-2: Population of the Villages of Leiali‘i Project

	2020	2025	2030	2035
Full-Time Residents				
CONCEPT ONE				
Phase A	2,561	3,588	3,588	3,588
Phase B	-	-	1,025	3,586
CONCEPT TWO				
Phase A	2,561	5,123	6,457	6,457
Phase B	-	-	1,025	3,586
CONCEPT THREE				
Phase A	2,561	5,123	6,662	6,662
Phase B	-	-	1,025	3,586
Part-Time Residents				
CONCEPT ONE				
Phase A	73	102	102	102
Phase B	-	-	29	102
CONCEPT TWO				
Phase A	73	146	183	183
Phase B	-	-	29	102
CONCEPT THREE				
Phase A	73	146	189	189
Phase B	-	-	29	102
	-			
Total	-			
CONCEPT ONE	2,634	3,690	4,744	7,378
CONCEPT TWO	2,634	5,268	7,694	10,328
CONCEPT THREE	2,634	5,268	7,905	10,539

Notes: A 3 percent average vacancy rate is assumed for all concepts. Some 20 percent of market units are expected to be acquired eventually by non-residents. Resident population is estimated using data from the 2006-2008 three-year American Community Survey for Maui County:

Average household size, owner-occupant	3.12	persons
Average household size, rented	2.50	persons
Given 30 percent rented, 70 percent owner-occupied:		2.93 persons
For units leased by non-residents	2.50	persons, in residence for 30 percent of year

Source: US Census, American Community Survey data posted at http://hawaii.gov/dbedt/info/census/ACS2008/. Non-resident household size estimated by Belt Collins Hawaii.

3.2 Housing

Table 3-3 lists assumptions used here to estimate the mix of rental, affordable for-lease and market for-lease housing units in the project and the pricing of those units. These assumptions are developed to provide reasonable estimates of likely housing on-site, but do not constitute a commitment or a statement of intent on the part of HHFDC.

Table 3-3: Key Assumptions used to Project Housing and Economic Impacts

Phase A construction completed	2028
Phase B construction completed	2036
Housing cost levels produced, all concepts (1)	
Rental A, priced for 80% of area median income (AMI) or less	7%
Rental B, priced for 140% of AMI or less	8%
Workforce home for sale A, priced for 80 to 120% of AMI	10%
Workforce home for sale B, priced for 120% to 140% of AMI	26%
Market	49%
Pricing, 2009 $s (2)	
Rental A, average of range = 70% of median, monthly:	$1,345
Rental B, average of range = 120% of median, monthly:	$2,035
Workforce A, average price for median income	
Single family	$308,900
Multifamily	$278,000
Workforce B, average price for 130% of median income	
Single family	$401,600
Multifamily	$361,400
Market	
Single family	$660,250
Multifamily	$379,050

Notes: For this analysis, all property within the project area is assumed to be leased to the developer on a 65-year term, and then subleased to residents and other tenants.

(1) HHFDC is committed to the production of units for the resident workforce. The actual distribution of units by tenure and price level will be negotiated with the selected developer, and may differ from that assumed here. All units for sale are assumed to be limited to owner-occupants.

(2) Affordable prices are derived from the 2009 schedule of Maui affordable housing for rent and sale. Market sales prices reflect a 5 percent discount for leasehold property. Market price is based on average 2009 market values for Lahaina and Nāpili-Honokōwai.

Sources: Realtors Association of Maui, 2010 (posted at www.ramaui.com); Maui Department of Housing and Human Concerns, 2009 (posted at www.co.maui.hi.us/documents/Housing%20and%20Human%20Concerns/Housing%20Division/2009%20Workforce%20Hsg%20-%20Affordable%20Sales%20Guidelines%20Final1.PDF).

The project constitutes a significant increase in the number of housing units built on Maui. New housing production has averaged about 900 units islandwide; the project anticipates construction of 200 units per year in much of the development period.

The project is expected to have impacts on the West Maui and MMA housing markets. If the project is offered in leasehold, market prices at Leialiʻi are likely to be lower than those offered for comparable products elsewhere on Maui, so the project would work to limit the inflation of prices for new units and resales that has characterized the Maui market. Units rented or sold to particular income levels would remain affordable to families in those income levels in the future, even after resale.

Leialiʻi would change housing in West Maui. First, the project creates major new neighborhoods for residents, especially for workforce families. As of 2000, the larger West Maui CDPs had 10,300 jobs and a resident population of nearly 17,300, about 1.7 residents per job. When fully built out, the project would have space for some 2,000 to 2,250 on-site operations jobs (calculated below, in Section 3.3.2), and would house up to 10,350 residents – a ratio of 4.6 residents per job on site. West Maui housing for residents would likely improve in quality and decline in price with a major increase in supply.

In recent years, most new resident housing was built in Central Maui. The project would increase the rate of housing development in West Maui as well as the mix of resident vs. vacation units.

3.3 Employment and Wages

3.3.1 Construction

Construction of the project will create jobs both on site and elsewhere. Most direct construction jobs will be on site. Indirect jobs, created when the firms involved in direct construction purchase materials, other goods, and services, will include suppliers on Maui and elsewhere in Hawaiʻi. Table 3-4 shows the number of jobs produced both in sample years and cumulatively over the entire construction period. Employment is estimated in terms of full-time job person-years. The cumulative total direct employment shown for Concept One – 3,160 person-years for Phase A and 2,945 for Phase B – is over a period of 23 years, from 2013 to 2036. The average direct construction employment for Concept One is 263 jobs (full-time-equivalent person-years) per year. For Concept Three, the average reaches 302 jobs.

Direct construction jobs are shown in the first rows of Table 3-4 and included below, as part of direct, indirect, and induced jobs. The rows dealing with direct jobs and wages show the immediate impact of the project; the later rows draw on the State Input-Output Model to estimate the islandwide and statewide employment associated with the project. The average annual total construction jobcount is estimated as in the range of 539 jobs (for Concept One) to 619 jobs (for Concept Three) per year.

Table 3-4: Construction-Related Employment and Wages

	2015	2020	2025	2030	Buildout	Cumulative through Buildout
CONCEPT ONE						
PHASE A						
Direct construction jobs (1)	308	313	58	-	-	3,113
Direct construction wages (Million 2009 $s) (2)	$17.8	$18.1	$3.4	$0.0	$0.0	$180.1
Direct, Indirect and Induced Jobs (3)						
Maui	486	495	91	-	-	4,914
Rest of State	145	147	27	-	-	1,462
Wages (4)						
Maui	$24.6	$25.0	$4.6	$0.0	$0.0	$248.4
Rest of State	$5.9	$6.0	$1.1	$0.0	$0.0	$59.8
PHASE B						
Direct construction jobs (1)	-	-	-	363	233	2,945
Direct construction wages (Million 2009 $s) (2)	$0.0	$0.0	$0.0	$21.0	$13.5	$170.4
Direct, Indirect and Induced Jobs (3)						
Maui	-	-	-	573	368	4,648
Rest of State	-	-	-	170	109	1,383
Wages (4)						
Maui	$0.0	$0.0	$0.0	$29.0	$18.6	$235.0
Rest of State	$0.0	$0.0	$0.0	$7.0	$4.5	$56.5

Table 3-4: Construction-Related Employment and Wages *(continued)*

	2015	2020	2025	2030	Buildout	Cumulative through Buildout
CONCEPT TWO						
PHASE A						
Direct construction jobs (1)	316	205	205	-	-	3,292
Direct construction wages (Million 2009 $s) (2)	$18.3	$11.9	$11.8	$0.0	$0.0	$190.5
Direct, Indirect and Induced Jobs (3)						
Maui	499	324	323	-	-	5,196
Rest of State	149	96	96	-	-	1,546
Wages (4)						
Maui	$25.2	$16.4	$16.3	$0.0	$0.0	$262.6
Rest of State	$6.1	$3.9	$3.9	$0.0	$0.0	$63.2
PHASE B						
Direct construction jobs (1)	-	-	-	363	233	2,944
Direct construction wages	$0.0	$0.0	$0.0	$21.0	$13.5	$170.3
Direct, Indirect and Induced Jobs (3)						
Maui	-	-	-	573	368	4,647
Rest of State	-	-	-	170	109	1,383
Wages (4)						
Maui	$0.0	$0.0	$0.0	$29.0	$18.6	$234.9
Rest of State	$0.0	$0.0	$0.0	$7.0	$4.5	$56.5

Table 3-4: Construction-Related Employment and Wages *(continued)*

	2015	2020	2025	2030	Buildout	Cumulative through Buildout
CONCEPT THREE						
PHASE A						
Direct construction jobs (1)	317	313	212	-	-	4,039
Direct construction wages	$18.3	$18.1	$12.3	$0.0	$0.0	$233.7
Direct, Indirect and Induced Jobs (3)						
Maui	500	495	334	-	-	6,374
Rest of State	149	147	99	-	-	1,897
Wages (4)						
Maui	$25.3	$25.0	$16.9	$0.0	$0.0	$322.2
Rest of State	$6.1	$6.0	$4.1	$0.0	$0.0	$77.5
PHASE B						
Direct construction jobs (1)	-	-	-	446	531	2,913
Direct construction wages (Million 2009 $s) (2)	$0.0	$0.0	$0.0	$25.8	$30.7	$168.6
Direct, Indirect and Induced Jobs (3)						
Maui	-	-	-	704	838	4,598
Rest of State	-	-	-	209	249	1,368
Wages (4)						
Maui	$0.0	$0.0	$0.0	$35.6	$42.3	$232.4
Rest of State	$0.0	$0.0	$0.0	$8.6	$10.2	$55.9

Notes: Jobs are person-years of full-time employment. Wages are total annual wages, in millions of 2009 $s. Construction costs were estimated from recent bids, the Rider Leavitt Bucknall Construction Cost Report, and the R. S. Means cost estimator website.

(1) Direct jobs are estimated on the basis of average construction employment per construction spending, adjusted for type of construction (heavy construction, single family, other buildings).

(2) Construction wages are estimated from the average Maui County construction wage in 2008, adjusted to 2009 $s according to the increase in the cost of living in Hawaiʻi (Honolulu CPI-Urban).

(3) Indirect and induced jobs estimated for construction on Maui using the Intercounty Input-Output Model. Maui vs. Rest of Hawaiʻi shares estimated by Belt Collins Hawaii.

(4) For indirect and induced jobs, the average covered employment wage for 2008 (on Maui or statewide) was taken to be the average wage, and adjusted to 2009 values according to increase in the Consumer Price Index.

3.3.2 Operations

Once parts of the project are built, operations jobs will be located on-site. These include real estate property management jobs, maintenance, landscaping and security work, retail and service jobs in the commercial areas, and industrial jobs (largely in warehousing, transportation, and utilities). When schools are built, these will be staffed, serving the children of the project and nearby subdivisions.

Operations jobs differ from construction jobs in important ways. First, operations jobs continue from year to year, while construction jobs exist only during a short period. Second, all construction-related jobs constitute project impacts: these particular jobs would not exist or be supported if this project did not go forward. On-site jobs in property management and maintenance are obvious impacts of the development of the site. Other on-site operations jobs respond to existing markets; arguably they are housed at the project site but not an impact of the project. The Villages of Leialiʻi project serves the Maui resident market, and its commercial and industrial spaces serve the West Maui region. On-site jobs in schools, stores and warehouses would exist even if the project were not built. Accordingly, while indirect and induced impacts of all on-site operations jobs are calculated here, the project impact may be much smaller, i.e., the indirect and induced jobs associated with property management and maintenance.

Table 3-5 shows direct operations employment. Table 3-6 deals with employment impacts. Table 3-7 provides estimates of wages for direct, indirect, and induced workers.

Table 3-5: On-site Operations Jobs

	2015	2020	2025	2030	2036
CONCEPT ONE					
PHASE A					
Property Management [1]	3	13	19	19	19
Retail [2]	-	-	609	1,067	1,067
Office [3]	-	-	220	387	387
Industrial [4]	-	188	282	375	375
Education [5]	-	-	49	49	49
PHASE B					
Property Management [1]	-	-	-	2	2
Education [5]	-	-	-	-	34
	3	201	1,179	1,899	1,933
CONCEPT TWO					
PHASE A					
Property Management [1]	3	23	43	53	53
Retail [2]	-	-	609	1,067	1,067
Office [3]	-	-	220	387	387
Industrial [4]	-	188	282	375	375
Education [5]	-	-	49	49	49
PHASE B					
Property Management [1]	-	-	-	2	2
Education [5]	-	-	-	-	34
	3	211	1,203	1,934	1,968
CONCEPT THREE					
PHASE A					
Property Management [1]	3	13	32	44	44
Retail [2]	-	-	615	1,075	1,075
Office [3]	-	-	312	545	545
Industrial [4]	-	188	282	476	476
Education [5]	-	-	49	49	49
PHASE B					
Property Management [1]	-	-	-	6	15
Industrial [4]	-	-	-	2	7
Education [5]	-	-	-	-	34
	3	201	1,289	2,198	2,246

Notes: 2036 is shown as the expected buildout year.

[1] This category includes building management, maintenance and landscaping. After initial increment for the project as a whole, jobs are associated with multifamily units (2 jobs per 100 units).

[2] Retail jobs estimated at 2.5 jobs per 1,000 square feet occupied commercial area (at 95 percent occupancy).

[3] Office jobs estimated at 4 jobs per 1,000 square feet occupied commercial space (at 95 percent occupancy).

[4] Industrial space may be used for typical light industrial uses and for photovoltaics. Here, half the developed industrial acreage is assumed to be for a mix of transportation, warehousing and wholesale trade, and half for solar farms.

[5] School employment varies with the student population. A new elementary school is here anticipated to have a staff of 33.5, soon growing to 49. These estimates are based on analysis of elementary school staffing on Maui as of 2009.

Table 3-6: Operations-Related Employment

	2015	2020	2025	2030	2036
CONCEPT ONE					
PHASE A					
On-site Jobs	3	201	1,179	1,897	1,897
Other Maui Jobs	1	270	622	913	913
Rest of Hawaii	1	83	318	496	496
PHASE B					
On-site Jobs	-	-	-	2	36
Other Maui Jobs	-	-	-	1	6
Rest of Hawaii	-	-	-	0	7
	5	554	2,119	3,309	3,355
CONCEPT TWO					
PHASE A					
On-site Jobs	3	211	1,203	1,932	1,932
Other Maui Jobs	1	274	632	926	926
Rest of Hawaii	1	86	324	504	504
PHASE B					
On-site Jobs	-	-	-	2	36
Other Maui Jobs	-	-	-	1	6
Rest of Hawaii	-	-	-	0	7
	5	571	2,159	3,366	3,411
CONCEPT THREE					
PHASE A					
On-site Jobs	3	201	1,289	2,190	2,190
Other Maui Jobs	1	270	664	1,128	1,128
Rest of Hawaii	1	83	345	585	585
PHASE B					
On-site Jobs	-	-	-	8	56
Other Maui Jobs	-	-	-	7	28
Rest of Hawaii	-	-	-	3	15
	5	554	2,298	3,921	4,002

Notes: Number of indirect and induced jobs is taken from DBEDT *InterCounty Input-Output Model for 2005.* Allocation of these to Maui vs. the rest of the state was estimated by Belt Collins, based on the Input-Output model.

Table 3-7: Operations-Related Wages

	2015	2020	2025	2030	2036
CONCEPT ONE					
PHASE A					
On-site Jobs	$0.1	$23.2	$72.9	$110.4	$110.4
Other Maui Jobs	$0.0	$10.3	$23.6	$34.6	$34.6
Rest of Hawaii	$0.0	$3.4	$13.0	$20.3	$20.3
PHASE B					
On-site Jobs	$0.0	$0.0	$0.0	$0.1	$2.3
Other Maui Jobs	$0.0	$0.0	$0.0	$0.0	$0.2
Rest of Hawaii	$0.0	$0.0	$0.0	$0.0	$0.3
	$0.2	$36.8	$109.5	$165.4	$168.2
CONCEPT TWO					
PHASE A					
On-site Jobs	$0.1	$23.7	$74.1	$112.1	$112.1
Other Maui Jobs	$0.0	$10.4	$23.9	$35.1	$35.1
Rest of Hawaii	$0.0	$3.5	$13.2	$20.6	$20.6
PHASE B					
On-site Jobs	$0.0	$0.0	$0.0	$0.1	$2.3
Other Maui Jobs	$0.0	$0.0	$0.0	$0.1	$0.3
Rest of Hawaii	$0.0	$0.0	$0.0	$0.0	$0.3
	$0.2	$37.6	$111.3	$168.0	$170.8
CONCEPT THREE					
PHASE A					
On-site Jobs	$0.1	$23.2	$78.2	$131.7	$131.7
Other Maui Jobs	$0.0	$10.3	$25.2	$42.8	$42.8
Rest of Hawaii	$0.0	$3.4	$14.1	$23.9	$23.9
PHASE B					
On-site Jobs	$0.0	$0.0	$0.0	$0.6	$4.1
Other Maui Jobs	$0.0	$0.0	$0.0	$0.3	$1.1
Rest of Hawaii	$0.0	$0.0	$0.0	$0.1	$0.6
	$0.2	$36.8	$117.5	$199.4	$204.1

Notes: Wages are estimated by industry for on-site jobs, from Maui County 2008 annual data, adjusted to 2009 $s with the Consumer Price Index. Wages for indirect and induced jobs are estimated using the total covered employment average wages for Maui and for the state as a whole.

Sources: DLIR, *Employment and Payrolls in Hawaii, 2008*; DBEDT, *Quarterly Statistical and Economic Report, First Quarter, 2010.*

3.4 Labor Force Impacts

The Leiali‘i project will affect the regional labor force in part by creating jobs, but more importantly, by providing new housing for service, retail, managerial, and professional workers. As more housing units are built, fewer workers would face unacceptable housing choices and/or difficult daily commutes.

By shortening the commute time for workers and their families, the project could increase labor force participation, with some joining the labor force and others changing from part-time to full-time employment. For young people, the number of easily accessible jobs is greater in Lahaina than in communities such as Waiehu and Pukalani. Consequently, high-school student participation in the labor force may increase.

With fewer obstacles to work, residents living near job centers are more likely to keep their jobs than ones with long commutes. A long-term result of increasing the housing stock for West Maui workers will likely be lower job turnover.

3.5 Fiscal Impacts

Some of the impacts of a major project on government finances can be calculated with precision. Others are less certain. For example, real property taxes on new commercial property can be estimated from values and current tax rates, assuming that these change little over time, apart from inflation. With a new community, local government will seek to provide services but cannot be expected to provide new facilities and staff as quickly as it collects new taxes. As a result, it is far simpler to estimate government revenues associated with a project than government expenditures.

Since the project’s full-time residents are already residents of the island, it is not their numbers that affect government services – they would use schools and parks on Maui with or without the project – but their location at Leiali‘i. Three aspects of that location are important:

- Leiali‘i is in West Maui, convenient for a large part of Maui’s workforce.
- Leiali‘i is a “smart growth” planned community, with infrastructure to be built to current codes, sites dedicated for schools, and roads and bikeways designed to encourage alternatives to dependence on automobiles.
- New developments are increasingly subject to impact fees levied to help pay the cost of government infrastructure – and Leiali‘i will be subject to such fees. (While the right to levy impact fees is well established, the amounts to be levied are still being drafted. Discussion of those fees in this document is preliminary, anticipating both future government proposals and the developer’s responses.)

Impacts on the county’s transportation systems will be complex. For some residents, use of routes within West Maui would replace long-distance commuting. Some may be able to rely on public transportation to commute to work, instead of relying only on automobiles. For others, the move to Leiali‘i would involve little change or even a reversal of commuting patterns. Again, impacts on schools are due to relocation of students from communities served by existing schools to a new community. (Many families would move from West Maui neighborhoods to the project, so their children would continue to attend West Maui schools.) At Leiali‘i land will be

set aside for schools and the developer will be expected to pay impact fees levied on new housing projects to help pay for school construction.

The cost of providing services to new part-time residents can be estimated from the average cost that the State and County pay for services per non-resident. Average costs are calculated below.

3.5.1 State of Hawai‘i

Tax Revenues

Construction of the project will create several cash flows leading to State taxes, as shown in Table 3-8. Since the Villages of Leiali‘i project is an affordable housing project, direct construction spending is treated as exempt from State general excise tax.

Table 3-8: State of Hawai‘i Tax Revenues Derived from Project Construction

	Phase A	Phase B	Combined
Total construction costs (Millions of 2009 $s)			
Concept One	$662.6	$579.6	$1,242.2
Concept Two	$723.0	$579.3	$1,302.3
Concept Three	$861.3	$565.1	$1,426.3
Total construction-related wages (Millions of 2009 $s)			
Concept One	$308.1	$291.5	$599.7
Concept Two	$325.8	$291.4	$617.2
Concept Three	$399.7	$288.3	$688.1
Corporate income taxes (Millions of $s) (1)			
Concept One	$0.8	$0.7	$1.5
Concept Two	$0.9	$0.7	$1.6
Concept Three	$1.1	$0.7	$1.8
Excise Tax on workforce spending (Millions of $s) (2)			
Concept One	$7.7	$7.3	$15.0
Concept Two	$8.2	$7.3	$15.5
Concept Three	$10.0	$7.2	$17.2
Personal Income Tax (Millions of $) (3)			
Concept One	$18.9	$17.9	$36.8
Concept Two	$20.0	$17.9	$37.9
Concept Three	$24.5	$17.7	$42.2
Total State Revenues (Millions of $s)			
Concept One	$27.5	$25.9	$53.4
Concept Two	$29.1	$25.9	$55.0
Concept Three	$35.6	$25.6	$61.3

Notes:
(1) Corporate income tax historically averages 0.125 percent of corporate revenues (data from 2002).
(2) Excise tax at 4 percent of workforce disposable income. Share of spending subject to excise tax estimated from 2002 expenditure data.
(3) Personal income tax historically 6.14 percent of resident incomes (2005).

Sources: Hawai‘i State Department of Taxation, 2006, 2008. DBEDT, 2009.

Other Revenues

Urbanization of the State land at Leialiʻi will result in increased value. The future developer's lease will include payments to the State for the opportunity to use that land. The amount will be negotiated in the future. A 20 percent share of state lease revenues will go to the Office of Hawaiian Affairs (OHA).

As the project builds out, lease revenues would increase. Assuming (a) a land value of developable acreage of about $1.7 million per acre (based on assessed values of urbanized vacant lands in West Maui), (b) lease rents calculated for half the residential land and all the commercial and industrial land, and (c) a seven percent annual return on value, the total lease rent could climb to $25 million or more annually. Using that preliminary figure as a basis, OHA's share of the lease rent would amount to $5 million annually at buildout.

The State Board of Education has developed a West Hawaiʻi impact fee schedule and has announced plans to levy a West Maui fee using a similar methodology. Maui fees will vary depending on student generation rates, the capacity of existing schools to handle growth, and land and construction costs. Taking the West Hawaiʻi fees as a model, the land requirement associated with the project's student population would be from 7.2 to 11.7 acres

Table 3-9: Potential Student Population

	Students, at Buildout
CONCEPT ONE	
PHASE A	388
PHASE B	533
	921
CONCEPT TWO	
PHASE A	555
PHASE B	533
	1,087
CONCEPT THREE	
PHASE A	641
PHASE B	442
	1,083

Note: The student generation rates developed in the West Hawaiʻi study were 35 students per 100 single family units, and 22 students per 100 multifamily units. The DOE approach, used here, includes all units, whether likely to be occupied by full- or part-time residents.

Source: Hawaiʻi State Department of Education, *An Analysis of the Proposed West Hawaii School Impact Fee District.* 2010. Posted at http://www.boe.k12.hi.us/STATE/BOE/Agenda.nsf/657db2f5950da6b40a256530000a8e69/7d616204122a697c0a2576eb000ad1b4/$FILE/West%20HI%20Appendix%20AB.pdf

The proposed impact fees address both provision of school sites and construction of new buildings. Table 3-10 shows fee calculations for each concept and phase, with an estimate of the amount credited when the DOE accepts the school sites in each phase.

When Maui County adopts impact fees for major roadways (discussed in the next section), the State of Hawaiʻi will gain revenues, since the major roadway improvements in West Maui, on Honoapiʻilani Highway and the Lahaina Bypass, are on State roads.

Table 3-10: Potential School Impact Fees (based on West Hawaiʻi Fee Schedule)

	Estimated Student Population	Construction Fee	Land Required (acres)	Extra Land [1]	Land Credit [2]	Net Impact Fee
CONCEPT ONE						
PHASE A	388	$1,750,977	7.2	4.85	$1,941,971	-$190,994
PHASE B	533	$2,448,585	10.0	1.98	$790,790	$1,657,795
CONCEPT TWO						
PHASE A	555	$2,446,733	10.0	2.05	$818,803	$1,627,930
PHASE B	533	$2,448,585	10.0	1.98	$790,790	$1,657,795
CONCEPT THREE						
PHASE A	641	$2,863,928	11.7	0.33	$130,547	$2,733,380
PHASE B	442	$2,004,762	8.2	4.38	$1,752,653	$252,109

Notes: All calculations use 2010 West Hawaiʻi impact fee factors as a preliminary indicator of West Maui values.
[1] The project area includes 12.01 acres in each phase for a school site (except for Concept Three, Phase B, in which 12.58 acres have been designated). This calculation presumes that the DOE accepts all that acreage as school sites.
[2] The land credit is based on an appraised value for improved vacant land. In West Hawaiʻi, the DOE has used $400,000 per acre as a rule of thumb initial estimate for such values; that figure is used here as well.
Source: Hawaiʻi State DOE, *An Analysis of the Proposed West Hawaii School Impact Fee District.* 2010.

Some State tax receipts can be calculated on the basis of non-resident spending. Expenditures by vacationers on Maui averaged $107.50 per day per person in 2008, excluding lodging costs.[13] Total visitor-related tax receipts come to 7.5 percent of visitor spending.[14]

Cost of Public Facilities and Services: Average Cost Estimate

The State of Hawaiʻi spent, on average, $191 of its own funds per visitor or part-time resident in 2009, as shown in Table 3-11. The next table applies that analysis to the part-time resident population of the Leialiʻi project.

[13] DBEDT, *2008 Annual Visitor Research Report.* Honolulu, HI 2009.

[14] DBEDT, *2008 State of Hawaii Data Book.* Honolulu, HI, 2009. This calculation includes both State and County revenues. Since State revenues account for slightly more than 80 percent of total tax revenues in Hawaiʻi, the State share of taxes from visitor-related cash flows is approximately 6 percent.

Table 3-11: Average Cost of State Public Service Expenditures

	Expenditures, FY 2008	Service Population	Expenditures per -- *Resident*	*Visitor*
Expenditures (in $1,000s)				
General government	$537,541	De Facto	$387.11	$387.11
Public safety	$411,152	De Facto	$296.09	$296.09
Highways	$406,795	De Facto	$292.95	$292.95
Conservation of natural resources	$103,596	De Facto	$74.60	$74.60
Health	$863,914	Residents	$670.64	$0.00
Welfare	$1,857,473	Residents	$1,441.92	$0.00
Lower education	$2,201,901	Residents	$1,709.29	$0.00
Higher education	$815,116	Residents	$632.76	$0.00
Other education	$23,206	De Facto	$16.71	$16.71
Culture and recreation	$110,404	De Facto	$79.51	$79.51
Urban redevelopment & housing	$255,783	Residents	$198.56	$0.00
Economic devel. & assistance	$149,075	Residents	$115.72	$0.00
Other	$5,880	Residents	$4.56	$0.00
Debt service	$478,735	Residents	$371.63	$0.00
Principal	$231,478	De Facto	$166.70	$166.70
Interest and others	$247,257	De Facto	$178.06	$178.06
			$6,636.81	$1,491.73
Less intergovernmental revenues	$1,807,376	De Facto	-$1,301.58	-$1,301.58
Average cost per person, FY2008			$5,335.23	$190.16
Adjusted to 2009, per CPI (up 0.5%)			$5,360.87	$191.07

Table 3-12: Average Cost of State Expenditures, Part-Time Residents at Leialiʻi

	2020	2025	2030	2035	Buildout
Part-Time Residents					
CONCEPT ONE					
Phase A	73	102	102	102	102
Phase B	-	-	29	102	111
CONCEPT TWO					
Phase A	73	146	183	183	183
Phase B	-	-	29	102	111
CONCEPT THREE					
Phase A	73	146	189	189	189
Phase B	-	-	29	102	102
State Average Cost (Annual)					
CONCEPT ONE					
Phase A	$13,900	$19,474	$19,474	$19,474	$19,474
Phase B	$0	$0	$5,560	$19,461	$21,156
CONCEPT TWO					
Phase A	$13,900	$27,801	$35,043	$35,043	$35,043
Phase B	$0	$0	$5,560	$19,461	$21,156
CONCEPT THREE					
Phase A	$13,900	$27,801	$36,155	$36,155	$36,155
Phase B	$0	$0	$5,560	$19,461	$19,461
State Average Cost (Cumulative)					
CONCEPT ONE					
Phase A	$41,701	$136,280	$233,652	$331,024	$350,499
Phase B	$0	$0	$8,340	$77,842	$98,999
CONCEPT TWO					
Phase A	$41,701	$152,904	$321,975	$497,190	$532,233
Phase B	$0	$0	$8,340	$77,842	$98,999
CONCEPT THREE					
Phase A	$41,701	$152,904	$325,311	$506,086	$542,241
Phase B	$0	$0	$8,340	$77,842	$97,303

Net Fiscal Impact

Table 3-13 compiles most of the quantifiable impacts discussed above for the period through 2036, the estimated buildout date. It shows revenues to exceed costs significantly. It does not include revenues, such as lease payments, which depend on future negotiations. Additional costs, not included here, could also develop. However, evidence of a positive net fiscal impact is clear.

Table 3-13: Net Impact of Project on State Finances at Buildout

All values are Million 2009 $s	***Concept One***		***Concept Two***		***Concept Three***	
	A	*Both A, B*	*A*	*Both A, B*	*A*	*Both A, B*
Estimated Revenues						
Construction-Related Taxes	$27.5	$53.4	$29.1	$55.0	$35.6	$61.3
School Impact Fees	($0.2)	$1.7	$1.6	$1.7	$2.7	$0.3
Taxes on Part-Time Resident Spending	$4.5	$5.8	$6.8	$8.1	$7.0	$8.2
	$31.8	$60.8	$37.5	$64.7	$45.3	$69.7
Estimated Costs						
Average Cost, Part-Time Residents	$0.4	$0.4	$0.5	$0.6	$0.5	$0.6
Net Benefit > Cost	$31.4	$60.4	$37.0	$64.1	$44.8	$69.1

3.5.2 Maui County

Tax Revenues

Maui County derives about half its operating revenue from property tax collections. The Leiali‘i site currently yields a total of $150 annually in property taxes. With reclassification and development, that amount would climb sharply. For this analysis, valuation and taxes have been calculated for different types of development (as shown in Table 3-14). The next table shows both annual and cumulative property taxes on developed acreage dedicated to housing, commercial, and industrial uses. The County is expected to receive a continuing cash flow of $2.7 to $3.9 million (2009 $s) annually.

Table 3-14: Per-Unit Values and Real Property Tax Calculations

	Value/ unit	Exemption	Taxable Value	Rate/ $1,000	Annual Tax/ Unit
SF					
Rental A	$182,920		$182,920	$4.85	$887
Rental B	$276,760		$276,760	$4.85	$1,342
Workforce for Sale A	$308,900	$300,000	$8,900	$2.00	$150
Workforce for Sale B	$401,600	$300,000	$101,600	$2.00	$203
Market: Full-time Residents	$660,250	$300,000	$360,250	$2.00	$721
Market: Part-time Residents	$660,250		$660,250	$4.85	$3,202
MF					
Rental A	$182,920		$182,920	$4.55	$832
Rental B	$276,760		$276,760	$4.55	$1,259
Workforce for Sale A	$278,000	$300,000	$0	$2.00	$150
Workforce for Sale B	$361,400	$300,000	$61,400	$2.00	$150
Market	$379,050	$300,000	$79,050	$2.00	$158
Market: Part-time Residents	$379,050		$379,050	$4.55	$1,725
Commercial					
Retail	$194,449		$194,449	$6.25	$1,215
Office	$296,449		$296,449	$6.25	$1,853
Industrial	$138,050		$138,050	$6.50	$897

Notes: For production schedules, see Table 3.1. For assumptions about housing mix and pricing, see Table 3.3. The analysis assumes that housing for all rent and sale levels is produced in each year. The value of housing for sale is based on sales price. For rentals, value is derived from average rental payment, minus 15 percent for operations cost, with a 7.5 percent cap rate. Units for commercial and industrial property are 1,000 square feet of built space. Values for these are based on estimated construction costs for retail, office and industrial uses, and on land value. Land value is estimated from assessed values of vacant urbanized parcels of 10 acres or more, outside resorts, in West Maui. Industrial value shown is for a mix of light industrial uses and photovoltaics. All parks, schools, roads are excluded from the analysis. Tax rates are for Residential ($4.85), Apartment ($4.55), Commercial ($6.25), Industrial ($6.50) and Homeowner ($2.00) property classes. It is assumed here that all for-sale units and 80 percent of market units go to owner-occupants. A minimum tax charge of $150/unit is included, per Maui County Code 3.48.590.

Table 3-15: Estimated Real Property Tax Revenues

All values are Millions of 2009 $s	2015	2020	2025	2030	2036
ANNUAL TAX COLLECTIONS					
CONCEPT ONE					
PHASE A	$0.0	$0.7	$1.5	$1.9	$1.9
PHASE B	$0.0	$0.0	$0.0	$0.2	$0.8
CONCEPT TWO					
PHASE A	$0.0	$0.7	$1.7	$2.3	$2.3
PHASE B	$0.0	$0.0	$0.0	$0.3	$1.3
CONCEPT THREE					
PHASE A	$0.0	$1.0	$2.1	$3.0	$3.0
PHASE B	$0.0	$0.0	$0.0	$0.3	$2.0
CUMULATIVE TAX COLLECTIONS					
CONCEPT ONE					
PHASE A	$0.0	$2.2	$7.9	$16.8	$28.1
PHASE B	$0.0	$0.0	$0.0	$0.3	$3.7
CONCEPT TWO					
PHASE A	$0.0	$2.1	$8.1	$19.1	$33.2
PHASE B	$0.0	$0.0	$0.0	$0.5	$5.9
CONCEPT THREE					
PHASE A	$0.0	$3.1	$11.2	$25.0	$42.8
PHASE B	$0.0	$0.0	$0.0	$0.5	$8.2

Note: See notes to preceding tables for development schedule, valuation and rates. If the future developer designates more than half the housing units for workforce families, the tax collections would be less than shown here.

Other Revenues

The County of Maui has an impact fee structure for transportation infrastructure in West Maui (Maui County Code 14.62) but fees have not yet been set. Currently, two studies are in progress. One deals with transportation impacts and is expected to result in fee calculations to be incorporated in the ordinance. The other study will estimate additional impact fees for such public services as water, wastewater, drainage control, police, fire, and recreation. To date, no fee has been proposed, much less adopted by Maui County. While these fees cannot be calculated, it is likely that some fees will be adopted by the County before construction of the Leiali‘i project. In addition, the project developer is expected to make contributions to cover water transmission, wastewater, and solid waste treatment. (HHFDC’s predecessor agency has already paid for expansion of the Lahaina Wastewater Treatment Plant.)

Cost of Public Facilities and Services

The County may make significant investments in infrastructure and public services to serve the Leiali‘i resident population. That population is part of the anticipated resident population growth on Maui, and the County would as a matter of course fund increases in police, fire control, and other services for the growing island population. From that perspective, little of the cost of public facilities for Leiali‘i residents should count as a new project-related impact. Tables 3-16 and 3-17 use the average-cost method to calculate the cost of service provision to part-time residents at Leiali‘i.

Table 3-16: Average Cost of Maui County Public Service Expenditures

	Expenditures, FY 2008	Service Population	Expenditures per -- *Resident*	*Visitor*
Expenditures				
General government:	18971.114	De Facto	$104.47	$104.47
Public safety	47823.905	De Facto	$263.35	$263.35
Highways	8525.102	De Facto	$46.94	$46.94
Health and sanitation	18703.395	De Facto	$102.99	$102.99
Public welfare	32007.995	Residents	$222.76	$0.00
Recreation	20906.716	De Facto	$115.13	$115.13
Interest	10997.161	De Facto	$60.56	$60.56
Bond redemption	13593.905	De Facto	$74.86	$74.86
Pension and retirement	25757.174	De Facto	$141.84	$141.84
Miscellaneous	13408.304	De Facto	$73.84	$73.84
Cash capital improvements	10580.271	De Facto	$58.26	$58.26
			$1,264.99	$1,042.23
Less Intergovernmental Revenues	44968.189	De Facto	-$247.62	-$247.62
Average cost per person, FY2008			$1,017.36	$794.61
Adjusted to 2009, per CPI (up 0.5%)			$1,022.25	$798.42

Table 3-17: Average Cost of County Expenditures, Part-Time Residents of Villages of Leialiʻi

	2020	2025	2030	2035	Buildout
County Average Cost (Annual)					
CONCEPT ONE					
Phase A	$58,085	$81,378	$81,378	$81,378	$81,378
Phase B	$0	$0	$23,234	$81,320	$88,406
CONCEPT TWO					
Phase A	$58,085	$116,171	$146,433	$146,433	$146,433
Phase B	$0	$0	$23,234	$81,320	$88,406
CONCEPT THREE					
Phase A	$58,085	$116,171	$151,080	$151,080	$151,080
Phase B	$0	$0	$23,234	$81,320	$81,320
County Average Cost (Cumulative)					
CONCEPT ONE					
Phase A	$174,256	$569,469	$976,357	$1,383,245	$1,464,623
Phase B	$0	$0	$34,851	$325,278	$413,684
CONCEPT TWO					
Phase A	$174,256	$638,939	$1,345,432	$2,077,598	$2,224,031
Phase B	$0	$0	$34,851	$325,278	$413,684
CONCEPT THREE					
Phase A	$174,256	$638,939	$1,359,372	$2,114,773	$2,265,853
Phase B	$0	$0	$34,851	$325,278	$406,598

Net Fiscal Impact

Table 3-18 compiles most of the quantifiable County fiscal impacts discussed above for the period through 2036, the estimated buildout date. Property tax revenues would continue to accumulate after that time. The table shows revenues to exceed costs significantly. Additional costs, not included here, could also occur. However, evidence of a positive net fiscal impact is clear.

Table 3-18: Net Impact of Project on County Finances at Buildout

All values are Million 2009 $s	***Concept One***		***Concept Two***		***Concept Three***	
	A	*Both A, B*	*A*	*Both A, B*	*A*	*Both A, B*
Estimated Revenues						
Property Taxes	$28.1	$31.8	$33.2	$39.1	$42.8	$51.0
Estimated Costs						
Average Cost, Part-Time Residents	$1.5	$1.9	$2.2	$2.6	$2.3	$2.7
Net Benefit > Cost	$26.7	$29.9	$31.0	$36.5	$40.5	$48.4

4 SOCIAL IMPACTS

4.1 Impacts on the Maui Resident Community

The most general social impact of the project is that it would provide more housing on an island with strong demand and very high housing prices. By increasing the housing stock, the Leiali‘i project would help to limit increases in the cost of housing. Moreover, housing at Leiali‘i will be developed to meet the needs of Maui residents. Most lessees will be owner-occupants; about 15 percent will be long-term resident renters. Rents and resale prices on workforce housing units will be controlled for at least ten years. If, as seems likely, the land remains in leasehold, the resale price of units for workforce families can be kept from increasing with the overall housing market. The impact would be to keep home prices attractive for working families for many years.

Based on the County’s estimate, some 1,380 new homes are needed annually to meet demand. Over the 22-year period for which the Villages of Leiali’i project is expected to deliver housing, the project would provide from 9.6 percent (Concept One) to 13.5 percent (Concept Three) of that demand.

Next, it will make resident housing available near job centers in Kā‘anapali Resort and Lahaina. For many workers living at the project, commute times would shorten. Transit options – public transit or private shuttles between the community and employment sites – may further reduce the number of residents commuting by automobile. The result is likely to be less congestion on the route between West Maui and the rest of the island, as well as lower demand for employee parking at job centers.

With increased resident housing available in Lahaina, areas that now serve a mix of residents and visitors – parts of Honokōwai and Kīhei – could see reduced resident demand and, hence, a change in neighborhood character towards becoming largely visitor-oriented areas. Such change would occur only over a long term and would be a cumulative impact of many trends on Maui, not just of the project.

4.2 Impacts on West Maui and the Lahaina Community

As a general rule, the shorter the commute, the easier it is for adults to participate in the life of their home communities, whether as volunteers, as parents involved with their children’s schools and teams, or simply as participants in everyday life. Community involvement is likely to increase. On the other hand, residents moving from areas in which they grew up and have family ties can find a new development to be less vibrant and lacking the networks, occasions, and places in which they enjoy community life. The Leiali‘i project’s design as a walkable community with parks and schools nearby will help to encourage resident community participation. On balance, then, the project is likely to increase West Maui residents’ ability to contribute to community life.

With new housing at Leiali‘i, Lahaina as a community would change. With more housing in the immediate area, crowding is likely to decrease. Also, with more full-time residents in the community, some retail areas would target the resident market rather than visitors.

Growth of the resident community will increase demand for limited public facilities. Enrollment and volunteer support for activities such as youth soccer, baseball, and paddling are likely to grow.

The impact of the project on existing neighborhoods includes a mix of possible changes:

- Traffic on Leiali‘i Parkway and other roads between the project and Honoapi‘ilani Highway would increase. With through traffic, these roads (Leiali‘i, Wahikuli, Kapunakea) will no longer function solely as local subdivision roads, and residents may experience a loss of valued community isolation.
- With development of the project, the mauka boundary of DHHL Leiali‘i and Wahikuli would no longer face untended fields of dry grass. In the past, residents reported the project site as home to rats. Some thought that thieves used the project site to reach the back of the residential area, and then escape via the cane roads. With the project, the boundary between the project and older subdivisions would largely consist of a landscaped border incorporating drainage control features. The project site would no longer be a source of nuisances and threats.
- The Bypass Highway will bring changes to traffic on Lahainaluna Road, taking students from all over West Maui to the schools at the top of Kelawea Mauka. The project will contribute some of the middle and high school student enrollment. However, the major change to Kelawea Mauka, improved traffic flow on Lahainaluna Road, will be brought by the Bypass Highway, independent of the Leiali‘i project.
- Little or no impact will be felt in the Historic District. That area is largely devoted to the visitor industry. It draws visitors, especially first-time visitors, rather than residents.

With the project, the population of West Maui would grow at a faster rate than in recent years and reach levels higher than those currently projected by the County of Maui Planning Department. This population growth could accelerate if some of the other projects slated to provide housing for resident workforce families are developed.

Development of the project will exert pressure on other developers of resident housing projects to make their housing and prices more attractive to potential buyers or renters. The result is expected to be beneficial for residents.

The Leiali‘i project will develop at a pace responsive to market conditions. Many Maui families will be interested in moving to West Maui, but not ready to do so while they hold jobs in both West and Central Maui, or are sending young people to high schools in Central or South Maui. Project development is estimated as occurring over about a 20-year period and could take longer. The resulting regional change would be gradual.

4.3 Mitigation of Potential Adverse Socio-Economic Impacts

The key adverse impact noted here, increased demand for limited recreational facilities, will be addressed in part through the development of parks and school facilities within the Leiali‘i project. It may also be addressed by the County’s efforts to provide services.

The fiscal analysis shows that project development would result in net gains for both state and county finances. The increased revenue can be used in part to provide public facilities and services needed by the community.

While residents of subdivisions makai of the project would lose some of their sense of living in small neighborhood communities, the project would offer them access to the Lahaina Bypass, new parks, and a new elementary school. These changes may mitigate the loss of felt separation.

As noted earlier, many view the Leiali‘i property as Crown land, as in some sense reserved for Native Hawaiians. The project will respond to restrictions flowing from the status of the land. OHA will receive a share of state leasehold revenues appropriate for ceded land. HHFDC has discussed and will continue to discuss with DHHL, OHA, and members of the West Maui community ways to respond to Native Hawaiians’ interests and concerns. HHFDC will also require the future developer to work with Native Hawaiian families to assure appropriate access to and preservation of culturally important sites.

Appendix L

Traffic Impact Assessment Report

TRAFFIC IMPACT ASSESSMENT REPORT FOR VILLAGES OF LEIALI'I AFFORDABLE HOUSING PROJECT

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December 2010

FEHR & PEERS
TRANSPORTATION CONSULTANTS

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CHAPTER 1. INTRODUCTION

This report documents the results of a traffic study conducted by Fehr & Peers to evaluate the potential traffic impacts associated with the proposed Villages of Leiali'i Affordable Housing Project in Lahaina on the island of Maui. The report includes a description of the assumptions and methods used to conduct the study, as well as a discussion of the results.

PROJECT DESCRIPTION

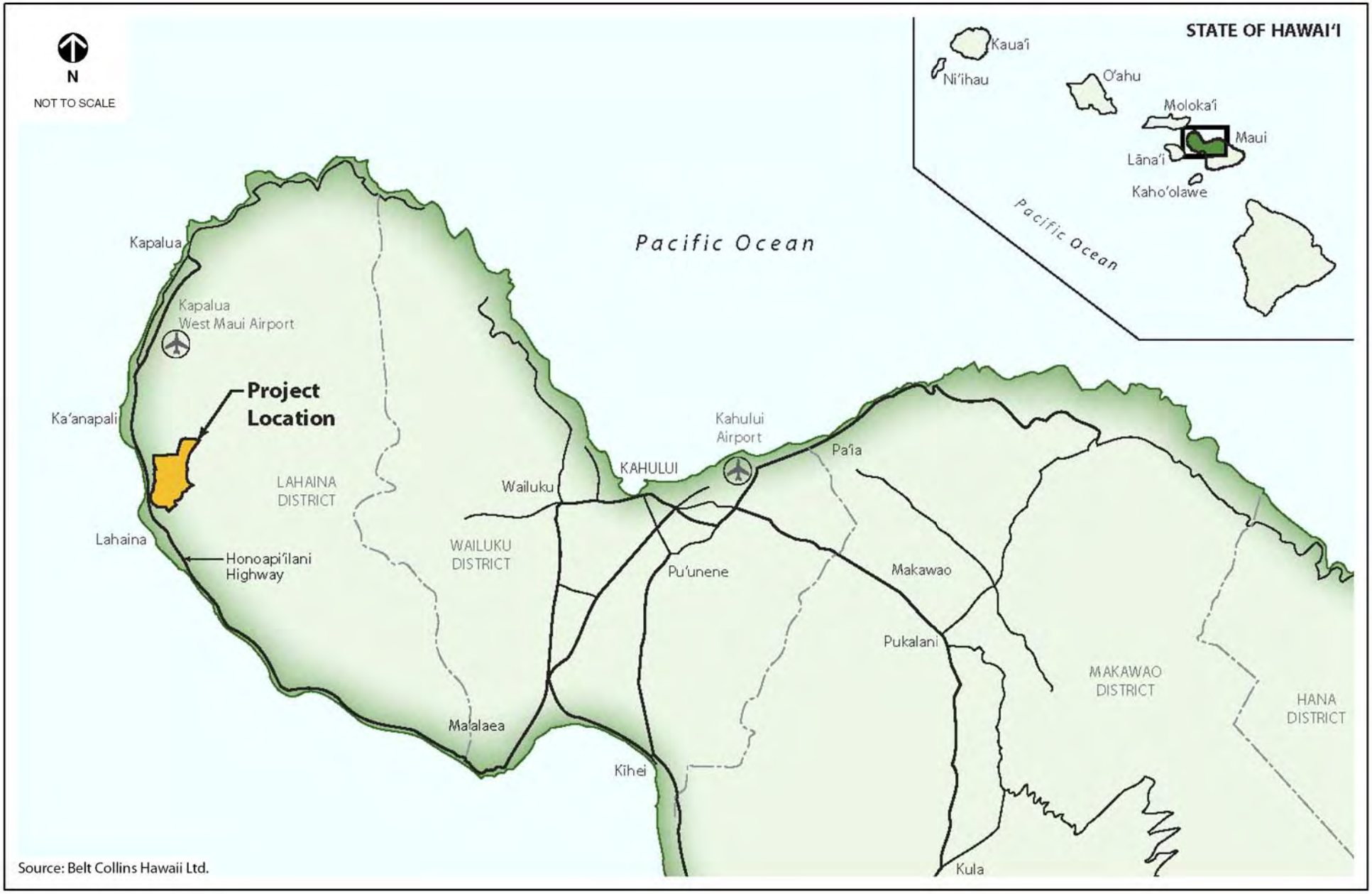
The Villages of Leiali'i Affordable Housing Project would construct a new mixed-use neighborhood on approximately 1,033 acres of vacant land in the area northeast of the intersection of Honoapi'ilani Highway (SR 30) and Keawe Street. Figure 1 illustrates the regional location of the proposed project. Three project alternatives or concepts, as well as the No Action alternative, have been assessed. Concepts 1 and 2 would have similar street and land use patterns but would vary in the overall intensity of development and distribution of land uses. Concept 3 has different land use, circulation, and open space patterns, as Leadership in Energy and Environmental Design for Neighborhood Design (LEED-ND) criteria were used to inform layout of the plan. Each housing component of the development alternatives is divided into two phases, referred to as Phase A and Phase B and generally located makai and mauka of the future Lahaina Bypass Highway, respectively. Figures 2 through 4 present the proposed land use plan and street network for Concepts 1 through 3, respectively.

At completion, the three concepts would include the following land uses:

- Between 1,386 and 2,135 single-family dwelling units
- Between 788 and 2,719 multi-family dwelling units
- Between 449,100 and 452,700 square feet of retail
- Between 101,900 and 143,300 square feet of office
- Between 17.2 and 21.8 acres of light industrial space
- Between 313,800 and 321,300 square feet of elementary school buildings
- Between 38 and 44 acres of park space
- Multi-acre archeological preserve

Under all three concepts, completion of Phase A of the project is anticipated by 2028, and Phase B is anticipated to be complete by 2036. All three land use concepts assume that 200 residential units will be constructed by the end of 2016 with 200 additional residential units per year thereafter until completion. All of the office, retail, and industrial development is assumed to be constructed by the end of Phase A, while residential, school, and park development will occur in both phases. Concept 3 includes a photovoltaic farm that would be constructed in Phase B. The intent of analyzing three development scenarios for the site is to identify a range of future traffic conditions that could occur with development of the site.

Planned connections from the site to the surrounding street system are the same for Concepts 1 and 2, while a greater number of connections from the site to the surrounding street system will be provided under Concept 3. Under all three concepts, primary access would be via the Lahaina Bypass Highway, of which a portion is now under construction. Under all three concepts, connections to the existing street system would be provided via planned connections to Keawe Street, Leiali'i Parkway, and Wahikuli Road, while under Concept 3, additional access would be provided via planned connections with Kaniau Road and Kapunakea Street. Figures 2 and 3 show that 12 vehicular access points would be provided under Concepts 1 and 2. Figure 4 shows that 16 vehicular access points would be provided under Concept 3. Roads and connections makai of the Lahaina Bypass Highway are anticipated to be complete in Phase A, while roads and connections mauka of the Lahaina Bypass Highway are anticipated to be complete in Phase B.



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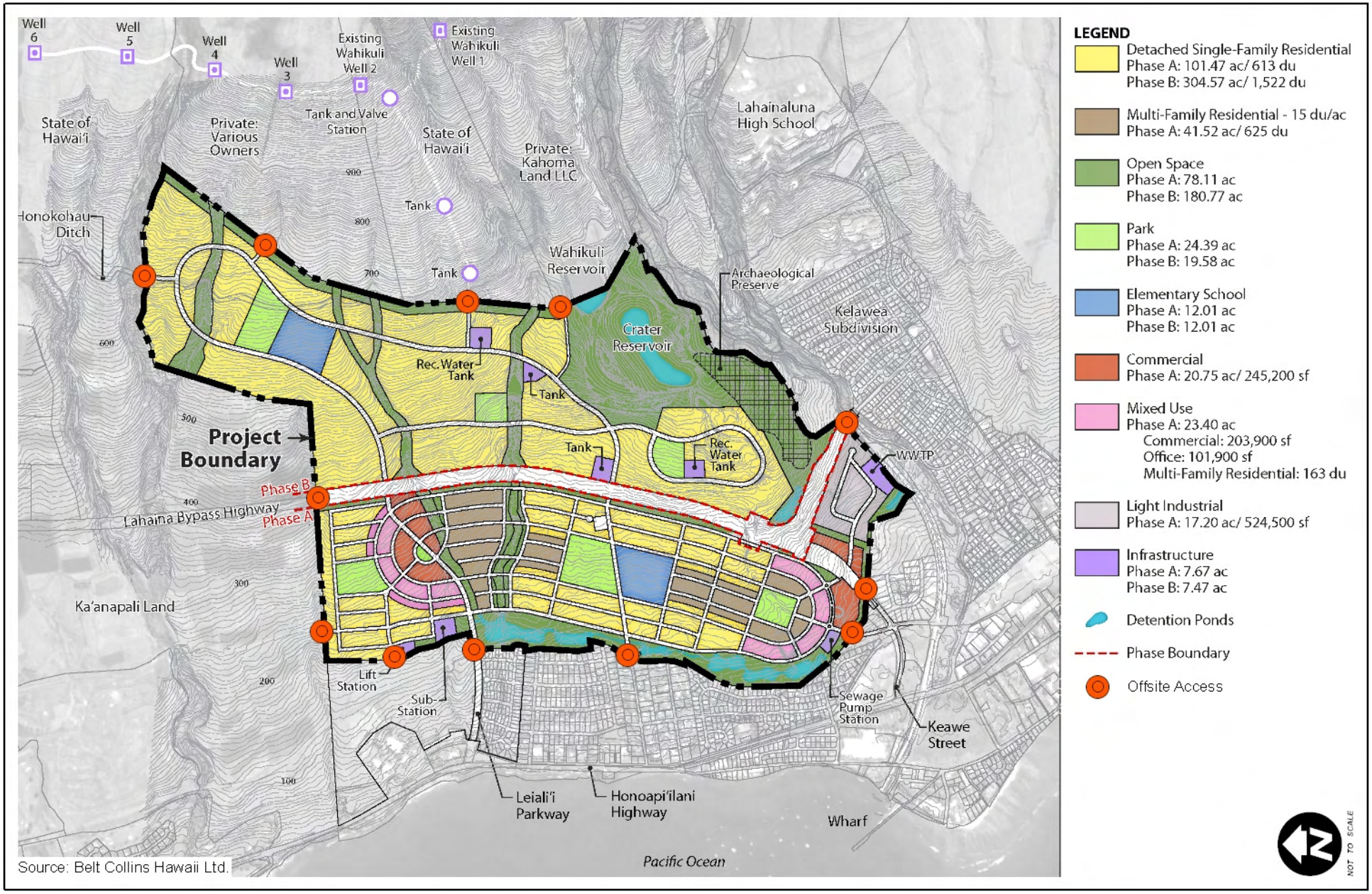
REGIONAL LOCATION MAP
FIGURE 1



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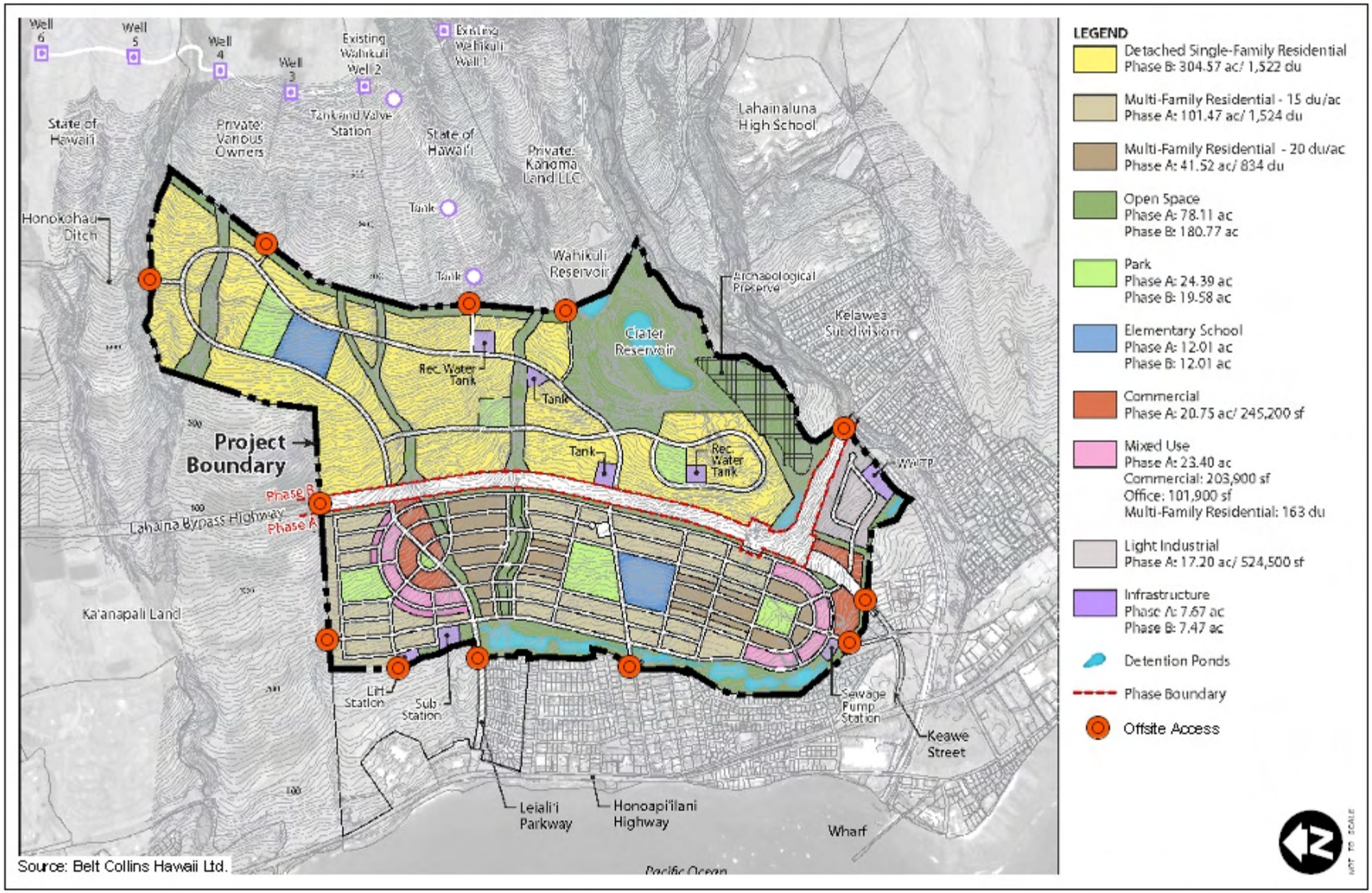
LAND USE PLAN CONCEPT 1

FIGURE 2



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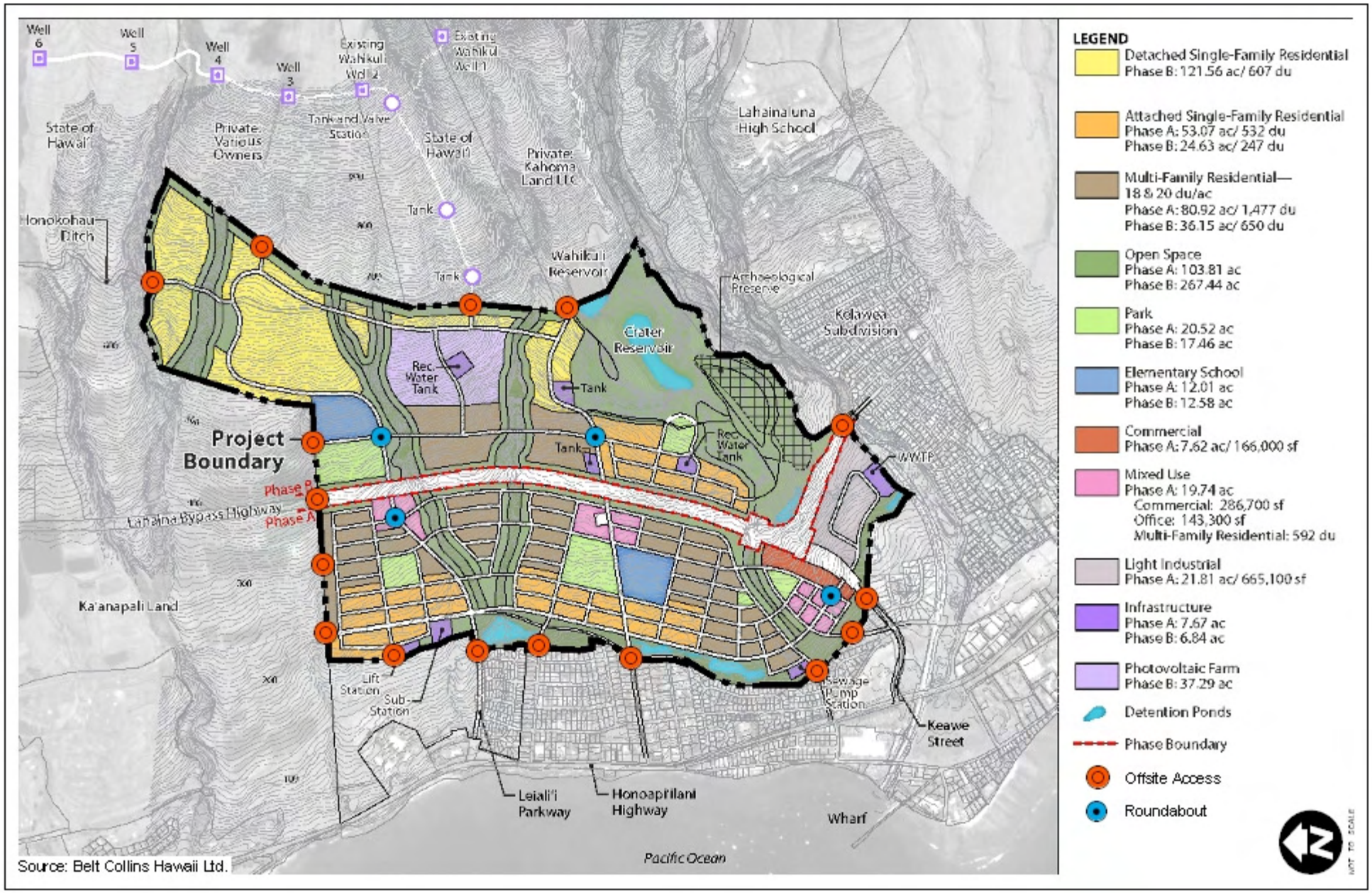
LAND USE PLAN CONCEPT 2

FIGURE 3



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LAND USE PLAN CONCEPT 3

FIGURE 4

Construction of the initial segment of the Lahaina Bypass Highway between Keawe Street and Lahainaluna Road is currently underway. By the end of 2028, when Phase A of development under the Villages of Leiali'i Affordable Housing Project would be completed, the entire Lahaina Bypass Highway will be complete from Puumana south of Lahaina to north of Ka'anapali.

STUDY SCOPE

The study analyzes potential project-related traffic impacts on the roadway system in the vicinity of the proposed project. The study evaluates projected future conditions with and without the proposed project in place. The following traffic scenarios are analyzed in the study:

- Existing Conditions (2010) – The analysis of existing traffic conditions provides a basis for the remainder of the study. The existing conditions analysis includes an assessment of streets, traffic volumes, and operating conditions.

- Cumulative Base (No Project) Conditions (2028 and 2036) – The objective of these scenarios is to project future traffic growth and operating conditions in each horizon year resulting from regional growth and related projects in the vicinity of the project site, without consideration of traffic generated by the proposed project itself.

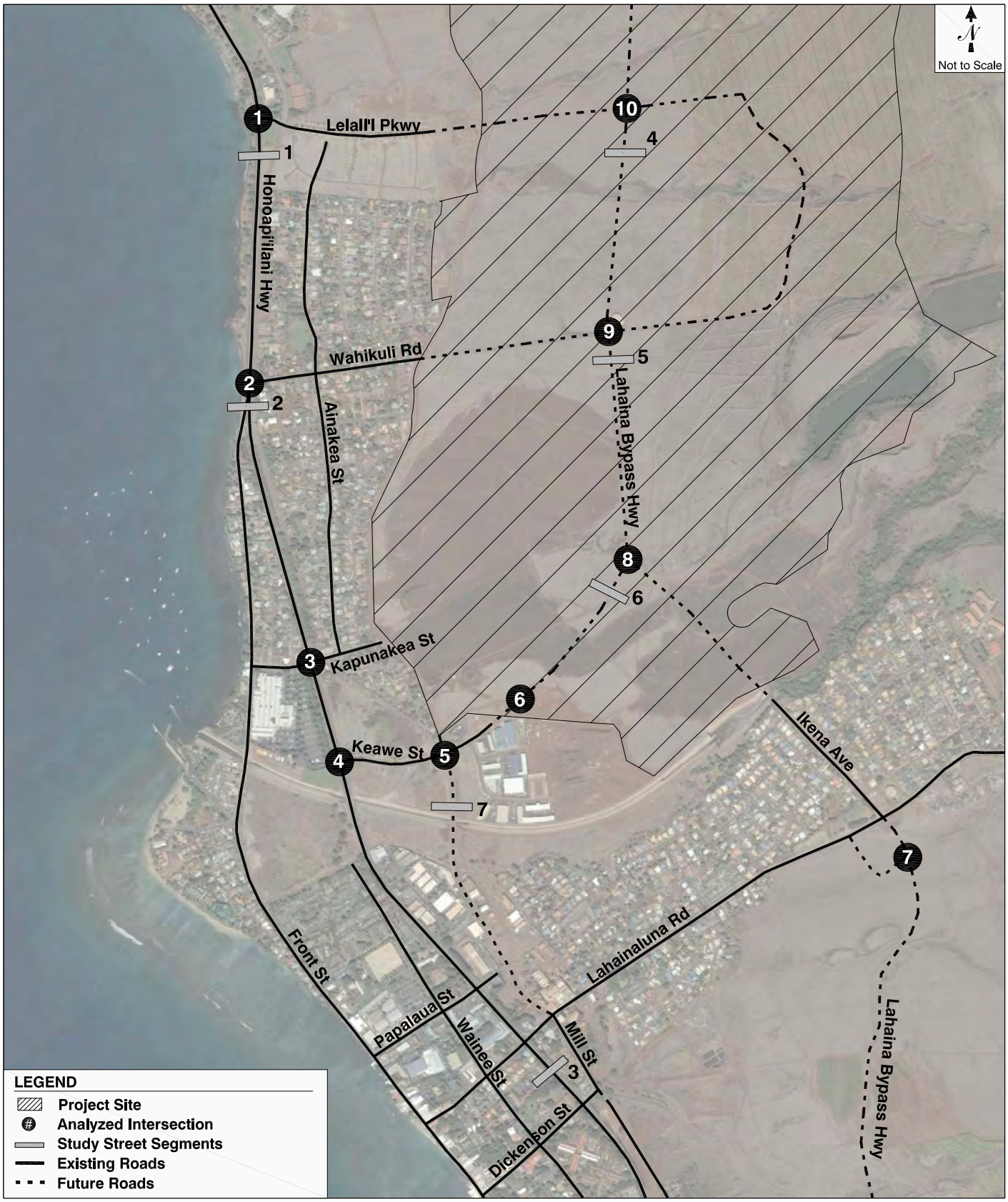
- Cumulative plus Project Conditions (2028 and 2036) – The objective of these scenarios is to assess potential impacts of the proposed project on future traffic operating conditions with project traffic added to the cumulative base traffic forecasts. Concepts 1, 2 and 3 are fully analyzed for each of the two horizon years.

The study analyzed the potential project-related traffic impacts under typical weekday AM and PM peak hour traffic conditions at four existing and six future intersections (a total of 10 intersections) in the vicinity of the proposed project. The analyzed intersections are listed below and are shown in Figure 5:

1. Honoapi'ilani Highway & Leiali'i Parkway
2. Honoapi'ilani Highway & Wahikuli Road
3. Honoapi'ilani Highway & Kapunakea Street
4. Honoapi'ilani Highway & Keawe Street
5. Mill Street & Keawe Street (future intersection)
6. Keawe Street & Phase A Connection to Industrial Area (future intersection)
7. Lahaina Bypass Highway & Lahainaluna Road (future intersection)
8. Lahaina Bypass Highway & Keawe Street (future intersection)
9. Lahaina Bypass Highway & Wahikuli Road (future intersection)
10. Lahaina Bypass Highway & Leiali'i Parkway (future intersection)

The impact of project-related traffic was also measured on the three existing and four future street segments (a total of seven street segments) listed below and shown in Figure 5:

1. Honoapi'ilani Highway south of Leiali'i Parkway
2. Honoapi'ilani Highway south of Wahikuli Road
3. Honoapi'ilani Highway south of Lahainaluna Road
4. Lahaina Bypass Highway south of Leiali'i Parkway (future roadway)
5. Lahaina Bypass Highway south of Wahikuli Road (future roadway)
6. Keawe Street south of Lahaina Bypass Highway (future roadway
7. Mill Street south of Keawe Street (future roadway)



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STUDY AREA AND ANALYZED LOCATIONS

FIGURE 5

ORGANIZATION OF THE REPORT

This report is divided into six chapters, including this introduction. Chapter 2 describes the existing circulation system, traffic volumes, and operating conditions in the study area. The methodologies used to forecast future cumulative and project traffic volumes and the resultant forecasts are described in Chapter 3. Chapter 4 presents an assessment of future traffic impacts at intersections in the surrounding area and identifies mitigation measures to address both cumulative and project-specific impacts. Chapter 5 contains an assessment of potential future street segment impacts and discusses potential mitigation measures. Finally, the conclusions of the study are summarized in Chapter 6.

CHAPTER 2. EXISTING CONDITIONS

A comprehensive data collection effort was undertaken to identify existing transportation conditions in the vicinity of the proposed project. The assessment of existing conditions relevant to this study includes an inventory of the street and highway system, traffic volumes on these facilities, and operating conditions at key intersections and street segments. Existing public transit service and bicycle and pedestrian facilities are also described.

EXISTING ROADWAY SYSTEM

The study area includes the northern area of Lahaina, as shown in Figure 5. Primary regional access to the area is provided by Honoapi'ilani Highway (SR 30), which runs north-south makai of the site of the proposed project. Several mauka-makai roads provide access to the existing residential neighborhoods and commercial development in the town of Lahaina. Descriptions of the key roadways in the area are provided below. With the exception noted below, no bicycle lanes or bicycle paths are provided on the streets in the study area. Diagrams of the existing lane configurations at the four existing study intersections are provided in Figure 6.

- Honoapi'ilani Highway (SR 30) is a major arterial that provides regional access around the western side of Maui, linking Kapalua with central Maui. In the project area, this primary arterial provides four travel lanes (two in each direction) and includes separate lanes for left and right turns at many intersections. Parking is not permitted on most segments of Honoapi'ilani Highway, and sidewalks are not provided.

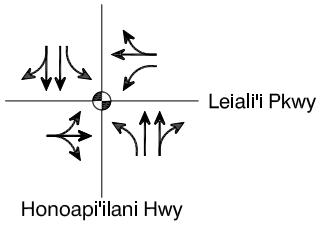
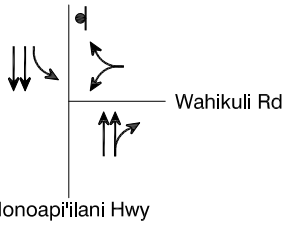
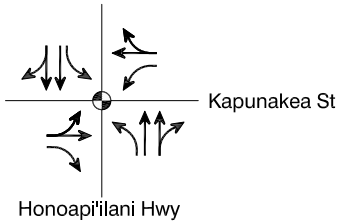
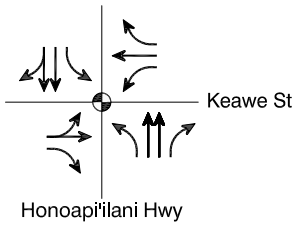
- Leiali'i Parkway is currently a two-lane arterial street that runs mauka from Honoapi'ilani Highway and provides local access to the Lahaina Civic and Recreation Center and to a residential neighborhood. Mauka of Ka'a'ahi Street, a future (makai-bound) two-lane section of roadway is constructed but not yet opened to traffic. Parking is generally permitted and sidewalks are provided along most of Leiali`i Parkway.

- Wahikuli Road is a two-lane collector street that runs mauka from Honoapi'ilani Highway and provides access to the residential neighborhood. Parking is permitted, and sidewalks are not provided.

- Kapunakea Street is a two-lane secondary arterial that runs mauka and makai from Honoapi'ilani Highway. It provides access to the Lahaina Cannery Shopping Center and to nearby residential areas. Sidewalks are generally provided, and parking is permitted in the residential area mauka of Honoapi'ilani Highway.

- Keawe Street is a four-lane secondary arterial street that provides access to newer commercial and industrial uses mauka of Honoapi'ilani Highway. It includes bike lanes, landscaped center medians and left-turn pockets. Parking is generally permitted, and sidewalks are provided. Makai of Honoapi'ilani Highway, Keawe Street aligns with a major driveway of the Lahaina Cannery Shopping Center.

- Ainakea Road is a collector street that runs north-south mauka of Honoapi'ilani Highway through the study area. It lies between Kapunakea Street to the residential neighborhood south of Leiali'i Parkway (Department of Hawaiian Home Lands [DHHL] Village 1 Phase 1) and provides two lanes, with parking permitted. Sidewalks are not provided.

INTERSECTION	EXISTING CONDITIONS
1. Honoapi'ilani Hwy & Leiali'i Pkwy	
2. Honoapi'ilani Hwy & Wahikuli Rd	
3. Honoapi'ilani Hwy & Kapunakea St	
4. Honoapi'ilani Hwy & Keawe St	
5. Mill St & Keawe St (future intersection)	Future Intersection
6. Keawe St/Phase A Connection to Industrial Area (future intersection)	Future Intersection
7. Lahaina Bypass Hwy & Lahainaluna Rd (future intersection)	Future Intersection

LEGEND
- Traffic Signal
- Stop Controlled

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EXISTING INTERSECTION LANE CONFIGURATIONS

FIGURE 6

INTERSECTION	EXISTING CONDITIONS
8. Lahaina Bypass Hwy & Keawe St (future intersection)	Future Intersection
9. Lahaina Bypass Hwy & Wahikuli Rd (future intersection)	Future Intersection
10. Lahaina Bypass Hwy & Leiali'i Pkwy (future intersection)	Future Intersection

LEGEND

Traffic Signal

Stop Controlled

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EXISTING INTERSECTION LANE CONFIGURATIONS

FIGURE 6

EXISTING TRANSIT SERVICE

The Maui Bus service provides public transit service around the island with 12 local and regional routes and four commuter routes. Four of these bus routes serve the Lahaina area near the project site. Each route operates seven days a week, including holidays. The Wharf Cinema Center in Lahaina is a designated transfer location.

- The Lahaina Villager Route (#23) provides hourly service in the village of Lahaina. It originates at the Wharf Cinema Center and operates on Honoapi'ilani Highway, Lahainaluna Road, Ainakea Road, Front Street as well as local streets.

- The Lahaina Islander Route (#20) provides hourly service between the Wharf Cinema Center in Lahaina and Kahului. In the study area, this route operates on Honoapi'ilani Highway.

- The Ka'anapali Islander Route (#25) provides hourly service between the Wharf Cinema Center in Lahaina and Ka'anapali. In the study area, this route operates on Honoapi'ilani Highway.

- The Makawao-Kapalua Commuter Route provides regional commuter service between Kapalua, Lahaina, Kahului and Makawao with two northbound runs in the AM period and two southbound runs in the PM period. The stop in Lahaina is at the Lahaina Cannery Shopping Center.

EXISTING TRAFFIC VOLUMES AND OPERATING CONDITIONS

The following sections present the existing peak hour traffic volumes at the four existing study intersections, a description of the methodology used to analyze operating conditions, and the resulting level of service (LOS) at each location under existing conditions.

Existing Peak Hour Traffic Volumes

New weekday peak period intersection turning movement counts were collected between 6:00 and 9:00 AM and between 3:00 and 6:00 PM at the four existing study intersections on Wednesday, May 5, 2010 and Thursday, May 6, 2010. Existing weekday peak hour volumes at these intersections are illustrated in Figure 7 and the traffic count data sheets are provided in Appendix A.

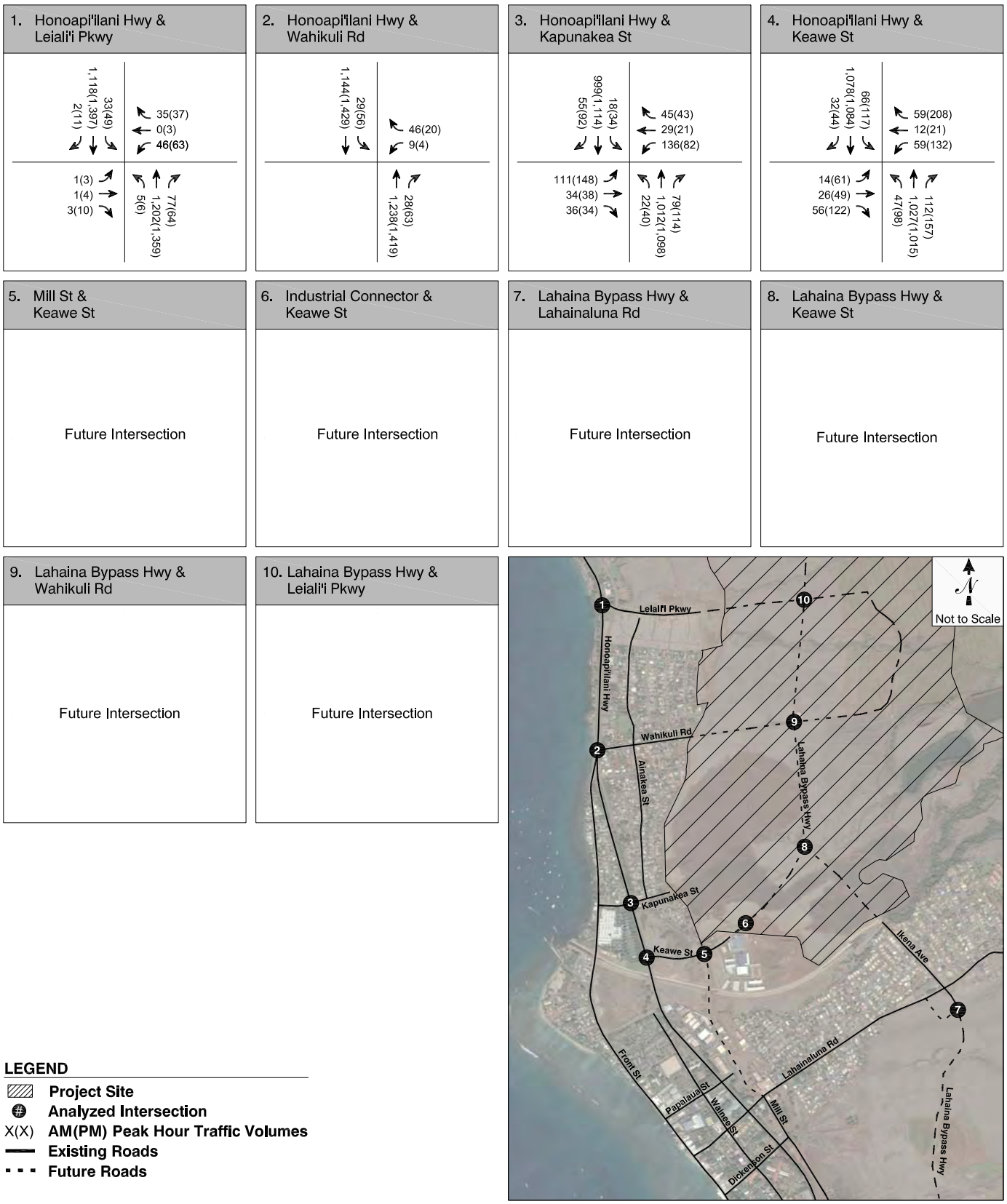
Level of Service Methodology

LOS is a qualitative measure used to describe the condition of traffic flow ranging from excellent conditions at LOS A to overload conditions at LOS F. LOS definitions for signalized and unsignalized intersections are provided in Tables 1 and 2, respectively. LOS D is considered to be the minimum desirable operating level of service in this area.

LOS analyses were conducted at each of the existing study intersections to determine their current operating conditions using the operations methodology for signalized intersections and the two-way stop-controlled methodology for unsignalized intersections from *2000 Highway Capacity Manual* (2000 HCM) (Transportation Research Board, 2000).

Existing Peak Hour Intersection Levels of Service

The existing weekday AM and PM peak hour turning movements depicted in Figure 7 were used in conjunction with the LOS methodologies described above to determine existing operating conditions at the four existing study intersections. Detailed LOS calculation worksheets are included in Appendix B.



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EXISTING PEAK HOUR TRAFFIC VOLUMES

FIGURE 7

TABLE 1
LEVEL OF SERVICE DEFINITIONS FOR SIGNALIZED INTERSECTIONS

Level of Service	Volume/Capacity	Average Stopped Delay per Vehicle (seconds)*
A	0.000 - 0.600	≤10
B	>0.600 - 0.700	>10 and ≤20
C	>0.700 - 0.800	>20 and ≤35
D	>0.800 - 0.900	>35 and ≤55
E	>0.900 - 1.000	>55 and ≤80
F	> 1.000	>80

Source: *Highway Capacity Manual*, Transportation Research Board, 2000.

TABLE 2
LEVEL OF SERVICE DEFINITIONS FOR UNSIGNALIZED INTERSECTIONS

Level of Service	Average Total Delay (seconds/vehicle)
A	$\leq$ 10
B	> 10 and $\leq$ 15
C	> 15 and $\leq$ 25
D	> 25 and $\leq$ 35
E	> 35 and $\leq$ 50
F	> 50

Source: *Highway Capacity Manual*, Transportation Research Board, 2000.

Table 3 summarizes the results of this analysis, including the average control delay and corresponding LOS during the AM and PM peak hours. Calculated volume-to-capacity (V/C) ratios are also shown for signalized intersections in Table 3. As indicated in the table, the intersection of Honoapi'ilani Highway & Wahikuli Road is currently operating at LOS F during the PM peak hour, based on the delay experienced by drivers on the most constrained (westbound) movement. The other three existing study intersections are operating at LOS D or better during both the AM and PM peak hours.

TABLE 3
EXISTING (2010) LEVELS OF SERVICE

No.	Intersection	Peak Hour	Critical Movement*	Existing Conditions		
				V/C	Del/Veh*	LOS
1	Honoapi'ilani Highway &	A.M.	Average Delay	0.48	13	B
	Leiali'i Parkway	P.M.	Average Delay	0.55	13	B
2	Honoapi'ilani Highway &	A.M.	WB Approach	NC	31	D
		A.M.	NB Through/Right		12	B
	Wahikuli Road [a]	P.M.	WB Approach		51	F
		P.M.	NB Through/Right		15	C
3	Honoapi'ilani Highway &	A.M.	Average Delay	0.54	16	B
	Kapunakea Street	P.M.	Average Delay	0.59	21	C
4	Honoapi'ilani Highway &	A.M.	Average Delay	0.47	22	C
	Keawe Street	P.M.	Average Delay	0.63	29	C
5	Mill Street &	A.M.		Constructed in Future		
	Keawe Street	P.M.				
6	Phase A Connection to Industrial Area &	A.M.		Constructed in Future		
	Keawe Street	P.M.				
7	Lahaina Bypass Highway &	A.M.		Constructed in Future		
	Lahainaluna Road	P.M.				
8	Lahaina Bypass Highway &	A.M.		Constructed in Future		
	Keawe Street	P.M.				
9	Lahaina Bypass Highway &	A.M.		Constructed in Future		
	Wahikuli Road	P.M.				
10	Lahaina Bypass Highway &	A.M.		Constructed in Future		
	Leiali'i Parkway	P.M.				

Notes:

* Delay indicates average stopped delay per vehicle in seconds for signalized intersections. The vehicular delay for critical movements is reported for stop-controlled intersections.

** Indicates oversaturated conditions. Delay cannot be calculated.

NC = Not Calculated

[a] Intersection is controlled by stop signs on the minor approach.

CHAPTER 3. FUTURE TRAFFIC PROJECTIONS

To evaluate the potential impact of traffic generated by the proposed project on the surrounding street system, it was necessary to develop estimates of future traffic conditions in the area both with and without the project. Future traffic conditions without the proposed project reflect traffic increases due to general regional growth and development, as well as traffic increases generated by other specific developments near the project site. These conditions are referred to as the cumulative base condition (i.e., no project conditions). The sum of the cumulative base and project-generated traffic represents the cumulative plus project conditions. Development of these future traffic scenarios is described in this chapter.

CUMULATIVE BASE TRAFFIC PROJECTIONS

The cumulative base traffic projections include two elements: 1) growth in the existing background traffic volumes reflecting the effects of overall regional growth and development in and around the study area, referred to as ambient growth, and 2) traffic generated by specific cumulative projects located in or near the study area.

Areawide Traffic Growth and Cumulative Development Projects

In a traffic study prepared for a project in this area (*Traffic Impact Report for the Kahoma Residential Development* [Wilson Okamoto Corporation, October 2007]), average daily traffic estimates were increased at an average rate of 1.6% per year. That estimate was based on data provided in the 1997 Maui Long Range Land Transportation Plan (MLRLTP) and is consistent with the ambient growth rate identified in other traffic impact analysis reports for projects in this area. A review of available Hawaii Department of Transportation (HDOT) Traffic Station Maps traffic volume data from 1999 to 2008 in the Lahaina area reveals average annual growth rates of 1.8% for daily traffic, 1.1% for PM peak hour traffic, and 3.3% for AM peak hour traffic. This data generally corroborates the annual ambient growth rate provided in the MLRLTP. Application of the 1.6% annual growth rate in the MLRLTP leads to estimated traffic growth of 29% from 2010 to 2028, and 42% through 2036. Because future volumes in the vicinity will be distributed between both Honoapi'ilani Highway and the Lahaina Bypass Highway, the total traffic growth applied to the existing volumes at locations along Honoapi'ilani Highway includes the volumes along the Lahaina Bypass Highway. The 29% and 42% growth rate was not applied uniformly to each movement at the analyzed intersections; rather, the ambient growth rate is reflected in the intersection volume totals in the 2028 and 2036 cumulative base conditions relative to existing conditions.

Information was obtained on approved and planned development projects throughout West Maui and was used to estimate future traffic growth from the anticipated projects in the Lahaina area that could affect conditions on the streets near the project now under study. Table 4 includes available project description information of the cumulative projects in the vicinity.

The overall level of increase in traffic in the area (29% or 42% above the existing level, for 2028 and 2036, respectively) was compared with the estimated trip generation of known cumulative development projects to develop estimates of total traffic growth in the vicinity. To the extent that the cumulative development projections resulted in traffic growth of more than 1.6% per year on a particular turning movement at any analyzed intersection, they were used in the forecasts of future traffic volumes at the analyzed locations.

Estimated trips from the related projects were assigned to the roadway system based on their locations and anticipated distribution patterns. The geographic distribution of traffic generated by new developments depends on several factors, such as the type and density of the proposed land uses, the geographic distribution of the population from which employees and/or patrons may be drawn, the geographic distribution of activity centers (employment, commercial, and other) to which residents of proposed

TABLE 4
WEST MAUI CUMULATIVE PROJECTS LIST

ID	Project Name
1	Honokawai - DHHL
2	Lahaina Infill Weinberg
3	Mahinahina - Pulelehua
4	Pu'unoa
5	Ka'anapali Coffee Farms
6	Ka'anapali Residences Landtech Parcel
7	Kapalua Mauka Residential
8	Lanikeha Ka'anapali
9	Pailolo Place
10	Villages of Leiali'i Ph. 1B
11	West Maui Breakers
12	West Maui Village
13	Makila Rural Service Center
14	Makila Rural Lots
15	Ukumehame Homes
16	Pu'ukoli'i Villages
17	Kahoma Lots
18	Kahoma Resident Housing
19	Napilihau Mauka Residences
20	Pineapple Ridge
21	Waine'e Residential Community
22	Olowalu Ekolu
23	Ka'anapali Town
24	Olowalu Mauka & Makai Plan

residential projects may be drawn, and the location of those developments in relation to the surrounding street system.

The resulting cumulative base traffic volumes, representing future conditions without the project for year 2028 and 2036, are presented in Figures 8 and 9, respectively. These future projections take into account the estimated overall growth in the surrounding area without the addition of traffic generated by the proposed Villages of Leiali'i Affordable Housing project.

