DRAFT
ENVIRONMENTAL IMPACT STATEMENT – VOLUME II
TECHNICAL APPENDICES

THE VILLAGE OF ‘ĀINA LE‘A

Waikōloa, South Kohala District, Island of Hawai‘i
TMK: (3) 6-8-001: 25, 36, 37, 38, 39 (por.) and 40 (por.)
and (3) 6-8-002:19 (por.)

Accepting Authority: County of Hawai‘i Planning Department

Applicant: DW ‘Āina Le‘a Development, LLC
(Prior Applicant: Bridge ‘Āina Le‘a, LLC)

Prepared By:

J M Leonard Planning, LLC

May 2010

THE VILLAGE OF ʻĀINA LEʻA

DRAFT ENVIRONMENTAL IMPACT STATEMENT

This DEIS has been submitted pursuant to Chapter 343, Hawaiʻi Revised Statutes; the Department of Health's Title 11, Chapter 200, Hawaiʻi Administrative Rules; the Environmental Impact Statement Rules of the Office of Environmental Quality Control; and the County of Hawaiʻi environmental reporting requirements as set forth in Sections 25-1-5, 25-2-42 and 25-6-44, Hawaiʻi County Code, and County Planning Department Rule 14.

Accepting Authority: County of Hawaiʻi Planning Department

Applicant: DW ʻĀina Leʻa Development, LLC
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VOLUME II APPENDICES

LIST OF APPENDICES

Appendix A	**Amended and Restated Purchase and Sale Agreement, excluding exhibits**
Appendix B	**Rezoning Ordinance No. 96-153**
Appendix C	**Agreement: County of Hawaiʻi Water Board and Bridge ʻĀina Leʻa LLC**
Appendix D	**Preliminary Engineering Report**
Appendix D1	**Temporary, Phase 1 Wastewater Treatment Plant Design Report**
Appendix E	**Master Drainage Report**
Appendix F	**Assessment of the Potential Impact on Water Resources**
Appendix G	**Botanical Survey Report**
Appendix G1	**Botanical Preservation Plan/Agency Correspondence**
Appendix H	**Survey of the Avifauna and Feral Mammals**
Appendix H1	**Flora and Fauna Survey–Utility Corridors**
Appendix I	**Archaeological Inventory Survey Report/SHPD Correspondence**
Appendix I1	**Archaeological Assessment, Utility Corridor**
Appendix J	**Archaeological Data Recovery Report/SHPD Correspondence**
Appendix K	**Archaeological Burial Treatment Plan/SHPD Correspondence**
Appendix L	**Cultural Impact Assessment**
Appendix L1	**Cultural Impact Assessment First Addendum–Cattle Trail**
Appendix L2	**Cultural Impact Assessment Second Addendum–Utility Corridors**
Appendix M	**Traffic Impact Analysis Report**
Appendix N	**Noise Quality Impact Report**
Appendix O	**Air Quality Impact Report**
Appendix P	**Socio-Economic Assessment**

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Appendix A

Amended and Restated Purchase and Sale Agreement, excluding exhibits (Dated Feb. 9, 2009)

AMENDED AND RESTATED PURCHASE AND SALE AGREEMENT

THIS AMENDED AND RESTATED PURCHASE AND SALE AGREEMENT ("**Agreement**") is effective as of February 9, 2009 ("**Effective Date**") by and between **BRIDGE AINA LE'A, LLC**, a Hawaii limited liability company ("**Seller**"), **RELCO CORP.**, a Nevada corporation ("**Relco**"), and **DW AINA LE'A DEVELOPMENT, LLC**, a Nevada limited liability company ("**Buyer**"). Seller and Buyer are hereinafter sometimes referred to collectively as the "**Parties**" and individually as a "**Party**."

BACKGROUND INFORMATION

WHEREAS, Seller is the owner in fee simple of those certain six lots identified by Tax Map Key Numbers (3) 6-8-001: 025, 036, 037, 038, 039 and 040, comprising Lots A-1, B-1, C-1, D-1, E-1 and F-1 (sometimes collectively referred to as the **"Overall Property"**) located at Waikoloa, South Kohala, Island and County of Hawaii, State of Hawaii.

WHEREAS, said Lots are shown on and legally described in File Plan No. 1919 ("**File Plan**") recorded on January 26, 1988 in the Bureau of Conveyances of the State of Hawaii (**"Bureau"**), as amended by Owner's Affidavit dated January 17, 2006 and recorded in the Bureau as Document No. 2006-012590.

WHEREAS, attached to said Owner's Affidavit is Surveyor's Affidavit dated December 7, 2005 recorded in the Bureau as Document No. 2005-253830, and attached to said Surveyor's Affidavit is Final Subdivision Approval No. SUB-04-000077, the Final Plat Map and the metes and bounds descriptions for said Lots as approved by the Planning Department of the County of Hawaii by letters dated September 8, 2005 and November 23, 2005. The File Plan, as amended by the attached Owner's Affidavit inclusive of attached Surveyor's Affidavit, is sometimes called the **"File Plan Amendment."**

WHEREAS, substantially all of Lots A-1 and F-1, herein sometimes collectively referred to as the **"Ag Land"**, are within the Land Use Boundary for the "Agricultural District" as established by the State of Hawaii, and substantially all of Lots B-1 thru E-1, inclusive, comprising 1092.542 acres, more or less, and herein sometimes collectively referred to as the **"Urban Land"**, have been reclassified from "Agricultural District" to "Urban District" by the Land Use Commission of the State of Hawaii (**"Commission"**) by Decision and Order in Docket No. A87-617 dated January 17, 1989, as amended several times ("**D/O**"), which amended D/O is stated in an Amended and Restated Certificate and Consent made by Seller dated January 20, 2006 and recorded in the Bureau on February 2, 2006 as Document No. 2006-021470 (**"Amended and Restated Certificate and Consent"**).

WHEREAS, substantially all of Lots C-1 and E-1, herein sometimes collectively referred to as the "**Retail Property**", have been zoned for commercial use, and substantially all of Lots B-1 and D-1, herein sometimes collectively referred to as the **"Residential Property"**, have been zoned for residential and golf course use, by the County of Hawaii by its Zoning Ordinance No.

96-153, as modified by the non-significant changes adopted on November 29, 2000 (**"Zoning Ordinance"**).

WHEREAS, Seller is also the owner in fee simple of three (3) well sites identified as Tax Map Key Numbers: (3) 6-2-001: 087, 088 & 089 (**"Ouli Wells"**) located about five (5) miles from the Overall Property at Ouli, District of South Kohala, Island and County of Hawaii, State of Hawaii.

WHEREAS, Seller and Relco entered into that certain Purchase and Sale Agreement effective October 1, 2008 ("**PSA**") relative to the subject matter of this Agreement.

WHEREAS, the PSA provided for the assignment of Relco's interests in the PSA to Buyer on Seller's consent, and the Parties and Relco, by their signatures hereto, do hereby acknowledge and agree that the PSA has been and is so assigned by Relco to Buyer upon and subject to the terms and conditions of this Agreement;

WHEREAS, the Parties wish to amend and restate the PSA in its entirety, and the Parties, by their signatures hereto, do acknowledge and agree that this Agreement sets forth the entire amended and restated agreement of the Parties with respect to the matters set forth herein;

WHEREAS, Seller is in the process of making, and, subject to the provisions of this Agreement otherwise authorizing Buyer with respect to the Urban Land, reserves the right and will continue from and after the Effective Date to make, various arrangements with respect to the Overall Property and the Ouli Wells and their development, including without limitation: **(1)** provisions for utilities service; **(2)** contracts with design professionals, land planners, contractors, and other third parties; and **(3)** the refinement of the Aina Le'a Master Plan for the Overall Property prepared by Architects Hawaii Ltd., dated March 2004, as revised by PBR Hawaii up to and including a draft Conceptual Master Plan dated August 13, 2007 (**"Revised Master Plan"**), including but not limited to revisions to address the possibility of:

a) increasing the density and number of residential units on the Urban Land pursuant to Section 201H of the Hawaii Revised Statutes and Section 11-8 of the County of Hawaii Code;
b) locating the sewage treatment plant within the buffer on the Ag Land;
c) locating the undeveloped land to be dedicated as a school site on the Ag Land; and
d) locating a park site to be dedicated to the County on the Ag Land.

WHEREAS, the Parties contemplate that the interests of Buyer under this Agreement will be assigned, no later than the first Closing as defined herein, to Island Vistas LLC, a Hawaii limited liability company ("**Venture**"), all upon and subject to the terms and conditions of this Agreement, whereupon the term "Buyer" shall mean and refer to Venture.

WHEREAS, in order to provide consistency in the development of the Overall Property, and pursuant and subject to the terms and conditions of this Agreement, the Parties contemplate: (a) the conveyance of the Urban Land to Buyer; (b) a Joint Development Agreement ("**JDA**") between Seller as the owner of the Ag Land and Buyer as the owner of the Urban Land; (c) a lease

of the Ouli Wells to Buyer together with certain rights, responsibilities, and obligations appurtenant thereto or otherwise necessary to develop the Ouli Wells to provide potable water for the development of the Overall Property ("**Ouli Wells Lease**"); and (d) bills of sale conveying to Buyer ownership of certain personal property and other intangible rights appurtenant to or otherwise accompanying the Urban Land and/or the Ouli Wells.

WHEREAS, Seller and Buyer desire that, pursuant and subject to the terms and conditions of this Agreement, Seller convey to Buyer: (a) a fee simple interest in the Residential Property; (b) a fee simple interest in the Retail Property; (c) a leasehold interest in the Ouli Wells and certain associated agreements; (d) a fee simple interest, upon subdivision as and when set forth herein, in the Affordable Housing Parcel (as defined in Paragraph 2.A below); and (e) a fee simple interest, upon subdivision as and when set forth herein, in the Additional Urban Land (as defined in Paragraph 2.B below) (all of which Residential Property, Retail Property, Ouli Wells Lease, Affordable Housing Parcel and Additional Urban Land is referred to herein collectively as the "**Property**".

WHEREAS, the Parties acknowledge and agree that Buyer has completed its due diligence review of the Property and the Parties have agreed upon the form and content of various documents and instruments including the following, copies of which are attached to this Agreement:

I. A separate JDA between Seller and Buyer for the joint development, construction, operation, maintenance and use of certain facilities that will benefit and service both the Property to be owned by Buyer and the Ag Land which Seller will continue to own, including, without limitation, water supply, sewage treatment, electrical and sewer utilities, pedestrian and vehicular roadways and access easements and the creation of one or more separate utility companies, and to address other matters affecting both the Property and the Ag Land;

II. The Affordable Housing Parcel Deed, Residential Property Deed and Retail Property Deed as defined herein;

III. The Ouli Wells Lease; and

IV. The Bill of Sale as defined herein.

NOW, THEREFORE:

In consideration of the mutual covenants contained herein, together with other valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the Parties agree to the terms and conditions herein set forth.

1. EXHIBITS.

A. The following exhibits ("**Exhibits**") are completed and attached to this Agreement and made a part hereof by reference as of the Effective Date; provided, however, that, concurrently with the conveyance by Seller to Buyer of any Property and the fulfillment by the Parties of any

and all related obligations as and when set forth in this Agreement (which transaction is referred to as a "**Closing**"), the Parties shall supplement this Agreement to confirm and update as applicable each Exhibit:

No.	Exhibit Completed and Attached as of the Effective Date--Description
[1]	File Plan Amendment, subject to revision to correct reference to Royal Patent Number.
[2]	Amended and Restated Certificate and Consent.
[3]	Zoning Ordinance, subject to supplementation, if any.
[4]	Revised Master Plan.
[5]	Title Commitments and Policies as follows (all of which shall be updated as of the relevant Closing):

5.1 Commitment dated January 7, 2009 (amended) from Stewart Title Guaranty Company (**"Title Company"**) for the issuance at Closing of an ALTA Owners Policy for the Residential Property (**"Residential Property Title Commitment"**), together with a pro forma of said Policy (**"Residential Property Pro Forma Title Policy"**).

5.2 Commitment dated January 7, 2009 (amended) from the Title Company for the issuance at Closing of an ALTA Owners Policy for the Retail Property (**"Retail Property Title Commitment"**), together with a pro forma of said Policy (**"Retail Property Pro Forma Title Policy"**).

5.3 Commitment dated January 7, 2009 (amended) from the Title Company for the issuance at Closing of an ALTA Leasehold Owners Policy for the Lease of the Ouli Wells (**"Ouli Wells Title Commitment"**), together with a pro forma of said Policy (**"Ouli Wells Pro Forma Title Policy"**).

[6] The following easements and agreements (collectively, **"Ouli Wells Agreements"**):

6.1 Restated Water Agreement dated April 1, 2003 between Hale Wailani Partners, LP and Seller, a short form of which, also dated April 1, 2003, was recorded in the Bureau on February 22, 2005 as Document No. 2005-035372 (**"HWP Agreement"**).

6.2 Grant of Easement from Mauna Kea Development Corp. in favor of Seller dated April 17, 2006 and recorded in the Bureau on April 18, 2006 as Document No. 2006-072169.

6.3 Utility and Holding Reservoir Easement Agreement dated December 17, 2003 from the Waikoloa Village Association in favor of Seller recorded in the Bureau on December 22, 2003 as Document No. 2003-281789.

6.4 Unrecorded Agreement dated September 26, 2006 between the Department of Water Supply, County of Hawaii and Seller (**"Ouli Water Development Agreement"**).

[7] Community Facilities District Finance Plan (**"CFD"**) approved by the Council of the County of Hawaii, State of Hawaii, on October 31, 2006 as part of its Resolution of Intention (Resolution No. 486 06).

[8] ALTA/ASCM Land Title Survey performed on August 25, 2005 by Ross K. Tanaka and prepared December 9, 2005 (**"Property Survey"**), to be revised to include current title information and certification to the Title Company and the Parties.

[9] Agreements dated February 1, 2006 and November 2, 2006 between Hawaii Electric Light Company (**"HELCO"**) and Seller.

[10] Certain Closing Documents:

10.1 Residential Property Deed (as defined in Paragraph 2.B below).

10.2 Ouli Wells Lease (as defined in Paragraph 2.D below).

10.3 Bill of Sale (as defined in Paragraphs 9.A(6) below).

10.4 Retail Property Deed (as defined in Paragraph 2.C below).

[11] Map of Additional Urban Land.

[12] List of Due Diligence Documents (**"DD Documents"**), to be supplemented as of Closing.

[13] Section 11-8, County of Hawaii Code.

[14] The following unrecorded agreements (**"Development Agreements"**):

14.1 Dated March 2006, between land planners Sidney Fuke and Aaron Chung and Seller, as or as it may be amended.

14.2 Dated November 15, 2006, between Goodfellow Bros. Inc., a civil contractor, and Seller.

14.3 Dated October 19, 2005, between Tom Nance, hydrologist, and Seller.

15.4 Dated January 17, 2007, between PBR Hawaii, architect, and Seller.

14.5 Dated December 7, 2006, between SSFM International and Seller.

14.6 Dated April 19, 2007, between Knowledge Based Consulting Group and Seller.

[15] JDA, a short form of which shall be recorded at each Closing.

[16] List of Personal Property (as defined in Paragraph 9.A(6)) to be assigned to Buyer.

[17] Articles of Organization/Operating Agreement for Venture.

[18] Map of Affordable Housing Parcel (Lot D-1-B thereon).

The execution of this Agreement by Buyer shall constitute Buyer's acknowledgement and agreement that it has received and has accepted and waived any and all objections to each of the foregoing Exhibits as of the Effective Date.

2. CONVEYANCE. Upon and subject to the terms and conditions of this Agreement, the Property shall be conveyed by Seller to Buyer when and as follows:

A. **Affordable Housing Parcel**. On the Affordable Housing Parcel Closing Date (as defined in Paragraph 8 below) and at Closing, a currently-unsubdivided portion of the Residential Property ("**Affordable Housing Parcel**") denoted as "Lot D-1-B" identified on the map attached as Exhibit 18 and consisting of 61.387 acres. The Parties acknowledge and agree that Buyer, at Buyer's sole expense and on Seller's behalf and utilizing such instruments of authority from Seller as Buyer shall reasonably request, will, as soon as is reasonably practical after the Effective Date, obtain approval for the subdivision of the Affordable Housing Parcel from the Residential Property so as to constitute the Affordable Housing Parcel as a separate subdivided lot; provided, however, that, if and to the extent such subdivision approval requires the commitment by Seller to the Affordable Housing Parcel of potable water from the Ouli Wells, Seller shall do so, in such form as shall be reasonably required by the County of Hawaii, and upon and subject to all terms and conditions of this Agreement including but not limited to (a) the provisions of the Ouli Wells Agreements as applicable to such commitment including but not limited to the Ouli Water Development Agreement, (b) the "Urban Land Water Requirement" as defined and set forth in paragraph 3.2 of the JDA, and (c) the requirement that the development of the "Water System" as defined in paragraph 3.1 of the JDA shall be undertaken solely by Buyer and at Buyer's sole expense, all in accordance with the JDA and otherwise pursuant to this Agreement. If and when the Affordable Housing Parcel is conveyed to Buyer hereunder, such land shall be deemed to be included within the Property for purposes of this Agreement. The Affordable Housing Parcel shall be conveyed to Buyer by limited warranty deed ("**Affordable Housing Parcel Deed**") in form and substance identical to the Residential Property Deed as defined below except with respect to the title and exceptions description:

- ☐ together with all right, title and interest of Seller in and to any buildings, structures or other improvements existing thereon, all surface mineral rights, all tenements, hereditaments and appurtenances, all land lying in the beds of any streets, avenues, alleys or passages, open or proposed, bounding or abutting the Affordable Housing Parcel, any easements, rights of way or passageways appurtenant to or benefiting the Affordable Housing Parcel,

- ☐ together further with all articles of personal property as of Closing owned by Seller and located on or used in connection with the Affordable Housing Parcel, including without limitation if and as applicable the personal property so owned and located and listed in said Exhibit 16, as well as all currently existing and effective claims, guaranties, warranties, indemnifications and all other rights, if any, which Seller may have against suppliers, laborers, materialmen, contractors, or sub-contractors arising out of or in connection with the installation, construction and maintenance of the Affordable Housing Parcel, and all project rights, permits, entitlements, certifications, authorizations, approvals, licenses, engineering and all reports, studies, assessments, records, plans and specifications, files and commitments and all contracts and agreements, including without limitation those listed in the Exhibits hereto, for or related to the development of the Affordable Housing Parcel, which personal property shall be conveyed to (and with respect to those contracts and agreement listed in Exhibit 14, respectively, shall be assumed by) Buyer at Closing, each by a Bill of Sale.

- ☐ subject to the JDA (ref. Exhibit 15), and

- ☐ subject to those liens and encumbrances with respect to the Affordable Housing Parcel as are set forth in an Affordable Housing Parcel title commitment current to such Closing (excluding any mortgages and related security interests) and such other liens and encumbrances as the Parties shall mutually agree upon (said permitted liens and encumbrances being herein sometimes referred to as the **"Affordable Housing Parcel Permitted Exceptions"**).

B. Residential Property. On the Residential Property Closing Date (as defined in Paragraph 8 below) and at Closing, the Residential Property, by limited warranty deed (**"Residential Property Deed"**— ref. Exhibit 10.1):

- ☐ together with all right, title and interest of Seller in and to any buildings, structures or other improvements existing thereon, all surface mineral rights, all tenements, hereditaments and appurtenances, all land lying in the beds of any streets, avenues, alleys or passages, open or proposed, bounding or abutting the Residential Property, any easements, rights of way or passageways appurtenant to or benefiting the Residential Property,

- ☐ together further with all articles of personal property as of Closing owned by Seller and located on or used in connection with the Residential Property, including without limitation if and as applicable the personal property so owned and located and listed in said Exhibit 16, as well as all currently existing and effective claims, guaranties, warranties, indemnifications and all other rights, if any, which Seller may have against suppliers, laborers, materialmen, contractors, or sub-contractors arising out of or in connection with the installation, construction and maintenance of the Residential Property, and all project rights, permits, entitlements, certifications, authorizations, approvals, licenses, engineering and all reports, studies, assessments, records, plans and specifications, files and commitments and

all contracts and agreements, including without limitation those listed in the Exhibits hereto, for or related to the development of the Residential Property, which personal property shall be conveyed to (and with respect to those contracts and agreement listed in Exhibit 14, respectively, shall be assumed by) Buyer at Closing, each by a Bill of Sale.

☐ subject to the JDA (ref. Exhibit 15), and

☐ subject to those liens and encumbrances with respect to the Residential Property as are set forth in the updated Residential Property Title Commitment (ref. Exhibit 5.1) (excluding any mortgages and related security interests with the exception of the D-1 Mortgage as defined below) and such other liens and encumbrances as the Parties shall mutually agree upon (said permitted liens and encumbrances being herein sometimes referred to as the **"Residential Property Permitted Exceptions"**);

Provided, however, that if, and only if, the Residential Property is conveyed by Seller to Buyer pursuant to this Agreement, then Buyer will, at Buyer's sole expense and on Seller's behalf, as soon as is reasonably practical after the Residential Property Closing Date in connection with any further subdivision requests and per the agreement of Seller and Buyer, further subdivide the Ag Land so as to constitute the Additional Urban Land either as separate subdivided lots and/or as consolidated with the Urban Land, whereupon Seller will convey such Additional Urban Land to Buyer for no further consideration as set forth in this Agreement. The **"Additional Urban Land"** shall refer to: (1) those portions of Lot A-1 currently included within the State Land Use Urban district as shown on the map attached as Exhibit 11; and (2) certain other portions of the Ag Land for a (a) school (no more than 32 acres), (b) wastewater reclamation facility (no more than 10 acres), (c) active park (no more than 10 acres) (as set forth in the Zoning Ordinance), (d) passive park (no more than 16 acres) (as set forth in the Zoning Ordinance), and (e) if and only if Buyer develops on the Urban Land a second eighteen-hole golf course, land (no more than 15 acres) for such purpose, all as, where and when specifically agreed by Seller and Buyer. On a date that is no later than thirty (30) days after the date upon which the Additional Urban Land is so subdivided or otherwise legally conveyable, Seller shall convey the Additional Urban Land to Buyer by limited warranty deed and upon and subject to substantially the same provisions and conditions as apply to the Residential Property and Retail Property as set forth in Paragraphs 2.B and 2.C above. If and when the Additional Urban Land is conveyed to Buyer hereunder, such land shall be deemed to be included within the Property for purposes of this Agreement. The obligations of Seller and Buyer under this section shall survive Closing.

C. Retail Property. On the Retail Property Closing Date (as defined in Paragraph 8 below) and at Closing, the Retail Property, by limited warranty deed (**"Retail Property Deed"**—ref. Exhibit 10.4):

☐ together with all right, title and interest of Seller in and to any buildings, structures or other improvements existing thereon, all surface mineral rights, all tenements, hereditaments and appurtenances, all land lying in the beds of any streets, avenues, alleys or passages, open or proposed, bounding or abutting the Retail Property, any

easements, rights of way or passageways appurtenant to or benefiting the Retail Property,

☐ together further with all articles of personal property as of Closing owned by Seller and located on or used in connection with the Retail Property, including without limitation if and as applicable the personal property so owned and located and listed in said Exhibit 16, as well as all currently existing and effective claims, guaranties, warranties, indemnifications and all other rights, if any, which Seller may have against suppliers, laborers, materialmen, contractors, or sub-contractors arising out of or in connection with the installation, construction and maintenance of the Retail Property, and all project rights, permits, entitlements, certifications, authorizations, approvals, licenses, engineering and all reports, studies, assessments, records, plans and specifications, files and commitments and all contracts and agreements, including without limitation those listed in the Exhibits hereto, for or related to the development of the Retail Property, which personal property shall be conveyed to (and with respect to those contracts and agreement listed in Exhibit 14, respectively, shall be assumed by) Buyer at Closing, each by a Bill of Sale.

☐ subject to the JDA,

☐ subject to those liens and encumbrances with respect to the Retail Property as are set forth in the updated Retail Property Title Commitment (ref. Exhibit 5.2) (excluding any mortgages and related security interests) and such other liens and encumbrances as the Parties shall mutually agree upon (said permitted liens and encumbrances being herein sometimes referred to as the **"Retail Property Permitted Exceptions"**).

D. Ouli Wells Leasehold. On the Ouli Wells Lease Closing Date (as defined in Paragraph 8 below), a leasehold interest in and to the Ouli Wells by lease (**"Ouli Wells Lease"**—ref. Exhibit 10.2):

☐ together with the Ouli Wells Agreements (ref. Exhibit 6),

☐ together further with all articles of personal property as of Closing owned by Seller and located on or used in connection with the Ouli Wells, including without limitation if and as applicable the personal property so owned and located and listed in said Exhibit 16, as well as all currently existing and effective claims, guaranties, warranties, indemnifications and all other rights, if any, which Seller may have against suppliers, laborers, materialmen, contractors, or sub-contractors arising out of or in connection with the installation, construction and maintenance of the Ouli Wells, and all project rights, permits, entitlements, certifications, authorizations, approvals, licenses, engineering and all reports, studies, assessments, records, plans and specifications, files and commitments and all contracts and agreements, including without limitation those listed in the Exhibits hereto, for or related to the development of the Ouli Wells, which personal property shall be conveyed to (and

with respect to those contracts and agreement listed in Exhibit 14, respectively, shall be assumed by) Buyer at Closing, each by a Bill of Sale.

☐ subject to the covenants, conditions, obligations, security interests, and restrictions as set forth in the Ouli Wells Agreements and the Ouli Wells Lease,

☐ subject to the JDA, and

☐ subject to the HWP Agreement (ref. Exhibit 6.1), those liens and encumbrances with respect to the Ouli Well and Ouli Water Agreements as are set forth in the updated Ouli Wells Title Commitment (ref. Exhibit 5.3) (excluding any mortgages and related security interests), any terms and conditions of any commitment made by Seller in connection with the subdivision of the Affordable Housing Parcel as set forth in Paragraph 2.A, and such other liens and encumbrances as the Parties shall mutually agree upon (said permitted liens and encumbrances being herein sometimes referred to herein as the **"Ouli Wells Permitted Exceptions"**).

3. PURCHASE PRICE; DEVELOPMENT EXPENSES.

A. **Purchase Price.** For the purchase set forth in Paragraph 2 above and in consideration of the other covenants and agreements of Seller otherwise set forth in this Agreement, Buyer shall pay Seller a purchase price of [redacted] (subject to (1) increase pursuant to subsection (3) and Paragraph 6 below and (2) reduction by [redacted] pursuant to subsection (6) below) (**"Purchase Price"**), together with Buyer's share of the Closing Costs (as defined in Paragraph 10 below), when and as follows and in the following amounts:

(1) On and as of the Effective Date, [redacted] as a nonrefundable contribution toward certain fees and costs incurred and to be incurred by Seller in the negotiation, preparation, execution and implementation of this Agreement [redacted] **Payment**") (and in addition to a prior payment by Buyer to Seller of an identical nonrefundable amount for the same purpose), the payment in full of which [redacted] Payment by Buyer to Seller (and prior payment) is mutually acknowledged;

(2) On and as of the Effective Date, [redacted], the payment in full of which amount by Buyer to Seller is mutually acknowledged for payment by Seller to First Hawaiian Bank (**"FHB"**) in repayment of Seller's current loan from FHB secured by Seller's interest in a portion of the Property;

(3) On the Affordable Housing Parcel Closing Date, [redacted], subject to increase upon and pursuant to the conditions set forth in Paragraph 8 below, of which [redacted] shall be for payment by Seller to FHB for the purpose set forth in subsection (2) above [redacted];

(4) On each of June 30, 2009 and September 30, 2009 (in the event that both of the Residential Property Closing Date and the Retail Property Closing Date have not yet occurred), [redacted] ("**Quarterly Payments**");

(5) On and as of the Residential Property Closing Date: (a) [redacted] (provided, however, that the [redacted] Payment and any Quarterly Payments, and only such payments, to the extent paid in full on and as of the Residential Property Closing Date, may be credited against such payment); and (b) [redacted] as a nonrefundable deposit against the allocated portion of the Purchase Price for the Retail Property ("**Retail Deposit**") (provided, however, that the payment referenced in subsection (2) above and the balance of the payment referenced in subsection (3) above after allocation of the [redacted] payment pursuant to subpart (a) above, which two payments total [redacted], and only such payments, to the extent paid in full on and as of the Residential Property Closing Date, may be credited against the Retail Deposit);

(6) On and as of the Retail Property Closing Date, [redacted]; provided, however, that, if the Retail Property Closing Date occurs on or before June 30, 2009, said amount will be reduced by [redacted] to [redacted]; provided further, however, that the [redacted] Payment and the amounts described in subsections (2) through (4) above (to the extent not previously credited against the Purchase Price for the Residential Property), and the Retail Deposit, if and to the extent paid to Seller in full, shall be credited against said amount.

(7) On each of the Affordable Housing Parcel Closing Date, Residential Property Closing Date and Retail Property Closing Date, Buyer's share of the Closing Costs, for disbursement to the appropriate third parties in accordance with the Closing Statement (as set forth in Paragraph 9.A(9) below).

B. **Payment.** All payments by Buyer of the Purchase Price shall be in the form of good and immediately available United States of America funds. The payments described in subparagraphs A.(1) through (4) above have been made or will be made directly by Buyer to Seller. The payments described in subparagraphs A.(5) through (7) above shall be made by Buyer to Hawaii Escrow & Title, Inc. (**"Escrow Agent"**) in connection with the respective Closing Date; provided, however, that all such payments shall be made in full to Escrow Agent no later than three (3) days before such Closing Date.

C. **Development Expenses.** In addition to the Purchase Price, Buyer shall make the following payments at the following times and in the following ways, all in the form of good and immediately available United States of America funds, and all toward the purpose of compensating Seller for certain Property development and carrying costs until the Property is conveyed to Buyer and otherwise:

(1) On and as of the Effective Date, Buyer has paid Seller [redacted], the payment in full of which amount by Buyer to Seller is mutually acknowledged;

(2) On the last day of each calendar month, beginning with May 31, 2009 and continuing on every such day until the date of Closing on the last of the Property or termination of this Agreement, Buyer will pay Seller [redacted]; provided, however, that if such date of Closing on the last of the Property or termination of this Agreement is on a day other than the last day of a calendar month, then Buyer will additionally pay Seller a prorated amount of such monthly payment for the period from the last day of the calendar month immediately preceding such day through such date of Closing on the last of the Property or termination of this Agreement.

D. **Nonrefundable Payments.** The [redacted] Payment (and additional payment referenced in Paragraph 3.A(1)) shall not be refundable to Buyer under any circumstance. All remaining payments as set forth above shall not be refundable by Seller to Buyer except in the sole event that Buyer is not in default under this Agreement and Seller refuses to convey the Property to Buyer as and when provided under this Agreement.

E. **Interest.** Interest, if any, on any amounts deposited with Escrow Agent hereunder shall accrue to the benefit of the depositor.

4. **TITLE INSURANCE.** The Parties have secured from the Title Company the title commitments referenced in Paragraph 1.A.[5] above, insuring, among other things, that upon Closing title will be vested in the name of Buyer, subject to the Urban Land and Ouli Wells Permitted Exceptions as applicable. Nothing in this Agreement shall prohibit Buyer, at its own cost and expense, from attempting to obtain such additional endorsements or the deletion of title exceptions, and Seller agrees to cooperate with Buyer in requesting such additional endorsements or the deletion of title exceptions; provided that in no case shall the failure of Buyer to obtain such additional endorsements or deletions prevent or delay Closing; provided further that Seller's representations and warranties as to the status of title and encumbrances on it shall be strictly limited to that stated in Paragraph 6.A.(1) below. The cost of the commitments and related title policies shall be borne by Buyer.

5. **SATISFACTION OF DUE DILIGENCE.** By executing this Agreement, Buyer declares, warrants and represents that, as of the Effective Date, Buyer is satisfied with the Property, including but not limited to the physical condition of the Property and its development viability, the DD Documents, the Title Commitments and Pro Forma Title Policies, subject to updates as set forth under Paragraph 1.A.[5] above, the Property Survey, and all exhibits to this Agreement, including without limitation the JDA and the Ouli Wells Lease, and intends unconditionally to proceed with Closing subject only to the conditions precedent as set forth in Paragraph 7 of this Agreement.

6. **REPRESENTATIONS AND WARRANTIES.**

A. **Seller's Representations and Warranties.** To induce Buyer to enter into this Agreement, Seller makes the following representations and warranties, all of which shall be true and correct as of the Effective Date and as of the applicable Closing Date except as expressly indicated below:

(1) Seller holds fee simple title to the Property and the Ouli Wells, has the good right to convey to Buyer fee simple title in the former and a leasehold interest in the latter, and has not placed, permitted or suffered any liens or other encumbrances on the Property from May 17, 1999 to the Closing Date except for the Permitted Exceptions and Bridge Capital D-1 Mortgage (provided that Buyer must look to the Title Policies for all other title assurances).

(2) Seller is a limited liability company duly organized and validly existing under the laws of the State of Hawaii, and Seller has obtained all requisite company approvals to execute and deliver this Agreement and to perform its obligations hereunder.

(3) Seller is not currently in possession of any written notice of any special tax assessments levied against or relating to the Property and has no actual knowledge that any such special assessments are proposed, except that the Property may be subject to roll-back taxes and special assessments as proposed pursuant to the CFD.

(4) On or after the applicable Closing Date, except as otherwise disclosed in the DD Documents, there will be no leases which will affect the Property other than the leases contemplated herein and in the JDA, and Seller will not have granted any party an option to purchase, right of first refusal, right of first offer, or any other rights to acquire any interest in the Property or any part thereof.

(5) Seller has no actual receipt of any written notice and has no actual knowledge of any violations of any law, ordinance, rule, order, regulation, code or requirement which are applicable to the Property or to any part thereof or which are applicable to the proposed use or manner of use, occupancy, possession or operation of the Property which have not heretofore been corrected.

(6) To the best of Seller's commercially reasonable knowledge, all DD Documents provided to Buyer are in all material aspects true, correct and complete copies, and Seller has not knowingly deleted, removed or withheld any material parts, portions, or information therefrom.

(7) Pending Closing hereunder, and except as otherwise provided herein including but not limited to Paragraph 12, Seller shall conduct its business involving the Property and its development in the manner as it did prior to the Effective Date.

Except as otherwise provided above, the above representations and warranties shall survive the applicable Closing and shall remain effective and enforceable for one (1) year after the applicable Closing Date.

B. **Buyer's Agreements, Representations and Warranties.** To induce Seller to enter into this Agreement, Buyer makes the following agreements, representations and warranties,

all of which shall be true and correct as of the Effective Date, and up to and including the applicable Closing Date:

(1) Buyer is a limited liability company duly organized and validly existing under the laws of the State of Nevada, and Buyer has obtained all requisite company approvals to execute and deliver this Agreement and to perform its obligations hereunder.

(2) Buyer has, will have, or will have arranged for financing to provide by at least three business days prior to each Closing Date the applicable portion of the Purchase Price and all other sums due and owing by Buyer at Closing pursuant hereto in good and immediately available funds.

(3) Buyer has confirmed, and shall confirm as of each Closing Date by a separate writing, that, in consultation with such of its attorneys, land planners, and other professionals as it has deemed necessary or appropriate, it has made, its own examination, inspection and investigation of the condition of the Property (including, without limitation, all matters pertaining to environmental hazards, archeological matters, status of title and encumbrances thereon, all laws affecting the Property, its development and any construction thereon, all entitlements and permitting with respect thereto, engineering, provisions for utilities service, and all other conditions which may affect the development thereof and construction thereon, as it deems necessary or appropriate), and further that it has had full and complete access to the Property and to documentation regarding the Property in order to make such examination, inspection and investigation.

(4) Buyer accepts and agrees and confirms that Seller shall not be responsible or liable to Buyer for any conditions affecting the Property or its development or any construction thereon, as Buyer is purchasing the Property **AS-IS, WHERE-IS and WITH ALL FAULTS,** and not in reliance on any representations or warranties from Seller, except for those stated above in Paragraph 6.A above.

(5) **Purchase As-Is**. EXCEPT FOR THE REPRESENTATIONS OF SELLER EXPRESSLY SET FORTH IN THIS AGREEMENT, BUYER WARRANTS AND ACKNOWLEDGES TO AND AGREES WITH SELLER THAT BUYER IS PURCHASING THE PROPERTY IN ITS "AS-IS, WHERE IS" CONDITION "WITH ALL FAULTS" AND DEFECTS AS OF THE CLOSING DATE AND SPECIFICALLY AND EXPRESSLY WITHOUT ANY WARRANTIES, REPRESENTATIONS OR GUARANTEES, EITHER EXPRESS OR IMPLIED, AS TO ITS CONDITION, FITNESS FOR ANY PARTICULAR PURPOSE, MERCHANTABILITY, OR ANY OTHER WARRANTY OF ANY KIND, NATURE, OR TYPE WHATSOEVER FROM OR ON BEHALF OF SELLER. EXCEPT FOR THE REPRESENTATIONS OF SELLER EXPRESSLY SET FORTH IN THIS AGREEMENT, SELLER SPECIFICALLY DISCLAIMS ANY WARRANTY, GUARANTY OR REPRESENTATION, ORAL OR WRITTEN, PAST OR PRESENT, EXPRESS OR IMPLIED, CONCERNING (A) THE VALUE, NATURE, QUALITY OR CONDITION OF THE PROPERTY, INCLUDING, WITHOUT LIMITATION, THE WATER, STRUCTURAL INTEGRITY, SOIL AND GEOLOGY; (B) THE INCOME TO BE DERIVED FROM THE SUBJECT PROPERTY; (C) THE SUITABILITY OF THE PROPERTY FOR ANY AND ALL ACTIVITIES AND USES WHICH BUYER MAY CONDUCT THEREON, INCLUDING THE

POSSIBILITIES FOR FUTURE DEVELOPMENT OF THE PROPERTY; (D) THE COMPLIANCE OF OR BY THE PROPERTY OR ITS OPERATION WITH ANY LAWS, RULES, ORDINANCES OR REGULATIONS OF ANY APPLICABLE GOVERNMENTAL AUTHORITY OR BODY; (E) THE HABITABILITY, MERCHANTABILITY, MARKETABILITY, PROFITABILITY OR FITNESS FOR A PARTICULAR PURPOSE OF THE PROPERTY; (F) THE MANNER OR QUALITY OF THE CONSTRUCTION OR MATERIALS, IF ANY, INCORPORATED INTO THE PROPERTY; (G) THE MANNER, QUALITY, STATE OF REPAIR OR LACK OF REPAIR OF THE PROPERTY; (H) THE PRESENCE OR ABSENCE OF HAZARDOUS MATERIALS AT, ON, UNDER, OR ADJACENT TO THE PROPERTY OR ANY OTHER ENVIRONMENTAL MATTER OR CONDITION OF THE PROPERTY; (I) ANY OTHER MATTER WITH RESPECT TO THE PROPERTY. BUYER ACKNOWLEDGES AND AGREES THAT, EXCEPT FOR THE REPRESENTATIONS AND WARRANTIES OF SELLER CONTAINED IN SECTION 6.A OF THIS AGREEMENT, ANY INFORMATION PROVIDED BY OR ON BEHALF OF SELLER WITH RESPECT TO THE PROPERTY WAS OBTAINED FROM A VARIETY OF SOURCES AND THAT SELLER HAS NOT MADE ANY INDEPENDENT INVESTIGATION OR VERIFICATION OF SUCH INFORMATION AND MAKES NO REPRESENTATIONS AS TO THE ACCURACY OR COMPLETENESS OF SUCH INFORMATION. SELLER IS NOT LIABLE OR BOUND IN ANY MANNER BY ANY ORAL OR WRITTEN STATEMENTS, REPRESENTATIONS OR INFORMATION PERTAINING TO THE PROPERTY, OR THE OPERATION THEREOF, FURNISHED BY ANY REAL ESTATE BROKER, AGENT, CONSULTANT, COUNSEL, EMPLOYEE, SERVANT OR OTHER PERSON EXCEPT FOR THE EXPRESS REPRESENTATIONS SET FORTH IN THIS AGREEMENT. BUYER FURTHER ACKNOWLEDGES AND AGREES THAT BUYER IS A SOPHISTICATED AND EXPERIENCED PURCHASER OF PROPERTIES SUCH AS THE PROPERTY AND HAS BEEN DULY REPRESENTED BY COUNSEL IN CONNECTION WITH THE NEGOTIATION OF THIS AGREEMENT. EXCEPT AS MAY OTHERWISE BE PROVIDED HEREIN, SELLER HAS MADE NO AGREEMENT TO ALTER, REPAIR OR IMPROVE ANY OF THE PROPERTY.

The above agreements, representations and warranties shall survive any Closing and shall remain effective and enforceable after all Closing Dates.

7. CONDITIONS PRECEDENT.

A. Seller's obligation to close and consummate the transactions contemplated by this Agreement is subject to the condition precedent that the agreements, representations and warranties of Buyer contained herein shall be true and correct on each Closing Date and confirmed as of each Closing Date by a separate writing. Only Seller may waive such condition precedent. In the event that such condition precedent is not satisfied at Closing, Seller shall be entitled to exercise its rights and remedies as a non-defaulting party under Paragraph 18 below.

B. Buyer's obligation to close and consummate the transactions contemplated by this Agreement is subject to the condition precedent that the representations and warranties of Seller contained herein shall be true and correct on each Closing Date and confirmed as of the Closing Date by a separate writing. Only Buyer may waive such condition precedent. In the event that

such condition precedent is not satisfied at Closing, Buyer shall be entitled to exercise its rights and remedies as a non-defaulting party under Paragraph 18 below.

8. **CLOSING.** The Affordable Housing Parcel Closing shall occur on or before June 1, 2009 ("**Affordable Housing Parcel Closing Date**"); provided, however, that Buyer, on at least seven (7) days written notice to Seller prior to such date, may elect a one-time extension of the Affordable Housing Parcel Closing Date to a date certain which is no later than June 30, 2009 on the condition that the Purchase Price and the amount thereof payable on the extended Affordable Housing Parcel Closing Date shall be increased by Three Thousand and No/100 Dollars ($3,000.00) for each day after June 1, 2009 through and including the revised Affordable Housing Parcel Closing Date. The Residential Property Closing shall occur on or before September 30, 2009 ("**Residential Property Closing Date**"). The Retail Property Closing shall occur on or before October 31, 2009 ("**Retail Property Closing Date**"); provided, however, that in no event shall the Retail Property Closing Date occur before the Residential Property Closing. Buyer, in the event it is not then in default under this Agreement and pursuant to this Agreement, may designate an earlier Closing Date than the dates set forth above for any of the Affordable Housing Parcel, Residential Property or Retail Property on at least seven (7) days written notice to Seller. The Ouli Wells Lease Closing shall occur on the first to occur (if any) of the following dates: (a) the second to occur of the Affordable Housing Parcel Closing Date and the Residential Property Closing Date; (b) the provision by Buyer, as Seller's assignee, of the performance and payment bond referenced in paragraph 1.k of the Ouli Water Development Agreement, which bond shall name Seller as an additional obligee to the extent Seller may be so named; and (c) a separate payment by Buyer to Seller in the amount of Five Million and No/100 Dollars ($5,000,000.00), which payment shall not be deemed a portion of the Purchase Price nor in satisfaction of any other obligation of Buyer hereunder, but shall instead be in the nature of a fee for the early release of water by Seller to Buyer ("**Ouli Wells Closing Date**"). Each Closing shall be made through an escrow arrangement with the Escrow Agent coordinated by counsel for Seller and Buyer, including at a meeting ("**Pre-Closing Conference**") to be held one (1) day prior to the Closing Date at 10:00 A.M. at the offices of the Escrow Agent unless otherwise agreed by Seller and Buyer or their counsel. Notice shall be given to Escrow Agent at least five (5) days in advance of the date established by the Parties for Closing. Each Closing shall be as of 8:01 A.M., Hawaii Standard Time on the Closing Date unless otherwise agreed by Seller and Buyer or their counsel.

9. **DELIVERIES.**

A. At or before the Pre-Closing Conference for each Closing Date, except as otherwise expressly provided, Seller and Buyer shall execute and deliver the following documents and/or undertake the following:

(1) All corporate or applicable partnership certifications, resolutions and approvals necessary to evidence both Seller's and Buyer's authority to enter into and consummate the transactions contemplated by this Agreement.

(2) A release and termination by the secured party of any mortgages or other monetary liens recorded against the Property to be conveyed (except, with respect to Lot D-1 of the Residential Property, a Mortgage, Security Agreement and Financing Statement by Seller in favor

of Carombola Management, LLC, a CNMI limited liability company, and UCC Financing Statement, both dated as of the Effective Date and recorded in the Bureau as Document Nos. 2009-_____ and 2009- _____ (collectively, "**D-1 Mortgage**")), which documents shall be recorded at Closing.

(3) The Affordable Housing Parcel Deed, Residential Property Deed, Retail Property Deed and Ouli Wells Lease by Seller to Buyer, executed by the signatory parties thereto, all of which shall be recorded at Closing.

(4) The JDA executed by Seller and Buyer, a short form of which shall also be executed and recorded at Closing.

(5) An Amendment to the Amended and Restated Certificate and Consent (ref. Exhibit 2) executed by Buyer, whereby Buyer consents to and assumes the obligations stated in the Amended and Restated Certificate and Consent, which Amendment shall be recorded at Closing.

(6) A Bill of Sale from Seller to Buyer (**"Bill of Sale"**) quitclaiming the Property Personal Property (**"Personal Property"**) as appropriate.

(7) Separate confirmations of their respective agreements, representations and warranties from Seller and Buyer as stated in Paragraphs 6.A and 6.B, respectively.

(8) An Affidavit of Non-Foreign Status by Seller and the HARPTA form executed by Seller.

(9) A Closing Statement executed by Seller and Buyer.

(10) Such other documents as are reasonably necessary to close and consummate the transaction contemplated by this Agreement.

(11) All existing plans and specifications, including all third-party warranties and guaranties, relating to the development of the Property and the improvements located upon or planned for the Property, which are in Seller's possession or reasonably accessible to Seller, to be delivered to Buyer after Closing.

(12) Assignments and Assumptions of all Property Development Agreements and any other agreements to be assumed by Buyer at Closing.

(13) Certificates of Good Standing from the State of Hawaii for Seller and Buyer.

(14) By Buyer to Escrow Agent, all cash balances due hereunder and authorization for Escrow Agent's disbursement of the same in accordance with the Closing Statement.

(15) A short form of this Agreement, which short form shall be executed and recorded on the Property to be conveyed at Closing to the extent such short form has not been previously recorded thereon pursuant to Paragraph 9.B.

The documents to be recorded shall be recorded as of the Closing in the order indicated above.

B. On or before the Affordable Housing Parcel Closing Date, and if and only if Buyer has then paid in full (a) all amounts under Paragraph 3.A(2) and (3), (b) the first Quarterly Payment under Paragraph 3.A(4) if then due, and (c) all amounts payable to such date under Paragraph 3.C, and is otherwise then in full compliance with its obligations under this Agreement, Seller will deliver to Escrow Agent an executed short form of this Agreement, which short form shall be recorded on the Property.

10. **CLOSING COSTS.** Seller shall pay for the costs of preparing the deeds and bills of sale, and any fees related to the release of any mortgages required to be released from the Property at Closing. Buyer shall pay all of the cost of any and all conveyance tax imposed upon the transfer of the Property to Buyer, all of the cost of title insurance including all requested endorsements, commitments and policies, and all recording fees and escrow fees and costs. Each Party shall bear its own attorneys' fees and other professional costs, except as otherwise provided for herein. The closing costs described herein are referred to herein collectively as the "**Closing Costs**."

11. **PRORATIONS.** Unless the Parties otherwise agree in connection with the negotiation of the closing documentation, all taxes and other operating expenses and revenue of the Property shall be prorated as of the Closing Date.

12. **PRE-CLOSING POSSESSION/DEVELOPMENT RESPONSIBILITY.** From and after the Effective Date and prior to any Closing, for so long as Buyer is not in default of its obligations under this Agreement, and upon and subject to the terms and conditions of this Agreement, Seller shall deliver to Buyer exclusive possession of the Urban Land. Buyer shall thereafter, pursuant to the terms and conditions of this Agreement and of all related undertakings and agreements of Seller, proceed to take all actions and do all things, and is so authorized by Seller, to develop the Urban Land in accordance with the D/O, Zoning Ordinance, Revised Master Plan and other applicable documents and requirements, all at Buyer's sole expense including the costs of all related consultants and studies retained and undertaken by Seller; provided, however, that Buyer agrees that it will not enter into any contract or other arrangement over $25,000.00 individually except with the prior written consent of Seller (which Seller covenants it shall not unreasonably withhold or delay its response to a request for consent, and further Seller covenants that if it should elect not to consent, then its shall state in detail and with specificity its reasons for not giving its consent, otherwise Seller shall be deemed to have given its consent); provided further, however, that during said period Buyer will continue to maintain and repair the Urban Land in at least the manner which Seller has previously maintained and repaired the Urban Land, will permit or commit no waste of the Urban Land, will pay and otherwise keep in effect Seller's existing policies of insurance covering the Property, and will pay all real property taxes and assessments on the Urban Land. For purposes of this subsection, Seller's failure to respond to a request for consent from Buyer within five (5) business days after receipt of said request shall automatically be deemed consent to said request. Seller further undertakes to cooperate with Buyer in good faith and to undertake any related action reasonably requested by Buyer; provided, however, that Seller does not undertake any responsibility for initiating any related action or incurring any related expense. Seller will keep Buyer informed of any relevant information or

communication received by Seller through the last Closing. Buyer will provide Seller, on or before the first day of each calendar month commencing with March 1, 2009 and through the last Closing, with a monthly status report of all of Buyer's actions and expenses pursuant to this paragraph. In fulfilling Buyer's undertakings under this paragraph, the applicable provisions of the JDA shall apply to Buyer as if it were executed between the Parties. Seller similarly agrees that, during the period of Buyer's exclusive possession of the Urban Land hereunder, Seller will not enter into any contract or other arrangement over $25,000.00 individually with respect to the Urban Land except with the prior written consent of Buyer (which Buyer covenants it shall not unreasonably withhold or delay its response to a request for consent, and that Buyer's failure to respond to a request for consent from Seller within five (5) business days after receipt of said request shall automatically be deemed consent to said request, and further Buyer covenants that if it should elect not to consent, then its shall state in detail and with specificity its reasons for not giving its consent, otherwise Buyer shall be deemed to have given its consent).

13. **EMINENT DOMAIN.** For purposes of this Agreement, a **"minor condemnation"** shall be any taking or condemnation by any body having the power of condemnation or eminent domain which causes damages of less than Five Hundred Thousand and No/100 Dollars ($500,000.00) to the Property and that does not affect access from the highway adjacent to the Property. Any other taking or condemnation shall be a "major condemnation". If prior to any Closing the applicable Property is subjected to a major or minor condemnation of which Seller becomes aware, Seller shall give Buyer prompt written notice thereof. If such condemnation is a minor condemnation, this Agreement shall remain in full force and effect and the transaction contemplated herein, less any interest taken by eminent domain or condemnation, shall be effected with no further adjustment, and at Closing, Seller shall assign, transfer and set over to Buyer as the case may be all of the right, title and interest of Seller in and to any awards that have been or that may thereafter be made for such taking If such condemnation is a major condemnation, the real property subject to the major condemnation shall be considered a defective parcel and Buyer shall have the right to terminate this Agreement, the Retail Deposit shall be returned to Buyer, and the Parties will be released from any further liability hereunder, except as otherwise expressly provided herein.

14. **HART-SCOTT-RODINO.** Seller and Buyer acknowledge that to the best of each of their understanding this statute does not apply because the Property falls under an exception to the obligation to file; provided, however, that if it is determined to be applicable in the future, Buyer shall make the appropriate filings on an expedited basis and all costs and expenses of compliance with the statute shall be borne by Buyer.

15. **NOTICES.** All notices and other communications under this Agreement shall be in writing and shall be effectively given only if sent by nationally recognized overnight courier service, postage prepaid, return receipt requested, addressed as follows:

To Seller:	Bridge Aina Le'a, LLC 2500 Kalakaua, #2404 Honolulu, Hawaii 96815 Fax No.: (808) 926-9767 Attention: Jim Baldwin and Hoolae Paoa
with a copy to:	Bays Deaver Lung Rose & Holma 16th Floor Alii Place 1099 Alakea Street Honolulu, Hawaii 96813 Fax No.: (808) 533-4184 Attention: Edward E. Case
and a copy to:	John Baldwin or Richard Pipes Bridge Capital, LLC Marina Heights II Building Saipan, MP 96950 Fax No.: (670) 322-2323
And by email to:	John Baldwin at jkb@bccnmi.com Richard Pipes at rp@bccnmi.com
To Buyer:	Relco Corp. 3231 La Mancha Henderson, NV 89041 Fax No.: (702) 454-0652 Attn.: Robert Wessels E-mail: rwess43@aol.com
and a copy to:	Law Offices of Richard P. Bernstein 650 Howe Ave., Suite 730 Sacramento, CA 95825 Fax No.: (916) 921-7712 Attention: Richard Bernstein E-mail: rbernstein@rpblegal.com
and a copy to:	Rubin & Bailin, LLP 501 Madison Avenue, 14th Floor New York City, NY 10022 Fax No.: (212) 826-9307 Attention: Marc L. Bailin

or such other address as the Party to be notified shall have designated to the other Parties hereby by notice delivered in accordance herewith. All such notices shall be deemed given on the business day next following the day such notice is accepted for delivery by the overnight courier service.

16. ASSIGNMENT OF NAME. At the first Closing, Seller shall assign to Buyer, without limitation, all of its right, title and interest in the trade name "The Villages at Aina Le'a" registered with the State of Hawaii.

17. ASSIGNMENT. Neither Party may assign its rights and interests under this Agreement to any party other than a designated affiliate approved by the other Party, which approval shall not be unreasonably withheld, delayed or conditioned. Notwithstanding the foregoing, Buyer shall be entitled to assign its rights and interests under this Agreement to the Venture from and after the Effective Date, which Venture shall thereafter operate under this Agreement in accordance with its documents of organization and operation, copies of which are attached as Exhibit 17; provided, however, that it shall be a condition precedent to any Closing that Buyer's interests hereunder shall have been assigned to the Venture. In no event shall Buyer be released from any obligations under this Agreement, the JDA, the Ouli Lease or any other agreement to which Seller is a party or a beneficiary as a result of such designation, and Buyer shall remain as a guarantor of all responsibilities, obligations and liabilities of such designated affiliate under the same.

18. DEFAULT BY SELLER OR BUYER. If, under the provisions of this Agreement, Seller shall be obligated to complete any conveyance transaction but fails to do so within the applicable period provided for any Closing, or shall otherwise fail to perform any of the other obligations of Seller hereunder within the required time period, Buyer shall have the option, as its sole and exclusive remedy for such default, and provided that Buyer is not then in default and that Seller's default was not caused in whole or in part by Buyer: (a) to terminate this Agreement; or (b) to sue for specific performance. If, under the provisions of this Agreement, Buyer shall be obligated to complete any conveyance transaction but fails to do so within the applicable period provided for Closing, or shall otherwise fail to perform any of the other obligations of Buyer hereunder within the required time period and such applicable cure periods have expired, Seller shall have the right, as its sole and exclusive remedy for such default, to terminate this Agreement, retaining any deposits including the Retail Deposit and other payments made hereunder to the date of such default.

19. WAIVER; REMEDIES CUMULATIVE. The rights and remedies of the Parties to this Agreement are cumulative and not alternative. Neither any failure nor any delay by any Party in exercising any right, power or privilege under this Agreement or any of the documents referred to in this Agreement will operate as a waiver of such right, power or privilege, and no single or partial exercise of any such right, power or privilege will preclude any other or further exercise of such right, power or privilege or the exercise of any other right, power or privilege. To the maximum extent permitted by applicable law: (a) no claim or right arising out of this Agreement or any of the documents referred to in this Agreement can be discharged by one Party, in whole or in part, by a waiver or renunciation of the claim or right unless in writing signed by the other Party; (b) no waiver that may be given by a Party will be applicable except in the specific instance for which it is given; and (c) no notice to or demand on one Party will be deemed to be a waiver of any obligation of that Party or of the right of the Party giving such notice or demand to take further action without notice or demand as provided in this Agreement or the documents referred to in this Agreement.

20. **ADVISOR'S/BROKER'S COMMISSION.** Seller and Buyer each warrant that there are no real estate advisors, brokers or finders of any type involved in this transaction. Seller shall indemnify and hold harmless Buyer from any claim from any party claiming to have acted as a broker, advisor or finder on behalf of Seller. Buyer shall indemnify and hold harmless Seller from any claim from any party claiming to have acted as a broker, advisor or finder on behalf of Buyer. This provision shall survive Closing.

21. **SURVIVAL OF AGREEMENT.** The terms and conditions of this Agreement which expressly so state shall survive any Closing hereunder.

22. **TIME IS OF THE ESSENCE.** Seller and Buyer acknowledge that time is of the essence of this Agreement and of every agreement entered into pursuant hereto. This provision shall survive any Closing.

23. **MODIFICATIONS.** The Parties acknowledge that this Agreement is the entire agreement between the Parties with respect to the subject matter hereof and that this Agreement cannot be modified without a written agreement executed by both Parties.

24. **ATTORNEYS' FEES.** In the event of any litigation between the Parties arising out of this Agreement, or the collection of any funds due Buyer or Seller pursuant to this Agreement, the prevailing Party shall be entitled to recover all costs incurred and reasonable attorneys' fees and expenses incurred. As used herein and throughout this Agreement, the term "attorneys' fees" shall be deemed to include all fees incurred whether by attorneys, paralegals, legal assistants or law clerks whether in pretrial, trial, appeal, bankruptcy, collection or declaratory proceedings. This provision shall survive Closing.

25 **CONSTRUCTION.** This Agreement has been negotiated between the Parties, each of whom has been represented by counsel. Accordingly, this Agreement shall not be construed against either Party as the drafter of the Agreement in the event of any litigation with respect to it.

26. **AGREEMENT CONSTITUTES ESCROW INSTRUCTIONS.** A signed copy of this Agreement shall be deposited with Escrow Agent and Escrow Agent will be authorized and instructed to act in accordance with the provisions of this Agreement, which shall constitute escrow instructions. The Parties shall each execute and deliver to Escrow Agent such other instructions, instrument and funds as are necessary to close escrow and consummate this transaction in accordance with the terms hereof. By signing below, Escrow Agent agrees to accept this Agreement as joint escrow instructions of the Parties and to proceed in accordance with the terms and conditions set forth herein unless otherwise directed by a writing signed by all Parties. This provision shall survive Closing.

27. **CHOICE OF LAW.** This Agreement is made and entered into in the State of Hawaii, without regard to any conflict of laws provisions, and shall in all respects be interpreted, enforced and governed under the laws of the State of Hawaii. This provision shall survive Closing.

28. **WAIVER OF JURY TRIAL.** Seller and Buyer knowingly, voluntarily and intentionally waive any right to trial by jury in respect to any litigation arising out of, under or in connection with this Agreement or the transaction described herein. This provision shall survive Closing.

29. **COUNTERPART EXECUTION.** This Agreement may be executed in several counterparts, each of which shall be fully effective as an original and all of which together shall constitute one and the same instrument.

30. **FACSIMILE.** A facsimile of this Agreement or any portion hereof, including the signature page of any party, shall be deemed an original for all purposes.

31. **1031 EXCHANGES AND FUTURE TAX PLANNING.** Buyer agrees that Seller may elect to complete this transaction as a 1031 exchange, or some other reasonable tax structure, and Buyer agrees to reasonably cooperate with Seller in completing such exchange provided that there is no additional cost, liability or expense to Buyer as a result of such transaction.

32. **SEVERABILITY.** If any provision of this Agreement is held invalid or unenforceable by any court of competent jurisdiction, the other provisions of this Agreement will remain in full force and effect. Any provision of this Agreement held invalid or unenforceable only in part or degree will remain in full force and effect to the extent not held invalid or unenforceable.

33. **COOPERATION; FURTHER ASSURANCES.** Each of Seller and Buyer, from time to time, upon request of the other Party and without further consideration, shall at their own expense, execute and deliver such documents and take such further actions as such other Party may reasonably request in order to more effectively consummate the transactions described in this Agreement. This provision shall survive Closing.

34. **TIME PERIODS.** If the final day of any time period or limitation set out in any provision of this Agreement falls on a Saturday, Sunday or legal holiday of the State of Hawaii or federal government, then and in such event, the time of such period shall be extended to the next day which is not a Saturday, Sunday or legal holiday. Time is of the essence of this Agreement with respect to all dates set forth herein including the scheduled Closing Dates subject to any provisions herein for extension thereof. Unless otherwise specifically stated, as used herein "**days**" shall mean calendar days.

35. **COMMISSION NOTIFICATION**. As soon as practical after any Closing, Seller shall notify the Commission of the transfer of the applicable Property to Buyer.

IN WITNESS WHEREOF, the Parties hereto have hereunto set their hands effective the Effective Date.

BRIDGE AINA LE`A, LLC

By:_____
Name:_____
Its:_____

"Seller"

RELCO CORP.

By:_____
Name: Robert Wessels
Its: Pres.

"Relco"

DW AINA LE'A DEVELOPMENT, LLC

Relco CORP

By:_____
Name: Robert Wessels
Its: Pres

"Buyer"

IN WITNESS WHEREOF, the Parties hereto have hereunto set their hands effective the Effective Date.

BRIDGE AINA LE'A, LLC

By: _____
Name: John K Baldwin
Its: Manager

"Seller"

RELCO CORP.

By: _____
Name: _____
Its: _____

"Relco"

DW AINA LE'A DEVELOPMENT, LLC

By: _____
Name: _____
Its: _____

"Buyer"

JOINDER BY ESCROW AGENT

Hawaii Escrow & Title Inc., referred to in this Agreement as the **"Escrow Agent,"** hereby acknowledges that it received this Agreement executed by Seller and Buyer effective February 9, 2009, and accepts the obligations of the Escrow Agent as set forth herein. It further acknowledges that it hereby assumes all responsibilities for information reporting required under Section 6045(e) of the Internal Revenue Code.

Hawaii Escrow & Title, Inc.

By: Denise M Kaeh
Print Name: Denise M Kaeh
Title: President

50914-1

STATE OF NEVADA

ROSS MILLER
Secretary of State

SCOTT W. ANDERSON
Deputy Secretary
for Commercial Recordings

OFFICE OF THE
SECRETARY OF STATE

Filing Acknowledgement

June 12, 2007

Job Number	Limited Liability Company Number	
C20070612-1075	E0410792007-0	
Filing Description	**Document Filing Number**	**Date/Time of Filing**
Articles of Organization	20070403940-79	June 12, 2007 08:00:22 AM

Limited Liability Company Name	Resident Agent
DW AINA LE'A DEVELOPMENT, LLC	ROBERT J. WESSELS

The attached document(s) were filed with the Nevada Secretary of State, Commercial Recordings Division. The filing date and time have been affixed to each document, indicating the date and time of filing. A filing number is also affixed and can be used to reference this document in the future.

Respectfully,

ROSS MILLER
Secretary of State

Commercial Recording Division
202 N. Carson Street
Carson City, Nevada 89701-4069
Telephone (775) 684-5708
Fax (775) 684-7138

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Appendix B
Rezoning Ordinance No. 96-153

COUNTY OF HAWAII STATE OF HAWAII

BILL NO. 353
(Draft 3)

ORDINANCE NO. 96 153

AN ORDINANCE AMENDING ORDINANCE NO. 93-1 WHICH CHANGED THE DISTRICT CLASSIFICATION FROM UNPLANNED (U) TO RESIDENTIAL AND AGRICULTURAL (RA-1a); MULTIPLE-FAMILY RESIDENTIAL (RM-4), (RM-7) AND (RM-14.5) AND VILLAGE COMMERCIAL (CV-10) AT WAIKOLOA, WAIMEA, SOUTH KOHALA, HAWAII, COVERED BY TAX MAP KEY 6-8-01:PORTIONS OF 25, 36, 37, 38, 39 AND 40.

BE IT ORDAINED BY THE COUNCIL OF THE COUNTY OF HAWAII:

SECTION 1. Ordinance No. 93-1 is amended as follows:

"SECTION 2. These changes in district classification are conditioned upon the following:

(A) the applicant, successors or assigns shall be responsible for complying with all of the stated conditions of approval;

(B) within three years from the enactment of this amendment [the effective date of the rezoning shall be (1) when] the applicant shall provide [provides] assurance satisfactory to the Department[s] of Water Supply and the Planning Director, upon consultation with the State Department of Health and Department of Land and Natural Resources, that a water source(s) of sufficient quality and quantity has (have) been established. [within two years from the enactment of this ordinance; provided that a maximum one-year extension may be granted by the Planning Director with reasonable and sufficient justification; and (2) an agreement, together with the appropriate bond, surety or other security deemed acceptable by the Planning Director, is executed between the applicant and the County through its Departments of Water Supply and Planning for the actual development of a proven source(s) and its water transmission and distribution

system within one year from the official date of compliance with Condition B(1); provided that a one-year extension may be granted by the Planning Director with reasonable and sufficient justification;] The effective date of the changes in district classification(s) shall be the date on which the Planning Director has certified such assurance to be satisfactory. Such satisfactory assurance can be met by the actual drilling and testing of a well site of the water source or by the submittal of a hydrological study certifying that a water source(s) of sufficient quality and quantity can be established at the designated location(s). The actual development of the water source and its water transmission and distribution system shall be developed in conjunction with the subdivision approval process; provided that the water source shall be drilled and tested prior to final subdivision approval. Notwithstanding the provisions of Condition R, final inspection of the residential or commercial structures shall not be issued until the approved water source to the subject property and its transmission and distribution system for such source to the subject property has been constructed;

[(C) upon compliance with Condition B(1) and (2), each village shall be developed in two increments. The first increment of each village shall consist of a maximum of sixty percent (60%) of the total number of lots and units proposed within each village. The second increment shall consist of the remaining forty percent (40%) of the lots/units proposed. Subdivision plans or plans for plan approval may be submitted for the second increment only after development has occurred in the first increment as determined by the Planning Director. "Development" means that building permits have been issued for dwelling units/lots and construction has been partially completed to the extent that roofs have been constructed on a minimum of twenty-five percent (25%) of the number of RA-1a lots and fifteen percent (15%) of the number of RM lots/units proposed for the first increment in each village. In lieu of actual construction, the applicant may enter into an

agreement with the Planning Department to assure the County that the dwellings will be constructed by way of a surety bond, certified check or other security acceptable to Corporation Counsel and the Planning Department. Upon final execution of such agreement and filing of the security with the County, subdivision plans or plans for plan approval for the second increment may be submitted prior to the actual construction of the dwellings in the first increment;]

[(D)](C) [upon compliance with Conditions (B)(1) and (2), subdivision plans or plans for plan approval for the first zoned increment or portions thereof of the first village, shall be submitted to the Planning Department within one year from the effective date of the rezoning as determined in Condition B and tentative subdivision approval shall be secured one year thereafter. Final Subdivision approval or final plan approval shall be secured within two years from the date of submitting final subdivision plans or plans for plan approval;]

Subdivision plans for any portion of the subject property shall be submitted to the Planning Director and final subdivision approval for the first residential subdivision shall be secured within five (5) years from the effective date of the rezoning as determined in Condition B of this ordinance. A master plan of the subject property shall be submitted with plans for subdivision review.

[(E)](D) the applicant shall obtain plan approval from the Planning Director for all uses within 1,200 feet of Queen Kaahumanu Highway right-of-way;

[(F)](E) [a] the wastewater treatment system(s) shall be constructed to service the residential and commercial developments meeting with the approval of the Department of Health;

[(G)](F) a drainage system meeting with the approval of the Department of Public Works shall be installed;

[(H)](G) to ensure that the Goals and Policies of the Recreation Element of the General Plan are implemented, the applicant shall:

(1) construct a 10-acre park site within the [project site] subject property for active park and recreational uses available for public use in perpetuity. [The park shall be developed and available for public use in conjunction with the completion of the first golf course or the first residential subdivision.] The [active recreational uses which may include] configuration and construction of improvements, including but not limited to grading, grassing, the construction of soccer fields, baseball fields, basketball and volleyball courts and football fields, fencing and parking, shall be approved by the Planning [Department] Director in consultation with the Parks and Recreation Department;

(2) [set aside] provide an additional 16-acre park site within the subject property for primarily passive recreational uses available for public use in perpetuity. The configuration and construction of improvements shall include but not limited to grading and grassing, and parking [park shall be developed and available for public use in conjunction with final subdivision approval of the third village and established no later by the year 2000];

(3) construct a five-mile bicycle and pedestrian path adjacent to the loop road and frontage road system which shall be improved upon the completion of the loop road and frontage system.

[Development of] The value of the land and the cost of improvements for the [parks] 10-acre park and 16-acre park sites [beyond the minimum grading and grassing] shall be credited against the [total park area requirement] the applicant's fair share contribution park set forth in Condition G, herein. [The parks shall remain in private ownership and be privately maintained except as may be developed by others. A development, maintenance, and operating plan] A park plan including the location of the park sites, configuration, phasing of the park site developments and bicycle/pedestrian path, ownership, control and maintenance of the sites, conditions and limitations regarding the terms of use and hours of operation of the sites, and improvements, shall be submitted [when appropriate for each park] prior to receipt of final subdivision approval or final plan approval of any subdivision or residential units within the subject property and shall be [reviewed and] approved by the Planning [Department] Director in consultation with the Department of Parks and Recreation. The park areas and bicycle/pedestrian path shall be developed and available for public use in accordance with the approved park plan. Prior to the opening of each park required for public use, the applicant shall record a covenant or similar legal encumbrance meeting with the approval of the Planning Director, in consultation with the Corporation Counsel and the Department of Parks and Recreation, which shall obligate the subdividers, purchasers, occupants, and/or association in the affected residential units or subdivision to maintain the park sites in perpetuity, or until the park sites and improvements are dedicated to and accepted by the County;

[(I)](H) access to the commercial area, golf academy, pedestrian/bike loop trail, 10-acre and 16-acre parks shall be available for public use;

[(J) the satisfaction of Condition No. 5 of Use Permit No. 90 shall be complied with by providing Big Island residents 168 rounds of golf daily on reasonably

maintained golf courses, and shall be consistent with other terms of the agreement contained as herein attached;]

[(K)](I) a revised archaeological inventory survey report and a detailed preservation plan for Site 15,033 shall be prepared and submitted for approval by the Planning [Department] Director, in consultation with the Department of Land and Natural Resources, prior to submitting plans for preliminary subdivision or plan approval review. The plan shall consist of an archaeological data recovery plan and preservation plan. Approved mitigation measures shall be implemented prior to or in conjunction with any land alterations in the [project area] subject property;

[(L)](J) should any unidentified sites or remains such as artifacts, shell, bone, or charcoal deposits, human burials, rock or coral alignments, pavings or walls be encountered, work in the immediate area shall cease and the Planning [Department] Director shall be immediately notified. Subsequent work shall proceed upon an archaeological clearance from the Planning [Department] Director in consultation with the Department of Land and Natural Resources-Historic Preservation Division, when it finds that sufficient mitigative measures have been taken;

[(M)](K) to ensure that the Goals and Policies of the Housing Element of the General Plan are implemented, the applicant shall [work with] secure the concurrence of the Office of Housing and Community Development [and the Planning Department to formulate a housing plan for the development, which shall be consistent with the housing policy of the Hawaii County Housing Agency. This housing plan shall be approved by the County Housing Agency prior to final subdivision approval of any portion of the residential zoned area; provided that the applicant shall notify the County Housing Agency of any intent to sell, lease, assign, place in trust, or otherwise voluntarily alter the ownership interest in the property prior to visible

commencement of construction on the property provided further that the applicant may transfer ownership in the property to an affiliate or in a manner consistent with prior representations to the County Housing Agency] that the applicant's affordable housing requirements for the residential development of the subject property, if any, have been mutually agreed to prior to final subdivision approval for any portion of the subject property;

[(N)](L) restrictive covenants in the deeds of all the proposed Residential and Agricultural zoned lots shall prohibit the construction of a second dwelling unit on each lot within the subject property. A copy of the [proposed] covenant(s) with this requirement [to be recorded with the Bureau of Conveyances] shall be submitted to the Planning [Department] Director for review and approval and a copy of the approved covenant shall be recited in an instrument executed by the applicant and the County [prior to] in conjunction with final subdivision approval for any portion of the subject property. A copy of [a typically] the recorded [covenant] document shall be filed with the Planning [Department within one year from the date of final subdivision approval] Director upon its receipt from the Bureau of Conveyances;

[(O)](M) a solid waste management plan for the subject property shall be prepared meeting with the approval of the Department of Public Works prior to submitting plans for subdivision approval. Approved recommendations and mitigation measures shall be implemented [in a manner] meeting with the approval of the Department of Public Works;

[(P)](N) a botanical preservation and mitigation plan of the Ophioglossum fern and Abutilon menziesii (red 'ilima) shall be submitted to the Department of Land and Natural Resources and the Department of Interior, as appropriate, for review and approval prior to any land alterations on the [project site subject property;

[(Q)](Q) access(es) to the [project site] subject property shall meet with the approval of the Departments of Transportation-Highways Division and Public Works as follows:

(1) Interim intersection improvements, including full channelization of the northern and southern access road intersections with Queen Kaahumanu Highway, shall be constructed meeting with the approval of the Department of Transportation prior to final subdivision approval of any increment gaining access from the respective intersection. The cost of such improvements shall be borne by the applicant and shall [not] be credited to or deducted from the applicant's fair share contribution for road and traffic improvements, as required under Condition [S]Q;

(2) future long-term transportation improvements attributed to the project as identified by the State Department of Transportation, including a grade-separated interchange and frontage road system shall be constructed as required by the Department of Transportation. The applicant's share of the cost of such improvements shall be credited to or deducted from the applicant's fair share contribution for road and traffic improvements as required under Condition [S]Q;

(3) the applicant shall participate in the funding and construction of any regional roadway improvements pursuant to an adopted plan, provided that any costs borne by the applicant shall be credited and limited to the amount of its fair share contribution for regional road and traffic impacts, as required in Condition [S]Q;

[(R)](P) the applicant shall designate an 80-foot wide mauka-makai easement from the eastern property boundary to the Queen Kaahumanu Highway at a location meeting with the approval of the Departments of Public Works and

Transportation. This easement may be needed in the future for the development of a connector road between Queen Kaahumanu Highway and Waikoloa Village and shall be delineated on plans submitted for plan approval review or subdivision. A final determination as to whether the road is needed and as to its location will be based on regional studies to be completed by the Department of Public Works and/or the Department of Transportation. The applicant's share of the cost of this regional road, interchange, roadway improvements, and the cost of the easement shall be credited and limited to the amount of its fair share contribution for regional road and traffic impacts, as required in Condition [S]Q. The credit shall be based on the value and land use of the property prior to enactment of this ordinance, and shall be adjusted annually based on the percentage change in the Honolulu Consumer Price Index. This connector road will be a public right-of-way maintained by appropriate governmental agencies;

[(S)](Q) [the applicant shall make its fair share contribution to address potential regional impacts of the project with respect to fire, police, solid waste disposal facilities, and roads. The fair share contribution shall initially based on the representations contained within the change of zone application and may be increased or reduced proportionally if unit counts or commercial areas are adjusted. The fair share contribution described below shall be adjusted annually based on the percentage change in the Honolulu Consumer Price Index (HCPI). A pro rata portion of the contribution, based upon the density and commercial area of the land affected, shall become due and payable, at the discretion of the County Council, in the event the applicant conveys an ownership, leasehold, or controlling subdivision approval or final plan approval in the proposed project. Subsequent to the initial subdivision approval or final plan approval, a pro rata portion of the contribution shall be paid by the applicant upon conveyance of an ownership, leasehold, or controlling development interest of any residential lot or unit or, in the case of commercial development, upon conveyance of an ownership, leasehold, or

controlling development interest of any commercial lot or on or before the issuance of a building permit for any commercial structure, which occurs first. The fair share contribution for each residential lot shall be based on a maximum density for each lot as determined by the Planning Department, with the concurrence of the applicant. The Fair Share contributions shall be as follows: (1) $749,050 to the County to support the fire protection functions in the Kohala region; (2) $324,678 to the County to support police functions within the Kohala region; (3) $6,291,197 to the State or County to support road and traffic improvements within the Kohala region; (4) $366,914 to the County to support solid waste disposal functions within the West Hawaii region. In lieu of paying the fair share contribution, the applicant may construct such improvements/facilities meeting with the approval of the appropriate agency;]

the applicant shall make its fair share contribution to mitigate the potential impacts of the subject property with respect to parks and recreation, fire, police, solid waste disposal facilities, and roads. The amount of the fair share contribution shall be the sum which is the product of multiplying the number of residential units proposed to be developed by the amounts allocated hereinbelow for each such unit, and shall become due and payable prior to final subdivision approval or final plan approval, as applicable, for any portion of the subject property or its increments. If the subject property is developed in two or more increments, the amount of the fair share contribution due and payable prior to final subdivision approval or final plan approval of each increment shall be a sum calculated in the same manner according to the number of proposed residential units in each such increment. The fair share contribution may be in a form of cash, land, facilities, or any combination thereof acceptable to the Planning Director in consultation with the affected agencies. The fair share contribution shall have a maximum combined value of **$4,645.29 per multiple-family residential unit** and **$7,239.16 per single-family residential unit**. Based upon

the applicant's representation of intent to develop up to 2,658 residential units, the indicated total fair share contribution for 1,795 multiple family residential units is **$8,338,295.50** and for 863 single family residential units is **$6,247,395.00** whichever is applicable. However, the total amount shall be increased or reduced in proportion with the actual number of lots/units according to the calculation and payment provisions set forth in this Condition Q. The fair share contribution shall be allocated as follows:

1. $2,291.39 per multiple-family residential unit for an indicated total of **$4,113,045.00** and $3,490.85 per single-family residential unit for an indicated total of **$3,012,603.50** to the County to support park and recreational improvements and facilities;

2. $72.42 per multiple-family residential unit for an indicated total of **$129,993.90** and $168.40 per single-family residential unit for an indicated total of **$145,329.20** to the County to support police facilities;

3. $222.77 per multiple-family residential unit for an indicated total of **$399,872.15** and $332.61 per single-family residential unit for an indicated total of **$287,042.43** to the County to support fire facilities;

4. $99.29 per multiple-family residential unit for an indicated total of **$178,225.55** and $145.62 per single-family residential unit for an indicated total of **$125,670.06** to the County to support solid waste facilities;

5. $1,959.42 per multiple-family residential unit for an indicated total of **$3,517,158.90** and $3,101.68 per single-family residential unit for an

indicated total of **$2,676,749.80** to the State or County to support road and traffic improvements.

The fair share contributions described above shall be adjusted annually beginning three years after the effective date of the change of zone, based on the percentage change in the Honolulu Consumer Price Index (HCPI). In lieu of paying the fair share contribution, the applicant may construct and contribute land, improvements/facilities related to parks and recreation, fire, police, solid waste disposal facilities, and roads within the region impacted by the proposed development, subject to the approval of the Planning Director. The cost of constructing the improvements and the fair market value of land contributed set forth in Conditions G, O, and P, shall be credited against the sum specified in Condition Q(1) for parks and recreation and in Condition Q(5) for road and traffic improvements. For purposes of administering Condition Q, the fair market value of land contributed or the cost of any improvements required or made in lieu of the fair share contribution shall be subject to the review and approval of the Planning Director, upon consultation with the appropriate agencies;

(R) In lieu of actual construction of infrastructural improvements as required herein, the applicant may enter into an agreement with the Planning Director and the Department of Public Works and the Department of Water Supply, if applicable, to assure the County that the infrastructural improvements will be constructed together with the appropriate bond, surety or other security deemed acceptable to the Planning Director and Corporation Counsel. Upon execution of such agreement and/or filing of the security with the County, final subdivision approval and/or final plan approval, as applicable for the subject property or portions thereof, may be granted prior to the actual construction of required infrastructural improvements unless otherwise restricted herein;

[(T)](S) the applicant shall work with the State Department of Education and the Planning [Department] Director to provide its pro rata share for school facilities. The pro rata share determination and its implementation shall be approved by the Planning [Department] Director, in consultation with the Department of Education, in conjunction with final subdivision approval or final plan approval of any residential area [of the development] within the subject property;

[(U)](T) the applicant shall disclose to all potential buyers of lots or units within the [proposed project at] subject property that internal infrastructure and community facilities shall be developed and maintained privately and that the County is not obligated to construct any public facilities with the project area;

[(V)](U) a fire emergency preparedness and response plan shall be submitted for review by the Planning [Department Director in consultation with the Fire Department and the Civil Defense Agency prior to the issuance of a Certificate of Occupancy for any residential unit within the subject property. The plan shall be limited to a review of the emergency roadway network and emergency contact people or association;

[(W)](V) comply with the conditions of the State Land Use Commission's Decision and Order;

[(X)](W) No application for real property tax relief shall be made for agricultural use on any lands within this development and a provision shall be recited within the CCR's, covenants, and deed of the respective properties;

[(Y)](X) comply with all applicable laws, rules, regulations and requirements;

[(Z)](Y) should the Council adopt a Unified Impact Fees ordinance setting forth criteria for the imposition of exactions or the assessment of impact fees, conditions included herein may, at the developer's election, be satisfied by performance in accordance with the requirements of the Unified Impact Fees Ordinance;

[(AA)](Z) an annual progress report shall be submitted to the Planning Department prior to the anniversary date of the approval of this change of zone. The report shall address in detail the status of the development of each area (including number of lots created and the number of units constructed) and the compliance with the conditions of approval. This condition shall remain in effect until all of the conditions of approval have been complied with and the Planning Department acknowledges that further reports are not required; and

[(BB)](AA) an extension of time for the performance of conditions, except Condition B, within the ordinance may be granted by the Planning Department upon the following circumstances:

(1) the non-performance is the result of conditions that could not have been foreseen or are beyond the control of the applicant, successors or assigns, and that are not the result of their fault or negligence;

(2) granting of the time extension would not be contrary to the General Plan or Zoning Code;

(3) granting of the time extension would not be contrary to the original reasons for the granting of the change of zone;

(4) the time extension granted shall be for a period not to exceed the period originally granted for performance (i.e., a condition to be performed within one year may be extended for up to one additional year); and

(5) if the applicant should require an additional extension of time, the Planning Department shall submit the applicant's request to the County Council for appropriate action. Further, should any of the conditions not be met or substantially complied with in a timely fashion, the Director shall initiate rezoning of the area to its original or more appropriate designation."

SECTION 2. In the event that any portion of this ordinance is declared invalid, such invalidity shall not affect the other parts of this ordinance.

SECTION 3. This ordinance shall take effect upon its approval.

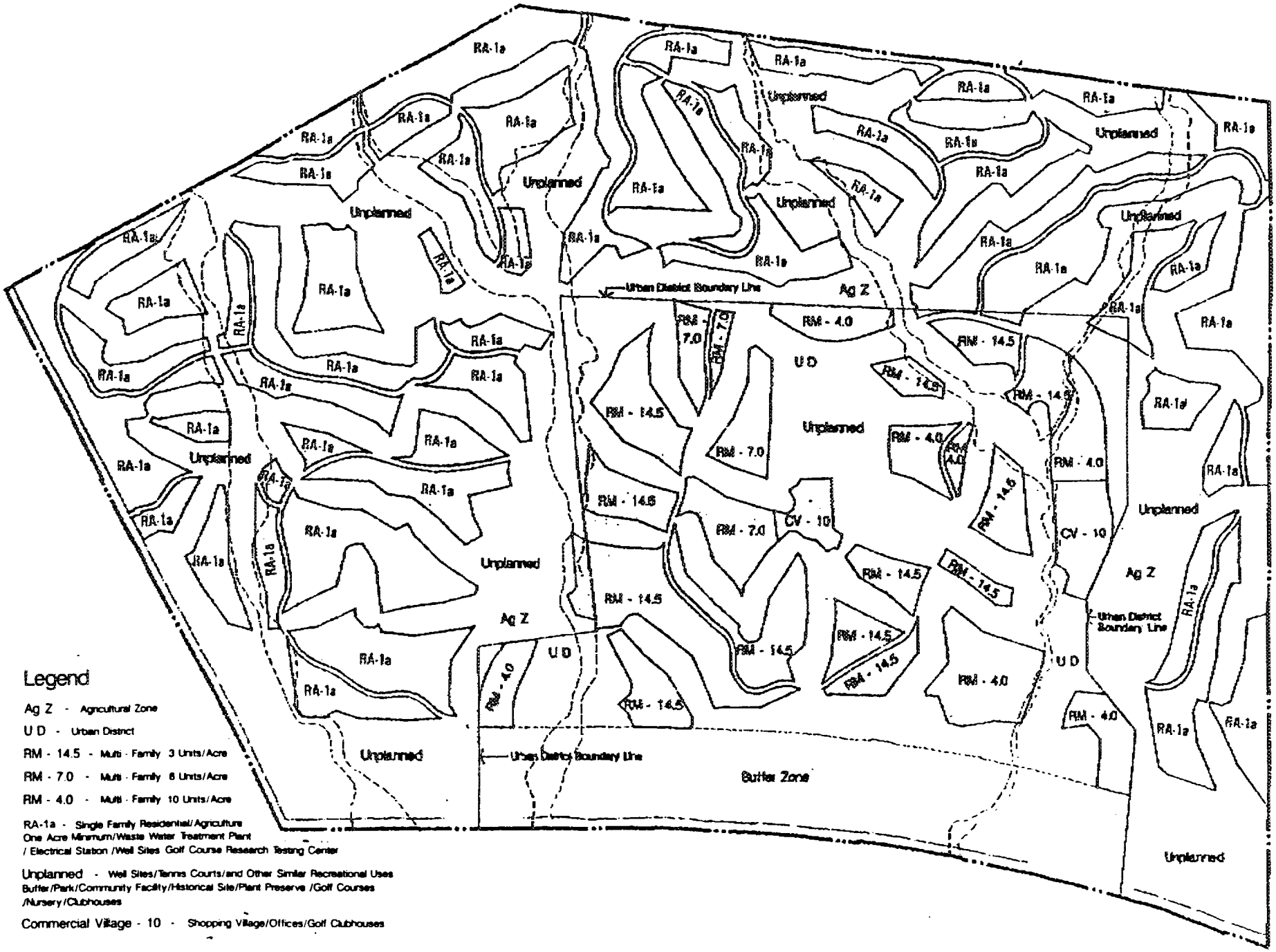
INTRODUCED BY:

COUNCIL MEMBER, COUNTY OF HAWAII

Hilo, Hawaii
Date of Introduction: November 6, 1996
Date of 1st Reading: November 6, 1996
Date of 2nd Reading: November 21, 1996
Effective Date: December 5, 1996

APPROVED AS TO FORM AND LEGALITY

DEPUTY CORPORATION COUNSEL
DATED: 11/26/96



Puako

Residential Golf Community
South Kohala Hawaii

ZONING MAP
ORDINANCE NO. 93-01

North
Scale 1" = 400' 0 400 800 1600'

Figure: 6

Puako Urban Properties

OFFICE OF THE COUNTY CLERK
County of Hawaii
Hilo, *Hawaii*

Introduced By: Takashi Domingo
Date Introduced: November 6, 1996
First Reading: November 6, 1996
Published: November 15, 1996

REMARKS:

(DRAFT 2)

ROLL CALL VOTE				
	AYES	NOES	ABS	EX
Arakaki	X			
Easley	X			
Childs	X			
De Lima	X			
Domingo	X			
Osorio	X			
Van De Car	X			
Ray	X			
Smith	X			
	9	0	0	0

Second Reading: November 21, 1996
To Mayor: November 25, 1996
Returned: December 5, 1996
Effective: December 5, 1996
Published December 13, 1996

REMARKS:

(DRAFT 3)

ROLL CALL VOTE				
	AYES	NOES	ABS	EX
Arakaki	X			
Easley	X			
Childs	X			
De Lima	X			
Domingo	X			
Osorio	X			
Van De Car		X		
Ray	X			
Smith	X			
	8	1	0	0

I DO HEREBY CERTIFY that the foregoing BILL was adopted by the County Council and published as indicated above.

COUNCIL CHAIRMAN

COUNTY CLERK

Approved/~~Disapproved~~ this 5 *day of* December, *19* 96.

MAYOR, COUNTY OF HAWAII

Bill No.: 353 (DRAFT 3)
Reference: C-1409/PC-166
Ord. No.: 96 153

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Appendix C
Agreement: County of Hawai‘i Water Board and Bridge ‘Āina Le‘a LLC (Dated Sept. 26, 2006)

WATER DEVELOPMENT AGREEMENT

This Water Development Agreement ("Agreement") is entered into this 26th day of September, 2006, by and between the WATER BOARD OF THE COUNTY OF HAWAI'I ("Water Board"), and BRIDGE AINA LE'A, LLC, a Hawai'i Limited Liability Company ("Bridge"):

RECITALS

WHEREAS, Bridge is the fee simple owner of, and is desirous of developing, those certain parcels of real property situate at Waikoloa, District of South Kohala, Island and County of Hawai'i, State of Hawai'i, identified as Tax Map Key Numbers: (3) 6-8-001:portions of 025, 036, 037, 038, 039 and 040, and containing an area of approximately 3000 acres, hereinafter referred to collectively as the "Land";

WHEREAS, the County Council of the County of Hawai'i has, by enactment of Ordinance No. 93-1, as amended by Ordinance 96-153 (hereinafter referred to as the "Rezoning Ordinance"), imposed certain conditions with respect to the change of the district classifications of the Land from Unplanned (U) to Residential and Agricultural (RA-1a); Multiple Family Residential (RM-4), (RM-7) and (RM-14.5) and Village Commercial (CV-10), which include, but are not limited to the following;

> (1) Within three years from the enactment of the ordinance the applicant [Bridge] shall provide assurance satisfactory to the Department of Water Supply and the Planning Director, upon consultation with the Department of Health and the Department of Land and Natural Resources, that a water source(s) of sufficient quality, quantity, and related transmission and storage systems has (have) been established.
>
> (2) The actual development of the water source and its water transmission and distribution system shall be developed in conjunction with the subdivision approval process;
>
> (3) The proposed dwelling units shall not exceed the number of units of water that are available and have been committed to the subject property by the Department of Water Supply or other approved water source. Any further development shall occur only when sufficient County water becomes available by construction of on-site and off-site water system improvements. All water system improvements shall meet with the requirements of the Department of Water Supply prior to the issuance of the Certificate of Occupancy for any residential unit;

WHEREAS, Bridge is or shall be the fee simple owner at the time of dedication of those certain parcels of real property situate at Ouli, District of South Kohala, Island and County of Hawai'i, State of Hawai'i, identified by Tax Map Key Numbers: (3) 6-2-001:075 (por.), and 088, upon which development of well sites is permitted, one of which is presently in existence (hereinafter referred to as "State No. 6046-01");

WHEREAS, pursuant to and upon the conditions of that certain Restated Water Agreement entered into between Bridge and Hale Wailani Partners LP, dated April 1, 2003, a Short Form Agreement of which was recorded with the Bureau of Conveyances as Document No. 2005-035372, hereinafter referred to as the "Restated Water Agreement", Bridge has, among other things, and upon certain conditions, the option to develop an additional well upon that certain adjoining parcel of real property identified by Tax Map Key Number: (3) 6-2-01:075, such well to hereinafter be referred to as the "Hale Wailani Well". All four (4) well sites allowed to be developed by Bridge, including the Hale Wailani Well, should they decide to exercise their option to develop it, shall hereinafter be referred to collectively as the "Ouli Well Field";

WHEREAS, the Department of Water Supply, hereinafter referred to as "DWS", currently owns, operates and maintains the Lalamilo Water System, hereinafter referred to as the "Lalamilo System", in South Kohala, which system, in conjunction with its connection to the Mauna Kea Uplands system, services the South Kohala and Kawaihae coast;

WHEREAS, in order to facilitate the development of the Land as proposed by Bridge, Bridge is willing, upon the terms and conditions set forth in this Agreement, to drill and develop the Ouli Well Field, and design, construct, replace, and otherwise create and establish a transmission system, and other necessary storage and distribution facilities required in connection with its desired arrangement of connecting its Ouli Well Field to the existing DWS water system within the Mauna Kea Uplands subdivision (which is currently served from the Lalamilo System), and drawing water from DWS' Lalamilo System to provide water service to the Land;

WHEREAS, off-site water system improvements are being completed by another developer, Mauna Lani Service, Inc. and Mauna Kea Properties ("MLS/MKP"). The improvements for MLS/MKP, when completed, along with Bridge's completed improvements as outlined in this agreement, will be necessary for Bridge to provide any water to the Land as provided for in this agreement;

WHEREAS, the parties are desirous of entering into an agreement which will serve to both enhance DWS' water service capabilities in the South Kohala area and enable Bridge to develop its Land pursuant to Ordinance 96-153;

NOW THEREFORE, in consideration of the covenants, conditions, and agreements of the parties as set forth herein, and the mutual benefit to be derived by the parties therefrom, the parties hereby agree as follows:

1. **BRIDGE'S OBLIGATIONS**

a. Bridge shall proceed at its sole cost and expense to develop, construct and/or install, upon consultation with and written approval by DWS and the Commission on Water Resource Management ("CWRM"), up to four (4) wells at the Ouli Well Field, which shall include the existing well (State No. 6046-01). The existing well has been constructed with a 14-inch casing. The three (3) additional wells shall be constructed with 16-inch casings. The initial construction increment shall include, at a minimum, development and outfitting of three (3) wells—the existing well and two (2) new wells. In the event that Bridge shall seek to develop more than four (4) wells, or wells outside of the Ouli Well Field to service its Land, it shall be allowed to do so only upon the express written approval of CWRM, and

such additional wells shall automatically be subject to the terms, conditions, rights and obligations of this agreement, including but not limited to those set forth in Paragraph 1.e. of this agreement.

b. Pending final pump testing, identical capacity pumps will be installed in each well. The anticipated capacity for each well is in the range of 700 to 850 gallons per minute (1.0 to 1.2 million gallons per day). Shaft-enclosed, water-lubricated line shaft pumps are to be installed. Owing to the depths of the pumps, the warranty period for the pumps and motors shall be 24 months from the time of conveyance to and acceptance of the wells by the Water Board.

c. Connection of these wells to DWS' system will be via a new mauka-makai transmission route down the southern boundaries of TMK Nos. (3) 6-2-001:018 and 051. The point of connection will be the 0.3 MG, 780-foot tank now under construction on that parcel of land identified as TMK No. (3) 6-2-001:090. The new mauka-makai transmission improvements (hereinafter collectively the "Ouli Improvements") shall include:

1) a 1.0 MG control tank on land within or near the Ouli Well Field.

2) a transmission pipeline sized to accommodate all wells pumping at once (tentatively a 16-inch line);

3) an intervening PRV station;

4) an inlet control valve station and 1.0 MG tank adjacent to the 0.30 MG 780-foot tank now under construction;

5) a parallel 12-inch pipeline between the 780- and 618-foot tanks;

6) improvements at the existing 618-foot and 404-foot tanks, including but not limited to retrofitting piping and controls to allow water to flow in opposite directions; and

7) all other necessary improvements to enable delivery of water from the Ouli wells into DWS' existing system in the South Kohala coastal area.

In order to define all other necessary improvements cited in Paragraph 1.C.7) above, within 45 days of the execution of this Agreement by the parities, Bridge shall submit to DWS for its review and approval appropriate hydraulic analyses which identify those modifications and additions necessary to deliver water from the Ouli wells into DWS' existing South Kohala system. The costs of these modifications and additions shall be included in the estimate of the total cost of construction to be submitted by Bridge to DWS in conformance with paragraph 1.j. of this agreement. These improvements are located schematically on Figure 1, attached hereto and made a part hereof. All construction and installation by Bridge pursuant to

this agreement shall conform to and be in compliance with the Rules and Regulations of the DWS and the Water System Standards and all such construction and installation shall be approved by DWS.

d. Upon completion, the tank and well sites will be conveyed by Bridge to the Water Board via warranty deed, free and clear of all liens and encumbrances in fee. Pipelines/Transmission Lines and all improvements constructed or installed by Bridge pursuant to this Agreement shall be conveyed to the Water Board by Bill of Sale with Grants of Easements. Access to such pipelines and improvements shall be provided by Grants of Easement executed in favor of the Water Board.

e. Allocation of the supply for the wells, which may be developed incrementally, shall be as follows:

1) The safe capacity of the Ouli Well Field shall be defined with one well (of the largest capacity if they are not all the same) designated as standby. Bridge shall not be allocated any share of this standby well as it is intended to be used purely as a back-up source should any of the other wells fail. If the wells are drilled incrementally, and Bridge only develops one well, then Bridge shall not be allocated any water until it develops at least one other well.

2) Of the combined capacity of the remaining wells other than the standby well, twenty percent (20%) shall be allocated to DWS and eighty percent (80%) shall be allocated to Bridge, with the exception that should Bridge develop the Hale Wailani Well, fifteen percent (15%) of that well's capacity shall be allocated to DWS and eighty-five percent (85%) shall be allocated to Bridge. Bridge specifically agrees to the allocations provided herein notwithstanding any prior agreement or agreements between DWS and Bridge to the contrary, including but not limited to the terms of the Memorandum of Agreement Re: Hale Wailani Partners, LLP v. Bridge Aina Le'a, LLC, et al., Civil No., 01-1-0465, attached as Exhibit 1 to that certain Settlement and Mutual Release Agreement entered into by and among Bridge, the Water Board and the Department of Water Supply of the County of Hawai'i, Hale Wailani Partners, LLP, and Marshall Medoff. Moreover, it shall be the responsibility of Bridge to perfect any and all of its rights to exercise its option to develop the Hale Wailani Well, prior to developing said well, and nothing herein shall be construed so as to affect the rights and responsibilities of Bridge and Hale Wailani, each to the other, under any agreements pertaining to the development of the Ouli Well Field.

3) The capacities outlined in this section shall be based on continuous 24-hour-a-day pumping and shall be equivalent to the maximum day allocable supply. Average day supply shall be equivalent to the maximum day supply divided by 1.50.

4) It is expressly understood by Bridge that any water allocation owed to Hale Wailani Partners, LLP or its successors or

assigns as a result of the Restated Water Agreement, will be taken from Bridge's share of the allocation.

f. The allocable supply to Bridge specified in paragraph e., above, shall be contingent on the wells being able to produce water with chloride levels of 150 MG/L or less. If the chloride level in any well rises above 150 MG/L before 10,000 hours of pumping that well has been reached, as measured by an hour meter, use of that well shall be curtailed or adjusted by DWS to maintain chlorides below 150 MG/L. If such curtailment or adjustment causes the well pump's wire-to-water efficiency to drop more than three (3) percentage points, Bridge shall be required to provide and install a replacement pump designed to run at peak efficiency at the curtailed rate. Bridge's allocable supply shall also be reduced correspondingly.

g. Bridge's allocated supply from the Ouli Well Field may be used to supply Bridge's development project in Aina Le'a on TMK Nos. (3) 6-8-001:025, 036, 037, 038, 039 and 040, or may be assigned by Bridge or its successors and assigns for use by other property in DWS' Lalamilo Water System owned by Bridge or its successors and assigns and their related and affiliated entities subject to DWS and Water Board approval. Water shall be delivered to Bridge's project from DWS' existing Lalamilo System via the infrastructure improvements to be constructed by Bridge pursuant to this Agreement and as depicted in Figure 2, attached hereto and made a part hereof. These improvements (hereinafter collectively the "Lalamilo Improvements") shall include the following:

1) A connection to DWS' existing Lalamilo transmission corridor at or above the existing 1.0 MG, 610-foot tank. In order to accommodate DWS' future installation of a hydropower generator above the 610-foot tank, Bridge's connection point shall be installed at a location and in such a manner approved by DWS so as to minimize the impact on the hydropower generator. If DWS so requires, the connection point may require booster pumping from the 610-foot tank to the 630-foot tank described in paragraph 3) below.

2) A transmission pipeline that will run makai (west) in DWS' easement and then south in Bridge's easement obtained from the Waikoloa Village Association to Bridge's Puako property. The pipeline, tentatively selected as 16-inch, shall be sized to convey the maximum day supply to Bridge's Puako project.

3) A storage reservoir, tentatively selected to be a 1.0 MG capacity with a 630-foot spillway elevation, for distribution to the Bridge Puako project's upper and lower service zones.

4) A master meter shall be installed on the inlet to the 630-foot tank or other location on the transmission line to meter all usage by Bridge's Puako project. Total use as measured by this meter shall be the basis of determining Bridge's use of supply from the Ouli wells it has developed and its remaining allocable supply. DWS shall keep a tally of this actual use and the moving 12-month average of this use

(12-month MAV). The well supply used by Bridge shall be defined as 1.5 times the 12-MAV. Bridge's remaining allocable supply shall be eighty percent (80%) of the total supply from the Ouli wells, as defined in paragraph e. above, less 1.5 times the 12-MAV.

The Ouli Improvements and the Lalamilo Improvements are sometimes hereinafter referred to collectively as the "Infrastructure."

It is expressly understood that DWS/Water Board are under no obligation and shall not be subject to any liability, nor do they represent/warrant or guarantee that the infrastructure to be built by Mauna Lani Service, Inc. and Mauna Kea Properties or any other third party shall be timely constructed. Bridge hereby waives any claims, demands or damages against DWS and the Water Board and agrees that it will be solely responsible for any delays in construction by those third parties, and understands that it will not be able to receive water until the ML/MK infrastructure is complete.

h. The Water Board has entered into an Agreement dated April 6, 2006 with Mauni Lani Service, Inc. ("MLS") and Mauna Kea Properties, Inc. ("MKP"), relating to the proposed development of Parker Wells Nos. 3 and 4 and the allocation of water from those wells and the Lalamilo System ("the Water Board/MLS/MKP Agreement"). If MLS and/or MKP allege or claim that the entering of this Bridge/Water Board agreement is a breach of the Water Board/MLS/MKP Agreement or any of the covenants or conditions contained therein, Bridge agrees that it will indemnify, defend, and hold harmless DWS, the Water Board, its officers, employees, members, agents and representatives against any and all claims, suits, actions, proceedings, losses, expenses, liabilities, and damages arising therefrom. If at any time after the execution of this Agreement the DWS notifies Bridge that any of the Infrastructure or wells constructed by Bridge, or use of the Lalamilo System by Bridge or use of Ouli water by MLS or MKP have caused a material reduction in the quality or quantity of water allocated to any party or their successors or assigns under the Water Board/MLS/MKP Agreement, then DWS shall give written notice to Bridge of such determination and the basis for DWS' concern. Bridge shall then have ninety (90) days from receipt of such notice to repair, alter, or amend the Infrastructure and wells or their use thereof, to correct the problems identified by DWS. Following the ninety (90) day period, Bridge and DWS shall meet and confer in good faith to discuss whether Bridge's efforts have corrected the problems identified by DWS, and whether additional measures should be undertaken by Bridge. In the event that Bridge is unable to correct the problems and Bridge and DWS are unable to agree on additional remedial measures, Bridge thereafter will defend, indemnify, and hold harmless DWS, the Water Board, and their officers, employees, members, agents, and representatives from and against any claims, lawsuits, actions, or proceedings that any of the Infrastructure or wells constructed by Bridge under this Agreement or the use of the Lalalmilo Water System by Bridge or the use of Ouli water by MLS and/or MKP have caused a material reduction in the quality or quantity of water allocated to MLS or MKP under the Water Board/MLS/MKP Agreement.

Under no circumstances shall Bridge be obligated to indemnify or defend DWS, the Water Board and its officers, employees, members, agents and representatives from and against any claims made by MLS, MKP, or any other person that DWS or the Water Board have breached their obligations under the Water Board/MLS/MKP Agreements or any other agreement or duty of DWS or the Water Board, other than as stated herein. In the event MLS or MKP brings or files any action with multiple claims, Bridge shall have no obligation to defend, indemnify, and hold harmless, DWS, the Water Board, and its officers, employees, members, agents and representatives from and against any claim by MLS or MKP other than a claim that the Infrastructure or wells constructed by Bridge under this Agreement or the use of the Lalalmilo Water System by Bridge or the use of Ouli water by MLS and/or MKP have caused a material reduction in the quality or quantity of water allocated to MLS or MKP under the Water Board/MLS/MKP Agreement. As to any claim for which Bridge is obligated to provide a defense and indemnity under this paragraph, Bridge shall have the right to select the counsel to defend the claim and shall have the right to direct the conduct, strategy, settlement, or trial of the defense of such claim.

i. Water shall be available for allocation to Bridge's project in Puako upon satisfactory completion of all the Infrastructure and dedication of the same to the Water Board, and DWS' commencement of use of these facilities. Additionally, Bridge shall be entitled only to withdraw an equivalent amount of water from the Lalamilo System that is transmitted to users throughout the South Kohala System from Bridge's share of the Ouli Well Field up to Bridge's allocable share. It is also expressly understood by Bridge that no water meters for service shall be issued until the Infrastructure is completed and dedicated.

j. In order to ensure timely completion of the water system Infrastructure on Bridge's part, Bridge shall within sixty (60) days of execution of this Agreement provide to DWS for its review and approval an estimate of the total costs of construction of three (3) wells and the Infrastructure.

k. Within ninety (90) days of DWS' acceptance of pump testing results confirming well production sufficient for dedication to the County of Hawaii for the initial three wells, Bridge shall provide a performance and payment bond or other security, including the establishment of an escrow account, as approved by DWS in an amount estimated by DWS for the cost of the Infrastructure plus an additional thirty percent (30%). The additional thirty percent (30%) shall be deemed reflective of DWS' administrative costs in the event that it must act on the bond or other security for the completion of the Infrastructure. However, DWS and the Water Board shall be under no obligation to so complete the Infrastructure. If Bridge fails to post the required security in the time period as specified, then this agreement is automatically terminated and neither party shall have any further obligation hereunder.

l. Bridge shall complete the Infrastructure within five (5) years from the date Bridge submits its performance and payment bond or other security, including escrow account monies. If Bridge has actually begun construction of the Infrastructure, and is proceeding in a commercially reasonable manner, but its completion of the Infrastructure is delayed by any act of God, war, strikes, work stoppages, or other similar matters outside Bridge's control, the Water Board shall grant to Bridge a two (2) year extension to complete the Infrastructure, provided Bridge provides additional security and/or deposits further monies into the escrow account in an amount as determined by DWS/the Water Board. The Water Board may grant additional extensions to this Agreement in its sole discretion. This agreement will be considered terminated and DWS and the Water Board shall have no obligation hereunder including but not limited to the obligation to provide water to Bridge's Land if the Infrastructure is not completed within the time frames set forth in this paragraph, including any extensions.

2. **WATER BOARD'S OBLIGATIONS**

a. Bridge shall be eligible for Facilities Charge Credits in accordance with DWS' Rules and Regulations. The credits shall be based on actual construction costs up to, but not greater than, the portions of the Facilities Charge attributable to wells (22%), well outfitting (15%), reservoirs (26%), and transmission pipelines (24%). Subject to Bridge's actual costs, the Facilities Charge credits shall not exceed eighty-seven percent (87%) of the Facilities Charge. For purposes of assessing the remaining thirteen percent (13%) of the Facilities Charge for various projects within Bridge's development of the Land, water will be assigned from Bridge's allocable supply from the Ouli wells in water commitments of 400 GPD average day supply. However, in the event that actual average day consumption exceeds the supply allocated in 400 GPD commitment units, Bridge's remaining allocable supply shall be reduced by the actual consumption in excess of the commitment as specified in paragraph 1.g.4.

b. DWS is not obligated to recommend tentative subdivision approval for any portion of Bridge's Lands based on this agreement unless and until DWS is satisfied that the Ouli Well Field is capable of providing adequate allocable water resources for the development of that portion of Bridge's land and that the Infrastructure proposed herein makes it possible to serve all current customers and comply with all outstanding agreements and commitments in addition to Bridge. Furthermore, DWS and the Water Board may impose any conditions or obligations that are not contrary to this Agreement, as they deem necessary when and if it does recommend tentative subdivision approval for any portion of Bridge's lands including but not limited to the requirement that Bridge develop adequate additional source and infrastructure to serve its projects. However, such additional source and infrastructure does not have to be dedicated to the Water Board, and the Water Board will not be obligated to accept such additional source and infrastructure. DWS and the Water Board specifically agree that they will not seek to change the allocations set forth in this Agreement as a condition recommending subdivision approval.

c. It is specifically understood by Bridge that should DWS recommend tentative subdivision approval for any of Bridge's lands, such recommendation shall not obligate DWS to recommend final subdivision approval unless all of Bridge's obligations under this Agreement, as they pertain to the production and delivery of water, and all conditions of tentative subdivision approval have been satisfied. As it pertains to the foregoing, Bridge for itself and on behalf of its successors and assigns hereby waives their rights to any claim they may have under a theory of vested rights or any similar legal theory.

3. **INDEMNIFICATION**

Bridge agrees to indemnify, hold harmless and defend the Water Board, DWS, and all of its officers, employees, agents and representatives from and against any and all claims, suits, actions, proceedings, losses, expenses, liabilities or damages, including costs, expenses, and reasonable attorneys' fees, arising out of its obligations or alleged breach under the Restated Water Agreement and the Settlement and Mutual Release Agreement dated August 8, 2003 and entered into by and among Bridge, the Water Board and DWS (collectively referred to therein as "Water Board"), Hale Wailani Partners LP, and Marshall Medoff, as well as the Memorandum of Agreement attached thereto, entered into by and among Bridge, the Water Board and Hale Wailani Partners LP. Such obligation to indemnify, hold harmless and defend shall continue in effect even after various rights to land and Infrastructure relating to this agreement have been conveyed by Bridge to the Water Board and DWS, and shall survive the termination of this agreement.

4. **AUTOMATIC EXPIRATION**

Except as otherwise provided herein, the effective duration for this agreement, and the allocation of water herein and Facility Charge Credit as provided herein shall expire within twenty (20) years of the date of this agreement if not actually in use, and any unfulfilled duties and obligations of the parties to this Agreement shall cease and be null and void without further action by any party.

5. **NO DEEMED APPROVAL**

Nothing contained in this Agreement shall be deemed to be an approval of any construction or installation of Bridge pursuant to this Agreement by any County of Hawai'i department or agency, nor shall this Agreement be deemed to require any County of Hawai'i department or agency to approve any proposed development of the Land by Bridge.

6. **ENTIRE AGREEMENT**

This agreement contains the entire understanding between the two parties, and there are not any agreements, understandings, warranties or representations between the parties except as set forth herein. Any and all oral or written representations, correspondence, and agreements are merged into and superseded by this agreement and shall be of no force or effect.

7. **SEVERABILITY**

If any provision of this Agreement is deemed invalid for any reason, such invalidity shall not affect other parts of this Agreement, unless such invalidity renders inapplicable the intent of this Agreement, in which case the Agreement shall be considered null and void and neither party shall have any further obligation or duty hereunder.

8. **NO PARTY DEEMED DRAFTER**

The Parties agree that no party shall be deemed to be the drafter of this Agreement, and further that in the event this Agreement is ever construed by a court of law, such court shall not construe this Agreement or any provision of this Agreement against any party as the drafter of this Agreement.

9. **APPLICABLE LAW**

This Agreement shall be governed and construed in accordance with the laws of the State of Hawai'i and any lawsuit shall be brought in the Circuit Court of the Third Circuit of the State of Hawai'i.

10. **MODIFICATIONS IN WRITING**

This writing contains the entire agreement of the parties hereto concerning the subject matter hereof, and this Agreement supersedes all other agreements and understandings (whether oral or written) heretofore or contemporaneously herewith among the parties. The provisions of this Agreement may not be modified, altered or changed except by another written instrument executed by the parties hereto.

11. **BENEFIT**

All of the terms, rights, obligations, covenants and agreements of the parties set forth in this Agreement shall be binding upon and be for the benefit of the parties hereto and their respective successors and assigns and shall be recorded at the State of Hawai'i Bureau of Conveyances and/or Land Court as applicable

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the date and year set forth.

RECOMMEND APPROVAL:

Milton D. Pavao
Manager
Department of Water Supply

WATER BOARD OF THE COUNTY OF HAWAI'I

By:
Its ~~Chairman~~ Vice-Chairman

APPROVED AS TO
FORM AND LEGALITY:

Deputy Corporation Counsel
County of Hawai'i

Date: 9/26/08

BRIDGE AINA LE'A, LLC
a Hawai'i Limited Liability Company

By:
Its CEO, Its Authorized Agent

05-89_bridge agrmt

STATE OF HAWAI'I)
) SS.
COUNTY OF HAWAI'I)

On this 26th of September, 2006, before me appeared THOMAS S. GOYA, to me personally known, who, being by me duly sworn, did say that he is the Vice-Chairman of the Water Board of the County of Hawai'i and that the seal affixed to the foregoing instrument is the seal of the Department of Water Supply of the County of Hawai'i, and that the instrument was signed and sealed in behalf of the Water Board by authority of the Water Board and said THOMAS S. GOYA, acknowledged the instrument to be the free act and deed of the Water Board.

L.S.

Doreen M. Shirota
Notary Public – Doreen M. Shirota
State of Hawai'i

My commission expires: July 9, 2010

STATE OF Hawaii)
) SS.
COUNTY OF Hawaii)

On this 20th day of September, 2006, before me personally appeared Hoolae Paoa, to me personally known, who by me duly sworn, did say that he is the chief executive officer and authorized agent of BRIDGE AINA LE'A, LLC, a limited liability company, and that the instrument was signed in behalf of the company by the authority of its managing manager, and HOOLAE PAOA acknowledged the instrument to be the free act and deed of the company.

A. Wamar
Notary Public, State of Hawaii
Notary Name: A. Wamar
My Commission Expires: 2/6/08

38.

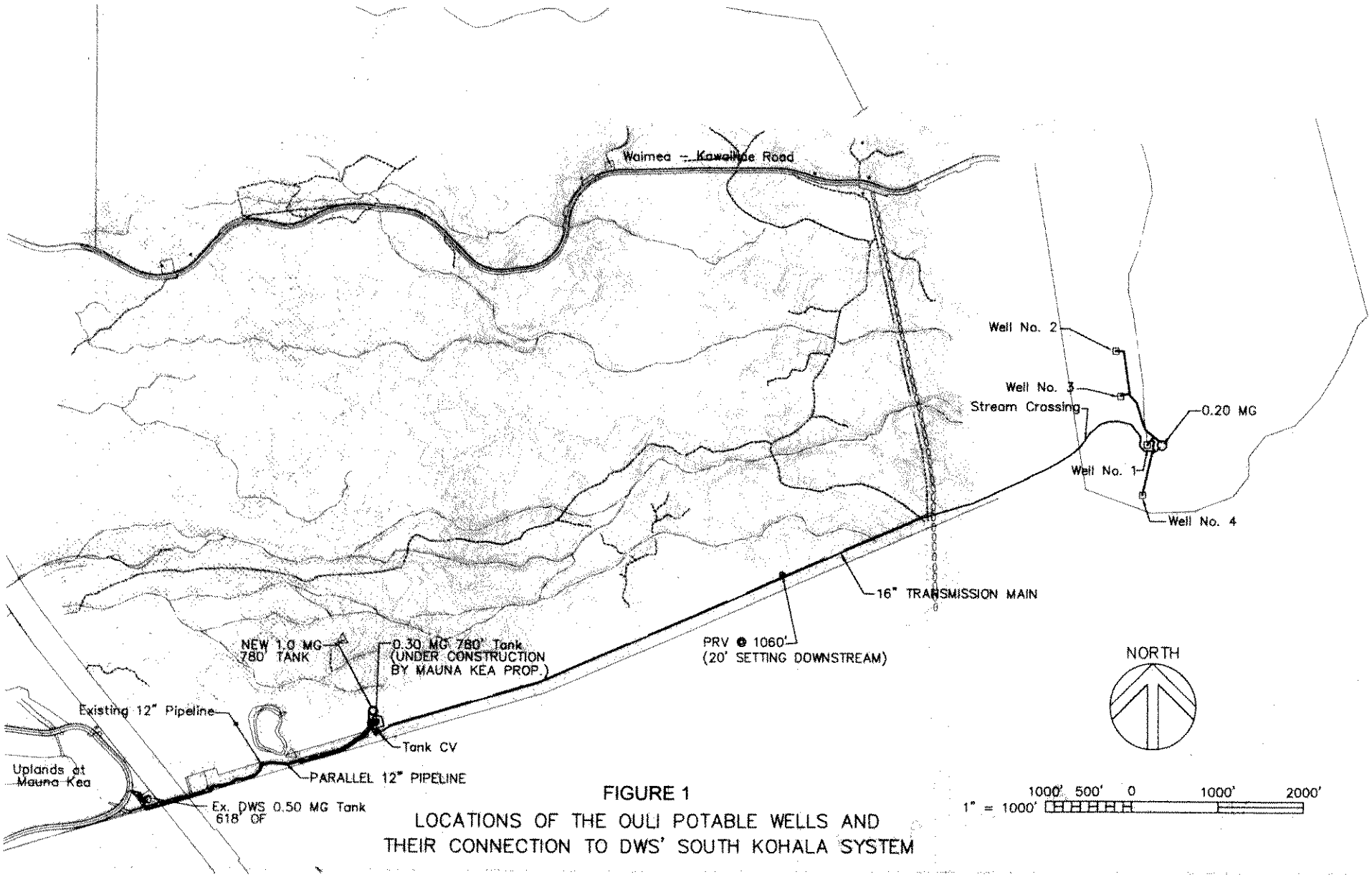

FIGURE 1

LOCATIONS OF THE OULI POTABLE WELLS AND THEIR CONNECTION TO DWS' SOUTH KOHALA SYSTEM

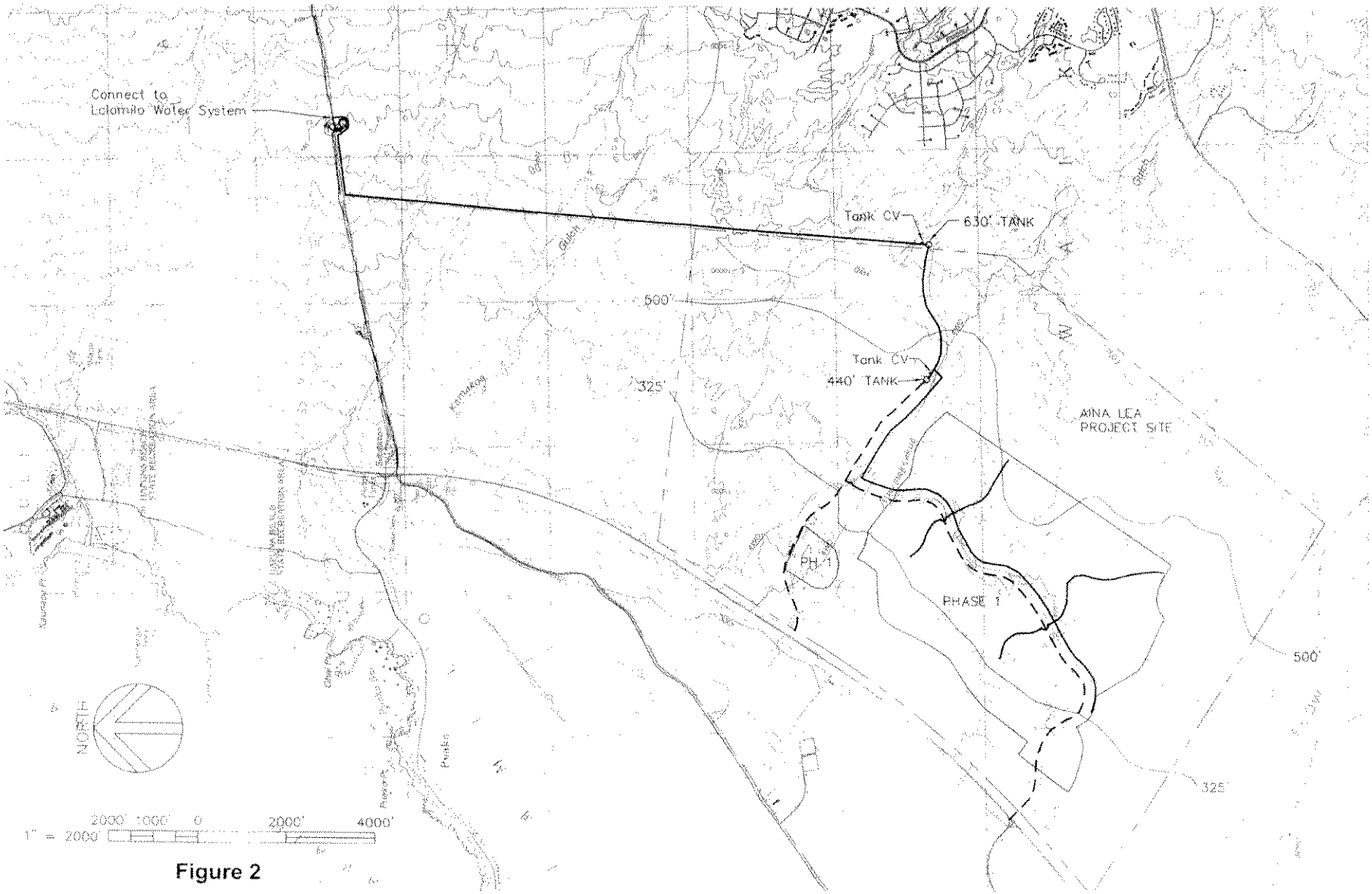
Connect to
Lalamilo Water System
Tank CV
630' TANK
500'
Tank CV
440' TANK
325'
AINA LEA
PROJECT SITE
PH 1
PHASE 1
500'
325'
NORTH
2000' 1000' 0 2000' 4000'
1" = 2000'

Figure 2

BRIDGE AINA LE'A, LLC

RESOLUTION TO ENTER INTO AGREEMENTS AND SIGN DOCUMENTS

The undersigned do hereby certify that they are the Sole Members of Bridge Aina Le'a, LLC , an Hawaii limited liability company (the "Company") and do hereby consent to the adoption of the following resolutions:

RESOLVED, that the Company is herby authorized to enter into certain agreements and contracts with the Department of Water Supply, County of Hawaii.

RESOLVED, that Hoolae Paoa is authorized, on behalf of the Company, to execute, sign and otherwise deliver any contracts, agreements or other documents relating to the transaction.

These Resolutions now stand of record on the books of the Company, are in full force and effect, and have not been modified or revoked in any manner whatsoever.

Dated this 14th day of September, 2006

John K. Baldwin
Member

Shawn Scott
Member

Appendix D
Preliminary Engineering Report (SSFM, February 2009)

The Villages of Aina Le`a

PRELIMINARY ENGINEERING REPORT

July 2009

Project Managers, Planners and Engineers
501 Sumner Street, Suite 620
Honolulu, Hawaii 96817
www.ssfm.com
(808) 531-1308 Office
contactus@ssfm.com

PRELIMINARY ENGINEERING REPORT

FOR

THE VILLAGES OF AINA LE‘A

WAIKOLOA, HAWAI‘I

July 15, 2009

PREPARED FOR:

D.W. AINA LE‘A

PREPARED BY:

Project Managers, Planners and Engineers
501 Sumner Street, Suite 620
Honolulu, Hawaii 96817
www.ssfm.com

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Table of Contents

I. INTRODUCTION 5

II. NEARBY AREAS (SEE FIGURE 1 FOR PROJECT LOCATION MAP AND ADJACENT LANDS - AT END OF THIS REPORT) 6

Kona Town 6
Kona International Airport at Keahole 7
Mauna Lani Resort 7
Waikoloa Village 7
Existing Police, Fire and Emergency Facilities 8

III. PROJECT BACKGROUND 8

Existing Uses 9
Topographical Features 9
Geology 9
Soils 10
Climate 10
Land Use and Zoning 11

IV. DRAINAGE 12

Watershed Hydrology 12
Drainage Criteria and Standards 13
Existing Conditions 13
Modifications After Development 14
Storm Water Quality 14
Off-Site Improvements 14

V. GRADING AND SOIL EROSION 15

Grading 15
Soil Erosion 16
Impact of the Proposed Work 20
Construction (short term) Impacts 21

VI. ROADS (SEE FIGURE 2 – LAND USE SUMMARY FOR PROPOSED ROADWAYS) 22

Existing Conditions 22
Modifications After Development 22
Impacts and Mitigation 23

VII. WATER (SEE APPENDIX) 23

Existing Conditions 23

Proposed Water System and Description of Groundwater 23

IX. WASTEWATER (SEE FIGURE 4 FOR ON-SITE PROPOSED SEWER SYSTEM) 23

Existing Conditions 23
Proposed Wastewater System 24
Projected Wastewater Flows 24
Sewage Solid Waste 25
Modifications After Development 26
Impacts and Mitigation 26

X. SOLID WASTE (TRASH) 27

Existing Conditions 27
Projected Trash Generation and Characteristics 27
Impacts and Mitigation 27

XI. POWER AND COMMUNICATIONS 28

Existing Conditions 28
Modifications After Development 28
Impacts and Mitigation 28

XII. PHASING PLAN 29

XIII. PERMITS 29

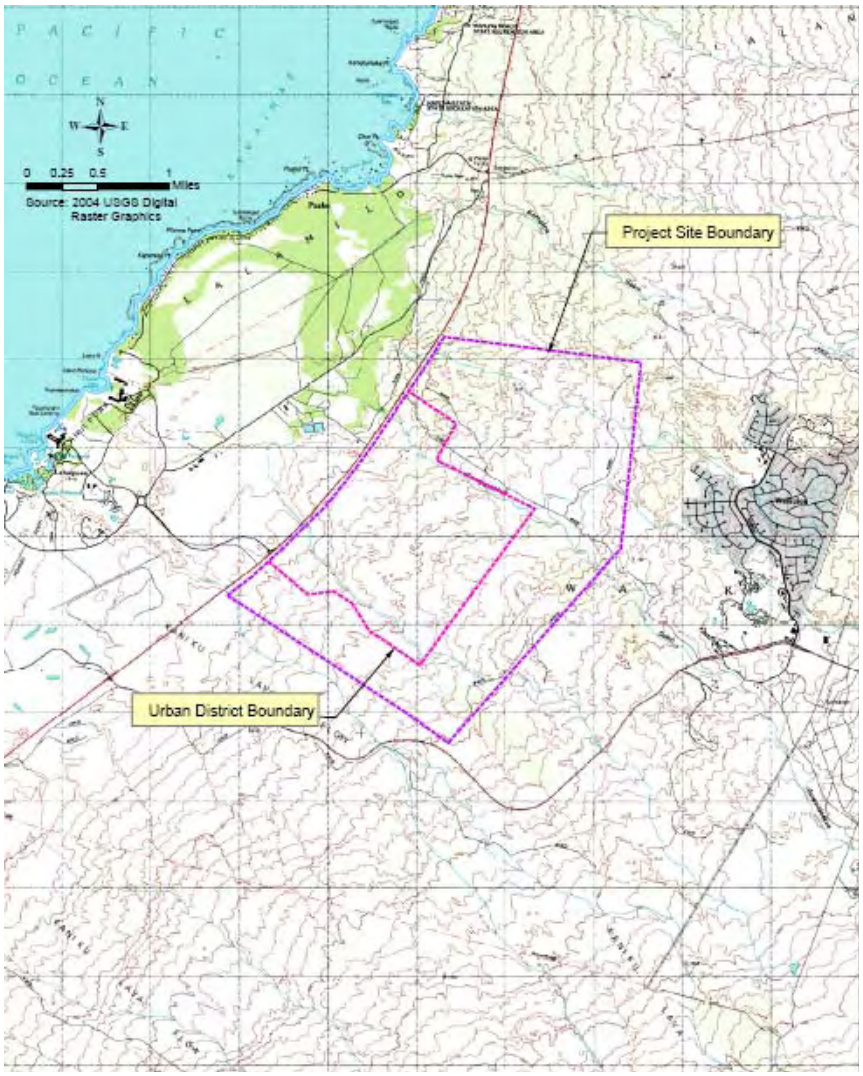
- Grading, Grubbing and Stockpiling Permits 29
- Storm Water Drainage Connection Permits 29
- National Pollution Discharge Elimination Permit (NPDES) 29
- Clean Water Act Section 401 Water Quality Certification (WQC) 30

APPENDIX 31

I. INTRODUCTION

The project known as Villages of Aina Le'a, herein after identified as "Aina Le'a", is located in the District of South Kohala on the island of Hawaii, locally known as the "Big Island" to differentiate itself as one of the islands comprising the "State of Hawaii".

The project site is on the northwestern portion of the Big Island and south of Kawaihae Harbor as shown on the Location Map below. The west boundary of the project site is the Queen Kaahumanu Highway.



The project site's western-most land is approximately two miles from the coast line. The Mauna Lani and Waikoloa Resorts are situated west-southwest of the project site. About one mile to the east of the project site is the Waikoloa Villages, a residential-golf course community.

The project site's 3,000 acres may be found on the State of Hawaii tax maps identified as TMK Nos. 6-8-01: portion 25, 36, 37, 38, 39, and 40.

The project site is within a part of the 91,000 acres of land once leased by the U.S. Navy from Parker Ranch in 1943. Later, the leased area was expanded to 123,000 acres. The land was used for military training exercises and as an artillery firing range by the 2nd and later 5th Marine Divisions and V Amphibious Corps during the period from December 1943 to June 1946.

Live ammunition and other explosives were employed during the military occupation of the area. Ordinance clearance efforts of the training area were performed in 1946 by the Marine Corps. However, much of the area is made up of jagged "aa" lava and the technology of 60+ years ago was insufficient to clear the area of surface and buried ordinances. "Walk-throughs" of certain areas were conducted in 1991 for surface ordinances. In 2004, contractors began clearing subsurface ordinances in the 123,000 acre site. According to previous reports, unexploded ordinances might still remain on the site in limited quantities.

The area was returned to Parker Ranch in September 1946. Parker Ranch, located in Waimea on the Big Island, was founded in 1847. It is one of the oldest and largest ranches in the United States, spreading over approximately 150,000 acres of the Big Island.

II. NEARBY AREAS (See Figure 1 for Project Location Map and adjacent lands - at end of this report)

Kona Town

The town of Kailua-Kona is about a 30+ minute drive to the south along the Queen Kaahumanu Highway. Recent improvements to a portion of this Highway include the addition of two lanes and median dividing the highway beginning at the Kailua-Kona end and going north towards this development. The improvements are being done in phases and the next phase is planned to be done in 2009. The 35-mile Queen Kaahumanu Highway was constructed in 1977 as a two lane highway connecting Kailua-Kona to Kawaihae Road to the north. Prior to the construction of this Highway, there were no roads connecting most of

the shoreline areas from Kailua-Kona to Kawaihae. Travel from Kona to Kawaihae required driving east to Mamalahoa Highway from Kailua-Kona, then driving north along Mamalahoa Highway to Waimea town, then from Waimea town driving west along the Kawaihae road to the ocean.

Kona International Airport at Keahole

The State of Hawaii Keahole Airport, also known as the Kona International Airport, is about a 20 minute drive south of Aina Le'a along the Queen Kaahumanu Highway.

The airport accommodates domestic overseas, international, interisland, commuter and air taxi services, and other general aviation activities. It has an 11,000-foot runway and a complex of facilities at the eastern edge of the airfield for arrival and departure of passengers, air cargo and mail, airport support, and general aviation operations. There are facilities for public parking, and rental car check-in and returns. There are also facilities for rental car agencies, general maintenance and storage along the airport access roadway connecting to Queen Kaahumanu Highway. General aviation, cargo, and related facilities are located to the south of the passenger terminal.

Mauna Lani Resort

Approximately two miles to the west of Aina Le'a is the resort development of Mauna Lani. Mauna Lani Resort opened over 25 years ago and encompasses more than 3,000 acres on the Kohala Coast. Mauna Lani Resort has restored and preserves a 15-acre fishpond dating back historically to the 1200s. Additionally, Mauna Lani is the home of 27 acres of historic parks. Both the fishpond and historic parks are opened to the public.

There are two championship golf courses on the Resort.

Waikoloa Village

In 1968, Boise Cascade Company started the Waikoloa Village project from lands purchased from Parker Ranch. The area was previously used for cattle grazing and during WWII as training grounds for the military. Waikoloa Village is a suburban community with house lots ranging from 7,500 to 10,000 square feet.

The Village has an 18-hole golf course with swimming pool and tennis courts. There is a neighborhood shopping center, the Waikoloa Shopping Center. The Shopping Center consists of a grocery store, gasoline service station, small shops and restaurants. Waikoloa

Elementary School is located towards the northern part of the Village. There are several community churches within the Village. The Village is a rapidly growing community and in 2007 the population of Waikoloa was estimated at 7,000 persons.

Meetings have been held between representatives of the Aina Le'a project and the Waikoloa Village Association. There will likely be some sharing of services between the two developments, for example, roadway access from Waikoloa to Queen Kaahumanu Highway via Aina Le'a.

Existing Police, Fire and Emergency Facilities

Waikoloa Village's and South Kohala's Volunteer Fire Station can provide both fire and emergency medical services for the area. Police services are available from the Waimea, Waikoloa and Kalahuipua'a Police Stations. Also, there are the South Kona Fire Station and the Kalahuipua'a Police Station.

III. PROJECT BACKGROUND

The Villages of Aina Le'a, was originally known as the Puako Hawaii Project dating back to 1989, when then owner Signal Puako planned to build six golf courses with over 2,600 dwellings. In 1990, Nansay Hawai'i, a Japanese firm, took over the project. This project, which proposed 1,550 homes and six golf courses on about 3,000 acres, did not happen. Subsequently the land was sold at a foreclosure in 1998 and acquired by Bridge Capital in 1999.

The project name has been named by the developer as "The Villages of Aina Le'a". Bridge Aina Le'a is part of Bridge Capital (USVI) LLC, an international financial and development company based in the U.S. Virgin Islands. Bridge Capital, LLC sold the 1,092 acres to DW Aina Le'a Development, LLC in 2008. The remaining acreage, which is zoned Agriculture, is currently still owned by Bridge Capital LLC.

The Aina Le'a project site is planned to be developed on 3,000 acres of which 1,060 acres has been designated by the State Land Use Commission as Urban and consisting of zone designations CV-10, RM-4, RM-7 and RM-14.5.

The developer plans to build about 2,462 family units, a golf course, golf course club house, 36 acres of commercial development, and other improvements on the Urban designated

acres. Also, planned to be developed on the remaining lands are 863 agricultural lots. The project is proposed to include parks, open spaces, walking and bike paths.

The 1,060 acre portion of the project is a master planned golf community with approximately 500 units to be designated for affordable and work-force housing.

Additional golf courses are proposed for the remaining 1940 acres (3000 acres minus 1060 acres) along with other improvements, that may include but not limited to, residential units, parks, open spaces, walking and bike paths.

Existing Uses

Currently, there are no existing uses on the property, although historically the property was used for cattle grazing, and as indicated in the introduction of this report, as training grounds for the U.S. Marines during World War II.

Topographical Features

The project site generally slopes downward from east to west from six (6) to twenty (20) percent (%) grade. The ground elevation ranges from about 200 feet above mean sea level on the west boundary and 680 feet on the east boundary.

Overland drainage flows are in a westerly direction towards the ocean.

Some shrubs, wild grasses and trees, mostly Algarroba trees (also known as Mesquite or locally as Keawe trees), can be found on the northern portion of the site. The southern portion is generally covered with “aa” lava flows, some wild grasses and isolated Algarroba trees. Boulders and cobble-stones may be found under the grasses. The “aa” lava creates a rugged looking ground surface.

Geology

The area is generally composed of a mix of a’a and pahoehoe lava flows. According to geologists, some of the lava flows are very old from Mauna Kea estimated to be 65,000 to 250,000 years ago. Other flows, about 14,000 to 65,000 years ago, include the flow below Auwaiakeakua Gulch from Mauna Loa.

Soils

A soils investigation, "Geotechnical Engineering Reconnaissance Puako Residential Golf Community" was prepared for the site in October 7, 1991. From 1991 to present day, soils conditions have not changed.

Additionally, a Draft EIS was prepared around 2006 for an emergency road connecting Waikoloa Village through the project area. In that report, the soils were identified as "Kawaihae extremely stony, very fine sandy loam."

The northern portion of the site is generally vegetated with a thin cover of wild grasses with scattered thickets of Keawe trees. In the southern portion of the site, the ground surface is generally exposed as "aa" and "pahoehoe" lava flows with some wild grasses and isolated Keawe trees.

The "Geotechnical Engineering Reconnaissance Puako Residential Golf Community" Report indicated "it appears that surface soils only occur in the northern portion of the site".

The soil types within the project site are identified in the U.S. Department of Agriculture, Soil Conservation Service, Soil Survey. The major soil types are as follows.

rLV	"aa" Lava flows
KNC	Kawaihae extremely stony very fine sandy loam
PVD	Puu Pa extremely stony very fine sandy loam
rVS	Very stony land

Climate

The project area is considered arid with an average annual rainfall ranging from 10 to 15 inches per year. For stormy years, rainfall might be as much as 40 inches for that year. The average daily high temperature is between 77 to 85 degrees Fahrenheit and hotter sometimes in the summer. The average daily low temperature is between 65 to 70 degrees, mostly in the winter months. Cool breezes and winds sweeping down from the tops of the mountains in the mornings, coming from the easterly direction, causes cool mornings. In the afternoons, the direction of the breezes and winds turn around and comes from the ocean or from the west. This is sometimes known as the *Naulu* wind, a convection wind, where heated air moves up the slopes of the mountains and pulls along the air from the ocean. These winds will often bring rain during the winter storm months.

This area is reported to be the only region in the Hawaiian Islands where summer rainfall will sometimes exceed winter rainfall. There is a marked diurnal wind regime, with well-developed and reliable land and sea breezes, especially in the summer. Summer is the season with a high frequency of late afternoon or early evening showers.

It is noteworthy that in these dry areas throughout Hawaiian Islands, August and September are the warmest months of the year, August tending to be the warmest on Kauai, the northernmost island of the State, and September the warmest on the Big Island, the southernmost island. This occurrence of highest temperatures in late summer and early autumn is typical of areas that are overlain by fresh ocean air.

Land Use and Zoning

In late 2004, the Hawaii County Land Use Commission considered the Bridge Aina Le'a motion to amend Land Use Commission Order of July 1, 1991. The Hawaii Land Use Commission approved a plan to build over 2,000 new homes, a golf course, a shopping center and other facilities for the project site.

DW Aina Le'a, LLC proposes to amend the current County commercial, multi-family residential, and agricultural zoning to "Project District" zoning to accommodate market and site considerations as well as compliance with appropriate governmental regulations and policies.

Changes to the development's requirements, to comply with current local standards, will include Affordable Housing units.

The proposed "Land Use Summary" (Land within the Urban District) is as indicated in the following table.

(See Figure 2 for Land Use Summary)

Land Use	Proposed Approx. Acres	Percent of Total	Proposed Approx. Units	Approx. Gross Floor Areas (sf)
Single Family (SF)	255	7.57%	790	-
Multi Family (MF)	165	5.63%	1,047	-
Mixed Use (MU)	25	0.83%	125	80,000
Affordable/ Workforce Housing	46	1.07%	500	-

Commercial (C)	36	1.20%	-	340,000
Golf Course (GC)	250	8.37%	-	-
Golf Course Club House	4	0.13%	-	-
Highway Buffer	234	7.80%	-	-
Parks/Open Space	37	1.23%	-	-
Major Roadways	40	1.50%	-	-
TOTALS	**1,092±**	**100%**	**2,462±**	**420,000±**

Note that the total proposed acres include 234 acres of "Highway Buffer". The "Highway Buffer" is open space along the 1,200 feet Queen Kaahumanu Highway frontage.

IV. DRAINAGE

A preliminary drainage report titled, "PRELIMINARY MASTER DRAINAGE REPORT for The Villages of Aina Le'a", was prepared by SSFM International Inc., in June 2009. Some of the highlights of this report are included in this Preliminary Engineer Report.

The project is in an area that has a moderate or minimal hazard from the flooding.

Watershed Hydrology

The development is located within the Pohakuloa watershed. The total tributary area of the Pohakuloa watershed is approximately 507 square miles. However, site conditions indicate that only a fraction of water from the Pohakuloa watershed area passes down or along the project site.

Originating high up in the slopes of Mauna Loa, the watershed for this development slopes downward in a northwest direction terminating at the Mauna Lani Resort development.

Land use in the watershed area is almost completely undeveloped, with most of the lands in lava flows are with fauna and flora.

Analysis of GIS data, as well as the visual inspection of the project site, indicated three gulches enter the project site. These three gulches are Puako Gulch #4, Auwaiakeakua Gulch plus a tributary, and an unnamed gulch herein called "South Gulch". These gulches cross

into the project site at four locations along the eastern boundary and all three discharges along the western boundary of the project site. The watershed descriptions are as follows.

Puako Gulch No. 4
Puako Gulch No. 4 originates on the slopes of Mauna Kea. This gulch flows westerly, through the Waikoloa Village, and into the site.

Auwaiakeakua Gulch
The Auwaiakeakua Gulch originates on the slopes of Mauna Kea. This gulch flows westerly and south of Waikoloa Village, and into the site, and the Auwaiakeakua Gulch-North Tributary also originates on the slopes of Mauna Kea. This gulch flows westerly, through the Waikoloa Village, and into the site.

South Gulch
The South Gulch originates on the slopes of Mauna Kea. This gulch flows westerly and south of Waikoloa Village, and into the site.

Drainage Criteria and Standards

The design standards and requirements of the State Department of Transportation (DOT) and the County of Hawaii were applied to this Preliminary Engineering Report.

The watersheds were analyzed using the NRCS Method. The basis for runoff calculation input-values was the County of Hawaii Storm Drainage Standard and the NRCS TR-55 Manual.

> The areas indicated in the "Land Use" table on page 3 and the collector street areas were analyzed using the Rational Method. The basis for runoff calculation input-values was the County of Hawaii Storm Drainage Standard and the NRCS TR-55 Manual.

Rainfall Intensity Maps from the County of Hawaii Drainage standards were used to calculate rainfall. These intensities were then used to estimate peak flows for a 10-year, 50-year and 100-year return period event.

Existing Conditions

There are no drainage improvements on the site. The several gulches that pass through the site do not appear to convey any storm water from the upper reaches of the watershed.

There is an appearance however of these gulches and that immediately above the site to have carried storm waters from heavy localized storms.

Modifications After Development

After development, the amount of storm water runoff developed from the project site will decrease because of grassing of the golf courses, landscaping of roadside and developed areas, and the drainage system.

Development will impact the hydrology of the watershed as sections of undeveloped areas and rangeland will be replaced with impervious surfaces (roads, buildings, etc.) and the small amount of existing vegetative surface cover will be altered. The corresponding impact will result in lower runoff volumes and peak flows because of the grassing of the golf course and roadside landscaping. Although the areas above the project site (offsite) will remain undeveloped, the impact on peak flows downstream of the site will be reduced. Culverts and drainage structures will be sized to accommodate peak flows in accordance with drainage standards.

As the development proceeds, due to the construction of new roadways, golf course and facilities, commercial areas and residential neighborhoods, some of the existing drainage patterns and sub-catchment areas will likely be altered.

Storm Water Quality

During development, except during the grading of the project sites, storm water quality will remain the same or be improved because of soil erosion prevention and fugitive dust protection that will be practiced.

After development, the storm water quality will be improved because of the grassing, landscaping and drainage structure improvements.

Off-Site Improvements

Off-site improvements are not associated with this phase of work. As the development progresses however, drainage structures, manholes, pipes and other off-site associated drainage improvements will likely have to be provided.

V. GRADING AND SOIL EROSION

Grading

Grading in the project area will be moderate and general existing drainage patterns will be retained. To avoid erosion, most, if not all, of the runoff will be retained on the site by the golf courses. A comprehensive drainage plan will have to be developed and is not within the purview of this Preliminary Engineering Report.

Grading work will consist of sub-grading the proposed roads, rough grading the golf course and golf course facilities sites, sub-grading the commercial center site, and installation of temporary culverts under the proposed roads. Residential building pads and local roads will not be graded as part of the Master Grading Permit work. The project site will only be graded in selected areas and road paving will not be done at this time.

Grading will take place in phases so that the amount of exposed graded land will not be more than 20 acres. The grading phases for the initial development of 285 acres, more or less, are as identified in the following table.

PHASE	TOTAL AREA OF GRADING (Acres)	DESCRIPTION OF AREA	SOIL TYPE	AREA PERCENTAGE (%)	K VALUE
		Road 3 - Section 2	KNC	57.86	0.32
		Road 5	rLV	14.39	0.20
1A	17.44	Waterline Access	rLV	27.75	0.20
1B	11.87	Road 2 - Section 2	rLV	100.00	0.20
1C	19.47	Road 1	rLV	100.00	0.20
1D	11.71	Commercial 1	rLV	100.00	0.20
1E	23.44	Commercial 2	rLV	100.00	0.20
1F	10.21	Affordable Housing	rLV	100.00	0.20
2	15.00	Road 2 - Section 3	rLV	53.07	0.20
		Road 4	rLV	46.93	0.20
3A	16.23	Hole 7, Hole 8(clearing , grubbing, and crunching only)	rLV	100.00	0.20
3B	14.51	Holed 5 and 6	rLV	100.00	0.20
3C	13.61	Hole 3, 4, and 9	rLV	100.00	0.20
3D	17.69	Hole 1, 2, and 18	rLV	100.00	0.20

3E	15.84	Hole 10 and Driving Range	rLV	100.00	0.20
3F	14.49	Hole 14, Holes 15,16,17(clearing, grubbing, and crunching only)	rLV	100.00	0.20
3G	18.10	Holes 11, 12, 13 (clearing, grubbing and crunching only)	rLV	100.00	0.20
4	9.47	Road 2 - Section 4	rLV	19.75	0.20
			PVD	25.55	0.37
			KNC	54.59	0.32
5	0.96	Road 3 - Queen Kaahumanu Hwy Intersection	KNC	100.00	0.32
6	19.96	Road 3 - Section 1	KNC	100.00	0.32
7A	17.94	Club House	rLV	26.25	0.20
		Golf Academy	rLV	61.37	0.20
		Golf Maintenance	rLV	12.37	0.20
7B	17.40	Road 2 - Section 1	rLV	19.94	0.20
		Road 6	rLV	80.06	0.20

The gulch areas will generally remain mostly undeveloped. However, some grading in the gulches will be required for the proposed roads, drainage culverts, and golf course.

Some areas will be crunched only, that is, crushed in place and in some other areas the sites will be leveled-off.

Cut and fill earthwork quantities will be balanced as much as possible for soil economics. This will minimize the cost of importing borrow material and disposing of excess material to and from off-site locations. Grading operations will be in conformance with the applicable ordinances of the County of Hawaii.

Soils engineering will be performed at specific sites as the sites are developed. Soils Engineers will be consultant for recommendations on mitigation measures for the various buildings and development types and locations. These may include the removal of unsuitable soils under foundations and or special foundation designs. When pockets of soils are found, the soil will be saved (stock piled) for finish grading and planting purposes.

Soil Erosion

The U.S. Department of Agriculture, Soil Conservation Service's "Universal Soil Loss Equation (USLE)" was used to estimate long-term average annual soil erosion losses from sheet and fill erosion. The equation is used to estimate erosion on forestland, farm fields, construction/development sites, and other areas. Soil losses can be estimated for present conditions or for a future condition using the equation as follows.

$$A = RKLSCP$$

where:
A = soil loss (tons/acre/year)
R = rainfall factor
K = soil erodible factor
L = slope length factor
S = slope gradient factor
C = cover and management factor
P = erosion control practice factor

The rainfall factor (R) was based on the U.S. Soil Conservation Service (SCS) Erosion and Sediment Control Guide for Hawaii. The soil erosion factor (K) for each sub-area was selected after evaluating the U.S. Department of Agriculture Soil Survey and City and County of Honolulu Soil Erosion Standards and Guidelines, and is based upon the weighted average of all K values for soil types in each sub-area. The cover and management factor (C) was also based on a weighted average for C values within each sub-area and calculated to reflect conditions both before and after the development of the project. Both R and K factors remain constant for the site before and after the proposed project is constructed.

The slope length factor (L) and slope gradient factor (S) were combined into an LS factor for the calculations. The differences in LS factors between sub-areas reflect the differences in topography. The LS factors show a decrease with development due to site grading and construction of an underground drainage system, which reduced the slope and length of overland flow.

The project site has been divided into seven sub-areas for calculating soil erosion for the initial development of 285 acres. These sub-areas represent sites that vary in soil erosion potential characteristics such as terrain, soil types and/or drainage network.

The total calculated soil loss for the seven (7) sub-areas under existing conditions is 126,730 tons/year as shown on the following table "Estimated Soil Loss Due to Storm Runoff – Existing Conditions. The seven sub-areas in turn were subdivided so that any one area will not exceed 20 acres.

Estimated Soil Loss Due to Storm Runoff - Existing Conditions

SUB-AREA	R	K	L, ft	El Start	El End	S	LS	CP	E	Acres	F	D	Tons/yr
1A	90	0.32	917.81	609.57	540.41	7.54	2.773	1.000	79.87	10	4	2	11,284
	90	0.20	206.65	580.26	546.49	16.34	4.314	1.000	77.65	3	4	2	2,728
	90	0.20	476.64	494.60	441.52	11.14	3.546	1.000	63.83	5	4	2	4,325
1B	90	0.20	409.96	428.81	384.68	10.76	3.122	1.000	56.20	12	4	2	9,339
1C	90	0.20	668.71	354.93	339.77	2.27	0.393	1.000	7.08	19	4	2	1,929
1D	90	0.20	693.98	204.19	179.50	3.56	0.765	1.000	13.77	12	4	2	2,257
1E	90	0.20	870.64	262.00	214.57	5.45	1.758	1.000	31.64	20	4	2	10,382
1F	90	0.20	900.72	302.00	243.47	6.50	2.246	1.000	40.42	10	4	2	5,778
2	90	0.20	415.70	445.05	415.05	7.22	1.758	1.000	31.65	15	4	2	6,646
3A	90	0.20	793.89	422.50	394.93	3.47	0.787	1.000	14.16	16	4	2	3,218
3B	90	0.20	3058.34	394.93	330.31	2.11	0.585	1.000	10.54	15	4	2	2,140
3C	90	0.20	940.34	360.26	305.00	5.88	2.011	1.000	36.20	14	4	2	6,898
3D	90	0.20	1039.49	304.65	249.72	5.28	1.849	1.000	33.28	18	4	2	8,242
3E	90	0.20	720.32	391.64	376.69	2.08	0.374	1.000	6.73	16	4	2	1,492
3F	90	0.20	899.32	336.03	280.85	6.14	2.080	1.000	37.44	14	4	2	7,596
3G	90	0.20	1593.34	393.98	339.69	3.41	1.019	1.000	18.35	18	4	2	4,649
4	90	0.31	394.91	234.56	213.94	5.22	1.123	1.000	31.33	9	4	2	4,153
5	90	0.32	122.00	122.09	109.96	9.94	1.510	1.000	43.49	1	4	2	585
6	90	0.32	779.14	233.15	177.26	7.17	2.387	1.000	68.75	20	4	2	19,211
7A	90	0.20	725.70	370.98	344.66	3.63	0.795	1.000	14.30	5	4	2	943
	90	0.20	482.77	433.59	389.12	9.21	2.682	1.000	48.28	11	4	2	7,441
	90	0.20	437.23	349.40	339.69	2.22	0.340	1.000	6.12	2	4	2	190
7B	90	0.20	1443.19	383.13	323.39	4.14	1.210	1.000	21.77	17	4	2	5,304
								TOTALS		**285**			**126,730**

The total calculated soil loss for the seven (7) sub-areas under developed conditions is 111,389 tons/year as shown on the following table "Estimated Soil Loss Due to Storm Runoff – Developed Conditions. The seven sub-areas in turn were subdivided so that any one area will not exceed 20 acres.

Estimated Soil Loss Due to Storm Runoff - Developed Conditions

SUB-AREA	R	K	L, ft	El Start	El End	S	LS	CP	E	Acres	F	D	Tons/yr
1A	90	0.32	3071.31	603.58	469.28	4.37	1.742	0.850	42.64	10	4	2	6,024
	90	0.20	2241.35	610.03	499.28	4.94	1.774	0.850	27.15	3	4	2	954
	90	0.20	1124.71	495.00	424.83	6.24	2.378	0.850	36.38	5	4	2	2,465
1B	90	0.20	3860.51	423.56	337.97	2.22	0.653	0.850	9.99	12	4	2	1,660
1C	90	0.20	6220.29	374.17	162.15	3.41	1.758	0.850	26.90	19	4	2	7,332
1D	90	0.20	736.02	211.50	184.00	3.74	0.825	0.500	7.43	12	4	2	1,217
1E	90	0.20	1134.81	267.18	206.09	5.38	1.977	0.850	30.25	20	4	2	9,926
1F	90	0.20	1027.92	303.65	240.87	6.11	2.211	0.850	33.82	10	4	2	4,835
2	90	0.20	2159.92	420.00	328.56	4.23	1.458	0.850	22.31	15	4	2	4,685
3A	90	0.20	660.79	427.22	395.00	4.88	1.071	0.850	16.39	16	4	2	3,724
3B	90	0.20	955.93	398.77	359.61	4.10	1.014	0.850	15.51	15	4	2	3,151
3C	90	0.20	407.36	347.51	324.86	5.56	1.234	0.850	18.87	14	4	2	3,596
3D	90	0.20	634.46	308.50	274.97	5.28	1.445	0.850	22.10	18	4	2	5,474
3E	90	0.20	658.04	388.18	365.00	3.52	0.741	0.850	11.34	16	4	2	2,514
3F	90	0.20	434.43	325.74	291.73	7.83	2.013	0.850	30.80	14	4	2	6,248
3G	90	0.20	394.91	234.56	213.94	5.22	1.123	0.850	17.18	18	4	2	4,353
4	90	0.31	2643.09	328.56	242.66	3.25	1.189	0.850	28.20	9	4	2	3,738
5	90	0.32	160.65	120.00	117.18	1.76	0.210	0.850	5.13	1	4	2	69
6	90	0.32	4785.40	415.00	120.00	6.16	4.828	0.850	118.19	20	4	2	33,027
7A	90	0.20	291.86	375.03	355.20	6.79	1.357	0.850	20.76	5	4	2	1,369
	90	0.20	670.69	420.00	385.00	5.22	1.462	0.850	22.37	11	4	2	3,448
	90	0.20	213.39	350.28	346.96	1.56	0.210	0.850	3.21	2	4	2	100
7B	90	0.20	613.00	350.95	336.46	2.36	0.397	0.850	6.07	17	4	2	1,480
								TOTALS		**285**			**111,389**

Impact of the Proposed Work

Based on the USLE, the soil erosion potential at the project site is estimated to decrease about 12% as a result of this grading work. This decrease in soil erosion results from a reduction of erodible surfaces with planting of temporary grasses, reduction of length and slope of overland flow from site grading designs, construction of a storm drain systems, and an increase in landscaped area (reduction of bare ground). The estimated soil erosion potential for the project is calculated to decrease by 15,341 tons/year; or about a 3 percent reduction resulting from the proposed work. This is a summarized in the "Summary of Soil Erosion Potential" table below.

Summary of Soil Erosion Potential

SUB-AREA	Existing Conditions (ton/yr)	Developed Conditions (ton/yr)	Changes decrease - increase +	Percent Increase (%)	Percent Decrease (%)
1A	18,337	9,443	-8,894		-49%
1B	9,339	1,660	-7,679		-82%
1C	1,929	7,332	5,403	280%	
1D	2,257	1,217	-1,040		-46%
1E	10,382	9,926	-456		-4%
1F	5,778	4,835	-943		-16%
2	6,646	4,685	-1,961		-30%
3A	3,218	3,724	506	16%	
3B	2,140	3,151	1,011	47%	
3C	6,898	3,596	-3,302		-48%
3D	8,242	5,474	-2,768		-34%
3E	1,492	2,514	1,022	68%	
3F	7,596	6,248	-1,348		-18%
3G	4,649	4,353	-296		-6%
4	4,153	3,738	-415		-10%
5	585	69	-516		-88%
6	19,211	33,027	13,816	72%	
7A	8,574	4,917	-3,657		-43%
7B	5,304	1,480	-3,824		-72%
TOTALS	**126,730**	**111,389**	**-15,341**		

Construction (short term) Impacts

Grading, grubbing and stockpiling work on the project will involve land disturbing activities that may result in soil erosion, some removal of existing vegetation and leveling of materials, including removing, stockpiling, and soil replacement.

Erosion Control Plans will be in compliance with Chapter 10, "Erosion and Sedimentation Control" of the County of Hawaii Code. The contractor will be required to perform all grading, grubbing and stockpiling operations in conformance with the applicable provisions of the County of Hawaii Code and Chapter 55 (Water Pollution Control) of Title 11 Administrative Rules of the State Department of Health, and any subsequent amendments to these requirements.

Soil erosion prevention and fugitive dust protection will be practiced, and best management practices mitigation measures to be provided include, but will not be limited to, the following.

1. Implementing measures such as limiting grading to not more than 20 acres at a time until dust and erosion controls are provided.
2. Minimizing time of opened graded areas.
3. Grading, as much as possible, perpendicular to slopes as opposed to grading along the slopes (up and down the slopes).
4. Retaining existing vegetation until just prior to construction start in the area.
5. Constructing drainage control features, such as, erosion control fences.
6. Using temporary area sprinklers in non-active construction areas when existing vegetation has been removed.
7. Using water trucks during construction periods for dust control.
8. Using temporary berms and cut-off ditches for control of erosion.
9. Thorough watering or other erosion control method provided on graded areas in anticipation of weekends and holidays.
10. Implementing of sedimentation basins
11. Sodding and or planting the cut and fill slopes that are subject to erosion.
12. Using slope stabilization materials when needed.

The project site is divided into seven sub-areas for calculating soil erosion potential. For identification of the sub-areas, see the "**Summary of Soil Erosion Potential"** on the previous page.

VI. ROADS (See Figure 2 – Land Use Summary for Proposed Roadways)

Existing Conditions

There are no existing roads within the project site other than some undefined vehicular trails.

In 2005, the Hawai'i County Department of Public Works proposed to construct a single-lane gravel-surface road through the Aina Le'a site for emergency access of Waikoloa Village to Queen Ka'ahumanu Highway. This emergency road has not been constructed.

Modifications After Development

It is likely that permanent and temporary roads through the Aina Le'a project will be brought to the mauka boundary of the project site for eventual connection to Hulu Street in Waikoloa Village. This will provide Waikoloa Village with an access route to Queen Ka'ahumanu Highway during emergencies.

Improved and unimproved roadways developed for the construction access and access to the project's improvements will remain for fire access. Presently there are no roads serving as emergency fire access.

The proposed project access will align with the Mauna Lani Drive at the Queen Kaahumanu Highway intersection. Acceleration and deceleration lanes to and from Queen Kaahumanu Highway to the project's access will be provided. The project's intersection will be designed to allow traffic to flow to and from the Mauna Lani Resort development.

The Master Plan for Aina Le'a requires a "Natural Highway Buffer Zone" of 234± acres parallel to and along mauka side Queen Kaahumanu Highway right-of-way. The set-back depth for this buffer zone, from Queen Kaahumanu Highway to the Aina Le'a improvements will range from approximately 550 feet to 1200+ feet.

Onsite roadways will consist of collector, local roads and maintenance roads (golf course) serving the individual developments within the project site. The collector roads will provide access for the various developments and will be rough graded during this phase of work. Roadway paving will occur during the construction of the various individual development sites.

Impacts and Mitigation

Impacts and mitigation are further identified in the Traffic Impact Analysis Report (TIAR) titled "Traffic Impact Analysis Report - The Villages of Aina L'ea", July 2007. In general, the project will generate additional traffic to and from Queen Kaahumanu Highway. The TIAR outlines the requirements and impacts for access to the development and improvements to supporting infrastructure.

VII. WATER (see Appendix)

Existing Conditions

Currently, the County of Hawaii does not serve the project site with a potable water system. Water for this project is proposed to be obtained from the South Kohala water system located to the north of the project site.

Proposed Water System and Description of Groundwater

The water system proposed by the Aina Le'a water consultant Tom Nance Water Resource Engineering is detailed in the Appendix "Assessment of the Potential Impact on Water Resources of the Development of the Aina Le'a Village Project in South Kohala, Hawaii" dated July 2009.

IX. WASTEWATER (See Figure 4 for On-Site Proposed Sewer System)

Existing Conditions

There are no existing wastewater facilities within the project site. Likewise, there are no municipal sewer mains near the project site.

Proposed Wastewater System

A wastewater treatment plant, gravity mains, force mains, and pump stations is proposed for the project. The plant will likely be designed and constructed to allow expansion for meeting increasing wastewater flows as the population in the project area increases.

There have also been discussions with the Mauna Lani Resort development located about 2 miles west of the project site about some or all of Aina Le'a's wastewater transmitted to the resort's existing wastewater facilities for treatment. Although this is a viable alternative, Aina Le'a continues to focus on having its own wastewater treatment plant, so that recycled water and biosolids from the treatment can be available for irrigation and composited fertilizer purposes respectively.

Projected Wastewater Flows

Wastewater will be generated from the various facilities within the proposed Aina Le'a project at an estimated average daily flow of 1.5 million gallons. The estimated wastewater design peak flow calculations are based on the City and County of Honolulu's Wastewater Standards. Listed below are the wastewater contributions for each of the proposed land uses of the Aina Le'a project.

TABLE 1
SUMMARY OF PROJECTED WASTEWATER FLOWS

Land Use	No. of Units	Per- capita / Unit	Est. popu-lation	GPD per person	Est. Ave. Wastewater Flow (GPD)
Single Family	790	4	3,160	112	353,920
Multi-Family	1,047	4	4,188	112	469,000
Mixed Uses	125	4	500	112	280,000
Affordable Housing	500	4	1,540	112	123,200
Commercial	36 acres	140/cap./acre	5,040	112	5,040
Golf Course Club House	4 acres	200/cap./acre	800	25	800
			TOTAL		**1,232,000**

The projected design average flow for the urban development is estimated to be 1.23 MGD with an estimated design maximum flow rate of about 5.8 million gallons, and an estimated 6.5 million gallons with estimated infiltration/inflow included.

Sewage Solid Waste

Solid wastes, including liquids and sludge, from the treatment of the Aina Lea's wastewater will not be disposed of at the existing Kealakehe Wastewater Treatment Plant.

As a part of the development of Aina Le'a, best practice methods for sewage disposal will be identified for consideration. As previously indicated two alternatives are under consideration. One is to provide wastewater treatment within the project site, and the alternative to transmit untreated wastewater to the Mauna Lani's existing plant.

Presently, stabilization treatment processes of biosolids include the following.

- Aerobic stabilization in an open containment area using aerobic bacteria to convert biosolids to carbon dioxide, water and nitrogen.
- Anaerobic stabilization in closed container using anaerobic bacteria to reduce organic matter.
- Chemical treatment
- Composting causing decomposition of organic matter. It has been reported that this process provides excellent soil conditioning properties.
- Heat drying using dryers to remove liquids, however cost to process sludge by heat drying is high.

Aerobic stabilization and composting may be the best practice methods, and a combination of both methods may be used. For example, the biosolids that have been treated with aerobic stabilization and composting can be spread out on the golf courses. It has been found that composted biosolids have valuable properties, such as, slow release of nutrients that provide long-term nourishment to plants.

Modifications After Development

A network of sewer lines will be provided for the project, and wastewater will be transmitted to a secondary sewer treatment plant proposed at the southwest corner of the project site.

It is proposed that after the secondary treatment, effluent will be treated further at the plant's water recycling facility for roadside landscape irrigation purposes and for golf course irrigation. The sewer treatment plant will be designed for an average dry weather flow liquid capacity of about 2.0 MGD, and designed to handle a peak flow rate of 10.5 million gallons.

Also under consideration is that the biosolids, sludge, be composited on a portion of the 3000 acres that will developed some time in the future and located where odors will not be a problem. Alternatively, the biosolids can be covered with soil to minimize odor problems.

The collection system will consist of gravity sewers, force mains, and sewage pumping stations all within sewer and roadway easements. Preliminary pipe sizes will likely range from 8" to 12" mains and with 4" to 6" sewer laterals. The onsite wastewater collection system is proposed to be dedicated to the County of Hawaii, and therefore design and construction of the collection system will be in accordance with County of Hawaii Standards. Prior to implementation of the proposed improvements a comprehensive sewer master plan will be prepared and submitted to the County of Hawaii.

Impacts and Mitigation

The sewer collection lines will be installed along with the construction of the wastewater treatment plant and within road right-of-ways and easements.

X. SOLID WASTE (TRASH)

Existing Conditions

There is no refuse (household trash) service for the project site. Currently, the site is undeveloped and trash is not generated.

Projected Trash Generation and Characteristics

During construction the project will generate trash consisting primarily of vegetation, rocks, and debris resulting from clearing of the site. Some of the wastes will be combustible.

For the development, typical range of per capita trash generation from a municipal source (residential and commercial) is 2.0 to 5.0 pounds per capita per day (lb/capita/day). A study of the following areas that are near this project area was conducted in FY 00 to FY 03. Trash generation in these areas were as follows.

Area	Pop.	Tons/yr	Tons per cap./year	Lbs./year	Lbs/day
Kailua Kona	21000	8021	0.3820	764	2.09
Puako	5600	2297	0.4102	820	2.25
Waimea	11700	5160	0.4410	882	2.42

Trash generation from the proposed development is estimated to be10 tons/day based on an average generation rate of 2.5 lbs/per capita/day.

Because the general public is becoming more aware of recycling of disposables, it is anticipated that the average generation rate of 2.5 lbs/per capita/day will be within the solid wastes generated for the project.

Impacts and Mitigation

The proposed development will be a new generator of trash. Generation of construction wastes due to clearing of the site will be a short term impact. The contractor will be required to remove all debris from the project site to mitigate any environmental impact.

Refuse generated by the project will be collected by a private refuse collection service, or it will be required for the homeowners to take their refuse to a County of Hawaii transfer station or landfill. A transfer station is located in Puako, and a land fill to the south at Puuanahulu. The County of Hawaii has implemented a recycling and reuse of green waste program.

XI. POWER AND COMMUNICATIONS

Existing Conditions

There is no power or communications at the project site.

Hawaii Electric Light Company (HELCO) provides electrical power on the Big Island. Off-site sub-transmission lines and distribution lines coexist with Hawaii Electric Light Company wood poles. The following is a general description of the utility lines that impact the project site.

From an existing HELCO substation located near the intersections of Hoohana Street and Puako Beach Drive with Queen Kaahumanu Highway, electrical power is proposed to be brought to the northeast corner of the project site through easements.

Modifications After Development

It is anticipated that HELCO will provide the necessary electrical system, and likewise for the other utilities, such as, telephone, cable TV, and high-speed internet services to the project site. At this time, electrical demand for the entire development has not been determined. The power requirement is beyond the purview of this Preliminary Engineering Report.

Impacts and Mitigation

The transmission and sub-transmission lines will not have a visual impact on the view planes of this project when looking east toward the Pacific Ocean. The lines will be in view

when looking west towards the summit of the Mauna Kea, Mauna Loa and the Kohala mountains.

Within the project site, all electrical, telephone and cable TV lines will be buried underground and will not therefore cause a visual impact on the view planes.

XII. PHASING PLAN

The Grading Phasing Plan for this Preliminary Engineering Report is as identified under the "Grading" portion of the report. There are seven (7) phases of grading proposed. After completion of the grading phase of work, the developer will begin developing the commercial, residential and housing, golf course and club house sites. Phasing of these sites has not yet been determined.

XIII. PERMITS

The following summarizes the anticipated permits requirements. There may be other permits that will be required as the development of the project proceeds.

- Grading, Grubbing and Stockpiling Permits
  Grading, Grubbing and Stockpiling permits will be required. Permit applications must meet requirements of the grading, grubbing and stockpiling ordinances of the County of Hawaii and also where applicable the rules and regulations of the State of Hawaii.

- Storm Water Drainage Connection Permits
  Storm water drainage connection permits will be required from the County of Hawaii and the State of Hawaii Department of Transportation.

- National Pollution Discharge Elimination Permit (NPDES)
  National Pollution Discharge Elimination System (NPDES) permits will be required for this project. The following are the anticipated NPDES permits that will be required.

  Form C
  More than 1 acre of land will be disturbed during construction. A NPDES General Permit Coverage Authorizing Discharges of Storm Water Associated with Construction Activities will be required for this project. Since the project site is classified as a Class 2 area (Water Quality Standard Maps published by the Office of Environmental Planning, Department of Health October 1987) and none of the waterways appears to run through

State Parks, it is anticipated that the general application will be applicable, and an individual application will not be required.

Form F
NPDES General Permit Coverage Authorizing Discharge of Hydro-testing Waters will be required if the hydro-testing waters will be discharged on site and allowed to enter the storm drainage system.

Form G
NPDES General Permit Coverage Authorizing Discharges of Associated with Construction Activity Dewatering. This permit may not be required if groundwater is not likely to be encountered. Groundwater existence will be confirmed when geotechnical investigations are completed.

- Clean Water Act Section 401 Water Quality Certification (WQC)
  This permit, issued by the State of Hawaii Department of Health, Environmental Management Division, Clean Water Branch, is required for applicants conducting activities, including the construction or operation of facilities, which might result in any discharge into navigable waters. This project will need to obtain a determination from the Clean Water Branch as to whether a WQC will be required.

- U.S. Army Corps of Engineers Permit
  If it is determined that storm waters from this project discharges into navigable waters, a permit from the Corps of Engineers might be required.

- Solid Waste Disposal
  This permit, issued by the County of Hawaii, is required for disposal at any County landfill or other waste facility.

- Underground Injection Control (UIC)
  The project is located above the UIC line. According to the State of Hawaii Department of Health's (DOH) UIC map, the mauka boundary of Queen Kaahumanu Highway Right-of-Way is the dividing line for above and below the UIC line. Below the UIC line, the underlying aquifer is considered to be a drinking water source and therefore limited types of injection wells are allowed. Above the UIC line, injection wells are permitted for injecting water or other fluids into the ground subject to DOH approval. DOH provides the conditions governing the location, construction, and operation of injection wells so that injected fluids do not migrate and pollute underground sources of drinking water. A permit will be required for UIC wells. A submittal to DOH will be required.

Appendix D1

Temporary, Phase 1 Wastewater Treatment Plant Design Report
(Waterworks Engineers, February 2010)

Villages of Aina Le'a
Wastewater Treatment Facilities
Phase 1 Facility Basis of Design

Table of Contents

Table of Contents 1
Background 3
Precipitation and Evaporation at the Site 8
Wastewater Flow Projections 13
Raw Wastewater Characteristics 15
Effluent Requirements 16
Non-Potable Water Demands and Supply 16
Non-Potable Water Demands 16
Construction Dust Control 16
Landscape Irrigation 17
Golf Course Irrigation 17
Non-Potable Water Supply 17
Water Balance 18
Project Schedule 21
Phase 1 Facility Schedule 21
Phase 2 Facility Schedule 21
Phase 1 Treatment Facility Details 21
Mass Balance 22
Raw Wastewater Delivery to the Facility 22

WATERWORKS ENGINEERS

Influent Screening 22
Wastewater Equalization 23
Activated Sludge Bioreactor 25
Feed-Forward Pumps 26
Membrane Tanks 26
Blowers 27
Recycled Water Wetwell & Transfer Pump Station 28
Disinfection & Chlorine Feed 28
Recycled Water Storage and Pumping 29
Emergency Disposal 29
WAS Dewatering 30
Plant Service Water 30
Electrical and Control 31
Odor Control 32
Site Work 32
Visual Impact Control 32
Contingency Planning 32
Reliability Provisions 32
Assessment of Compliance 34
Operations Planning 35

Drawings

G-001	Cover Sheet
C-001	Phase 1 Development Plan
C-002	Phase 1 WWTP Vicinity Plan
C-003	Site Grading Plan
C-004	Site Layout
C-005	Yard Piping Plan
C-006	Sewer Line Profile
PI-001	Process Schematic Symbols & Abbreviations
PI-211	Process Schematic , Screening, EQ and Bioreactor
PI-212	Process Schematic , Membrane Filtration
PI-213	Process Schematic , Blowers and Process Air
PI-214	Process Schematic, Disinfection and Recycled Water
S-002	Structural, Treatment Tank Lower Plan

S-003	Structural, Treatment Tank Top Plan
S-004	Structural, Treatment Tank Sections
M-002	Mechanical, Treatment Tank Plan
M-003	Mechanical, Treatment Tank Sections

Background

The Villages of Aina Le`a is a master-planned golf course community located on the South Kohala Coast of the Big Island of Hawaii near Waikoloa. The general location on the island is shown in Figure 1. Basic data on the proposed WWTP is as follows:

Facility Name	Aina Le'a WWTP
Facility Address	Not Available
Tax Map Key for Facility	(3) 6-8-001: 25
Facility Owner	DW Aina Le'a Development, LLC P.O. Box 383129 Waikoloa, HI 96738

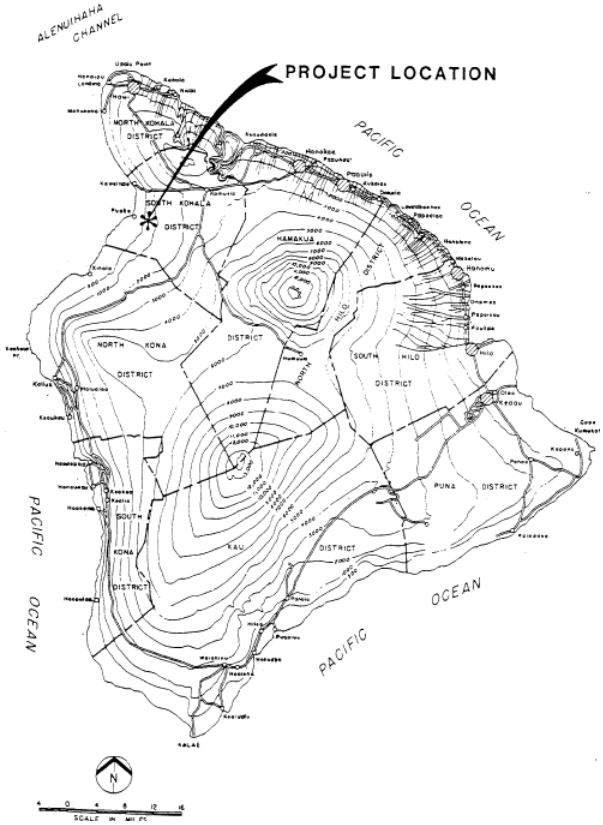


Figure 1 – Project Location

The development comprises approximately 1092 acres and is located *mauka*, or inland of the Queen Ka'ahamanu Highway, as shown in Figures 2 and 3. The Highway serves as the underground injection

control (UIC) line for this part of the island, which means that the development overlays a protected aquifer. The tax map keys for the parcels included in the development are: TMK Nos. (3) 6-8-001: 25, 36, 37, 38, 39 and 40.

Figure 2 – Aerial Photo of Project Location

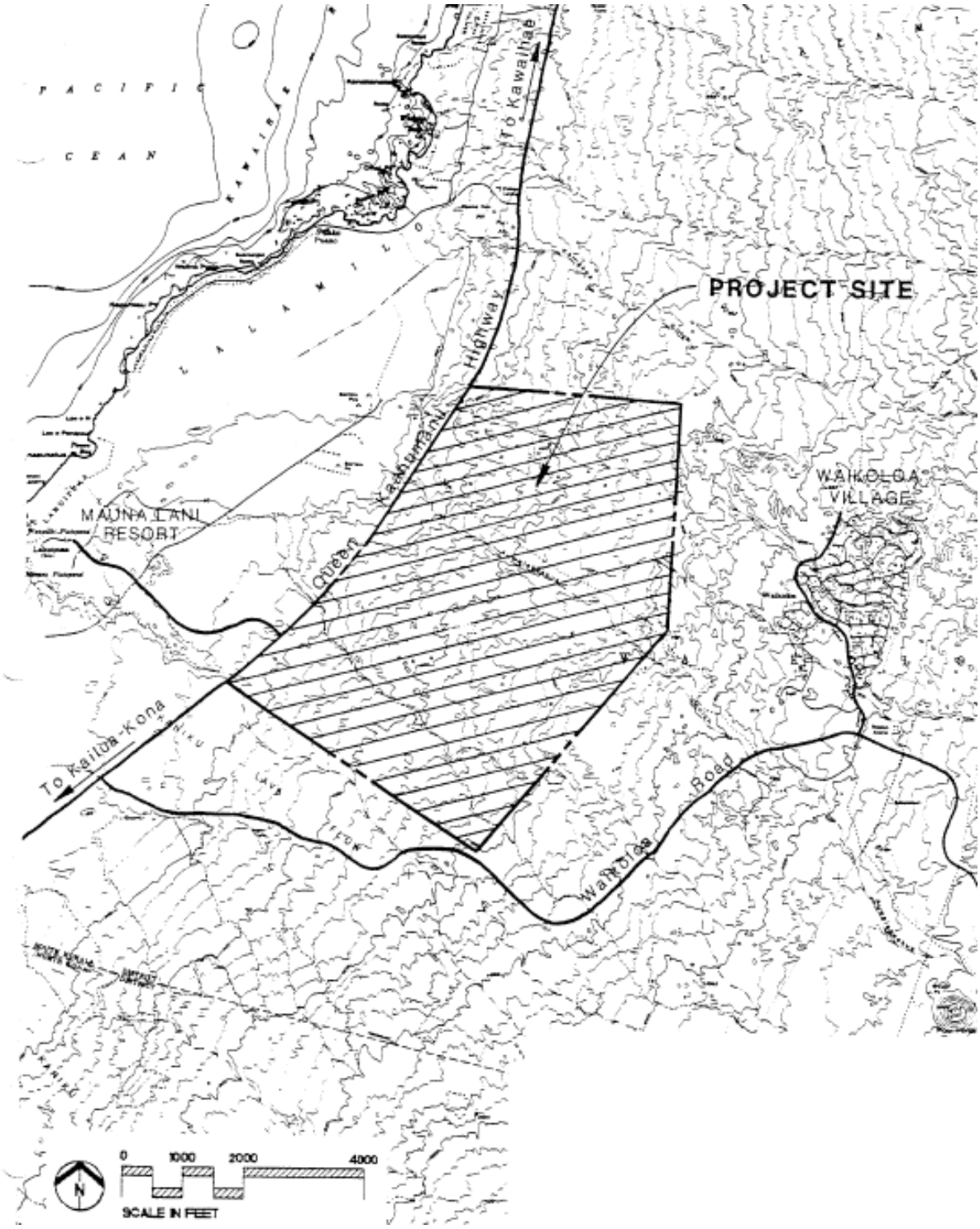


Figure 3 – Project Site

The development will include a lodge, homes, condominiums, world class golf and spa facilities, a shopping center, a Village Center, commercial offices and medical facilities, and more. The Conceptual Master Plan for the development is shown in Figure 4.

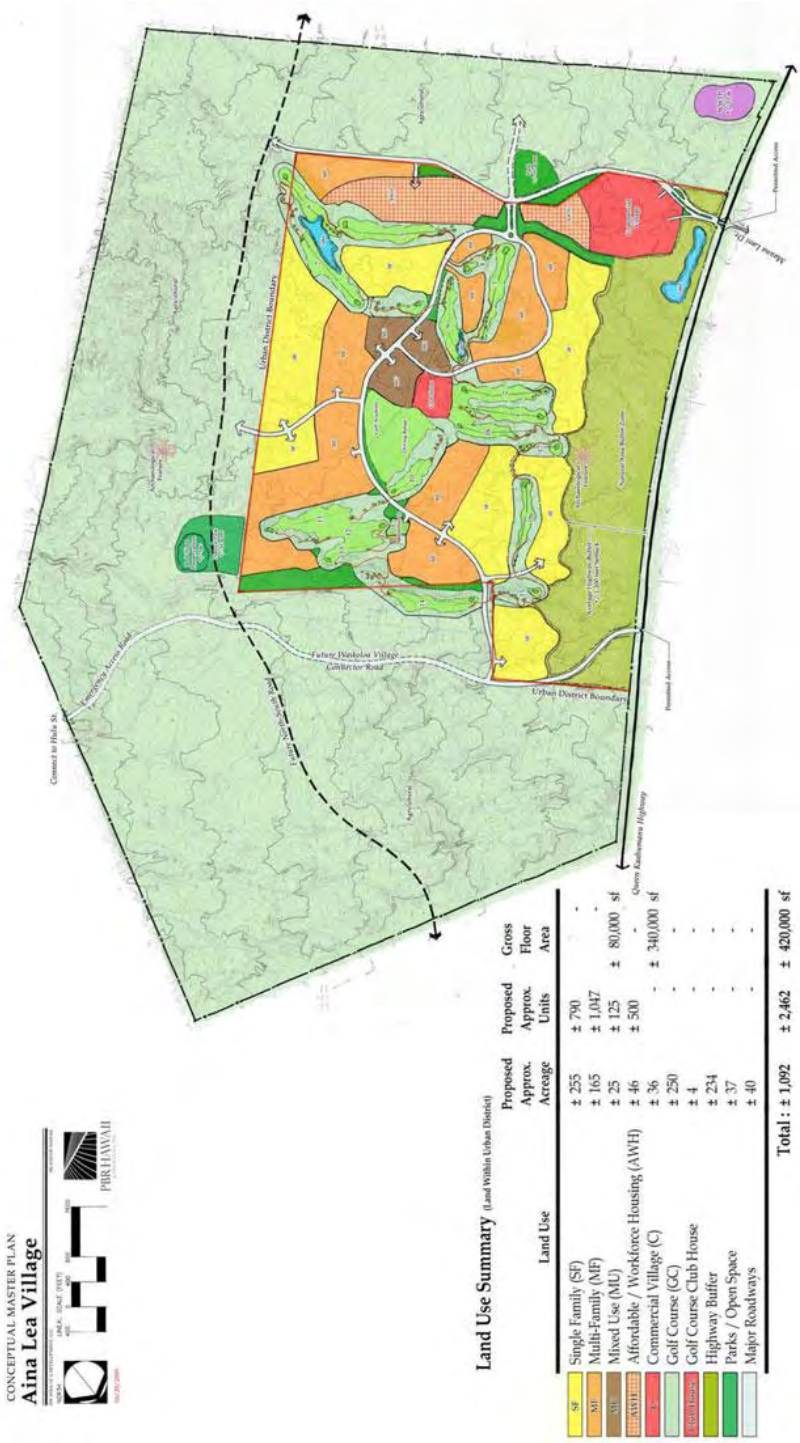


Figure 4 –Conceptual Master Plan

The first phase of the development, which is the subject of this Basis of Design Report, includes the construction of up to 450 condominums in the south east portion of the development. The preliminary Phase 1 development plan is shown in Figure 5.

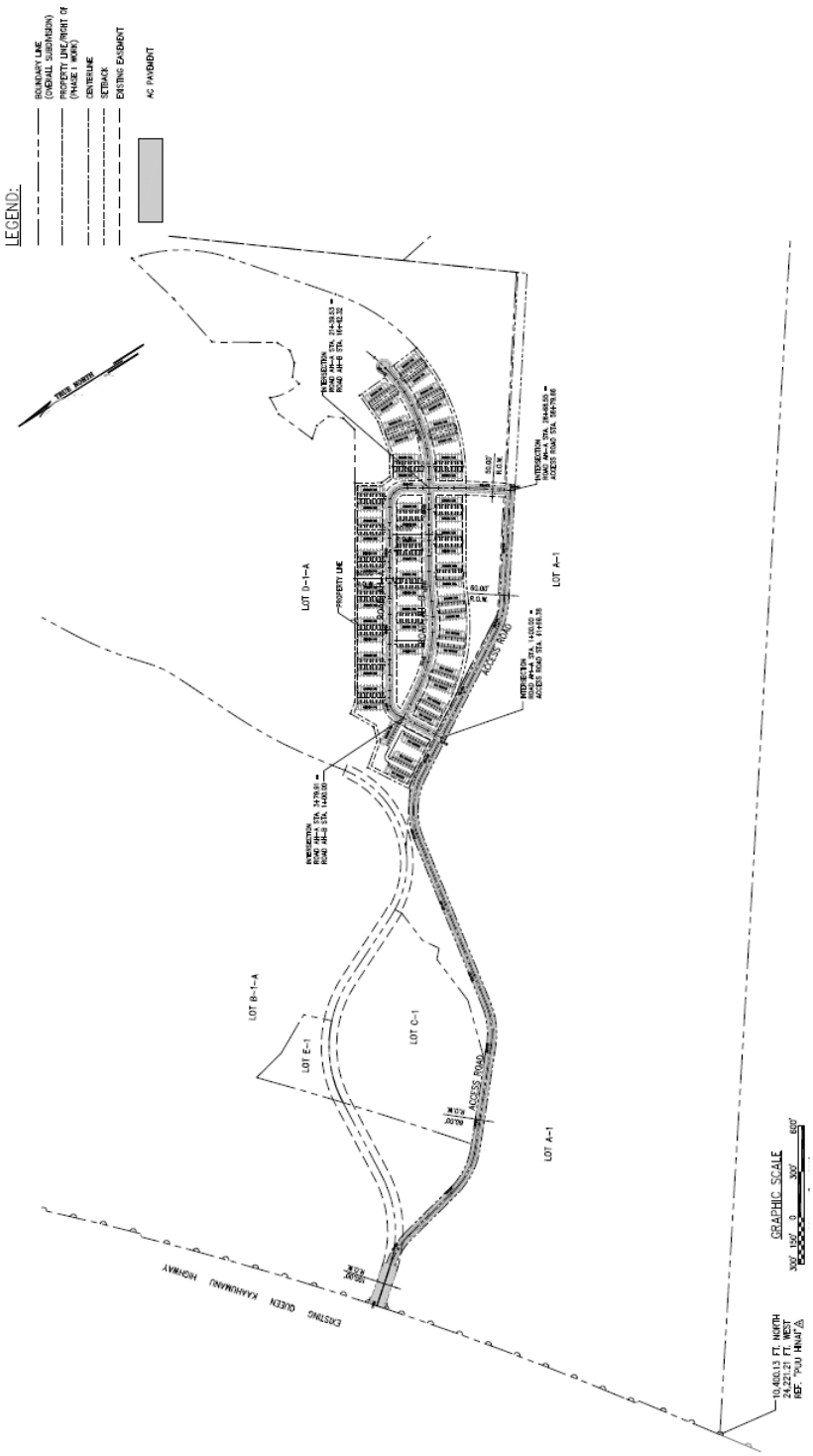


Figure 5 – Phase 1 Development Plan

Precipitation and Evaporation at the Site

The project is located in the rain-shadow of Mauna Loa, as shown in Figures 6 and 7, which results in total average annual rainfall of 10 to 12 inches in the project area.

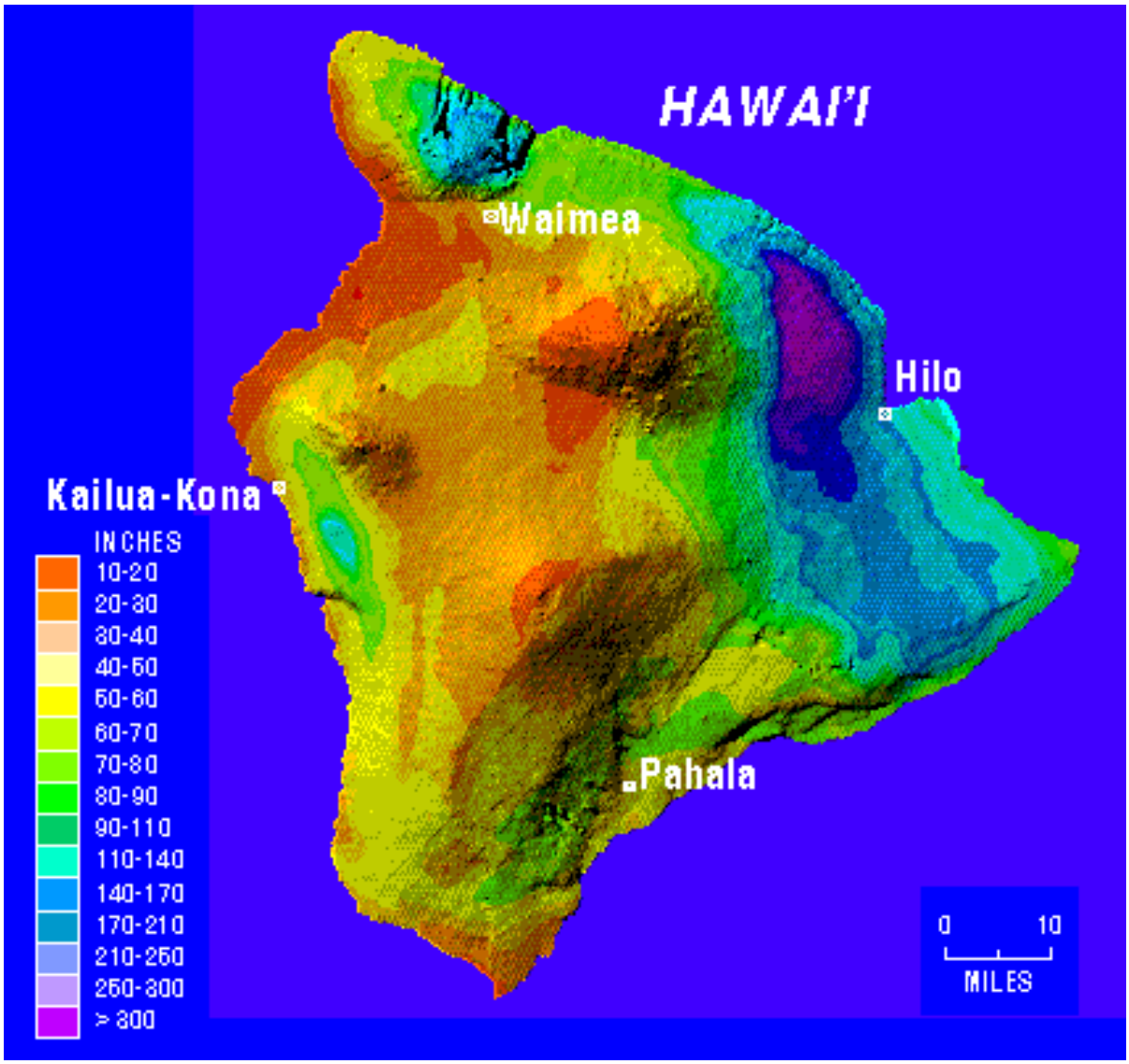


Figure 6 – Precipitation Profiles on the Big Island of Hawaii

Figure 7 – Annual Precipitation Isopleths for the Waikoloa Area

Daily precipitation data was obtained from the National Oceanic and Atmospheric Administration (NOAA). The weather station selected for this analysis was **Waikoloa 95.8** due to its proximity to the site. A 34-year historical record was available for this site (July 1975 -May 2009). Figure 8 shows the

location of the station with respect to the Aina Le'a Development; the weather station is approximately 2 miles away from the irrigation areas.

Figure 8 – Waikoloa 95.8 Weather Station Location

Table 1 shows the monthly and annual rainfall recorded at this station for the last 34 years. The annual rainfall at the Waikoloa 95.8 site has averaged 12.5 inches and varied from 4.3 inches to 28.5 inches. Average monthly rainfall distribution is shown in Figure 9; the rainfall pattern is typified by relatively dry summers and wet winters.

Table 1 -- Historical Monthly and Annual Rainfall Data for Waikoloa 95.8

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1975	--	--	--	--	--	--	0.01	0.61	0.61	0.15	0.25	1.43	
1976	3.06	1.94	2.42	0.50	0.02	0.52	0.05	0.00	0.06	0.10	0.22	0.02	8.91
1977	0.87	0.06	0.23	1.19	0.95	0.38	0.04	0.59	0.00	0.88	0.02	0.79	6.00
1978	0.68	0.05	0.35	0.47	1.23	0.67	0.29	0.97	0.23	1.48	1.47	1.35	9.24
1979	1.02	3.82	0.07	3.38	2.15	1.18	0.18	--	1.16	2.00	1.05	2.16	18.17
1980	6.44	0.87	2.04	0.39	2.70	1.23	0.22	0.65	1.10	0.03	0.09	1.10	16.86
1981	0.46	0.56	0.22	1.56	0.14	0.00	0.19	0.20	0.02	0.72	0.22	1.98	6.27
1982	3.31	6.95	2.38	1.98	0.94	1.24	0.44	0.45	1.41	1.56	0.56	2.45	23.67
1983	0.16	0.03	0.02	0.42	0.24	0.01	0.09	0.53	3.16	0.72	0.05	5.27	10.70
1984	1.28	0.25	0.79	1.01	0.84	0.26	1.69	0.10	0.13	0.77	0.22	1.99	9.33
1985	2.70	1.08	0.15	0.13	0.13	0.17	0.24	0.09	0.13	0.28	2.89	1.03	9.02
1986	0.16	4.19	0.68	0.99	1.35	0.40	0.31	0.43	1.99	1.53	2.24	2.96	17.23
1987	0.16	0.37	1.83	1.94	0.11	0.17	0.15	0.06	1.10	0.46	1.29	3.83	11.47
1988	2.10	2.08	1.53	0.71	1.21	0.07	0.25	2.20	1.47	0.69	1.36	4.09	17.76
1989	0.90	4.02	2.66	3.22	0.48	0.57	0.72	0.60	0.25	2.76	0.46	1.80	18.44
1990	4.01	2.85	2.23	0.79	0.10	0.03	1.88	0.00	0.07	0.36	4.02	2.31	18.65
1991	3.94	0.19	2.19	0.28	1.04	0.73	0.46	0.00	0.43	1.56	0.19	0.02	11.03
1992	0.53	0.08	0.08	0.84	0.14	0.12	0.68	0.32	3.12	0.23	1.00	4.37	11.51
1993	4.93	0.05	0.16	0.00	0.06	0.40	0.64	0.00	0.58	2.22	0.30	0.00	9.34
1994	0.72	2.78	1.55	0.00	0.71	0.12	0.31	0.37	0.17	0.53	0.12	0.00	7.38
1995	0.18	0.55	0.24	0.63	0.01	0.53	0.07	0.02	0.66	0.01	1.36	0.14	4.40
1996	4.69	0.66	0.74	1.16	1.07	2.98	0.10	0.06	6.55	1.30	0.95	8.25	28.51
1997	5.00	0.48	3.11	0.83	1.66	0.67	0.50	0.02	0.13	0.17	1.44	0.15	14.16
1998	0.94	0.07	0.06	0.50	0.22	0.32	0.00	0.31	2.01	0.20	1.49	0.08	6.20
1999	0.58	0.00	0.28	0.11	0.34	0.00	0.02	0.00	0.06	1.82	0.15	0.91	4.27
2000	0.02	0.02	1.42	0.39	0.26	0.32	0.00	0.12	0.79	0.31	2.10	0.00	5.75
2001	0.08	1.28	0.76	0.23	0.53	0.51	0.42	0.15	0.27	0.12	2.74	0.18	7.27
2002	4.45	0.91	0.15	2.47	2.22	0.54	0.00	1.03	0.14	1.70	0.01	0.00	13.62
2003	1.07	1.17	0.79	0.96	0.04	0.64	0.01	0.09	0.42	0.14	0.09	3.05	8.47
2004	4.45	5.41	2.85	1.26	3.72	0.70	0.59	1.36	0.00	3.02	1.03	0.50	24.89
2005	5.89	1.09	4.16	0.15	0.89	0.88	0.70	1.86	0.16	0.02	0.60	0.03	16.43
2006	2.39	0.61	5.74	0.31	1.27	0.27	0.04	0.33	0.21	5.33	0.27	0.12	16.89
2007	0.13	1.09	0.54	0.25	0.10	0.73	0.59	0.53	2.82	0.06	1.84	4.74	13.42
2008	0.05	0.19	0.00	1.60	0.78	0.13	0.74	0.07	0.18	0.02	0.14	3.83	7.73
2009	1.94	0.27	0.85	0.34	0.35	--	--	--	--	--	--	--	
Average	2.04	1.35	1.27	0.91	0.82	0.53	0.37	0.43	0.93	0.98	0.95	1.79	12.51
Maximum	6.44	6.95	5.74	3.38	3.72	2.98	1.88	2.20	6.55	5.33	4.02	8.25	28.51
Minimum	0.02	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	4.27

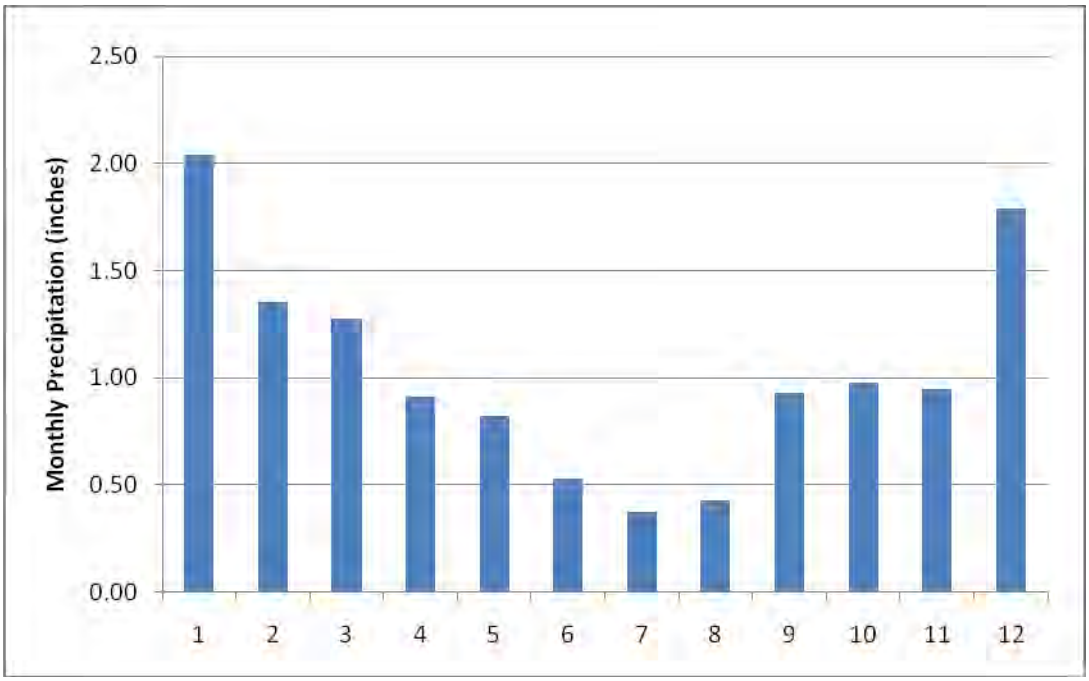


Figure 9 – Average Monthly Rainfall

The annual pan evaporation rate at the site totals 108 inches. Monthly distribution of the pan evaporation rate is shown in Figure 10.