Baseline Street System Improvements

Discussions were held with County and State agency staff regarding the roadway improvements in or near the study area planned for completion by 2028. These improvements, whether the result of local capital improvement programs or in connection with planned or approved projects, would result in dramatically improved mobility options for residents and visitors and capacity changes at various locations throughout the study area as discussed below.

The initial phase of the Lahaina Bypass Highway is now under construction in the study area. For future intersections, lane configurations and traffic control were based on review of planning documents related to the Lahaina Bypass Highway and the proposed Villages of Leiali'i Affordable Housing project. The following sources were also used as reference for relevant information pertaining to future street improvements:

- *Maui Long Range Land Transportation Plan* (State of Hawaii Department of Transportation, 1997)
- *Lahaina Traffic Circulation Plan* (State of Hawaii Department of Transportation, 1991)
- *Joint State/County Maui Interim Transportation Plan* (HDOT, 2002)
- *Draft Maui Island General Plan 2030* (County of Maui Planning Department, 2009)

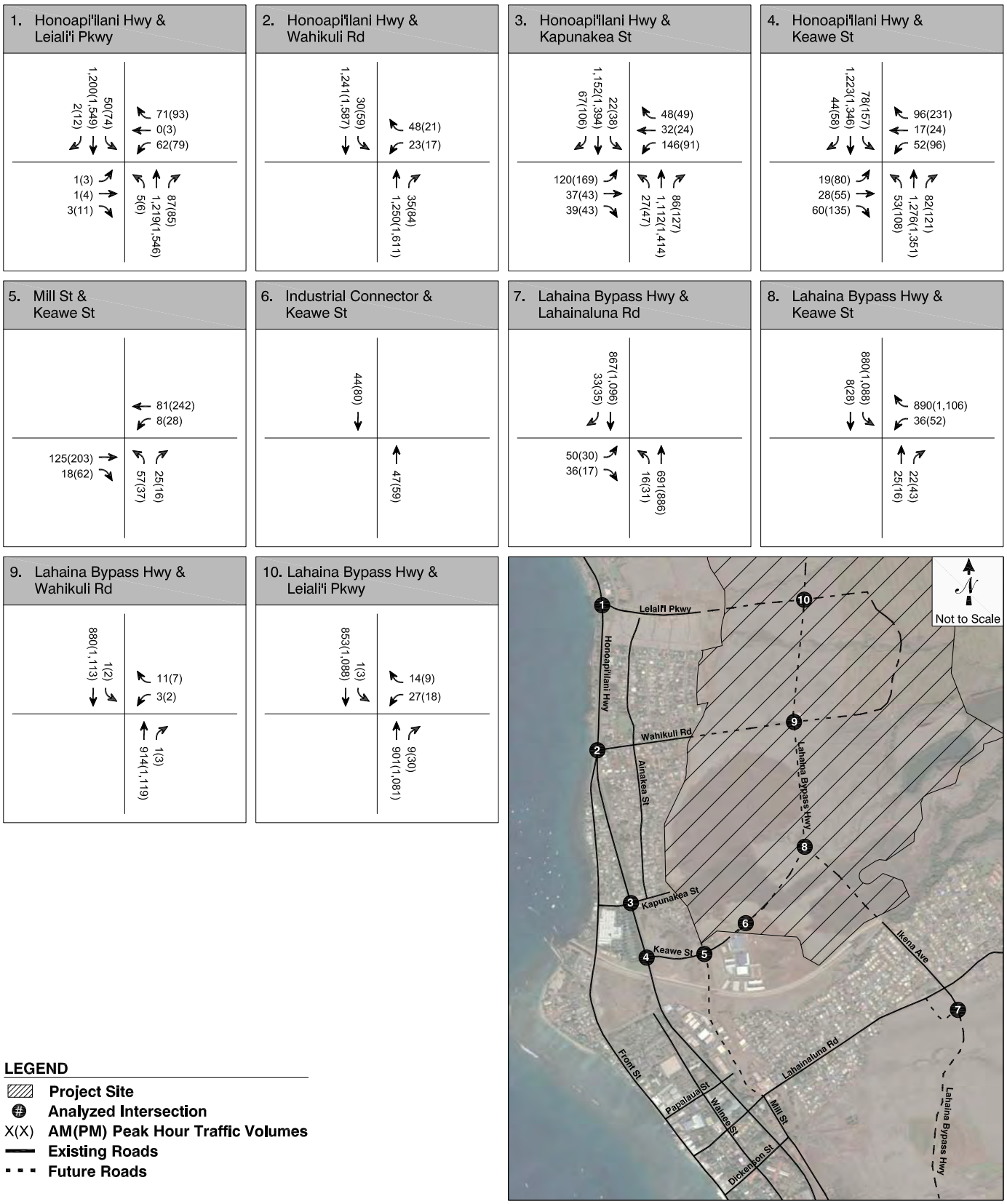
Based on the information received from agency staff, the proposed transportation system changes that are projected to occur between 2010 and 2028 are included in the cumulative base traffic network. The improvements are listed in detail below and illustrated in Figure 22 in Chapter 4:

- Lahaina Bypass Highway – This new major arterial roadway will extend between Launiupoko south of Lahaina and Honokowai to the north. Two lanes will be provided in each direction, and left-turn lanes and traffic signals will be provided at key intersections, including several future study intersections (discussed below).

- Mill Street – This alignment exists in the form of a dirt road between Lahainaluna Road and beyond Keawe Street. This section will be improved and built as a new collector street, and the section south of Lahainaluna Road to Dickenson Street will be improved.

- Honoapi'ilani Highway (SR 30) & Keawe Street – This intersection will be reconfigured from one right-turn lane and one shared through/left-turn lane on both the eastbound and westbound approaches to include one left-turn lane and one shared through/right-turn lane on the eastbound approach and one left-turn lane, one through lane, and one right-turn lane on the westbound approach.

- Keawe Street & Mill Street – This side street stop-controlled intersection will be constructed in the future and will consist of a northbound approach including a left-turn lane and right-turn lane, an eastbound approach including one through lane and one shared through/right-turn lane, and westbound approach including one left-turn lane and two through lanes.



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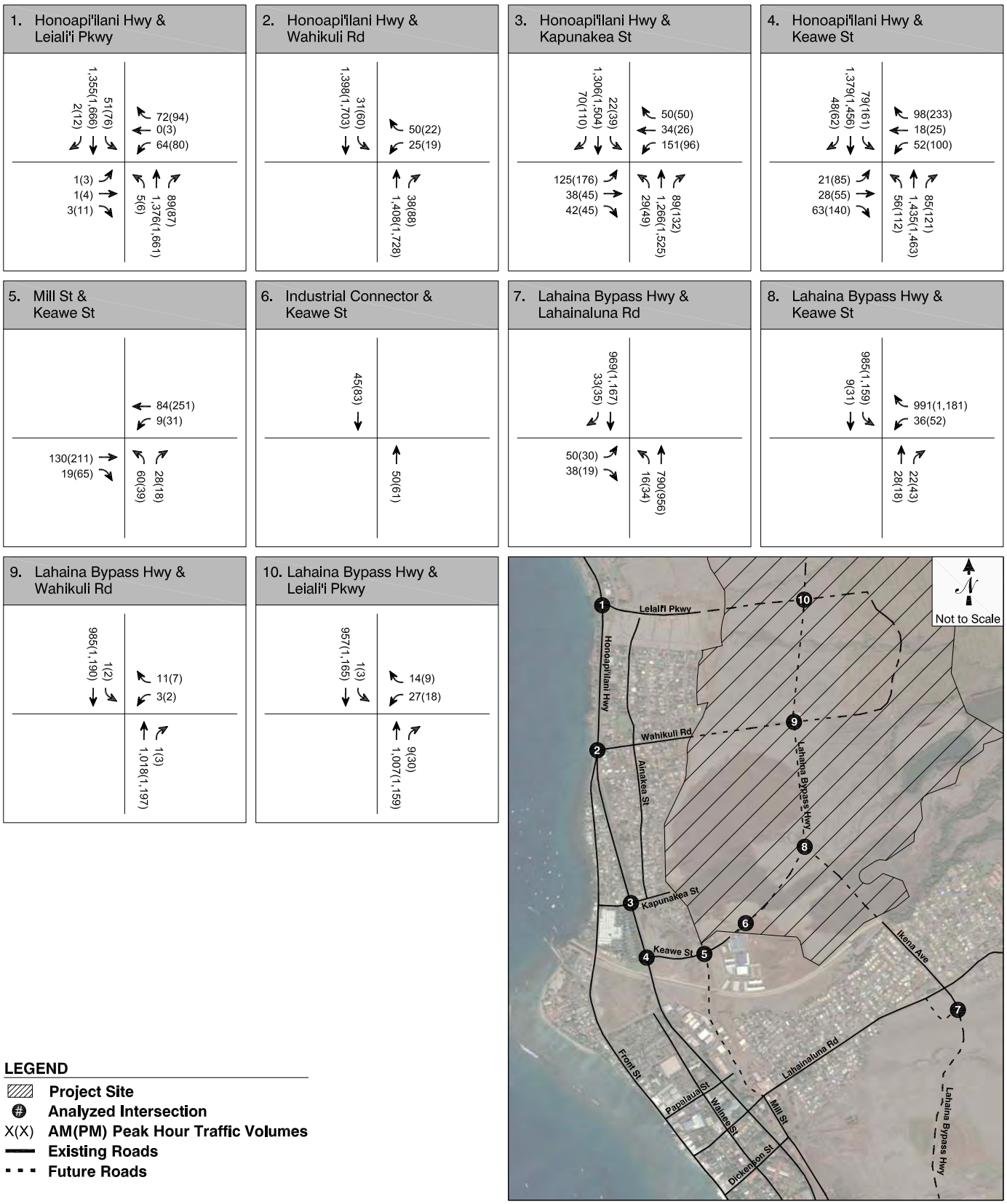
CUMULATIVE BASE (2028)
PEAK HOUR TRAFFIC VOLUMES

FIGURE 8



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CUMULATIVE BASE (2036)
PEAK HOUR TRAFFIC VOLUMES

FIGURE 9

- Lahaina Bypass Highway & Lahainaluna Road Connector – The Lahaina Bypass Highway will be grade-separated at Lahainaluna Road, with a short roadway providing a connection for traffic between the two roads and a northbound on-ramp to the Lahaina Bypass Highway from Lahainaluna Road. The analyzed intersection lies on the Lahaina Bypass Highway where the connecting road joins it. This intersection will consist of a northbound approach that provides one left-turn lane and two through lanes, a southbound approach that provides one right-turn lane and two through lanes, and one eastbound approach consisting of one left-turn lane and one right-turn lane.

- Lahaina Bypass Highway & Keawe Street – This future signalized intersection will consist of a northbound approach that provides one through lane and one right-turn lane, a southbound approach that provides one through lane and two left-turn lanes, and a westbound approach including two free right-turn lanes and one left-turn lane, which will be controlled by the traffic signal. The initial phase of this portion of the Lahaina Bypass Highway is currently under construction.

- Lahaina Bypass Highway & Wahikuli Road – This future side-street stop-controlled intersection will consist of a northbound approach that provides one through lane, and one shared through/right-turn lane, a southbound approach that provides one left-turn lane and two through lanes, and a westbound approach that provides one left-turn lane and one right-turn lane. This intersection is assumed to be constructed under cumulative base conditions, as it would provide access to a cumulative development project mauka of the Lahaina Bypass Highway, with the westbound approach stop-controlled.

- Lahaina Bypass Highway & Leiali`i Parkway – This future side-street stop-controlled intersection will consist of a northbound approach that provides one through lane, and one shared through/right-turn lane, a southbound approach that provides one left-turn lane and two through lanes, and a westbound approach that provides one left-turn lane and one right-turn lane. This intersection is assumed to be constructed under cumulative base conditions, as it would provide access to a cumulative development project mauka of the Lahaina Bypass Highway, with the westbound approach stop-controlled.

Cumulative Base Traffic Volumes

Forecasts of cumulative base traffic volumes were developed by adding the total projected traffic growth to the existing volumes and distributing it over the future street network. Estimated traffic shifts for the horizon year due to the Bypass Highway were developed based on field observations, previous reports, the future transportation network, and current and future land use patterns. Approximately 40% of the future through traffic in the area is expected to use the Lahaina Bypass Highway instead of Honoapi`ilani Highway. The resulting projected traffic volumes at the analyzed intersections, illustrated in Figures 8 and 9, represent the 2028 and 2036 cumulative base conditions (i.e., future conditions without the project), respectively.

PROJECT TRAFFIC PROJECTIONS

Development of future traffic projections for the proposed project involved a three-step process. This process included the estimation of project trip generation, trip distribution, and trip assignment.

Project Street System Improvements

Based on the information received from agency staff and review of the proposed street network, the proposed transportation system changes described above are anticipated to occur between 2010 and 2028/2036 and are therefore included in the cumulative base traffic network. Additional improvements will be made as part of the proposed project and are listed in detail below and illustrated Figure 22 in Chapter 4:

- Keawe Street & Mill Street – This side street stop-controlled intersection will be a three-legged intersection under cumulative base conditions. The fourth leg will be constructed as part of the project, resulting in north and southbound approaches including a left-turn lane and shared through/right-turn lane and east and westbound approaches including one left-turn lane, one through lane, and one shared through/right-turn lane.

- Keawe Street & Phase A Connection to Industrial Area – This future intersection will be constructed as part of the proposed project. It is assumed to be configured as a side street stop-controlled intersection with eastbound and westbound approaches that provide one left-turn lane and one shared through/right-turn lane and north and southbound approaches that provide one left-turn lane, one through lane, and one shared through/right-turn lane.

- Lahaina Bypass Highway & Wahikuli Road – This side street stop-controlled intersection will be a three-legged intersection under cumulative base conditions and the fourth (eastbound) leg will be constructed as part of the project. It is assumed that the eastbound approach will be configured with a left-turn lane and a shared through/right-turn lane, similar to the assumed future westbound approach. This will result in northbound and southbound approaches with one left-turn lane, one through lane, and one shared through/right-turn lane, and eastbound and westbound approaches as described.

- Lahaina Bypass Highway & Leiali`i Parkway – This side street stop-controlled intersection will be a three-legged intersection under cumulative base conditions, and the fourth (eastbound) leg will be constructed as part of the project. It is assumed that the eastbound approach will be configured with a left-turn lane and a shared through/right-turn lane, similar to the assumed future westbound approach. This will result in northbound and southbound approaches with one left-turn lane, one through lane, and one shared through/right-turn lane, and eastbound and westbound approaches as described.

Project Trip Generation

Vehicle trip rates presented in *Trip Generation 8th Edition* (Institute of Transportation Engineers, 2008) were used to estimate number of trips to and from the proposed project. The trip generation rates used in this study and the estimated new numbers of trips generated by the proposed project Concepts 1, 2 and 3 are summarized in Tables 5, 6, and 7, respectively.

Project trip generation estimates are commonly developed using Institute of Transportation Engineers (ITE) rates. However, ITE rates are typically obtained from isolated, suburban developments generally not sensitive to the trip-making characteristics of mixed-use developments such as the proposed project. In fact, few methodologies are available to estimate the unique trip generation characteristics of mixed-use and infill developments. One of the most commonly used methods is to use trip generation rates or equations from *Trip Generation* and apply reductions from the mixed-use internalization spreadsheet from *Trip Generation Handbook, 2nd Edition* (ITE, 2004). This method has some shortcomings in that it is based on a limited sample of six mixed-use sites in Florida, it is limited to three land use types (residential, retail, and office), and it does not take into account the influence of nearby land uses.

TABLE 5
TRIP GENERATION ESTIMATES
VILLAGES OF LEIALI'I AFFORDABLE HOUSING MASTER PLAN
CONCEPT 1 [a]

Land Use	ITE#	Rate	Daily	AM Peak Hour			PM Peak Hour		
				In	Out	Total	In	Out	Total
Trips Generation Rates [b]									
Single-Family Housing	210	per Dwelling Unit [1]	[c]	25%	75%	[c]	63%	37%	[c]
Apartments	220	per Dwelling Unit [1]	[c]	20%	80%	[c]	65%	35%	[c]
Office	710	per 1,000 square feet [2]	[c]	88%	12%	[c]	17%	83%	[c]
Retail	820	per 1,000 square feet [2]	[c]	61%	39%	[c]	49%	51%	[c]
Light Industrial	110	per 1,000 square feet [2]	6.97	88%	12%	[c]	12%	88%	[c]
Elementary School	520	per student	1.29	55%	45%	0.45	49%	51%	0.15

Land Use	ITE#	Size	Daily	AM Peak Hour			PM Peak Hour		
				In	Out	Total	In	Out	Total
Phase A									
Single-Family Housing	210	613 DU	5,513	110	329	439	338	199	537
Apartments	220	788 DU	4,899	78	312	390	293	158	451
Office	710	101.9 ksf	1,354	167	23	190	33	160	193
Retail	820	449.1 ksf	18,029	228	146	374	835	905	1,740
Light Industrial	110	749.2 ksf	5,222	700	95	795	110	804	914
Elementary School	520	600 students	774	149	121	270	44	46	90
Less: Internal Capture 20% [d]			*(7,169)*	*(286)*	*(205)*	*(492)*	*(331)*	*(455)*	*(785)*
SUBTOTAL (PHASE A)			*28,678*	*1,146*	*821*	*1,966*	*1,323*	*1,818*	*3,141*
Phase B									
Single Family Housing	210	1,522 DU	12,728	269	806	1,075	767	451	1,218
Elementary School	520	450 students	581	112	91	203	33	35	68
Less: Internal Capture 20% [d]			*(2,671)*	*(76)*	*(179)*	*(256)*	*(160)*	*(97)*	*(257)*
SUBTOTAL (PHASE B)			*10,683*	*305*	*718*	*1,022*	*640*	*390*	*1,030*
Net New Trips			**39,361**	**1,451**	**1,539**	**2,988**	**1,963**	**2,208**	**4,171**

Notes:
[1] Dwelling Unit = DU
[2] 1,000 square feet = ksf
[a] Source: *Villages of Leiali'i Affordable Housing Master Plan, Hawaii* by Belt Collins Hawaii Ltd. (December 2009)
[b] Source: *ITE Trip Generation Manual, 8th Edition, 2008.*
[c] Fitted curve equations were used to derive AM peak hour, PM peak hour, and daily trip generation.
[d] Internal trip capture estimated at 20%. MXD process estimates peak hour internalization at 21% to 24%.

TABLE 6
TRIP GENERATION ESTIMATES
VILLAGES OF LEIALI'I AFFORDABLE HOUSING MASTER PLAN
CONCEPT 2 [a]

Land Use	ITE#	Rate	Daily	AM Peak Hour			PM Peak Hour		
				In	Out	Total	In	Out	Total
Trips Generation Rates [b]									
Single-Family Housing	210	per Dwelling Unit [1]	[c]	25%	75%	[c]	63%	37%	[c]
Apartments	220	per Dwelling Unit [1]	[c]	20%	80%	[c]	65%	35%	[c]
Office	710	per 1,000 square feet [2]	[c]	88%	12%	[c]	17%	83%	[c]
Retail	820	per 1,000 square feet [2]	[c]	61%	39%	[c]	49%	51%	[c]
Light Industrial	110	per 1,000 square feet [2]	6.97	88%	12%	[c]	12%	88%	[c]
Elementary School	520	per student	1.29	55%	45%	0.45	49%	51%	0.15

Land Use	ITE#	Size	Daily	AM Peak Hour			PM Peak Hour		
				In	Out	Total	In	Out	Total
Phase A									
Apartments	220	2,521 DU	15,401	248	991	1,239	913	491	1,404
Office	710	101.9 ksf	1,354	167	23	190	33	160	193
Retail	820	449.1 ksf	18,029	228	146	374	835	905	1,740
Light Industrial	110	749.2 ksf	5,222	700	95	795	110	804	914
Elementary School	520	600 students	774	149	121	270	44	46	90
Less: Internal Capture 20% [d]			*(8,167)*	*(298)*	*(275)*	*(574)*	*(387)*	*(481)*	*(868)*
SUBTOTAL (PHASE A)			*32,669*	*1,194*	*1,101*	*2,294*	*1,548*	*1,925*	*3,474*
Phase B									
Single Family Housing	210	1,522 DU	12,728	269	806	1,075	767	451	1,218
Elementary School	520	450 students	581	112	91	203	33	35	68
Less: Internal Capture 20% [d]			*(2,671)*	*(76)*	*(179)*	*(256)*	*(160)*	*(97)*	*(257)*
SUBTOTAL (PHASE B)			*10,683*	*305*	*718*	*1,022*	*640*	*390*	*1,030*
Net New Trips			**43,352**	**1,499**	**1,819**	**3,316**	**2,188**	**2,315**	**4,504**

Notes:
[1] Dwelling Unit = DU
[2] 1,000 square feet = ksf
[a] Source: *Villages of Leiali'i Affordable Housing Master Plan, Hawaii* by Belt Collins Hawaii Ltd. (December 2009)
[b] Source: *ITE Trip Generation Manual, 8th Edition, 2008.*
[c] Fitted curve equations were used to derive AM peak hour, PM peak hour, and daily trip generation.
[d] Internal trip capture estimated at 20%. MXD process estimates peak hour internalization at 21% to 24%.

TABLE 7
TRIP GENERATION ESTIMATES
VILLAGES OF LEIALI'I AFFORDABLE HOUSING MASTER PLAN
CONCEPT 3 [a]

Land Use	ITE#	Rate	Daily	AM Peak Hour			PM Peak Hour		
				In	Out	Total	In	Out	Total
Trips Generation Rates [b]									
Single-Family Housing	210	per Dwelling Unit [1]	[c]	25%	75%	[c]	63%	37%	[c]
Apartments	220	per Dwelling Unit [1]	[c]	20%	80%	[c]	65%	35%	[c]
Office	710	per 1,000 square feet [2]	[c]	88%	12%	[c]	17%	83%	[c]
Retail	820	per 1,000 square feet [2]	[c]	61%	39%	[c]	49%	51%	[c]
Light Industrial	110	per 1,000 square feet [2]	6.97	88%	12%	[c]	12%	88%	[c]
Elementary School	520	per student	1.29	55%	45%	0.45	49%	51%	0.15

Land Use	ITE#	Size	Daily	AM Peak Hour			PM Peak Hour		
				In	Out	Total	In	Out	Total
Phase A									
Single-Family Housing	210	532 DU	4,839	96	286	382	298	175	473
Apartments	220	2,069 DU	12,662	204	814	1,018	751	405	1,156
Office	710	143.3 ksf	1,760	220	30	250	41	198	239
Retail	820	452.7 ksf	18,122	229	146	375	840	910	1,750
Light Industrial	110	950.5 ksf	6,625	908	124	1,032	144	1,058	1,202
Elementary School	520	600 students	774	149	121	270	44	46	90
Less: Internal Capture 20% [d]			*(8,966)*	*(361)*	*(304)*	*(665)*	*(424)*	*(559)*	*(982)*
SUBTOTAL (PHASE A)			*35,864*	*1,445*	*1,217*	*2,662*	*1,694*	*2,234*	*3,929*
Phase B									
Single Family Housing	210	854 DU	7,480	152	456	608	456	268	724
Apartments	220	650 DU	4,063	64	258	322	244	131	375
Elementary School	520	450 students	581	112	91	203	33	35	68
Less: Internal Capture 20% [d]			*(2,433)*	*(66)*	*(161)*	*(227)*	*(147)*	*(87)*	*(234)*
SUBTOTAL (PHASE B)			*9,731*	*262*	*644*	*906*	*586*	*348*	*934*
Net New Trips			**45,595**	**1,707**	**1,861**	**3,568**	**2,280**	**2,582**	**4,863**

Notes:
[1] Dwelling Unit = DU
[2] 1,000 square feet = ksf
[a] Source: *Villages of Leiali'i Affordable Housing Master Plan, Hawaii* by Belt Collins Hawaii Ltd. (December 2009)
[b] Source: *ITE Trip Generation Manual, 8th Edition, 2008.*
[c] Fitted curve equations were used to derive AM peak hour, PM peak hour, and daily trip generation.
[d] Internal trip capture estimated at 20%. MXD process estimates peak hour internalization at 21% to 24%.

A more comprehensive analysis of mixed-use and infill trip generation was developed and is presented in the paper, *Traffic Generated by Mixed-Use Developments – A Six-Region Study Using Consistent Built Environmental Measures* (Reid Ewing et al., September 2008). This mixed-use development (MXD) approach refines traditional trip generation estimates approaches by incorporating reductions associated with the density, diversity of land uses, and design of the internal roadway system, as well as the proposed pedestrian and bicycle facilities. The study gathered data from 239 sites/data sources, developed a trip internalization methodology (MXD model), and validated the methodology at 16 sites. Among the validation sites, use of the MXD model produced superior statistical performance of estimated versus observed external vehicle trips when compared to applications of the ITE rates alone or application of the ITE rates with the ITE trip internalization technique.

Accordingly, internalization reductions at the proposed Villages of Leiali'i project were estimated using both methods. The ITE reductions ranged from 13% to 17% during the peak hours and the MXD reductions ranged from 21% to 26%. It was determined that a 20% reduction was appropriate to account for the infill and mixed-use nature of the land use plan where vehicle trips would be linked and or replaced with walk and bicycle trips to nearby land uses, as shown in Tables 5, 6, and 7.

As shown in Table 5, Concept 1 is expected to generate approximately 39,360 daily trips, including approximately 2,990 trips during the morning peak hour (1,451 inbound and 1,539 outbound) and approximately 4,170 trips during the evening peak hour (1,963 inbound and 2,208 outbound).

As shown in Table 6, Concept B is expected to generate approximately 43,352 daily trips, including approximately 3,320 trips during the morning peak hour (1,499 inbound and 1,819 outbound) and approximately 4,500 trips during the evening peak hour (2,188 inbound and 2,315 outbound).

As shown in Table 7, Concept C is expected to generate approximately 45,595 daily trips, including approximately 3,570 trips during the morning peak hour (1,707 inbound and 1,861 outbound) and approximately 4,860 trips during the evening peak hour (2,280 inbound and 2,580 outbound).

Figures 10, 11, and 12 illustrate the 2028 project generated traffic volumes for the AM and PM peak hours at each of the 10 study intersections under Concepts 1, 2, and 3, respectively. Figures 16, 17, and 18 illustrate the 2036 project-generated traffic volumes with Phase B for the AM and PM peak hours at each of the 10 study intersections under Concepts 1, 2, and 3, respectively.

Project Trip Distribution and Trip Assignment

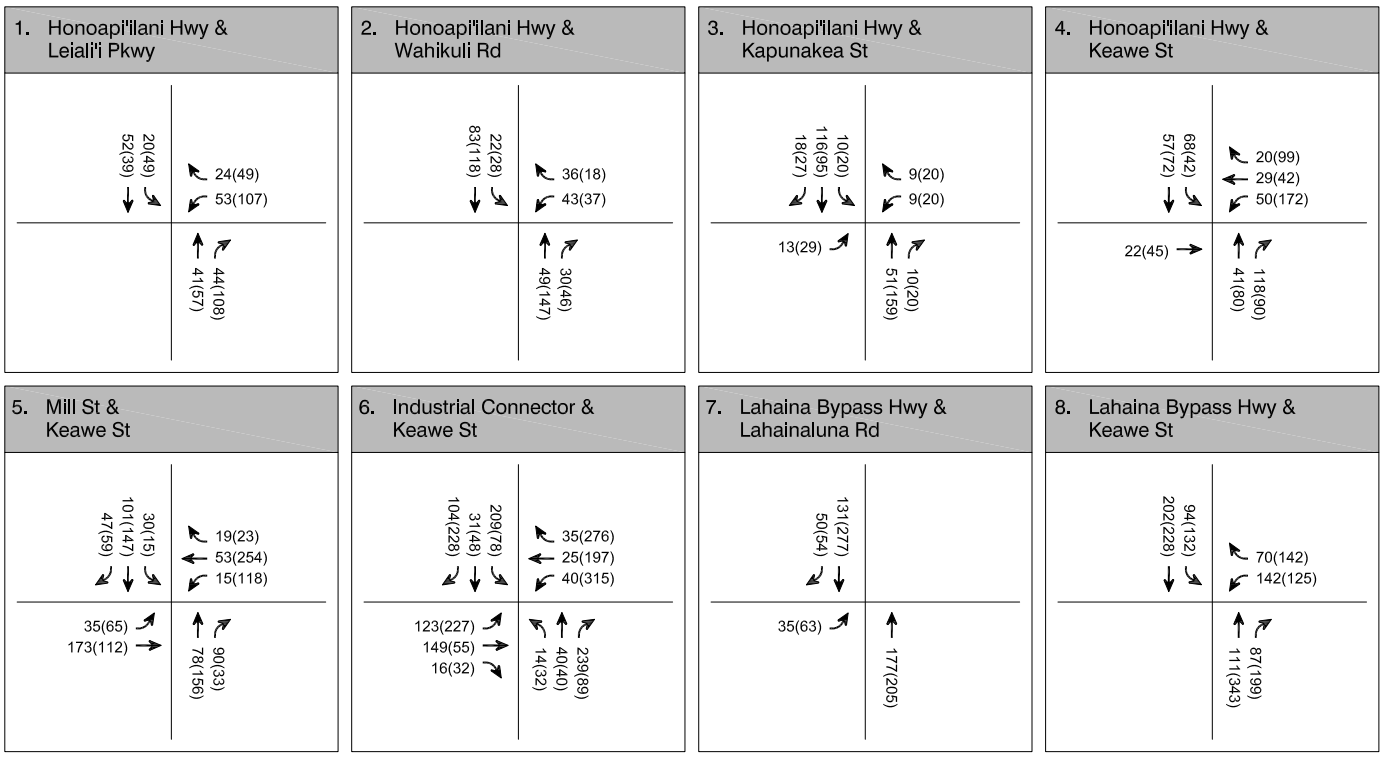
Factors considered in the development of the project trip distribution estimates include previous studies in the area, observations of actual traffic patterns, the geographic distribution of employment and commercial activity in the vicinity, proposed developments in the area, and the proposed construction of the Lahaina Bypass Highway as described in *Lahaina Bypass Modified Alignment Kahoma Stream to Keawe Street Extension* (Department of Transportation, Highways Division, State of Hawaii, March 2009). Based on these elements at this time, the following overall trip distribution pattern was estimated for the project-generated traffic:

- North 40%
- West/south (local Lahaina area) 30%
- Southeast (regional central and southern Maui) 30%

The estimated project trips were assigned to the future roadway network that will be in place by 2028 and 2036, the horizon years in which full buildout dates of Phases A and B of the proposed project are planned, respectively. As discussed, this report assumes that the Lahaina Bypass Highway would be in place to serve project-related and other traffic.

CUMULATIVE PLUS PROJECT TRAFFIC PROJECTIONS

The project-generated traffic volumes were added to the cumulative base traffic projections to develop the cumulative plus project traffic forecasts for 2028 and 2036. Figures 13, 14, and 15 illustrate the projected 2028 cumulative plus project AM and PM peak hour traffic volumes at each of the 10 study intersections. Figures 19, 20, and 21 illustrate the projected 2036 cumulative plus project AM and PM peak hour traffic volumes at each of the 10 study intersections. Figure 22 in Chapter 4 depicts the anticipated future lane configurations at each of the study intersections. At a few locations, differences in the future roadway network with the project will result in a slightly different trip assignment than under cumulative base conditions. Examples of this include the eastbound and westbound approaches of Intersections 9 and 10, where under the cumulative base conditions vehicles may only go left or right; however, with the project vehicles will also have the option of through travel. Therefore, at these locations the addition of cumulative base and project only volumes will differ slightly from the volumes shown under cumulative plus project conditions.



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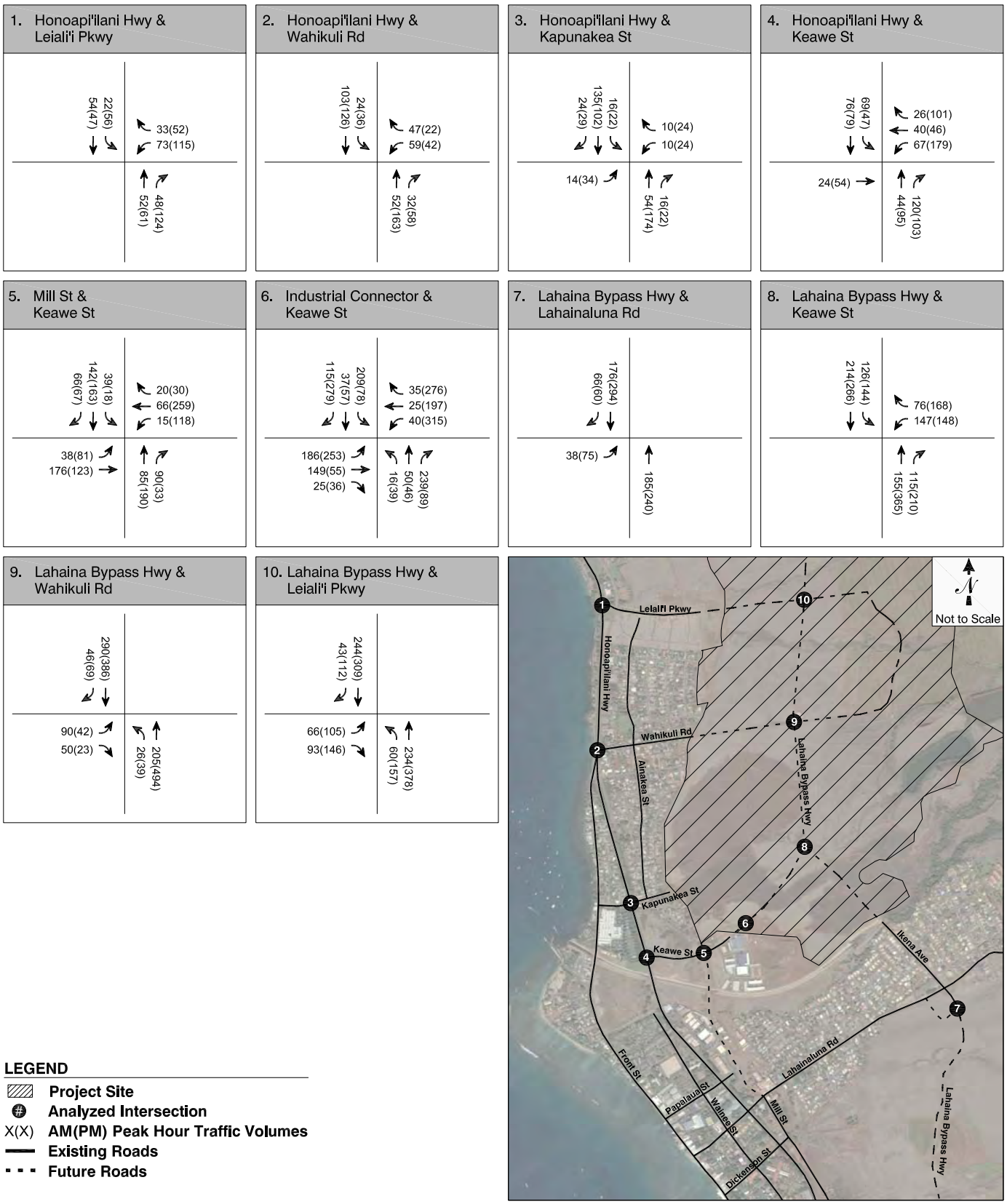
PROJECT ONLY (2028) CONCEPT 1
PEAK HOUR TRAFFIC VOLUMES

FIGURE 10



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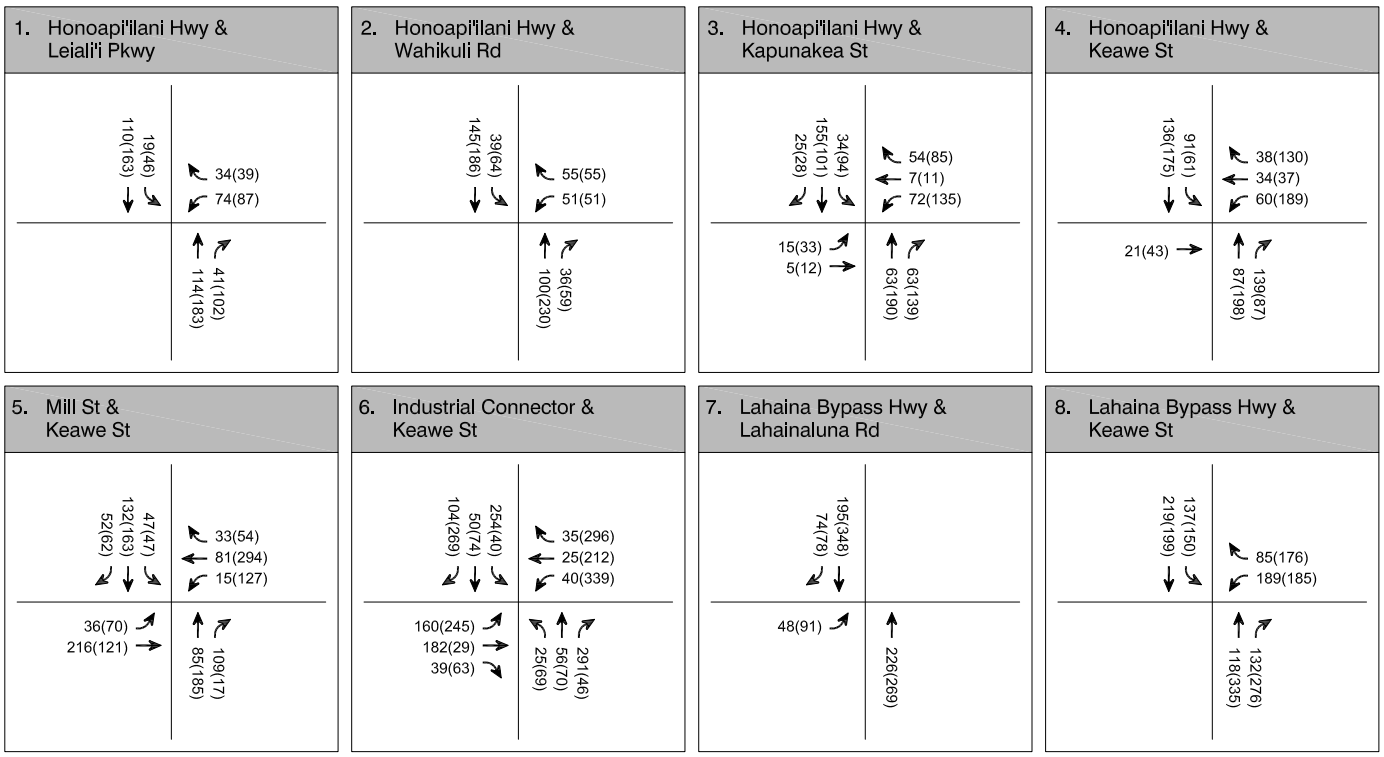
PROJECT ONLY (2028) CONCEPT 2
PEAK HOUR TRAFFIC VOLUMES

FIGURE 11



LEGEND

- Project Site
- Analyzed Intersection
- X(X) AM(PM) Peak Hour Traffic Volumes
- Existing Roads
- Future Roads

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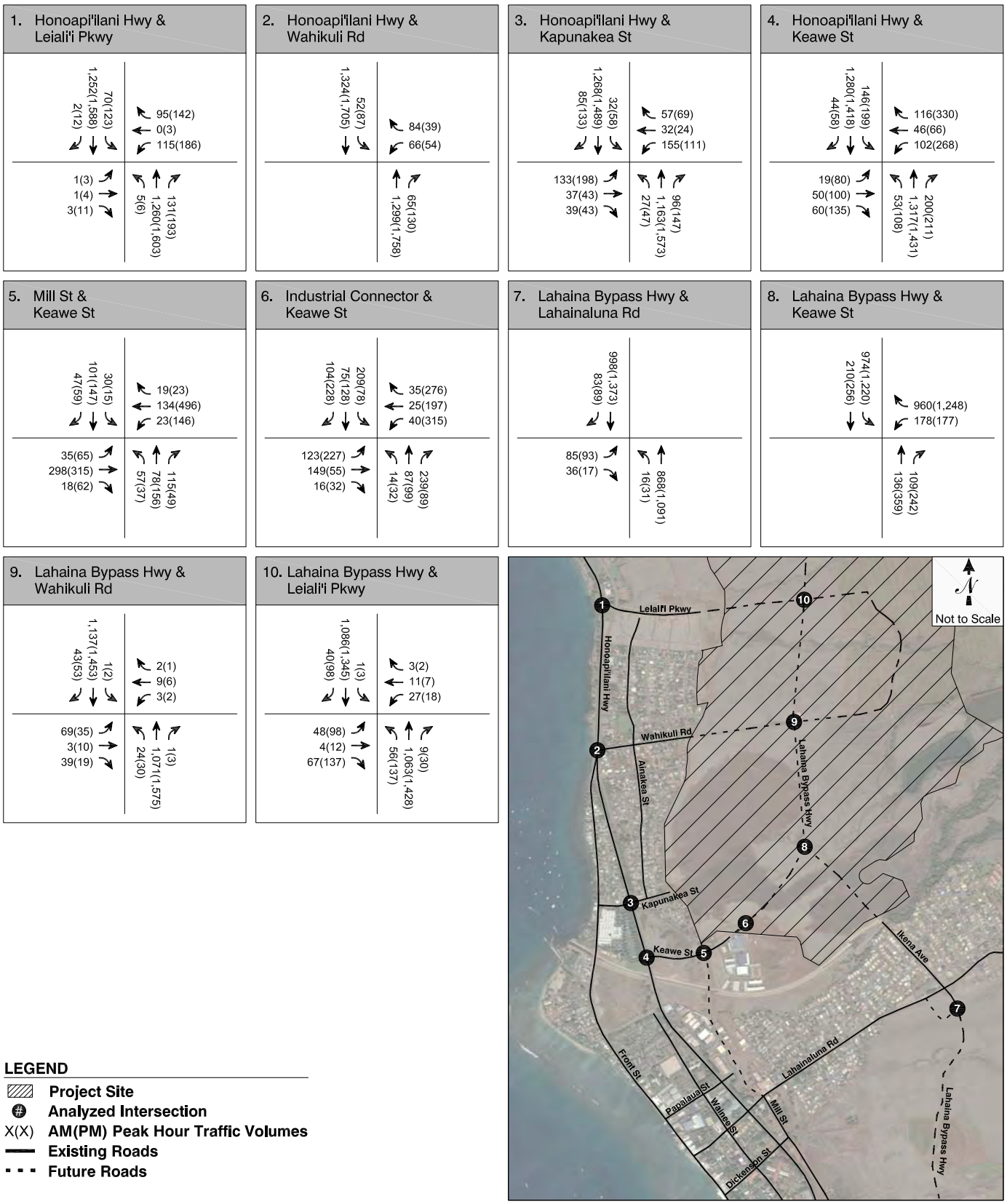
PROJECT ONLY (2028) CONCEPT 3 PEAK HOUR TRAFFIC VOLUMES

FIGURE 12



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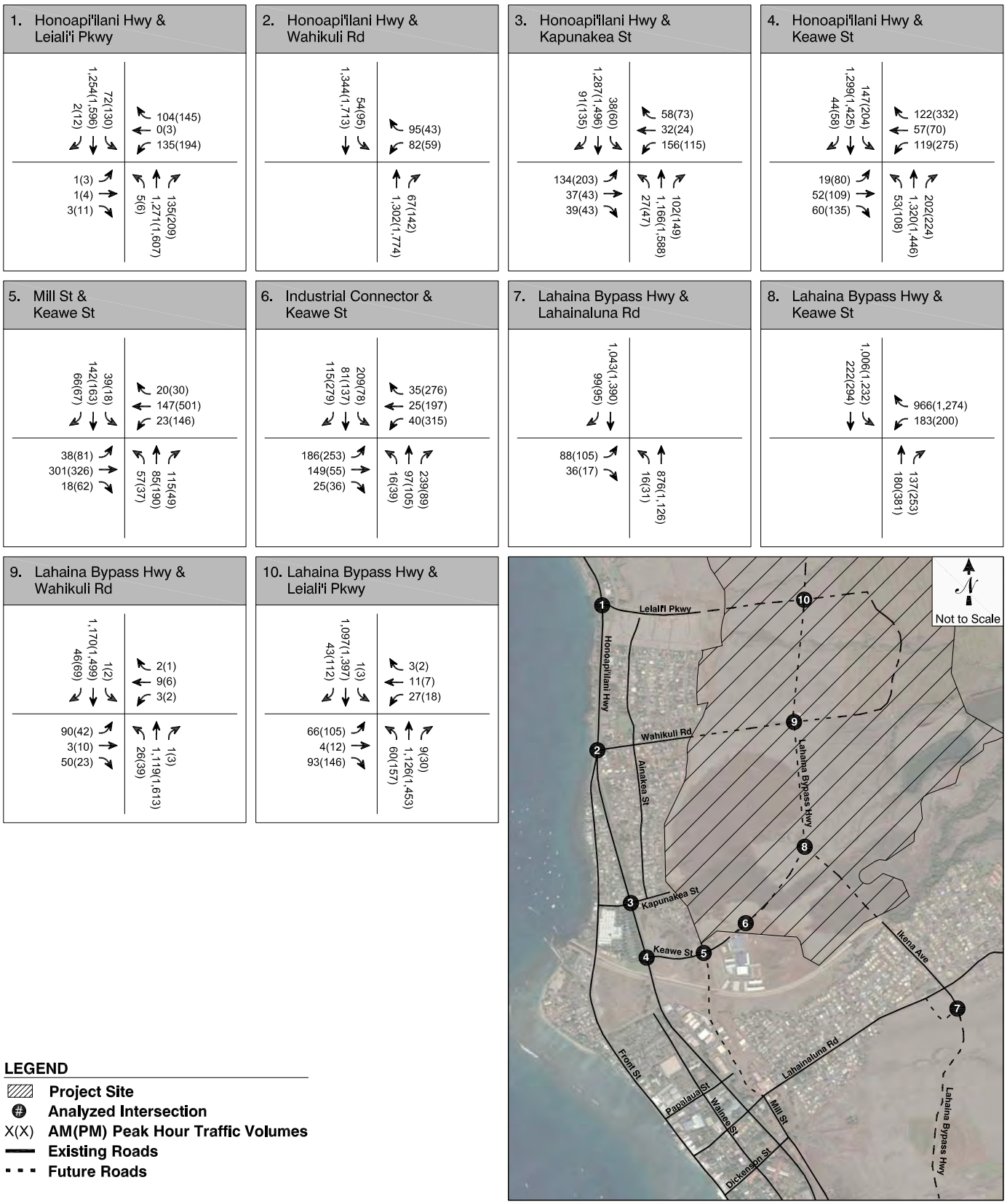
CUMULATIVE PLUS PROJECT (2028) CONCEPT 1
PEAK HOUR TRAFFIC VOLUMES

FIGURE 13



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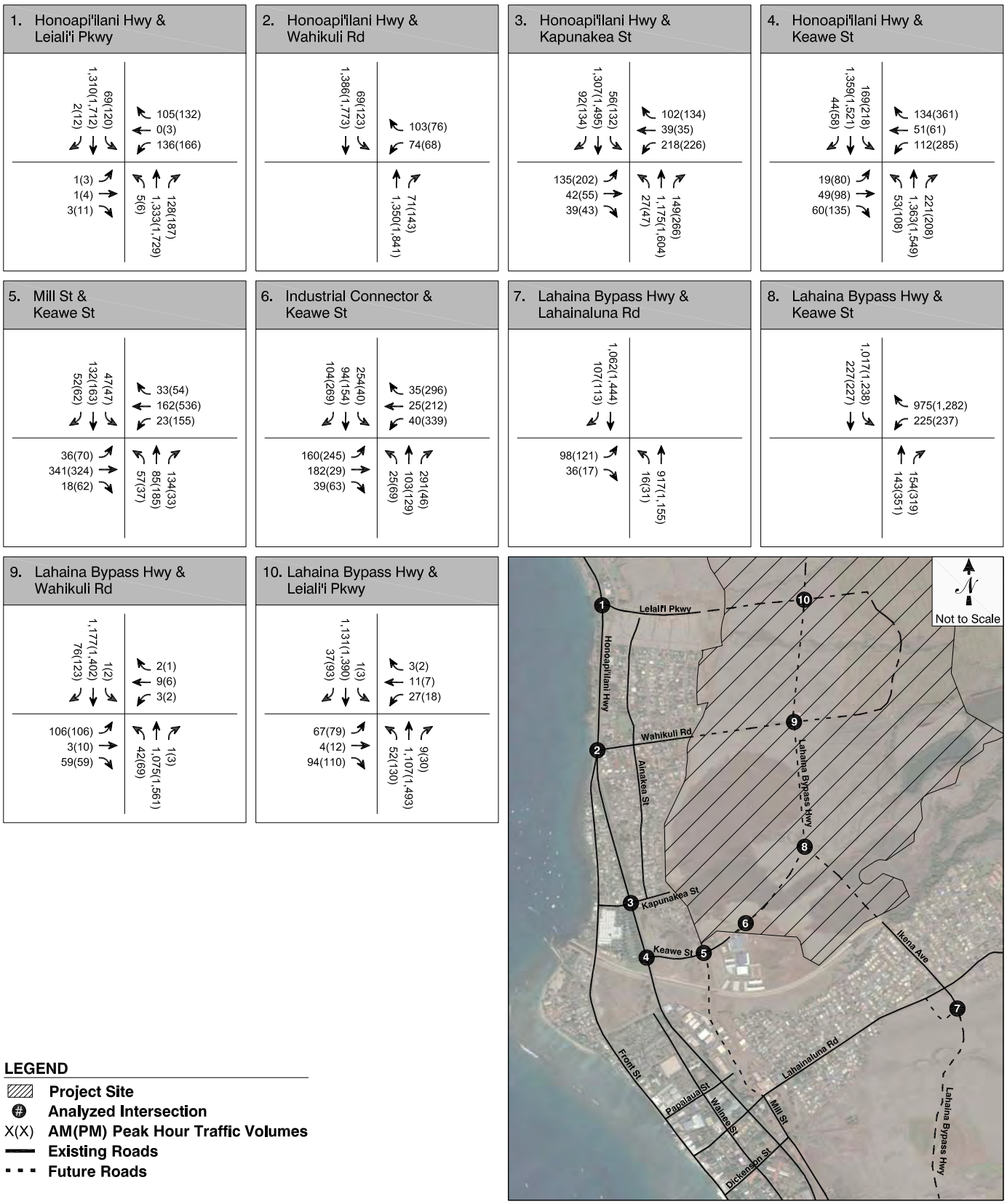
CUMULATIVE PLUS PROJECT (2028) CONCEPT 2
PEAK HOUR TRAFFIC VOLUMES

FIGURE 14



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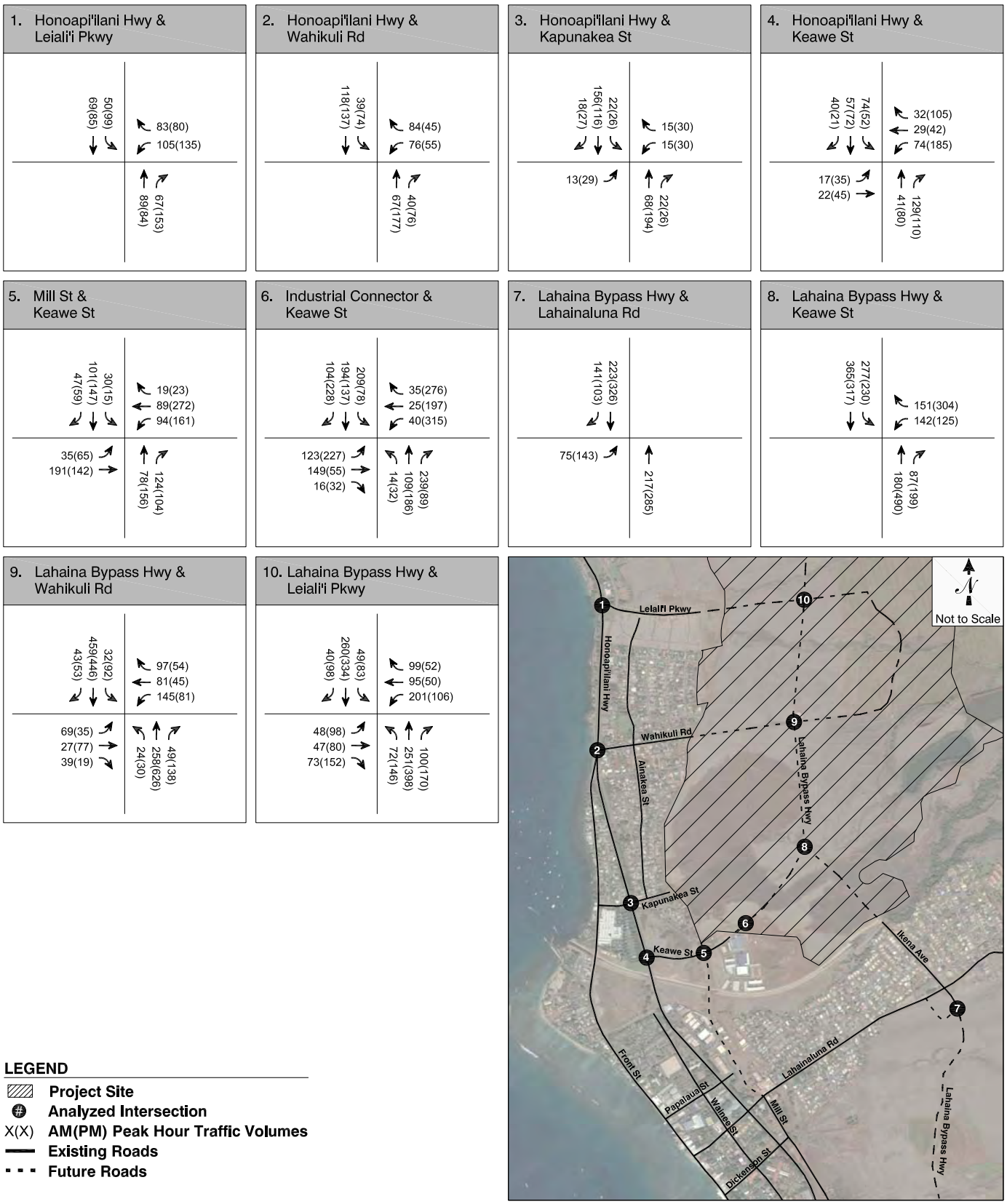
CUMULATIVE PLUS PROJECT (2028) CONCEPT 3
PEAK HOUR TRAFFIC VOLUMES

FIGURE 15



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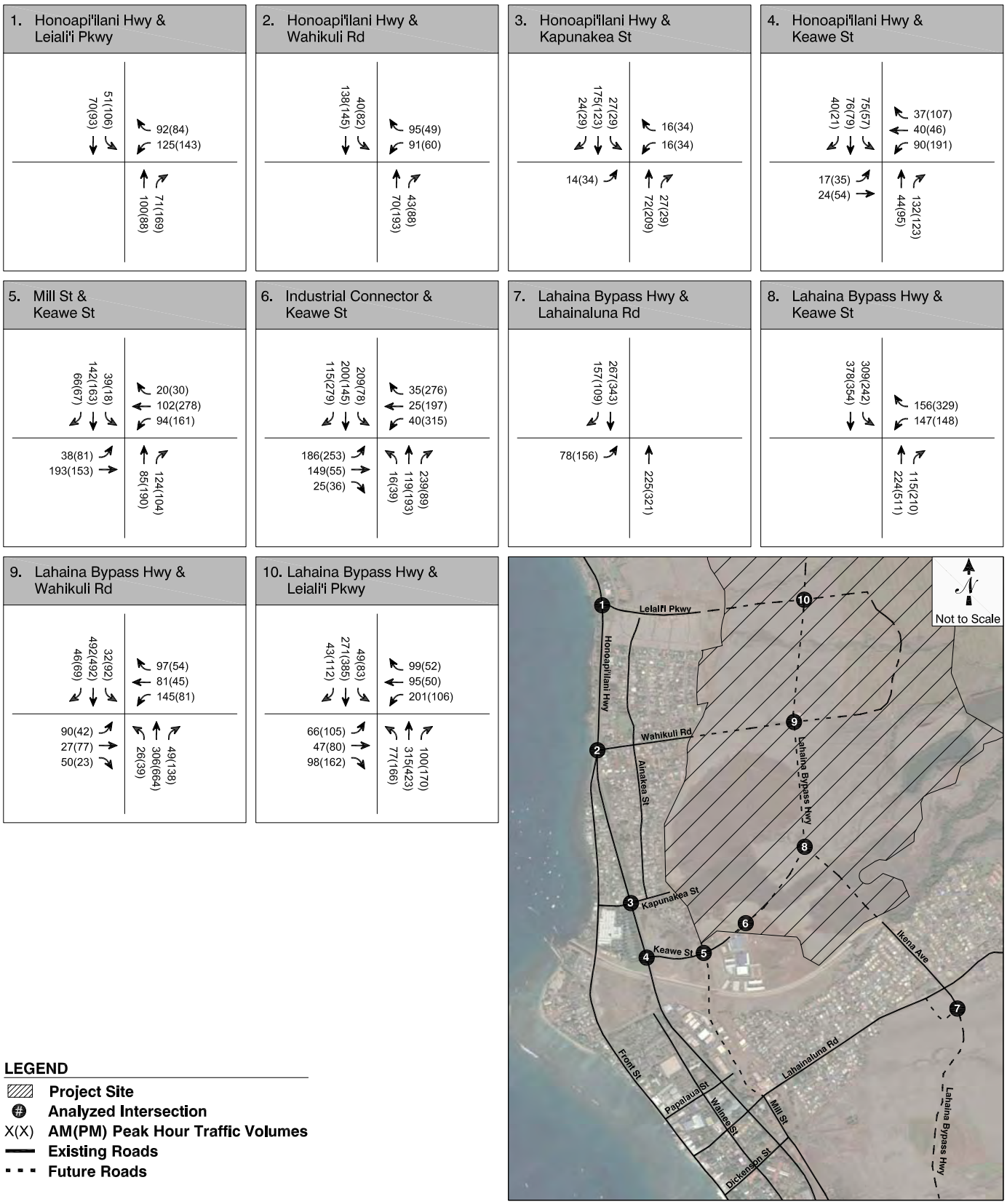
PROJECT ONLY (2036) CONCEPT 1
PEAK HOUR TRAFFIC VOLUMES

FIGURE 16



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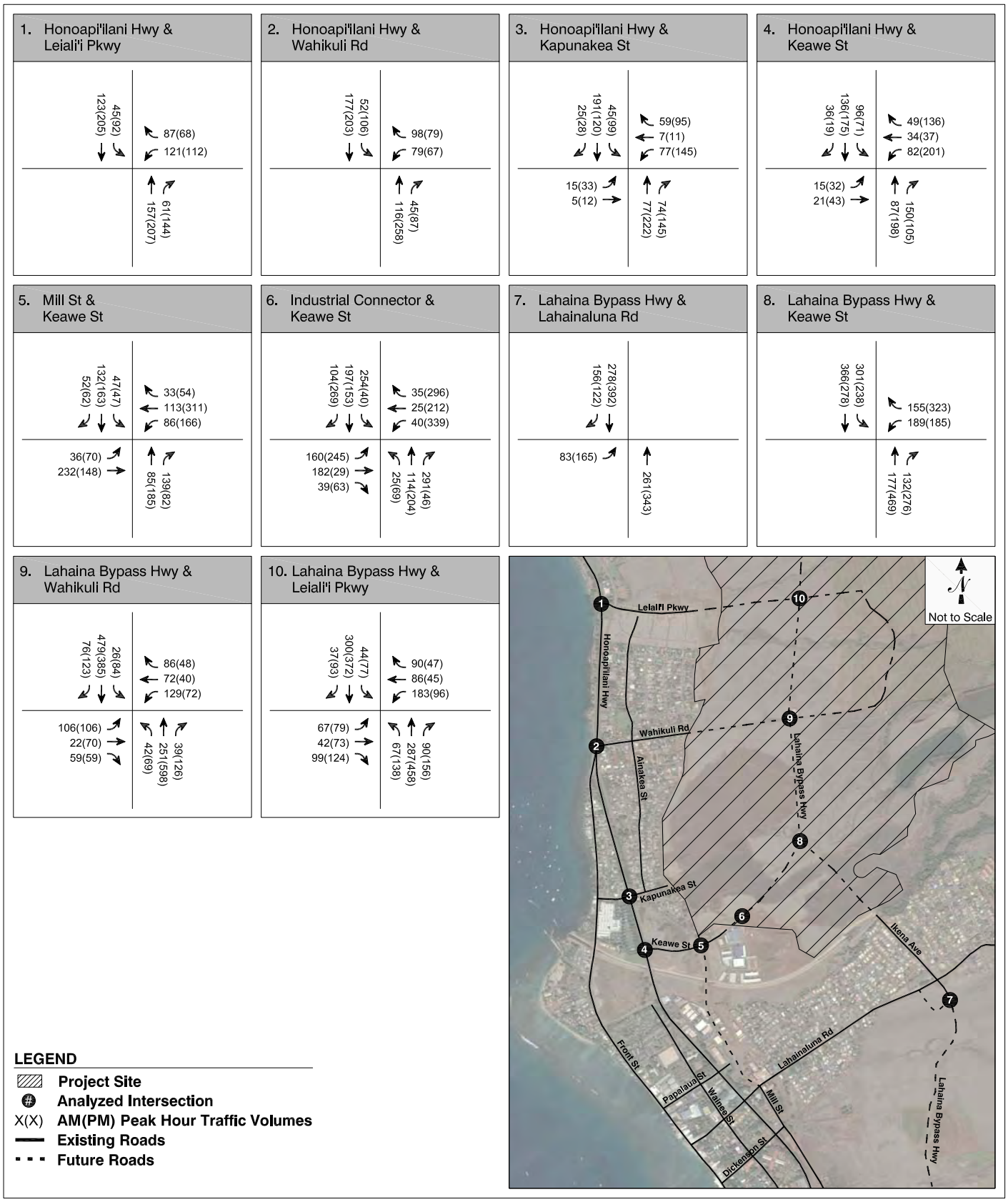
PROJECT ONLY (2036) CONCEPT 2
PEAK HOUR TRAFFIC VOLUMES

FIGURE 17



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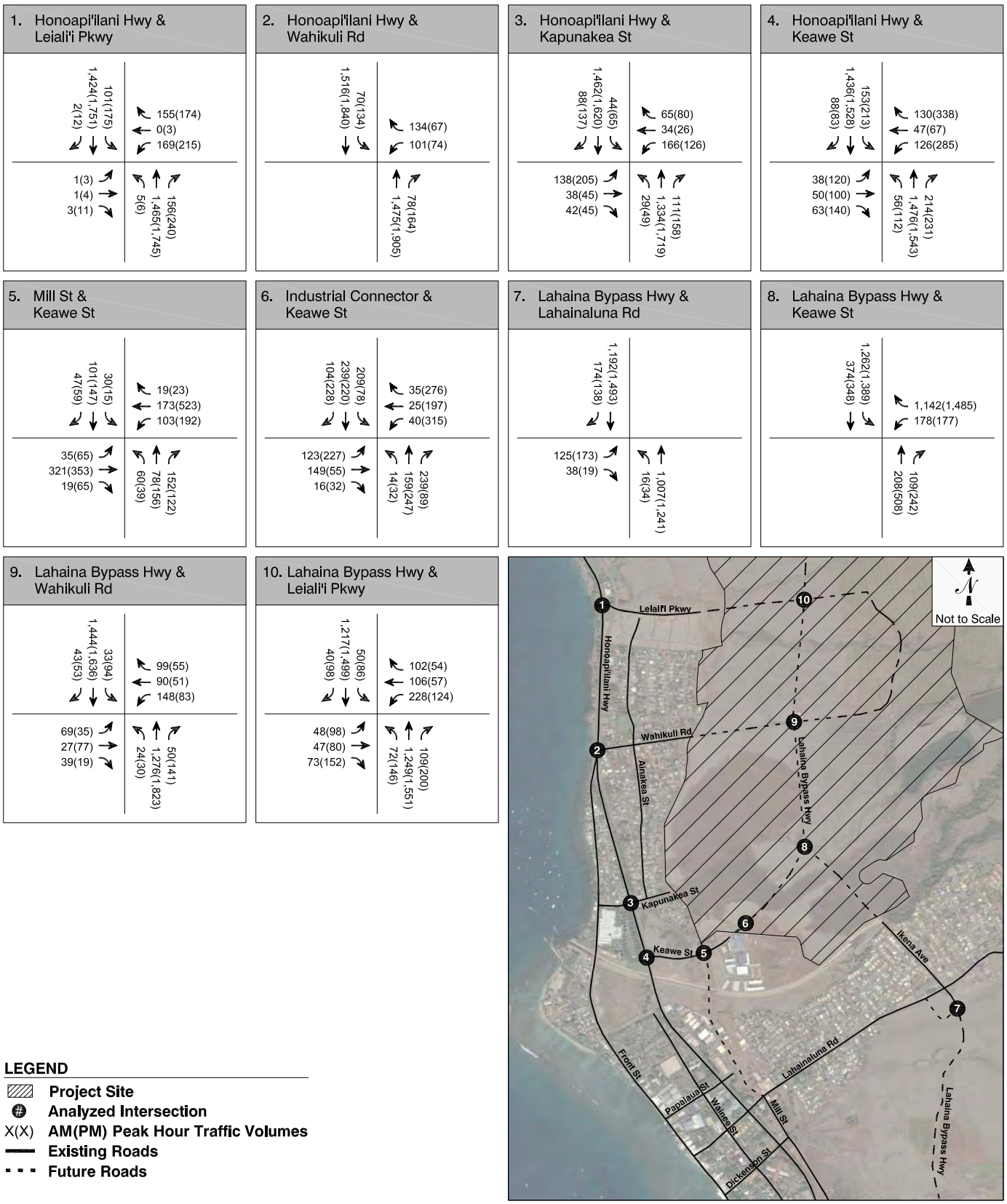
PROJECT ONLY (2036) CONCEPT 3
PEAK HOUR TRAFFIC VOLUMES

FIGURE 18



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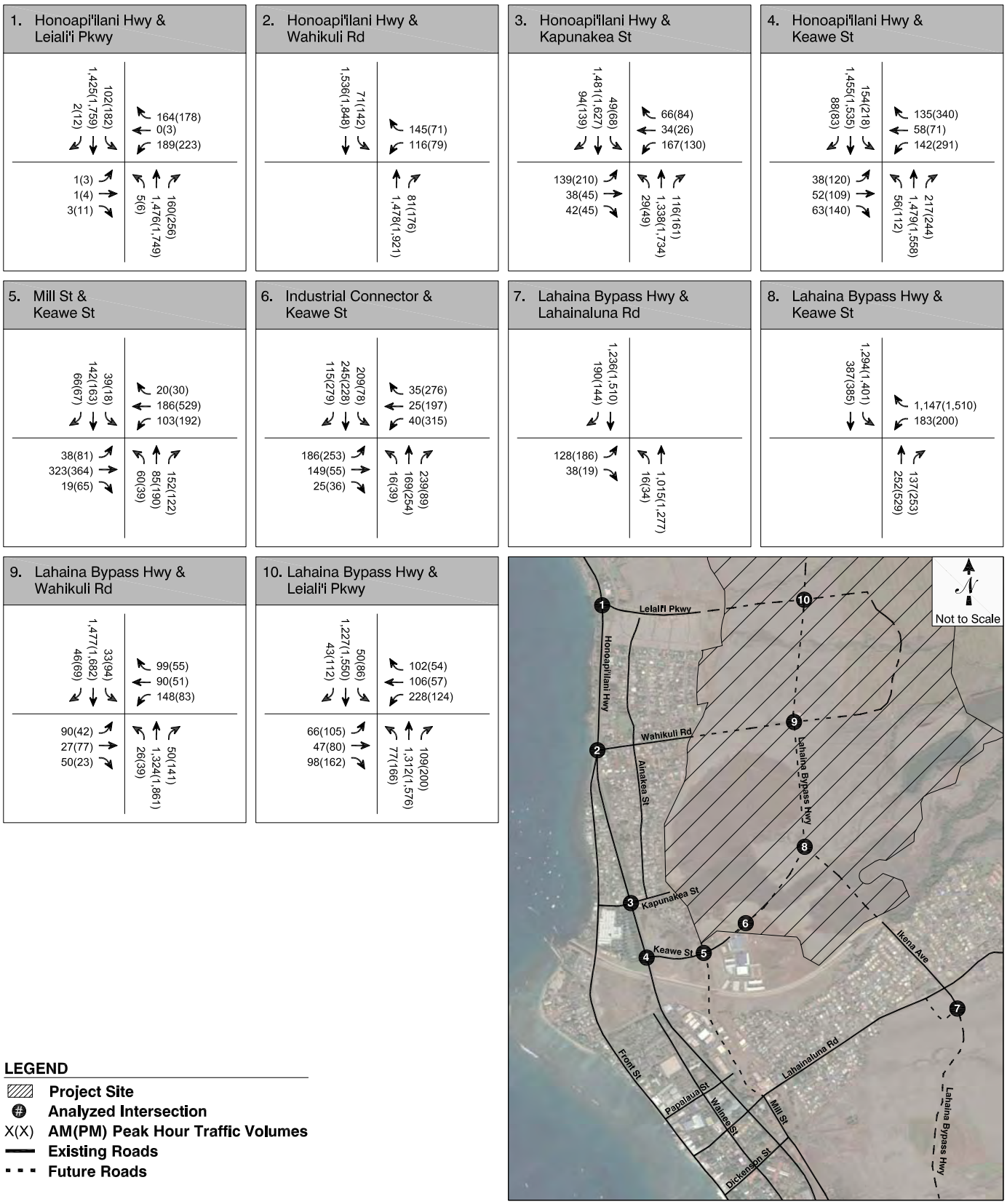
CUMULATIVE PLUS PROJECT (2036) CONCEPT 1
PEAK HOUR TRAFFIC VOLUMES

FIGURE 19



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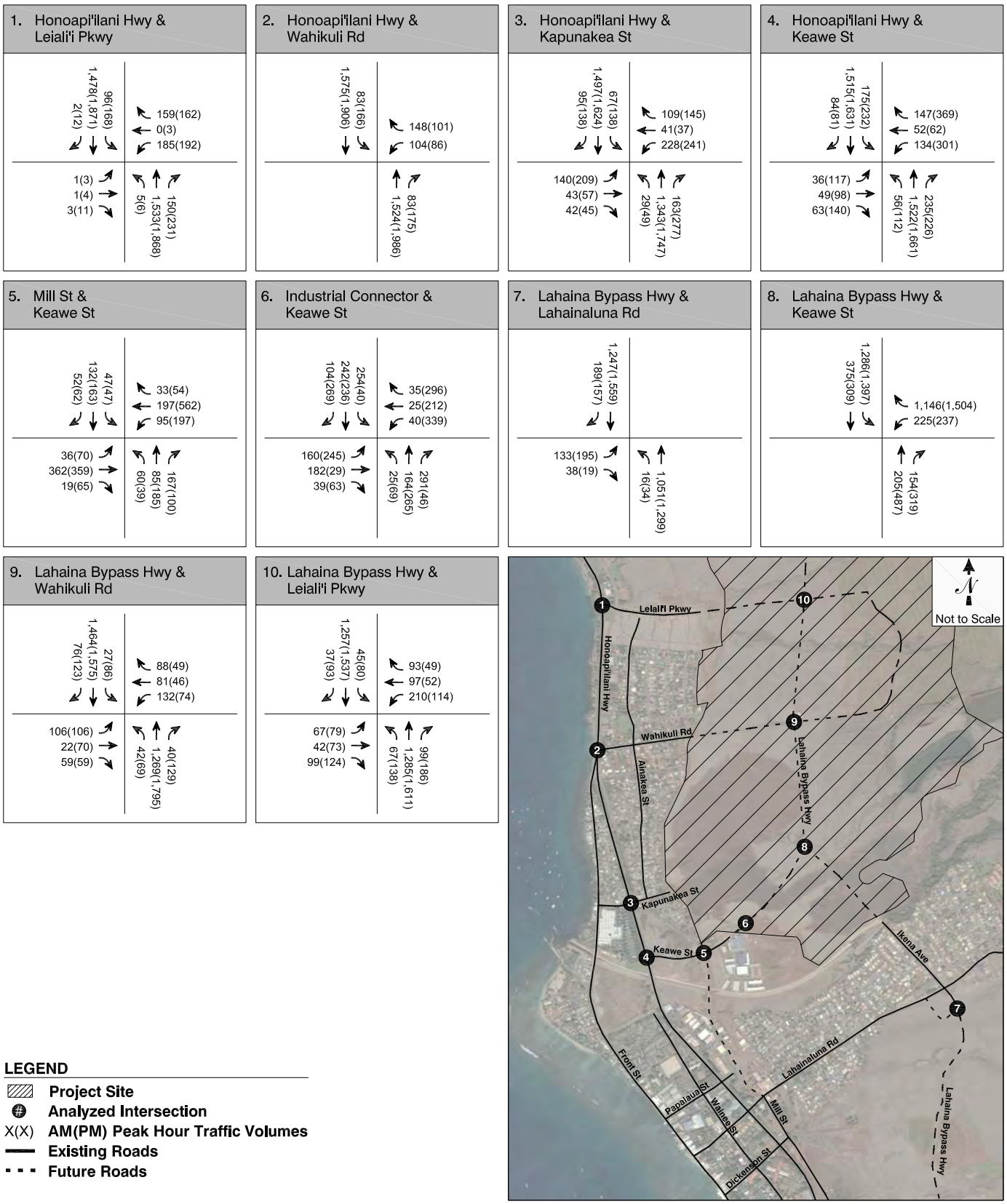
CUMULATIVE PLUS PROJECT (2036) CONCEPT 2
PEAK HOUR TRAFFIC VOLUMES

FIGURE 20



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CUMULATIVE PLUS PROJECT (2036) CONCEPT 3
PEAK HOUR TRAFFIC VOLUMES

FIGURE 21

CHAPTER 4. INTERSECTION ANALYSIS

This chapter presents an analysis of the potential impacts on the roadway system due to projected increases in traffic, including traffic generated by the proposed project, under each of the three project development concepts. The analysis compares the projected levels of service at each study intersection under cumulative conditions for 2028 and 2036 both with and without the proposed project to determine potential project impacts.

INTERSECTION SIGNIFICANT IMPACT CRITERIA

The levels of service range from low delay conditions at LOS A to overloaded conditions at LOS F. LOS D is considered the minimum desirable LOS in this area. If LOS E or F were projected under cumulative base conditions, this would be characterized as a cumulative deficiency. If the addition of project-generated traffic alone were to result in LOS E or F, this would be characterized as a project-specific impact.

CUMULATIVE BASE TRAFFIC CONDITIONS 2028

This section presents an analysis of potential future traffic conditions under projected for the year 2028. The cumulative base traffic volumes projected in Chapter 3 were analyzed using the methodologies described in Chapter 2 to forecast cumulative base peak hour LOS at the study intersections. The first columns in Tables 8, 9, and 10 summarize the results of this analysis.

The stop-controlled approaches at the following intersections are projected to operate at LOS E or F during one or both peak hours in 2028:

- Honoapi'ilani Highway & Wahikuli Road (Intersection 2)
- Lahaina Bypass Highway & Wahikuli Road (Intersection 9)
- Lahaina Bypass Highway & Leiali'i Parkway (Intersection 10)

The remaining seven study intersections are expected to continue operating at a desirable LOS (LOS D or better) during both peak hours.

CUMULATIVE PLUS PROJECT (2028) TRAFFIC CONDITIONS

The cumulative plus project Concept 1, 2, and 3 peak hour traffic volumes illustrated in Figures 13, 14 and 15, respectively, were analyzed to determine 2028 operating conditions with the addition of project-related traffic. The results of the cumulative plus project analysis are presented in Tables 8, 9, and 10. The proposed project would contribute to cumulative impacts (LOS E or F conditions) during one or both peak hours at three study intersections:

- Honoapi'ilani Highway & Wahikuli Road (Intersection 2)
- Lahaina Bypass Highway & Wahikuli Road (Intersection 9)
- Lahaina Bypass Highway & Leiali'i Parkway (Intersection 10)

In addition, project-specific impacts are identified at intersections where the addition of project-generated traffic would cause them to decline below LOS D in the peak hours. The project-related impacts are identified by concept plan:

Concept 1 (five locations):

- Intersection 2 - Honoapi'ilani Highway & Wahikuli Road (cumulative and project-specific impact)
- Intersection 5 - Mill Street & Keawe Street (project-specific impact)

TABLE 8
FUTURE (2028) LEVELS OF SERVICE - VILLAGES AT LEIALI'I CONCEPT 1

No.	Intersection	Peak Hour	Critical Movement*	Cumulative Base			Cumulative plus Project			V/C or Delay Change	LOS D OR BETTER?	With Mitigation			LOS D OR BETTER?
				V/C	Del/Veh*	LOS	V/C	Del/Veh*	LOS			V/C	Del/Veh*	LOS	
1	Honoapi'ilani Highway &	A.M.	Average Delay	0.52	14	B	0.62	16	B	0.10	YES	*No Mitigation Required*			
	Leiali'i Parkway	P.M.	Average Delay	0.67	15	B	0.83	24	C	0.16	YES	*No Mitigation Required*			
2	Honoapi'ilani Highway &	A.M.	WB Approach	NC	74	F	NC	**	F	**	**NO**	0.49	5	A	YES
		A.M.	NB Through/Right		12	B		13	B	1	YES				
	Wahikuli Road [a]	P.M.	WB Approach	NC	**	F	NC	**	F	**	**NO**	0.69	11	B	YES
		P.M.	NB Through/Right		18	C		24	C	6	YES				
3	Honoapi'ilani Highway &	A.M.	Average Delay	0.62	17	B	0.66	19	B	0.04	YES	*No Mitigation Required*			
	Kapunakea Street	P.M.	Average Delay	0.73	24	C	0.88	36	D	0.15	YES	*No Mitigation Required*			
4	Honoapi'ilani Highway &	A.M.	Average Delay	0.55	17	B	0.67	26	C	0.12	YES	*No Mitigation Required*			
	Keawe Street	P.M.	Average Delay	0.75	30	C	0.97	53	D	0.22	YES	*No Mitigation Required*			
5	Mill Street &	A.M.	WB Left	NC	8	A	NC	8	A	1	YES	0.25	42	D	YES
		A.M.	NB Through/Right		9	A		15	C	6	YES				
		A.M.	NB Left		10	B		24	C	13	YES				
	Keawe Street [a]	P.M.	WB Left	NC	8	A	NC	9	A	1	YES	0.37	46	D	YES
		P.M.	NB Through/Right		9	A		**	F	**	**NO**				
		P.M.	NB Left		13	B		**	F	**	**NO**				
6	Phase A Connection to Industrial Area &	A.M.	WB Left	NC	0	A	NC	16	C	16	YES	0.36	36	D	YES
		A.M.	EB Left		0	A		40	E	40	**NO**				
		A.M.	EB Through/Right		0	A		115	F	115	**NO**				
	Keawe Street [a]	P.M.	WB Left	NC	0	A	NC	83	F	83	**NO**	0.63	46	D	YES
		P.M.	EB Left		0	A		**	F	**	**NO**				
		P.M.	EB Through/Right		0	A		94	F	94	**NO**				
7	Lahaina Bypass Highway &	A.M.	Average Delay	0.31	5	A	0.38	6	A	0.07	YES	*No Mitigation Required*			
	Lahainaluna Road	P.M.	Average Delay	0.38	3	A	0.51	6	A	0.13	YES	*No Mitigation Required*			
8	Lahaina Bypass Highway &	A.M.	Average Delay	0.53	30	C	0.63	30	C	0.10	YES	*No Mitigation Required*			
	Keawe Street	P.M.	Average Delay	0.60	22	C	0.77	27	C	0.17	YES	*No Mitigation Required*			
9	Lahaina Bypass Highway &	A.M.	EB/WB Approach	NC	37	E	NC	**	F	**	**NO**	0.44	6	A	YES
	Wahikuli Road [a]	P.M.	EB/WB Approach	NC	60	F	NC	**	F	**	**NO**	0.54	3	A	YES
10	Lahaina Bypass Highway &	A.M.	EB/WB Approach	NC	44	E	NC	**	F	**	**NO**	0.41	7	A	YES
	Leiali'i Parkway [a]	P.M.	EB/WB Approach	NC	73	F	NC	**	F	**	**NO**	0.71	11	B	YES

Notes:

* Delay indicates average stopped delay per vehicle in seconds for signalized intersections. The vehicular delay for critical movements is reported for stop-controlled intersections.
** Indicates oversaturated conditions. Delay cannot be accurately calculated.
NC = Not Calculated
[a] Intersection is or is assumed to be controlled by stop signs on the minor approach(es). Because the proposed mitigation measure at these locations is signalization, the LOS displayed under this condition is based on average control delay for the intersection as a whole, rather than the operation of constrained turning movements.

TABLE 9
FUTURE (2028) LEVELS OF SERVICE - VILLAGES AT LEIALI'I CONCEPT 2

No.	Intersection	Peak Hour	Critical Movement*	Cumulative Base			Cumulative plus Project			V/C or Delay Change	LOS D OR BETTER?	With Mitigation			LOS D OR BETTER?
				V/C	Del/Veh*	LOS	V/C	Del/Veh*	LOS			V/C	Del/Veh*	LOS	
1	Honoapi'ilani Highway &	A.M.	Average Delay	0.52	14	B	0.64	17	B	0.12	YES	*No Mitigation Required*			
	Leiali'i Parkway	P.M.	Average Delay	0.67	15	B	0.85	24	C	0.18	YES	*No Mitigation Required*			
2	Honoapi'ilani Highway &	A.M.	WB Approach	NC	74	F	NC	**	F	**	**NO**	0.52	6	A	YES
		A.M.	NB Through/Right		12	B		14	B	1	YES				
	Wahikuli Road [a]	P.M.	WB Approach	NC	**	F	NC	**	F	**	**NO**	0.8	12	B	YES
		P.M.	NB Through/Right		18	C		26	D	8	YES				
3	Honoapi'ilani Highway &	A.M.	Average Delay	0.62	17	B	0.68	20	B	0.06	YES	*No Mitigation Required*			
	Kapunakea Street	P.M.	Average Delay	0.73	24	C	0.91	40	D	0.18	YES	*No Mitigation Required*			
4	Honoapi'ilani Highway &	A.M.	Average Delay	0.55	17	B	0.67	28	C	0.12	YES	0.61	16	B	YES
	Keawe Street	P.M.	Average Delay	0.75	30	C	0.99	57	E	0.24	**NO**	0.95	34	C	YES
5	Mill Street &	A.M.	WB Left	NC	8	A	NC	8	A	1	YES	0.26	40	D	YES
		A.M.	NB Through/Right		9	A		16	C	7	YES				
		A.M.	NB Left		10	B		32	D	21	YES				
	Keawe Street [a]	P.M.	WB Left	NC	8	A	NC	9	A	1	YES	0.40	44	D	YES
		P.M.	NB Through/Right		9	A		**	F	**	**NO**				
		P.M.	NB Left		13	B		**	F	**	**NO**				
6	Phase A Connection to Industrial Area &	A.M.	WB Left	NC	0	A	NC	17	C	17	YES	0.37	39	D	YES
		A.M.	EB Left		0	A		86	F	86	**NO**				
		A.M.	EB Through/Right		0	A		159	F	159	**NO**				
	Keawe Street [a]	P.M.	WB Left	NC	0	A	NC	118	F	118	**NO**	0.65	46	D	YES
		P.M.	EB Left		0	A		**	F	**	**NO**				
		P.M.	EB Through/Right		0	A		125	F	125	**NO**				
7	Lahaina Bypass Highway &	A.M.	Average Delay	0.31	5	A	0.40	6	A	0.09	YES	*No Mitigation Required*			
	Lahainaluna Road	P.M.	Average Delay	0.38	3	A	0.52	6	A	0.14	YES	*No Mitigation Required*			
8	Lahaina Bypass Highway &	A.M.	Average Delay	0.53	30	C	0.64	30	C	0.11	YES	*No Mitigation Required*			
	Keawe Street	P.M.	Average Delay	0.60	22	C	0.81	28	C	0.21	YES	*No Mitigation Required*			
9	Lahaina Bypass Highway &	A.M.	EB/WB Approach	NC	37	E	NC	**	F	**	**NO**	0.47	7	A	YES
	Wahikuli Road [a]	P.M.	EB/WB Approach	NC	60	F	NC	**	F	**	**NO**	0.56	4	A	YES
10	Lahaina Bypass Highway &	A.M.	EB/WB Approach	NC	44	E	NC	**	F	**	**NO**	0.43	8	A	YES
	Leiali'i Parkway [a]	P.M.	EB/WB Approach	NC	73	F	NC	**	F	**	**NO**	0.89	13	B	YES

Notes:

* Delay indicates average stopped delay per vehicle in seconds for signalized intersections. The vehicular delay for critical movements is reported for stop-controlled intersections.
** Indicates oversaturated conditions. Delay cannot be accurately calculated.
NC = Not Calculated
[a] Intersection is or is assumed to be controlled by stop signs on the minor approach(es). Because the proposed mitigation measure at these locations is signalization, the LOS displayed under this condition is based on average control delay for the intersection as a whole, rather than the operation of constrained turning movements.

TABLE 10
FUTURE (2028) LEVELS OF SERVICE - VILLAGES AT LEIALI'I CONCEPT 3

No.	Intersection	Peak Hour	Critical Movement*	Cumulative Base			Cumulative plus Project			V/C or Delay Change	LOS D OR BETTER?	With Mitigation			LOS D OR BETTER?
				V/C	Del/Veh*	LOS	V/C	Del/Veh*	LOS			V/C	Del/Veh*	LOS	
1	Honoapi'ilani Highway &	A.M.	Average Delay	0.52	14	B	0.66	17	B	0.14	YES	*No Mitigation Required*			
	Leiali'i Parkway	P.M.	Average Delay	0.67	15	B	0.85	22	C	0.18	YES	*No Mitigation Required*			
2	Honoapi'ilani Highway & Wahikuli Road [a]	A.M.	WB Approach	NC	74	F	NC	**	F	**	**NO**	0.53	6	A	YES
		A.M.	NB Through/Right		12	B		14	B	2	YES				
		P.M.	WB Approach	NC	**	F	NC	**	F	**	**NO**	1.18	18	B	YES
		P.M.	NB Through/Right		18	C		33	D	15	YES				
3	Honoapi'ilani Highway &	A.M.	Average Delay	0.62	17	B	0.79	36	D	0.17	YES	0.69	30	C	YES
	Kapunakea Street	P.M.	Average Delay	0.73	24	C	1.32	96	F	0.59	**NO**	0.98	37	D	YES
4	Honoapi'ilani Highway &	A.M.	Average Delay	0.55	17	B	0.69	31	C	0.14	YES	0.68	23	C	YES
	Keawe Street	P.M.	Average Delay	0.75	30	C	1.04	73	E	0.29	**NO**	1.01	45	D	YES
5	Mill Street & Keawe Street [a]	A.M.	WB Left	NC	8	A	NC	8	A	1	YES	0.28	44	D	YES
		A.M.	NB Through/Right		9	A		18	C	9	YES				
		A.M.	NB Left		10	B		33	D	23	YES				
		P.M.	WB Left	NC	8	A	NC	9	A	1	YES	0.4	47	D	YES
		P.M.	NB Through/Right		9	A		**	F	**	**NO**				
		P.M.	NB Left		13	B		**	F	**	**NO**				
6	Phase A Connection to Industrial Area & Keawe Street [a]	A.M.	WB Left	NC	0	A	NC	21	C	21	YES	0.46	39	D	YES
		A.M.	EB Left		0	A		148	F	148	**NO**				
		A.M.	EB Through/Right		0	A		**	F	**	**NO**				
		P.M.	WB Left	NC	0	A	NC	144	F	144	**NO**	0.65	47	D	YES
		P.M.	EB Left		0	A		**	F	**	**NO**				
		P.M.	EB Through/Right		0	A		142	F	142	**NO**				
7	Lahaina Bypass Highway &	A.M.	Average Delay	0.31	5	A	0.41	6	A	0.10	YES	*No Mitigation Required*			
	Lahainaluna Road	P.M.	Average Delay	0.38	3	A	0.55	7	A	0.17	YES	*No Mitigation Required*			
8	Lahaina Bypass Highway &	A.M.	Average Delay	0.53	30	C	0.68	41	D	0.15	YES	*No Mitigation Required*			
	Keawe Street	P.M.	Average Delay	0.60	22	C	0.82	30	C	0.22	YES	*No Mitigation Required*			
9	Lahaina Bypass Highway &	A.M.	EB/WB Approach	NC	37	E	NC	**	F	**	**NO**	0.5	8	A	YES
	Wahikuli Road [a]	P.M.	EB/WB Approach	NC	60	F	NC	**	F	**	**NO**	0.6	10	A	YES
10	Lahaina Bypass Highway &	A.M.	EB/WB Approach	NC	44	E	NC	**	F	**	**NO**	0.44	8	A	YES
	Leiali'i Parkway [a]	P.M.	EB/WB Approach	NC	73	F	NC	**	F	**	**NO**	0.68	9	A	YES

Notes:

* Delay indicates average stopped delay per vehicle in seconds for signalized intersections. The vehicular delay for critical movements is reported for stop-controlled intersections.
** Indicates oversaturated conditions. Delay cannot be accurately calculated.
NC = Not Calculated
[a] Intersection is or is assumed to be controlled by stop signs on the minor approach(es). Because the proposed mitigation measure at these locations is signalization, the LOS displayed under this condition is based on average control delay for the intersection as a whole, rather than the operation of constrained turning movements.