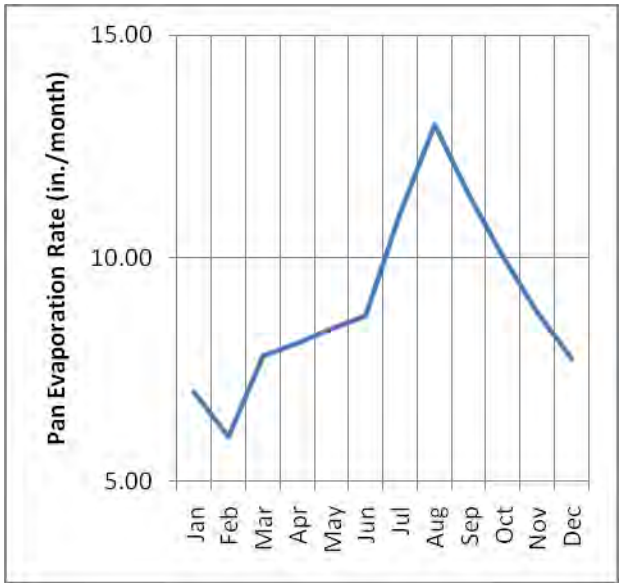


Figure 10 – Pan Evaporation Rate

Wastewater Flow Projections

The current development plans call for a project build-out that includes 450 condominiums (town homes), 1945 single-family homes and 400,000 square feet of commercial facilities. Using standard wastewater flow generation rates from the City & County of Honolulu (85 gpcd), the average wastewater production at build-out is projected to average just under 850,000 gpd, as detailed in Table 2. Note that these projections use a higher occupancy density for Town Homes than is required under the City & County of Honolulu guidelines to better reflect the occupancy anticipated for these units.

Table 2 – Wastewater Flow Projections

Category	Number of Units	Occupancy Density (persons/unit)	Unit Production	AAD Wastewater Production (gpd)
Town Homes	450	4.0	340 gpd/unit	153,000
Single-Family Homes	1945	4.0	340 gpd/unit	661,300
Commercial	400,000 sq. ft.	--	80 gpd/1000 sf	32,000
Total				846,300

The current development plans project that initial occupancy will occur in Fall, 2010 and the development will be constructed and homes sold over a 6-year period. The rate of increase for wastewater generation over the development period, based on the current absorption plan, is shown in Figure 11.

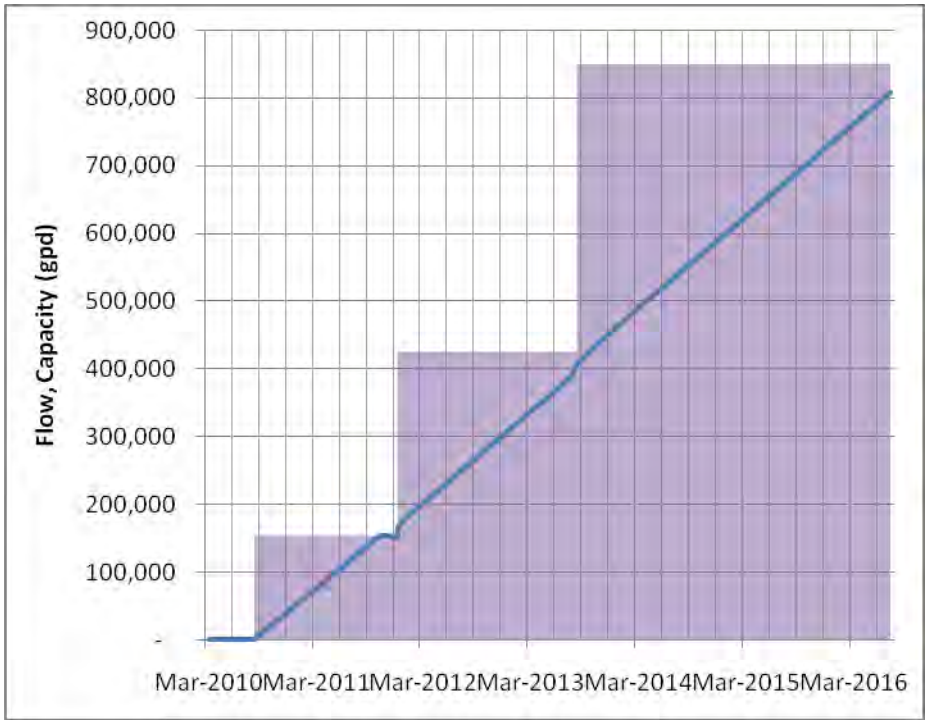


Figure 11 – Wastewater Generation and WWTP Capacity Phasing Over Project Development Life

Wastewater Treatment Capacity will be developed in four phases, as described in Table 3.

Table 3 – Wastewater Treatment Development Phases

Phase	Capacity (gpd)	Date On-Line	Description
1	153,000	Oct, 2010	Temporary WWTP Facility
2	425,000	Dec, 2011 (est)	Initial Phase of Permanent WWTP Facility
3	850,000	Aug, 2013 (est)	Final Phase of Permanent WWTP Facility

These development phases will have the capacity of the following development units:

Table 4 – Equivalent Dwelling Unit Capacity by Wastewater Treatment Phases

Number of Units by Category	**Phase 1**	**Phase 2**	**Phase 3**
Town Homes	450	450	450
Single Family Homes	0	750	1945
Commercial (sf)	-	200,000	400,000
Wastewater by Category (gpd)			
Town Homes	153,000	153,000	153,000
Single Family Homes	-	255,000	661,300
Commercial	-	16,000	32,000
Total	153,000	424,000	846,300

The first phase will be constructed at a temporary site in what will become the commercial area of the development. This will allow unhindered access for construction of the permanent wastewater treatment site for Phases 2 and 3.

Flow peaking factors by phase were estimated using the Babbitt formula, which bases peak wet-weather flow on the population served. Peak daily flows for each phase were estimated based on an assumed daily peaking factor of 2.0, as observed at similar-sized facilities.

Table 5 – WWTP Flow Peaking Factors by Phase

	Phase 1	**Phase 2**	**Phase 3**
Average Daily Flow (gpd)	153,000	425,000	850,000
Equivalent Population (persons)	1,800	5,000	10,000
Peaking Factor (Babbitt)	4.45	3.62	3.15
Peak Hour Flow (gpd)	680,000	1,540,000	2,682,000
Peak Day Flow (gpd)	306,000	850,000	1,700,000

Evaluation of equalization requirements was done assuming an average day followed by a peak day followed by an average day, with each day achieving the peak hour flow. Hourly flow rates used for evaluating Phases 1 and 2 are provided in Table 6.

Table 6 – Design Hourly Flows (mgd)

	Phase 1 Diurnal Flow				**Phase 2 Diurnal Flow**		
	Time	Peak Hr Over Average Day	Peak Hr Over Peak Day		**Time**	Peak Hr Over Average Day	Peak Hr Over Peak Day
	12:00 AM	0.079	0.157		12:00 AM	0.218	0.437
	1:00 AM	0.026	0.130		1:00 AM	0.080	0.378
	2:00 AM	0.010	0.054		2:00 AM	0.032	0.234
	3:00 AM	0.010	0.054		3:00 AM	0.032	0.181
	4:00 AM	0.010	0.054		4:00 AM	0.032	0.170
	5:00 AM	0.010	0.054		5:00 AM	0.032	0.191
	6:00 AM	0.026	0.115		6:00 AM	0.085	0.319
	7:00 AM	0.090	0.210		7:00 AM	0.291	0.582
	8:00 AM	0.329	0.497		8:00 AM	0.914	1.328
	9:00 AM	0.680	0.680		9:00 AM	1.540	1.540
	10:00 AM	0.122	0.344		10:00 AM	0.432	1.169
	11:00 AM	0.055	0.295		11:00 AM	0.234	0.900
	12:00 PM	0.052	0.252		12:00 PM	0.181	0.808
	1:00 PM	0.052	0.252		1:00 PM	0.159	0.765
	2:00 PM	0.052	0.252		2:00 PM	0.159	0.754
	3:00 PM	0.052	0.252		3:00 PM	0.159	0.776
	4:00 PM	0.052	0.252		4:00 PM	0.181	0.797
	5:00 PM	0.079	0.298		5:00 PM	0.218	0.850
	6:00 PM	0.105	0.352		6:00 PM	0.291	0.988
	7:00 PM	0.153	0.436		7:00 PM	0.425	1.211
	8:00 PM	0.329	0.536		8:00 PM	0.914	1.488
	9:00 PM	0.520	0.645		9:00 PM	1.445	1.540
	10:00 PM	0.520	0.643		10:00 PM	1.445	1.540
	11:00 PM	0.252	0.520		11:00 PM	0.701	1.445
Average		0.153	0.306	Average		0.42500	0.850
Peak		0.680	0.680	Peak		1.540	1.540
Ratio		4.45	2.22	Ratio		3.62	1.81

Raw Wastewater Characteristics

The average raw wastewater characteristics used for design of the facility are provided in Table 7. The design assumes that the raw wastewater concentrations remain relatively constant over the range of plant flows, and thus the constituent loading patterns follow the diurnal flow patterns.

Table 7 – Average Raw Wastewater Concentrations

Parameter	Average Concentration
BOD_5 (mg/L)	350 mg/L
TSS (mg/L)	285 mg/L
VSS (mg/L)	215 mg/L
TKN (mg/L as N)	40 mg/L
NH_3 (mg/L as N)	25 mg/L
$NO_3 + NO_2$ (mg/L as N)	0 mg/L
Alkalanity (mg/L as $CaCO_3$)	210 mg/L

Raw wastewater temperatures will vary over the range of 25 to 30 deg C.

Coupled with the estimated per-capita wastewater production rates, these wastewater characteristics provide treatment capacity for 0.25 lbs BOD_5/capita/day and 0.20 lbs TSS/capita/day.

Effluent Requirements

Effluent from the facilities will meet the Hawaii R-1 treatment requirements, as detailed in the HDOH Guidelines[1]. In addition, the biological treatment system will produce effluent with a 30-day average total nitrogen concentration of less than 10 mg/L as N. A summary of the treatment requirements is provided below:

Parameter	Single-Sample	30-Day	7-Day Median
Fecal Coliform	< 200 MPN/100 mL	Max 1 sample > 23 MPN/100 mL	< 2.2 MPN/100 mL
Turbidity	< 0.5 NTU	<0.2 NTU (95% of Time)	--
BOD_5	< 60 mg/L	< 30 mg/L	--
TSS	--	< 30 mg/L	--

Non-Potable Water Demands and Supply

Non-Potable Water Demands

Construction Dust Control

Significant grading and other civil construction will occur over the first several years of construction. It is anticipated that at least 175,000 gallons per day of non-potable water will be used for construction dust control through the October of 2011. The grading contractor has currently developed a 700,000 gallon lined storage pond that is supplied with groundwater and used to fill the dust-control watering trucks. That storage pond will remain in use at least through the end of 2010.

[1] Guidelines for the Treatment and Use of Recycled Water, Hawaii State Department of Health, Wastewater Branch, May 15, 2002.

Landscape Irrigation

The development plan currently includes 27 acres of irrigated landscaped areas. A list of the currently planned irrigation areas is provided below. The first three areas will be developed by October, 2010.

Irrigation Zone	Area (SF)	Average Irrigation Use (gpd)
Entry	9,108	1,226
Access Drive	131,641	17,724
Affordable Housing	630,000	86,311
Commercial	392,040	53,488
Total	1,163,000	158,749

After Phase 1, irrigation will also be provided in the Single Family Home area of the development. This irrigation demand will be a part of the Phase 2 WWTP facility.

Plans for these areas are not fully developed at this time. Upon development of the plans, an engineering report for irrigation of those areas with recycled water will be prepared and submitted to the HDOH.

Golf Course Irrigation

The development plan currently includes 250 acres of golf course. Irrigation at the golf course will begin by January, 2011. Again, the golf course plan is not fully developed at this time. Upon development of the plan, an engineering report for irrigation of those areas with recycled water will be prepared and submitted to the HDOH.

Non-Potable Water Supply

The non-potable water demands will be supplied through a combination of recycled water (R-1 standards) and groundwater. The developer had previously constructed a water supply well and 700,000 gallon lined storage pond to supply non-potable water to meet construction needs. The existing 700,000 gallon lined storage pond will continue to serve as a holding pond to buffer supply against demand in the initial phase of the development. Expanded storage capacity, as required, will be added to supplement this existing pond, as described below.

This Basis of Design Report is limited to the Phase 1 WWTP and recycled water demands. Since the Phase 1 recycled water demands will be limited to construction water, no details on the development of a recycled water distribution system, metering program and use areas, etc. are included in this report. Those items will be the subject of a subsequent report and developed as the Phase 2 project is developed.

Water Balance

It is proposed to use recycled water to supply a portion of the potential non-potable water uses through all of the phases of the Aina Le'a development. Water demands in excess of recycled water supply will be provided by groundwater, however the non-potable water system will be developed in conformance with the State of Hawaii design parameters for the distribution of recycled water. Recycled water used to provide a portion of the non-potable water supply will meet the State's R-1 recycled water requirements. While this analysis is not necessarily relevant to meeting construction dust control (for Phase 1), we have taken the conservative approach of assuming that for days when the evaportranspiration requirements are exceeded, dust control water would also not be needed. Furthermore, we have provided this water balance to provide the long-term view of the future phases of the development.

According to Chapter IV, Section K.2 of the HDOH guidelines, a minimum of 20-days storage volume is to be provided for recycled water systems unless a water balance is performed to demonstrate that less or no storage is required. The water balance is to be performed using at least 30 years of historical precipitation and evaporation data. This was done using the historical evaporation and precipitation data for Waikoloa described above. Water balances were calculated for each of four development phases using the wastewater flows and irrigation areas also described above. The calculation of daily evapotranspiration (ET) was based on the use of Bermuda grass as the dominant plant in the landscaped and golf course areas; pan evaporation rates were used to estimate the ET rates of Bermuda grass (i.e., $K_c = 1.0$), as suggested by the HDOH guidelines.

The minimum storage requirements resulting from these water balance calculations are presented in Table 8.

Table 8 – Water Balance Results

Phase	Average Day WW Flow (gpd)	Date On-Line	Irrigation Acres	Storage Reqd	
				(gallons)	(acre-ft)
1	153,000	Oct, 2010	37	720,000	2.2
2	425,000	Dec, 2011	287	1,780,000	5.5
3	850,000	Aug, 2013	287	3,905,000	12.0

The water balance was analyzed for each of the three phases on a daily basis over the entire 34 year data record. However, in each case, a single week during February, 1982 controlled the recycled water storage requirement. The precipitation for that week and the storage volume required for Phase 3 are shown in Figure 12. That week saw five consecutive days of rainfall, four of which exceeded the turf water demand and therefore required complete storage of the recycled water.

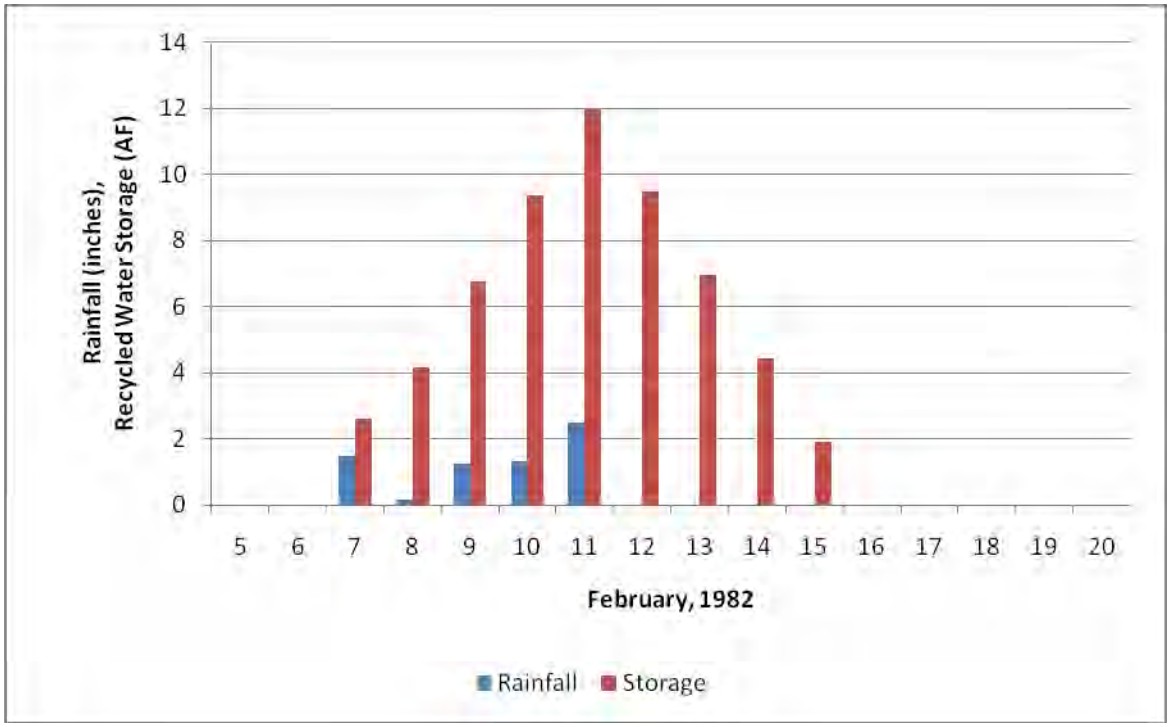


Figure 12 – Worst-Case Week for Phase 3 Recycled Water Condition

The month of February, 1982 had the 2nd highest monthly rainfall on record for the Waikoloa 95.8 site. The worst month, December, 1996, displayed spread-out, high-intensity storms, which would not have required storage for as long a period as the February 1982 event. The daily rainfall for these two months are presented in Figure 13.

For most years, the required recycled water storage volume will be significantly less than that listed in Table 3. For example, the recurrence interval for the storage required under the Phase 3 conditions is presented in Figure 14. As discussed above, the single worst year (over the 34-year period of record) required 12.0 acre-feet of storage. Every year on record requires at least one full day of storage (2.6 acre-feet) and at most once every 18 years, two full days of wastewater (5.2 acre-feet) must be stored. The 30-year recurrence interval, based on a 34-year data set, requires 6.6 acre-feet of storage. Since the data set extends only marginally beyond the required 30-year interval, the worst-case year over the 34-year period will be used to size the required storage.

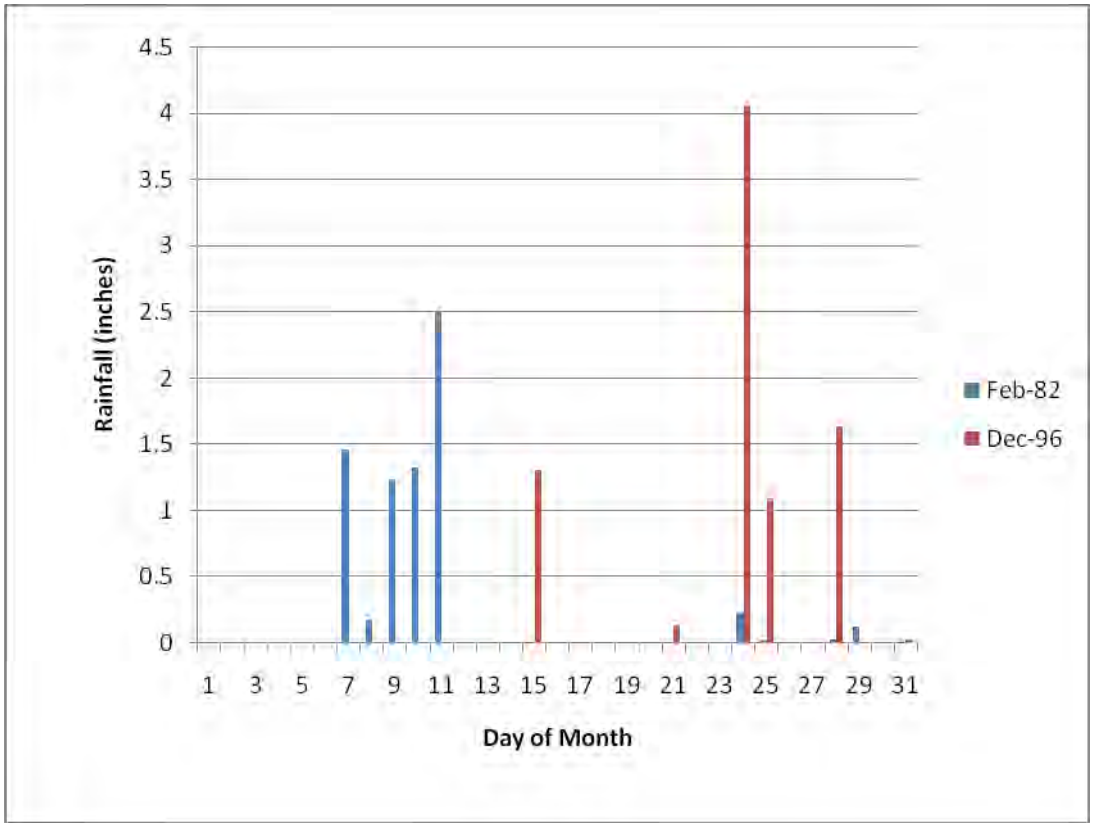


Figure 13 – Peak Month Rainfall Events

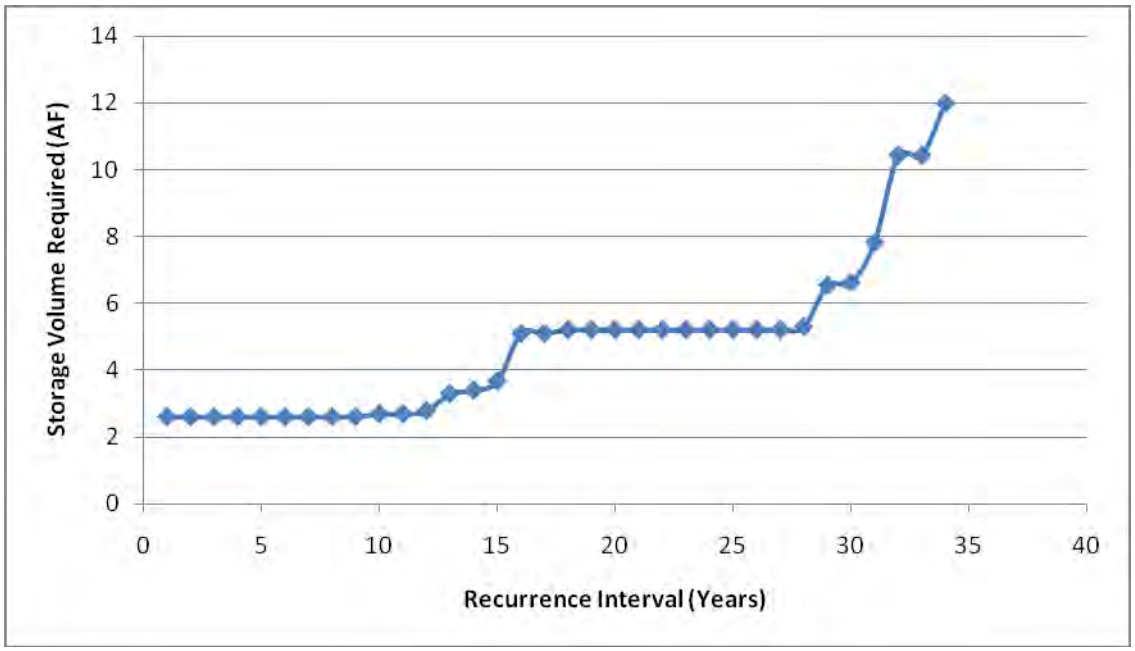


Figure 14 – Recurrence Interval for Storage Required for Phase 3 Conditions

The existing 700,000 gallon storage basin will provide sufficient storage volume for Phase 1 of the project development. In Phase 2, a new storage facility will be developed to provide a total storage volume of 12 acre-feet (3.9 million gallons). This storage volume will be sufficient through the life of the project.

Project Schedule

Phase 1 Facility Schedule

The Phase 1 treatment facility will be a temporary facility constructed at the site of the future commercial area. This facility will be delivered, constructed, and started according to the following schedule:

Activity	Date
Order Placed	2/9/10
Equipment Submittals Complete	4/13/10
Equipment Delivered to Site	8/17/10
Facility Startup	10/5/10

It is anticipated that the Phase 1 facility will operate for a period between 1 year and 5 years, depending on the absorption rate of the development.

Phase 2 Facility Schedule

The Phase 2 treatment facility will be the first of two phases of a permanent facility located on a dedicated site, separate from the Phase 1 facility. The exact schedule for the Phase 2 facility is unknown at this time, however the current assumptions regarding Phase 2 delivery schedule is as follows:

Activity	Date
Order Placed	Q4 2010/Q1 2011
Equipment Submittals Complete	Q1/Q2 2011
Equipment Delivered to Site	Q2/Q3 2011
Facility Startup	Q4 2011/Q1 2012

Once the Phase 2 facility is fully operational, the Phase 1 facility will be decommissioned. Most of the equipment installed in the Phase 1 facility will be relocated to the Phase 2 facility for use as standby/redundant equipment.

Phase 1 Treatment Facility Details

The Phase 1 treatment facility will be a temporary facility constructed at the site of the future commercial area. All phases of the treatment facility will be constructed as extended aeration activated

sludge systems, with membrane bioreactors used for liquid/solids separation. Membrane modules used in Phase 1 will be selected to allow them to be reused in the ultimate facility.

Schematic diagrams for Phase 1 are shown in the attached preliminary drawings, as PI-211 through PI-214. The location of the Phase 1 facility is shown in drawings C-001 through C-005.

Mass Balance

A biological simulation model (Biowin) was run for both average annual steady-state and peak day dynamic conditions. The Peak Day dynamic conditions were used to size the aeration system. The results of the simulation are presented below:

	Flow (mgd)	COD (ppd)	TSS (mg/L)	TSS (ppd)	Total N (ppd)	Total N (mg/L)
Influent	0.15	855	250	319	51.1	40.0
Anoxic Effluent	0.75	50,639	8,184	51,093	2,806	449
Aerobic Effluent	0.74	50,049	8,175	50,750	2,782	448
Membrane Filtrate	0.15	46.06	0	0	7.5	6.0
WAS	0.0042	286	8,184	288	16	449

Raw Wastewater Delivery to the Facility

A gravity sewer for the Phase 1 development has been designed by others and will be terminated near the west end of the condominium development. Under the wastewater treatment facility project, the 8-inch sewer will be extended down the access road and terminated uphill of the treatment facility, as shown on drawing C-002. The terminal manhole will include a plugged stub-out for future continuation of the gravity sewer line to the Phase 2 WWTP.

A 6-inch gravity force main will be routed from the terminal sewer to the treatment facility. While flow will be by gravity, the piping will be constructed as a pressure pipe to provide the head required to transport the sewage into an at-grade screening box described below.

Influent Screening

An in-tank screening unit that contains two screens with 1 mm openings will be installed on a slab on grade at the head of the Phase 1 treatment facility. The screening unit will be constructed of stainless steel. Each screen in the Phase 1 screening unit will be sized for the Phase 1 peak hour flow rate to provide complete redundancy.

The screening tank will contain internal separation walls to allow isolation of individual screening units. The screening tank assembly shall be constructed of Type 304 stainless steel. To minimize odors and nuisance insect populations, the screen transport system and compaction/dewatering system shall be

completely enclosed. Provide a 4-inch diameter flanged vent pipe, fabricated of stainless steel, to allow withdrawal of foul air from the tank.

The screen unit will include a washer/compactor conveyor and shall produce dewatered screenings capable of passing the EPA paint filter test as described in Method 9095 of EPA Publication SW-486. All electrical components of the screen facility, including motors, conduit fittings and level elements, will be explosion proof, for operation in a Class I, Division 2 classified area.

The screen unit will be provided with a NEMA 4X control panel for stanchion mounting in close proximity to the screen unit (but outside of the classified area). The panel shall be provided with the following components to provide proper monitoring and operation of the equipment:

1. Step down transformer and fused disconnect
2. Drive motor starter for each driven motor
3. Emergency stop pushbutton
4. HOA selector switches for the drive(s) and spray wash
5. Directional switches for screen, washer/compactor or conveyor, as appropriate
6. ETM for each motor
7. High level alarm
8. Level indicator
9. Programmable control relay to provide necessary control logic and monitor equipment-mounted electrical devices.
10. Run and alarm auxiliary contacts for use by the plant control system

Potable water behind a backflow preventer (W2) will be used to supply the screenings washer.

The Phase 1 screens will be relocated to the permanent facility in a new screening box during decommissioning.

Number of Screens	2
Peak Flow Capacity per Screen	700 gpm
Screen Opening	1 mm
Screen Drive, each	0.25 hp
Screenings Washer/Converyor Drive	0.25 hp

Wastewater Equalization

Flow variations between the influent flow and the membrane permeate flow will be equalized by allowing the level in the anoxic basins to vary (discussed in next section) along with bypassing raw wastewater to a separate equalization tank. A flow routing analysis was carried out to determine the required amount of equalization volume. Diurnal profiles were constructed for peak hour flows over both average and peak days from flow profiles observed at other Hawaii WWTPs and adjusted to give peak day and hour flows presented in Table 6.

MBR permeate flows were determined using peak day and peak hour flows as presented below:

Table 9 – Phase 1 WWTP Membrane Permeate Flows

	Phase 1	
	Flow (mgd)	Flux (gfd)
Average Day	0.153	12.3
Peak Day	0.306	24.5
Peak Hour	0.306	24.5

The flow routing was done by modeling hourly flow over three consecutive days, assuming that a peak day was in the middle of two average days. Peak hour permeate flows were allowed for up to 4 hours on an "average" day. A graphical representation of the flow routing for Phase 1 flows is shown in Figure 15.

The flow routing evaluation showed that the required equalization volume is 67,200 gallons for Phase 1 flows. The equalization storage will be provided using a bolted-steel tank. The storage tank will be aerated using coarse bubble diffusers and aeration will be initiated based on level in the tank. Equalized flow will be pumped back to the treatment train using horizontal non-clog centrifugal pumps installed next to the tank.

Tank Volume	67,200 gallons (9,000 cf)
Tank Type	Bolted Steel
Tank Diameter	35'-0"
Tank Sidewall Height	12'-0"
Maximum Liquid Depth	9'-4"
Number of EQ Return Pumps	1 + 1 standby
EQ Return Pump Capacity, each	125 gpm
EQ Return Pump Drive	Variable Frequency Drive
Minimum Aeration Rate	30 scfm/1000 cf
Aeration Supply	270 scfm
# of Coarse Bubble Diffusers	29
Airflow per Diffuser	9.3 scfm

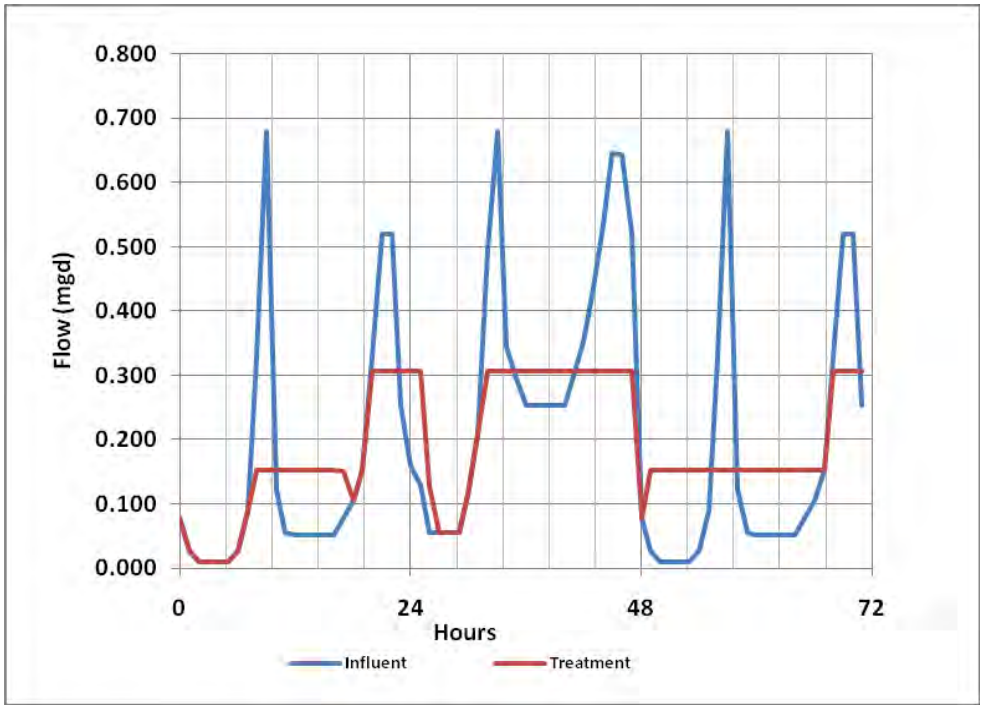


Figure 15 – Phase 1 Inflow vs. Permeate Flow

A single bi-directional flow meter will measure flow into and out of the EQ basin. When the influent flow exceeds the maximum allowable treatment rate, the EQ diversion valve will be opened and modulated to divert flow in excess of the maximum allowable treatment rate into the EQ tank. When there is wastewater in the EQ tank, and the influent flow is less than the maximum allowable treatment rate, the EQ return pump will turn on and its speed adjusted to pump equalized wastewater into the treatment process so that the combined rate is less than or equal to the maximum allowable treatment rate. Two EQ return pumps will be provided, each sized for the maximum EQ return rate (complete redundancy).

Activated Sludge Bioreactor

The bioreactors shall be designed with a Modified Ludzig-Ettinger (MLE) configuration (anoxic zone followed by aerobic zone). Each anoxic zone shall be mixed using a submersible mixer with an input energy of at least 40 hp/MG at maximum depth. The aeration basins (oxic zones) shall be provided with diffused aeration systems adequate to maintain a dissolved oxygen concentration of at least 1.0 mg/L under peak hour loading conditions. The bioreactors shall be sized to maintain at least a 12 day solids retention time under average loading conditions and a design MLSS concentraiton in the membrane tank of 12,000 mg/L.

A two-train, two-stage bioreactor will be constructed out of concrete in Phase 1. Each train will consist of anoxic and aerobic cells using tanks with a common wall as detailed on drawings S-002 through S-004 and M-002, M-003. The anoxic tank will be mixed with a submersible mixer. The aerobic zone will be aerated and mixed using fine-bubble diffusers.

	Phase 1
Number of Trains	2
Anoxic Zone Length per Train	10'-6"
Train Width	8'-6"
Maximum Depth, Anoxic Zone	7'-0"
Sidewall Height	13'-0"
Anoxic Volume per Train (Max)	4,700 gallons
Aerobic Zone Length per Train	22'-0"
Aerobic Zone Depth	11'-0"
Aerobic Volume per Train	15,400 gallons
Anoxic Volume, % of Total	23%
Number of Anoxic Mixers per Train	1
Anoxic Mixer Size	2.3 hp
Unit Mixing	128 hp/MG
Total Aeration Diffuser SOTR, Average Load	38 lb/hr
Total Aeration Diffuser SOTR, Peak	59 lb/hr
Peak Air Flow Required (2 Trains)	337 scfm
Diffuser Type	EDI Flex-Air Fine Bubble Diffusers

Feed-Forward Pumps

Two feed-forward pumps will be installed in each anoxic tank. The feed-forward pump will be a submersible centrifugal pump designed to pump 5 times the average permeate flow rate. Each pump will be provided with a variable frequency drive to pace the feed-forward flow with the permeate flow rate.

	Phase 1
Number of Pumps	2 Firm + 2 Standby
Capacity, gpm each	266 gpm
Total Firm Capacity	532 gpm
TDH, feet	15 feet
Pump hp, each	3.0

Membrane Tanks

Two trains of membrane tanks will be constructed adjacent to the bioreactors.

	Phase 1
Number of Tank Cells	2
Number of Membrane Units per Train	2
Membrane Unit (SMU)	RM-200
Membrane Cartridge Type	Type 515 Flat Sheet
Membrane Materials	Chlorinated flat sheet
Mean pore size	0.2 – 0.4 µm
Number of Cartridges per Unit	200
Filtration Area per Cartridge	15.6 ft^2
Total Surface Area per Unit	3,120 ft^2
Total Surface Area per Train	6,240 ft^2
Average Flow Rate	0.153 mgd
Peak Flow Rate	0.306 mgd
Flux at Average Flow Rate	12.3 gfd
Flux at Peak Flow Rate	24.5 gfd
Tank Dimensions	14'-0" x 8'-6"
Liquid Depth	10'-0"
Wall Height	13'-0"
Membrane Air Scour per Unit	60 scfm
Total Scour Air Reqd. per Train	120 scfm

Permeate from the membrane units will normally flow by gravity through the membrane and into the recycled water wetwell, installed with its top at-grade. With a membrane tank water level 10'-0" above the ground, there will be more than sufficient head available to flow by gravity up to a maximum TMP of 3.0 psi (7.0 feet). Permeate pumps will be provided to assist when necessary.

The membrane system will include a chemical dosing train for flux maintenance cleaning. Containment pallets for two chemical drums (citric acid and sodium hypochlorite) will be provided. A peristaltic metering pump will be used to add the chemical to non-potable dilution water, which will be supplied from the recycled water pump station.

Blowers

Six positive displacement blower packages driven by variable frequency drives will be installed as scheduled below. Two blower shall be provided, with each sized to handle the peak air flow requirements of the bioreactors (i.e., one redundant unit). Those blowers will be installed adjacent to the bioreactor, as shown on drawing M-002. For the other 4 blowers , one blower shall be sized to handle the mixing requirements of the EQ basin, two blowers shall be sized to handle the air scour requirements of the membranes and the remaining blower shall be provided to act as a standby blower for either of these two services, and shall be sized to match the greater of these air demands.

Blowers will be positive displacement units mounted in sound enclosures, size to be reused in Phases 2 and 3. Blowers will be powered from variable frequency drives to allow adjustment of the air flow.

	MBR & EQ Blowers	**Aeration Blowers**
Number of Blowers	4	2
Manufacturer/Model	Aerzen/GM-10S	Aerzen/GM-25S
Nominal Blower Capacity, each	293 scfm	720 scfm
Blower Discharge Pressure	7.5 psig	7.5 psig
Blower Hp, each	20	50

Recycled Water Wetwell & Transfer Pump Station

A recycled water wetwell will be constructed as a precast concrete wetwell downhill of the treatment structure and will have sufficient volume to provide 10 minutes of detention time at Phase 1 peak hour flows. This will provide sufficient chlorine contact time to measure the chlorine residual and adjust the feed rate to account for the actual chlorine demand. The wetwell will be outfitted with two constant-speed submersible centifugal pumps to transfer recycled water to the storage pond. The pumps will be sized to transfer the Phase 1 peak hour permeate flow.

Wetwell Diameter	8'-0"
Maximum Liquid Depth (Pump Stop)	7'-6" (EL 290.00)
Minimum Liquid Depth (Pump Start)	6'-0" (EL 288.50)
Total Wetwell Depth	8'-0"
Number of Pumps	1 + 1 standby
Pump Capacity, each	212.5 gpm (0.306 mgd)
EL of Discharge into Storage Pond	310.00
Maximum Static Head	21.5 feet
Pump TDH	29.0 feet
Pump HP, each	7.5
Detention Time at Minimum Liquid Depth	10.1 minutes

Disinfection & Chlorine Feed

A pipeline will be constructed from the Phase 1 WWTP to the existing non-potable water storage pond with the routing shown on Drawing C-002. That pipeline will be used for conveyance as well as to achieve the 90-minute modal contact time (450 mg/L-min CT) required to achieve R-1 effluent disinfection requirements. Since the pipeline will exhibit nearly perfect plug-flow characteristics, the modal and theoretical contact times will be practically equivalent. When combined with the 10 minute detention time in the wetwell, a minimum total modal contact time of over 90 minutes will always be achieved. A tracer study will be conducted during facility startup to demonstrate the modal contact time compliance.

Average Flow	0.153 mgd
Peak Hour Permeate Flow	0.306 mgd
Pipeline Length	730 LF
Pipe Material	HDPE – SDR 32.5
Nominal Pipe Diameter	28"
Pipe Inside Diameter	26.17"
Theoretical Detention Time at Average Flow in Pipeline	192 minutes
Theoretical Detention Time at Peak Flow in Pipeline	96 minutes
Total Theoretical Detention Time at Peak Flow	106 minutes

12% sodium hypochlorite will be used as the disinfectant. 55-gallon drums of the chemical will be placed on a containment pallet and dosed into the filtered water using a peristaltic pump mounted on the top of the lead drum. The pump rate will be automatically paced off of the permeate flow rate and the chlorine residual downstream of the recycled water pumps using a compound control loop.

Design Chlorine Dose	10 mg/L
Design Chlorine Residual	5 mg/L
Hypo Usage, Peak	21.8 gallons/day
Hypo Usage, Average	10.9 gallons/day
Storage Tank	55 gallon drums
Number of Drums on Containment Pallet	2
Number of Pumps	1
Pump Type	Peristaltic
Pump Mounting	On Top of Drum

Recycled Water Storage and Pumping

The existing 700,000 gallon lined storage pond will be used to store recycled water for reuse. During Phase 1, water will be extracted from the pond for use in dust control for the construction activities.

Emergency Disposal

The HDOH Guidelines for the Treatment and Use of Recycled Water, Section IV-L requires the provision of an emergency effluent disposal system (as one of several options) for the condition that the disinfection or turbidity requirements are not met. For this plant, a leach field will be constructed with the capacity to dispose of the Phase 1 peak-hour flow (0.306 mgd) in the event that the membrane permeate turbidity exceeds 0.2 NTU or the chlorine residual at the recycled water pump discharge falls below 5.0 mg/L. The plant control system will automatically open the leach field supply valve in the event of plant failure.

A geotechnical investigation has not yet been performed at the site, however it is anticipated that the percolation rate at the site will be approximately 1.0 minutes per inch.

Design Percolation Rate	1.0 minutes/inch
Peak Flow Rate (Phase 1)	306,000 gpd
Leach Area Required	341 ft^2
Leach Field Length	58'-0"
Leach Field Width	6'-0"
Number of Laterals	2
Lateral Spacing	3'-0"

WAS Dewatering

Waste activated sludge will be pumped from the process into one of two gravity dewatering tanks (Detainers). The dewatering tanks will be installed on a sloped concrete pad with a drain at its center to capture drainage water. A polymer dosing system will be installed. The drainage water will be piped to a sump pump station, and then pumped back to the screen box.

Number of WAS Pumps	1
WAS Pump Capacity	100 gpm
Maximum WAS Rate	3,900 gpd
WAS Pump Operating Time, Max	39 minutes/day
WAS Pump Motor Size	2 hp
Number of Dewatering Tanks	2
Nominal Length	23'-8"
Nominal Width	8'-3"
Maximum Height	8'-6"
Sludge Volume per Tank	40 cy
Target Dewatered Solids Concentration	11.5%
Days to fill One Tank	26
Filtrate Sump Pumps	1 + 1 Standby
Type	Packaged Drainage Station
Capacity	100 gpm

Plant Service Water

Potable water will be brought into the facility from the 16" main on the access road. A fire hydrant will be placed on the access road at the entrance to the plant, and will be within 500-feet of the Phase 1 facility. A 2-inch water line will be run from the main to the facility. An unprotected branch of that line will feed a single safety shower/eyewash in the chemical area. A branch protected with a backflow preventer will serve as the supply of plant service water for raw wastewater screen sprays.

A 2-inch recycled water line will be run from the discharge of the recycled water transfer pump back to the chemical area to provide dilution water for the chemical cleaning of the membranes.

Electrical and Control

Power to the equipment will be provided by a new service to the site provided by Hawaii Electric Company. A new pad-mounted transformer will be installed by Helco at the site. The connected load is provided in the table below and totals under 200 kVA. A portable standby generator will be rented and used on-site with an automatic transfer switch. Firm loads total approximately 125 kVA.

All variable frequency drives and motor control panels will be mounted on the exterior wall of the treatment basin or be provided with local stanchion mounting.

Tag	Desc	Load (hp)	Voltage	Phase	Firm?
	Screen Rake Drive	0.25	480 VAC	3	Yes
	Screen Rake Drive	0.25	480 VAC	3	No
	Screens Washer/Conveyor	0.25	480 VAC	3	Yes
PMP-111	EQ Return Pump 1	3	480 VAC	3	Yes
PMP-112	EQ Return Pump 2	3	480 VAC	3	No
MIX-211	Anoxic Mixer 1	2.3	480 VAC	3	Yes
MIX-221	Anoxic Mixer 2	2.3	480 VAC	3	Yes
PMP-211	Feed Forward Pump 1A	3	480 VAC	3	Yes
PMP-212	Feed Forward Pump 1B	3	480 VAC	3	No
PMP-221	Feed Forward Pump 2A	3	480 VAC	3	Yes
PMP-222	Feed Forward Pump 2B	3	480 VAC	3	No
PMP-311	Permeate Pump 1	5	480 VAC	3	No
PMP-312	Permeate Pump 2	5	480 VAC	3	No
PMP-321	WAS Pump	2	480 VAC	3	Yes
BLR-411	Air Scour Blower 1	20	480 VAC	3	Yes
BLR-412	Air Scour Blower 2	20	480 VAC	3	No
BLR-413	Air Scour Blower 3	20	480 VAC	3	Yes
BLR-414	Aeration Basin Blower 1	50	480 VAC	3	No
BLR-415	Aeration Basin Blower 2	50	480 VAC	3	Yes
BLR-416	Process Air Blower 6	20	480 VAC	3	Yes
MP-331	CIP Chemical Metering Pump		120 VAC	1	Yes
MP-511	NaOCl Metering Pump		120 VAC	1	Yes
MP-611	Polymer Metering Pump		120 VAC	1	Yes
PMP-521	Recycled Water Transfer Pump	7.5	480 VAC	3	Yes
PMP-522	Recycled Water Transfer Pump	7.5	480 VAC	3	No
Total		**230.35**			

A SCADA computer will be provided for installation in small portable office (trailer). The SCADA computer will have display pages showing run status and alarms, and allows for remote starting and stopping of all equipment.

Odor Control

Foul air from the influent screening box will be collected and treated in an adsorbent media foul air scrubber.

Each treatment basin will be covered and exhaust process air (aeration zone, membrane tank and EQ tank) will be collected in foul-air ducts and sent to a biofilter for treatment. The biofilter media will be compost. A fan will draw approximately 10% excess air to create a slight negative pressure in the head space above the tanks. The biofilter design parameters are given below:

Design Foul Air Rate	847 scfm
Foul Air Fan, Number	1
Foul Air Fan Capacity	1000 scfm
Foul Air Fan Static Pressure	12 in. w.c.
Biofilter Loading Rate	2.0 scfm/ft^2
Biofilter Area	750 ft^2
Biofilter Dimensions	25' x 30'
Biofilter Media Depth	3.0 ft.
Biofilter Media Volume	85 cy

Site Work

The WWTP will be surrounded by a 6-foot chain link fence. The area inside the fence will be finished with gravel surfacing. A portable office (trailer) will be provided on the site to provide a place for the operator to retain facility records and do sample preparation. The trailer will also house the SCADA computer.

Visual Impact Control

The Phase 1 facility will be constructed with the upstream process units set into the sloping hillside as shown on drawing C-003. Furthermore, the area around the plant will be regraded to provided a berm to screen the facility from view from the access road.

Contingency Planning

Reliability Provisions

This section provides details of the reliability requirements of the HDOH Recycled Water Guidelines and the provisions made in the design of this facility to meet those requirements.

Process	Equipment Item	Reliability Provision
Influent Screening	Fine Screens	• One redundant screen is provided
Equalization Basin	EQ Tank EQ Pumps EQ Blowers	• A redundant EQ return pump is provided. • A redundant blower (shared with WAS storage) is provided.
Biological Treatment	Process Tanks	• 2 parallel trains provided. Each train is rated to treat a peak flow of 0.115 mgd. One train can provide treatment for 75% of AAD flow to meet R-2 standards for emergency discharge • Piping allows for taking one bioreactor train out of service without impacting the operation of the membrane filtration system.
	Anoxic Zone Mixer	• No redundancy. However, mixing is not critical to process operation.
	Feed Forward Pumps	• A redundant Feed Forward pump is provided in each cell
	PA Blowers	• A redundant blower will be provided
Membrane Filtration	Air Scour Blower	• One redundant blower is provided
	Membranes	• Sample ports are provided on each submerged membrane unit (SMU) to take turbidity samples to determine membrane unit integrity. Each membrane tank has 2 SMUs. An SMU that fails can be removed from service, with filtration carried out with remaining SMUs • In case of a membrane tank failure, filtration can be carried out with one membrane tank at a maximum day flow rate and flux for 1 day. • In case of turbidity level failure, automatic discharge of effluent to a subsurface trench is provided
Recycled Water Transfer	Pumps	• A redundant pump will be provided
Recycled Water Storage	Storage Pond	• The 0.7 mgd recycled water storage pond provides 4.5 days of storage.
Back Up Power System	Generator	• A 125 kW generator with automatic transfer switch is provided.

Assessment of Compliance

A number of continuous monitoring devices will be provided at the WWTP process trains to assess whether the unit processes and the process trains as a whole are meeting their performance expectations. Two ranges for each of these critical monitoring devices will be established. An alarm range will be established to alert the operations staff to an unusual condition that requires investigation. If the process parameter continues further out of its normal range to a point where the unit may be damaged or discharge requirements might be violated, the relevant unit process will be shut down.

Process Parameter	Limit	Action on Exceedence
Power Supply	Loss of Power	Alarm on loss of power
High water level, Recycled Water Wetwell		Alarm
High water level, EQ Tank		Alarm
High water level, Anoxic Tank		Alarm
High water level, Screen Box		Alarm
Aeration Basin Dissolved Oxygen Concentration	< 0.5 mg/L	Alarm
Membrane Permeate Turbidity	> 0.2 NTU	Alarm
	> 0.5 NTU	Shut Down Unit and Alarm. Electric Actuated valve automatically opened for discharge to Leach Field
Recycled Water Chlorine Residual	< 5 mg/L	Alarm. Electric Actuated valve automatically opened for discharge to Leach Field

Continuous recording instruments will record the following information on the plant for compliance reporting:

Location	Parameter
Raw Wastewater	Influent Flow
Equalization	Flow sent to and brought back from equalization tank
Aeration Tanks	Dissolved Oxygen (one per train) Temperature (one per train)
Membrane Filtate	Turbidity (one per train)
Membrane Filtrate	Effluent Flow (with totalizer), one per train
Membrane Filtration	Trans-Membrane Pressure
Recycled Water Pump Discharge	Chlorine Residual
Waste Activated Sludge	WAS Flow (with totalizer)

Two composite samplers will be installed in the facility; one at the influent splitter box and one on the recycled water pump discharge. Composite samples will consist of 8 or more aliquots over a 24-hour sampling period. The raw wastewater sampler will be paced off of the influent flow meter. The effluent sampler will be paced off of the MF permeate flow meters.

The parameters that will be monitored and the frequency of monitoring per Hawaii Administration Rules Title 11, Section 62-26 are summarized in the table below:

Parameter	**Sampling Frequency**	**Standard**
Effluent BOD_5	Weekly Composite Weekly Grab	< 30 mg/L < 60 mg/L
Effluent TSS	Weekly Composite Weekly Grab	< 30 mg/L < 60 mg/L
Aeration Tank DO	Weekly	n/a
Total Daily Flow	Weekly	n/a
Chlorine Residual	Continuous	5 mg/L or greater
Fecal Coliform	Daily Grab	< 200/100 mL Single Sample Max >23/100 mL in, at most, 1 sample per 30-days < 2.2/100 mL 7-day Median
Turbidity	Continuous	< 0.5 NTU single reading in 24-hr period < 0.2 NTU Average 24-hr

Operations Planning

This facility will be operated by a private wastewater operations contractor. That contractor has not been selected at this time. Since the operations are highly automated, it is anticipated that the plant will be have regularly scheduled operations visits for 2 hours per day, 5 days per week. At other times, an operator will be designated as being "on-duty". Plant alarms will be connected to an auto-dialer which will contact the on-duty operator, who will then respond as appropriate.

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AINA LE'A WWTP
PHASE 1 WWTP
VILLAGES OF AINA LE'A

VOLUME 1 - DRAWINGS

INDEX OF DRAWINGS

G-001	COVER SHEET
C-001	PHASE 1 DEVELOPMENT PLAN
C-002	PHASE 1 WWTP VICINITY PLAN
C-003	SITE GRADING PLAN
C-004	SITE LAYOUT
C-005	YARD PIPING PLAN
C-006	SEWER LINE PROFILE
PI-001	PROCESS SCHEMATIC, SYMBOLS & ABBREVIATIONS
PI-211	PROCESS SCHEMATIC, INFLUENT, EQ AND BIOREACTORS
PI-212	PROCESS SCHEMATIC, MEMBRANE FILTRATION
PI-213	PROCESS SCHEMATIC, BLOWERS
PI-214	PROCESS SCHEMATIC, DISINFECTION & RECYCLED WATER
S-002	STRUCTURAL, TREATMENT TANK LOWER PLAN
S-003	STRUCTURAL, TREATMENT TANK TOP PLAN
S-004	STRUCTURAL, TREATMENT TANK SECTIONS
M-002	MECHANICAL, TREATMENT TANK PLAN
M-003	MECHANICAL, TREATMENT TANK SECTIONS
M-004	MECHANICAL, EQUALIZATION TANK

30% DESIGN DOCUMENTS

WATERWORKS ENGINEERS

JANUARY, 2010

PRELIMINARY – NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD

DESIGN JJG
DRAWN
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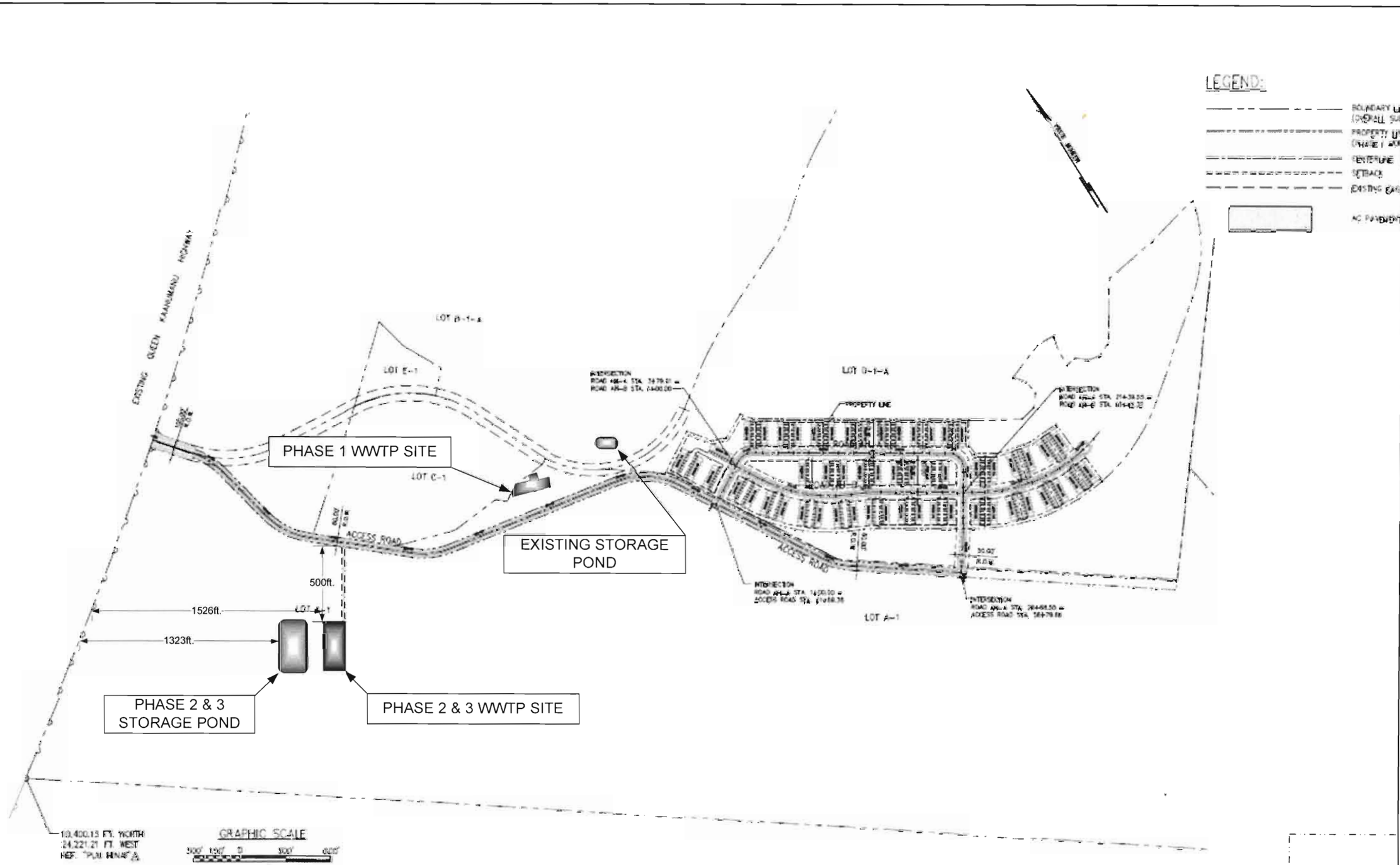
WATERWORKS ENGINEERS

THE VILLAGES OF AINA LE'A PHASE 1 WWTP

COVER SHEET

DATE 2/2/10
PROJECT NUMBER 09-030
DRAWING NUMBER G-001
SHEET NUMBER



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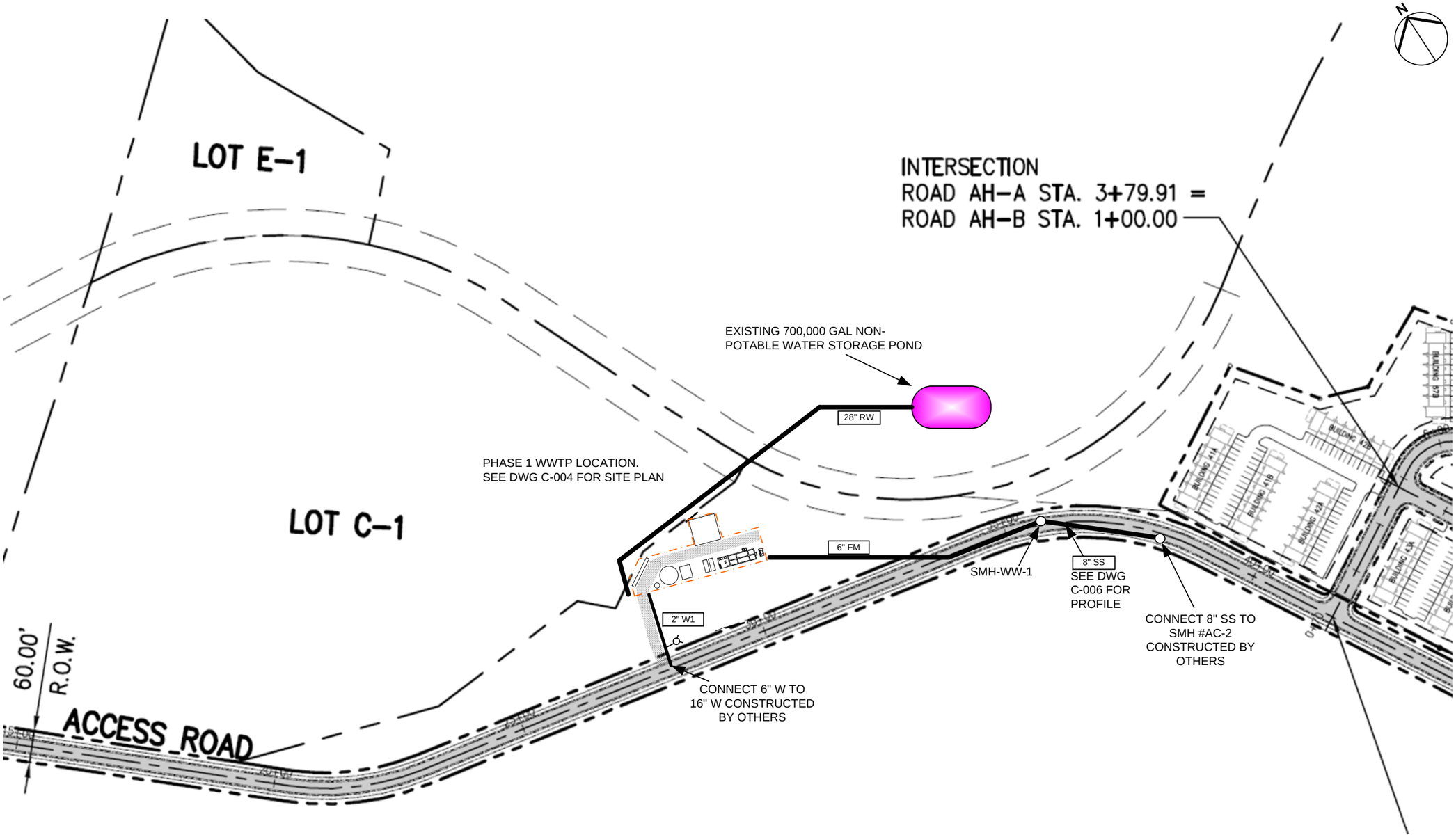
THE VILLAGES OF AINA LE'A
PHASE 1 WWTP

CIVIL
PHASE 1
DEVELOPMENT PLAN

DATE 2/2/10
PROJECT NUMBER 09-030
DRAWING NUMBER C-001
SHEET NUMBER



SCALE: 1"=200'

0 ft. 120 ft. 200 ft. 400 ft.

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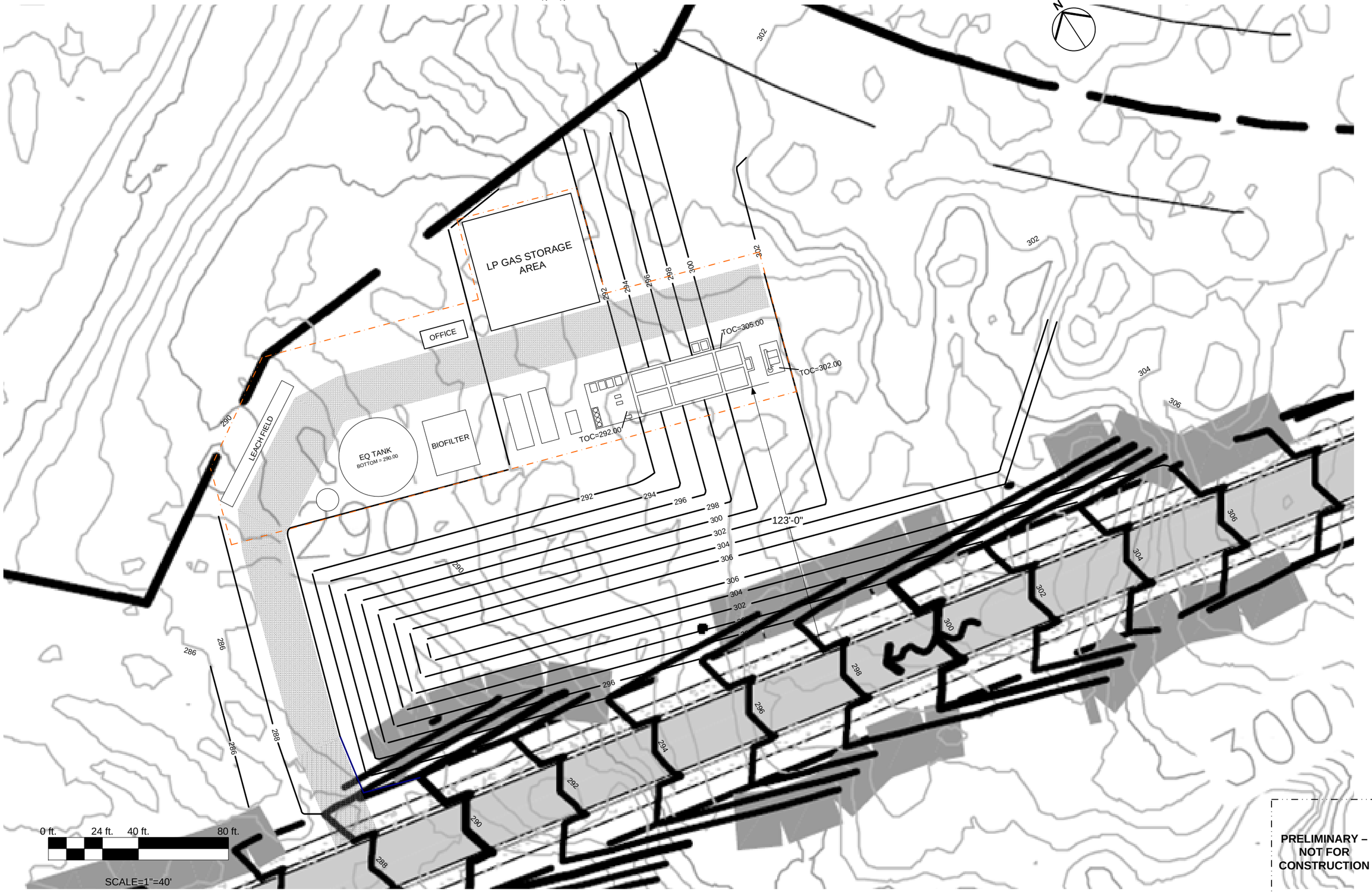
THE VILLAGES OF AINA LE'A
PHASE 1 WWTP

CIVIL
PHASE 1 WWTP VICINITY PLAN

DATE 2/2/10
PROJECT NUMBER 09-030
DRAWING NUMBER C-002
SHEET NUMBER



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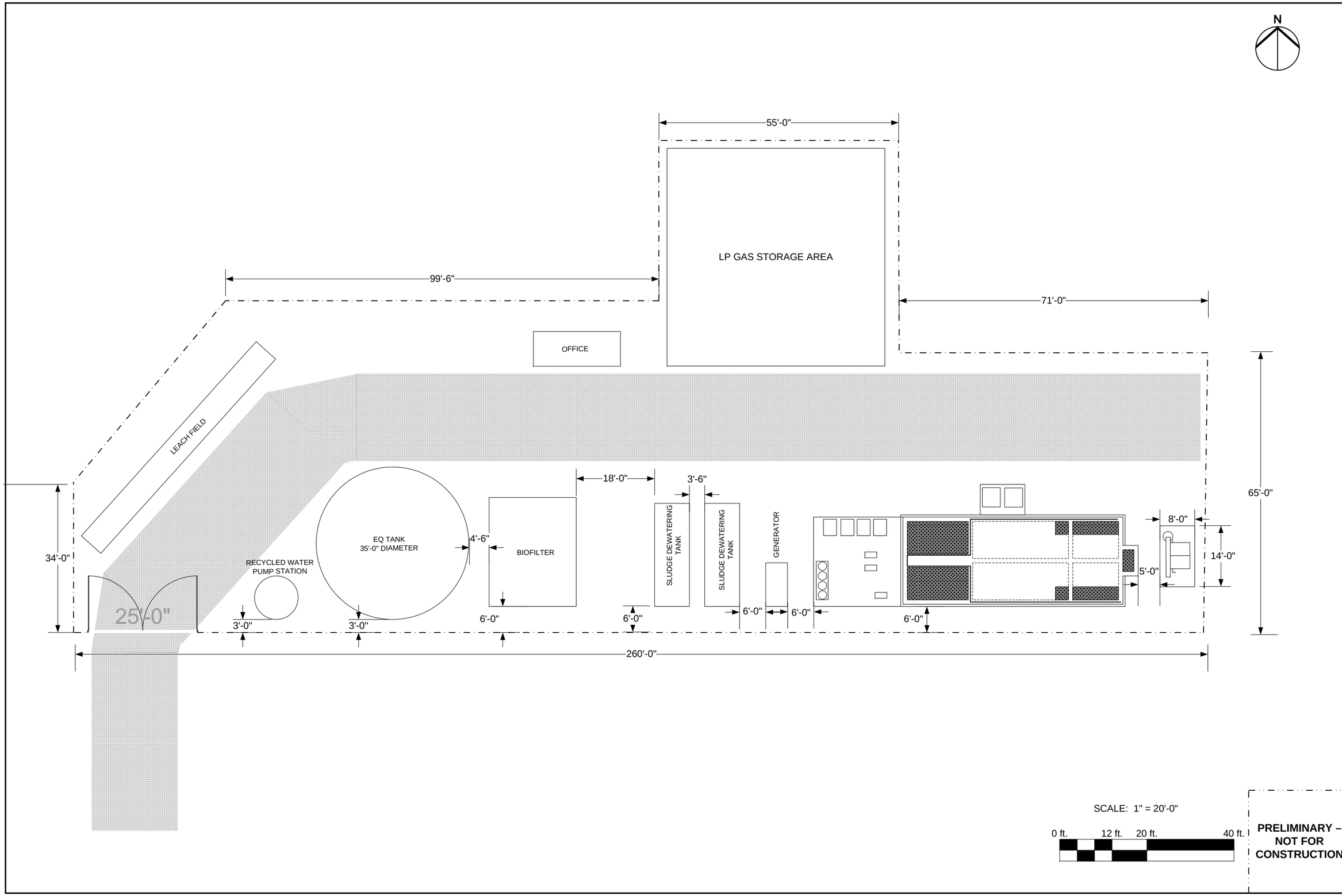
THE VILLAGES OF AINA LE'A
PHASE 1 WWTP

CIVIL
PHASE 1 WWTP
SITE GRADING PLAN

DATE 2/2/10
PROJECT NUMBER 09-030
DRAWING NUMBER C-003
SHEET NUMBER



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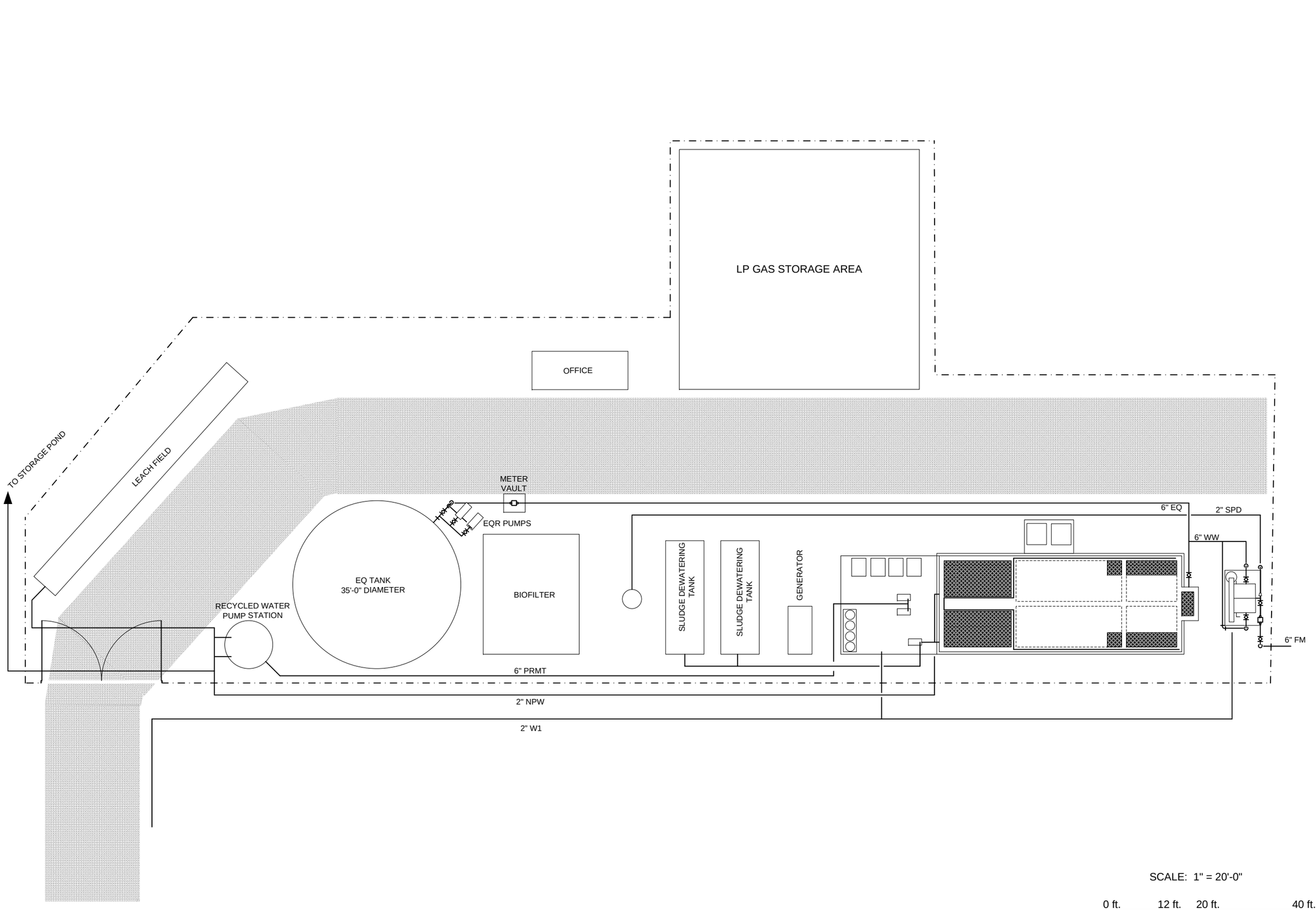
THE VILLAGES OF AINA LE'A
PHASE 1 WWTP

CIVIL
PHASE 1 WWTP
SITE LAYOUT

DATE: 2/2/10
PROJECT NUMBER: 09-030
DRAWING NUMBER: C-004
SHEET NUMBER



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THE VILLAGES OF AINA LE'A PHASE 1 WWTP

CIVIL
PHASE 1 WWTP
YARD PIPING

DATE 2/2/10
PROJECT NUMBER 09-030
DRAWING NUMBER C-005
SHEET NUMBER

VALVE AND FITTING SYMBOLS

- PLUG VALVE
- GATE VALVE
- GLOBE VALVE
- SWING CHECK VALVE
- BALL CHECK VALVE
- BALL VALVE
- BUTTERFLY VALVE
- REDUCER
- PRESSURE RELIEF VALVE (ANGLE)
- DIAPHRAGM CONTROLLED REGULATING VALVE
- NEEDLE VALVE
- WYE-STRAINER
- 3-WAY PLUG VALVE
- SOLENOID VALVE
- DRAIN
- PRESSURE REDUCING VALVE

MISCELLANEOUS SYMBOLS

B | M-004

PROCESS CONTINUED ON ANOTHER SHEET

6" CSL

PIPE CODE SHOWING NOMINAL SIZE AND SERVICE. FOR SERVICE ABBREVIATIONS, SEE BELOW

CODE	SERVICE
BWW	BACKWASH WASTEWATER
DR	DRAIN
FE	FILTERED EFFLUENT
MLR	MIXED LIQUOR RETURN
OF	OVERFLOW
POL	POLYMER SOLUTION
PA	PROCESS AIR
SE	SECONDARY EFFLUENT
WAS	WASTE ACTIVATED SLUDGE
WW	WASTEWATER
W2	POTABLE WATER

EQUIPMENT SYMBOLS

- CENTRIFUGAL PUMP
- BLOWER
- M — MAGNETIC FLOWMETER
- THERMAL DISPERSION FLOWMETER
- WEIR OR OVERFLOW POINT
- STATIC MIXER
- FI — ROTAMETER
- CALIBRATION COLUMN
- SLIDE GATE

DATA SYMBOLS

- ANALOG INPUT
- ANALOG OUTPUT
- DIGITAL INPUT
- DIGITAL OUTPUT

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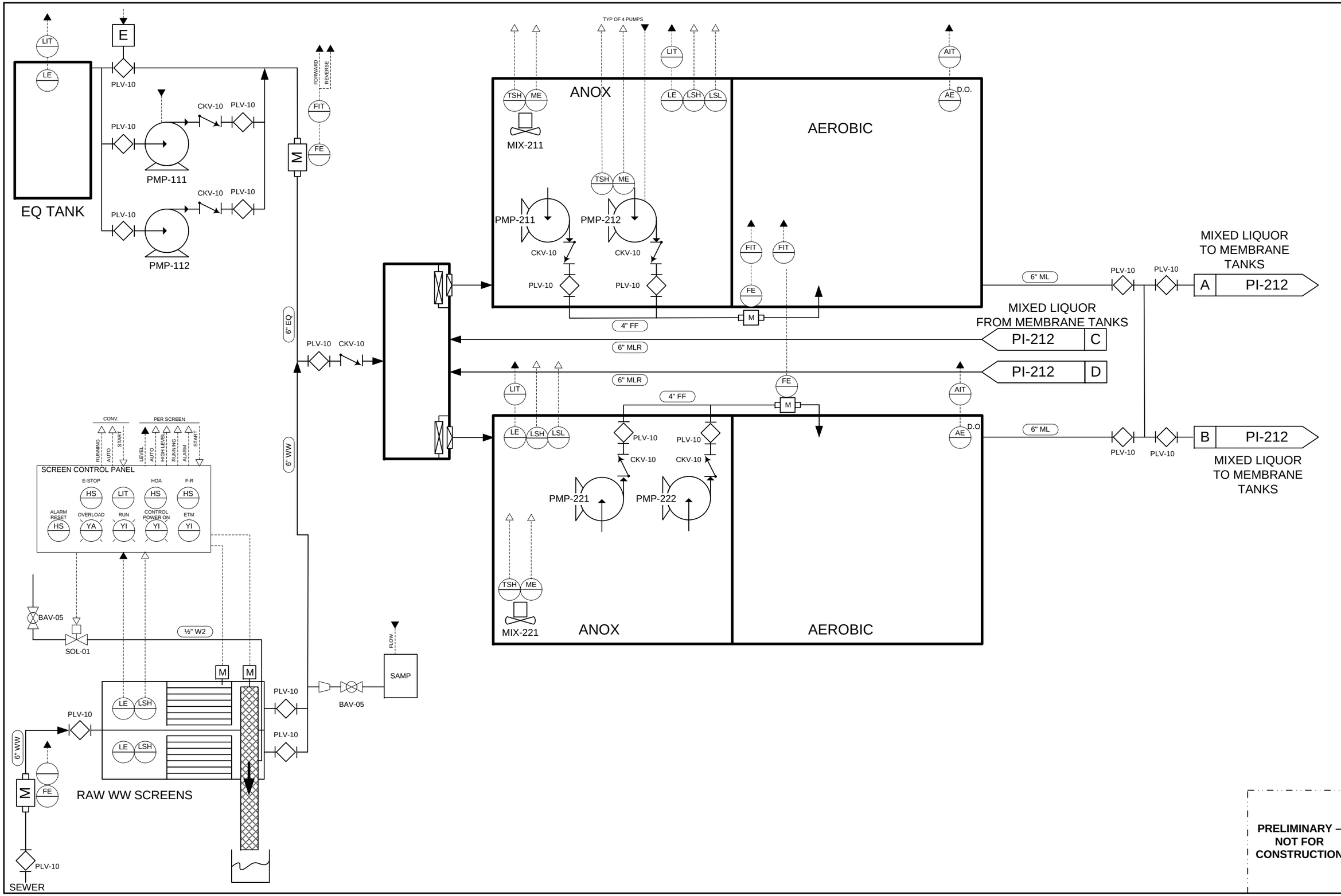
THE VILLAGES OF AINA LE'A PHASE 1 WWTP

PROCESS SCHEMATIC SYMBOLS & ABBREVIATIONS

DATE: 1/22/2010
PROJECT NUMBER: 09-030
DRAWING NUMBER: PI-001
SHEET NUMBER



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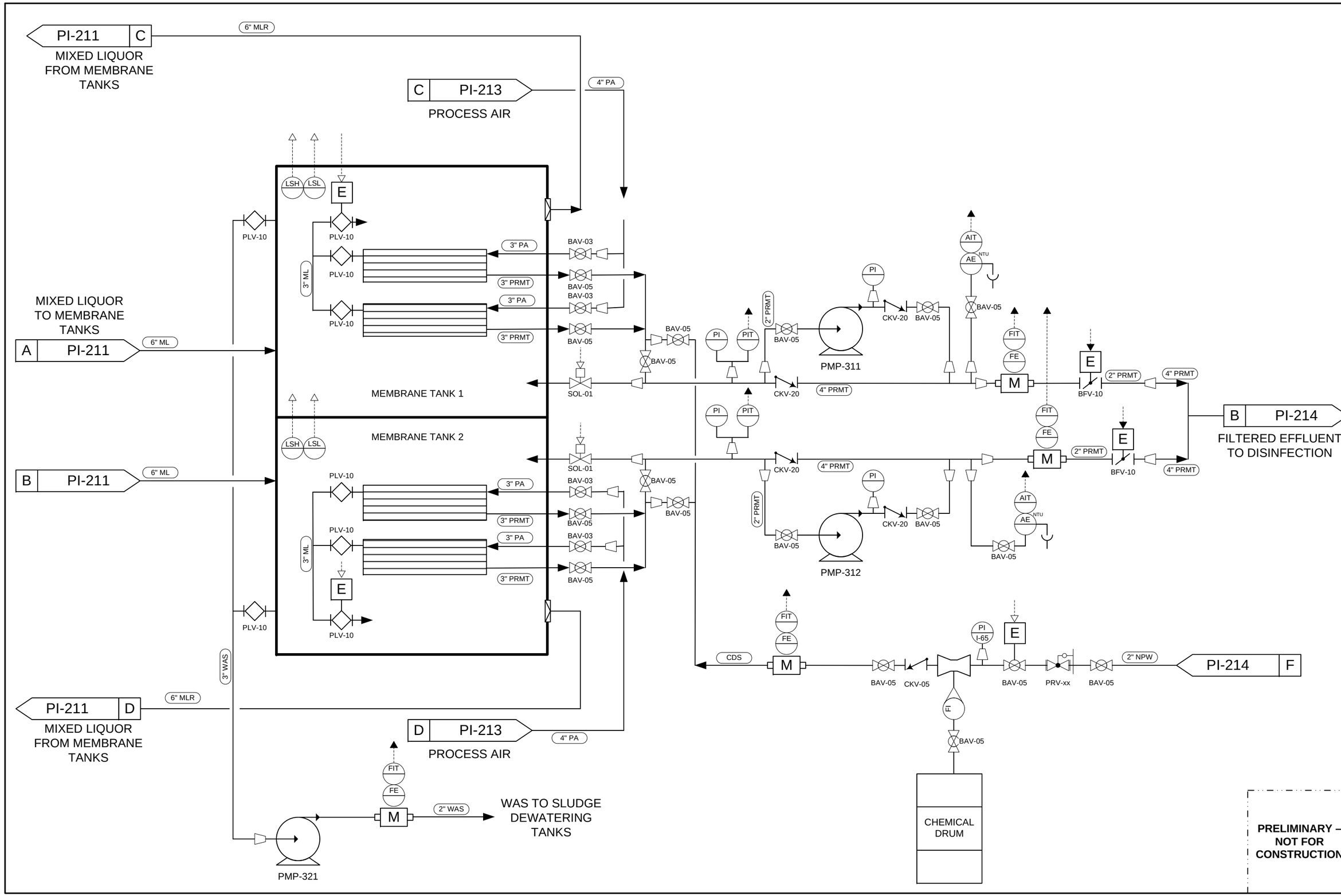
THE VILLAGES OF AINA LE'A PHASE 1 WWTP

PROCESS SCHEMATIC 1
INFLUENT, EQ & BIOREACTORS

DATE 1/22/2010
PROJECT NUMBER 09-030
DRAWING NUMBER PI-211
SHEET NUMBER



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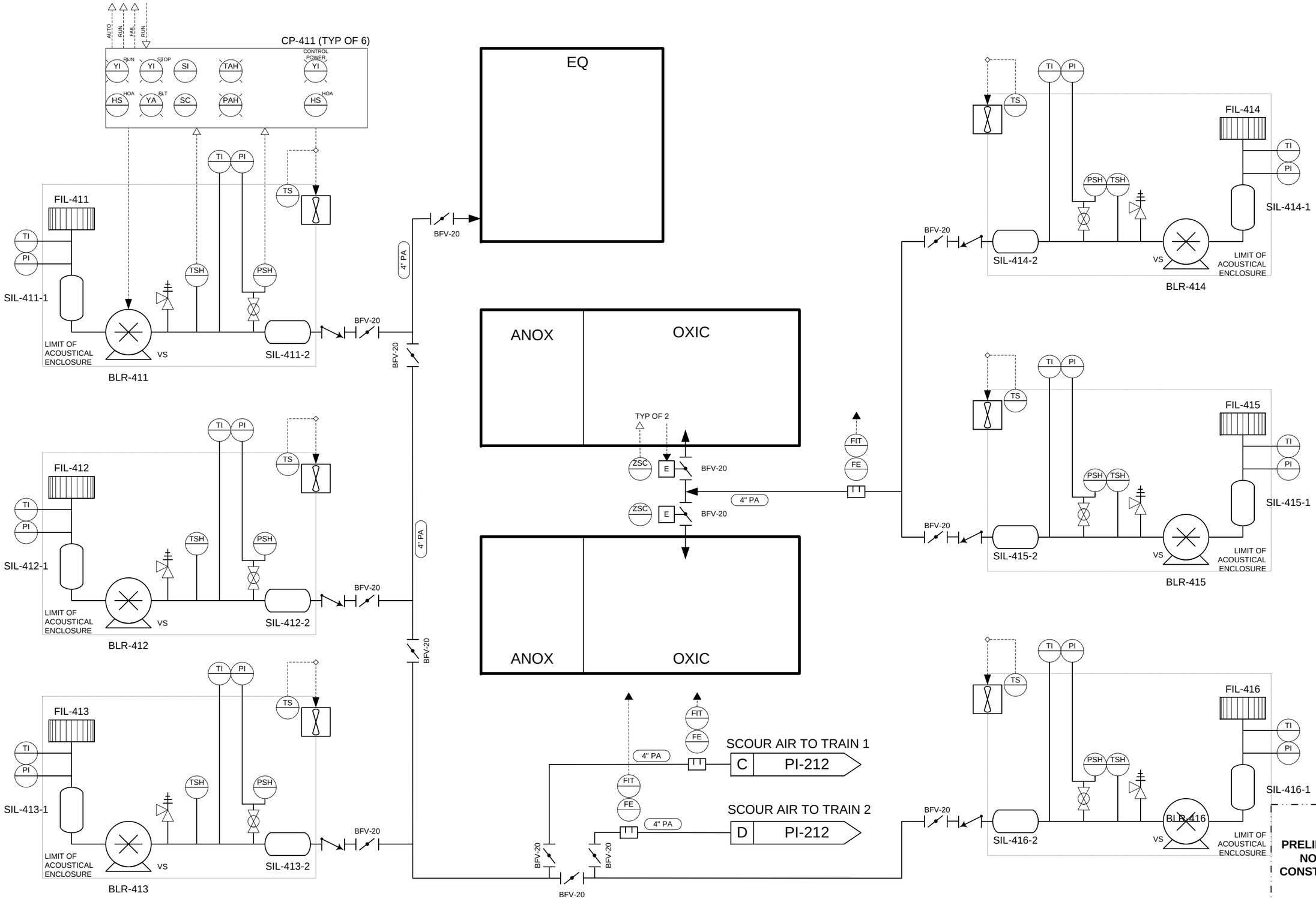
THE VILLAGES OF AINA LE'A PHASE 1 WWTP

PROCESS SCHEMATIC 2
MEMBRANE FILTRATION

DATE 1/22/2010
PROJECT NUMBER 09-030
DRAWING NUMBER PI-212
SHEET NUMBER



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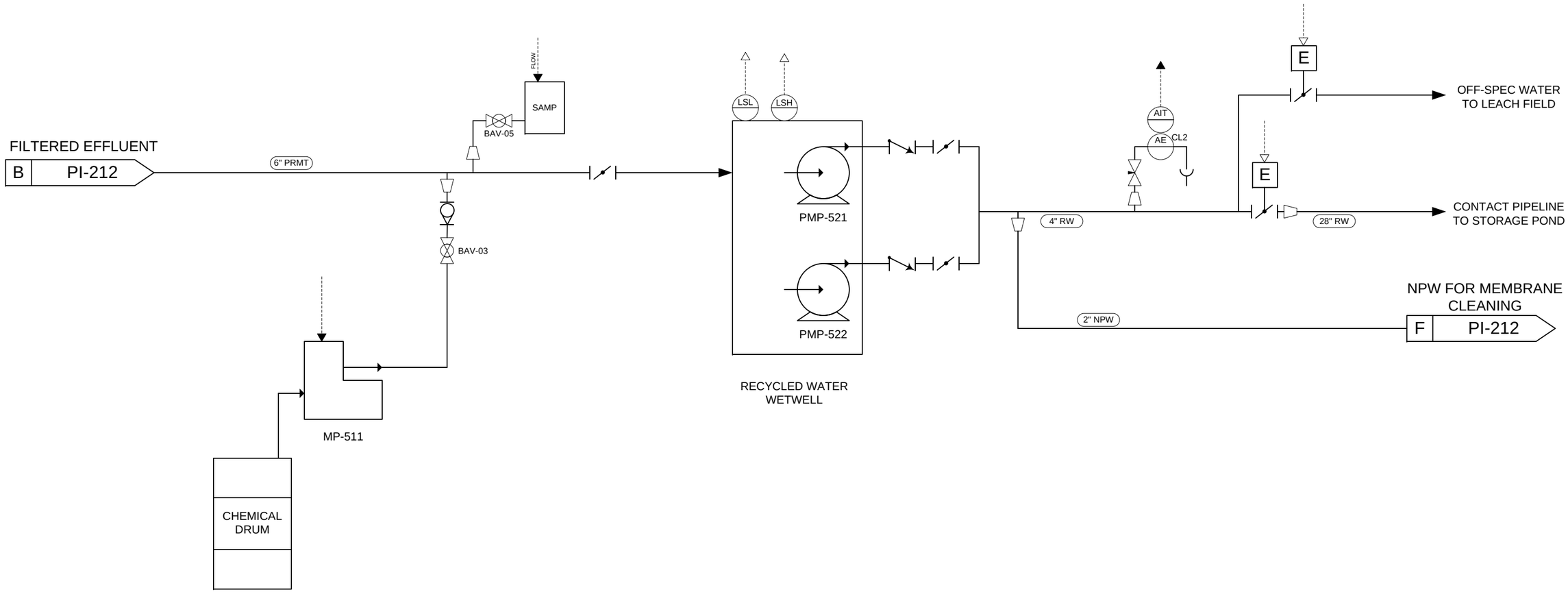
THE VILLAGES OF AINA LE'A PHASE 1 WWTP

PROCESS SCHEMATIC 3 BLOWERS

DATE 1/22/2010
PROJECT NUMBER 09-030
DRAWING NUMBER PI-213
SHEET NUMBER



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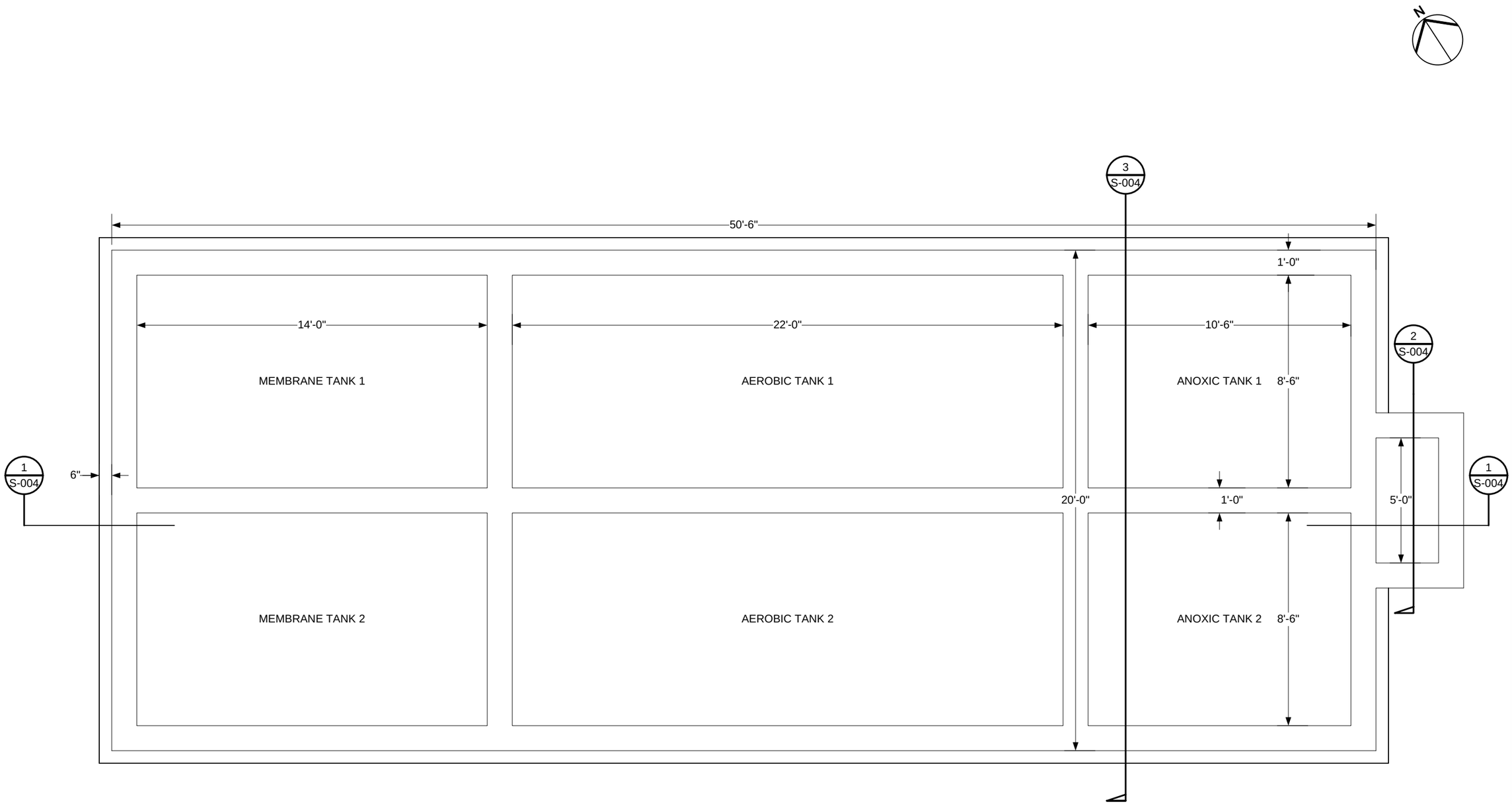
WATERWORKS ENGINEERS

THE VILLAGES OF AINA LE'A PHASE 1 WWTP

PROCESS SCHEMATIC 4
DISINFECTION & RECYCLED WATER

DATE 1/22/2010
PROJECT NUMBER 09-030
DRAWING NUMBER PI-214
SHEET NUMBER



SCALE: 1/4"=1'-0"

0.0 ft. 2.4 ft. 4.0 ft. 8.0 ft.

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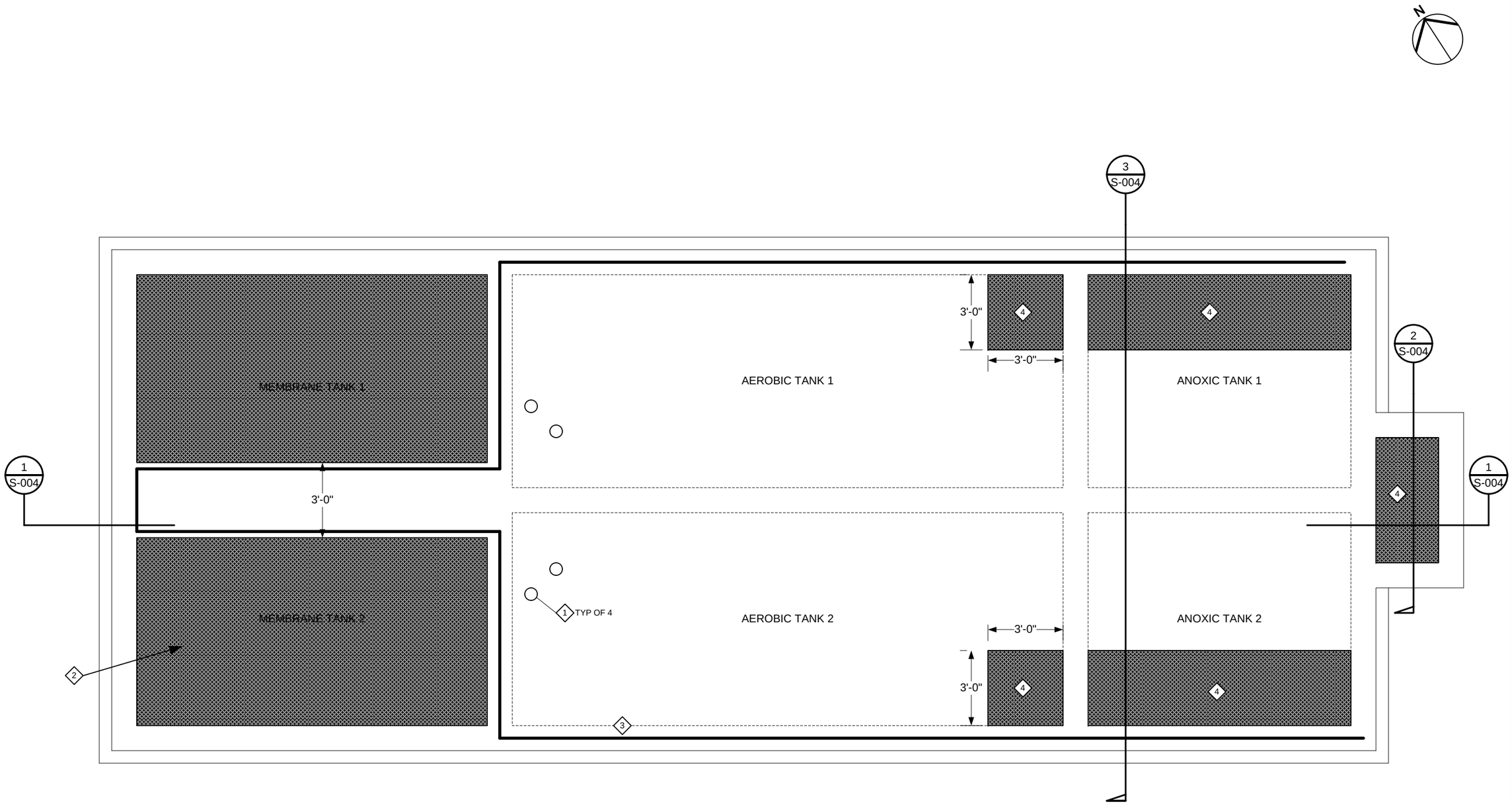
WATERWORKS ENGINEERS

THE VILLAGES OF AINA LE'A PHASE 1 WWTP

STRUCTURAL TREATMENT TANK LOWER PLAN

DATE 2/2/10
PROJECT NUMBER 09-030
DRAWING NUMBER S-002
SHEET NUMBER



NOTES:

1. VALVE BOX CAST IN SLAB. VALVE BOX SHALL BE NEENAH R-7506B, 6-INCH DIA. FLOOR BOX FRAME AND LID.
2. REMOVABLE COVERS OVER MEMBRANE TANK
3. ALUM HANDRAIL. SEE DETAIL 5200
4. LEDGER ANGLE SUPPORTED GALV STEEL CHECKERED PLATE

SCALE: 1/4"=1'-0"

0.0 ft. 2.4 ft. 4.0 ft. 8.0 ft.

PRELIMINARY – NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD

DESIGN JJG
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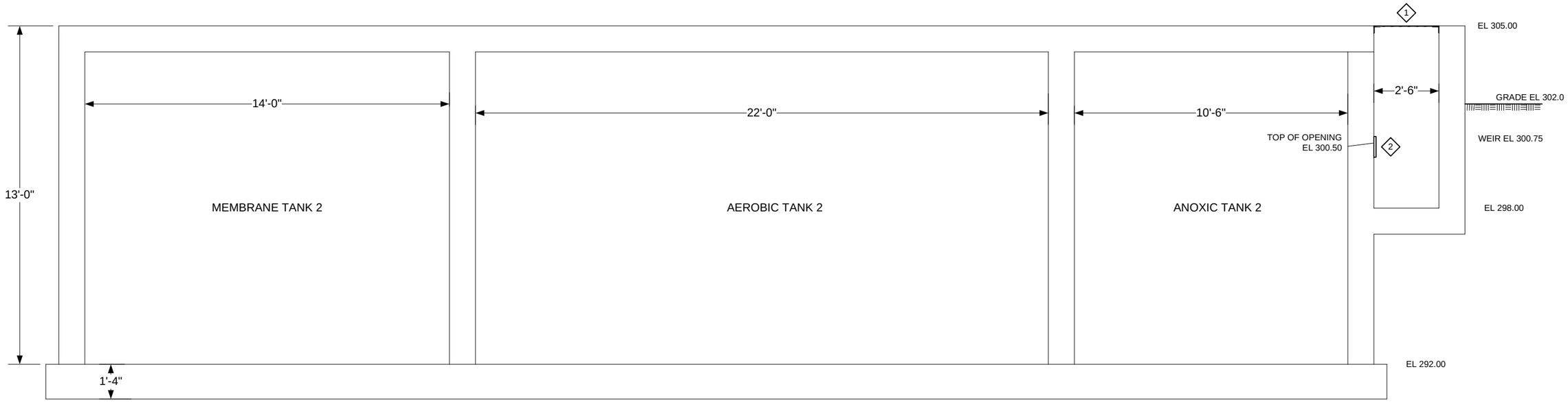
WATERWORKS ENGINEERS

THE VILLAGES OF AINA LE'A PHASE 1 WWTP

STRUCTURAL TREATMENT TANK TOP PLAN

DATE 2/2/10
PROJECT NUMBER 09-030
DRAWING NUMBER S-003
SHEET NUMBER



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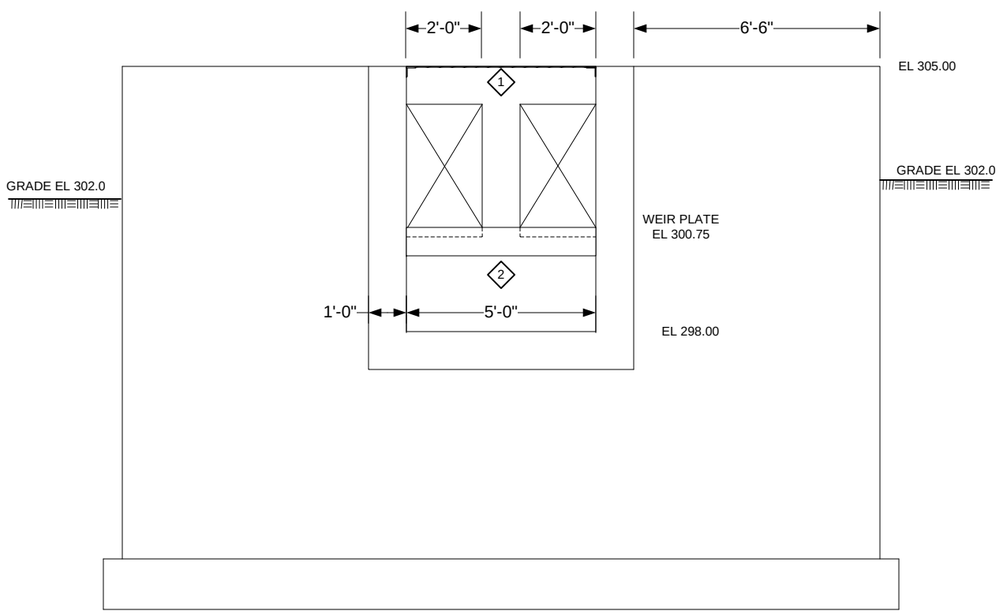
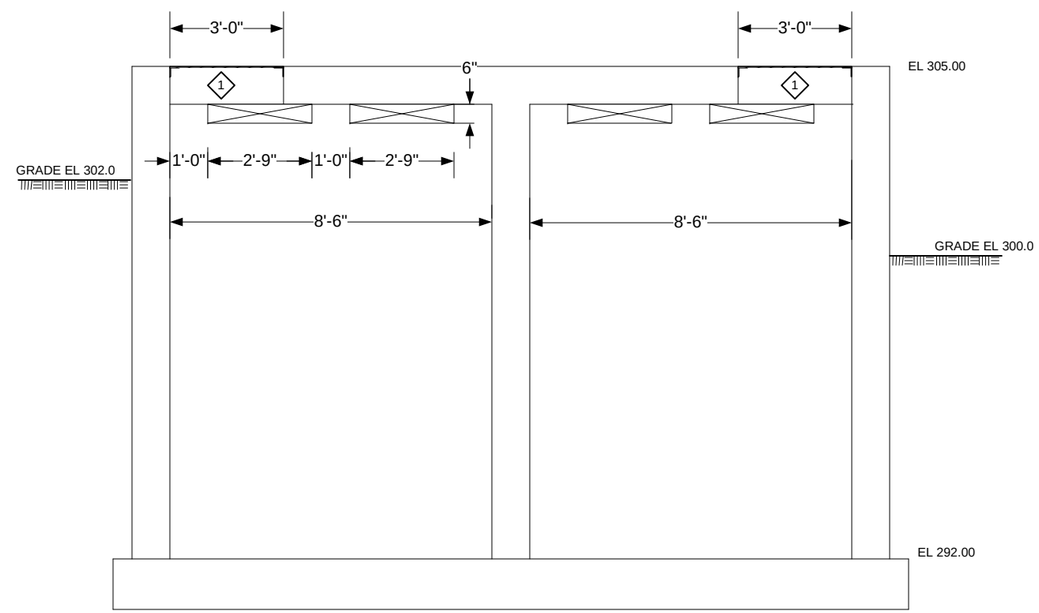


2 S-002 SECTION
¼"=1'-0"



3 S-002 SECTION
¼"=1'-0"

NOTES:

1. LEDGER ANGLE SUPPORTED GALV STEEL CHECKERED PLATE
2. WEIR PLATE WITH HANDLE SET IN SLIDE PLATE GROOVE. PROVIDE ONE SLIDE PLATE FOR TANK ISOLATION

0.0 ft. 2.4 ft. 4.0 ft. 8.0 ft.

PRELIMINARY – NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD

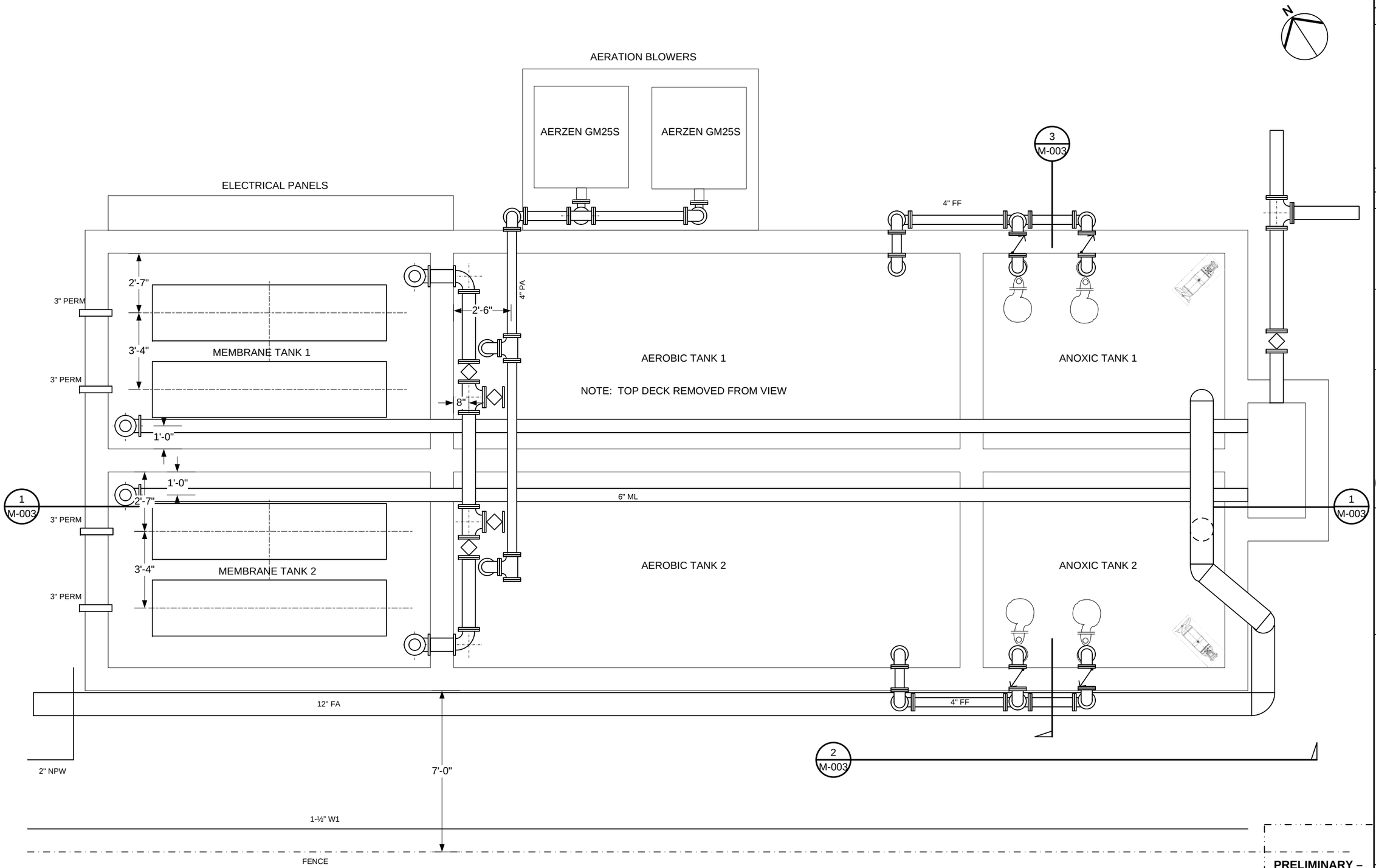
DESIGN JJG
DRAWN
CHECKED
APPROVED

WATERWORKS ENGINEERS

THE VILLAGES OF AINA LE'A PHASE 1 WWTP

STRUCTURAL TREATMENT TANK SECTIONS

DATE 2/2/10
PROJECT NUMBER 09-030
DRAWING NUMBER S-004
SHEET NUMBER



SCALE: 1/4"=1'-0"

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PRELIMINARY – NOT FOR CONSTRUCTION

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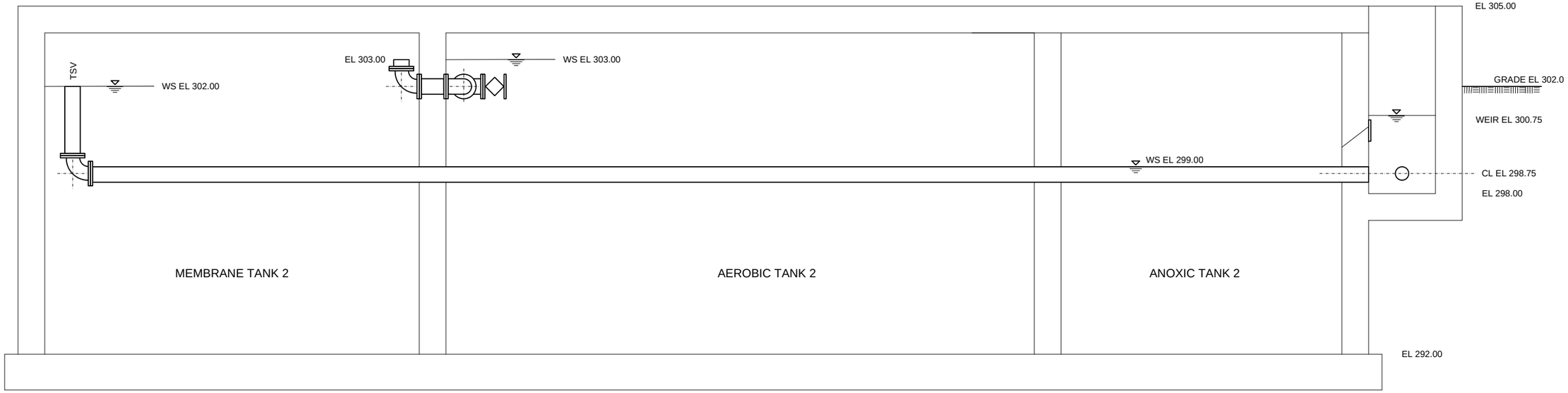
THE VILLAGES OF AINA LE'A PHASE 1 WWTP

MECHANICAL TREATMENT UNIT MECHANICAL PLAN

DATE 2/2/10
PROJECT NUMBER 09-030
DRAWING NUMBER M-002
SHEET NUMBER



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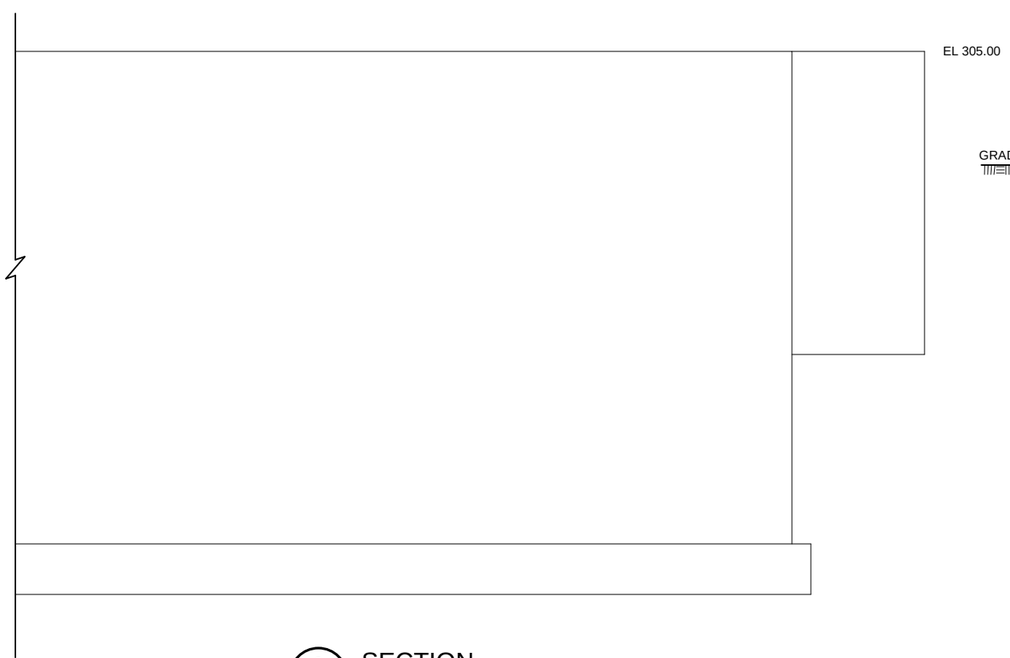

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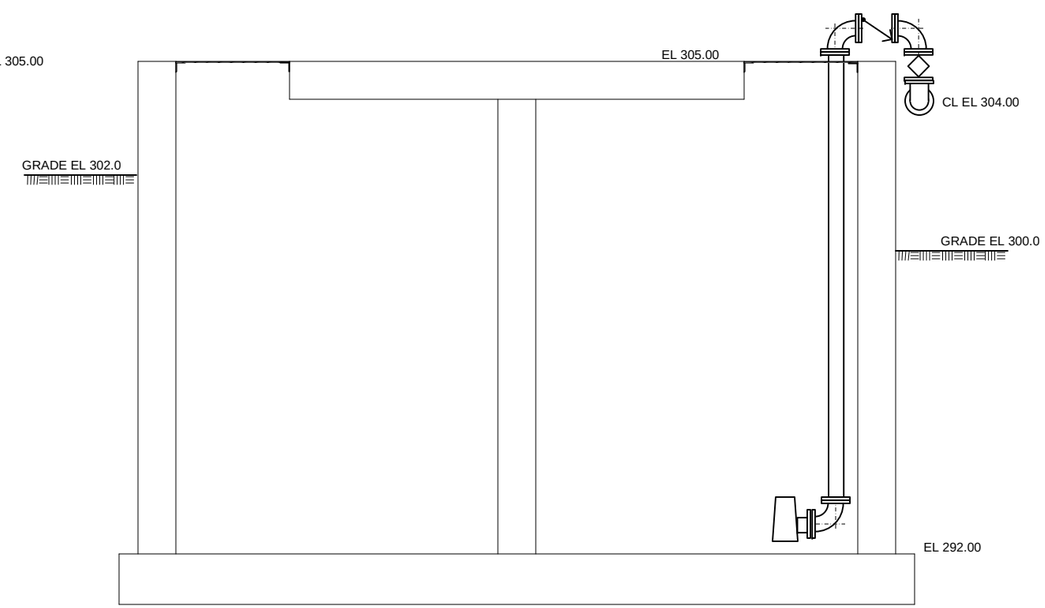

3 / S-002 SECTION
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PRELIMINARY – NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD

DESIGN JJG
DRAWN
CHECKED
APPROVED

WATERWORKS ENGINEERS

THE VILLAGES OF AINA LE'A PHASE 1 WWTP

MECHANICAL TREATMENT TANK SECTIONS

DATE 2/2/10
PROJECT NUMBER 09-030
DRAWING NUMBER M-003
SHEET NUMBER

Appendix E
Conceptual Master Plan Drainage Report (SSFM, July 2009)

Aina Le`a Villages

CONCEPTUAL MASTER PLAN DRAINAGE REPORT

July 2009

Project Managers, Planners and Engineers
501 Sumner Street, Suite 620
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Statement of SSFM International, Inc.'s Quality Process

It is the policy of SSFM to have a consistent and systematic approach to the development and review of its reports and other project deliverables.

All projects and products of our service are subject to a quality process and in no case will the quality review be eliminated. The main purpose of this process is to assure:

- Clarity, completeness, coordination, and accuracy of documents.
- That the project, study or investigation meets the Client's objectives.
- That the requirements of our Agreement with the Client have been met, and the Client has received the value of the fee to be paid.

The Preparation of This Report Was The Responsibility of and Completed By:

Geoffrey L. Casburn, P.E. date
P.E. License: 8416-C License Expires: April 2010

The Quality Review Of This Report Was The Responsibility Of And Completed By:

signature date

TABLE OF CONTENTS

I. INTRODUCTION 5
1.0 PURPOSE AND SCOPE 5
1.1 LOCATION 5
1.2 PROJECT SITE DESCRIPTION 6
1.3 HISTORICAL BACKGROUND 9
1.4 MASTER PLAN 9
II. HYDROLOGY 11
2.1 HYDROLOGIC METHODS 11
2.2 PRECIPITATION 11
2.2.1 24-hour Precipitation 11
2.2.2 Short-period Precipitation 13
2.3 OFF-SITE WATERSHEDS 13
2.3.1 Regional Watershed 13
2.3.2 Major Watershed Descriptions 14
2.3.3 South Stream Watershed Area 14
2.3.4 Watershed Area Estimates 15
2.3.5 Minor Off-site Watersheds 16
2.3.6 Watershed Soils 17
2.3.7 Watershed Makai of Site 18
2.4 ON-SITE WATERSHEDS 19
2.5 HYDROLOGIC CALCULATIONS 19
2.5.1 General 19
2.5.2 Pre-project Flows for Urban District 19
2.5.3 Build-out Flows for Urban District 20
2.5.4 Urban District Flow Change 21
2.5.5 Runoff Volume Change 21
2.5.6 General Discussion 22
III. HYDRAULICS 24
3.1 GENERAL 24
3.2 HIGHWAY CULVERTS 24
*RMT Study 25
3.3 Master Plan Culverts 25
3.4 DISCHARGE TO GOLF COURSE 25
3.5 DETENTION AND RETENTION BASINS AT BUILD-OUT 26
3.6 FLOOD MAPPING 27
3.6.1 Existing Drainageways: 27
Detailed floodplain boundaries would be determined within the Urban District

boundary during preparation of the grading/drainage plan for the site. 27
IV. STORMWATER QUALITY 27
4.1 Water Quality Flow & Volume 28
BIBLIOGRAPHY 29

LIST OF TABLES

Table 1- 1 - Land Use Summary 9

Table 2- 1 - 24-Hour Rainfall Depths 11
Table 2- 2 - Stream Watersheds - Mauka of Project Site 16
Table 2- 3 - Minor Off-Site Watersheds 16
Table 2- 4 - Pre-project Flow from Urban District. 20
Table 2- 5- Build-out Flow from Development of Urban District. 21
Table 2- 6 - Increased **Flows** at Build-out -Urban District 21
Table 2- 7 - Build-out 50-Yr Runoff **Volumes** – Urban District 22
Table 4- 8 -Land Use Water Quality Flows and Volumes for SDOT Compliance 28

Table 3- 1 - Highway 19 Culverts at Site 25
Table 3- 2- Infiltration Areas for Urban District 26

LIST OF FIGURES

Figure 1- 1 Location Map 6
Figure 1- 2 USGS Map 7
Figure 1- 3 Aerial Site Photograph 8
Figure 1- 4- Aina Le'a VillageMaster Plan 10

Figure 2- 1 Isohytal Map 12
Figure 2- 2 Regional Watershed from GIS Data 13
Figure 2- 3 Tributary Watershed Areas 15
Figure 2- 4 Minor off-site watersheds 17
Figure 2- 5 Soils Map 18

APPENDIX

1. Calculations

I. INTRODUCTION

1.0 PURPOSE AND SCOPE

SSFM International, Inc. was retained to complete a Drainage Report for Aina Le`a Village Project Conceptual Master Plan, dated April 20, 2009. The Project Site is shown in Figure 1-1 Location Map

The project site is a 2,300 acre parcel. The Urban District is a portion of that parcel approximately 1,000 acres in size. The Urban District boundary is shown in Figure 1-2 USGS Map. **Calculations in this report determining the impact of urbanization on storm drainage will be limited to the Urban District portion of the project site.**

The purpose and scope of the report are to first identify and quantify the increases in storm water runoff resulting from build-out of the Urban District greater than storm runoff occurring for the existing conditions of the Urban District. Second, to estimate the size and configuration of storm water management facilities required for the completed development to ensure that the storm water runoff rates and volumes leaving the Urban District would remain at or below the levels of the pre-developed Urban District. The report also addresses storm water quality and the use of the highway buffer areas for storm water management facilities.

Urban District storm drain design was carried out for the 50-year storm event. This was done to reflect the need to convey and/or detain that level of storm in the event of a “sump” condition and/or when a watershed size exceeds 100 acres. In final design, culverts would be sized for the 10-year event when these two conditions are absent.

1.1 LOCATION

The project site is located on the northwestern portion of the Big Island of Hawaii in the South Kohala District. Its western-most edge is approximately two miles inland from the coast. The site is bordered to the west by Queen Kaahumanu Highway. Both the Mauna Lani and Waikoloa Resorts and their Golf Courses occupy large portions of the coastal zone to the southwest of the site. One mile from the eastern border of the project site is the Waikoloa Villages, a residential community with a golf course. (TMK Nos. 6-8-01: portion 25, 36, 37, 38, 39, and 40).

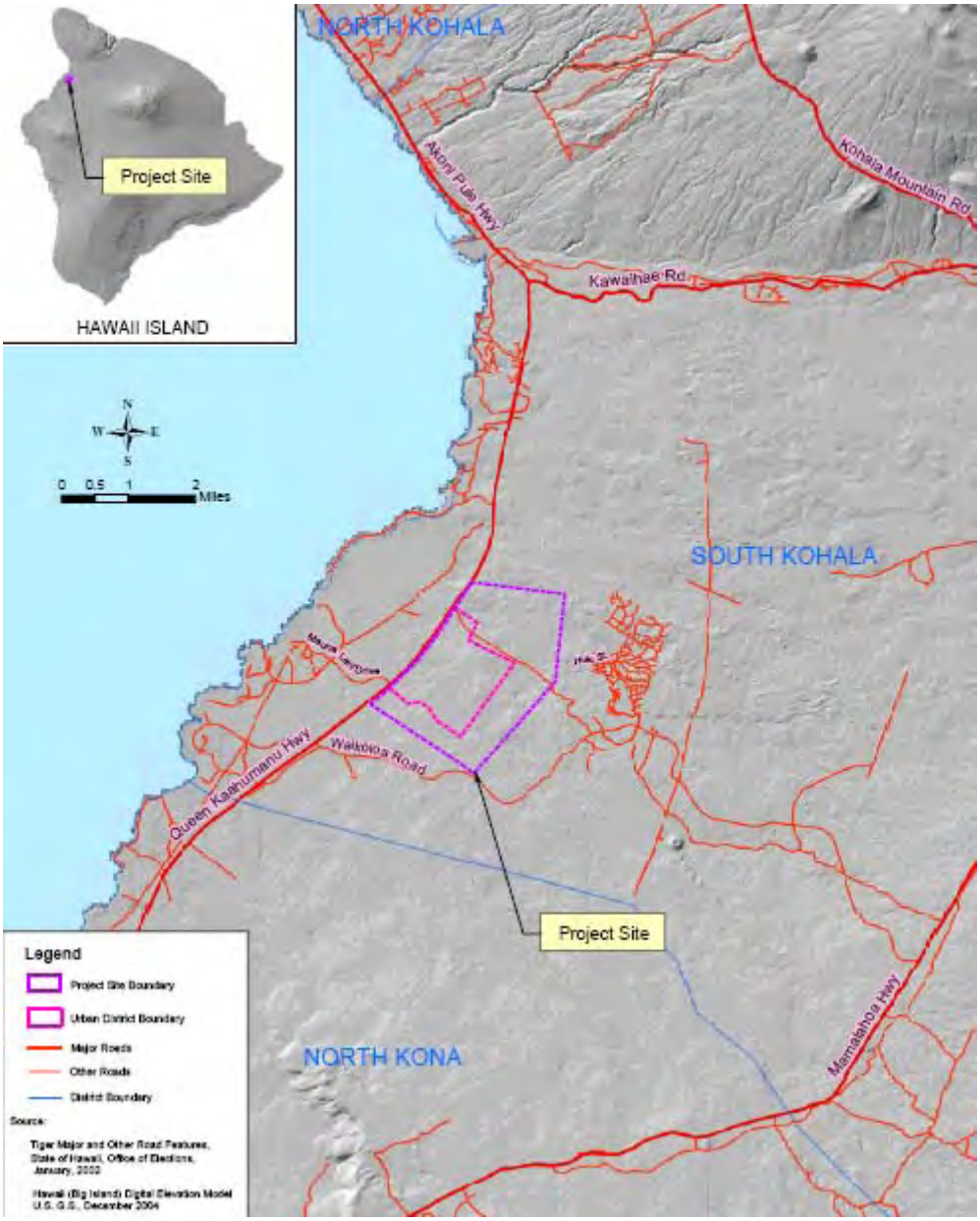

Figure 1- 1 Location Map

1.2 PROJECT SITE DESCRIPTION

The project site is generally characterized by a topography which rises from approximately 150 feet at its western-most boundary gently rising to about 700 feet at its eastern border. The prominent Awaiakeakua Gulch, which runs across the property in an east-west direction, serves as a divider between the distinct northern and southern sections of the site. The

soil in the smaller northern section is characterized by extremely stony very fine sandy loam while the soil in the southern section is characterized by a`a lava flows from the eruptions of Mauna Loa volcano located 36 miles southeast from the site. Project site boundaries are shown on a USGS quad in Figure 1-2 USGS Map. An aerial photograph of the project site is shown in Figure 1-3 Site Aerial Photograph

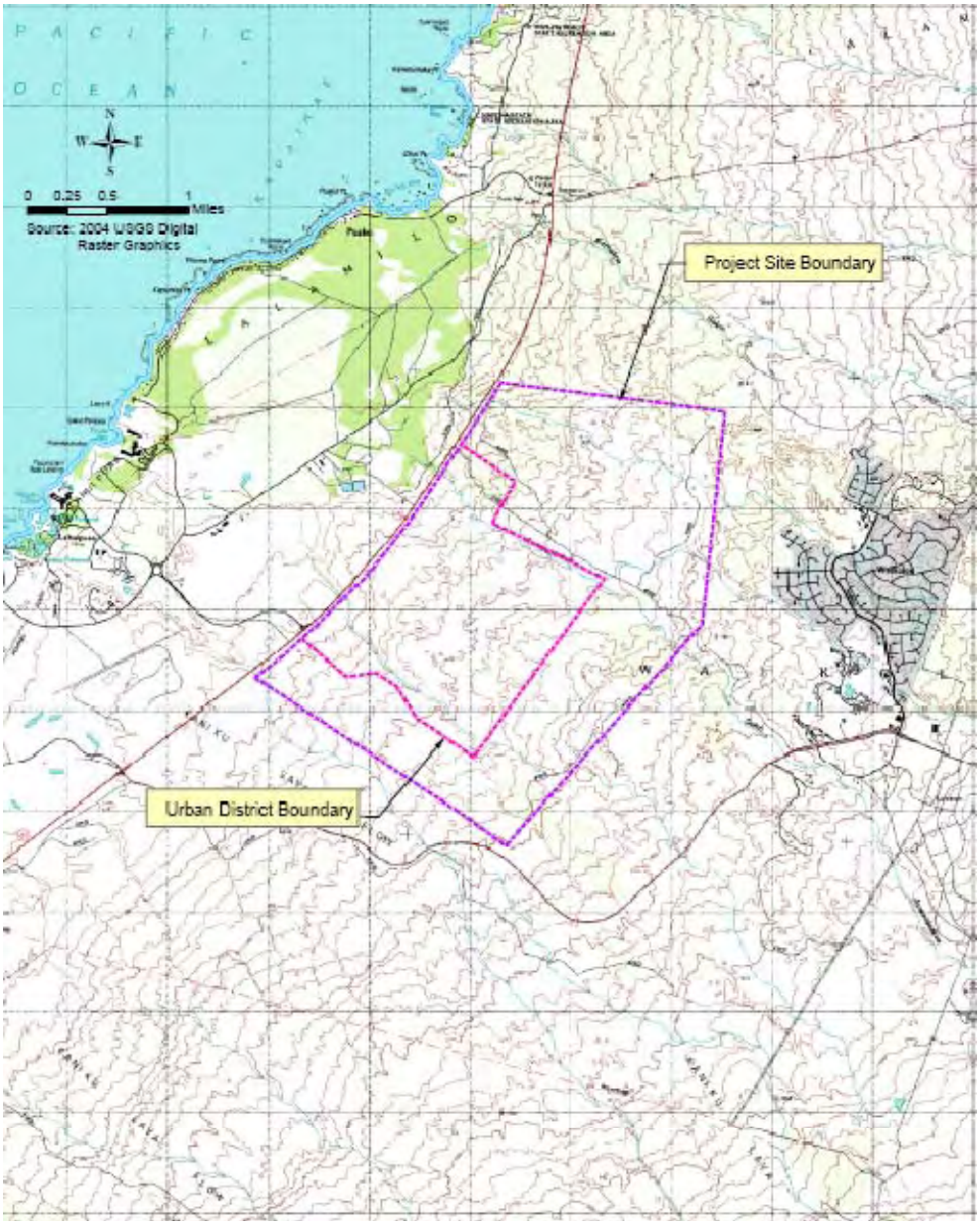

Figure 1- 2 USGS Map

Figure 1- 3 Aerial Site Photograph

1.3 HISTORICAL BACKGROUND

The project site was part of the land acquired by the U.S. Navy from Parker Ranch in 1943. This property was used for military training exercises and as an artillery firing range by the 2nd, and later the 5th, Marine Divisions during the period from December 1943 to June 1946. Live ammunition and other explosives were employed during military use of the area. The area was returned to Parker Ranch in September 1946. Two ordnance clearance efforts of the training area were performed in 1946 and 1954 respectively. According to previous reports, unexploded ordnance probably remains on-site in limited quantities.

1.4 MASTER PLAN

A master plan was developed by PBR Hawai‘i, Inc (PBR). It is shown in Figure 1-4 – Aina Le’a Village Master Plan - dated April 20, 2009 ("master plan"). Each of the individual colored areas (a.k.a., pod) shown on the master plan is an area of uniform land use. For example, each of the yellow areas shown in the master plan will be developed for single-family residential use. The plan consists of one 18-hole golf course surrounded by multiple “pods.” Each pod is a super-block area ranging from 4 acres to 57 acres. Each pod has been assigned specific land uses. Table 1-1 – Land Use Summary, prepared by PBR, shows the proposed approximate acreage of each land use, as well as proposed numbers of units and gross building floor area where applicable.

Table 1- 1 - Land Use Summary

Land Use	ID	Area (Acres)	Units (Approximate)	Gross Floor Area (Sq Ft)
Single Family	SF	255	790	
Multi-family	MF	165	1,047	
Mixed Use	MU	25	125	80,000
Affordable/Workforce Housing	AWH	46	500	
Commercial Village	C	36		340,000
Golf Course	GC	250		
Golf Course Club House	GCH	4		
Highway Buffer	HB	234		
Parks/Open Space	O	37		
Major roadways	RD	40		
	Total	**1,092**	**2,462**	**420,000**

Figure 1- 4- Aina Le'a Village Conceptual Master Plan, dated April 20, 2009

II. HYDROLOGY

2.1 HYDROLOGIC METHODS

A number of methods have been used over the years to calculate the design flows and storm volumes for streams on the Kona coast. These methods are outlined below:

1. Rational Method

   Simplified method developed for use with small watersheds. This method is not applicable for major streams.

2. National Resources and Conservation Service (NRCS) Method, formerly the Soil Conservation Service (SCS) Method

   This is a unit hydrograph method developed by the SCS. This method is used for watersheds or sub-watersheds of less than 200 sq miles. This method reflects the timing of the flow out of the watershed; plus the topography, soil type and land use values for the watershed.

2.2 PRECIPITATION

2.2.1 24-hour Precipitation

The 24-hour precipitation depths for various storm events for the site were obtained from the *Rainfall Frequency Atlas of The Hawaiian Islands, Technical Paper No. 43 ("TP-43"), U.S. Weather Bureau*, and are summarized below.

Table 2- 1 - 24-Hour Rainfall Depths

Return Period	Precipitation Depth (inches)
1-year, 24-hour	2.5
2-year, 24-hour	3.0
5-year, 24-hour	4.0
10-year, 24-hour	4.5
25-year, 24-hour	5.0
50-year, 24-hour	6.0
100-year, 24-hour	7.5

The 50-year 24-Hour isohytal map from TP-43 is shown in Figure 2-1 - Isohytal Map. These values are used in the NRCS Method. This publication has an isohytal map for each time period and for storm frequency. Values in the table were taken from the applicable isohytal map.

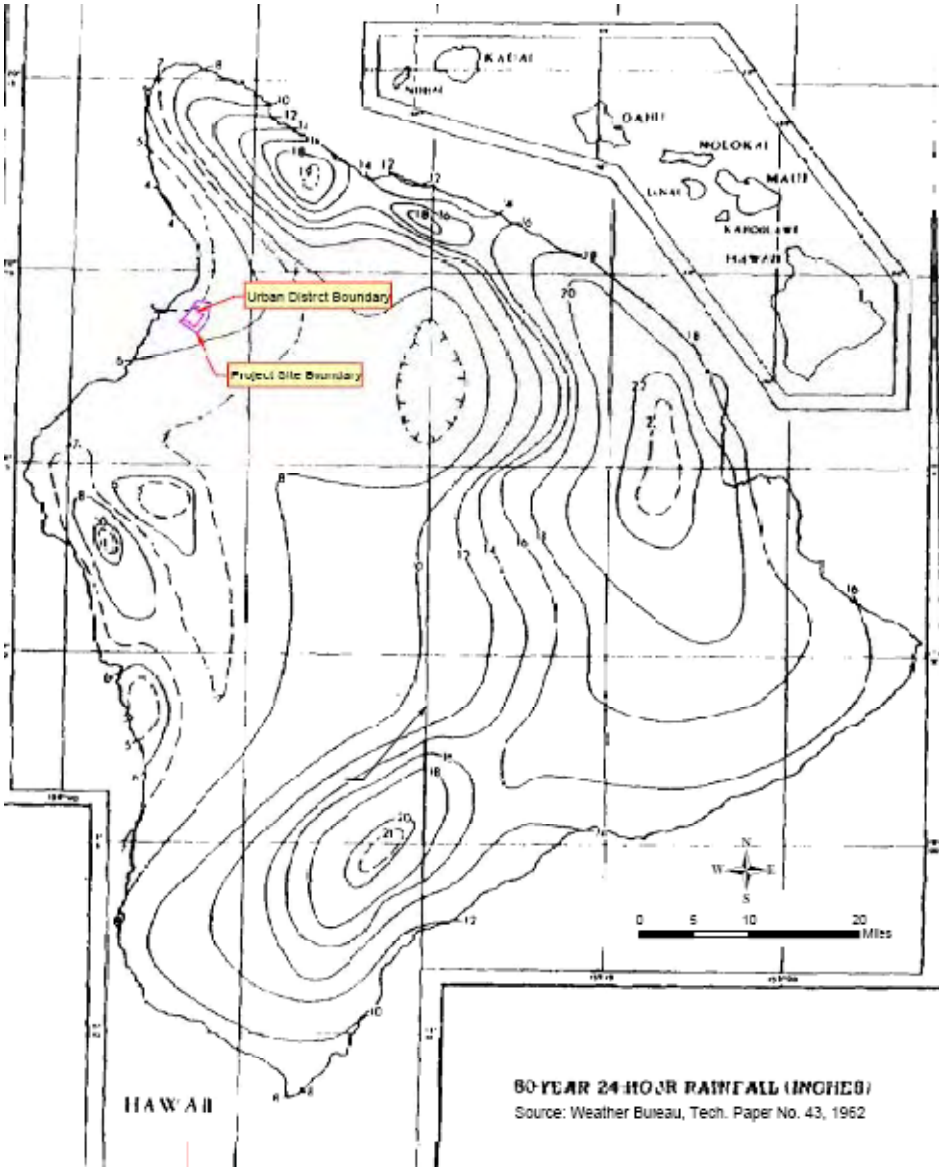

Figure 2- 1 Isohytal Map

2.2.2 Short-period Precipitation

Short period rainfall intensities are required in order to apply the Rational Method to small watersheds. The County of Hawaii ("COH") Drainage Standards provide a method for determining the short-period rainfall depths and intensities for a specific site. See **Appendix 1** for the calculation of these values for the project site.

2.3 OFF-SITE WATERSHEDS

2.3.1 Regional Watershed

The regional watershed at the project site is the Pohakuloa watershed. The total tributary area of the Pohakuloa watershed is approximately 507 square miles as shown in Figure 2-2 Regional Watershed from GIS Data. However, only a fraction of this watershed area drains to the project site.

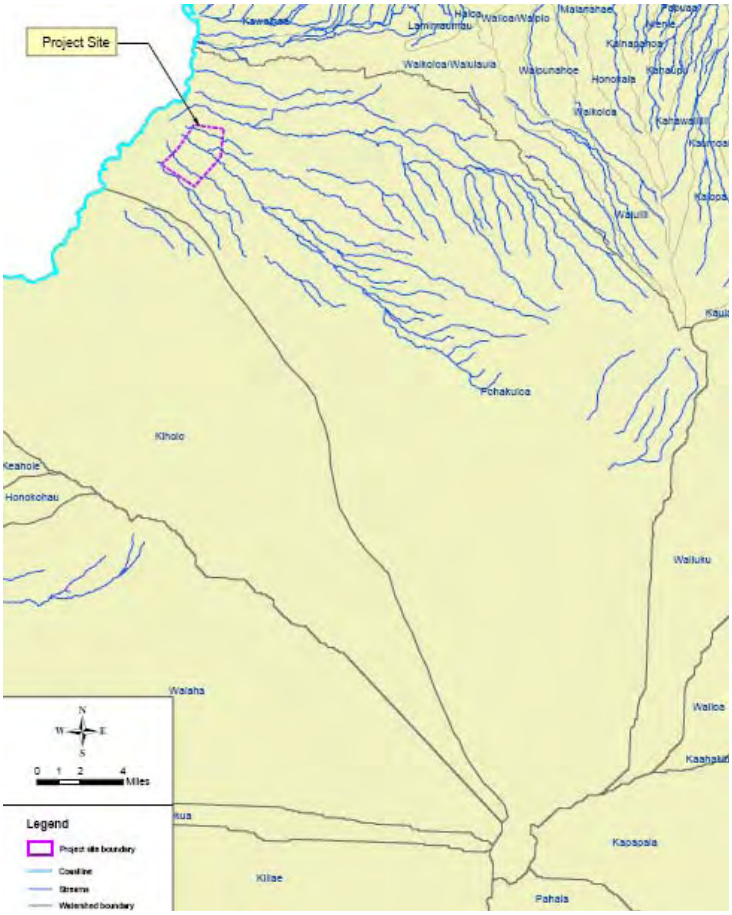

Figure 2- 2 Regional Watershed from GIS Data

2.3.2 Major Watershed Descriptions

Analysis of the GIS data for the regional watershed, as well as the visual inspection of the project site, shows that there are three gulches entering the project site from the tributary watersheds. These three gulches are Puako Gulch #4; Auwaiakeakua Gulch and Auwaiakeakua Gulch tributary. These gulches cross into the project site at four locations along the eastern boundary and all three discharges along the western boundary of the project site. The watersheds are:

Puako Gulch No. 4: Puako Gulch No. 4 originates on the slopes of Mauna Kea. The watershed boundaries are shown in Figure 2-3. This stream flows westerly, through the Waikoloa Village, and into the property.

Auwaiakeakua Gulch-North Tributary: The Auwaiakeakua Gulch-North Tributary originates on the slopes of Mauna Kea. The watershed boundaries are shown in **Figure 2-3**. This stream flows westerly, through the Waikoloa Village, and into the property.

Auwaiakeakua Gulch: The Auwaiakeakua Gulch originates on the slopes of Mauna Kea. The watershed boundaries are shown in **Figure 2-3**. This stream flows westerly and south of Waikoloa Village, and into the site.

2.3.3 South Stream Watershed Area

South Stream is an un-named stream that originates at Waikoloa Road. The watershed boundaries are shown in Figure 2-4. This stream flows south of Waikoloa Village, and then into the Urban District. The South Stream watershed was a one-time substantially larger than it is currently. The watershed has been substantially reduced in size by a number of events, including the construction of Waikoloa Road, “recent” lava flows plus the inability of the upper watersheds in this area to form new channels through young lava. The tributary watershed to the Aina Le`a project has been reduced to approximately 0.9 square miles.

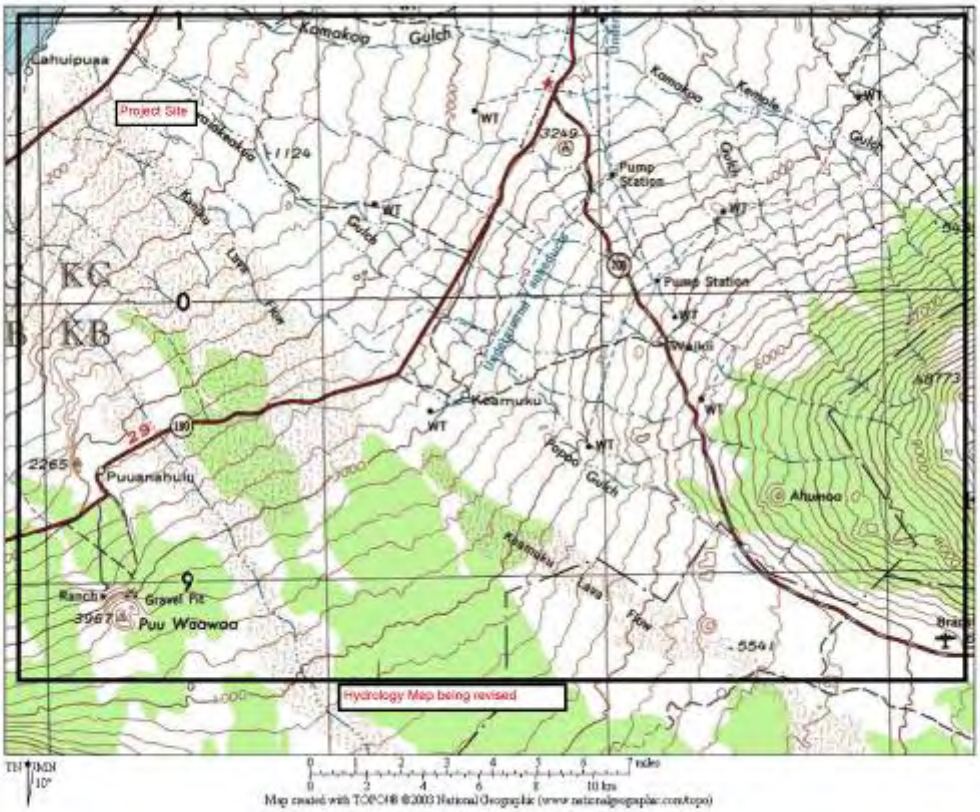

Figure 2- 3 Tributary Watershed Areas

2.3.4 Watershed Area Estimates

Each tributary watershed was analyzed using the 7.5 minute USGS quadrangle sheets and also using any available drainage reports. The results of this analysis are shown Table 2-2 - Stream Watersheds - Mauka of Project Site.

Table 2- 2 - Stream Watersheds - Mauka of Project Site

Stream Name	Mauka Watershed Area (Sq. Miles)	Source of Data
Puako Gulch No. 4	1.6	USGS Quad
Auwaiakeakua Gulch-North Tributary	17	USGS Quad
Auwaiakeakua Gulch	55	State DOT Drainage Reports and USGS Quad

2.3.5 Minor Off-site Watersheds

For the purposes of this report a minor off-site watershed is defined as a watershed with an area less than one square mile. There are a total of six (6) minor off-sites watersheds draining to the site, as shown in **Figure 2-4**. The watershed areas are shown in **Table 2-3**.

Table 2- 3 - Minor Off-Site Watersheds

Watershed	Area Tributary to Project Site Acres	Tributary to On-site Watershed
I	30	E-1
II	60	E-1
III	170	E-2
IV	30	E-4
V*	590	E-5
VI*	10	E-5

*South Stream lava field

2.3.6 Watershed Soils

Existing ground conditions consist of rock outcrops, loose "ash" type soil, a'a lava flows, rock land, and limited ground cover. Elevations within the project range from 170-feet MSL to 640-feet MSL. The watershed was mapped in the Soil Survey as **a`a lava** flow (Map Unit: rLV), **Puu Pa fine sandy loam** (Map Unit: PVD), **very stony land** (Map Unit: rVS) and **Kawaihae fine sandy loam** (Map Unit: KNC). Areas of coverage are show in **Figure 2-5 – Soils map**.

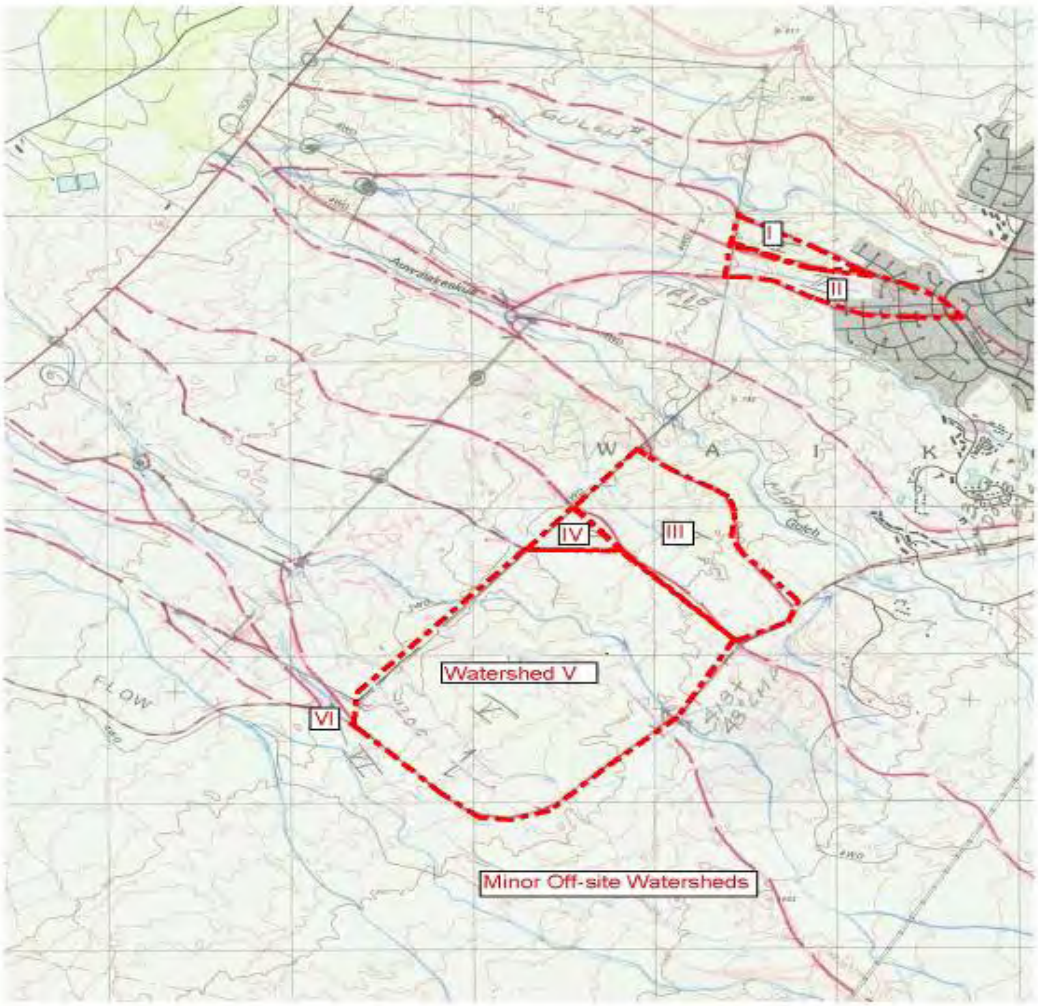

Figure 2- 4 Minor off-site watersheds

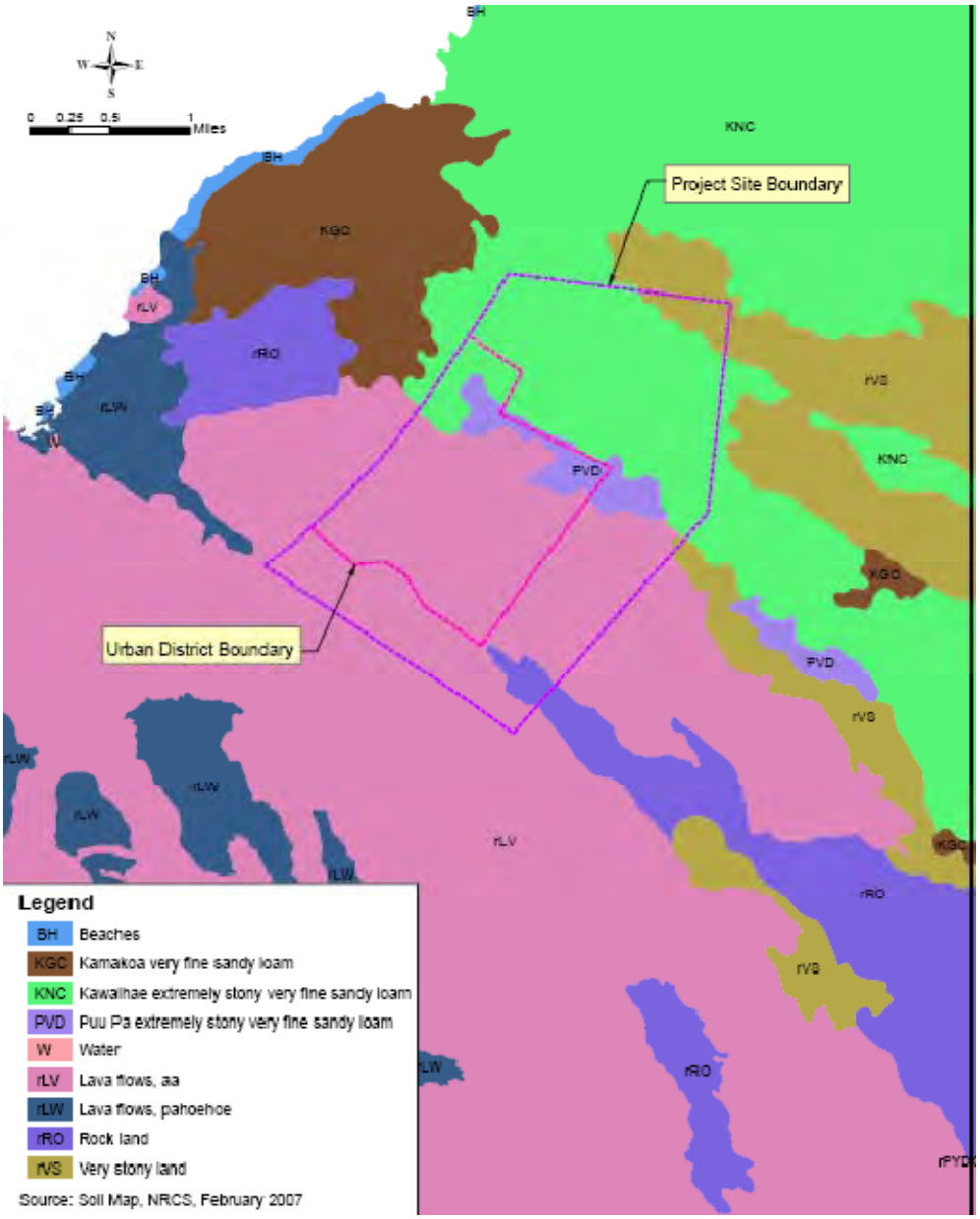

Figure 2- 5 Soils Map

2.3.7 Watershed Makai of Site

Significant off-site flows enter the project site. The on-site storm drain system would be designed to collect these flows and convey them through the site to the culverts located beneath Highway 19. There are total of eight (8) culverts that currently drain runoff away from the project site. Five of these culverts drain the Urban District.

These culverts discharge to streams makai of the highway and then flow to the ocean through the Puako Road floodplain. The Puako Road floodplain is a defined FEMA Flood Hazard Area.

2.4 ON-SITE WATERSHEDS

For the developed condition, the off-site tributary watersheds do not change. However, because of the improvements proposed in the Urban District, the drainage flows for the developed condition would be increased.

2.5 HYDROLOGIC CALCULATIONS

2.5.1 General

The Urban District was analyzed using the Rational Method. The basis for runoff calculation input-values was the COH Storm Drainage Standard and the NRCS TR-55 Manual.

Calculations were performed using the InteliSOLVE program HydraFlow Hydrographs 2007. HydraFlow is used to model watersheds using the Rational Method.

The rational method requires the input of three variables for each land use:

- land use area (acres)
  - provided by PBR in Table1-1– Land Use Summary
- Time of Concentration Tc (minutes)
  - The time of concentration for each watershed was set to 15 minutes for pre-project conditions.
- Runoff Coefficient (“C”)
  - calculated for each land-use using COH standards and PBR assigned land-use densities

2.5.2 Pre-project Flows for Urban District

Flows for each land use were calculated using the Rational Method. Land use characteristics are shown in Table 2.6 - Pre-project Flow from Urban District.

Table 2- 4 - Pre-project Flow from Urban District.

Land Use	ID	Area (Acres)	Density	"C"	Tc (min)	I (In/Hr)	Q-50 (CFS)
Single Family	SF	255	Undeveloped	0.10	15	3.7	94
Multi-family	MF	165	Undeveloped	0.10	15	3.7	61
Mixed Use	MU	25	Undeveloped	0.10	15	3.7	9
Affordable/Workforce Housing	AWH	46	Undeveloped	0.10	15	3.7	17
Commercial Village	C	36	Undeveloped	0.10	15	3.7	13
Golf Course	GC	250	Undeveloped	0.10	15	3.7	93
Golf Course Club House	GCH	4	Undeveloped	0.10	15	3.7	1
Highway Buffer	HB	234	Undeveloped	0.10	15	3.7	87
Parks/Openspace	O	37	Undeveloped	0.10	15	3.7	14
Major roadways	RD	40	Undeveloped	0.10	15	3.7	15
	Total	**1,092**					**404**

The total 50-year flow from the undeveloped Urban District is approximately 400 cfs.

2.5.3 Build-out Flows for Urban District

Build-out condition covers the hydrology when all pods have been developed to the Master Plan level of development. The build-out flows for the development pods are shown in Table 2.7 - Build-out From Development of Urban Areas. The total estimated peak storm drain flow calculated for the Urban District after build-out would be 1,956 cfs.

Table 2- 5- Build-out Flow from Development of Urban District.

Land Use	ID	Area (Acres)	Density	"C"	Tc (min)	I (In/Hr)	Q-50 (CFS)
Single Family	SF	255	3 DU/AC	0.63	10	4.3	691
Multi-family	MF	165	6 DU/AC	0.68	10	4.3	482
Mixed Use	MU	25	5 DU/AC	0.58	10	4.3	62
Affordable/Workforce Housing	AWH	46	11 DU/AC	0.70	10	4.3	138
Commercial Village	C	36	N/A	0.70	10	4.3	108
Golf Course	GC	250	N/A	0.14	10	4.3	151
Golf Course Club House	GCH	4	N/A	0.80	10	4.3	14
Highway Buffer	HB	234	N/A	0.14	10	4.3	141
Parks/Openspace	O	37	N/A	0.14	10	4.3	22
Major roadways	RD	40	N/A	0.85	10	4.3	146
	Total	**1,092**					**1,956**

2.5.4 Urban District Flow Change

The changes by watershed in 50-year peak storm flows resulting from build-out of the Urban District are summarized **in Table 2.8** - Increased Flows at Build-out -Urban District.

Table 2- 6 - Increased **Flows** at Build-out -Urban District

Urban District	Pre-project 50-Yr Flow (cfs)	Build-out 50-yr Flow (cfs)	Change in Peak Flow (cfs)
Totals	**404**	**1956**	**1552**

2.5.5 Runoff Volume Change

The Master Plan would provide storm water retention facilities for the completed development, including undeveloped space. These retention facilities would be constructed in each pre-development watershed in order to mitigate increases in both the flow rates and volumes. A summary of the volume changes is shown in Table 2-9 - Build-out 50-Yr Runoff Volumes – Urban District. The volume increase for the Urban District at build-out for the 50-year storm is 1,600,000 cubic feet or approximately 37 acre feet.

Table 2- 7 - Build-out 50-Yr Runoff **Volumes** – Urban District

Land Use	ID	Area (Acres)	Q-50 Volume Post-project (Million Cu Ft)	Q-50 Volume Pre-project (Million Cu Ft)	Increase (Million Cu Ft)
Single Family	SF	255	0.83	0.17	0.66
Multi-family	MF	165	0.58	0.11	0.47
Mixed Use	MU	25	0.07	0.02	0.06
Affordable/Workforce Housing	AWH	46	0.17	0.03	0.14
Commercial Village	C	36	0.13	0.02	0.11
Golf Course	GC	250	0.18	0.17	0.01
Golf Course Club House	GCH	4	0.02	0.00	0.01
Highway Buffer	HB	234	0.17	0.16	0.01
Parks/Openspace	O	37	0.03	0.02	0.00
Major roadways	RD	40	0.18	0.03	0.15
	Total	**1,092**	**2.3**	**0.7**	**1.6**

2.5.6 General Discussion

The Master Plan build-out would complete the following work:

- Collector roads and storm drain culverts
- Golf course
- Retention/Detention basins, as described in this section
- Flood control improvements
- Utility distribution systems

Residential buildings, commercial buildings and local roads would then be completed as part of build-out of <u>each pod</u>. Pods would be sold unimproved. Improvements, including local streets, drainage system, local stormwater quality management facilities and utility connections would be installed the time of each pod is developed. All pod-related facilities would be designed and constructed by the pod owners.

The County requires the project to retain any increase in peak flow and runoff volume for up to the 50-year storm. The increased peak flow would be retained, and increased volume would be detained and percolated into the Urban District soils. This would be accomplished through the use of a combination of drywells and un-lined surface basins.

The master plan facilities would include retention facilities for the full development. These retention facilities would be constructed within each pre-development land use area in order to mitigate increases in runoff flows and volumes.

On-site drainage facilities will be designed for the 10-year or for the 50-year storm, as required, meeting the COH Drainage Standards. Drainage improvements would include open channels, storm drains, culverts, catch basins, drywells, and roadway swales. The Urban District storm water conveyance systems would discharge into the golf course and/or into the Highway Buffer area at Highway 19.

III. HYDRAULICS

3.1 GENERAL

The master plan work would include the design and construction of culverts for the 50-yr storm. The development of the pods would occur at a later date. Detention/retention facilities would be designed for the 50-year storm. Major waterway structures would be sized for the 100-year storm.

The State and County require that the peak flow and the total volume of the 50-year storm reaching each culvert located under Highway 19, be at or less than pre-development values. The culvert system would provide a discharge point or points for each pod. These discharge points would be established to reflect the topography of each pod, the slope and location of collector roads, and the pre-development on-the site watershed boundaries.

The build-out hydrology estimated the flow of runoff that would be discharged from each land use type for a 50-yr storm at the Master Plan level of development. These estimated runoff flows are the maximum values that may be discharged from each land use type. On-pod retention or detention is required if the flows or volumes would exceed the tabulated values. Each pod system would also provide treatment in order to meet state and federal requirements for maintaining adequate runoff water quality. Design for both the treatment and the conveyance of flow through the pods would be the responsibility of the pod design professional.

3.2 HIGHWAY CULVERTS

There are five (5) culverts beneath the State Highway . The culvert characteristics are summarized in Table 3-1 - Highway 19 Culverts at Site.

Table 3- 1 - Highway 19 Culverts at Site

Highway Station**	Diameter (In)	No. Barrels	Material	Capacity (cfs)*	Stream Name
1254+85	180	1	6"x2" St Pl Pipe	2,300	Unnamed
1279+12	**30**	**1**	**CMP**	**30**	**Unnamed**
1291+00	**216**	**4**	**6"x2" St Pl Pipe**	**14,600**	**Kamakoa Gulch-**
1326+50	**84**	**1**	**3"x1" CMP**	**250**	**Unnamed**
1335+80	**60**	**1**	**3"x1" CMP**	**130**	**Unnamed**
1242+90	**180**	**4**	**6"x2" St Pl Pipe**	**9,200**	**Auwaiakeakua Gulch**
1349+93	72	1	3"x1" CMP	220	Unnamed
1366+05	84	4	3"x1" CMP	1,300	Puako Gulch No. 4

*RMT Study
Bold indicates culvert serving Urban District

3.3 Master Plan Culverts

The Master Plan storm drain system would provide drainage facilities in order to convey the design flow beneath collector roads installed as part of the Master Plan work. Culverts would be located in order to drain pre-development watersheds under the roads. We estimate at this point that there would be approximately 20 culverts constructed than eighth the Master plan roads. The location and size of these culverts would be determined during the preparation of the grading/drainage plans for the Urban District.

3.4 DISCHARGE TO GOLF COURSE

Runoff would be discharged to the golf course at several locations. The location of these discharges would be established by pre-project topography plus the location of the collector roads. Points of discharge and flows at each point would be established during preparation of the grading/drainage plans for the Urban District. There are two ponds proposed for use within the golf course. These ponds would be designed

during the preparation of golf course plans.

3.5 DETENTION AND RETENTION BASINS AT BUILD-OUT

The peak 50-year flow and volume that may be discharged to the culverts located Benes Highway 19 are limited by County and State regulations. Both the maximum peak flow and volume are limited to the pre-project levels for each culvert. Flow reduction would be accomplished by detention of the peak flow during the 50-year storm. The retention basin discussed below would provide a portion of the needed detention capacity.

Flow reduction would be accomplished by detention of the peak flow during the storm. If hydraulically feasible, the basins would be installed in the highway buffer area.

Volume reduction must be accomplished by retention of the storm flow and the infiltration of that flow into the ground. The project must provide a basin(s) that are designed to empty within 72 hours of the end of a storm so that the facility is available for use should another large storm follow on.

A volume reduction of 1,600,000 cubic feet in 72 hours would require that approximately 22,000 cu-ft per hour be infiltrated into the Urban District soils. This is approximately 0.5 acre-feet per hour (an acre foot is defined as that volume of water required to flood a 1 acre area to depth of 1 foot. This volume is equal to 43,560 cubic feet of water). Table 3-2 - shows the relationship of required basin size to the Design Infiltration Rate. .

Table 3- 2- Infiltration Areas for Urban District

Design Infiltration rate* (inches/hour)	Infiltration Volume (Acre Feet /Hour)	Required Infiltration Basin Area (Acres)
1	0.5	6
2	0.5	3
3	0.5	2
4	0.5	1.5
5	1.1	1.2

*The design infiltration rate would be determined by the geotechnical

engineer during the design phase of the project based on testing at the on-site basin locations.

3.6 FLOOD MAPPING

COH requires that any new development be protected from flooding resulting from a 100-year storm. The project storm drain system is designed for a 50-year storm. During a 100-year storm the Urban District storm drain system capacity would be exceeded.

Major streams must be analyzed and the 100-year floodplain identified. The development must meet the conditions of Chapter 27, Flood Control. The development should not encroach on the 100-year floodplain. And, the development must be elevated **above** the 100-year base flood elevation ("BFE").

Design flow rates for major streams and minor watersheds were determined in **Section II. HYDROLOGY.** These flows would be used in conjunction with the site topographic map for determining the 100-year floodplain boundaries.

3.6.1 Existing Drainageways:

Detailed floodplain boundaries would be determined within the Urban District boundary during preparation of the grading/drainage plan for the site.

IV. STORMWATER QUALITY

With development, various pollutants are introduced to the storm water runoff. Therefore, the quality of storm water runoff leaving the project site is of concern. The State of Hawaii (SDOT) requires that the project provide water quality treatment of the urban runoff in order to discharge to state-owned culverts. Since runoff from the project will ultimately discharge through the State's DOT storm drainage system via the culverts beneath and across Highway 19 (Queen Kaahumanu), it is also anticipated that the project will need to incorporate permanent BMPs in conformance with SDOT requirements.

In order to address the issue of storm water quality, retention/infiltration using open basins and/or drywells are proposed. All developed areas of the site are designed to drain into detention basins or drywells. The retention portion of the detention basins provides good storm water treatment by transferring surface

runoff to the groundwater regime. This filters out suspended pollutants and provides for other treatment processes before water returns to the surface system. The volume of the detention basins below the low flow outlet removes pollutants through sedimentation.

4.1 Water Quality Flow & Volume

For Water Quality Treatment Requirements, each land use area would provide runoff treatment facilities adequate to meet the State requirements for discharge to a State-owned culvert. The design flows and volumes for required treatment facilities are shown in Table 4.1 -Land Use Water Quality Flows and Volumes for SDOT Compliance.

Table 4- 8 -Land Use Water Quality Flows and Volumes for SDOT Compliance

Land Use	ID	Area (Acres)	Density (DU/AC)	Impervious Area (%)	Volume (Cu/ft)	Qwq (cfs)
Single Family	SF	255	3	45	2,269	63.8
Multi-family	MF	165	6	55	2,450	44.6
Mixed Use	MU	25	5	35	2,087	5.8
Affordable/Workforce Housing	AWH	46	11	60	2,541	12.9
Commercial Village	C	36	N/A	60	2,541	10.1
Golf Course	GC	250	N/A	5	508	14.0
Golf Course Club House	GCH	4	N/A	80	2,904	1.3
Highway Buffer	HB	234	N/A	5	508	13.1
Parks/Openspace	O	37	N/A	5	508	2.1
Major roadways	RD	40	N/A	90	3,086	13.6
	Total	**1,092**			**19,402**	**181**

As shown in Table 4-1, the storm water management facilities within the Urban District would have to retain on-site a total of approximately 20,000 ft.^{3} of storm water runoff during each 50 year storm. The water quality treatment facilities located within the Urban District would have to have a minimum treatment capacity of 181 CFS.

This report was prepared to comply with the guidelines established by the Department of Health, State of Hawaii and the Department of Public Works, County of Hawaii, and their representatives. Evaluation of the appropriateness of these guidelines and the accuracy of their data was beyond the scope of this work.

Usage of the report is limited to address the purpose and scope previously defined. SSFM International, Inc. shall not be held responsible for any unauthorized application of this report and the contents herein.

The opinions presented in this report have been derived in accordance with current standards of civil engineering practice. No other warranty is expressed or implied.

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Appendix F

Assessment of the Potential Impact on Water Resources
(Tom Nance Water Resource Engineering, Revised July 2009)

Assessment of the Potential Impact on Water Resources of the Development of the Aina Lea Village Project in South Kohala, Hawaii

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Table of Contents

	Page
Introduction	1
Description of the Project	1
Identification of the Project's Potential Changes to Water Resources	1
Use of Potable and Brackish Groundwater	1
Treatment and Disposal of Domestic Wastewater	5
Percolation of Excess Golf and Landscape Irrigation Water	5
Collection and Disposal of Stormwater Runoff	7
Description of the Groundwater Beneath and Inland of the Project Site	7
Groundwater Occurrence	7
Groundwater Flowrate	11
Groundwater Quality	11
Assessment of the Project's Potential Impact on Water Resources	17
Change in the Groundwater Flowrate Discharging Along the South Kohala Shoreline	17
Nutrient Additions to Groundwater Moving Beneath the Project Site	17
Availability of Groundwater Supply	21
References	24

List of Figures

No.	Title	Page
1	Location of the Aina Lea Project Site and Existing Wells in the Region	2
2	Conceptual Master Plan	3

List of Tables

No.	Title	Page
1	Proposed Land Uses for the 1060-Acre Urban Area of the Aina Lea Village Project	4
2	Estimated Average Potable Supply for Aina Lea's 1060-Acre Urban Area at Full Build-Out	6
3	Estimated Average Non-Potable Supply for the Aina Lea Project	6
4	Active Potable Quality Wells in the South Kohala Coastal Area	8
5	Active Brackish Irrigation Wells in the South Kohala Coastal Area	9
6	Inactive Potable Quality Wells in the South Kohala Coastal Area	10
7	Inactive Brackish Quality Wells in the South Kohala Coastal Area	10
8	Quality of Groundwater in Wells Directly Downgradient of the Aina Lea Project Site	12

Table of Contents

List of Tables
(continued)

No.	Title	Page
9	Quality of Groundwater in Wells Downgradient and to the North and South of the Aina Lea Project Site	13
10	Quality of Groundwater in Wells on or Near to the Aina Lea Project Site	14
11	Quality of Groundwater in Wells Upgradient of the Aina Lea Project Site	15
12	Summary Comparison of Regional Groundwater Quality Referenced to the Aina Lea Project Site	16
13	Changes to the Groundwater Flowrate by the Aina Lea Project	18
14	Quality of Treated Wastewater Effluent	20
15	Summary of Estimated Changes in the Nitrogen and Phosphorus in Groundwater as a Result of the Development of the 3000-Acre Aina Lea Project (Including the Proposed Three Golf Courses)	22
16	Present and Possible Future Groundwater Pumpage in the Aina Lea Project's Mauka-Makai Corridor	23

Introduction

This report presents an assessment of the potential impact on water resources of the development of the Aina Lea Village project on a 3000-acre site in South Kohala, Hawaii. The site is shown on Figure 1. It is comprised of TMKs 6-8-01:25 and 36 to 40. An interior 1060-acre portion of the site, also identified on Figure 1, has an Urban land use designation. The surrounding 1940 acres have an Agriculture land use classification.

Description of the Project

Information on the project used for this assessment has been obtained from the following sources: Conceptual Master Plan, Aina Lea Village by PBR Hawaii (April 20, 2009); Project District Application and Amendments to Ordinance 96-153 by Sidney M. Fuke, Planning Consultant (September 2007); Preliminary Engineering Report for the Villages of Aina Lea by SSFM International, Inc. (August 2007); and Master Drainage Report for the Villages of Aina Lea by SSFM International, Inc. (June 2007). Figure 2 illustrates the project's development plan developed by PBR Hawaii and Table 1 is a compilation of the proposed land uses within the 1060-acre urbanized project area. These uses include 2462 residential units, related commercial areas, one golf course, and substantial open space. Of the 1060 acres, about 490 acres would remain as undisturbed open space or would be landscaped parks and golf course. Development plans for the 1940-acre remaining area of the project are less defined, but it may include up to 863 agricultural residences and two more golf courses.

Identification of the Project's Potential Changes to Water Resources

The following four activities associated with the construction and occupation of the project have the potential to affect the region's water resources: (1) use of potable and brackish quality groundwater; (2) disposal of domestic wastewater; (3) percolation of excess landscape irrigation water to the underlying groundwater; and (4) the collection and disposal of stormwater runoff. Each of these is described below.

Use of Potable and Brackish Groundwater. Aina Lea has entered into agreement with the County Department of Water Supply (DWS) to develop up to four wells in the Ouli parcel and related reservoir storage and transmission improvements in the Ouli corridor just to the south and parallel to the Waimea-Kawaihae Road. Potable water from the Ouli wells would be added into the northern end of DWS' South Kohala system, thereby enabling the Aina Lea project to draw its potable water supply from DWS' existing infrastructure in the Lalamilo corridor. It is expected that each of the Ouli wells will be outfitted with a 700 to 850 gallons per minute (GPM) pump. By terms of the agreement, one of these wells will be considered standby and 20 percent of the capacity of the three remaining wells will be reserved for DWS. Based on the expected range of well pump capacities, the maximum day supply available to Aina Lea would be in the range of 2.4 to 2.9 million gallons per day (MGD). By DWS' design standards, this is equivalent to an average day supply of 1.61 to 1.96 MGD.

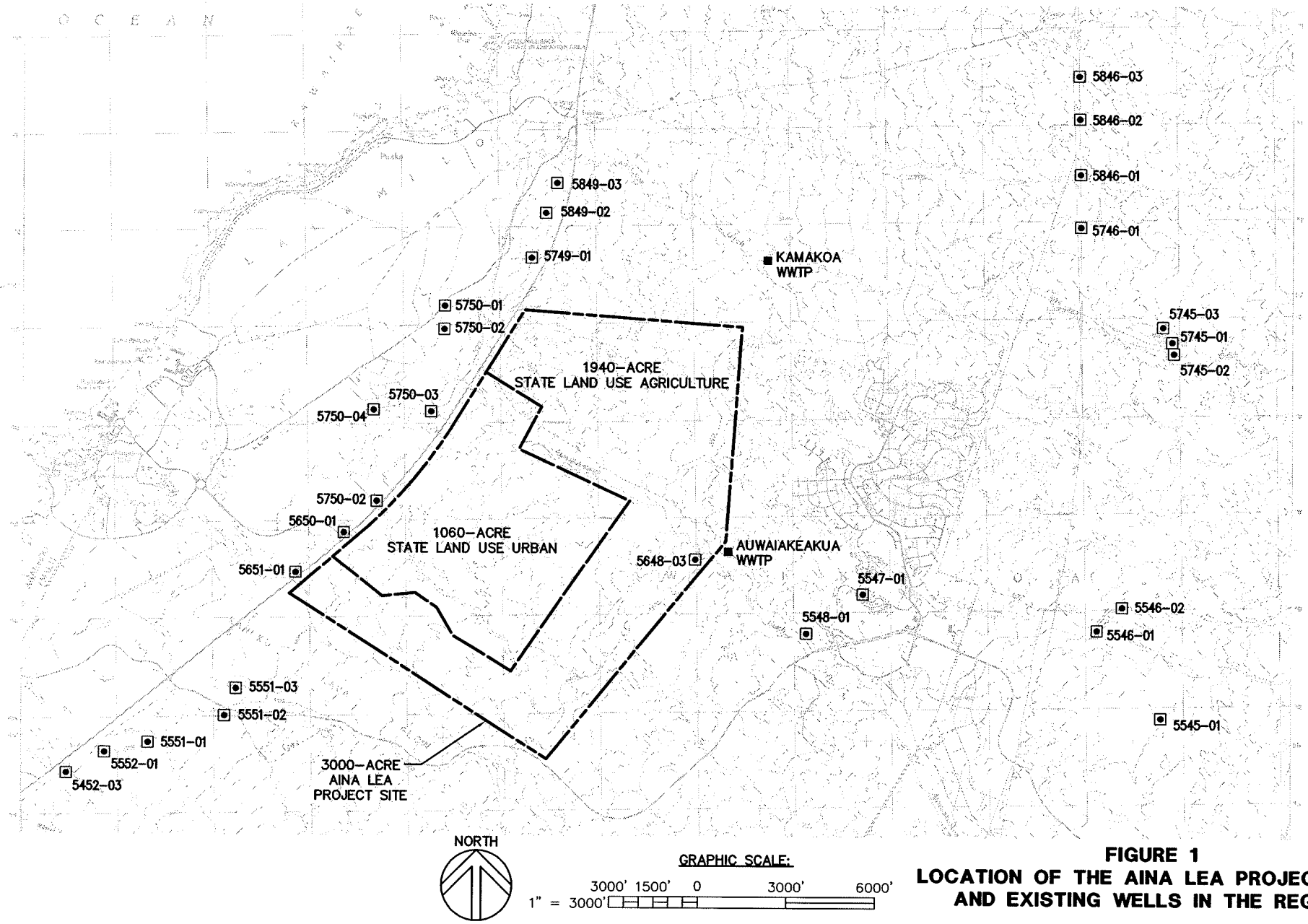


FIGURE 1
LOCATION OF THE AINA LEA PROJECT SITE AND EXISTING WELLS IN THE REGION

CONCEPTUAL MASTER PLAN

Aina Lea Village

Figure 2

DW AINA LE A DEVELOPMENT LLC

ISLAND OF HAWAII

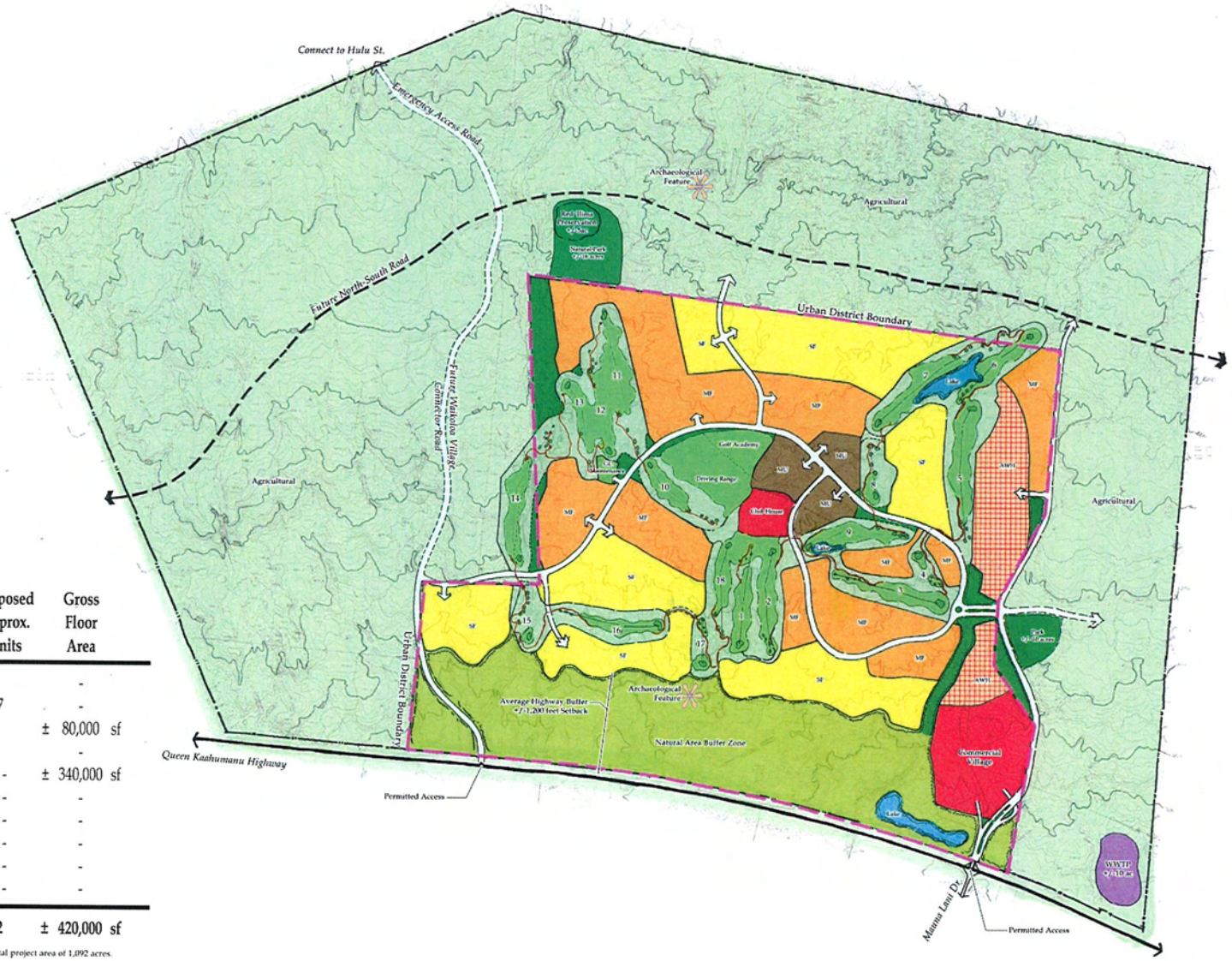
NORTH

LINEAR SCALE (FEET)

400 0 400 800 1600

PBR HAWAII

07/16/2009



Land Use Summary (Land Within Urban District)

	Land Use	Proposed Approx. Acreage	Proposed Approx. Units	Gross Floor Area
SF	Single Family (SF)	± 255	± 790	-
MF	Multi-Family (MF)	± 165	± 1,047	-
MU	Mixed Use (MU)	± 25	± 125	± 80,000 sf
AWH	Affordable / Workforce Housing (AWH)	± 46	± 500	-
C	Commercial Village (C)	± 36	-	± 340,000 sf
	Golf Course (GC)	± 218	-	-
Club House	Golf Course Club House	± 4	-	-
	Highway Buffer	± 234	-	-
	Parks / Open Space	± 37	-	-
	Major Roadways	± 40	-	-
	Total :	**± 1,060***	**± 2,462**	**± 420,000 sf**

* Note: DW Aina Lea Development, LLC owns an additional 32 acres in the Agricultural District for a total project area of 1,092 acres.

Table 1

Proposed Land Uses for the
1060-Acre Urban Area of the Aina Lea Project

Type of Land Use	Gross Area (Acres)	Number of Residential Units	Floor Area (Square Feet)
Single Family	255	790	
Multi-Family	165	1,047	
Affordable / Workforce Housing	46	500	
Mixed Use	25	125	80,000
Commercial	36		340,000
Golf Course	218		
Golf Course Clubhouse	4		
Parks / Open Space	37		
Major Roadways	40		
Highway Buffer	234		
Totals	1,060	2,462	420,000

Table 2 is a compilation of the average potable supply requirements for the Aina Lea project, based primarily on actual consumption rates in nearby Waikoloa Village which are somewhat higher than DWS' standards. The 1060-acre urbanized project area would require 1.32 MGD. Based on the range of supply to be provided by the Ouli wells, the available supply from the Ouli wells will be adequate for the urbanized area. However, that supply is not likely to be sufficient for 863 potential residential lots in the remaining 1940-acre Agricultural area. Assuming a use rate of 750 GPD per agricultural residential lot and one golf course clubhouse, the supply remaining after development of the 1060-acre urban area might accommodate between 360 and 830 residential lots in the remaining agricultural area.

Brackish groundwater would be used to irrigate the golf courses and roadways. Table 3 provides estimates of the necessary non-potable irrigation supply. The required 0.54 MGD for the 1090-acre urbanized area and the 1.0 MGD for the remaining 1940 acres would be provided by onsite brackish wells and reclaimed domestic wastewater .

Treatment and Disposal of Domestic Wastewater. All development in the 1060-acre urbanized project area would be sewered. Treatment would likely be at an onsite wastewater treatment plant (WWTP). As an alternative to an onsite WWTP, wastewater delivered to the Mauna Lani WWTP on the makai side of Queen Kaahumanu Highway for treatment there is also being considered. For the purpose of this assessment, however, it is assumed that an onsite WWTP is constructed and that its treated effluent is reused for golf course irrigation. The agricultural residential lots in the project site's remaining 1940 acres would have individual wastewater treatment and disposal systems comprised of septic tanks and leach fields in each lot.

As a basis for evaluating the impact of the project's wastewater treatment and reuse, it is assumed that 35 percent of the potable water use becomes wastewater. This assumed percentage is substantially higher than actual wastewater production in the South Kohala coastal resort area which ranges from 12 to 20 percent of potable water use. Treatment would be to an R-1 (tertiary) quality level so that the effluent could be reused for golf course irrigation. To avoid adversely impacting the Mauna Lani Resort's (MLR's) golf course irrigation wells which are directly downgradient (refer back to Figure 1), onsite R-1 treatment to maximize wastewater effluent reuse is appropriate.

Percolation of Excess Golf and Landscape Irrigation Water. Brackish (onsite) groundwater and reclaimed wastewater effluent would be used for golf course and roadway irrigation and potable water would be used for other landscape irrigation. For the analyses herein, it is assumed that 10 percent of the applied irrigation water will pass the plants' root zone and ultimately reach groundwater. This water will have picked up dissolved fertilizer in its movement through the soil and plant root zone.

Table 2

Estimated Average Potable Supply
for Aina Lea's 1060-Acre Urban Area at Full Build-Out

Type of Land Use	No. of Residential Units	Unit Use Rate (GPD / Unit)	Year-Round Average Water Use (GPD)
Single Family Residential	790	600	474,000
Multi-Family Residential	1,047	500	523,500
Affordable Residential	500	400	200,000
Mixed Use (MF Residential)	125	400	50,000
Mixed Use (Commercial)	80,000 ft^2	120 / 1000 ft^2	9,600
Commercial	340,000 ft^2	121 / 1000 ft^2	40,800
Golf Course Clubhouse	--	--	15,000
Parks / Open Space	--	--	10,000
Total for 1060-Acre Urban Area			1,322,900

Table 3

Estimated Average Non-Potable Supply
for the Aina Lea Project

Development Area	Land Use (Acres)	Irrigated Area (Acres)	Unit Use Rate (GPD / Acre)	Average Water Use (GPD)
1060-Acre Urban Area	Golf Course	90	5,500	495,000
	Roadway	8	4,000	32,000
	Total	98	--	527,000
1940-Acre of Agricultural Land	Golf Courses (2)	180	5,500	990,000
Total Non-Potable Supply for the 3,000-Acre Aina Lea Site				1,517,000

Collection and Disposal of Stormwater Runoff. There are four large pipe culverts in Queen Kaahumanu Highway that were designed to receive runoff generated on the project site and from lands further inland. However, only the two northern culverts have ever had any runoff from the mauka lands reach or pass through them since their installation in the early 1970s. On the southern half of the project site where most of the ground surface unweathered a'a lava, the drainageway delineations on the USGS Puu Hinai quadrangle map are not actually stormwater gulches. They are simply the lateral boundaries of various lava flows which appear, in aerial photos, to be drainageways.

The two gulches which cross the north end of the project, Auwaiakeakua and the unnamed gulch to the north of Auwaiakeakua, do convey runoff through the project site, beneath Queen Kaahumanu Highway, and onto the Puako Flats area. At this end of the project site, the lavas are older and the areal coverage of the ash soil deposits on the lava flows is greater. However, runoff in these gulches is infrequent, typically of less than once in three years average occurrence.

The design intent for handling stormwater runoff, as described in the SSFM drainage report, is to utilize retention/detention basins and "drywells" so that there will be no increase in runoff leaving the site as a consequence of its development. With the high permeability of the ground surface and sparse nature of development, this seems is achievable. For the analyses herein, it is assumed that this drainage scheme is successfully implemented. As a result, this assessment of the project's impact on water resources is limited to changes in the quality of rainfall percolating to groundwater, not a change in the quantity or as a contribution to surface runoff leaving the site.

Description of the Groundwater Beneath and Inland of the Project Site

Groundwater Occurrence. Knowledge of groundwater occurrence in the South Kohala coastal area comes primarily from the numerous drilled wells which have been constructed and operated since the early 1960s. Locations of some of these that are closest to the project site are shown on Figure 1 and information on all of the South Kohala coastal wells is compiled in Tables 4 to 7. Groundwater in the South Kohala coastal area to at least four miles from the shoreline occurs as a basal lens floating on saline water at depth and in hydraulic contact with the ocean at the shoreline. Generalizations about this groundwater occurrence are as follows:

- Groundwater stands about 1.5 to 2.0 feet above the ocean level along the makai end of the project site and about 3.0 feet above ocean level along the inland end of the site. The groundwater level moves up and down semi-diurnally with the ocean tide. More significantly, it also moves up and down with longer term fluctuations of the ocean's mean water level due to large-scale meteorological events.

Table 4

Active Potable Quality Wells in the South Kohala Coastal Area

Well		Owner / Operator	Year Drilled	Year in Service	Ground Elevation (Feet MSL)	Total Depth (Feet)	Casing Diameter (Inches)	Installed Pump Capacity (GPM)	Average Use in 1999 (MGD)	Representative Chlorides (MG/L)	Water Temperature (° F.)	Static Water Level (Feet MSL)	Distance Inland (Miles)
State No.	Name												
5546-01	DW-2	West Hawaii Utilities	1989	1991	1193	1317	16	1000	0.04	104	83.3	8.0	5.21
5546-02	DW-3	West Hawaii Utilities	1991	1997	1219	1330	16	1000	0.45	63	82.6	9.6	5.20
5545-01	DW-6	West Hawaii Utilities	2004	2007	1319	1390	16	1000	0.40	75	83.0	6.8	6.25
5745-01	DW-5	West Hawaii Utilities	1969	1975	1207	1236	12	700	1.31	24	79.7	17	4.77
5745-02	DW-4	West Hawaii Utilities	1969	1975	1203	1231	12	700	0.92	27	79.9	17	4.83
5745-03	DW-1	West Hawaii Utilities	1988	1989	1196	1333	16	1500	0.33	25	79.8	17	4.66
5846-01	Parker 2	Hawaii County DWS	1992	1999	1146	1240	20	1200	0.78	60		6.4	3.75
5846-02	Parker 1	Hawaii County DWS	1993	2000	1178	1275	20	1200	Not in Service in 1999	32	79.8	6.4	3.79
5946-01	Lalamilo A	Hawaii County DWS	1977	1983	1172	1277	12	700	0.49	78	79.7	8.2	3.54
5946-02	Lalamilo B	Hawaii County DWS	1980	1981	1089	1158	16	1000	0.91	40	80.6	6.6	3.36
5946-03	Lalamilo C	Hawaii County DWS	1980	1985	1087	1158	16	1000	0.82	58	79.2	7.6	3.22
5946-04	Lalamilo D	Hawaii County DWS	1985	1992	1084	1144	16	1000	Out of Service	90		7.0	3.19

Notes:
1. Use of Parker 2 (No. 5846-01) began in June 1999. For the last seven months of the year, its average use was 1.32 MGD.
2. Parker 1 (No. 5846-02) was put into service in May 2000.
3. Lalamilo D (No. 5946-04) has been out of service since April 1997.

m_06-47_puako_08-68

Table 5

Active Brackish Irrigation Wells in the South Kohala Coastal Area

Well		Owner / Operator	Year Drilled	Year in Service	Ground Elevation (Feet MSL)	Total Depth (Feet)	Casing Diameter (Inches)	Installed Pump Capacity (GPM)	Average Use in 1999 (MGD)	Representative Chlorides (MG/L)	Water Temperature (° F.)	Static Water Level (Feet MSL)	Distance Inland (Miles)
State No.	Name												
5352-02	Landfill	Puu Anahulu Landfill	1993	1994	191	220	8	100	- -	925			1.84
5452-01	Nursery	West Hawaii Utilities	1980	1981	40	43	Dug Pit	900	0.34	770	76.8		0.70
5452-02	Well 51	West Hawaii Utilities	1980	1981	51	53	72	700	0.78	550	74.0		0.87
5452-03	Irrig. No. 1	West Hawaii Utilities	1988	1988	51	62	12	350	0.46	675	75.4		1.08
5551-01	Irrig. No. 3	West Hawaii Utilities	1990	1990	92	110	12	500	0.56	600	75.7		1.61
5552-01	Irrig. No. 2	West Hawaii Utilities	1988	1988	81	91	12	700	0.65	510	75.9		1.31
5548-01	Parker 1	West Hawaii Utilities	1968	1975	814	849	12	700	0.48	650	84.2	6.1	3.96
5547-01	WVA GC	Waikoloa Village Assoc.	2007	2008									
5650-02	Culvert	Mauna Lani Service	1991	1992	118	160	12	300	0.20	950	81.4		1.65
5651-01	Highway	Mauna Lani Service	1988	1990	121	130	12	450	0.59	760	77.9		1.57
5749-01	North	Mauna Lani Service	1991	1995	90	100	12	460	0.61	615	80.3		1.01
5750-01	Puako Shaft	Mauna Lani Service	1960	1988	37	39	Horiz. Shaft	1320	1.47	890	82.3	1.8	1.18
5750-02	Parker 6	Mauna Lani Service	1909	1988	51	55	66	75	0.01	765	82.6		1.17
5750-03	Fire Station	Mauna Lani Service	1988	1990	58	70	12	425	0.38	840			1.71
5750-04	STP	Mauna Lani Service	1989	1990	54	70	12	360	0.38	940	81.8		1.42
5948-01	Hapuna	State Parks	1970	1975	247	268	10	- -	- -	435			0.82
6047-01	Ouli C	Mauna Kea Properties	1990	1996	724	764	12	450	0.45	295	79.9	4.6	2.17
6047-02	Ouli D	Mauna Kea Properties	1991	1996	707	758	12	450	0.41	350	78.4	4.3	2.06
6048-02	MKBH No. 1	Mauna Kea Properties	1963	1965	342	376	10	425	0.57	440			0.86
6049-01	MKBH No. 2	Mauna Kea Properties	1963	1965	186	218	12	300	0.28	470			0.42

Note: Waikoloa's Parker 1 well has been out of service since October 1997. Its average use for the first nine months of 1999 was 0.64 MGD.

m_06-47_puako_08-68

Table 6

Inactive Potable Quality Wells in the South Kohala Coastal Area

Well		Owner / Developer	Year Drilled	Ground Elevation (Feet MSL)	Total Depth (Feet)	Casing Diameter (Inches)	Representative Chlorides (MG/L)	Water Temperature (° F.)	Static Water Level (Feet MSL)	Distance Inland (Miles)
State No.	Name									
5347-01	Puu Anahulu	State DLNR	1994	1545	1557	- -	- -	- -	- -	6.88
5545-01	Waikoloa DW-7	Waikoloa Development Co.	2008	1185	1285	18	25	79.6	14.5	4.75
5846-03	Parker 3	Mauna Lani Service	2005	1176	1257	20	25	79.7	4.8	3.74
5746-01	Parker 4	Mauna Lani Service	2005	1110	1183	20	75	80.3	7.0	3.93
6046-01	Ouli 1	Nansay	1989	1302	1400	14	40	78.8	12.2	3.77
6145-01	Ouli Kawamata	Kawamata	1995	1575	1670	20	90	- -	- -	4.39
6146-01	Ouli 2	Nansay		1306	1362	- -	50	82.0	10.3	3.69

Table 7

Inactive Brackish Quality Wells in the South Kohala Coastal Area

Well		Owner / Developer	Year Drilled	Ground Elevation (Feet MSL)	Total Depth (Feet)	Casing Diameter (Inches)	Representative Chlorides (MG/L)	Water Temperature (° F.)	Static Water Level (Feet MSL)	Distance Inland (Miles)
State No.	Name									
5551-02	Irrig. No. 4	Waikoloa Development Co.	1991	95	114	12	420	75.4	1.86	1.83
5551-03	Irrig. No. 5	Waikoloa Development Co.	1991	126	141	12	430	74.9	1.63	1.80
5648-01	Parker 2	Boise Cascade	1968	621	651	3	370	81.5	5.1	3.11
5648-03	Puako No. 1	Nansay	1992	597	637	14	800	81.5		3.07
5650-01	Entry	Mauna Lani Service	1991	134	180	8	935			1.61
5849-02	Well No. 8	Mauna Lani Service	1999	144	160	12	440	79.2		0.84
5849-03	Well No. 9	Mauna Lani Service	1999	140	158	12	470	79.5		0.71
6048-01	Kawaihae Well 2	State DLNR	1961	392	430	10	505	79.1	3.3	0.94
6048-03	Ouli North	Mauna Kea Properties	1980	315	347	14	730		3.0	0.79
6049-05	Ouli South	Mauna Kea Properties	1979	300	340	14	575		3.0	0.86
6147-01	Kawaihae Well 16	State DLNR	1963	982	1046	8	265	95.2	5.0	2.58
6148-01	Kawaihae Well 1	Hawaii DWS	1961	583	601	10	385	81.0	3.3	1.63
6148-02		Hawaii DWS	1969	583	601	10	460	79.5	3.3	1.63

- The ocean's tidal variation is transmitted inland as a pressure wave in basal groundwater. Its amplitude is attenuated and its arrival time is lagged with distance inland. At locations further inland than the project site, tidally-driven water level variations are too small to be discernable. However, there are semi-diurnal groundwater level variations due to changes in barometric pressure at these inland wells.
- Along with an increasing thickness of the basal lens with distance inland, there is typically a decrease in salinity. However, there is significant variability in groundwater movement through various mauka-makai corridors due to geologic control. This produces substantial variations in salinity from one location to the next.
- Most well water temperatures are elevated by geothermal heating to at least some extent. Groundwater temperatures are generally in the high 70s to the low 80s in Fahrenheit degrees. Regionally, the highest temperatures are found along the Waimea-Kawaihae Road (95.2° F. in Well 6147-01, for example) and in the vicinity of Kawaihae Harbor.
- With some notable exceptions, formation permeabilities, as discerned by drawdown in wells due to pumping, are very high. This has enabled large capacity wells to be developed with relatively modest drawdowns. Pumping rates from wells have generally been determined by supply requirements, cost, infrastructure capacity, and avoiding salinity intrusion. They are not typically limited by formation permeability.