- Intersection 6 - Keawe Street & Phase A Connection to Industrial Area (project-specific impact)
- Intersection 9 - Lahaina Bypass Highway & Wahikuli Road (cumulative and project-specific impact)
- Intersection 10 - Lahaina Bypass Highway & Leiali'i Parkway (cumulative and project-specific impact)

Concept 2 (six locations):

- Intersection 2 - Honoapi'ilani Highway & Wahikuli Road (cumulative and project-specific impact)
- Intersection 4 - Honoapi'ilani Highway & Keawe Street (project-specific impact)
- Intersection 5 - Mill Street & Keawe Street (project-specific impact)
- Intersection 6 - Keawe Street & Phase A Connection to Industrial Area (project-specific impact)
- Intersection 9 - Lahaina Bypass Highway & Wahikuli Road (cumulative and project-specific impact)
- Intersection 10 - Lahaina Bypass Highway & Leiali'i Parkway (cumulative and project-specific impact)

Concept 3 (seven locations):

- Intersection 2 - Honoapi'ilani Highway & Wahikuli Road (cumulative and project-specific impact)
- Intersection 3 - Honoapi'ilani Highway & Kapunakea Street (project-specific impact)
- Intersection 4 - Honoapi'ilani Highway & Keawe Street (project-specific impact)
- Intersection 5 - Mill Street & Keawe Street (project-specific impact)
- Intersection 6 - Keawe Street & Phase A Connection to Industrial Area (project-specific impact)
- Intersection 9 - Lahaina Bypass Highway & Wahikuli Road (cumulative and project-specific impact)
- Intersection 10 - Lahaina Bypass Highway & Leiali'i Parkway (cumulative and project-specific impact)

The number of traffic impacts differs under Concepts 1, 2, and 3; however, the magnitude of those impacts at locations in common would be greatest with Concept C.

CUMULATIVE BASE (2036) TRAFFIC CONDITIONS

This section presents an analysis of potential future traffic conditions projected for the year 2036. The cumulative base traffic volumes projected in Chapter 3 were analyzed using the methodologies described in Chapter 2 to forecast cumulative base peak hour LOS at the study intersections. The first columns in Tables 11, 12, and 13 summarize the results of this analysis.

The stop-controlled approaches at the following intersections are projected to operate at LOS E or F during one or both peak hours in 2036:

- Honoapi'ilani Highway & Wahikuli Road (Intersection 2)
- Lahaina Bypass Highway & Wahikuli Road (Intersection 9)
- Lahaina Bypass Highway & Leiali'i Parkway (Intersection 10)

The remaining seven study intersections are expected to continue operating at a desirable LOS (LOS D or better) during both peak hours.

CUMULATIVE PLUS PROJECT (2036) TRAFFIC CONDITIONS

The cumulative plus project Concepts 1, 2, and 3 peak hour traffic volumes illustrated in Figures 19, 20, and 21, respectively, were analyzed to determine 2036 operating conditions with the addition of project-related traffic. The results of the cumulative plus project analysis are presented in Tables 11, 12, and 13.

TABLE 11
FUTURE (2036) LEVELS OF SERVICE - VILLAGES AT LEIALI'I CONCEPT 1

No.	Intersection	Peak Hour	Critical Movement*	Cumulative Base			Cumulative plus Project			V/C or Delay Change	LOS D OR BETTER?	With Mitigation			LOS D OR BETTER?
				V/C	Del/Veh*	LOS	V/C	Del/Veh*	LOS			V/C	Del/Veh*	LOS	
1	Honoapi'ilani Highway &	A.M.	Average Delay	0.57	15	B	0.76	21	C	0.19	YES	*No Mitigation Required*			
	Leiali'i Parkway	P.M.	Average Delay	0.71	15	B	0.95	33	C	0.24	YES	*No Mitigation Required*			
2	Honoapi'ilani Highway & Wahikuli Road [a]	A.M.	WB Approach	NC	172	F	NC	**	F	**	**NO**	0.61	10	A	YES
		A.M.	NB Through/Right		14	B		16	C	2	YES				
		P.M.	WB Approach	NC	**	F	NC	**	F	**	**NO**	1.49	24	C	YES
		P.M.	NB Through/Right		20	C		41	E	21	**NO**				
3	Honoapi'ilani Highway &	A.M.	Average Delay	0.68	17	B	0.76	23	C	0.08	YES	*No Mitigation Required*			
	Kapunakea Street	P.M.	Average Delay	0.78	25	C	1.00	44	D	0.22	YES	*No Mitigation Required*			
4	Honoapi'ilani Highway &	A.M.	Average Delay	0.60	18	B	0.74	29	C	0.14	YES	0.68	18	B	YES
	Keawe Street	P.M.	Average Delay	0.79	32	C	1.03	74	E	0.24	**NO**	0.89	51	D	YES
5	Mill Street & Keawe Street [a]	A.M.	WB Left	NC	8	A	NC	8	A	1	YES	0.33	42	D	YES
		A.M.	NB Through/Right		9	A		21	C	12	YES				
		A.M.	NB Left		11	B		50	E	39	**NO**				
		P.M.	WB Left	NC	8	A	NC	9	A	1	YES	0.45	44	D	YES
		P.M.	NB Through/Right		9	A		**	F	**	**NO**				
		P.M.	NB Left		14	B		**	F	**	**NO**				
6	Phase A Connection to Industrial Area & Keawe Street [a]	A.M.	WB Left	NC	0	A	NC	21	C	21	YES	0.4	52	D	YES
		A.M.	EB Left		0	A		104	F	104	**NO**				
		A.M.	EB Through/Right		0	A		**	F	**	**NO**				
		P.M.	WB Left	NC	0	A	NC	**	F	**	**NO**	0.65	45	D	YES
		P.M.	EB Left		0	A		**	F	**	**NO**				
		P.M.	EB Through/Right		0	A		**	F	**	**NO**				
7	Lahaina Bypass Highway &	A.M.	Average Delay	0.35	5	A	0.47	8	A	0.12	YES	*No Mitigation Required*			
	Lahainaluna Road	P.M.	Average Delay	0.40	3	A	0.60	9	A	0.20	YES	*No Mitigation Required*			
8	Lahaina Bypass Highway &	A.M.	Average Delay	0.57	28	C	0.71	26	C	0.14	YES	*No Mitigation Required*			
	Keawe Street	P.M.	Average Delay	0.64	23	C	0.93	32	C	0.29	YES	*No Mitigation Required*			
9	Lahaina Bypass Highway &	A.M.	EB/WB Approach	NC	46	E	NC	**	F	**	**NO**	0.65	19	B	YES
	Wahikuli Road [a]	P.M.	EB/WB Approach	NC	72	F	NC	**	F	**	**NO**	0.99	13	B	YES
10	Lahaina Bypass Highway &	A.M.	EB/WB Approach	NC	60	F	NC	**	F	**	**NO**	0.69	23	C	YES
	Leiali'i Parkway [a]	P.M.	EB/WB Approach	NC	94	F	NC	**	F	**	**NO**	1.23	30	C	YES

Notes:

* Delay indicates average stopped delay per vehicle in seconds for signalized intersections. The vehicular delay for critical movements is reported for stop-controlled intersections.
** Indicates oversaturated conditions. Delay cannot be accurately calculated.
NC = Not Calculated
[a] Intersection is or is assumed to be controlled by stop signs on the minor approach(es). Because the proposed mitigation measure at these locations is signalization, the LOS displayed under this condition is based on average control delay for the intersection as a whole, rather than the operation of constrained turning movements.

TABLE 12
FUTURE (2036) LEVELS OF SERVICE - VILLAGES AT LEIALI'I CONCEPT 2

No.	Intersection	Peak Hour	Critical Movement*	Cumulative Base			Cumulative plus Project			V/C or Delay Change	LOS D OR BETTER?	With Mitigation			LOS D OR BETTER?
				V/C	Del/Veh*	LOS	V/C	Del/Veh*	LOS			V/C	Del/Veh*	LOS	
1	Honoapi'ilani Highway &	A.M.	Average Delay	0.57	15	B	0.78	21	C	0.21	YES	*No Mitigation Required*			
	Leiali'i Parkway	P.M.	Average Delay	0.71	15	B	0.97	34	C	0.26	YES	*No Mitigation Required*			
2	Honoapi'ilani Highway &	A.M.	WB Approach	NC	172	F	NC	**	F	**	**NO**	0.63	12	B	YES
		A.M.	NB Through/Right		14	B		16	C	2	YES				
	Wahikuli Road [a]	P.M.	WB Approach	NC	**	F	NC	**	F	**	**NO**	1.67	29	C	YES
		P.M.	NB Through/Right		20	C		47	E	26	**NO**				
3	Honoapi'ilani Highway &	A.M.	Average Delay	0.68	17	B	0.77	23	C	0.09	YES	*No Mitigation Required*			
	Kapunakea Street	P.M.	Average Delay	0.78	25	C	1.03	47	D	0.25	YES	*No Mitigation Required*			
4	Honoapi'ilani Highway &	A.M.	Average Delay	0.60	18	B	0.76	31	C	0.16	YES	0.7	18	B	YES
	Keawe Street	P.M.	Average Delay	0.79	32	C	1.05	73	E	0.26	**NO**	0.93	31	C	YES
5	Mill Street &	A.M.	WB Left	NC	8	A	NC	8	A	1	YES	0.33	41	D	YES
		A.M.	NB Through/Right		9	A		23	C	15	YES				
		A.M.	NB Left		11	B		99	F	89	**NO**				
	Keawe Street [a]	P.M.	WB Left	NC	8	A	NC	9	A	1	YES	0.47	41	D	YES
		P.M.	NB Through/Right		9	A		**	F	**	**NO**				
		P.M.	NB Left		14	B		**	F	**	**NO**				
6	Phase A Connection to Industrial Area &	A.M.	WB Left	NC	0	A	NC	22	C	22	YES	0.43	40	D	YES
		A.M.	EB Left		0	A		**	F	**	**NO**				
		A.M.	EB Through/Right		0	A		**	F	**	**NO**				
	Keawe Street [a]	P.M.	WB Left	NC	0	A	NC	**	F	**	**NO**	0.47	41	D	YES
		P.M.	EB Left		0	A		**	F	**	**NO**				
		P.M.	EB Through/Right		0	A		**	F	**	**NO**				
7	Lahaina Bypass Highway &	A.M.	Average Delay	0.35	5	A	0.49	8	A	0.14	YES	*No Mitigation Required*			
	Lahainaluna Road	P.M.	Average Delay	0.40	3	A	0.61	10	A	0.21	YES	*No Mitigation Required*			
8	Lahaina Bypass Highway &	A.M.	Average Delay	0.57	28	C	0.72	26	C	0.15	YES	*No Mitigation Required*			
	Keawe Street	P.M.	Average Delay	0.64	23	C	0.96	35	C	0.32	YES	*No Mitigation Required*			
9	Lahaina Bypass Highway &	A.M.	EB/WB Approach	NC	46	E	NC	**	F	**	**NO**	0.71	24	C	YES
	Wahikuli Road [a]	P.M.	EB/WB Approach	NC	72	F	NC	**	F	**	**NO**	1.06	14	B	YES
10	Lahaina Bypass Highway &	A.M.	EB/WB Approach	NC	60	F	NC	**	F	**	**NO**	0.74	25	C	YES
	Leiali'i Parkway [a]	P.M.	EB/WB Approach	NC	94	F	NC	**	F	**	**NO**	1.52	37	D	YES

Notes:

* Delay indicates average stopped delay per vehicle in seconds for signalized intersections. The vehicular delay for critical movements is reported for stop-controlled intersections.
** Indicates oversaturated conditions. Delay cannot be accurately calculated.
NC = Not Calculated
[a] Intersection is or is assumed to be controlled by stop signs on the minor approach(es). Because the proposed mitigation measure at these locations is signalization, the LOS displayed under this condition is based on average control delay for the intersection as a whole, rather than the operation of constrained turning movements.

TABLE 13
FUTURE (2036) LEVELS OF SERVICE - VILLAGES AT LEIALI'I CONCEPT 3

No.	Intersection	Peak Hour	Critical Movement*	Cumulative Base			Cumulative plus Project			V/C or Delay Change	LOS D OR BETTER?	With Mitigation			LOS D OR BETTER?
				V/C	Del/Veh*	LOS	V/C	Del/Veh*	LOS			V/C	Del/Veh*	LOS	
1	Honoapi'ilani Highway &	A.M.	Average Delay	0.57	15	B	0.79	21	C	0.22	YES	*No Mitigation Required*			
	Leiali'i Parkway	P.M.	Average Delay	0.71	15	B	0.96	29	C	0.25	YES	*No Mitigation Required*			
2	Honoapi'ilani Highway &	A.M.	WB Approach	NC	172	F	NC	**	F	**	**NO**	0.64	12	B	YES
		A.M.	NB Through/Right		14	B		17	C	3	YES				
	Wahikuli Road [a]	P.M.	WB Approach	NC	**	F	NC	**	F	**	**NO**	2.56	45	D	YES
		P.M.	NB Through/Right		20	C		69	F	49	**NO**				
3	Honoapi'ilani Highway &	A.M.	Average Delay	0.68	17	B	0.88	42	D	0.20	YES	0.76	25	C	YES
	Kapunakea Street	P.M.	Average Delay	0.78	25	C	1.47	111	F	0.69	**NO**	1.07	45	D	YES
4	Honoapi'ilani Highway &	A.M.	Average Delay	0.60	18	B	0.78	34	C	0.18	YES	0.76	27	C	YES
	Keawe Street	P.M.	Average Delay	0.79	32	C	1.08	87	F	0.29	**NO**	0.97	43	D	YES
5	Mill Street &	A.M.	WB Left	NC	8	A	NC	9	A	1	YES	0.35	43	D	YES
		A.M.	NB Through/Right		9	A		26	D	17	YES				
		A.M.	NB Left		11	B		94	F	83	**NO**				
	Keawe Street [a]	P.M.	WB Left	NC	8	A	NC	9	A	1	YES	0.46	42	D	YES
		P.M.	NB Through/Right		9	A		**	F	**	**NO**				
		P.M.	NB Left		14	B		**	F	**	**NO**				
6	Phase A Connection to Industrial Area &	A.M.	WB Left	NC	0	A	NC	28	D	28	YES	0.49	39	D	YES
		A.M.	EB Left		0	A		**	F	**	**NO**				
		A.M.	EB Through/Right		0	A		**	F	**	**NO**				
	Keawe Street [a]	P.M.	WB Left	NC	0	A	NC	**	F	**	**NO**	0.64	49	D	YES
		P.M.	EB Left		0	A		**	F	**	**NO**				
		P.M.	EB Through/Right		0	A		**	F	**	**NO**				
7	Lahaina Bypass Highway &	A.M.	Average Delay	0.35	5	A	0.49	8	A	0.14	YES	*No Mitigation Required*			
	Lahainaluna Road	P.M.	Average Delay	0.40	3	A	0.64	10	B	0.24	YES	*No Mitigation Required*			
8	Lahaina Bypass Highway &	A.M.	Average Delay	0.57	28	C	0.74	28	C	0.17	YES	*No Mitigation Required*			
	Keawe Street	P.M.	Average Delay	0.64	23	C	0.96	36	D	0.32	YES	*No Mitigation Required*			
9	Lahaina Bypass Highway &	A.M.	EB/WB Approach	NC	46	E	NC	**	F	**	**NO**	0.70	20	B	YES
	Wahikuli Road [a]	P.M.	EB/WB Approach	NC	72	F	NC	**	F	**	**NO**	0.95	17	B	YES
10	Lahaina Bypass Highway &	A.M.	EB/WB Approach	NC	60	F	NC	**	F	**	**NO**	0.71	24	C	YES
	Leiali'i Parkway [a]	P.M.	EB/WB Approach	NC	94	F	NC	**	F	**	**NO**	1.13	25	C	YES

Notes:

* Delay indicates average stopped delay per vehicle in seconds for signalized intersections. The vehicular delay for critical movements is reported for stop-controlled intersections.
** Indicates oversaturated conditions. Delay cannot be accurately calculated.
NC = Not Calculated
[a] Intersection is or is assumed to be controlled by stop signs on the minor approach(es). Because the proposed mitigation measure at these locations is signalization, the LOS displayed under this condition is based on average control delay for the intersection as a whole, rather than the operation of constrained turning movements.

The proposed project would contribute to cumulative impacts (LOS E or F conditions) during one or both peak hours at three study intersections:

- Honoapi'ilani Highway & Wahikuli Road (Intersection 2)
- Lahaina Bypass Highway & Wahikuli Road (Intersection 9)
- Lahaina Bypass Highway & Leiali'i Parkway (Intersection 10)

In addition, project-specific impacts are identified at future intersections, as the addition of project-generated traffic would cause them to decline below LOS D in the peak hours. The project-specific impacts are identified by concept plan:

Concepts 1 and 2 (six locations):

- Intersection 2 - Honoapi'ilani Highway & Wahikuli Road (cumulative and project-specific impact)
- Intersection 4 - Honoapi'ilani Highway & Keawe Street (project-specific impact)
- Intersection 5 - Mill Street & Keawe Street (project-specific impact)
- Intersection 6 - Keawe Street/Phase A Connection to Industrial Area (project-specific impact)
- Intersection 9 - Lahaina Bypass Highway & Wahikuli Road (cumulative and project-specific impact)
- Intersection 10 - Lahaina Bypass Highway & Leiali'i Parkway (cumulative and project-specific impact)

Concept 3 (seven locations):

- Intersection 2 - Honoapi'ilani Highway & Wahikuli Road (cumulative and project-specific impact)
- Intersection 3 - Honoapi'ilani Highway & Kapunakea Street (project-specific impact)
- Intersection 4 - Honoapi'ilani Highway & Keawe Street (project-specific impact)
- Intersection 5 - Mill Street & Keawe Street (project-specific impact)
- Intersection 6 - Keawe Street & Phase A Connection to Industrial Area (project-specific impact)
- Intersection 9 - Lahaina Bypass Highway & Wahikuli Road (cumulative and project-specific impact)
- Intersection 10 - Lahaina Bypass Highway & Leiali'i Parkway (cumulative and project-specific impact)

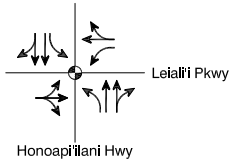
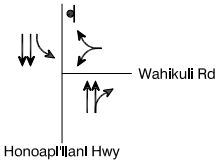
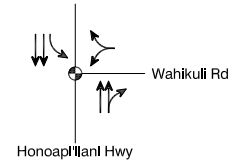
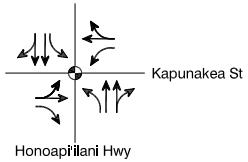
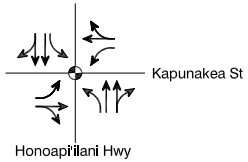
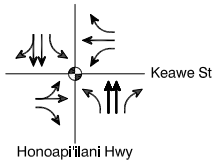
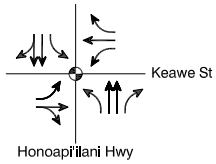
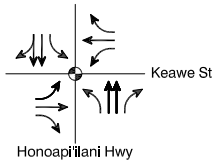
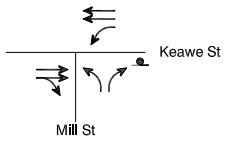
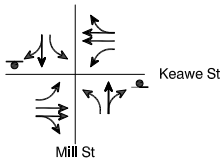
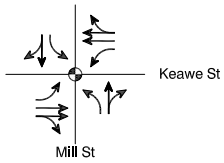
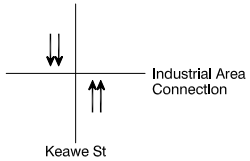
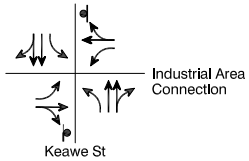
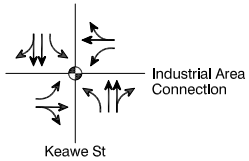
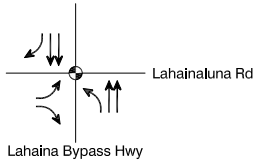
The number of traffic impacts differs under Concepts 1, 2, and 3; however, the magnitude of those impacts at locations in common would be greatest with Concept 3.

PROPOSED MITIGATION MEASURES

A mitigation program for the proposed project was developed to identify measures that would increase the capacity and/or efficiency of the roadway system at the locations where the addition of project-related traffic would cause or contribute to projected poor operating conditions. The initial emphasis was to identify physical and/or operational improvements that could be implemented within the existing or planned roadway rights-of-way. The recommended intersection improvement measures are illustrated in Figure 22. Tables 8 through 13 summarize the projected LOS in 2028/2036 at the impacted locations with these mitigation measures in place.

The recommended mitigation measures to address the identified traffic impacts, both project-related and cumulative, are described below. Each of the identified cumulative and project-related impacts would be fully mitigated (i.e., the recommended improvements would result in LOS D or better).

The proposed mitigation measures to address the project-related impacts are discussed in detail below for each location:

INTERSECTION	EXISTING CONDITIONS	CUMULATIVE BASE	PHASE A (2028)	PHASE B (2036)	PHYSICAL MITIGATION
1. Honoapi'ilani Hwy & Leiali'i Pkwy		Same As Existing Conditions	Same As Existing Conditions	Same As Existing Conditions	Same As Existing Conditions
2. Honoapi'ilani Hwy & Wahikuli Rd		Same As Existing Conditions	Same As Existing Conditions	Same As Existing Conditions	
3. Honoapi'ilani Hwy & Kapunakea St		Same As Existing Conditions	Same As Existing Conditions	Same As Existing Conditions	
4. Honoapi'ilani Hwy & Keawe St			Same As Cumulative Base	Same As Cumulative Base	
5. Mill St & Keawe St (future intersection)	Future Intersection			Same As Phase A (2028)	
6. Keawe St/Phase A Connection to Industrial Area (future intersection)	Future Intersection			Same As Phase A (2028)	
7. Lahaina Bypass Hwy & Lahainaluna Rd (future intersection)	Future Intersection		Same As Cumulative Base	Same As Cumulative Base	Same As Cumultaive Base

LEGEND
- Traffic Signal
- Stop Controlled

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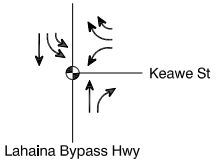
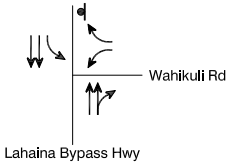
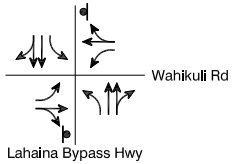
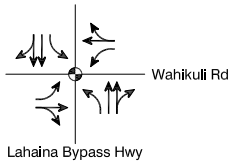
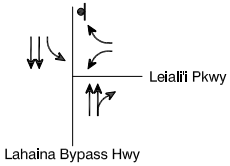
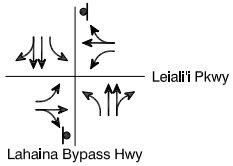
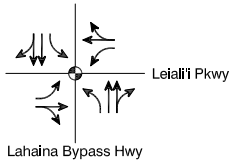
INTERSECTION LANE CONFIGURATIONS

FIGURE 22

INTERSECTION	EXISTING CONDITIONS	CUMULATIVE BASE	PHASE A (2028)	PHASE B (2036)	PHYSICAL MITIGATION
8. Lahaina Bypass Hwy & Keawe St (future intersection)	Future Intersection		Same As Cumulative Base	Same as Cumulative Base	Same As Cumulative Base
9. Lahaina Bypass Hwy & Wahikuli Rd (future intersection)	Future Intersection			Same As Phase A (2028)	
10. Lahaina Bypass Hwy & Leiali'i Pkwy (future intersection)	Future Intersection			Same As Phase A (2028)	

LEGEND
- Traffic Signal
- Stop Controlled

FEHR & PEERS
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INTERSECTION LANE CONFIGURATIONS

FIGURE 22

- Honoapi'ilani Highway & Wahikuli Road (Intersection 2) – The impact at this intersection could be mitigated by installing a traffic signal with the existing lane configuration. Signal warrant analysis was conducted based on the Peak Hour Warrant found in *Manual on Uniform Traffic Control Devices* (MUTCD) (National Committee on Uniform Traffic Control Devices, 2003) and is included in Appendix C. It indicates that a traffic signal at this intersection would be warranted under future plus project conditions, but not under cumulative base conditions.

- Honoapi'ilani Highway & Kapunakea Street (Intersection 3) – The impact at this intersection could be mitigated by converting the eastbound approach from a shared through/left-turn lane and right-turn lane to a left-turn lane and shared through/right-turn lane, resulting in similar eastbound and westbound approach configurations. No changes are proposed to the signal phasing.

- Honoapi'ilani Highway & Keawe Street Year 2028 (Intersection 4) – The impact at this intersection could be mitigated by converting left-turn signal phasing from protected left turns to protected-permitted left turns on all approaches (concept plans 2 and 3).

- Honoapi'ilani Highway & Keawe Street – Year 2036 (Intersection 4) – The impact at this intersection could be mitigated by converting the eastbound approach from a left-turn lane and shared through/right-turn lane to a left-turn lane, through lane, and right-turn lane, and converting left-turn signal phasing from protected left turns to protected-permitted left turns on all approaches (the latter is implemented in Phase A for Concepts 2 and 3). Adding the right-turn lane to the eastbound approach may require widening. The estimated 95th percentile queue length for the eastbound left turn is up to 140 feet. The estimated 95th percentile queue length for the eastbound right turn is up to 100 feet.

- Keawe Street & Mill Street (Intersection 5) – The impact at this intersection could be mitigated during both peak periods by installing a traffic signal with the assumed future lane configuration and protected left-turns on the eastbound and westbound approaches. The MUTCD peak hour signal warrant indicates that a traffic signal at this intersection would be warranted under future plus project (Year 2036, Concepts 2 and 3) conditions, but not under cumulative base conditions, nor under Year 2028 (Concepts 1, 2 or 3) or under Year 2036 (Concept 1) conditions. It is recommended that the need for a traffic signal at this location be monitored as development of the Villages of Leiali'i project proceeds and that such installation be dependent on future traffic engineering studies.

- Keawe Street & Phase A Connection to Industrial Area (Intersection 6) – The impact at this intersection could be mitigated during both peak periods by installing a traffic signal with the assumed future lane configuration and protected left turns on all approaches. The MUTCD peak hour signal warrant indicates that a traffic signal at this intersection would be warranted under future plus project (Year 2036, Concepts 1, 2 and 3) conditions and under Year 2028 (Concepts 2 and 3) conditions, but not under cumulative base conditions, nor under Year 2028 (Concept 1) conditions. It is recommended that the need for a traffic signal at this location be monitored as development of the Villages of Leiali'i project proceeds and that such installation be dependent on future traffic engineering studies.

- Lahaina Bypass Highway & Wahikuli Road (Intersection 9) – The impact at this intersection could be mitigated during both peak periods by installing a traffic signal with the assumed future lane configuration and permissive left-turn phasing. The MUTCD peak hour signal warrant indicates that a traffic signal at this intersection would be warranted under future plus project (Year 2036, Concepts 1, 2 and 3) conditions, but not under cumulative base conditions, nor under Year 2028 (Concepts 1, 2 or 3) conditions. It is recommended that the need for a traffic signal at this location be monitored as development of the Villages of Leiali'i project proceeds and that such installation be dependent on future traffic engineering studies.

- Lahaina Bypass Highway & Leiali'i Parkway (Intersection 10) – The impact at this intersection could be mitigated during both peak periods by installing a traffic signal with the assumed future lane configuration and permissive left-turn phasing. The MUTCD peak hour signal warrant analysis indicates that a traffic signal at this intersection would be warranted under future plus project conditions, but not under cumulative base conditions.

MITIGATION CONTRIBUTION CALCULATIONS

As discussed, mitigation measures are proposed at intersections identified as significantly impacted for any of the three development concepts under 2028 or 2036 cumulative plus project conditions. Thus, the recommended mitigation program includes improvements at six intersections, except Concept 3 under 2036 cumulative plus project conditions, where seven intersection improvements are proposed. The purpose of this section is to document planning level cost estimates and the contribution calculations prepared for each development concept.

The project's estimated contribution to the estimated cost for each of the traffic mitigation measures identified in the traffic impact analysis is presented in Tables 14 through 16. The project's share of the cost of the improvements at the location where the project would contribute to an identified cumulative impact is based on the proportion of peak hour traffic contributed by the project at each location relative to the total estimated growth in peak hour traffic volumes between 2010 and either 2028 or 2036. Calculations have been made for both the AM and the PM peak hours and the maximum project contribution identified. At up to four intersections (Intersections 3, 4, 5, and 6), the impacts identified are project-specific rather than cumulative impacts to which the project would contribute. At those locations, the project would be responsible for 100% of the mitigation costs. Detailed cost estimates for the mitigation measures were provided by Belt Collins Hawaii, Ltd. and are included in Appendix D.

Phase A – 2028

Mitigation contributions for the significantly impacted intersections in 2028 under all three concept plans, except as noted, are summarized below and in Tables 14 through 16.

- Honoapi'ilani Highway & Wahikuli Road (Intersection 2) – The cost estimate for the proposed mitigation measures at this location is approximately $580,000. The project's contribution varies by each concept plan as follows:
    - Concept 1 – Approximately 66% or $385,000 of the mitigation costs are attributable to the project.
    - Concept 2 – Approximately 70% or $409,000 of the mitigation costs are attributable to the project.
    - Concept 3 – Approximately 76% or $442,000 of the mitigation costs are attributable to the project.

- Honoapi'ilani Highway & Kapunakea Street (Intersection 3, Concept 3 only) – The cost estimate for the proposed mitigation measure at this location is approximately $9,000, of which 100% is attributable to the project.

- Honoapi'ilani Highway & Keawe Street (Intersection 4) – The cost estimate for the proposed mitigation measure at this location in 2028 is approximately $45,000, of which 100% is attributable to the project. This mitigation applies only to Concepts 2 and 3 under 2028 cumulative plus project conditions.

- Mill Street & Keawe Street (Intersection 5) – The cost estimate for the proposed mitigation measure at this location is approximately $442,000, of which 100% is attributable to the project.

TABLE 14

PROJECT'S ESTIMATED SHARE OF TRAFFIC MITIGATION COSTS (YEARS 2028 AND 2036)

CONCEPT 1

Int #	Intersection	AM Peak Hour					PM Peak Hour					Maximum Contribution	Cost Estimate for the Mitigation Measures	Leiali'i Share
		Existing Traffic	2028 with Project Traffic	Project Traffic	Total New Traffic	Project % of New Traffic	Existing Traffic	2028 with Project Traffic	Project Traffic	Total New Traffic	Project % of New Traffic			
Mitigation for Phase A - 2028														
2	Honoapi'ilani Hwy (SR-30) & Wahikuli Road*	2,494	2,890	263	396	66.4%	2,991	3,773	394	782	50.4%	66.4%	$580,000	$385,202
5	Mill Street & Keawe St	0	956	641	956	67.1%	0	1,570	982	1,570	62.5%	100.0%	$442,000	$442,000
6	Keawe St & Industrial Phase A Connection	0	1,116	1,025	1,116	91.8%	0	1,756	1,617	1,756	92.1%	100.0%	$442,000	$442,000
9	Lahaina Bypass Highway and Wahikuli Rd	0	2,402	589	2,402	24.5%	0	3,189	933	3,189	29.3%	29.3%	$442,000	$129,315
10	Lahaina Bypass Highway and Leiali'i Parkway	0	2,416	615	2,416	25.5%	0	3,315	1,080	3,315	32.6%	32.6%	$442,000	$144,000
												Phase A Subtotal	*$2,348,000*	*$1,542,517*
Additional Mitigation for Phases A + B - 2036														
4	Honoapi'ilani Hwy (SR-30) & Keawe St	2,588	3,877	515	1,289	40.0%	3,108	4,760	747	1,652	45.2%	100.0%	$499,000	$499,000
												Phase B Subtotal	*$499,000*	*$499,000*
TOTAL													**$2,847,000**	**$2,041,517**

Notes:

* The impact at this location is identified as both a cumulative impact and a project-specific impact. Cost estimates for each mitigation measure were provided by Belt Collins Hawaii, Ltd.

TABLE 15

PROJECT'S ESTIMATED SHARE OF TRAFFIC MITIGATION COSTS (YEARS 2028 AND 2036)

CONCEPT 2

Int #	Intersection	AM Peak Hour					PM Peak Hour					Maximum Contribution	Cost Estimate for the Mitigation Measures	Leiali'i Share
		Existing Traffic	2028 with Project Traffic	Project Traffic	Total New Traffic	Project % of New Traffic	Existing Traffic	2028 with Project Traffic	Project Traffic	Total New Traffic	Project % of New Traffic			
Mitigation for Phase A - 2028														
2	Honoapi'ilani Hwy (SR-30) & Wahikuli Road*	2,494	2,944	317	450	70.4%	2,991	3,826	447	835	53.5%	70.4%	$580,000	$408,578
4	Honoapi'ilani Hwy (SR-30) & Keawe St	2,588	3,493	466	905	51.5%	3,108	4,466	704	1,358	51.8%	100.0%	$45,000	$45,000
5	Mill Street & Keawe St	0	1,052	737	1,052	70.1%	0	1,670	1,082	1,670	64.8%	100.0%	$442,000	$442,000
6	Keawe St & Industrial Phase A Connection	0	1,217	1,126	1,217	92.5%	0	1,859	1,720	1,859	92.5%	100.0%	$442,000	$442,000
9	Lahaina Bypass Highway and Wahikuli Rd	0	2,520	707	2,520	28.1%	0	3,309	1,053	3,309	31.8%	31.8%	$442,000	$140,655
10	Lahaina Bypass Highway and Leiali'i Parkway	0	2,537	740	2,537	29.2%	0	3,442	1,207	3,442	35.1%	35.1%	$442,000	$154,995
												Phase A Subtotal	*$2,393,000*	*$1,633,228*
Additional Mitigation for Phases A + B - 2036														
4	Honoapi'ilani Hwy (SR-30) & Keawe St	2,588	3,937	575	1,349	42.6%	3,108	4,821	808	1,713	47.2%	100.0%	$454,000	$454,000
												Phase B Subtotal	*$454,000*	*$454,000*
TOTAL													**$2,847,000**	**$2,087,228**

Notes:

* The impact at this location is identified as both a cumulative impact and a project-specific impact. Cost estimates for each mitigation measure were provided by Belt Collins Hawaii, Ltd.

TABLE 16

PROJECT'S ESTIMATED SHARE OF TRAFFIC MITIGATION COSTS (YEARS 2028 AND 2036)

CONCEPT 3

Int #	Intersection	AM Peak Hour					PM Peak Hour					Maximum Contribution	Cost Estimate for the Mitigation Measures	Leiali'i Share
		Existing Traffic	2028 with Project Traffic	Project Traffic	Total New Traffic	Project % of New Traffic	Existing Traffic	2028 with Project Traffic	Project Traffic	Total New Traffic	Project % of New Traffic			
Mitigation for Phase A - 2028														
2	Honoapi'ilani Hwy (SR-30) & Wahikuli Road*	2,494	3,053	426	559	76.2%	2,991	4,024	645	1,033	62.4%	76.2%	$580,000	$442,004
3	Honoapi'ilani Hwy (SR-30) & Kapunakea Street	2,576	3,797	493	1,221	40.4%	2,858	4,707	828	1,849	44.8%	100.0%	$9,000	$9,000
4	Honoapi'ilani Hwy (SR-30) & Keawe St	2,588	3,633	606	1,045	58.0%	3,108	4,682	920	1,574	58.4%	100.0%	$45,000	$45,000
5	Mill Street & Keawe St	0	1,121	806	1,121	71.9%	0	1,728	1,140	1,728	66.0%	100.0%	$442,000	$442,000
6	Keawe St & Industrial Phase A Connection	0	1,352	1,261	1,352	93.3%	0	1,891	1,752	1,891	92.6%	100.0%	$442,000	$442,000
9	Lahaina Bypass Highway and Wahikuli Rd	0	2,551	741	2,551	29.0%	0	3,334	1,088	3,334	32.6%	32.6%	$442,000	$144,240
10	Lahaina Bypass Highway and Leiali'i Parkway	0	2,540	743	2,540	29.3%	0	3,355	1,132	3,355	33.7%	33.7%	$442,000	$149,125
												Phase A Subtotal	*$2,402,000*	*$1,673,369*
Additional Mitigation for Phases A + B - 2036														
4	Honoapi'ilani Hwy (SR-30) & Keawe St	2,588	4,068	706	1,480	47.7%	3,108	5,030	1,017	1,922	52.9%	100.0%	$454,000	$454,000
												Phase B Subtotal	*$454,000*	*$454,000*
TOTAL													**$2,856,000**	**$2,127,369**

Notes:

* The impact at this location is identified as both a cumulative impact and a project-specific impact. Cost estimates for each mitigation measure were provided by Belt Collins Hawaii, Ltd.

- Keawe Street & Industrial Phase A Connection (Intersection 6) – The cost estimate for the proposed mitigation measure at this location is approximately $442,000, of which 100% is attributable to the project.

- Lahaina Bypass Highway & Wahikuli Road (Intersection 9) – The cost estimate for the proposed mitigation measures at this location is approximately $442,000. The project's contribution varies by each concept plan as follows:

    - Concept 1 – Approximately 29% or $129,000 of the mitigation costs are attributable to the project.
    - Concept 2 – Approximately 32% or $141,000 of the mitigation costs are attributable to the project.
    - Concept 3 – Approximately 33% or $144,000 of the mitigation costs are attributable to the project.

- Lahaina Bypass Highway & Leiali'i (Intersection 10) – The cost estimate for the proposed mitigation measures at this location is approximately $442,000. The project's contribution varies by each concept plan as follows:

    - Concept 1 – Approximately 33% or $144,000 of the mitigation costs are attributable to the project.
    - Concept 2 – Approximately 35% or $155,000 of the mitigation costs are attributable to the project.
    - Concept 3 – Approximately 34% or $149,000 of the mitigation costs are attributable to the project.

Phase B – 2036

The additional mitigation costs for the significantly impacted intersections in 2036 under all three concept plans, except as noted, are summarized below and in Tables 14 through 16.

- Honoapi'ilani Highway & Wahikuli Road (Intersection 2) – The impact at this intersection is mitigated by the improvement in Phase A; no additional mitigation is required.

- Honoapi'ilani Highway & Kapunakea Street (Intersection 3, Concept 3 only) – The impact at this intersection is mitigated by the improvement in Phase A; no additional mitigation is required.

- Honoapi'ilani Highway & Keawe Street (Intersection 4) – Under Concepts 2 and 3 the cost estimate for the proposed mitigation measure at this location is approximately $454,000, of which 100% is attributable to the project. Under Concept 1 the cost estimate for the proposed measures is $499,000 ($45,000 + $454,000), as it includes both elements of the improvement program developed for this intersection.

- Mill Street & Keawe Street (Intersection 5) – The impact at this intersection is mitigated by the improvement in Phase A; no additional mitigation is required.

- Keawe Street & Industrial Phase A Connection (Intersection 6) – The impact at this intersection is mitigated by the improvement in Phase A; no additional mitigation is required.

- Lahaina Bypass Highway & Wahikuli Road (Intersection 9) – The impact at this intersection is mitigated by the improvement in Phase A; no additional mitigation is required.

- Lahaina Bypass Highway & Leiali'i (Intersection 10) – The impact at this intersection is mitigated by the improvement in Phase A; no additional mitigation is required.

Under 2028 conditions, as shown in Tables 14, 15 and 16, the project's estimated contribution for the identified intersection improvement costs ranges from $1,542,500 (under Concept 1) to $1,633,200 (Concept 2) to $1,673,400 (Concept 3). Under 2036 conditions, the project's additional contribution for the identified intersection improvement costs ranges from $499,000 (Concept 1) to $454,000 (Concept 2) to $454,000 (Concept 3). The total project contribution for the identified intersection improvement costs ranges from $2,041,500 (Concept 1) to $2,087,200 (Concept 2) to $2,127,400 (Concept 3), as shown in Tables 14, 15, and 16, respectively.

ASSESSMENT OF PROPOSED PEDESTRIAN, BICYCLE AND STREET NETWORK

The Villages of Leiali`i Affordable Housing Project follows new urbanist design principles that include compact, higher-density, mixed-uses, and an emphasis on walkability and connectivity. The three Concept Plans differ in terms of land use layouts, densities, and types, however; all three concepts provide extensive pedestrian and bicycle networks on the project site.

Under Concepts 1, 2, and 3, the makai phase of the project to be completed by 2028 predominantly consists of a grid street network with relatively short and similarly spaced blocks. Pedestrian circulation is accommodated by the provision of sidewalks on all streets. As a result, pedestrian access is provided to retail, office, school, park, and residential uses. The proposed project improves on the existing pedestrian network in the area, which lacks sidewalks in many locations and limits pedestrian accessibility at locations with cul-de-sacs. The mauka phase of the project to be completed by 2036 also provides sidewalks on all streets; however; the pedestrian circulation system differs in that it does not reflect a grid network.

It is recommended that the use of long cul-de-sac streets be minimized and local street connectivity be promoted, which would make walking to schools, parks, and other pedestrian generators a viable transport option in all phases of the project. Relocation of the elementary school in Phase B to a more central location could improve the accessibility to pedestrians in the southern and central area of Phase B, subject to the constraints of topography. It is recommended that high demand pedestrian generators include amenities such as shade, benches, trash receptacles, pedestrian scale lighting, wayfinding, and compliance with ADA best practices for pedestrians.

Both phases of the project propose bike lanes under Concepts 1, 2, and 3. Under all three concepts, at least two bike lanes providing north-south access and two bike lanes providing east-west access are proposed in Phase A (makai). In Phase B (mauka), all three concepts propose bike lanes for the two major circulator roads serving the residential and school uses. It is recommended that short-term and long-term bicycle parking be provided at major traffic generators such as retail, office, schools, parks, and civic uses.

Four roundabouts would be constructed as part of Concept 3. Fehr & Peers evaluated the proximity of the plan's proposed roundabouts to the Lahaina Bypass Highway and to Keawe Street. Specifically, the estimated queues on the side streets were reviewed at the key Lahaina Bypass Highway and Keawe Street intersections listed below for the purpose of determining if the projected queues could impact the operations of the adjacent roundabouts.

- West of Phase A Connection to Industrial Area & Keawe Street (Intersection 6)
- East of Lahaina Bypass Highway & Wahikuli Road (Intersection 9)
- East and west of Lahaina Bypass Highway & Leiali'i Parkway (Intersection 10)

Recognizing that the site plan for Concept 3 shown in Figure 4 (page 5 of this report) is conceptual at this time, the general location of the roundabouts in relation to the nearby arterial streets was reviewed. While the location of the roundabouts near Intersections 9 and 10 appears to allow for adequate queue length storage, the projected maximum eastbound queue at Intersection 6 appears to exceed the available queuing space. The projected 95th percentile queue on the eastbound approach to Intersection 6 under Concept 3 is up to 325 feet. Therefore the ultimate design of the project in that area, if Concept 3 is pursued, should allow for at least that much distance between Intersection 6 and the roundabout. On the westbound approach to Intersection 9, at least 225 feet of queuing space should be provided. On the eastbound and westbound approaches to Intersection 10, at least 200 feet and 300 feet of queuing space should be provided, respectively. As design of the roadway system in the project area occurs, the need to provide adequate distance between the proposed roundabouts and nearby intersections should be taken into account.

CHAPTER 5. STREET SEGMENT ANALYSIS

This chapter presents an analysis of the proposed project's potential impacts on several key street segments in the project vicinity. The analysis was conducted to ensure the local roadway was properly sized and includes the following seven street segments, shown in Figure 5:

1. Honoapi'ilani Highway south of Leiali'i Parkway
2. Honoapi'ilani Highway south of Wahikuli Road
3. Honoapi'ilani Highway south of Lahainaluna Road
4. Lahaina Bypass Highway south of Leiali'i Parkway (future roadway)
5. Lahaina Bypass Highway south of Wahikuli Road (future roadway)
6. Keawe Street south of Lahaina Bypass Highway (future roadway
7. Mill Street south of Keawe Street (future roadway)

The peak hour volumes at each existing location were based on traffic counts conducted at adjacent intersections in May 2010, as well as new 24-hour machine counts. The peak hour traffic volumes on the seven study street segments under existing conditions are shown in Tables 17 through 22.

For the purpose of this analysis, the classification of each analyzed street segment was based on its physical and functional characteristics. The capacity of each facility was defined as the maximum hourly rate at which vehicles can reasonably be expected to traverse a point or uniform section of a roadway under prevailing roadway, traffic, and control conditions. *Highway Capacity Manual* standards were used to determine segment LOS. A capacity of 1,250 vehicles per hour per lane (vphpl) was used for major arterial streets (Honoapi'ilani Highway and Lahaina Bypass), 800 vphpl was used for secondary arterial streets (Keawe Street) and 600 vphpl was used for collector streets (Mill Street).

Estimates of future peak hour traffic volumes for the seven street segments were developed by increasing the existing peak hour traffic volumes to reflect the ambient growth and related development projects on the street system in the study area (cumulative base conditions) and then assigning the new project-generated trips using the same geographic distribution pattern described in Chapter 3. The existing and forecast peak hour street segment traffic volumes are presented in Tables 17 through 22 for Concepts 1, 2, and 3, respectively. Level of service definitions for street segments are provided in Table 23.

As shown, each of the analyzed directional street segments is projected to operate at LOS D or better under both cumulative base and cumulative base plus project conditions. Thus, no cumulative or project-specific impacts are identified on the seven analyzed street segments.

TABLE 17
STREET SEGMENT IMPACT ANALYSIS 2028 - CONCEPT 1

Segment	Location	Facility Type	Peak Hour	Dir.	EXISTING (2010)			CUMULATIVE BASE (2028)			CUMULATIVE PLUS PROJECT (2028)			LOS D OR BETTER
					Volumes	V/C	LOS	Volumes	V/C	LOS	Volumes	V/C	LOS	
1. Honoapi'ilani Hwy	south of Leiali'i Pkwy	Major Arterial	A.M.	NB	1,284	0.51	A	1,311	0.52	A	1,396	0.56	A	YES
				SB	1,167	0.47	A	1,265	0.51	A	1,370	0.55	A	YES
			P.M.	NB	1,429	0.57	A	1,637	0.65	B	1,802	0.72	C	YES
				SB	1,470	0.59	A	1,639	0.66	B	1,785	0.71	C	YES
2. Honoapi'ilani Hwy	south of Wahikuli Rd	Major Arterial	A.M.	NB	1,266	0.51	A	1,285	0.51	A	1,364	0.55	A	YES
				SB	1,153	0.46	A	1,264	0.51	A	1,390	0.56	A	YES
			P.M.	NB	1,482	0.59	A	1,695	0.68	B	1,888	0.76	C	YES
				SB	1,433	0.57	A	1,604	0.64	B	1,759	0.70	B	YES
3. Honoapi'ilani Hwy	south of Lahainaluna Rd	Major Arterial	A.M.	NB	847	0.34	A	1,047	0.42	A	1,154	0.46	A	YES
				SB	1,086	0.43	A	1,274	0.51	A	1,346	0.54	A	YES
			P.M.	NB	881	0.35	A	1,266	0.51	A	1,381	0.55	A	YES
				SB	1,158	0.46	A	1,456	0.58	A	1,622	0.65	B	YES
4. Lahaina Bypass Hwy	south of Leiali'i Pkwy	Major Arterial	A.M.	NB	Future Segment			910	0.36	A	1,128	0.45	A	YES
				SB				880	0.35	A	1,180	0.47	A	YES
			P.M.	NB				1,111	0.44	A	1,595	0.64	B	YES
				SB				1,106	0.44	A	1,500	0.60	A	YES
5. Lahaina Bypass Hwy	south of Wahikuli Rd	Major Arterial	A.M.	NB	Future Segment			915	0.37	A	1,096	0.44	A	YES
				SB				883	0.35	A	1,179	0.47	A	YES
			P.M.	NB				1,122	0.45	A	1,608	0.64	B	YES
				SB				1,115	0.45	A	1,474	0.59	A	YES
6. Keawe Street	south of Lahaina Bypass Hwy	Secondary Arterial	A.M.	NB	Future Segment			47	0.02	A	245	0.10	A	YES
				SB				44	0.02	A	388	0.16	A	YES
			P.M.	NB				59	0.02	A	601	0.24	A	YES
				SB				80	0.03	A	433	0.17	A	YES
7. Mill Street	south of Keawe St	Collector Road	A.M.	NB	Future Segment			82	0.03	A	250	0.10	A	YES
				SB				27	0.01	A	143	0.06	A	YES
			P.M.	NB				54	0.02	A	243	0.10	A	YES
				SB				90	0.04	A	355	0.14	A	YES

TABLE 18
STREET SEGMENT IMPACT ANALYSIS 2028 - CONCEPT 2

Segment	Location	Facility Type	Peak Hour	Dir.	EXISTING (2010)			CUMULATIVE BASE (2028)			CUMULATIVE PLUS PROJECT (2028)			LOS D OR BETTER
					Volumes	V/C	LOS	Volumes	V/C	LOS	Volumes	V/C	LOS	
1. Honoapi'ilani Hwy	south of Leiali'i Pkwy	Major Arterial	A.M.	NB	1,284	0.51	A	1,311	0.52	A	1,411	0.56	A	YES
				SB	1,167	0.47	A	1,265	0.51	A	1,392	0.56	A	YES
			P.M.	NB	1,429	0.57	A	1,637	0.65	B	1,822	0.73	C	YES
				SB	1,470	0.59	A	1,639	0.66	B	1,801	0.72	C	YES
2. Honoapi'ilani Hwy	south of Wahikuli Rd	Major Arterial	A.M.	NB	1,266	0.51	A	1,285	0.51	A	1,369	0.55	A	YES
				SB	1,153	0.46	A	1,264	0.51	A	1,426	0.57	A	YES
			P.M.	NB	1,482	0.59	A	1,695	0.68	B	1,916	0.77	C	YES
				SB	1,433	0.57	A	1,604	0.64	B	1,772	0.71	C	YES
3. Honoapi'ilani Hwy	south of Lahainaluna Rd	Major Arterial	A.M.	NB	847	0.34	A	1,047	0.42	A	1,158	0.46	A	YES
				SB	1,086	0.43	A	1,274	0.51	A	1,371	0.55	A	YES
			P.M.	NB	881	0.35	A	1,266	0.51	A	1,401	0.56	A	YES
				SB	1,158	0.46	A	1,456	0.58	A	1,631	0.65	B	YES
4. Lahaina Bypass Hwy	south of Leiali'i Pkwy	Major Arterial	A.M.	NB	Future Segment			910	0.36	A	1,195	0.48	A	YES
				SB				880	0.35	A	1,217	0.49	A	YES
			P.M.	NB				1,111	0.44	A	1,640	0.66	B	YES
				SB				1,106	0.44	A	1,561	0.62	B	YES
5. Lahaina Bypass Hwy	south of Wahikuli Rd	Major Arterial	A.M.	NB	Future Segment			915	0.37	A	1,146	0.46	A	YES
				SB				883	0.35	A	1,223	0.49	A	YES
			P.M.	NB				1,122	0.45	A	1,655	0.66	B	YES
				SB				1,115	0.45	A	1,524	0.61	B	YES
6. Keawe Street	south of Lahaina Bypass Hwy	Secondary Arterial	A.M.	NB	Future Segment			47	0.02	A	317	0.13	A	YES
				SB				44	0.02	A	405	0.16	A	YES
			P.M.	NB				59	0.02	A	634	0.25	A	YES
				SB				80	0.03	A	494	0.20	A	YES
7. Mill Street	south of Keawe St	Collector Road	A.M.	NB	Future Segment			82	0.03	A	257	0.10	A	YES
				SB				27	0.01	A	184	0.07	A	YES
			P.M.	NB				54	0.02	A	277	0.11	A	YES
				SB				90	0.04	A	371	0.15	A	YES

TABLE 19
STREET SEGMENT IMPACT ANALYSIS 2028 - CONCEPT 3

Segment	Location	Facility Type	Peak Hour	Dir.	EXISTING (2010)			CUMULATIVE BASE (2028)			CUMULATIVE PLUS PROJECT (2028)			LOS D OR BETTER
					Volumes	V/C	LOS	Volumes	V/C	LOS	Volumes	V/C	LOS	
1. Honoapi'ilani Hwy	south of Leiali'i Pkwy	Major Arterial	A.M.	NB	1,284	0.51	A	1,311	0.52	A	1,466	0.59	A	YES
				SB	1,167	0.47	A	1,265	0.51	A	1,449	0.58	A	YES
			P.M.	NB	1,429	0.57	A	1,637	0.65	B	1,922	0.77	C	YES
				SB	1,470	0.59	A	1,639	0.66	B	1,889	0.76	C	YES
2. Honoapi'ilani Hwy	south of Wahikuli Rd	Major Arterial	A.M.	NB	1,266	0.51	A	1,285	0.51	A	1,421	0.57	A	YES
				SB	1,153	0.46	A	1,264	0.51	A	1,460	0.58	A	YES
			P.M.	NB	1,482	0.59	A	1,695	0.68	B	1,984	0.79	C	YES
				SB	1,433	0.57	A	1,604	0.64	B	1,841	0.74	C	YES
3. Honoapi'ilani Hwy	south of Lahainaluna Rd	Major Arterial	A.M.	NB	847	0.34	A	1,047	0.42	A	1,206	0.48	A	YES
				SB	1,086	0.43	A	1,274	0.51	A	1,417	0.57	A	YES
			P.M.	NB	881	0.35	A	1,266	0.51	A	1,479	0.59	A	YES
				SB	1,158	0.46	A	1,456	0.58	A	1,720	0.69	B	YES
4. Lahaina Bypass Hwy	south of Leiali'i Pkwy	Major Arterial	A.M.	NB	Future Segment			910	0.36	A	1,168	0.47	A	YES
				SB				880	0.35	A	1,252	0.50	A	YES
			P.M.	NB				1,111	0.44	A	1,653	0.66	B	YES
				SB				1,106	0.44	A	1,518	0.61	B	YES
5. Lahaina Bypass Hwy	south of Wahikuli Rd	Major Arterial	A.M.	NB	Future Segment			915	0.37	A	1,118	0.45	A	YES
				SB				883	0.35	A	1,239	0.50	A	YES
			P.M.	NB				1,122	0.45	A	1,633	0.65	B	YES
				SB				1,115	0.45	A	1,463	0.59	A	YES
6. Keawe Street	south of Lahaina Bypass Hwy	Secondary Arterial	A.M.	NB	Future Segment			47	0.02	A	297	0.12	A	YES
				SB				44	0.02	A	452	0.18	A	YES
			P.M.	NB				59	0.02	A	670	0.27	A	YES
				SB				80	0.03	A	464	0.19	A	YES
7. Mill Street	south of Keawe St	Collector Road	A.M.	NB	Future Segment			82	0.03	A	276	0.11	A	YES
				SB				27	0.01	A	174	0.07	A	YES
			P.M.	NB				54	0.02	A	256	0.10	A	YES
				SB				90	0.04	A	380	0.15	A	YES

TABLE 20
STREET SEGMENT IMPACT ANALYSIS 2036 - CONCEPT 1

Segment	Location	Facility Type	Peak Hour	Dir.	EXISTING (2010)			CUMULATIVE BASE (2036)			CUMULATIVE PLUS PROJECT (2036)			LOS D OR BETTER
					Volumes	V/C	LOS	Volumes	V/C	LOS	Volumes	V/C	LOS	
1. Honoapi'ilani Hwy	south of Leiali'i Pkwy	Major Arterial	A.M.	NB	1,284	0.51	A	1,470	0.59	A	1,626	0.65	B	YES
				SB	1,167	0.47	A	1,422	0.57	A	1,596	0.64	B	YES
			P.M.	NB	1,429	0.57	A	1,754	0.70	B	1,991	0.80	C	YES
				SB	1,470	0.59	A	1,757	0.70	B	1,977	0.79	C	YES
2. Honoapi'ilani Hwy	south of Wahikuli Rd	Major Arterial	A.M.	NB	1,266	0.51	A	1,446	0.58	A	1,553	0.62	B	YES
				SB	1,153	0.46	A	1,423	0.57	A	1,617	0.65	B	YES
			P.M.	NB	1,482	0.59	A	1,816	0.73	C	2,069	0.83	D	YES
				SB	1,433	0.57	A	1,722	0.69	B	1,914	0.77	C	YES
3. Honoapi'ilani Hwy	south of Lahainaluna Rd	Major Arterial	A.M.	NB	847	0.34	A	1,201	0.48	A	1,320	0.53	A	YES
				SB	1,086	0.43	A	1,429	0.57	A	1,525	0.61	B	YES
			P.M.	NB	881	0.35	A	1,374	0.55	A	1,509	0.60	A	YES
				SB	1,158	0.46	A	1,571	0.63	B	1,749	0.70	B	YES
4. Lahaina Bypass Hwy	south of Leiali'i Pkwy	Major Arterial	A.M.	NB	Future Segment			1,016	0.41	A	1,430	0.57	A	YES
				SB				984	0.39	A	1,518	0.61	B	YES
			P.M.	NB				1,189	0.48	A	1,897	0.76	C	YES
				SB				1,183	0.47	A	1,775	0.71	C	YES
5. Lahaina Bypass Hwy	south of Wahikuli Rd	Major Arterial	A.M.	NB	Future Segment			1,019	0.41	A	1,350	0.54	A	YES
				SB				988	0.40	A	1,631	0.65	B	YES
			P.M.	NB				1,200	0.48	A	1,994	0.80	C	YES
				SB				1,192	0.48	A	1,738	0.70	B	YES
6. Keawe Street	south of Lahaina Bypass Hwy	Secondary Arterial	A.M.	NB	Future Segment			50	0.02	A	317	0.13	A	YES
				SB				45	0.02	A	552	0.22	A	YES
			P.M.	NB				61	0.02	A	750	0.30	A	YES
				SB				83	0.03	A	525	0.21	A	YES
7. Mill Street	south of Keawe St	Collector Road	A.M.	NB	Future Segment			88	0.04	A	290	0.12	A	YES
				SB				28	0.01	A	223	0.09	A	YES
			P.M.	NB				57	0.02	A	317	0.13	A	YES
				SB				96	0.04	A	404	0.16	A	YES

TABLE 21
STREET SEGMENT IMPACT ANALYSIS 2036 - CONCEPT 2

Segment	Location	Facility Type	Peak Hour	Dir.	EXISTING (2010)			CUMULATIVE BASE (2036)			CUMULATIVE PLUS PROJECT (2036)			LOS D OR BETTER
					Volumes	V/C	LOS	Volumes	V/C	LOS	Volumes	V/C	LOS	
1. Honoapi'ilani Hwy	south of Leiali'i Pkwy	Major Arterial	A.M.	NB	1,284	0.51	A	1,470	0.59	A	1,641	0.66	B	YES
				SB	1,167	0.47	A	1,422	0.57	A	1,617	0.65	B	YES
			P.M.	NB	1,429	0.57	A	1,754	0.70	B	2,011	0.80	C	YES
				SB	1,470	0.59	A	1,757	0.70	B	1,993	0.80	C	YES
2. Honoapi'ilani Hwy	south of Wahikuli Rd	Major Arterial	A.M.	NB	1,266	0.51	A	1,446	0.58	A	1,559	0.62	B	YES
				SB	1,153	0.46	A	1,423	0.57	A	1,652	0.66	B	YES
			P.M.	NB	1,482	0.59	A	1,816	0.73	C	2,097	0.84	D	YES
				SB	1,433	0.57	A	1,722	0.69	B	1,927	0.77	C	YES
3. Honoapi'ilani Hwy	south of Lahainaluna Rd	Major Arterial	A.M.	NB	847	0.34	A	1,201	0.48	A	1,324	0.53	A	YES
				SB	1,086	0.43	A	1,429	0.57	A	1,549	0.62	B	YES
			P.M.	NB	881	0.35	A	1,374	0.55	A	1,529	0.61	B	YES
				SB	1,158	0.46	A	1,571	0.63	B	1,759	0.70	B	YES
4. Lahaina Bypass Hwy	south of Leiali'i Pkwy	Major Arterial	A.M.	NB	Future Segment			1,007	0.40	A	1,499	0.60	A	YES
				SB				984	0.39	A	1,554	0.62	B	YES
			P.M.	NB				1,183	0.47	A	1,942	0.78	C	YES
				SB				1,183	0.47	A	1,836	0.73	C	YES
5. Lahaina Bypass Hwy	south of Wahikuli Rd	Major Arterial	A.M.	NB	Future Segment			1,019	0.41	A	1,400	0.56	A	YES
				SB				988	0.40	A	1,675	0.67	B	YES
			P.M.	NB				1,200	0.48	A	2,041	0.82	D	YES
				SB				1,192	0.48	A	1,788	0.72	C	YES
6. Keawe Street	south of Lahaina Bypass Hwy	Secondary Arterial	A.M.	NB	Future Segment			50	0.02	A	389	0.16	A	YES
				SB				45	0.02	A	570	0.23	A	YES
			P.M.	NB				61	0.02	A	782	0.31	A	YES
				SB				83	0.03	A	585	0.23	A	YES
7. Mill Street	south of Keawe St	Collector Road	A.M.	NB	Future Segment			88	0.04	A	297	0.12	A	YES
				SB				28	0.01	A	264	0.11	A	YES
			P.M.	NB				57	0.02	A	351	0.14	A	YES
				SB				96	0.04	A	420	0.17	A	YES

TABLE 22
STREET SEGMENT IMPACT ANALYSIS 2036 - CONCEPT 3

Segment	Location	Facility Type	Peak Hour	Dir.	EXISTING (2010)			CUMULATIVE BASE (2036)			CUMULATIVE PLUS PROJECT (2036)			LOS D OR BETTER
					Volumes	V/C	LOS	Volumes	V/C	LOS	Volumes	V/C	LOS	
1. Honoapi'ilani Hwy	south of Leiali'i Pkwy	Major Arterial	A.M.	NB	1,284	0.51	A	1,470	0.59	A	1,688	0.68	B	YES
				SB	1,167	0.47	A	1,422	0.57	A	1,666	0.67	B	YES
			P.M.	NB	1,429	0.57	A	1,754	0.70	B	2,105	0.84	D	YES
				SB	1,470	0.59	A	1,757	0.70	B	2,074	0.83	D	YES
2. Honoapi'ilani Hwy	south of Wahikuli Rd	Major Arterial	A.M.	NB	1,266	0.51	A	1,446	0.58	A	1,607	0.64	B	YES
				SB	1,153	0.46	A	1,423	0.57	A	1,679	0.67	B	YES
			P.M.	NB	1,482	0.59	A	1,816	0.73	C	2,161	0.86	D	YES
				SB	1,433	0.57	A	1,722	0.69	B	1,992	0.80	C	YES
3. Honoapi'ilani Hwy	south of Lahainaluna Rd	Major Arterial	A.M.	NB	847	0.34	A	1,201	0.48	A	1,370	0.55	A	YES
				SB	1,086	0.43	A	1,429	0.57	A	1,593	0.64	B	YES
			P.M.	NB	881	0.35	A	1,374	0.55	A	1,605	0.64	B	YES
				SB	1,158	0.46	A	1,571	0.63	B	1,847	0.74	C	YES
4. Lahaina Bypass Hwy	south of Leiali'i Pkwy	Major Arterial	A.M.	NB	Future Segment			1,007	0.40	A	1,451	0.58	A	YES
				SB				984	0.39	A	1,566	0.63	B	YES
			P.M.	NB				1,183	0.47	A	1,935	0.77	C	YES
				SB				1,183	0.47	A	1,775	0.71	C	YES
5. Lahaina Bypass Hwy	south of Wahikuli Rd	Major Arterial	A.M.	NB	Future Segment			1,019	0.41	A	1,351	0.54	A	YES
				SB				988	0.40	A	1,655	0.66	B	YES
			P.M.	NB				1,200	0.48	A	1,993	0.80	C	YES
				SB				1,192	0.48	A	1,708	0.68	B	YES
6. Keawe Street	south of Lahaina Bypass Hwy	Secondary Arterial	A.M.	NB	Future Segment			50	0.02	A	359	0.14	A	YES
				SB				45	0.02	A	600	0.24	A	YES
			P.M.	NB				61	0.02	A	806	0.32	A	YES
				SB				83	0.03	A	546	0.22	A	YES
7. Mill Street	south of Keawe St	Collector Road	A.M.	NB	Future Segment			88	0.04	A	312	0.12	A	YES
				SB				28	0.01	A	246	0.10	A	YES
			P.M.	NB				57	0.02	A	324	0.13	A	YES
				SB				96	0.04	A	425	0.17	A	YES

TABLE 23
STREET SEGMENT LEVEL OF SERVICE DEFINITIONS

LOS	V/C	Definition
A	0.000 - 0.600	Describes primarily free-flow conditions at average travel speeds, usually about 90% of the free-flow speed. Vehicles are completely unimpeded in their ability to maneuver within the traffic stream. Control delay at intersections is minimal.
B	0.600 - 0.700	Describes reasonably unimpeded operations at average travel speeds, usually about 70% of free-flow speed. The ability to maneuver within the traffic stream is only slightly restricted, and control delays at intersections are not significant.
C	0.700 - 0.800	Describes stable operation; however, ability to maneuver and change lanes in mid-block locations may be more restricted than at LOS B, and longer queues, adverse signal coordination, or both may contribute to lower average travel speeds of about 50% of free-flow speed.
D	0.800 - 0.900	Borders on a range in which small increases in flow may cause substantial increases in delay and decreases in travel speed. LOS D may be due to adverse signal progression, inappropriate signal timing, high volumes or a combination of these factors. Average travel speeds are about 40% of free-flow speed.
E	0.900 - 1.000	Characterized by significant delays and average travel speeds of 33% or less of free-flow speed. Such operations are caused by a combination of adverse progression, high signal density, high volumes, extensive delays at critical intersections, and inappropriate signal timing.
F	> 1.000	Characterized by urban street flow at extremely low speeds, typically one-third to one-fourth of the free-flow speed. Intersection congestion is likely at critical signalized locations, with high delays, high volumes, and extensive queuing.

Source: Highway Capacity Manual (Transportation Research Board, 2000).

CHAPTER 6. SUMMARY AND CONCLUSIONS

This study was undertaken to analyze potential traffic impacts of the proposed Villages of Leiali'i Affordable Housing Project in Lahaina. The following summarizes the key findings of the study:

- The proposed project is composed of two phases, located makai of the Lahaina Bypass Highway (Phase A) and mauka of the Lahaina Bypass Highway (Phase B). Phase A is planned for completion by 2028 and Phase B is planned for completion by 2036. Three alternative development scenarios, varying in the amount of new land uses that would be constructed, are analyzed in this traffic impact analysis report. The alternatives include the following range of land uses:

    - Between 1,386 and 2,135 single-family dwelling units
    - Between 788 and 2,719 multi-family dwelling units
    - Between 449,100 and 452,700 square feet of retail
    - Between 101,900 and 143,300 square feet of office
    - Between 17.2 and 21.8 acres of light industrial space
    - Between 313,800 and 321,300 square feet of elementary school buildings
    - Between 38 and 44 acres of park space
    - Multi-acre archeological preserve

- Peak hour capacity analyses were conducted for four existing and six future intersections in the vicinity of the project site. Three of the four existing intersections currently operate at LOS D or better during the weekday peak hours.

- Street segment analysis was conducted for seven street segments. Each of the three analyzed street segments that currently exist are operating at LOS D or better during the weekday peak hours.

- Concept 1 is expected to generate approximately 39,361 weekday daily trips, including approximately 2,990 trips during the weekday morning peak hour, and 4,170 trips during the weekday afternoon peak hour. Concept 2 is expected to generate approximately 43,352 weekday daily trips, including approximately 3,320 trips during the weekday morning peak hour, and 4,500 trips during the weekday afternoon peak hour. Concept 3, which generates the most project trips, is expected to generate approximately 45,595 weekday daily trips, including approximately 3,570 trips during the weekday morning peak hour, and 4,860 trips during the weekday afternoon peak hour.

- Analysis of projected year 2028 and 2036 cumulative base conditions, representing future conditions without the proposed project, indicates that three stop-controlled approaches at analyzed intersections would operate at LOS E or F during the AM peak hour, the PM peak hour, or both.

- Analysis of projected year 2028 cumulative base plus project conditions indicates that five, six, and seven of the analyzed intersections would operate at LOS E or F during one or both peak hours under Concept 1, Concept 2, and Concept 3, respectively. The project would result in two, three, or four project-specific traffic impacts (under Concepts 1, 2 and 3, respectively) and would contribute to three cumulative traffic impacts. The number of traffic impacts varies under Concepts 1, 2 and 3; however, the magnitude of those impacts would be greatest with Concept 3.

- Under year 2036 cumulative base plus project conditions, the analysis indicates that six of the study intersections would operate at LOS E or F during one or both peak hours under Concepts 1 and 2 and that seven analyzed intersections would operate at LOS E or F during one or both peak hours under Concept 3. The project would result in three or four project-specific traffic impacts and would contribute to three cumulative traffic impacts. The number of traffic impacts is the same Concepts 1 and 2, with an additional impact under Concept 3.

- Mitigation strategies were developed to address the identified deficiencies at the six study intersections with projected poor levels of service (LOS E or F). Each of the identified cumulative and project-related impacts could be fully mitigated with the recommended improvements.

- The estimated share of traffic mitigation costs was calculated for the proposed mitigations under year 2028 and 2036 cumulative base plus project conditions. The total project contribution for the identified intersection improvement costs ranges from $2,041,500 (Concept 1) to $2,087,200 (Concept 2) to $2,127,400 (Concept 3).

- Future increases in peak hour traffic volumes were evaluated for seven street segments. Street segment analysis of projected year 2028 and 2036 cumulative base plus project conditions indicates that all seven of those street segments could adequately accommodate the projected increase in peak hour volumes.

REFERENCES

2000 Highway Capacity Manual, Transportation Research Board, 2000.

Lahaina Bypass Modified Alignment Kahoma Stream to Keawe Street Extension, Department of Transportation, Highways Division, State of Hawaii, March 2009.

Manual on Uniform Traffic Control Devices, National Committee on Uniform Traffic Control Devices, 2003.

Traffic Generated by Mixed-Use Developments – A Six-Region Study Using Consistent Built Environmental Measures, Reid Ewing et al., September 2008.

Trip Generation, 8th Edition, Institute of Transportation Engineers, 2009.

Trip Generation Handbook, 2nd Edition, Institute of Transportation Engineers, 2004.

Villages of Leiali'i Affordable Housing Master Plan, Belt Collins Hawaii Ltd., December 2009.

APPENDIX A:
TRAFFIC COUNT DATA

Intersection Turning Movement

Prepared by:

National Data & Surveying Services

Honoapiilani Hwy and Leialii Pkwy , City of Lahaina

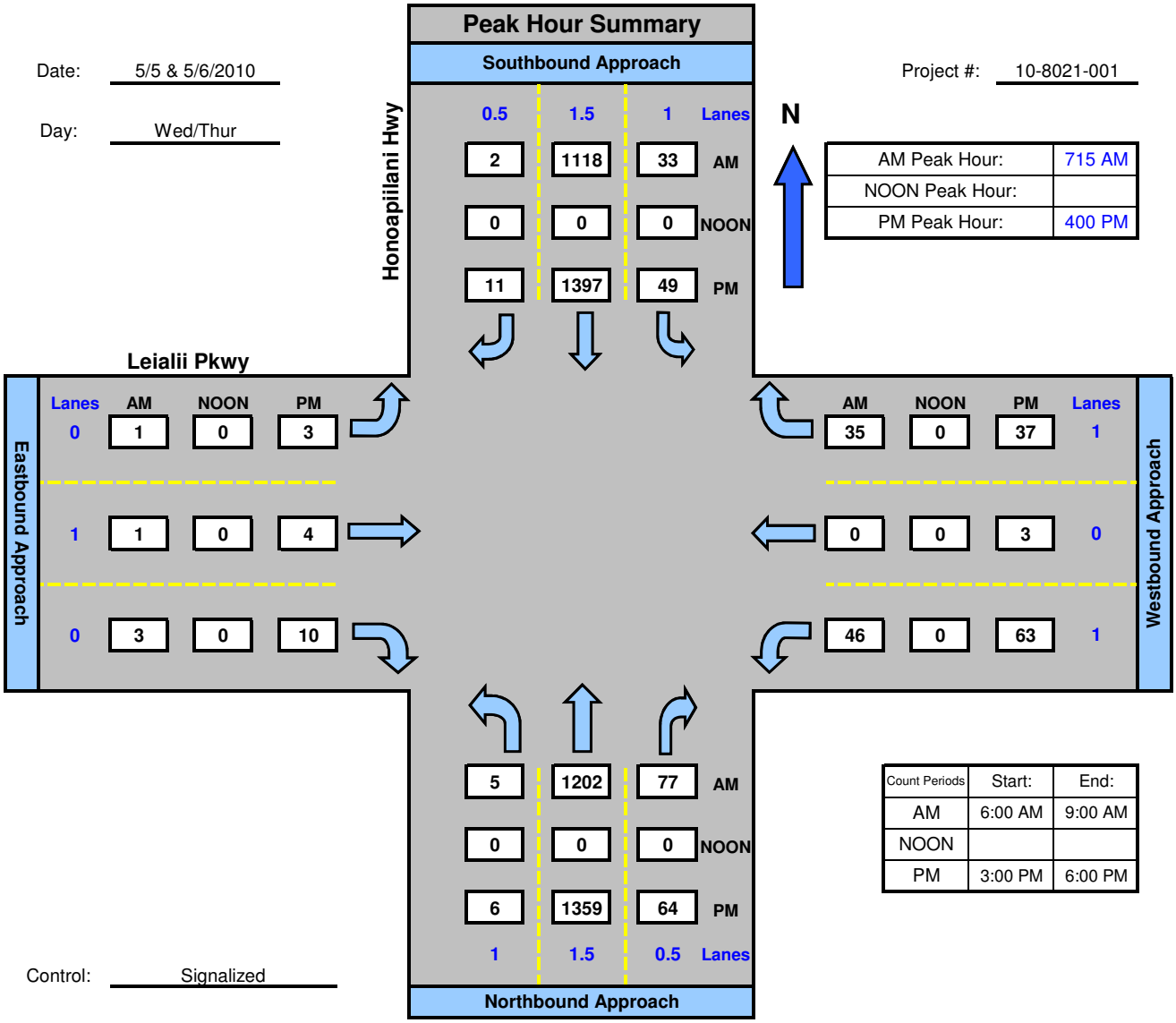
Date: 5/5 & 5/6/2010

Day: Wed/Thur

Project #: 10-8021-001

Peak Hour Summary

AM Peak Hour:	715 AM
NOON Peak Hour:	
PM Peak Hour:	400 PM



Count Periods	Start:	End:
AM	6:00 AM	9:00 AM
NOON		
PM	3:00 PM	6:00 PM

Control: Signalized

Intersection Turning Movement

Prepared by:

National Data & Surveying Services

Honoapiilani Hwy and Wahikuli Rd , City of Lahaina

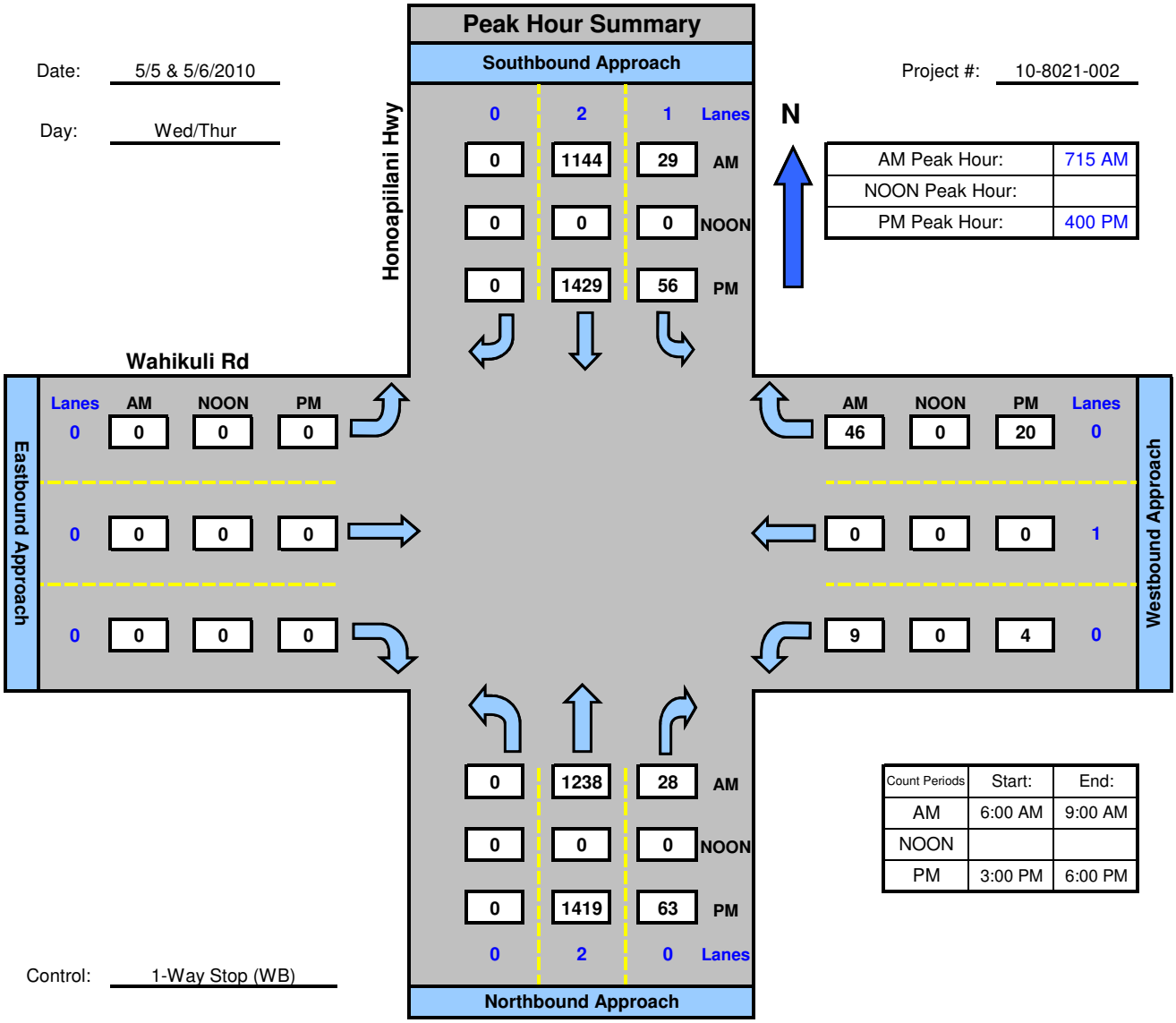
Date: 5/5 & 5/6/2010

Day: Wed/Thur

Project #: 10-8021-002

Peak Hour Summary

	AM Peak Hour:	715 AM
	NOON Peak Hour:	
	PM Peak Hour:	400 PM



Count Periods	Start:	End:
AM	6:00 AM	9:00 AM
NOON		
PM	3:00 PM	6:00 PM

Control: 1-Way Stop (WB)

Intersection Turning Movement

Prepared by:

National Data & Surveying Services

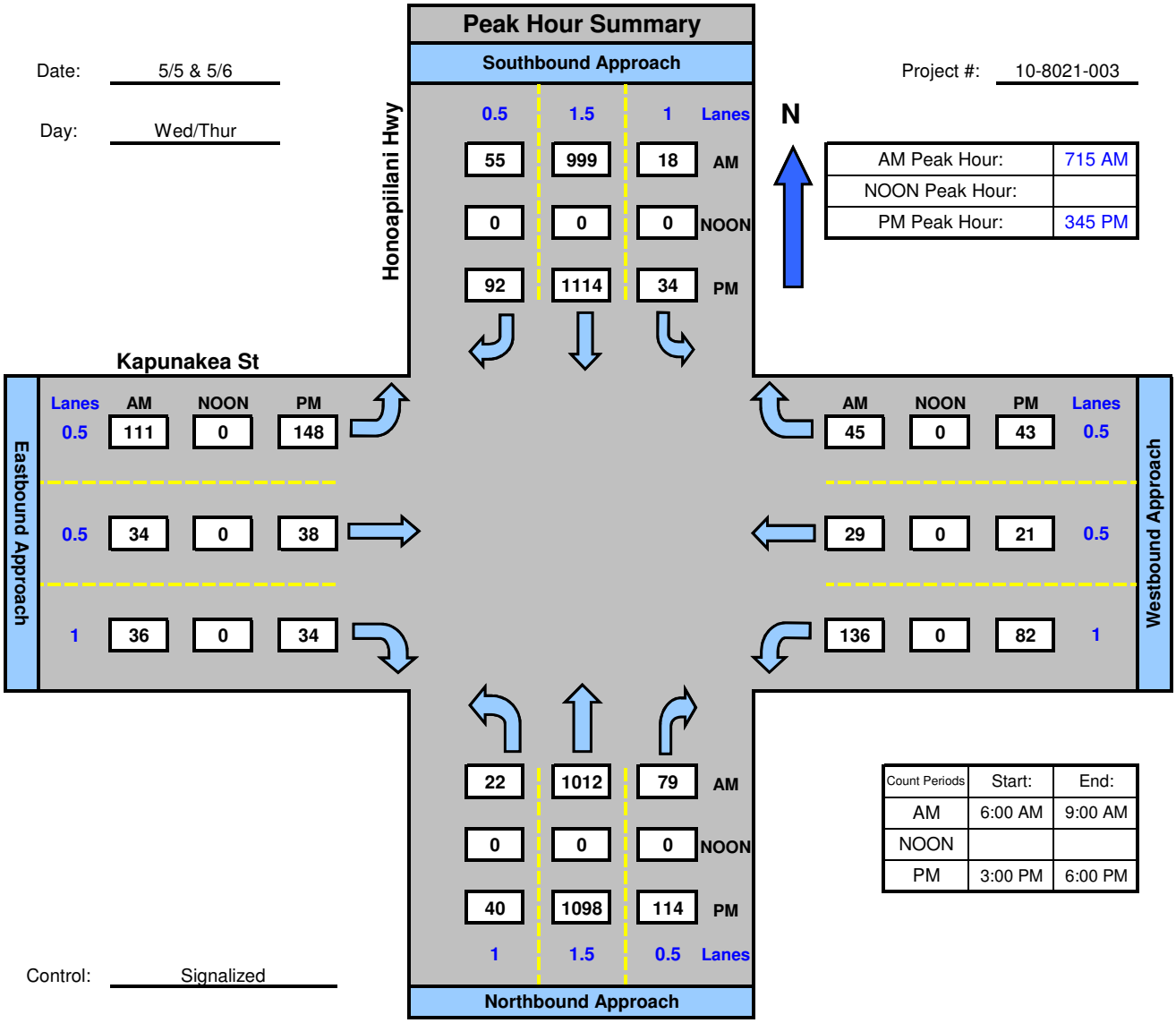
Honoapiilani Hwy and Kapunakea St , City of Lahaina

Date: 5/5 & 5/6

Day: Wed/Thur

Project #: 10-8021-003

AM Peak Hour:	715 AM
NOON Peak Hour:	
PM Peak Hour:	345 PM



Count Periods	Start:	End:
AM	6:00 AM	9:00 AM
NOON		
PM	3:00 PM	6:00 PM

Control: Signalized

Intersection Turning Movement

Prepared by:

National Data & Surveying Services

Honoapiilani Hwy and Keawe St , City of Lahaina

Date: 5/5 & 5/6/2010

Day: Wed/Thur

Project #: 10-8021-004

AM Peak Hour:	715 AM
NOON Peak Hour:	
PM Peak Hour:	400 PM

Peak Hour Summary

Southbound Approach — Honoapiilani Hwy

Lanes	0.5	1.5	1
AM	32	1078	66
NOON	0	0	0
PM	44	1084	117

N

Keawe St

Eastbound Approach

Lanes	AM	NOON	PM
0.5	14	0	61
0.5	26	0	49
1	56	0	122

Westbound Approach

AM	NOON	PM	Lanes
59	0	208	1
12	0	21	0.5
59	0	132	0.5

Northbound Approach

Lanes	1	2	1
AM	47	1027	112
NOON	0	0	0
PM	98	1015	157

Count Periods	Start:	End:
AM	6:00 AM	9:00 AM
NOON		
PM	3:00 PM	6:00 PM

Control: Signalized

APPENDIX B:
LEVEL OF SERVICE CALCULATIONS

EXISTING CONDITIONS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.92		1.00	0.85		1.00	0.99		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1695		1770	1583		1770	3507		1770	3538	
Flt Permitted		0.98		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1677		1405	1583		1770	3507		1770	3538	
Volume (vph)	1	1	3	46	0	35	5	1202	77	33	1118	2
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	1	1	3	49	0	37	5	1279	82	35	1189	2
RTOR Reduction (vph)	0	2	0	0	29	0	0	3	0	0	0	0
Lane Group Flow (vph)	0	3	0	49	8	0	5	1358	0	35	1191	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		3			7		5	2		1	6	
Permitted Phases	3			7								
Actuated Green, G (s)		31.0		31.0	31.0		5.0	89.2		5.8	90.0	
Effective Green, g (s)		32.0		32.0	32.0		5.0	90.2		5.8	91.0	
Actuated g/C Ratio		0.23		0.23	0.23		0.04	0.64		0.04	0.65	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		383		321	362		63	2260		73	2300	
v/s Ratio Prot					0.01		0.00	c0.39		c0.02	0.34	
v/s Ratio Perm		0.00		c0.03								
v/c Ratio		0.01		0.15	0.02		0.08	0.60		0.48	0.52	
Uniform Delay, d1		41.7		43.2	41.9		65.3	14.5		65.6	12.9	
Progression Factor		1.00		1.00	1.00		1.11	0.45		1.00	1.00	
Incremental Delay, d2		0.0		1.0	0.1		0.2	1.1		1.8	0.8	
Delay (s)		41.7		44.2	42.0		72.5	7.6		67.4	13.8	
Level of Service		D		D	D		E	A		E	B	
Approach Delay (s)		41.7			43.2			7.9			15.3	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	12.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	51.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	9	46	1238	28	29	1144
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	9	47	1276	29	30	1179
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1940	653			1305	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1940	653			1305	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	83	88			94	
cM capacity (veh/h)	54	410			526	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	57	851	454	30	590	590
Volume Left	9	0	0	30	0	0
Volume Right	47	0	29	0	0	0
cSH	197	1700	1700	526	1700	1700
Volume to Capacity	0.29	0.50	0.27	0.06	0.35	0.35
Queue Length 95th (ft)	28	0	0	5	0	0
Control Delay (s)	30.5	0.0	0.0	12.3	0.0	0.0
Lane LOS	D			B		
Approach Delay (s)	30.5	0.0		0.3		
Approach LOS	D					

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	45.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.91		1.00	0.99		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1794	1583	1770	1693		1770	3501		1770	3511	
Flt Permitted		0.69	1.00	0.48	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1281	1583	896	1693		1770	3501		1770	3511	
Volume (vph)	111	34	36	136	29	45	22	1012	79	18	999	55
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	118	36	38	145	31	48	23	1077	84	19	1063	59
RTOR Reduction (vph)	0	0	31	0	39	0	0	4	0	0	3	0
Lane Group Flow (vph)	0	154	7	145	40	0	23	1157	0	19	1119	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		24.0	24.0	24.0	24.0		3.0	100.0		2.0	99.0	
Effective Green, g (s)		25.0	25.0	25.0	25.0		3.0	101.0		2.0	100.0	
Actuated g/C Ratio		0.18	0.18	0.18	0.18		0.02	0.72		0.01	0.71	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		229	283	160	302		38	2526		25	2508	
v/s Ratio Prot					0.02		c0.01	c0.33		0.01	0.32	
v/s Ratio Perm		0.12	0.00	c0.16								
v/c Ratio		0.67	0.02	0.91	0.13		0.61	0.46		0.76	0.45	
Uniform Delay, d1		53.7	47.4	56.4	48.4		67.9	8.1		68.8	8.4	
Progression Factor		1.00	1.00	1.00	1.00		0.98	0.43		1.33	0.45	
Incremental Delay, d2		7.6	0.0	44.5	0.2		16.0	0.6		68.7	0.5	
Delay (s)		61.2	47.5	100.8	48.6		82.5	4.0		160.4	4.3	
Level of Service		E	D	F	D		F	A		F	A	
Approach Delay (s)		58.5			82.4			5.5			6.9	
Approach LOS		E			F			A			A	

Intersection Summary			
HCM Average Control Delay	16.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	52.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1830	1583	1770	1863	1583	1770	3539	1583	1770	3524	
Flt Permitted		0.93	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)		1730	1583	1770	1863	1583	1770	3539	1583	1770	3524	
Volume (vph)	14	26	56	59	12	59	47	1027	112	66	1078	32
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	15	27	59	62	13	62	49	1081	118	69	1135	34
RTOR Reduction (vph)	0	0	43	0	0	40	0	0	53	0	2	0
Lane Group Flow (vph)	0	42	16	62	13	22	49	1081	65	69	1168	0
Turn Type	Perm		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases		4		3	8		5	2		1	6	
Permitted Phases	4		4			8			2			
Actuated Green, G (s)		36.9	36.9	8.9	49.8	49.8	7.2	67.9	67.9	8.3	69.0	
Effective Green, g (s)		37.9	37.9	8.9	50.8	50.8	7.2	68.9	68.9	8.3	70.0	
Actuated g/C Ratio		0.27	0.27	0.06	0.36	0.36	0.05	0.49	0.49	0.06	0.50	
Clearance Time (s)		5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)		468	429	113	676	574	91	1742	779	105	1762	
v/s Ratio Prot				c0.04	0.01		0.03	0.31		c0.04	c0.33	
v/s Ratio Perm		c0.02	0.01			0.01			0.04			
v/c Ratio		0.09	0.04	0.55	0.02	0.04	0.54	0.62	0.08	0.66	0.66	
Uniform Delay, d1		38.2	37.6	63.6	28.6	28.8	64.8	26.0	18.8	64.5	26.2	
Progression Factor		1.00	1.00	1.00	1.00	1.00	1.44	0.56	0.07	1.35	0.66	
Incremental Delay, d2		0.4	0.2	5.4	0.1	0.1	2.3	1.2	0.2	9.7	1.8	
Delay (s)		38.5	37.8	69.0	28.7	29.0	95.3	15.9	1.5	96.9	18.9	
Level of Service		D	D	E	C	C	F	B	A	F	B	
Approach Delay (s)		38.1			47.0			17.7			23.3	
Approach LOS		D			D			B			C	

Intersection Summary			
HCM Average Control Delay	22.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	54.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.92		1.00	0.86		1.00	0.99		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1695		1770	1603		1770	3515		1770	3535	
Flt Permitted		0.97		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1660		1389	1603		1770	3515		1770	3535	
Volume (vph)	3	4	10	63	3	37	6	1359	64	49	1397	11
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	3	4	11	66	3	39	6	1431	67	52	1471	12
RTOR Reduction (vph)	0	9	0	0	33	0	0	2	0	0	0	0
Lane Group Flow (vph)	0	9	0	66	9	0	6	1496	0	52	1483	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)		20.0		20.0	20.0		5.0	94.0		7.0	96.0	
Effective Green, g (s)		21.0		21.0	21.0		5.0	95.0		7.0	97.0	
Actuated g/C Ratio		0.16		0.16	0.16		0.04	0.70		0.05	0.72	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		258		216	249		66	2474		92	2540	
v/s Ratio Prot					0.01		0.00	c0.43		c0.03	0.42	
v/s Ratio Perm		0.01		c0.05								
v/c Ratio		0.03		0.31	0.04		0.09	0.60		0.57	0.58	
Uniform Delay, d1		48.4		50.5	48.4		62.8	10.3		62.5	9.2	
Progression Factor		1.00		1.00	1.00		1.20	0.85		1.00	1.00	
Incremental Delay, d2		0.1		3.6	0.3		0.2	1.0		4.7	1.0	
Delay (s)		48.4		54.2	48.7		75.5	9.7		67.2	10.2	
Level of Service		D		D	D		E	A		E	B	
Approach Delay (s)		48.4			52.0			10.0			12.1	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	12.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	57.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	4	20	1419	63	56	1429
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	4	21	1510	67	60	1520
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2422	788			1577	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2422	788			1577	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	81	94			86	
cM capacity (veh/h)	23	334			414	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	26	1006	570	60	760	760
Volume Left	4	0	0	60	0	0
Volume Right	21	0	67	0	0	0
cSH	102	1700	1700	414	1700	1700
Volume to Capacity	0.25	0.59	0.34	0.14	0.45	0.45
Queue Length 95th (ft)	23	0	0	12	0	0
Control Delay (s)	51.4	0.0	0.0	15.2	0.0	0.0
Lane LOS	F			C		
Approach Delay (s)	51.4	0.0		0.6		
Approach LOS	F					

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	56.5%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.90		1.00	0.99		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1791	1583	1770	1675		1770	3489		1770	3499	
Flt Permitted		0.71	1.00	0.41	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1327	1583	755	1675		1770	3489		1770	3499	
Volume (vph)	148	38	34	82	21	43	40	1098	114	34	1114	92
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	161	41	37	89	23	47	43	1193	124	37	1211	100
RTOR Reduction (vph)	0	0	30	0	38	0	0	5	0	0	4	0
Lane Group Flow (vph)	0	202	7	89	32	0	43	1312	0	37	1307	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		26.0	26.0	26.0	26.0		6.4	88.9		6.1	88.6	
Effective Green, g (s)		27.0	27.0	27.0	27.0		6.4	89.9		6.1	89.6	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.05	0.67		0.05	0.66	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		265	317	151	335		84	2323		80	2322	
v/s Ratio Prot					0.02		c0.02	c0.38		0.02	0.37	
v/s Ratio Perm		c0.15	0.00	0.12								
v/c Ratio		0.76	0.02	0.59	0.10		0.51	0.56		0.46	0.56	
Uniform Delay, d1		51.0	43.4	49.0	44.1		62.8	12.1		62.9	12.2	
Progression Factor		1.00	1.00	1.00	1.00		0.76	1.56		1.30	0.50	
Incremental Delay, d2		18.6	0.1	5.8	0.1		1.9	0.9		1.3	0.8	
Delay (s)		69.5	43.5	54.7	44.2		49.5	19.7		82.8	6.9	
Level of Service		E	D	D	D		D	B		F	A	
Approach Delay (s)		65.5			50.1			20.7			9.0	
Approach LOS		E			D			C			A	

Intersection Summary			
HCM Average Control Delay	20.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	57.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected		0.97	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1812	1583	1770	1863	1583	1770	3539	1583	1770	3518	
Flt Permitted		0.83	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)		1544	1583	1770	1863	1583	1770	3539	1583	1770	3518	
Volume (vph)	61	49	122	132	21	208	98	1015	157	117	1084	44
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	66	53	133	143	23	226	107	1103	171	127	1178	48
RTOR Reduction (vph)	0	0	104	0	0	144	0	0	81	0	2	0
Lane Group Flow (vph)	0	119	29	143	23	82	107	1103	90	127	1224	0
Turn Type	Perm		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases		4		3	8		5	2		1	6	
Permitted Phases	4		4			8			2			
Actuated Green, G (s)		28.6	28.6	15.4	48.0	48.0	12.0	60.2	60.2	12.8	61.0	
Effective Green, g (s)		29.6	29.6	15.4	49.0	49.0	12.0	61.2	61.2	12.8	62.0	
Actuated g/C Ratio		0.22	0.22	0.11	0.36	0.36	0.09	0.45	0.45	0.09	0.46	
Clearance Time (s)		5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)		339	347	202	676	575	157	1604	718	168	1616	
v/s Ratio Prot				c0.08	0.01		0.06	0.31		c0.07	c0.35	
v/s Ratio Perm		c0.08	0.02			0.05			0.06			
v/c Ratio		0.35	0.08	0.71	0.03	0.14	0.68	0.69	0.12	0.76	0.76	
Uniform Delay, d1		44.6	41.9	57.6	27.7	28.9	59.6	29.3	21.4	59.6	30.3	
Progression Factor		1.00	1.00	1.00	1.00	1.00	1.28	0.47	0.18	1.21	0.72	
Incremental Delay, d2		2.8	0.5	10.8	0.1	0.5	8.1	2.1	0.3	13.6	2.9	
Delay (s)		47.4	42.4	68.4	27.8	29.4	84.7	15.9	4.1	85.5	24.6	
Level of Service		D	D	E	C	C	F	B	A	F	C	
Approach Delay (s)		44.8			43.5			19.7			30.4	
Approach LOS		D			D			B			C	

Intersection Summary			
HCM Average Control Delay	28.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	60.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

CUMULATIVE BASE (2028) CONDITIONS

HCM Signalized Intersection Capacity Analysis
1: Leiali'i Pkwy & Honoapi'ilani Hwy

9/28/2010

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.92		1.00	0.85		1.00	0.99		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1695		1770	1583		1770	3504		1770	3538	
Flt Permitted		0.98		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1672		1405	1583		1770	3504		1770	3538	
Volume (vph)	1	1	3	62	0	71	5	1219	87	50	1200	2
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	1	1	3	66	0	76	5	1297	93	53	1277	2
RTOR Reduction (vph)	0	2	0	0	59	0	0	4	0	0	0	0
Lane Group Flow (vph)	0	3	0	66	17	0	5	1386	0	53	1279	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		3			7		5	2		1	6	
Permitted Phases	3			7								
Actuated Green, G (s)		31.0		31.0	31.0		5.0	88.8		6.2	90.0	
Effective Green, g (s)		32.0		32.0	32.0		5.0	89.8		6.2	91.0	
Actuated g/C Ratio		0.23		0.23	0.23		0.04	0.64		0.04	0.65	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		382		321	362		63	2248		78	2300	
v/s Ratio Prot					0.01		0.00	c0.40		c0.03	0.36	
v/s Ratio Perm		0.00		c0.05								
v/c Ratio		0.01		0.21	0.05		0.08	0.62		0.68	0.56	
Uniform Delay, d1		41.7		43.7	42.1		65.3	14.9		65.9	13.4	
Progression Factor		1.00		1.00	1.00		1.06	0.36		1.00	1.00	
Incremental Delay, d2		0.0		1.4	0.3		0.2	1.1		16.9	1.0	
Delay (s)		41.7		45.2	42.4		69.2	6.6		82.8	14.4	
Level of Service		D		D	D		E	A		F	B	
Approach Delay (s)		41.7			43.7			6.8			17.1	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	13.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	58.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	23	48	1250	35	30	1241
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	24	49	1289	36	31	1279
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2008	662			1325	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2008	662			1325	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	51	88			94	
cM capacity (veh/h)	48	404			517	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	73	859	466	31	640	640
Volume Left	24	0	0	31	0	0
Volume Right	49	0	36	0	0	0
cSH	119	1700	1700	517	1700	1700
Volume to Capacity	0.61	0.51	0.27	0.06	0.38	0.38
Queue Length 95th (ft)	77	0	0	5	0	0
Control Delay (s)	74.1	0.0	0.0	12.4	0.0	0.0
Lane LOS	F			B		
Approach Delay (s)	74.1	0.0		0.3		
Approach LOS	F					

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	46.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.91		1.00	0.99		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1794	1583	1770	1695		1770	3501		1770	3510	
Flt Permitted		0.68	1.00	0.47	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1261	1583	867	1695		1770	3501		1770	3510	
Volume (vph)	120	37	39	146	32	48	27	1112	86	22	1152	67
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	128	39	41	155	34	51	29	1183	91	23	1226	71
RTOR Reduction (vph)	0	0	33	0	39	0	0	4	0	0	3	0
Lane Group Flow (vph)	0	167	8	155	46	0	29	1270	0	23	1294	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		25.6	25.6	25.6	25.6		3.0	97.4		3.0	97.4	
Effective Green, g (s)		26.6	26.6	26.6	26.6		3.0	98.4		3.0	98.4	
Actuated g/C Ratio		0.19	0.19	0.19	0.19		0.02	0.70		0.02	0.70	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		240	301	165	322		38	2461		38	2467	
v/s Ratio Prot					0.03		c0.02	0.36		0.01	c0.37	
v/s Ratio Perm		0.13	0.00	c0.18								
v/c Ratio		0.70	0.03	0.94	0.14		0.76	0.52		0.61	0.52	
Uniform Delay, d1		52.9	46.2	55.9	47.2		68.1	9.7		67.9	9.8	
Progression Factor		1.00	1.00	1.00	1.00		0.92	0.39		1.32	0.50	
Incremental Delay, d2		8.5	0.0	51.8	0.2		46.5	0.6		15.1	0.7	
Delay (s)		61.4	46.2	107.7	47.4		109.1	4.4		104.8	5.6	
Level of Service		E	D	F	D		F	A		F	A	
Approach Delay (s)		58.4			86.3			6.7			7.3	
Approach LOS		E			F			A			A	

Intersection Summary			
HCM Average Control Delay	16.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	57.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.90		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1671		1770	1863	1583	1770	3539	1583	1770	3521	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1671		1770	1863	1583	1770	3539	1583	1770	3521	
Volume (vph)	19	28	60	52	17	96	53	1276	82	78	1223	44
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	20	29	63	55	18	101	56	1343	86	82	1287	46
RTOR Reduction (vph)	0	51	0	0	0	78	0	0	33	0	2	0
Lane Group Flow (vph)	20	41	0	55	18	23	56	1343	53	82	1331	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	3.6	26.6		7.6	30.6	30.6	7.2	78.1	78.1	9.7	80.6	
Effective Green, g (s)	3.6	27.6		7.6	31.6	31.6	7.2	79.1	79.1	9.7	81.6	
Actuated g/C Ratio	0.03	0.20		0.05	0.23	0.23	0.05	0.56	0.56	0.07	0.58	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	46	329		96	421	357	91	2000	894	123	2052	
v/s Ratio Prot	0.01	c0.02		c0.03	0.01		0.03	c0.38		c0.05	0.38	
v/s Ratio Perm						c0.01			0.03			
v/c Ratio	0.43	0.13		0.57	0.04	0.06	0.62	0.67	0.06	0.67	0.65	
Uniform Delay, d1	67.2	46.3		64.6	42.4	42.6	65.0	21.3	13.7	63.6	19.6	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.40	0.38	0.01	1.29	0.49	
Incremental Delay, d2	6.5	0.8		8.0	0.2	0.3	5.4	1.1	0.1	8.6	1.4	
Delay (s)	73.7	47.1		72.6	42.6	42.9	96.3	9.3	0.2	90.4	11.0	
Level of Service	E	D		E	D	D	F	A	A	F	B	
Approach Delay (s)		51.8			52.2			12.1			15.6	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	17.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	59.1%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	125	18	8	81	0	57	0	25	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	136	20	9	88	0	62	0	27	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	88			155			207	251	78	201	261	44
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	88			155			207	251	78	201	261	44
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			99			91	100	97	100	100	100
cM capacity (veh/h)	1506			1422			729	647	967	716	639	1016

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2
Volume Total	0	91	65	9	59	29	62	27
Volume Left	0	0	0	9	0	0	62	0
Volume Right	0	0	20	0	0	0	0	27
cSH	1700	1700	1700	1422	1700	1700	729	967
Volume to Capacity	0.00	0.05	0.04	0.01	0.03	0.02	0.09	0.03
Queue Length 95th (ft)	0	0	0	0	0	0	7	2
Control Delay (s)	0.0	0.0	0.0	7.5	0.0	0.0	10.4	8.8
Lane LOS				A			B	A
Approach Delay (s)	0.0			0.7			9.9	
Approach LOS							A	

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	16.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	0	0	0	0	0	0	47	0	0	44	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	0	0	0	0	51	0	0	48	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	73	99	24	75	99	26	48			51		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	73	99	24	75	99	26	48			51		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	100	100	100			100		
cM capacity (veh/h)	909	790	1047	906	790	1044	1558			1553		

Direction, Lane #	NB 1	NB 2	SB 1	SB 2
Volume Total	26	26	24	24
Volume Left	0	0	0	0
Volume Right	0	0	0	0
cSH	1700	1700	1700	1700
Volume to Capacity	0.02	0.02	0.01	0.01
Queue Length 95th (ft)	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0
Lane LOS				
Approach Delay (s)	0.0		0.0	
Approach LOS				

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	6.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.30	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	557	3539	3539	1583
Volume (vph)	50	36	16	691	867	33
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	54	39	17	751	942	36
RTOR Reduction (vph)	0	37	0	0	0	4
Lane Group Flow (vph)	54	2	17	751	942	32
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	7.6	7.6	124.4	124.4	124.4	124.4
Effective Green, g (s)	7.6	7.6	124.4	124.4	124.4	124.4
Actuated g/C Ratio	0.05	0.05	0.89	0.89	0.89	0.89
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	96	86	495	3145	3145	1407
v/s Ratio Prot	c0.03			0.21	c0.27	
v/s Ratio Perm		0.00	0.03			0.02
v/c Ratio	0.56	0.02	0.03	0.24	0.30	0.02
Uniform Delay, d1	64.6	62.7	0.9	1.1	1.2	0.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	7.3	0.1	0.1	0.2	0.2	0.0
Delay (s)	71.9	62.8	1.0	1.3	1.4	0.9
Level of Service	E	E	A	A	A	A
Approach Delay (s)	68.1			1.3	1.4	
Approach LOS	E			A	A	

Intersection Summary			
HCM Average Control Delay	4.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.31		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	34.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	36	890	25	22	880	8
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	39	967	27	24	957	9
RTOR Reduction (vph)	0	0	0	23	0	0
Lane Group Flow (vph)	39	967	27	1	957	9
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	7.0	140.0	78.5	7.0	42.5	125.0
Effective Green, g (s)	7.0	140.0	78.5	7.0	42.5	125.0
Actuated g/C Ratio	0.05	1.00	0.56	0.05	0.30	0.89
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	89	2787	1045	79	1042	1663
v/s Ratio Prot	0.02		0.01	0.00	c0.28	0.00
v/s Ratio Perm		c0.35				
v/c Ratio	0.44	0.35	0.03	0.02	0.92	0.01
Uniform Delay, d1	64.6	0.0	13.7	63.2	47.1	0.8
Progression Factor	1.00	1.00	0.65	0.91	1.00	1.00
Incremental Delay, d2	3.4	0.3	0.0	0.1	12.4	0.0
Delay (s)	68.0	0.3	8.9	57.4	59.5	0.8
Level of Service	E	A	A	E	E	A
Approach Delay (s)	3.0		31.7			59.0
Approach LOS	A		C			E

Intersection Summary			
HCM Average Control Delay	30.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	41.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	3	11	914	1	1	880
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	12	993	1	1	957
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1474	497			995	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1474	497			995	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	97	98			100	
cM capacity (veh/h)	117	518			691	

Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	3	12	662	332	1	478	478
Volume Left	3	0	0	0	1	0	0
Volume Right	0	12	0	1	0	0	0
cSH	117	518	1700	1700	691	1700	1700
Volume to Capacity	0.03	0.02	0.39	0.20	0.00	0.28	0.28
Queue Length 95th (ft)	2	2	0	0	0	0	0
Control Delay (s)	36.6	12.1	0.0	0.0	10.2	0.0	0.0
Lane LOS	E	B			B		
Approach Delay (s)	17.4		0.0		0.0		
Approach LOS	C						

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	35.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	27	14	901	9	1	853
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	29	15	979	10	1	927
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1450	495			989	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1450	495			989	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	76	97			100	
cM capacity (veh/h)	122	520			695	

Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	29	15	653	336	1	464	464
Volume Left	29	0	0	0	1	0	0
Volume Right	0	15	0	10	0	0	0
cSH	122	520	1700	1700	695	1700	1700
Volume to Capacity	0.24	0.03	0.38	0.20	0.00	0.27	0.27
Queue Length 95th (ft)	22	2	0	0	0	0	0
Control Delay (s)	43.8	12.1	0.0	0.0	10.2	0.0	0.0
Lane LOS	E	B			B		
Approach Delay (s)	33.0		0.0		0.0		
Approach LOS	D						

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	35.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.91		1.00	0.85		1.00	0.99		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1691		1770	1592		1770	3512		1770	3535	
Flt Permitted		0.97		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1648		1388	1592		1770	3512		1770	3535	
Volume (vph)	3	4	11	79	3	93	6	1546	85	74	1549	12
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	3	4	12	83	3	98	6	1627	89	78	1631	13
RTOR Reduction (vph)	0	10	0	0	83	0	0	3	0	0	0	0
Lane Group Flow (vph)	0	9	0	83	18	0	6	1713	0	78	1644	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)		20.0		20.0	20.0		5.0	92.1		8.9	96.0	
Effective Green, g (s)		21.0		21.0	21.0		5.0	93.1		8.9	97.0	
Actuated g/C Ratio		0.16		0.16	0.16		0.04	0.69		0.07	0.72	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		256		216	248		66	2422		117	2540	
v/s Ratio Prot					0.01		0.00	c0.49		c0.04	c0.46	
v/s Ratio Perm		0.01		c0.06								
v/c Ratio		0.03		0.38	0.07		0.09	0.71		0.67	0.65	
Uniform Delay, d1		48.4		51.2	48.7		62.8	12.7		61.6	10.0	
Progression Factor		1.00		1.00	1.00		1.20	0.73		1.00	1.00	
Incremental Delay, d2		0.1		5.1	0.6		0.2	1.3		10.6	1.3	
Delay (s)		48.4		56.3	49.3		75.7	10.5		72.2	11.3	
Level of Service		D		E	D		E	B		E	B	
Approach Delay (s)		48.4			52.4			10.8			14.0	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	14.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	70.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	17	21	1611	84	59	1587
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	18	22	1714	89	63	1688
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2728	902			1803	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2728	902			1803	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	92			81	
cM capacity (veh/h)	13	281			338	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	40	1143	661	63	844	844
Volume Left	18	0	0	63	0	0
Volume Right	22	0	89	0	0	0
cSH	28	1700	1700	338	1700	1700
Volume to Capacity	1.43	0.67	0.39	0.19	0.50	0.50
Queue Length 95th (ft)	118	0	0	17	0	0
Control Delay (s)	531.6	0.0	0.0	18.1	0.0	0.0
Lane LOS	F			C		
Approach Delay (s)	531.6	0.0		0.6		
Approach LOS	F					

Intersection Summary			
Average Delay	6.3		
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.90		1.00	0.99		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1791	1583	1770	1675		1770	3495		1770	3502	
Flt Permitted		0.69	1.00	0.34	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1288	1583	640	1675		1770	3495		1770	3502	
Volume (vph)	169	43	43	91	24	49	47	1414	127	38	1394	106
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	184	47	47	99	26	53	51	1537	138	41	1515	115
RTOR Reduction (vph)	0	0	38	0	42	0	0	5	0	0	4	0
Lane Group Flow (vph)	0	231	9	99	37	0	51	1670	0	41	1626	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		26.0	26.0	26.0	26.0		6.6	88.7		6.3	88.4	
Effective Green, g (s)		27.0	27.0	27.0	27.0		6.6	89.7		6.3	89.4	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.05	0.66		0.05	0.66	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		258	317	128	335		87	2322		83	2319	
v/s Ratio Prot					0.02		c0.03	c0.48		0.02	0.46	
v/s Ratio Perm		c0.18	0.01	0.15								
v/c Ratio		0.90	0.03	0.77	0.11		0.59	0.72		0.49	0.70	
Uniform Delay, d1		52.6	43.5	51.1	44.2		62.9	14.6		62.8	14.4	
Progression Factor		1.00	1.00	1.00	1.00		0.68	1.45		1.30	0.56	
Incremental Delay, d2		34.5	0.2	24.7	0.1		3.8	1.2		1.3	1.4	
Delay (s)		87.1	43.6	75.8	44.3		46.4	22.2		83.1	9.5	
Level of Service		F	D	E	D		D	C		F	A	
Approach Delay (s)		79.7			61.8			22.9			11.3	
Approach LOS		E			E			C			B	

Intersection Summary			
HCM Average Control Delay	23.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	68.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.89		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1664		1770	1863	1583	1770	3539	1583	1770	3517	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1664		1770	1863	1583	1770	3539	1583	1770	3517	
Volume (vph)	80	55	135	96	24	231	108	1351	121	157	1346	58
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	60	147	104	26	251	117	1468	132	171	1463	63
RTOR Reduction (vph)	0	65	0	0	0	162	0	0	48	0	2	0
Lane Group Flow (vph)	87	142	0	104	26	89	117	1468	84	171	1524	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	9.5	25.4		11.1	27.0	27.0	11.7	65.2	65.2	15.3	68.8	
Effective Green, g (s)	9.5	26.4		11.1	28.0	28.0	11.7	66.2	66.2	15.3	69.8	
Actuated g/C Ratio	0.07	0.20		0.08	0.21	0.21	0.09	0.49	0.49	0.11	0.52	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	125	325		146	386	328	153	1735	776	201	1818	
v/s Ratio Prot	0.05	c0.09		c0.06	0.01		0.07	0.41		c0.10	c0.43	
v/s Ratio Perm						0.06			0.05			
v/c Ratio	0.70	0.44		0.71	0.07	0.27	0.76	0.85	0.11	0.85	0.84	
Uniform Delay, d1	61.3	47.8		60.4	43.0	44.9	60.3	30.0	18.5	58.7	27.8	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.19	0.48	0.11	1.33	0.60	
Incremental Delay, d2	15.5	4.2		15.1	0.3	2.0	10.9	3.1	0.2	20.9	3.6	
Delay (s)	76.9	52.0		75.5	43.3	47.0	82.5	17.5	2.2	99.1	20.3	
Level of Service	E	D		E	D	D	F	B	A	F	C	
Approach Delay (s)		59.3			54.5			20.7			28.3	
Approach LOS		E			D			C			C	

Intersection Summary			
HCM Average Control Delay	29.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	75.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	203	62	28	242	0	37	0	16	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	221	67	30	263	0	40	0	17	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	263			288			447	578	144	452	612	132
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	263			288			447	578	144	452	612	132
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			98			92	100	98	100	100	100
cM capacity (veh/h)	1298			1271			486	415	877	473	397	894

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2
Volume Total	0	147	141	30	175	88	40	17
Volume Left	0	0	0	30	0	0	40	0
Volume Right	0	0	67	0	0	0	0	17
cSH	1700	1700	1700	1271	1700	1700	486	877
Volume to Capacity	0.00	0.09	0.08	0.02	0.10	0.05	0.08	0.02
Queue Length 95th (ft)	0	0	0	2	0	0	7	2
Control Delay (s)	0.0	0.0	0.0	7.9	0.0	0.0	13.1	9.2
Lane LOS				A			B	A
Approach Delay (s)	0.0			0.8			11.9	
Approach LOS							B	

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	24.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	0	0	0	0	0	0	59	0	0	80	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	0	0	0	0	64	0	0	87	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	119	151	43	108	151	32	87			64		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	119	151	43	108	151	32	87			64		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	100	100	100			100		
cM capacity (veh/h)	844	740	1017	860	740	1034	1507			1536		

Direction, Lane #	NB 1	NB 2	SB 1	SB 2
Volume Total	32	32	43	43
Volume Left	0	0	0	0
Volume Right	0	0	0	0
cSH	1700	1700	1700	1700
Volume to Capacity	0.02	0.02	0.03	0.03
Queue Length 95th (ft)	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0
Lane LOS				
Approach Delay (s)	0.0		0.0	
Approach LOS				

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	6.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.23	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	430	3539	3539	1583
Volume (vph)	30	17	31	886	1096	35
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	33	18	34	963	1191	38
RTOR Reduction (vph)	0	17	0	0	0	3
Lane Group Flow (vph)	33	1	34	963	1191	35
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	5.1	5.1	121.9	121.9	121.9	121.9
Effective Green, g (s)	5.1	5.1	121.9	121.9	121.9	121.9
Actuated g/C Ratio	0.04	0.04	0.90	0.90	0.90	0.90
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	67	60	388	3196	3196	1429
v/s Ratio Prot	c0.02			0.27	c0.34	
v/s Ratio Perm		0.00	0.08			0.02
v/c Ratio	0.49	0.01	0.09	0.30	0.37	0.02
Uniform Delay, d1	63.7	62.5	0.7	0.9	1.0	0.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	5.6	0.1	0.4	0.2	0.3	0.0
Delay (s)	69.3	62.6	1.1	1.1	1.3	0.7
Level of Service	E	E	A	A	A	A
Approach Delay (s)	66.9			1.1	1.3	
Approach LOS	E			A	A	

Intersection Summary			
HCM Average Control Delay	2.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	40.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	52	1106	16	43	1088	28
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	57	1202	17	47	1183	30
RTOR Reduction (vph)	0	0	0	44	0	0
Lane Group Flow (vph)	57	1202	17	3	1183	30
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	7.9	143.0	62.2	7.9	60.9	127.1
Effective Green, g (s)	7.9	143.0	62.2	7.9	60.9	127.1
Actuated g/C Ratio	0.06	1.00	0.43	0.06	0.43	0.89
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	98	2787	810	87	1462	1656
v/s Ratio Prot	0.03		0.01	0.00	c0.34	0.02
v/s Ratio Perm		c0.43				
v/c Ratio	0.58	0.43	0.02	0.03	0.81	0.02
Uniform Delay, d1	65.9	0.0	23.0	63.9	36.0	0.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	8.5	0.5	0.0	0.1	3.4	0.0
Delay (s)	74.4	0.5	23.1	64.1	39.4	0.9
Level of Service	E	A	C	E	D	A
Approach Delay (s)	3.8		53.2			38.4
Approach LOS	A		D			D

Intersection Summary			
HCM Average Control Delay	21.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	143.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	47.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	2	7	1119	3	2	1113
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	8	1216	3	2	1210
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1827	610			1220	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1827	610			1220	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	97	98			100	
cM capacity (veh/h)	68	438			568	

Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	2	8	811	409	2	605	605
Volume Left	2	0	0	0	2	0	0
Volume Right	0	8	0	3	0	0	0
cSH	68	438	1700	1700	568	1700	1700
Volume to Capacity	0.03	0.02	0.48	0.24	0.00	0.36	0.36
Queue Length 95th (ft)	2	1	0	0	0	0	0
Control Delay (s)	59.7	13.4	0.0	0.0	11.4	0.0	0.0
Lane LOS	F	B			B		
Approach Delay (s)	23.7		0.0		0.0		
Approach LOS	C						

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	41.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	18	9	1081	30	3	1088
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	20	10	1175	33	3	1183
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1789	604			1208	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1789	604			1208	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	73	98			99	
cM capacity (veh/h)	72	442			574	

Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	20	10	783	424	3	591	591
Volume Left	20	0	0	0	3	0	0
Volume Right	0	10	0	33	0	0	0
cSH	72	442	1700	1700	574	1700	1700
Volume to Capacity	0.27	0.02	0.46	0.25	0.01	0.35	0.35
Queue Length 95th (ft)	24	2	0	0	0	0	0
Control Delay (s)	72.8	13.3	0.0	0.0	11.3	0.0	0.0
Lane LOS	F	B			B		
Approach Delay (s)	53.0		0.0		0.0		
Approach LOS	F						

Intersection Summary			
Average Delay	0.7		
Intersection Capacity Utilization	40.8%	ICU Level of Service	A
Analysis Period (min)	15		

CUMULATIVE BASE (2036) CONDITIONS

HCM Signalized Intersection Capacity Analysis
1: Leiali'i Pkwy & Honoapi'ilani Hwy

9/28/2010

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.92		1.00	0.85		1.00	0.99		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1695		1770	1583		1770	3507		1770	3538	
Flt Permitted		0.98		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1672		1405	1583		1770	3507		1770	3538	
Volume (vph)	1	1	3	64	0	72	5	1376	89	51	1355	2
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	1	1	3	68	0	77	5	1464	95	54	1441	2
RTOR Reduction (vph)	0	2	0	0	59	0	0	3	0	0	0	0
Lane Group Flow (vph)	0	3	0	68	18	0	5	1556	0	54	1443	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		3			7		5	2		1	6	
Permitted Phases	3			7								
Actuated Green, G (s)		31.0		31.0	31.0		5.0	88.8		6.2	90.0	
Effective Green, g (s)		32.0		32.0	32.0		5.0	89.8		6.2	91.0	
Actuated g/C Ratio		0.23		0.23	0.23		0.04	0.64		0.04	0.65	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		382		321	362		63	2249		78	2300	
v/s Ratio Prot					0.01		0.00	c0.44		c0.03	0.41	
v/s Ratio Perm		0.00		c0.05								
v/c Ratio		0.01		0.21	0.05		0.08	0.69		0.69	0.63	
Uniform Delay, d1		41.7		43.8	42.1		65.3	16.2		66.0	14.5	
Progression Factor		1.00		1.00	1.00		1.00	0.39		1.00	1.00	
Incremental Delay, d2		0.0		1.5	0.3		0.2	1.5		19.2	1.3	
Delay (s)		41.7		45.3	42.4		65.2	7.9		85.2	15.8	
Level of Service		D		D	D		E	A		F	B	
Approach Delay (s)		41.7			43.7			8.1			18.3	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	14.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	59.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	25	50	1408	38	31	1398
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	26	52	1452	39	32	1441
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2256	745			1491	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2256	745			1491	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	20	86			93	
cM capacity (veh/h)	32	356			447	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	77	968	523	32	721	721
Volume Left	26	0	0	32	0	0
Volume Right	52	0	39	0	0	0
cSH	82	1700	1700	447	1700	1700
Volume to Capacity	0.94	0.57	0.31	0.07	0.42	0.42
Queue Length 95th (ft)	127	0	0	6	0	0
Control Delay (s)	172.1	0.0	0.0	13.7	0.0	0.0
Lane LOS	F			B		
Approach Delay (s)	172.1	0.0		0.3		
Approach LOS	F					

Intersection Summary			
Average Delay	4.5		
Intersection Capacity Utilization	51.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.91		1.00	0.99		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1794	1583	1770	1696		1770	3504		1770	3512	
Flt Permitted		0.67	1.00	0.46	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1246	1583	856	1696		1770	3504		1770	3512	
Volume (vph)	125	38	42	151	34	50	29	1266	89	22	1306	70
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	133	40	45	161	36	53	31	1347	95	23	1389	74
RTOR Reduction (vph)	0	0	36	0	38	0	0	3	0	0	3	0
Lane Group Flow (vph)	0	173	9	161	51	0	31	1439	0	23	1460	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		26.4	26.4	26.4	26.4		3.0	96.6		3.0	96.6	
Effective Green, g (s)		27.4	27.4	27.4	27.4		3.0	97.6		3.0	97.6	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.02	0.70		0.02	0.70	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		244	310	168	332		38	2443		38	2448	
v/s Ratio Prot					0.03		c0.02	0.41		0.01	c0.42	
v/s Ratio Perm		0.14	0.01	c0.19								
v/c Ratio		0.71	0.03	0.96	0.15		0.82	0.59		0.61	0.60	
Uniform Delay, d1		52.6	45.5	55.7	46.7		68.2	10.9		67.9	11.0	
Progression Factor		1.00	1.00	1.00	1.00		0.87	0.54		1.33	0.49	
Incremental Delay, d2		9.1	0.0	56.5	0.2		57.1	0.7		14.2	0.9	
Delay (s)		61.7	45.6	112.2	46.9		116.6	6.6		104.8	6.3	
Level of Service		E	D	F	D		F	A		F	A	
Approach Delay (s)		58.3			89.0			8.9			7.8	
Approach LOS		E			F			A			A	

Intersection Summary			
HCM Average Control Delay	17.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	62.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.90		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1669		1770	1863	1583	1770	3539	1583	1770	3521	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1669		1770	1863	1583	1770	3539	1583	1770	3521	
Volume (vph)	21	28	63	52	18	98	56	1435	85	79	1379	48
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	22	29	66	55	19	103	59	1511	89	83	1452	51
RTOR Reduction (vph)	0	53	0	0	0	80	0	0	30	0	2	0
Lane Group Flow (vph)	22	42	0	55	19	23	59	1511	59	83	1501	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	3.6	26.6		7.6	30.6	30.6	7.3	78.1	78.1	9.7	80.5	
Effective Green, g (s)	3.6	27.6		7.6	31.6	31.6	7.3	79.1	79.1	9.7	81.5	
Actuated g/C Ratio	0.03	0.20		0.05	0.23	0.23	0.05	0.56	0.56	0.07	0.58	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	46	329		96	421	357	92	2000	894	123	2050	
v/s Ratio Prot	0.01	c0.03		c0.03	0.01		0.03	c0.43		c0.05	0.43	
v/s Ratio Perm						c0.01			0.04			
v/c Ratio	0.48	0.13		0.57	0.05	0.07	0.64	0.76	0.07	0.67	0.73	
Uniform Delay, d1	67.3	46.3		64.6	42.4	42.6	65.1	23.1	13.8	63.6	21.3	
Progression Factor	1.00	1.00		0.94	1.03	1.41	1.40	0.40	0.01	1.27	0.46	
Incremental Delay, d2	7.6	0.8		8.0	0.2	0.4	5.2	1.3	0.1	8.8	1.9	
Delay (s)	74.9	47.1		68.6	44.1	60.5	96.0	10.6	0.2	89.8	11.8	
Level of Service	E	D		E	D	E	F	B	A	F	B	
Approach Delay (s)		52.3			61.3			13.0			15.9	
Approach LOS		D			E			B			B	

Intersection Summary			
HCM Average Control Delay	18.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	63.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	130	19	9	84	0	60	0	28	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	141	21	10	91	0	65	0	30	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	91			162			217	262	81	212	273	46
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	91			162			217	262	81	212	273	46
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			99			91	100	97	100	100	100
cM capacity (veh/h)	1501			1414			717	637	963	700	628	1014

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2
Volume Total	94	68	10	46	46	65	30
Volume Left	0	0	10	0	0	65	0
Volume Right	0	21	0	0	0	0	30
cSH	1700	1700	1414	1700	1700	717	963
Volume to Capacity	0.06	0.04	0.01	0.03	0.03	0.09	0.03
Queue Length 95th (ft)	0	0	1	0	0	7	2
Control Delay (s)	0.0	0.0	7.6	0.0	0.0	10.5	8.9
Lane LOS			A			B	A
Approach Delay (s)	0.0		0.7			10.0	
Approach LOS						A	

Intersection Summary			
Average Delay	2.9		
Intersection Capacity Utilization	17.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	0	0	0	0	0	0	50	0	0	45	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	0	0	0	0	54	0	0	49	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	76	103	24	79	103	27	49			54		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	76	103	24	79	103	27	49			54		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	100	100	100			100		
cM capacity (veh/h)	905	786	1046	901	786	1042	1556			1549		

Direction, Lane #	NB 1	NB 2	SB 1	SB 2
Volume Total	27	27	24	24
Volume Left	0	0	0	0
Volume Right	0	0	0	0
cSH	1700	1700	1700	1700
Volume to Capacity	0.02	0.02	0.01	0.01
Queue Length 95th (ft)	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0
Lane LOS				
Approach Delay (s)	0.0		0.0	
Approach LOS				

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	6.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.27	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	494	3539	3539	1583
Volume (vph)	50	38	16	790	969	33
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	54	41	17	859	1053	36
RTOR Reduction (vph)	0	39	0	0	0	4
Lane Group Flow (vph)	54	2	17	859	1053	32
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	7.6	7.6	124.4	124.4	124.4	124.4
Effective Green, g (s)	7.6	7.6	124.4	124.4	124.4	124.4
Actuated g/C Ratio	0.05	0.05	0.89	0.89	0.89	0.89
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	96	86	439	3145	3145	1407
v/s Ratio Prot	c0.03			0.24	c0.30	
v/s Ratio Perm		0.00	0.03			0.02
v/c Ratio	0.56	0.03	0.04	0.27	0.33	0.02
Uniform Delay, d1	64.6	62.7	0.9	1.1	1.2	0.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	7.3	0.1	0.2	0.2	0.3	0.0
Delay (s)	71.9	62.8	1.1	1.4	1.5	0.9
Level of Service	E	E	A	A	A	A
Approach Delay (s)	68.0			1.4	1.5	
Approach LOS	E			A	A	

Intersection Summary			
HCM Average Control Delay	4.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	36.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	36	991	28	22	985	9
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	39	1077	30	24	1071	10
RTOR Reduction (vph)	0	0	0	23	0	0
Lane Group Flow (vph)	39	1077	30	1	1071	10
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	7.0	140.0	73.2	7.0	47.8	125.0
Effective Green, g (s)	7.0	140.0	73.2	7.0	47.8	125.0
Actuated g/C Ratio	0.05	1.00	0.52	0.05	0.34	0.89
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	89	2787	974	79	1172	1663
v/s Ratio Prot	0.02		0.02	0.00	c0.31	0.01
v/s Ratio Perm		c0.39				
v/c Ratio	0.44	0.39	0.03	0.02	0.91	0.01
Uniform Delay, d1	64.6	0.0	16.2	63.2	44.1	0.8
Progression Factor	1.00	1.00	0.67	0.88	1.00	1.00
Incremental Delay, d2	3.4	0.4	0.1	0.1	10.9	0.0
Delay (s)	68.0	0.4	10.9	55.7	55.0	0.8
Level of Service	E	A	B	E	E	A
Approach Delay (s)	2.8		30.8			54.5
Approach LOS	A		C			D

Intersection Summary			
HCM Average Control Delay	28.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	44.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	3	11	1018	1	1	985
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	3	12	1107	1	1	1071
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1645	554			1108	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1645	554			1108	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	96	97			100	
cM capacity (veh/h)	90	476			626	

Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	3	12	738	370	1	535	535
Volume Left	3	0	0	0	1	0	0
Volume Right	0	12	0	1	0	0	0
cSH	90	476	1700	1700	626	1700	1700
Volume to Capacity	0.04	0.03	0.43	0.22	0.00	0.31	0.31
Queue Length 95th (ft)	3	2	0	0	0	0	0
Control Delay (s)	46.4	12.8	0.0	0.0	10.8	0.0	0.0
Lane LOS	E	B			B		
Approach Delay (s)	20.0		0.0		0.0		
Approach LOS	C						

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	38.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	27	14	1007	9	1	957
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	29	15	1095	10	1	1040
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1622	552			1104	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1622	552			1104	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	69	97			100	
cM capacity (veh/h)	93	477			628	

Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	29	15	730	375	1	520	520
Volume Left	29	0	0	0	1	0	0
Volume Right	0	15	0	10	0	0	0
cSH	93	477	1700	1700	628	1700	1700
Volume to Capacity	0.31	0.03	0.43	0.22	0.00	0.31	0.31
Queue Length 95th (ft)	30	2	0	0	0	0	0
Control Delay (s)	60.3	12.8	0.0	0.0	10.7	0.0	0.0
Lane LOS	F	B			B		
Approach Delay (s)	44.0		0.0		0.0		
Approach LOS	E						

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	38.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.91		1.00	0.85		1.00	0.99		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1691		1770	1592		1770	3513		1770	3535	
Flt Permitted		0.97		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1648		1388	1592		1770	3513		1770	3535	
Volume (vph)	3	4	11	80	3	94	6	1661	87	76	1666	12
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	3	4	12	84	3	99	6	1748	92	80	1754	13
RTOR Reduction (vph)	0	10	0	0	84	0	0	3	0	0	0	0
Lane Group Flow (vph)	0	9	0	84	18	0	6	1837	0	80	1767	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)		20.0		20.0	20.0		5.0	92.0		9.0	96.0	
Effective Green, g (s)		21.0		21.0	21.0		5.0	93.0		9.0	97.0	
Actuated g/C Ratio		0.16		0.16	0.16		0.04	0.69		0.07	0.72	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		256		216	248		66	2420		118	2540	
v/s Ratio Prot					0.01		0.00	c0.52		c0.05	c0.50	
v/s Ratio Perm		0.01		c0.06								
v/c Ratio		0.03		0.39	0.07		0.09	0.76		0.68	0.70	
Uniform Delay, d1		48.4		51.2	48.7		62.8	13.7		61.6	10.7	
Progression Factor		1.00		1.00	1.00		1.21	0.74		1.00	1.00	
Incremental Delay, d2		0.1		5.2	0.6		0.1	1.5		11.5	1.6	
Delay (s)		48.4		56.4	49.3		76.4	11.6		73.1	12.3	
Level of Service		D		E	D		E	B		E	B	
Approach Delay (s)		48.4			52.5			11.9			14.9	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	15.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	74.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	19	22	1728	88	60	1703
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	20	23	1838	94	64	1812
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2919	966			1932	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2919	966			1932	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	91			79	
cM capacity (veh/h)	10	254			301	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	44	1226	706	64	906	906
Volume Left	20	0	0	64	0	0
Volume Right	23	0	94	0	0	0
cSH	20	1700	1700	301	1700	1700
Volume to Capacity	2.21	0.72	0.42	0.21	0.53	0.53
Queue Length 95th (ft)	145	0	0	20	0	0
Control Delay (s)	966.9	0.0	0.0	20.2	0.0	0.0
Lane LOS	F			C		
Approach Delay (s)	966.9	0.0		0.7		
Approach LOS	F					

Intersection Summary			
Average Delay	11.3		
Intersection Capacity Utilization	60.6%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.90		1.00	0.99		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1791	1583	1770	1679		1770	3497		1770	3503	
Flt Permitted		0.68	1.00	0.32	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1275	1583	605	1679		1770	3497		1770	3503	
Volume (vph)	176	45	45	96	26	50	49	1525	132	39	1504	110
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	191	49	49	104	28	54	53	1658	143	42	1635	120
RTOR Reduction (vph)	0	0	39	0	43	0	0	4	0	0	4	0
Lane Group Flow (vph)	0	240	10	104	39	0	53	1797	0	42	1751	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		26.0	26.0	26.0	26.0		6.7	88.7		6.3	88.3	
Effective Green, g (s)		27.0	27.0	27.0	27.0		6.7	89.7		6.3	89.3	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.05	0.66		0.05	0.66	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		255	317	121	336		88	2324		83	2317	
v/s Ratio Prot					0.02		c0.03	c0.51		0.02	0.50	
v/s Ratio Perm		c0.19	0.01	0.17								
v/c Ratio		0.94	0.03	0.86	0.12		0.60	0.77		0.51	0.76	
Uniform Delay, d1		53.2	43.5	52.2	44.2		62.8	15.6		62.8	15.5	
Progression Factor		1.00	1.00	1.00	1.00		0.70	1.40		1.30	0.54	
Incremental Delay, d2		43.0	0.2	41.7	0.2		4.0	1.3		1.3	1.8	
Delay (s)		96.2	43.6	93.9	44.4		47.9	23.2		83.1	10.2	
Level of Service		F	D	F	D		D	C		F	B	
Approach Delay (s)		87.3			72.0			23.9			11.9	
Approach LOS		F			E			C			B	

Intersection Summary			
HCM Average Control Delay	25.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	71.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.89		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1662		1770	1863	1583	1770	3539	1583	1770	3518	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1662		1770	1863	1583	1770	3539	1583	1770	3518	
Volume (vph)	85	55	140	100	25	233	112	1463	121	161	1456	62
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	92	60	152	109	27	253	122	1590	132	175	1583	67
RTOR Reduction (vph)	0	68	0	0	0	147	0	0	46	0	2	0
Lane Group Flow (vph)	92	144	0	109	27	106	122	1590	86	175	1648	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	9.6	25.0		10.0	25.4	25.4	11.4	66.8	66.8	15.2	70.6	
Effective Green, g (s)	9.6	26.0		10.0	26.4	26.4	11.4	67.8	67.8	15.2	71.6	
Actuated g/C Ratio	0.07	0.19		0.07	0.20	0.20	0.08	0.50	0.50	0.11	0.53	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	126	320		131	364	310	149	1777	795	199	1866	
v/s Ratio Prot	0.05	c0.09		c0.06	0.01		0.07	0.45		c0.10	c0.47	
v/s Ratio Perm						0.07			0.05			
v/c Ratio	0.73	0.45		0.83	0.07	0.34	0.82	0.89	0.11	0.88	0.88	
Uniform Delay, d1	61.4	48.2		61.7	44.3	46.8	60.8	30.4	17.7	59.0	28.0	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.15	0.57	0.10	1.35	0.56	
Incremental Delay, d2	19.4	4.5		34.1	0.4	3.0	12.8	3.3	0.1	23.7	4.5	
Delay (s)	80.8	52.7		95.8	44.7	49.8	82.5	20.6	1.9	103.3	20.1	
Level of Service	F	D		F	D	D	F	C	A	F	C	
Approach Delay (s)		61.2			62.3			23.4			28.1	
Approach LOS		E			E			C			C	

Intersection Summary			
HCM Average Control Delay	31.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	79.7%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	211	65	31	251	0	39	0	18	0	0	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	229	71	34	273	0	42	0	20	0	0	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	273			300			468	605	150	474	640	136
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	273			300			468	605	150	474	640	136
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			97			91	100	98	100	100	100
cM capacity (veh/h)	1287			1258			468	399	870	453	381	887

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2
Volume Total	153	147	34	136	136	42	20
Volume Left	0	0	34	0	0	42	0
Volume Right	0	71	0	0	0	0	20
cSH	1700	1700	1258	1700	1700	468	870
Volume to Capacity	0.09	0.09	0.03	0.08	0.08	0.09	0.02
Queue Length 95th (ft)	0	0	2	0	0	7	2
Control Delay (s)	0.0	0.0	7.9	0.0	0.0	13.5	9.2
Lane LOS			A			B	A
Approach Delay (s)	0.0		0.9			12.1	
Approach LOS						B	

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	24.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	0	0	0	0	0	0	0	61	0	0	83	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	0	0	0	0	66	0	0	90	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	123	157	45	111	157	33	90			66		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	123	157	45	111	157	33	90			66		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	100	100	100			100		
cM capacity (veh/h)	838	734	1015	855	734	1033	1503			1533		

Direction, Lane #	NB 1	NB 2	SB 1	SB 2
Volume Total	33	33	45	45
Volume Left	0	0	0	0
Volume Right	0	0	0	0
cSH	1700	1700	1700	1700
Volume to Capacity	0.02	0.02	0.03	0.03
Queue Length 95th (ft)	0	0	0	0
Control Delay (s)	0.0	0.0	0.0	0.0
Lane LOS				
Approach Delay (s)	0.0		0.0	
Approach LOS				

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	6.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.21	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	396	3539	3539	1583
Volume (vph)	30	19	34	956	1167	35
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	33	21	37	1039	1268	38
RTOR Reduction (vph)	0	20	0	0	0	3
Lane Group Flow (vph)	33	1	37	1039	1268	35
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	5.1	5.1	121.9	121.9	121.9	121.9
Effective Green, g (s)	5.1	5.1	121.9	121.9	121.9	121.9
Actuated g/C Ratio	0.04	0.04	0.90	0.90	0.90	0.90
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	67	60	358	3196	3196	1429
v/s Ratio Prot	c0.02			0.29	c0.36	
v/s Ratio Perm		0.00	0.09			0.02
v/c Ratio	0.49	0.01	0.10	0.33	0.40	0.02
Uniform Delay, d1	63.7	62.5	0.7	0.9	1.0	0.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	5.6	0.1	0.6	0.3	0.4	0.0
Delay (s)	69.3	62.6	1.3	1.2	1.4	0.7
Level of Service	E	E	A	A	A	A
Approach Delay (s)	66.7			1.2	1.3	
Approach LOS	E			A	A	

Intersection Summary			
HCM Average Control Delay	2.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	42.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	52	1181	18	43	1159	31
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	57	1284	20	47	1260	34
RTOR Reduction (vph)	0	0	0	44	0	0
Lane Group Flow (vph)	57	1284	20	3	1260	34
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	7.9	143.0	62.2	7.9	60.9	127.1
Effective Green, g (s)	7.9	143.0	62.2	7.9	60.9	127.1
Actuated g/C Ratio	0.06	1.00	0.43	0.06	0.43	0.89
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	98	2787	810	87	1462	1656
v/s Ratio Prot	0.03		0.01	0.00	c0.37	0.02
v/s Ratio Perm		c0.46				
v/c Ratio	0.58	0.46	0.02	0.03	0.86	0.02
Uniform Delay, d1	65.9	0.0	23.1	63.9	37.2	0.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	8.5	0.6	0.1	0.1	5.5	0.0
Delay (s)	74.4	0.6	23.1	64.1	42.7	0.9
Level of Service	E	A	C	E	D	A
Approach Delay (s)	3.7		51.8			41.6
Approach LOS	A		D			D

Intersection Summary			
HCM Average Control Delay	23.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	143.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	49.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	2	7	1197	3	2	1190
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	2	8	1301	3	2	1293
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1954	652			1304	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1954	652			1304	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	96	98			100	
cM capacity (veh/h)	56	410			527	

Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	2	8	867	437	2	647	647
Volume Left	2	0	0	0	2	0	0
Volume Right	0	8	0	3	0	0	0
cSH	56	410	1700	1700	527	1700	1700
Volume to Capacity	0.04	0.02	0.51	0.26	0.00	0.38	0.38
Queue Length 95th (ft)	3	1	0	0	0	0	0
Control Delay (s)	72.1	13.9	0.0	0.0	11.9	0.0	0.0
Lane LOS	F	B			B		
Approach Delay (s)	26.9		0.0		0.0		
Approach LOS	D						

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	43.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	18	9	1159	30	3	1165
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	20	10	1260	33	3	1266
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1916	646			1292	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1916	646			1292	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	67	98			99	
cM capacity (veh/h)	59	414			532	

Direction, Lane #	WB 1	WB 2	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	20	10	840	453	3	633	633
Volume Left	20	0	0	0	3	0	0
Volume Right	0	10	0	33	0	0	0
cSH	59	414	1700	1700	532	1700	1700
Volume to Capacity	0.33	0.02	0.49	0.27	0.01	0.37	0.37
Queue Length 95th (ft)	30	2	0	0	0	0	0
Control Delay (s)	93.6	13.9	0.0	0.0	11.8	0.0	0.0
Lane LOS	F	B			B		
Approach Delay (s)	67.0		0.0		0.0		
Approach LOS	F						

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	43.0%	ICU Level of Service	A
Analysis Period (min)	15		

CUMULATIVE PLUS PROJECT CONDITIONS

CUMULATIVE PLUS PROJECT (2028) CONDITIONS – CONCEPT 1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.92		1.00	0.85		1.00	0.99		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1695		1770	1583		1770	3489		1770	3538	
Flt Permitted		0.98		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1669		1405	1583		1770	3489		1770	3538	
Volume (vph)	1	1	3	115	0	95	5	1260	131	70	1252	2
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	1	1	3	122	0	101	5	1340	139	74	1332	2
RTOR Reduction (vph)	0	2	0	0	78	0	0	6	0	0	0	0
Lane Group Flow (vph)	0	3	0	122	23	0	5	1473	0	74	1334	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		3			7		5	2		1	6	
Permitted Phases	3			7								
Actuated Green, G (s)		31.0		31.0	31.0		5.0	87.3		7.7	90.0	
Effective Green, g (s)		32.0		32.0	32.0		5.0	88.3		7.7	91.0	
Actuated g/C Ratio		0.23		0.23	0.23		0.04	0.63		0.06	0.65	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		381		321	362		63	2201		97	2300	
v/s Ratio Prot					0.01		0.00	c0.42		c0.04	c0.38	
v/s Ratio Perm		0.00		c0.09								
v/c Ratio		0.01		0.38	0.06		0.08	0.67		0.76	0.58	
Uniform Delay, d1		41.7		45.6	42.3		65.3	16.5		65.2	13.8	
Progression Factor		1.00		0.98	1.25		1.01	0.38		1.00	1.00	
Incremental Delay, d2		0.0		3.4	0.3		0.2	1.4		26.7	1.1	
Delay (s)		41.7		48.0	53.3		66.1	7.7		92.0	14.8	
Level of Service		D		D	D		E	A		F	B	
Approach Delay (s)		41.7			50.4			7.9			18.9	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	15.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	65.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	66	84	1299	65	52	1324
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	68	87	1339	67	54	1365
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2162	703			1406	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2162	703			1406	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	77			89	
cM capacity (veh/h)	36	380			481	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	155	893	513	54	682	682
Volume Left	68	0	0	54	0	0
Volume Right	87	0	67	0	0	0
cSH	73	1700	1700	481	1700	1700
Volume to Capacity	2.12	0.53	0.30	0.11	0.40	0.40
Queue Length 95th (ft)	357	0	0	9	0	0
Control Delay (s)	640.2	0.0	0.0	13.4	0.0	0.0
Lane LOS	F			B		
Approach Delay (s)	640.2	0.0		0.5		
Approach LOS	F					

Intersection Summary			
Average Delay	33.5		
Intersection Capacity Utilization	58.7%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.90		1.00	0.99		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1793	1583	1770	1683		1770	3499		1770	3506	
Flt Permitted		0.65	1.00	0.45	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1216	1583	838	1683		1770	3499		1770	3506	
Volume (vph)	133	37	39	155	32	57	27	1163	96	32	1268	85
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	141	39	41	165	34	61	29	1237	102	34	1349	90
RTOR Reduction (vph)	0	0	33	0	46	0	0	4	0	0	3	0
Lane Group Flow (vph)	0	180	8	165	49	0	29	1335	0	34	1436	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		27.0	27.0	27.0	27.0		3.0	95.0		4.0	96.0	
Effective Green, g (s)		28.0	28.0	28.0	28.0		3.0	96.0		4.0	97.0	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.02	0.69		0.03	0.69	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		243	317	168	337		38	2399		51	2429	
v/s Ratio Prot					0.03		0.02	0.38		c0.02	c0.41	
v/s Ratio Perm		0.15	0.01	c0.20								
v/c Ratio		0.74	0.03	0.98	0.14		0.76	0.56		0.67	0.59	
Uniform Delay, d1		52.6	45.0	55.8	46.1		68.1	11.2		67.3	11.2	
Progression Factor		1.00	1.00	1.00	1.00		0.90	0.41		1.27	0.60	
Incremental Delay, d2		11.5	0.0	63.8	0.2		44.3	0.7		19.8	0.9	
Delay (s)		64.1	45.1	119.6	46.3		105.6	5.3		105.6	7.7	
Level of Service		E	D	F	D		F	A		F	A	
Approach Delay (s)		60.5			92.8			7.4			9.9	
Approach LOS		E			F			A			A	

Intersection Summary			
HCM Average Control Delay	18.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	62.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1711		1770	1863	1583	1770	3539	1583	1770	3522	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1711		1770	1863	1583	1770	3539	1583	1770	3522	
Volume (vph)	19	50	60	102	46	116	53	1317	200	146	1280	44
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	20	53	63	107	48	122	56	1386	211	154	1347	46
RTOR Reduction (vph)	0	31	0	0	0	92	0	0	84	0	2	0
Lane Group Flow (vph)	20	85	0	107	48	30	56	1386	127	154	1391	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	3.6	26.6		10.0	33.0	33.0	7.2	74.4	74.4	11.0	78.2	
Effective Green, g (s)	3.6	27.6		10.0	34.0	34.0	7.2	75.4	75.4	11.0	79.2	
Actuated g/C Ratio	0.03	0.20		0.07	0.24	0.24	0.05	0.54	0.54	0.08	0.57	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	46	337		126	452	384	91	1906	853	139	1992	
v/s Ratio Prot	0.01	c0.05		c0.06	0.03		0.03	c0.39		c0.09	c0.40	
v/s Ratio Perm						0.02			0.08			
v/c Ratio	0.43	0.25		0.85	0.11	0.08	0.62	0.73	0.15	1.11	0.70	
Uniform Delay, d1	67.2	47.5		64.3	41.2	40.9	65.0	24.5	16.2	64.5	21.8	
Progression Factor	1.00	1.00		0.96	0.99	1.03	1.39	0.43	0.08	1.29	0.53	
Incremental Delay, d2	6.5	1.8		38.3	0.5	0.4	4.5	1.3	0.2	99.8	1.6	
Delay (s)	73.7	49.3		99.7	41.1	42.6	94.9	11.8	1.5	182.8	13.1	
Level of Service	E	D		F	D	D	F	B	A	F	B	
Approach Delay (s)		52.9			64.4			13.3			30.0	
Approach LOS		D			E			B			C	

Intersection Summary			
HCM Average Control Delay	25.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	66.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	35	298	18	23	134	19	57	78	115	30	101	47
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	38	324	20	25	146	21	62	85	125	33	110	51
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	166			343			639	626	172	611	626	83
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	166			343			639	626	172	611	626	83
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			98			76	78	85	87	71	95
cM capacity (veh/h)	1409			1212			256	380	842	257	381	960

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	38	216	128	25	97	69	62	210	33	161
Volume Left	38	0	0	25	0	0	62	0	33	0
Volume Right	0	0	20	0	0	21	0	125	0	51
cSH	1409	1700	1700	1212	1700	1700	256	565	257	471
Volume to Capacity	0.03	0.13	0.08	0.02	0.06	0.04	0.24	0.37	0.13	0.34
Queue Length 95th (ft)	2	0	0	2	0	0	23	43	11	37
Control Delay (s)	7.6	0.0	0.0	8.0	0.0	0.0	23.5	15.1	21.0	16.6
Lane LOS	A			A			C	C	C	C
Approach Delay (s)	0.8			1.0			17.0		17.3	
Approach LOS							C		C	

Intersection Summary			
Average Delay	8.1		
Intersection Capacity Utilization	40.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	123	149	16	40	25	35	14	87	239	209	75	104
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	134	162	17	43	27	38	15	95	260	227	82	113
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	722	977	97	848	904	177	195			354		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	722	977	97	848	904	177	195			354		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	42	19	98	39	88	95	99			81		
cM capacity (veh/h)	231	200	940	71	221	835	1376			1201		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	134	179	43	65	15	63	291	227	54	140
Volume Left	134	0	43	0	15	0	0	227	0	0
Volume Right	0	17	0	38	0	0	260	0	0	113
cSH	231	216	71	387	1376	1700	1700	1201	1700	1700
Volume to Capacity	0.58	0.83	0.61	0.17	0.01	0.04	0.17	0.19	0.03	0.08
Queue Length 95th (ft)	81	155	67	15	1	0	0	17	0	0
Control Delay (s)	39.9	70.8	114.9	16.2	7.6	0.0	0.0	8.7	0.0	0.0
Lane LOS	E	F	F	C	A			A		
Approach Delay (s)	57.6		55.7		0.3			4.7		
Approach LOS	F		F							

Intersection Summary			
Average Delay	21.6		
Intersection Capacity Utilization	47.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.25	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	473	3539	3539	1583
Volume (vph)	85	36	16	868	998	83
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	92	39	17	943	1085	90
RTOR Reduction (vph)	0	36	0	0	0	11
Lane Group Flow (vph)	92	3	17	943	1085	79
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	9.8	9.8	122.2	122.2	122.2	122.2
Effective Green, g (s)	9.8	9.8	122.2	122.2	122.2	122.2
Actuated g/C Ratio	0.07	0.07	0.87	0.87	0.87	0.87
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	124	111	413	3089	3089	1382
v/s Ratio Prot	c0.05			0.27	c0.31	
v/s Ratio Perm		0.00	0.04			0.05
v/c Ratio	0.74	0.02	0.04	0.31	0.35	0.06
Uniform Delay, d1	63.9	60.6	1.2	1.5	1.6	1.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	21.1	0.1	0.2	0.3	0.3	0.1
Delay (s)	84.9	60.7	1.4	1.8	1.9	1.3
Level of Service	F	E	A	A	A	A
Approach Delay (s)	77.7			1.8	1.9	
Approach LOS	E			A	A	

Intersection Summary			
HCM Average Control Delay	6.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	39.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	178	960	136	109	974	210
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	193	1043	148	118	1059	228
RTOR Reduction (vph)	0	0	0	102	0	0
Lane Group Flow (vph)	193	1043	148	16	1059	228
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	19.4	140.0	61.3	19.4	47.3	112.6
Effective Green, g (s)	19.4	140.0	61.3	19.4	47.3	112.6
Actuated g/C Ratio	0.14	1.00	0.44	0.14	0.34	0.80
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	245	2787	816	219	1160	1498
v/s Ratio Prot	c0.11		0.08	0.01	c0.31	0.12
v/s Ratio Perm		c0.37				
v/c Ratio	0.79	0.37	0.18	0.07	0.91	0.15
Uniform Delay, d1	58.3	0.0	24.0	52.5	44.4	3.1
Progression Factor	1.00	1.00	0.90	1.01	1.00	1.00
Incremental Delay, d2	15.3	0.4	0.5	0.1	10.9	0.2
Delay (s)	73.6	0.4	22.2	53.1	55.3	3.3
Level of Service	E	A	C	D	E	A
Approach Delay (s)	11.8		35.9			46.1
Approach LOS	B		D			D

Intersection Summary			
HCM Average Control Delay	29.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	54.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	69	0	39	3	9	2	24	1071	1	1	1137	43
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	75	0	42	3	10	2	26	1164	1	1	1236	47
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1903	2479	641	1879	2502	583	1283			1165		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1903	2479	641	1879	2502	583	1283			1165		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	90	91	64	100	95			100		
cM capacity (veh/h)	29	28	417	38	27	456	537			595		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	75	42	3	12	26	776	389	1	824	459
Volume Left	75	0	3	0	26	0	0	1	0	0
Volume Right	0	42	0	2	0	0	1	0	0	47
cSH	29	417	38	32	537	1700	1700	595	1700	1700
Volume to Capacity	2.60	0.10	0.09	0.37	0.05	0.46	0.23	0.00	0.48	0.27
Queue Length 95th (ft)	223	8	7	30	4	0	0	0	0	0
Control Delay (s)	1015.8	14.6	109.4	170.4	12.0	0.0	0.0	11.1	0.0	0.0
Lane LOS	F	B	F	F	B			B		
Approach Delay (s)	654.3		157.3		0.3			0.0		
Approach LOS	F		F							

Intersection Summary			
Average Delay	30.5		
Intersection Capacity Utilization	50.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	48	0	67	27	11	3	56	1063	9	1	1086	40
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	52	0	73	29	12	3	61	1155	10	1	1180	43
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1913	2491	612	1947	2508	583	1224			1165		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1913	2491	612	1947	2508	583	1224			1165		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	83	1	52	99	89			100		
cM capacity (veh/h)	24	26	436	30	25	456	565			595		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	52	73	29	15	61	770	395	1	787	437
Volume Left	52	0	29	0	61	0	0	1	0	0
Volume Right	0	73	0	3	0	0	10	0	0	43
cSH	24	436	30	31	565	1700	1700	595	1700	1700
Volume to Capacity	2.22	0.17	0.99	0.49	0.11	0.45	0.23	0.00	0.46	0.26
Queue Length 95th (ft)	164	15	83	40	9	0	0	0	0	0
Control Delay (s)	908.0	14.9	358.2	200.6	12.1	0.0	0.0	11.1	0.0	0.0
Lane LOS	F	B	F	F	B			B		
Approach Delay (s)	387.7		304.3		0.6			0.0		
Approach LOS	F		F							

Intersection Summary			
Average Delay	24.0		
Intersection Capacity Utilization	54.0%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: Leiali'i Pkwy & Honoapi'ilani Hwy

9/28/2010

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.91		1.00	0.85		1.00	0.98		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1691		1770	1589		1770	3482		1770	3535	
Flt Permitted		0.96		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1640		1388	1589		1770	3482		1770	3535	
Volume (vph)	3	4	11	186	3	142	6	1603	193	123	1588	12
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	3	4	12	196	3	149	6	1687	203	129	1672	13
RTOR Reduction (vph)	0	10	0	0	121	0	0	7	0	0	0	0
Lane Group Flow (vph)	0	9	0	196	31	0	6	1883	0	129	1685	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)		20.0		20.0	20.0		5.0	91.0		10.0	96.0	
Effective Green, g (s)		21.0		21.0	21.0		5.0	92.0		10.0	97.0	
Actuated g/C Ratio		0.16		0.16	0.16		0.04	0.68		0.07	0.72	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		255		216	247		66	2373		131	2540	
v/s Ratio Prot					0.02		0.00	c0.54		c0.07	0.48	
v/s Ratio Perm		0.01		c0.14								
v/c Ratio		0.03		0.91	0.13		0.09	0.79		0.98	0.66	
Uniform Delay, d1		48.4		56.0	49.1		62.8	14.9		62.4	10.2	
Progression Factor		1.00		1.15	1.78		1.22	0.81		1.00	1.00	
Incremental Delay, d2		0.1		26.3	0.6		0.1	1.7		73.3	1.4	
Delay (s)		48.5		90.7	88.1		76.9	13.8		135.7	11.6	
Level of Service		D		F	F		E	B		F	B	
Approach Delay (s)		48.5			89.5			14.0			20.4	
Approach LOS		D			F			B			C	

Intersection Summary			
HCM Average Control Delay	23.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	84.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	54	39	1758	130	87	1705
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	57	41	1870	138	93	1814
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	3031	1004			2009	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3031	1004			2009	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	83			67	
cM capacity (veh/h)	7	240			281	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	99	1247	762	93	907	907
Volume Left	57	0	0	93	0	0
Volume Right	41	0	138	0	0	0
cSH	11	1700	1700	281	1700	1700
Volume to Capacity	8.68	0.73	0.45	0.33	0.53	0.53
Queue Length 95th (ft)	Err	0	0	35	0	0
Control Delay (s)	Err	0.0	0.0	24.0	0.0	0.0
Lane LOS	F			C		
Approach Delay (s)	Err	0.0		1.2		
Approach LOS	F					

Intersection Summary			
Average Delay	247.0		
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.89		1.00	0.99		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1789	1583	1770	1655		1770	3494		1770	3496	
Flt Permitted		0.63	1.00	0.28	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1181	1583	519	1655		1770	3494		1770	3496	
Volume (vph)	198	43	43	111	24	69	47	1573	147	58	1489	133
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	215	47	47	121	26	75	51	1710	160	63	1618	145
RTOR Reduction (vph)	0	0	38	0	60	0	0	5	0	0	5	0
Lane Group Flow (vph)	0	262	9	121	41	0	51	1865	0	63	1758	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		26.0	26.0	26.0	26.0		6.6	88.1		6.9	88.4	
Effective Green, g (s)		27.0	27.0	27.0	27.0		6.6	89.1		6.9	89.4	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.05	0.66		0.05	0.66	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		236	317	104	331		87	2306		90	2315	
v/s Ratio Prot					0.02		0.03	c0.53		c0.04	0.50	
v/s Ratio Perm		0.22	0.01	c0.23								
v/c Ratio		1.11	0.03	1.16	0.12		0.59	0.81		0.70	0.76	
Uniform Delay, d1		54.0	43.5	54.0	44.3		62.9	16.7		63.0	15.5	
Progression Factor		1.00	1.00	1.00	1.00		0.68	1.70		1.23	0.78	
Incremental Delay, d2		91.3	0.2	138.8	0.2		2.2	1.1		13.4	1.8	
Delay (s)		145.3	43.6	192.8	44.5		45.0	29.5		90.8	13.9	
Level of Service		F	D	F	D		D	C		F	B	
Approach Delay (s)		129.8			125.3			29.9			16.6	
Approach LOS		F			F			C			B	

Intersection Summary			
HCM Average Control Delay	36.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	74.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.91		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1702		1770	1863	1583	1770	3539	1583	1770	3518	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1702		1770	1863	1583	1770	3539	1583	1770	3518	
Volume (vph)	80	100	135	268	66	330	108	1431	211	199	1418	58
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	109	147	291	72	359	117	1555	229	216	1541	63
RTOR Reduction (vph)	0	36	0	0	0	154	0	0	82	0	2	0
Lane Group Flow (vph)	87	220	0	291	72	205	117	1555	147	216	1602	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	11.0	25.0		21.0	35.0	35.0	9.0	56.0	56.0	15.0	62.0	
Effective Green, g (s)	11.0	26.0		21.0	36.0	36.0	9.0	57.0	57.0	15.0	63.0	
Actuated g/C Ratio	0.08	0.19		0.16	0.27	0.27	0.07	0.42	0.42	0.11	0.47	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	144	328		275	497	422	118	1494	668	197	1642	
v/s Ratio Prot	0.05	c0.13		c0.16	0.04		0.07	c0.44		c0.12	0.46	
v/s Ratio Perm						0.13			0.09			
v/c Ratio	0.60	0.67		1.06	0.14	0.49	0.99	1.04	0.22	1.10	0.98	
Uniform Delay, d1	59.9	50.5		57.0	37.8	41.7	63.0	39.0	24.8	60.0	35.2	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.26	0.42	0.10	1.19	0.64	
Incremental Delay, d2	7.0	10.4		70.4	0.6	4.0	55.1	28.1	0.4	79.6	12.9	
Delay (s)	66.9	60.9		127.4	38.4	45.7	134.2	44.6	2.8	150.9	35.5	
Level of Service	E	E		F	D	D	F	D	A	F	D	
Approach Delay (s)		62.4			77.9			45.0			49.2	
Approach LOS		E			E			D			D	

Intersection Summary			
HCM Average Control Delay	52.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	92.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	65	315	62	146	496	23	37	156	49	15	147	59
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	71	342	67	159	539	25	40	170	53	16	160	64
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	564			410			1248	1399	205	1320	1420	282
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	564			410			1248	1399	205	1320	1420	282
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	93			86			0	0	93	0	0	91
cM capacity (veh/h)	1004			1146			0	112	802	0	108	715

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	71	228	182	159	359	205	40	223	16	224
Volume Left	71	0	0	159	0	0	40	0	16	0
Volume Right	0	0	67	0	0	25	0	53	0	64
cSH	1004	1700	1700	1146	1700	1700	0	141	0	143
Volume to Capacity	0.07	0.13	0.11	0.14	0.21	0.12	Err	1.59	Err	1.56
Queue Length 95th (ft)	6	0	0	12	0	0	Err	391	Err	388
Control Delay (s)	8.9	0.0	0.0	8.6	0.0	0.0	Err	351.0	Err	340.9
Lane LOS	A			A			F	F	F	F
Approach Delay (s)	1.3			1.9			Err		Err	
Approach LOS							F		F	

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	46.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	227	55	32	315	197	276	32	99	89	78	128	228
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	247	60	35	342	214	300	35	108	97	85	139	248
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	963	707	193	529	782	102	387			204		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	963	707	193	529	782	102	387			204		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	82	96	0	27	68	97			94		
cM capacity (veh/h)	55	326	815	332	295	933	1168			1364		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	247	95	342	514	35	72	133	85	93	294
Volume Left	247	0	342	0	35	0	0	85	0	0
Volume Right	0	35	0	300	0	0	97	0	0	248
cSH	55	419	332	491	1168	1700	1700	1364	1700	1700
Volume to Capacity	4.49	0.23	1.03	1.05	0.03	0.04	0.08	0.06	0.05	0.17
Queue Length 95th (ft)	Err	21	300	385	2	0	0	5	0	0
Control Delay (s)	Err	16.1	94.3	82.7	8.2	0.0	0.0	7.8	0.0	0.0
Lane LOS	F	C	F	F	A			A		
Approach Delay (s)	7233.0		87.3		1.2			1.4		
Approach LOS	F		F							

Intersection Summary			
Average Delay	1333.1		
Intersection Capacity Utilization	67.4%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.16	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	298	3539	3539	1583
Volume (vph)	93	17	31	1091	1373	89
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	101	18	34	1186	1492	97
RTOR Reduction (vph)	0	13	0	0	0	9
Lane Group Flow (vph)	101	5	34	1186	1492	88
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	10.1	10.1	116.9	116.9	116.9	116.9
Effective Green, g (s)	10.1	10.1	116.9	116.9	116.9	116.9
Actuated g/C Ratio	0.07	0.07	0.87	0.87	0.87	0.87
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	132	118	258	3065	3065	1371
v/s Ratio Prot	c0.06			0.34	c0.42	
v/s Ratio Perm		0.00	0.11			0.06
v/c Ratio	0.77	0.04	0.13	0.39	0.49	0.06
Uniform Delay, d1	61.3	58.0	1.4	1.8	2.1	1.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	22.8	0.1	1.1	0.4	0.6	0.1
Delay (s)	84.1	58.1	2.4	2.2	2.7	1.4
Level of Service	F	E	A	A	A	A
Approach Delay (s)	80.2			2.2	2.6	
Approach LOS	F			A	A	

Intersection Summary			
HCM Average Control Delay	5.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	49.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	177	1248	359	242	1220	256
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	192	1357	390	263	1326	278
RTOR Reduction (vph)	0	0	0	202	0	0
Lane Group Flow (vph)	192	1357	390	61	1326	278
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	18.2	135.0	47.4	18.2	57.4	108.8
Effective Green, g (s)	18.2	135.0	47.4	18.2	57.4	108.8
Actuated g/C Ratio	0.13	1.00	0.35	0.13	0.43	0.81
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	239	2787	654	213	1460	1501
v/s Ratio Prot	c0.11		c0.21	0.04	c0.39	0.15
v/s Ratio Perm		0.49				
v/c Ratio	0.80	0.49	0.60	0.28	0.91	0.19
Uniform Delay, d1	56.7	0.0	35.9	52.5	36.3	3.0
Progression Factor	1.00	1.00	0.97	0.94	1.00	1.00
Incremental Delay, d2	17.5	0.6	4.0	0.7	8.5	0.3
Delay (s)	74.1	0.6	39.0	50.1	44.8	3.3
Level of Service	E	A	D	D	D	A
Approach Delay (s)	9.7		43.5			37.6
Approach LOS	A		D			D

Intersection Summary			
HCM Average Control Delay	27.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	73.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	35	0	19	2	6	1	30	1575	3	2	1453	53
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	38	0	21	2	7	1	33	1712	3	2	1579	58
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2538	3393	818	2593	3420	858	1637			1715		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2538	3393	818	2593	3420	858	1637			1715		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	94	80	0	100	92			99		
cM capacity (veh/h)	0	7	319	11	6	300	392			366		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	38	21	2	8	33	1141	574	2	1053	584
Volume Left	38	0	2	0	33	0	0	2	0	0
Volume Right	0	21	0	1	0	0	3	0	0	58
cSH	0	319	11	7	392	1700	1700	366	1700	1700
Volume to Capacity	Err	0.06	0.20	1.03	0.08	0.67	0.34	0.01	0.62	0.34
Queue Length 95th (ft)	Err	5	13	43	7	0	0	0	0	0
Control Delay (s)	Err	17.1	411.1	969.0	15.0	0.0	0.0	14.9	0.0	0.0
Lane LOS	F	C	F	F	C			B		
Approach Delay (s)	Err		845.1		0.3			0.0		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	58.9%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	98	0	137	18	7	2	137	1428	30	3	1345	98
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	107	0	149	20	8	2	149	1552	33	3	1462	107
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2602	3404	784	2753	3441	792	1568			1585		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2602	3404	784	2753	3441	792	1568			1585		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	56	0	0	99	64			99		
cM capacity (veh/h)	0	5	336	4	4	332	417			411		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	107	149	20	10	149	1035	550	3	975	594
Volume Left	107	0	20	0	149	0	0	3	0	0
Volume Right	0	149	0	2	0	0	33	0	0	107
cSH	0	336	4	6	417	1700	1700	411	1700	1700
Volume to Capacity	Err	0.44	5.29	1.77	0.36	0.61	0.32	0.01	0.57	0.35
Queue Length 95th (ft)	Err	55	Err	55	40	0	0	1	0	0
Control Delay (s)	Err	24.0	Err	1567.9	18.4	0.0	0.0	13.8	0.0	0.0
Lane LOS	F	C	F	F	C			B		
Approach Delay (s)	Err		7188.6		1.6			0.0		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	72.8%	ICU Level of Service	C
Analysis Period (min)	15		

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.92		1.00	0.85		1.00	0.99		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1695		1770	1583		1770	3488		1770	3538	
Flt Permitted		0.97		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1668		1405	1583		1770	3488		1770	3538	
Volume (vph)	1	1	3	135	0	104	5	1271	135	72	1254	2
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	1	1	3	144	0	111	5	1352	144	77	1334	2
RTOR Reduction (vph)	0	2	0	0	86	0	0	6	0	0	0	0
Lane Group Flow (vph)	0	3	0	144	25	0	5	1490	0	77	1336	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		3			7		5	2		1	6	
Permitted Phases	3			7								
Actuated Green, G (s)		31.0		31.0	31.0		5.0	87.2		7.8	90.0	
Effective Green, g (s)		32.0		32.0	32.0		5.0	88.2		7.8	91.0	
Actuated g/C Ratio		0.23		0.23	0.23		0.04	0.63		0.06	0.65	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		381		321	362		63	2197		99	2300	
v/s Ratio Prot					0.02		0.00	c0.43		c0.04	c0.38	
v/s Ratio Perm		0.00		c0.10								
v/c Ratio		0.01		0.45	0.07		0.08	0.68		0.78	0.58	
Uniform Delay, d1		41.7		46.4	42.3		65.3	16.7		65.2	13.8	
Progression Factor		1.00		1.01	1.40		1.00	0.38		1.00	1.00	
Incremental Delay, d2		0.0		4.4	0.4		0.2	1.5		28.7	1.1	
Delay (s)		41.7		51.1	59.4		65.2	7.9		93.9	14.9	
Level of Service		D		D	E		E	A		F	B	
Approach Delay (s)		41.7			54.7			8.1			19.2	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	16.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	67.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	82	95	1302	67	54	1344
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	85	98	1342	69	56	1386
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2181	706			1411	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2181	706			1411	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	74			88	
cM capacity (veh/h)	35	378			479	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	182	895	516	56	693	693
Volume Left	85	0	0	56	0	0
Volume Right	98	0	69	0	0	0
cSH	68	1700	1700	479	1700	1700
Volume to Capacity	2.70	0.53	0.30	0.12	0.41	0.41
Queue Length 95th (ft)	453	0	0	10	0	0
Control Delay (s)	898.1	0.0	0.0	13.5	0.0	0.0
Lane LOS	F			B		
Approach Delay (s)	898.1	0.0		0.5		
Approach LOS	F					

Intersection Summary			
Average Delay	54.2		
Intersection Capacity Utilization	61.8%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.90		1.00	0.99		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1792	1583	1770	1682		1770	3496		1770	3504	
Flt Permitted		0.65	1.00	0.45	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1211	1583	829	1682		1770	3496		1770	3504	
Volume (vph)	134	37	39	156	32	58	27	1166	102	38	1287	91
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	143	39	41	166	34	62	29	1240	109	40	1369	97
RTOR Reduction (vph)	0	0	33	0	47	0	0	5	0	0	3	0
Lane Group Flow (vph)	0	182	8	166	49	0	29	1344	0	40	1463	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		27.0	27.0	27.0	27.0		3.0	95.0		4.0	96.0	
Effective Green, g (s)		28.0	28.0	28.0	28.0		3.0	96.0		4.0	97.0	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.02	0.69		0.03	0.69	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		242	317	166	336		38	2397		51	2428	
v/s Ratio Prot					0.03		0.02	0.38		c0.02	c0.42	
v/s Ratio Perm		0.15	0.01	c0.20								
v/c Ratio		0.75	0.03	1.00	0.15		0.76	0.56		0.78	0.60	
Uniform Delay, d1		52.7	45.0	56.0	46.1		68.1	11.2		67.6	11.3	
Progression Factor		1.00	1.00	1.00	1.00		0.90	0.41		1.26	0.65	
Incremental Delay, d2		12.4	0.0	69.9	0.2		44.3	0.7		45.3	1.0	
Delay (s)		65.1	45.1	125.9	46.3		105.5	5.3		130.7	8.3	
Level of Service		E	D	F	D		F	A		F	A	
Approach Delay (s)		61.4			96.7			7.4			11.5	
Approach LOS		E			F			A			B	

Intersection Summary			
HCM Average Control Delay	19.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	62.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1714		1770	1863	1583	1770	3539	1583	1770	3522	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1714		1770	1863	1583	1770	3539	1583	1770	3522	
Volume (vph)	19	52	60	119	57	122	53	1320	202	147	1299	44
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	20	55	63	125	60	128	56	1389	213	155	1367	46
RTOR Reduction (vph)	0	29	0	0	0	97	0	0	84	0	2	0
Lane Group Flow (vph)	20	89	0	125	60	31	56	1389	129	155	1411	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	3.6	26.6		10.0	33.0	33.0	7.2	74.4	74.4	11.0	78.2	
Effective Green, g (s)	3.6	27.6		10.0	34.0	34.0	7.2	75.4	75.4	11.0	79.2	
Actuated g/C Ratio	0.03	0.20		0.07	0.24	0.24	0.05	0.54	0.54	0.08	0.57	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	46	338		126	452	384	91	1906	853	139	1992	
v/s Ratio Prot	0.01	c0.05		c0.07	0.03		0.03	0.39		c0.09	c0.40	
v/s Ratio Perm						0.02			0.08			
v/c Ratio	0.43	0.26		0.99	0.13	0.08	0.62	0.73	0.15	1.12	0.71	
Uniform Delay, d1	67.2	47.6		65.0	41.5	40.9	65.0	24.5	16.2	64.5	22.0	
Progression Factor	1.00	1.00		0.95	0.98	1.02	1.39	0.43	0.08	1.28	0.54	
Incremental Delay, d2	6.5	1.9		77.4	0.6	0.4	4.5	1.3	0.2	101.7	1.7	
Delay (s)	73.7	49.5		139.4	41.3	42.1	94.9	11.8	1.4	184.4	13.5	
Level of Service	E	D		F	D	D	F	B	A	F	B	
Approach Delay (s)		53.0			80.8			13.3			30.4	
Approach LOS		D			F			B			C	

Intersection Summary			
HCM Average Control Delay	27.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	67.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	38	301	18	23	147	20	57	85	115	39	142	66
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	41	327	20	25	160	22	62	92	125	42	154	72
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	182			347			698	651	173	638	650	91
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	182			347			698	651	173	638	650	91
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			98			68	75	85	82	58	92
cM capacity (veh/h)	1391			1209			196	367	840	239	367	949

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	41	218	129	25	107	75	62	217	42	226
Volume Left	41	0	0	25	0	0	62	0	42	0
Volume Right	0	0	20	0	0	22	0	125	0	72
cSH	1391	1700	1700	1209	1700	1700	196	543	239	456
Volume to Capacity	0.03	0.13	0.08	0.02	0.06	0.04	0.32	0.40	0.18	0.50
Queue Length 95th (ft)	2	0	0	2	0	0	32	48	16	67
Control Delay (s)	7.7	0.0	0.0	8.0	0.0	0.0	31.6	16.0	23.3	20.4
Lane LOS	A			A			D	C	C	C
Approach Delay (s)	0.8			1.0			19.5		20.9	
Approach LOS							C		C	

Intersection Summary			
Average Delay	10.1		
Intersection Capacity Utilization	40.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	186	149	25	40	25	35	16	97	239	209	81	115
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	202	162	27	43	27	38	17	105	260	227	88	125
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	744	1005	107	877	938	183	213			365		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	744	1005	107	877	938	183	213			365		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	8	16	97	27	87	95	99			81		
cM capacity (veh/h)	221	192	927	59	210	829	1354			1190		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	202	189	43	65	17	70	295	227	59	154
Volume Left	202	0	43	0	17	0	0	227	0	0
Volume Right	0	27	0	38	0	0	260	0	0	125
cSH	221	216	59	372	1354	1700	1700	1190	1700	1700
Volume to Capacity	0.92	0.87	0.73	0.18	0.01	0.04	0.17	0.19	0.03	0.09
Queue Length 95th (ft)	190	172	79	16	1	0	0	18	0	0
Control Delay (s)	86.3	79.0	158.5	16.7	7.7	0.0	0.0	8.7	0.0	0.0
Lane LOS	F	F	F	C	A			A		
Approach Delay (s)	82.8		73.4		0.3			4.5		
Approach LOS	F		F							