Groundwater Flowrate. A number of prior studies have provided estimates of the magnitude of the groundwater flowrate. These studies are, in chronological order: Kanehiro and Petersen, 1977; Nance, 1981; George A.L. Yuen & Associates, 1992; and Water Resource Associates, 1992. A summary evaluation of these is presented in Tom Nance Water Resource Engineering (TNWRE), 2000. Drawing primarily from TNWRE 2000, the following flowrate estimates will be used for subsequent calculations herein: over the nine-mile long coastal segment between Kawaihae Harbor on the north and Anaehoomalu Bay on the south, the total groundwater flowrate is about 90 million gallons per day (MGD); pumpage of all wells is approximately 15 MGD; the remaining 75 MGD discharges into the marine environment, equivalent to an average of about eight MGD per coastal mile; groundwater flowing directly beneath the 1.6-mile wide urbanized area is about 11 MGD; and groundwater flowing directly beneath the 2.9-mile wide entire project area is about 20 MGD. These flowrates beneath the project site are about 10 percent less than the overall average between Kawaihae Harbor and Anaehoomalu Bay, an appropriate reduction based on observed salinities of the various wells.

Groundwater Quality. Tables 8 through 11 are compilations of the groundwater quality presented by geographic areas in relation to the Aina Lea project site. Table 12 is a summary of average constituent concentrations by geographic area. Several of the most important groundwater quality characteristics are noted below.

Table 8. Quality of Groundwater in Wells Directly Downgradient of the Aina Lea Project Site

Wells State No.	Name	Sample Date	NO3 (µM)	NH4 (µM)	DON (µM)	TN (µM)	PO4 (µM)	DOP (µM)	TP (µM)	Si (µM)	Salinity (o/oo)
5650-01	Highway	08-Oct-07	62.80	1.65	6.35	70.80	1.35	0.15	1.50	848	1.840
		22-Oct-07	77.30	1.10	4.90	83.30	1.55	0.60	2.15	1038	1.846
		16-May-08	87.10	4.40	10.90	102.40	2.20	0.60	2.80	962	1.840
		25-Sep-08	64.56	0.72	8.08	73.36	1.44	0.64	2.08	949	1.832
		22-Dec-08	68.90	2.60	21.90	93.40	3.00	3.30	6.30	930	1.827
		Averages	72.13	2.09	10.43	84.65	1.91	1.06	2.97	945	1.837
5650-02	Culvert	05-Oct-06	99.20	3.04	2.96	105.20	1.12	1.04	2.16	967	1.812
		08-Oct-07	96.70	0.65	5.10	102.50	1.10	0.10	1.20	930	1.820
		22-Oct-07	117.60	0.30	16.30	134.20	1.70	0.70	2.40	1141	1.824
		05-May-08	99.80	1.00	36.20	137.00	1.80	0.90	2.70	994	1.816
		16-May-08	106.60	5.60	16.10	128.30	2.20	0.50	2.70	1063	1.811
		19-May-08	107.50	1.70	29.60	138.80	2.00	0.50	2.50	1069	1.816
		25-Sep-08	90.16	0.56	7.60	98.32	1.52	0.24	1.76	1001	1.818
		22-Dec-08	102.60	2.30	26.60	131.50	3.00	2.70	5.70	1004	1.818
		Averages	102.52	1.89	17.56	121.98	1.81	0.84	2.64	1021	1.817
5750-04	STP	05-Oct-06	124.88	1.12	6.32	132.32	1.36	0.80	2.16	943	1.907
		30-Apr-07	127.12	2.32	49.44	176.88	1.60	0.48	2.08	922	1.851
		07-May-07	126.88	2.72	37.84	167.44	1.84	0.32	2.16	909	1.845
		14-May-07	135.84	2.32	19.52	157.68	1.44	0.40	1.84	957	1.875
		08-Oct-07	125.60	0.55	3.95	130.10	1.45	0.10	1.55	886	1.920
		22-Oct-07	143.10	0.00	4.15	147.20	1.55	0.45	2.00	1046	1.914
		05-May-08	123.00	1.40	29.10	153.50	1.80	0.70	2.50	932	1.915
		16-May-08	133.50	3.60	32.40	168.50	2.00	0.60	2.60	988	1.892
		19-May-08	132.40	2.20	19.00	153.60	2.00	0.30	2.30	981	1.910
		25-Sep-08	128.24	0.56	4.56	133.36	1.44	0.32	1.76	968	1.926
		12-Dec-08	131.30	1.40	3.10	135.80	1.40	0.80	2.20	928	1.861
		15-Dec-08	122.90	2.10	41.40	166.40	1.80	2.20	4.00	931	1.884
		22-Dec-08	131.50	0.10	18.20	149.80	3.10	2.70	5.80	961	1.937
		Averages	129.71	1.57	20.69	151.74	1.75	0.78	2.53	950	1.895
5750-03	Fire Station	05-Oct-06	126.40	1.60	10.27	138.27	1.12	1.04	2.16	972	2.163
		30-Apr-07	126.48	2.40	34.64	163.52	1.68	0.72	2.40	928	2.175
		07-May-07	*127.76*	*2.40*	16.24	146.40	1.84	0.16	2.00	940	2.124
		14-May-07	133.36	2.24	15.04	150.64	1.52	0.16	1.68	956	2.174
		08-Oct-07	125.00	0.85	8.10	134.00	1.05	0.15	1.02	902	2.190
		22-Oct-07	148.10	0.45	0.55	149.10	1.95	0.30	2.25	1067	2.133
		05-May-08	129.60	3.10	22.80	155.50	1.80	0.60	2.40	955	2.181
		16-May-08	140.60	4.90	5.00	150.50	2.10	0.40	2.50	1027	2.178
		19-May-08	140.50	1.20	24.70	166.40	2.00	0.50	2.50	1040	2.184
		25-Sep-08	124.56	0.80	5.68	131.04	1.28	0.40	1.68	957	2.199
		15-Dec-08	127.20	1.40	42.10	170.70	1.40	1.60	3.00	935	2.175
		22-Dec-08	134.80	0.20	28.80	163.80	2.90	2.70	5.60	963	2.186
		Averages	132.03	1.80	17.83	151.66	1.72	0.73	2.43	970	2.172
5750-02	Parker Shaft	07-May-07	140.96	3.92	11.04	155.92	2.40	0.16	2.56	960	2.072
		14-May-07	146.48	4.24	14.64	165.36	1.76	0.24	2.00	969	2.070
		22-Oct-07	162.90	0.20	2.25	165.40	1.20	0.50	1.70	1093	2.086
		05-May-08	140.60	5.60	1.10	147.30	2.10	0.00	2.10	940	2.063
		16-May-08	151.50	5.10	10.20	166.80	2.00	0.50	2.50	1016	2.047
		19-May-08	163.20	3.70	26.80	193.70	2.10	0.60	2.70	1080	2.074
		25-Sep-08	141.84	2.72	10.00	154.56	1.36	0.32	1.68	967	2.077
		15-Dec-08	146.50	1.00	34.30	181.80	1.30	0.90	2.20	954	2.032
		22-Dec-08	153.70	1.00	9.90	164.60	3.10	3.90	7.00	994	2.074
		Averages	149.74	3.05	13.36	166.16	1.92	0.79	2.72	997	2.066
5750-01	Puako Shaft	12-Jul-06	148.00	2.20	2.60	152.80	1.90	2.20	4.10	1084	1.848
		05-Oct-06	126.32	1.52	1.10	128.94	1.36	1.04	2.40	933	1.769
		30-Apr-07	127.28	1.76	6.48	135.52	1.52	0.56	2.08	962	2.090
		07-May-07	127.12	3.12	17.04	147.28	2.16	0.16	2.32	936	2.077
		14-May-07	131.66	2.24	26.40	160.32	1.44	0.48	1.92	968	2.098
		08-Oct-07	126.00	1.80	4.80	132.60	1.35	0.20	1.55	910	2.110
		22-Oct-07	148.90	1.15	8.60	158.60	1.60	0.70	2.30	1083	2.090
		05-May-08	133.80	4.30	19.00	157.10	2.10	0.30	2.40	951	1.933
		16-May-08	139.60	2.70	11.50	153.80	2.10	0.50	2.60	996	2.016
		19-May-08	141.60	3.70	16.70	162.00	2.80	0.20	3.00	1001	1.960
		25-Sep-08	133.76	2.16	3.60	139.52	1.20	0.48	1.68	973	2.074
		12-Dec-08	116.90	0.60	1.00	118.50	1.40	0.80	2.20	941	1.775
		15-Dec-08	133.00	1.50	39.80	174.30	1.70	3.10	4.80	935	2.000
		22-Dec-08	140.10	2.60	13.00	155.70	2.60	2.80	5.40	970	1.999
		Averages	133.86	2.24	12.26	148.36	1.80	0.97	2.77	974	1.989
Average of the Six Wells			120.00	2.11	15.35	137.42	1.82	0.86	2.68	976	1.963

Notes: 1. All samples collected by Tom Nance of Tom Nance Water Resource Engineering.
2. All analyses by Marine Analytical Specialists.

Table 9. Quality of Groundwater in Wells Downgradient and to the North and South of the Aina Lea Project Site

Location of the Wells	Wells State No.	Name	Sample Date	NO3 (µM)	NH4 (µM)	DON (µM)	TN (µM)	PO4 (µM)	DOP (µM)	TP (µM)	Si (µM)	Salinity (o/oo)
To the North	5749-01	North	12-Jul-06	113.30	0.90	13.80	128.00	2.30	2.30	4.60	1077	1.559
			05-Oct-06	90.88	1.36	14.29	106.53	1.20	1.04	2.24	926	1.556
			30-Apr-07	94.48	2.00	1.84	98.32	2.00	0.32	2.32	945	1.553
			07-May-07	95.84	3.12	30.24	129.20	2.32	0.16	2.48	943	1.555
			14-May-07	102.16	2.40	18.08	122.64	1.92	0.16	2.02	966	1.550
			08-Oct-07	89.85	1.30	2.55	93.70	1.55	0.25	1.80	866	1.560
			22-Oct-07	110.90	1.10	8.85	120.90	1.85	0.50	2.35	1099	1.552
			05-May-08	92.10	5.50	22.80	120.40	2.10	0.30	2.40	921	1.541
			16-May-08	99.70	3.30	26.00	129.00	2.20	1.10	3.30	991	1.543
			19-May-08	101.80	4.00	25.70	131.50	2.20	0.40	2.60	1008	1.547
			25-Sep-08	93.12	1.92	0.16	95.20	1.60	0.32	1.92	962	1.547
			12-Dec-08	93.90	4.20	1.10	99.20	2.30	0.10	2.40	929	1.522
			15-Dec-08	89.30	0.90	24.20	114.40	1.80	0.80	2.60	925	1.540
			22-Dec-08	97.10	2.60	10.10	109.80	2.90	3.70	6.60	976	1.544
			Averages	97.46	2.47	14.27	114.20	2.02	0.82	2.83	967	1.548
	5849-02	MLR 8	12-Jul-06	103.80	2.20	16.30	122.30	2.50	2.20	4.70	1055	1.169
			05-Oct-06	83.84	4.88	6.50	95.22	1.44	0.80	2.24	888	1.162
			30-Apr-07	86.32	2.08	12.96	101.36	2.00	0.48	2.48	950	1.167
			07-May-07	85.44	3.76	20.56	109.76	2.32	0.24	2.56	916	1.170
			14-May-07	95.3.6	1.68	22.16	119.20	2.00	0.08	2.08	942	1.166
			08-Oct-07	83.20	1.45	0.20	84.85	1.45	0.10	1.55	871	1.170
			22-Oct-07	98.55	1.65	4.50	104.70	1.80	0.55	2.35	1048	1.171
			05-May-08	80.80	4.80	33.60	119.20	2.00	0.20	2.20	892	1.169
			16-May-08	76.00	4.50	6.90	87.40	2.30	0.40	2.70	1006	1.176
			19-May-08	93.90	3.30	31.30	128.50	2.30	0.50	2.80	1026	1.175
			25-Sep-08	81.84	1.76	7.68	91.28	1.36	0.56	1.92	959	1.182
			12-Dec-08	83.20	2.90	3.90	90.10	2.20	0.20	2.40	915	1.177
			15-Dec-08	68.60	1.70	39.90	110.20	1.10	1.70	2.80	897	1.181
			22-Dec-08	87.80	2.70	24.50	115.00	3.00	3.90	6.90	952	1.185
			Averages	85.64	2.81	16.50	105.65	1.98	0.85	2.83	951	1.173
	5849-03	MLR 9	12-Jul-06	108.10	2.30	11.80	122.20	2.80	2.00	4.80	1010	1.117
			05-Oct-06	88.32	4.72	3.60	96.64	1.76	0.90	2.56	942	1.115
			30-Apr-07	84.16	1.12	93.28	178.56	1.52	0.96	2.48	934	1.122
			05-May-08	86.20	5.80	12.30	104.30	2.10	0.10	2.20	931	1.120
			16-May-08	93.80	0.00	31.80	125.60	2.40	0.60	3.00	1018	1.130
			19-May-08	96.60	5.50	14.90	117.00	2.20	0.40	2.60	1038	1.142
			25-Sep-08	78.96	2.08	6.56	87.60	1.36	0.56	1.92	958	1.147
			12-Dec-08	82.50	2.40	1.90	86.80	2.20	0.50	2.70	914	1.133
			15-Dec-08	84.60	0.90	18.10	103.60	1.50	0.60	2.10	930	1.136
			22-Dec-08	88.20	0.90	27.90	117.00	3.10	4.00	7.10	957	1.147
			Averages	89.14	2.57	22.21	113.93	2.09	1.06	3.15	963	1.131
	Average of the Three Wells			90.75	2.62	17.66	111.26	2.03	0.91	2.94	960	1.284
To the South	5452-03	WBR Irrig 1	25-Aug-03	43.80	10.00	35.80	89.60	0.80	3.40	4.20	938	1.792
			24-Nov-08	52.96	5.60	22.00	80.56	1.52	1.44	2.96	847	1.765
	5552-01	WBR Irrig 2	25-Aug-03	45.70	7.00	25.80	78.50	0.50	3.00	3.50	936	1.736
			25-Sep-08	47.04	1.84	5.60	54.48	1.60	0.48	2.08	894	1.763
			28-Nov-08	43.80	3.40	13.30	60.50	2.00	0.70	2.70	845	1.752
	5551-01	WBR Irrig 3	25-Aug-03	45.40	6.00	26.10	77.50	1.40	2.40	3.80	966	1.488
			25-Sep-08	41.20	0.40	6.08	47.68	1.44	0.56	2.00	879	1.483
			24-Nov-08	57.52	3.20	44.40	105.12	1.76	1.52	3.28	864	1.424
	5551-03	WBR Irrig 5	25-Aug-03	48.60	14.10	54.30	117.00	1.70	1.50	3.20	950	1.236
			28-Nov-08	45.70	4.80	0.40	50.90	3.60	0.20	3.80	855	1.187
	Averages to the South			47.17	5.63	23.38	76.18	1.63	1.52	3.15	897	1.563

Notes: 1. All samples collected by Tom Nance of Tom Nance Water Resource Engineering.

Table 10. Quality of Groundwater in Wells on or Near to the Aina Lea Project Site

Location of the Wells	Wells State No.	Name	Sample Date	NO3 (µM)	NH4 (µM)	DON (µM)	TN (µM)	PO4 (µM)	DOP (µM)	TP (µM)	Si (µM)	Salinity (o/oo)
Onsite	5648-01	Aina Lea	25-Sep-08	71.28	0.40	10.24	81.92	1.04	0.72	1.76	951	2.052
			12-Dec-08	71.20	5.00	1.30	77.50	1.20	0.90	2.10	925	2.056
			22-Dec-08	76.40	0.90	22.70	100.00	2.60	3.80	6.40	949	2.068
			Averages	72.96	2.10	11.41	86.47	1.61	1.81	3.42	941	2.059
Immediately Upgradient	5548-01	Parker 1	25-Aug-03	59.10	11.40	22.10	92.60	1.00	1.90	2.90	1052	1.747
			16-May-08	64.00	0.64	2.96	67.60	0.56	0.72	1.28	1041	1.742
			19-May-08	63.30	6.50	16.40	86.20	1.50	0.40	1.90	1027	1.759
			25-Sep-08	55.20	1.36	6.24	62.80	1.12	0.56	1.68	973	1.760
			28-Nov-08	60.90	6.70	11.20	78.80	4.20	2.70	6.90	889	1.730
			12-Dec-08	53.30	2.90	0.70	56.90	1.40	3.30	4.70	824	1.690
			Averages	59.30	4.92	9.93	74.15	1.63	1.60	3.23	968	1.738

Notes:
1. All samples collected by Tom Nance of Tom Nance Water Resource Engineering.
2. All analyses by Marine Analytical Specialists.

Table 11. Quality of Groundwater in Wells Upgradient of the Aina Lea Project Site

Location of the Wells	Wells State No.	Name	Sample Date	NO3 (µM)	NH4 (µM)	DON (µM)	TN (µM)	PO4 (µM)	DOP (µM)	TP (µM)	Si (µM)	Salinity (o/oo)
Directly Mauka	5546-01	DW-2	16-May-08	97.60	1.00	23.40	122.00	2.70	0.40	3.10	1090	0.423
			19-May-08	99.50	4.70	15.30	119.50	2.60	0.20	2.80	1114	0.424
			25-Sep-08	85.92	1.92	2.72	90.56	1.92	0.64	2.56	1016	0.408
	5546-02	DW-3	16-May-08	102.96	1.84	26.64	131.44	2.00	0.88	2.88	100	0.305
			19-May-08	104.60	5.40	8.40	118.40	2.70	0.40	3.10	1093	0.290
	5545-01	DW-6	25-Sep-08	77.36	1.84	3.04	82.24	1.76	0.64	2.40	1051	0.424
	Averages			94.66	2.78	13.25	110.69	2.28	0.53	2.81	911	0.379
To the North	5745-01	DW-5	12-Jul-06	116.20	2.70	5.20	124.10	3.00	1.40	4.40	1136	0.195
			16-May-08	100.88	2.00	11.60	114.48	2.00	0.80	2.80	1044	0.198
			19-May-08	102.30	6.10	14.70	123.10	2.30	0.20	2.50	1059	0.206
			25-Sep-08	91.92	2.32	2.96	97.20	2.16	0.48	2.64	988	0.197
	5745-02	DW-4	12-Jul-06	118.08	1.70	14.50	135.00	3.10	1.90	5.00	1129	0.204
			16-May-08	106.16	1.68	14.80	122.64	2.24	0.56	2.80	1057	0.196
			19-May-08	109.20	8.30	9.30	126.80	2.70	0.50	3.20	1087	0.195
			25-Sep-08	93.20	0.48	3.84	97.52	2.00	0.40	2.40	993	0.199
	5745-03	DW-1	12-Jul-06	110.10	2.30	9.10	121.50	3.00	1.40	4.40	1098	0.188
			16-May-08	101.12	2.40	6.80	110.32	2.40	0.72	3.12	1069	0.189
			19-May-08	102.20	5.70	13.30	121.20	2.70	0.30	3.00	1065	0.197
			25-Sep-08	87.28	0.96	4.96	93.20	1.84	0.48	2.32	981	0.194
	Averages			103.22	3.05	9.26	115.59	2.45	0.76	3.22	1059	0.197

Table 12. Summary Comparison of Regional Groundwater Quality Referenced to the Aina Lea Project Site

Location of the Wells	NO3 (µM)	NH4 (µM)	DON (µM)	TN (µM)	PO4 (µM)	DOP (µM)	TP (µM)	Si (µM)	Salinity (o/oo)
Downgradient									
Directly Makai	120.00	2.11	15.35	137.42	1.82	0.86	2.68	976	1.963
to the North	90.75	2.62	22.21	111.26	2.03	0.91	2.94	960	1.284
to the South	47.17	5.63	27.51	76.18	1.61	1.52	3.15	897	1.563
Onsite	72.96	2.10	11.41	86.47	1.04	1.81	3.42	941	2.059
Directly Upgradient	94.66	2.78	13.25	110.69	2.28	0.53	2.81	911	0.379

- The salinities of Aina Lea's onsite well (No. 5648-01) and the well directly inland (No. 5548-01) are notably higher than in downgradient wells to the north and south of the project site, even though these wells are much closer to the shoreline. This is a reflection of a lesser groundwater flowrate directly beneath the project site in comparison to the mauka-makai corridors to the north and south.

- In comparison to regional averages, nitrogen, particularly as NO_3, is highest in the wells directly makai of the project site. Also in comparison to regional averages, nitrogen levels are exceptionally low within and to the south of the project site.

- The upgradient wells summarized in Table 12 are all inland of Waikoloa Village. Their nutrient levels (ie. nitrogen and phosphorus) are generally as high or even higher than wells which are downgradient of the influence of activities in Waikoloa Village. In addition to golf course and landscape irrigation, these activities include the direct disposal of treated wastewater effluent from Waikoloa's Auwaiakeakua and Kamakoa WWTPs in shallow pits at rates of 0.20 and 0.06 MGD on average, respectively. The locations of these disposals are also shown on Figure 1. Disposal of the Auwaiakeakua WWTP effluent is directly upgradient of the Aina Lea site. Disposal of the Kamakoa WWTP effluent is to the north of the Aina Lea site. The lack of an identifiable impact of Waikoloa Village generally and its pit disposal of wastewater specifically on regional groundwater quality is quite significant.

Assessment of the Project's Potential Impact on Water Resources

Change in the Groundwater Flowrate Discharging Along the South Kohala Shoreline. The project will extract groundwater from wells in Ouli for potable use and onsite for (brackish) irrigation. It will return water to the underlying groundwater as excess applied irrigation water and discharge from individual wastewater disposal systems in the ag-residential lots. At full build-out, meaning development limited by the available potable supply from the Ouli wells as described previously, the net decrease in groundwater flow to discharge along the South Kohala shoreline would be as compiled in Table 13. Total potable and brackish groundwater withdrawals would be 2.7 to 3.0 MGD. Total return to groundwater by percolation and effluent disposal would be 0.35 to 0.50 MGD. The net decrease of about 2.5 MGD is about 3.3 percent of the estimated 75 MGD discharging along to shoreline between Kawaihae Harbor and Anaehoomalu Bay. Within the mauka-makai corridor of the 3000-acre project area itself, the net decrease of groundwater would be on the order of 0.6 to 0.7 MGD or three percent of this corridor's groundwater flowrate.

Nutrient Additions to Groundwater Moving Beneath the Project Site. Potential additions of nitrogen and phosphorus to groundwater moving beneath the project site have been calculated based on the following:

Table 13

Changes to the Groundwater Flowrate
by the Aina Lea Project

	MGD
• Average Pumpage From the Ouli Potable Wells	
For the 1060-Acre Urban Area (Table 2)	1.32
For the Remaining 1940-Acre Area	0.29 to 0.63
Total for the Project	1.61 to 1.95
• Average Pumpage From Onsite Brackish Irrigation Wells	
Total Non-Potable Irrigation (Table 3)	1.52
Irrigation Provided by WWTP Effluent	0.46
Net Supply by Onsite Brackish Wells	1.06
• Return of Excess Applied Irrigation Water	
10% of Potable Water Used for Irrigation	0.10 to 0.13
10% of Non-Potable Water Used for Irrigation	0.15
Total	0.25 to 0.28
• Return of Wastewater From Septic Systems in the Ag-Residential Area	0.10 to 0.22

- The groundwater flow moving beneath top end of the 2.9-mile wide project site is 20 MGD. Changes to this flowrate would be as described below.

- Nitrogen and phosphorus concentrations in this groundwater at the inland edge of the site are 86 and 3.4 μM, respectively (concentrations in Well 5648-01 presented in Table 10). These are equivalent to 1.20 and 0.105 milligrams per liter (mg/l) as nitrogen and phosphorus.

- Nutrients in applied irrigation water that percolates to the groundwater below would be of two origins, dissolved in the water before its use for irrigation or dissolved into the water from applied fertilizers. For the originally dissolved constituents, it assumed that 50 percent of the nitrogen and phosphorus are taken up by plants and the remainder passes below the plant root zone. For the dissolution of applied fertilizer, the following series of assumptions have been made:

  - On the golf courses, nitrogen is applied at 8 pounds/year/1000 ft^2 of landscaped area and phosphorus is applied at 1 pound/year/1000 ft^2. Of these applications, 10 percent of nitrogen and two percent of the phosphorus would be carried below the plant root zone.

  - On other landscaped areas, fertilizer application rates are 70 percent of the rates on golf courses. Loss rates below the root zone are the same 10 and two percent of the applied fertilizer.

  - Percolating excess irrigation water must pass through hundreds of feet of dry lava before reaching the groundwater body near sea level. Nutrient removal during this passage through the vadose zone is similar to a "trickling filter" (as documented in TNWRE, 2002). It is assumed that these natural removal rates are 85 percent for nitrogen and 98 percent for phosphorus.

- Wastewater discharged from the residential septic systems in the 1940-acre portion of the project, which would amount to 35 percent of the 0.29 to 0.63 MGD of potable use, will have concentrations similar to the Auwaiakeakua WWTP (Table 14). These concentrations are 1917 μM (26.8 MG/L) as nitrogen and 158 μM (4.90 MG/L) as phosphorus. During passage through the vadose zone, removal rates will be 85 and 98 percent, respectively.

- Rainfall across the site averages 10 inches per year. As a first order approximation, it is assumed that half of this percolates to groundwater (5 inches/year over 3000 acres amounts to an average of 1.12 MGD) and that this amount is essentially unchanged after development. Data on the quality of stormwater runoff are relatively scarce, but that which is available (TNWRE, 2002) indicate that nitrogen and phosphorus levels in stormwater runoff are actually lower than in groundwater. Based on this, it is assumed that percolating stormwater has 20 and 2 μM increases of nitrogen and phosphorus after the project is developed in comparison to present conditions. Removal rates on passage through the vadose zone are 85 and 98 percent for nitrogen and phosphorus, respectively.

Table 14. Quality of Treated Wastewater Effluent

Treatment Plant	Sample Date	NO3 (µM)	NH4 (µM)	DON (µM)	TN (µM)	PO4 (µM)	DOP (µM)	TP (µM)	Si (µM)	Salinity (o/oo)
Waikoloa Beach Resort	28-Nov-08	574.3	6.9	35.2	616.4	162.0	0.5	162.5	779	0.680
	12-Dec-08	796.5	13.5	30.0	840.0	144.0	1.5	145.5	634	0.656
	15-Dec-08	833.0	19.8	86.0	938.8	148.0	1.2	149.2	629	0.656
	22-Dec-08	912.0	8.3	9.8	930.0	152.0	1.3	153.3	573	0.693
	Averages	779.0	12.1	40.2	831.3	151.5	1.1	152.6	654	0.671
Mauna Lani Resort	12-Dec-08	625.0	28.8	65.8	719.5	173.5	0.3	173.8	444	1.932
Auwaiakeakua (Waikoloa Village)	12-Dec-08	826.0	1123.8	8.3	1958.0	128.8	0.3	129.1	993	0.467
	15-Dec-08	1427.3	339.8	174.8	1941.8	193.5	0.5	194.0	1027	0.450
	22-Dec-08	1335.3	361.3	154.8	1851.3	146.5	4.8	151.3	1039	0.429
	Averages	1196.2	608.3	112.6	1917.0	156.3	1.8	158.1	1019	0.449

Notes:
1. All samples collected by Tom Nance of Tom Nance Water Resource Engineering.
2. All analyses by Marine Analytical Specialists.
3. All samples collected at the point of plant discharge.

Based on all of the foregoing assumptions, Table 15 is a quantification of all of the estimated changes to the quantity and nutrient concentrations of groundwater as a result of the project's full development. These results can be summarized as follows:

- A reduction of the groundwater flowrate of 2.6 to 3.3 percent is computed. This range and the constituent concentration changes depend on how many residential lots in the 1940-acre agricultural area can be developed with the available potable supply.
- A modest increase in nitrogen in groundwater, between 0.2 and 2.2 percent, is estimated.
- A decrease in phosphorus in groundwater on the order of 3.9 to 4.4 percent is calculated. These calculations indicate that the quantity of phosphorus in groundwater withdrawn for irrigation would be greater than the amount returned to groundwater via excess landscape irrigation and the discharge from individual wastewater systems in the agricultural-zoned area.

Availability of Groundwater Supply. The most significant long term issue in the development of the Aina Lea is the sufficiency of the groundwater flowrate in the project's mauka-makai corridor to accommodate its use and the planned use of groundwater by others. In the 3.6-mile coastal segment between Ohai Point and Makaiwa Bay, the total (natural) groundwater flowrate is probably on the order of 35 to 40 MGD (discounting ongoing pumpage by wells). The safely developable long term supply is probably on the order of 12 to 18 MGD. Pumpage in excess of that would likely result in steady salinity increases, particularly in the irrigation wells closer to the shoreline in Mauna Lani Resort. Table 16 is a compilation of present and potential groundwater pumpage in this corridor. Present pumpage of about 10 MG has produced stable salinity levels in all the wells, although salinities in some of the MLR wells are near the maximum useable for golf course irrigation. Possible future use of up to 23 MGD may not be sustainable by pumpage from wells in this mauka-makai corridor alone. This potential shortfall could be offset, to at least some extent, by maximizing irrigation reuse of treated wastewater effluent from Waikoloa Village and Mauna Lani Resort.

Table 15

Summary of Estimated Changes in the Nitrogen and Phosphorus in Groundwater as a Result of the Development of the 3000-Acre Aina Lea Project (Including the Proposed Three Golf Courses)

I t e m	Flowrate (MGD)	Nitrogen (lbs / day)	Phosphorus (lbs / day)
Existing Conditions			
• Groundwater Entering Mauka End of Site	20.0	200.6	17.6
• Addition of Onsite Rainfall-Recharge	1.116	Neg.	Neg.
Groundwater Leaving the Makai End of Site	21.116	200.6	17.6
Changes as a Result of the Project's Development			
• Withdrawal by Onsite Irrigation Wells	-1.06	-10.6	-0.93
• Rainfall-Recharge	No Change	0.39	0.0116
• Golf Course and Roadway Excess Applied Irrigation on 270 Acres (Three Golf Courses)			
▪ Brackish Groundwater	0.106	0.079	0.0009
▪ WWTP Effluent	0.046	0.771	0.0188
▪ Applied Fertilizer	--	3.87	0.013
• Other Landscape Irrigation With Potable Water on 250± Acres			
▪ Percolating Potable Water	0.105 to 0.127	0.079 to 0.095	0.0009 to 0.0011
▪ Applied Fertilizer	--	2.506	0.0119
• Individual Septic Systems in the Ag-Residential Area	0.102 to 0.221	3.40 to 7.38	0.0829 to 0.1800
Total of All Changes	-0.56 to -0.70	0.495 to 4.491	-0.69 to -0.79
Post-Development Groundwater Leaving the Makai End of the Site			
• Quantities	20.416 to 20.556	201.095 to 205.091	16.81 to 19.91
• Percent Change	2.6 to 3.3% Decrease	0.2 to 2.2% Increase	3.9 to 4.4% Decrease

Table 16

Present and Possible Future Groundwater Pumpage in the
Aina Lea Project's Mauka-Makai Corridor

Location of Groundwater Use	Present Use (Avg. MGD)	Potential Future Use (Avg. MGD)
Potable Quality Wells		
• DWS Parker 2 and 4	1.2	2.4
• Waikoloa North Well Field	2.6	6.9
• Waikoloa South Well Field	2.5	6.8
Total for Potable Wells	6.3	16.1
WVA Golf Course Brackish	0.6	0.6
Aina Lea (Three Golf Courses)	0.0	1.1
1010 Puako (200 Ag-Residential Lots)	0.0	1.0 (?)
Mauna Lani Resort Golf Courses	3.0	4.5
Total in the Mauka-Makai Corridor	9.9	23.3

Notes:
1. Future pumpage from Waikoloa's North and South Well fields taken from its October 2006 Water Master Plan.
2. It is not known if the 1010 Puako project will use onsite brackish groundwater for irrigation.
3. Mauna Lani Resort now irrigates two 18-hole golf courses. A third is planned and two wells have already been developed for its irrigation.

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Appendix G
Botanical Survey Report (Botanical Consultants, 1991)

BOTANICAL SURVEY REPORT OF THE PUAKO RESIDENTIAL GOLF COMMUNITY

for

Puako Hawaii Properties
Kamuela Business Center
Kamuela, Hawaii 96743-0020

by

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TABLE OF CONTENTS

Page

INTRODUCTION....1

METHODS....1

BOTANICAL HISTORY....1

RESULTS....3

Prosopis/Fountain Grass....3

Prosopis/Grass....3

Savanna....6

Prosopis/Chenopodium....6

ENDANGERED SPECIES....10

RECOMMENDATIONS....10

LIMITATIONS OF THE SURVEY....11

LITERATURE CITED....13

SPECIES LIST....14

LIST OF FIGURES

FIGURE 1. VEGETATION MAP....4

FIGURE 2. PROSOPIS/FOUNTAIN GRASS....5

FIGURE 3. HAWAIIAN WILIWILI TREE....5

FIGURE 4. PROSOPIS TREES AND UNDERSTORY OF BUFFEL GRASS....7

FIGURE 5. SAVANNA AND GENTLY ROLLING HILLS....7

FIGURE 6. PROSOPIS TREES AND NATIVE CHENOPODIUM....9

FIGURE 7 *OPHIOGLOSSUM CONSINNUM* GROWING UNDER BUFFEL GRASS....9

FIGURE 8 *ABUTILON MENZIEII* UNDER PROSOPIS TREES....12

INTRODUCTION

A botanical survey of the proposed Puako Residential Golf Community Site was carried out in January and February of 1991. The purpose of the survey was to collect data for the preparation of a species list; to describe the vegetation of the site; and to ascertain if any proposed or listed, threatened or endangered plants are growing in the area (USFWS 1990).

METHODS

The transect method was used during the data collection phase of the survey. There is a jeep road which traverses the site from Queen Kaahumanu Highway to the Waikoloa development. This road was used as a centerline and the northern half of the site was covered by running transects from this road to the northern boundary. The southern part of the site was surveyed by running transects from the jeep road to the vegetation line of the broad, red, clinker lava field located in the southern portion of the site. These transects were run parallel to Queen Kaahumanu Highway.

The transects varied from 20 to 50 m apart depending on the vegetation and the terrain. The survey team varied from 2 to 4 individuals and all vegetated parts of the site were examined.

BOTANICAL HISTORY

The proposed Puako Residential Golf Community Site contains several of the lowland dry communities described by Gayne and Cuddihy (Wagner et al 1990). At least three of these communities can be distinguished; lowland dry grasslands, lowland dry scrub lands, and lowland dry forest. Earlier writers described this area as "open country, grass covered, with isolated trees or clumps of trees" (Hillebrand 1888) and Rock labelled simply "the lowland zone" (Rock 1913). Rock observed that the area was "open grassland

with kiawe (*Prosopis pallida* (Humb. & Bonpl. ex Willd.) Kunth), pili grass (*Hetropogon contortus* (L.) P. Beauv.), and alien species from many countries", some of which he referred to as obnoxious.

The designations of Hillebrand and Rock were incorporated into Ripperton and Hosaka's effort to describe all of the vegetation of the Hawaiian Islands (Ripperton & Hosaka 1942). In their scheme, all of the coastal lowlands were included in the " Zone A" or areas characterized by low rainfall, high daytime temperatures and xerophytic or dryland vegetation.

Because, in much of the leeward coastal lowlands, harsh environmental conditions, extensive and varied disturbance, and the high percentage of alien species which characterize Zone A, are present, these areas have been rendered fairly uninteresting for botanical studies. As a result, little research has been done on the vegetation of the higher parts of the coastal lowlands. Not until the enactment of the endangered species act of 1973 and the advent of the environmental impact process in 1970 has this general area been scrutinized.

During the 1980s, three environmental impact statements for projects in and around the study site were filed. One by the Corps of Engineers (USACOE 1985) and one by Belt Collins (Belt Collins and Associates 1987). No plant species on the federal list of proposed or threatened and endangered species were reported in these studies. Then in 1989, Belt Collins (Belt Collins and Associates 1989), in an EIS for the Mauna Lani Cove Hotel, noted the presence of seven colonies of the ephemeral fern, pololei, (*Ophioglossum concinnum* Brack.) on their site. Populations from Oahu, Molokai, Maui, Lanai and Kauai were also reported. Today, *Ophioglossum concinnum* is regarded as a Category 1 endangered species and awaits listing (Pers. comm. Derral Herbst Ph.D.- Botanist USFWS).

RESULTS

Apart from the very young, black lava flow at the south end of the site, four vegetations types were found (Figure 1). They are (1) Prosopis/Fountain Grass, (2) Prosopis/Grass, (3) Savanna, and (4) Prosopis/Chenopodium.

1. Prosopis/Fountain Grass. Between the black lava field and the stream which crosses the site from east to west near the center, is a broad, red a'a or clinker lava field. From its northern edge, near the stream, to the black lava field the vegetation gradually changes from a fairly dense cover of Prosopis trees and fountain grass to widely scattered tufts of fountain grass (*Pennisetum setaceum* (Forssk.) Choiv.) (Figure 2). This area, although not species rich, contains large patches of 'Ilima (*Sida fallax* Walp.) and huge colonies of wild, red zinnias (*Zinnia peruviana* (L.) L.

The red, clinker lava is sharp and unstable and provides well protected niches for the Category 1 fern. The south-east corner of this wide lava flow is also the home of many Wiliwili trees (*Erythrina sandwicensis* Degener), a beautiful, native tree which has evolved to withstand the harsh growing conditions of this area (Figure 3). On the northern slope of the red clinker flow, the vegetation is much denser and the percent cover gradually increases near the flood plain.

2. Prosopis/Grass. Prosopis/Grass is the vegetation type found on the the flood plain of the stream that flows through the central part of the site. The flood plain varies in width from a few meters to several hundred meters across. The water table in the area is quite high and the Prosopis trees are very robust and green. Often the only other vegetation is buffel grass (*Cenchurus ciliaris* L.) (Figure 4). However, colonies of fountain

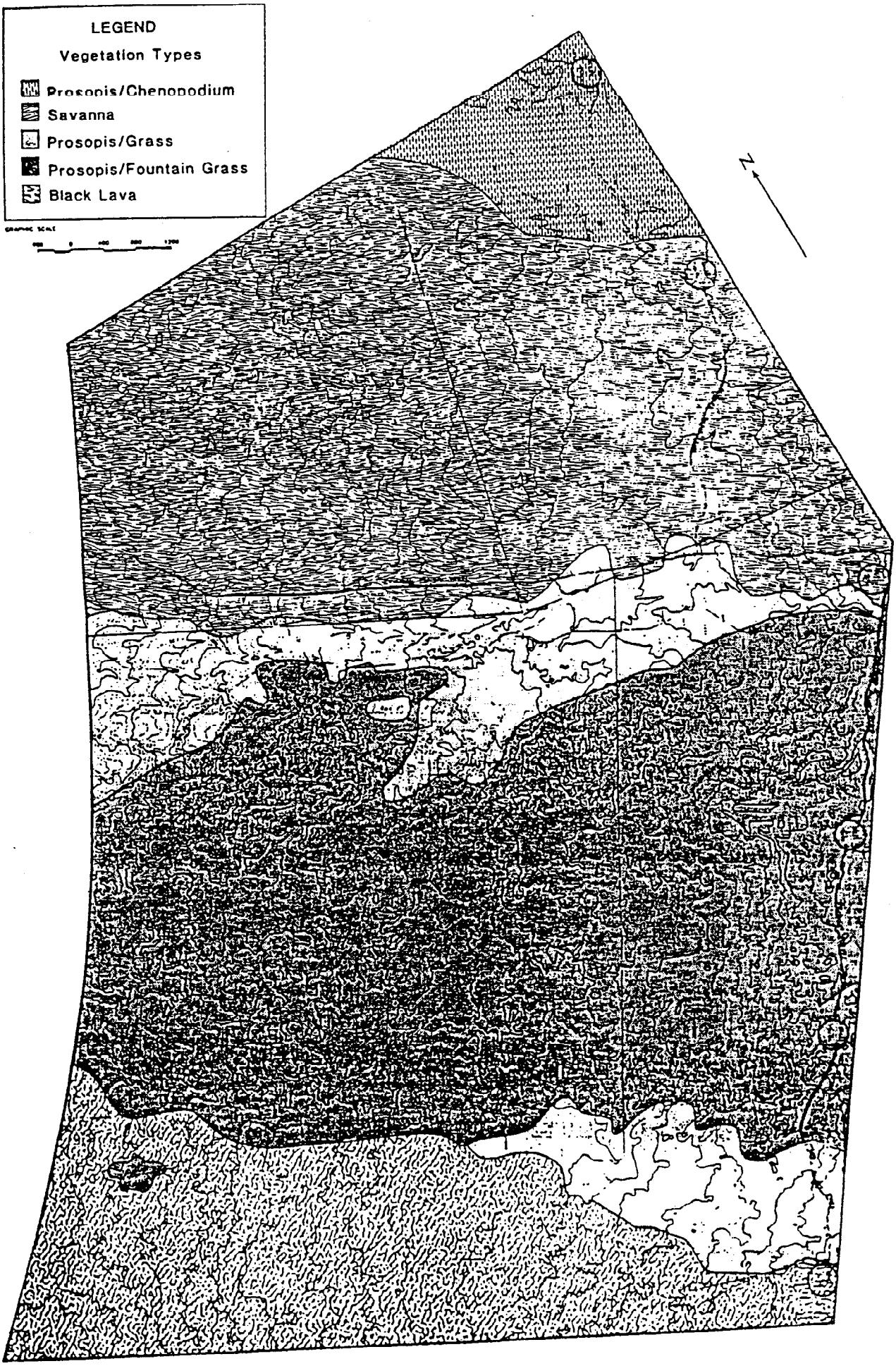
LEGEND
Vegetation Types
Prosopis/Chenopodium
Savanna
Prosopis/Grass
Prosopis/Fountain Grass
Black Lava
N

FIGURE 2. Prosopis/Fountain Grass

FIGURE 3. Wiliwili tree

grass, zinnias and other alien species can be found, especially along the stream. Hidden under the buffel grass cover were found large colonies of *Ophioglossum consinnum*.

3. Savanna. Open savanna or grasslands are found in the northern part of the study site, from the flood plain to the northern boundary (Figure 5). At the time of the survey the grass was still green on the gently rolling hills, but when the dry season comes, this area will turn golden-brown. The species composition of the grassland changes from the uphill edge to Queen Ka'ahumanu Highway. At the upper boundary, native *Eragrostis* spp., *Aristida adscensionis* L., and pili grass (*Heteropogon contortus* (L.) P. Beauv. are part of the uneven mix as are scattered patches of 'Ilima, *Wikstroemia phillyreifolia* A. Gray, shrubs and very scrubby Prosopis trees. Near Queen Ka'ahumanu Highway the native morningglory pa'uohi'iaka or *Jacquemontia ovalifloria* Choisy is very common.

Numerous rock outcrops are to be found throughout this huge grassland. A limited number of both native and introduced taxa inhabit the rock outcrops. The most surprising of these are two species of the delicate appearing little fern *Doryopteris* spp. Small patches of *Ophioglossum consinnum* also inhabit the rock outcrops.

4. Prosopis/Chenopodium. At the northeast corner of the site are some steeper hills which are vegetated by a fourth vegetation type. Here, Prosopis trees are still the dominant, but the understory is dominated by a native Chenopodium, *Chenopodium oahuense* (Mellen) Aellen (Figure 6). Within the Prosopis/chenopodium cover, Eragrostis spp., piligrass, 'A'ali'i (*Dodonaea viscosa* Jacq.), 'ilima, and the red flowered zinnias are common. Because, elevationally this part of the site is a little higher, the

Figure 4. Prosopis Trees and Buffel Grass.

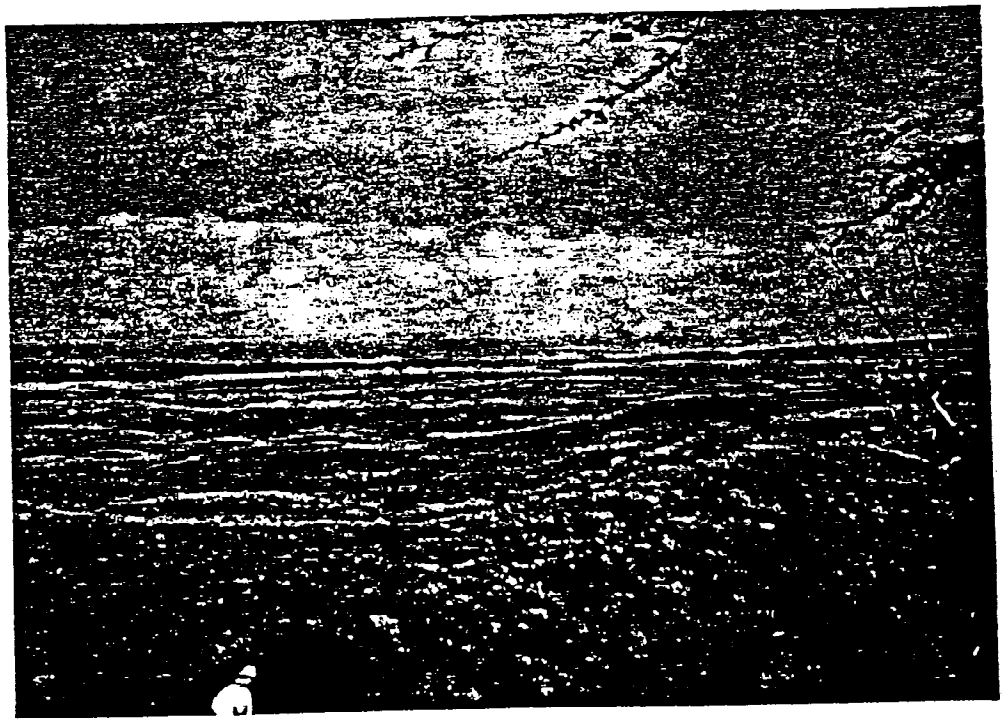

Figure 5. Savanna and Gently Rolling Hills.

vegetation on these low hills appears to comb moisture from the low lying clouds.

There are no clear lines separating these plant communities. As a general rule, the change from one vegetation type to the other is gradual. All of the vegetation of this site appeared to be, and very likely is, summer deciduous.

One Category I - *a taxon for which the Service* (U. S. Fish and WildLife Service) *has on file enough substantial information on biological vulnerability and threat (s) to support proposals to list it as an endangered or threatened species* - was found on the proposed Puako Residential Golf Community site. The Category I species is *Ophioglossum consinnum* Brack. (Figure 7). This small (5 to 8 cm) fern appears five to seven days after it has rained. For this reason the true size of Ophioglossum populations on all the islands has been somewhat of a mystery. It had rained a week before this survey began and there was a heavy rain during the survey. As a result, large Ophioglossum populations were found in all parts of the 3,000 acre site except on the black lava flow and the northwest corner near Queen Ka'ahumanu Highway. By actual count, fifteen thousand plants were recorded, but because of the width of the transects and the futility of trying to count so many small plants, the tally was abandoned. A conservative estimate is that at least sixty-thousand Ophioglossum plants are distributed on this site. In view of such numbers, on this and other sites, the listing of this species as a Category 1 taxon should be reconsidered.

Ophioglossum concinnum Brack. has been a Category I species since 1975 and as such it enjoys no protection under the Endangered Species Act of 1973.

Figure 6. Prosopis Trees and Native Chenopodium.

Figure 7. *Ophioglossum consinnum* (Arrow) Growing Under Buffelgrass.

ENDANGERED SPECIES

The federally listed endangered species found on the site is *Abutilon menziesii* Seem., also known as Ko'oloa'ula or red 'ilima (USFWS 1990) (Figure 1*). The last known collection of this plant, on the island of Hawaii, came from the Puako area in 1956. It had been grown in a private garden until two years ago when the last plant was lost in a storm. There are small, wild populations on Maui and Lanai.

Abutilon menziesii is a member of the hibiscus family (Malvaceae). The plant attains a height of 2 to 3 m (Figure 8). It has downey, heart shaped leaves and it produces a profusion of solitary, five petalled, maroon flowers. The plant is easily propagated by seed and cuttings.

The Puako population is composed of thirty-eight individuals, twenty adult and eighteen seedlings. Botanically, this is a very significant find.

RECOMMENDATIONS

The Ophioglossum of the site can be protected if some areas are left undisturbed. Because of its wide distribution and ephemeral characteristics, it is fair to assume that the plant will persist in any undisturbed area. However, a more certain strategy would be to move some plants from areas to be developed into undevelopable areas. These plants withstand transplantation with a fairly high survival rate (Pers. comm. Spokesman National Tropical Botanical Garden, Lawai, Kauai).

Both the US Government and the state government allow mitigation measures in cases where endangered species are located on privately held land. As a federally listed endangered species, *Abutilon menziesii* Seem. and its habitat should be protected and preserved. *Abutilon* has been grown in cultivation, it is adapted to the Puako environment, and it is a plant of

great beauty. It should be propagated, planted and capitalized upon by the developer, i.e. the Red 'Ilima Gardens or the Ko'oloa'ula dining room.

A third native plant, although neither threatened nor endangered, but present on the site is *Jacquemontia ovalifolia* or pa'uohi'iaka. This taxon is a member of the morningglory family and grows in great profusion in the northwest portion of the study site. It has been cultivated as a ground cover in xeric (dry) situations and should be considered for the same purpose in this setting.

The earlier mentioned wiliwili trees which are now growing in the southeastern part of the site should become part of the landscaping. They are beautiful trees, they are well adapted to the site, they produce a profusion of orange and greenish flowers, and they are full grown trees.

LIMITATIONS OF THE SURVEY

This survey was undertaken in late Janurary when the area was just beginning to react to winter rains, well before annual plants had had time to flower. Many annuals were found as seedlings. A similar survey a little later in the wet season would probably have resulted in a more extensive list of introduced species.

CHECKLIST OF PLANT SPECIES FOUND ON THE PUAKO RESIDENTAIL GOLF COMMUNITY

Scientific Name	Common Name	Abundance
FERNS		
OPHIOGLOSSACEAE - Adder's Tongue Family		
Ophioglossum concinnum Brack.		Common
POLYPODIACEAE - Common Fern Family		
**Pellea ternifolia* (Cav.) Link	Cliffbrake	Occasional
PTERIDACEAE - Pteris Family		
Doryopteris decipiens (Hook.) Sm.	Iwaiwa	Common
Doryopteris decora Brack.	Desert Doryopteris	Common
MONOCOTYLEDONES		
GRAMINEAE - Grass Family		
**Aristida adscensionis* L.		Common
**Briza maxima* L.	Big quaking grass	Locally abundant
**Briza minor* L.	Little quaking grass	Occasional
**Cenchrus ciliaris* L.	Buffel grass	Abundant
**Cynodon dactylon* (L.) Pers.	Bermuda grass	Occasional
**Digitaria ciliaris* (Retz.) Koeler	Henry's crab grass	Occasional
**Elucine indica* (L.) Gaertn.	Goosegrass	Occasional
Eragrostis sp.		Common
Eragrostis leptophylla Hitch.		Common
**Hetropogon contortus* (L.) P. Beauv.	Pili grass	Common
Ischaemum byrone (Trin.) Hitch		Locally abundant
**Melinis minutiflora* P. Beauv.	Molassesgrass	Locally abundant
Panicum torridum Gaud.	Torrid panic-grass	Uncommon
**Pennisetum setaceum* (Frossk.) Chiov	Fountain grass	Common
**Rhynchelytrum repens* C.E.Hubb	Natal redtop	Common
DICOTYLEDONES		
AMARANTHACEAE - Amaranth Family		
**Amaranthus spinosus* L.	Spiny amaranth	Common

Scientific Name	Common Name	Abundance
ASTERACEAE - Sunflower Family		
**Ageratum conyzoides* L.	Ageratum	Common
**Bidens cynapiifolia* Kunth		Occasional
**Bidens pilosa* L.	Spanish needle	Common
**Emilia sonchifolia* (L.) DC	Flora's paintbrush	Occasional
**Erechtites hieracifolia* (L.) Raf. ex DC		Occasional
**Galinsoga parviflora* Cav.		Occasional
**Gnaphalium purpureum* L.	Purple cudweed	Occasional
**Osteospermum calendulaceum* L.		Common
**Parthenium hysterophorus* L.		Locally abundant
Lipochaeta lavarum (Gaud.) DC		Uncommon
**Verbesina encelioides* Cav.	Golden crown-beard	Occasional
**Zinnia peruviana* (L.) L.		Common
BRASSICACEAE - Mustard Family		
**Brassica campestris* L.	Field Mustard	Occasional
**Brassica nigra* (L.) W. Koch.	Black mustard	Occasional
**Coronopus didymus* (L.) Sm.	Swinecress	Locally abundant
**Lepidium virginicum* L.		Occasional
CAPPARACEAE - Caper Family		
**Cleome gynandra* L.	Wild spider flower	Common
CARYOPHYLLACEAE - Pink Family		
**Spergula arvensis* L.	Corn spurry	Locally abundant
CHENOPODIACEAE - Goosefoot Family		
**Chenopodium ambrosioides* L.	Mexican tea	Locally abundant
**Chenopodium carinatum* R. Br.		Locally aboundant
Chenopodium oahuense (Meyen) Aellen	'Aheahea	Common
**Chenopodium murale* L.	'Aheahea	Occasional
CONVOLVULACEAE - Moringglory Family		
**Jacquemontia ovalifolia* (Choisy) H. Hallier	Pa'uohi'iaka	Common
**Merremia aegyptia* (L.) Urban	Hairy Merremia	Common
CUCURBITACEAE - Cucumber Family		
**Cucumis dipsaceus* Ehranb. ex Spach	Hedgehog Gourd	Occasional
Sicyos anunu (St. John) Telford		Uncommon

Scientific Name	Common Name	Abundance
EUPHORBIACEAE - Spurge Family		
Chamaesyce hirta L.	Hairy spurge	Common
Chamaesyce hypericifolia Mellsp.	Graceful spurge	Occasional
Ricinus communis L.	Castor bean	Common
FABACEAE - Bean Family		
Crotalaria pallida Aiton	Smooth rattle-pod	Occasional
Erythrina sandwicensis Degener	Wiliwili	Locally abundant
Indigofera suffruticoas Mill.	Iniko	Common
Leucaena leucocephala deWit	Koa-haole	Common
Macroptilium lathyroides (L.) Urb.	Wild bean	Locally abundant
Medicago minima (L.) Bartal.	Small bur clover	Locally abundant
Prosopis pallida HBK	Kiawe, algaroba	Occasional
MALVACEAE - Mallow Family		
Abutilon menziesii Seem	Ko'oloa'ula	Uncommon
Malva parviflora L.	Cheese weed	Occasional
Malvastrum coromandelianum Garcke	False marrow	Common
Sida fallax Walp.	'Ilima	Common
Sida rhombifolia L.	Cuba jute	Occasional
MOLLUGINACEAE - Carpetweed Family		
Mollugo cerviana (L.) Ser.	Threadstem carpetweed	Common
NYCTAGINACEAE - Four o'clock Family		
Boerhavia coccinea Mill.		Occasional
Boerhavia repens L.	Alena	Common
OXALIDACEAE - Wood Sorrel Family		
Oxalis corniculata L.	Wood sorrel	Occasional
POLYGONEACE - Buckwheat Family		
Rumex sp.		Occasional
PORTULACACEAE - Portulaca Family		
Portulaca sp.		Occasional
Portulaca oleracea L.	Pigweed	Occasional
Portulaca pilosa L.	Akulikuli	Occasional
PRIMULACEAE - Primrose Family		
Anagallis arvensis L.	Scarlet pimpernel	Locally abundant

Scientific Name	Common Name	Abundance
SAPINDACEAE - Soapberry Family		
Dodonaea viscosa Jacq.	A'ali'i	Common
SCROPHULARIACEAE -Figwort Family		
Verbascum sp.	Mullein	Occasional
SOLANACEAE - Tomato Family		
Datura stranonum L.	Jimson weed	Common
Solanium americanum Mill.	Popolo berry	Occasional
STERCULIACEAE - Stink tree Family		
Waltheria indica L.	Hi'aloa, uha-loa	Common
THYMELAEACEAE - Akia Family		
Wikstroemia phillyreifolia A. Gray	Akia	Common

Appendix G1
Botanical Preservation Plan/Agency Correspondence
(Botanical Consultants, 2000)

botanical consultants
240 makee, suite 7b honolulu, hawaii 96815 (808) 923-4193 fax (808) 923-4193

September 29, 2000

Mr. Thomas H. Yamamoto
Eugene A. McCain, Jr.
Bridge Aina Lea, LLC.
Post Office Box 548
Kamuela, Hawaii 96743

Re: Botanical Preservation and Mitigation Plan for Endangered Species Found on the Proposed Villages of 'Aina Le'a Development Site

Gentlemen,

You have asked me to provide you with a botanical preservation and mitigation plan as called for in conditions to your development rights.

The following are my recommendations, which I believe constitute the best botanical preservation and mitigation program for your property at this time.

Ophioglossum concinnum Breck.

As noted in my 1991 report, we estimated the presence of some 60,000 individuals of this fern on the subject property. This fern has been found in great quantities at various locations within the Hawaiian Islands. In 1992, Warren Herbert Wagner, Jr., Ph.D. Professor of Biology and Natural Resources & Curator of Pteridophytes in the University Herbarium, University of Michigan and the world authority on fern taxonomy declared "Ophioglossum concinnum was far from being an Hawaiian endemic" and "there is no reason to regard it as endangered or threatened". Ophioglossum concinnum has since been de-listed and no longer requires a preservation plan.

Abutilon menziesii Seem.

I have recently conducted a search of the subject property to determine the presence of *Abutilon menziesii* Seem. As noted in the August 2000 report, the *Abutilon menziesii* Seem. appears to have succumbed to the severe drought and wind conditions at this location and cannot be found. Without the presence of the plant it is difficult to recommend a location as an appropriate habitat for a preservation site.

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We do not know with certainty if there are viable seeds of the Abutilon in the seed bank which could produce new plants under more normal weather conditions. With this in mind, we are recommending that an area be set aside for the time being and another botanical survey be done when more normal weather conditions prevail. At the time of the next survey we can determine if *Abutilon menziesii* Seem. has survived. Based on new findings and if warranted, we can make new recommendations for the plants' preservation and a proper mitigation plan.

For now our recommended preservation and mitigation is for you to not disturb the land within 500 feet of the location where the *Abutilon menziesii* Seem. had been previously found and so noted on the map attached hereto. This "set aside" area includes the northwest corner TMK parcel 37 and the southwest corner of TMK parcel 36. The remaining parcels: TMK 3/6-8-1-25, 38, 39, and 40, are not effected by this plan.

I recommend that you allow the subject area to respond to the changing weather conditions. Within one year, and prior to any disturbance of the land in the area described above, you should undertake another botanical survey .

While there may be no federal requirement for you to involve the U.S.F.W.S., I recommend that the new report on the next survey be forwarded to them for their comments and recommendations

Once their recommendations are received I would prepare a final preservation and mitigation plan which would incorporate their recommendations.

Thank you for the opportunity to assist you in this matter.

Yours Truly,

Evangeline J Funk PhD

Evangeline J. Funk, Ph.D.
Botanical Consultants

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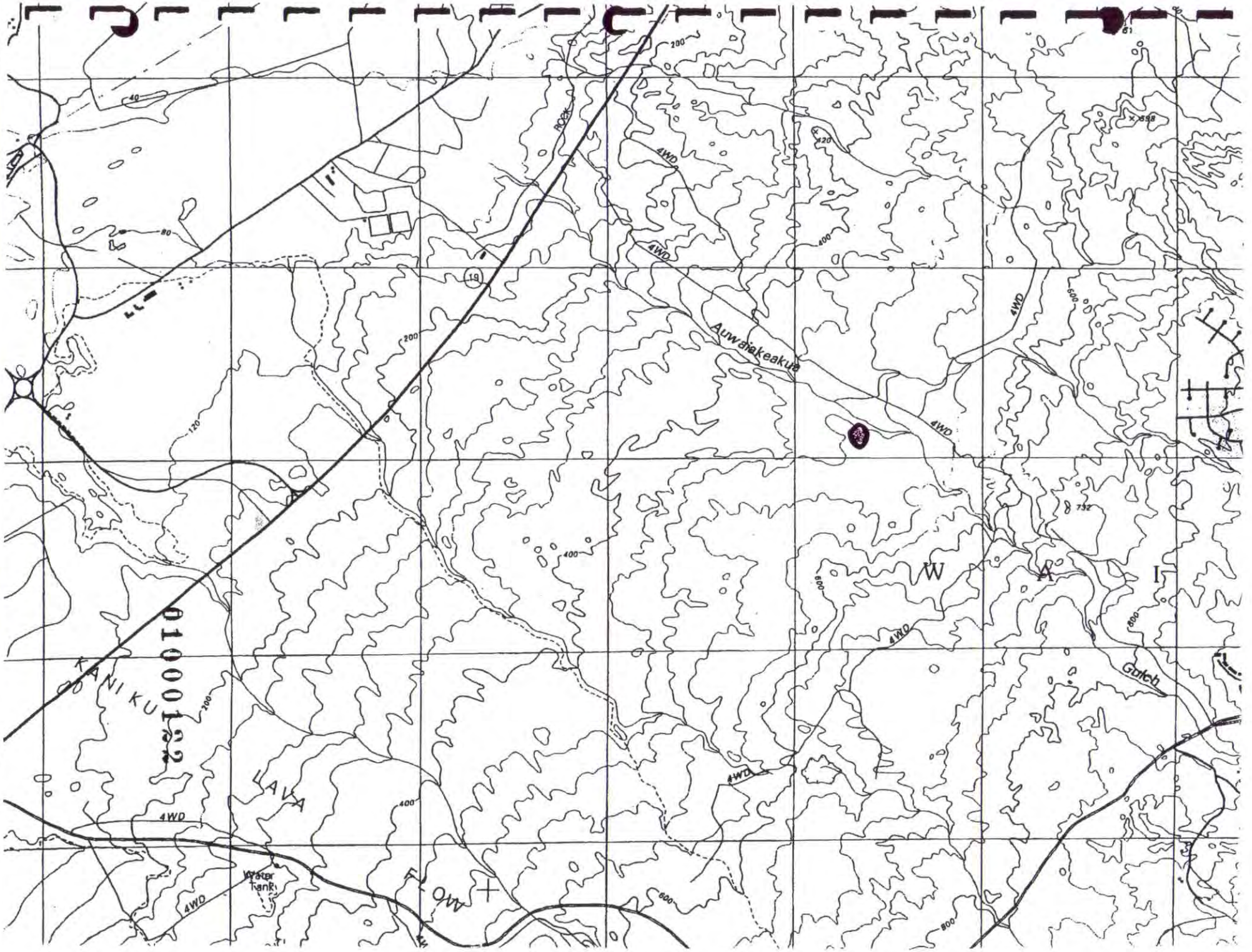
KANIKU
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Water Tank
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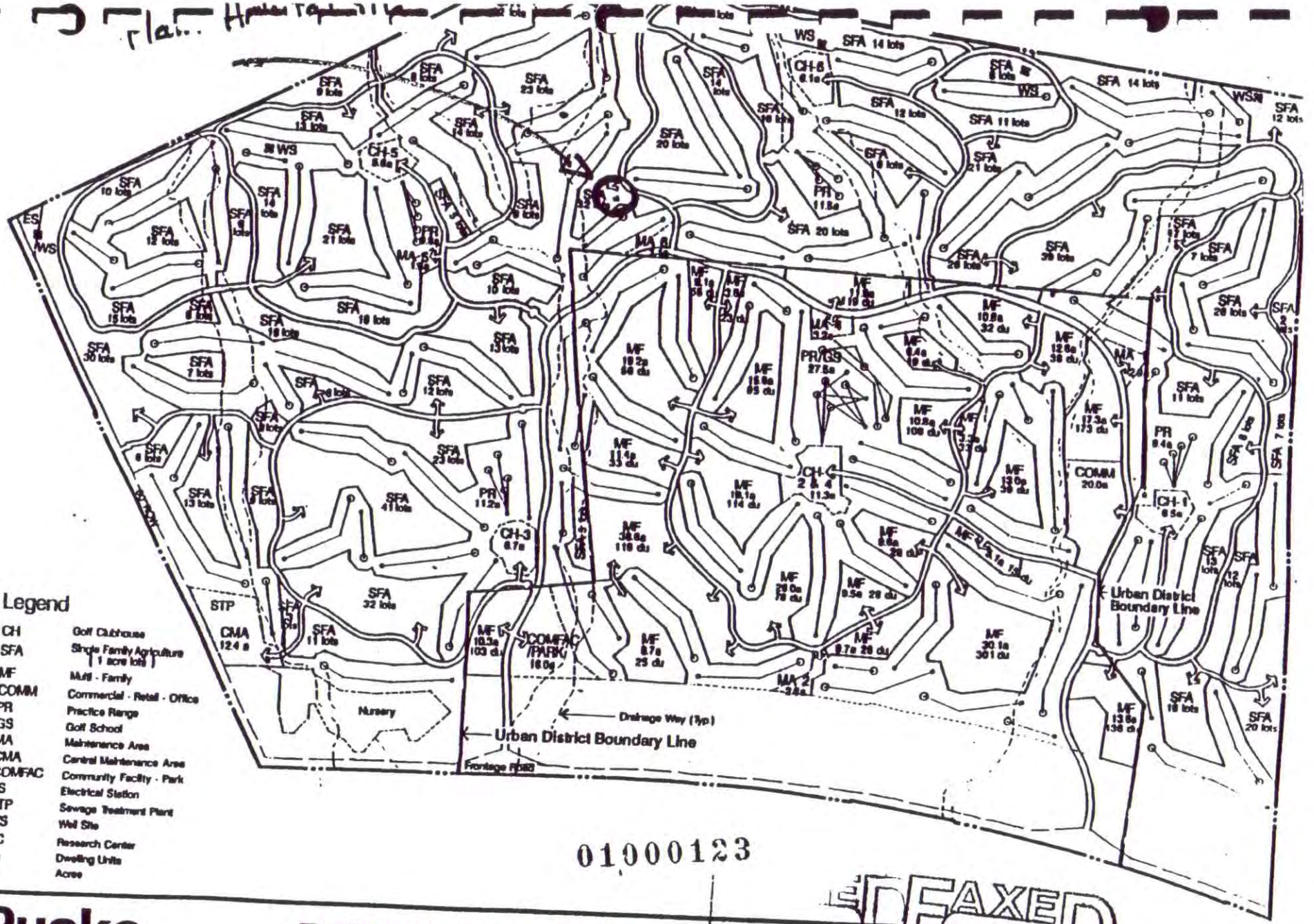

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FAXED

11/16/00 to Pa..., P.C.

Puako

Residential Golf Community
South Kohala, Hawaii

Puako Hawaii Properties

DEVELOPMENT CONCEPT PLAN

North

Scale: 1" = 400'

0' 400' 800' 1600'

FIGURE

botanical consultants
240 makee, suite 7b honolulu, hawaii 96815 (808) 923-4193 fax (808) 923-4193

August 21, 2000

Mr. Thomas H. Yamamoto
Thomas H. Yamamoto Inc.
Box 6150
Kamuela, Hawaii 96741

Dear Mr. Yamamoto,

On August 18, 2000 my assistant and I searched that part of your Puako, Hi. Development site that resembled the area in which we had previously found the endangered *Abutilon menziesii* Seem. in Jan. 1991. The plant had been found growing among ilima (*Sida fallax* Walp.), uhaloa (*Waltheria indica* L.), and buffel grass (*Cenchrus ciliaris* L.) under a kiawe tree (*Prosopis pallida* Kunth.).

We found that three years of drought and the desiccating wind have left the vegetation of the Aina Le'a site either dead or dying. Even such drought resistant taxa as 'ilima, 'uhaloa, and buffel grass are crisp and dry. Many of the summer deciduous kiawe and wiliwili trees are dry and their bark is peeling off. Only very rarely did we encounter a kiawe tree with one or two green leaves.

After an exhaustive search we had to conclude that the Abutilon menziesii plants had probably succumbed to the hot dry conditions. It is possible, but unlikely that seeds may survive this long dry spell without water.

The following four photographs are included to illustrate our findings. The map shows about where the plants had been found.

Yours truly,

Evangeline J Funk PhD

Evangeline J. Funk, Ph.D.

Cc:Sandy Marr
1055 East Tropicana Ave., Suite 700
Las Vegas, Nevada 89119

Figure 1. Vegetation of the Abutilon menziesii habitat is all dead.

Figure 2. Habitat of Abutilon menziesii.

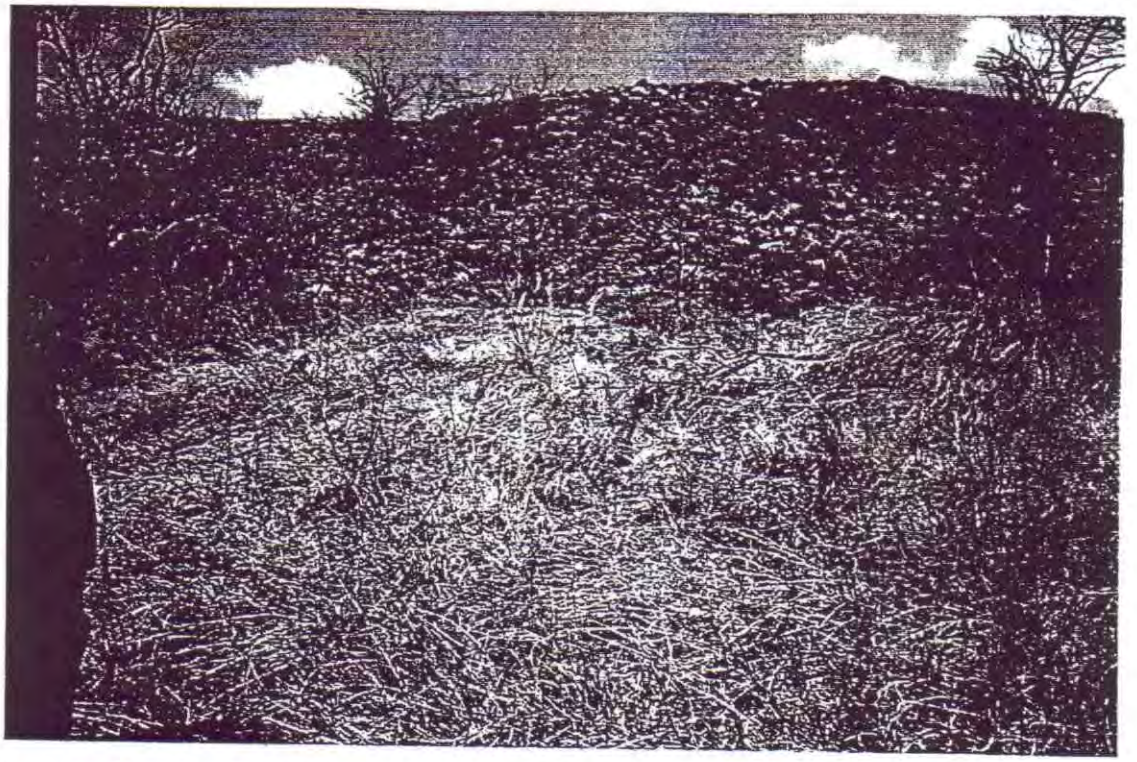

Figure 3. Even the buffel grass is gray and dry.

Figure 4. Trunk of kiawe tree with peeling bark.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
PACIFIC ISLANDS ECOREGION
300 ALA MOANA BOULEVARD, ROOM 3108
BOX 50088
HONOLULU, HAWAII 96850
PHONE: (808) 541-3441 FAX: (808) 541-3470

OCT 12 2000

In reply refer to: JMC

Mr. Eugene A. McCain, Jr.
Mr. Thomas Yamamoto
Bridge 'Aina Le'a LLC
Post Office Box 548
Kamuela, Hawaii 96743

Re: Preservation and Mitigation Plan for Endangered Species at Bridge 'Aina Le'a, South Kohala, Hawaii.

Dear Gentlemen:

The U.S. Fish and Wildlife Service (Service) has reviewed the September 29, 2000, "Botanical Preservation and Mitigation Plan for Endangered Species Found on the Proposed Villages of 'Aina Le'a Development Site" prepared by Dr. Evangeline Funk of Botanical Consultants and provided in Mr. McCain's October 6, 2000, facsimile transmittal. We have also reviewed an August 21, 2000 letter from Botanical Consultants to Mr. Yamamoto regarding their Aug. 18, 2000 site visit; information provided in a telephone conversation between Mr. McCain and Service biologist Mick Castillo on October 7, 2000; and information provided in a September 21, 2000, telephone conversation between Dr. Funk and Mr. Castillo.

The proposed Bridge 'Aina Le'a development project located mauka from Puako in the District of South Kohala includes the construction of low and medium-density family housing and a golf course with associated structures. As stated in Dr. Funk's report, conditions resulting from the current three-year drought in coastal South Kohala have left few woody plants alive. However, viable seed may occur within the seedbank where the population of 39 adult and seedling *Abutilon menzesii* (red 'ilima), a listed endangered species, were found in 1991. We have discussed the matter with Dr. Funk and support her recommendation to avoid disturbance within 500 ft. from the location where the red 'ilima were previously found until a subsequent survey can be conducted following a period of more normal weather conditions.

Concerning the *Ophioglossum concinnum*, we can confirm Dr. Funk's statement that this is not a listed plant and does not require a mitigation or preservation plan.

We look forward to receiving the report from the next survey and reviewing Dr. Funk's recommendations at that time. Meanwhile, we encourage any interest you have in incorporating

red 'ilima and other unique endemic dry forest plant species into your project either as artificially established wild populations or as horticultural use plants and will support such an effort in the way of technical assistance. Thank you for soliciting our comments on this project. We look forward to working with you in the future. If you have questions, please contact Fish and Wildlife Biologist Mick Castillo at (808) 541-3441.

Sincerely,

Donald Palawski

for Paul Henson
Field Supervisor
Ecological Services

cc: Vicki Caraway, Oahu DOFAW
Lyman Perry, Hawaii DOFAW

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
P.O. BOX 4849
HILO, HAWAII 96720
(808) 974-4221
FAX (808) 974-4226

NOV 1 5 2000

Virginia Goldstein
Planning Director
Hawaii County Planning Department
25 Aupuni Street, Room 109
Hilo, Hawaii 96720

Madam,

The Department of Land and Natural Resources' Division of Forestry and Wildlife has reviewed the preservation and mitigation plan for the Aina Lea development in South Kohala. We agree with the U.S. Fish and Wildlife Service's comments regarding endangered plant species at this location. If the applicant will set aside the area demarcated by Dr. Evangeline Funk's botanical survey as habitat for the formerly occurring endangered *Abutilon menziesii* there should be no adverse impact to endangered plant species from this project.

If you should have additional questions about this endangered plant or other endangered plant issues please contact us: 974-4221 or 974-4226 fax.

Sincerely,

Jon Giffin
Hawaii District Manager
Division of Forestry and Wildlife
19 E. Kawili Street
Hilo, HI 96720

01000114

Appendix H

Survey of the Avifauna and Feral Mammals

(Phillip L. Bruner, January 1991)

SURVEY OF THE AVIFAUNA AND FERAL MAMMALS
AT PUAKO, SOUTH KOHALA, HAWAII

Prepared for

Puako Hawaii Properties

by

Phillip L. Bruner
Assistant Professor of Biology
Director, Museum of Natural History
Environmental Consultant Faunal (Bird and Mammal) Surveys

25 January 1991

INTRODUCTION

The purpose of this report is to summarize the findings of a three day (19-21 January 1991) bird and mammal field survey of property located at Puako, South Kohala, Hawaii. Also included are references to pertinent literature as well as unpublished faunal reports from similar lands.

The objectives of the field survey were to:

1- Document what bird and mammal species occur on the property or may likely occur given the type of habitats available.

2- Provide some baseline data on the relative (estimated) abundance of each species.

3- Determine the presence or likely occurrence of any native faunal particularly any that are considered "Endangered" or "Threatened". If such occur or may likely be found on or near the property identify what features of the habitat may be essential for these species.

4- Identify any special or unique habitats for wildlife that may occur on the site and note what importance these areas may have for the fauna in this region.

GENERAL SITE DESCRIPTION

Figure One indicates the limits of the property. The northern portion of the site is covered in grass with scattered Kiawe trees (Prosopis pallida). The southern section is composed of more recent lava flows. Kiawe is the dominant vegetation in this area.

Weather during the field survey was clear with cool mornings. Wind was from the east at 10-15 mph.

STUDY METHODS

Field observations were made with the aid of binoculars and by listening for vocalizations. These observations were concentrated during the peak bird activity periods of early morning and late afternoon. Attention was also paid to the presence of tracks and scats as indicators of bird and mammal activity. At various locations (see Fig.1) eight minute counts were made of all birds seen or heard. Between these count (census) stations observations of birds seen or heard were also noted. These data provide the basis for the relative (estimated) abundance figures given in this report (Table 1). Published and unpublished reports of birds known from similar habitat on lands close to this site and elsewhere in West Hawaii were also consulted in order to acquire a more complete picture of the possible species

that might occur in the area (Bruner 1979, 1980, 1984a, 1984b, 1984c, 1985a, 1985b, 1986, 1988a, 1988b, 1989a, 1989b, 1989c, 1990a, 1990b, 1990c, 1990d; Pratt et al. 1987; Hawaii Audubon Society 1989; David 1989, 1990). Observations of feral mammals were limited to visual sightings and evidence in the form of scats and tracks. No attempts were made to trap mammals in order to obtain data on their relative (estimated) abundance and distribution. Two evenings were devoted to searching for the presence of owls and the Hawaiian Hoary Bat (Lasiurus cinereus semotus).

Scientific names used herein follow those given in the most recent American Ornithologist's Union Checklist (A.O.U. 1983); Hawaii's Birds (Hawaii Audubon Society 1989); A Field Guide to the Birds of Hawaii and the Tropical Pacific (Pratt et al. 1987); Mammals Species of the World (Honacki et al. 1982) and Hawaiian Coastal Plants (Merlin 1977).

RESULTS AND DISCUSSION

Resident Endemic (Native) Land and Water Birds:

No Short-eared Owl or Pueo (Asio flammeus sandwichensis) were observed but this bird could potentially occur on occasion at this location. Pueo are relatively common on the island of Hawaii particularly at higher elevations (Berger 1972; Pratt et al. 1987; Hawaii Audubon Society 1989).

'Io or Hawaiian Hawk (Buteo solitarius) may also forage in this area, although none were seen over the course of the survey.

'Io are an endangered species. They can, however, be seen fairly regularly in Kohala.

No wetlands occur on the property, therefore no native waterbirds would be expected. The disturbed nature of the habitat and its location make it highly unlikely that any other endemic birds, aside from the two mentioned, would utilize this property.

Migratory Indigenous (Native) Birds:

Migratory shorebirds winter in Hawaii between the months of August through May. Some juveniles will stay through the summer months as well (Johnson and Johnson 1983). Of all the shorebirds species which winter in Hawaii the Pacific Golden Plover (Pluvialis fulva) are the most abundant. Plover prefer open areas such as exposed intertidal reef, rocky shorelines, mud flats, lawns, pastures, plowed fields and sparce grasslands. They arrive in Hawaii in early August and depart to their arctic breeding grounds during the last week of April (Johnson et al. 1981). Bruner (1983) and Johnson et al. (1989) have also shown plover are extremely site-faithful on their wintering grounds and many establish foraging territories which they defend vigorously. Such behavior makes it possible to acquire a fairly good estimate of the abundance of plover in any one area. These populations likewise remain relatively stable over many years (Johnson et al. 1989). A total of 28 Pacific Golden Plover were recorded during the survey. These birds were observed flying over the property and resting

on open lava patches. The dry grassland sector contained few plover. Six Ruddy Turnstone (Arenaria interpres) were also recorded. These two species are the most common migrants that would be expected in upland grassland habitat.

Resident Indigenous (Native) Birds:

No indigenous species were recorded. The only species in this category is the Black-crowned Night Heron (Nycticorax nycticorax). The absence of wetland habitat precludes the occurrence of this species.

Resident Indigenous (Native) Seabirds:

No seabirds were observed on the property. The presence of predators make this site unsuitable for nesting or roosting seabirds.

Exotic (Introduced) Birds:

A total of 14 species of exotic birds were recorded during the field survey. The most abundant species were Zebra Dove (Geopelia striata), Eurasian Skylark (Alauda arvensis) and Warbling Silverbill (Lonchura malabarica). Populations of normally abundant species such as Japanese White-eye (Zosterops japonicus) and House Finch (Carpodacus mexicanus) were low due in part to the time of the year and abscence of Kiawe flower. The most unusual exotic bird recorded was Chestnut-bellied

Sandgrouse (Pterocles exustus). This species is uncommon and usually quite localized in its distribution on the island. (Pratt et al. 1987).

Given the habitats found on the property as well as data from surveys elsewhere in West Hawaii (Bruner 1979, 1980, 1984a, 1984b, 1984c, 1985a, 1985b, 1986, 1988a, 1988b, 1989a, 1989b, 1989c, 1990a, 1990b, 1990c, 1990d and information provided in Berger (1972); Pratt et al. 1987; Hawaii Audubon Society 1989 and David (1989, 1990) the following exotic bird species might also be expected to occur on or near the property: Barn Owl (Tyto alba), Ring-necked Pheasant (Phasianus colchicus), California Quail (Callipepla californica) Japanese Quail (Coturnix japonica), Lavender Waxbill (Estrilda caerulescens(, Yellow-fronted Canary (Serinus mozambicus) and Saffron Finch (Sicalis flaveola).

Feral Mammals:

Small Indian Mongoose (Herpestes auropunctatus) were seen and evidence of feral cats was also found on the survey. Feral Goats (Capra hircus) were abundant,over 150 animals were counted. Despite "No Hunting" signs hunters were seen and heard. Goats were most commonly observed on the southern half of the property where the jumbled lava flows may provide them some cover. No trapping was conducted in order to assess the relative abundance of mammals.

Records of the endemic and endangered Hawaiian Hoary Bat are sketchy but the species has been reported from this region (Tomich 1986; Kepler and Scott 1990). None were observed on this field survey despite evening searches of the area. This species roosts primarily in trees. Much remains to be known about the natural history of this bat and its ecological requirements here in Hawaii.

CONCLUSION

A brief field survey such as this one can at best provide only a limited perspective of the wildlife which utilize the area. Not all species will necessarily be observed and information on their use of the site must be sketched together from brief observations and the available literature. The number of species and the relative abundance of each species may vary throughout the year due to available resources and reproductive success. Species which are migratory will quite obviously be a part of the faunal picture only at certain times during the year. Exotic species sometimes prosper for a time only to later disappear or become a less significant part of the ecosystem (Williams 1987; Moulton et al. 1990). Thus only long term studies can provide a comprehensive view of the bird and mammal populations in a particular area. However, when brief field studies are viewed in the light of data gathered from other similar habitats the value of the conclusions drawn can be significantly increased.

The following are some general conclusions related to bird and mammal activity on the property:

1- All representative types of habitat found on the property were censused. The more densely forested sections of the property support the greatest number and diversity of birds.

2- No endemic birds were found at this site. Plover and Turnstone are migratory inhabitants of the area. Their numbers were relatively low due to limited suitable habitat. The conversion of this site into golf course and residential property should result in an increase in the population of plover and turnstone. These birds prefer lawns for foraging.

3- The property supports the normal array of exotic species of birds one would expect in this type of environment in Hawaii. The most unusual species was the Chestnut-bellied Sandgrouse. Populations of this bird are small and usually localized. Some potential species were not recorded. This could have been due to the fact that the survey was too brief, or that their numbers are so low that they went undetected or a combination of these and other factors.

4- In order to obtain more definitive data on mammals a trapping program would be required. Feral goats are common at this location. No sightings of the Hawaiian Hoary Bat were obtained.

5- No special or unique environmental resources were discovered. Disturbed habitats of the sort found on this site are common in this region of the island. The native floral and faunal communities have been replaced by introduced plants and animals.

6- Habitat alteration as the result of development might decrea the attractiveness of the area for certain introduced specie of birds such as francolin while at the same time increase the suitability of the property for other species. Common Myna (Acridotheres tristis), House Sparrow (Passer domesticu and Japanese White-eye (Zosterops japonicus) will increase with development of a more urban habitat.

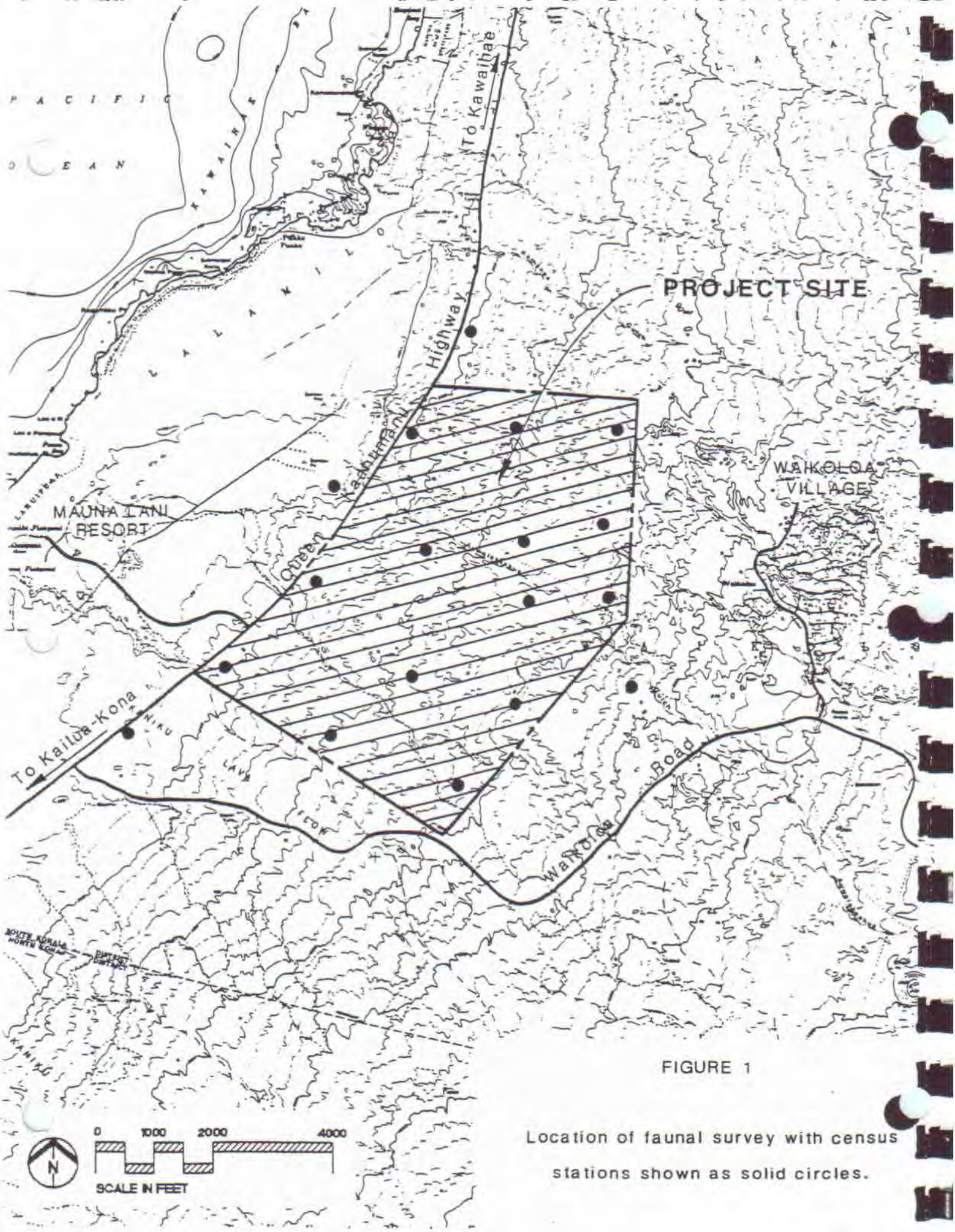

FIGURE 1

Location of faunal survey with census stations shown as solid circles.

TABLE 1

Exotic (introduced) birds recorded at Puako, South Kohala, Hawaii

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE*
Black Francolin	Francolinus francolinus	C = 7
Gray Francolin	Francolinus pondicerianus	U = 3
Chestnut-bellied Sandgrouse	Pterocles exustus	R = 1
Spotted Dove	Streptopelia chinensis	U = 2
Zebra Dove	Geopelia striata	A = 13
Common Myna	Acridotheres tristis	R = 6
Yellow-billed Cardinal	Paroaria capitata	C = 6
Northern Cardinal	Cardinalis cardinalis	U = 4
Northern Mockingbird	Mimus polyglottus	C = 6
Japanese White-eye	Zosterops japonicus	U = 3
Eurasian Skylark	Alauda arvensis	A = 11
Nutmeg Mannikin	Lonchura Punctulata	C = 8
Warbling Silverbill	Lonchura malabarica	A = 14
House Finch	Carpodacus mexicanus	U = 4

* (see page 12 for key to symbols)

KEY TO TABLE 1

Relative (estimate) abundance = number of times observed during survey or average number on eight minute counts.

A = abundant (ave. 10+) number which follows is average of data from all survey days

C = common (ave. 5-10) number which follows is average of data from all survey days

U = uncommon (ave. less than 5) number which follows is average of data from all survey days

R = recorded (seen or heard at times other than on 8 min. counts or on one count only) number which follows is the total number seen or heard over the duration of the survey.

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Appendix H1

Flora and Fauna Survey, Utility Corridors
(Geometrican Associates, LLC, February 2010)

Flora and Fauna Survey
Villages at ‘Aina Le‘a Offsite Utility Corridors,
Puako, South Kohala, Island of Hawai‘i

By Ron Terry, Ph.D. and Patrick J. Hart, Ph.D.
Geometrician Associates, LLC
Prepared for DW ‘Aina Le‘a Development LLC.
February 2010

Introduction

DW ‘Āina Le‘a Development, LLC and Relco Corp (“DW”) purchased ±1,092 acres of land between Queen Ka‘ahumanu Highway and Waikoloa Village on the Island of Hawai‘i in 2008 from Bridge Aina Le‘a, LLC (“Bridge”). These lands are identified by TMKs: (3) 6-8-001:25, 36, 38, and 39. DW plans development on these properties as well as portions of adjacent properties owned by Bridge, identified as portions of TMKs (3) 6-8-001: 40 and 37, totaling a project area of approximately 1,128 acres (Figures 1-2).

The project as proposed by DW and described by project planners includes ±790 single-family residential lots, ±1,047 multiple-family residential units, ±125 residential units in a mixed use (commercial/ residential) setting, up to 500 affordable/workforce housing units, a golf course, with driving range, clubhouse and amenities, golf lodge up to 40 units, a golf academy, a commercial village, a mixed use core, parks and open space including a plant preserve, and related infrastructure, including a possible wastewater treatment plant (Figure 3).

In addition to the development within the project area, certain power and water utility connections will be made to the project from the existing HELCO and Waikoloa Village utility systems in the area. These utility corridors, which extend over the adjoining Waikoloa Village Association property (TMK 6-8-02:19), would allow for power and water utility line extensions, as well as the water tanks and utility access road improvements related to these. The location and alignment of the electrical power and water utility associated with the Project are shown in Figure 4.

All of the area currently planned for development except the utility corridors was surveyed for flora in 1991 by botanist Evangeline Funk, Ph.D. With the exception of one small area, the vegetation was almost completely alien and no rare, threatened or endangered species were found to be present. Dominated by kiawe (*Prosopis pallida*) and buffel grass (*Cenchrus ciliaris*), the general area also offered very poor habitat for native fauna. In one location just south of Auwaiakeakua Gulch, at approximately UTM coordinates 205330/2207110 based on Dr. Funk’s map, a patch of the regionally common indigenous herbs ‘ilima (*Sida fallax*) and ‘uhaloa (*Waltheria indica*) also sheltered the extremely rare and endangered “red ‘ilima”, or *Abutilon menziesii*. A 2000 botanical resurvey by Dr. Funk found no *Abutilon menziesii*, which she judged to have succumbed to drought.

Areas and Scope of Survey

This report describes the results of a survey of the offsite (i.e., not within the property already surveyed) electric line and water line utility shown in Figure 4. The survey involved a full assessment of flora and vegetation. The objectives of the botanical survey were to 1) describe the vegetation; 2) list all species encountered; and 3) identify threatened or endangered plant species. The area was surveyed by Ron Terry and Pat Hart in January 2010. Plant species were identified in the field and, as necessary, collected and keyed out in the laboratory. Special attention was given to the possible presence of any federally (USFWS 2006) listed threatened or endangered plant species, particularly *Abutilon menziesii*.

The survey also included a limited faunal survey restricted to a list of birds observed during the days of botanical survey. Also considered in this report is the general value of the habitat for native birds and the Hawaiian hoary bat. Not included are evaluation of impacts to downstream marine life; introduced mammals, reptiles, or amphibians; and invertebrates.

Limitations

No biological survey of a large area can claim to have detected every species present. Some plant species are cryptic in juvenile or even mature stages of their life cycle. Dry conditions can render almost undetectable plants that extended rainfall may later invigorate and make obvious. Thick brush can obscure even large, healthy specimens. Birds utilize different patches of habitat during different times of the day and seasons, and only long-term study can determine the exact species composition. The findings of this survey must therefore be interpreted with proper caution; in particular, there is no warranty as to the absence of any particular species.

Vegetation Type and Influences

The geologic substrate in the surveyed areas is Pleistocene-era lavas from Mauna Kea (Wolfe and Morris 1996). Parts of the DW and Bridge properties to the south are also located on much more recent Mauna Loa lava flows. The area is one of the driest on the Big Island, with an average annual rainfall of about 10 inches (UH Hilo Dept. of Geography 1998:57). It is difficult to speculate on the pre-human vegetation of the area, since the introduction of certain grasses, grazing animals and fire have changed the soil and microclimate of the area. Gagne and Cuddihy (1990) described the vegetation in fairly undisturbed areas with similar geology and climate as Coastal Dry Forest, which used to be dominated by pili grass (*Heteropogon contortus*) and shrubs such as ‘ilima (*Sida fallax*) with a perhaps diverse but fairly sparse cover of native dry-forest trees and shrubs.
The current vegetation of the area is a savanna comprised primarily of the alien plants kiawe (*Prosopis pallida*) and buffel grass (*Cenchrus ciliaris*). Over most of the surveyed area, we estimate that these two plants account for more than 99 percent of biomass. The low diversity was created and is maintained by the combination of low average annual rainfall, periodic severe droughts, intense overgrazing by feral goats (and some donkeys), and fire.

Flora

A full list of plant species found in the surveyed areas is contained in Table 1, below. Only three of the plants found on the property are natives, two of which are indigenous (found in Hawai‘i as well as elsewhere) and one endemics (found in Hawai‘i and nowhere else). All are very common in leeward areas.