Intersection Summary			
Average Delay	32.1		
Intersection Capacity Utilization	49.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.24	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	448	3539	3539	1583
Volume (vph)	88	36	16	876	1043	99
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	96	39	17	952	1134	108
RTOR Reduction (vph)	0	36	0	0	0	12
Lane Group Flow (vph)	96	3	17	952	1134	96
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	10.0	10.0	122.0	122.0	122.0	122.0
Effective Green, g (s)	10.0	10.0	122.0	122.0	122.0	122.0
Actuated g/C Ratio	0.07	0.07	0.87	0.87	0.87	0.87
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	126	113	390	3084	3084	1379
v/s Ratio Prot	c0.05			0.27	c0.32	
v/s Ratio Perm		0.00	0.04			0.06
v/c Ratio	0.76	0.02	0.04	0.31	0.37	0.07
Uniform Delay, d1	63.8	60.5	1.2	1.6	1.7	1.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	23.4	0.1	0.2	0.3	0.3	0.1
Delay (s)	87.2	60.6	1.4	1.8	2.0	1.3
Level of Service	F	E	A	A	A	A
Approach Delay (s)	79.5			1.8	2.0	
Approach LOS	E			A	A	

Intersection Summary			
HCM Average Control Delay	6.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	40.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	183	966	180	137	1006	222
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	199	1050	196	149	1093	241
RTOR Reduction (vph)	0	0	0	128	0	0
Lane Group Flow (vph)	199	1050	196	21	1093	241
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	19.9	140.0	59.1	19.9	49.0	112.1
Effective Green, g (s)	19.9	140.0	59.1	19.9	49.0	112.1
Actuated g/C Ratio	0.14	1.00	0.42	0.14	0.35	0.80
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	252	2787	786	225	1202	1492
v/s Ratio Prot	c0.11		0.11	0.01	c0.32	0.13
v/s Ratio Perm		c0.38				
v/c Ratio	0.79	0.38	0.25	0.09	0.91	0.16
Uniform Delay, d1	58.0	0.0	26.1	52.2	43.4	3.2
Progression Factor	1.00	1.00	0.92	1.02	1.00	1.00
Incremental Delay, d2	15.1	0.4	0.8	0.2	10.1	0.2
Delay (s)	73.1	0.4	24.8	53.5	53.5	3.4
Level of Service	E	A	C	D	D	A
Approach Delay (s)	12.0		37.2			44.4
Approach LOS	B		D			D

Intersection Summary			
HCM Average Control Delay	29.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	58.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	90	0	50	3	9	2	26	1119	1	1	1170	46
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	98	0	54	3	10	2	28	1216	1	1	1272	50
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1971	2573	661	1966	2597	609	1322			1217		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1971	2573	661	1966	2597	609	1322			1217		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	87	90	58	100	95			100		
cM capacity (veh/h)	24	24	405	31	23	438	519			569		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	98	54	3	12	28	811	407	1	848	474
Volume Left	98	0	3	0	28	0	0	1	0	0
Volume Right	0	54	0	2	0	0	1	0	0	50
cSH	24	405	31	28	519	1700	1700	569	1700	1700
Volume to Capacity	4.11	0.13	0.10	0.43	0.05	0.48	0.24	0.00	0.50	0.28
Queue Length 95th (ft)	Err	12	8	34	4	0	0	0	0	0
Control Delay (s)	Err	15.3	134.0	208.2	12.3	0.0	0.0	11.3	0.0	0.0
Lane LOS	F	C	F	F	B			B		
Approach Delay (s)	6433.4		192.3		0.3			0.0		
Approach LOS	F		F							

Intersection Summary			
Average Delay	359.0		
Intersection Capacity Utilization	52.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	66	0	93	27	11	3	60	1126	9	1	1097	43
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	72	0	101	29	12	3	65	1224	10	1	1192	47
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1970	2582	620	2059	2601	617	1239			1234		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1970	2582	620	2059	2601	617	1239			1234		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	77	0	44	99	88			100		
cM capacity (veh/h)	19	22	431	22	22	433	558			560		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	72	101	29	15	65	816	418	1	795	444
Volume Left	72	0	29	0	65	0	0	1	0	0
Volume Right	0	101	0	3	0	0	10	0	0	47
cSH	19	431	22	27	558	1700	1700	560	1700	1700
Volume to Capacity	3.77	0.23	1.32	0.56	0.12	0.48	0.25	0.00	0.47	0.26
Queue Length 95th (ft)	Err	22	95	44	10	0	0	0	0	0
Control Delay (s)	Err	15.9	559.5	248.2	12.3	0.0	0.0	11.4	0.0	0.0
Lane LOS	F	C	F	F	B			B		
Approach Delay (s)	4159.8		453.2		0.6			0.0		
Approach LOS	F		F							

Intersection Summary			
Average Delay	268.4		
Intersection Capacity Utilization	55.3%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.91		1.00	0.85		1.00	0.98		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1691		1770	1589		1770	3478		1770	3535	
Flt Permitted		0.96		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1639		1388	1589		1770	3478		1770	3535	
Volume (vph)	3	4	11	194	3	145	6	1607	209	130	1596	12
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	3	4	12	204	3	153	6	1692	220	137	1680	13
RTOR Reduction (vph)	0	10	0	0	121	0	0	7	0	0	0	0
Lane Group Flow (vph)	0	9	0	204	35	0	6	1905	0	137	1693	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)		20.0		20.0	20.0		5.0	91.0		10.0	96.0	
Effective Green, g (s)		21.0		21.0	21.0		5.0	92.0		10.0	97.0	
Actuated g/C Ratio		0.16		0.16	0.16		0.04	0.68		0.07	0.72	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		255		216	247		66	2370		131	2540	
v/s Ratio Prot					0.02		0.00	c0.55		c0.08	0.48	
v/s Ratio Perm		0.01		c0.15								
v/c Ratio		0.03		0.94	0.14		0.09	0.80		1.05	0.67	
Uniform Delay, d1		48.4		56.4	49.2		62.8	15.1		62.5	10.3	
Progression Factor		1.00		1.17	1.85		1.21	0.83		1.00	1.00	
Incremental Delay, d2		0.1		9.3	0.1		0.1	1.7		91.4	1.4	
Delay (s)		48.5		75.1	90.9		76.3	14.2		153.9	11.7	
Level of Service		D		E	F		E	B		F	B	
Approach Delay (s)		48.5			82.0			14.4			22.3	
Approach LOS		D			F			B			C	

Intersection Summary			
HCM Average Control Delay	24.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	85.7%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	59	43	1774	142	95	1713
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	63	46	1887	151	101	1822
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	3076	1019			2038	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3076	1019			2038	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	80			63	
cM capacity (veh/h)	6	234			273	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	109	1258	780	101	911	911
Volume Left	63	0	0	101	0	0
Volume Right	46	0	151	0	0	0
cSH	10	1700	1700	273	1700	1700
Volume to Capacity	10.82	0.74	0.46	0.37	0.54	0.54
Queue Length 95th (ft)	Err	0	0	41	0	0
Control Delay (s)	Err	0.0	0.0	25.7	0.0	0.0
Lane LOS	F			D		
Approach Delay (s)	Err	0.0		1.4		
Approach LOS	F					

Intersection Summary			
Average Delay	267.2		
Intersection Capacity Utilization	74.7%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.89		1.00	0.99		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1789	1583	1770	1653		1770	3494		1770	3495	
Flt Permitted		0.62	1.00	0.27	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1162	1583	496	1653		1770	3494		1770	3495	
Volume (vph)	203	43	43	115	24	73	47	1588	149	60	1496	135
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	221	47	47	125	26	79	51	1726	162	65	1626	147
RTOR Reduction (vph)	0	0	38	0	63	0	0	5	0	0	5	0
Lane Group Flow (vph)	0	268	9	125	42	0	51	1883	0	65	1768	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		26.0	26.0	26.0	26.0		6.6	88.1		6.9	88.4	
Effective Green, g (s)		27.0	27.0	27.0	27.0		6.6	89.1		6.9	89.4	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.05	0.66		0.05	0.66	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		232	317	99	331		87	2306		90	2314	
v/s Ratio Prot					0.03		0.03	c0.54		c0.04	0.51	
v/s Ratio Perm		0.23	0.01	c0.25								
v/c Ratio		1.16	0.03	1.26	0.13		0.59	0.82		0.72	0.76	
Uniform Delay, d1		54.0	43.5	54.0	44.3		62.9	16.9		63.1	15.6	
Progression Factor		1.00	1.00	1.00	1.00		0.67	1.77		1.22	0.79	
Incremental Delay, d2		107.4	0.2	176.7	0.2		1.9	1.0		16.4	1.8	
Delay (s)		161.4	43.6	230.7	44.5		44.2	30.9		93.6	14.2	
Level of Service		F	D	F	D		D	C		F	B	
Approach Delay (s)		143.8			145.7			31.2			17.0	
Approach LOS		F			F			C			B	

Intersection Summary			
HCM Average Control Delay	39.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	76.7%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1708		1770	1863	1583	1770	3539	1583	1770	3518	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1708		1770	1863	1583	1770	3539	1583	1770	3518	
Volume (vph)	80	109	135	275	70	332	108	1446	224	204	1425	58
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	118	147	299	76	361	117	1572	243	222	1549	63
RTOR Reduction (vph)	0	33	0	0	0	163	0	0	86	0	2	0
Lane Group Flow (vph)	87	232	0	299	76	198	117	1572	157	222	1610	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	11.0	25.0		21.0	35.0	35.0	9.0	55.0	55.0	16.0	62.0	
Effective Green, g (s)	11.0	26.0		21.0	36.0	36.0	9.0	56.0	56.0	16.0	63.0	
Actuated g/C Ratio	0.08	0.19		0.16	0.27	0.27	0.07	0.41	0.41	0.12	0.47	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	144	329		275	497	422	118	1468	657	210	1642	
v/s Ratio Prot	0.05	c0.14		c0.17	0.04		0.07	c0.44		c0.13	0.46	
v/s Ratio Perm						0.13			0.10			
v/c Ratio	0.60	0.70		1.09	0.15	0.47	0.99	1.07	0.24	1.06	0.98	
Uniform Delay, d1	59.9	50.9		57.0	37.8	41.5	63.0	39.5	25.7	59.5	35.4	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.26	0.43	0.10	1.18	0.64	
Incremental Delay, d2	7.0	12.0		79.5	0.7	3.7	54.1	39.0	0.4	65.0	13.6	
Delay (s)	66.9	62.9		136.5	38.5	45.2	133.2	55.8	2.9	135.1	36.3	
Level of Service	E	E		F	D	D	F	E	A	F	D	
Approach Delay (s)		63.9			81.6			53.8			48.2	
Approach LOS		E			F			D			D	

Intersection Summary			
HCM Average Control Delay	56.7	HCM Level of Service	E
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	93.8%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	81	326	62	146	501	30	37	190	49	18	163	67
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	88	354	67	159	545	33	40	207	53	20	177	73
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	577			422			1315	1459	211	1388	1476	289
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	577			422			1315	1459	211	1388	1476	289
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	91			86			0	0	93	0	0	90
cM capacity (veh/h)	992			1134			0	100	795	0	98	708

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	88	236	186	159	363	214	40	260	20	250
Volume Left	88	0	0	159	0	0	40	0	20	0
Volume Right	0	0	67	0	0	33	0	53	0	73
cSH	992	1700	1700	1134	1700	1700	0	122	0	131
Volume to Capacity	0.09	0.14	0.11	0.14	0.21	0.13	Err	2.12	Err	1.91
Queue Length 95th (ft)	7	0	0	12	0	0	Err	542	Err	491
Control Delay (s)	9.0	0.0	0.0	8.7	0.0	0.0	Err	590.0	Err	493.1
Lane LOS	A			A			F	F	F	F
Approach Delay (s)	1.6			1.9			Err		Err	
Approach LOS							F		F	

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	48.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	253	55	36	315	197	276	39	105	89	78	137	279
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	275	60	39	342	214	300	42	114	97	85	149	303
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	1019	766	226	560	869	105	452			211		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1019	766	226	560	869	105	452			211		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	80	95	0	18	68	96			94		
cM capacity (veh/h)	38	299	777	306	260	929	1105			1357		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	275	99	342	514	42	76	135	85	99	353
Volume Left	275	0	342	0	42	0	0	85	0	0
Volume Right	0	39	0	300	0	0	97	0	0	303
cSH	38	395	306	449	1105	1700	1700	1357	1700	1700
Volume to Capacity	7.26	0.25	1.12	1.15	0.04	0.04	0.08	0.06	0.06	0.21
Queue Length 95th (ft)	Err	24	346	464	3	0	0	5	0	0
Control Delay (s)	Err	17.1	124.9	118.2	8.4	0.0	0.0	7.8	0.0	0.0
Lane LOS	F	C	F	F	A			A		
Approach Delay (s)	7358.4		120.9		1.4			1.2		
Approach LOS	F		F							

Intersection Summary			
Average Delay	1413.4		
Intersection Capacity Utilization	70.8%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.15	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	286	3539	3539	1583
Volume (vph)	105	17	31	1126	1390	95
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	114	18	34	1224	1511	103
RTOR Reduction (vph)	0	12	0	0	0	11
Lane Group Flow (vph)	114	6	34	1224	1511	92
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	12.4	12.4	114.6	114.6	114.6	114.6
Effective Green, g (s)	12.4	12.4	114.6	114.6	114.6	114.6
Actuated g/C Ratio	0.09	0.09	0.85	0.85	0.85	0.85
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	163	145	243	3004	3004	1344
v/s Ratio Prot	c0.06			0.35	c0.43	
v/s Ratio Perm		0.00	0.12			0.06
v/c Ratio	0.70	0.04	0.14	0.41	0.50	0.07
Uniform Delay, d1	59.5	55.9	1.7	2.4	2.7	1.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	12.3	0.1	1.2	0.4	0.6	0.1
Delay (s)	71.8	56.0	3.0	2.8	3.3	1.7
Level of Service	E	E	A	A	A	A
Approach Delay (s)	69.7			2.8	3.2	
Approach LOS	E			A	A	

Intersection Summary			
HCM Average Control Delay	5.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	50.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	200	1274	381	253	1232	294
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	217	1385	414	275	1339	320
RTOR Reduction (vph)	0	0	0	200	0	0
Lane Group Flow (vph)	217	1385	414	75	1339	320
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	20.0	135.0	45.8	20.0	57.2	107.0
Effective Green, g (s)	20.0	135.0	45.8	20.0	57.2	107.0
Actuated g/C Ratio	0.15	1.00	0.34	0.15	0.42	0.79
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	262	2787	632	235	1455	1477
v/s Ratio Prot	c0.12		c0.22	0.05	c0.39	0.17
v/s Ratio Perm		0.50				
v/c Ratio	0.83	0.50	0.66	0.32	0.92	0.22
Uniform Delay, d1	55.8	0.0	37.9	51.4	36.7	3.5
Progression Factor	1.00	1.00	0.98	0.95	1.00	1.00
Incremental Delay, d2	18.9	0.6	5.2	0.8	9.8	0.3
Delay (s)	74.8	0.6	42.2	49.6	46.5	3.8
Level of Service	E	A	D	D	D	A
Approach Delay (s)	10.7		45.1			38.3
Approach LOS	B		D			D

Intersection Summary			
HCM Average Control Delay	28.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	76.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	42	0	23	2	6	1	39	1613	3	2	1499	69
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	46	0	25	2	7	1	42	1753	3	2	1629	75
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2637	3512	852	2684	3548	878	1704			1757		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2637	3512	852	2684	3548	878	1704			1757		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	92	75	0	100	89			99		
cM capacity (veh/h)	0	5	303	9	5	291	369			352		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	46	25	2	8	42	1169	588	2	1086	618
Volume Left	46	0	2	0	42	0	0	2	0	0
Volume Right	0	25	0	1	0	0	3	0	0	75
cSH	0	303	9	6	369	1700	1700	352	1700	1700
Volume to Capacity	Err	0.08	0.25	1.30	0.11	0.69	0.35	0.01	0.64	0.36
Queue Length 95th (ft)	Err	7	15	45	10	0	0	0	0	0
Control Delay (s)	Err	18.0	522.0	1286.0	16.0	0.0	0.0	15.3	0.0	0.0
Lane LOS	F	C	F	F	C			C		
Approach Delay (s)	Err		1116.2		0.4			0.0		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	60.3%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	105	0	146	18	7	2	157	1453	30	3	1397	112
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	114	0	159	20	8	2	171	1579	33	3	1518	122
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2723	3539	820	2861	3584	806	1640			1612		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2723	3539	820	2861	3584	806	1640			1612		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	50	0	0	99	56			99		
cM capacity (veh/h)	0	3	318	2	3	325	391			401		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	114	159	20	10	171	1053	559	3	1012	628
Volume Left	114	0	20	0	171	0	0	3	0	0
Volume Right	0	159	0	2	0	0	33	0	0	122
cSH	0	318	2	4	391	1700	1700	401	1700	1700
Volume to Capacity	Err	0.50	7.84	2.51	0.44	0.62	0.33	0.01	0.60	0.37
Queue Length 95th (ft)	Err	66	Err	58	54	0	0	1	0	0
Control Delay (s)	Err	27.1	Err	2348.5	21.2	0.0	0.0	14.1	0.0	0.0
Lane LOS	F	D	F	F	C			B		
Approach Delay (s)	Err		7448.8		2.0			0.0		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	75.8%	ICU Level of Service	D
Analysis Period (min)	15		

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.92		1.00	0.85		1.00	0.99		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1695		1770	1583		1770	3493		1770	3538	
Flt Permitted		0.97		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1668		1405	1583		1770	3493		1770	3538	
Volume (vph)	1	1	3	136	0	105	5	1333	128	69	1310	2
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	1	1	3	145	0	112	5	1418	136	73	1394	2
RTOR Reduction (vph)	0	2	0	0	86	0	0	5	0	0	0	0
Lane Group Flow (vph)	0	3	0	145	26	0	5	1549	0	73	1396	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		3			7		5	2		1	6	
Permitted Phases	3			7								
Actuated Green, G (s)		31.0		31.0	31.0		5.0	87.3		7.7	90.0	
Effective Green, g (s)		32.0		32.0	32.0		5.0	88.3		7.7	91.0	
Actuated g/C Ratio		0.23		0.23	0.23		0.04	0.63		0.06	0.65	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		381		321	362		63	2203		97	2300	
v/s Ratio Prot					0.02		0.00	c0.44		c0.04	c0.39	
v/s Ratio Perm		0.00		c0.10								
v/c Ratio		0.01		0.45	0.07		0.08	0.70		0.75	0.61	
Uniform Delay, d1		41.7		46.5	42.3		65.3	17.2		65.2	14.2	
Progression Factor		1.00		1.00	1.25		0.99	0.41		1.00	1.00	
Incremental Delay, d2		0.0		4.5	0.4		0.2	1.6		24.9	1.2	
Delay (s)		41.7		50.9	53.1		64.5	8.7		90.1	15.4	
Level of Service		D		D	D		E	A		F	B	
Approach Delay (s)		41.7			51.9			8.9			19.1	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	16.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	68.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	74	103	1350	71	69	1386
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	76	106	1392	73	71	1429
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2285	732			1465	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2285	732			1465	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	71			84	
cM capacity (veh/h)	28	363			457	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	182	928	537	71	714	714
Volume Left	76	0	0	71	0	0
Volume Right	106	0	73	0	0	0
cSH	61	1700	1700	457	1700	1700
Volume to Capacity	3.00	0.55	0.32	0.16	0.42	0.42
Queue Length 95th (ft)	Err	0	0	14	0	0
Control Delay (s)	Err	0.0	0.0	14.3	0.0	0.0
Lane LOS	F			B		
Approach Delay (s)	Err	0.0		0.7		
Approach LOS	F					

Intersection Summary			
Average Delay	580.0		
Intersection Capacity Utilization	63.8%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.89		1.00	0.98		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1794	1583	1770	1660		1770	3479		1770	3504	
Flt Permitted		0.53	1.00	0.43	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		990	1583	801	1660		1770	3479		1770	3504	
Volume (vph)	135	42	39	218	39	102	27	1175	149	56	1307	92
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	144	45	41	232	41	109	29	1250	159	60	1390	98
RTOR Reduction (vph)	0	0	33	0	68	0	0	7	0	0	3	0
Lane Group Flow (vph)	0	189	8	232	82	0	29	1402	0	60	1485	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		27.0	27.0	27.0	27.0		3.0	94.0		5.0	96.0	
Effective Green, g (s)		28.0	28.0	28.0	28.0		3.0	95.0		5.0	97.0	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.02	0.68		0.04	0.69	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		198	317	160	332		38	2361		63	2428	
v/s Ratio Prot					0.05		0.02	0.40		c0.03	c0.42	
v/s Ratio Perm		0.19	0.01	c0.29								
v/c Ratio		0.95	0.03	1.45	0.25		0.76	0.59		0.95	0.61	
Uniform Delay, d1		55.4	45.0	56.0	47.1		68.1	12.1		67.4	11.5	
Progression Factor		1.00	1.00	1.00	1.00		0.89	0.42		1.26	0.63	
Incremental Delay, d2		50.6	0.0	233.9	0.4		43.2	0.8		87.0	1.0	
Delay (s)		105.9	45.1	289.9	47.5		103.9	5.9		172.2	8.1	
Level of Service		F	D	F	D		F	A		F	A	
Approach Delay (s)		95.1			194.7			7.9			14.5	
Approach LOS		F			F			A			B	

Intersection Summary			
HCM Average Control Delay	36.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	77.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1710		1770	1863	1583	1770	3539	1583	1770	3523	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1710		1770	1863	1583	1770	3539	1583	1770	3523	
Volume (vph)	19	49	60	112	51	134	53	1363	221	169	1359	44
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	20	52	63	118	54	141	56	1435	233	178	1431	46
RTOR Reduction (vph)	0	31	0	0	0	107	0	0	90	0	2	0
Lane Group Flow (vph)	20	84	0	118	54	34	56	1435	143	178	1475	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	3.6	26.6		10.0	33.0	33.0	7.2	74.4	74.4	11.0	78.2	
Effective Green, g (s)	3.6	27.6		10.0	34.0	34.0	7.2	75.4	75.4	11.0	79.2	
Actuated g/C Ratio	0.03	0.20		0.07	0.24	0.24	0.05	0.54	0.54	0.08	0.57	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	46	337		126	452	384	91	1906	853	139	1993	
v/s Ratio Prot	0.01	c0.05		c0.07	0.03		0.03	0.41		c0.10	c0.42	
v/s Ratio Perm						0.02			0.09			
v/c Ratio	0.43	0.25		0.94	0.12	0.09	0.62	0.75	0.17	1.28	0.74	
Uniform Delay, d1	67.2	47.5		64.7	41.3	41.0	65.0	25.1	16.4	64.5	22.7	
Progression Factor	1.00	1.00		0.94	0.97	0.99	1.39	0.44	0.08	1.24	0.59	
Incremental Delay, d2	6.5	1.8		60.2	0.5	0.5	4.1	1.4	0.2	158.8	1.8	
Delay (s)	73.7	49.2		120.9	40.5	41.0	94.8	12.4	1.5	238.7	15.2	
Level of Service	E	D		F	D	D	F	B	A	F	B	
Approach Delay (s)		52.9			71.1			13.6			39.2	
Approach LOS		D			E			B			D	

Intersection Summary			
HCM Average Control Delay	30.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	69.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	36	341	18	23	162	33	57	85	134	47	132	52
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	39	371	20	25	176	36	62	92	146	51	143	57
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	212			390			725	721	195	699	712	106
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	212			390			725	721	195	699	712	106
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			98			67	72	82	75	58	94
cM capacity (veh/h)	1356			1165			189	335	813	203	338	928

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	39	247	143	25	117	95	62	238	51	200
Volume Left	39	0	0	25	0	0	62	0	51	0
Volume Right	0	0	20	0	0	36	0	146	0	57
cSH	1356	1700	1700	1165	1700	1700	189	523	203	412
Volume to Capacity	0.03	0.15	0.08	0.02	0.07	0.06	0.33	0.46	0.25	0.49
Queue Length 95th (ft)	2	0	0	2	0	0	34	59	24	64
Control Delay (s)	7.7	0.0	0.0	8.2	0.0	0.0	33.0	17.5	28.6	21.7
Lane LOS	A			A			D	C	D	C
Approach Delay (s)	0.7			0.9			20.7		23.1	
Approach LOS							C		C	

Intersection Summary			
Average Delay	10.3		
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	160	182	39	40	25	35	25	103	291	254	94	104
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	174	198	42	43	27	38	27	112	316	276	102	113
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	873	1193	108	1069	1092	214	215			428		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	873	1193	108	1069	1092	214	215			428		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	95	0	83	95	98			76		
cM capacity (veh/h)	162	137	926	0	158	791	1352			1128		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	174	240	43	65	27	75	354	276	68	147
Volume Left	174	0	43	0	27	0	0	276	0	0
Volume Right	0	42	0	38	0	0	316	0	0	113
cSH	162	161	0	296	1352	1700	1700	1128	1700	1700
Volume to Capacity	1.07	1.49	Err	0.22	0.02	0.04	0.21	0.24	0.04	0.09
Queue Length 95th (ft)	221	390	Err	21	2	0	0	24	0	0
Control Delay (s)	147.7	301.2	Err	20.6	7.7	0.0	0.0	9.2	0.0	0.0
Lane LOS	F	F	F	C	A			A		
Approach Delay (s)	236.7		Err		0.5			5.2		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	54.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.23	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	433	3539	3539	1583
Volume (vph)	98	36	16	917	1062	107
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	107	39	17	997	1154	116
RTOR Reduction (vph)	0	36	0	0	0	16
Lane Group Flow (vph)	107	3	17	997	1154	100
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	12.0	12.0	115.0	115.0	115.0	115.0
Effective Green, g (s)	12.0	12.0	115.0	115.0	115.0	115.0
Actuated g/C Ratio	0.09	0.09	0.85	0.85	0.85	0.85
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	157	141	369	3015	3015	1348
v/s Ratio Prot	c0.06			0.28	c0.33	
v/s Ratio Perm		0.00	0.04			0.06
v/c Ratio	0.68	0.02	0.05	0.33	0.38	0.07
Uniform Delay, d1	59.6	56.2	1.5	2.1	2.2	1.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	11.5	0.1	0.2	0.3	0.4	0.1
Delay (s)	71.2	56.2	1.8	2.4	2.6	1.7
Level of Service	E	E	A	A	A	A
Approach Delay (s)	67.2			2.3	2.5	
Approach LOS	E			A	A	

Intersection Summary			
HCM Average Control Delay	6.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	41.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	225	975	143	154	1017	227
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	245	1060	155	167	1105	247
RTOR Reduction (vph)	0	0	0	141	0	0
Lane Group Flow (vph)	245	1060	155	26	1105	247
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	22.3	143.0	63.0	22.3	45.7	112.7
Effective Green, g (s)	22.3	143.0	63.0	22.3	45.7	112.7
Actuated g/C Ratio	0.16	1.00	0.44	0.16	0.32	0.79
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	276	2787	821	247	1097	1468
v/s Ratio Prot	c0.14		0.08	0.02	c0.32	0.13
v/s Ratio Perm		c0.38				
v/c Ratio	0.89	0.38	0.19	0.11	1.01	0.17
Uniform Delay, d1	59.1	0.0	24.4	51.8	48.6	3.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	27.1	0.4	0.5	0.2	29.0	0.2
Delay (s)	86.2	0.4	24.9	52.0	77.6	3.9
Level of Service	F	A	C	D	E	A
Approach Delay (s)	16.5		39.0			64.2
Approach LOS	B		D			E

Intersection Summary			
HCM Average Control Delay	40.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	143.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	106	0	59	3	9	2	42	1075	1	1	1177	76
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	115	0	64	3	10	2	46	1168	1	1	1279	83
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2005	2584	681	1966	2624	585	1362			1170		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2005	2584	681	1966	2624	585	1362			1170		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	84	89	54	100	91			100		
cM capacity (veh/h)	21	23	393	29	21	454	501			593		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	115	64	3	12	46	779	391	1	853	509
Volume Left	115	0	3	0	46	0	0	1	0	0
Volume Right	0	64	0	2	0	0	1	0	0	83
cSH	21	393	29	26	501	1700	1700	593	1700	1700
Volume to Capacity	5.52	0.16	0.11	0.46	0.09	0.46	0.23	0.00	0.50	0.30
Queue Length 95th (ft)	Err	14	9	36	7	0	0	0	0	0
Control Delay (s)	Err	15.9	143.6	232.1	12.9	0.0	0.0	11.1	0.0	0.0
Lane LOS	F	C	F	F	B			B		
Approach Delay (s)	6429.3		213.1		0.5			0.0		
Approach LOS	F		F							

Intersection Summary			
Average Delay	417.2		
Intersection Capacity Utilization	54.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	67	0	94	27	11	3	52	1107	9	1	1131	37
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	73	0	102	29	12	3	57	1203	10	1	1229	40
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1976	2578	635	2040	2593	607	1270			1213		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1976	2578	635	2040	2593	607	1270			1213		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	76	0	46	99	90			100		
cM capacity (veh/h)	19	23	421	23	22	440	543			571		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	73	102	29	15	57	802	411	1	820	450
Volume Left	73	0	29	0	57	0	0	1	0	0
Volume Right	0	102	0	3	0	0	10	0	0	40
cSH	19	421	23	28	543	1700	1700	571	1700	1700
Volume to Capacity	3.75	0.24	1.28	0.55	0.10	0.47	0.24	0.00	0.48	0.26
Queue Length 95th (ft)	Err	23	94	43	9	0	0	0	0	0
Control Delay (s)	Err	16.3	532.8	239.1	12.4	0.0	0.0	11.3	0.0	0.0
Lane LOS	F	C	F	F	B			B		
Approach Delay (s)	4170.6		432.5		0.6			0.0		
Approach LOS	F		F							

Intersection Summary			
Average Delay	271.7		
Intersection Capacity Utilization	56.2%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: Leiali'i Pkwy & Honoapi'ilani Hwy

9/29/2010

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.91		1.00	0.85		1.00	0.99		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1691		1770	1589		1770	3487		1770	3535	
Flt Permitted		0.96		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1641		1388	1589		1770	3487		1770	3535	
Volume (vph)	3	4	11	166	3	132	6	1729	187	120	1712	12
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	3	4	12	175	3	139	6	1820	197	126	1802	13
RTOR Reduction (vph)	0	10	0	0	114	0	0	6	0	0	0	0
Lane Group Flow (vph)	0	9	0	175	28	0	6	2011	0	126	1815	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)		20.0		20.0	20.0		5.1	91.0		10.0	95.9	
Effective Green, g (s)		21.0		21.0	21.0		5.1	92.0		10.0	96.9	
Actuated g/C Ratio		0.16		0.16	0.16		0.04	0.68		0.07	0.72	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		255		216	247		67	2376		131	2537	
v/s Ratio Prot					0.02		0.00	c0.58		c0.07	0.51	
v/s Ratio Perm		0.01		c0.13								
v/c Ratio		0.03		0.81	0.11		0.09	0.85		0.96	0.72	
Uniform Delay, d1		48.4		55.1	49.0		62.7	16.2		62.3	11.0	
Progression Factor		1.00		1.15	1.77		1.22	0.74		1.00	1.00	
Incremental Delay, d2		0.1		16.2	0.5		0.1	1.6		66.2	1.8	
Delay (s)		48.5		79.6	87.2		76.4	13.6		128.5	12.8	
Level of Service		D		E	F		E	B		F	B	
Approach Delay (s)		48.5			83.0			13.8			20.3	
Approach LOS		D			F			B			C	

Intersection Summary			
HCM Average Control Delay	22.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	86.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	68	76	1841	143	123	1773
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	72	81	1959	152	131	1886
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	3239	1055			2111	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3239	1055			2111	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	64			49	
cM capacity (veh/h)	4	222			256	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	153	1306	805	131	943	943
Volume Left	72	0	0	131	0	0
Volume Right	81	0	152	0	0	0
cSH	7	1700	1700	256	1700	1700
Volume to Capacity	20.97	0.77	0.47	0.51	0.55	0.55
Queue Length 95th (ft)	Err	0	0	67	0	0
Control Delay (s)	Err	0.0	0.0	32.9	0.0	0.0
Lane LOS	F			D		
Approach Delay (s)	Err	0.0		2.1		
Approach LOS	F					

Intersection Summary			
Average Delay	358.8		
Intersection Capacity Utilization	80.7%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.88		1.00	0.98		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1792	1583	1770	1641		1770	3464		1770	3495	
Flt Permitted		0.45	1.00	0.24	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		845	1583	450	1641		1770	3464		1770	3495	
Volume (vph)	202	55	43	226	35	134	47	1604	266	132	1495	134
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	220	60	47	246	38	146	51	1743	289	143	1625	146
RTOR Reduction (vph)	0	0	38	0	102	0	0	10	0	0	5	0
Lane Group Flow (vph)	0	280	9	246	82	0	51	2022	0	143	1766	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		26.0	26.0	26.0	26.0		6.6	86.0		9.0	88.4	
Effective Green, g (s)		27.0	27.0	27.0	27.0		6.6	87.0		9.0	89.4	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.05	0.64		0.07	0.66	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		169	317	90	328		87	2232		118	2314	
v/s Ratio Prot					0.05		0.03	c0.58		c0.08	0.51	
v/s Ratio Perm		0.33	0.01	c0.55								
v/c Ratio		1.66	0.03	2.73	0.25		0.59	0.91		1.21	0.76	
Uniform Delay, d1		54.0	43.5	54.0	45.5		62.9	20.5		63.0	15.6	
Progression Factor		1.00	1.00	1.00	1.00		0.68	1.72		1.23	0.68	
Incremental Delay, d2		320.4	0.2	810.4	0.4		0.6	0.7		138.6	1.8	
Delay (s)		374.4	43.6	864.4	45.9		43.2	36.0		216.3	12.4	
Level of Service		F	D	F	D		D	D		F	B	
Approach Delay (s)		326.8			514.1			36.2			27.6	
Approach LOS		F			F			D			C	

Intersection Summary			
HCM Average Control Delay	96.0	HCM Level of Service	F
HCM Volume to Capacity ratio	1.32		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	100.1%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.91		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1701		1770	1863	1583	1770	3539	1583	1770	3520	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1701		1770	1863	1583	1770	3539	1583	1770	3520	
Volume (vph)	80	98	135	285	61	361	108	1549	208	218	1521	58
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	107	147	310	66	392	117	1684	226	237	1653	63
RTOR Reduction (vph)	0	36	0	0	0	162	0	0	75	0	2	0
Lane Group Flow (vph)	87	218	0	310	66	230	117	1684	151	237	1714	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	11.0	25.0		21.0	35.0	35.0	9.0	55.0	55.0	16.0	62.0	
Effective Green, g (s)	11.0	26.0		21.0	36.0	36.0	9.0	56.0	56.0	16.0	63.0	
Actuated g/C Ratio	0.08	0.19		0.16	0.27	0.27	0.07	0.41	0.41	0.12	0.47	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	144	328		275	497	422	118	1468	657	210	1643	
v/s Ratio Prot	0.05	c0.13		c0.18	0.04		0.07	c0.48		c0.13	0.49	
v/s Ratio Perm						0.15			0.10			
v/c Ratio	0.60	0.66		1.13	0.13	0.54	0.99	1.15	0.23	1.13	1.04	
Uniform Delay, d1	59.9	50.5		57.0	37.6	42.5	63.0	39.5	25.6	59.5	36.0	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.26	0.41	0.09	1.14	0.74	
Incremental Delay, d2	7.0	10.1		93.0	0.6	5.0	49.0	69.7	0.3	73.8	25.0	
Delay (s)	66.9	60.6		150.0	38.2	47.5	128.1	86.1	2.7	141.4	51.6	
Level of Service	E	E		F	D	D	F	F	A	F	D	
Approach Delay (s)		62.2			88.0			79.2			62.5	
Approach LOS		E			F			E			E	

Intersection Summary			
HCM Average Control Delay	73.0	HCM Level of Service	E
HCM Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	97.4%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	70	324	62	155	536	54	37	185	33	47	163	62
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	76	352	67	168	583	59	40	201	36	51	177	67
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	641			420			1322	1516	210	1414	1521	321
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	641			420			1322	1516	210	1414	1521	321
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	92			85			0	0	95	0	0	90
cM capacity (veh/h)	939			1136			0	93	796	0	92	675

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	76	235	185	168	388	253	40	237	51	245
Volume Left	76	0	0	168	0	0	40	0	51	0
Volume Right	0	0	67	0	0	59	0	36	0	67
cSH	939	1700	1700	1136	1700	1700	0	107	0	121
Volume to Capacity	0.08	0.14	0.11	0.15	0.23	0.15	Err	2.22	Err	2.03
Queue Length 95th (ft)	7	0	0	13	0	0	Err	515	Err	501
Control Delay (s)	9.2	0.0	0.0	8.7	0.0	0.0	Err	642.5	Err	549.4
Lane LOS	A			A			F	F	F	F
Approach Delay (s)	1.4			1.8			Err		Err	
Approach LOS							F		F	

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	49.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	245	29	63	339	212	296	69	129	46	40	154	269
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	266	32	68	368	230	322	75	140	50	43	167	292
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	1058	741	230	570	862	95	460			190		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1058	741	230	570	862	95	460			190		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	90	91	0	12	66	93			97		
cM capacity (veh/h)	28	309	773	315	263	943	1098			1381		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	266	100	368	552	75	93	97	43	112	348
Volume Left	266	0	368	0	75	0	0	43	0	0
Volume Right	0	68	0	322	0	0	50	0	0	292
cSH	28	525	315	453	1098	1700	1700	1381	1700	1700
Volume to Capacity	9.53	0.19	1.17	1.22	0.07	0.05	0.06	0.03	0.07	0.20
Queue Length 95th (ft)	Err	17	390	546	5	0	0	2	0	0
Control Delay (s)	Err	13.5	141.6	144.1	8.5	0.0	0.0	7.7	0.0	0.0
Lane LOS	F	B	F	F	A			A		
Approach Delay (s)	7273.0		143.1		2.4			0.7		
Approach LOS	F		F							

Intersection Summary			
Average Delay	1360.7		
Intersection Capacity Utilization	73.0%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.14	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	263	3539	3539	1583
Volume (vph)	121	17	31	1155	1444	113
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	132	18	34	1255	1570	123
RTOR Reduction (vph)	0	10	0	0	0	13
Lane Group Flow (vph)	132	8	34	1255	1570	110
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	13.6	13.6	113.4	113.4	113.4	113.4
Effective Green, g (s)	13.6	13.6	113.4	113.4	113.4	113.4
Actuated g/C Ratio	0.10	0.10	0.84	0.84	0.84	0.84
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	178	159	221	2973	2973	1330
v/s Ratio Prot	c0.07			0.35	c0.44	
v/s Ratio Perm		0.01	0.13			0.07
v/c Ratio	0.74	0.05	0.15	0.42	0.53	0.08
Uniform Delay, d1	59.0	54.9	2.0	2.7	3.1	1.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	15.3	0.1	1.5	0.4	0.7	0.1
Delay (s)	74.3	55.0	3.5	3.1	3.8	2.0
Level of Service	E	E	A	A	A	A
Approach Delay (s)	72.0			3.1	3.7	
Approach LOS	E			A	A	

Intersection Summary			
HCM Average Control Delay	6.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	53.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	237	1282	351	319	1238	227
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	258	1393	382	347	1346	247
RTOR Reduction (vph)	0	0	0	274	0	0
Lane Group Flow (vph)	258	1393	382	73	1346	247
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	22.9	135.0	42.7	22.9	57.4	104.1
Effective Green, g (s)	22.9	135.0	42.7	22.9	57.4	104.1
Actuated g/C Ratio	0.17	1.00	0.32	0.17	0.43	0.77
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	300	2787	589	269	1460	1437
v/s Ratio Prot	c0.15		c0.21	0.05	c0.39	0.13
v/s Ratio Perm		0.50				
v/c Ratio	0.86	0.50	0.65	0.27	0.92	0.17
Uniform Delay, d1	54.5	0.0	39.7	48.8	36.7	4.1
Progression Factor	1.00	1.00	0.97	0.94	1.00	1.00
Incremental Delay, d2	21.4	0.6	5.4	0.5	9.9	0.3
Delay (s)	75.9	0.6	43.9	46.5	46.6	4.3
Level of Service	E	A	D	D	D	A
Approach Delay (s)	12.4		45.1			40.0
Approach LOS	B		D			D

Intersection Summary			
HCM Average Control Delay	29.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	76.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	106	0	59	2	6	1	69	1561	3	2	1402	123
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	115	0	64	2	7	1	75	1697	3	2	1524	134
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2598	3445	829	2679	3510	850	1658			1700		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2598	3445	829	2679	3510	850	1658			1700		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	80	69	0	100	81			99		
cM capacity (veh/h)	0	5	314	7	5	304	385			371		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	115	64	2	8	75	1131	569	2	1016	642
Volume Left	115	0	2	0	75	0	0	2	0	0
Volume Right	0	64	0	1	0	0	3	0	0	134
cSH	0	314	7	6	385	1700	1700	371	1700	1700
Volume to Capacity	Err	0.20	0.31	1.34	0.19	0.67	0.33	0.01	0.60	0.38
Queue Length 95th (ft)	Err	19	16	45	18	0	0	0	0	0
Control Delay (s)	Err	19.4	660.8	1340.7	16.6	0.0	0.0	14.8	0.0	0.0
Lane LOS	F	C	F	F	C			B		
Approach Delay (s)	Err		1189.6		0.7			0.0		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	69.1%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	79	0	110	18	7	2	130	1493	30	3	1390	93
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	86	0	120	20	8	2	141	1623	33	3	1511	101
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2668	3506	806	2803	3540	828	1612			1655		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2668	3506	806	2803	3540	828	1612			1655		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	63	0	0	99	65			99		
cM capacity (veh/h)	0	4	325	4	4	314	401			386		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	86	120	20	10	141	1082	574	3	1007	605
Volume Left	86	0	20	0	141	0	0	3	0	0
Volume Right	0	120	0	2	0	0	33	0	0	101
cSH	0	325	4	5	401	1700	1700	386	1700	1700
Volume to Capacity	Err	0.37	5.08	2.05	0.35	0.64	0.34	0.01	0.59	0.36
Queue Length 95th (ft)	Err	41	Err	56	39	0	0	1	0	0
Control Delay (s)	Err	22.4	Err	1858.5	18.8	0.0	0.0	14.4	0.0	0.0
Lane LOS	F	C	F	F	C			B		
Approach Delay (s)	Err		7285.5		1.5			0.0		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	69.6%	ICU Level of Service	C
Analysis Period (min)	15		

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.92		1.00	0.85		1.00	0.99		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1695		1770	1583		1770	3488		1770	3539	
Flt Permitted		0.97		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1662		1405	1583		1770	3488		1770	3539	
Volume (vph)	1	1	3	169	0	155	5	1465	156	101	1424	2
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	1	1	3	180	0	165	5	1559	166	107	1515	2
RTOR Reduction (vph)	0	2	0	0	98	0	0	6	0	0	0	0
Lane Group Flow (vph)	0	3	0	180	67	0	5	1719	0	107	1517	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		3			7		5	2		1	6	
Permitted Phases	3			7								
Actuated Green, G (s)		31.0		31.0	31.0		5.0	87.0		8.0	90.0	
Effective Green, g (s)		32.0		32.0	32.0		5.0	88.0		8.0	91.0	
Actuated g/C Ratio		0.23		0.23	0.23		0.04	0.63		0.06	0.65	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		380		321	362		63	2192		101	2300	
v/s Ratio Prot					0.04		0.00	c0.49		c0.06	c0.43	
v/s Ratio Perm		0.00		c0.13								
v/c Ratio		0.01		0.56	0.19		0.08	0.78		1.06	0.66	
Uniform Delay, d1		41.7		47.8	43.5		65.3	19.0		66.0	15.0	
Progression Factor		1.00		0.85	0.62		1.00	0.45		1.00	1.00	
Incremental Delay, d2		0.0		6.6	1.1		0.2	2.4		106.5	1.5	
Delay (s)		41.7		47.3	27.8		65.4	11.0		172.5	16.5	
Level of Service		D		D	C		E	B		F	B	
Approach Delay (s)		41.7			38.0			11.2			26.8	
Approach LOS		D			D			B			C	

Intersection Summary			
HCM Average Control Delay	20.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	77.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	101	134	1475	78	70	1516
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	104	138	1521	80	72	1563
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2487	801			1601	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2487	801			1601	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	58			82	
cM capacity (veh/h)	20	328			405	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	242	1014	587	72	781	781
Volume Left	104	0	0	72	0	0
Volume Right	138	0	80	0	0	0
cSH	43	1700	1700	405	1700	1700
Volume to Capacity	5.66	0.60	0.35	0.18	0.46	0.46
Queue Length 95th (ft)	Err	0	0	16	0	0
Control Delay (s)	Err	0.0	0.0	15.8	0.0	0.0
Lane LOS	F			C		
Approach Delay (s)	Err	0.0		0.7		
Approach LOS	F					

Intersection Summary			
Average Delay	696.8		
Intersection Capacity Utilization	71.0%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.90		1.00	0.99		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1792	1583	1770	1679		1770	3498		1770	3509	
Flt Permitted		0.63	1.00	0.43	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1172	1583	809	1679		1770	3498		1770	3509	
Volume (vph)	138	38	42	166	34	65	29	1334	111	44	1462	88
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	147	40	45	177	36	69	31	1419	118	47	1555	94
RTOR Reduction (vph)	0	0	36	0	50	0	0	4	0	0	3	0
Lane Group Flow (vph)	0	187	9	177	55	0	31	1533	0	47	1646	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		27.0	27.0	27.0	27.0		3.0	95.0		4.0	96.0	
Effective Green, g (s)		28.0	28.0	28.0	28.0		3.0	96.0		4.0	97.0	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.02	0.69		0.03	0.69	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		234	317	162	336		38	2399		51	2431	
v/s Ratio Prot					0.03		0.02	0.44		c0.03	c0.47	
v/s Ratio Perm		0.16	0.01	c0.22								
v/c Ratio		0.80	0.03	1.09	0.16		0.82	0.64		0.92	0.68	
Uniform Delay, d1		53.3	45.1	56.0	46.3		68.2	12.3		67.8	12.4	
Progression Factor		1.00	1.00	1.00	1.00		0.85	0.57		1.26	0.69	
Incremental Delay, d2		17.1	0.0	97.6	0.2		53.5	0.8		84.3	1.2	
Delay (s)		70.5	45.1	153.6	46.6		111.4	7.9		169.5	9.8	
Level of Service		E	D	F	D		F	A		F	A	
Approach Delay (s)		65.5			113.8			9.9			14.2	
Approach LOS		E			F			A			B	

Intersection Summary			
HCM Average Control Delay	23.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	68.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1708		1770	1863	1583	1770	3539	1583	1770	3508	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1708		1770	1863	1583	1770	3539	1583	1770	3508	
Volume (vph)	38	50	63	126	47	130	56	1476	214	153	1436	88
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	40	53	66	133	49	137	59	1554	225	161	1512	93
RTOR Reduction (vph)	0	32	0	0	0	106	0	0	79	0	3	0
Lane Group Flow (vph)	40	87	0	133	49	31	59	1554	146	161	1602	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	4.8	25.8		10.0	31.0	31.0	7.3	75.2	75.2	11.0	78.9	
Effective Green, g (s)	4.8	26.8		10.0	32.0	32.0	7.3	76.2	76.2	11.0	79.9	
Actuated g/C Ratio	0.03	0.19		0.07	0.23	0.23	0.05	0.54	0.54	0.08	0.57	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	61	327		126	426	362	92	1926	862	139	2002	
v/s Ratio Prot	0.02	c0.05		c0.08	0.03		0.03	0.44		c0.09	c0.46	
v/s Ratio Perm						0.02			0.09			
v/c Ratio	0.66	0.27		1.06	0.12	0.09	0.64	0.81	0.17	1.16	0.80	
Uniform Delay, d1	66.8	48.2		65.0	42.8	42.5	65.1	25.9	16.0	64.5	23.7	
Progression Factor	1.00	1.00		0.94	0.93	0.99	1.39	0.46	0.05	1.26	0.51	
Incremental Delay, d2	22.6	2.0		95.6	0.5	0.5	3.6	1.2	0.1	113.3	2.5	
Delay (s)	89.4	50.2		156.5	40.5	42.5	93.9	13.1	0.9	194.8	14.5	
Level of Service	F	D		F	D	D	F	B	A	F	B	
Approach Delay (s)		60.1			89.7			14.2			31.0	
Approach LOS		E			F			B			C	

Intersection Summary			
HCM Average Control Delay	29.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	35	321	19	103	173	19	60	78	152	30	101	47
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	38	349	21	112	188	21	65	85	165	33	110	51
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	209			370			859	868	185	880	868	104
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	209			370			859	868	185	880	868	104
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			91			55	67	80	75	57	95
cM capacity (veh/h)	1359			1186			143	254	826	131	254	930

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	38	233	137	112	125	83	65	250	33	161
Volume Left	38	0	0	112	0	0	65	0	33	0
Volume Right	0	0	21	0	0	21	0	165	0	51
cSH	1359	1700	1700	1186	1700	1700	143	469	131	331
Volume to Capacity	0.03	0.14	0.08	0.09	0.07	0.05	0.45	0.53	0.25	0.49
Queue Length 95th (ft)	2	0	0	8	0	0	52	77	23	63
Control Delay (s)	7.7	0.0	0.0	8.4	0.0	0.0	49.5	21.1	41.4	25.8
Lane LOS	A			A			E	C	E	D
Approach Delay (s)	0.7			2.9			27.0		28.4	
Approach LOS							D		D	

Intersection Summary			
Average Delay	12.3		
Intersection Capacity Utilization	45.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	123	149	16	40	25	35	14	159	239	209	239	104
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	134	162	17	43	27	38	15	173	260	227	260	113
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	939	1234	186	1016	1160	216	373			433		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	939	1234	186	1016	1160	216	373			433		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	12	0	98	0	82	95	99			80		
cM capacity (veh/h)	151	138	824	0	153	788	1182			1123		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	134	179	43	65	15	115	317	227	173	200
Volume Left	134	0	43	0	15	0	0	227	0	0
Volume Right	0	17	0	38	0	0	260	0	0	113
cSH	151	150	0	289	1182	1700	1700	1123	1700	1700
Volume to Capacity	0.88	1.19	Err	0.23	0.01	0.07	0.19	0.20	0.10	0.12
Queue Length 95th (ft)	152	255	Err	21	1	0	0	19	0	0
Control Delay (s)	103.7	194.0	Err	21.1	8.1	0.0	0.0	9.0	0.0	0.0
Lane LOS	F	F	F	C	A			A		
Approach Delay (s)	155.4		Err		0.3			3.4		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	49.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.20	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	365	3539	3539	1583
Volume (vph)	125	38	16	1007	1192	174
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	136	41	17	1095	1296	189
RTOR Reduction (vph)	0	22	0	0	0	23
Lane Group Flow (vph)	136	19	17	1095	1296	166
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	14.1	14.1	117.9	117.9	117.9	117.9
Effective Green, g (s)	14.1	14.1	117.9	117.9	117.9	117.9
Actuated g/C Ratio	0.10	0.10	0.84	0.84	0.84	0.84
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	178	159	307	2980	2980	1333
v/s Ratio Prot	c0.08			0.31	c0.37	
v/s Ratio Perm		0.01	0.05			0.10
v/c Ratio	0.76	0.12	0.06	0.37	0.43	0.12
Uniform Delay, d1	61.3	57.3	1.8	2.5	2.8	1.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	17.5	0.3	0.3	0.4	0.5	0.2
Delay (s)	78.9	57.6	2.2	2.9	3.2	2.1
Level of Service	E	E	A	A	A	A
Approach Delay (s)	73.9			2.9	3.1	
Approach LOS	E			A	A	

Intersection Summary			
HCM Average Control Delay	7.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	46.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	178	1142	208	109	1262	374
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	193	1241	226	118	1372	407
RTOR Reduction (vph)	0	0	0	102	0	0
Lane Group Flow (vph)	193	1241	226	16	1372	407
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	19.4	140.0	46.7	19.4	61.9	112.6
Effective Green, g (s)	19.4	140.0	46.7	19.4	61.9	112.6
Actuated g/C Ratio	0.14	1.00	0.33	0.14	0.44	0.80
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	245	2787	621	219	1518	1498
v/s Ratio Prot	c0.11		0.12	0.01	c0.40	0.22
v/s Ratio Perm		c0.45				
v/c Ratio	0.79	0.45	0.36	0.07	0.90	0.27
Uniform Delay, d1	58.3	0.0	35.4	52.5	36.3	3.4
Progression Factor	1.00	1.00	0.89	1.03	1.00	1.00
Incremental Delay, d2	15.3	0.5	1.6	0.1	7.9	0.4
Delay (s)	73.6	0.5	33.2	54.2	44.2	3.9
Level of Service	E	A	C	D	D	A
Approach Delay (s)	10.4		40.4			35.0
Approach LOS	B		D			C

Intersection Summary			
HCM Average Control Delay	25.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	66.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	69	27	39	148	90	99	24	1276	50	33	1444	43
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	75	29	42	161	98	108	26	1387	54	36	1570	47
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2567	3158	808	2380	3154	721	1616			1441		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2567	3158	808	2380	3154	721	1616			1441		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	87	0	0	71	93			92		
cM capacity (veh/h)	0	9	324	0	9	370	399			467		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	75	72	161	205	26	925	517	36	1046	570
Volume Left	75	0	161	0	26	0	0	36	0	0
Volume Right	0	42	0	108	0	0	54	0	0	47
cSH	0	21	0	19	399	1700	1700	467	1700	1700
Volume to Capacity	Err	3.37	Err	11.04	0.07	0.54	0.30	0.08	0.62	0.34
Queue Length 95th (ft)	Err	Err	Err	Err	5	0	0	6	0	0
Control Delay (s)	Err	Err	Err	Err	14.6	0.0	0.0	13.4	0.0	0.0
Lane LOS	F	F	F	F	B			B		
Approach Delay (s)	Err		Err		0.3			0.3		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	65.9%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	48	47	73	228	106	102	72	1249	109	50	1217	40
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	52	51	79	248	115	111	78	1358	118	54	1323	43
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2457	3086	683	2448	3048	738	1366			1476		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2457	3086	683	2448	3048	738	1366			1476		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	80	0	0	69	84			88		
cM capacity (veh/h)	0	9	392	0	9	360	499			452		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	52	130	248	226	78	905	571	54	882	484
Volume Left	52	0	248	0	78	0	0	54	0	0
Volume Right	0	79	0	111	0	0	118	0	0	43
cSH	0	21	0	18	499	1700	1700	452	1700	1700
Volume to Capacity	Err	6.08	Err	12.83	0.16	0.53	0.34	0.12	0.52	0.28
Queue Length 95th (ft)	Err	Err	Err	Err	14	0	0	10	0	0
Control Delay (s)	Err	Err	Err	Err	13.6	0.0	0.0	14.0	0.0	0.0
Lane LOS	F	F	F	F	B			B		
Approach Delay (s)	Err		Err		0.7			0.5		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	74.2%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.91		1.00	0.85		1.00	0.98		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1691		1770	1588		1770	3475		1770	3535	
Flt Permitted		0.96		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1634		1388	1588		1770	3475		1770	3535	
Volume (vph)	3	4	11	215	3	174	6	1745	240	175	1751	12
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	3	4	12	226	3	183	6	1837	253	184	1843	13
RTOR Reduction (vph)	0	10	0	0	113	0	0	8	0	0	0	0
Lane Group Flow (vph)	0	9	0	226	73	0	6	2082	0	184	1856	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)		20.0		20.0	20.0		5.0	91.0		10.0	96.0	
Effective Green, g (s)		21.0		21.0	21.0		5.0	92.0		10.0	97.0	
Actuated g/C Ratio		0.16		0.16	0.16		0.04	0.68		0.07	0.72	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		254		216	247		66	2368		131	2540	
v/s Ratio Prot					0.05		0.00	c0.60		c0.10	0.52	
v/s Ratio Perm		0.01		c0.16								
v/c Ratio		0.03		1.05	0.29		0.09	0.88		1.40	0.73	
Uniform Delay, d1		48.4		57.0	50.4		62.8	17.1		62.5	11.3	
Progression Factor		1.00		1.00	1.10		1.21	0.83		1.00	1.00	
Incremental Delay, d2		0.1		52.9	1.3		0.1	2.6		221.3	1.9	
Delay (s)		48.5		110.1	56.7		76.3	16.8		283.8	13.2	
Level of Service		D		F	E		E	B		F	B	
Approach Delay (s)		48.5			86.0			17.0			37.6	
Approach LOS		D			F			B			D	

Intersection Summary			
HCM Average Control Delay	32.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	94.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	74	67	1905	164	134	1840
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	79	71	2027	174	143	1957
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	3378	1101			2201	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3378	1101			2201	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	66			40	
cM capacity (veh/h)	2	207			236	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	150	1351	850	143	979	979
Volume Left	79	0	0	143	0	0
Volume Right	71	0	174	0	0	0
cSH	4	1700	1700	236	1700	1700
Volume to Capacity	35.12	0.79	0.50	0.60	0.58	0.58
Queue Length 95th (ft)	Err	0	0	88	0	0
Control Delay (s)	Err	0.0	0.0	41.2	0.0	0.0
Lane LOS	F			E		
Approach Delay (s)	Err	0.0		2.8		
Approach LOS	F					

Intersection Summary			
Average Delay	338.3		
Intersection Capacity Utilization	83.5%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.89		1.00	0.99		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1789	1583	1770	1651		1770	3494		1770	3498	
Flt Permitted		0.60	1.00	0.26	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1121	1583	481	1651		1770	3494		1770	3498	
Volume (vph)	205	45	45	126	26	80	49	1719	158	65	1620	137
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	223	49	49	137	28	87	53	1868	172	71	1761	149
RTOR Reduction (vph)	0	0	39	0	70	0	0	5	0	0	4	0
Lane Group Flow (vph)	0	272	10	137	45	0	53	2035	0	71	1906	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		26.0	26.0	26.0	26.0		6.7	88.0		7.0	88.3	
Effective Green, g (s)		27.0	27.0	27.0	27.0		6.7	89.0		7.0	89.3	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.05	0.66		0.05	0.66	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		224	317	96	330		88	2303		92	2314	
v/s Ratio Prot					0.03		0.03	c0.58		c0.04	0.54	
v/s Ratio Perm		0.24	0.01	c0.28								
v/c Ratio		1.21	0.03	1.43	0.14		0.60	0.88		0.77	0.82	
Uniform Delay, d1		54.0	43.5	54.0	44.4		62.8	18.8		63.2	17.0	
Progression Factor		1.00	1.00	1.00	1.00		0.70	1.69		1.22	0.77	
Incremental Delay, d2		130.2	0.2	242.0	0.2		0.7	0.5		21.3	2.4	
Delay (s)		184.2	43.6	296.0	44.6		44.8	32.2		98.6	15.5	
Level of Service		F	D	F	D		D	C		F	B	
Approach Delay (s)		162.7			181.3			32.5			18.5	
Approach LOS		F			F			C			B	

Intersection Summary			
HCM Average Control Delay	43.6	HCM Level of Service	D
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	81.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.91		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1700		1770	1863	1583	1770	3539	1583	1770	3512	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1700		1770	1863	1583	1770	3539	1583	1770	3512	
Volume (vph)	120	100	140	285	67	338	112	1543	231	213	1528	83
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	130	109	152	310	73	367	122	1677	251	232	1661	90
RTOR Reduction (vph)	0	37	0	0	0	136	0	0	83	0	3	0
Lane Group Flow (vph)	130	224	0	310	73	231	122	1677	168	232	1748	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	12.4	25.0		21.0	33.6	33.6	9.0	56.0	56.0	15.0	62.0	
Effective Green, g (s)	12.4	26.0		21.0	34.6	34.6	9.0	57.0	57.0	15.0	63.0	
Actuated g/C Ratio	0.09	0.19		0.16	0.26	0.26	0.07	0.42	0.42	0.11	0.47	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	163	327		275	477	406	118	1494	668	197	1639	
v/s Ratio Prot	0.07	c0.13		c0.18	0.04		0.07	c0.47		c0.13	0.50	
v/s Ratio Perm						0.15			0.11			
v/c Ratio	0.80	0.68		1.13	0.15	0.57	1.03	1.12	0.25	1.18	1.07	
Uniform Delay, d1	60.1	50.7		57.0	38.9	43.7	63.0	39.0	25.2	60.0	36.0	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.25	0.41	0.09	1.19	0.64	
Incremental Delay, d2	23.1	11.1		93.0	0.7	5.7	54.6	58.3	0.3	104.6	37.5	
Delay (s)	83.2	61.8		150.0	39.5	49.4	133.6	74.3	2.5	176.2	60.7	
Level of Service	F	E		F	D	D	F	E	A	F	E	
Approach Delay (s)		68.9			90.0			69.1			74.2	
Approach LOS		E			F			E			E	

Intersection Summary			
HCM Average Control Delay	74.0	HCM Level of Service	E
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	97.4%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	65	353	65	192	523	23	39	156	122	15	147	59
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	71	384	71	209	568	25	42	170	133	16	160	64
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	593			454			1406	1571	227	1549	1594	297
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	593			454			1406	1571	227	1549	1594	297
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	93			81			0	0	83	0	0	91
cM capacity (veh/h)	979			1103			0	82	776	0	80	700

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	71	256	199	209	379	214	42	302	16	224
Volume Left	71	0	0	209	0	0	42	0	16	0
Volume Right	0	0	71	0	0	25	0	133	0	64
cSH	979	1700	1700	1103	1700	1700	0	135	0	107
Volume to Capacity	0.07	0.15	0.12	0.19	0.22	0.13	Err	2.23	Err	2.10
Queue Length 95th (ft)	6	0	0	17	0	0	Err	633	Err	476
Control Delay (s)	9.0	0.0	0.0	9.0	0.0	0.0	Err	630.2	Err	589.9
Lane LOS	A			A			F	F	F	F
Approach Delay (s)	1.2			2.3			Err		Err	
Approach LOS							F		F	

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	54.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	227	55	32	315	197	276	32	247	89	78	220	228
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	247	60	35	342	214	300	35	268	97	85	239	248
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	1143	967	243	740	1043	183	487			365		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1143	967	243	740	1043	183	487			365		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	74	95	0	0	64	97			93		
cM capacity (veh/h)	0	227	757	215	205	829	1072			1190		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	247	95	342	514	35	179	186	85	159	328
Volume Left	247	0	342	0	35	0	0	85	0	0
Volume Right	0	35	0	300	0	0	97	0	0	248
cSH	0	306	215	365	1072	1700	1700	1190	1700	1700
Volume to Capacity	Err	0.31	1.60	1.41	0.03	0.11	0.11	0.07	0.09	0.19
Queue Length 95th (ft)	Err	32	546	650	3	0	0	6	0	0
Control Delay (s)	Err	22.0	328.9	227.5	8.5	0.0	0.0	8.3	0.0	0.0
Lane LOS	F	C	F	F	A			A		
Approach Delay (s)	Err		268.1		0.7			1.2		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	69.9%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.13	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	236	3539	3539	1583
Volume (vph)	173	19	34	1241	1493	138
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	188	21	37	1349	1623	150
RTOR Reduction (vph)	0	8	0	0	0	18
Lane Group Flow (vph)	188	13	37	1349	1623	132
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	17.2	17.2	109.8	109.8	109.8	109.8
Effective Green, g (s)	17.2	17.2	109.8	109.8	109.8	109.8
Actuated g/C Ratio	0.13	0.13	0.81	0.81	0.81	0.81
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	226	202	192	2878	2878	1288
v/s Ratio Prot	c0.11			0.38	c0.46	
v/s Ratio Perm		0.01	0.16			0.08
v/c Ratio	0.83	0.07	0.19	0.47	0.56	0.10
Uniform Delay, d1	57.5	51.8	2.8	3.8	4.3	2.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	22.2	0.1	2.2	0.6	0.8	0.2
Delay (s)	79.7	52.0	5.0	4.4	5.2	2.7
Level of Service	E	D	A	A	A	A
Approach Delay (s)	76.9			4.4	4.9	
Approach LOS	E			A	A	

Intersection Summary			
HCM Average Control Delay	9.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	57.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	177	1485	508	242	1389	348
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	192	1614	552	263	1510	378
RTOR Reduction (vph)	0	0	0	140	0	0
Lane Group Flow (vph)	192	1614	552	123	1510	378
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	16.0	135.0	45.0	16.0	62.0	111.0
Effective Green, g (s)	16.0	135.0	45.0	16.0	62.0	111.0
Actuated g/C Ratio	0.12	1.00	0.33	0.12	0.46	0.82
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	210	2787	621	188	1577	1532
v/s Ratio Prot	c0.11		c0.30	0.08	c0.44	0.20
v/s Ratio Perm		0.58				
v/c Ratio	0.91	0.58	0.89	0.65	0.96	0.25
Uniform Delay, d1	58.8	0.0	42.6	56.9	35.2	2.7
Progression Factor	1.00	1.00	0.96	0.95	1.00	1.00
Incremental Delay, d2	38.9	0.9	17.1	7.8	13.8	0.4
Delay (s)	97.8	0.9	58.0	61.7	49.0	3.1
Level of Service	F	A	E	E	D	A
Approach Delay (s)	11.2		59.2			39.8
Approach LOS	B		E			D

Intersection Summary			
HCM Average Control Delay	31.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	86.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	35	77	19	83	51	55	30	1823	141	94	1636	53
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	38	84	21	90	55	60	33	1982	153	102	1778	58
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	3155	4211	918	3279	4164	1067	1836			2135		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	3155	4211	918	3279	4164	1067	1836			2135		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	92	0	0	73	90			59		
cM capacity (veh/h)	0	1	274	0	1	218	328			250		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	38	104	90	115	33	1321	814	102	1186	650
Volume Left	38	0	90	0	33	0	0	102	0	0
Volume Right	0	21	0	60	0	0	153	0	0	58
cSH	0	1	0	2	328	1700	1700	250	1700	1700
Volume to Capacity	Err	77.72	Err	47.94	0.10	0.78	0.48	0.41	0.70	0.38
Queue Length 95th (ft)	Err	Err	Err	Err	8	0	0	47	0	0
Control Delay (s)	Err	Err	Err	Err	17.2	0.0	0.0	28.9	0.0	0.0
Lane LOS	F	F	F	F	C			D		
Approach Delay (s)	Err		Err		0.3			1.5		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	81.4%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	98	80	152	124	57	54	146	1551	200	86	1499	98
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	107	87	165	135	62	59	159	1686	217	93	1629	107
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	3120	4090	868	3322	4035	952	1736			1903		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	3120	4090	868	3322	4035	952	1736			1903		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	44	0	0	77	56			70		
cM capacity (veh/h)	0	1	296	0	1	260	359			309		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	107	252	135	121	159	1124	779	93	1086	650
Volume Left	107	0	135	0	159	0	0	93	0	0
Volume Right	0	165	0	59	0	0	217	0	0	107
cSH	0	3	0	2	359	1700	1700	309	1700	1700
Volume to Capacity	Err	91.81	Err	59.78	0.44	0.66	0.46	0.30	0.64	0.38
Queue Length 95th (ft)	Err	Err	Err	Err	55	0	0	31	0	0
Control Delay (s)	Err	Err	Err	Err	22.8	0.0	0.0	21.6	0.0	0.0
Lane LOS	F	F	F	F	C			C		
Approach Delay (s)	Err		Err		1.8			1.1		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	87.8%	ICU Level of Service	E
Analysis Period (min)	15		

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.92		1.00	0.85		1.00	0.99		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1695		1770	1583		1770	3487		1770	3539	
Flt Permitted		0.97		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1661		1405	1583		1770	3487		1770	3539	
Volume (vph)	1	1	3	189	0	164	5	1476	160	102	1425	2
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	1	1	3	201	0	174	5	1570	170	109	1516	2
RTOR Reduction (vph)	0	2	0	0	97	0	0	6	0	0	0	0
Lane Group Flow (vph)	0	3	0	201	77	0	5	1734	0	109	1518	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		3			7		5	2		1	6	
Permitted Phases	3			7								
Actuated Green, G (s)		31.0		31.0	31.0		5.0	87.0		8.0	90.0	
Effective Green, g (s)		32.0		32.0	32.0		5.0	88.0		8.0	91.0	
Actuated g/C Ratio		0.23		0.23	0.23		0.04	0.63		0.06	0.65	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		380		321	362		63	2192		101	2300	
v/s Ratio Prot					0.05		0.00	c0.50		c0.06	c0.43	
v/s Ratio Perm		0.00		c0.14								
v/c Ratio		0.01		0.63	0.21		0.08	0.79		1.08	0.66	
Uniform Delay, d1		41.7		48.6	43.8		65.3	19.2		66.0	15.0	
Progression Factor		1.00		0.87	0.66		1.01	0.45		1.00	1.00	
Incremental Delay, d2		0.0		8.4	1.3		0.2	2.5		112.5	1.5	
Delay (s)		41.7		50.7	30.3		66.4	11.2		178.5	16.5	
Level of Service		D		D	C		E	B		F	B	
Approach Delay (s)		41.7			41.3			11.4			27.4	
Approach LOS		D			D			B			C	

Intersection Summary			
HCM Average Control Delay	21.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	78.7%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	116	145	1477	81	71	1535
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	120	149	1523	84	73	1582
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2502	803			1606	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2502	803			1606	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	54			82	
cM capacity (veh/h)	19	326			403	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	269	1015	591	73	791	791
Volume Left	120	0	0	73	0	0
Volume Right	149	0	84	0	0	0
cSH	40	1700	1700	403	1700	1700
Volume to Capacity	6.65	0.60	0.35	0.18	0.47	0.47
Queue Length 95th (ft)	Err	0	0	16	0	0
Control Delay (s)	Err	0.0	0.0	15.9	0.0	0.0
Lane LOS	F			C		
Approach Delay (s)	Err	0.0		0.7		
Approach LOS	F					

Intersection Summary			
Average Delay	762.3		
Intersection Capacity Utilization	72.7%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.90		1.00	0.99		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1792	1583	1770	1678		1770	3497		1770	3508	
Flt Permitted		0.63	1.00	0.43	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1167	1583	805	1678		1770	3497		1770	3508	
Volume (vph)	139	38	42	167	34	66	29	1338	116	49	1481	94
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	148	40	45	178	36	70	31	1423	123	52	1576	100
RTOR Reduction (vph)	0	0	36	0	50	0	0	5	0	0	3	0
Lane Group Flow (vph)	0	188	9	178	56	0	31	1542	0	52	1673	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		27.0	27.0	27.0	27.0		3.0	94.0		5.0	96.0	
Effective Green, g (s)		28.0	28.0	28.0	28.0		3.0	95.0		5.0	97.0	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.02	0.68		0.04	0.69	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		233	317	161	336		38	2373		63	2431	
v/s Ratio Prot					0.03		0.02	0.44		c0.03	c0.48	
v/s Ratio Perm		0.16	0.01	c0.22								
v/c Ratio		0.81	0.03	1.11	0.17		0.82	0.65		0.83	0.69	
Uniform Delay, d1		53.4	45.1	56.0	46.4		68.2	12.9		67.1	12.6	
Progression Factor		1.00	1.00	1.00	1.00		0.85	0.56		1.25	0.74	
Incremental Delay, d2		18.2	0.0	102.0	0.2		53.4	0.9		46.2	1.3	
Delay (s)		71.6	45.1	158.0	46.6		111.6	8.1		129.8	10.7	
Level of Service		E	D	F	D		F	A		F	B	
Approach Delay (s)		66.5			116.4			10.1			14.3	
Approach LOS		E			F			B			B	

Intersection Summary			
HCM Average Control Delay	23.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	69.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1710		1770	1863	1583	1770	3539	1583	1770	3509	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1710		1770	1863	1583	1770	3539	1583	1770	3509	
Volume (vph)	38	52	63	142	58	135	56	1479	217	154	1455	88
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	40	55	66	149	61	142	59	1557	228	162	1532	93
RTOR Reduction (vph)	0	31	0	0	0	110	0	0	80	0	3	0
Lane Group Flow (vph)	40	90	0	149	61	32	59	1557	148	162	1622	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	4.8	25.8		10.0	31.0	31.0	7.3	75.2	75.2	11.0	78.9	
Effective Green, g (s)	4.8	26.8		10.0	32.0	32.0	7.3	76.2	76.2	11.0	79.9	
Actuated g/C Ratio	0.03	0.19		0.07	0.23	0.23	0.05	0.54	0.54	0.08	0.57	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	61	327		126	426	362	92	1926	862	139	2003	
v/s Ratio Prot	0.02	c0.05		c0.08	0.03		0.03	0.44		c0.09	c0.46	
v/s Ratio Perm						0.02			0.09			
v/c Ratio	0.66	0.28		1.18	0.14	0.09	0.64	0.81	0.17	1.17	0.81	
Uniform Delay, d1	66.8	48.3		65.0	43.1	42.5	65.1	26.0	16.0	64.5	24.0	
Progression Factor	1.00	1.00		0.94	0.94	0.96	1.39	0.46	0.05	1.26	0.50	
Incremental Delay, d2	22.6	2.1		137.2	0.7	0.5	3.5	1.2	0.1	115.3	2.6	
Delay (s)	89.4	50.4		198.2	41.2	41.3	93.8	13.1	1.0	196.8	14.6	
Level of Service	F	D		F	D	D	F	B	A	F	B	
Approach Delay (s)		60.1			107.7			14.2			31.1	
Approach LOS		E			F			B			C	

Intersection Summary			
HCM Average Control Delay	31.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	73.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	38	322	19	103	185	20	60	85	152	39	142	66
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	41	350	21	112	201	22	65	92	165	42	154	72
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	223			371			916	890	185	905	889	111
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	223			371			916	890	185	905	889	111
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			91			32	62	80	65	37	92
cM capacity (veh/h)	1343			1184			96	246	825	120	246	920

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	41	233	137	112	134	89	65	258	42	226
Volume Left	41	0	0	112	0	0	65	0	42	0
Volume Right	0	0	21	0	0	22	0	165	0	72
cSH	1343	1700	1700	1184	1700	1700	96	448	120	321
Volume to Capacity	0.03	0.14	0.08	0.09	0.08	0.05	0.68	0.58	0.35	0.70
Queue Length 95th (ft)	2	0	0	8	0	0	85	88	36	125
Control Delay (s)	7.8	0.0	0.0	8.4	0.0	0.0	99.4	23.4	50.7	39.0
Lane LOS	A			A			F	C	F	E
Approach Delay (s)	0.8			2.8			38.7		40.8	
Approach LOS							E		E	

Intersection Summary			
Average Delay	18.5		
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	186	149	25	40	25	35	16	169	239	209	245	115
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	202	162	27	43	27	38	17	184	260	227	266	125
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	961	1261	196	1044	1194	222	391			443		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	961	1261	196	1044	1194	222	391			443		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	97	0	81	95	99			80		
cM capacity (veh/h)	144	132	813	0	145	782	1164			1113		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	202	189	43	65	17	122	321	227	178	214
Volume Left	202	0	43	0	17	0	0	227	0	0
Volume Right	0	27	0	38	0	0	260	0	0	125
cSH	144	150	0	277	1164	1700	1700	1113	1700	1700
Volume to Capacity	1.41	1.26	Err	0.24	0.01	0.07	0.19	0.20	0.10	0.13
Queue Length 95th (ft)	327	279	Err	22	1	0	0	19	0	0
Control Delay (s)	276.5	216.7	Err	22.0	8.1	0.0	0.0	9.1	0.0	0.0
Lane LOS	F	F	F	C	A			A		
Approach Delay (s)	247.6		Err		0.3			3.3		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	51.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.19	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	345	3539	3539	1583
Volume (vph)	128	38	16	1015	1236	190
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	139	41	17	1103	1343	207
RTOR Reduction (vph)	0	19	0	0	0	25
Lane Group Flow (vph)	139	22	17	1103	1343	182
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	14.3	14.3	117.7	117.7	117.7	117.7
Effective Green, g (s)	14.3	14.3	117.7	117.7	117.7	117.7
Actuated g/C Ratio	0.10	0.10	0.84	0.84	0.84	0.84
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	181	162	290	2975	2975	1331
v/s Ratio Prot	c0.08			0.31	c0.38	
v/s Ratio Perm		0.01	0.05			0.12
v/c Ratio	0.77	0.14	0.06	0.37	0.45	0.14
Uniform Delay, d1	61.2	57.2	1.9	2.6	2.9	2.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	17.6	0.4	0.4	0.4	0.5	0.2
Delay (s)	78.8	57.6	2.3	2.9	3.4	2.2
Level of Service	E	E	A	A	A	A
Approach Delay (s)	74.0			2.9	3.2	
Approach LOS	E			A	A	

Intersection Summary			
HCM Average Control Delay	7.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	47.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	183	1147	252	137	1294	387
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	199	1247	274	149	1407	421
RTOR Reduction (vph)	0	0	0	128	0	0
Lane Group Flow (vph)	199	1247	274	21	1407	421
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	19.9	140.0	45.0	19.9	63.1	112.1
Effective Green, g (s)	19.9	140.0	45.0	19.9	63.1	112.1
Actuated g/C Ratio	0.14	1.00	0.32	0.14	0.45	0.80
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	252	2787	599	225	1547	1492
v/s Ratio Prot	c0.11		0.15	0.01	c0.41	0.23
v/s Ratio Perm		c0.45				
v/c Ratio	0.79	0.45	0.46	0.09	0.91	0.28
Uniform Delay, d1	58.0	0.0	37.8	52.2	35.8	3.6
Progression Factor	1.00	1.00	0.91	1.04	1.00	1.00
Incremental Delay, d2	15.1	0.5	2.5	0.2	8.2	0.5
Delay (s)	73.1	0.5	37.0	54.6	44.0	4.1
Level of Service	E	A	D	D	D	A
Approach Delay (s)	10.5		43.2			34.8
Approach LOS	B		D			C

Intersection Summary			
HCM Average Control Delay	26.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	70.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	90	27	50	148	90	99	26	1324	50	33	1477	46
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	98	29	54	161	98	108	28	1439	54	36	1605	50
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2635	3252	828	2466	3250	747	1655			1493		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2635	3252	828	2466	3250	747	1655			1493		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	83	0	0	70	93			92		
cM capacity (veh/h)	0	8	314	0	8	356	386			445		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	98	84	161	205	28	959	534	36	1070	585
Volume Left	98	0	161	0	28	0	0	36	0	0
Volume Right	0	54	0	108	0	0	54	0	0	50
cSH	0	21	0	16	386	1700	1700	445	1700	1700
Volume to Capacity	Err	3.97	Err	12.91	0.07	0.56	0.31	0.08	0.63	0.34
Queue Length 95th (ft)	Err	Err	Err	Err	6	0	0	7	0	0
Control Delay (s)	Err	Err	Err	Err	15.1	0.0	0.0	13.8	0.0	0.0
Lane LOS	F	F	F	F	C			B		
Approach Delay (s)	Err		Err		0.3			0.3		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	68.1%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	66	47	98	228	106	102	77	1312	109	50	1227	43
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	72	51	107	248	115	111	84	1426	118	54	1334	47
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2515	3178	690	2560	3142	772	1380			1545		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2515	3178	690	2560	3142	772	1380			1545		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	73	0	0	68	83			87		
cM capacity (veh/h)	0	7	387	0	8	342	492			426		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	72	158	248	226	84	951	594	54	889	491
Volume Left	72	0	248	0	84	0	0	54	0	0
Volume Right	0	107	0	111	0	0	118	0	0	47
cSH	0	22	0	15	492	1700	1700	426	1700	1700
Volume to Capacity	Err	7.21	Err	15.12	0.17	0.56	0.35	0.13	0.52	0.29
Queue Length 95th (ft)	Err	Err	Err	Err	15	0	0	11	0	0
Control Delay (s)	Err	Err	Err	Err	13.8	0.0	0.0	14.7	0.0	0.0
Lane LOS	F	F	F	F	B			B		
Approach Delay (s)	Err		Err		0.7			0.6		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	77.5%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.91		1.00	0.85		1.00	0.98		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1691		1770	1588		1770	3472		1770	3536	
Flt Permitted		0.96		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1634		1388	1588		1770	3472		1770	3536	
Volume (vph)	3	4	11	223	3	178	6	1749	256	182	1759	12
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	3	4	12	235	3	187	6	1841	269	192	1852	13
RTOR Reduction (vph)	0	10	0	0	112	0	0	9	0	0	0	0
Lane Group Flow (vph)	0	9	0	235	78	0	6	2101	0	192	1865	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)		20.0		20.0	20.0		5.0	91.0		10.0	96.0	
Effective Green, g (s)		21.0		21.0	21.0		5.0	92.0		10.0	97.0	
Actuated g/C Ratio		0.16		0.16	0.16		0.04	0.68		0.07	0.72	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		254		216	247		66	2366		131	2541	
v/s Ratio Prot					0.05		0.00	c0.61		c0.11	0.53	
v/s Ratio Perm		0.01		c0.17								
v/c Ratio		0.03		1.09	0.31		0.09	0.89		1.47	0.73	
Uniform Delay, d1		48.4		57.0	50.6		62.8	17.3		62.5	11.3	
Progression Factor		1.00		1.01	1.15		1.22	0.78		1.00	1.00	
Incremental Delay, d2		0.1		47.3	0.3		0.1	2.6		246.3	1.9	
Delay (s)		48.5		104.9	58.5		76.5	16.1		308.8	13.2	
Level of Service		D		F	E		E	B		F	B	
Approach Delay (s)		48.5			84.2			16.3			40.8	
Approach LOS		D			F			B			D	

Intersection Summary			
HCM Average Control Delay	33.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	95.6%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	79	71	1921	176	142	1848
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	84	76	2044	187	151	1966
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	3422	1115			2231	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3422	1115			2231	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	63			34	
cM capacity (veh/h)	2	202			229	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	160	1362	868	151	983	983
Volume Left	84	0	0	151	0	0
Volume Right	76	0	187	0	0	0
cSH	3	1700	1700	229	1700	1700
Volume to Capacity	46.60	0.80	0.51	0.66	0.58	0.58
Queue Length 95th (ft)	Err	0	0	102	0	0
Control Delay (s)	Err	0.0	0.0	46.5	0.0	0.0
Lane LOS	F			E		
Approach Delay (s)	Err	0.0		3.3		
Approach LOS	F					

Intersection Summary			
Average Delay	355.5		
Intersection Capacity Utilization	85.3%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.89		1.00	0.99		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1789	1583	1770	1649		1770	3494		1770	3497	
Flt Permitted		0.59	1.00	0.25	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1102	1583	462	1649		1770	3494		1770	3497	
Volume (vph)	210	45	45	130	26	84	49	1734	161	68	1627	139
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	228	49	49	141	28	91	53	1885	175	74	1768	151
RTOR Reduction (vph)	0	0	39	0	73	0	0	5	0	0	4	0
Lane Group Flow (vph)	0	277	10	141	46	0	53	2055	0	74	1915	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		26.0	26.0	26.0	26.0		6.7	86.7		8.3	88.3	
Effective Green, g (s)		27.0	27.0	27.0	27.0		6.7	87.7		8.3	89.3	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.05	0.65		0.06	0.66	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		220	317	92	330		88	2270		109	2313	
v/s Ratio Prot					0.03		0.03	c0.59		c0.04	0.55	
v/s Ratio Perm		0.25	0.01	c0.31								
v/c Ratio		1.26	0.03	1.53	0.14		0.60	0.91		0.68	0.83	
Uniform Delay, d1		54.0	43.5	54.0	44.4		62.8	20.1		62.0	17.1	
Progression Factor		1.00	1.00	1.00	1.00		0.71	1.60		1.22	0.78	
Incremental Delay, d2		147.9	0.2	286.7	0.2		0.7	0.7		8.4	2.4	
Delay (s)		201.9	43.6	340.7	44.6		45.1	32.9		83.8	15.8	
Level of Service		F	D	F	D		D	C		F	B	
Approach Delay (s)		178.1			205.2			33.2			18.3	
Approach LOS		F			F			C			B	

Intersection Summary			
HCM Average Control Delay	46.5	HCM Level of Service	D
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	83.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1705		1770	1863	1583	1770	3539	1583	1770	3512	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1705		1770	1863	1583	1770	3539	1583	1770	3512	
Volume (vph)	120	109	140	291	71	340	112	1558	244	218	1535	83
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	130	118	152	316	77	370	122	1693	265	237	1668	90
RTOR Reduction (vph)	0	35	0	0	0	136	0	0	87	0	3	0
Lane Group Flow (vph)	130	235	0	316	77	234	122	1693	178	237	1755	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	12.4	25.0		20.0	32.6	32.6	9.0	57.0	57.0	15.0	63.0	
Effective Green, g (s)	12.4	26.0		20.0	33.6	33.6	9.0	58.0	58.0	15.0	64.0	
Actuated g/C Ratio	0.09	0.19		0.15	0.25	0.25	0.07	0.43	0.43	0.11	0.47	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	163	328		262	464	394	118	1520	680	197	1665	
v/s Ratio Prot	0.07	c0.14		c0.18	0.04		0.07	c0.48		c0.13	0.50	
v/s Ratio Perm						0.15			0.11			
v/c Ratio	0.80	0.72		1.21	0.17	0.59	1.03	1.11	0.26	1.20	1.05	
Uniform Delay, d1	60.1	51.1		57.5	39.7	44.7	63.0	38.5	24.7	60.0	35.5	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.24	0.42	0.09	1.20	0.64	
Incremental Delay, d2	23.1	12.7		123.1	0.8	6.5	51.5	54.1	0.2	113.8	32.5	
Delay (s)	83.2	63.7		180.6	40.5	51.1	129.4	70.1	2.4	185.8	55.2	
Level of Service	F	E		F	D	D	F	E	A	F	E	
Approach Delay (s)		70.0			103.7			64.9			70.7	
Approach LOS		E			F			E			E	

Intersection Summary			
HCM Average Control Delay	73.2	HCM Level of Service	E
HCM Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	98.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	81	364	65	192	529	30	39	190	122	18	163	67
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	88	396	71	209	575	33	42	207	133	20	177	73
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	608			466			1473	1632	233	1618	1651	304
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	608			466			1473	1632	233	1618	1651	304
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	91			81			0	0	83	0	0	89
cM capacity (veh/h)	967			1091			0	74	769	0	72	692

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	88	264	203	209	383	224	42	339	20	250
Volume Left	88	0	0	209	0	0	42	0	20	0
Volume Right	0	0	71	0	0	33	0	133	0	73
cSH	967	1700	1700	1091	1700	1700	0	114	0	97
Volume to Capacity	0.09	0.16	0.12	0.19	0.23	0.13	Err	2.97	Err	2.57
Queue Length 95th (ft)	7	0	0	18	0	0	Err	802	Err	579
Control Delay (s)	9.1	0.0	0.0	9.1	0.0	0.0	Err	968.8	Err	805.5
Lane LOS	A			A			F	F	F	F
Approach Delay (s)	1.4			2.3			Err		Err	
Approach LOS							F		F	

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	56.9%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	253	55	36	315	197	276	39	254	89	78	228	279
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	275	60	39	342	214	300	42	276	97	85	248	303
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	1199	1027	276	772	1130	186	551			373		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1199	1027	276	772	1130	186	551			373		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	71	95	0	0	64	96			93		
cM capacity (veh/h)	0	207	722	196	180	824	1015			1182		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	275	99	342	514	42	184	189	85	165	386
Volume Left	275	0	342	0	42	0	0	85	0	0
Volume Right	0	39	0	300	0	0	97	0	0	303
cSH	0	289	196	331	1015	1700	1700	1182	1700	1700
Volume to Capacity	Err	0.34	1.75	1.55	0.04	0.11	0.11	0.07	0.10	0.23
Queue Length 95th (ft)	Err	37	594	736	3	0	0	6	0	0
Control Delay (s)	Err	23.8	399.9	292.5	8.7	0.0	0.0	8.3	0.0	0.0
Lane LOS	F	C	F	F	A			A		
Approach Delay (s)	Err		335.4		0.9			1.1		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	73.2%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.12	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	228	3539	3539	1583
Volume (vph)	186	19	34	1277	1510	144
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	202	21	37	1388	1641	157
RTOR Reduction (vph)	0	8	0	0	0	19
Lane Group Flow (vph)	202	13	37	1388	1641	138
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	18.2	18.2	108.8	108.8	108.8	108.8
Effective Green, g (s)	18.2	18.2	108.8	108.8	108.8	108.8
Actuated g/C Ratio	0.13	0.13	0.81	0.81	0.81	0.81
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	239	213	184	2852	2852	1276
v/s Ratio Prot	c0.11			0.39	c0.46	
v/s Ratio Perm		0.01	0.16			0.09
v/c Ratio	0.85	0.06	0.20	0.49	0.58	0.11
Uniform Delay, d1	57.0	51.0	3.0	4.2	4.7	2.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	23.0	0.1	2.4	0.6	0.9	0.2
Delay (s)	80.0	51.1	5.5	4.8	5.6	3.0
Level of Service	F	D	A	A	A	A
Approach Delay (s)	77.3			4.8	5.4	
Approach LOS	E			A	A	

Intersection Summary			
HCM Average Control Delay	9.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	58.7%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	200	1510	529	253	1401	385
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	217	1641	575	275	1523	418
RTOR Reduction (vph)	0	0	0	141	0	0
Lane Group Flow (vph)	217	1641	575	134	1523	418
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	17.0	135.0	44.4	17.0	61.6	110.0
Effective Green, g (s)	17.0	135.0	44.4	17.0	61.6	110.0
Actuated g/C Ratio	0.13	1.00	0.33	0.13	0.46	0.81
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	223	2787	613	199	1566	1518
v/s Ratio Prot	c0.12		c0.31	0.08	c0.44	0.22
v/s Ratio Perm		0.59				
v/c Ratio	0.97	0.59	0.94	0.67	0.97	0.28
Uniform Delay, d1	58.8	0.0	44.0	56.4	35.9	3.0
Progression Factor	1.00	1.00	0.97	0.95	1.00	1.00
Incremental Delay, d2	52.3	0.9	23.8	8.7	16.6	0.4
Delay (s)	111.0	0.9	66.2	62.2	52.4	3.4
Level of Service	F	A	E	E	D	A
Approach Delay (s)	13.8		64.9			41.9
Approach LOS	B		E			D

Intersection Summary			
HCM Average Control Delay	34.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.96		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	88.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	42	77	23	83	51	55	39	1861	141	94	1682	69
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	46	84	25	90	55	60	42	2023	153	102	1828	75
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	3254	4331	952	3370	4292	1088	1903			2176		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	3254	4331	952	3370	4292	1088	1903			2176		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	90	0	0	72	86			58		
cM capacity (veh/h)	0	1	260	0	1	211	309			241		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	46	109	90	115	42	1349	828	102	1219	684
Volume Left	46	0	90	0	42	0	0	102	0	0
Volume Right	0	25	0	60	0	0	153	0	0	75
cSH	0	1	0	2	309	1700	1700	241	1700	1700
Volume to Capacity	Err	100.80	Err	62.95	0.14	0.79	0.49	0.42	0.72	0.40
Queue Length 95th (ft)	Err	Err	Err	Err	12	0	0	49	0	0
Control Delay (s)	Err	Err	Err	Err	18.5	0.0	0.0	30.5	0.0	0.0
Lane LOS	F	F	F	F	C			D		
Approach Delay (s)	Err		Err		0.4			1.6		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	82.4%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	105	80	162	124	57	54	166	1576	200	86	1550	112
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	114	87	176	135	62	59	180	1713	217	93	1685	122
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	3240	4224	903	3432	4176	965	1807			1930		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	3240	4224	903	3432	4176	965	1807			1930		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	37	0	0	77	46			69		
cM capacity (veh/h)	0	1	280	0	1	255	337			301		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	114	263	135	121	180	1142	788	93	1123	683
Volume Left	114	0	135	0	180	0	0	93	0	0
Volume Right	0	176	0	59	0	0	217	0	0	122
cSH	0	2	0	1	337	1700	1700	301	1700	1700
Volume to Capacity	Err	137.64	Err	90.71	0.54	0.67	0.46	0.31	0.66	0.40
Queue Length 95th (ft)	Err	Err	Err	Err	75	0	0	32	0	0
Control Delay (s)	Err	Err	Err	Err	27.4	0.0	0.0	22.2	0.0	0.0
Lane LOS	F	F	F	F	D			C		
Approach Delay (s)	Err		Err		2.3			1.1		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	90.0%	ICU Level of Service	E
Analysis Period (min)	15		

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.92		1.00	0.85		1.00	0.99		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1695		1770	1583		1770	3492		1770	3539	
Flt Permitted		0.97		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1661		1405	1583		1770	3492		1770	3539	
Volume (vph)	1	1	3	185	0	159	5	1533	150	96	1478	2
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	1	1	3	197	0	169	5	1631	160	102	1572	2
RTOR Reduction (vph)	0	2	0	0	94	0	0	5	0	0	0	0
Lane Group Flow (vph)	0	3	0	197	75	0	5	1786	0	102	1574	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		3			7		5	2		1	6	
Permitted Phases	3			7								
Actuated Green, G (s)		31.0		31.0	31.0		5.0	87.0		8.0	90.0	
Effective Green, g (s)		32.0		32.0	32.0		5.0	88.0		8.0	91.0	
Actuated g/C Ratio		0.23		0.23	0.23		0.04	0.63		0.06	0.65	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		380		321	362		63	2195		101	2300	
v/s Ratio Prot					0.05		0.00	c0.51		c0.06	c0.44	
v/s Ratio Perm		0.00		c0.14								
v/c Ratio		0.01		0.61	0.21		0.08	0.81		1.01	0.68	
Uniform Delay, d1		41.7		48.5	43.7		65.3	19.8		66.0	15.4	
Progression Factor		1.00		0.88	0.67		1.00	0.49		1.00	1.00	
Incremental Delay, d2		0.0		8.2	1.3		0.2	2.8		92.3	1.7	
Delay (s)		41.7		50.8	30.6		65.1	12.5		158.3	17.1	
Level of Service		D		D	C		E	B		F	B	
Approach Delay (s)		41.7			41.4			12.7			25.7	
Approach LOS		D			D			B			C	

Intersection Summary			
HCM Average Control Delay	21.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	79.4%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	104	148	1524	83	83	1575
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	107	153	1571	86	86	1624
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2597	828			1657	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2597	828			1657	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	51			78	
cM capacity (veh/h)	16	314			385	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	260	1047	609	86	812	812
Volume Left	107	0	0	86	0	0
Volume Right	153	0	86	0	0	0
cSH	36	1700	1700	385	1700	1700
Volume to Capacity	7.28	0.62	0.36	0.22	0.48	0.48
Queue Length 95th (ft)	Err	0	0	21	0	0
Control Delay (s)	Err	0.0	0.0	17.0	0.0	0.0
Lane LOS	F			C		
Approach Delay (s)	Err	0.0		0.9		
Approach LOS	F					

Intersection Summary			
Average Delay	716.8		
Intersection Capacity Utilization	74.2%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.89		1.00	0.98		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1794	1583	1770	1660		1770	3482		1770	3508	
Flt Permitted		0.51	1.00	0.42	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		947	1583	777	1660		1770	3482		1770	3508	
Volume (vph)	140	43	42	228	41	109	29	1343	163	67	1497	95
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	149	46	45	243	44	116	31	1429	173	71	1593	101
RTOR Reduction (vph)	0	0	36	0	68	0	0	7	0	0	3	0
Lane Group Flow (vph)	0	195	9	243	92	0	31	1595	0	71	1691	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		27.0	27.0	27.0	27.0		3.0	94.0		5.0	96.0	
Effective Green, g (s)		28.0	28.0	28.0	28.0		3.0	95.0		5.0	97.0	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.02	0.68		0.04	0.69	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		189	317	155	332		38	2363		63	2431	
v/s Ratio Prot					0.06		0.02	0.46		c0.04	c0.48	
v/s Ratio Perm		0.21	0.01	c0.31								
v/c Ratio		1.03	0.03	1.57	0.28		0.82	0.68		1.13	0.70	
Uniform Delay, d1		56.0	45.1	56.0	47.4		68.2	13.3		67.5	12.7	
Progression Factor		1.00	1.00	1.00	1.00		0.84	0.60		1.25	0.72	
Incremental Delay, d2		74.0	0.0	284.3	0.5		51.8	1.0		138.8	1.3	
Delay (s)		130.0	45.1	340.3	47.9		109.2	8.9		223.1	10.4	
Level of Service		F	D	F	D		F	A		F	B	
Approach Delay (s)		114.1			224.2			10.8			19.0	
Approach LOS		F			F			B			B	

Intersection Summary			
HCM Average Control Delay	41.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.7%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1706		1770	1863	1583	1770	3539	1583	1770	3511	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1706		1770	1863	1583	1770	3539	1583	1770	3511	
Volume (vph)	36	49	63	134	52	147	56	1522	235	175	1515	84
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	38	52	66	141	55	155	59	1602	247	184	1595	88
RTOR Reduction (vph)	0	32	0	0	0	120	0	0	84	0	3	0
Lane Group Flow (vph)	38	86	0	141	55	35	59	1602	163	184	1680	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	4.8	25.8		10.0	31.0	31.0	7.3	75.2	75.2	11.0	78.9	
Effective Green, g (s)	4.8	26.8		10.0	32.0	32.0	7.3	76.2	76.2	11.0	79.9	
Actuated g/C Ratio	0.03	0.19		0.07	0.23	0.23	0.05	0.54	0.54	0.08	0.57	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	61	327		126	426	362	92	1926	862	139	2004	
v/s Ratio Prot	0.02	c0.05		c0.08	0.03		0.03	0.45		c0.10	c0.48	
v/s Ratio Perm						0.02			0.10			
v/c Ratio	0.62	0.26		1.12	0.13	0.10	0.64	0.83	0.19	1.32	0.84	
Uniform Delay, d1	66.7	48.2		65.0	42.9	42.6	65.1	26.6	16.2	64.5	24.7	
Progression Factor	1.00	1.00		0.91	0.92	0.97	1.40	0.47	0.05	1.23	0.55	
Incremental Delay, d2	18.1	1.9		115.4	0.6	0.5	2.8	1.1	0.1	172.2	2.7	
Delay (s)	84.9	50.1		174.8	40.1	41.8	93.9	13.6	0.9	251.3	16.4	
Level of Service	F	D		F	D	D	F	B	A	F	B	
Approach Delay (s)		58.6			95.0			14.4			39.5	
Approach LOS		E			F			B			D	

Intersection Summary			
HCM Average Control Delay	33.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	75.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	36	362	19	95	197	33	60	85	167	47	132	52
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	39	393	21	103	214	36	65	92	182	51	143	57
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	250			414			924	939	207	941	931	125
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	250			414			924	939	207	941	931	125
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	97			91			34	60	77	52	39	94
cM capacity (veh/h)	1313			1141			99	232	799	106	234	902

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	39	262	152	103	143	107	65	274	51	200
Volume Left	39	0	0	103	0	0	65	0	51	0
Volume Right	0	0	21	0	0	36	0	182	0	57
cSH	1313	1700	1700	1141	1700	1700	99	438	106	296
Volume to Capacity	0.03	0.15	0.09	0.09	0.08	0.06	0.66	0.63	0.48	0.68
Queue Length 95th (ft)	2	0	0	7	0	0	82	104	53	113
Control Delay (s)	7.8	0.0	0.0	8.5	0.0	0.0	93.8	26.0	66.8	39.1
Lane LOS	A			A			F	D	F	E
Approach Delay (s)	0.7			2.5			39.0		44.8	
Approach LOS							E		E	

Intersection Summary			
Average Delay	18.4		
Intersection Capacity Utilization	47.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	160	182	39	40	25	35	25	164	291	254	242	104
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	174	198	42	43	27	38	27	178	316	276	263	113
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	1067	1421	188	1216	1319	247	376			495		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1067	1421	188	1216	1319	247	376			495		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	95	0	76	95	98			74		
cM capacity (veh/h)	108	98	822	0	113	753	1179			1065		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	174	240	43	65	27	119	376	276	175	201
Volume Left	174	0	43	0	27	0	0	276	0	0
Volume Right	0	42	0	38	0	0	316	0	0	113
cSH	108	116	0	224	1179	1700	1700	1065	1700	1700
Volume to Capacity	1.61	2.07	Err	0.29	0.02	0.07	0.22	0.26	0.10	0.12
Queue Length 95th (ft)	329	501	Err	29	2	0	0	26	0	0
Control Delay (s)	380.7	572.8	Err	27.6	8.1	0.0	0.0	9.6	0.0	0.0
Lane LOS	F	F	F	D	A			A		
Approach Delay (s)	492.1		Err		0.4			4.0		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	56.6%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.18	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	339	3539	3539	1583
Volume (vph)	133	38	16	1051	1247	189
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	145	41	17	1142	1355	205
RTOR Reduction (vph)	0	19	0	0	0	25
Lane Group Flow (vph)	145	22	17	1142	1355	180
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	14.7	14.7	117.3	117.3	117.3	117.3
Effective Green, g (s)	14.7	14.7	117.3	117.3	117.3	117.3
Actuated g/C Ratio	0.10	0.10	0.84	0.84	0.84	0.84
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	186	166	284	2965	2965	1326
v/s Ratio Prot	c0.08			0.32	c0.38	
v/s Ratio Perm		0.01	0.05			0.11
v/c Ratio	0.78	0.13	0.06	0.39	0.46	0.14
Uniform Delay, d1	61.1	56.9	1.9	2.7	3.0	2.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	18.4	0.4	0.4	0.4	0.5	0.2
Delay (s)	79.5	57.2	2.3	3.1	3.5	2.3
Level of Service	E	E	A	A	A	A
Approach Delay (s)	74.6			3.1	3.3	
Approach LOS	E			A	A	

Intersection Summary			
HCM Average Control Delay	7.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	48.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	225	1146	205	154	1286	375
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	245	1246	223	167	1398	408
RTOR Reduction (vph)	0	0	0	139	0	0
Lane Group Flow (vph)	245	1246	223	28	1398	408
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	23.2	140.0	42.5	23.2	62.3	108.8
Effective Green, g (s)	23.2	140.0	42.5	23.2	62.3	108.8
Actuated g/C Ratio	0.17	1.00	0.30	0.17	0.44	0.78
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	293	2787	566	262	1528	1448
v/s Ratio Prot	c0.14		0.12	0.02	c0.41	0.22
v/s Ratio Perm		c0.45				
v/c Ratio	0.84	0.45	0.39	0.11	0.91	0.28
Uniform Delay, d1	56.6	0.0	38.6	49.6	36.4	4.5
Progression Factor	1.00	1.00	0.90	1.11	1.00	1.00
Incremental Delay, d2	18.3	0.5	2.0	0.2	8.8	0.5
Delay (s)	74.8	0.5	36.9	55.2	45.2	4.9
Level of Service	E	A	D	E	D	A
Approach Delay (s)	12.7		44.7			36.1
Approach LOS	B		D			D

Intersection Summary			
HCM Average Control Delay	27.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	69.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	106	22	59	132	81	88	42	1269	40	27	1464	76
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	115	24	64	143	88	96	46	1379	43	29	1591	83
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2612	3205	837	2423	3225	711	1674			1423		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2612	3205	837	2423	3225	711	1674			1423		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	79	0	0	75	88			94		
cM capacity (veh/h)	0	8	310	0	8	375	379			474		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	115	88	143	184	46	920	503	29	1061	613
Volume Left	115	0	143	0	46	0	0	29	0	0
Volume Right	0	64	0	96	0	0	43	0	0	83
cSH	0	28	0	16	379	1700	1700	474	1700	1700
Volume to Capacity	Err	3.18	Err	11.53	0.12	0.54	0.30	0.06	0.62	0.36
Queue Length 95th (ft)	Err	Err	Err	Err	10	0	0	5	0	0
Control Delay (s)	Err	Err	Err	Err	15.8	0.0	0.0	13.1	0.0	0.0
Lane LOS	F	F	F	F	C			B		
Approach Delay (s)	Err		Err		0.5			0.2		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	68.4%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	67	42	99	210	97	93	67	1285	99	45	1257	37
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	73	46	108	228	105	101	73	1397	108	49	1366	40
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	2482	3134	703	2508	3101	752	1407			1504		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2482	3134	703	2508	3101	752	1407			1504		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	72	0	0	71	85			89		
cM capacity (veh/h)	0	8	380	0	9	353	481			441		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	73	153	228	207	73	931	573	49	911	496
Volume Left	73	0	228	0	73	0	0	49	0	0
Volume Right	0	108	0	101	0	0	108	0	0	40
cSH	0	26	0	17	481	1700	1700	441	1700	1700
Volume to Capacity	Err	5.84	Err	12.48	0.15	0.55	0.34	0.11	0.54	0.29
Queue Length 95th (ft)	Err	Err	Err	Err	13	0	0	9	0	0
Control Delay (s)	Err	Err	Err	Err	13.8	0.0	0.0	14.2	0.0	0.0
Lane LOS	F	F	F	F	B			B		
Approach Delay (s)	Err		Err		0.6			0.5		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	75.3%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt		0.91		1.00	0.85		1.00	0.98		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1691		1770	1588		1770	3481		1770	3536	
Flt Permitted		0.96		0.75	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1636		1388	1588		1770	3481		1770	3536	
Volume (vph)	3	4	11	192	3	162	6	1868	231	168	1871	12
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	3	4	12	202	3	171	6	1966	243	177	1969	13
RTOR Reduction (vph)	0	10	0	0	107	0	0	7	0	0	0	0
Lane Group Flow (vph)	0	9	0	202	67	0	6	2202	0	177	1982	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)		20.0		20.0	20.0		5.0	91.0		10.0	96.0	
Effective Green, g (s)		21.0		21.0	21.0		5.0	92.0		10.0	97.0	
Actuated g/C Ratio		0.16		0.16	0.16		0.04	0.68		0.07	0.72	
Clearance Time (s)		5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		254		216	247		66	2372		131	2541	
v/s Ratio Prot					0.04		0.00	c0.63		c0.10	0.56	
v/s Ratio Perm		0.01		c0.15								
v/c Ratio		0.03		0.94	0.27		0.09	0.93		1.35	0.78	
Uniform Delay, d1		48.4		56.3	50.2		62.8	18.6		62.5	12.2	
Progression Factor		1.00		1.01	1.11		1.21	0.74		1.00	1.00	
Incremental Delay, d2		0.1		29.5	1.3		0.1	2.5		199.8	2.4	
Delay (s)		48.5		86.3	57.0		75.8	16.4		262.3	14.6	
Level of Service		D		F	E		E	B		F	B	
Approach Delay (s)		48.5			72.7			16.5			34.9	
Approach LOS		D			E			B			C	

Intersection Summary			
HCM Average Control Delay	29.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.96		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	95.6%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Volume (veh/h)	86	101	1986	175	166	1906
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	91	107	2113	186	177	2028
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	3573	1149			2299	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3573	1149			2299	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	0	44			18	
cM capacity (veh/h)	1	192			216	

Direction, Lane #	WB 1	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	199	1409	890	177	1014	1014
Volume Left	91	0	0	177	0	0
Volume Right	107	0	186	0	0	0
cSH	2	1700	1700	216	1700	1700
Volume to Capacity	122.13	0.83	0.52	0.82	0.60	0.60
Queue Length 95th (ft)	Err	0	0	151	0	0
Control Delay (s)	Err	0.0	0.0	69.3	0.0	0.0
Lane LOS	F			F		
Approach Delay (s)	Err	0.0		5.6		
Approach LOS	F					

Intersection Summary			
Average Delay	425.6		
Intersection Capacity Utilization	90.6%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00	1.00	1.00	1.00		1.00	0.95		1.00	0.95	
Frt		1.00	0.85	1.00	0.88		1.00	0.98		1.00	0.99	
Flt Protected		0.96	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1792	1583	1770	1640		1770	3467		1770	3498	
Flt Permitted		0.42	1.00	0.22	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		788	1583	416	1640		1770	3467		1770	3498	
Volume (vph)	209	57	45	241	37	145	49	1747	277	138	1624	138
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	227	62	49	262	40	158	53	1899	301	150	1765	150
RTOR Reduction (vph)	0	0	39	0	97	0	0	9	0	0	4	0
Lane Group Flow (vph)	0	289	10	262	101	0	53	2191	0	150	1911	0
Turn Type	Perm		Perm	Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8								
Actuated Green, G (s)		26.0	26.0	26.0	26.0		6.7	86.0		9.0	88.3	
Effective Green, g (s)		27.0	27.0	27.0	27.0		6.7	87.0		9.0	89.3	
Actuated g/C Ratio		0.20	0.20	0.20	0.20		0.05	0.64		0.07	0.66	
Clearance Time (s)		5.0	5.0	5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)		3.0	3.0	3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)		158	317	83	328		88	2234		118	2314	
v/s Ratio Prot					0.06		0.03	c0.63		c0.08	0.55	
v/s Ratio Perm		0.37	0.01	c0.63								
v/c Ratio		1.83	0.03	3.16	0.31		0.60	0.98		1.27	0.83	
Uniform Delay, d1		54.0	43.5	54.0	46.0		62.8	23.2		63.0	17.0	
Progression Factor		1.00	1.00	1.00	1.00		0.72	1.54		1.22	0.67	
Incremental Delay, d2		396.7	0.2	1001.2	0.5		0.7	2.8		157.6	2.3	
Delay (s)		450.7	43.6	1055.2	46.6		45.9	38.6		234.5	13.8	
Level of Service		F	D	F	D		D	D		F	B	
Approach Delay (s)		391.7			621.1			38.8			29.8	
Approach LOS		F			F			D			C	

Intersection Summary			
HCM Average Control Delay	110.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.47		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	106.0%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.91		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1699		1770	1863	1583	1770	3539	1583	1770	3514	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1699		1770	1863	1583	1770	3539	1583	1770	3514	
Volume (vph)	117	98	140	301	62	369	112	1661	226	232	1631	81
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	127	107	152	327	67	401	122	1805	246	252	1773	88
RTOR Reduction (vph)	0	38	0	0	0	136	0	0	76	0	3	0
Lane Group Flow (vph)	127	221	0	327	67	265	122	1805	170	252	1858	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	12.4	25.0		19.0	31.6	31.6	8.0	58.0	58.0	15.0	65.0	
Effective Green, g (s)	12.4	26.0		19.0	32.6	32.6	8.0	59.0	59.0	15.0	66.0	
Actuated g/C Ratio	0.09	0.19		0.14	0.24	0.24	0.06	0.44	0.44	0.11	0.49	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	163	327		249	450	382	105	1547	692	197	1718	
v/s Ratio Prot	0.07	0.13		c0.18	0.04		0.07	c0.51		c0.14	0.53	
v/s Ratio Perm						c0.17			0.11			
v/c Ratio	0.78	0.68		1.31	0.15	0.69	1.16	1.17	0.25	1.28	1.08	
Uniform Delay, d1	60.0	50.6		58.0	40.3	46.7	63.5	38.0	24.0	60.0	34.5	
Progression Factor	1.00	1.00		0.94	0.96	0.95	1.22	0.42	0.09	1.17	0.72	
Incremental Delay, d2	20.6	10.7		166.5	0.7	10.0	82.6	75.8	0.1	129.3	38.0	
Delay (s)	80.5	61.3		220.8	39.4	54.4	160.0	91.8	2.2	199.6	62.7	
Level of Service	F	E		F	D	D	F	F	A	F	E	
Approach Delay (s)		67.6			121.6			85.5			79.0	
Approach LOS		E			F			F			E	

Intersection Summary			
HCM Average Control Delay	87.0	HCM Level of Service	F
HCM Volume to Capacity ratio	1.08		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	102.5%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Volume (veh/h)	70	359	65	197	562	54	39	185	100	47	163	62
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	76	390	71	214	611	59	42	201	109	51	177	67
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)		1042										
pX, platoon unblocked												
vC, conflicting volume	670			461			1467	1676	230	1625	1682	335
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	670			461			1467	1676	230	1625	1682	335
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	92			80			0	0	86	0	0	90
cM capacity (veh/h)	916			1097			0	70	772	0	69	661

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2
Volume Total	76	260	201	214	407	262	42	310	51	245
Volume Left	76	0	0	214	0	0	42	0	51	0
Volume Right	0	0	71	0	0	59	0	109	0	67
cSH	916	1700	1700	1097	1700	1700	0	102	0	92
Volume to Capacity	0.08	0.15	0.12	0.20	0.24	0.15	Err	3.03	Err	2.67
Queue Length 95th (ft)	7	0	0	18	0	0	Err	Err	Err	577
Control Delay (s)	9.3	0.0	0.0	9.1	0.0	0.0	Err	Err	Err	853.2
Lane LOS	A			A			F	F	F	F
Approach Delay (s)	1.3			2.2			Err		Err	
Approach LOS							F		F	

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	55.4%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	245	29	63	339	212	296	69	265	46	40	236	269
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	266	32	68	368	230	322	75	288	50	43	257	292
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)											654	
pX, platoon unblocked												
vC, conflicting volume	1221	978	274	762	1099	169	549			338		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1221	978	274	762	1099	169	549			338		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	86	91	0	0	62	93			96		
cM capacity (veh/h)	0	223	723	218	189	845	1017			1218		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	266	100	368	552	75	192	146	43	171	378
Volume Left	266	0	368	0	75	0	0	43	0	0
Volume Right	0	68	0	322	0	0	50	0	0	292
cSH	0	423	218	345	1017	1700	1700	1218	1700	1700
Volume to Capacity	Err	0.24	1.69	1.60	0.07	0.11	0.09	0.04	0.10	0.22
Queue Length 95th (ft)	Err	23	611	809	6	0	0	3	0	0
Control Delay (s)	Err	16.1	367.8	311.9	8.8	0.0	0.0	8.1	0.0	0.0
Lane LOS	F	C	F	F	A			A		
Approach Delay (s)	Err		334.3		1.6			0.6		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	75.2%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	1770	1583	1770	3539	3539	1583
Flt Permitted	0.95	1.00	0.11	1.00	1.00	1.00
Satd. Flow (perm)	1770	1583	210	3539	3539	1583
Volume (vph)	195	19	34	1299	1559	157
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	212	21	37	1412	1695	171
RTOR Reduction (vph)	0	6	0	0	0	21
Lane Group Flow (vph)	212	15	37	1412	1695	150
Turn Type		Perm	Perm			Perm
Protected Phases	4			2	6	
Permitted Phases		4	2			6
Actuated Green, G (s)	18.9	18.9	108.1	108.1	108.1	108.1
Effective Green, g (s)	18.9	18.9	108.1	108.1	108.1	108.1
Actuated g/C Ratio	0.14	0.14	0.80	0.80	0.80	0.80
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	248	222	168	2834	2834	1268
v/s Ratio Prot	c0.12			0.40	c0.48	
v/s Ratio Perm		0.01	0.18			0.09
v/c Ratio	0.85	0.07	0.22	0.50	0.60	0.12
Uniform Delay, d1	56.7	50.4	3.3	4.5	5.1	3.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	23.8	0.1	3.0	0.6	0.9	0.2
Delay (s)	80.5	50.5	6.3	5.1	6.1	3.2
Level of Service	F	D	A	A	A	A
Approach Delay (s)	77.8			5.1	5.8	
Approach LOS	E			A	A	

Intersection Summary			
HCM Average Control Delay	10.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	60.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.88	1.00	1.00	0.97	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	2787	1863	1583	3433	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	2787	1863	1583	3433	1863
Volume (vph)	237	1504	487	319	1397	309
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	258	1635	529	347	1518	336
RTOR Reduction (vph)	0	0	0	193	0	0
Lane Group Flow (vph)	258	1635	529	154	1518	336
Turn Type		Free		Over	Prot	
Protected Phases	8		2	8	1	6
Permitted Phases		Free				
Actuated Green, G (s)	20.0	135.0	41.6	20.0	61.4	107.0
Effective Green, g (s)	20.0	135.0	41.6	20.0	61.4	107.0
Actuated g/C Ratio	0.15	1.00	0.31	0.15	0.45	0.79
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	262	2787	574	235	1561	1477
v/s Ratio Prot	c0.15		c0.28	0.10	c0.44	0.18
v/s Ratio Perm		0.59				
v/c Ratio	0.98	0.59	0.92	0.66	0.97	0.23
Uniform Delay, d1	57.3	0.0	45.1	54.3	36.0	3.5
Progression Factor	1.00	1.00	0.97	0.95	1.00	1.00
Incremental Delay, d2	51.0	0.9	22.4	6.4	16.6	0.4
Delay (s)	108.3	0.9	65.9	58.1	52.6	3.9
Level of Service	F	A	E	E	D	A
Approach Delay (s)	15.5		62.8			43.7
Approach LOS	B		E			D

Intersection Summary			
HCM Average Control Delay	35.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.96		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	88.6%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	106	70	59	74	46	49	69	1795	129	86	1575	123
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	115	76	64	80	50	53	75	1951	140	93	1712	134
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	3170	4207	923	3316	4204	1046	1846			2091		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	3170	4207	923	3316	4204	1046	1846			2091		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	76	0	0	76	77			64		
cM capacity (veh/h)	0	1	272	0	1	225	325			261		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	115	140	80	103	75	1301	791	93	1141	704
Volume Left	115	0	80	0	75	0	0	93	0	0
Volume Right	0	64	0	53	0	0	140	0	0	134
cSH	0	2	0	2	325	1700	1700	261	1700	1700
Volume to Capacity	Err	76.01	Err	49.77	0.23	0.77	0.47	0.36	0.67	0.41
Queue Length 95th (ft)	Err	Err	Err	Err	22	0	0	39	0	0
Control Delay (s)	Err	Err	Err	Err	19.4	0.0	0.0	26.4	0.0	0.0
Lane LOS	F	F	F	F	C			D		
Approach Delay (s)	Err		Err		0.7			1.3		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	83.2%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	79	73	124	114	52	49	138	1611	186	80	1537	93
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	86	79	135	124	57	53	150	1751	202	87	1671	101
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	3152	4148	886	3336	4098	977	1772			1953		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	3152	4148	886	3336	4098	977	1772			1953		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	53	0	0	79	57			71		
cM capacity (veh/h)	0	1	288	0	1	250	347			295		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	86	214	124	110	150	1167	786	87	1114	658
Volume Left	86	0	124	0	150	0	0	87	0	0
Volume Right	0	135	0	53	0	0	202	0	0	101
cSH	0	2	0	2	347	1700	1700	295	1700	1700
Volume to Capacity	Err	89.05	Err	58.45	0.43	0.69	0.46	0.29	0.66	0.39
Queue Length 95th (ft)	Err	Err	Err	Err	53	0	0	30	0	0
Control Delay (s)	Err	Err	Err	Err	23.0	0.0	0.0	22.2	0.0	0.0
Lane LOS	F	F	F	F	C			C		
Approach Delay (s)	Err		Err		1.6			1.0		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	86.0%	ICU Level of Service	E
Analysis Period (min)	15		

CUMULATIVE PLUS PROJECT (2028) CONDITIONS WITH MITIGATIONS – CONCEPT 1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0		4.0	4.0
Lane Util. Factor	1.00		0.95		1.00	0.95
Frt	0.92		0.99		1.00	1.00
Flt Protected	0.98		1.00		0.95	1.00
Satd. Flow (prot)	1685		3514		1770	3539
Flt Permitted	0.98		1.00		0.17	1.00
Satd. Flow (perm)	1685		3514		323	3539
Volume (vph)	66	84	1299	65	52	1324
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	68	87	1339	67	54	1365
RTOR Reduction (vph)	43	0	1	0	0	0
Lane Group Flow (vph)	112	0	1405	0	54	1365
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	13.3		118.7		118.7	118.7
Effective Green, g (s)	13.3		118.7		118.7	118.7
Actuated g/C Ratio	0.10		0.85		0.85	0.85
Clearance Time (s)	4.0		4.0		4.0	4.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	160		2979		274	3001
v/s Ratio Prot	c0.07		c0.40			0.39
v/s Ratio Perm					0.17	
v/c Ratio	0.70		0.47		0.20	0.45
Uniform Delay, d1	61.4		2.7		1.9	2.6
Progression Factor	0.98		0.43		0.27	0.31
Incremental Delay, d2	13.0		0.5		1.3	0.4
Delay (s)	73.1		1.6		1.9	1.2
Level of Service	E		A		A	A
Approach Delay (s)	73.1		1.6			1.3
Approach LOS	E		A			A

Intersection Summary			
HCM Average Control Delay	5.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	58.7%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1711		1770	1863	1583	1770	3539	1583	1770	3522	
Flt Permitted	0.73	1.00		0.53	1.00	1.00	0.12	1.00	1.00	0.08	1.00	
Satd. Flow (perm)	1352	1711		983	1863	1583	223	3539	1583	154	3522	
Volume (vph)	19	50	60	102	46	116	53	1317	200	146	1280	44
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	20	53	63	107	48	122	56	1386	211	154	1347	46
RTOR Reduction (vph)	0	30	0	0	0	92	0	0	75	0	2	0
Lane Group Flow (vph)	20	86	0	107	48	30	56	1386	136	154	1391	0
Turn Type	pm+pt			pm+pt		Perm	pm+pt		Perm	pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8		8	2		2	6		
Actuated Green, G (s)	32.2	28.6		41.1	33.5	33.5	77.1	73.1	73.1	88.9	80.9	
Effective Green, g (s)	33.2	29.6		42.1	34.5	34.5	78.1	74.1	74.1	89.9	81.9	
Actuated g/C Ratio	0.24	0.21		0.30	0.25	0.25	0.56	0.53	0.53	0.64	0.59	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	331	362		343	459	390	169	1873	838	235	2060	
v/s Ratio Prot	0.00	0.05		c0.02	0.03		0.01	c0.39		c0.06	0.40	
v/s Ratio Perm	0.01			c0.07		0.02	0.18		0.09	0.37		
v/c Ratio	0.06	0.24		0.31	0.10	0.08	0.33	0.74	0.16	0.66	0.68	
Uniform Delay, d1	41.2	45.8		36.7	40.8	40.5	17.5	25.5	17.0	22.3	19.9	
Progression Factor	1.00	1.00		1.39	1.42	4.04	0.47	0.48	0.03	1.89	0.40	
Incremental Delay, d2	0.1	1.5		0.5	0.5	0.4	0.2	1.5	0.2	3.9	1.4	
Delay (s)	41.3	47.4		51.5	58.2	164.2	8.5	13.7	0.8	46.0	9.4	
Level of Service	D	D		D	E	F	A	B	A	D	A	
Approach Delay (s)		46.5			102.3			11.9			13.1	
Approach LOS		D			F			B			B	

Intersection Summary			
HCM Average Control Delay	20.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	66.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.98		1.00	0.91		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3508		1770	3472		1770	1696		1770	1774	
Flt Permitted	0.95	1.00		0.95	1.00		0.66	1.00		0.62	1.00	
Satd. Flow (perm)	1770	3508		1770	3472		1220	1696		1161	1774	
Volume (vph)	35	298	18	23	134	19	57	78	115	30	101	47
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	38	324	20	25	146	21	62	85	125	33	110	51
RTOR Reduction (vph)	0	4	0	0	11	0	0	14	0	0	5	0
Lane Group Flow (vph)	38	340	0	25	156	0	62	196	0	33	156	0
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	5.6	19.0		3.2	16.6		105.8	105.8		105.8	105.8	
Effective Green, g (s)	5.6	19.0		3.2	16.6		105.8	105.8		105.8	105.8	
Actuated g/C Ratio	0.04	0.14		0.02	0.12		0.76	0.76		0.76	0.76	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	71	476		40	412		922	1282		877	1341	
v/s Ratio Prot	c0.02	c0.10		0.01	0.05			c0.12			0.09	
v/s Ratio Perm							0.05			0.03		
v/c Ratio	0.54	0.71		0.62	0.38		0.07	0.15		0.04	0.12	
Uniform Delay, d1	65.9	57.9		67.8	56.9		4.4	4.7		4.3	4.6	
Progression Factor	1.05	1.14		1.21	0.85		1.00	1.00		1.00	1.00	
Incremental Delay, d2	7.2	4.8		26.6	0.6		0.1	0.3		0.1	0.2	
Delay (s)	76.4	70.6		108.6	48.9		4.5	5.0		4.4	4.8	
Level of Service	E	E		F	D		A	A		A	A	
Approach Delay (s)		71.2			56.7			4.9			4.7	
Approach LOS		E			E			A			A	

Intersection Summary			
HCM Average Control Delay	38.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.24		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	40.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.99		1.00	0.91		1.00	0.89		1.00	0.91	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1836		1770	1699		1770	3150		1770	3232	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1836		1770	1699		1770	3150		1770	3232	
Volume (vph)	123	149	16	40	25	35	14	87	239	209	75	104
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	134	162	17	43	27	38	15	95	260	227	82	113
RTOR Reduction (vph)	0	3	0	0	35	0	0	122	0	0	45	0
Lane Group Flow (vph)	134	176	0	43	30	0	15	233	0	227	150	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	15.7	17.8		7.6	9.7		14.1	74.3		24.3	84.5	
Effective Green, g (s)	15.7	17.8		7.6	9.7		14.1	74.3		24.3	84.5	
Actuated g/C Ratio	0.11	0.13		0.05	0.07		0.10	0.53		0.17	0.60	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	198	233		96	118		178	1672		307	1951	
v/s Ratio Prot	0.08	c0.10		c0.02	0.02		0.01	c0.07		c0.13	0.05	
v/s Ratio Perm												
v/c Ratio	0.68	0.75		0.45	0.25		0.08	0.14		0.74	0.08	
Uniform Delay, d1	59.7	59.0		64.2	61.7		57.1	16.6		54.8	11.5	
Progression Factor	1.00	1.00		1.00	1.00		0.60	0.09		0.91	0.27	
Incremental Delay, d2	8.8	12.9		3.3	1.1		0.2	0.2		8.9	0.1	
Delay (s)	68.5	71.9		67.5	62.8		34.7	1.7		58.8	3.2	
Level of Service	E	E		E	E		C	A		E	A	
Approach Delay (s)		70.4			64.7			3.1			33.2	
Approach LOS		E			E			A			C	

Intersection Summary			
HCM Average Control Delay	36.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	47.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.97		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1583		1770	1816		1770	3539		1770	3520	
Flt Permitted	0.75	1.00		0.73	1.00		0.20	1.00		0.23	1.00	
Satd. Flow (perm)	1397	1583		1359	1816		376	3539		430	3520	
Volume (vph)	69	0	39	3	9	2	24	1071	1	1	1137	43
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	75	0	42	3	10	2	26	1164	1	1	1236	47
RTOR Reduction (vph)	0	28	0	0	2	0	0	0	0	0	1	0
Lane Group Flow (vph)	75	14	0	3	10	0	26	1165	0	1	1282	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	11.6	11.6		11.6	11.6		120.4	120.4		120.4	120.4	
Effective Green, g (s)	11.6	11.6		11.6	11.6		120.4	120.4		120.4	120.4	
Actuated g/C Ratio	0.08	0.08		0.08	0.08		0.86	0.86		0.86	0.86	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	116	131		113	150		323	3044		370	3027	
v/s Ratio Prot		0.01			0.01			0.33			c0.36	
v/s Ratio Perm	c0.05			0.00			0.07			0.00		
v/c Ratio	0.65	0.11		0.03	0.07		0.08	0.38		0.00	0.42	
Uniform Delay, d1	62.2	59.4		59.0	59.2		1.5	2.0		1.4	2.2	
Progression Factor	1.12	1.29		1.00	1.00		0.99	0.97		0.91	0.91	
Incremental Delay, d2	9.9	0.3		0.1	0.2		0.5	0.4		0.0	0.4	
Delay (s)	79.6	76.9		59.1	59.4		1.9	2.4		1.3	2.4	
Level of Service	E	E		E	E		A	A		A	A	
Approach Delay (s)		78.6			59.3			2.3			2.4	
Approach LOS		E			E			A			A	

Intersection Summary			
HCM Average Control Delay	6.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	50.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.97		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1583		1770	1807		1770	3535		1770	3521	
Flt Permitted	0.75	1.00		0.57	1.00		0.22	1.00		0.23	1.00	
Satd. Flow (perm)	1393	1583		1065	1807		410	3535		437	3521	
Volume (vph)	48	0	67	27	11	3	56	1063	9	1	1086	40
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	52	0	73	29	12	3	61	1155	10	1	1180	43
RTOR Reduction (vph)	0	33	0	0	3	0	0	0	0	0	0	0
Lane Group Flow (vph)	52	40	0	29	12	0	61	1165	0	1	1223	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	8.1	8.1		8.1	8.1		123.9	123.9		123.9	123.9	
Effective Green, g (s)	8.1	8.1		8.1	8.1		123.9	123.9		123.9	123.9	
Actuated g/C Ratio	0.06	0.06		0.06	0.06		0.89	0.89		0.89	0.89	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	81	92		62	105		363	3128		387	3116	
v/s Ratio Prot		0.03			0.01			0.33			c0.35	
v/s Ratio Perm	c0.04			0.03			0.15			0.00		
v/c Ratio	0.64	0.44		0.47	0.12		0.17	0.37		0.00	0.39	
Uniform Delay, d1	64.5	63.7		63.9	62.6		1.1	1.4		0.9	1.4	
Progression Factor	1.01	1.35		1.00	1.00		1.01	0.78		1.00	1.00	
Incremental Delay, d2	11.8	2.3		5.5	0.5		0.9	0.3		0.0	0.4	
Delay (s)	77.1	88.4		69.3	63.0		2.0	1.4		0.9	1.8	
Level of Service	E	F		E	E		A	A		A	A	
Approach Delay (s)		83.7			67.2			1.4			1.8	
Approach LOS		F			E			A			A	

Intersection Summary			
HCM Average Control Delay	6.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	54.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0		4.0	4.0
Lane Util. Factor	1.00		0.95		1.00	0.95
Frt	0.94		0.99		1.00	1.00
Flt Protected	0.97		1.00		0.95	1.00
Satd. Flow (prot)	1708		3503		1770	3539
Flt Permitted	0.97		1.00		0.08	1.00
Satd. Flow (perm)	1708		3503		153	3539
Volume (vph)	54	39	1758	130	87	1705
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	57	41	1870	138	93	1814
RTOR Reduction (vph)	20	0	3	0	0	0
Lane Group Flow (vph)	78	0	2005	0	93	1814
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	11.2		115.8		115.8	115.8
Effective Green, g (s)	11.2		115.8		115.8	115.8
Actuated g/C Ratio	0.08		0.86		0.86	0.86
Clearance Time (s)	4.0		4.0		4.0	4.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	142		3005		131	3036
v/s Ratio Prot	c0.05		0.57			0.51
v/s Ratio Perm					c0.61	
v/c Ratio	0.55		0.67		0.71	0.60
Uniform Delay, d1	59.5		3.2		3.5	2.8
Progression Factor	0.94		2.34		2.65	2.83
Incremental Delay, d2	4.0		0.7		21.1	0.6
Delay (s)	60.1		8.1		30.4	8.6
Level of Service	E		A		C	A
Approach Delay (s)	60.1		8.1			9.6
Approach LOS	E		A			A

Intersection Summary			
HCM Average Control Delay	10.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.91		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1702		1770	1863	1583	1770	3539	1583	1770	3518	
Flt Permitted	0.71	1.00		0.24	1.00	1.00	0.06	1.00	1.00	0.06	1.00	
Satd. Flow (perm)	1323	1702		445	1863	1583	119	3539	1583	112	3518	
Volume (vph)	80	100	135	268	66	330	108	1431	211	199	1418	58
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	109	147	291	72	359	117	1555	229	216	1541	63
RTOR Reduction (vph)	0	36	0	0	0	137	0	0	82	0	2	0
Lane Group Flow (vph)	87	220	0	291	72	222	117	1555	147	216	1602	0
Turn Type	pm+pt			pm+pt		Perm	pm+pt		Perm	pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8		8	2		2	6		
Actuated Green, G (s)	30.0	25.0		46.0	37.0	37.0	69.1	61.6	61.6	79.0	67.5	
Effective Green, g (s)	31.0	26.0		47.0	38.0	38.0	70.1	62.6	62.6	80.0	68.5	
Actuated g/C Ratio	0.23	0.19		0.35	0.28	0.28	0.52	0.46	0.46	0.59	0.51	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	320	328		322	524	446	154	1641	734	231	1785	
v/s Ratio Prot	0.01	0.13		c0.11	0.04		0.04	0.44		c0.09	0.46	
v/s Ratio Perm	0.05			c0.20		0.14	0.35		0.09	c0.46		
v/c Ratio	0.27	0.67		0.90	0.14	0.50	0.76	0.95	0.20	0.94	0.90	
Uniform Delay, d1	42.1	50.5		36.3	36.3	40.5	28.0	34.6	21.4	43.8	30.1	
Progression Factor	1.00	1.00		1.76	1.58	2.29	1.68	0.45	0.10	1.46	0.57	
Incremental Delay, d2	0.5	10.4		26.2	0.5	3.7	8.7	7.1	0.3	30.6	5.1	
Delay (s)	42.6	60.9		89.9	57.9	96.6	55.7	22.6	2.3	94.6	22.3	
Level of Service	D	E		F	E	F	E	C	A	F	C	
Approach Delay (s)		56.3			90.0			22.2			30.9	
Approach LOS		E			F			C			C	

Intersection Summary			
HCM Average Control Delay	38.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	92.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.99		1.00	0.96		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3452		1770	3516		1770	1796		1770	1783	
Flt Permitted	0.95	1.00		0.95	1.00		0.58	1.00		0.58	1.00	
Satd. Flow (perm)	1770	3452		1770	3516		1084	1796		1086	1783	
Volume (vph)	65	315	62	146	496	23	37	156	49	15	147	59
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	71	342	67	159	539	25	40	170	53	16	160	64
RTOR Reduction (vph)	0	13	0	0	3	0	0	5	0	0	7	0
Lane Group Flow (vph)	71	396	0	159	561	0	40	218	0	16	217	0
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	9.1	32.5		15.0	38.4		75.5	75.5		75.5	75.5	
Effective Green, g (s)	9.1	32.5		15.0	38.4		75.5	75.5		75.5	75.5	
Actuated g/C Ratio	0.07	0.24		0.11	0.28		0.56	0.56		0.56	0.56	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	119	831		197	1000		606	1004		607	997	
v/s Ratio Prot	0.04	0.11		c0.09	c0.16			0.12			c0.12	
v/s Ratio Perm							0.04			0.01		
v/c Ratio	0.60	0.48		0.81	0.56		0.07	0.22		0.03	0.22	
Uniform Delay, d1	61.2	44.0		58.6	41.1		13.6	14.9		13.3	14.9	
Progression Factor	1.05	1.05		1.25	0.85		1.00	1.00		1.00	1.00	
Incremental Delay, d2	6.3	0.3		20.5	0.7		0.2	0.5		0.1	0.5	
Delay (s)	70.8	46.4		93.9	35.8		13.8	15.4		13.4	15.4	
Level of Service	E	D		F	D		B	B		B	B	
Approach Delay (s)		50.0			48.6			15.2			15.3	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	39.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	46.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.94		1.00	0.91		1.00	0.93		1.00	0.90	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1760		1770	1700		1770	3288		1770	3199	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1760		1770	1700		1770	3288		1770	3199	
Volume (vph)	227	55	32	315	197	276	32	99	89	78	128	228
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	247	60	35	342	214	300	35	108	97	85	139	248
RTOR Reduction (vph)	0	22	0	0	44	0	0	67	0	0	157	0
Lane Group Flow (vph)	247	73	0	342	470	0	35	138	0	85	230	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	23.5	10.2		54.0	40.7		5.2	41.4		13.4	49.6	
Effective Green, g (s)	23.5	10.2		54.0	40.7		5.2	41.4		13.4	49.6	
Actuated g/C Ratio	0.17	0.08		0.40	0.30		0.04	0.31		0.10	0.37	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	308	133		708	513		68	1008		176	1175	
v/s Ratio Prot	c0.14	0.04		0.19	c0.28		c0.02	0.04		c0.05	c0.07	
v/s Ratio Perm												
v/c Ratio	0.80	0.55		0.48	0.92		0.51	0.14		0.48	0.20	
Uniform Delay, d1	53.5	60.2		30.1	45.5		63.7	33.9		57.5	29.1	
Progression Factor	1.00	1.00		1.00	1.00		0.55	0.35		1.00	1.00	
Incremental Delay, d2	13.9	4.5		0.5	21.1		6.1	0.3		2.1	0.4	
Delay (s)	67.4	64.7		30.6	66.6		40.9	12.1		59.6	29.5	
Level of Service	E	E		C	E		D	B		E	C	
Approach Delay (s)		66.7			52.2			16.3			34.9	
Approach LOS		E			D			B			C	

Intersection Summary			
HCM Average Control Delay	46.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	67.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.98		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1583		1770	1828		1770	3538		1770	3520	
Flt Permitted	0.75	1.00		0.74	1.00		0.14	1.00		0.13	1.00	
Satd. Flow (perm)	1402	1583		1385	1828		261	3538		238	3520	
Volume (vph)	35	0	19	2	6	1	30	1575	3	2	1453	53
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	38	0	21	2	7	1	33	1712	3	2	1579	58
RTOR Reduction (vph)	0	10	0	0	1	0	0	0	0	0	0	0
Lane Group Flow (vph)	38	11	0	2	7	0	33	1715	0	2	1637	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	5.8	5.8		5.8	5.8		121.2	121.2		121.2	121.2	
Effective Green, g (s)	5.8	5.8		5.8	5.8		121.2	121.2		121.2	121.2	
Actuated g/C Ratio	0.04	0.04		0.04	0.04		0.90	0.90		0.90	0.90	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	60	68		60	79		234	3176		214	3160	
v/s Ratio Prot		0.01			0.00			c0.48			0.46	
v/s Ratio Perm	c0.03			0.00			0.13			0.01		
v/c Ratio	0.63	0.17		0.03	0.09		0.14	0.54		0.01	0.52	
Uniform Delay, d1	63.6	62.3		61.9	62.1		0.8	1.4		0.7	1.3	
Progression Factor	0.97	0.98		1.00	1.00		1.00	1.00		0.89	0.82	
Incremental Delay, d2	13.0	0.7		0.2	0.5		1.3	0.7		0.1	0.5	
Delay (s)	74.5	61.5		62.1	62.6		2.1	2.0		0.7	1.6	
Level of Service	E	E		E	E		A	A		A	A	
Approach Delay (s)		69.9			62.5			2.0			1.6	
Approach LOS		E			E			A			A	

Intersection Summary			
HCM Average Control Delay	3.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	58.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.97		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1583		1770	1807		1770	3528		1770	3503	
Flt Permitted	0.75	1.00		0.40	1.00		0.14	1.00		0.13	1.00	
Satd. Flow (perm)	1399	1583		737	1807		255	3528		250	3503	
Volume (vph)	98	0	137	18	7	2	137	1428	30	3	1345	98
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	107	0	149	20	8	2	149	1552	33	3	1462	107
RTOR Reduction (vph)	0	13	0	0	2	0	0	0	0	0	1	0
Lane Group Flow (vph)	107	136	0	20	8	0	149	1585	0	3	1568	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	16.6	16.6		16.6	16.6		110.4	110.4		110.4	110.4	
Effective Green, g (s)	16.6	16.6		16.6	16.6		110.4	110.4		110.4	110.4	
Actuated g/C Ratio	0.12	0.12		0.12	0.12		0.82	0.82		0.82	0.82	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	172	195		91	222		209	2885		204	2865	
v/s Ratio Prot		c0.09			0.00			0.45			0.45	
v/s Ratio Perm	0.08			0.03			c0.58			0.01		
v/c Ratio	0.62	0.70		0.22	0.04		0.71	0.55		0.01	0.55	
Uniform Delay, d1	56.2	56.8		53.4	52.2		5.4	4.1		2.3	4.1	
Progression Factor	1.26	1.31		1.00	1.00		0.88	0.95		1.00	1.00	
Incremental Delay, d2	3.4	5.2		1.2	0.1		16.5	0.7		0.1	0.8	
Delay (s)	74.2	79.6		54.6	52.2		21.2	4.5		2.4	4.8	
Level of Service	E	E		D	D		C	A		A	A	
Approach Delay (s)		77.3			53.8			5.9			4.8	
Approach LOS		E			D			A			A	

Intersection Summary			
HCM Average Control Delay	10.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	72.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

CUMULATIVE PLUS PROJECT (2028) CONDITIONS WITH MITIGATIONS – CONCEPT 2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0		4.0	4.0
Lane Util. Factor	1.00		0.95		1.00	0.95
Frt	0.93		0.99		1.00	1.00
Flt Protected	0.98		1.00		0.95	1.00
Satd. Flow (prot)	1689		3513		1770	3539
Flt Permitted	0.98		1.00		0.17	1.00
Satd. Flow (perm)	1689		3513		314	3539
Volume (vph)	82	95	1302	67	54	1344
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	85	98	1342	69	56	1386
RTOR Reduction (vph)	38	0	1	0	0	0
Lane Group Flow (vph)	145	0	1410	0	56	1386
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	16.2		115.8		115.8	115.8
Effective Green, g (s)	16.2		115.8		115.8	115.8
Actuated g/C Ratio	0.12		0.83		0.83	0.83
Clearance Time (s)	4.0		4.0		4.0	4.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	195		2906		260	2927
v/s Ratio Prot	c0.09		c0.40			0.39
v/s Ratio Perm					0.18	
v/c Ratio	0.74		0.49		0.22	0.47
Uniform Delay, d1	59.9		3.5		2.5	3.4
Progression Factor	0.97		0.47		0.34	0.45
Incremental Delay, d2	14.1		0.5		1.6	0.5
Delay (s)	72.4		2.1		2.4	2.0
Level of Service	E		A		A	A
Approach Delay (s)	72.4		2.1			2.0
Approach LOS	E		A			A

Intersection Summary			
HCM Average Control Delay	6.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	61.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1714		1770	1863	1583	1770	3539	1583	1770	3522	
Flt Permitted	0.72	1.00		0.52	1.00	1.00	0.11	1.00	1.00	0.08	1.00	
Satd. Flow (perm)	1337	1714		965	1863	1583	214	3539	1583	153	3522	
Volume (vph)	19	52	60	119	57	122	53	1320	202	147	1299	44
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	20	55	63	125	60	128	56	1389	213	155	1367	46
RTOR Reduction (vph)	0	29	0	0	0	96	0	0	77	0	2	0
Lane Group Flow (vph)	20	89	0	125	60	32	56	1389	136	155	1411	0
Turn Type	pm+pt			pm+pt		Perm	pm+pt		Perm	pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8		8	2		2	6		
Actuated Green, G (s)	30.6	27.6		41.1	34.1	34.1	77.2	73.2	73.2	88.9	80.9	
Effective Green, g (s)	31.6	28.6		42.1	35.1	35.1	78.2	74.2	74.2	89.9	81.9	
Actuated g/C Ratio	0.23	0.20		0.30	0.25	0.25	0.56	0.53	0.53	0.64	0.59	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	311	350		345	467	397	164	1876	839	233	2060	
v/s Ratio Prot	0.00	0.05		c0.02	0.03		0.01	c0.39		c0.06	0.40	
v/s Ratio Perm	0.01			c0.08		0.02	0.18		0.09	0.37		
v/c Ratio	0.06	0.26		0.36	0.13	0.08	0.34	0.74	0.16	0.67	0.69	
Uniform Delay, d1	42.4	46.8		37.1	40.6	40.1	17.7	25.4	16.9	22.8	20.1	
Progression Factor	1.00	1.00		1.44	1.42	4.38	0.52	0.47	0.03	1.92	0.41	
Incremental Delay, d2	0.1	1.8		0.6	0.6	0.4	0.2	1.4	0.2	4.3	1.5	
Delay (s)	42.5	48.5		54.0	58.3	176.1	9.4	13.3	0.8	48.1	9.7	
Level of Service	D	D		D	E	F	A	B	A	D	A	
Approach Delay (s)		47.6			104.8			11.6			13.5	
Approach LOS		D			F			B			B	

Intersection Summary			
HCM Average Control Delay	21.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	67.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.98		1.00	0.91		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3509		1770	3475		1770	1702		1770	1774	
Flt Permitted	0.95	1.00		0.95	1.00		0.61	1.00		0.62	1.00	
Satd. Flow (perm)	1770	3509		1770	3475		1137	1702		1149	1774	
Volume (vph)	38	301	18	23	147	20	57	85	115	39	142	66
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	41	327	20	25	160	22	62	92	125	42	154	72
RTOR Reduction (vph)	0	4	0	0	10	0	0	14	0	0	5	0
Lane Group Flow (vph)	41	343	0	25	172	0	62	203	0	42	221	0
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	7.2	20.7		3.2	16.7		104.1	104.1		104.1	104.1	
Effective Green, g (s)	7.2	20.7		3.2	16.7		104.1	104.1		104.1	104.1	
Actuated g/C Ratio	0.05	0.15		0.02	0.12		0.74	0.74		0.74	0.74	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	91	519		40	415		845	1266		854	1319	
v/s Ratio Prot	c0.02	c0.10		0.01	0.05			0.12			c0.12	
v/s Ratio Perm							0.05			0.04		
v/c Ratio	0.45	0.66		0.62	0.42		0.07	0.16		0.05	0.17	
Uniform Delay, d1	64.5	56.3		67.8	57.1		4.9	5.2		4.8	5.3	
Progression Factor	1.09	1.18		1.07	0.88		1.00	1.00		1.00	1.00	
Incremental Delay, d2	3.4	3.0		26.6	0.7		0.2	0.3		0.1	0.3	
Delay (s)	73.7	69.5		98.9	51.1		5.0	5.5		4.9	5.5	
Level of Service	E	E		F	D		A	A		A	A	
Approach Delay (s)		70.0			56.9			5.4			5.4	
Approach LOS		E			E			A			A	

Intersection Summary			
HCM Average Control Delay	36.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.26		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	40.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.98		1.00	0.91		1.00	0.89		1.00	0.91	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1823		1770	1699		1770	3161		1770	3228	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1823		1770	1699		1770	3161		1770	3228	
Volume (vph)	186	149	25	40	25	35	16	97	239	209	81	115
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	202	162	27	43	27	38	17	105	260	227	88	125
RTOR Reduction (vph)	0	5	0	0	36	0	0	126	0	0	53	0
Lane Group Flow (vph)	202	184	0	43	29	0	17	239	0	227	160	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	20.4	18.5		8.8	6.9		16.2	72.2		24.5	80.5	
Effective Green, g (s)	20.4	18.5		8.8	6.9		16.2	72.2		24.5	80.5	
Actuated g/C Ratio	0.15	0.13		0.06	0.05		0.12	0.52		0.18	0.58	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	258	241		111	84		205	1630		310	1856	
v/s Ratio Prot	c0.11	0.10		c0.02	0.02		0.01	c0.08		c0.13	0.05	
v/s Ratio Perm												
v/c Ratio	0.78	0.76		0.39	0.34		0.08	0.15		0.73	0.09	
Uniform Delay, d1	57.7	58.6		63.0	64.4		55.3	17.8		54.6	13.3	
Progression Factor	1.00	1.00		1.00	1.00		0.50	0.17		0.87	0.48	
Incremental Delay, d2	14.3	13.3		2.2	2.4		0.2	0.2		8.5	0.1	
Delay (s)	72.0	71.9		65.2	66.8		27.9	3.2		56.1	6.4	
Level of Service	E	E		E	E		C	A		E	A	
Approach Delay (s)		72.0			66.2			4.3			32.0	
Approach LOS		E			E			A			C	

Intersection Summary			
HCM Average Control Delay	38.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	49.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.97		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1583		1770	1816		1770	3539		1770	3519	
Flt Permitted	0.75	1.00		0.72	1.00		0.19	1.00		0.21	1.00	
Satd. Flow (perm)	1397	1583		1345	1816		352	3539		397	3519	
Volume (vph)	90	0	50	3	9	2	26	1119	1	1	1170	46
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	98	0	54	3	10	2	28	1216	1	1	1272	50
RTOR Reduction (vph)	0	24	0	0	2	0	0	0	0	0	1	0
Lane Group Flow (vph)	98	30	0	3	10	0	28	1217	0	1	1321	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	15.2	15.2		15.2	15.2		116.8	116.8		116.8	116.8	
Effective Green, g (s)	15.2	15.2		15.2	15.2		116.8	116.8		116.8	116.8	
Actuated g/C Ratio	0.11	0.11		0.11	0.11		0.83	0.83		0.83	0.83	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	152	172		146	197		294	2953		331	2936	
v/s Ratio Prot		0.02			0.01			0.34			c0.38	
v/s Ratio Perm	c0.07			0.00			0.08			0.00		
v/c Ratio	0.64	0.17		0.02	0.05		0.10	0.41		0.00	0.45	
Uniform Delay, d1	59.8	56.7		55.7	55.9		2.1	2.9		1.9	3.1	
Progression Factor	1.10	1.18		1.00	1.00		1.05	1.04		0.90	0.88	
Incremental Delay, d2	8.2	0.4		0.1	0.1		0.6	0.4		0.0	0.5	
Delay (s)	74.1	67.6		55.8	56.1		2.8	3.5		1.7	3.2	
Level of Service	E	E		E	E		A	A		A	A	
Approach Delay (s)		71.8			56.0			3.5			3.2	
Approach LOS		E			E			A			A	

Intersection Summary			
HCM Average Control Delay	7.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	52.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.97		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1583		1770	1807		1770	3535		1770	3519	
Flt Permitted	0.75	1.00		0.47	1.00		0.21	1.00		0.21	1.00	
Satd. Flow (perm)	1393	1583		881	1807		396	3535		398	3519	
Volume (vph)	66	0	93	27	11	3	60	1126	9	1	1097	43
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	72	0	101	29	12	3	65	1224	10	1	1192	47
RTOR Reduction (vph)	0	31	0	0	3	0	0	0	0	0	1	0
Lane Group Flow (vph)	72	70	0	29	12	0	65	1234	0	1	1238	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	11.5	11.5		11.5	11.5		120.5	120.5		120.5	120.5	
Effective Green, g (s)	11.5	11.5		11.5	11.5		120.5	120.5		120.5	120.5	
Actuated g/C Ratio	0.08	0.08		0.08	0.08		0.86	0.86		0.86	0.86	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	114	130		72	148		341	3043		343	3029	
v/s Ratio Prot		0.04			0.01			0.35			c0.35	
v/s Ratio Perm	c0.05			0.03			0.16			0.00		
v/c Ratio	0.63	0.54		0.40	0.08		0.19	0.41		0.00	0.41	
Uniform Delay, d1	62.2	61.7		61.0	59.4		1.6	2.1		1.4	2.1	
Progression Factor	1.06	1.31		1.00	1.00		1.00	0.75		1.00	1.00	
Incremental Delay, d2	7.7	3.0		3.7	0.2		1.2	0.4		0.0	0.4	
Delay (s)	73.5	84.0		64.6	59.6		2.8	1.9		1.4	2.5	
Level of Service	E	F		E	E		A	A		A	A	
Approach Delay (s)		79.6			62.9			2.0			2.5	
Approach LOS		E			E			A			A	

Intersection Summary			
HCM Average Control Delay	8.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0		4.0	4.0
Lane Util. Factor	1.00		0.95		1.00	0.95
Frt	0.94		0.99		1.00	1.00
Flt Protected	0.97		1.00		0.95	1.00
Satd. Flow (prot)	1707		3500		1770	3539
Flt Permitted	0.97		1.00		0.08	1.00
Satd. Flow (perm)	1707		3500		145	3539
Volume (vph)	59	43	1774	142	95	1713
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	63	46	1887	151	101	1822
RTOR Reduction (vph)	20	0	4	0	0	0
Lane Group Flow (vph)	89	0	2034	0	101	1822
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	11.8		115.2		115.2	115.2
Effective Green, g (s)	11.8		115.2		115.2	115.2
Actuated g/C Ratio	0.09		0.85		0.85	0.85
Clearance Time (s)	4.0		4.0		4.0	4.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	149		2987		124	3020
v/s Ratio Prot	c0.05		0.58			0.51
v/s Ratio Perm					c0.70	
v/c Ratio	0.60		0.68		0.81	0.60
Uniform Delay, d1	59.3		3.5		4.8	3.0
Progression Factor	0.91		2.37		2.67	2.76
Incremental Delay, d2	5.7		0.7		32.9	0.7
Delay (s)	59.7		8.9		45.6	8.9
Level of Service	E		A		D	A
Approach Delay (s)	59.7		8.9			10.8
Approach LOS	E		A			B

Intersection Summary			
HCM Average Control Delay	11.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	74.7%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1708		1770	1863	1583	1770	3539	1583	1770	3518	
Flt Permitted	0.71	1.00		0.22	1.00	1.00	0.06	1.00	1.00	0.06	1.00	
Satd. Flow (perm)	1318	1708		414	1863	1583	118	3539	1583	111	3518	
Volume (vph)	80	109	135	275	70	332	108	1446	224	204	1425	58
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	118	147	299	76	361	117	1572	243	222	1549	63
RTOR Reduction (vph)	0	33	0	0	0	127	0	0	86	0	2	0
Lane Group Flow (vph)	87	232	0	299	76	234	117	1572	157	222	1610	0
Turn Type	pm+pt			pm+pt		Perm	pm+pt		Perm	pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8		8	2		2	6		
Actuated Green, G (s)	30.0	25.0		46.0	37.0	37.0	68.0	62.0	62.0	79.0	69.0	
Effective Green, g (s)	31.0	26.0		47.0	38.0	38.0	69.0	63.0	63.0	80.0	70.0	
Actuated g/C Ratio	0.23	0.19		0.35	0.28	0.28	0.51	0.47	0.47	0.59	0.52	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	319	329		315	524	446	134	1652	739	226	1824	
v/s Ratio Prot	0.01	0.14		c0.12	0.04		0.04	0.44		c0.09	0.46	
v/s Ratio Perm	0.05			c0.21		0.15	0.41		0.10	c0.49		
v/c Ratio	0.27	0.70		0.95	0.15	0.52	0.87	0.95	0.21	0.98	0.88	
Uniform Delay, d1	42.1	50.9		37.2	36.3	40.9	28.2	34.5	21.3	44.9	28.9	
Progression Factor	1.00	1.00		1.72	1.54	2.31	1.74	0.47	0.09	1.46	0.55	
Incremental Delay, d2	0.5	12.0		35.6	0.5	4.1	22.7	7.2	0.3	42.3	4.3	
Delay (s)	42.6	62.9		99.3	56.4	98.7	71.9	23.4	2.3	108.0	20.2	
Level of Service	D	E		F	E	F	E	C	A	F	C	
Approach Delay (s)		57.9			94.6			23.7			30.8	
Approach LOS		E			F			C			C	

Intersection Summary			
HCM Average Control Delay	39.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	93.8%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.99		1.00	0.97		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3455		1770	3509		1770	1806		1770	1781	
Flt Permitted	0.95	1.00		0.95	1.00		0.56	1.00		0.55	1.00	
Satd. Flow (perm)	1770	3455		1770	3509		1035	1806		1018	1781	
Volume (vph)	81	326	62	146	501	30	37	190	49	18	163	67
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	88	354	67	159	545	33	40	207	53	20	177	73
RTOR Reduction (vph)	0	12	0	0	4	0	0	5	0	0	8	0
Lane Group Flow (vph)	88	409	0	159	574	0	40	255	0	20	242	0
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	11.3	33.9		15.5	38.1		73.6	73.6		73.6	73.6	
Effective Green, g (s)	11.3	33.9		15.5	38.1		73.6	73.6		73.6	73.6	
Actuated g/C Ratio	0.08	0.25		0.11	0.28		0.55	0.55		0.55	0.55	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	148	868		203	990		564	985		555	971	
v/s Ratio Prot	0.05	0.12		c0.09	c0.16			c0.14			0.14	
v/s Ratio Perm							0.04			0.02		
v/c Ratio	0.59	0.47		0.78	0.58		0.07	0.26		0.04	0.25	
Uniform Delay, d1	59.6	42.9		58.1	41.6		14.5	16.3		14.2	16.2	
Progression Factor	1.10	0.98		1.24	0.77		1.00	1.00		1.00	1.00	
Incremental Delay, d2	4.8	0.3		17.2	0.8		0.2	0.6		0.1	0.6	
Delay (s)	70.4	42.5		89.5	32.7		14.8	16.9		14.4	16.8	
Level of Service	E	D		F	C		B	B		B	B	
Approach Delay (s)		47.4			44.9			16.6			16.6	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	36.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	48.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.94		1.00	0.91		1.00	0.93		1.00	0.90	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1753		1770	1700		1770	3295		1770	3183	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1753		1770	1700		1770	3295		1770	3183	
Volume (vph)	253	55	36	315	197	276	39	105	89	78	137	279
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	275	60	39	342	214	300	42	114	97	85	149	303
RTOR Reduction (vph)	0	25	0	0	43	0	0	68	0	0	196	0
Lane Group Flow (vph)	275	74	0	342	471	0	42	143	0	85	256	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	25.3	10.2		55.8	40.7		5.5	39.7		13.3	47.5	
Effective Green, g (s)	25.3	10.2		55.8	40.7		5.5	39.7		13.3	47.5	
Actuated g/C Ratio	0.19	0.08		0.41	0.30		0.04	0.29		0.10	0.35	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	332	132		732	513		72	969		174	1120	
v/s Ratio Prot	c0.16	0.04		0.19	c0.28		c0.02	0.04		c0.05	c0.08	
v/s Ratio Perm												
v/c Ratio	0.83	0.56		0.47	0.92		0.58	0.15		0.49	0.23	
Uniform Delay, d1	52.8	60.2		28.8	45.5		63.6	35.2		57.6	30.8	
Progression Factor	1.00	1.00		1.00	1.00		0.59	0.39		1.00	1.00	
Incremental Delay, d2	15.5	5.4		0.5	21.2		10.9	0.3		2.2	0.5	
Delay (s)	68.3	65.6		29.3	66.8		48.6	13.9		59.8	31.3	
Level of Service	E	E		C	E		D	B		E	C	
Approach Delay (s)		67.6			51.8			19.7			35.8	
Approach LOS		E			D			B			D	

Intersection Summary			
HCM Average Control Delay	46.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	70.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.98		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1583		1770	1828		1770	3538		1770	3516	
Flt Permitted	0.75	1.00		0.74	1.00		0.13	1.00		0.12	1.00	
Satd. Flow (perm)	1402	1583		1380	1828		237	3538		223	3516	
Volume (vph)	42	0	23	2	6	1	39	1613	3	2	1499	69
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	46	0	25	2	7	1	42	1753	3	2	1629	75
RTOR Reduction (vph)	0	8	0	0	1	0	0	0	0	0	1	0
Lane Group Flow (vph)	46	17	0	2	7	0	42	1756	0	2	1703	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	7.6	7.6		7.6	7.6		119.4	119.4		119.4	119.4	
Effective Green, g (s)	7.6	7.6		7.6	7.6		119.4	119.4		119.4	119.4	
Actuated g/C Ratio	0.06	0.06		0.06	0.06		0.88	0.88		0.88	0.88	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	79	89		78	103		210	3129		197	3110	
v/s Ratio Prot		0.01			0.00			c0.50			0.48	
v/s Ratio Perm	c0.03			0.00			0.18			0.01		
v/c Ratio	0.58	0.19		0.03	0.07		0.20	0.56		0.01	0.55	
Uniform Delay, d1	62.2	60.7		60.2	60.3		1.1	1.8		0.9	1.7	
Progression Factor	0.96	0.97		1.00	1.00		1.00	1.00		0.90	0.81	
Incremental Delay, d2	6.6	0.6		0.1	0.3		2.1	0.7		0.1	0.6	
Delay (s)	66.4	59.4		60.3	60.6		3.2	2.5		0.9	2.0	
Level of Service	E	E		E	E		A	A		A	A	
Approach Delay (s)		64.0			60.6			2.5			2.0	
Approach LOS		E			E			A			A	

Intersection Summary			
HCM Average Control Delay	3.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	60.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.97		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1583		1770	1807		1770	3528		1770	3500	
Flt Permitted	0.75	1.00		0.38	1.00		0.12	1.00		0.13	1.00	
Satd. Flow (perm)	1399	1583		707	1807		230	3528		239	3500	
Volume (vph)	105	0	146	18	7	2	157	1453	30	3	1397	112
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	114	0	159	20	8	2	171	1579	33	3	1518	122
RTOR Reduction (vph)	0	11	0	0	2	0	0	0	0	0	2	0
Lane Group Flow (vph)	114	148	0	20	8	0	171	1612	0	3	1638	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	17.5	17.5		17.5	17.5		109.5	109.5		109.5	109.5	
Effective Green, g (s)	17.5	17.5		17.5	17.5		109.5	109.5		109.5	109.5	
Actuated g/C Ratio	0.13	0.13		0.13	0.13		0.81	0.81		0.81	0.81	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	181	205		92	234		187	2862		194	2839	
v/s Ratio Prot		c0.09			0.00			0.46			0.47	
v/s Ratio Perm	0.08			0.03			c0.74			0.01		
v/c Ratio	0.63	0.72		0.22	0.04		0.91	0.56		0.02	0.58	
Uniform Delay, d1	55.7	56.4		52.6	51.4		9.3	4.4		2.4	4.5	
Progression Factor	1.28	1.31		1.00	1.00		0.87	0.93		1.00	1.00	
Incremental Delay, d2	3.0	5.4		1.2	0.1		41.9	0.7		0.1	0.9	
Delay (s)	74.0	79.3		53.8	51.4		50.0	4.8		2.6	5.4	
Level of Service	E	E		D	D		D	A		A	A	
Approach Delay (s)		77.1			53.0			9.2			5.4	
Approach LOS		E			D			A			A	

Intersection Summary			
HCM Average Control Delay	12.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	75.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

CUMULATIVE PLUS PROJECT (2028) CONDITIONS WITH MITIGATIONS – CONCEPT 3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0		4.0	4.0
Lane Util. Factor	1.00		0.95		1.00	0.95
Frt	0.92		0.99		1.00	1.00
Flt Protected	0.98		1.00		0.95	1.00
Satd. Flow (prot)	1681		3513		1770	3539
Flt Permitted	0.98		1.00		0.16	1.00
Satd. Flow (perm)	1681		3513		297	3539
Volume (vph)	74	103	1350	71	69	1386
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	76	106	1392	73	71	1429
RTOR Reduction (vph)	44	0	1	0	0	0
Lane Group Flow (vph)	138	0	1464	0	71	1429
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	14.9		117.1		117.1	117.1
Effective Green, g (s)	14.9		117.1		117.1	117.1
Actuated g/C Ratio	0.11		0.84		0.84	0.84
Clearance Time (s)	4.0		4.0		4.0	4.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	179		2938		248	2960
v/s Ratio Prot	c0.08		c0.42			0.40
v/s Ratio Perm					0.24	
v/c Ratio	0.77		0.50		0.29	0.48
Uniform Delay, d1	60.9		3.2		2.5	3.1
Progression Factor	0.91		0.52		0.38	0.30
Incremental Delay, d2	17.7		0.5		2.3	0.5
Delay (s)	73.3		2.2		3.3	1.4
Level of Service	E		A		A	A
Approach Delay (s)	73.3		2.2			1.5
Approach LOS	E		A			A

Intersection Summary			
HCM Average Control Delay	6.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	63.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.93		1.00	0.89		1.00	0.98		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1730		1770	1660		1770	3479		1770	3504	
Flt Permitted	0.51	1.00		0.66	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	956	1730		1229	1660		1770	3479		1770	3504	
Volume (vph)	135	42	39	218	39	102	27	1175	149	56	1307	92
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	144	45	41	232	41	109	29	1250	159	60	1390	98
RTOR Reduction (vph)	0	23	0	0	68	0	0	7	0	0	3	0
Lane Group Flow (vph)	144	63	0	232	82	0	29	1402	0	60	1485	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	26.7	26.7		26.7	26.7		3.0	94.3		5.0	96.3	
Effective Green, g (s)	27.7	27.7		27.7	27.7		3.0	95.3		5.0	97.3	
Actuated g/C Ratio	0.20	0.20		0.20	0.20		0.02	0.68		0.04	0.69	
Clearance Time (s)	5.0	5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)	189	342		243	328		38	2368		63	2435	
v/s Ratio Prot		0.04			0.05		0.02	0.40		c0.03	c0.42	
v/s Ratio Perm	0.15			c0.19								
v/c Ratio	0.76	0.18		0.95	0.25		0.76	0.59		0.95	0.61	
Uniform Delay, d1	53.0	46.7		55.5	47.4		68.1	12.0		67.4	11.3	
Progression Factor	1.00	1.00		1.00	1.00		0.89	0.43		1.23	0.87	
Incremental Delay, d2	16.5	0.3		44.9	0.4		43.2	0.8		90.0	1.0	
Delay (s)	69.5	47.0		100.4	47.8		103.9	5.9		172.9	10.8	
Level of Service	E	D		F	D		F	A		F	B	
Approach Delay (s)		61.1			79.7			7.9			17.1	
Approach LOS		E			E			A			B	

Intersection Summary			
HCM Average Control Delay	22.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	73.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1710		1770	1863	1583	1770	3539	1583	1770	3523	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	1710		1770	1863	1583	1770	3539	1583	1770	3523	
Volume (vph)	19	49	60	112	51	134	53	1363	221	169	1359	44
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	20	52	63	118	54	141	56	1435	233	178	1431	46
RTOR Reduction (vph)	0	31	0	0	0	107	0	0	90	0	2	0
Lane Group Flow (vph)	20	84	0	118	54	34	56	1435	143	178	1475	0
Turn Type	Prot			Prot		Perm	Prot		Perm	Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	3.6	26.6		10.0	33.0	33.0	7.2	74.4	74.4	11.0	78.2	
Effective Green, g (s)	3.6	27.6		10.0	34.0	34.0	7.2	75.4	75.4	11.0	79.2	
Actuated g/C Ratio	0.03	0.20		0.07	0.24	0.24	0.05	0.54	0.54	0.08	0.57	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	46	337		126	452	384	91	1906	853	139	1993	
v/s Ratio Prot	0.01	c0.05		c0.07	0.03		0.03	0.41		c0.10	c0.42	
v/s Ratio Perm						0.02			0.09			
v/c Ratio	0.43	0.25		0.94	0.12	0.09	0.62	0.75	0.17	1.28	0.74	
Uniform Delay, d1	67.2	47.5		64.7	41.3	41.0	65.0	25.1	16.4	64.5	22.7	
Progression Factor	1.00	1.00		1.13	1.45	4.61	1.39	0.44	0.08	1.25	0.53	
Incremental Delay, d2	6.5	1.8		60.0	0.5	0.5	4.1	1.4	0.2	161.6	1.9	
Delay (s)	73.7	49.2		133.1	60.3	189.4	94.8	12.4	1.5	242.5	13.9	
Level of Service	E	D		F	E	F	F	B	A	F	B	
Approach Delay (s)		52.9			145.9			13.6			38.5	
Approach LOS		D			F			B			D	

Intersection Summary			
HCM Average Control Delay	36.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	69.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.97		1.00	0.91		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3512		1770	3449		1770	1691		1770	1783	
Flt Permitted	0.95	1.00		0.95	1.00		0.63	1.00		0.60	1.00	
Satd. Flow (perm)	1770	3512		1770	3449		1170	1691		1118	1783	
Volume (vph)	36	341	18	23	162	33	57	85	134	47	132	52
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	39	371	20	25	176	36	62	92	146	51	143	57
RTOR Reduction (vph)	0	3	0	0	16	0	0	17	0	0	4	0
Lane Group Flow (vph)	39	388	0	25	196	0	62	221	0	51	196	0
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	7.2	22.2		3.3	18.3		102.5	102.5		102.5	102.5	
Effective Green, g (s)	7.2	22.2		3.3	18.3		102.5	102.5		102.5	102.5	
Actuated g/C Ratio	0.05	0.16		0.02	0.13		0.73	0.73		0.73	0.73	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	91	557		42	451		857	1238		819	1305	
v/s Ratio Prot	c0.02	c0.11		0.01	0.06			c0.13			0.11	
v/s Ratio Perm							0.05			0.05		
v/c Ratio	0.43	0.70		0.60	0.44		0.07	0.18		0.06	0.15	
Uniform Delay, d1	64.4	55.7		67.7	56.1		5.3	5.8		5.3	5.6	
Progression Factor	1.17	1.34		1.01	0.87		1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.4	2.9		20.5	0.7		0.2	0.3		0.1	0.2	
Delay (s)	77.5	77.5		89.0	49.6		5.5	6.1		5.4	5.9	
Level of Service	E	E		F	D		A	A		A	A	
Approach Delay (s)		77.5			53.7			6.0			5.8	
Approach LOS		E			D			A			A	

Intersection Summary			
HCM Average Control Delay	40.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.28		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.97		1.00	0.91		1.00	0.89		1.00	0.92	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1814		1770	1699		1770	3147		1770	3260	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1814		1770	1699		1770	3147		1770	3260	
Volume (vph)	160	182	39	40	25	35	25	103	291	254	94	104
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	174	198	42	43	27	38	27	112	316	276	102	113
RTOR Reduction (vph)	0	6	0	0	35	0	0	166	0	0	41	0
Lane Group Flow (vph)	174	234	0	43	30	0	27	262	0	276	174	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	19.0	22.3		7.7	11.0		5.3	66.6		27.4	88.7	
Effective Green, g (s)	19.0	22.3		7.7	11.0		5.3	66.6		27.4	88.7	
Actuated g/C Ratio	0.14	0.16		0.06	0.08		0.04	0.48		0.20	0.63	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	240	289		97	133		67	1497		346	2065	
v/s Ratio Prot	0.10	c0.13		c0.02	c0.02		c0.02	c0.08		c0.16	0.05	
v/s Ratio Perm												
v/c Ratio	0.72	0.81		0.44	0.23		0.40	0.18		0.80	0.08	
Uniform Delay, d1	58.0	56.8		64.1	60.5		65.8	21.0		53.7	9.9	
Progression Factor	1.00	1.00		1.00	1.00		1.32	0.25		0.81	0.10	
Incremental Delay, d2	10.4	15.6		3.2	0.9		3.8	0.2		11.7	0.1	
Delay (s)	68.4	72.4		67.3	61.4		90.6	5.6		55.1	1.1	
Level of Service	E	E		E	E		F	A		E	A	
Approach Delay (s)		70.7			63.7			10.6			31.5	
Approach LOS		E			E			B			C	

Intersection Summary			
HCM Average Control Delay	38.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	54.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.97		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1583		1770	1816		1770	3539		1770	3507	
Flt Permitted	0.75	1.00		0.69	1.00		0.18	1.00		0.22	1.00	
Satd. Flow (perm)	1397	1583		1290	1816		331	3539		416	3507	
Volume (vph)	106	0	59	3	9	2	42	1075	1	1	1177	76
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	115	0	64	3	10	2	46	1168	1	1	1279	83
RTOR Reduction (vph)	0	23	0	0	2	0	0	0	0	0	1	0
Lane Group Flow (vph)	115	41	0	3	10	0	46	1169	0	1	1361	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	16.9	16.9		16.9	16.9		115.1	115.1		115.1	115.1	
Effective Green, g (s)	16.9	16.9		16.9	16.9		115.1	115.1		115.1	115.1	
Actuated g/C Ratio	0.12	0.12		0.12	0.12		0.82	0.82		0.82	0.82	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	169	191		156	219		272	2910		342	2883	
v/s Ratio Prot		0.03			0.01			0.33			c0.39	
v/s Ratio Perm	c0.08			0.00			0.14			0.00		
v/c Ratio	0.68	0.22		0.02	0.05		0.17	0.40		0.00	0.47	
Uniform Delay, d1	59.0	55.6		54.2	54.4		2.6	3.3		2.2	3.6	
Progression Factor	1.06	1.11		1.00	1.00		1.11	0.97		0.91	0.88	
Incremental Delay, d2	9.6	0.5		0.0	0.1		1.3	0.4		0.0	0.5	
Delay (s)	72.2	61.9		54.3	54.5		4.2	3.6		2.0	3.7	
Level of Service	E	E		D	D		A	A		A	A	
Approach Delay (s)		68.5			54.5			3.6			3.7	
Approach LOS		E			D			A			A	

Intersection Summary			
HCM Average Control Delay	8.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	54.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.97		1.00	1.00		1.00	1.00	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1583		1770	1807		1770	3535		1770	3522	
Flt Permitted	0.75	1.00		0.48	1.00		0.20	1.00		0.22	1.00	
Satd. Flow (perm)	1393	1583		899	1807		381	3535		406	3522	
Volume (vph)	67	0	94	27	11	3	52	1107	9	1	1131	37
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	73	0	102	29	12	3	57	1203	10	1	1229	40
RTOR Reduction (vph)	0	27	0	0	3	0	0	0	0	0	0	0
Lane Group Flow (vph)	73	75	0	29	12	0	57	1213	0	1	1269	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	12.2	12.2		12.2	12.2		119.8	119.8		119.8	119.8	
Effective Green, g (s)	12.2	12.2		12.2	12.2		119.8	119.8		119.8	119.8	
Actuated g/C Ratio	0.09	0.09		0.09	0.09		0.86	0.86		0.86	0.86	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	121	138		78	157		326	3025		347	3014	
v/s Ratio Prot		0.05			0.01			0.34			c0.36	
v/s Ratio Perm	c0.05			0.03			0.15			0.00		
v/c Ratio	0.60	0.54		0.37	0.08		0.17	0.40		0.00	0.42	
Uniform Delay, d1	61.6	61.2		60.3	58.7		1.7	2.2		1.5	2.3	
Progression Factor	1.07	1.28		1.00	1.00		0.97	0.73		1.00	1.00	
Incremental Delay, d2	5.8	3.0		3.0	0.2		1.1	0.4		0.0	0.4	
Delay (s)	71.4	81.4		63.3	58.9		2.8	2.0		1.5	2.7	
Level of Service	E	F		E	E		A	A		A	A	
Approach Delay (s)		77.2			61.8			2.0			2.7	
Approach LOS		E			E			A			A	

Intersection Summary			
HCM Average Control Delay	8.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	56.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0		4.0	4.0
Lane Util. Factor	1.00		0.95		1.00	0.95
Frt	0.93		0.99		1.00	1.00
Flt Protected	0.98		1.00		0.95	1.00
Satd. Flow (prot)	1690		3501		1770	3539
Flt Permitted	0.98		1.00		0.07	1.00
Satd. Flow (perm)	1690		3501		126	3539
Volume (vph)	68	76	1841	143	123	1773
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	72	81	1959	152	131	1886
RTOR Reduction (vph)	31	0	4	0	0	0
Lane Group Flow (vph)	122	0	2107	0	131	1886
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	13.5		113.5		113.5	113.5
Effective Green, g (s)	13.5		113.5		113.5	113.5
Actuated g/C Ratio	0.10		0.84		0.84	0.84
Clearance Time (s)	4.0		4.0		4.0	4.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	169		2943		106	2975
v/s Ratio Prot	c0.07		0.60			0.53
v/s Ratio Perm					c1.04	
v/c Ratio	0.72		0.72		1.24	0.63
Uniform Delay, d1	58.9		4.3		10.8	3.7
Progression Factor	0.84		2.46		2.58	2.79
Incremental Delay, d2	11.3		0.6		149.7	0.7
Delay (s)	60.5		11.2		177.4	10.9
Level of Service	E		B		F	B
Approach Delay (s)	60.5		11.2			21.8
Approach LOS	E		B			C

Intersection Summary			
HCM Average Control Delay	17.9	HCM Level of Service	B
HCM Volume to Capacity ratio	1.18		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	80.7%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.93		1.00	0.88		1.00	0.98		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1740		1770	1641		1770	3464		1770	3495	
Flt Permitted	0.44	1.00		0.62	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	828	1740		1147	1641		1770	3464		1770	3495	
Volume (vph)	202	55	43	226	35	134	47	1604	266	132	1495	134
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	220	60	47	246	38	146	51	1743	289	143	1625	146
RTOR Reduction (vph)	0	21	0	0	102	0	0	10	0	0	5	0
Lane Group Flow (vph)	220	86	0	246	82	0	51	2022	0	143	1766	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	26.0	26.0		26.0	26.0		6.6	86.0		9.0	88.4	
Effective Green, g (s)	27.0	27.0		27.0	27.0		6.6	87.0		9.0	89.4	
Actuated g/C Ratio	0.20	0.20		0.20	0.20		0.05	0.64		0.07	0.66	
Clearance Time (s)	5.0	5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)	166	348		229	328		87	2232		118	2314	
v/s Ratio Prot		0.05			0.05		0.03	c0.58		c0.08	0.51	
v/s Ratio Perm	c0.27			0.21								
v/c Ratio	1.33	0.25		1.07	0.25		0.59	0.91		1.21	0.76	
Uniform Delay, d1	54.0	45.5		54.0	45.5		62.9	20.5		63.0	15.6	
Progression Factor	1.00	1.00		1.00	1.00		0.71	1.50		1.08	0.35	
Incremental Delay, d2	181.9	1.7		80.6	0.4		2.6	2.9		140.8	1.9	
Delay (s)	235.9	47.1		134.6	45.9		47.2	33.6		208.9	7.4	
Level of Service	F	D		F	D		D	C		F	A	
Approach Delay (s)		174.2			96.6			33.9			22.4	
Approach LOS		F			F			C			C	