Table 1
Plant Species Detected in Survey Areas

Scientific Name	Family	Common Name	Life Form	Status
Abutilon grandifolium	Malvaceae	Hairy abutilon	Shrub	A
Amaranthus spinosus	Amaranthaceae	Spiny amaranth	Herb	A
Cenchrus ciliaris	Poaceae	Buffel grass	Grass	A
Chenopodium murale	Chenopodiaceae	Lamb’s quarters	Shrub	A
Chenopodium oahuense	Chenopodiaceae	Aweoweo	Shrub	E
Leonotis nepetifolia	Lamiaceae	Lion’s ear	Herb	A
Leucaena leucocephala	Fabaceae	Koa haole	Tree	A
Malva parviflora	Malvaceae	Cheeseweed	Herb	A
Nicotiana glauca	Solanaceae	Tree tobacco	Shrub	A
Pennisetum setaceum	Poaceae	Fountain grass	Grass	A
Portulaca oleracea	Portulacaceae	Pig weed	Herb	A
Prosopis pallida	Fabaceae	Kiawe	Tree	A
Sida fallax	Malvaceae	‘ilima	Shrub	I
Waltheria indica	Sterculiaceae	‘Uhaloa	Herb	I
Xanthium strumarium	Asteraceae	Cocklebur	Shrub	A

A = Alien, I = Indigenous, E = Endemic

The vegetation of the electric corridor was dominated by kiawe trees and buffel grass (Figure 5). Some low-lying areas contain ‘uhaloa, ‘ilima, fountain grass, and koa haole. Fountain grass was more common in the northern part of the proposed electric corridor.

Dominated by kiawe trees and buffel grass, the proposed potable water corridor (Figure 6) also contained the largest proportion of natives, with ‘ilima and ‘uhaloa not uncommon. It also included a wider variety of weeds than the electric line. Tree tobacco, spiny amaranth, and cocklebur were present.

Figure 5
Vegetation on Offsite Electric Corridor

Figure 6
Vegetation on Offsite Potable Water Line Corridor

Threatened and Endangered Plant Species

No listed or proposed threatened or endangered plant species were found, including *Abutilon menziesii*. Given the current context, in an area prone to drought that is unprotected from intense goat grazing and fire, it is unlikely that one would be found.

Birds and the Hawaiian Hoary Bat

The species of birds detected during the survey are typical of those found in similar lowland highly disturbed habitat (Table 2). It should be noted that several other areas of the property were also examined on the survey days, and the list of birds reflects those found in all locations of the property. No native landbirds were detected and it would be unlikely to find any except perhaps the Short-eared Owl (*Asio flammeus sandwichensis*), the Hawaiian endemic sub-species of the Short-eared Owl. Also called *Pueo*, this diurnal bird of prey is regularly seen within the grasslands of North and South Kohala but was not noticed during the survey, although a nest of the introduced Barn Owl (*Tyto alba*) was spotted in Auwaiakeakua Gulch. There is some possibility the development of the property may temporarily displace Short-eared Owls. Any such disturbance will be of a temporary nature, as there is abundant additional suitable habitat within the Waimea plains area above for any displaced owls to move into. This species is currently widespread in Kohala and does not have special protective status under either the State or federal endangered species statutes.

Additionally, it is possible that small numbers of the endangered endemic Hawaiian Petrel (*Pterodroma sandwichensis*) and the threatened Newell's Shearwater (*Puffinus auricularis newelli*) over-fly the project area between the months of May and November. Hawaiian Petrels were

Table 2
Bird Species Detected in Survey Areas

Scientific Name	**Common Name**	**Status**
Acridotheres tristis	Common Myna	Alien Resident
Carpodacus mexicanus	House Finch	Alien Resident
Francolinus francolinus	Black Francolin	Alien resident
Geopelia striata	Zebra Dove	Alien Resident
Lonchura malabarica	Warbling Silverbill	Alien resident
Mimus polyglottos	Northern Mockingbird	Alien resident
Paroaria capitata	Yellow-Billed Cardinal	Alien Resident
Passer domesticus	House Sparrow	Alien Resident
Serinus mozambicus	Yellow-Fronted Canary	Alien Resident
Streptopelia chinensis	Spotted Dove	Alien Resident
Zenaida macroura	Mourning Dove	Alien resident
Zosterops japonicus	Japanese White-Eye	Alien Resident

formerly common on the Island of Hawai‘i. This pelagic seabird reportedly nested in large numbers on the slopes of Mauna Loa and in the saddle area between Mauna Loa and Mauna Kea, as well as at the mid-to-high elevations of Hualālai. It has within recent historic times been reduced to relict

breeding colonies located at high elevations on Mauna Loa and, possibly, Hualālai. Hawaiian Petrels were first listed as an endangered species by the USFWS in 1967 and by the State of Hawai‘i in 1973. Newell’s Shearwaters were also once common on the Island of Hawai‘i. This species breeds on Kaua‘i, Hawai‘i, and Moloka‘i. Newell’s Shearwater populations have dropped precipitously since the 1880s (Banko 1980, Day et al., 2003). This pelagic species nests high in the mountains in burrows excavated under thick vegetation, especially *uluhe* (*Dicranopteris linearis*) fern. Newell’s Shearwater was listed as a threatened species by the USFWS in 1975 and by the State of Hawai‘i in 1973.

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. 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. There is no suitable nesting habitat within or close to the project area for either of these pelagic seabird species.

Although not detected in the survey, which took place in daylight, the only native Hawaiian land mammal, the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*), may also be present in the general area, as it is present in many areas on the island of Hawai‘i and has been observed in kiawe scrub vegetation in Kona. They may forage for flying insects over portions of the project area on a seasonal basis, though the xeric nature of the habitat and the lack of dense vegetation provides little in the way of attractive food resources for a bat.

Impacts and Mitigation Measures

To minimize impacts to the endangered Hawaiian hoary bat, we recommend that woody plants greater than 15 feet will not be removed or trimmed during the bat birthing and pup rearing season (May 15 through August 15).

If the project incorporates outdoor lighting, it may attract Hawaiian Petrels and Newell’s Shearwaters, which may become disoriented by the lighting, resulting in birds being downed. To avoid the potential downing of Hawaiian Petrels and Newell’s Shearwaters by their interaction with outdoor lighting, no construction or unshielded equipment maintenance lighting should be permitted after dark between the months of April and October. All permanent lighting should be shielded in conformance with Hawai‘i County Outdoor Lighting Ordinance (Hawai‘i County Code Chapter 9, Article 14), which requires shielding of exterior lights so as to lower the ambient glare caused by unshielded lighting.

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Appendix I

Archaeological Inventory Survey Report/SHPD Correspondence
(Archaeological Consultants of the Pacific, Inc., Revised December 2002)

AN ARCHAEOLOGICAL INVENTORY SURVEY REPORT FOR THE BRIDGE 'AINA LEA RESIDENTIAL GOLF COMMUNITY DEVELOPMENT LOCATED AT TMK: 6-8-01: 25, 36, 37, 38, 39 & 40 (PORS.), IN THE AHUPUA'A OF WAIKOLOA, DISTRICT OF SOUTH KOHALA, ISLAND OF HAWAI'I

REVISED DECEMBER 2002

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Inventory Reports Data Recovery Reports Research Design Documents Monitoring Due Diligence Work Historical Studies Cultural Studies Burial Treatment Plans Preservation Plans Interpretive Reconstructions Restorations Qualified Expert Witness Testimony

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01006203

Abstract

The current project area was the subject of a reconnaissance survey conducted by Archaeological Consultants of Hawai'i, Inc. in June of 1987. At that time one site was identified consisting of "three ... features - a modified, shallow rock shelter, a small *ahu* and a low wall" (Kennedy 1987). Because it was known that at least one site of potential historic significance was present on the subject property, a complete inventory survey was conducted.

The current investigations took the form of a 100% surface survey of the subject property and limited subsurface testing at one feature. A total of ten sites (Sites 50-10-11-22509 through 22518) comprised of thirteen individual features were identified during the surface survey including the previously identified rock shelter, seven C-shaped walls with associated *ahu*, four independent *ahu* (three of which are in close proximity to one another) and a stone covered hearth. Subsurface testing was conducted at the previously documented rock shelter. Traditional cultural remains were recovered and a sample was collected which was radiocarbon dated to an age of AD 1480.

Of the features identified during the current investigations, the rock shelter, C-Shapes with associated *ahu* and the stone covered hearth (Sites 50-10-11-22509, 22510, 22512-22516 & 22518) are believed to have been utilized for temporary habitation during the pre-Contact Period with the utilization of some sites potentially extending into the early post-Contact Period. The four individual *ahu* (Sites 50-10-11-22511 & 22517) are believed to be boundary markers demarcating pasturelands utilized in the post-Contact Period.

Based upon the results of the current investigations, Archaeological Consultants of the Pacific, Inc. recommends that a determination be made that future construction activities would have an "adverse effect" on significant historic properties. It is also recommended that mitigation of the potential "adverse effect" consist of additional archaeological investigations in the form of Data Recovery as well as the Preservation of Site 22514. The details of both Data Recovery and the Preservation of Site 22514 will be presented in separate documents.

01006204

Table of Contents

Abstract i

List of Illustrations iii

Section 1: Introduction 1

Section 2: Physical Setting 3

Section 3: Historic Background 10

Section 3.1: Land Use History 10

Section 3.2: Previous Archaeology 12

Section 3.3: Summary of Settlement Patterns and Expected Finds 14

Section 4: Archaeological Methods 16

Section 5: Archaeological Findings 19

Section 6: Discussion of Archaeological Findings 53

Section 7: Evaluations of Site Significance 56

Table 1: Summary of Significance Criteria Evaluations 57

Conclusion 60

References Cited 61

Appendix A ..... Tables

Appendix B ..... Results of Radiometric Dating

Appendix C ..... Dr. Ziegler's Comments on Puakō Faunal Material

01006205

List of Illustrations

Figure 1: Project Location on a Map of Hawaii 2

Figure 2: Location of the Subject Property on a U.S.G.S. Topographic Map 4

Figure 3: Location of the Subject Property on a TMK Map 5

Figure 4: Site Locations on a Map of the Subject Property 6

Figure 5: Photograph of a Dry Waterfall Within the Auwaiakeakua 8

Figure 6: Top Plan of Site 22510 21

Figure 7: Illustration of Walled Shelters Identified by Ching 22

Figure 8: Photograph of Site 22510 24

Figure 9: Photograph of Site 22510 (C-shape) 25

Figure 10: Photograph of Site 22510 (*ahu*) 26

Figure 11: Photograph of Feature 22511:A 27

Figure 12: Top Plan of Site 22512 29

Figure 13: Photograph of Site 22512 30

Figure 14: Photograph of Site 22512 (posthole) 31

Figure 15: Top Plan of Site 22513 32

Figure 16: Photograph of Site 22513 33

Figure 17: Photograph of Site 22514 35

Figure 18: Photograph of Feature 22514:A 36

Figure 19: Photograph of Southeastern Wall Construction, 22514:A (Exterior View) 37

Figure 20: Photograph of Southeastern Wall Construction, 22514:A (Interior View) 37

Figure 21: Plan View of the Interior of Feature 22514:A 38

01006206

List of Illustrations (cont.)

Figure 22: Photograph of Floor of Feature 22514:A 39

Figure 23: Profile of Test Unit 1 (Feature 22514:A) 41

Figure 24: Top Plan of Feature 22514:B 42

Figure 25: Photograph of Feature 22514:B 43

Figure 26: Top Plan of Site 22515 45

Figure 27: Top Plan of Site 22516 46

Figure 28: Photograph of Site 22516 47

Figure 29: Top Plan of Site 22518 48

Figure 30: Photograph of Site 22518 49

Figure 31: Photograph of Site 22518 (posthole) 50

An Archaeological Inventory Survey Report for the Bridge 'Aina Lea Residential Golf Community Development Located at TMK: 6-8-01: 25, 36, 37, 38, 39 & 40 (Pors.), in the Ahupua'a of Waikoloa, District of South Kohala, Island of Hawai'i

Section 1: Introduction

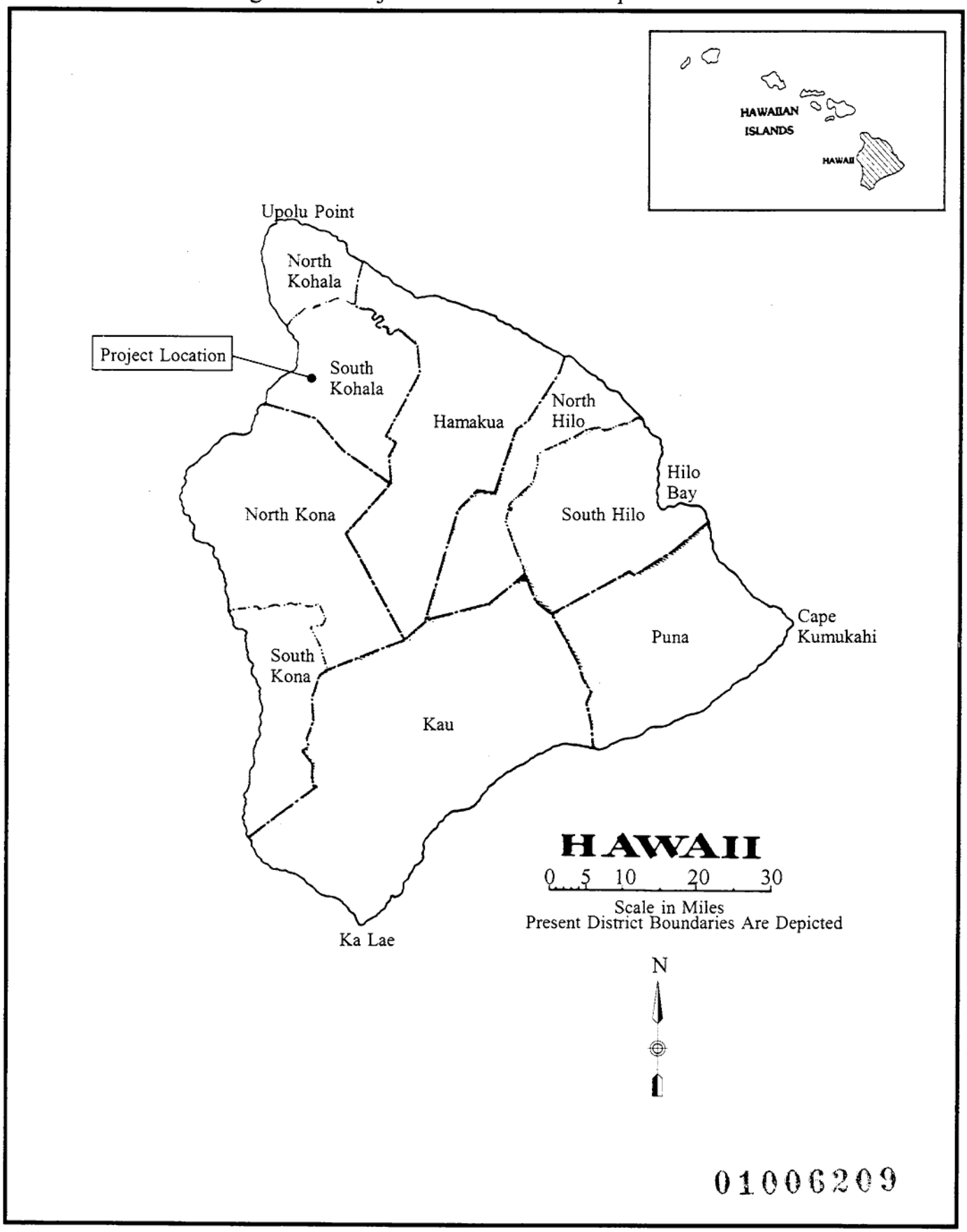
At the request of Mr. Tom Yamamoto of Bridge 'Aina Lea, Archaeological Consultants of the Pacific, Inc. (ACP) has conducted an Archaeological Inventory Survey of an approximate 1000-acre parcel located at TMK: 6-8-01: 25, 36, 37, 38, 39 and 40 (Pors.) as well as an adjoining proposed power line corridor, in the *ahupua'a* of Waikoloa, district of South Kohala on the island of Hawai'i (see Figure 1). Bridge 'Aina Lea is the current owner of the subject property. The proposed use of this parcel is to be developed into a Residential Golf Community. The 1000-acre parcel portion of the current project area is a part of a larger piece of land which is to be developed. Portions of TMK parcels 25, 36, 37, 38, 39 and 40 around the perimeter of the current 1000-acre parcel were the subject of an Inventory Survey conducted by Ogden Environmental and Energy Services (OEES) in the early 1990's (Schilz & Shun 1992).

The purpose of these archaeological investigations was to perform the tasks and meet the requirements specified by the State of Hawai'i, Department of Land and Natural Resources, State Historic Preservation Division (DLNR-SHPD). These investigations would allow for the identification of potential historic resources located on the property as well as an evaluation of their significance including their eligibility for inclusion in the National Register of Historic Places. These investigations also allow for the making of recommendations concerning the mitigation of the impact of future construction activities upon potentially significant historic resources.

The following report presents a background of the region which includes reviews of the previous archaeology conducted in the region, previous land uses and settlement patterns. Following these sections, detailed descriptions of the archaeological features inventoried throughout the investigation are provided. The descriptions are followed by discussions which focus on functional aspects of the features as well as their estimated ages.

01006208

Figure 1: Project Location on a Map of Hawaii



Puako TMK: 6-8-01:25, 36, 37, 38, 39 & 40 (Pors.)

After: Spriggs and Tanaka 1988

Section 2: Physical Setting

The subject property is located within lava flows which cross the Waikoloa region. There are two portions of the current subject property, a 1000-acre parcel located adjacent to Queen Ka'ahumanu Highway and a proposed power line corridor. The 1000-acre parcel is located between geographic grid coordinates 155°48'50"W to 155°50'35"W by 19°55'10"N to 19°56'10"N and between UTM coordinates 202250mE to 205500mE by 2209450mN to 2205250mN (see Figure 2). This parcel ranges in elevation from approximately 35 meters (m)(115 feet [ft]) above mean sea level (AMSL) along its northwestern edge (Queen Ka'ahumanu Highway) to approximately 160m (520ft) AMSL at its southeastern edge. The 1000-acre parcel measures approximately 2170m (7125ft) in length (southwest-northeast) by 1950m (6400ft) in width (*mauka-makai*) at its greatest dimensions (see Figure 3). The proposed power line corridor extends southeast from the eastern corner of the 1000-acre parcel for approximately 1100m then turns north extending an additional 4700m (see Figure 4). The corridor measured approximately 15m (50ft) in width along the 4700m long, north-south oriented segment while an expanded survey corridor measuring up to 300m in width was investigated along the 1100m long, southeast-northwest oriented segment.

As stated above, the current subject property is a portion of a larger parcel which is currently scheduled to be developed. The portions of TMK: 6-8-01: 25, 36, 37, 38, 39 and 40 outside of the current subject property were the subject of an Inventory Survey conducted by Ogden Environmental and Energy Services (OEES) in the early 1990's (Schilz & Shun 1992)(see Figures 3 & 4 and refer to Section 3.2). Only those areas within the boundaries of the current subject property are discussed in this section.

Topography

The 1000-acre portion of the subject property consists predominately of relatively recent, and substantial Mauna Loa and Mauna Kea lava accumulations of both *a'a* and *pahoehoe*. The dominant slope ranges in inclination from 10 to 15°.

Three separate geological areas are found within the 1000-acre portion of the current project parcel. The northern edge of the Kaniku Lava Flow runs along the southwestern boundary of the 1000-acre parcel (see Figure 2). Within the project area the Kaniku Lava Flow consists of a relatively flat expanse of *a'a* sloping gently from southeast to northwest.

Covering a large section across the center of the 1000-acre parcel there is a flow of very rough *a'a* within which outcroppings of smooth *pahoehoe* and collapsed blister domes are found. This flow is lava from the Laupahoehoe Volcanic Series of Mauna Kea formed roughly 2,500 to 7,500 years ago (MacDonald, Abbott & Peterson 1986:350, 351 & 360-364).

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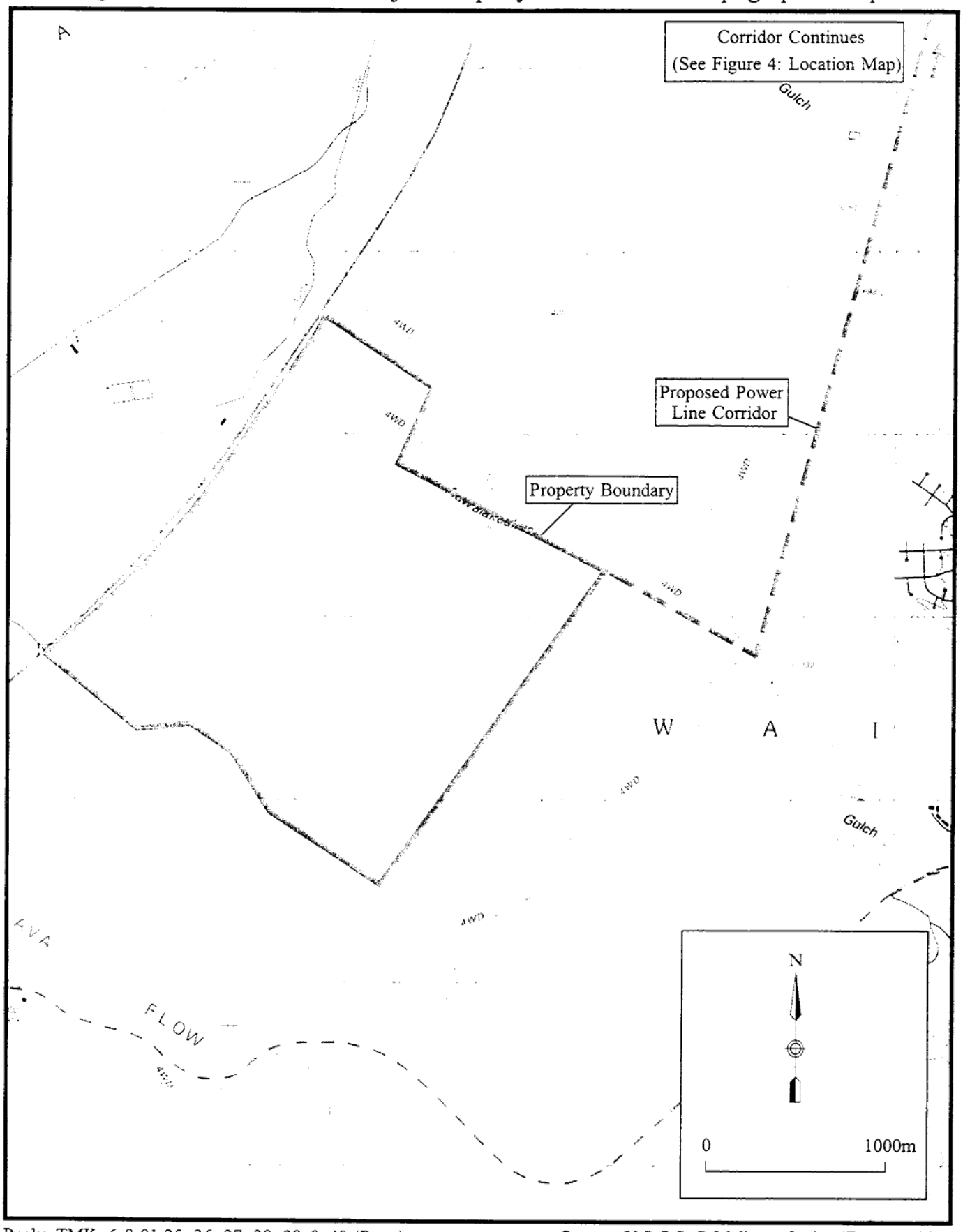
Figure 2: Location of the Subject Property on a U.S.G.S. Topographic Map



Puako TMK: 6-8-01:25, 36, 37, 38, 39 & 40 (Pors.)

Source: U.S.G.S. 7.5 Minute Series (Topographic)
Puu Hinai 1997

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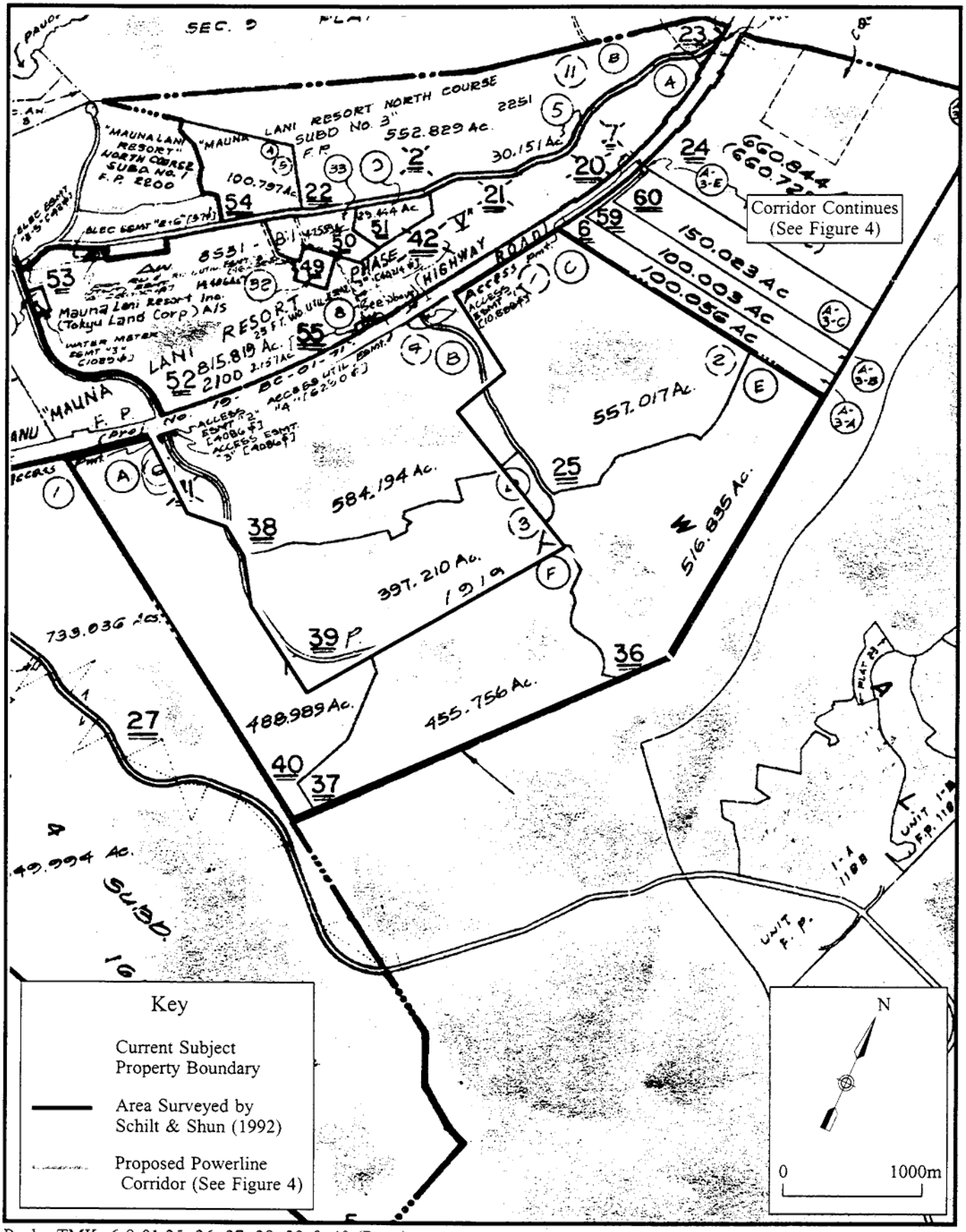
Figure 3: Location of the Subject Property on a TMK Map



Puako TMK: 6-8-01:25, 36, 37, 38, 39 & 40 (Pors.)

Source: Dept of Taxation, Tax Maps Branch 1971

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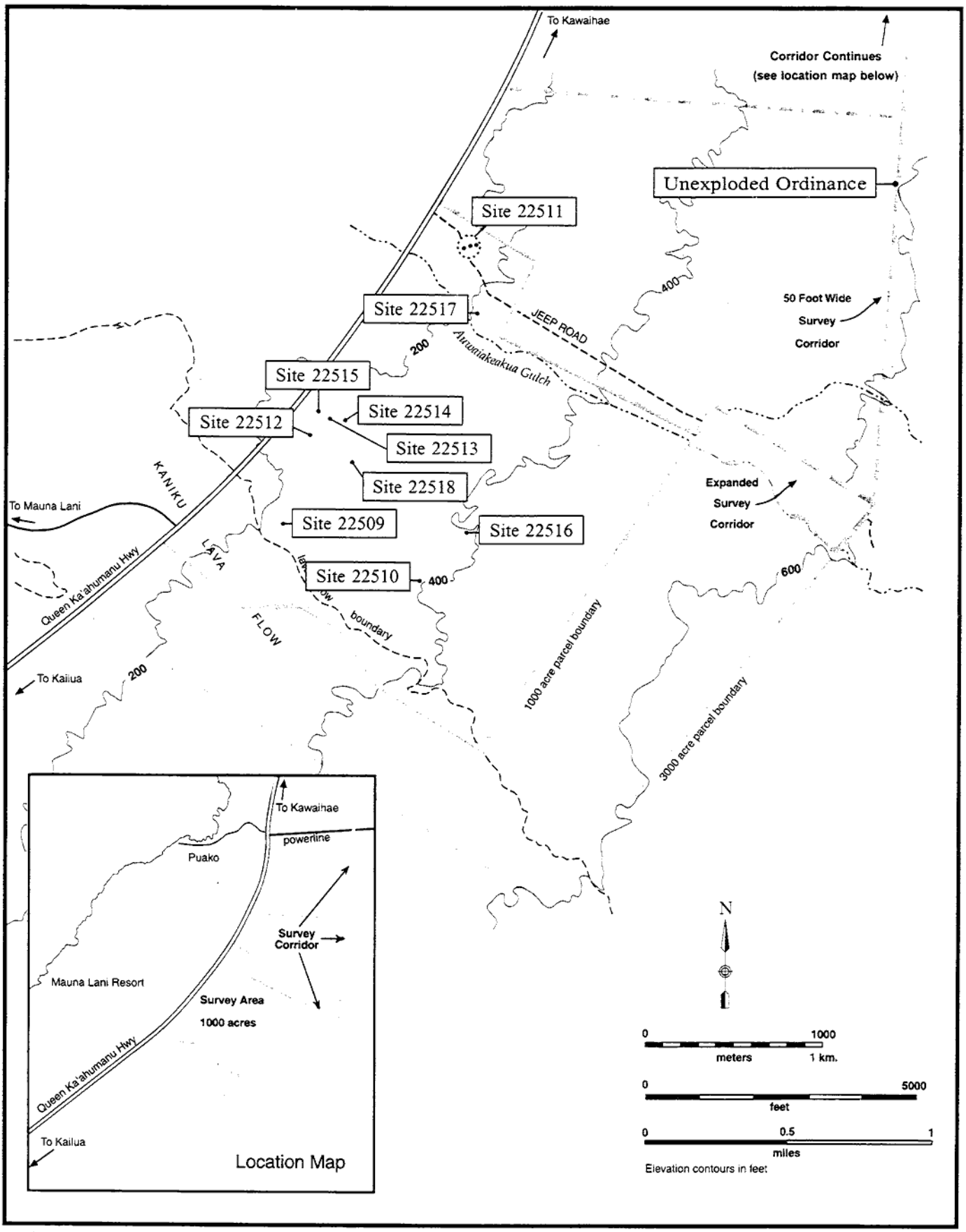
Figure 4: Site Locations on a Map of the Subject Property



Finally, the area along the northern boundary of the 1000-acre parcel (running from the highway to the *mauka* border) is marked by rolling hills formed from Pahala ash during the late Pleistocene epoch (Macdonald *et al.* 1986:349). Pahala ash consists of vitric ash and fragments of pumice which likely derived from eruptions on Mauna Kea. In this area small amounts of soil have had time to develop allowing some vegetation to become established. Also located in this geological zone along the northern boundary of the 1000-acre parcel is the Auwaiakeakua (also spelt Auwai-a-ke-kua), which literally translates to "watercourse of the god" (Pukui, Elbert & Mo'okini 1974). This feature consists of a relatively deep gulch which displayed evidence of substantial water flow in the recent past (see Figure 5). The proposed power line corridor also passes through these rolling hills formed from Pahala ash and found along the northern boundary of the 1000-acre parcel. This corridor passes through property utilized as pastureland which displays disturbances caused by active grazing.

Climate

Rainfall in the Waikoloa region averages less than 10 inches of rain per year (Giambelluca, Nullet & Schroeder 1986). The majority of this rain falls between November and March, the wet season. Droughts are a periodic problem in this zone (Giambelluca, Nullet, Ridgely, Eyre, Moncur & Price 1991). At Puakō temperatures range from monthly highs of 66° to 81° F in March to 73° to 89° F in September (Armstrong 1973:58). Ground surface temperatures in the lava fields are typically higher, often exceeding 130° F (Olson 1983). Relative humidity in Kawaihae, several miles northwest of the current survey parcel is about 48% to 86%.

Flora & Fauna

Vegetation on the subject property consists predominately of widely scattered scrub *kiawe* (*Prosopis pallida*) and occasional tufts of grass such as fountain grass (*Pennisetum setacaeum*) although along the northern boundary of the 1000-acre parcel the number of *kiawe* increases notably. The arid climate restricts the growth of much vegetation. Occasional individuals of the species *Capparis sandwichciana* were observed in places, these succulents appearing out of place in this harsh environment. This plant is known to have been used by Hawaiians to help heal broken bones and is typically found in coastal locations and within lava flows.

The harsh environment also restricts the fauna found in this region. Throughout the subject property the field crew observed feral goat (*Capra hircus*) droppings and goats themselves were sighted one day along the southeastern edge of the property. Occasional birds were also observed flying over the landscape.

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Figure 5: Photograph of a Dry Waterfall Within the Auwaiakeakua

View Facing Southeast

Expected Soils

The Soil Survey of the Island of Hawai'i depicts the majority of the current subject property as being covered with *a'a* lava flows (rLV)(Sato, Ikeda, Paeth, Smythe & Takehiro 1973). As described above, the flows actually encountered on the subject property consisted of the Kaniku Lava Flow along the southwestern boundary of the project area and a flow of the Laupahoehoe Series across the center of the property. As would be expected in a dry climate with little or no vegetation, virtually no soils have developed on these flows.

Along the northeastern boundary of the subject parcel on both sides of the Auwaiakeakua is an area of older volcanic deposits and in this area there has been some soil development. Sato *et al.*, depict the expected soils in this area to one of three types: 1) the Kamakoa Series of very fine sandy loam, 2) the Kawaihae Series of extremely stony very fine sandy loam, or 3) the Puu Pa Series of extremely stony very fine sandy loam. Because no subsurface investigations were conducted in this area, no analyses of the soils present were conducted. The soils actually encountered during subsurface testing were found within a rock shelter (Feature 22514:A) and, although similar, are not believed to be representative of the expected soils.

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Section 3: Historic Background

The project area is located in the *ahupua'a* of Waikoloa, in the district of South Kohala, on the island of Hawai'i. Waikoloa literally translates to "duck water" although the authors of *Place Names of Hawaii* alternatively suggest that the spelling could be "Wai-kō-loa" in which case the meaning refers the name of a cold northwest wind (Pukui *et al.* 1974). Within Waikoloa and near coast is a region known as Puakō. Puakō literally translates as sugar cane blossom. Of the historic information available regarding the past use of these lands, the most information available concerning the district is from Samuel M. Kamakau's "Ruling Chiefs" (Kamakau 1992).

The following sub-sections review the prior land uses of the Waikoloa area as well as settlement patterns associated with pre-Contact populations that occupied the South Kohala coast. In addition, a review of previous archaeological studies conducted in the Puakō area will be presented. This section concludes with a discussion of the types of sites expected to be identified in the parcel that was surveyed.

Section 3.1: Land Use History

Some of the earliest information concerning the history of the Puakō area comes by way of legends. The legendary dog *kupua*, Puapualenalena (alternatively Pupualenalena), was said to have lived at Puakō. Puapualenalena was known as a great thief and runner who could take the shape of a yellow dog. He is associated with the theft of the conch shell, Kiha-pu. In alternative versions of this legend the Kiha-pu has been either absconded by, or returned to, a band of spirits or *'e'epa* who disturb the sleep of a chief with their trumpeting of the shell. Because the chief's sleep is being disturbed, the dog *kupua* is to steal the Kiha-pu, in some versions after having been caught stealing one of the chief's *kapu* crops. This shell is said to have been handed down through the Kamehameha kings and is now preserved in the Bishop Museum (Beckwith 1970:349-351).

Located near the current survey parcel are the well known ancient trails of Puakō-Ke'amuku and Puakō-Waimea. These were primary trails utilized to get from coastal marine environments to upland agricultural areas. Portions of the Puakō-Ke'amuku Trail are believed to have run in the vicinity of northern boundary of the current subject parcel, possibly crossing one portion of the project area. The probable proximity of the Puakō-Ke'amuku Trail to the northern boundary of the current subject property as well as the Auwaiakeakua suggests that the presence of an intermittent/seasonal water source may have influenced the location and path of the trail. Based on archival information this trail has in the more recent past been associated with cattle ranching (Schilz & Shun 1992). The possibility exists, however, that this cattle trail utilized the path of a previously existing trail.

A story related to the Puakō-Waimea Trail is mentioned by Kamakau. Kamehameha was living with the chiefs at Waimea and working on the restoration of Uli Heiau. After this was completed all the people walked down to Puakō and gathered coconuts for the dedication. When everyone except Kamehameha and one other man had left, there still remained 480 coconuts.

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The two of them put the coconuts in nets and dragged them to Waimea. The road was twenty miles in length. Kamehameha told the man, Kuihelani, not to mention that he had helped him. Kuihelani became a favorite of King Kamehameha and held an important office. He was also allowed to have ten wives, a privilege allowed to only the most important men (Kamakau 1992).

Kohala was an area that was filled with history during the time leading up to Kamehameha's reign and directly after. This era is labeled by Kirch as the Proto-Historic Period (1985). The battle for control of the island of Hawai'i would eventually determine who ruled the entire archipelago.

Kamehameha emerged as the *ali'i* who would take the war to the chiefs of Maui. When Keoua Kuahu-'ula learned that Kamehameha with the assistance of Keawe-ma'u-hili had gone to make war against Maui, fearing that he would be their next target, Keoua attacked Keawe and his remaining forces and conquered Hilo. Keoua carried the war into Hamakua, Waimea and Kohala. "In Kohala, women and children were beaten, and the people cruelly treated. The low-born attacked the low-born and the high-born the high-born" (Kamakau 1992:151). Kamehameha, who was living on Molokai with his fighting men, heard how Keoua had ravaged Kohala and returned to Hawai'i.

He landed at Kawaihae and, accompanied by the Americans Young and Davis, marched towards Keoua's camp. By the time Kamehameha arrived, Keoua had retreated to Hamakua. At Hamakua a great battle took place and the famous cannon called Lopaka was instrumental in keeping Kamehameha's forces from being killed by the warriors Uhai and Ka-'ia'iaiea.

Even though Kamehameha's forces had muskets and cannon, Keoua's forces fought to a draw. Keoua retired to Hilo and Kamehameha to Kohala. War continued between these two for several years. The end came for Keoua when he attacked with 27 war canoes off the coast of Puakō. Kamehameha wanted to talk about a truce but things turned awry and Keoua and all who didn't jump overboard were killed. This ended the war for the island of Hawai'i. Within several years Kamehameha would unite the islands and thus end the Proto-Historic Period (Kirch 1985).

Regarding land ownership, at the time of first Western contact the current subject parcel was part of Waimea Ahupua'a. We know that up until 1848 many of the *'ili* of Waikoloa and Waimea Ahupua'a were crown lands. It is also known that the *'ili* of Waikoloa was given to Kamehameha's ally Issac Davis upon the unification of the Kingdom. During the Mahele of 1848, major portions of Waikoloa were granted to G.D. Hueu, son of Isaac Davis (LCA 8521-B, Royal Patent 7241).

The boundaries of Waikoloa were not decided until 1867 when Waikoloa was legally separated from the coastal strips of Puakō, Kalahuipua'a and 'Anaeho'omalu (Schilz & Shun 1992). After this time, the major portions of these coastal land units were claimed by Queen Kalama Ka-paku-haili, Kamehameha III's wife (Land Commission Award 4452:4, Royal Patent 7523: Barrera 1971:110; Board of Land Commissioners 1929:498).

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By 1881, Samuel Parker, grandson of John Palmer Parker, purchased *'ili* in Waimea for cattle grazing. After his death those *'ili* and the adjacent land areas (including the current subject parcel) were taken over by Parker's heirs. Parker Ranch utilized the region for cattle grazing from the late 1800's to the mid-1900's. Throughout World War II, lands owned by Parker Ranch were utilized by the U.S. Military as training and staging areas for troops headed for the Western Pacific.

Francis H. I'i Brown eventually purchased the land between 1932 and 1936. Brown sold this land in 1972 to Orchid Island Resort, who in turn sold it in 1973 to Mauna Loa Land, Inc.. The current subject parcel is currently owned by Bridge 'Aina Lea (previously Signal Properties, Inc.) and is scheduled to be developed into a modern resort.

Section 3.2: Previous Archaeology

Numerous archaeological surveys have been conducted in the South Kohala region, primarily due to resort development in this area. The lands surrounding the current project area have been the focus of many archaeological investigations (Ching 1971; Barrera 1971; Donham 1987; Drolet & Schilz 1991; Drolet & Clark 1997; Emory 1955; Jensen 1988; Jensen and Donham 1988; Kirch 1979; Kennedy 1987; Landrum *et al.* 1992; Reinecke 1930; Rosendahl 1972; Schilz & Shun 1992). During the last ten years reviews of these investigations have been presented by Jensen (1991), Landrum and Williams (1994) and Nees (1995). This section summarizes this previous research and the information recovered concerning pre-Contact settlement patterns of northwestern Hawai'i.

The earliest surveys along the 'Anaeho'omalu and Kalahuipua'a coasts were conducted by the Bishop Museum in the 1920's and 1930's. Reinecke (1930) identified three complexes which included over a dozen shelters along the rocky coastline between Waiulua Bay and Makaiwa Bay. Only brief descriptions and general locations are provided for these sites.

The first site excavations in this area were conducted by Dr. Kenneth P. Emory of the Bishop Museum (Kirch 1979). These consisted of midden deposit excavations in shelter caves near Makaiwa Bay (Site 50-Ha-E1-342 and Site H101). Subsequent excavations conducted at one of these sites by Kirch (1979) and Hommon (1982) resulted in a reexamination of the cultural deposits. They were found to still contain abundant resource remains and artifacts.

After Emory's work, the Bishop Museum returned to the Pauoa Bay area in the early 1960's. These investigations included a coastal midden site (HA-E3-2)(Smart 1964). Also, mapping was conducted of the Puakō petroglyph fields that had previously been identified by Reinecke (1930). The Bishop Museum study documented over 3,000 petroglyphs (Cox 1971), making it one of the largest petroglyph fields recorded in Hawai'i.

Two extensive surveys were completed by the Bishop Museum in 1970. Barrera (1970, 1971) completed a 503 acre survey of lands west of the King's Highway (Alaloa Trail). He identified 293 sites and collected over 12,000 artifacts. Donham (1987) and Jensen & Donham (1988) resurveyed portions of this area. Another major survey was conducted by Ching (1971) in

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association with the construction of Queen Ka'ahumanu Highway. This reconnaissance survey followed a 23-mile long corridor measuring 2000 feet in width. This survey ran along the current subject properties' northwestern boundary and would have included the first thousand feet extending *mauka* from and parallel to the highway. Additional surveys along the highway corridor were done by Austin (1971), Rosendahl (1972), Donham (1987) and Jensen and Donham (1988:9). Many of the sites identified during those surveys consisted of abrader manufacturing locales which led these investigators to focus on settlement pattern analysis as well as on the tool manufacturing specialization that developed in the marginal areas of this coastal interior zone (Drolet & Clark 1997).

The Mauna Lani Resort lands had subsequent surveys done by Cordy (1981; 1987), Jensen (1991) and Welch (1988) which confirmed the sites and features identified in this area represent a limited range of activities and reflect the specialized nature of the pre-Contact abrader industry. These reports indicate that this zone was deliberately exploited as early as AD 1400. The most recent investigations have identified over 100 sites extending from the interior lava fields to the coast (Drolet & Schilz 1991: Landrum *et al.* 1992; Landrum & Williams 1994; Nees 1995; Schilz & Shun 1992; Drolet & Clark 1997). The feature types encountered during the more recent investigations were consistent with those earlier recorded for both inland and coastal surveys including features utilized "for temporary habitation (paved areas, paved depressions, C-shaped enclosures, terraces, platforms & rock shelters), transportation (primary trails, secondary trails and trail markers), manufacturing (quarry pits, workshops), ceremonial activities (platforms, shrine offerings, upright shrines) and burial (burial blister caves, burial cairns and burial caves)" (Drolet & Clark 1997:13). Taking all the surveys into account the area has one of the most complete inventories of archaeological sites in western Hawai'i.

Of note, Landrum *et al.* (1992) identified quarry workshops in *a'a* flows, disputing previous ideas that only *pahoehoe* was being used as abraders. The exploitation of both *pahoehoe* and *a'a* flows in 'Anaeho'malu reveals that different material was being quarried and may suggest that specialization and technological innovation occurred over time in this abrader industry (Drolet & Clark 1997:13).

A 2000-acre parcel consisting of lands immediately adjacent to the current subject property was the subject of an inventory survey conducted by OEES in the early 1990's (Schilz & Shun 1992). The lands surveyed by OEES surround the current project area on three sides being contiguous with the southwestern, southeastern and northeastern boundaries of the subject property (see Figure 3). Schilz and Shun encountered a total of thirteen sites of which only one, "a modified lava tube containing the remains of a partial human burial" (Site 50-10-11-15033), was considered significant to the interest of historic preservation. The remaining features were attributed to being the remains of modern military and/or hunting activities (Schilz & Shun 1992:i & 19). Recent personal communications with Dr. Pat McCoy, the DLNR-SHPD Hawai'i Island Archaeologist, however, have indicated that the authors may be in the process of reinterpreting the age and function of some of these features in light of further investigations.

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Section 3.3: Summary of Settlement Patterns and Expected Finds

Evidence concerning the sequence of settlement in this area of West Hawai'i begins with radiocarbon dating which places the initial occupation of coastal 'Anaeho'omalu at between AD 900 and 1000 (Jensen 1991). This would place the initial occupation of the area during the late Developmental Period of Kirch's proposed Hawaiian cultural sequence (Kirch 1985). In contrast, the earliest radiocarbon dates recovered from archaeological sites at Kalahuipua'a date to between AD 1100 and 1200 (Jensen 1991), the early Expansion Period of Kirch's sequence. Overall, this information indicates that by AD 1100, the beginning of the Expansion Period, this area was likely being utilized on a recurrent, if not semi-permanent, basis. At this time occupation would likely have been limited to the coast where temporary habitation would occur by those utilizing littoral resources.

The population gradually increased in both areas and after around AD 1200 there appears to have been continuous expansion (Kirch 1979). By the beginning of Kirch's Proto-Historic Period around AD 1650, utilization of the area had developed into a pattern typical of that found along the northwestern coast of the Big Island. Permanent habitations were likely clustered around coastal bays while agriculturally utilized plots were found further inland where increased rainfall would support crops. The areas between coastal habitations and upland agricultural lands were likely utilized on a marginal basis for the gathering of resources such as lithic materials. Trails would link the coastal regions to upland areas with temporary habitation sites found in the intervening areas and amongst agricultural fields to provide shelter for those working the fields or traveling between areas. Occasional permanent habitation sites would also likely be found in some inland areas.

Dates obtained from inland sites suggest that utilization continued to expand *mauka* throughout the later pre-Contact era, between AD 1400 to 1801 (Jensen 1988:135). During this period intensification and expansion of inland agricultural field systems occurred and permanent habitation increased in these areas. Data concerning the expansion inland led Drolet and Clark to suggest that the interior abrader workshop industry developed during the late Expansion Period, a time when the coastal fishpond complex at Kalahuipua'a was established, interior-coastal exchange networks were operating, marine resource exploitation was intensifying and there was permanent or semi-permanent occupation of this marginal environmental area (Drolet & Clark 1997).

Culturally, the subject property is located in what has been termed a "transitional zone" by archaeologists, meaning that this portion of the island is situated between the coast (where a variety of cultural activities have been known to take place including the majority of permanent habitations) and the upland zone (the location of agriculturally related sites). There have been notable exceptions to this scenario. Numerous archaeological sites have been recorded in this "transitional" inland area, including temporary occupation and religious sites, trails and lithic workshops (Landrum & Williams 1994). An additional site type known to exist in this transitional zone of West Hawai'i are the lava tubes that served as burial grounds, refuge sites and sometimes the site of religious activities.

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The transitional zone is believed to have become increasingly utilized during the late Expansion Period as part of the inland abrader workshop industry. Trails and shelters are common in these inland lava fields. Both Kirch (1979) and Hommon (1982) noted that a trade network developed as early as AD 1200 between the coastal area and the interior uplands following a traditional *ahupua'a* exchange pattern. Exploitation of the scoriaceous lava took place in earnest after AD 1200. A number of the inhabitants of the *ahupua'a* likely took on this specialized task with labor from both the coast and the uplands likely working the abrader quarries. The number of workshop areas and quarries within the Puakō, Kalahuipua'a, 'Anaeho'omalu and Waikoloa areas would indicate that this arid, barren land was valued by Hawaiians.

Based on the available background information pertaining to the activities that took place in Waikoloa Ahupua'a, the current subject parcel is expected to yield archaeological features that are morphologically similar to and contemporaneous with previously recorded sites in the vicinity. As stated above, the range of activities which are believed to have occurred in the marginal transitional zone included temporary habitation, transportation, manufacturing, ceremonial activities and burial. Based upon the activities believed to have occurred, features which could be expected to be encountered on the subject property would include paved areas, paved depressions, C-shaped structures, terraces, platforms, rock shelters, primary trails, secondary trails, trail markers, quarry pits, workshops, ceremonial features, burial caves and burial cairns.

Section 4: Archaeological Methods

The current archaeological investigations were conducted from August 26th through September 1st, 2000. All fieldwork was conducted under the direction of the Principal Investigator, Joseph Kennedy, M.A.. Fieldwork was conducted by a crew of five including MaryAnne B. Maigret, M.A., James R. Moore, B.S., Brad Ostroff, B.A., Jim Powell, B.A., and Patrick Sarvak, B.A.. Only three members were in the field at any one time. Fieldwork methods consisted of both surface and subsurface investigations.

A pedestrian survey was utilized to systematically investigate the subject property. The purpose of the pedestrian survey was to identify all potentially significant historic properties which may be located on the surface of the subject property. The pedestrian survey was conducted by having a three-man field crew sweep the parcel on foot using transects spaced approximately 10 to 20 meters (m) apart. Transects ran roughly northwest to southeast. Visibility was relatively good with little to no vegetation covering the rocky terrain. The little vegetation that was present consisted of scattered scrub *kiawe* trees and occasional tufts of grass or weeds. Through the use of this procedure a 100% surface survey of the subject property was completed and all potentially significant historic properties were identified.

When features believed to be potentially significant historic properties were encountered during the pedestrian survey they were flagged with engineer's flagging tape marked with the date, job name, company name (ACP) and temporary identification numbers using the prefix "TF" to indicate the temporary "feature" designation. Features and/or groups of features which, upon completion of all investigations, were determined to be significant historic sites were subsequently assigned the permanent State Site numbers used in this document.

The locations of sites and features across the subject property were collected by recording GPS readings and were subsequently plotted onto a base map of the subject property provided to ACP by Bridge 'Aina Lea for presentation in this document. In addition, those sites and features which are believed to have been utilized for temporary habitation were sketch mapped using compass and tape at a scale which would allow for the depiction of structures in the appropriate detail.

Subsurface investigations took the form of one controlled manually excavated test unit placed at Feature 22514:A. The purpose of conducting subsurface excavations was to determine if cultural deposits were present at this feature and provide information which would allow for the evaluation of the site. The test unit measured 50cm by 50cm and was excavated by natural stratigraphic layers. The test unit was excavated until bedrock was reached. Soil and stones were removed by trowel and shovel and were sifted through one-eighth inch mesh screen in order to examine and collect potential cultural materials from the screen residuum.

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The controlled excavation of the test unit utilizing this methodology allowed for the thorough testing of stratigraphic layers in order to collect detailed information relating to the stratigraphy and potential cultural deposits. This procedure also allowed for the identification and controlled testing of potential subsurface features as well as the identification and controlled collection of potential artifacts encountered during excavation. All potential cultural materials recovered from the excavation of the test unit were collected. Soil samples were collected from each stratigraphic layer identified and a profile was drawn of one face of the unit.

A variety of techniques were utilized to ensure proper data collection. Selected features on the subject property were individually mapped using a compass and measuring tape while feature locations were recorded using the GPS and plotted on plans of the property drawn to scale. Photographs were taken of selected features and the excavation unit with representative photographs presented in this document. Notes were taken in the field describing the environmental setting of the subject property including indications of former modifications and/or modern developments made to the parcel. Detailed field notes were also taken describing the subsurface excavations with a summary of the basic findings from the unit. A representative profile was drawn to scale for the test unit. All of these methods in data collection were conducted in order to provide an accurate and detailed visual and written record of the findings on the subject property.

All sampling was conducted using standard archaeological methods including the screening of soils through one eighth inch mesh screen in order to retrieve potential cultural materials. Soil samples collected were placed in resealable bags and labeled with the appropriate provenience information for use in laboratory analyses. Similarly, any potential cultural materials were collected, placed in resealable bags and labeled with the appropriate provenience information for use in laboratory analyses. Potential datable samples were removed *in situ*, when possible, for the purpose of radiometric testing. The samples were collected with trowel or tweezers without coming into contact with human skin. The samples were carefully wrapped in aluminum foil in order to prevent the carbon from being exposed to sunlight and to avoid contact with other carbon based materials which would adversely affect the sample, placed in resealable bags and labeled with the appropriate provenience information.

Laboratory analyses included a range of diagnostic endeavors. All analyses were conducted according to standard scientific and archaeological methods and recorded on standardized analysis forms. Soils were analyzed by ACP laboratory personnel according to USDA standards in order to obtain a scientific determination of their composition and color. This aided in the distinction of the various stratigraphic deposits as they relate to geological and cultural events on the subject property.

All artifacts were also analyzed by ACP laboratory personnel. Artifacts were sorted by type, described in detail, weighed, measured and tabulated with the results presented by provenience in a detailed accession list. These analyses were conducted in order to provide a detailed record of the individual artifacts as well as densities of artifact types as they relate too their provenience. Ultimately, these analyses provide information which helped determine the range of activities that likely took place on the subject property.

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Invertebrate faunal remains were analyzed by ACP laboratory personnel with the samples being identified to the genus level as possible. The results of these analyses were prepared by being tabulated and presented by provenience and weight. These analyses were conducted in order to determine what types of invertebrates were utilized and in what amount yielding important information concerning some of the activities which likely took place at or in relation to the sites under investigation.

All vertebrate faunal remains were analyzed by Zoological Consultant, Alan Zeigler, Ph.D., with the samples identified to the species level, as possible. The results of these analyses were prepared by being tabulated and presented by provenience and weight. Again, these analyses were conducted in order to determine what species of vertebrates were utilized and in what amount yielding important information concerning some of the activities which likely took place at or in relation to the sites under investigation.

Additional analyses conducted for the current investigations include the radiometric dating of a carbon sample by Beta Analytic, Inc.. The dating of the sample provided information concerning the temporal context of the site under investigation.

This report provides complete descriptions of the investigations undertaken including written accounts, placement of the features and test unit on plans drawn to scale, and a profile depicting stratigraphic deposits encountered. The methods utilized aided in the production of an accurate and detailed report along with a determination of site significance as well as the impact of future construction endeavors.

All materials collected during test excavations will be bagged and labeled appropriately, placed in labeled and inventoried boxes, and curated at ACP facilities located at 59-624 Pupukea Road, Haleiwa, Hawai'i.

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Section 5: Archaeological Findings

Archaeological investigations conducted by ACP systematically surveyed the entire subject property. The current investigations identified 10 sites (Sites 50-10-11-22509 through 22518; please note that in the remainder of this document only the 5 digit individual site numbers will be cited) comprised of 13 individual features which were considered significant historic properties (see Figure 4). Site types included seven C-shaped walls with associated *ahu*, four independent *ahu*, a rock shelter and a stone covered hearth. In addition, one modern fire pit (distinguished by metal sawed wood recognizable in the charcoal remains), a possible lithic extraction site and a possible trail segment were encountered which were subsequently determined not to represent significant historic properties. Finally, during the survey of the proposed power line corridor, one unexploded 155mm piece of ordinance was identified.

In the text that follows, each of the sites identified within the project area will be described. The findings from subsurface testing at Feature 22514:A will also be discussed.

Section 5.1: Site Descriptions

Site 22509 (TF 1)

Site 22509 consists of a stone covered hearth located within the rough central portion of the subject property just north of the northern edge of the Kaniku Lava Flow towards the western corner of the survey area (see Figure 4). The site is situated near the top of and along the *makai* (northwestern) side of an escarpment-like ridge of *pahoehoe* which runs roughly from north-northeast to south-southwest. The site is at the southwestern end of the ridge along the side of a 30m in diameter, 10m deep depression. The feature is formed of two slabs of brown *pahoehoe* leaning against each other covering a stone lined hearth. The larger of the two leaning slabs measured approximately 120 centimeters (cm) by 75cm and 8 to 10cm in thickness and was oriented so as to block the prevailing northeasterly wind. The smaller of the two slabs measured 75cm by 65cm and was also 8 to 10cm in thickness. These two slabs leaned on each other creating an inverted "V".

The stones observed lining the floor of the hearth were of a darker (black colored), finer grained basalt than both the brown colored, more vesicular, *pahoehoe* slabs which covered the hearth and the brown colored vesicular basalt observed in the general vicinity of the site. The black colored angular basalt stones lining the hearth measured approximately 8 to 12cm in diameter and are believed to represent manuports collected from the Kaniku Lava Flow just over 100m to the southwest. Fine white ash was also seen in and around the inside of the hearth. An approximately 5m long stain or discoloration was observed down slope of the hearth on a small sloping outcrop of smooth *pahoehoe*. It should be noted that a scrub *kiawe* tree was growing just a few meters away and could have provided an easy source of wood for a small modern fire. Based upon the presence of manuported stones from the Kaniku Lava Flow, it is believed that this site was used for temporary habitation associated with the traditional utilization of this area and that this utilization likely occurred in the pre-Contact Period. It cannot be discounted, however, that the site was initially utilized or reutilized in the post-Contact or modern periods.

01006226

Site 22510 (TF A)

Site 22510 is one of seven features (Sites 22510, 22512, 22513, 22515, 22516 & 22518 and Feature 22514:B) identified during the current investigations which display the same morphological structure. These structures consist of two components, a C-shaped wall and an *ahu*. The two components are arranged with the *ahu* roughly situated across from the mouth of the "C" (see Figure 6). Each of these sites/features was situated atop smooth, elongated *pahoehoe* domes found running generally *mauka-makai* within the rough, mixed *a'a* and *pahoehoe* flow that covers the central portion of the subject property. In each case the mouth of the C-shaped wall was oriented roughly to the southwest such that the wall itself would block the prevailing northeasterly wind.

It is believed that both components of these features, the C-shaped wall and the *ahu*, formerly provided the support for a single structure. A structure morphologically similar was originally described by Ching as a "walled shelter" (1971). Ching provided minimal descriptions of this feature type stating that, "Features of this type are classified according to structural shape, i.e., C, U, L, etc., ... The walls are usually constructed of stacked pahoe'hoe or a'a. They may also be core filled. The features in this type have an average measurement of 2.5 square meters" (1971:41). Ching goes on to say that, "Of special interest are C-shape shelters with ahu in association" (1971:44). These feature associations were briefly discussed further by Ching in a section entitled "Significant Remains":

WALLED SHELTERS AND AHU(S)

> Ahu(s) found in association with walled shelters seem to function as supports for a superstructure. They therefore should be considered as a functioning part of the walled shelters (Ching 1971:117).

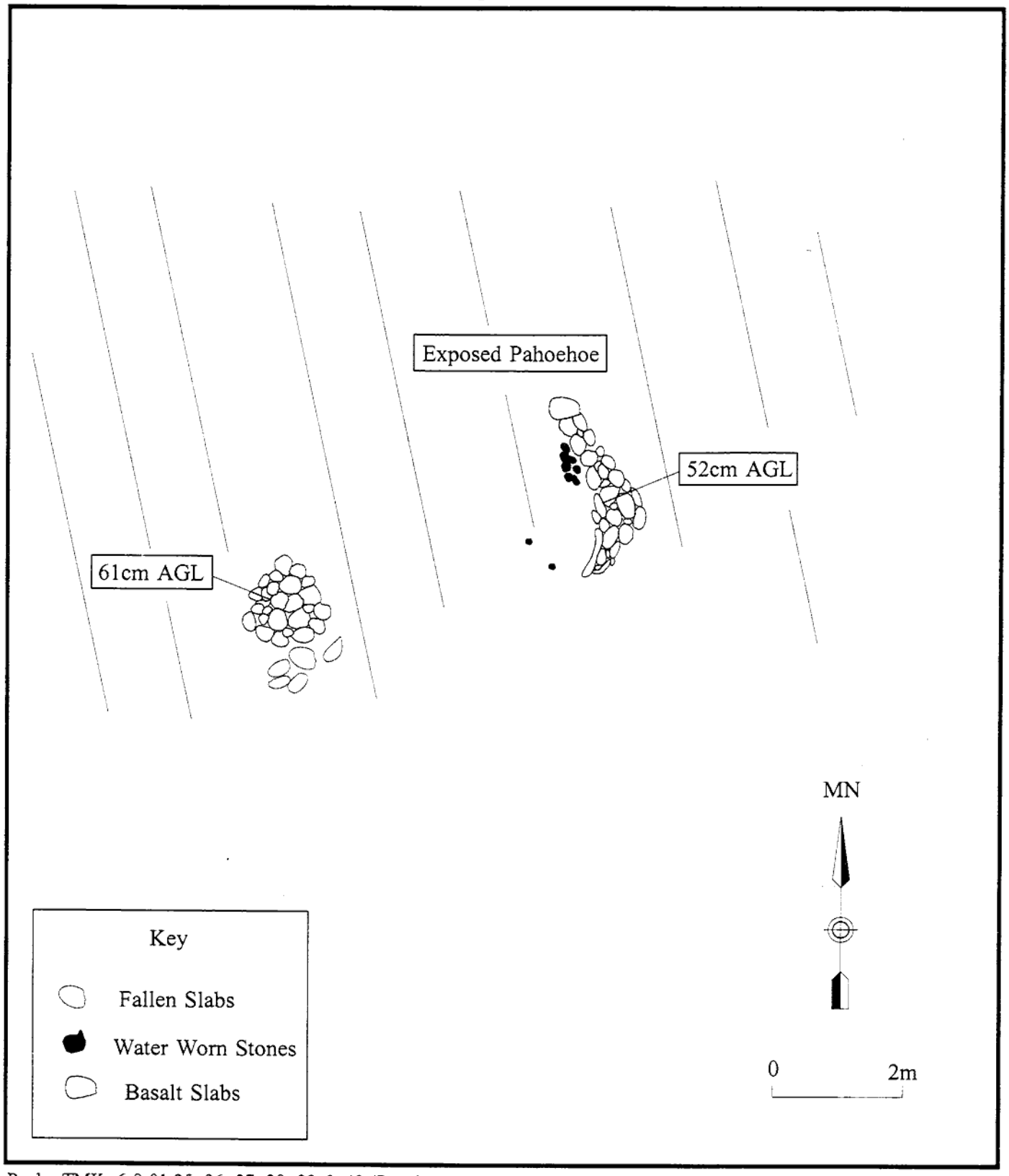
An illustration of this feature type presented in Ching (1971) is reproduced here as Figure 7.

During Ching's investigations for the Kailua-Kawaihae Road Corridor, a total of 315 walled shelters were identified of which 216 were in the form of C-shapes. Of these C-shaped shelters, only eight were associated with an *ahu*. However, of these eight, four were located in Waikoloa and three were found in "Area Epsilon", roughly in the vicinity of the current subject property. Of the remaining walled structures, six were associated with an *ahu* and of these, three were located in Waikoloa.

Based upon the similarities in morphology, it is believed that, functionally, the features described by Ching and those identified by ACP are similar with the *ahu* providing support for a superstructure which utilized the C-shape as its main foundation. These features are believed to have been used as temporary habitations in the pre-Contact Period by those passing through the region and/or utilizing local resources. During the current investigations, there was no soil present atop the smooth *pahoehoe* domes on which the structures were identified, therefore, no subsurface testing could be conducted at these features.

01006227

Figure 6: Top Plan of Site 22510



Puako TMK: 6-8-01:25, 36, 37, 38, 39 & 40 (Pors.)

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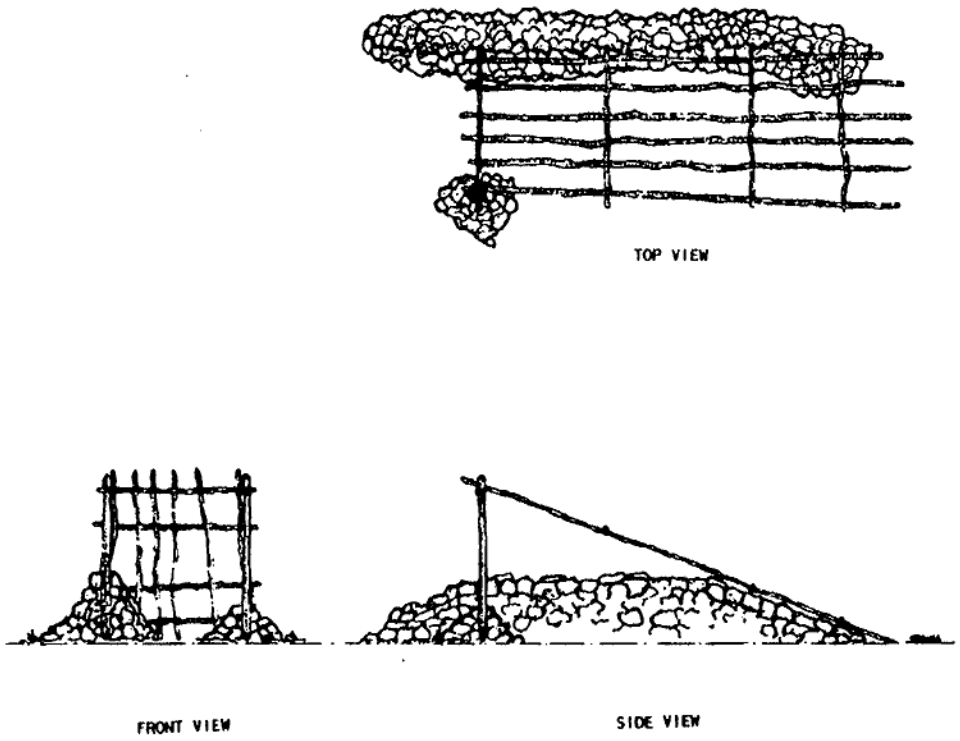
Figure 7: Illustration of Walled Shelters Identified by Ching



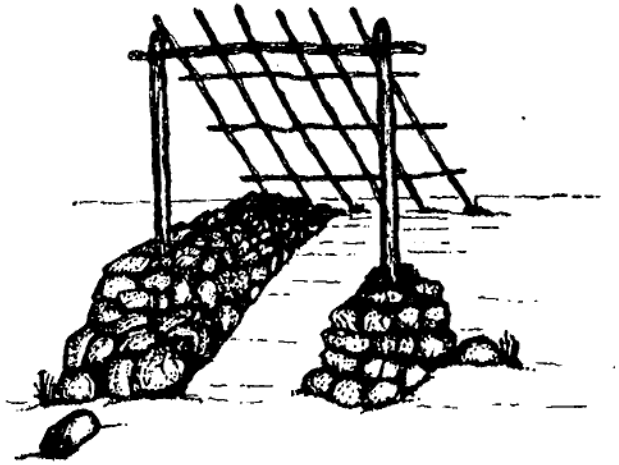


FIGURE 7

POSSIBLE RECONSTRUCTION OF ROOF STRUCTURAL POLES
OVER LINEAR SHELTER WITH AHU IN ASSOCIATION

Illustrated by J. Kruse
January 1971

not to scale

Puako TMK: 6-8-01:25, 36, 37, 38, 39 & 40 (Pors.)

Source: Ching 1971

01006229

Site 22510 is the first of the C-shaped wall with associated *ahu* features located within the mixed *a'a* and *pahoehoe* flow which crosses the center of the subject property (see Figure 4). As described above, this site is composed of two components, a C-shaped wall with an *ahu* situated across from the mouth of the "C" (see Figures 8, 9 & 10). Both were constructed of slabs of vesicular, angular basalt measuring 20 to 60cm in diameter and 5 to 15cm in thickness. The C-shaped wall stood three to four courses tall reaching a maximum of 52cm in height and measuring 2.9m in length. The *ahu* stood four to five courses tall reaching a maximum of 61cm in height above ground level (AGL) and was roughly round in shape measuring 150cm in diameter. The *ahu* was located approximately 4.3m from the center of the C-shaped wall (see Figure 6). Both of the structures at this site were intact and in relatively good condition although several basalt slabs had apparently fallen off the southeastern side of the *ahu*.

At Site 22510 a total of 16 waterworn stones were found along the interior edge of the C-shaped wall as well as a single sinker stone (Artifact #KPU-001; refer to Table 2; please note that all raw data tables are presented in Appendix A). The waterworn stones all measured between 3 and 6cm in diameter. All of these items are considered manuports as the nearest source of water worn stones would be the Auwaiakeakua. The sinker stone was of the bread loaf style but appeared to be unfinished. This was the only C-shaped wall with associated *ahu* site at which culturally deposited materials were present.

Site 22511

Site 22511 consists of three stone *ahu* located along a dirt/jeep road north of the Auwaiakeakua in the northern corner of the subject property (see Figure 4). The three features are in proximity to one another and are of identical morphology.

Feature 22511:A (TF 4)

This feature consisted of a small stone *ahu* located atop a low ridge in the oldest geological region of the current survey area. This area was formed from lava flows approximately 10,000 years old and has a comparatively significant amount of soil accumulation relative to those portions of the subject property south of the Auwaiakeakua. As such, the *ahu* rested on soil. The feature measured approximately 60cm in diameter by 50cm in height (see Figure 11). Feature 22511:A is constructed of angular basalt stones 30 to 50cm in diameter and stands three to four courses tall. This *ahu* was located close to the dirt/jeep road mentioned above and in the vicinity of old cattle ranching fence posts. The presence of soil allows this terrain to be covered with thinly scattered vegetation consisting of *kiawe* and fountain grass which could conceivably be utilized as pastureland during periods of rainfall.

Feature 22511:B (TF 5)

Feature 22511:B was a small stone *ahu* located along the same low ridge as Feature 22511:A, approximately 50m to the northeast and within eyesight of the previous feature. The *ahu* is constructed of angular basalt stones 30 to 50cm in diameter. The structure is 75cm in

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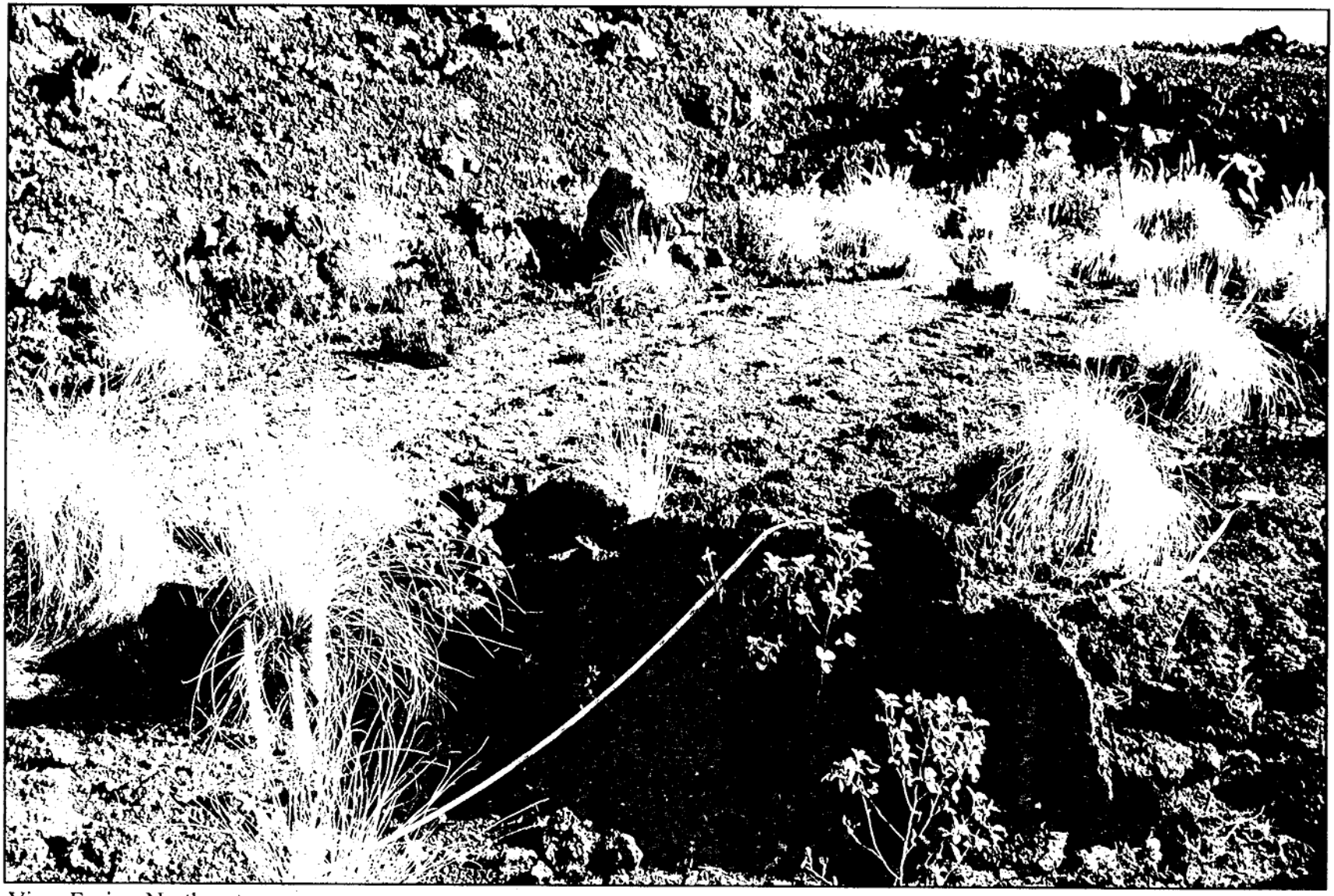
Figure 8: Photograph of Site 22510

View Facing Southwest

Figure 9: Photograph of Site 22510 (C-shape)



View Facing Northeast

Figure 10: Photograph of Site 22510 (ahu)

View Facing Southwest

Figure 11: Photograph of Feature 22511:A

View Facing Northeast

height and roughly oval in shape measuring 130cm by 80cm. The base of the feature is formed from two blocks, resting in soil, and the structure stands three to four courses tall.

Feature 22511:C (TF 6)

This feature is the last of the three associated *ahu*. This *ahu* measured 70cm in height and was roughly oval in shape measuring 120cm by 90cm. It was constructed of angular basalt stones 40 to 50cm in diameter and stands three to five courses tall. It was built on a small stone outcrop approximately 65m to the east-northeast of Feature 22511:B placing all three *ahu* of this site within eyesight of one another. The total distance between the three *ahu* measured no more than 110m and together they form a line which is roughly oriented from southwest to northeast. All three *ahu* were located along the northeastern property line of the subject property and, based upon the presence of nearby fence posts and the dirt/jeep road, it is likely that this line of *ahu* represents property markers utilized in the post-Contact Period to delineate pastureland.

Site 22512 (TF 8)

Site 22512 is another of the C-shaped wall with associated *ahu* features located within the mixed *a'a* and *pahoehoe* flow which crosses the center of the subject property (see Figure 4). As described above, this site is composed of two components, a C-shaped wall with an *ahu* situated in the mouth of the "C" (see Figures 12 & 13). Both were constructed of slabs of vesicular, angular basalt measuring 20 to 60cm in diameter and 5 to 15cm in thickness. The C-shaped wall stood three to four courses tall reaching a maximum of 62cm in height and measuring 2.4m in length. The *ahu* stood five to six courses tall reaching a maximum of 90cm in height above ground level (AGL) and was roughly oval measuring 150cm long by 125cm wide. The *ahu* was located approximately 2.0m from the center of the C-shaped wall. Both of the structures at this site were intact and in good condition. A distinct posthole was observed along the upper northeastern side of the *ahu* which measured approximately 15cm in diameter and was roughly oriented toward the mouth of the C-shape (see Figure 14).

Site 22513 (TF 9)

Site 22513 is another of the C-shaped wall with associated *ahu* features described above which are located within the mixed *a'a* and *pahoehoe* flow which crosses the center of the subject property (see Figure 4). Unlike Site 22512, at this feature the *ahu* has been completely disturbed and the C-shaped wall is collapsed in some sections (see Figures 15 & 16). As such, the measurements of the *ahu* were impossible to determine but it appeared to have been constructed out of less stone than had the *ahu* of Sites 22510 and 22512. Both components of this site had been constructed of slabs of vesicular, angular basalt measuring 20 to 60cm in diameter and 5 to 15cm in thickness. The C-shaped wall stood three to four courses tall reaching a maximum of 75cm in height in the section which remained intact. The wall measured approximately 4.3m in length but the southeastern end was significantly disturbed.

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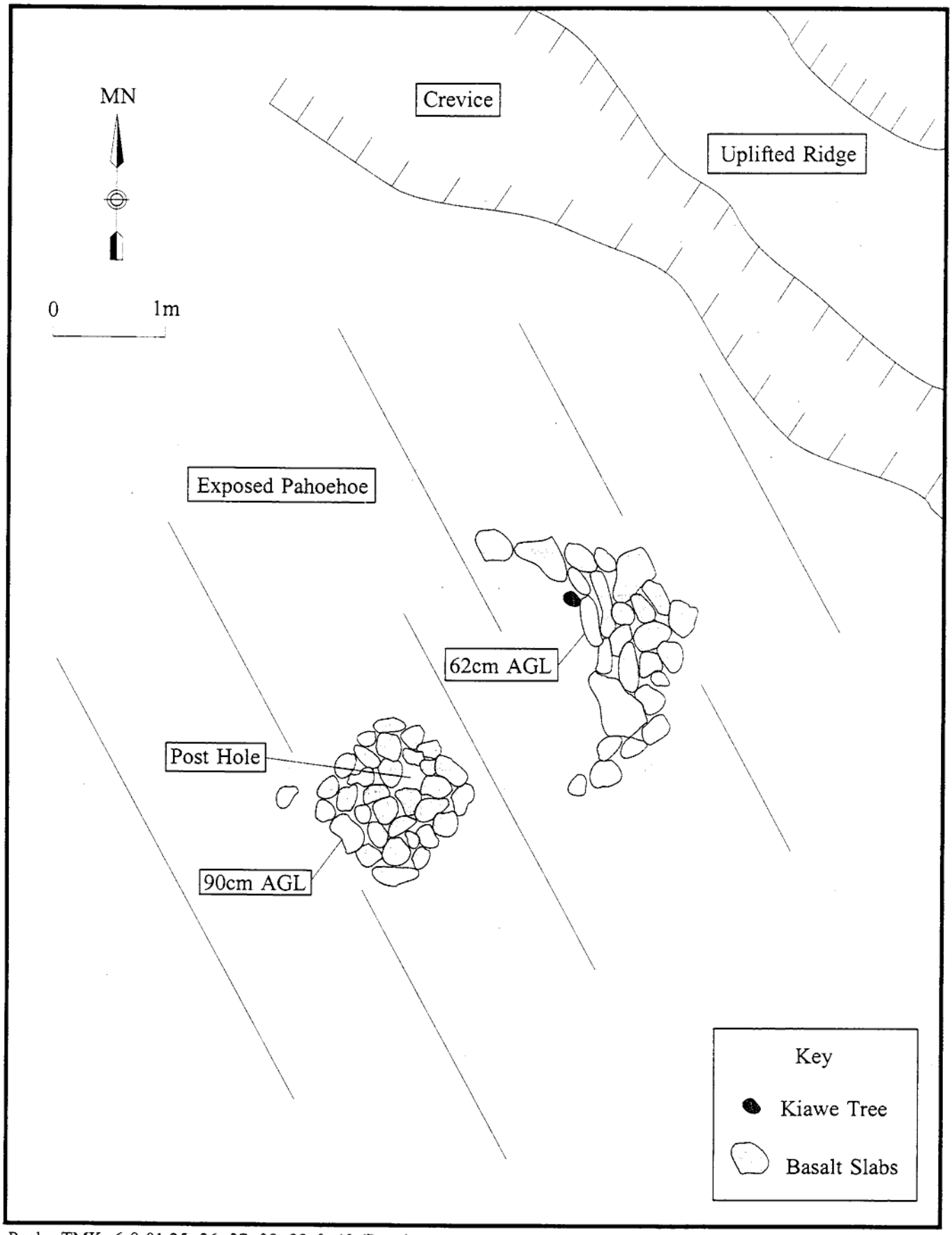
Figure 12: Top Plan of Site 22512



Puako TMK: 6-8-01:25, 36, 37, 38, 39 & 40 (Pors.)

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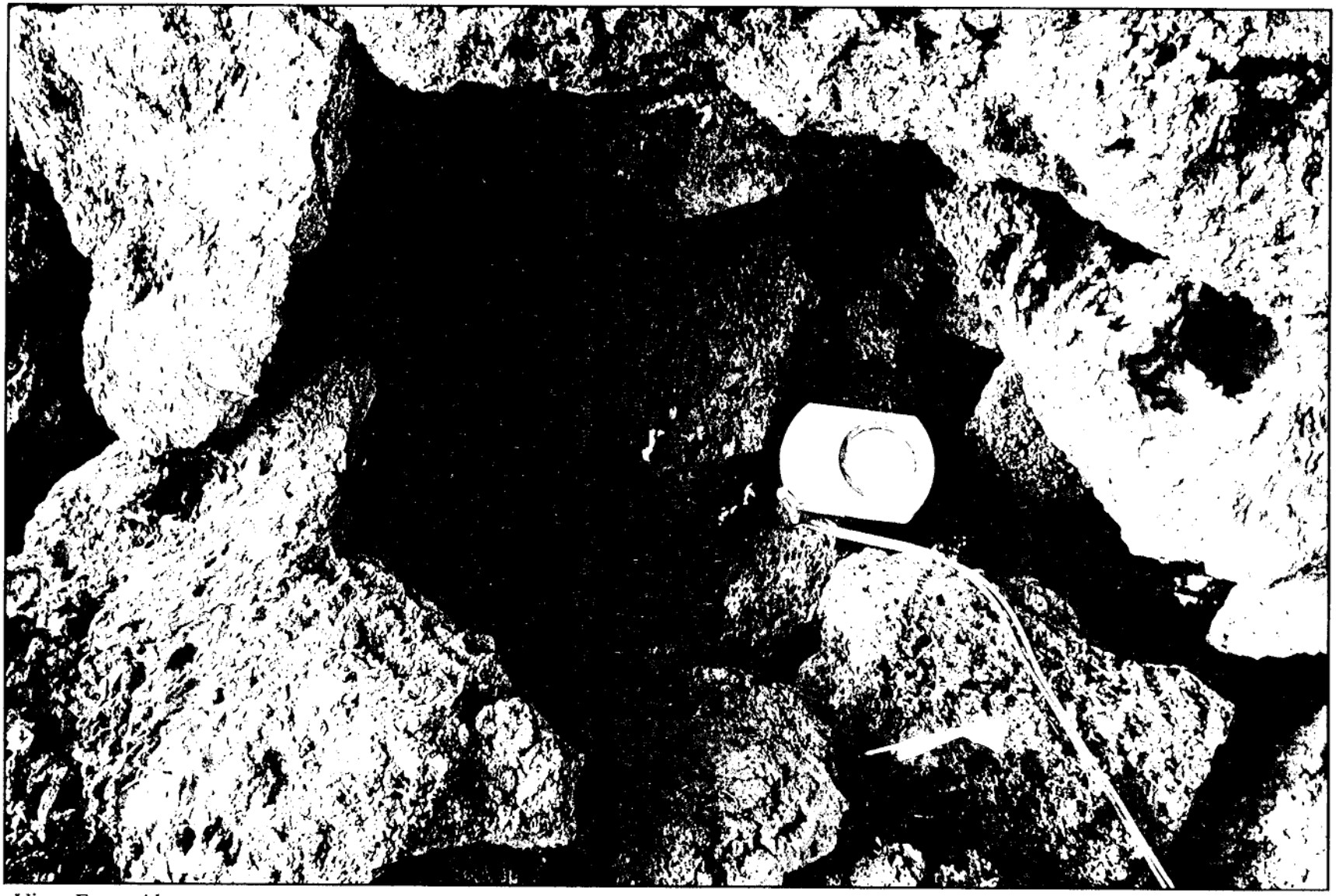
Figure 13: Photograph of Site 22512

View Facing North

0100623?

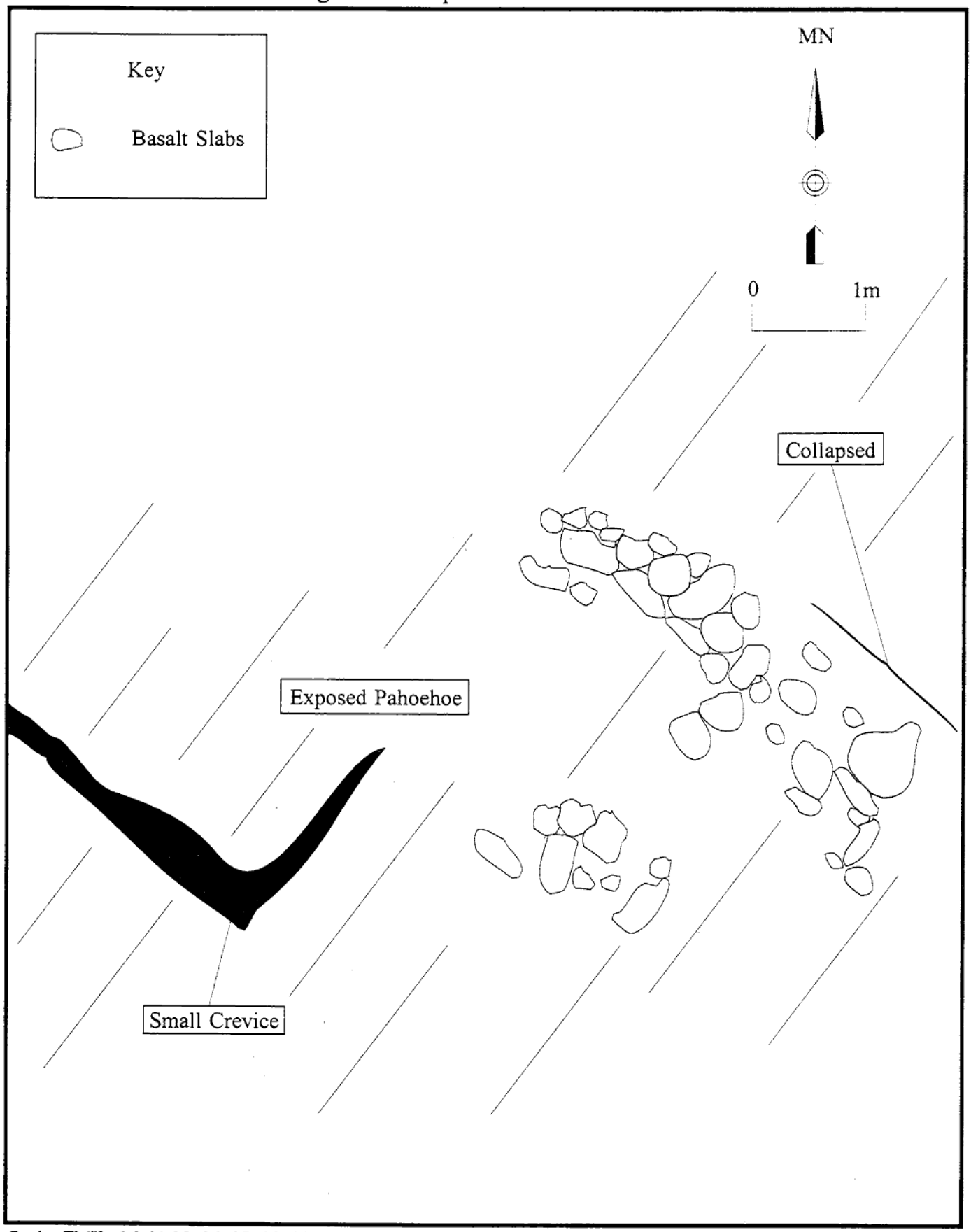
Figure 14: Photograph of Site 22512 (posthole)



View From Above

01006238

Figure 15: Top Plan of Site 22513



Puako TMK: 6-8-01:25, 36, 37, 38, 39 & 40 (Pors.)

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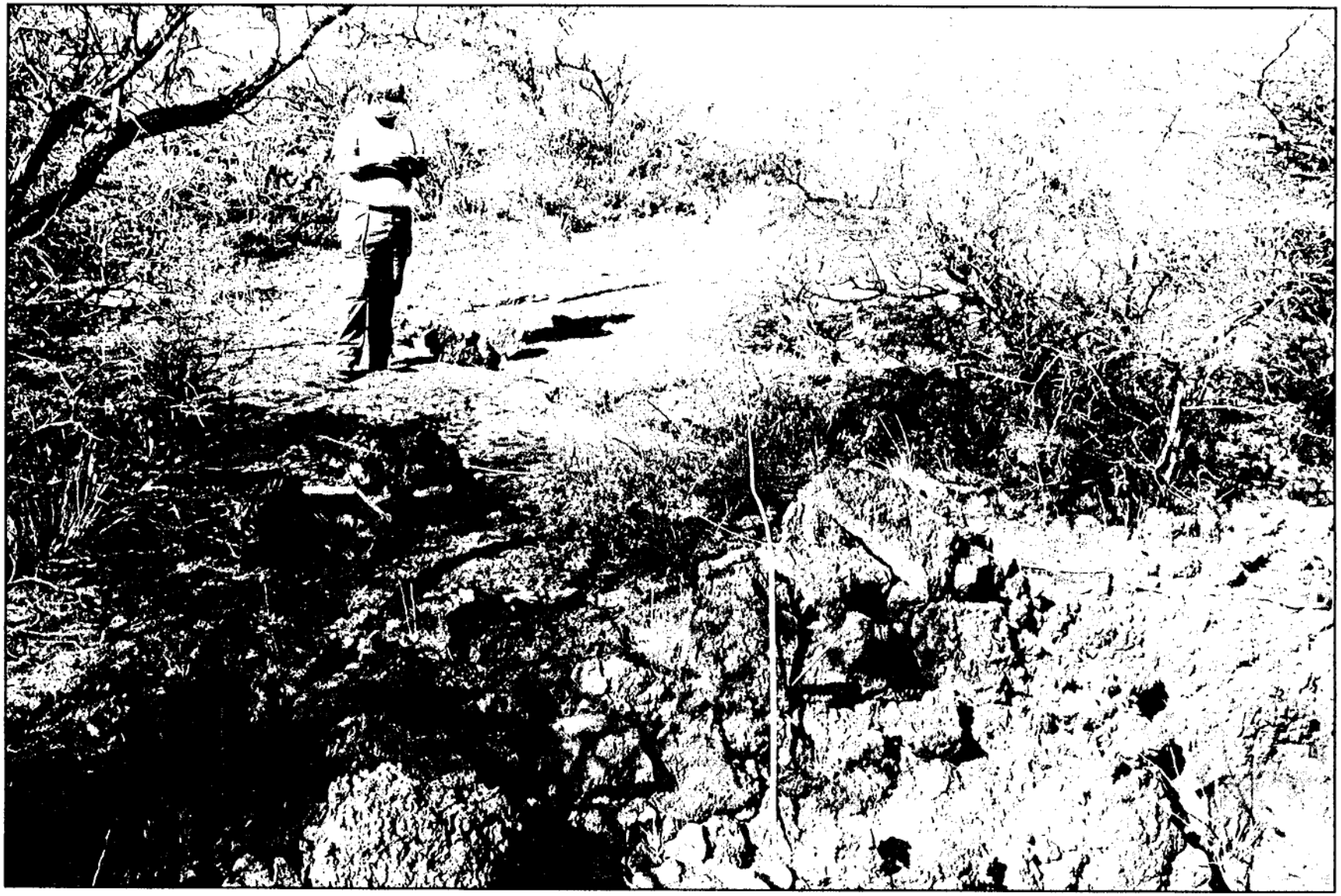
01006239

Figure 16: Photograph of Site 22513



View Facing South

Site 22514

This site consists of a pair of features, a rock shelter and a C-shaped wall with associated *ahu*, located in close proximity to one another within the mixed *a'a* and *pahoehoe* flow which crosses the center of the subject property (see Figure 4). The C-shaped wall with associated *ahu* is located just above the rock shelter on the surface of the *pahoehoe* dome that covers the shelter. This site was previously documented during a reconnaissance survey conducted by ACH (Kennedy 1987).

Feature 22514:A (TF 10A)

The rock shelter is located along the northeastern wall of rather large depression (approximately 100m in length by 50m in width) beneath the edge of an elongated *pahoehoe* dome (see Figures 17 & 18). The aperture to the rock shelter has been sealed with walls constructed of slabs of angular basalt. The walls extend from both ends of the aperture leaving a 1.5m wide opening in the center as an entrance. Both walls had been constructed from three to six courses of angular basalt slabs (15 to 20cm thick) stacked horizontally which supported slabs of basalt stacked vertically to seal the aperture of the rock shelter (see Figures 18, 19 & 20). The wall at the southeastern end of the feature is intact with vertical slabs still in place but the wall at the northwestern end of the shelter is deteriorated with its vertical slabs fallen. The shelter opens to the southwest protecting it from the sun for most of the day as well as from the prevailing northeasterly winds. It was noticeably cooler in the shelter than in the depression outside the shelter.

The rock shelter measured approximately 7m in length and was 3.2m deep in the center (see Figure 21). In the entranceway to the shelter the ceiling is at a height of 1.3m while at the back of the shelter it tapers to ground level. The ceiling also tapers to ground level at both ends of the shelter leaving an area measuring approximately 5.5m by 2.75m of usable living space (see Figure 22).

The only artifact identified outside of the shelter was a manuported piece of coral which was located approximately 1.5m outside of the entranceway. A surface collection was made of the entire floor of the interior of the shelter. A variety of culturally deposited material was recovered including a variety bird bones, a small amount of Polynesian rat remains (*Rattus exulans*), *opihi* (*Cellana* sp.) shell fragments, echinoderm remains, a possible adze preform (PKO-002) and a water worn basalt manuport (possibly a hammerstone; PKO-003)(refer to Appendix A; Tables 2 & 3). Small areas on the floor of the shelter were unreachable where the ceiling pinched down to the ground. Small amounts of additional bird bone was visible in these spaces but was unable to be collected. One additional item, a rusted tin can, was observed on the surface of the floor but was not collected.

Following the surface collection, a 50cm by 50cm manually excavated test unit was placed in the center of the floor of the shelter. The test unit was placed in what appeared to be an area used for a fire pit. This location was selected in the hopes of obtaining a datable sample.