Intersection Summary			
HCM Average Control Delay	44.6	HCM Level of Service	D
HCM Volume to Capacity ratio	1.01		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	94.8%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	0.91		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1701		1770	1863	1583	1770	3539	1583	1770	3520	
Flt Permitted	0.71	1.00		0.24	1.00	1.00	0.07	1.00	1.00	0.07	1.00	
Satd. Flow (perm)	1330	1701		452	1863	1583	128	3539	1583	128	3520	
Volume (vph)	80	98	135	285	61	361	108	1549	208	218	1521	58
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	107	147	310	66	392	117	1684	226	237	1653	63
RTOR Reduction (vph)	0	36	0	0	0	173	0	0	75	0	2	0
Lane Group Flow (vph)	87	218	0	310	66	219	117	1684	151	237	1714	0
Turn Type	pm+pt			pm+pt		Perm	pm+pt		Perm	pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8		8	2		2	6		
Actuated Green, G (s)	29.0	25.0		44.0	36.0	36.0	64.0	63.0	63.0	71.0	71.0	
Effective Green, g (s)	30.0	26.0		45.0	37.0	37.0	64.0	64.0	64.0	72.0	72.0	
Actuated g/C Ratio	0.22	0.19		0.33	0.27	0.27	0.47	0.47	0.47	0.53	0.53	
Clearance Time (s)	4.0	5.0		4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	309	328		297	511	434	134	1678	750	239	1877	
v/s Ratio Prot	0.01	0.13		c0.12	0.04		0.04	c0.48		0.10	c0.49	
v/s Ratio Perm	0.05			c0.23		0.14	0.37		0.10	c0.43		
v/c Ratio	0.28	0.66		1.04	0.13	0.51	0.87	1.00	0.20	0.99	0.91	
Uniform Delay, d1	43.0	50.5		40.6	36.9	41.3	54.9	35.5	20.6	62.6	28.7	
Progression Factor	1.00	1.00		1.77	1.59	2.58	0.50	0.40	0.06	1.26	0.67	
Incremental Delay, d2	0.5	10.1		62.3	0.5	3.9	18.8	13.9	0.2	43.1	5.4	
Delay (s)	43.5	60.6		134.0	59.2	110.4	46.3	28.0	1.5	121.8	24.6	
Level of Service	D	E		F	E	F	D	C	A	F	C	
Approach Delay (s)		56.2			115.5			26.1			36.4	
Approach LOS		E			F			C			D	

Intersection Summary			
HCM Average Control Delay	45.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	97.4%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.99		1.00	0.98		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3454		1770	3490		1770	1820		1770	1786	
Flt Permitted	0.95	1.00		0.95	1.00		0.56	1.00		0.57	1.00	
Satd. Flow (perm)	1770	3454		1770	3490		1043	1820		1054	1786	
Volume (vph)	70	324	62	155	536	54	37	185	33	47	163	62
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	76	352	67	168	583	59	40	201	36	51	177	67
RTOR Reduction (vph)	0	13	0	0	6	0	0	3	0	0	7	0
Lane Group Flow (vph)	76	406	0	168	636	0	40	234	0	51	237	0
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	9.4	33.2		16.8	40.6		73.0	73.0		73.0	73.0	
Effective Green, g (s)	9.4	33.2		16.8	40.6		73.0	73.0		73.0	73.0	
Actuated g/C Ratio	0.07	0.25		0.12	0.30		0.54	0.54		0.54	0.54	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	123	849		220	1050		564	984		570	966	
v/s Ratio Prot	0.04	0.12		c0.09	c0.18			0.13			c0.13	
v/s Ratio Perm							0.04			0.05		
v/c Ratio	0.62	0.48		0.76	0.61		0.07	0.24		0.09	0.25	
Uniform Delay, d1	61.1	43.5		57.2	40.4		14.8	16.3		15.0	16.4	
Progression Factor	1.04	1.09		1.19	0.89		1.00	1.00		1.00	1.00	
Incremental Delay, d2	6.8	0.3		14.1	1.0		0.2	0.6		0.3	0.6	
Delay (s)	70.4	47.8		82.3	37.1		15.0	16.9		15.3	17.0	
Level of Service	E	D		F	D		B	B		B	B	
Approach Delay (s)		51.2			46.5			16.6			16.7	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	38.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	49.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.90		1.00	0.91		1.00	0.96		1.00	0.90	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1673		1770	1700		1770	3400		1770	3201	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1673		1770	1700		1770	3400		1770	3201	
Volume (vph)	245	29	63	339	212	296	69	129	46	40	154	269
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	266	32	68	368	230	322	75	140	50	43	167	292
RTOR Reduction (vph)	0	64	0	0	44	0	0	23	0	0	189	0
Lane Group Flow (vph)	266	36	0	368	508	0	75	167	0	43	270	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	24.4	8.2		59.7	43.5		9.0	39.7		11.4	42.1	
Effective Green, g (s)	24.4	8.2		59.7	43.5		9.0	39.7		11.4	42.1	
Actuated g/C Ratio	0.18	0.06		0.44	0.32		0.07	0.29		0.08	0.31	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	320	102		783	548		118	1000		149	998	
v/s Ratio Prot	c0.15	0.02		0.21	c0.30		c0.04	0.05		0.02	c0.08	
v/s Ratio Perm												
v/c Ratio	0.83	0.35		0.47	0.93		0.64	0.17		0.29	0.27	
Uniform Delay, d1	53.3	60.9		26.5	44.2		61.4	35.4		58.0	34.9	
Progression Factor	1.00	1.00		1.00	1.00		0.59	0.46		1.00	1.00	
Incremental Delay, d2	16.6	2.1		0.4	21.8		10.2	0.3		1.1	0.7	
Delay (s)	69.9	63.0		27.0	66.0		46.5	16.8		59.1	35.6	
Level of Service	E	E		C	E		D	B		E	D	
Approach Delay (s)		68.0			50.4			25.2			37.6	
Approach LOS		E			D			C			D	

Intersection Summary			
HCM Average Control Delay	47.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	73.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.98		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1583		1770	1828		1770	3538		1770	3496	
Flt Permitted	0.75	1.00		0.70	1.00		0.12	1.00		0.12	1.00	
Satd. Flow (perm)	1402	1583		1303	1828		228	3538		215	3496	
Volume (vph)	106	0	59	2	6	1	69	1561	3	2	1402	123
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	115	0	64	2	7	1	75	1697	3	2	1524	134
RTOR Reduction (vph)	0	11	0	0	1	0	0	0	0	0	2	0
Lane Group Flow (vph)	115	53	0	2	7	0	75	1700	0	2	1656	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	16.5	16.5		16.5	16.5		110.5	110.5		110.5	110.5	
Effective Green, g (s)	16.5	16.5		16.5	16.5		110.5	110.5		110.5	110.5	
Actuated g/C Ratio	0.12	0.12		0.12	0.12		0.82	0.82		0.82	0.82	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	171	193		159	223		187	2896		176	2862	
v/s Ratio Prot		0.03			0.00			c0.48			0.47	
v/s Ratio Perm	c0.08			0.00			0.33			0.01		
v/c Ratio	0.67	0.28		0.01	0.03		0.40	0.59		0.01	0.58	
Uniform Delay, d1	56.7	53.8		52.1	52.2		3.3	4.3		2.2	4.2	
Progression Factor	0.92	0.91		1.00	1.00		1.00	1.00		0.89	0.84	
Incremental Delay, d2	5.3	0.4		0.0	0.1		6.3	0.9		0.1	0.7	
Delay (s)	57.4	49.4		52.1	52.3		9.6	5.2		2.1	4.3	
Level of Service	E	D		D	D		A	A		A	A	
Approach Delay (s)		54.5			52.2			5.3			4.3	
Approach LOS		D			D			A			A	

Intersection Summary			
HCM Average Control Delay	7.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	69.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.85		1.00	0.97		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1583		1770	1807		1770	3529		1770	3506	
Flt Permitted	0.75	1.00		0.46	1.00		0.13	1.00		0.13	1.00	
Satd. Flow (perm)	1399	1583		864	1807		247	3529		234	3506	
Volume (vph)	79	0	110	18	7	2	130	1493	30	3	1390	93
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	86	0	120	20	8	2	141	1623	33	3	1511	101
RTOR Reduction (vph)	0	12	0	0	2	0	0	0	0	0	1	0
Lane Group Flow (vph)	86	108	0	20	8	0	141	1656	0	3	1611	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	14.5	14.5		14.5	14.5		112.5	112.5		112.5	112.5	
Effective Green, g (s)	14.5	14.5		14.5	14.5		112.5	112.5		112.5	112.5	
Actuated g/C Ratio	0.11	0.11		0.11	0.11		0.83	0.83		0.83	0.83	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	150	170		93	194		206	2941		195	2922	
v/s Ratio Prot		c0.07			0.00			0.47			0.46	
v/s Ratio Perm	0.06			0.02			c0.57			0.01		
v/c Ratio	0.57	0.64		0.22	0.04		0.68	0.56		0.02	0.55	
Uniform Delay, d1	57.3	57.7		55.1	54.0		4.4	3.5		1.9	3.5	
Progression Factor	1.20	1.25		1.00	1.00		1.37	0.88		1.00	1.00	
Incremental Delay, d2	2.4	3.5		1.2	0.1		14.4	0.7		0.1	0.8	
Delay (s)	71.2	75.9		56.2	54.1		20.3	3.8		2.0	4.2	
Level of Service	E	E		E	D		C	A		A	A	
Approach Delay (s)		73.9			55.5			5.1			4.2	
Approach LOS		E			E			A			A	

Intersection Summary			
HCM Average Control Delay	9.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	69.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

CUMULATIVE PLUS PROJECT (2036) CONDITIONS WITH MITIGATIONS – CONCEPT 1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0		4.0	4.0
Lane Util. Factor	1.00		0.95		1.00	0.95
Frt	0.92		0.99		1.00	1.00
Flt Protected	0.98		1.00		0.95	1.00
Satd. Flow (prot)	1683		3513		1770	3539
Flt Permitted	0.98		1.00		0.13	1.00
Satd. Flow (perm)	1683		3513		234	3539
Volume (vph)	101	134	1475	78	70	1516
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	104	138	1521	80	72	1563
RTOR Reduction (vph)	38	0	2	0	0	0
Lane Group Flow (vph)	204	0	1599	0	72	1563
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	21.3		110.7		110.7	110.7
Effective Green, g (s)	21.3		110.7		110.7	110.7
Actuated g/C Ratio	0.15		0.79		0.79	0.79
Clearance Time (s)	4.0		4.0		4.0	4.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	256		2778		185	2798
v/s Ratio Prot	c0.12		c0.46			0.44
v/s Ratio Perm					0.31	
v/c Ratio	0.80		0.58		0.39	0.56
Uniform Delay, d1	57.3		5.6		4.4	5.5
Progression Factor	1.18		0.55		1.12	0.80
Incremental Delay, d2	15.4		0.7		4.6	0.6
Delay (s)	83.0		3.8		9.6	5.0
Level of Service	F		A		A	A
Approach Delay (s)	83.0		3.8			5.2
Approach LOS	F		A			A

Intersection Summary			
HCM Average Control Delay	10.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	71.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1863	1583	1770	1863	1583	1770	3539	1583	1770	3508	
Flt Permitted	0.73	1.00	1.00	0.63	1.00	1.00	0.07	1.00	1.00	0.06	1.00	
Satd. Flow (perm)	1351	1863	1583	1171	1863	1583	135	3539	1583	112	3508	
Volume (vph)	38	50	63	126	47	130	56	1476	214	153	1436	88
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	40	53	66	133	49	137	59	1554	225	161	1512	93
RTOR Reduction (vph)	0	0	53	0	0	106	0	0	77	0	3	0
Lane Group Flow (vph)	40	53	13	133	49	31	59	1554	148	161	1602	0
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		
Actuated Green, G (s)	30.6	25.8	25.8	39.3	30.5	30.5	81.7	76.7	76.7	90.7	81.7	
Effective Green, g (s)	31.6	26.8	26.8	40.3	31.5	31.5	82.7	77.7	77.7	91.7	82.7	
Actuated g/C Ratio	0.23	0.19	0.19	0.29	0.22	0.22	0.59	0.56	0.56	0.66	0.59	
Clearance Time (s)	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	319	357	303	378	419	356	138	1964	879	192	2072	
v/s Ratio Prot	0.00	0.03		c0.02	0.03		0.02	0.44		c0.06	0.46	
v/s Ratio Perm	0.02		0.01	c0.08		0.02	0.24		0.09	c0.49		
v/c Ratio	0.13	0.15	0.04	0.35	0.12	0.09	0.43	0.79	0.17	0.84	0.77	
Uniform Delay, d1	42.9	47.1	46.1	38.4	43.2	42.9	19.9	24.7	15.3	36.7	21.6	
Progression Factor	1.00	1.00	1.00	1.42	1.42	4.33	2.23	0.43	0.03	1.69	0.38	
Incremental Delay, d2	0.2	0.9	0.3	0.6	0.6	0.5	0.3	1.1	0.1	18.9	2.1	
Delay (s)	43.1	48.0	46.4	55.0	62.0	185.9	44.6	11.8	0.6	81.1	10.2	
Level of Service	D	D	D	E	E	F	D	B	A	F	B	
Approach Delay (s)		46.1			112.3			11.5			16.6	
Approach LOS		D			F			B			B	

Intersection Summary			
HCM Average Control Delay	23.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.98		1.00	0.90		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3509		1770	3486		1770	1678		1770	1774	
Flt Permitted	0.95	1.00		0.95	1.00		0.65	1.00		0.58	1.00	
Satd. Flow (perm)	1770	3509		1770	3486		1211	1678		1080	1774	
Volume (vph)	35	321	19	103	173	19	60	78	152	30	101	47
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	38	349	21	112	188	21	65	85	165	33	110	51
RTOR Reduction (vph)	0	3	0	0	8	0	0	26	0	0	6	0
Lane Group Flow (vph)	38	367	0	112	201	0	65	224	0	33	155	0
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	5.5	22.3		13.4	30.2		92.3	92.3		92.3	92.3	
Effective Green, g (s)	5.5	22.3		13.4	30.2		92.3	92.3		92.3	92.3	
Actuated g/C Ratio	0.04	0.16		0.10	0.22		0.66	0.66		0.66	0.66	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	70	559		169	752		798	1106		712	1170	
v/s Ratio Prot	0.02	c0.10		c0.06	0.06			c0.13			0.09	
v/s Ratio Perm							0.05			0.03		
v/c Ratio	0.54	0.66		0.66	0.27		0.08	0.20		0.05	0.13	
Uniform Delay, d1	66.0	55.2		61.1	45.7		8.6	9.4		8.4	8.9	
Progression Factor	1.11	1.14		0.93	1.22		1.00	1.00		1.00	1.00	
Incremental Delay, d2	7.7	2.6		9.3	0.2		0.2	0.4		0.1	0.2	
Delay (s)	80.7	65.6		66.4	56.1		8.8	9.8		8.5	9.1	
Level of Service	F	E		E	E		A	A		A	A	
Approach Delay (s)		67.0			59.7			9.6			9.0	
Approach LOS		E			E			A			A	

Intersection Summary			
HCM Average Control Delay	41.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.33		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	45.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.99		1.00	0.91		1.00	0.91		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1836		1770	1699		1770	3220		1770	3378	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1836		1770	1699		1770	3220		1770	3378	
Volume (vph)	123	149	16	40	25	35	14	159	239	209	239	104
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	134	162	17	43	27	38	15	173	260	227	260	113
RTOR Reduction (vph)	0	3	0	0	35	0	0	116	0	0	18	0
Lane Group Flow (vph)	134	176	0	43	30	0	15	317	0	227	355	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	15.8	17.8		7.6	9.6		3.2	76.4		22.2	95.4	
Effective Green, g (s)	15.8	17.8		7.6	9.6		3.2	76.4		22.2	95.4	
Actuated g/C Ratio	0.11	0.13		0.05	0.07		0.02	0.55		0.16	0.68	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	200	233		96	117		40	1757		281	2302	
v/s Ratio Prot	c0.08	c0.10		0.02	0.02		0.01	c0.10		c0.13	0.10	
v/s Ratio Perm												
v/c Ratio	0.67	0.75		0.45	0.25		0.38	0.18		0.81	0.15	
Uniform Delay, d1	59.6	59.0		64.2	61.8		67.4	16.0		56.8	7.9	
Progression Factor	1.00	1.00		1.00	1.00		0.59	4.04		0.86	1.13	
Incremental Delay, d2	8.5	12.9		3.3	1.1		5.7	0.2		14.9	0.1	
Delay (s)	68.1	71.9		67.5	62.9		45.6	64.9		63.8	9.1	
Level of Service	E	E		E	E		D	E		E	A	
Approach Delay (s)		70.3			64.7			64.3			29.8	
Approach LOS		E			E			E			C	

Intersection Summary			
HCM Average Control Delay	51.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	49.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.91		1.00	0.92		1.00	0.99		1.00	1.00	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1697		1770	1716		1770	3519		1770	3524	
Flt Permitted	0.26	1.00		0.68	1.00		0.13	1.00		0.16	1.00	
Satd. Flow (perm)	480	1697		1260	1716		234	3519		294	3524	
Volume (vph)	69	27	39	148	90	99	24	1276	50	33	1444	43
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	75	29	42	161	98	108	26	1387	54	36	1570	47
RTOR Reduction (vph)	0	9	0	0	16	0	0	1	0	0	1	0
Lane Group Flow (vph)	75	62	0	161	190	0	26	1440	0	36	1616	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	19.6	19.6		19.6	19.6		112.4	112.4		112.4	112.4	
Effective Green, g (s)	19.6	19.6		19.6	19.6		112.4	112.4		112.4	112.4	
Actuated g/C Ratio	0.14	0.14		0.14	0.14		0.80	0.80		0.80	0.80	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	67	238		176	240		188	2825		236	2829	
v/s Ratio Prot		0.04			0.11			0.41			c0.46	
v/s Ratio Perm	c0.16			0.13			0.11			0.12		
v/c Ratio	1.12	0.26		0.91	0.79		0.14	0.51		0.15	0.57	
Uniform Delay, d1	60.2	53.7		59.4	58.2		3.1	4.6		3.1	5.0	
Progression Factor	1.06	1.08		1.00	1.00		1.53	1.35		1.07	0.79	
Incremental Delay, d2	132.1	0.5		43.8	16.1		1.5	0.6		1.2	0.7	
Delay (s)	195.9	58.3		103.2	74.3		6.2	6.9		4.5	4.7	
Level of Service	F	E		F	E		A	A		A	A	
Approach Delay (s)		129.0			87.0			6.8			4.7	
Approach LOS		F			F			A			A	

Intersection Summary			
HCM Average Control Delay	18.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	65.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.91		1.00	0.93		1.00	0.99		1.00	1.00	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1693		1770	1726		1770	3497		1770	3523	
Flt Permitted	0.38	1.00		0.57	1.00		0.16	1.00		0.13	1.00	
Satd. Flow (perm)	706	1693		1068	1726		292	3497		249	3523	
Volume (vph)	48	47	73	228	106	102	72	1249	109	50	1217	40
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	52	51	79	248	115	111	78	1358	118	54	1323	43
RTOR Reduction (vph)	0	18	0	0	16	0	0	2	0	0	1	0
Lane Group Flow (vph)	52	112	0	248	210	0	78	1474	0	54	1365	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	30.4	30.4		30.4	30.4		101.6	101.6		101.6	101.6	
Effective Green, g (s)	30.4	30.4		30.4	30.4		101.6	101.6		101.6	101.6	
Actuated g/C Ratio	0.22	0.22		0.22	0.22		0.73	0.73		0.73	0.73	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	153	368		232	375		212	2538		181	2557	
v/s Ratio Prot		0.07			0.12			c0.42			0.39	
v/s Ratio Perm	0.07			c0.23			0.27			0.22		
v/c Ratio	0.34	0.30		1.07	0.56		0.37	0.58		0.30	0.53	
Uniform Delay, d1	46.3	45.9		54.8	48.9		7.2	9.1		6.7	8.6	
Progression Factor	1.56	1.69		1.00	1.00		0.80	0.74		1.00	1.00	
Incremental Delay, d2	0.6	0.2		78.5	1.9		4.4	0.9		4.2	0.8	
Delay (s)	73.0	77.9		133.3	50.8		10.1	7.6		10.9	9.4	
Level of Service	E	E		F	D		B	A		B	A	
Approach Delay (s)		76.5			94.0			7.7			9.5	
Approach LOS		E			F			A			A	

Intersection Summary			
HCM Average Control Delay	23.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	74.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0		4.0	4.0
Lane Util. Factor	1.00		0.95		1.00	0.95
Frt	0.94		0.99		1.00	1.00
Flt Protected	0.97		1.00		0.95	1.00
Satd. Flow (prot)	1699		3497		1770	3539
Flt Permitted	0.97		1.00		0.06	1.00
Satd. Flow (perm)	1699		3497		108	3539
Volume (vph)	74	67	1905	164	134	1840
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	79	71	2027	174	143	1957
RTOR Reduction (vph)	24	0	4	0	0	0
Lane Group Flow (vph)	126	0	2197	0	143	1957
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	13.7		113.3		113.3	113.3
Effective Green, g (s)	13.7		113.3		113.3	113.3
Actuated g/C Ratio	0.10		0.84		0.84	0.84
Clearance Time (s)	4.0		4.0		4.0	4.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	172		2935		91	2970
v/s Ratio Prot	c0.07		0.63			0.55
v/s Ratio Perm					c1.32	
v/c Ratio	0.73		0.75		1.57	0.66
Uniform Delay, d1	58.9		4.7		10.9	3.9
Progression Factor	1.27		2.47		2.47	2.64
Incremental Delay, d2	14.1		0.8		288.0	0.7
Delay (s)	88.8		12.4		314.8	11.0
Level of Service	F		B		F	B
Approach Delay (s)	88.8		12.4			31.7
Approach LOS	F		B			C

Intersection Summary			
HCM Average Control Delay	24.1	HCM Level of Service	C
HCM Volume to Capacity ratio	1.49		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1863	1583	1770	1863	1583	1770	3539	1583	1770	3512	
Flt Permitted	0.71	1.00	1.00	0.53	1.00	1.00	0.07	1.00	1.00	0.06	1.00	
Satd. Flow (perm)	1322	1863	1583	982	1863	1583	128	3539	1583	119	3512	
Volume (vph)	120	100	140	285	67	338	112	1543	231	213	1528	83
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	130	109	152	310	73	367	122	1677	251	232	1661	90
RTOR Reduction (vph)	0	0	123	0	0	180	0	0	82	0	3	0
Lane Group Flow (vph)	130	109	29	310	73	187	122	1677	169	232	1748	0
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		
Actuated Green, G (s)	36.6	25.2	25.2	49.1	33.7	33.7	65.5	57.4	57.4	75.9	63.8	
Effective Green, g (s)	37.6	26.2	26.2	50.1	34.7	34.7	66.5	58.4	58.4	76.9	64.8	
Actuated g/C Ratio	0.28	0.19	0.19	0.37	0.26	0.26	0.49	0.43	0.43	0.57	0.48	
Clearance Time (s)	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	406	362	307	481	479	407	162	1531	685	245	1686	
v/s Ratio Prot	0.03	0.06		c0.10	0.04		0.05	c0.47		c0.10	0.50	
v/s Ratio Perm	0.06		0.02	c0.14		0.12	0.33		0.11	0.44		
v/c Ratio	0.32	0.30	0.10	0.64	0.15	0.46	0.75	1.10	0.25	0.95	1.04	
Uniform Delay, d1	37.9	46.6	44.7	32.6	38.8	42.3	31.3	38.3	24.3	44.3	35.1	
Progression Factor	1.00	1.00	1.00	1.70	1.55	2.88	1.70	0.39	0.09	1.35	0.60	
Incremental Delay, d2	0.5	2.1	0.6	2.8	0.6	3.5	5.0	46.5	0.2	28.4	26.6	
Delay (s)	38.4	48.7	45.3	58.3	60.9	125.4	58.4	61.3	2.4	88.4	47.8	
Level of Service	D	D	D	E	E	F	E	E	A	F	D	
Approach Delay (s)		43.9			91.4			53.9			52.5	
Approach LOS		D			F			D			D	

Intersection Summary			
HCM Average Control Delay	58.1	HCM Level of Service	E
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.99		1.00	0.93		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3456		1770	3517		1770	1740		1770	1783	
Flt Permitted	0.95	1.00		0.95	1.00		0.58	1.00		0.52	1.00	
Satd. Flow (perm)	1770	3456		1770	3517		1085	1740		959	1783	
Volume (vph)	65	353	65	192	523	23	39	156	122	15	147	59
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	71	384	71	209	568	25	42	170	133	16	160	64
RTOR Reduction (vph)	0	13	0	0	3	0	0	14	0	0	7	0
Lane Group Flow (vph)	71	442	0	209	590	0	42	289	0	16	217	0
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	9.2	28.2		18.9	37.9		75.9	75.9		75.9	75.9	
Effective Green, g (s)	9.2	28.2		18.9	37.9		75.9	75.9		75.9	75.9	
Actuated g/C Ratio	0.07	0.21		0.14	0.28		0.56	0.56		0.56	0.56	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	121	722		248	987		610	978		539	1002	
v/s Ratio Prot	0.04	0.13		c0.12	c0.17			c0.17			0.12	
v/s Ratio Perm							0.04			0.02		
v/c Ratio	0.59	0.61		0.84	0.60		0.07	0.30		0.03	0.22	
Uniform Delay, d1	61.1	48.4		56.6	42.0		13.5	15.5		13.2	14.7	
Progression Factor	1.12	1.02		1.19	0.86		1.00	1.00		1.00	1.00	
Incremental Delay, d2	6.0	1.3		21.4	0.9		0.2	0.8		0.1	0.5	
Delay (s)	74.4	50.9		89.0	37.2		13.7	16.3		13.3	15.2	
Level of Service	E	D		F	D		B	B		B	B	
Approach Delay (s)		54.1			50.7			16.0			15.1	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	40.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	54.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.94		1.00	0.91		1.00	0.96		1.00	0.92	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1760		1770	1700		1770	3398		1770	3269	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1760		1770	1700		1770	3398		1770	3269	
Volume (vph)	227	55	32	315	197	276	32	247	89	78	220	228
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	247	60	35	342	214	300	35	268	97	85	239	248
RTOR Reduction (vph)	0	21	0	0	43	0	0	23	0	0	114	0
Lane Group Flow (vph)	247	74	0	342	471	0	35	342	0	85	373	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	23.0	10.3		53.3	40.6		4.7	42.7		12.7	50.7	
Effective Green, g (s)	23.0	10.3		53.3	40.6		4.7	42.7		12.7	50.7	
Actuated g/C Ratio	0.17	0.08		0.39	0.30		0.03	0.32		0.09	0.38	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	302	134		699	511		62	1075		167	1228	
v/s Ratio Prot	c0.14	0.04		0.19	c0.28		c0.02	c0.10		c0.05	0.11	
v/s Ratio Perm												
v/c Ratio	0.82	0.55		0.49	0.92		0.56	0.32		0.51	0.30	
Uniform Delay, d1	54.0	60.1		30.6	45.6		64.1	35.1		58.2	29.7	
Progression Factor	1.00	1.00		1.00	1.00		0.70	0.43		1.00	1.00	
Incremental Delay, d2	15.6	4.8		0.5	22.1		10.5	0.7		2.4	0.6	
Delay (s)	69.6	64.9		31.2	67.7		55.6	15.7		60.6	30.3	
Level of Service	E	E		C	E		E	B		E	C	
Approach Delay (s)		68.3			53.1			19.2			34.8	
Approach LOS		E			D			B			C	

Intersection Summary			
HCM Average Control Delay	44.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	69.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.97		1.00	0.92		1.00	0.99		1.00	1.00	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1807		1770	1717		1770	3501		1770	3522	
Flt Permitted	0.46	1.00		0.50	1.00		0.10	1.00		0.07	1.00	
Satd. Flow (perm)	857	1807		939	1717		188	3501		122	3522	
Volume (vph)	35	77	19	83	51	55	30	1823	141	94	1636	53
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	38	84	21	90	55	60	33	1982	153	102	1778	58
RTOR Reduction (vph)	0	5	0	0	3	0	0	1	0	0	0	0
Lane Group Flow (vph)	38	100	0	90	112	0	33	2134	0	102	1836	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	13.2	13.2		13.2	13.2		113.8	113.8		113.8	113.8	
Effective Green, g (s)	13.2	13.2		13.2	13.2		113.8	113.8		113.8	113.8	
Actuated g/C Ratio	0.10	0.10		0.10	0.10		0.84	0.84		0.84	0.84	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	84	177		92	168		158	2951		103	2969	
v/s Ratio Prot		0.06			0.07			0.61			0.52	
v/s Ratio Perm	0.04			c0.10			0.18			c0.84		
v/c Ratio	0.45	0.56		0.98	0.67		0.21	0.72		0.99	0.62	
Uniform Delay, d1	57.5	58.1		60.8	58.8		2.0	4.3		10.1	3.5	
Progression Factor	0.97	0.95		1.00	1.00		1.00	1.00		1.41	0.92	
Incremental Delay, d2	2.1	2.2		85.8	9.7		3.0	1.6		77.0	0.8	
Delay (s)	57.9	57.5		146.5	68.4		5.0	5.8		91.1	4.0	
Level of Service	E	E		F	E		A	A		F	A	
Approach Delay (s)		57.6			102.7			5.8			8.6	
Approach LOS		E			F			A			A	

Intersection Summary			
HCM Average Control Delay	13.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	81.4%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.90		1.00	0.93		1.00	0.98		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1680		1770	1727		1770	3479		1770	3506	
Flt Permitted	0.57	1.00		0.27	1.00		0.10	1.00		0.07	1.00	
Satd. Flow (perm)	1069	1680		505	1727		178	3479		135	3506	
Volume (vph)	98	80	152	124	57	54	146	1551	200	86	1499	98
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	107	87	165	135	62	59	159	1686	217	93	1629	107
RTOR Reduction (vph)	0	7	0	0	6	0	0	3	0	0	2	0
Lane Group Flow (vph)	107	245	0	135	115	0	159	1900	0	93	1734	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	25.2	25.2		25.2	25.2		101.8	101.8		101.8	101.8	
Effective Green, g (s)	25.2	25.2		25.2	25.2		101.8	101.8		101.8	101.8	
Actuated g/C Ratio	0.19	0.19		0.19	0.19		0.75	0.75		0.75	0.75	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	200	314		94	322		134	2623		102	2644	
v/s Ratio Prot		0.15			0.07			0.55			0.49	
v/s Ratio Perm	0.10			c0.27			c0.89			0.69		
v/c Ratio	0.54	0.78		1.44	0.36		1.19	0.72		0.91	0.66	
Uniform Delay, d1	49.6	52.3		54.9	47.9		16.6	9.0		13.1	8.1	
Progression Factor	1.47	1.45		1.00	1.00		0.78	0.83		1.00	1.00	
Incremental Delay, d2	0.2	1.1		246.5	0.7		124.7	1.3		67.5	1.3	
Delay (s)	73.0	77.1		301.4	48.5		137.6	8.8		80.6	9.4	
Level of Service	E	E		F	D		F	A		F	A	
Approach Delay (s)		75.8			181.9			18.7			13.0	
Approach LOS		E			F			B			B	

Intersection Summary			
HCM Average Control Delay	30.2	HCM Level of Service	C
HCM Volume to Capacity ratio	1.23		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	87.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

CUMULATIVE PLUS PROJECT (2036) CONDITIONS WITH MITIGATIONS – CONCEPT 2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0		4.0	4.0
Lane Util. Factor	1.00		0.95		1.00	0.95
Frt	0.93		0.99		1.00	1.00
Flt Protected	0.98		1.00		0.95	1.00
Satd. Flow (prot)	1686		3511		1770	3539
Flt Permitted	0.98		1.00		0.12	1.00
Satd. Flow (perm)	1686		3511		225	3539
Volume (vph)	116	145	1477	81	71	1535
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	120	149	1523	84	73	1582
RTOR Reduction (vph)	35	0	2	0	0	0
Lane Group Flow (vph)	234	0	1605	0	73	1582
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	23.8		108.2		108.2	108.2
Effective Green, g (s)	23.8		108.2		108.2	108.2
Actuated g/C Ratio	0.17		0.77		0.77	0.77
Clearance Time (s)	4.0		4.0		4.0	4.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	287		2714		174	2735
v/s Ratio Prot	c0.14		c0.46			0.45
v/s Ratio Perm					0.32	
v/c Ratio	0.82		0.59		0.42	0.58
Uniform Delay, d1	56.0		6.7		5.3	6.5
Progression Factor	1.17		0.62		1.14	0.89
Incremental Delay, d2	16.0		0.7		5.5	0.7
Delay (s)	81.6		4.9		11.6	6.5
Level of Service	F		A		B	A
Approach Delay (s)	81.6		4.9			6.7
Approach LOS	F		A			A

Intersection Summary			
HCM Average Control Delay	11.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	72.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1863	1583	1770	1863	1583	1770	3539	1583	1770	3509	
Flt Permitted	0.72	1.00	1.00	0.63	1.00	1.00	0.07	1.00	1.00	0.06	1.00	
Satd. Flow (perm)	1336	1863	1583	1169	1863	1583	125	3539	1583	108	3509	
Volume (vph)	38	52	63	142	58	135	56	1479	217	154	1455	88
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	40	55	66	149	61	142	59	1557	228	162	1532	93
RTOR Reduction (vph)	0	0	53	0	0	110	0	0	78	0	3	0
Lane Group Flow (vph)	40	55	13	149	61	32	59	1557	150	162	1622	0
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		
Actuated Green, G (s)	30.6	25.8	25.8	39.6	30.8	30.8	81.4	76.3	76.3	90.4	81.3	
Effective Green, g (s)	31.6	26.8	26.8	40.6	31.8	31.8	82.4	77.3	77.3	91.4	82.3	
Actuated g/C Ratio	0.23	0.19	0.19	0.29	0.23	0.23	0.59	0.55	0.55	0.65	0.59	
Clearance Time (s)	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	316	357	303	381	423	360	133	1954	874	190	2063	
v/s Ratio Prot	0.00	0.03		c0.03	0.03		0.02	0.44		c0.06	0.46	
v/s Ratio Perm	0.02		0.01	c0.09		0.02	0.24		0.09	c0.49		
v/c Ratio	0.13	0.15	0.04	0.39	0.14	0.09	0.44	0.80	0.17	0.85	0.79	
Uniform Delay, d1	42.9	47.2	46.1	38.6	43.2	42.7	20.7	25.1	15.5	37.8	22.1	
Progression Factor	1.00	1.00	1.00	1.42	1.40	4.51	2.22	0.44	0.03	1.64	0.42	
Incremental Delay, d2	0.2	0.9	0.3	0.7	0.7	0.5	0.3	1.1	0.1	21.1	2.2	
Delay (s)	43.1	48.1	46.4	55.6	61.3	192.9	46.3	12.2	0.7	83.2	11.5	
Level of Service	D	D	D	E	E	F	D	B	A	F	B	
Approach Delay (s)		46.2			112.0			11.9			18.0	
Approach LOS		D			F			B			B	

Intersection Summary			
HCM Average Control Delay	24.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	73.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.99		1.00	0.90		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3509		1770	3487		1770	1683		1770	1774	
Flt Permitted	0.95	1.00		0.95	1.00		0.60	1.00		0.58	1.00	
Satd. Flow (perm)	1770	3509		1770	3487		1117	1683		1073	1774	
Volume (vph)	38	322	19	103	185	20	60	85	152	39	142	66
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	41	350	21	112	201	22	65	92	165	42	154	72
RTOR Reduction (vph)	0	3	0	0	7	0	0	24	0	0	6	0
Lane Group Flow (vph)	41	368	0	112	216	0	65	233	0	42	220	0
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	7.0	21.5		13.1	27.6		93.4	93.4		93.4	93.4	
Effective Green, g (s)	7.0	21.5		13.1	27.6		93.4	93.4		93.4	93.4	
Actuated g/C Ratio	0.05	0.15		0.09	0.20		0.67	0.67		0.67	0.67	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	89	539		166	687		745	1123		716	1184	
v/s Ratio Prot	0.02	c0.10		c0.06	0.06			c0.14			0.12	
v/s Ratio Perm							0.06			0.04		
v/c Ratio	0.46	0.68		0.67	0.31		0.09	0.21		0.06	0.19	
Uniform Delay, d1	64.7	56.0		61.4	48.1		8.2	9.0		8.1	8.9	
Progression Factor	1.11	1.13		1.03	1.18		1.00	1.00		1.00	1.00	
Incremental Delay, d2	3.4	3.3		10.3	0.3		0.2	0.4		0.2	0.3	
Delay (s)	75.5	66.7		73.3	57.0		8.5	9.4		8.2	9.2	
Level of Service	E	E		E	E		A	A		A	A	
Approach Delay (s)		67.6			62.5			9.2			9.0	
Approach LOS		E			E			A			A	

Intersection Summary			
HCM Average Control Delay	40.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.34		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.98		1.00	0.91		1.00	0.91		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1823		1770	1699		1770	3228		1770	3369	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1823		1770	1699		1770	3228		1770	3369	
Volume (vph)	186	149	25	40	25	35	16	169	239	209	245	115
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	202	162	27	43	27	38	17	184	260	227	266	125
RTOR Reduction (vph)	0	5	0	0	36	0	0	113	0	0	21	0
Lane Group Flow (vph)	202	184	0	43	29	0	17	331	0	227	370	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	20.5	19.8		7.6	6.9		3.0	73.2		23.4	93.6	
Effective Green, g (s)	20.5	19.8		7.6	6.9		3.0	73.2		23.4	93.6	
Actuated g/C Ratio	0.15	0.14		0.05	0.05		0.02	0.52		0.17	0.67	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	259	258		96	84		38	1688		296	2252	
v/s Ratio Prot	c0.11	c0.10		0.02	0.02		0.01	c0.10		c0.13	0.11	
v/s Ratio Perm												
v/c Ratio	0.78	0.71		0.45	0.34		0.45	0.20		0.77	0.16	
Uniform Delay, d1	57.6	57.4		64.2	64.4		67.7	17.8		55.7	8.6	
Progression Factor	1.00	1.00		1.00	1.00		1.34	1.23		0.81	1.17	
Incremental Delay, d2	13.8	9.0		3.3	2.4		7.9	0.3		10.7	0.1	
Delay (s)	71.4	66.3		67.5	66.8		98.8	22.1		55.7	10.3	
Level of Service	E	E		E	E		F	C		E	B	
Approach Delay (s)		68.9			67.1			25.0			27.0	
Approach LOS		E			E			C			C	

Intersection Summary			
HCM Average Control Delay	39.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	51.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.90		1.00	0.92		1.00	0.99		1.00	1.00	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1681		1770	1716		1770	3520		1770	3523	
Flt Permitted	0.26	1.00		0.64	1.00		0.12	1.00		0.15	1.00	
Satd. Flow (perm)	489	1681		1190	1716		222	3520		274	3523	
Volume (vph)	90	27	50	148	90	99	26	1324	50	33	1477	46
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	98	29	54	161	98	108	28	1439	54	36	1605	50
RTOR Reduction (vph)	0	8	0	0	14	0	0	1	0	0	1	0
Lane Group Flow (vph)	98	75	0	161	192	0	28	1492	0	36	1654	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	19.8	19.8		19.8	19.8		112.2	112.2		112.2	112.2	
Effective Green, g (s)	19.8	19.8		19.8	19.8		112.2	112.2		112.2	112.2	
Actuated g/C Ratio	0.14	0.14		0.14	0.14		0.80	0.80		0.80	0.80	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	69	238		168	243		178	2821		220	2823	
v/s Ratio Prot		0.04			0.11			0.42			c0.47	
v/s Ratio Perm	c0.20			0.14			0.13			0.13		
v/c Ratio	1.42	0.32		0.96	0.79		0.16	0.53		0.16	0.59	
Uniform Delay, d1	60.1	54.0		59.7	58.1		3.2	4.8		3.2	5.2	
Progression Factor	1.05	1.06		1.00	1.00		1.63	1.45		1.08	0.83	
Incremental Delay, d2	245.6	0.6		56.5	16.0		1.8	0.7		1.4	0.8	
Delay (s)	308.8	58.2		116.2	74.1		7.0	7.6		4.8	5.1	
Level of Service	F	E		F	E		A	A		A	A	
Approach Delay (s)		193.9			92.6			7.6			5.1	
Approach LOS		F			F			A			A	

Intersection Summary			
HCM Average Control Delay	23.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	68.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.90		1.00	0.93		1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1674		1770	1726		1770	3499		1770	3521	
Flt Permitted	0.39	1.00		0.52	1.00		0.15	1.00		0.12	1.00	
Satd. Flow (perm)	733	1674		977	1726		281	3499		220	3521	
Volume (vph)	66	47	98	228	106	102	77	1312	109	50	1227	43
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	72	51	107	248	115	111	84	1426	118	54	1334	47
RTOR Reduction (vph)	0	17	0	0	12	0	0	2	0	0	1	0
Lane Group Flow (vph)	72	141	0	248	214	0	84	1542	0	54	1380	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	31.8	31.8		31.8	31.8		100.2	100.2		100.2	100.2	
Effective Green, g (s)	31.8	31.8		31.8	31.8		100.2	100.2		100.2	100.2	
Actuated g/C Ratio	0.23	0.23		0.23	0.23		0.72	0.72		0.72	0.72	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	166	380		222	392		201	2504		157	2520	
v/s Ratio Prot		0.08			0.12			c0.44			0.39	
v/s Ratio Perm	0.10			c0.25			0.30			0.25		
v/c Ratio	0.43	0.37		1.12	0.54		0.42	0.62		0.34	0.55	
Uniform Delay, d1	46.4	45.7		54.1	47.7		8.1	10.1		7.5	9.3	
Progression Factor	1.59	1.68		1.00	1.00		0.79	0.70		1.00	1.00	
Incremental Delay, d2	0.8	0.3		95.4	1.6		5.6	1.0		5.9	0.9	
Delay (s)	74.4	77.0		149.5	49.3		12.0	8.1		13.4	10.2	
Level of Service	E	E		F	D		B	A		B	B	
Approach Delay (s)		76.2			101.7			8.3			10.3	
Approach LOS		E			F			A			B	

Intersection Summary			
HCM Average Control Delay	24.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	77.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0		4.0	4.0
Lane Util. Factor	1.00		0.95		1.00	0.95
Frt	0.94		0.99		1.00	1.00
Flt Protected	0.97		1.00		0.95	1.00
Satd. Flow (prot)	1699		3495		1770	3539
Flt Permitted	0.97		1.00		0.05	1.00
Satd. Flow (perm)	1699		3495		101	3539
Volume (vph)	79	71	1921	176	142	1848
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	84	76	2044	187	151	1966
RTOR Reduction (vph)	24	0	5	0	0	0
Lane Group Flow (vph)	136	0	2226	0	151	1966
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	14.2		112.8		112.8	112.8
Effective Green, g (s)	14.2		112.8		112.8	112.8
Actuated g/C Ratio	0.11		0.84		0.84	0.84
Clearance Time (s)	4.0		4.0		4.0	4.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	179		2920		84	2957
v/s Ratio Prot	c0.08		0.64			0.56
v/s Ratio Perm					c1.49	
v/c Ratio	0.76		0.76		1.80	0.66
Uniform Delay, d1	58.7		5.0		11.1	4.1
Progression Factor	1.21		2.49		2.50	2.59
Incremental Delay, d2	15.5		0.8		386.8	0.7
Delay (s)	86.6		13.3		414.6	11.4
Level of Service	F		B		F	B
Approach Delay (s)	86.6		13.3			40.1
Approach LOS	F		B			D

Intersection Summary			
HCM Average Control Delay	28.5	HCM Level of Service	C
HCM Volume to Capacity ratio	1.67		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	85.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1863	1583	1770	1863	1583	1770	3539	1583	1770	3512	
Flt Permitted	0.71	1.00	1.00	0.51	1.00	1.00	0.06	1.00	1.00	0.06	1.00	
Satd. Flow (perm)	1317	1863	1583	945	1863	1583	109	3539	1583	103	3512	
Volume (vph)	120	109	140	291	71	340	112	1558	244	218	1535	83
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	130	118	152	316	77	370	122	1693	265	237	1668	90
RTOR Reduction (vph)	0	0	103	0	0	134	0	0	87	0	3	0
Lane Group Flow (vph)	130	118	49	316	77	236	122	1693	178	237	1755	0
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		
Actuated Green, G (s)	29.0	25.0	25.0	39.0	31.0	31.0	74.8	67.3	67.3	86.0	74.5	
Effective Green, g (s)	30.0	26.0	26.0	40.0	32.0	32.0	75.8	68.3	68.3	87.0	75.5	
Actuated g/C Ratio	0.22	0.19	0.19	0.30	0.24	0.24	0.56	0.51	0.51	0.64	0.56	
Clearance Time (s)	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	306	359	305	341	442	375	153	1790	801	248	1964	
v/s Ratio Prot	0.01	0.06		c0.07	0.04		0.04	0.48		c0.10	0.50	
v/s Ratio Perm	0.08		0.03	c0.21		0.15	0.40		0.11	c0.51		
v/c Ratio	0.42	0.33	0.16	0.93	0.17	0.63	0.80	0.95	0.22	0.96	0.89	
Uniform Delay, d1	44.4	47.0	45.4	45.7	41.0	46.2	30.9	31.6	18.6	46.1	26.2	
Progression Factor	1.00	1.00	1.00	1.39	1.29	1.90	1.56	0.60	0.08	1.48	0.50	
Incremental Delay, d2	1.0	2.4	1.1	29.1	0.8	7.4	6.4	3.6	0.2	29.6	3.7	
Delay (s)	45.4	49.4	46.5	92.6	53.8	95.1	54.7	22.5	1.7	97.8	16.8	
Level of Service	D	D	D	F	D	F	D	C	A	F	B	
Approach Delay (s)		47.0			89.9			21.8			26.4	
Approach LOS		D			F			C			C	

Intersection Summary			
HCM Average Control Delay	35.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	87.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.99		1.00	0.94		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3459		1770	3510		1770	1753		1770	1781	
Flt Permitted	0.95	1.00		0.95	1.00		0.56	1.00		0.48	1.00	
Satd. Flow (perm)	1770	3459		1770	3510		1037	1753		894	1781	
Volume (vph)	81	364	65	192	529	30	39	190	122	18	163	67
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	88	396	71	209	575	33	42	207	133	20	177	73
RTOR Reduction (vph)	0	12	0	0	4	0	0	12	0	0	8	0
Lane Group Flow (vph)	88	455	0	209	604	0	42	328	0	20	242	0
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	11.1	30.2		18.7	37.8		74.1	74.1		74.1	74.1	
Effective Green, g (s)	11.1	30.2		18.7	37.8		74.1	74.1		74.1	74.1	
Actuated g/C Ratio	0.08	0.22		0.14	0.28		0.55	0.55		0.55	0.55	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	146	774		245	983		569	962		491	978	
v/s Ratio Prot	0.05	0.13		c0.12	c0.17			c0.19			0.14	
v/s Ratio Perm							0.04			0.02		
v/c Ratio	0.60	0.59		0.85	0.61		0.07	0.34		0.04	0.25	
Uniform Delay, d1	59.8	46.8		56.8	42.3		14.3	16.9		14.1	15.9	
Progression Factor	1.07	0.85		1.19	0.76		1.00	1.00		1.00	1.00	
Incremental Delay, d2	5.8	1.0		23.1	1.1		0.3	1.0		0.2	0.6	
Delay (s)	69.6	40.7		90.5	33.3		14.6	17.9		14.2	16.5	
Level of Service	E	D		F	C		B	B		B	B	
Approach Delay (s)		45.3			47.9			17.5			16.3	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	37.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	56.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.94		1.00	0.91		1.00	0.96		1.00	0.92	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1753		1770	1700		1770	3401		1770	3247	
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1753		1770	1700		1770	3401		1770	3247	
Volume (vph)	253	55	36	315	197	276	39	254	89	78	228	279
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	275	60	39	342	214	300	42	276	97	85	248	303
RTOR Reduction (vph)	0	25	0	0	43	0	0	22	0	0	131	0
Lane Group Flow (vph)	275	74	0	342	471	0	42	351	0	85	420	0
Turn Type	Prot			Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases												
Actuated Green, G (s)	25.1	10.3		55.4	40.6		5.2	40.7		12.6	48.1	
Effective Green, g (s)	25.1	10.3		55.4	40.6		5.2	40.7		12.6	48.1	
Actuated g/C Ratio	0.19	0.08		0.41	0.30		0.04	0.30		0.09	0.36	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	329	134		726	511		68	1025		165	1157	
v/s Ratio Prot	c0.16	0.04		0.19	c0.28		c0.02	0.10		c0.05	c0.13	
v/s Ratio Perm												
v/c Ratio	0.84	0.55		0.47	0.92		0.62	0.34		0.52	0.36	
Uniform Delay, d1	53.0	60.1		29.1	45.6		63.9	36.7		58.3	32.1	
Progression Factor	1.00	1.00		1.00	1.00		0.65	0.45		1.00	1.00	
Incremental Delay, d2	16.6	4.9		0.5	22.1		14.3	0.8		2.7	0.9	
Delay (s)	69.5	65.0		29.6	67.7		55.7	17.3		61.0	33.0	
Level of Service	E	E		C	E		E	B		E	C	
Approach Delay (s)		68.3			52.5			21.2			36.7	
Approach LOS		E			D			C			D	

Intersection Summary			
HCM Average Control Delay	45.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	73.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.97		1.00	0.92		1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1799		1770	1717		1770	3502		1770	3518	
Flt Permitted	0.46	1.00		0.49	1.00		0.09	1.00		0.06	1.00	
Satd. Flow (perm)	860	1799		909	1717		171	3502		114	3518	
Volume (vph)	42	77	23	83	51	55	39	1861	141	94	1682	69
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	46	84	25	90	55	60	42	2023	153	102	1828	75
RTOR Reduction (vph)	0	5	0	0	3	0	0	1	0	0	1	0
Lane Group Flow (vph)	46	104	0	90	112	0	42	2175	0	102	1902	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	13.3	13.3		13.3	13.3		113.7	113.7		113.7	113.7	
Effective Green, g (s)	13.3	13.3		13.3	13.3		113.7	113.7		113.7	113.7	
Actuated g/C Ratio	0.10	0.10		0.10	0.10		0.84	0.84		0.84	0.84	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	85	177		90	169		144	2949		96	2963	
v/s Ratio Prot		0.06			0.07			0.62			0.54	
v/s Ratio Perm	0.05			c0.10			0.25			c0.90		
v/c Ratio	0.54	0.59		1.00	0.66		0.29	0.74		1.06	0.64	
Uniform Delay, d1	57.9	58.2		60.9	58.7		2.2	4.4		10.6	3.7	
Progression Factor	0.97	0.96		1.00	1.00		1.00	1.00		1.40	0.99	
Incremental Delay, d2	3.6	2.7		94.9	9.4		5.1	1.7		98.6	0.8	
Delay (s)	59.9	58.4		155.7	68.1		7.3	6.1		113.6	4.5	
Level of Service	E	E		F	E		A	A		F	A	
Approach Delay (s)		58.8			106.6			6.1			10.0	
Approach LOS		E			F			A			B	

Intersection Summary			
HCM Average Control Delay	14.1	HCM Level of Service	B
HCM Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	82.4%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.90		1.00	0.93		1.00	0.98		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1676		1770	1727		1770	3480		1770	3503	
Flt Permitted	0.58	1.00		0.26	1.00		0.08	1.00		0.07	1.00	
Satd. Flow (perm)	1080	1676		492	1727		156	3480		125	3503	
Volume (vph)	105	80	162	124	57	54	166	1576	200	86	1550	112
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	114	87	176	135	62	59	180	1713	217	93	1685	122
RTOR Reduction (vph)	0	6	0	0	6	0	0	4	0	0	2	0
Lane Group Flow (vph)	114	257	0	135	115	0	180	1926	0	93	1805	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	26.2	26.2		26.2	26.2		100.8	100.8		100.8	100.8	
Effective Green, g (s)	26.2	26.2		26.2	26.2		100.8	100.8		100.8	100.8	
Actuated g/C Ratio	0.19	0.19		0.19	0.19		0.75	0.75		0.75	0.75	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	210	325		95	335		116	2598		93	2616	
v/s Ratio Prot		0.15			0.07			0.55			0.52	
v/s Ratio Perm	0.11			c0.27			c1.16			0.75		
v/c Ratio	0.54	0.79		1.42	0.34		1.55	0.74		1.00	0.69	
Uniform Delay, d1	49.0	51.8		54.4	47.0		17.1	9.7		17.1	8.9	
Progression Factor	1.48	1.46		1.00	1.00		0.79	0.84		1.00	1.00	
Incremental Delay, d2	0.3	1.2		240.0	0.6		275.5	1.4		93.3	1.5	
Delay (s)	72.9	77.1		294.4	47.6		289.1	9.5		110.4	10.5	
Level of Service	E	E		F	D		F	A		F	B	
Approach Delay (s)		75.8			177.7			33.3			15.3	
Approach LOS		E			F			C			B	

Intersection Summary			
HCM Average Control Delay	37.4	HCM Level of Service	D
HCM Volume to Capacity ratio	1.52		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	90.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

CUMULATIVE PLUS PROJECT (2036) CONDITIONS WITH MITIGATIONS – CONCEPT 3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0		4.0	4.0
Lane Util. Factor	1.00		0.95		1.00	0.95
Frt	0.92		0.99		1.00	1.00
Flt Protected	0.98		1.00		0.95	1.00
Satd. Flow (prot)	1680		3512		1770	3539
Flt Permitted	0.98		1.00		0.11	1.00
Satd. Flow (perm)	1680		3512		214	3539
Volume (vph)	104	148	1524	83	83	1575
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	107	153	1571	86	86	1624
RTOR Reduction (vph)	39	0	2	0	0	0
Lane Group Flow (vph)	221	0	1655	0	86	1624
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	22.2		109.8		109.8	109.8
Effective Green, g (s)	22.2		109.8		109.8	109.8
Actuated g/C Ratio	0.16		0.78		0.78	0.78
Clearance Time (s)	4.0		4.0		4.0	4.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	266		2754		168	2776
v/s Ratio Prot	c0.13		c0.47			0.46
v/s Ratio Perm					0.40	
v/c Ratio	0.83		0.60		0.51	0.59
Uniform Delay, d1	57.1		6.2		5.4	6.0
Progression Factor	1.13		0.73		1.33	1.01
Incremental Delay, d2	18.6		0.7		7.9	0.7
Delay (s)	83.0		5.2		15.2	6.8
Level of Service	F		A		B	A
Approach Delay (s)	83.0		5.2			7.2
Approach LOS	F		A			A

Intersection Summary			
HCM Average Control Delay	11.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	74.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.93		1.00	0.89		1.00	0.98		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1725		1770	1660		1770	3482		1770	3508	
Flt Permitted	0.49	1.00		0.65	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	919	1725		1209	1660		1770	3482		1770	3508	
Volume (vph)	140	43	42	228	41	109	29	1343	163	67	1497	95
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	149	46	45	243	44	116	31	1429	173	71	1593	101
RTOR Reduction (vph)	0	25	0	0	68	0	0	7	0	0	3	0
Lane Group Flow (vph)	149	66	0	243	92	0	31	1595	0	71	1691	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	27.0	27.0		27.0	27.0		3.0	94.0		5.0	96.0	
Effective Green, g (s)	28.0	28.0		28.0	28.0		3.0	95.0		5.0	97.0	
Actuated g/C Ratio	0.20	0.20		0.20	0.20		0.02	0.68		0.04	0.69	
Clearance Time (s)	5.0	5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)	184	345		242	332		38	2363		63	2431	
v/s Ratio Prot		0.04			0.06		0.02	0.46		c0.04	c0.48	
v/s Ratio Perm	0.16			c0.20								
v/c Ratio	0.81	0.19		1.00	0.28		0.82	0.68		1.13	0.70	
Uniform Delay, d1	53.5	46.6		56.0	47.4		68.2	13.3		67.5	12.7	
Progression Factor	1.00	1.00		1.00	1.00		0.85	0.59		1.23	0.66	
Incremental Delay, d2	22.4	0.3		58.9	0.5		52.7	1.0		141.2	1.4	
Delay (s)	75.9	46.9		114.9	47.9		110.9	8.8		224.4	9.8	
Level of Service	E	D		F	D		F	A		F	A	
Approach Delay (s)		64.9			88.3			10.8			18.5	
Approach LOS		E			F			B			B	

Intersection Summary			
HCM Average Control Delay	25.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	79.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1863	1583	1770	1863	1583	1770	3539	1583	1770	3511	
Flt Permitted	0.72	1.00	1.00	0.63	1.00	1.00	0.06	1.00	1.00	0.05	1.00	
Satd. Flow (perm)	1343	1863	1583	1172	1863	1583	107	3539	1583	93	3511	
Volume (vph)	36	49	63	134	52	147	56	1522	235	175	1515	84
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	38	52	66	141	55	155	59	1602	247	184	1595	88
RTOR Reduction (vph)	0	0	53	0	0	120	0	0	83	0	2	0
Lane Group Flow (vph)	38	52	13	141	55	35	59	1602	164	184	1681	0
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		
Actuated Green, G (s)	30.6	25.8	25.8	39.5	30.7	30.7	80.6	75.5	75.5	90.5	81.4	
Effective Green, g (s)	31.6	26.8	26.8	40.5	31.7	31.7	81.6	76.5	76.5	91.5	82.4	
Actuated g/C Ratio	0.23	0.19	0.19	0.29	0.23	0.23	0.58	0.55	0.55	0.65	0.59	
Clearance Time (s)	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	318	357	303	380	422	358	123	1934	865	193	2066	
v/s Ratio Prot	0.00	0.03		c0.03	0.03		0.02	0.45		c0.08	0.48	
v/s Ratio Perm	0.02		0.01	c0.08		0.02	0.26		0.10	c0.55		
v/c Ratio	0.12	0.15	0.04	0.37	0.13	0.10	0.48	0.83	0.19	0.95	0.81	
Uniform Delay, d1	42.9	47.1	46.1	38.5	43.2	42.8	22.3	26.3	16.1	45.1	22.7	
Progression Factor	1.00	1.00	1.00	1.44	1.42	4.58	2.26	0.47	0.05	1.51	0.50	
Incremental Delay, d2	0.2	0.9	0.3	0.6	0.6	0.5	0.3	1.1	0.1	40.5	2.5	
Delay (s)	43.1	47.9	46.4	56.0	61.8	196.8	50.5	13.4	0.9	108.7	14.0	
Level of Service	D	D	D	E	E	F	D	B	A	F	B	
Approach Delay (s)		46.1			119.1			12.9			23.3	
Approach LOS		D			F			B			C	

Intersection Summary			
HCM Average Control Delay	27.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	75.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.98		1.00	0.90		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3512		1770	3463		1770	1677		1770	1783	
Flt Permitted	0.95	1.00		0.95	1.00		0.62	1.00		0.56	1.00	
Satd. Flow (perm)	1770	3512		1770	3463		1150	1677		1043	1783	
Volume (vph)	36	362	19	95	197	33	60	85	167	47	132	52
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	39	393	21	103	214	36	65	92	182	51	143	57
RTOR Reduction (vph)	0	3	0	0	12	0	0	28	0	0	6	0
Lane Group Flow (vph)	39	411	0	103	238	0	65	246	0	51	194	0
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	5.6	24.9		12.1	31.4		91.0	91.0		91.0	91.0	
Effective Green, g (s)	5.6	24.9		12.1	31.4		91.0	91.0		91.0	91.0	
Actuated g/C Ratio	0.04	0.18		0.09	0.22		0.65	0.65		0.65	0.65	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	71	625		153	777		748	1090		678	1159	
v/s Ratio Prot	0.02	c0.12		c0.06	0.07			c0.15			0.11	
v/s Ratio Perm							0.06			0.05		
v/c Ratio	0.55	0.66		0.67	0.31		0.09	0.23		0.08	0.17	
Uniform Delay, d1	66.0	53.6		62.0	45.2		9.1	10.0		9.0	9.6	
Progression Factor	1.12	1.20		1.14	1.29		1.00	1.00		1.00	1.00	
Incremental Delay, d2	7.4	2.2		11.0	0.2		0.2	0.5		0.2	0.3	
Delay (s)	81.2	66.6		81.6	58.5		9.3	10.5		9.2	9.9	
Level of Service	F	E		F	E		A	B		A	A	
Approach Delay (s)		67.9			65.3			10.3			9.8	
Approach LOS		E			E			B			A	

Intersection Summary			
HCM Average Control Delay	42.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	47.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.97		1.00	0.91		1.00	0.90		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1814		1770	1699		1770	3200		1770	3380	
Flt Permitted	0.95	1.00		0.95	1.00		0.53	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1814		1770	1699		985	3200		1770	3380	
Volume (vph)	160	182	39	40	25	35	25	164	291	254	242	104
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	174	198	42	43	27	38	27	178	316	276	263	113
RTOR Reduction (vph)	0	6	0	0	35	0	0	156	0	0	22	0
Lane Group Flow (vph)	174	234	0	43	30	0	27	338	0	276	354	0
Turn Type	Prot			Prot			Perm			Prot		
Protected Phases	7	4		3	8			2		1	6	
Permitted Phases							2					
Actuated Green, G (s)	19.1	22.4		7.6	10.9		66.9	66.9		27.1	98.0	
Effective Green, g (s)	19.1	22.4		7.6	10.9		66.9	66.9		27.1	98.0	
Actuated g/C Ratio	0.14	0.16		0.05	0.08		0.48	0.48		0.19	0.70	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	241	290		96	132		471	1529		343	2366	
v/s Ratio Prot	c0.10	c0.13		0.02	0.02			c0.11		c0.16	0.10	
v/s Ratio Perm							0.03					
v/c Ratio	0.72	0.81		0.45	0.23		0.06	0.22		0.80	0.15	
Uniform Delay, d1	57.9	56.7		64.2	60.6		19.6	21.3		53.9	7.0	
Progression Factor	1.00	1.00		1.00	1.00		0.74	1.13		0.80	0.71	
Incremental Delay, d2	10.2	15.1		3.3	0.9		0.2	0.3		12.0	0.1	
Delay (s)	68.1	71.8		67.5	61.5		14.7	24.5		55.0	5.2	
Level of Service	E	E		E	E		B	C		E	A	
Approach Delay (s)		70.2			63.9			24.0			26.3	
Approach LOS		E			E			C			C	

Intersection Summary			
HCM Average Control Delay	38.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	56.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.89		1.00	0.92		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1660		1770	1717		1770	3523		1770	3513	
Flt Permitted	0.34	1.00		0.63	1.00		0.11	1.00		0.16	1.00	
Satd. Flow (perm)	635	1660		1167	1717		214	3523		299	3513	
Volume (vph)	106	22	59	132	81	88	42	1269	40	27	1464	76
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	115	24	64	143	88	96	46	1379	43	29	1591	83
RTOR Reduction (vph)	0	9	0	0	16	0	0	1	0	0	1	0
Lane Group Flow (vph)	115	79	0	143	168	0	46	1421	0	29	1673	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	20.5	20.5		20.5	20.5		111.5	111.5		111.5	111.5	
Effective Green, g (s)	20.5	20.5		20.5	20.5		111.5	111.5		111.5	111.5	
Actuated g/C Ratio	0.15	0.15		0.15	0.15		0.80	0.80		0.80	0.80	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	93	243		171	251		170	2806		238	2798	
v/s Ratio Prot		0.05			0.10			0.40			c0.48	
v/s Ratio Perm	c0.18			0.12			0.22			0.10		
v/c Ratio	1.24	0.33		0.84	0.67		0.27	0.51		0.12	0.60	
Uniform Delay, d1	59.8	53.6		58.1	56.5		3.7	4.9		3.2	5.5	
Progression Factor	1.03	1.03		1.00	1.00		1.41	1.40		0.81	0.76	
Incremental Delay, d2	161.3	0.6		28.3	6.6		3.7	0.6		0.9	0.8	
Delay (s)	222.7	56.1		86.4	63.1		8.9	7.4		3.5	5.1	
Level of Service	F	E		F	E		A	A		A	A	
Approach Delay (s)		150.4			73.3			7.5			5.0	
Approach LOS		F			E			A			A	

Intersection Summary			
HCM Average Control Delay	20.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	68.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.89		1.00	0.93		1.00	0.99		1.00	1.00	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1667		1770	1726		1770	3501		1770	3524	
Flt Permitted	0.41	1.00		0.52	1.00		0.15	1.00		0.13	1.00	
Satd. Flow (perm)	759	1667		962	1726		279	3501		242	3524	
Volume (vph)	67	42	99	210	97	93	67	1285	99	45	1257	37
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	73	46	108	228	105	101	73	1397	108	49	1366	40
RTOR Reduction (vph)	0	16	0	0	14	0	0	2	0	0	1	0
Lane Group Flow (vph)	73	138	0	228	192	0	73	1503	0	49	1405	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	29.3	29.3		29.3	29.3		102.7	102.7		102.7	102.7	
Effective Green, g (s)	29.3	29.3		29.3	29.3		102.7	102.7		102.7	102.7	
Actuated g/C Ratio	0.21	0.21		0.21	0.21		0.73	0.73		0.73	0.73	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	159	349		201	361		205	2568		178	2585	
v/s Ratio Prot		0.08			0.11			c0.43			0.40	
v/s Ratio Perm	0.10			c0.24			0.26			0.20		
v/c Ratio	0.46	0.40		1.13	0.53		0.36	0.59		0.28	0.54	
Uniform Delay, d1	48.4	47.7		55.4	49.2		6.7	8.7		6.2	8.3	
Progression Factor	1.50	1.59		1.00	1.00		0.75	0.67		1.00	1.00	
Incremental Delay, d2	0.9	0.3		104.3	1.5		4.3	0.9		3.8	0.8	
Delay (s)	73.6	76.0		159.6	50.7		9.3	6.7		10.0	9.1	
Level of Service	E	E		F	D		A	A		B	A	
Approach Delay (s)		75.2			107.9			6.9			9.1	
Approach LOS		E			F			A			A	

Intersection Summary			
HCM Average Control Delay	23.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	75.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0		4.0	4.0
Lane Util. Factor	1.00		0.95		1.00	0.95
Frt	0.93		0.99		1.00	1.00
Flt Protected	0.98		1.00		0.95	1.00
Satd. Flow (prot)	1688		3496		1770	3539
Flt Permitted	0.98		1.00		0.04	1.00
Satd. Flow (perm)	1688		3496		77	3539
Volume (vph)	86	101	1986	175	166	1906
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	91	107	2113	186	177	2028
RTOR Reduction (vph)	13	0	3	0	0	0
Lane Group Flow (vph)	185	0	2296	0	177	2028
Turn Type					Perm	
Protected Phases	8		2			6
Permitted Phases					6	
Actuated Green, G (s)	18.2		108.8		108.8	108.8
Effective Green, g (s)	18.2		108.8		108.8	108.8
Actuated g/C Ratio	0.13		0.81		0.81	0.81
Clearance Time (s)	4.0		4.0		4.0	4.0
Vehicle Extension (s)	3.0		3.0		3.0	3.0
Lane Grp Cap (vph)	228		2818		62	2852
v/s Ratio Prot	c0.11		0.66			0.57
v/s Ratio Perm					c2.30	
v/c Ratio	0.81		0.81		2.85	0.71
Uniform Delay, d1	56.7		7.4		13.1	6.0
Progression Factor	0.99		0.28		1.73	1.52
Incremental Delay, d2	16.1		0.3		860.5	0.9
Delay (s)	72.4		2.3		883.1	10.0
Level of Service	E		A		F	A
Approach Delay (s)	72.4		2.3			80.1
Approach LOS	E		A			F

Intersection Summary			
HCM Average Control Delay	41.7	HCM Level of Service	D
HCM Volume to Capacity ratio	2.56		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	90.6%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.93		1.00	0.88		1.00	0.98		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1739		1770	1640		1770	3467		1770	3498	
Flt Permitted	0.47	1.00		0.63	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	872	1739		1172	1640		1770	3467		1770	3498	
Volume (vph)	209	57	45	241	37	145	49	1747	277	138	1624	138
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	227	62	49	262	40	158	53	1899	301	150	1765	150
RTOR Reduction (vph)	0	21	0	0	77	0	0	10	0	0	4	0
Lane Group Flow (vph)	227	90	0	262	121	0	53	2190	0	150	1911	0
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)	32.0	32.0		32.0	32.0		4.8	78.0		11.0	84.2	
Effective Green, g (s)	33.0	33.0		33.0	33.0		4.8	79.0		11.0	85.2	
Actuated g/C Ratio	0.24	0.24		0.24	0.24		0.04	0.59		0.08	0.63	
Clearance Time (s)	5.0	5.0		5.0	5.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		2.0	5.0		2.0	5.0	
Lane Grp Cap (vph)	213	425		286	401		63	2029		144	2208	
v/s Ratio Prot		0.05			0.07		0.03	c0.63		c0.08	0.55	
v/s Ratio Perm	c0.26			0.22								
v/c Ratio	1.07	0.21		0.92	0.30		0.84	1.08		1.04	0.87	
Uniform Delay, d1	51.0	40.6		49.7	41.6		64.7	28.0		62.0	20.2	
Progression Factor	1.00	1.00		1.00	1.00		1.07	0.27		1.16	0.71	
Incremental Delay, d2	80.1	1.1		31.9	0.4		23.3	39.0		74.2	3.5	
Delay (s)	131.1	41.8		81.5	42.0		92.4	46.4		146.2	17.9	
Level of Service	F	D		F	D		F	D		F	B	
Approach Delay (s)		101.8			64.5			47.5			27.3	
Approach LOS		F			E			D			C	

Intersection Summary			
HCM Average Control Delay	44.5	HCM Level of Service	D
HCM Volume to Capacity ratio	1.07		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	100.6%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	1863	1583	1770	1863	1583	1770	3539	1583	1770	3514	
Flt Permitted	0.71	1.00	1.00	0.62	1.00	1.00	0.06	1.00	1.00	0.06	1.00	
Satd. Flow (perm)	1322	1863	1583	1149	1863	1583	114	3539	1583	108	3514	
Volume (vph)	117	98	140	301	62	369	112	1661	226	232	1631	81
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	127	107	152	327	67	401	122	1805	246	252	1773	88
RTOR Reduction (vph)	0	0	115	0	0	183	0	0	73	0	3	0
Lane Group Flow (vph)	127	107	37	327	67	218	122	1805	173	252	1858	0
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		
Actuated Green, G (s)	33.6	25.0	25.0	37.6	27.0	27.0	72.4	64.3	64.3	86.4	73.3	
Effective Green, g (s)	34.6	26.0	26.0	38.6	28.0	28.0	73.4	65.3	65.3	86.4	74.3	
Actuated g/C Ratio	0.26	0.19	0.19	0.29	0.21	0.21	0.54	0.48	0.48	0.64	0.55	
Clearance Time (s)	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	2.0	5.0	5.0	2.0	5.0	
Lane Grp Cap (vph)	367	359	305	377	386	328	161	1712	766	280	1934	
v/s Ratio Prot	0.02	0.06		c0.07	0.04		0.05	c0.51		c0.11	c0.53	
v/s Ratio Perm	0.07		0.02	c0.18		0.14	0.37		0.11	0.46		
v/c Ratio	0.35	0.30	0.12	0.87	0.17	0.66	0.76	1.05	0.23	0.90	0.96	
Uniform Delay, d1	41.4	46.7	45.0	46.4	44.0	49.2	60.8	34.9	20.2	54.5	29.0	
Progression Factor	1.00	1.00	1.00	1.52	1.21	2.14	0.45	0.99	1.44	0.80	0.87	
Incremental Delay, d2	0.6	2.1	0.8	17.4	0.9	9.5	1.7	26.2	0.1	17.7	8.1	
Delay (s)	42.0	48.8	45.8	88.2	54.3	114.5	29.1	60.7	29.1	61.5	33.2	
Level of Service	D	D	D	F	D	F	C	E	C	E	C	
Approach Delay (s)		45.4			98.6			55.4			36.6	
Approach LOS		D			F			E			D	

Intersection Summary			
HCM Average Control Delay	53.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	92.1%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	0.98		1.00	0.99		1.00	0.95		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3457		1770	3492		1770	1765		1770	1786	
Flt Permitted	0.95	1.00		0.95	1.00		0.56	1.00		0.50	1.00	
Satd. Flow (perm)	1770	3457		1770	3492		1046	1765		939	1786	
Volume (vph)	70	359	65	197	562	54	39	185	100	47	163	62
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	76	390	71	214	611	59	42	201	109	51	177	67
RTOR Reduction (vph)	0	12	0	0	6	0	0	10	0	0	7	0
Lane Group Flow (vph)	76	449	0	214	664	0	42	300	0	51	237	0
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	9.3	27.2		22.0	39.9		73.8	73.8		73.8	73.8	
Effective Green, g (s)	9.3	27.2		22.0	39.9		73.8	73.8		73.8	73.8	
Actuated g/C Ratio	0.07	0.20		0.16	0.30		0.55	0.55		0.55	0.55	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	122	697		288	1032		572	965		513	976	
v/s Ratio Prot	0.04	0.13		c0.12	c0.19			c0.17			0.13	
v/s Ratio Perm							0.04			0.05		
v/c Ratio	0.62	0.64		0.74	0.64		0.07	0.31		0.10	0.24	
Uniform Delay, d1	61.1	49.5		53.8	41.4		14.5	16.7		14.7	16.0	
Progression Factor	0.67	0.94		1.25	0.66		1.00	1.00		1.00	1.00	
Incremental Delay, d2	8.2	1.8		9.3	1.3		0.2	0.8		0.4	0.6	
Delay (s)	49.3	48.3		76.6	28.5		14.7	17.6		15.1	16.6	
Level of Service	D	D		E	C		B	B		B	B	
Approach Delay (s)		48.4			40.1			17.2			16.3	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM Average Control Delay	35.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.90		1.00	0.91		1.00	0.98		1.00	0.92	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1673		1770	1700		1770	3461		1770	3257	
Flt Permitted	0.95	1.00		0.95	1.00		0.44	1.00		0.95	1.00	
Satd. Flow (perm)	1770	1673		1770	1700		823	3461		1770	3257	
Volume (vph)	245	29	63	339	212	296	69	265	46	40	236	269
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	266	32	68	368	230	322	75	288	50	43	257	292
RTOR Reduction (vph)	0	50	0	0	43	0	0	9	0	0	127	0
Lane Group Flow (vph)	266	50	0	368	509	0	75	329	0	43	422	0
Turn Type	Prot			Prot			Perm			Prot		
Protected Phases	7	4		3	8			2		1	6	
Permitted Phases							2					
Actuated Green, G (s)	24.2	35.7		31.9	43.4		44.7	44.7		6.7	55.4	
Effective Green, g (s)	24.2	35.7		31.9	43.4		44.7	44.7		6.7	55.4	
Actuated g/C Ratio	0.18	0.26		0.24	0.32		0.33	0.33		0.05	0.41	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	317	442		418	547		273	1146		88	1337	
v/s Ratio Prot	0.15	0.03		c0.21	c0.30			0.10		c0.02	c0.13	
v/s Ratio Perm							0.09					
v/c Ratio	0.84	0.11		0.88	0.93		0.27	0.29		0.49	0.32	
Uniform Delay, d1	53.5	37.6		49.7	44.3		33.2	33.4		62.5	27.0	
Progression Factor	1.00	1.00		1.00	1.00		0.65	0.62		0.97	0.50	
Incremental Delay, d2	17.4	0.1		18.9	22.8		2.3	0.6		3.6	0.5	
Delay (s)	70.9	37.8		68.7	67.1		24.0	21.3		63.9	14.0	
Level of Service	E	D		E	E		C	C		E	B	
Approach Delay (s)		61.8			67.7			21.8			17.6	
Approach LOS		E			E			C			B	

Intersection Summary			
HCM Average Control Delay	45.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	75.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.93		1.00	0.92		1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1735		1770	1719		1770	3504		1770	3501	
Flt Permitted	0.57	1.00		0.44	1.00		0.09	1.00		0.06	1.00	
Satd. Flow (perm)	1058	1735		827	1719		173	3504		118	3501	
Volume (vph)	106	70	59	74	46	49	69	1795	129	86	1575	123
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	115	76	64	80	50	53	75	1951	140	93	1712	134
RTOR Reduction (vph)	0	6	0	0	3	0	0	1	0	0	2	0
Lane Group Flow (vph)	115	134	0	80	100	0	75	2090	0	93	1844	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	17.6	17.6		17.6	17.6		109.4	109.4		109.4	109.4	
Effective Green, g (s)	17.6	17.6		17.6	17.6		109.4	109.4		109.4	109.4	
Actuated g/C Ratio	0.13	0.13		0.13	0.13		0.81	0.81		0.81	0.81	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	138	226		108	224		140	2840		96	2837	
v/s Ratio Prot		0.08			0.06			0.60			0.53	
v/s Ratio Perm	c0.11			0.10			0.43			c0.79		
v/c Ratio	0.83	0.59		0.74	0.45		0.54	0.74		0.97	0.65	
Uniform Delay, d1	57.3	55.3		56.5	54.2		4.3	6.0		11.3	5.1	
Progression Factor	0.95	0.95		1.00	1.00		1.83	2.12		1.02	0.83	
Incremental Delay, d2	15.8	1.7		23.6	1.4		12.0	1.5		74.5	0.9	
Delay (s)	70.3	54.2		80.1	55.6		19.9	14.2		86.1	5.2	
Level of Service	E	D		F	E		B	B		F	A	
Approach Delay (s)		61.5			66.3			14.4			9.1	
Approach LOS		E			E			B			A	

Intersection Summary			
HCM Average Control Delay	16.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.91		1.00	0.93		1.00	0.98		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	1686		1770	1728		1770	3484		1770	3509	
Flt Permitted	0.58	1.00		0.31	1.00		0.10	1.00		0.07	1.00	
Satd. Flow (perm)	1084	1686		572	1728		178	3484		133	3509	
Volume (vph)	79	73	124	114	52	49	138	1611	186	80	1537	93
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	86	79	135	124	57	53	150	1751	202	87	1671	101
RTOR Reduction (vph)	0	7	0	0	5	0	0	3	0	0	1	0
Lane Group Flow (vph)	86	207	0	124	105	0	150	1950	0	87	1771	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	22.1	22.1		22.1	22.1		104.9	104.9		104.9	104.9	
Effective Green, g (s)	22.1	22.1		22.1	22.1		104.9	104.9		104.9	104.9	
Actuated g/C Ratio	0.16	0.16		0.16	0.16		0.78	0.78		0.78	0.78	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	177	276		94	283		138	2707		103	2727	
v/s Ratio Prot		0.12			0.06			0.56			0.50	
v/s Ratio Perm	0.08			c0.22			c0.84			0.65		
v/c Ratio	0.49	0.75		1.32	0.37		1.09	0.72		0.84	0.65	
Uniform Delay, d1	51.3	53.8		56.5	50.3		15.0	7.6		9.8	6.8	
Progression Factor	1.38	1.37		1.00	1.00		1.02	0.84		1.00	1.00	
Incremental Delay, d2	0.2	1.1		200.4	0.8		89.7	1.2		53.7	1.2	
Delay (s)	70.8	74.8		256.8	51.1		105.0	7.6		63.5	8.0	
Level of Service	E	E		F	D		F	A		E	A	
Approach Delay (s)		73.7			160.1			14.6			10.6	
Approach LOS		E			F			B			B	

Intersection Summary			
HCM Average Control Delay	24.4	HCM Level of Service	C
HCM Volume to Capacity ratio	1.13		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	86.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX C:
SIGNAL WARRANT ANALYSIS

FEHR & PEERS
TRANSPORTATION CONSULTANTS

Sheet No	1	of	5

Project	Concept 1
Scenario	2028 Cumulative Plus Project
Peak Hour	AM

Major Street	Honoapi'ilan Hwy
Minor Street	Wahikuli Rd

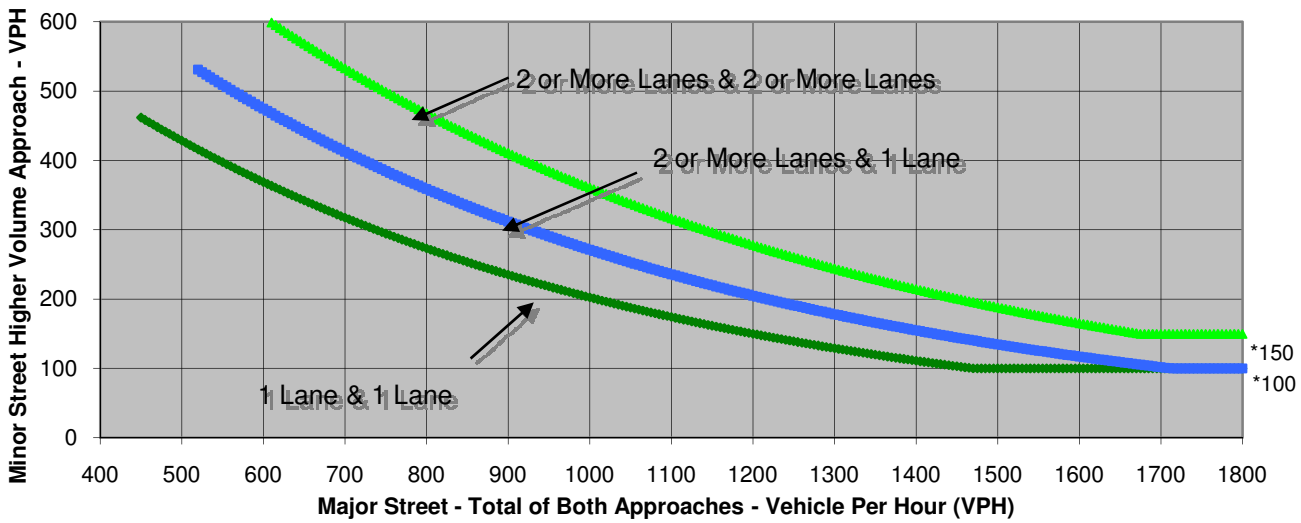
Turn Movement Volumes

	NB	SB	EB	WB
Left				66
Through	1,299	1,324		
Right	65			84
Total	1,364	1,324	0	150

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



* Note: 150 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 100 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Honoapi'ilan Hwy	Wahikuli Rd	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	2,688	150	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Sheet No	2	of	5

Project	Concept 1
Scenario	2028 Cumulative Plus Project
Peak Hour	AM

Major Street	Keawe St
Minor Street	Mill St

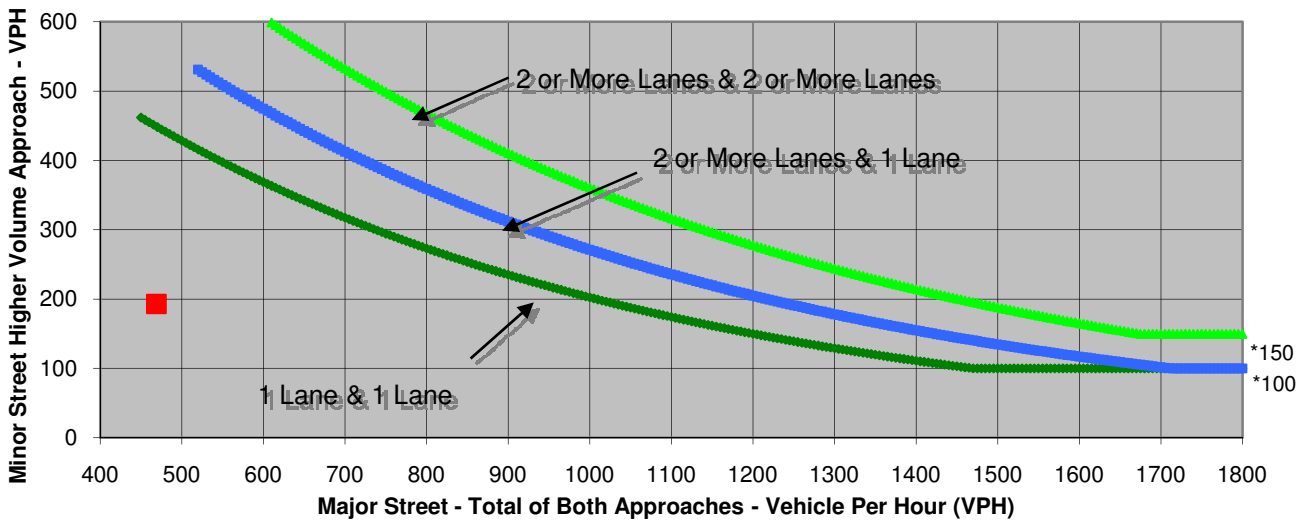
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	78	101	298	134
Right	115	47	18	19
Total	193	148	316	153

Major Street Direction

	North/South
x	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Keawe St	Mill St	
Number of Approach Lanes	4	1	NO
Traffic Volume (VPH) *	469	193	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

FEHR & PEERS
TRANSPORTATION CONSULTANTS

Sheet No	3	of	5

Project	Concept 1
Scenario	2028 Cumulative Plus Project
Peak Hour	AM

Major Street	Keawe St
Minor Street	Industrial Connector

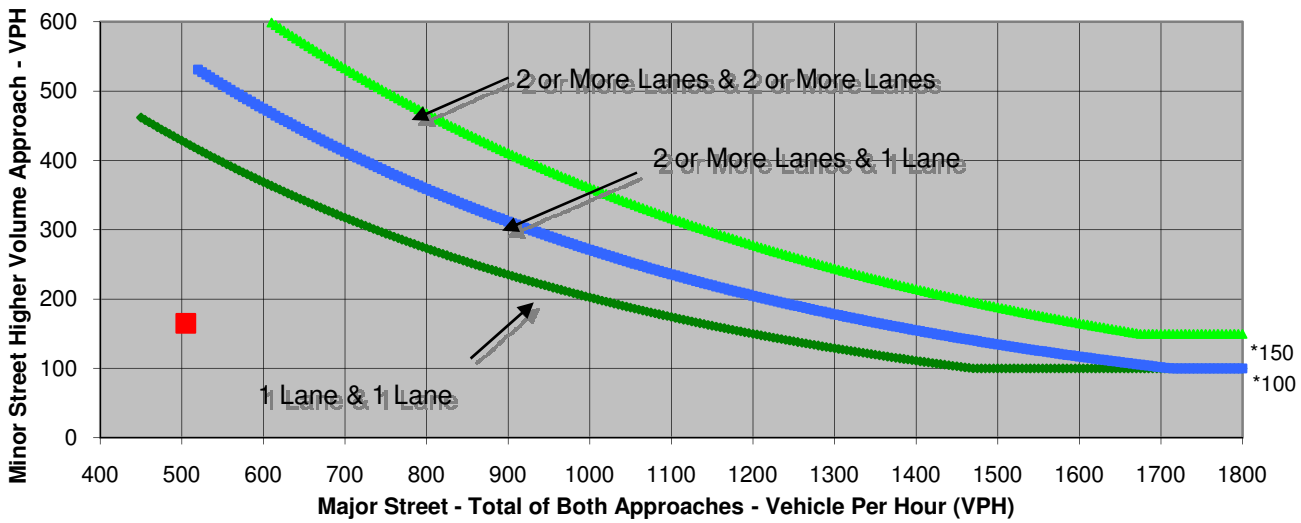
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	87	75	149	25
Right	239	104	16	35
Total	326	179	165	60

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Keawe St	Industrial Connector	
Number of Approach Lanes	4	1	NO
Traffic Volume (VPH) *	505	165	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Sheet No	4	of	5

Project	Concept 1
Scenario	2028 Cumulative Plus Project
Peak Hour	AM

Major Street	Lahaina Bypass Rd
Minor Street	Wahikuli Rd

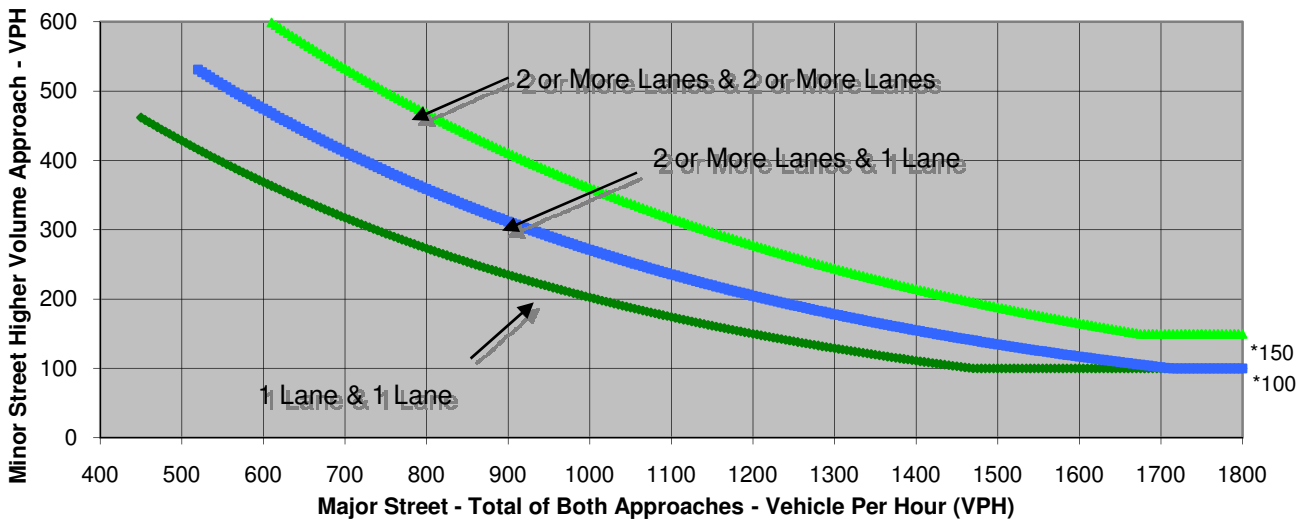
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	1,071	1,137	0	9
Right	1	43	39	2
Total	1,072	1,180	39	11