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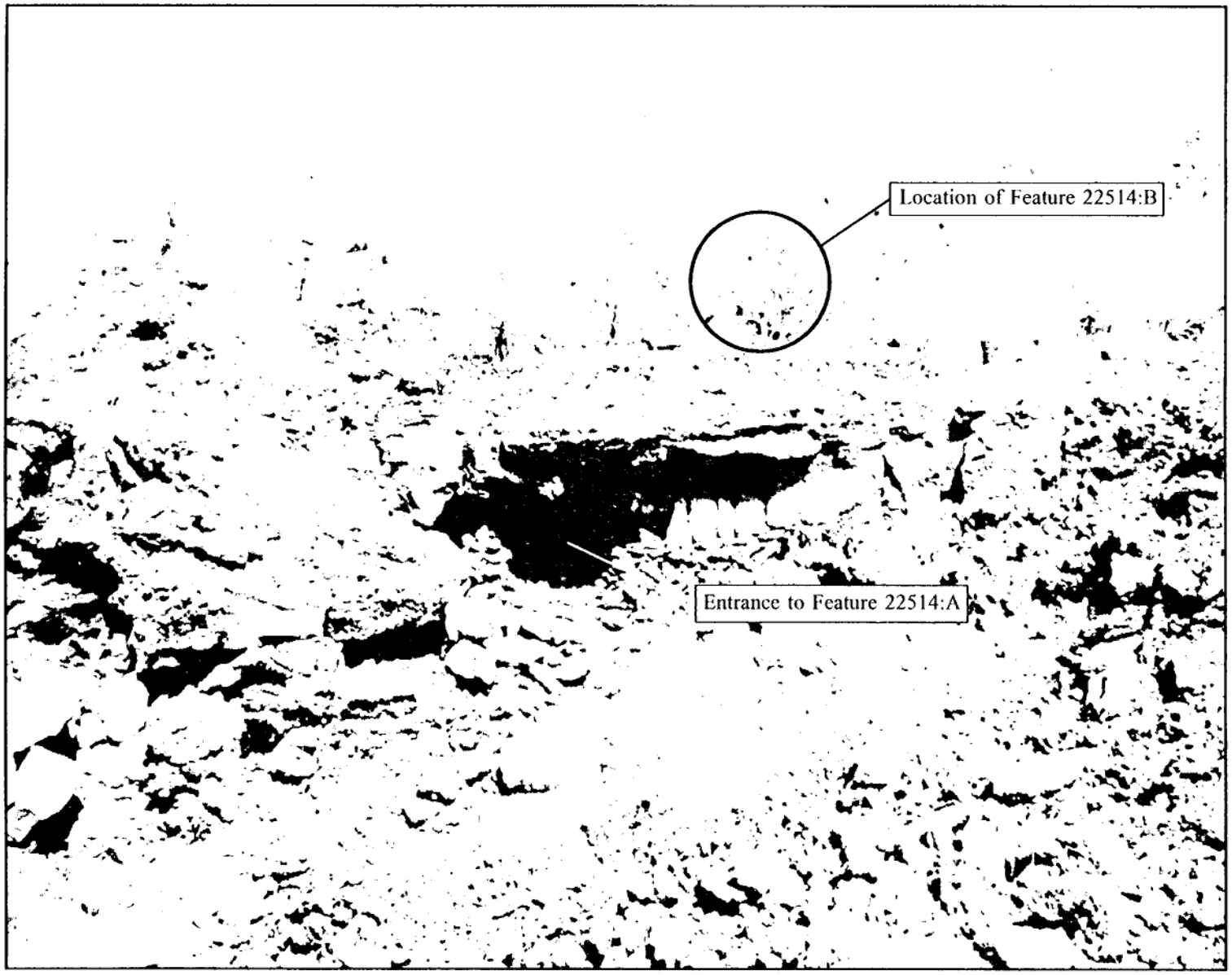
Figure 17: Photograph of Site 22514



View Facing East

Figure 18: Photograph of Site 22514:A

View Facing Northeast

Figure 19: Photograph of Southeastern Wall Construction, 22514:A

Exterior View Facing Southeast

Figure 20: Photograph of Southeastern Wall Construction, 22514:A

Interior View Facing Southeast

Figure 21: Plan View of the Interior of Feature 22514:A

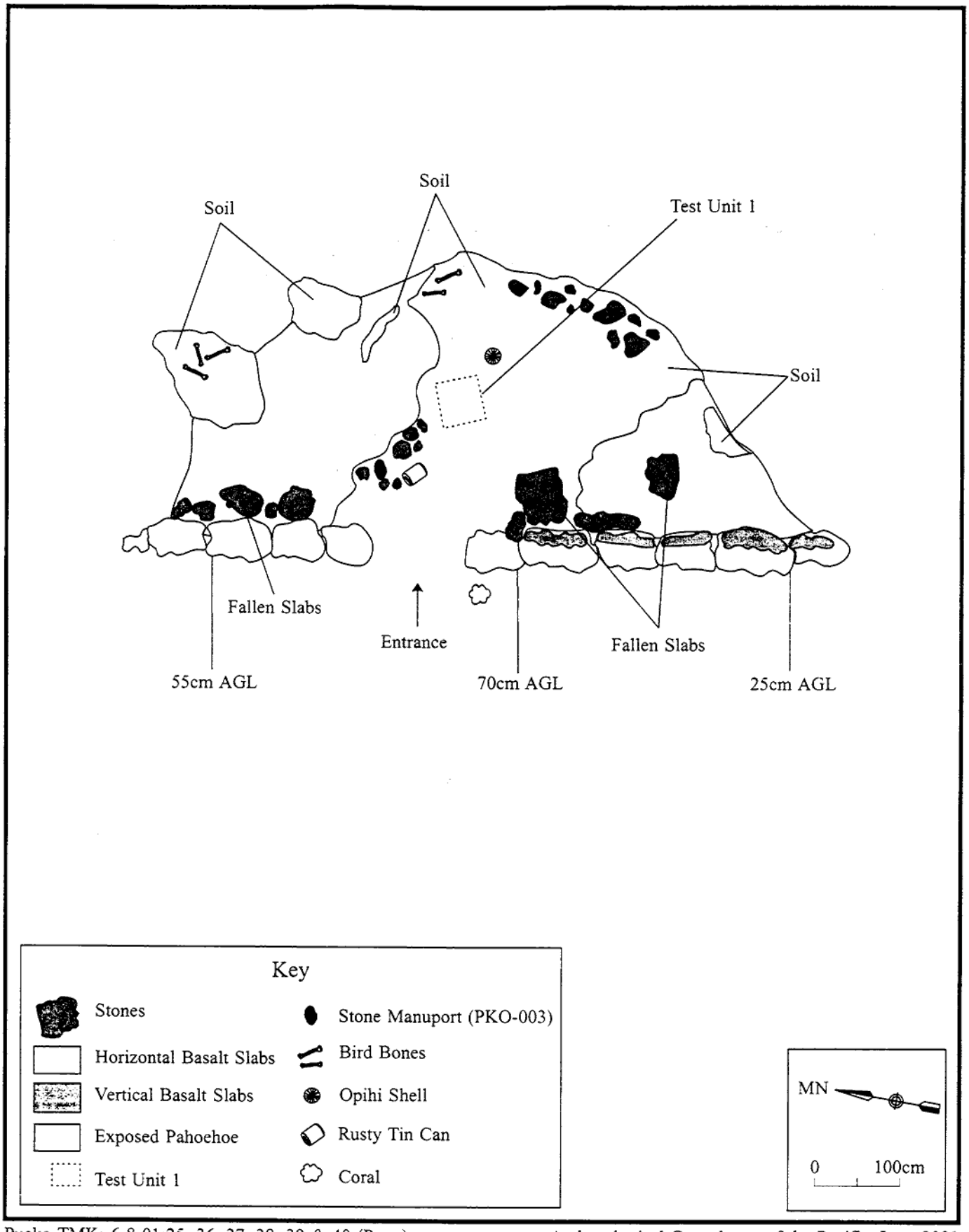
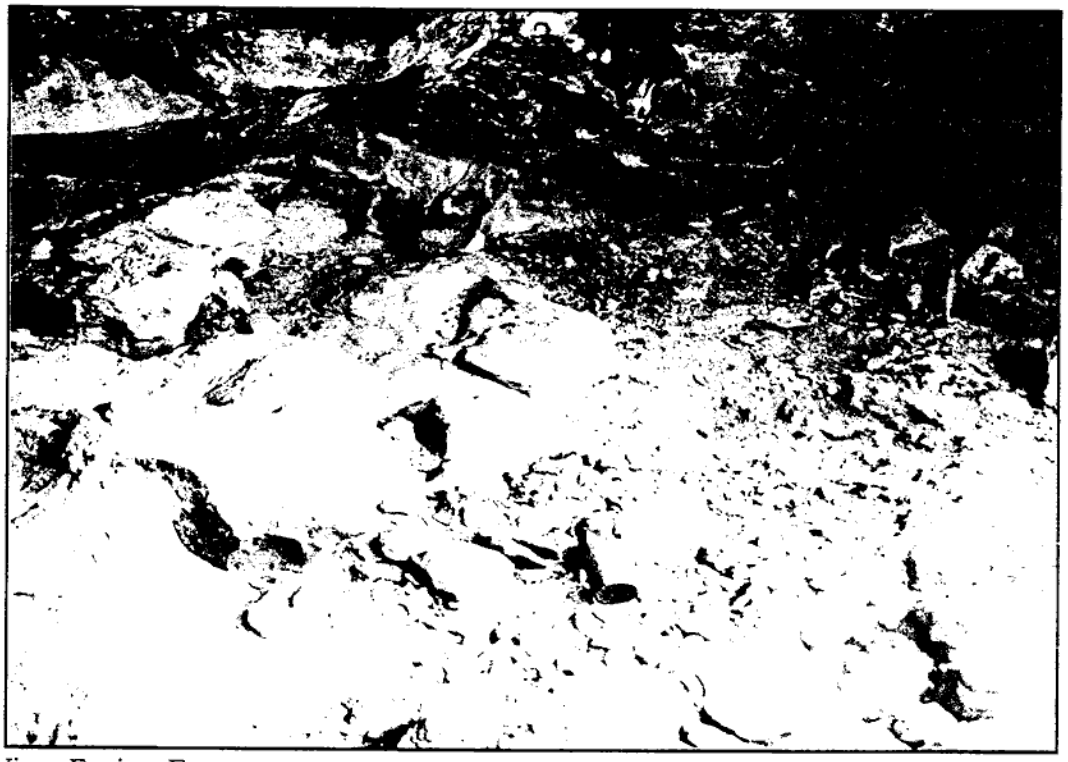


Figure 22: Photograph of Floor of Feature 22514:A



View Facing East

Excavation encountered a deposit (Layer I) of brown to dark brown (10YR 4/3) stony, fine silt loam which measured between 5 and 7cm in thickness reaching a maximum depth of 7cm below surface (cmbs)(see Figure 23). An occasional smear of black carbon was observed within Layer I but no datable material was recovered. Layer I yielded a variety of culturally deposited remains including a volcanic glass flake (PKO-004), a gourd fragment (PKO-005), fish scales, a variety of bird remains including several beaks, remains of the Polynesian rat, mouse remains (*Mus musculus*), *opihi* shell remains and echinoderm fragments (refer to Appendix A; Tables 2 & 3). Underlying Layer I excavation encountered a deposit of matted floral remains (Layer II) which measured up to 4cm in thickness reaching a maximum depth of 9cmbs. The matted floral remains (Layer II) were found to rest directly on bedrock over most of the floor of the test unit although in one spot Layer II was absent and Layer I rested directly on bedrock. The matted floral material is believed to possibly be the remains of a mat laid on the bedrock floor of the rock shelter during one of the feature's early episodes of utilization. A sample of this material was sent for radiometric analysis and determined to date to calibrated age of AD 1480 (refer to Appendix A; Table 4 and Appendix B). No additional cultural remains were recovered from the material which formed Layer II.

The findings from Test Unit 1 indicate that Feature 22514:A was utilized as a temporary habitation in the pre-Contact Period. Activities which occurred at the feature included the consumption of meals which included food items which were brought to the rock shelter from the coast. The small number of tools recovered were likely associated with the preparation of meals. The presence of the tin can indicates that the feature has continued to be visited in the post-Contact Period.

Feature 22514:B (TF 10B)

Located on the *pahoehoe* dome above Feature 22514:A is one of the C-shaped wall with associated *ahu* features. The *ahu* was no longer intact but the number of stones scattered in the vicinity was roughly equivalent to that observed at Site 22513, fewer than were used in the *ahu* at Sites 22510 and 22512. The C-shaped wall measured approximately 3.4m in length and stood at a height of 77cm AGL (see Figures 24 & 25). At Feature 22514:B the C-shaped wall was little more than a curved line, a characteristic observed at several of the other sites identified. The presence of Feature 22514:B, a feature type believed to have been utilized as a temporary habitation, in such close proximity to the rock shelter, Feature 22514:A (also believed to have been utilized as a temporary habitation) implies that the two features may not have been utilized contemporaneously or that they may have had different functions.

Site 22515 (TF 11)

Site 22515 is another of the C-shaped wall with associated *ahu* features described above which are located within the mixed *a'a* and *pahoehoe* flow which crosses the center of the subject property (see Figure 4). As with Site 22513 and Feature 22514:B, the *ahu* was collapsed but the wall was intact. Both had been constructed of slabs of vesicular, angular basalt similar in

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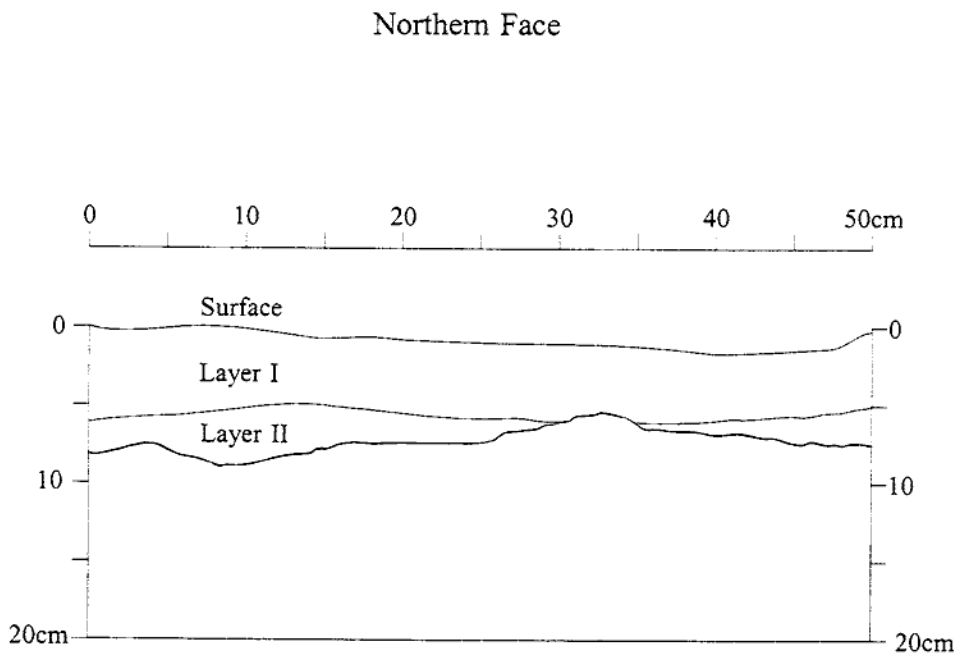
Figure 23: Profile of Test Unit 1(Feature 22514:A)



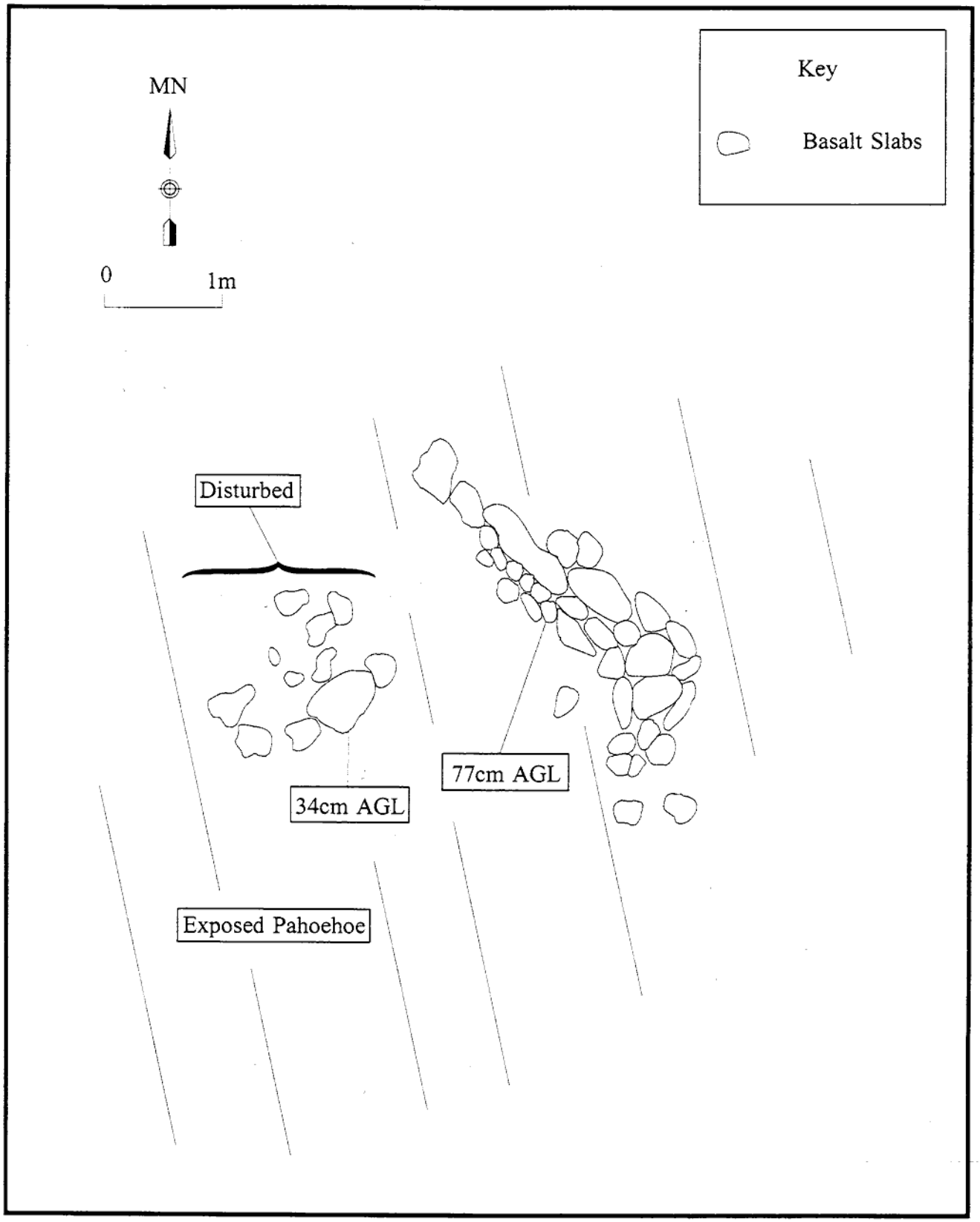
Layer I: Brown to dark brown (10YR 4/3) stony, fine silt loam

Layer II: Matted floral remains

Key

Bedrock

Feature 24: Top Plan of Feature 22514:B



Puako TMK: 6-8-01:25, 36, 37, 38, 39 & 40 (Pors.)

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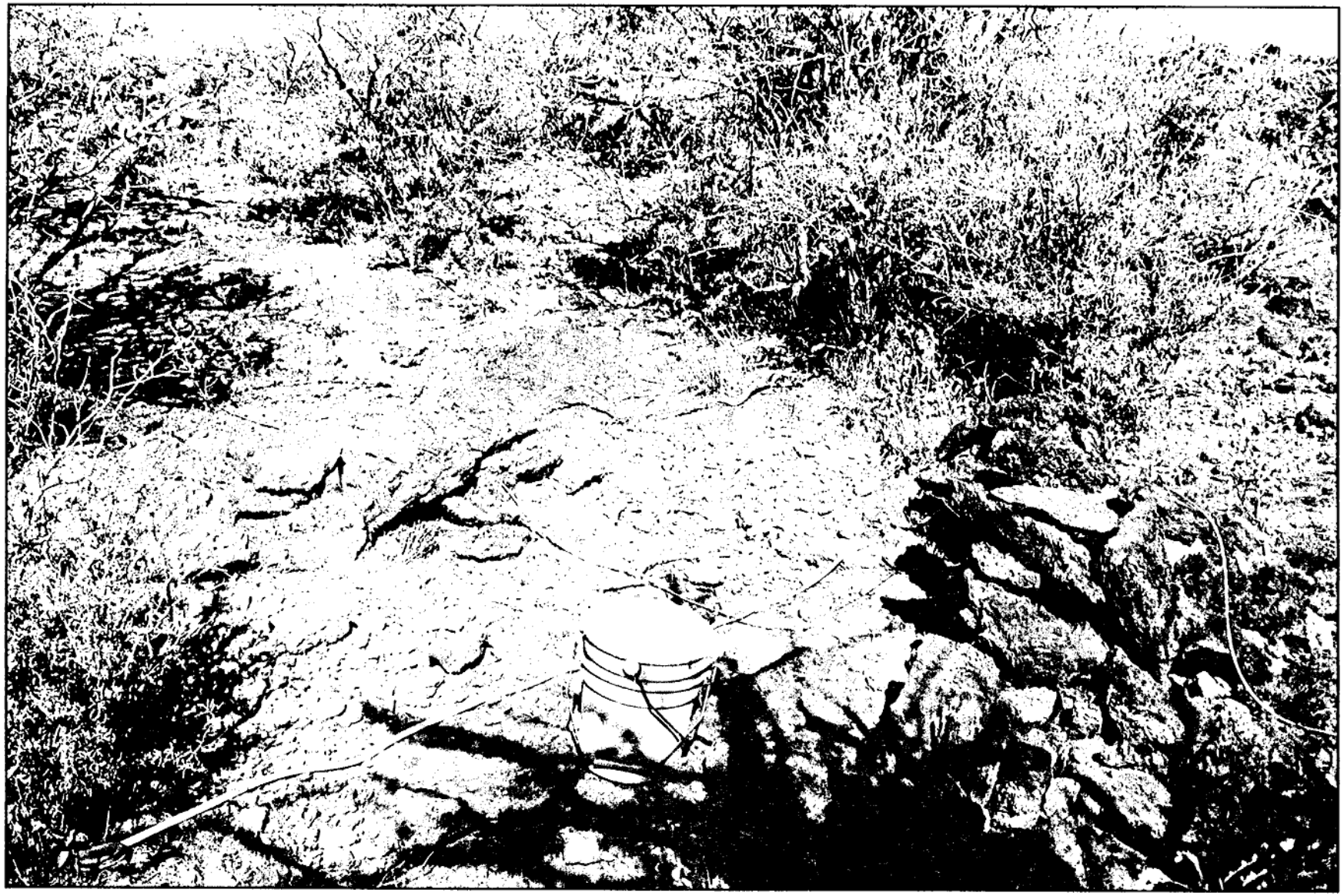
Figure 25: Photograph of Feature 22514:B



View Facing North

size to those described above. The C-shaped wall reached a maximum of 65cm in height and measured 3.6m in length (see Figure 26).

Site 22516 (TF 12)

This C-shaped wall with an associated *ahu* is also located within the mixed *a'a* and *pahoehoe* flow which crosses the center of the subject property (see Figure 4). Both components of the feature were intact and as with previous similar structures, both had been constructed of slabs of vesicular, angular basalt up to 60cm in diameter and approximately 10cm in thickness (see Figures 27 & 28). The *ahu* was rather large measuring 190cm by 210cm and standing up to 86cm in height. The C-shaped wall measured 3.2 meters in length and reached a maximum of 60cm in height. The *ahu* was located approximately 2.5m from the center of the C-shaped wall.

Site 22517 (TF 13)

Site 22517 consisted of a relatively large, intact *ahu* located on the northern side of the Auwaiakeakua near the northern corner of the subject property (see Figure 4). The *ahu* was constructed of slabs of vesicular, angular basalt up to 50cm in diameter and between 10 and 15cm in thickness which rested on the thin layer of soil which had formed in this area. The structure was roughly oval in shape measuring 200cm in length by 140cm in width reaching up to 60cm in height AGL. It likely that Site 22517 consists of a property marker located along the same border that had been delineated by the dirt/jeep road and Site 22511.

Site 22518 (TF 14)

Site 22518 is the last of the C-shaped wall with associated *ahu* features which are located within the mixed *a'a* and *pahoehoe* flow which crosses the center of the subject property (see Figure 4). Both components of this feature had been constructed of slabs of vesicular, angular basalt measuring 30 to 60cm in diameter and 5 to 15cm in thickness. The C-shaped wall measured 325cm in length and stood up to 71cm AGL in height (see Figures 29 & 30). The *ahu* was roughly oval in shape measuring 160cm in length by 112cm in width and reaching up to 79cm in height AGL. At Site 22518, the *ahu* was a relatively greater distance from the C-shape than the *ahu* found at the rest of these feature types being located approximately 6.5m from the center of the C-shaped wall. A distinct posthole was observed along the upper eastern side of the *ahu*. The posthole measured approximately 20cm in diameter and was roughly oriented toward the mouth of the C-shape (see Figure 31).

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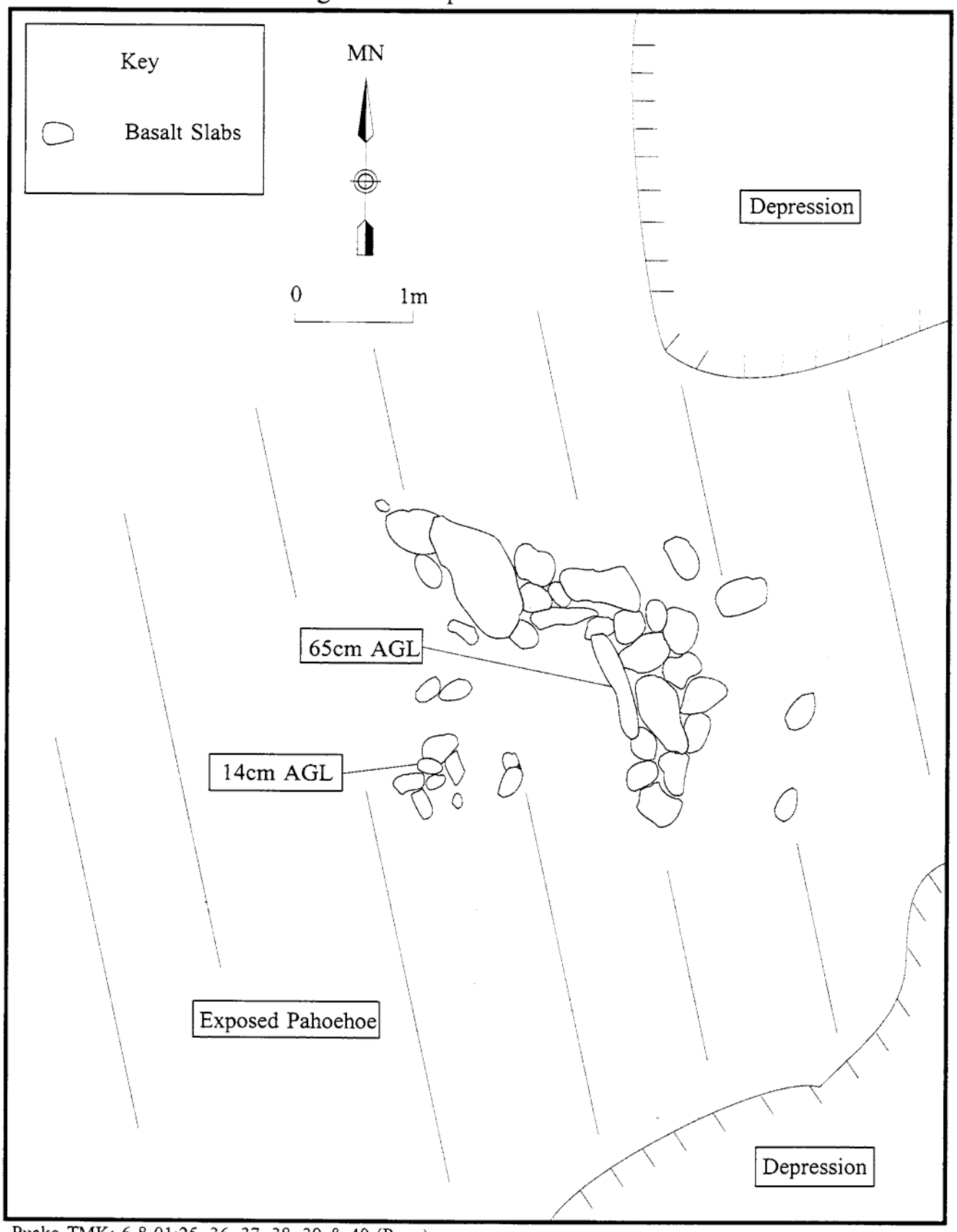
Figure 26: Top Plan of Site 22515



Puako TMK: 6-8-01:25, 36, 37, 38, 39 & 40 (Pors.)

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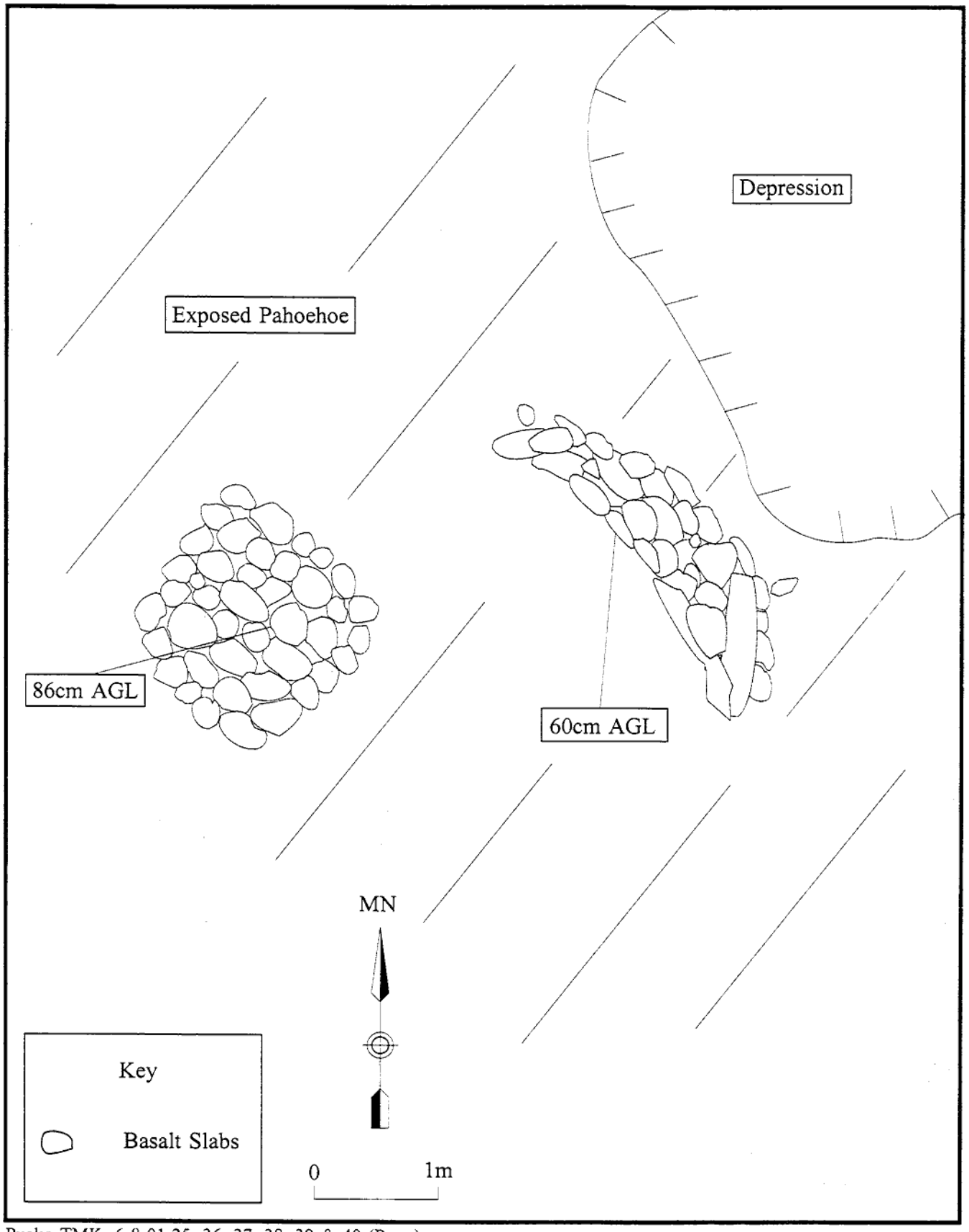
01006252

Figure 27: Top Plan of Site 22516



Puako TMK: 6-8-01:25, 36, 37, 38, 39 & 40 (Pors.)

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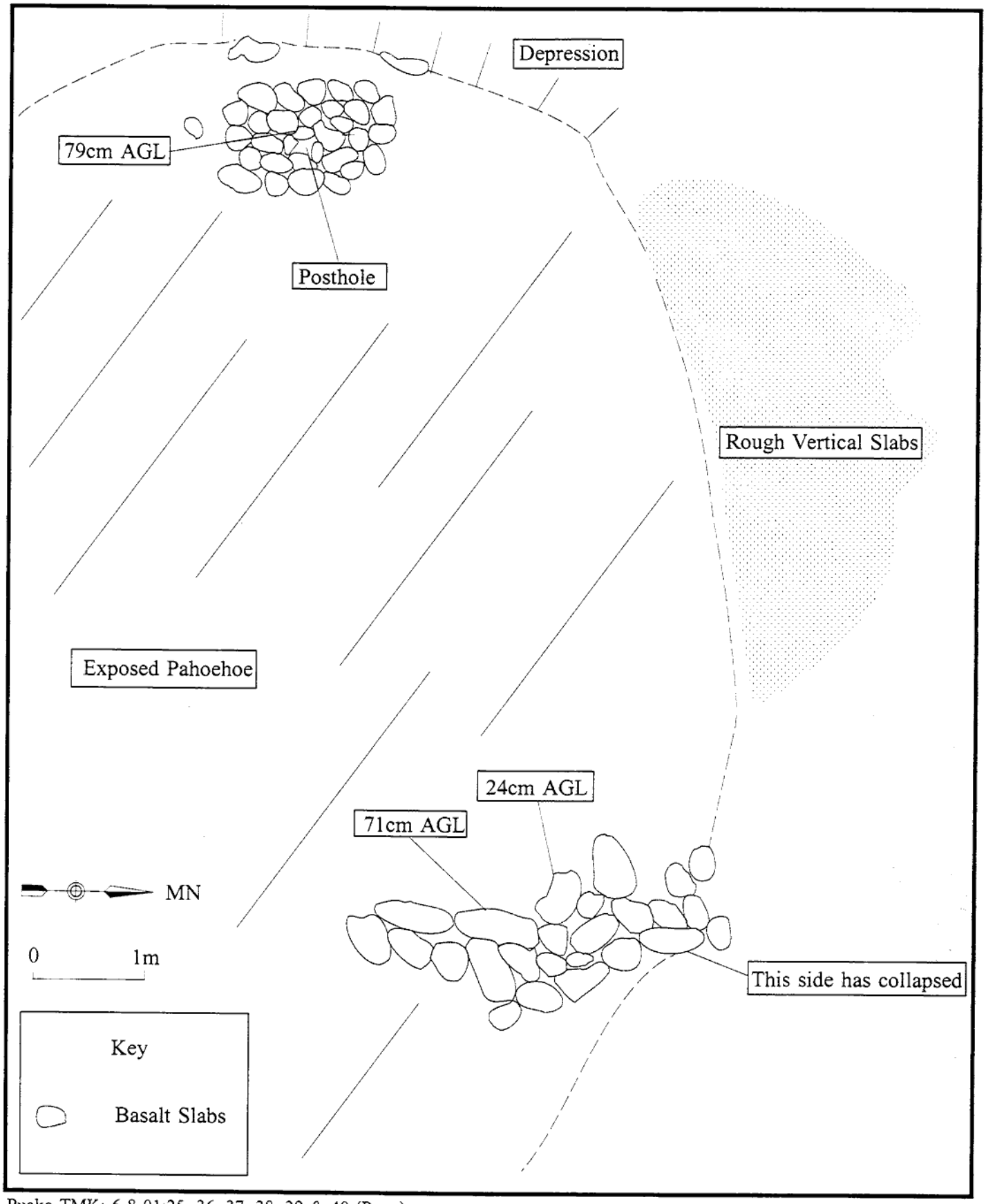
01006253

Figure 28: Photograph of Site 22516

View Facing Southwest

Figure 29: Top Plan of Site 22518



Puako TMK: 6-8-01:25, 36, 37, 38, 39 & 40 (Pors.)

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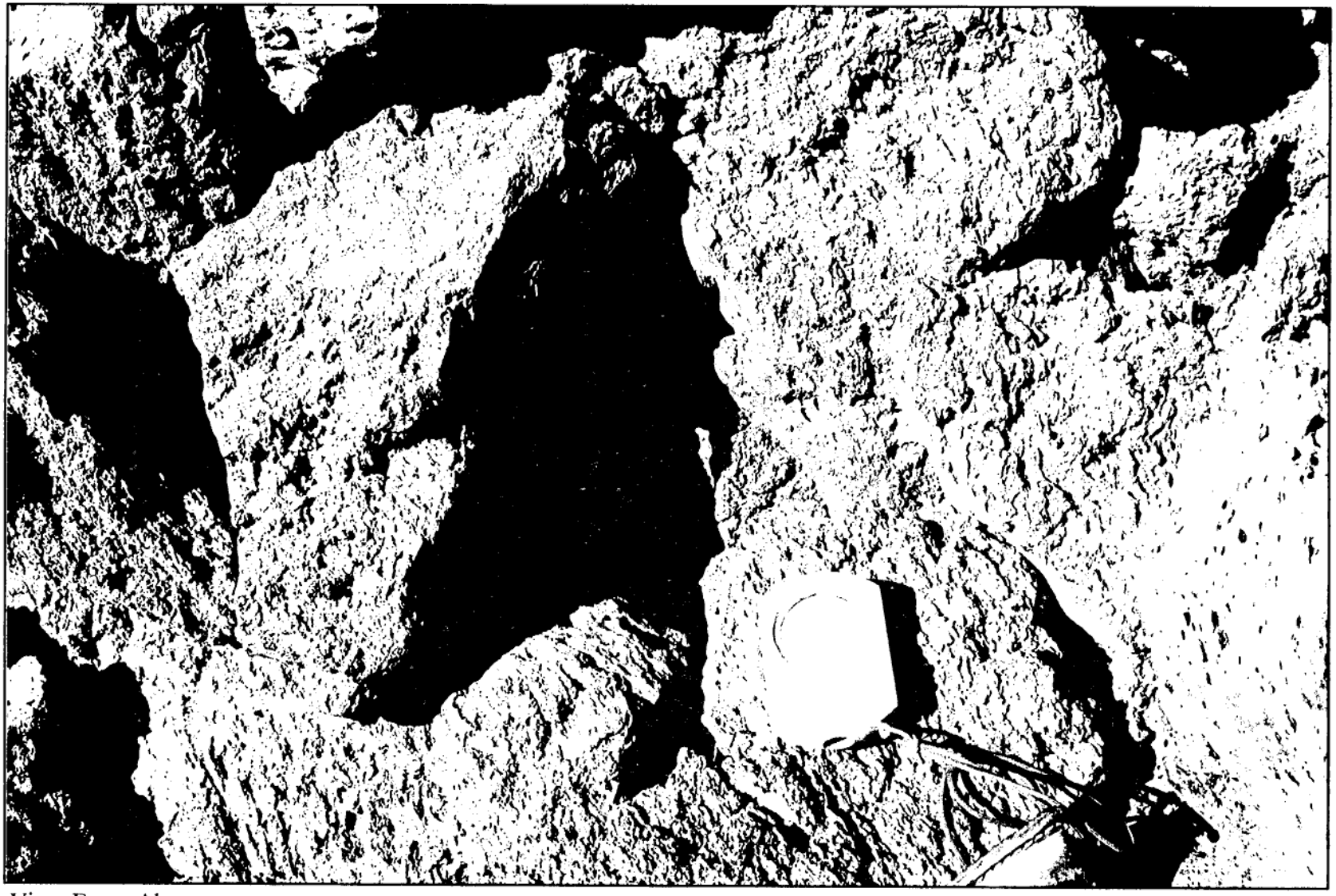
01006255

Figure 30: Photograph of Site 22518

View Facing West

Figure 31: Photograph of Site 22518 (posthole)



View From Above

In addition to the sites recorded above, three additional locations were flagged during the initial survey of the property which were considered potential historic properties. Upon further study, however, these locations were determined not to be significant to the interests of historic preservation. They will be briefly described below.

Temporary Feature 2 (TF 2)

This formation consists a gravel covered strip of land 60 to 80cm in width and approximately 10 to 12m in length which was considered a possible trail segment. This strip of land ran along a small gulch that separated the Kaniku Lava Flow and the rough, mixed *a'a/pahoehoe* flow of the Laupahoehoe series that covers the central portion of the subject property. TF 2 was located in the proximity of an exposed and fracturing basalt outcrop which was considered a possible lithic extraction site. Upon further examination of this location, no evidence of cultural modification or utilization could be discerned and therefore this temporary feature was not designated as an historic site.

Temporary Feature 3 (TF 3)

Temporary Feature 3 consists of an exposed and fracturing basalt outcrop located along the edge of the Kaniku Lava Flow which was considered a possible lithic extraction site. The outcropping appeared to consist of a relatively fine grained basalt forming a low ridge approximately 3m in length which was in the vicinity of the possible trail segment, TF 2. Several pieces of fractured basalt were observed on the ground below the outcropping. Upon closer inspection, however, the basalt appeared to be more crystalline than commonly used for tool manufacture and there was no evidence of the fracturing of the outcrop having been the result of cultural activities. Therefore, this temporary feature was not designated as an historic site.

Temporary Feature 7 (TF 7)

An additional man-made structure was identified during course of the current investigations and assigned a temporary feature designation. This feature consisted of an oval, fire pit partially ringed with stones located just off the dirt/jeep road that runs along the northeastern property line. Angular basalt stones typical of those found strewn across the surface of the ground in this area and, measuring 10 to 30cm in diameter, are stacked in a haphazard manner forming a partial ring around the fire pit. The crude ring is not, however, oriented as to block the prevailing wind. *Kiawe* wood was observed lying nearby with metal sawed ends and at least one piece of burnt wood with a metal sawed end was apparent within the remains of the fire. Based upon these observations, it was determined that this structure was modern and, therefore, not designated as a significant historic property.

01006258

Survey of the Proposed Power Line Corridor

During the survey of the proposed power line, remains of military activity were observed including shrapnel and one piece of unexploded ordinance. As described in Section 2 above, the survey corridor was formed by two legs, a 1100m long, southeast-northwest oriented segment and a 4700m long, north-south oriented segment. The 4700m long, north-south oriented segment followed a fence line through gently rolling hills currently used as pastureland. Much of the area was covered with bare dirt which displayed evidence of having been disturbed by active grazing. Along the northern portion of this leg of the proposed power line corridor shrapnel was observed and the one piece of unexploded ordinance identified (see Figure 4). This portion of the subject corridor is in the area which was said to have been utilized by the Marine Corps for training during World War II (Schilz & Shun 1992:13). The presence of the materials observed indicates that the military training activities which took place in the area likely included artillery practice.

01006259

Section 6: Discussion of Archaeological Findings

The historic background presented in Section 3 summarized previous investigations which have been conducted in the areas near the current subject property. Those investigations have documented evidence which indicates the interior lava fields of South Kohala were utilized for the production of basalt abraders and that a variety of feature types could be found associated with the lithic production industry.

Four feature types were identified making up the ten sites documented during the current investigations including *ahu*, C-shaped walls with associated *ahu*, a stone covered hearth and a rock shelter. None of these can be directly associated with the lithic production known to have been conducted in this area. In this discussion, the likely age and function of each of the feature types will be assessed.

Four stone *ahu* were identified at two sites (Sites 22511 & 22517) during the current investigations. All four were located along the northeastern property boundary of the current subject parcel on the northern side of the Auwaiakeakua. The structural components of these features were observed to rest on the ground surface as opposed to being deeply embedded in the soil. Fence posts were observed nearby and a dirt/jeep road runs parallel to the northeastern property boundary. Based upon this information, it is believed that these *ahu* likely date to the post-Contact Period when they were constructed as property markers delineating pasturelands.

Seven of the features identified during the current investigations consisted of C-shaped walls with associated *ahu* (Sites 22510, 22512, 22513, 22515, 22516, 22518 & Feature 22514:B). These feature types were determined to be morphologically similar to features described as "walled shelters" by Ching (1971). At these features the *ahu* is believed to have been used as the support for a pole which would support the superstructure of a shelter. Only Site 22510 was associated with any culturally deposited materials and because each of these features is situated atop exposed *pahoehoe*, no excavations were able to be conducted. Walled shelters such as these are believed to have been utilized as temporary habitations utilized in the pre-Contact Period by those traveling through the region or by those coming to this interior area for the purpose of utilizing the lithic resources.

The current investigations, however, raise questions regarding the hypothesis that these features were utilized simply for temporary shelter. If these features were utilized by those traveling through the region, why did they choose to travel through the rough terrain that is found across the center of the current subject property rather than traveling across the area immediately to the north of the Auwaiakeakua (approximately 1000m to the north), the area where the Puakō-Ke'amuku Trail is believed to have passed? In the area to the north of the Auwaiakeakua one can travel a mile in a matter of minutes. On the other hand, when crossing the terrain found across the center of the current subject property, traveling a mile takes hours, not minutes.

01006260

The possibility that these features were utilized by those coming to the area to exploit lithic resources also does not seem to be supported due to the absence of quarry sites in proximity to the shelters identified by ACP. The question then arises as to why temporary habitation features would be found in this inhospitable terrain. It was hypothesized that perhaps in the past there was a resource within this area not available elsewhere such as a medicinal plant or avifauna which lived in the exposed lava fields. An hypothesis related to the potential presence of a bird species which lived in an environmental niche such as found on the subject property is that the shelters may have served as blinds for those hunting the birds. However, there is no empirical evidence which would indicate that these features were utilized in ways other than originally hypothesized.

Site 22509 consisted of a stone covered hearth located near the edge of the Kaniku Lava Flow. The morphology of the structure and the presence of stone manuported from the adjacent lava flow implies that this site was utilized as a temporary habitation. It is likely that this utilization occurred in the pre-Contact Period although it cannot be discounted that the site was initially utilized or reutilized in the post-Contact Period.

The final feature type which was identified during the current investigations was the rock shelter, Feature 22514:A. The results of subsurface testing conducted within the rock shelter indicate that Feature 22514:A was likely utilized as a temporary habitation in the pre-Contact Period. Radiometric dating of a floral sample recovered from the base of the excavation unit indicated utilization of the feature had begun by approximately AD 1480 (refer to Appendix B).

Remains recovered included faunal remains, matted floral material, and artifacts. The range of materials recovered indicated that activities which took place at Feature 22514:A likely included the consumption of meals as well as over night stays. Food items identified included those which were brought to the rock shelter from the coast. Based upon his identifications of the vertebrate faunal remains, Dr. Ziegler noted that, "... the vertebrate remains suggest that (Feature 22514:A) was utilized by humans for at least preparing and (probably) cooking seabirds, and that these people were probably largely or wholly of Hawaiian cultural affinity, and that their use of the rock-shelter occurred sometime during the Polynesian Period and/or the first several decades of the Historic Period" (Ziegler 2000; refer to Appendix C). Another interesting observation made by Dr. Ziegler was related to a butchering technique used by Native Hawaiians in which many of the bones displayed "end breakage" caused by having been "separated at the joints" prior to cooking. The complete text of Dr. Ziegler's comments is presented in Appendix C.

Only four artifacts were recovered from Feature 22514:A during both the surface collection and the subsurface testing including a possible preform, a manuported water worn stone (possibly a hammerstone), a volcanic glass flake, and a gourd fragment. The gourd fragment was likely used to transport water to the site and the remaining tools were likely associated with the preparation of meals. The presence of the tin can indicates that the feature has continued to be visited in the post-Contact Period.

01006261

As mentioned above, the presence of the C-shaped wall with associated *ahu* (Feature 22514:B) on the surface of a *pahoehoe* outcrop directly above the rock shelter (Feature 22514:A) raises the question as to why two features both used as temporary habitations would be in such close proximity to one another. It seems unlikely that one would take the time and effort to construct a "walled shelter" such as the C-shaped wall with associated *ahu* when a natural formation such as a rock shelter was available nearby. The question regarding the proximity of these two features may be explained by assuming that the utilization of the two features was not contemporaneous. Alternatively, it is possible that two features were utilized for different functions. An hypothesis discussed above speculated that the C-shaped walls with associated *ahu* may have served as blinds for those hunting birds or for some other specialized activity. However, as stated above, in the absence of empirical evidence, the only reasonable deduction is that both features were utilized simply as temporary habitations.

01006262

Section 7: Evaluations of Site Significance

A total of ten sites of significance to the interests of historic preservation were identified during the current investigations. Site 22509 consisted of a stone covered hearth believed to have been utilized for temporary habitation which likely occurred in the pre-Contact Period. This site qualifies to be considered significant under Criterion D (site has yielded, or is likely to yield, information important in prehistory or history) of the National Register of Historic Places criteria but because sufficient information has been recovered during the current investigations the site is considered "no longer significant" (refer to Table 1). No further archaeological work is recommended for this site.

Site 22510 is the first of the C-shaped wall with associated *ahu* features identified on the subject property. The two structures together are believed to have supported a feature type described by Ching (1971) as a "walled shelter". This site is believed to have been utilized for temporary habitation during the pre-Contact Period. Site 22510 qualifies to be considered significant under Criterion D (site has yielded, or is likely to yield, information important in prehistory or history) of the National Register of Historic Places criteria (refer to Table 1). Because of the absence of excavatable deposits in the locations at which these site types are found and because this site type has been sufficiently documented, no further archaeological work is recommended for this site.

Site 22511 consisted of three *ahu* in relative proximity to one another which are believed to have been utilized as boundary markers delineating pastureland in the post-Contact Period. This site qualifies to be considered significant under Criterion D (site has yielded, or is likely to yield, information important in prehistory or history) of the National Register of Historic Places criteria but because sufficient information has been recovered during the current investigations the site is considered "no longer significant" (refer to Table 1). No further archaeological work is recommended for this site.

Sites 22512 and 22513 are both made up of a C-shaped wall with associated *ahu*. These feature types are believed to have been utilized for temporary habitation during the pre-Contact Period. These sites qualify to be considered significant under Criterion D (site has yielded, or is likely to yield, information important in prehistory or history) of the National Register of Historic Places criteria (refer to Table 1). No further archaeological work is recommended for these sites.

Site 22514 consisted of two adjacent features, a rock shelter and a C-shaped wall with associated *ahu*. Both are believed to have been utilized for temporary habitation during the pre-Contact Period. This site qualifies to be considered significant under Criterion D (site has yielded, or is likely to yield, information important in prehistory or history) of the National Register of Historic Places criteria (refer to Table 1). This site is recommended for data recovery and preservation the details of which will be presented in separate documents.

01006263

Table 1: Summary of Significance Criteria Evaluations

Site	Feature	Description	Function	Significance Criteria	Recommended Treatment
22509		Stone Covered Hearth	TH	NLS	NFW
22510		C-Shape w/Ahu	TH	D	NFW
22511		Associated Ahu	Ag/BM	NLS	NFW
	A	Ahu			
	B	Ahu			
	C	Ahu			
22512		C-Shape w/Ahu	TH	D	NFW
22513		C-Shape w/Ahu	TH	D	NFW
22514		Rock Shelter & C-Shape /Ahu	TH	D	DR
	A	Rock Shelter			
	B	C-Shape w/Ahu			
22515		C-Shape w/Ahu	TH	D	NFW
22516		C-Shape w/Ahu	TH	D	NFW

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Table 1: Summary of Significance Criteria Evaluations (cont.)

Site	Feature	Description	Function	Significance Criteria	Recommended Treatment
22517		Ahu	Ag/BM	NLS	NFW
22518		C-Shape w/Ahu	TH	D	NFW

Code for Significance Evaluations

A - Site is associated with events that have made a significant contribution to the broad patterns of history.

B - Site is associated with the lives of persons significant in the past.

C - Site embodies the distinctive characteristics of a type, period, or method of construction; or is the work of a master; or possesses high artistic values; or represents a significant distinguishable entity.

D - Site has yielded or is likely to yield information important in prehistory or history.

E - Site has Cultural Significance (*heiau*, shrine, burial, etc.).

NS - Not Significant.

NLS - No Longer Significant

Criteria A - D represent National Register of Historic Places criteria.
Criterion E represents Hawaii Register of Historic Places criterion.
NS and NLS represent designations acceptable to the DLNR-SHPD.

note:

Ag = Agricultural
TH = Temporary Habitation
LP = Lithic Processing & Production
BM = Boundary Marker
NFW = No Further Work
DR = Data Recovery

01006265

Site 22515 is another of the C-shaped wall with associated *ahu* features believed to have been utilized for temporary habitation during the pre-Contact Period. This site qualifies to be considered significant under Criterion D (site has yielded, or is likely to yield, information important in prehistory or history) of the National Register of Historic Places criteria (refer to Table 1). No further archaeological work is recommended for this site.

Site 22516 is also one of the C-shaped wall with associated *ahu* features believed to have been utilized for temporary habitation during the pre-Contact Period. This site qualifies to be considered significant under Criterion D (site has yielded, or is likely to yield, information important in prehistory or history) of the National Register of Historic Places criteria (refer to Table 1). No further archaeological work is recommended for this site.

Site 22517 consisted of an isolated *ahu* which was believed to have been utilized as a boundary marker delineating pastureland in the post-Contact Period. This site qualifies to be considered significant under Criterion D (site has yielded, or is likely to yield, information important in prehistory or history) of the National Register of Historic Places criteria but because sufficient information has been recovered during the current investigations the site is considered "no longer significant" (refer to Table 1). No further archaeological work is recommended for this site.

Site 22518 is the last of the C-shaped wall with associated *ahu* features believed to have been utilized for temporary habitation during the pre-Contact Period. This site qualifies to be considered significant under Criterion D (site has yielded, or is likely to yield, information important in prehistory or history) of the National Register of Historic Places criteria (refer to Table 1). No further archaeological work is recommended for this site.

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Conclusion

The current project area was the subject of a reconnaissance survey conducted by ACH in June of 1987 (Kennedy 1987). Because it was known that at least one site of potential historic significance was present on the subject property, a complete inventory survey was conducted.

The current investigations took the form of a 100% surface survey of the subject property and limited subsurface testing at one feature. A total of ten sites (Sites 50-10-11-22509 through 22518) comprised of thirteen individual features were identified. Of the features identified during the current investigations, the rock shelter, C-Shapes with associated *ahu* and the stone covered hearth (Sites 50-10-11-22509, 22510, 22512-22516 & 22518) are believed to have been utilized for temporary habitation during the pre-Contact Period with the utilization of some potentially extending into the early post-Contact Period. The four individual *ahu* (Sites 50-10-11-22511 & 22517) are believed to be boundary markers demarcating pasturelands utilized in the post-Contact Period.

Based upon the results of the current investigations, Archaeological Consultants of the Pacific, Inc. recommends that a determination be made that future construction activities would have an "adverse effect" on significant historic properties. It is also recommended that mitigation of the potential "adverse effect" consist of additional archaeological investigations in the form of Data Recovery as well as the Preservation of Site 22514. The details of both Data Recovery and the Preservation of Site 22514 will be presented in separate documents.

01006267

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01006272

APPENDIX A

Tables

01006273

Table 2: Artifact Accession List

Feature	Provenience	Layer	Depth (cmbs)	Artifact #	Material	Object	Weight (g)	Size (cm)			Count	Description
								Length	Width	Thickness		
22510	Surface collection	NA	NA	PKO-001	Basalt	Sinker Stone/Net Weight	83	6.2	4.9	3.4	1	Rough groove etched around the perimeter of the stone.
22514:A	Surface Collection	NA	NA	PKO-002	Basalt	Possible Adze Preform	580	17.0	6.5	4.5	1	Possible evidence of modification; probable manuport
22514:A	Surface Collection	NA	NA	PKO-003	Basalt	Manuport	670	10.5	9.0	7.0	1	Water worn w/ breakage at one end (possible hammerstone?)
22514:A	Test Unit 1	1	0 - 7	PKO-004	Volcanic Glass	Flake Tool	0.3	1.7	0.7	0.2	1	Probable use wear on cutting edge
22514:A	Test Unit 1	1	0 - 7	PKO-005	Floral	Gourd Shell	2.0	3.6	3.3	0.5	1	Manuport

01006274

Table 3: Identification of Faunal Remains

Classification	Surface Collection	Test Unit 1
		Layer I (0-7cmbs)
Vertebrate		
Fish Scales		Trace (< 0.1)
Class Aves		
Order Procellariiformes		
Family Procellariidae		
Bulwerii bulwerii	9.2 (MNI = 7)	5.4 (MNI = 6)
Pterodroma phaeopygia	6.8 (MNI = 2)	0.4
Family Hydrobatidae		
Oceanodroma castro	0.1	0.3 (MNI = 2)
Order Pelicaniformes		
Family Phaethontidae		
Phaethon lepturus	0.4	0.6
Order & Family Indeterminate		
Medium Bird	2.1	5.8
Small, Medium or Large Bird	Trace (< 0.1)	
Class Mammalia		
Order Rodentia		
Family Muridae		
Rattus exulans	0.1	0.3 (MNI = 2)
Mus musculus		0.1
Non-Vertebrate		
Cellana sp.	12.8 (MNI = 2)	Trace (< 0.1)
Echinoderm	0.2	0.4

Results presented in weight by gram.

01006275

Table 4: Radiocarbon Dating Results

Test Unit	Feature	Layer	Depth (cmbs)	Beta #	Conventional C14 Age	Most Probable Calibrated Age Ranges AD	
						1 Sigma	2 Sigma
1	22514:A	II	6-9	147050	380 +/- 70 BP	1448-1524	1428-1653

Calibrated using the University of Washington, Quaternary Isotope Lab's Radiocarbon Calibration Program Ver. 3.0.3.

01006276

APPENDIX B

Results of Radiometric Dating

01006277

BETA

BETA ANALYTIC INC.

DR. M.A. TAMERS and MR. D.G. HOOD

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REPORT OF RADIOCARBON DATING ANALYSES

Mr. Joseph Kennedy

Report Date: 10/22/00

Archaeological Consultants

Material Received: 9/18/00

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 147050	330 +/- 70 BP	-22.1 o/oo	380 +/- 70 BP

SAMPLE : PUAKO
ANALYSIS : Radiometric-Standard delivery
MATERIAL/PRETREATMENT : (plant material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 1420 to 1660 (Cal BP 530 to 290)

01006278

B1

Dates are reported as RCYBP (radiocarbon years before present, "present" = 1950A.D.). By International convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-22.1:lab. mult=1)

Laboratory number: **Beta-147050**

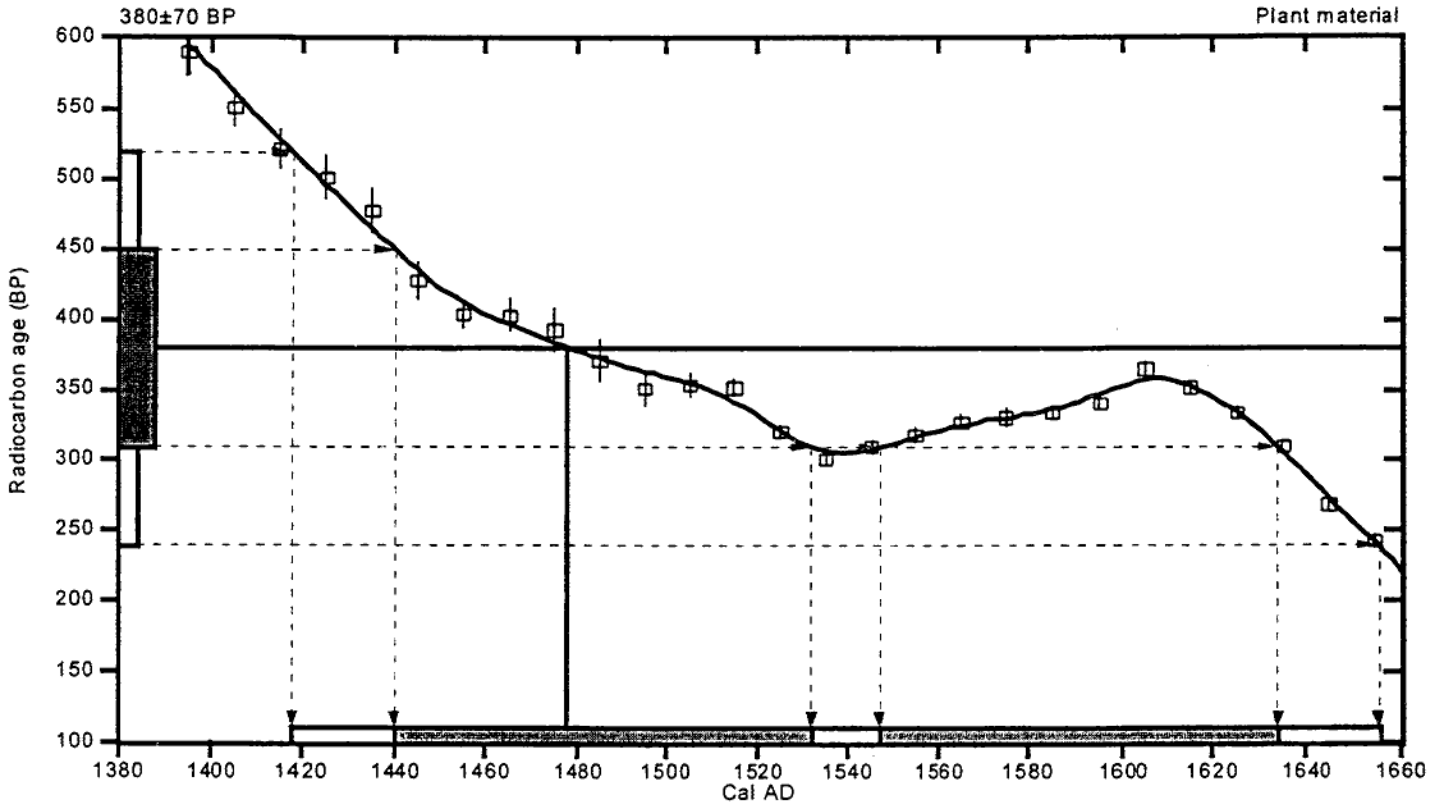
Conventional radiocarbon age: **380±70 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 1420 to 1660 (Cal BP 530 to 290)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1480 (Cal BP 470)

1 Sigma calibrated results: (68% probability) Cal AD 1440 to 1530 (Cal BP 510 to 420) and Cal AD 1550 to 1630 (Cal BP 400 to 320)



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QUATERNARY ISOTOPE LAB
RADIOCARBON CALIBRATION PROGRAM REV 3.0.3
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Calibration file(s): UWTEN93.14C
Listing file: C14FIL.TXT

ACP PUAKO IS

Radiocarbon Age BP 380 ± 70 Reference(s)
Calibrated age(s) cal AD 1489 (Stuiver and Becker, 1993)

cal AD/BC age ranges obtained from intercepts (Method A):
one Sigma** cal AD 1440 - 1638
two Sigma** cal AD 1415 - 1660

Summary of above:

minimum of cal age ranges (cal ages) maximum of cal age ranges:
1σ cal AD 1440 (1489) 1638
2σ cal AD 1415 (1489) 1660

cal AD/BC age ranges (cal ages as above)
from probability distribution (Method B):

% area enclosed	cal AD age ranges	relative area under probability distribution
68.3 (1σ)	cal AD 1448 - 1524	.55
	1563 - 1628	.45
95.4 (2σ)	cal AD 1428 - 1653	1.00

References for datasets used:
Stuiver, M and Becker, B, 1993, Radiocarbon, 35, 35-65.

Comments:
+This standard deviation (error) includes a lab error multiplier.
** 1 sigma = square root of (sample std. dev.^{2}+ curve std. dev.^{2})
2 sigma = 2 x square root of (sample std. dev.^{2}+ curve std. dev.^{2})

0* represents a "negative" age BP
1955* denotes influence of bomb C-14
For cal yrs between 5500-5190 BC an offset of 25 years is possible.
NOTE: Cal ages and ranges are rounded to the nearest year which may be too precise in many instances. Users are advised to round results to the nearest 10 yr for samples with standard deviation in the radiocarbon age greater than 50 yr.

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APPENDIX C

Dr. Ziegler's Comments on Puakō Faunal Material

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COMMENTS ON PUAKŌ, SOUTH KOHALA, HAWAI'I, FAUNAL MATERIAL

The Surface and Layer 1 vertebrate lots from TF 10A both contain the same four species of seabirds: *Bulweria bulwerii* (Bulwer's Petrel), *Pterodroma phaeopygia* (Hawaiian Petrel), *Oceanodroma castro* (Band-rumped Storm-Petrel), and *Phaethon lepturus* (White-tailed Tropicbird). Judging from the appearance of the otherwise unidentified "Small and/or Medium Bird" items, it seems likely none represents species other than these four. The only other vertebrates present in the TF 10A material are two rodent species: the prehistorically introduced *Rattus exulans* (Polynesian Rat) and the historically introduced *Mus musculus* (House Mouse). Presumably, neither of these mammal species served as a human dietary item here, and the scant remains of both most likely are present through natural deaths due to other than anthropogenous factors.

I suspect at least a majority of the birds represented were eaten by the site's human users, because a great many of the bones show what I term--for lack of a better available designation--"end-breakage". In this, the terminal several millimeters of one or both ends of at least the larger bones of the skeleton appear either roughly broken off or rather cleanly cut away, usually leaving the entire intervening shaft entire. This condition is commonly found among culturally related bird bones from all of at least the larger Main Islands, although the procedure causing it is apparently not recorded in any Hawaiian ethnographic account. Evidently, this particular type of breakage is the result of a Native Hawaiian butchering technique (--usually of Petrels and Shearwaters, but also occasionally of other medium and large birds--) in which many bones--even some of the quite small distal wing elements--were separated at the joints, using some type of (presumably) stone chopping or cutting implement. Apparently, it was carried out prior to cooking of the birds, but it is not clear just why such a procedure was employed.

A few of the present bones do not show "end-breakage", and it is possible some or all of these unmodified elements belong to birds dying naturally in the rock-shelter. (I have seen isolated complete skeletons of such birds--especially the Hawaiian Petrel--on the floors of lava-blister caves in Hawai'i's "Saddle Area", which sites also contained numerous other dissociated bones showing obvious "end-breakage".) Incidently, none of the TF 10A bird bones are those of immature individuals, so the people using the site were not raiding rookeries for young birds--or if they were, the immature individuals were not eaten here.

The cultural affinity of the site's users is not surely ascertainable from the vertebrates present, but it might be noted that the four seabird species recovered are among the number of birds typical of a Polynesian-type diet, but not usually associated with that of Europeans or other foreigners.

In regard to the time-period during which humans used the site, all of the four seabird species utilized can probably still be encountered on the island of Hawai'i (although the Band-rumped Storm-Petrel is not surely known to now nest there), so none can be used to establish deposition time. The Polynesian Rat

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material could have been laid down at any time between the early Polynesian Period and the present day. The House Mouse remains, however, could only have been deposited sometime in the Historic Period (but I tend to think from other evidence that the species was present in the Hawaiian Islands rather early in this cultural period--possibly arriving by at least the first two or three decades of the 1800s).

Thus, in summary, the vertebrate remains suggest that the TF 10A site was utilized by humans for at least preparing and (probably) cooking seabirds, and that these people were probably largely or wholly of Hawaiian cultural affinity, and that their use of the rock-shelter occurred sometime during the Polynesian Period and/or first several decades of the Historic Period.

I hope this information will be of interest and use to you. Many thanks for the chance to see this material. Please be sure to let me know if there are any questions on any of my procedures, identifications or comments. Continued best in everything !!

* * *

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
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ENGINEERING
FORESTRY AND WILDLIFE
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KAHOOLAWE ISLAND RESERVE COMMISSION
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STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

HISTORIC PRESERVATION DIVISION
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July 1, 2003

Mr. James Moore
Archaeological Consultants
of the Pacific, Inc.
59-624 Pupukea Road
Haleiwa, Hawaii 96712

LOG NO: 2003.1087
DOC NO: 0306PM16

Dear Mr. Moore:

SUBJECT: Chapter 6E-42 Historic Preservation Review of a Final Revised Report "Archaeological Inventory Survey Report for the Bridge 'Aina Lea Residential Golf Community Development Located at TMK: 6-8-01:25, 36, 37, 38, 39 &40 (Poor.), in the Ahupua'a of Waikoloa, District of South Kohala, Island of Hawai'i" (Moore, Ostroff and Kennedy 2002)

Thank you for your letter of January 28, 2003 and copy of the subject report for our review and approval. The report was revised to respond to the comments in our review letter of May 18, 2001 (Log No. 27511; Doc No. 0105PM13).

As indicated in our earlier review letter, we believe that the archaeological inventory survey of the approximately 1000-acre parcel and a 50 ft wide proposed power line corridor was adequate. Ten historic sites were found in the survey, including one previously recorded rock shelter (Site 22514). The nine new sites include six C-shape enclosures with ahu (Sites 22510, 22512, 22513, 22515, 22516 and 22518), two *ahu* (Sites 22511 and 22517)), and an isolated hearth (Site 22509).

All ten sites were initially evaluated as significant under Criterion "d" for their information content. Three sites (22509, 22511 and 22517) were subsequently evaluated as "no longer significant" because of the belief that they have been adequately documented and hold no further research potential. We concur with these evaluations.

We also concur with the proposed site treatments. No further work will be required, except for the rock shelter (Site 22514) which is recommended for data recovery.

Mr. James Moore

The revised report meets with our approval. Please mail a copy of the report to MaryAnne Maigret for our Kona office library.

Aloha,

P. Holly McEldowney

P. Holly McEldowney, Acting Administrator
State Historic Preservation Division

c. Mr. Chris Yuen, Director, Dept of Planning, County of Hawaii

PM:ak

JUL - 7 2003

Appendix I1

Archaeological Assessment, Utility Corridor
(Haun & Associates, January 2010)

Report 711-012910

ARCHAEOLOGICAL ASSESSMENT

PORTION OF TMK: (3) 6-8-02:19

LAND OF WAIKOLOA

SOUTH KOHALA DISTRICT

ISLAND OF HAWAI‘I

By:

Alan E. Haun, Ph.D.

Dave Henry, B. S.

and

Solomon H. Kailihiwa, III, B.A.

Prepared for:

D W ‘Aina Le‘a Development LLC
P.O. Box 383129
Waikoloa, Hawaii 96738

January 2010

Haun & Associates

Archaeological, Cultural, and Historical Resource Management Services
73-1168 Kahuna A‘o Road, Kailua-Kona Hawai‘i 96740 Phone: 982-7755 Fax: 325-1520

Introduction

At the request of D W ‘Aina Le‘a Development LLC, Haun & Associates has prepared an archaeological assessment for a proposed potable water easement located within TMK: (3) 6-8-02:19 in Waikoloa Ahupua‘a, South Kohala District, Island of Hawai‘i (*Figures 1-4*). The objective of the survey was to satisfy historic preservation regulatory review requirements of the Department of Land and Natural Resources-Historic Preservation Division (DLNR-SHPD), as contained within Hawaii Administrative Rules, Title 13, DLNR, Subtitle 13, State Historic Preservation Rules (2003).

No archaeological sites or features were identified during the survey, therefore the project is documented as an archaeological assessment pursuant to Chapter 13-284-5(5A). As required, this report contains a description of the project area and field methods.

Project Area Description

The project area consists of a 30 ft wide easement located in the inland portions of the Land of Waikoloa at elevations ranging from c. 645 to 685 ft. The corridor is situated 3.7 m inland from the shoreline (see *Figure 1*). It is marked along its centerline by stakes placed at 50 ft intervals. The corridor originates at the western end of Hulu Street in Waikoloa Village (see *Figure 3* and *Figure* 5) and extends 1,959 ft (597 m) to where it terminates at the inland boundary of TMK: (3) 6-8-01:37. From the inland end, the corridor extends 638 ft (194.5 m) to the south-southwest, then angles to the west-southwest for 392 ft (119.5 m). The corridor then turns to the west for 549 ft (167 m), then angles to the southwest for 380 ft (116 m) where it terminates. The corridor crosses a branch of Auwaiakeakua Stream gulch ca. 828 ft (252 m) seaward of the inland end.

The soil within the project area is very stony land, described by Sato et al. (1973:52) as a miscellaneous land type consisting of very shallow soil and a high proportion of A‘a lava outcrops. This soil exhibits a slight erosion hazard and is classified as suitable for pasture, watershed and wildlife habitat. According to Wolfe and Morris, the lava flows in the area were deposited during the Pleistocene from Hamakua volcanics with the flows consisting of “aa and pahoehoe from vents widely distributed over the subaerial flanks of the volcano” (2001:52).

Vegetation within the area consists of sparse *kiawe* (*Prosopis pallida*), *koa haole* (*Leucaena glauca*), *Ilima (Sida fallax* Walp.*)* and low grasses. Rainfall in the vicinity of the project area averages less than 10 inches per year (Juvik and Juvik 1998:57). Overviews of the arid project area are illustrated in *Figures 6* and *7*.

Methods

The survey fieldwork was conducted by Juliana Kailihiwa and Solomon Kailihiwa under the direction of Dr. Alan Haun. Approximately one person day was required to complete the fieldwork portion of the project. The archaeological investigation of the project area consisted of a 100% surface examination with the surveyors walking transects parallel to the centerline of the corridor, spaced at 10-meter intervals. Ground surface visibility throughout the project area was excellent. No subsurface testing was conducted and no cultural remains were recovered for analysis.

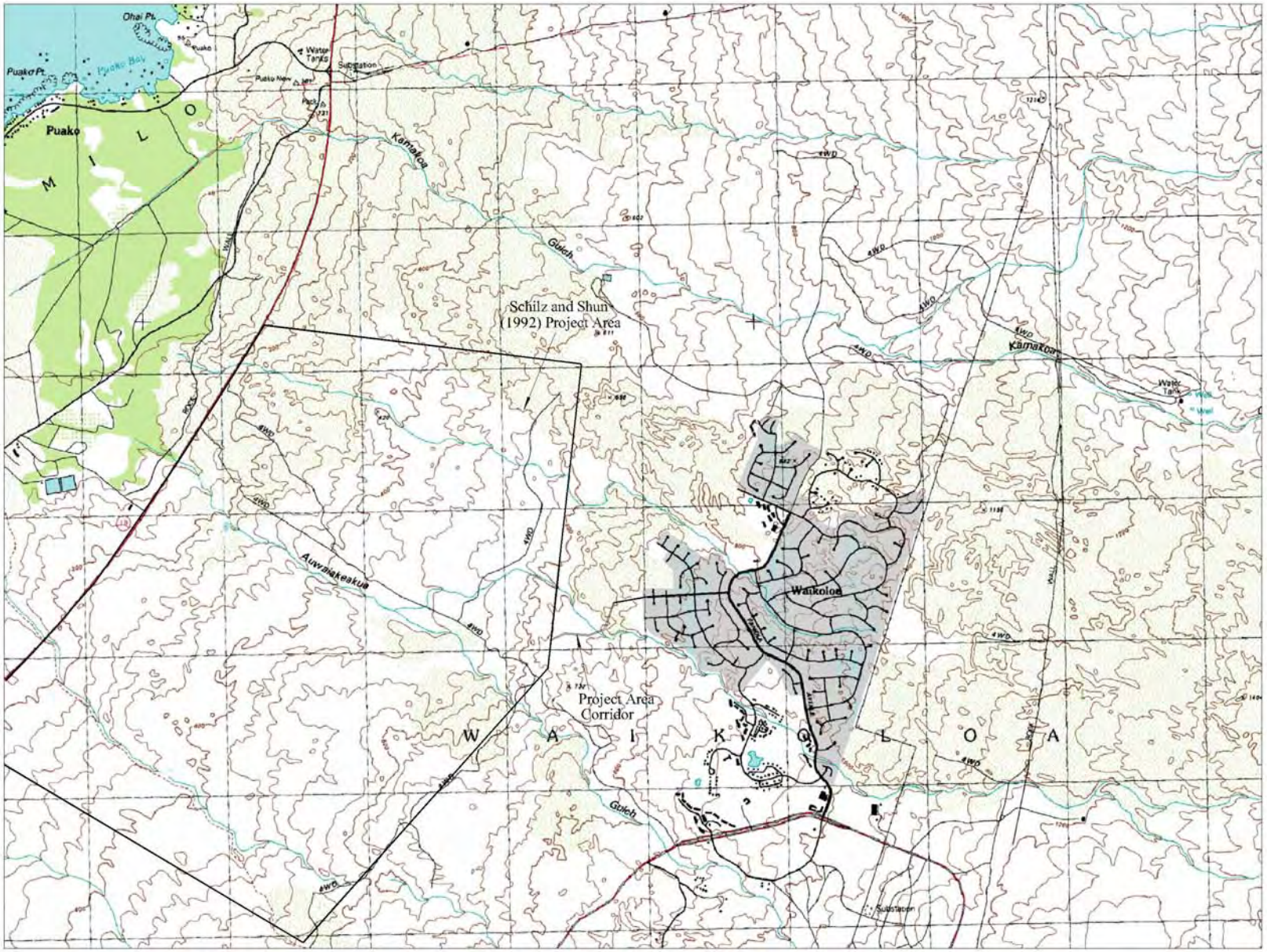

Figure 1. Portion of USGS Anaehoomalu Quadrangle showing Project Area Corridor

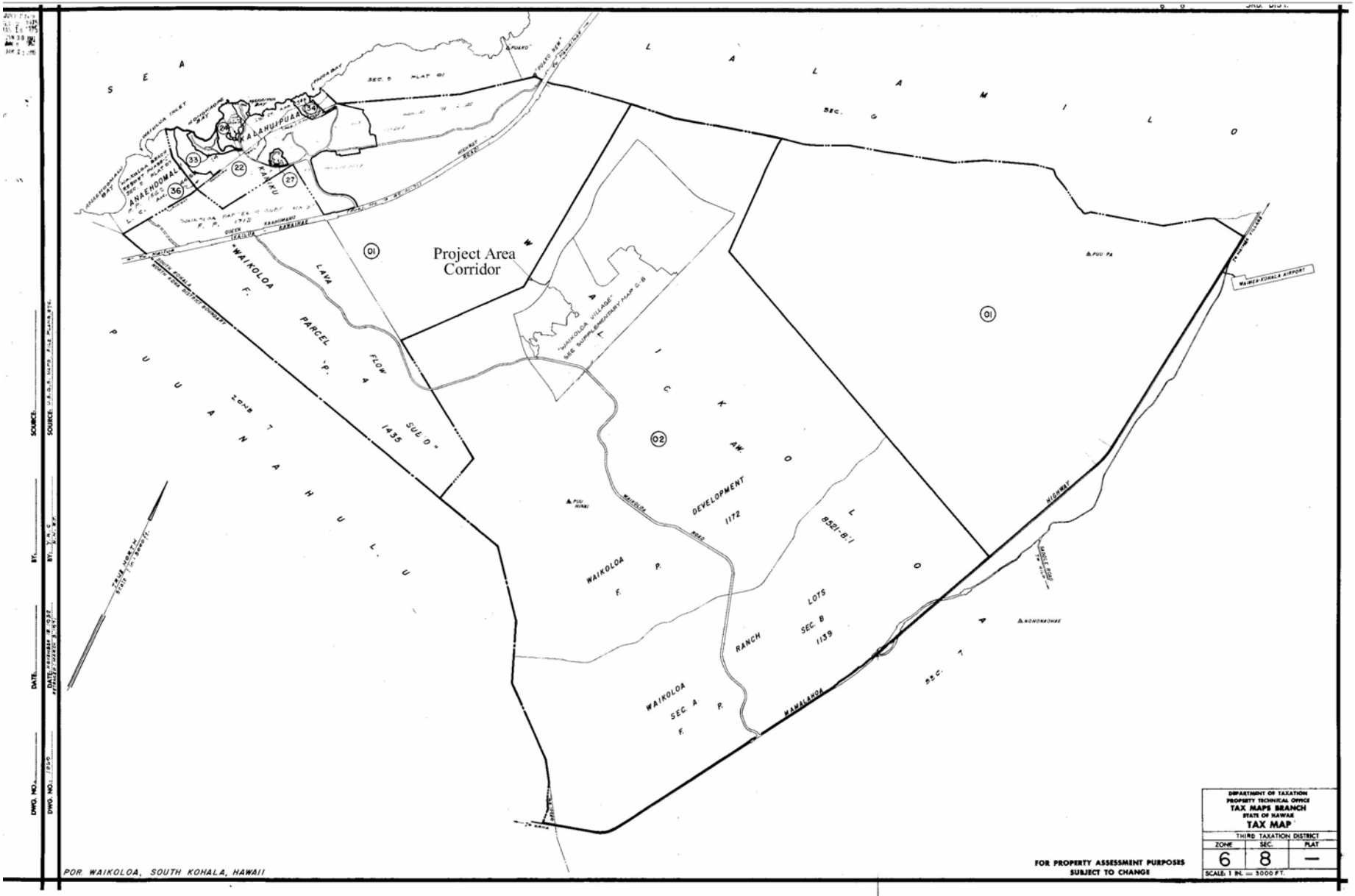

Figure 2. Tax Map Key 6-8 showing Project Area Corridor

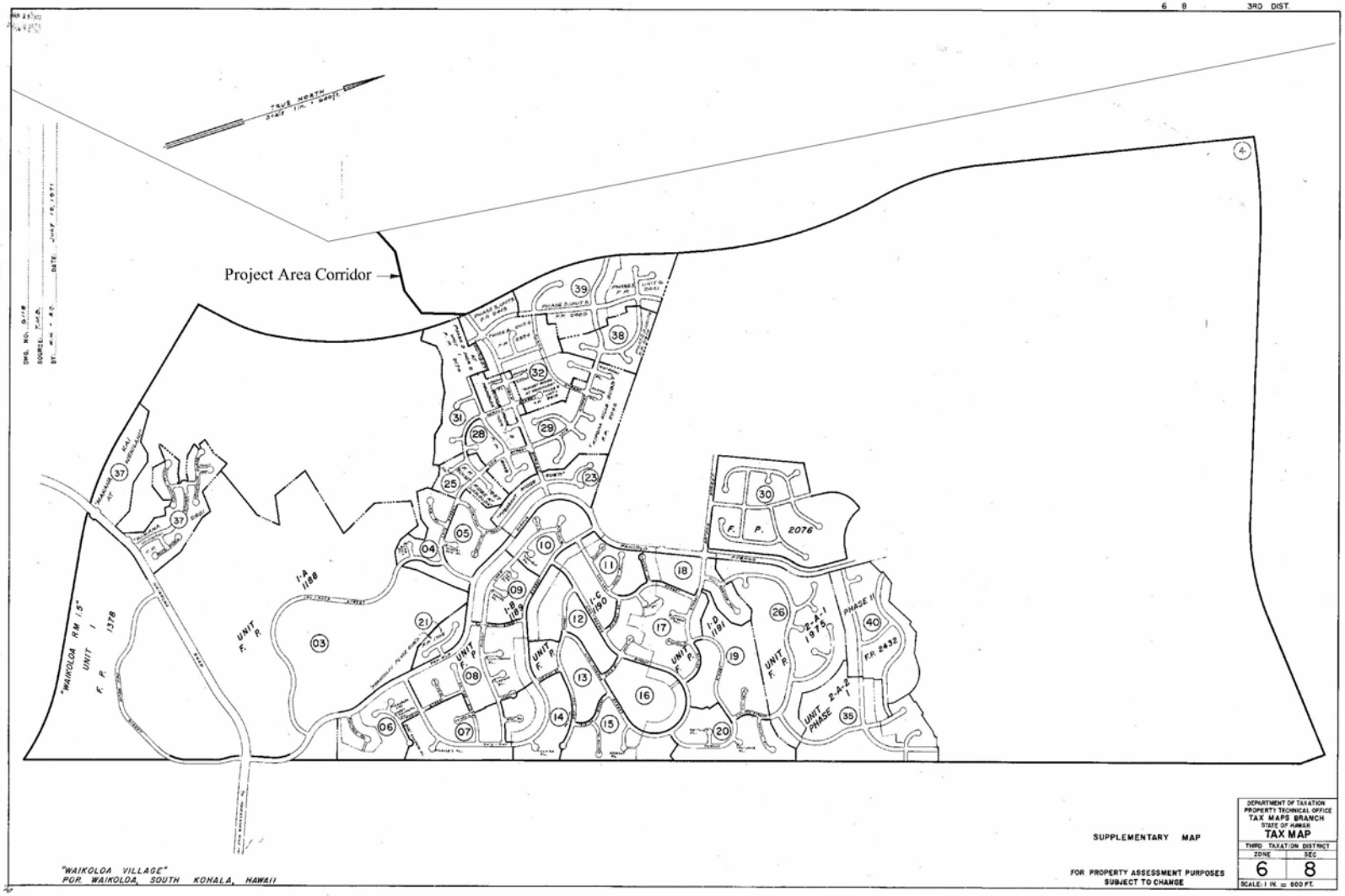

Figure 3. Tax Map Key Supplemental Map 6-8 showing Project Area Corridor

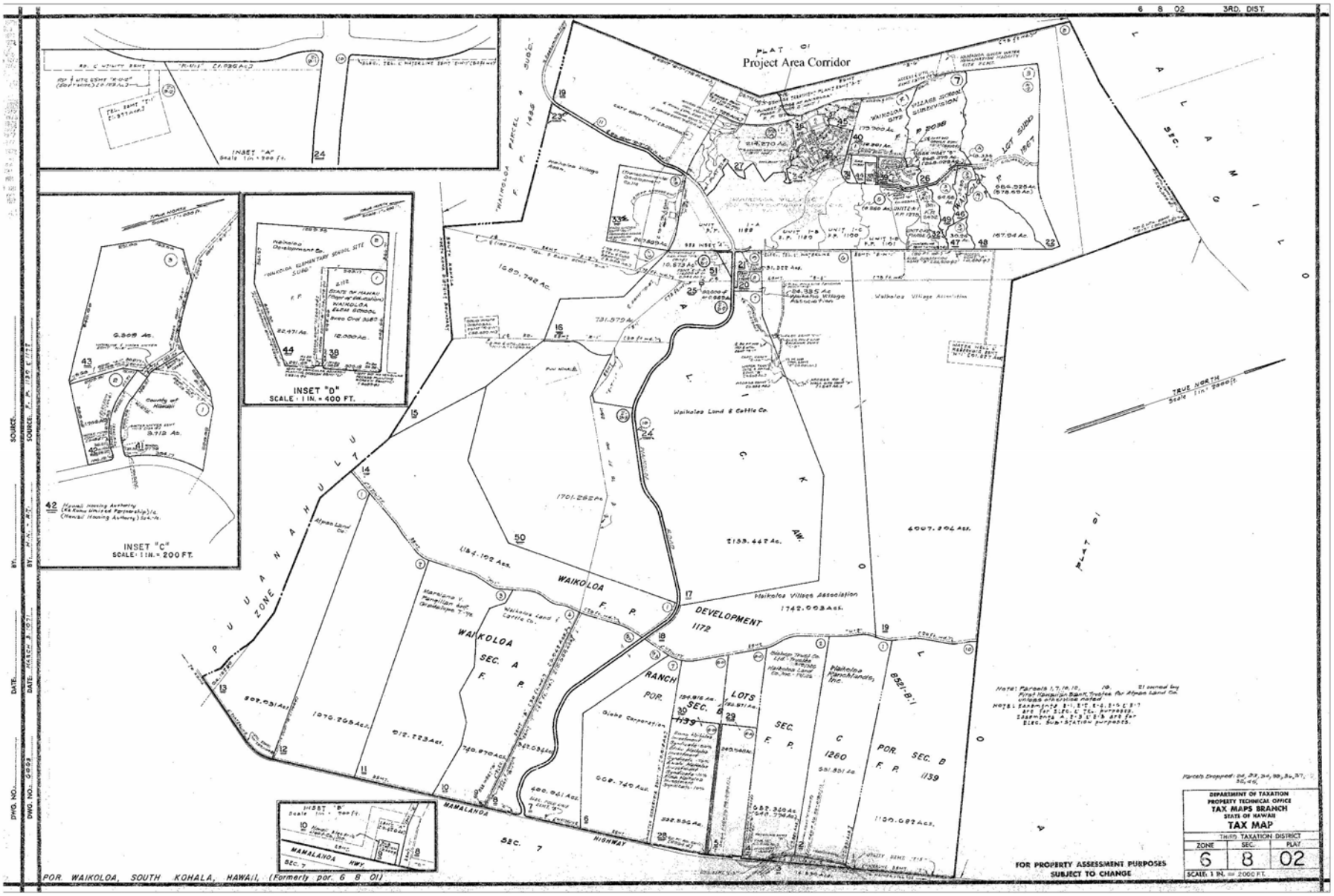

Figure 4. Tax Map Key 6-8-02 showing Project Area Corridor

Figure 5. Aerial View of Project Area Corridor (from Google Earth)

Figure 6. Project Area Overview, view to south

Figure 7. Project Area Overview, view to southwest

Background

Historical Documentary Research

Haun et al. (2003), Welch (1989) and Barrere (1971, 1983) discuss the traditional land divisions of Waikoloa and the adjacent lands of Kalahuipua‘a, and ‘Anaeho‘omalu (*Figure 8*). Their research focused on Land Commission Award (LCA) testimony, Boundary Commission testimony, and other historic documents. In earlier times, Waimea was a sub-district of Kohala that included all of the land in the district south of Waikoloa Stream. Waimea was composed of eight subdivisions with the majority of the district being composed of the *‘ili* of Waikoloa and Pu‘ukapu. The remainder consisted of the *‘ili* of Wai‘aka, Lalamilo, ‘Anaeho‘omalu, Kalahuipua‘a, Puako, and Ouli.

At the *Mahele*, Waikoloa was deemed Crown Land, of which Isaac Davis received a large portion. Waikoloa (LCA 8521-B) was sometimes referred to as “Waikoloa Nui” and “Waikoloa Iki”, differentiating between the Crown Land and Davis’ land respectively. The Crown Land portion later became known as Lalamilo and Davis’ portion as simply Waikoloa. The coastal lands of ‘Anaeho‘omalu and Kalahuipua‘a were retained by the Crown as *‘ili kupono*. Kamehameha III gave these lands to his wife Kalama (LCA 4452). ‘Anaeho‘omalu was claimed by Kahenehene (LCA 4100), but she relinquished it (Maly 2000:19).

Traditional and legendary references to ‘Anaeho‘omalu, located seaward of the project area, are presented in detail by Maly (2000) and Barrere (1971) which are summarized here. According to legendary accounts in about the thirteenth century, Kama‘iole, a cruel chief, was killed in a battle at ‘Anaeho‘omalu. During the same period, fishing and salt making are described.

In the sixteenth century, the Hawai‘i Island ruler Lono-i-ka-makahiki, the grandson of ‘Umi-a-Liloa, put down a revolt by a group of rebel chiefs who were encamped at ‘Anaeho‘omalu. Lono-i-ka-makahiki erected an altar, Ke-Ahu-a Lono, on the boundary between Kona and Kohala at ‘Anaeho‘omalu to consecrate a cooperative covenant between the chief and his trusted advisor, Kapaihiahilina, who had been slandered. The altar was built at the time Lono-i-ka-makahiki was preparing to battle the invading forces of the Maui king Kama-lala-walu.

Early historic accounts from Cook’s voyage in 1779 and Arago in 1819 describe the general vicinity as desolate and sparsely inhabited based on observations made from the ships (Maly 2000). Ellis traveled from Kawaihae to Kailua by canoe in 1823 stopping at Puako and Kapalaoa, a small settlement a short distance south of ‘Anaeho‘omalu.

Kahenehene’s (LCA 4100) 1848 claim testimony for a parcel at ‘Anaeho‘omalu describes *kou* and coconut trees and salt making ponds (Maly 2000). The claim included four houses that were enclosed. Boundary Commission testimony from 1873 describes a small *heiau* called Hiakalaihi at the coast on the boundary between ‘Anaeho‘omalu and Puuanahulu. Ke-Ahu-a Lono was situated inland of the *heiau*. A large rock called Pohakuloa at the coast was described as marking the boundary between ‘Anaeho‘omalu and Kalahuipua‘a.

John Palmer Parker settled in Hawai‘i in 1815 and became a renowned bullock hunter (Haun et al. 2003). He became friends with John Young and spent much of his early years at Kealakekua, where Kamehameha held court. After the death of Kamehameha in 1819, Parker moved to Waiapuka in Kohala with his *ali‘i* wife, Kipikane and their new-born daughter (Wellmon 1970: 20-26).

In 1850, John Parker purchased 640 acres of land at Mana from the Hawaiian Government. The following year, Parker purchased an additional 1,000 acres. In 1852, Kamehameha III granted a lease to Parker for the lands of Waikoloa, giving Parker the competitive edge to control the developing ranching industry (Wellmon 1970:75). Parker’s grandson, Samuel Parker, purchased ‘Anaeho‘omalu and Kalahuipua‘a from the estate of Charles Kanaina, Queen Kalama’s uncle, in 1878 (Barrere 1971). These lands were used by the ranch for recreation, fishing, and aquaculture.

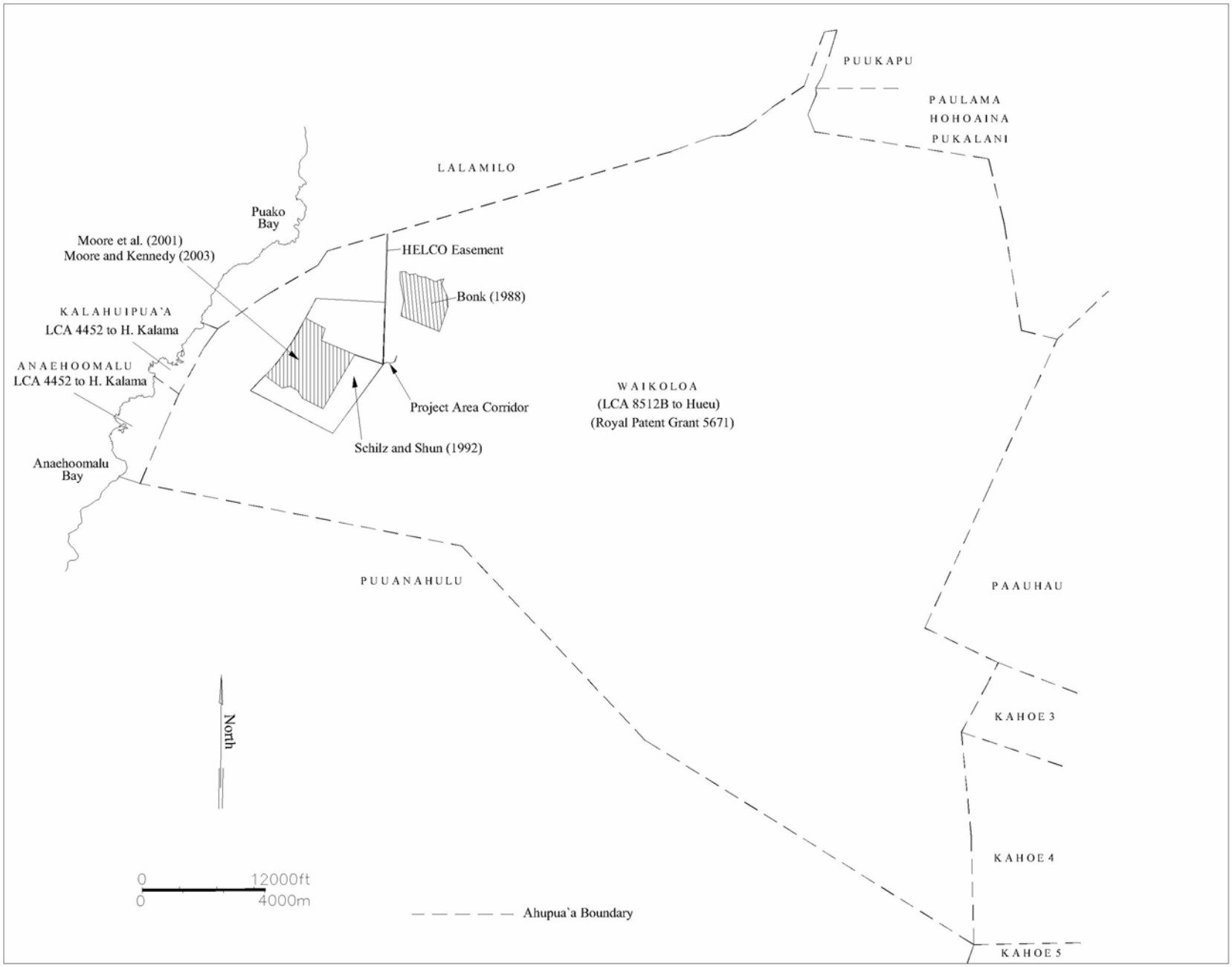

Figure 8. Ahupua`a Boundaries, Land Commission Awards and Previous Archaeological Studies near Project Area

In the early 1900s, the Parker family acquired Waikoloa and Ouli in fee-simple, giving them 100,000 acres of grazing land (Wellmon 1970: 75). Alfred W. Carter, guardian of Thelma Parker and manager of Parker Ranch, did much to aid ranching by improving cattle stock, conserve tree-less ranch lands by planting new and better grasses, and organizing the Hawai‘i Meat Company to provide ranchers an outlet to market their beef and beef products (Brundage 1971:59,28). The ranch sold Kalahuipua‘a and ‘Anaeho‘omalu to Francis I‘i Brown in 1936 (Maly 1999:126). Mr. Carter managed Parker Ranch until 1937 when his son, Hartwell Carter took over the position of ranch manager and remained in that capacity for the next twenty-five years.

As a major supplier of beef, Parker Ranch played a pivotal role in providing beef and mutton to the Armed Forces in Hawai‘i during both WWI and WWII. The Waikoloa Maneuver Area, an area of 91,000 acres acquired by the U.S. Navy in December 1943 through a license agreement with Richard Smart of Parker Ranch for the sum of $1.00 (Brundage 1971: 109). The training area extended from the ocean to the Pohakuloa Training Area, and from the Waimea-Kawaihae Road to south of the Waikoloa Road. The area was used for military exercises including the use of live ammunition and other explosives. The land was returned to Parker Ranch in September 1946. The project area is undeveloped, though the area inland of the corridor is occupied by the community of Waikoloa Village.

Previous Archaeological Work

Several archaeological studies have been conducted in the immediate vicinity of the project area corridor. The locations of these investigations are depicted in *Figure 8.* Bonk (1988) conducted a reconnaissance survey of c. 580 acres just north of Waikoloa Village. This survey identified numerous modern military shrapnel fragments though no archaeological sites or features were identified.

A survey of c. 3,000-acres of Waikoloa located adjacent to the project area corridor to the west was undertaken by Schilz and Shun (1992). This survey resulted in the identification of 13 sites with 34 features. Of these 13 sites, however, only one was assigned a SIHP site designation. This consists of a burial cave designated Site 15033 located c. 1,300 m south-southwest of the project area corridor at c. 580 ft elevation. The 12 remaining sites were designated as modern military features consisting of cairns, walled shelters, rock mounds and C-shaped enclosures. According to the authors, the paucity of archaeological sites was not surprising as the terrain was, “too rugged and inhospitable for human use and habitation” (1992:21).

A subsequent archaeological inventory survey of a c. 1000-acre portion of the Schilz and Shun (1992) study area and a 50 ft wide HELCO easement was conducted by Archaeological Consultants of the Pacific (Moore et al. 2001). This survey identified ten sites with 15 features consisting of a hearth (Site 22509), a trail segment leading to a small stone quarry (22510), three *ahu* along an existing jeep trail (22511), several C-shaped walls with an associated *ahu* (22512, 22513, 22515, 22516, 22518, 22514-B), a rock shelter (22514-A), a large *ahu* (22517), and a modern fire pit. These features are all located in the seaward portion of the project area, below c. 400 ft elevation. The survey of the HELCO easement noted shrapnel and a piece of unexploded ordnance, none of which were assigned site numbers.

Data Recovery excavations were subsequently undertaken at one of the ten sites noted within the 1000-acre survey area (Moore and Kennedy 2003). The excavations at the Site 22514-A rock shelter yielded food remains and stone tools along with a large number of seabird remains. The amount of seabird remains recovered suggested that this shelter was associated with the harvesting of seabirds in the immediate area, and that the C-shapes with associated *ahu* noted during the inventory survey could have been set up as hunting blinds for those involved in seabird catching activities. C-14 dating put the utilization of this site as early as the 1300's AD.

These studies have resulted in the examination of c. 3,580-acre within the immediate vicinity of the present project area. However, only 11 sites with 15 features were identified. These findings indicate an extremely low site density, with one site present per every 325-acres or .003 sites per acre.

Findings

No archaeological sites or features were identified within the project area. The absence of sites is likely attributable to the rugged and arid conditions within the area. As discussed above, the paucity of archaeological remains in this area has been well documented during previous studies in vicinity and the negative findings of the present survey project are not unexpected. No further archaeological work is recommended, based on the survey results.