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



* Note: 150 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 100 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Lahaina Bypass Rd	Wahikuli Rd	
Number of Approach Lanes	4	1	NO
Traffic Volume (VPH) *	2,252	39	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Sheet No	5	of	5

Project	Concept 1
Scenario	2028 Cumulative Plus Project
Peak Hour	AM

Major Street	Lahaina Rd
Minor Street	Leiali'I Pkwy

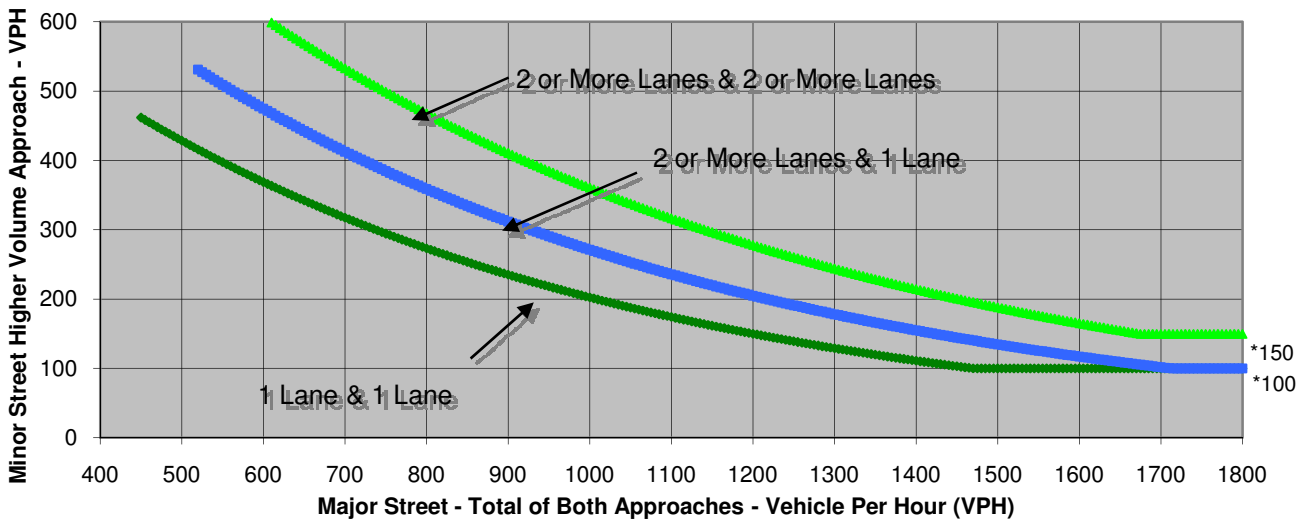
Turn Movement Volumes

	NB	SB	EB	WB
Left	0	1	48	27
Through	1,063	1,086	0	11
Right	9	40	67	3
Total	1,072	1,127	115	41

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	**Minor Street**	**Warrant Met**
	Lahaina Rd	Leiali'I Pkwy	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	2,199	115	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Sheet No	1	of	5

Project	Concept 2
Scenario	2028 Cumulative Plus Project
Peak Hour	PM

Major Street	Honoapi'ilan Hwy
Minor Street	Wahikuli Rd

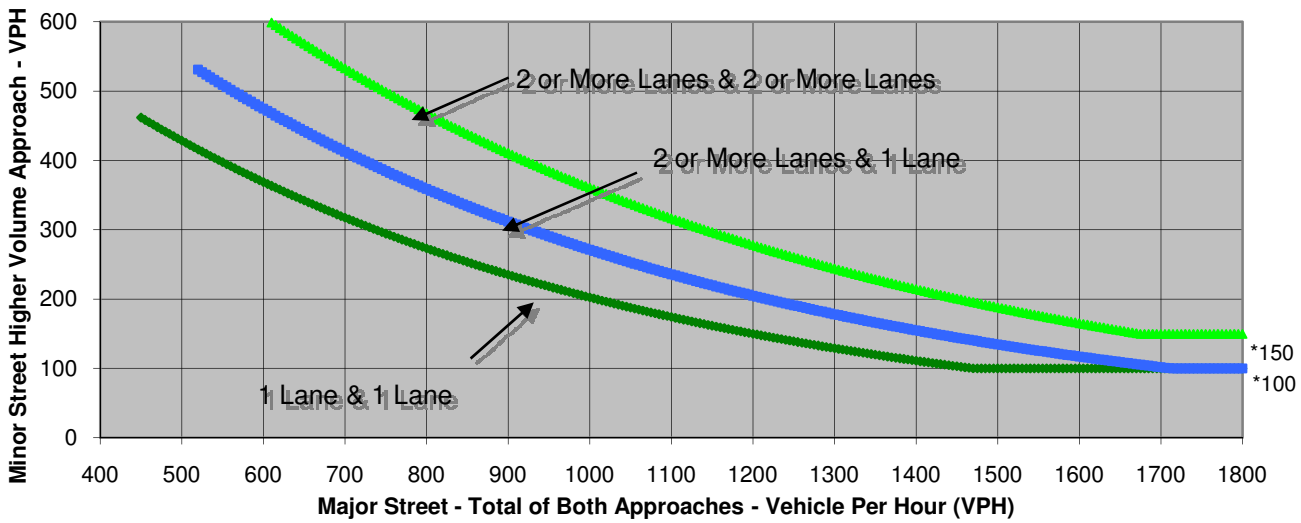
Turn Movement Volumes

	NB	SB	EB	WB
Left		0		59
Through	1,174	1,713		
Right	142			43
Total	1,316	1,713	0	102

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	**Minor Street**	**Warrant Met**
	Honoapi'ilan Hwy	Wahikuli Rd	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	3,029	102	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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TRANSPORTATION CONSULTANTS

Sheet No	2	of	5

Project	Concept 2
Scenario	2028 Cumulative Plus Project
Peak Hour	PM

Major Street	Keawe St
Minor Street	Mill St

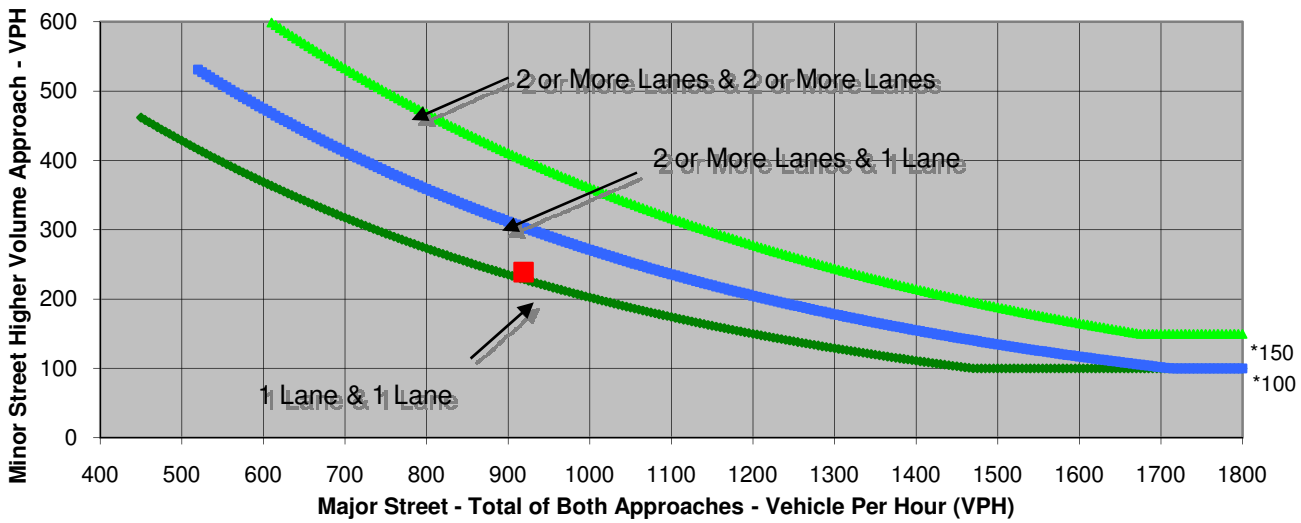
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	190	163	326	501
Right	49	67	62	30
Total	239	230	388	531

Major Street Direction

	North/South
x	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Keawe St	Mill St	
Number of Approach Lanes	4	1	NO
Traffic Volume (VPH) *	919	239	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

FEHR & PEERS
TRANSPORTATION CONSULTANTS

Sheet No	3	of	5

Project	Concept 2
Scenario	2028 Cumulative Plus Project
Peak Hour	PM

Major Street	Keawe St
Minor Street	Industrial Connector

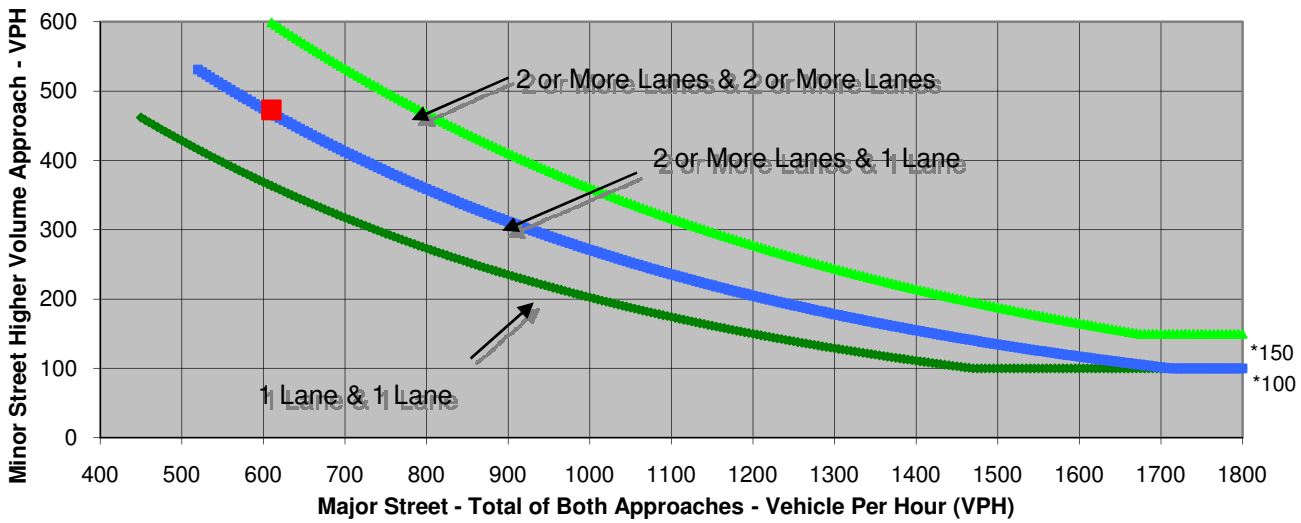
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	105	137	55	197
Right	89	279	36	276
Total	194	416	91	473

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Keawe St	Industrial Connector	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	610	473	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Sheet No	4	of	5

Project	Concept 2
Scenario	2028 Cumulative Plus Project
Peak Hour	PM

Major Street	Lahaina Bypass Rd
Minor Street	Wahikuli Rd

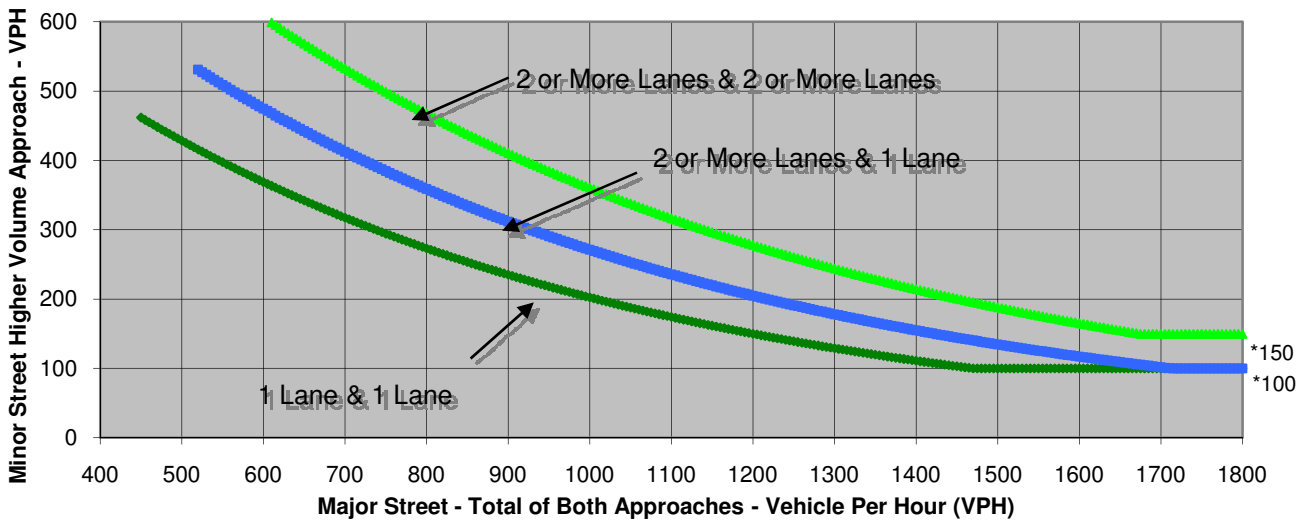
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	1,613	1,499	0	6
Right	3	69	23	1
Total	1,616	1,568	23	7

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Lahaina Bypass Rd	Wahikuli Rd	
Number of Approach Lanes	4	1	NO
Traffic Volume (VPH) *	3,184	23	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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TRANSPORTATION CONSULTANTS

Sheet No	5	of	5

Project	Concept 2
Scenario	2028 Cumulative Plus Project
Peak Hour	PM

Major Street	Lahaina Bypass Rd
Minor Street	Leiali'I Pkwy

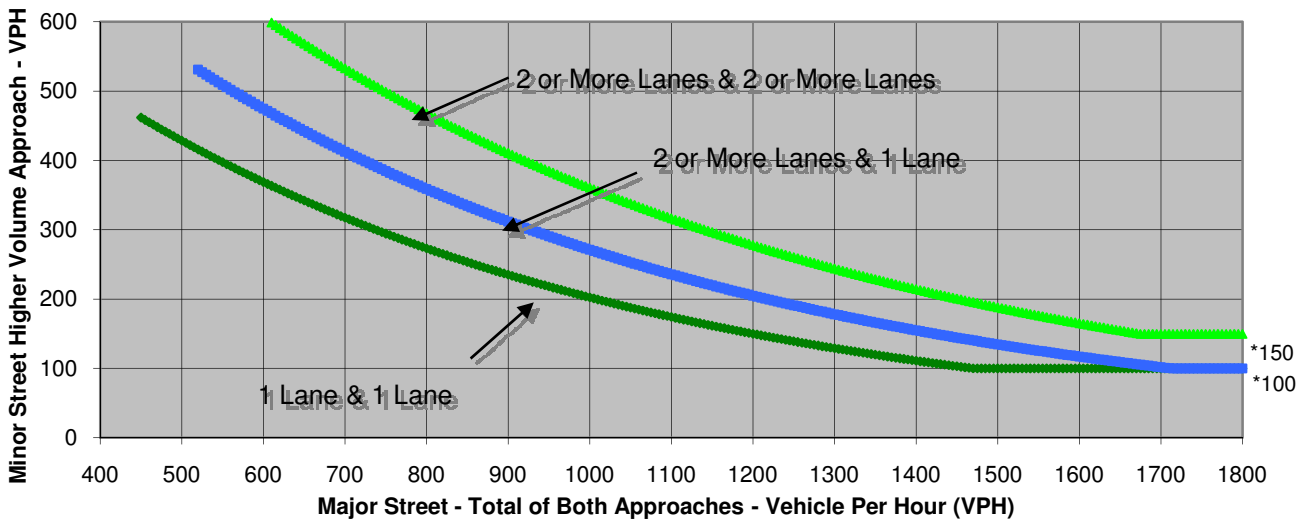
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	1,453	1,397	0	7
Right	30	112	146	2
Total	1,483	1,509	146	9

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Lahaina Bypass Rd	Leiali'I Pkwy	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	2,992	146	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

FEHR & PEERS
TRANSPORTATION CONSULTANTS

Sheet No	1	of	5

Project	Concept 3
Scenario	2028 Cumulative Plus Project
Peak Hour	PM

Major Street	Honoapi'ilan Hwy
Minor Street	Wahikuli Rd

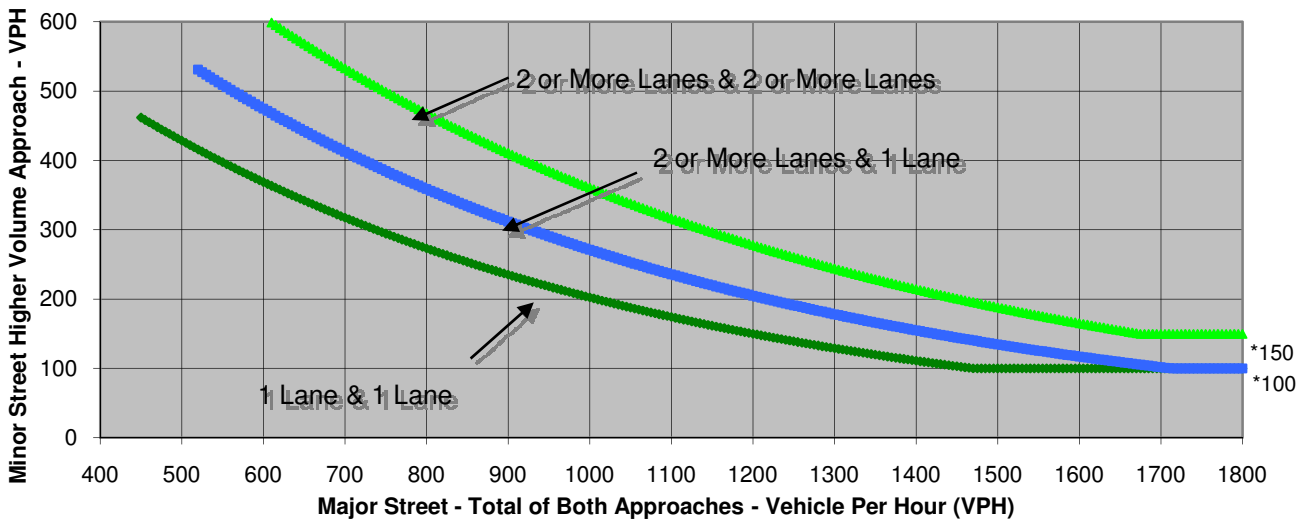
Turn Movement Volumes

	NB	SB	EB	WB
Left				68
Through	1,841	1,773		
Right	143			76
Total	1,984	1,773	0	144

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	**Minor Street**	**Warrant Met**
	Honoapi'ilan Hwy	Wahikuli Rd	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	3,757	144	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

FEHR & PEERS
TRANSPORTATION CONSULTANTS

Sheet No	2	of	5

Project	Concept 3
Scenario	2028 Cumulative Plus Project
Peak Hour	PM

Major Street	Keawe St
Minor Street	Mill St

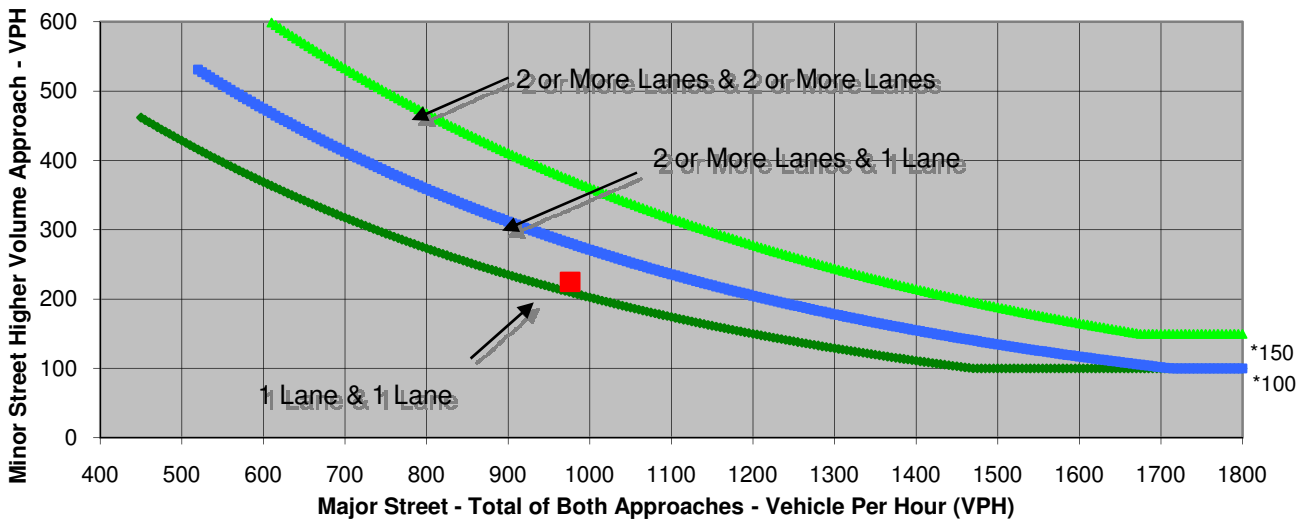
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	185	163	324	536
Right	33	62	62	54
Total	218	225	386	590

Major Street Direction

	North/South
x	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Keawe St	Mill St	
Number of Approach Lanes	4	1	NO
Traffic Volume (VPH) *	976	225	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

FEHR & PEERS
TRANSPORTATION CONSULTANTS

Sheet No	3	of	5

Project	Concept 3
Scenario	2028 Cumulative Plus Project
Peak Hour	PM

Major Street	Keawe St
Minor Street	Industrial Connector

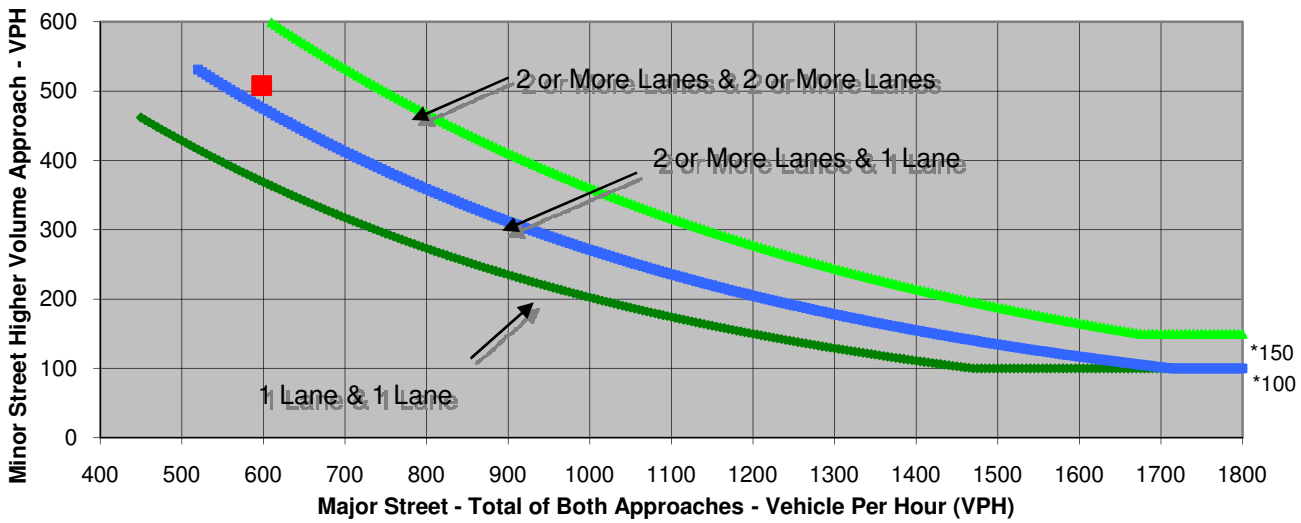
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	129	154	29	212
Right	46	269	63	296
Total	175	423	92	508

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Keawe St	Industrial Connector	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	598	508	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

FEHR & PEERS
TRANSPORTATION CONSULTANTS

Sheet No	4	of	5

Project	Concept 3
Scenario	2028 Cumulative Plus Project
Peak Hour	PM

Major Street	Lahaina Bypass Rd
Minor Street	Wahikuli Rd

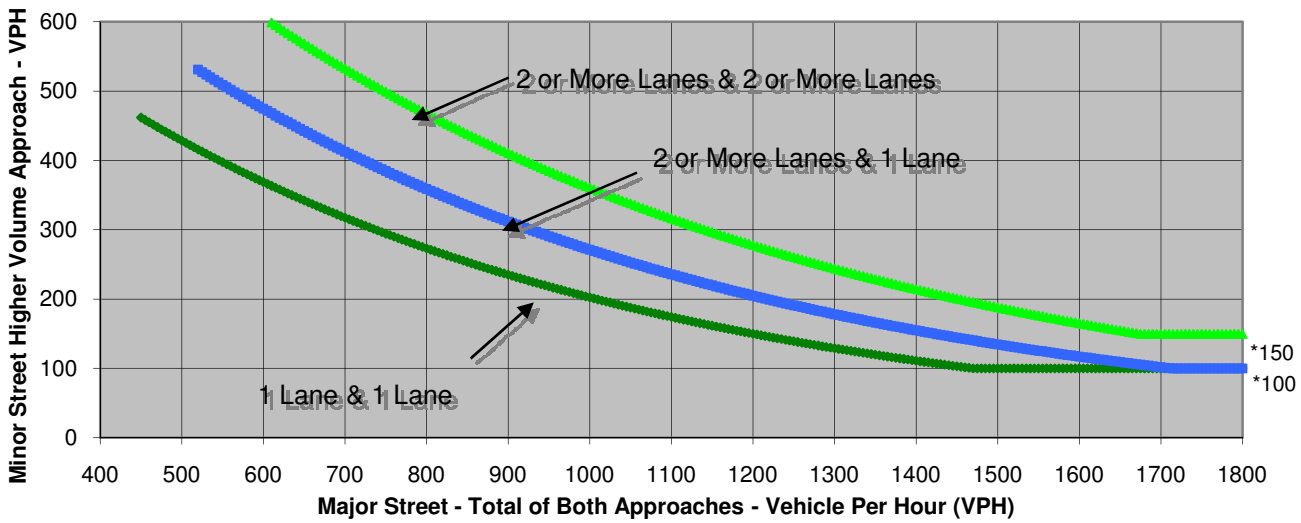
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	1,561	1,402	0	6
Right	3	123	59	1
Total	1,564	1,525	59	7

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Lahaina Bypass Rd	Wahikuli Rd	
Number of Approach Lanes	4	1	NO
Traffic Volume (VPH) *	3,089	59	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

FEHR & PEERS
TRANSPORTATION CONSULTANTS

Sheet No	5	of	5

Project	Concept 3
Scenario	2028 Cumulative Plus Project
Peak Hour	PM

Major Street	Lahaina Rd
Minor Street	Leiali'I Pkwy

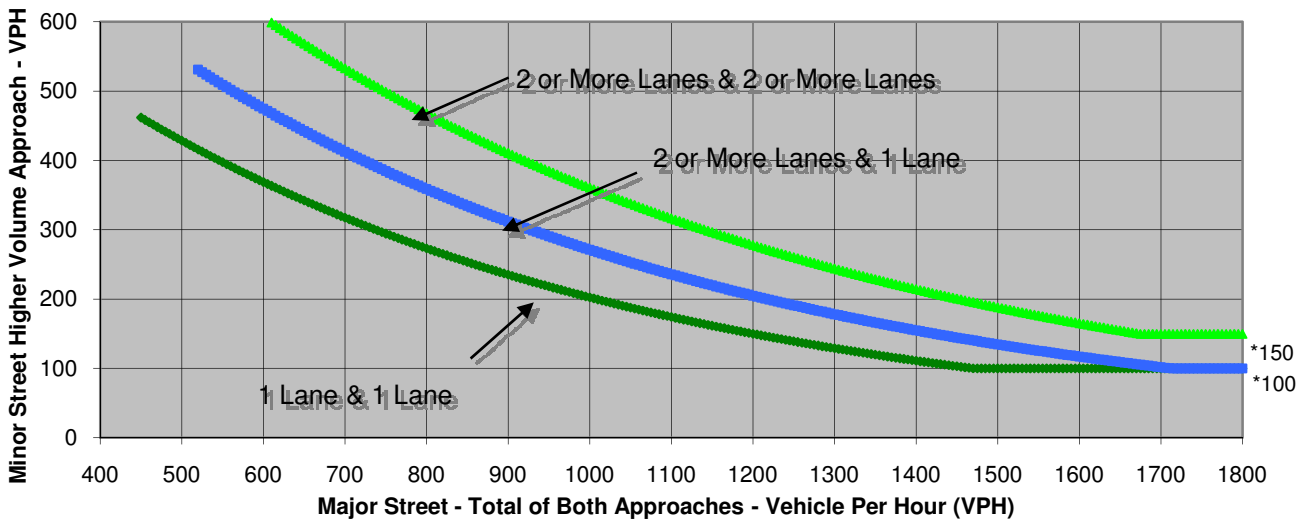
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	1,493	1,390	0	7
Right	30	93	110	2
Total	1,523	1,483	110	9

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Lahaina Rd	Leiali'I Pkwy	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	3,006	110	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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TRANSPORTATION CONSULTANTS

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Project	Concept 1
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Honoapi'ilan Hwy
Minor Street	Wahikuli Rd

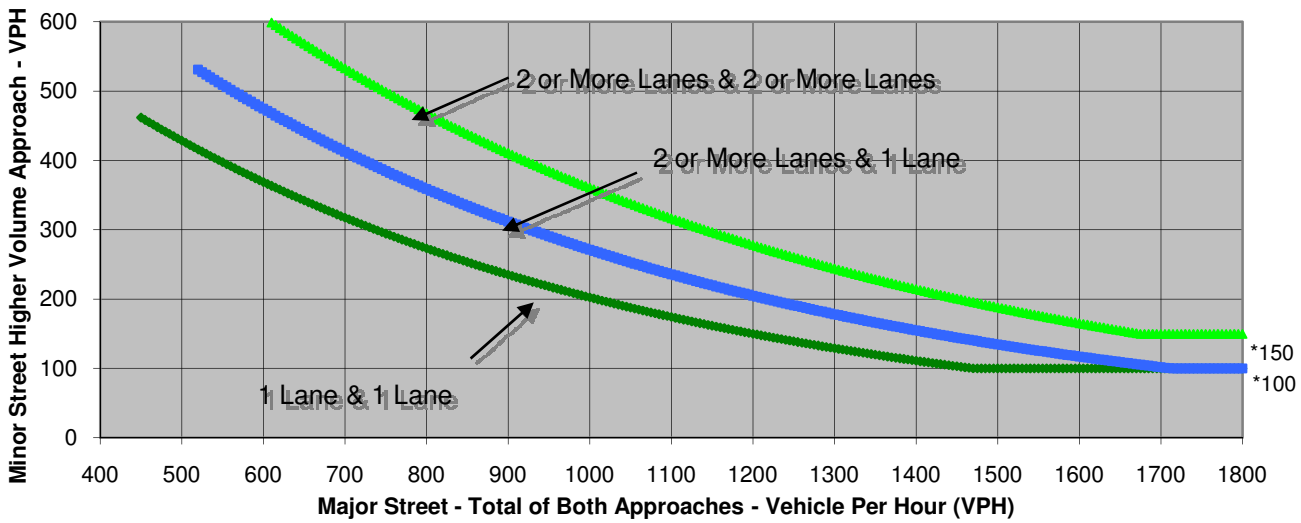
Turn Movement Volumes

	NB	SB	EB	WB
Left				74
Through	1,905	1,840		
Right	164			67
Total	2,069	1,840	0	141

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



* Note: 150 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 100 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	**Minor Street**	**Warrant Met**
	Honoapi'ilan Hwy	Wahikuli Rd	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	3,909	141	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Project	Concept 1
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Keawe St
Minor Street	Mill St

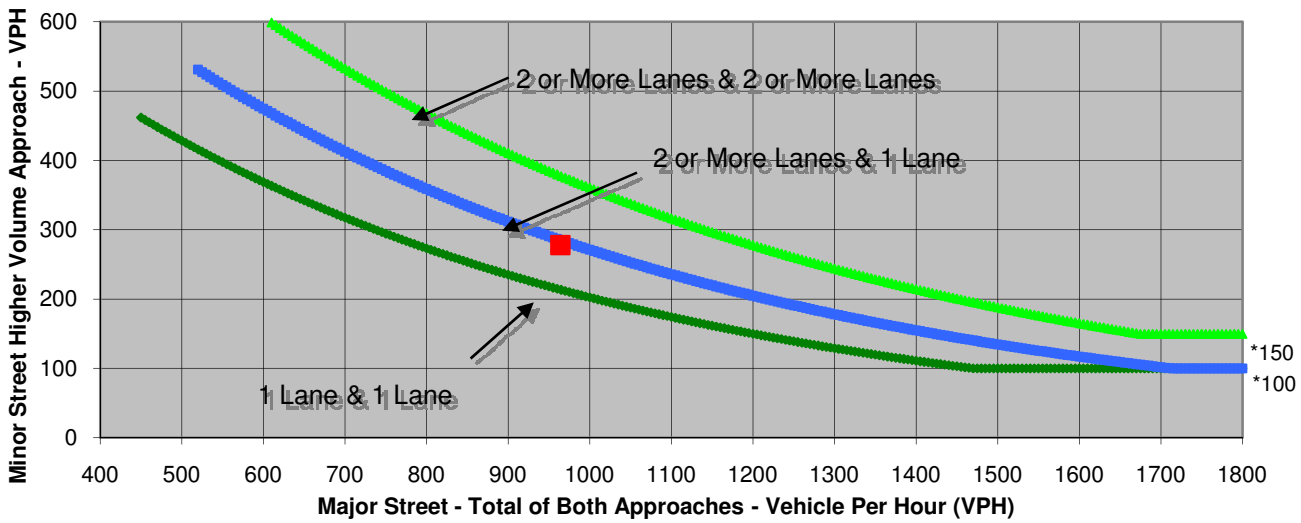
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	156	147	353	523
Right	122	59	65	23
Total	278	206	418	546

Major Street Direction

	North/South
x	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Keawe St	Mill St	
Number of Approach Lanes	4	1	NO
Traffic Volume (VPH) *	964	278	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Sheet No	3	of	5

Project	Concept 1
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Keawe St
Minor Street	Industrial Connector

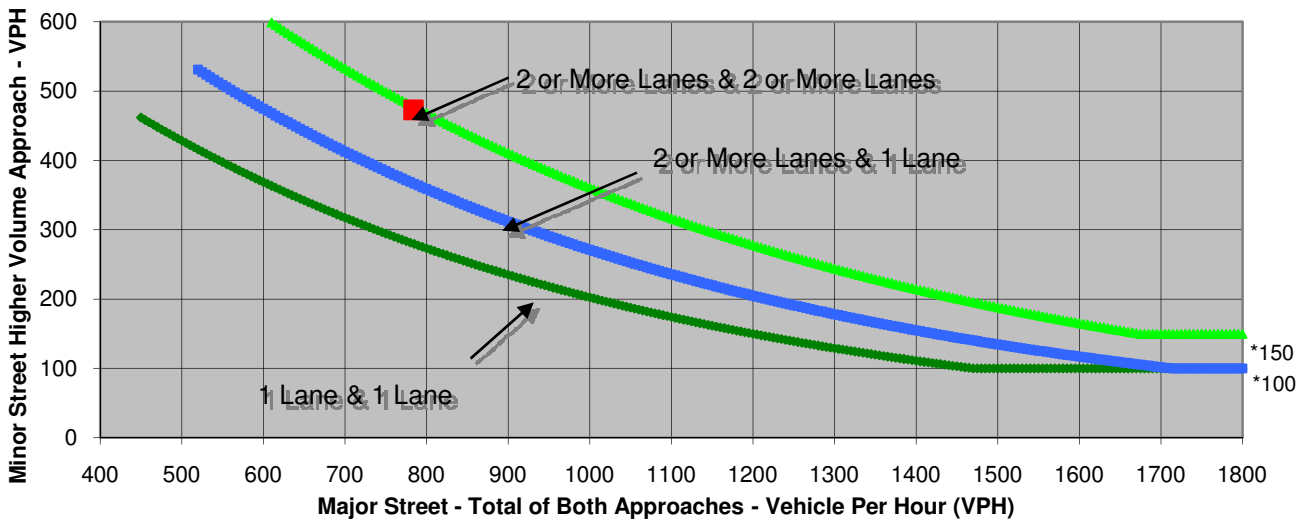
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	247	220	55	197
Right	89	228	32	276
Total	336	448	87	473

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Keawe St	Industrial Connector	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	784	473	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Project	Concept 1
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Lahaina Bypass Rd
Minor Street	Wahikuli Rd

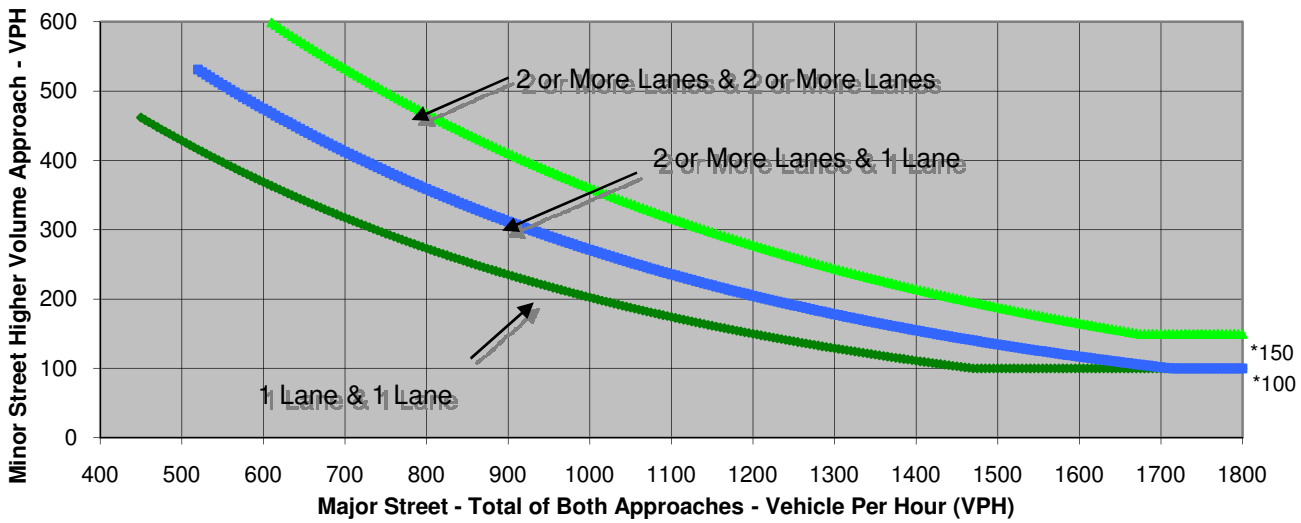
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	1,823	1,636	77	51
Right	141	53	19	55
Total	1,964	1,689	96	106

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Lahaina Bypass Rd	Wahikuli Rd	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	3,653	106	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Project	Concept 1
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Lahaina Rd
Minor Street	Leiali'I Pkwy

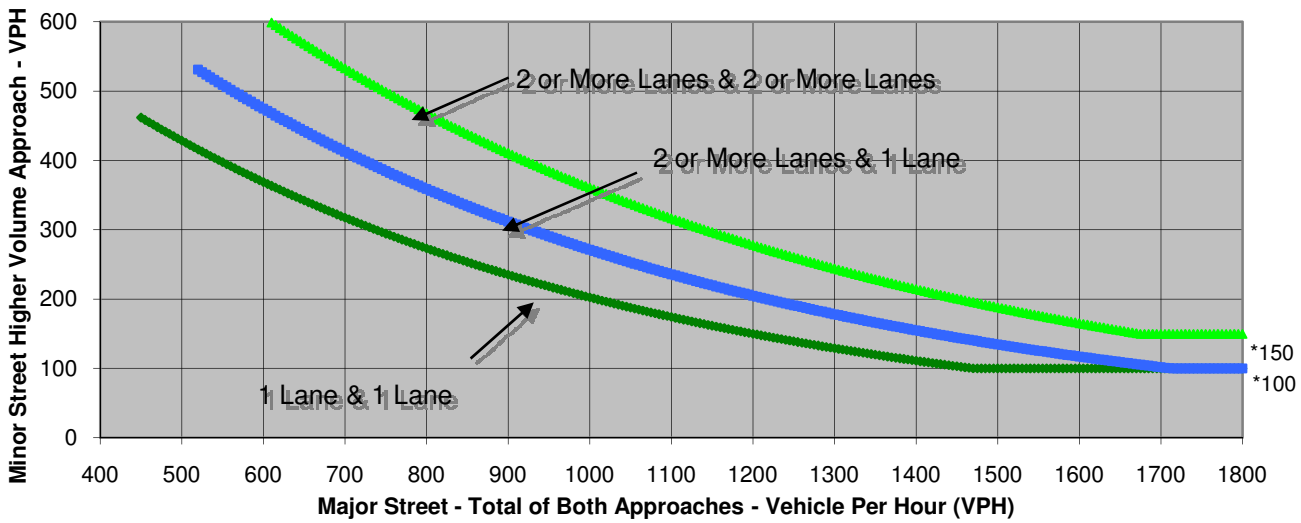
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	1,551	1,499	80	57
Right	200	98	152	54
Total	1,751	1,597	232	111

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Lahaina Rd	Leiali'I Pkwy	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	3,348	232	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Project	Concept 2
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Honoapi'ilan Hwy
Minor Street	Wahikuli Rd

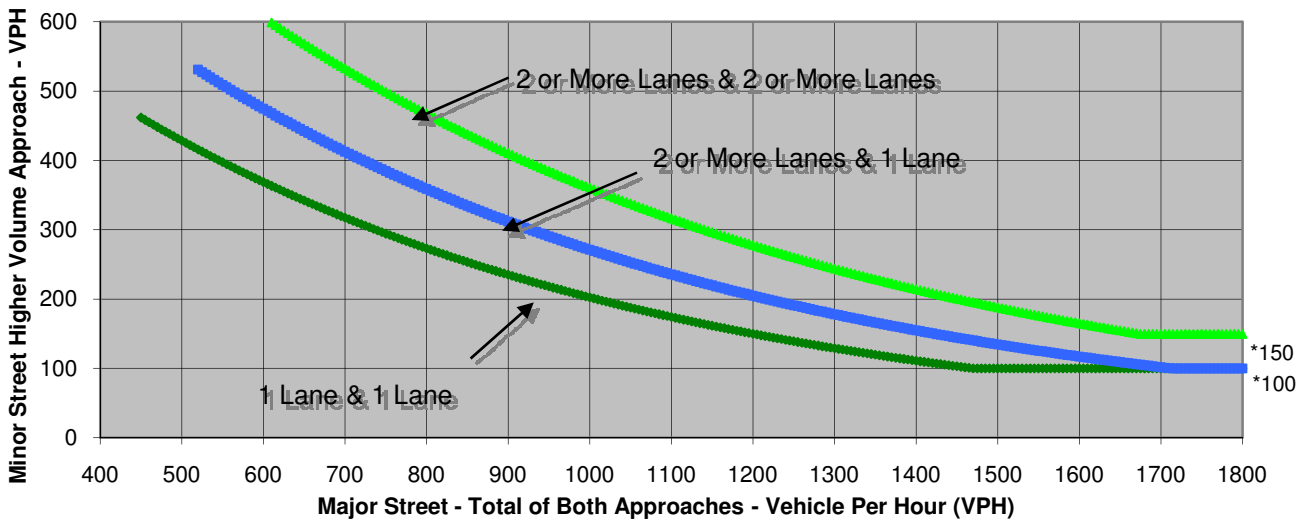
Turn Movement Volumes

	NB	SB	EB	WB
Left				79
Through	1,921	1,848		
Right	176			71
Total	2,097	1,848	0	150

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Honoapi'ilan Hwy	Wahikuli Rd	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	3,945	150	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Project	Concept 2
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Keawe St
Minor Street	Mill St

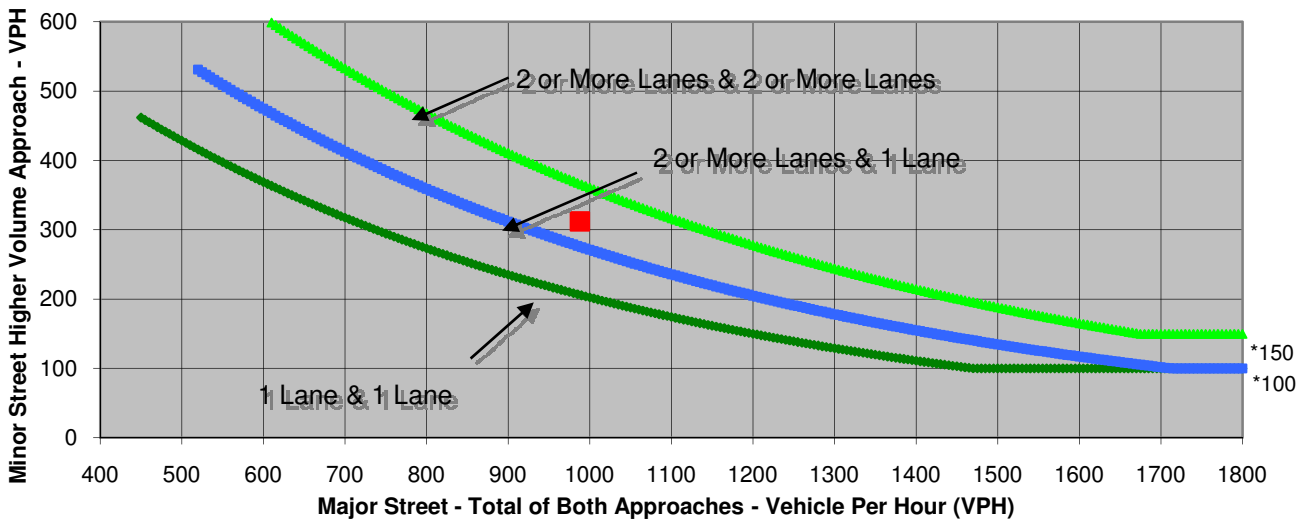
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	190	163	364	529
Right	122	67	65	30
Total	312	230	429	559

Major Street Direction

	North/South
x	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Keawe St	Mill St	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	988	312	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Project	Concept 2
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Keawe St
Minor Street	Industrial Connector

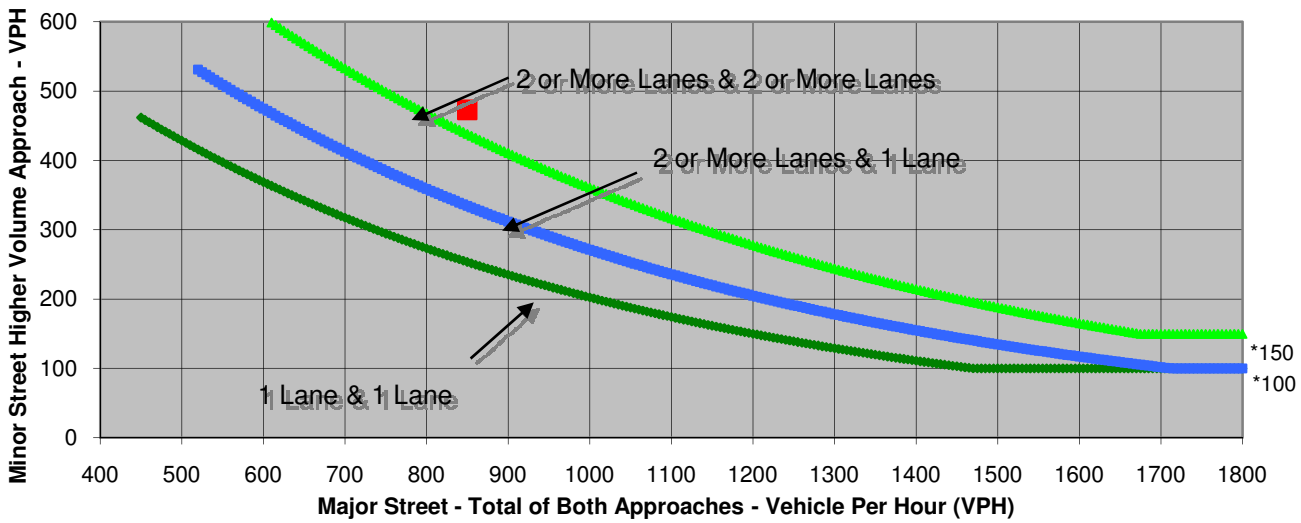
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	254	228	55	197
Right	89	279	36	276
Total	343	507	91	473

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Keawe St	Industrial Connector	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	850	473	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Project	Concept 2
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Lahaina Bypass Rd
Minor Street	Wahikuli Rd

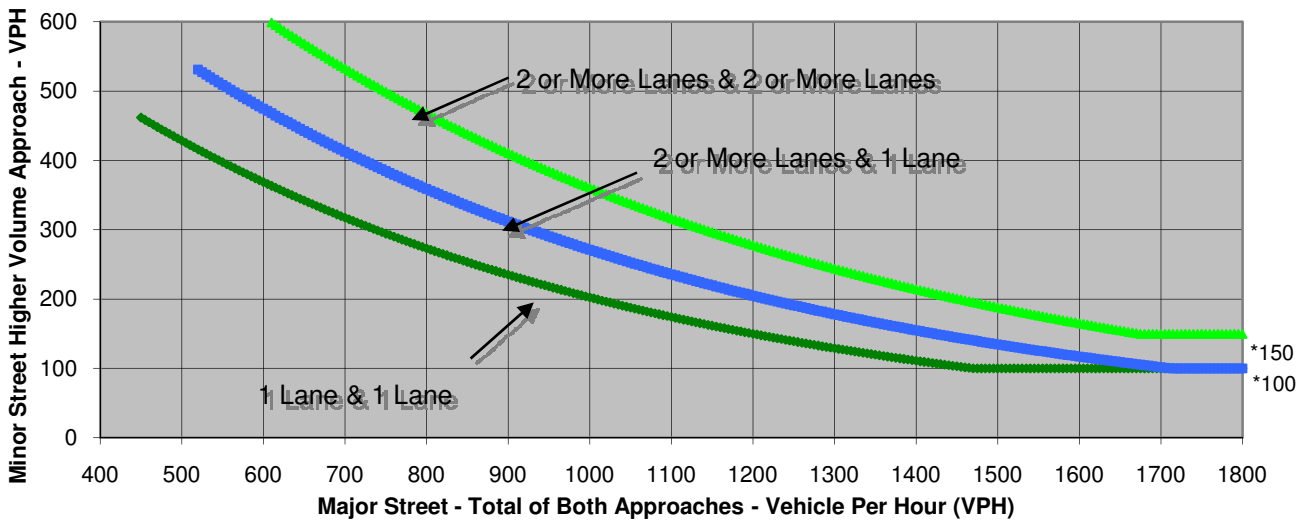
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	1,861	1,682	77	51
Right	141	69	23	55
Total	2,002	1,751	100	106

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Lahaina Bypass Rd	Wahikuli Rd	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	3,753	106	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Project	Concept 2
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Lahaina Rd
Minor Street	Leiali'I Pkwy

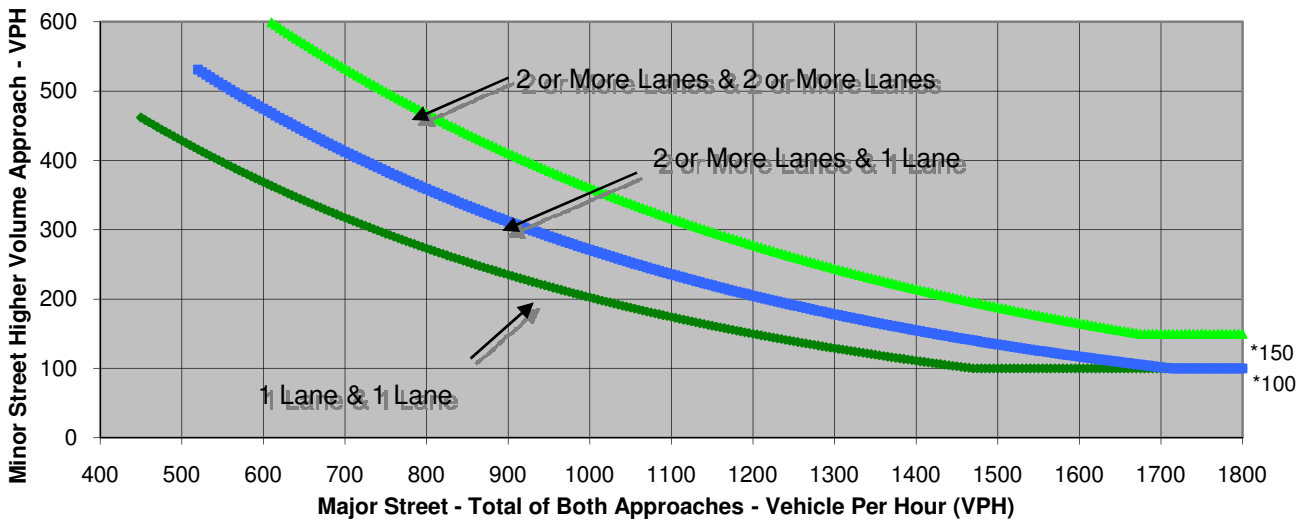
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	1,576	1,550	80	57
Right	200	112	162	54
Total	1,776	1,662	242	111

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Lahaina Rd	Leiali'I Pkwy	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	3,438	242	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Project	Concept 3
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Honoapi'ilan Hwy
Minor Street	Wahikuli Rd

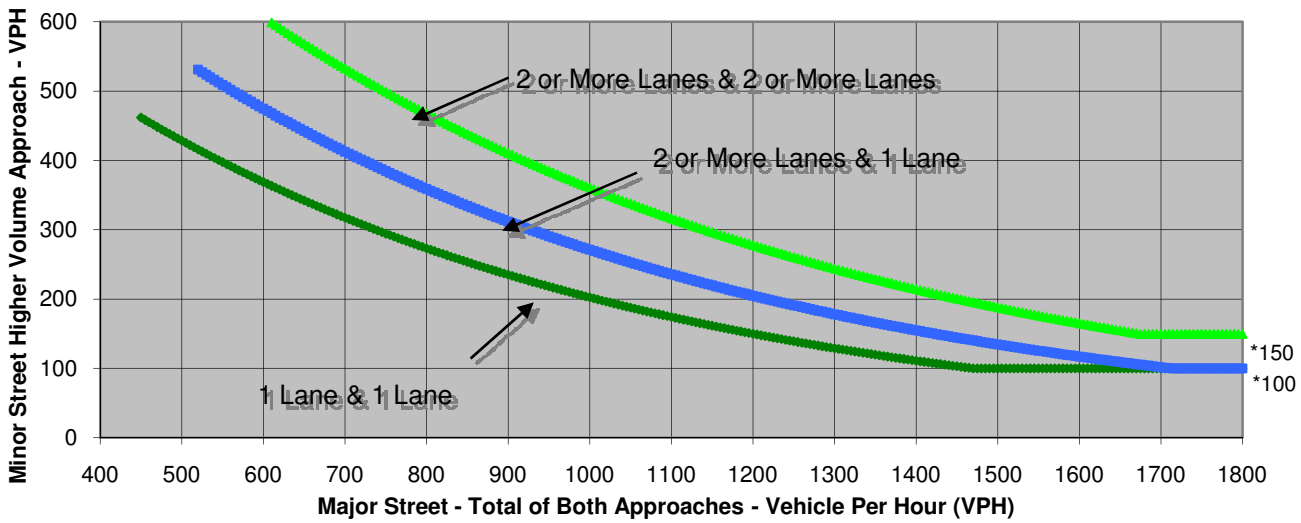
Turn Movement Volumes

	NB	SB	EB	WB
Left				86
Through	1,986	1,906		
Right	175			101
Total	2,161	1,906	0	187

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	**Minor Street**	**Warrant Met**
	Honoapi'ilan Hwy	Wahikuli Rd	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	4,067	187	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

FEHR & PEERS
TRANSPORTATION CONSULTANTS

Sheet No	2	of	5

Project	Concept 3
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Keawe St
Minor Street	Mill St

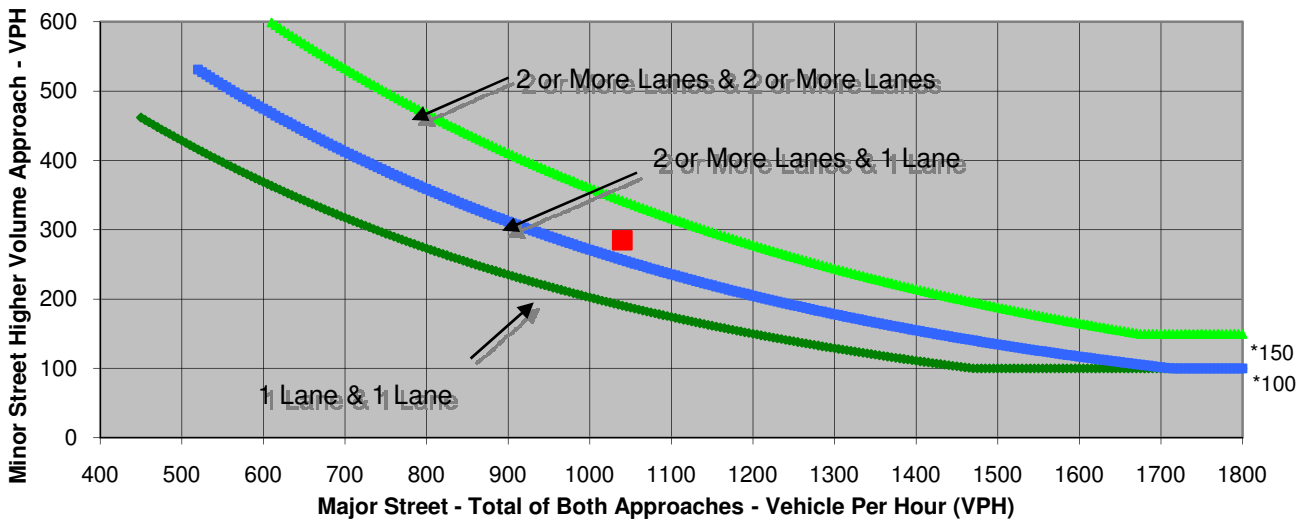
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	185	163	359	562
Right	100	62	65	54
Total	285	225	424	616

Major Street Direction

	North/South
x	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Keawe St	Mill St	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	1,040	285	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

FEHR & PEERS
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Sheet No	3	of	5

Project	Concept 3
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Keawe St
Minor Street	Industrial Connector

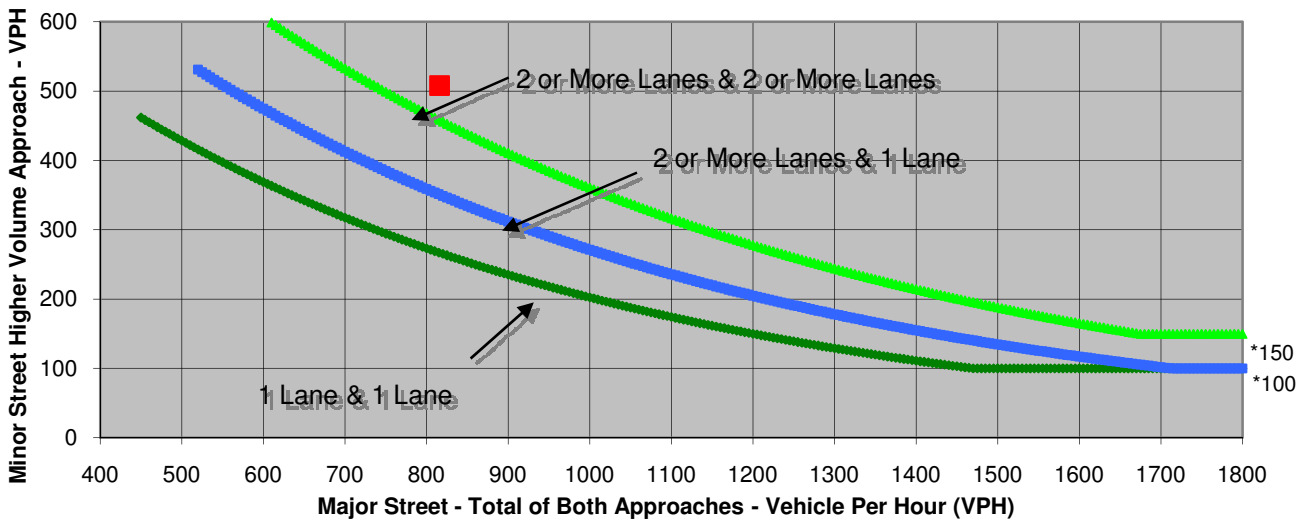
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	265	236	29	212
Right	46	269	63	296
Total	311	505	92	508

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Keawe St	Industrial Connector	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	816	508	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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TRANSPORTATION CONSULTANTS

Sheet No	4	of	5

Project	Concept 3
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Lahaina Bypass Rd
Minor Street	Wahikuli Rd

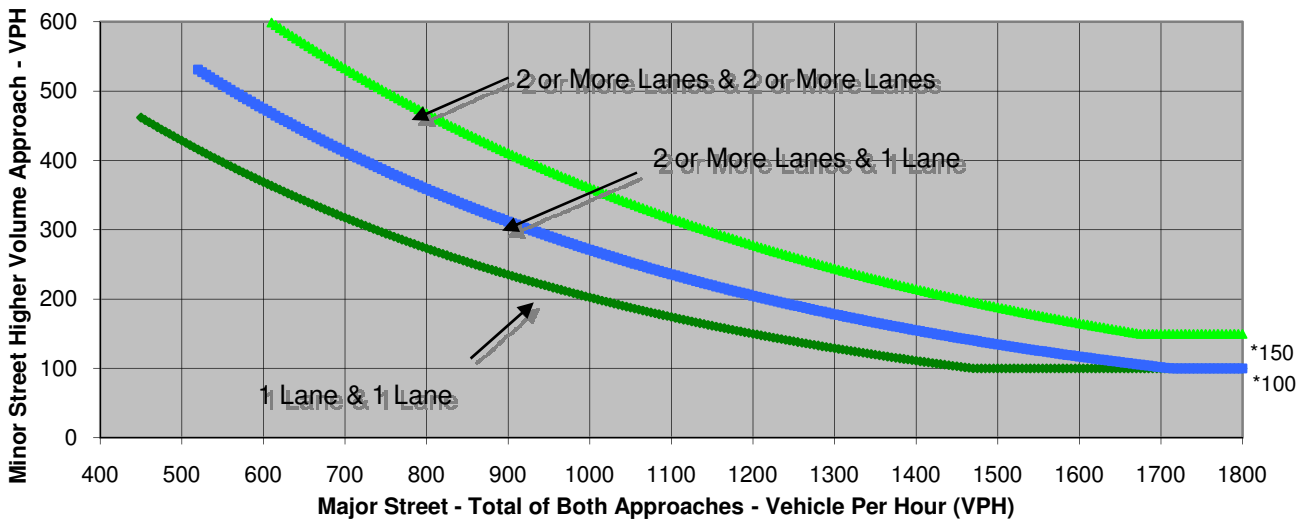
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	1,795	1,575	70	46
Right	129	123	59	49
Total	1,924	1,698	129	95

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Lahaina Bypass Rd	Wahikuli Rd	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	3,622	129	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Sheet No	5	of	5

Project	Concept 3
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Lahaina Rd
Minor Street	Leiali'I Pkwy

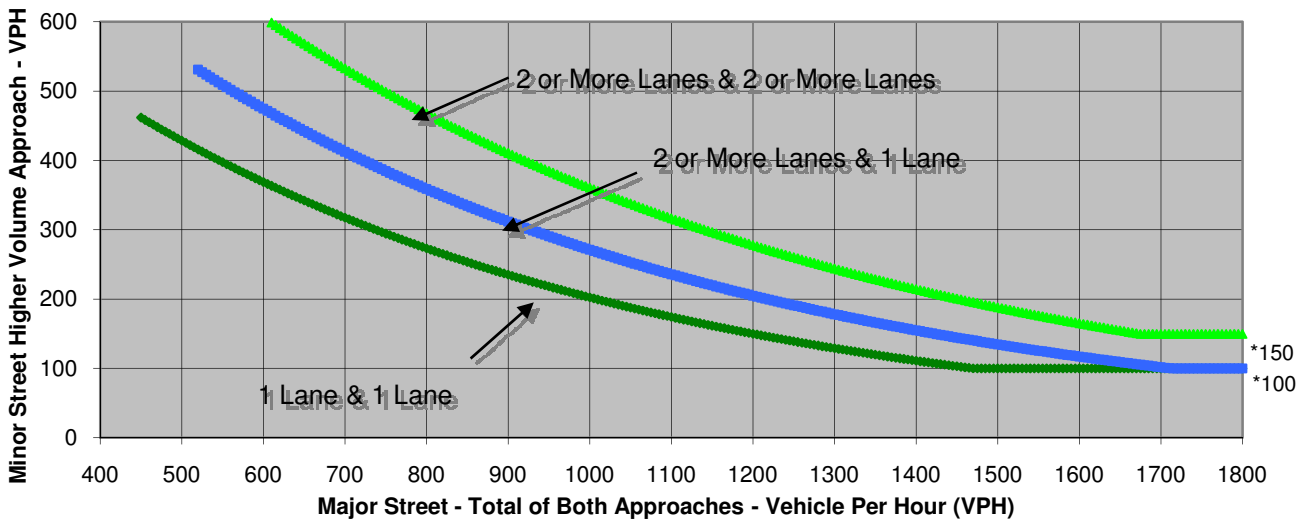
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	1,611	1,537	73	52
Right	186	93	124	49
Total	1,797	1,630	197	101

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Lahaina Rd	Leiali'I Pkwy	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	3,427	197	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Sheet No	1	of	5

Project	Concept 3
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Honoapi'ilan Hwy
Minor Street	Wahikuli Rd

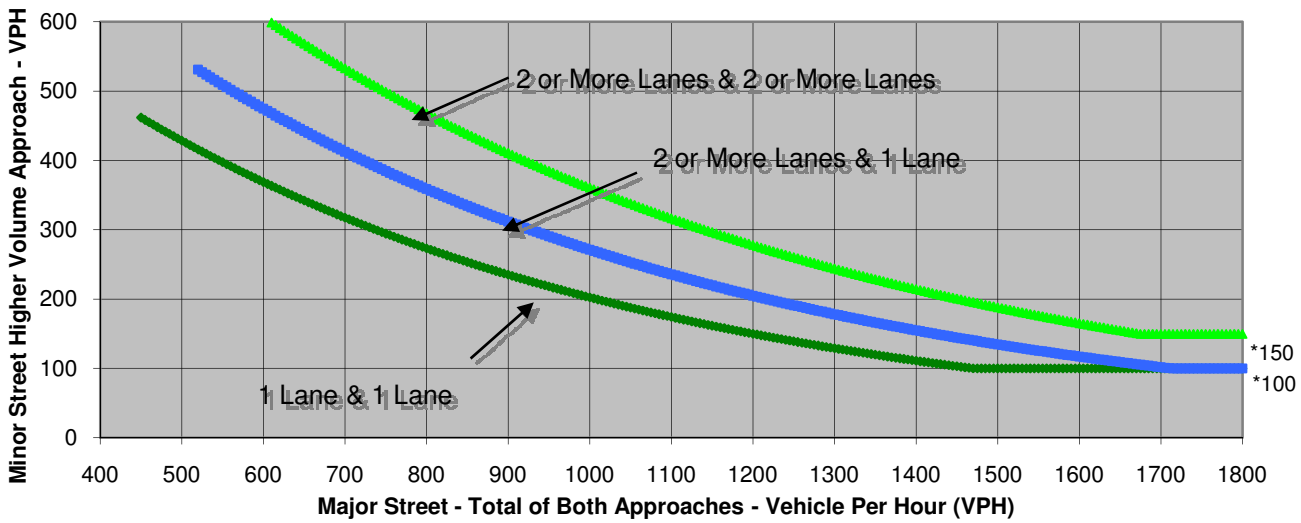
Turn Movement Volumes

	NB	SB	EB	WB
Left				86
Through	1,986	1,906		
Right	175			101
Total	2,161	1,906	0	187

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



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Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	**Minor Street**	**Warrant Met**
	Honoapi'ilan Hwy	Wahikuli Rd	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	4,067	187	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

FEHR & PEERS
TRANSPORTATION CONSULTANTS

Sheet No	2	of	5

Project	Concept 3
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Keawe St
Minor Street	Mill St

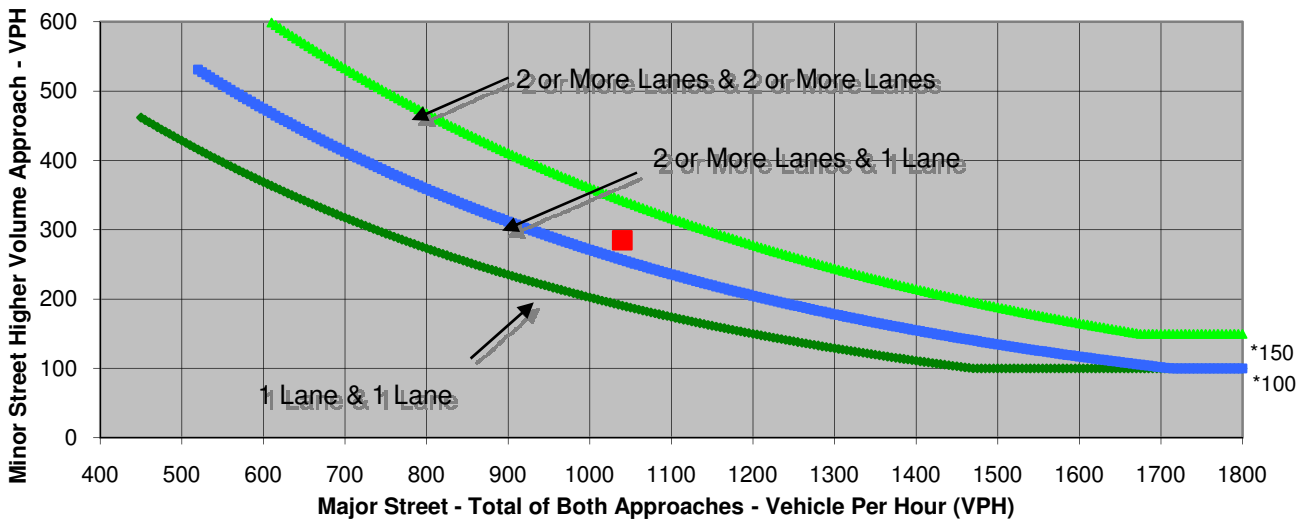
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	185	163	359	562
Right	100	62	65	54
Total	285	225	424	616

Major Street Direction

	North/South
x	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



* Note: 150 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 100 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Keawe St	Mill St	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	1,040	285	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

FEHR & PEERS
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Sheet No	3	of	5

Project	Concept 3
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Keawe St
Minor Street	Industrial Connector

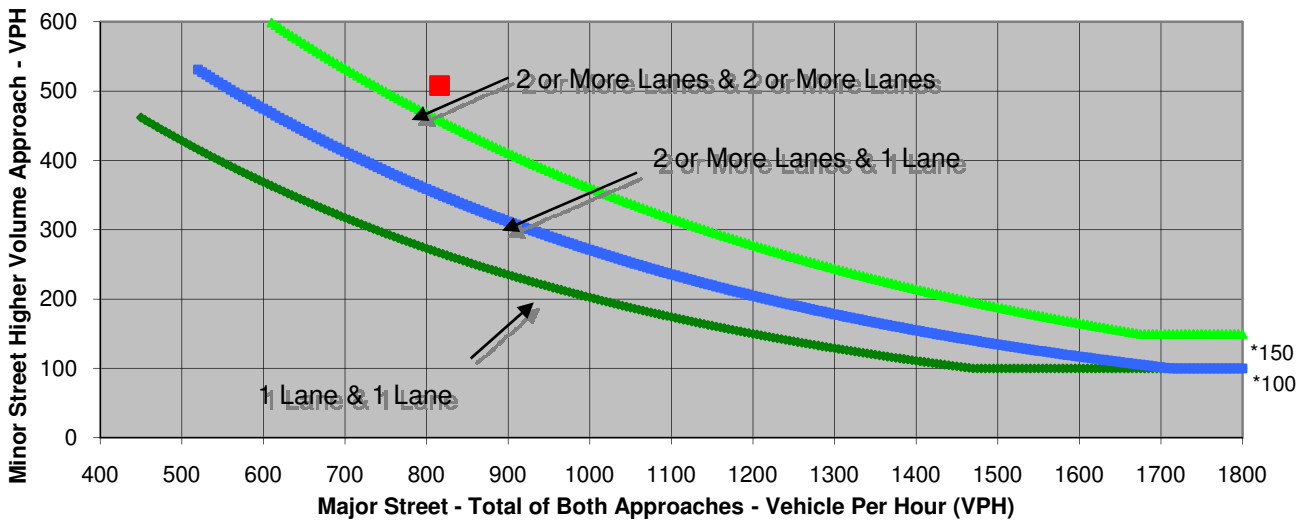
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	265	236	29	212
Right	46	269	63	296
Total	311	505	92	508

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



* Note: 150 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 100 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Keawe St	Industrial Connector	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	816	508	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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Sheet No	4	of	5

Project	Concept 3
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Lahaina Bypass Rd
Minor Street	Wahikuli Rd

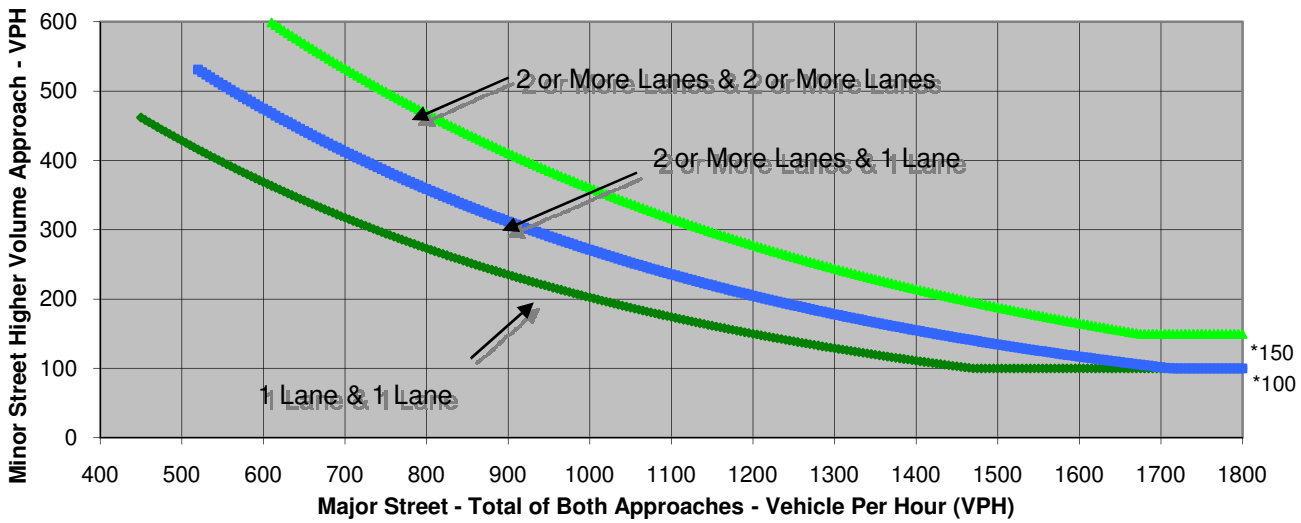
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	1,795	1,575	70	46
Right	129	123	59	49
Total	1,924	1,698	129	95

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



* Note: 150 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 100 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Lahaina Bypass Rd	Wahikuli Rd	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	3,622	129	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

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TRANSPORTATION CONSULTANTS

Sheet No	5	of	5

Project	Concept 3
Scenario	2036 Cumulative Plus Project
Peak Hour	PM

Major Street	Lahaina Rd
Minor Street	Leiali'I Pkwy

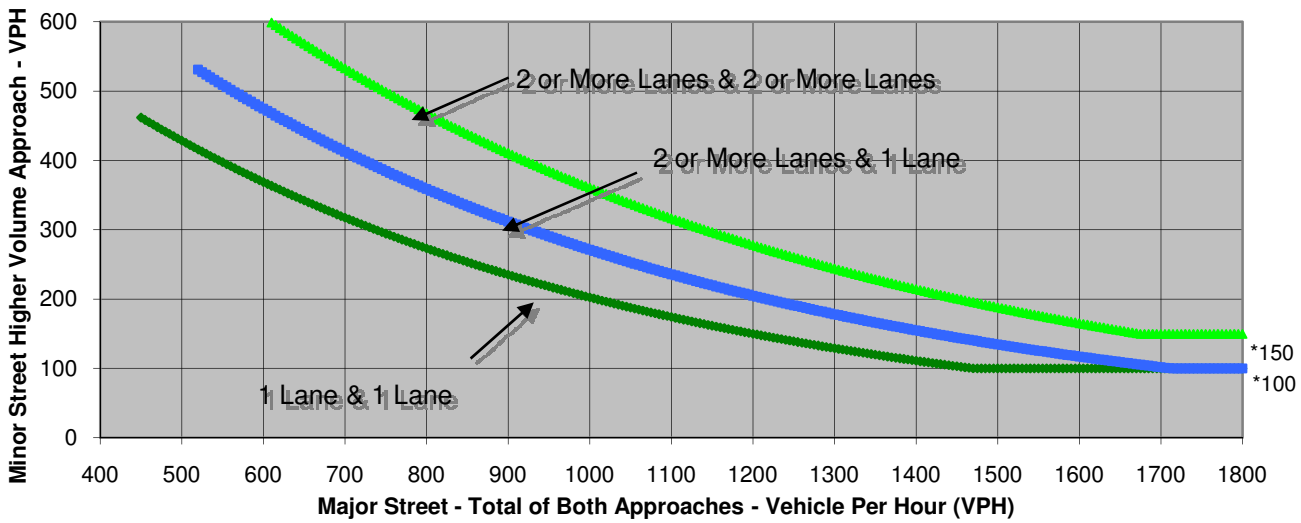
Turn Movement Volumes

	NB	SB	EB	WB
Left				
Through	1,611	1,537	73	52
Right	186	93	124	49
Total	1,797	1,630	197	101

Major Street Direction

x	North/South
	East/West

Figure 4C-3
Warrant 3, Peak Hour
(Urban Areas)



* Note: 150 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 100 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

Source: *California Manual on Uniform Traffic Control Devices*, Caltrans, 2006

	Major Street	Minor Street	Warrant Met
	Lahaina Rd	Leiali'I Pkwy	
Number of Approach Lanes	4	1	YES
Traffic Volume (VPH) *	3,427	197	

* Note: Traffic Volume for Major Street is Total Volume of Both Approches.
Traffic Volume for Minor Street is the Volume of High Volume Approach.

APPENDIX D:
TRAFFIC MITIGATION COST ESTIMATES

HHFDC Leialii
Traffic Mitigation Costs

SUMMARY OF TRAFFIC MITIGATION MEASURES

Item No.	Estimated Quantity	Description		Total
		Honoapiilani Highway and Wahikuli Road Intersection	$	580,000
		Honoapiilani Highway and Kapunakea Street Intersection	$	9,000
		Honoapiilani Highway and Keawe Street Intersection (Year 2028)	$	45,000
		Honoapiilani Highway and Keawe Street Intersection (Year 2036)	$	454,000
		Keawe Street and Mill Street Intersection	$	442,000
		Keawe Street and Phase A Connection Intersection	$	442,000
		Lahaina Bypass Highway and Wahikuli Road Intersection	$	442,000
		Lahaina Bypass Highway and Leialii Parkway Intersection	$	442,000
		Total	$	**2,856,000**

Notes: Cost is 2009 dollars.

HHFDC Leialii
Traffic Mitigation Costs

TRAFFIC MITIGATION MEASURES

Item No.	Estimated Quantity	Description	Unit Price	Total
Honoapiilani Highway and Wahikuli Road Intersection				
1- 1	1	Lump Sum, Traffic Signal	$ 400,000	$ 400,000
1- 2	1	Lump Sum, Mobilization/Demobilization	$ 20,000	$ 20,000
		Subtotal for Intersection		$ 420,000
		Contingency (20%)		$ 84,000
		Subtotal		$ 504,000
		Design and Construction Services (15%)		$ 75,600
		Total		$ 579,600
		SAY		**$ 580,000**

Honoapiilani Highway and Wahikuli Road Intersection

Notes: Add traffic signals with the existing lane configuration
Cost is 2009 dollars.

HHFDC Leialii
Off-Site Traffic Mitigation Costs

TRAFFIC MITIGATION MEASURES

Item No.	Estimated Quantity	Description	Unit Price	Total
Honoapiilani Highway and Kapunakea Street Intersection				
1- 1	1	Lump Sum, Striping and Marking	$ 5,000	$ 5,000
1- 2	1	Lump Sum, Construction Surveys	$ 500	$ 500
1- 3	1	Lump Sum, Mobilization/Demobilization	$ 1,000	$ 1,000
		Subtotal for Intersection		$ 6,500
		Contingency (20%)		$ 1,300
		Subtotal		$ 7,800
		Design and Construction Services (15%)		$ 1,170
		Total		$ 8,970
		SAY		**$ 9,000**

Honoapiilani Highway and Kapunakea Street Intersection

Notes: Convert East bound approach striping to left-turn lane and shared thru/right turn lane
Cost is 2009 dollars.

HHFDC Leialii
Off-Site Traffic Mitigation Costs

TRAFFIC MITIGATION MEASURES

Item No.	Estimated Quantity	Description	Unit Price	Total
Honoapiilani Highway and Keawe Street Intersection (Year 2028)				
1- 1	1	Lump Sum, Replace Traffic Signal Heads	$ 30,000	$ 30,000
1- 2	1	Lump Sum, Mobilization/Demobilization	$ 2,000	$ 2,000
		Subtotal for Intersection		$ 32,000
		Contingency (20%)		$ 6,400
		Subtotal		$ 38,400
		Design and Construction Services (15%)		$ 5,760
		Total		$ 44,160
		SAY		**$ 45,000**

Honoapiilani Highway and Keawe Street Intersection (Year 2028)

Notes: Modify traffic signal heads.
Cost is 2009 dollars.

HHFDC Leialii
Off-Site Traffic Mitigation Costs

TRAFFIC MITIGATION MEASURES

Item No.	Estimated Quantity	Description	Unit Price	Total
Honoapiilani Highway and Keawe Street Intersection (Year 2036)				
1- 1	0.2	Acres, Clearing and Grubbing	$ 5,000	$ 1,000
1- 2	1	Lump Sum, Water Pollution and Erosion Control Measures	$ 3,000	$ 3,000
1- 3	300	Lin. Ft., Demolish/Remove Concrete Curb	$ 5.30	$ 1,590
1- 4	2,900	Sq. Ft., Demolish/Remove Concrete Sidewalk	$ 2.50	$ 7,250
1- 5	0.2	Acres, Earthwork	$ 47,916.00	$ 9,583
1- 6	0.2	Acres, Grading	$ 29,200.00	$ 5,840
1- 7	4,140	Sq. Ft., AC Pavement (4" AC / 8" BC / 12" SBC)	$ 9.80	$ 40,572
1- 8	300	Lin. Ft., Concrete Curb	$ 31	$ 9,300
1- 9	1	Lump Sum, Striping and Marking	$ 5,000	$ 5,000
1- 10	1	Each, Sign, Post and Footing	$ 550	$ 550
1- 11	1	Lump Sum, Traffic Signal Standards, Mast Arms, pullboxes, loops	$ 150,000	$ 150,000
1- 12	13	Each, Trees	$ 2,000.00	$ 26,000
1- 13	0.1	Acre, Soil Preparation	$ 10,900	$ 1,090
1- 14	3,000	Sq. Ft., Irrigation	$ 3	$ 7,500
1- 15	1	Lump Sum, Construction Surveys	$ 10,000	$ 10,000
1- 16	1	Lump Sum, Mobilization/Demobilization	$ 50,000	$ 50,000
		Subtotal for Intersection		$ 328,275
		Contingency (20%)		$ 65,655
		Subtotal		$ 393,930
		Design and Construction Services (15%)		$ 59,090
		Total		$ 453,020
		SAY		**$ 454,000**

Honoapiilani Highway and Keawe Street Intersection (Year 2036)

Notes: Add right turn lane, 100-feet storage plus 200-foot taper for 3-lane (left, thru and right) approach from Lahaina Cannery Mall.
Modify traffic signal standards.
Replace landscaping.
Cost is 2009 dollars.

HHFDC Leialii
Off-Site Traffic Mitigation Costs

TRAFFIC MITIGATION MEASURES

Item No.	Estimated Quantity	Description	Unit Price	Total
Keawe Street and Mill Street Intersection				
1- 1	1	Lump Sum, Traffic Signal	$ 300,000	$ 300,000
1- 2	1	Lump Sum, Mobilization/Demobilization	$ 20,000	$ 20,000
		Subtotal for Intersection		$ 320,000
		Contingency (20%)		$ 64,000
		Subtotal		$ 384,000
		Design and Construction Services (15%)		$ 57,600
		Total		$ 441,600
		SAY		**$ 442,000**

Keawe Street and Mill Street Intersection

Notes: Add traffic signals.
Cost is 2009 dollars.

HHFDC Leialii
Off-Site Traffic Mitigation Costs

TRAFFIC MITIGATION MEASURES

Item No.	Estimated Quantity	Description	Unit Price	Total
Keawe Street and Phase A Intersection				
1- 1	1	Lump Sum, Traffic Signal	$ 300,000	$ 300,000
1- 2	1	Lump Sum, Mobilization/Demobilization	$ 20,000	$ 20,000
		Subtotal for Intersection		$ 320,000
		Contingency (20%)		$ 64,000
		Subtotal		$ 384,000
		Design and Construction Services (15%)		$ 57,600
		Total		$ 441,600
		SAY		**$ 442,000**

Keawe Street and Phase A Intersection

Notes: Add traffic signals.
Cost is 2009 dollars.

HHFDC Leialii
Off-Site Traffic Mitigation Costs

TRAFFIC MITIGATION MEASURES

Item No.	Estimated Quantity	Description	Unit Price	Total
Lahaina Bypass Highway and Wahikuli Road Intersection				
1- 1	1	Lump Sum, Traffic Signal	$ 300,000	$ 300,000
1- 2	1	Lump Sum, Mobilization/Demobilization	$ 20,000	$ 20,000
		Subtotal for Intersection		$ 320,000
		Contingency (20%)		$ 64,000
		Subtotal		$ 384,000
		Design and Construction Services (15%)		$ 57,600
		Total		$ 441,600
		SAY		**$ 442,000**

Lahaina Bypass Highway and Wahikuli Road Intersection

Notes: Add traffic signals.
Cost is 2009 dollars.

HHFDC Leialii
Off-Site Traffic Mitigation Costs

TRAFFIC MITIGATION MEASURES

Item No.	Estimated Quantity	Description	Unit Price	Total
Lahaina Bypass Highway and Leialii Parkway Intersection				
1- 1	1	Lump Sum, Traffic Signal	$ 300,000	$ 300,000
1- 2	1	Lump Sum, Mobilization/Demobilization	$ 20,000	$ 20,000
		Subtotal for Intersection		$ 320,000
		Contingency (20%)		$ 64,000
		Subtotal		$ 384,000
		Design and Construction Services (15%)		$ 57,600
		Total		$ 441,600
		SAY		**$ 442,000**

Lahaina Bypass Highway and Leialii Parkway Intersection

Notes: Add traffic signals.
Cost is 2009 dollars.