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Appendix J

Archaeological Data Recovery Report/SHPD Correspondence
(Archaeological Consultants of the Pacific, Inc., Revised September 2005)

H-02266

AN ARCHAEOLOGICAL DATA RECOVERY REPORT FOR THE BRIDGE 'AINA LEA RESIDENTIAL GOLF COMMUNITY DEVELOPMENT LOCATED AT TMK: 6-8-01: 25, 36, 37, 38, 39 & 40, IN THE AHUPUA'A OF WAIKOLOA, DISTRICT OF SOUTH KOHALA, ISLAND OF HAWAI'I REVISED SEPTEMBER 2005

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Abstract

Archaeological data recovery investigations have been conducted on a property (TMK: 6-8-01: 25, 36, 37, 38, 39 & 40) located in Waikoloa Ahupua'a, district of South Kohala, Island of Hawai'i. Following previous archaeological inventory survey investigations, a Data Recovery Plan was implemented in order to help mitigate the effects of proposed development activities to significant historic properties located on the subject property.

Data recovery targeted a rock shelter (Feature 22514:A) found within a rugged mixed *a'a* and *pahoehoe* lava flow which crosses the center of the project area. Investigations took the form of six manually excavated test units covering a total area of just over two square meters. Test units were placed in the interior floor of the rock shelter in areas containing excavatable soils in between sections of exposed *pahoehoe*. Excavations revealed that only a thin layer of soil existed over the majority of the floor of the rock shelter. A variety of culturally deposited materials were recovered which were subsequently subjected to laboratory analyses.

Data recovery yielded evidence indicating that the utilization of the rock shelter consisted of recurrent use over a period of time beginning as early as the AD 1300's. Cultural remains indicate that a variety of activities took place at Feature 22514:A. Faunal remains indicate that one of the activities occurring at the feature consisted of the preparation and consumption of meals. The prevalence of seabirds in the faunal assemblage led Dr. Ziegler to state the rock shelter was "occupied by people while primarily carrying out the traditional Hawaiian practice of harvesting seabirds". Indications that tool manufacture likely took place at the feature derive from the recovery of the grinding stone and basalt preform. The presence of these artifacts as well as the echinoderm spine abraders implies that more than one stage of tool manufacture took place or that more than one type of tool manufacturing activity was occurring at the feature. The recovery of *kukui* nut shell fragments implies that the extraction of *kukui* nut oil may have been taking place.

Table of Contents

Abstract i

List of Illustrations iii

Section 1: Introduction 1

Section 2: Physical Setting 6

Section 3: Research Design 8

Section 4: The Methodology of Data Recovery 9

Section 5: Archaeological Findings 11

Section 5.1: Description of Site 22514 11

Section 5.2: Excavation Results 14

Section 6: Discussion 24

Conclusion 28

References Cited 29

Appendix A ..... Tables

Appendix B ..... Results of Radiometric Dating

Appendix C ..... Dr. Ziegler's Comments on Puakō Data Recovery Faunal Material

List of Illustrations

Figure 1: Project Location on a Map of Hawaii 2

Figure 2: Location of the Subject Property on a U.S.G.S. Topographic Map 3

Figure 3: Location of the Subject Property on a TMK Map 4

Figure 4: Photograph of Site 22514 12

Figure 5: Plan View of the Interior of Feature 22514:A with Test Unit Descriptions 13

Figure 6: Plan View Depicting the Surface of Layer I Prior to Excavation 15

Figure 7: Plan View Depicting the Surface of Layer I Following Excavation 17

Figure 8: Photograph of the Interior of Feature 22514:A Following Excavation 18

Figure 9: Profile of Test Unit 2 (Feature 22514:A) 20

Figure 10: Test Unit 2; Plan View at the Base of Layer I 21

An Archaeological Data Recovery Report for the Bridge 'Aina Lea Residential Golf Community Development Located at TMK: 6-8-01: 25, 36, 37, 38, 39 & 40 in the Ahupua'a of Waikoloa, District of South Kohala, Island of Hawai'i Revised September 2005

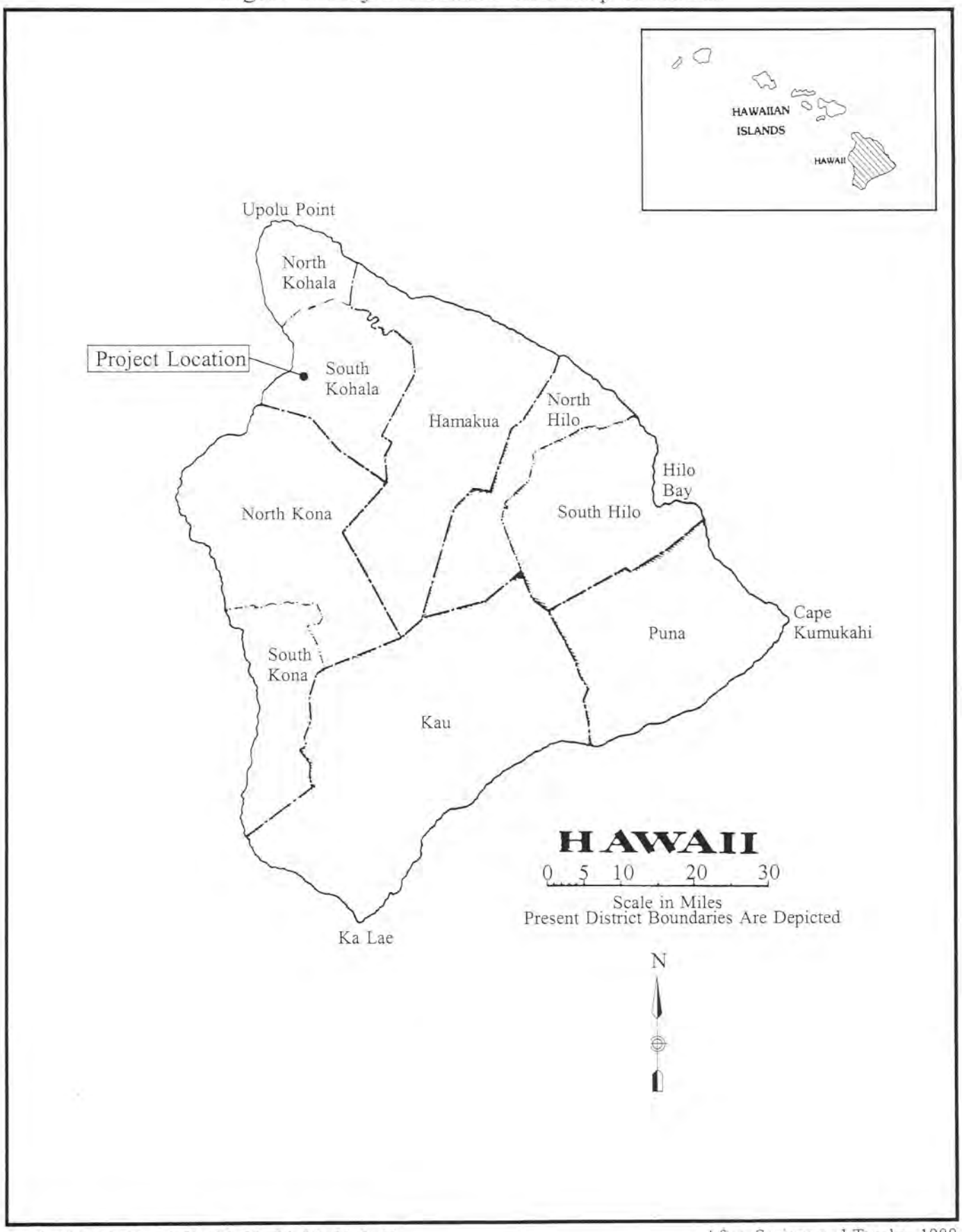
Section 1: Introduction

At the request of Mr. Jim Baldwin of Bridge 'Aina Lea LLC, Archaeological Consultants of the Pacific, Inc. (ACP) has prepared this Data Recovery Report for a property located at TMK: 6-8-01: 25, 36, 37, 38, 39 and 40 in the *ahupua'a* of Waikoloa, district of South Kohala on the island of Hawai'i (see Figure 1). Bridge 'Aina Lea LLC is the current owner of the subject property. Previous archaeological investigations conducted on the subject parcel have identified properties significant to the interests of historic preservation. Because it was determined that proposed development of the subject property would have an "adverse effect" on these significant historic properties, Data Recovery was recommended.

The current subject property has been the subject of three previous archaeological investigations. In June of 1987, Archaeological Consultants of Hawai'i (ACH) conducted a reconnaissance survey of approximately 1000 acres covering a large portion of the center of the current subject property (see Figures 2 & 3). At that time, one site (Site 50-10-11-22514; please note that in the remainder of this document only the individual five digit site numbers will be cited) was identified consisting of "three … features - a modified, shallow rock shelter, a small *ahu* and a low wall" (Kennedy 1987). Kennedy noted the presence of modern debris and a single *opihi* (*Cellana* sp.) shell within the rock shelter but did not investigate the site more thoroughly.

Archaeological investigations were continued by Ogden Environmental and Energy Services (OEES) who, in the early 1990's, conducted an inventory survey of the portions of TMK: 6-8-01: 25, 36, 37, 38, 39 and 40 located outside the area previously surveyed by ACH (Schilz & Shun 1992). A total of thirteen sites were identified by OEES, however, twelve of these were "attributed to military training activities or hunting" and not considered significant. The thirteenth site identified by OEES (Site 50-10-11-15033) consisted of a modified lava tube containing the partial remains of a human burial. It was hypothesized that the site's primary use had been as a burial cave.

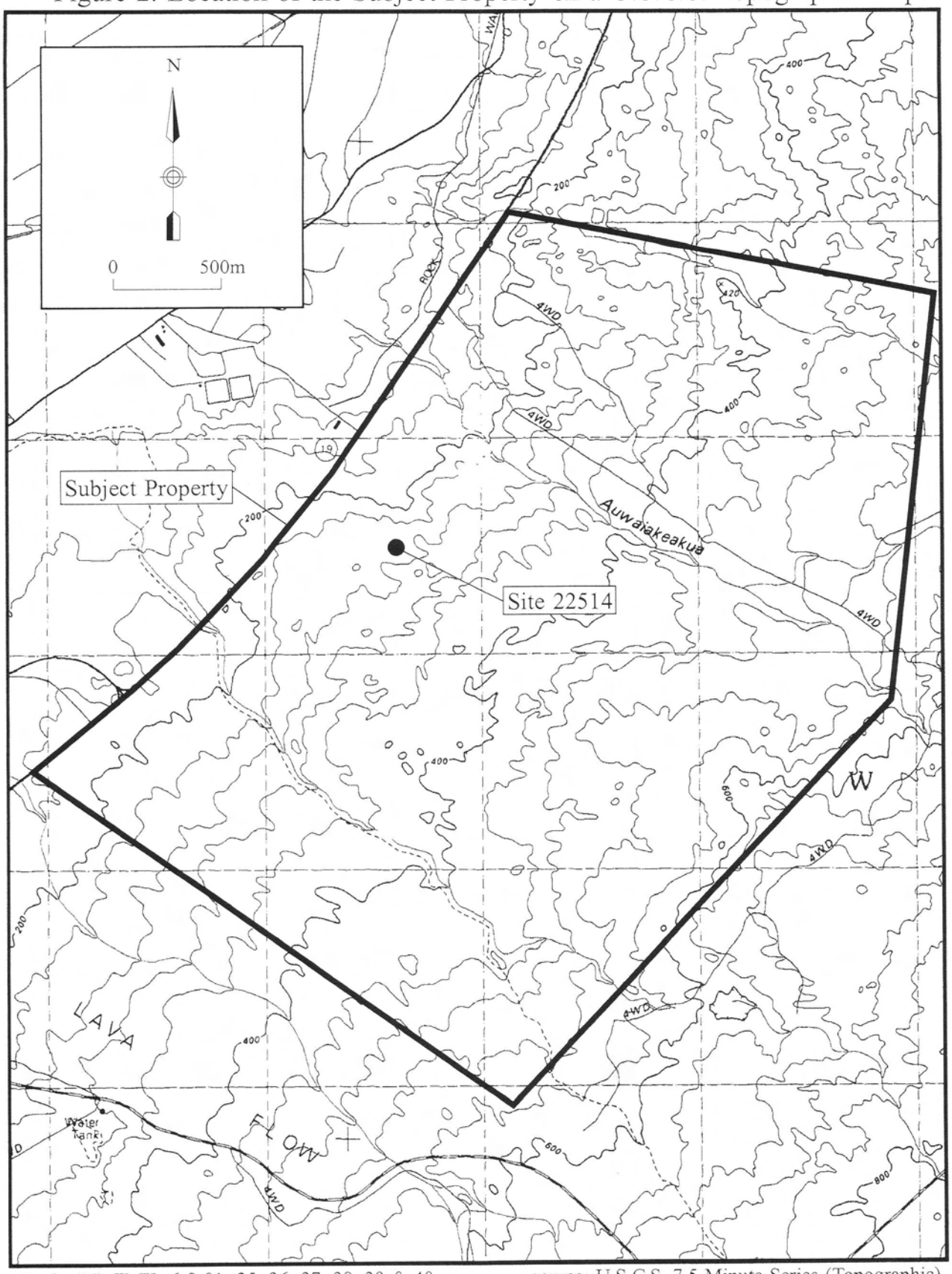
Figure 1: Project Location on a Map of Hawaii



Puako DR TMK: 6-8-01: 25, 36, 37, 38, 39 & 40

After: Spriggs and Tanaka 1988

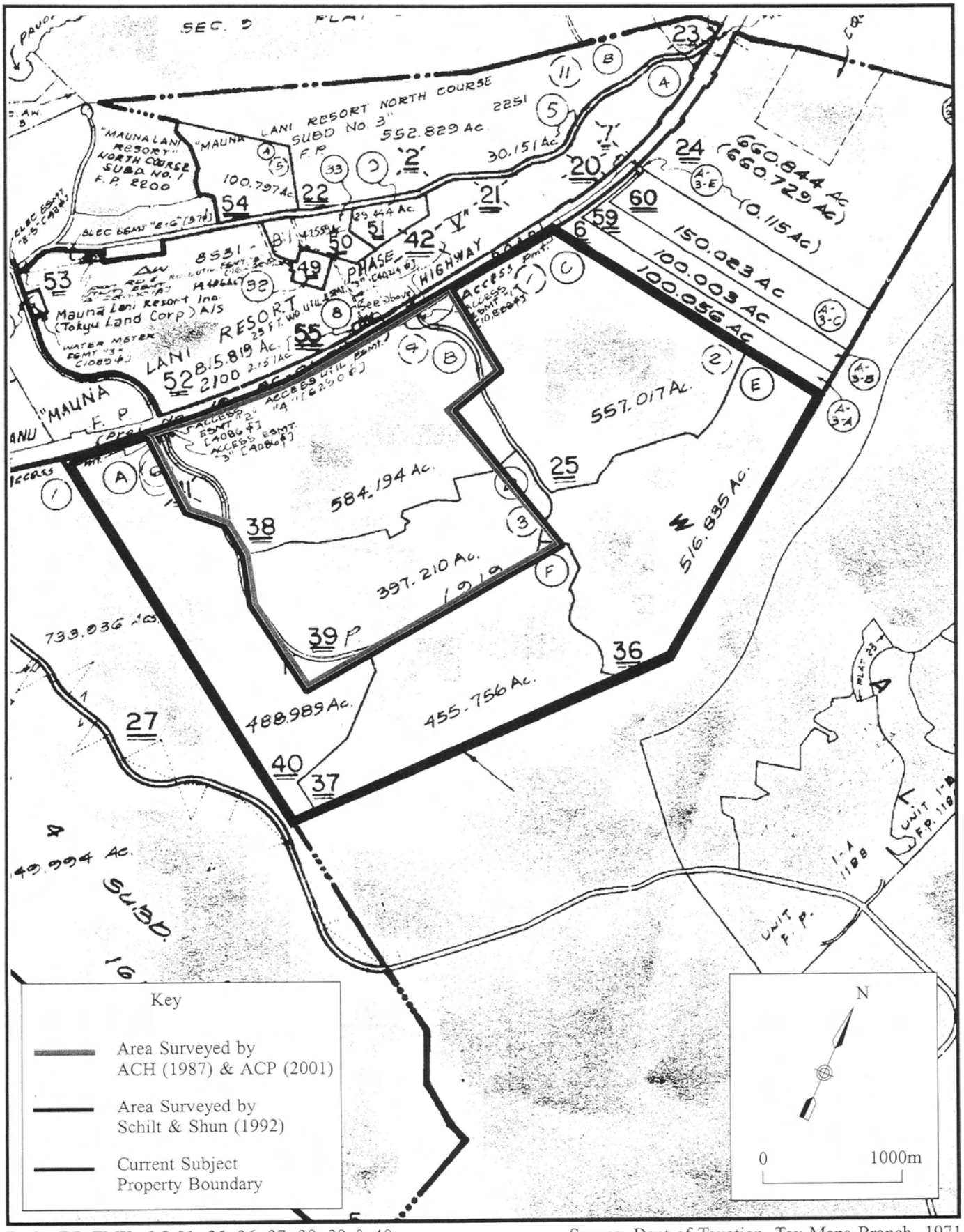
Figure 2: Location of the Subject Property on a U.S.G.S. Topographic Map



Puako DR TMK: 6-8-01: 25, 36, 37, 38, 39 & 40

source: U.S.G.S. 7.5 Minute Series (Topographic)
Puu Hinai 1997

Figure 3: Location of the Subject Property on a TMK Map



Puako DR TMK: 6-8-01: 25, 36, 37, 38, 39 & 40

Source: Dept of Taxation, Tax Maps Branch 1971

Finally, in early 2001, ACP conducted an inventory survey of the 1000 acres which had been the subject of the reconnaissance survey in 1987. A total of ten sites (Sites 22509 through 22518) consisting of thirteen individual features were identified including the previously identified rock shelter, seven C-shaped walls with associated *ahu*, four additional *ahu* (three of which are in close proximity to one another comprising a single site) and a stone covered hearth (Moore, Ostroff & Kennedy 2002). Subsurface testing was conducted at Feature 22514:A, the previously documented rock shelter. Traditional cultural remains were recovered and a sample was collected which was radiocarbon dated to a most probable age of AD 1480.

In conjunction with the previously undertaken investigations, recommendations were made for data recovery at the burial cave (Site 15033) and the rock shelter (Feature 22514:A). However, since the time of the initial recommendation for data recovery at Site 15033 which was made by Schilz & Shun in 1992, the Department of Land and Natural Resources, Burials Program (DLNR-BP) has instituted rules which preclude the testing of sites in which burials are interred. Therefore, the current data recovery investigations took place only at Feature 22514:A. Both Site 15033 and Feature 22514:A were also recommended for preservation, the details of which will be presented in a separate document.

This report presents the results of Data Recovery investigations conducted at Feature 22514:A as well as a discussion of the results in relation to the research questions posed. The execution of the fieldwork called for in the data recovery plan, the production of this report and the future implementation of an approved preservation plan will help mitigate the potential adverse effects of proposed development on the significant historic properties located on the current subject property.

Section 2: Physical Setting

The current subject property includes the areas surveyed by both ACP and OEES comprising a total of approximately 3000 acres. This land is located within lava flows which cross the Waikoloa region. Specifically, the subject property is located adjacent to Queen Ka'ahumanu Highway at an elevation of between 120 and 700 feet (ft) above mean sea level (AMSL) at a distance of between 3000 and 6000 meters (m) from the shore (see Figures 2 & 3). The topography, climate, flora & fauna and expected soils for the area are briefly described below.

Topography

The current subject property consists predominately of relatively recent and substantial Mauna Loa and Mauna Kea lava accumulations of both *a'a* and *pahoehoe*. The dominant slope ranges in inclination from 10 to 15°.

Three separate geological areas are found across the current project parcel. The northern edge of the Kaniku Lava Flow runs across the southwestern portion of the subject property (see Figure 2). Within the project area, the Kaniku Lava Flow consists of a relatively flat expanse of *a'a* sloping gently from southeast to northwest.

Covering a large section across the center of the subject parcel is a flow of very rough *a'a* within which outcroppings of smooth *pahoehoe* and collapsed blister domes are found. This flow is lava from the Laupahoehoe Volcanic Series of Mauna Kea formed roughly 2,500 to 7,500 years ago (MacDonald, Abbott & Peterson 1986:350, 351 & 360-364).

Finally, the area across the northern portion of the subject property is marked by rolling hills formed from Pahala ash during the late Pleistocene epoch (Macdonald *et al.* 1986:349). Pahala ash consists of vitric ash and fragments of pumice which likely derived from eruptions on Mauna Kea. In this area, small amounts of soil have had time to develop allowing some vegetation to become established. A distinct geological feature which crosses the northern portion of the subject property is the Auwaiakeakua (also spelt Auwai-a-ke-kua), which literally translates to "watercourse of the god" (Pukui, Elbert & Mo'okini 1974). This feature consists of a relatively deep gulch which displayed evidence of substantial water flow in the recent past.

Climate

Rainfall in the Waikoloa region averages less than 10 inches per year (Giambelluca, Nullet & Schroeder 1986). The majority of this rain falls between November and March, the wet season. Droughts are a periodic problem in this area (Giambelluca, Nullet, Ridgely, Eyre, Moncur & Price 1991). At Puakō, average temperatures generally range from 66° to 81° F in March and from 73° to 89° F in September (Armstrong 1973:58). Ground surface temperatures in the lava fields are typically higher, often exceeding 130° F (Olson 1983). Relative humidity at Kawaihae, several miles northwest of the current survey parcel is about 48% to 86%.

Flora & Fauna

Vegetation on the subject property consists predominately of widely scattered scrub *kiawe* (*Prosopis pallida*) and occasional tufts of grass such as fountain grass (*Pennisetum setacaeum*) although in the northern portions of the project area the number of *kiawe* trees and grasses increases notably. The arid climate restricts the growth of much vegetation. During the inventory survey conducted by ACP in 2001, occasional individuals of the species *Capparis sandwichciana* were observed in places, these succulents appearing out of place in this harsh environment. This plant is known to have been used by Hawaiians to help heal broken bones and is typically found in coastal locations and within lava flows.

The harsh environment also restricts the fauna found in this region. The droppings of feral goats (*Capra hircus*) were relatively common but no evidence of other amphibian, reptile or mammal species was observed. Avifauna was present across the subject property, although they too were relatively sparse with only occasional birds observed flying over the arid landscape.

Expected Soils

The Soil Survey of the Island of Hawai'i depicts the majority of the current subject property as being covered with *a'a* lava flows (rLV)(Sato, Ikeda, Paeth, Smythe & Takehiro 1973). As described above, the flows actually encountered on the subject property consisted of the Kaniku Lava Flow along the southwestern boundary of the project area and a flow of the Laupahoehoe Series across the center of the property. As would be expected in a dry climate with little or no vegetation, virtually no soils have developed on these flows.

Along the northern portions of the subject parcel on both sides of the Auwaiakeakua is an area of older volcanic deposits and in this area there has been some soil development. Sato *et al.*, depict the expected soils in this area to one of three types: 1) the Kamakoa Series of very fine sandy loam, 2) the Kawaihae Series of extremely stony very fine sandy loam, or 3) the Puu Pa Series of extremely stony very fine sandy loam. Because no subsurface investigations were conducted in this northern portion of the project area during previous investigations, no analyses of the soils present were conducted.

Section 3: Research Design

The current subject property is located in a region within which relatively few archaeological sites are expected to be found because of the rugged *a'a* lava flows which cover the area and the aridity of the environment. Inventory survey investigations, however, were able to identify several sites and features across the property. A number of these were considered recent historic features, not archaeological in nature. There were several features, however, which were determined to be archaeological sites and considered significant historic properties.

Of those significant sites identified on the subject property, two sites/features were recommended for data recovery following inventory survey investigations (Site 15033, a lava tube containing a partial human burial and Feature 22514:A, a rock shelter). However, since the time of the initial recommendation for data recovery at Site 15033 which was made by Schilz & Shun in 1992, the Department of Land and Natural Resources, Burials Program (DLNR-BP) has instituted rules which preclude the testing of sites in which burials are interred. Therefore, data recovery investigations took place only at Feature 22514:A, a rock shelter known to have been utilized for temporary habitation during the pre-Contact Period.

Prior to data recovery investigations a research design was formulated which asked, "How extensive was the utilization of the rock shelter (Feature 22514:A) and did this feature have a function other than temporary habitation?" Investigations were to focus on collecting additional cultural remains through subsurface testing. Through additional subsurface testing it was hoped that evidence would be recovered indicating whether the shelter was used on a recurrent basis or if the feature saw limited utilization. Additionally, ACP had hypothesized that a possible function of the C-shaped features with associated *ahu* found in the area surrounding Feature 22514:A may have been as hunting blinds utilized in the pre-Contact or early post-Contact periods by those in search of avifauna or other potential prey. It is possible that those utilizing the C-shaped feature groups for specific limited activities may have also used Feature 22514:A (perhaps for overnight shelter) and, in the process, deposited potential cultural materials which would shed light on activities that may have taken place at these nearby features.

Section 4: The Methodology of Data Recovery

The current archaeological data recovery investigations were conducted from November 20th through 26th, 2002. All fieldwork was conducted under the direction of the Principal Investigator, Joseph Kennedy, M.A.. Fieldwork was conducted by a two-man field crew consisting of James R. Moore, B.S., and Allan B. Cobb, B.S.. Fieldwork methods consisted entirely of subsurface investigations within Feature 22514:A.

The Data Recovery Plan called for subsurface testing to take the form of the manual excavation of controlled test units. Specifically, it was recommended that a minimum of two 1m by 1m test units be excavated at Feature 22514:A. However, because of the shape of the rock shelter whose back wall was aligned on diagonals in relation to its aperture as well as the presence of areas of exposed *pahoehoe* on the floor of the feature, two square 1m by 1m units were unable to placed within the feature. Therefore, six individual test units of varying size were excavated covering a total area of just over two square meters. The number of and exact locations and orientations of the units excavated took into account the available soil covered surface, the location of the test unit excavated during inventory survey investigations and the portions of the cave floor in which exposed *pahoehoe* bedrock was present.

The first of the units excavated (Test Unit 2) was placed adjoining the south-southeastern side of Test Unit 1 (excavated during the inventory survey) and measured 50 centimeter (cm) by 50cm, square (refer to Section 5, Figures 5, 6 & 7). Because the excavation of Test Unit 1 had revealed the presence of only two thin deposits, the excavation of Test Unit 2 was conducted in controlled 5cm levels in an attempt to discern variations in the material culture within the stratigraphic layers. The second unit excavated (Test Unit 3) was subsequently placed adjoining the south-southeastern side of Test Unit 2 and also measured 50cm by 50cm, square. The excavation of this unit also began in controlled 5cm levels. However, before completing the first level bedrock had been exposed over 50% of the unit. Therefore, the remainder of Layer I, which was found to have a maximum thickness of 12cm only in crevices through the middle and along the western edge of the unit, was removed as a single level.

The next three units excavated (Test Units 4, 5 & 6) varied in size and were placed adjoining Test Units 2 and 3 to the south and east (refer to Section 5 for the exact dimensions and see Figures 5, 6 & 7). In each, Layer I was removed as a single level which never exceeded 12cm in thickness and rested on bedrock. The final unit excavated (Test Unit 7) was placed just to the north-northwest of Test Unit 1 and again measured 50cm by 50cm, square. Layer I was found to measure between 3 and 13cm in thickness and was excavated as a single level.

All subsurface sampling was conducted by manually excavating test units using standard archaeological methods including the screening of all soils using one eighth inch mesh screens in order to retrieve significant cultural deposits. Soil samples were collected from every stratigraphic layer identified, placed in airtight resealable bags and labeled for use in laboratory analyses. Midden and artifacts collected from screened soils were similarly bagged. Samples collected for radiocarbon dating were gathered, without coming into contact with human skin, wrapped in aluminum foil and sealed in a labeled airtight resealable bag. All cultural materials recovered were delivered to ACP facilities, 59-624 Pupukea Rd., Haleiwa, HI, for laboratory analyses.

Following the fieldwork phase of investigations, laboratory analyses covered a range of diagnostic endeavors. All vertebrate faunal remains were identified by Dr. Alan Ziegler to the species level, as possible, with the results being tabulated and presented by provenience and weight. Marine shellfish remains were similarly treated with the samples being identified by ACP personnel to the genus level, as possible. Artifacts were sorted by type, counted and measured with selected items photographed or illustrated and the results tabulated for presentation by provenience. Only one datable sample of sufficient size was recovered and sent to Beta Analytic, Inc. for radiocarbon dating analysis.

All materials collected during test excavations will be bagged and labeled appropriately, placed in labeled and inventoried boxes, and curated at ACP facilities located at 59-624 Pupukea Rd., Haleiwa, HI..

Section 5: Archaeological Findings

Section 5.1: Description of Site 22514

Site 22514 was initially identified by ACH in 1987 and further documented by ACP in 2002. This site consists of a pair of features, a rock shelter and a C-shaped wall with associated *ahu*, located in close proximity to one another within the mixed *a'a* and *pahoehoe* flow which crosses the center of the subject property (see Figure 2). The C-shaped wall with associated *ahu* is located just above the rock shelter on the surface of the *pahoehoe* dome that covers the shelter. Both features will be described below although only Feature 22514:A, the rock shelter, was recommended for data recovery.

Feature 22514:A

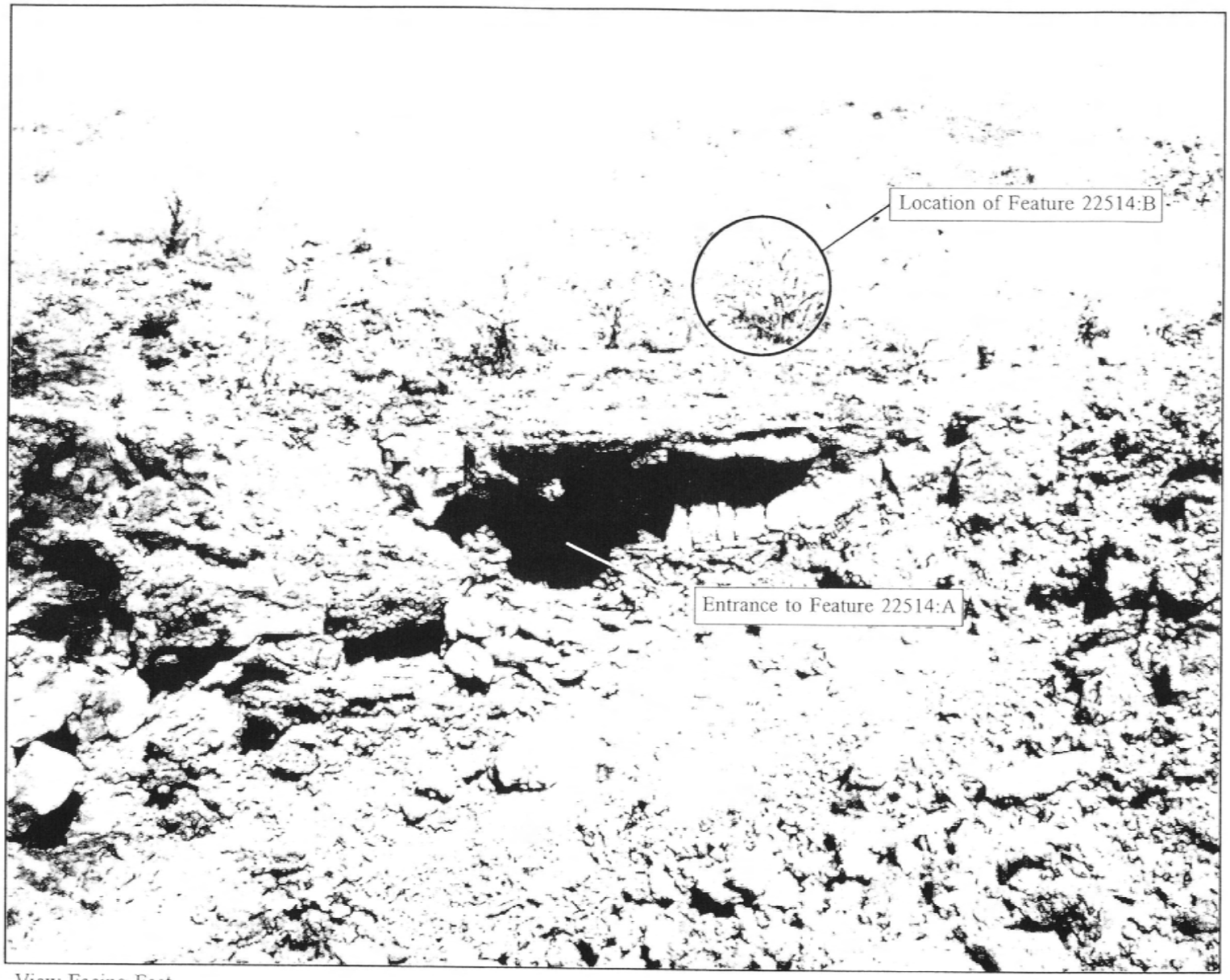
Feature 22514:A consists of a rock shelter located along the northeastern wall of rather large depression in the *a'a* flow (approximately 100m in length by 50m in width) beneath the edge of an elongated *pahoehoe* dome. The aperture to the rock shelter has been partially sealed with walls constructed of slabs of angular basalt. The walls extend from both ends of the aperture leaving a 1.5m wide opening in the center as an entrance (see Figure 4). Both walls had been constructed from angular basalt slabs (15 to 20cm thick each and reaching up to 70cm above ground level [AGL]) stacked horizontally which supported slabs of basalt stacked vertically to seal the aperture of the rock shelter. The wall at the southeastern end of the feature is intact with vertical slabs still in place but the wall at the northwestern end of the shelter is deteriorated with its vertical slabs fallen. The shelter opens to the southwest protecting it from the sun for most of the day as well as from the prevailing northeasterly winds. It was noticeably cooler in the shelter than in the depression outside the shelter.

The rock shelter measured approximately 9.6m in length and was 3.2m deep in the center (see Figure 5). In the entranceway to the shelter the ceiling is at a height of 1.3m while at the back of the shelter it tapers to ground level. The ceiling also tapers to ground level at both ends of the shelter leaving an area measuring approximately 5.5m by 2.75m of usable living space.

Feature 22514:B

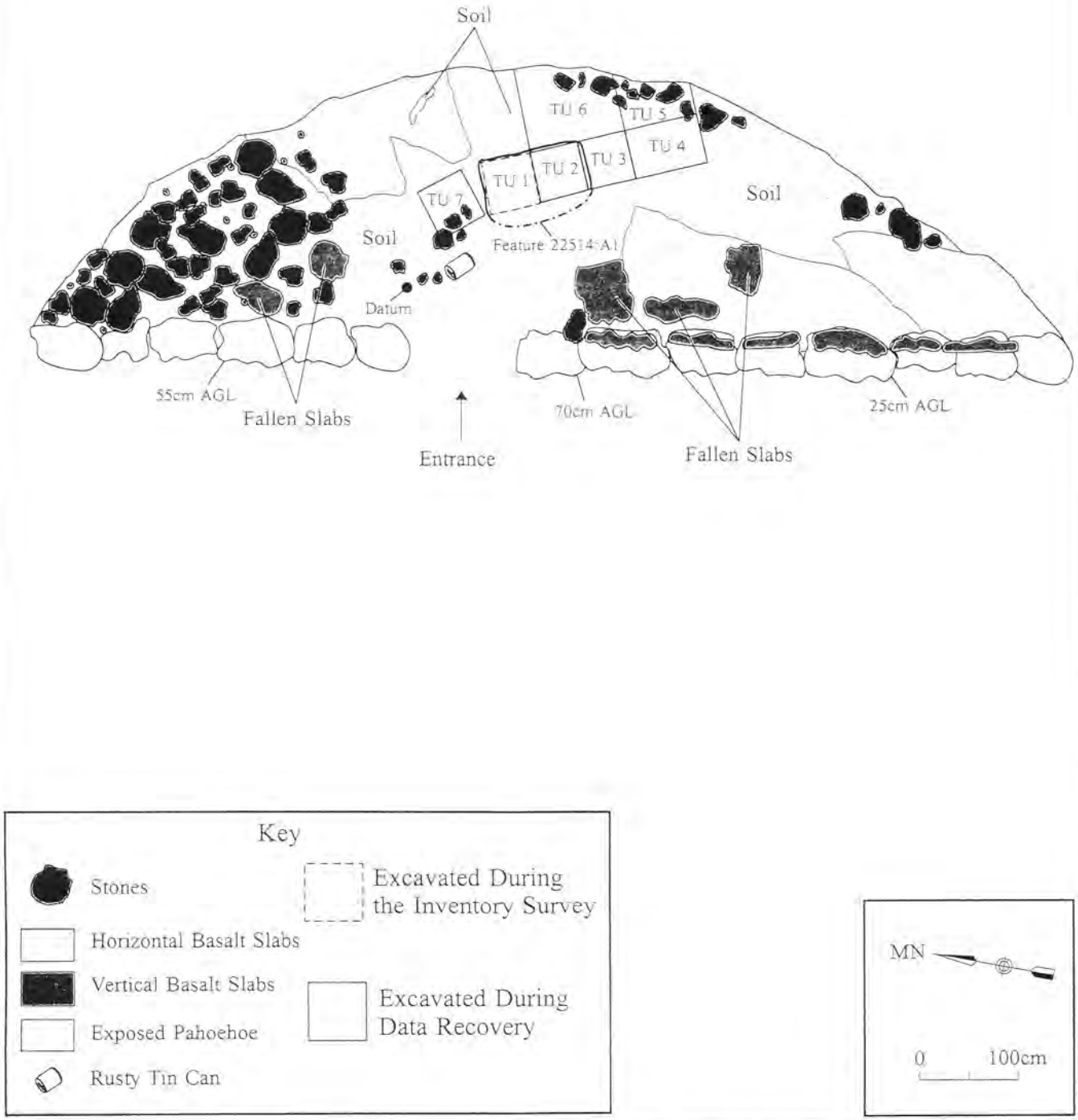
Located on the *pahoehoe* dome above Feature 22514:A is a C-shaped wall with an associated *ahu*. Kennedy (1987) had documented the presence of an *ahu* but by 2002 it was no longer intact. However, the number of stones scattered in the vicinity was equivalent to that observed in the intact *ahu* of other sites found on the subject property. The C-shaped wall measured 2.8m in length and stood at a height of 70 to 80cm AGL. At Feature 22514:B, the C-shaped wall was little more than a curved line, not nearly as "C" shaped as had been observed at other sites identified on the subject property. The presence of Feature 22514:B, a feature type believed to have been utilized as a temporary habitation, in such close proximity to the rock shelter, Feature 22514:A (also believed to have been utilized as a temporary habitation) implies that the two features may not have been utilized contemporaneously or that they may have had different functions.

Figure 4: Photograph of Site 22514



View Facing East

Figure 5: Plan View of the Interior of Feature 22514:A with Test Unit Locations



Section 5.2: Excavation Results

Inventory Survey

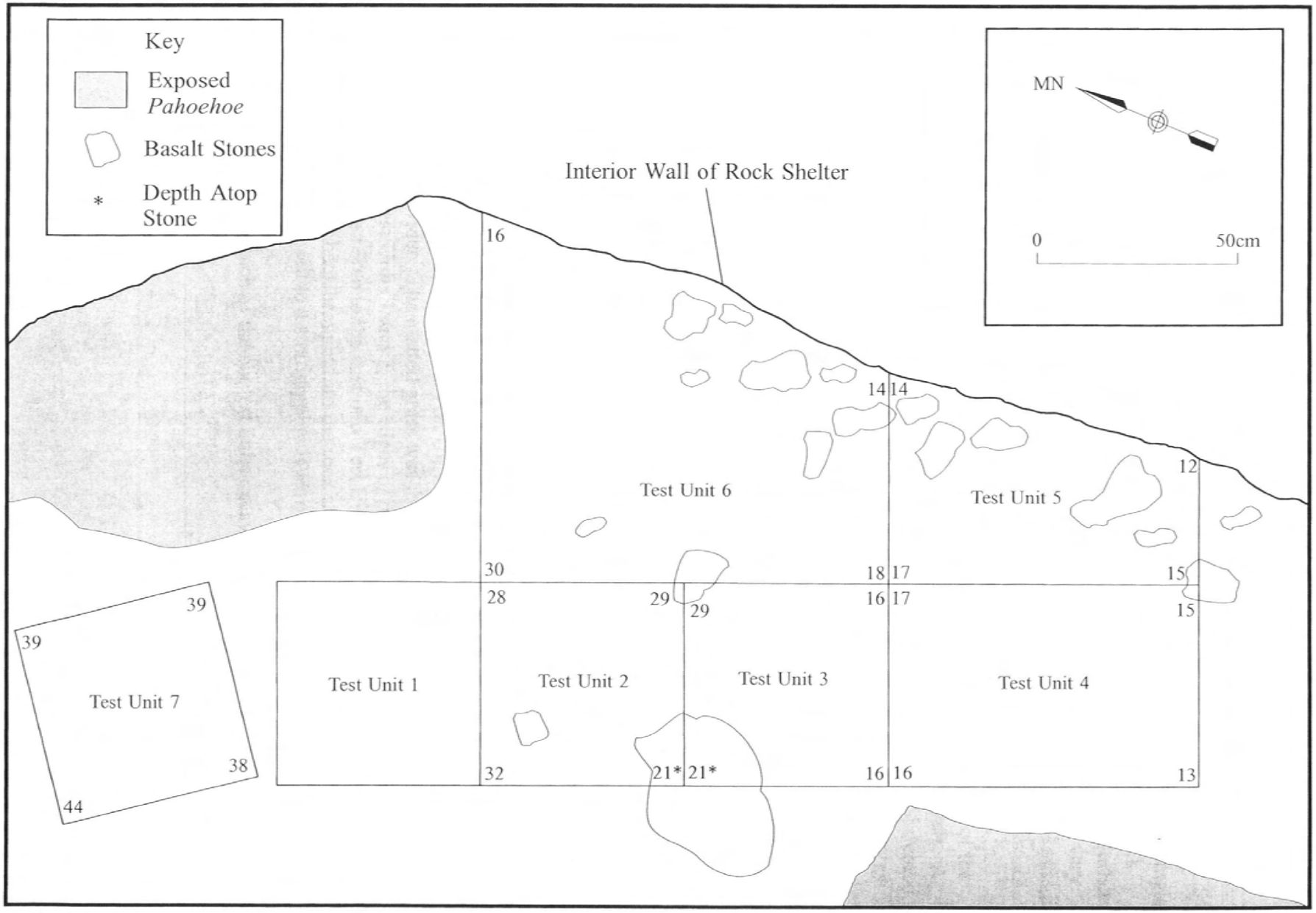
A variety of culturally deposited material was recovered as part of a surface collection of the interior of Feature 22514:A during the inventory survey including faunal remains, a water worn stone which was a manuport (and possibly used as a hammerstone) and an adze preform of medium to fine grained basalt that was clearly a manuport as well (Moore *et al.* 2002). While the adze preform was rather crude in nature, it was clearly reduced on all surfaces and was approaching rectangular in shape having past the stage of manufacture at which it would have been considered a blank rather than a preform. In addition to the surface collection, subsurface testing was conducted which consisted of a manually excavated test unit (Test Unit 1) placed in the center of the floor of the shelter. The excavation of Test Unit 1 encountered two distinct strata designated Layers I and II. Layer I consisted of a deposit of brown to dark brown (10YR 4/3) stony, fine silt loam which measured between 5 and 7cm in thickness. Layer I yielded a range of culturally deposited materials including a gourd fragment, fish scales, a variety of bird remains, remains of the Polynesian rat (*Rattus exulans*), mouse remains (*Mus musculus*), *opihi* shell remains (*Cellana* sp.), echinoderm fragments and a flake of volcanic glass. Underlying Layer I a deposit of partially decomposed, matted floral remains (Layer II - subsequently designated Feature 22514:A1) was encountered which rested on bedrock and measured up to 4cm in thickness reaching a maximum depth of 9cmbs. No cultural materials were recovered from this deposit. The decomposing floral material was hypothesized to be the remains of some kind of mat laid on the bedrock floor of the rock shelter during one of the feature's early episodes of utilization. A sample of this material was sent for radiometric analysis and determined to date to most probable calibrated age range of AD 1448 to 1524 at one σ (1428 to 1653 at two σ)(as calibrated utilizing the University of Washington, Quaternary Isotope Lab's Radiocarbon Calibration Program Ver. 3.0.3) or an age of AD 1480 based upon intercept data provided by Beta Analytic, Inc. (Beta Lab # 147050; refer to Table 3 & Appendix B).

The findings from inventory survey investigations at Feature 22514:A determined that the rock shelter was likely utilized as a temporary habitation in the pre-Contact Period. Activities which occurred at the feature included the consumption of meals which included food items which were brought to the rock shelter from the coast. The small number of tools recovered were likely associated with the preparation of meals. The presence of a tin can indicated that the feature had continued to be visited in the post-Contact Period.

Data Recovery

Subsurface testing conducted for data recovery covered over eight times the areal extent of inventory survey excavations. In beginning the data recovery investigations, a datum was established to the northwest of the location of Test Unit 1 (see Figure 5). This datum was utilized for all six of the test units excavated (Test Units 2-7). Prior to the excavation of each unit, the surface depths of the corners of the units were measured from the fixed datum (see Figure 6). This figure reveals that the surface of the floor of the rock shelter sloped gradually from southeast to northwest.

Figure 6: Plan View Depicting the Surface of Layer I Prior to Excavation (depths in cm below datum)



Following the recordation of surface corner depths, each of the units was excavated individually. These excavations revealed that over most of the floor of Feature 22514:A a single deposit (Layer I) of brown to dark brown (10YR 4/3) stony, fine silt loam was present which rested on bedrock. Following the excavation of each unit, the depths below datum of the corners of the units at the base of excavation were measured (see Figure 7). Layer I was found to vary from less than 1cm in thickness in the southwestern corner of Test Unit 4 to 13cm in thickness in the southwestern corner of Test Unit 7.

In Test Unit 2, however, the stratigraphy became more complex. Being the first of the test units excavated, the excavation of Test Unit 2 was conducted in controlled 5cm levels. At the base of the second level excavated (Layer I, level 2) at a depth of between 37 and 38.5cmbd, the matted floral material, which had been encountered in Test Unit 1 during inventory survey investigations, was encountered. As the excavation of Test Unit 2 continued, the matted floral material was found to measure approximately 10cm in thickness reaching a depth of 48cmbd. Underlying the matted floral material additional deposits of the stony, fine silt loam which make up Layer I were encountered which extended to depths of up to 68cmbd. Because the deposits of stony, fine silt loam were separated by the matted floral material they have been designated Layers Ia and Ib.

Test Unit 2 was the only unit excavated in which deposits were more than 13cm in thickness. This is due to ridges of *pahoehoe* which run along the floor of the rock shelter. A photograph of the floor of the feature following the excavation of all test units clearly shows one ridge extending just to the northern edge of Test Unit 3 (see Figure 8).

The data recovery investigations also revealed that the decomposing floral material consisted of matted grasses and was not the remains of an actual mat. The matted grass covered an area approximately 105cm in length by at least 50cm in width (see Figure 5). Because excavations did not extend to the west of Test Units 1 and 2 it is possible that the extent of this material is somewhat wider. The matted grass was found primarily in Test Units 1 and 2. Beyond the limits of Test Units 1 and 2, the edges of this material extended only 5cm to the south into Test Unit 3 and 3cm to the east into Test Unit 6. Because the grasses covered a limited area and they had been brought into the rock shelter purposefully they are considered a subsurface feature as opposed to a stratigraphic layer or lens and designated Feature 22514:A1.

The findings from each of the six test units excavated during data recovery are presented below.

Figure 8: Photograph of the Interior of Feature 22514:A Following the Excavation of Test Units 2-7

View Facing South-southeast

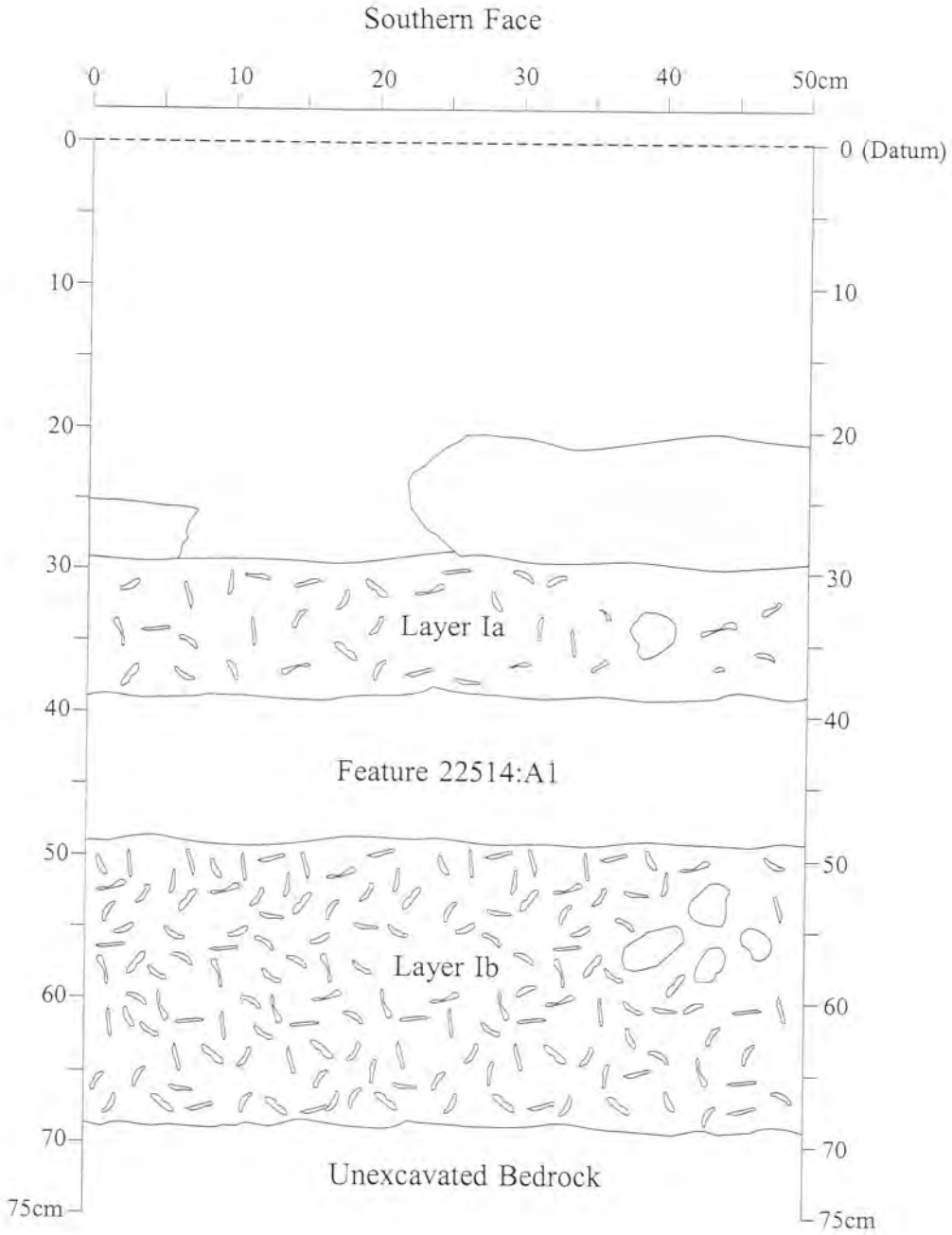
Test Unit 2 (TU 2): Test Unit 2 was placed adjoining the south-southeastern side of Test Unit 1 and measured 50cm by 50cm, square (see Figures 5 & 6). Excavation encountered a deposit (Layer Ia) of brown to dark brown (10YR 4/3) stony, fine silt loam which measured between 8 and 10cm in thickness reaching a maximum depth of 38.5cmbd (see Figure 9). At the base of Layer Ia excavation encountered several exposed stones and a deposit of matted grasses now designated Feature 22514:A1 (originally designated Layer II during the inventory survey)(see Figure 10). The matted grasses of Feature 22514:A1 measured 9 to 10cm in thickness and reached a maximum depth of 48cmbd. Feature 22514:A1 rested on a deposit (Layer Ib) of grayish brown (10YR 5/2) very stony, fine silt loam which reached bedrock at depths of from 53 to 68cmbd.

A variety of culturally deposited materials were recovered during the excavation of Test Unit 2 (refer to Tables 1 & 2). Layer Ia yielded the remains of several seabirds (including *Bulweria bulwerii*, *Oceanodroma castro*, indeterminate medium sized procellariid and indeterminate small to medium sized birds), the Polynesian rat (*Rattus exulans*), the house mouse (*Mus musculus*), an indeterminate small to medium sized vertebrate, an *opihi* shell fragment (*Cellana* sp.), coral and a *kukui* nut shell fragment. Feature 22514:A1 also yielded the remains of seabirds (*Bulweria bulwerii*, *Oceanodroma castro*, indeterminate medium sized procellariid and indeterminate small to medium sized birds), the Polynesian rat (*Rattus exulans*), an indeterminate small sized vertebrate, an *opihi* shell fragment (*Cellana* sp.) and echinoderm remains. Finally, Layer Ib yielded indeterminate fish remains, the remains of seabirds (*Bulweria bulwerii*, *Oceanodroma castro* and indeterminate small to medium sized bird remains), the hoary bat (*Lasiurus cinereus*), the Polynesian rat (*Rattus exulans*), several species of marine shell (*Cellana* sp., *Hipponix* sp., *Cypraea* sp. and a small amount of unidentified marine shell), echinoderm and crustacean. It is interesting to note that the amount of marine remains recovered from Layer Ib, although not great in quantity, noticeably increased.

In addition to the faunal and floral remains recovered, three traditionally modified artifacts were recovered. An echinoderm spine abrader with one worn surface (Artifact #PKO-006) was recovered from Layer Ib, level 1 while Layer Ib, level 2 yielded a second echinoderm spine abrader with one worn surface (Artifact #PKO-007) and a vesicular basalt grinding stone with one ground surface (Artifact #PKO-008)(refer to Table 1).

During the excavation of Layer Ib, level 1, an *in situ* sample of charcoal was encountered at a depth of 51cmbd. This charcoal sample was collected and subsequently sent to Beta Analytic, Inc. for radiometric analysis (Beta Lab # 173721). The results of the radiocarbon dating yielded a most probable age range of AD 1287 to 1452 (at two σ; calibrated utilizing the University of Washington, Quaternary Isotope Lab's Radiocarbon Calibration Program Ver. 3.0.3; refer to Table 3 & Appendix B) or an age of AD 1410 based upon intercept data provided by Beta Analytic, Inc. (please note that calibrations prepared by Beta Analytic, Inc. which vary slightly from those obtained from U of W's program are also presented in Appendix B).

Figure 9: Profile of Test Unit 2 (Feature 22514:A)



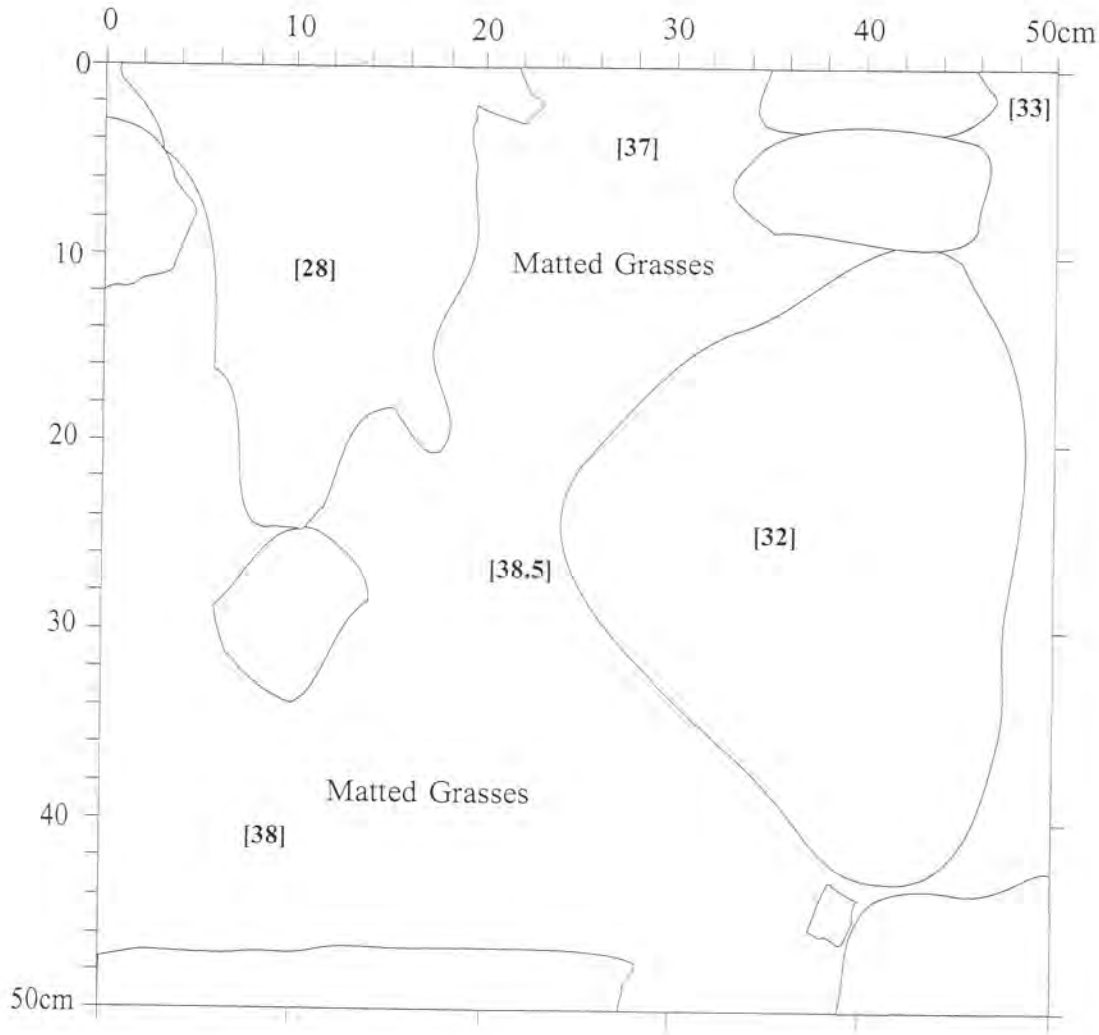
Key

Stone

Layer Ia: Brown to dark brown (10YR 4/3) stony, fine silt loam

Layer Ib: Grayish brown (10YR 5/2) very stony, fine silt loam

Figure 10: Test Unit 2; Plan View at the Base of Layer I



Key

Exposed Stone

[28] Centimeters Below Datum

Test Unit 3 (TU 3): Test Unit 3 was placed adjoining the south-southeastern side of Test Unit 2 and measured 50cm by 50cm, square (see Figures 5 & 6). Excavation encountered a deposit (Layer I) of brown to dark brown (10YR 4/3) stony, fine silt loam which measured between 8 and 12cm in thickness and rested on bedrock. TU 3 reached a maximum depth of 39cmbd in a small crevice in the northeastern corner of the unit (see Figures 7 & 8).

A small amount of culturally deposited materials were recovered from Test Unit 3 (refer to Tables 1 & 2). Faunal materials recovered included the remains of seabirds (*Bulweria bulwerii*, *Oceanodroma castro*, indeterminate medium sized procellariid and indeterminate small to medium sized birds), the Polynesian rat (*Rattus exulans*) and several pieces of echinoderm. Artifactual material recovered consisted of an echinoderm spine abrader with one worn surface (Artifact #PKO-009) and a second echinoderm spine with one possibly worn surface representing a possible abrader (Artifact #PKO-010).

Test Unit 4 (TU 4): Test Unit 4 was placed adjoining the south-southeastern side of Test Unit 3 and measured 75cm in length by 50cm in width (see Figures 5 & 6). Excavation encountered a deposit (Layer I) of brown to dark brown (10YR 4/3) stony, fine silt loam which measured between 0 and 12cm in thickness and rested on bedrock. TU 4 reached a maximum depth of 28cmbd in the northwestern corner of the unit (see Figure 7).

A small amount of culturally deposited materials were recovered from Test Unit 4 (refer to Tables 1 & 2). Faunal materials recovered included the remains of seabirds (*Bulweria bulwerii*, *Oceanodroma castro*, indeterminate medium sized procellariid and indeterminate small to medium sized birds), the hoary bat (*Lasiurus cinereus*), the Polynesian rat (*Rattus exulans*) and a small amount of echinoderm. No artifacts or potential artifactual material was recovered from TU 4.

Test Unit 5 (TU 5): Test Unit 5 was placed adjoining the eastern side of Test Unit 4 and measured 75cm in length by 30 to 50cm in width (see Figures 5 & 6). Excavation encountered a deposit (Layer I) of brown to dark brown (10YR 4/3) stony, fine silt loam which measured between 8 and 12cm in thickness and rested on bedrock. TU 5 reached a maximum depth of 26cmbd in the northwestern corner of the unit (see Figure 7).

A variety of culturally deposited materials were recovered from Test Unit 5 (refer to Tables 1 & 2). Faunal materials recovered included indeterminate fish remains, the remains of seabirds (*Bulweria bulwerii*, *Oceanodroma castro*, indeterminate medium sized procellariid and indeterminate small to medium sized birds), the Polynesian rat (*Rattus exulans*), the house mouse (*Mus musculus*), an indeterminate small to medium sized vertebrate, a small amount of echinoderm, coral and *kukui* nut shell fragments. Artifactual material recovered was limited to a single gourd fragment (Artifact #PKO-011) considered a manuport.

Test Unit 6 (TU 6): Test Unit 6 was placed adjoining the eastern side of Test Units 2 & 3 and measured 100cm in length by 50 to 90cm in width, the largest unit excavated (see Figures 5 & 6). Excavation encountered a deposit (Layer I) of brown to dark brown (10YR 4/3) stony, fine silt loam which measured between 7 and 12cm in thickness and rested on bedrock. TU 6 reached a maximum depth of 42cmbd in the northwestern corner of the unit (see Figure 7).

A variety of culturally deposited materials were recovered from Test Unit 6 (refer to Tables 1 & 2). Faunal materials recovered included indeterminate fish remains, the remains of seabirds (*Bulweria bulwerii*, *Pterodroma phaeopygia*, *Oceanodroma castro*, *Phaethon lepturus*, indeterminate medium sized procellariid, indeterminate small passeriform and indeterminate small to medium sized birds), the Polynesian rat (*Rattus exulans*), a small amount of echinoderm, a fragment of *Cypraea* sp. and *kukui* nut shell fragments. Artifactual material recovered was limited to a single gourd fragment (Artifact #PKO-012) considered a manuport.

Test Unit 7 (TU 7): Test Unit 7 was placed immediately to the north-northwest of Test Unit 1 and measured 50cm by 50cm, square (see Figures 5 & 6). Excavation encountered a deposit (Layer I) of brown to dark brown (10YR 4/3) stony, fine silt loam which measured between 3 and 13cm in thickness and rested on bedrock. TU 7 reached a maximum depth of 51cmbd in three of the four corners of the unit (see Figure 7).

A small amount of culturally deposited materials were recovered from Test Unit 7 (refer to Tables 1 & 2). Faunal materials recovered included the remains of seabirds (*Bulweria bulwerii*, *Oceanodroma castro*, *Phaethon lepturus*, indeterminate medium sized procellariid and indeterminate small to medium sized birds), a small amount of echinoderm and small amounts of marine shell (*Cellana* sp. and *Hipponix* sp.). Artifactual material recovered was limited to a piece of volcanic glass (Artifact #PKO-013) with retouched edges and evidence of use wear. This item was likely utilized as a cutting tool.

Section 6: Discussion

Previous investigations conducted in the Puakō/Waikoloa area (i.e. in the vicinity the current subject property) have documented evidence which indicates that the interior lava fields of South Kohala were utilized for the production of basalt abraders and that a variety of feature types could be found associated with the lithic production industry (Walker & Rosendahl 1986; Landrum, Reinman & Schilz 1992 and Landrum & Williams 1994). During inventory survey investigations conducted on the current subject property several sites and features were identified. A number of these were considered recent historic features, not archaeological in nature, while several features were determined to be archaeological sites utilized as temporary habitations. However, the possibility that these features were utilized by those coming to the area to exploit lithic resources was not supported due to the absence of quarry sites in proximity to the features identified.

This information raised questions regarding the presence of temporary habitations in the harsh environment found on the lava flow which crosses the middle portions of the subject property. If those utilizing these features were not coming to the area to exploit lithic resources, why were they coming here? It could be suggested that these features were utilized by those traveling through the region, between coastal habitation sites and upland agricultural lands. If so, why did they choose to travel through the rough terrain that is found across the center of the current subject property rather than traveling across the area immediately to the north of the Auwaiakeakua (approximately 1000m to the north), the area where the Puakō-Ke'amuku Trail is believed to have passed? In the area to the north of the Auwaiakeakua one can travel a mile in a matter of minutes. On the other hand, when crossing the terrain found across the center of the current subject property, traveling a mile can take hours, not minutes.

An alternative hypothesis is that those utilizing the temporary habitations came to exploit a resource within this area not available elsewhere in the region such as a medicinal plant or avifauna which lived in the exposed lava fields. Inventory survey investigations at Feature 22514:A found evidence in the form of the remains of seabirds which suggested this may be the case.

All of the sites determined to represent temporary habitations were found atop exposed *pahoehoe* domes where no soil deposits exist, precluding subsurface testing, except the rock shelter (Feature 22514:A). Therefore, the research design for data recovery targeted this rock shelter. Specifically, the research design asked, "How extensive was the utilization of the rock shelter (Feature 22514:A) and did this feature have a function other than temporary habitation?"

Subsurface testing conducted during data recovery was successful in recovering additional culturally deposited materials. Excavations revealed that only a thin layer of soil existed over the majority of the floor of the rock shelter. This soil rested on *pahoehoe* bedrock which formed ridges with small crevices sloping from southeast to northwest (see Figures 7 & 8). Only one location near the center of the rock shelter contained deeper deposits in a spot where a

ridge of *pahoehoe* abruptly ends (ie. the location where Test Unit 2 happened to be placed). Excavations also encountered a deposit of matted grasses which covered a small area in the center of the rock shelter. It was determined that this material had been purposefully brought into the structure and placed in the center of the floor and was therefore considered a subsurface feature (22514:A1).

The amount of artifactual material recovered was relatively sparse with a total of 12 artifacts being recovered during both the inventory survey and data recovery (refer to Table 1). Artifacts included three items of basalt (two of which were medium to fine grained and could not have originated on the lava flow which crosses the current subject property), several echinoderm spine abraders, two volcanic glass tools and three fragments of gourd.

This assemblage of artifacts represents a range of potential activities which likely took place at this feature. The basalt adze preform, the basalt grinding stone and the echinoderm spine abraders indicate that some tool manufacture and/or repair took place at the rock shelter. The presence of both the grinding stone (generally used for rough or crude grinding applications) and abraders (used for finer polishing applications) implies that more than one stage of tool manufacture may have been occurring or that more than one type of tool manufacturing activity was occurring at the feature. Artifacts that were likely utilized in association with food preparation are represented by the volcanic glass cutting tools. It is likely that the water worn basalt manuport/possible hammerstone was associated with either stone tool manufacture or with the unique end-breakage observed on many of the bird bones recovered (discussed further below). Finally, the gourd fragments likely represent the remains of containers used to carry water to and/or store water at the site. There is no known source of water in the immediate vicinity of the site.

An analysis of the remaining culturally deposited materials reveals that seabirds dominate the faunal assemblage. In fact, based solely on his identification of the material in the faunal assemblage, Dr. Ziegler stated, "... it appears that essentially the sole reason for people occupying ... (Feature 22514:A) ... was for the preparation and consumption of seabirds ..., presumably all taken nearby" (refer to Appendix C for Dr. Ziegler's complete comments). Dr. Ziegler also noted that many of the bird bones displayed evidence of "end breakage", where "... the <u>terminal</u> several millimeters of one or both ends of at least the major limb bones are broken off ...". Dr. Ziegler attributes the "end breakage" to, "... a pre-cooking butchering technique, in which the major bones of the present birds' skeletons were roughly separated at the joints utilizing, probably, a basalt fragment or other lithic implement ...".

Another observation made by Dr. Ziegler was the absence of immature individuals in the seabird bone assemblage. Dr. Ziegler hypothesized that "... the collectors either were not raiding active rookeries to obtain them or, if they were, any young birds also taken were not eaten at the areas excavated". This would be consistent with traditional Hawaiian *kapu* practices regarding hunting, fishing and gathering, etc..

Several additional pieces of information are able to be discerned from the faunal assemblage recovered. The overwhelming majority of the faunal remains are derived from

species found in Hawai'i in the pre-Contact period. The only post-Contact introduction represented consists of a very small amount of house mouse remains which were recovered from the upper few centimeters of the deposits in two units representing an individual(s) who likely died naturally and were not deposited culturally.

Likewise, the small amount of bat remains recovered is not believed to be due to their utilization as a food source. Rather they are the result of the natural deaths of the animals here. Because it is unlikely that bats and humans would occupy the rock shelter contemporaneously, the presence of bat remains embedded within Layer Ib and beneath Feature 22514:A1 (formerly designated Layer II) implies that there were periods of time after the initial use of the shelter and prior to the deposition of the matted grasses during which the rock shelter was not in use by Hawaiians.

Finally, there was a noticeable increase in the quantity and diversity of marine shellfish remains and a corresponding decrease in seabird remains in Layer Ib deposits, underlying the matted floral material (Feature 22514:A1/Layer II) in Test Unit 2 (refer to Table 2). This implies that during the early utilization of the rock shelter a wider diversity of faunal species were being consumed and that over time those occupying the feature became more selective favoring seabirds for consumption.

The information presented in Section 5 and summarized above provides additional evidence concerning the utilization of Feature 22514:A. Radiometric dating analysis of a sample obtained from Test Unit 2, Layer Ib (stratigraphically underlying the matted grasses of Feature 22514:A1/Layer II) indicates that the rock shelter was initially utilized as early as the mid-1300's to early 1400's (AD)(refer to Table 3). The utilization of the feature was not limited to a single one-time use but consisted of recurrent use over an extended period of time. The two radiocarbon age ranges obtained had no area of overlap at 1σ and only a narrow range of overlap at 2σ according to calibrations conducted by Beta Analytic, Inc. and ACP (ACP's calibration utilized the University of Washington, Quaternary Isotope Lab's Radiocarbon Calibration Program Ver. 3.0.3; refer to Appendix B).

The cultural materials recovered indicate that a variety of activities took place at Feature 22514:A. Faunal remains indicate that one of the activities occurring consisted of the preparation and consumption of meals. Meals consumed early in the utilization included a wider range of marine fauna than those consumed in later episodes of use when seabirds dominated the faunal assemblage. The prevalence of seabirds in the faunal assemblage led Dr. Ziegler to state the rock shelter was "occupied by people while primarily carrying out the traditional Hawaiian practice of harvesting seabirds" (refer to Appendix C).

Indications that tool manufacture likely took place at the feature derive from the recovery of the grinding stone and basalt preform. The presence of these artifacts as well as the echinoderm spine abraders implies that more than one stage of tool manufacture was likely occurring or that more than one type of tool manufacturing activity was occurring at the feature.

The recovery of *kukui* nut shell fragments implies that the extraction of *kukui* nut oil may have been taking place. One of the uses of *kukui* nut oil is as a fuel for a lamp. Gourd fragments were also present which likely represent the remains of containers used to transport and/or store water by those utilizing Feature 22514:A. Together these two pieces of information imply that overnight stays may have occurred at the rock shelter.

Summarizing, Feature 22514:A consists of a rock shelter utilized as a temporary habitation in the pre-Contact period. Utilization was on a recurrent basis with utilization occurring over an extended period beginning as early as the AD 1300's and possibly continuing into the post-Contact period. There is also evidence that indicates that there were periods of time during which the rock shelter was not in use. Activities which occurred at the feature included the consumption of meals, the use and/or manufacture of tools and over night stays. The primary utilization of the rock shelter appears to have been associated with the harvesting of seabirds. This fact lends support to the hypothesis that the nearby sites which consist of C-shaped walls with associated *ahu* were utilized as hunting blinds by those harvesting these birds.

Conclusion

Archaeological data recovery investigations have been conducted on a property located in Waikoloa Ahupua'a, district of South Kohala, Island of Hawai'i. Data recovery targeted a rock shelter (Feature 22514:A) found within a rugged mixed *a'a* and *pahoehoe* lava flow which crosses the center of the project area. Investigations took the form of six manually excavated test units which recovered a variety of culturally deposited materials.

This report presents the results of Data Recovery investigations conducted at Feature 22514:A as well as a discussion of the results in relation to the research questions posed. The execution of the fieldwork called for in the data recovery plan, the production of this report and the future implementation of an approved preservation plan will help mitigate the potential adverse effects of proposed development on the significant historic properties located on the current subject property.

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APPENDIX A

Tables

Table 1: Artifact Accession List

Artifact #	Feature	Provenience	Layer	Depth	Material	Object	Weight (g)	Size (cm)			Count	Description
								Length	Width	Thickness		
Inventory Survey				(cmbs)								
PKO-002	22514:A	Surface Collection	NA	NA	Basalt	Adze Preform	580	17.0	6.5	4.5	1	Manuport with distinct evidence of modification
PKO-003	22514:A	Surface Collection	NA	NA	Basalt	Manuport	670	10.5	9.0	7.0	1	Water worn w/ breakage at one end (possible hammerstone?)
PKO-004	22514:A	Test Unit 1	I	0 - 7	Volcanic Glass	Flake Tool	0.3	1.7	0.7	0.2	1	Probable use wear on cutting edge
PKO-005	22514:A	Test Unit 1	I	0 - 7	Floral	Gourd Fragment	2.0	3.6	3.3	0.5	1	Manuport
Data Recovery				(cmbd)								
PKO-006	22514:A	Test Unit 2	Ib/1	48-53	Echinoderm	Abrader	0.1	1.5	0.8	0.2	1	*Wana* spine w/one worn surface
PKO-007	22514:A	Test Unit 2	Ib/2	53-58	Echinoderm	Abrader	0.6	3.6	0.8	0.4	1	*Wana* spine w/one worn surface
PKO-008	22514:A	Test Unit 2	Ib/2	53-58	Basalt	Grinding Stone	590.1	18.0	11.0	2.5	1	Vesicular basalt w/one ground surface
PKO-009	22514:A	Test Unit 3	I	16-39	Echinoderm	Abrader	0.2	1.8	0.6	0.4	1	*Wana* spine w/one worn surface
PKO-010	22514:A	Test Unit 3	I	16-39	Echinoderm	Abrader?	0.1	1.1	0.7	0.4	1	*Wana* spine w/one possibly worn surface
PKO-011	22514:A	Test Unit 5	I	12-26	Floral	Gourd Fragment	TR.	0.6	0.5	0.3	1	Manuport
PKO-012	22514:A	Test Unit 6	I	14-42	Floral	Gourd Fragment	0.7	2.4	1.5	0.4	1	Manuport
PKO-013	22514:A	Test Unit 7	I	38-51	Volcanic Glass	Cutting Tool	0.8	1.8	1.4	0.4	1	Retouched edges w/evidence of use wear

Table 2: Midden Analysis

Test Unit	2	2	2	2	2	2	2
Layer/Level	Ia/1	Ia/2	Feature A1/Level 1	Feature A1/Level 2	Ib/1	Ib/2	Ib/3
Depth (cmbd)	28-33	33-37/38.5	37/38.5-43	43-48	48-53	53-58	58-63+
Vertebrate Faunal Remains							
Chondrichthyes/Osteichthyes							
Indeterminate Fish					0.2	TR.	
Aves							
Order Procellariiformes							
Family Procellariidae							
Bulweria bulwerii	0.3 (MNI=2)	2.1 (MNI=2)	3.6 (MNI=4)	0.9	0.8 (MNI=2)	1.7 (MNI=2)	0.7
Pterodroma phaeopygia							
Medium Procellariid		0.2	0.3	0.1			
Family Hydrobatidae							
Oceanodroma castro	TR.	0.3	0.4 (MNI=2)				0.1
Order Pelicaniformes							
Family Phaethontidae							
Phaethon lepturus							
Order Passeriformes							
Family Indeterminate							
Small Passeriform							
Order and Family Indeterminate							
Small and/or Medium Bird	3.2	0.9	2.7	1.9	1.1	0.8	0.6
Mammalia							
Order Chiroptera							
Family Vespertilionidae							
Lasiurus cinereus						0.2	
Order Rodentia							
Family Muridae							
Rattus exulans	0.2	0.1	0.6	0.2	0.2 (MNI=2)	0.3 (MNI=3)	0.2
Mus musculus		0.1					
Class Indeterminate							
Order and Family Indeterminate							
Small Vertebrate				TR.			
Small to Medium Vertebrate	0.5						
Invertebrate Faunal Remains							
Gastropoda							
Cellana sp.		TR.	0.5	0.2	0.8	1.1	TR.
Hipponix sp.					0.1		
Cypraea sp.					3.0		
Unidentified Marine Shell					TR.		
Echinoderm				TR.	0.1	0.1	TR.
Crustacean						0.2	
Other							
Coral		2.1					
Kukui Nut Shell	1.0						

Table 2: Midden Analysis (cont.)

Test Unit	3	4	5	6	7
Layer	I	I	I	I	I
Depth (cmbd)	16-39	13-28	12-26	14-42	38-51
Vertebrate Faunal Remains					
Chondrichthyes/Osteichthyes					
Indeterminate Fish			0.2	TR.	
Aves					
Order Procellariiformes					
Family Procellariidae					
Bulweria bulwerii	0.5	0.4	3.3 (MNI=3)	16.6 (MNI=16)	2.6 (MNI=3)
Pterodroma phaeopygia				1.0	
Medium Procellariid	0.1	0.3	3.0	4.3	0.2
Family Hydrobatidae					
Oceanodroma castro	0.2	0.1	0.3 (MNI=2)	1.4 (MNI=5)	TR.
Order Pelicaniformes					
Family Phaethontidae					
Phaethon lepturus				3.4 (MNI=2)	0.2
Order Passeriformes					
Family Indeterminate					
Small Passeriform				TR.	
Order and Family Indeterminate					
Small and/or Medium Bird	1.9	1.0	5.3	13.4	3.7
Mammalia					
Order Chiroptera					
Family Vespertilionidae					
Lasiurus cinereus		0.1			
Order Rodentia					
Family Muridae					
Rattus exulans	0.3	0.2	0.3 (MNI=2)	0.4 (MNI=2)	
Mus musculus			TR.		
Class Indeterminate					
Order and Family Indeterminate					
Small Vertebrate					
Small to Medium Vertebrate			TR.		
Invertebrate Faunal Remains					
Gastropoda					
Cellana sp.					0.1
Hipponix sp.					TR.
Cypraea sp.				1.1	
Unidentified Marine Shell					
Echinoderm	0.4	TR.	1.0	0.8	0.3
Crustacean					
Other					
Coral			0.5		
Kukui Nut Shell			3.8	1.9	

Table 3: Radiocarbon Dating Results

Test Unit	Feature	Layer	Depth (cmbs/cmbd)	Beta #	Conventional C14 Age	Most Probable Calibrated Age Ranges** (AD)	
						1 Sigma	2 Sigma
Inventory Survey							
1	22514:A	II*	6-9	147050	380 +/- 70 BP	1448-1524	1428-1653
Data Recovery							
2	22514:A	Ib/1	51	173721	560 +/- 70 BP	1387-1433	1287-1452

* Designated Feature 22514:A1 during the Data Recovery.

** Calibrated using the University of Washington, Quaternary Isotope Lab's Radiocarbon Calibration Program Ver. 3.0.3.

APPENDIX B

Results of Radiometric Dating

BETA

BETA ANALYTIC INC.

DR. M.A. TAMERS and MR. D.G. HOOD

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964
E-MAIL: beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Mr. Joseph Kennedy

Report Date: 10/22/00

Archaeological Consultants

Material Received: 9/18/00

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 147050	330 +/- 70 BP	-22.1 o/oo	380 +/- 70 BP

SAMPLE : PUAKO
ANALYSIS : Radiometric-Standard delivery
MATERIAL/PRETREATMENT : (plant material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 1420 to 1660 (Cal BP 530 to 290)

B1

Dates are reported as RCYBP (radiocarbon years before present, "present" = 1950A.D.). By International convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

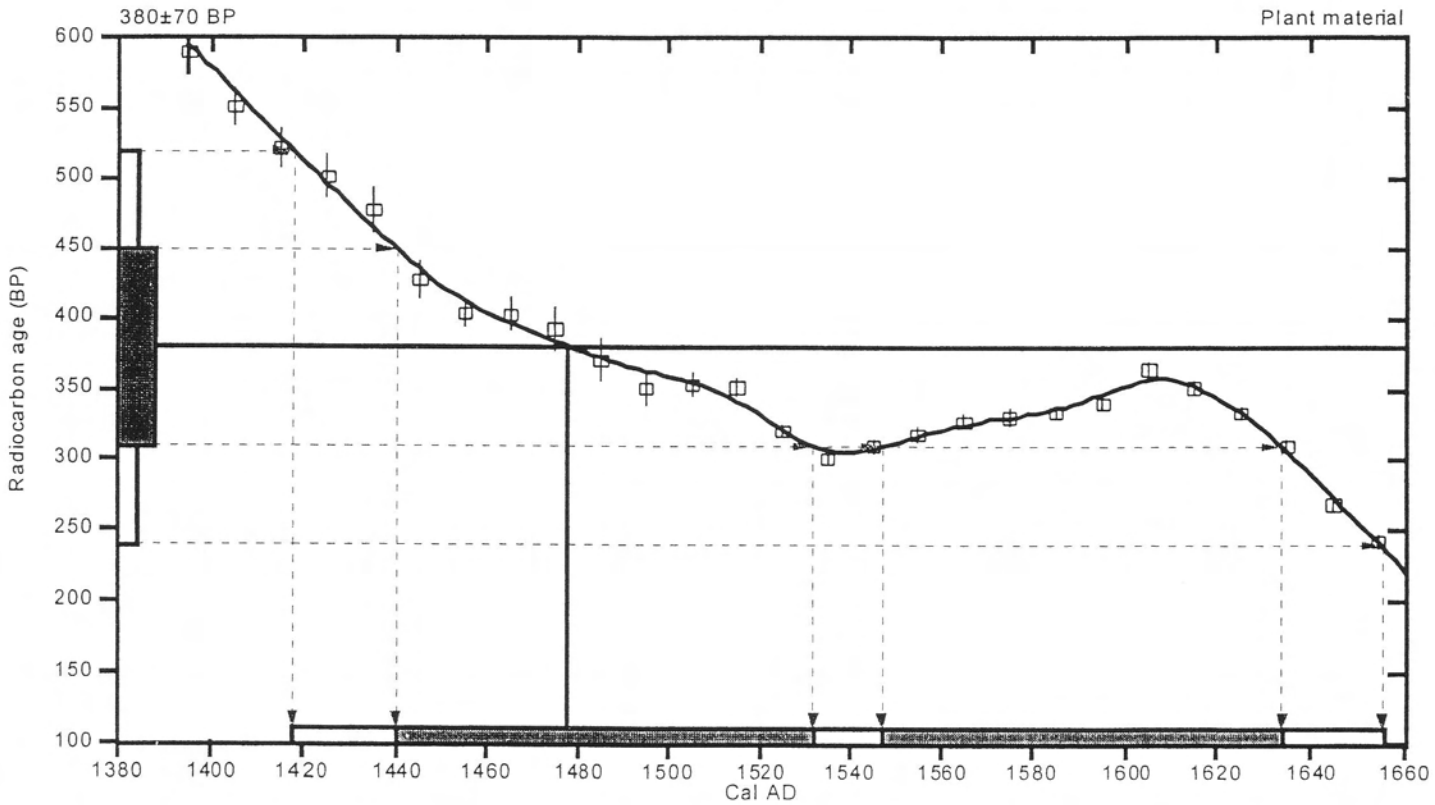
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-22.1:lab. mult=1)

Laboratory number:	**Beta-147050**
Conventional radiocarbon age:	**380±70 BP**
2 Sigma calibrated result: (95% probability)	**Cal AD 1420 to 1660 (Cal BP 530 to 290)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal AD 1480 (Cal BP 470)
1 Sigma calibrated results: (68% probability)	Cal AD 1440 to 1530 (Cal BP 510 to 420) and Cal AD 1550 to 1630 (Cal BP 400 to 320)



References:

Database used

Calibration Database
Editorial Comment
Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii
INTCAL 98 Radiocarbon Age Calibration
Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083
Mathematics
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Beta Analytic Inc.

4985 SW 74 Court, Miami, Florida 33155 USA • Tel: (305) 667 5167 • Fax: (305) 663 0964 • E-Mail: beta@radiocarbon.com

UNIVERSITY OF WASHINGTON
QUATERNARY ISOTOPE LAB
RADIOCARBON CALIBRATION PROGRAM REV 3.0.3
Stuiver, M. and Reimer, P.J., 1993, Radiocarbon, 35, p. 215-230.

Calibration file(s): UWTEN93.14C
Listing file: C14FIL.TXT

ACP PUAKO IS

Radiocarbon Age BP 380 ± 70
Calibrated age(s) cal AD 1489

Reference(s)
(Stuiver and Becker, 1993)

cal AD/BC age ranges obtained from intercepts (Method A):
one Sigma** cal AD 1440 - 1638
two Sigma** cal AD 1415 - 1660

Summary of above:

minimum of cal age ranges (cal ages) maximum of cal age ranges:
1σ cal AD 1440 (1489) 1638
2σ cal AD 1415 (1489) 1660

cal AD/BC age ranges (cal ages as above)
from probability distribution (Method B):

% area enclosed	cal AD age ranges	relative area under probability distribution
68.3 (1σ)	cal AD 1448 - 1524	.55
	1563 - 1628	.45
95.4 (2σ)	cal AD 1428 - 1653	1.00

References for datasets used:
Stuiver, M and Becker, B, 1993, Radiocarbon, 35, 35-65.

Comments:
†This standard deviation (error) includes a lab error multiplier.
** 1 sigma = square root of (sample std. dev.^{2}+ curve std. dev.^{2})
2 sigma = 2 x square root of (sample std. dev.^{2}+ curve std. dev.^{2})

0* represents a "negative" age BP
1955* denotes influence of bomb C-14
For cal yrs between 5500-5190 BC an offset of 25 years is possible.
NOTE: Cal ages and ranges are rounded to the nearest year which may be too precise in many instances. Users are advised to round results to the nearest 10 yr for samples with standard deviation in the radiocarbon age greater than 50 yr.

BETA

BETA ANALYTIC INC.

DR. M.A. TAMERS and MR. D.G. HOOD

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
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E-MAIL: beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Mr. Joseph Kennedy

Report Date: 1/14/03

Archaeological Consultants of the Pacific, Incorporated

Material Received: 12/10/02

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 173721	430 +/- 70 BP	-17.1 o/oo	560 +/- 70 BP

SAMPLE : PUAKO DR
ANALYSIS : Radiometric-Standard delivery (with extended counting)
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal AD 1290 to 1450 (Cal BP 660 to 500)

B4

Dates are reported as RCYBP (radiocarbon years before present, "present" = 1950A.D.). By International convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-17.1:lab. mult=1)

Laboratory number: **Beta-173721**

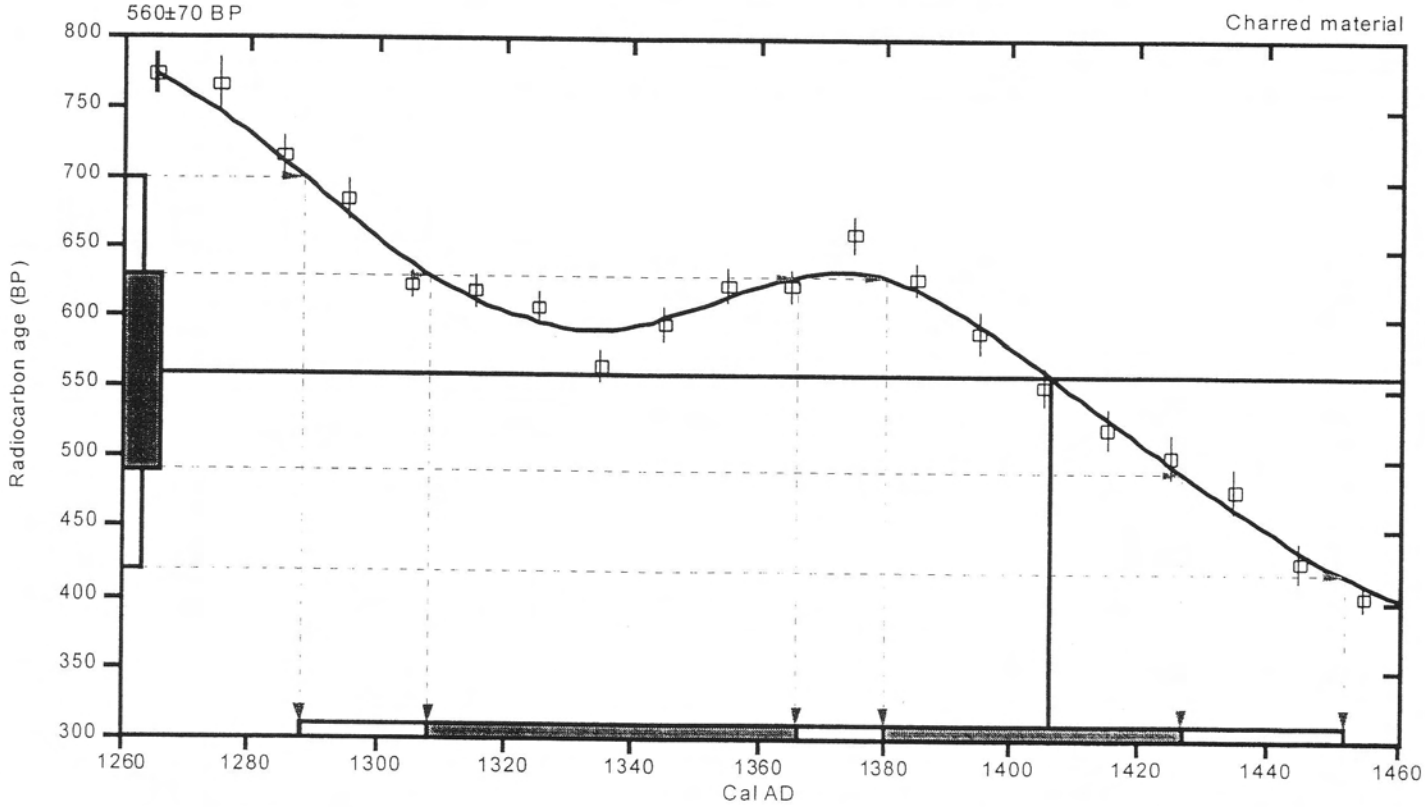
Conventional radiocarbon age: **560±70 BP**

2 Sigma calibrated result: (95% probability) **Cal AD 1290 to 1450 (Cal BP 660 to 500)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 1410 (Cal BP 540)

1 Sigma calibrated results: (68% probability) Cal AD 1310 to 1370 (Cal BP 640 to 580) and Cal AD 1380 to 1430 (Cal BP 570 to 520)



References:

Database used

Calibration Database
Editorial Comment
Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii
INTCAL98 Radiocarbon Age Calibration
Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083
Mathematics
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Beta Analytic Inc.

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UNIVERSITY OF WASHINGTON
QUATERNARY ISOTOPE LAB
RADIOCARBON CALIBRATION PROGRAM REV 3.0.3
Stuiver, M. and Reimer, P.J., 1993, Radiocarbon, 35, p. 215-230.

Calibration file(s): UWTEN93.14C
Listing file: C14FIL.TXT

ACP PUAKO DR

Radiocarbon Age BP 560 ± 70 Reference(s)
Calibrated age(s) cal AD 1408 (Stuiver and Becker, 1993

cal AD/BC age ranges obtained from intercepts (Method A):
one Sigma** cal AD 1321 - 1369 1387 - 1434
two Sigma** cal AD 1289 - 1449

Summary of above:

minimum of cal age ranges (cal ages) maximum of cal age ranges:
1σ cal AD 1321 (1408) 1434
2σ cal AD 1289 (1408) 1449

cal AD/BC age ranges (cal ages as above)
from probability distribution (Method B):

% area enclosed	cal AD age ranges	relative area under probability distribution
68.3 (1σ)	cal AD 1321 - 1369	.48
	1387 - 1433	.52
95.4 (2σ)	cal AD 1287 - 1452	.99
	1463 - 1472	.01

References for datasets used:
Stuiver, M and Becker, B, 1993, Radiocarbon, 35, 35-65.

Comments:
†This standard deviation (error) includes a lab error multiplier.
** 1 sigma = square root of (sample std. dev.^{2}+ curve std. dev.^{2})
2 sigma = 2 x square root of (sample std. dev.^{2}+ curve std. dev.^{2})

0* represents a "negative" age BP
1955* denotes influence of bomb C-14
For cal yrs between 5500-5190 BC an offset of 25 years is possible.
NOTE: Cal ages and ranges are rounded to the nearest year which may be too precise in many instances. Users are advised to round results to the nearest 10 yr for samples with standard deviation in the radiocarbon age greater than 50 yr.

APPENDIX C

Dr. Ziegler's Comments on Puakō Data Recovery Faunal Material

COMMENTS ON PUAKŌ, SOUTH KOHALA, HAWAI'I, FAUNAL MATERIAL

GENERAL. I will not give here a complete listing of the types and numbers of vertebrates from the various excavation units, because you will have these same data available from any tabulation you may make of the identified material. I do, however, present below just a few general remarks on the vertebrates identified.

The vertebrate remains from all of the T.U.'s seem obviously to have been deposited in one or more relatively dry places, such as would be provided by a lava tube or other type of sheltered rock cavity, rather than in an open area with deeper soil exposed to rainwater and other elements. The present evidence of this includes the somewhat light coloration and "splintery" condition of the bones in general, the lack of any significant amount of soil in the cavities of broken bones, and the preservation of feathers in some T.U.'s.

A great many of the individual bird bones show what I refer to--for want of an established term--as "end breakage." In this, only the terminal several millimeters of one or both ends of at least the major limb bones are broken off, while the long bone-shaft fragments remain entire. (This is well illustrated by, for example, the T.U. 6 material of the categories "*Bulweria bulwerii*," "*Phaethon lepturus*," and "Small and/or Medium Bird.") If this "end-breakage" were due simply to deposited bones being broken underfoot, it would be expected that the breakage would most often occur somewhere along the shaft rather than at the extreme terminal portions. It thus appears to me that "end-breakage" is the result of a pre-cooking butchering technique, in which the major bones of the present birds' skeletons were roughly separated at the joints utilizing, probably, a basalt fragment or other lithic implement, and thus damaging only the articular areas of the bones.

I have no idea as to why this type of butchering was employed, but it appears to have been used--especially, but not exclusively, for seabirds--at a number of sites on various Hawaiian Islands.

TYPE OF SITE USAGE. I presume that at least a major portion of the present material--consisting almost entirely of bones of seabirds, whether "end-broken" or not--represents human food remains (--although the natural death here of an occasional bird might have been involved). This collective type of putative midden is, at least, not inconsistent with a traditional Hawaiian diet; that is, such noticeably fishy-tasting avian types are not usually eaten by people of non-Polynesian origin that have come to Hawai'i. All of the bird bones present are of mature individuals, so the collectors either were not raiding active rookeries to obtain them or, if they were, any young birds also taken were not eaten at the areas excavated.

The bones of a very occasional fish could also be this human food midden, because these seem to be from individuals of a body size larger than would be expected to appear in the stomach contents of the particular types of seabirds in the present vertebrate lots. I am unsure of whether the rodents represented were also eaten; very likely the bats were not, the latter probably resulting from natural deaths of the animals here.

Judging from the relative abundance of various seabirds, the virtual absence of any other avian types as well as fishes, the complete absence of other human dietary items such as at least dog and pig, and the lack of artifactual material and human remains, it appears that essentially the sole reason for people occupying all of the present excavation units was for the preparation and consumption of seabirds, which comprise at least four species, presumably all taken nearby. Fishing was rarely, if ever, practiced here, but the presence of occasional fragments representing "Echinoderm" and "Crustacean" in the material sent me indicate at least some collection of marine invertebrates occurred.

The noticeable scarcity of small vertebrates such as lizards, most small land birds, and rodents strongly suggests the areas investigated never habitually served as feeding, nesting, or denning areas of avian raptors and/or nonhuman mammalian predators.

TIME OF SITE USAGE. There are no surely identifiable vertebrate remains (such as those of certainly prehistorically extinct species) that would obviously restrict the time of deposition to a period significantly preceding Contact. There are, however, a very few bones of the historically introduced *Mus musculus* (House Mouse). Because there are no bones of other historically introduced vertebrates present, it is conceivable that these mouse bones are intrusive from the surface or another younger level; perhaps their excavators have more definitive information on this possibility.

CONCLUSIONS. In view of the foregoing observations, solely on the basis of the vertebrate material examined, I tend to think all or essentially all of the present excavated areas were occupied by people while primarily carrying out the traditional Hawaiian practice of harvesting seabirds, and that this occupation occurred either during the (later) pre-Contact Period or during this time and/or the first several decades of the post-Contact Period before essentially any of the historically introduced vertebrate species became common in the general Feature area.

I hope this information will be of interest and use to you. Many thanks for the chance to see this material. Please be sure to let me know if there are any questions on any of my procedures, identifications or comments. Continued best in everything !!

* * *

LINDA LINGLE
GOVERNOR OF HAWAII

NOV - 1 2005

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT T. MASUDA
DEPUTY DIRECTOR - LAND

DEAN NAKANO
ACTING DEPUTY DIIRECTOR – WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING, ROOM 555
KAPOLEI, HAWAII 96707

October 27, 2005

Mr. James Moore
Archaeological Consultants of the Pacific
59-624 Pupukea Road
Haleiwa, Hawaii 96712

LOG NO: 2005.2343
DOC NO: 0510MM03

Dear Mr. Moore:

SUBJECT: 6E-42 Historic Preservation Review, Revised Data Recovery Report
Waikoloa, South Kohala, Hawaii
TMK: (3) 6-8-001:025 (por), 36, 37, 38, 39 and 40

Thank you for submitting replacement pages to revise this data recovery report. The revisions were undertaken in response to our review comments dated July 2, 2003 (Log No. 2003.1089, Doc No. 0307PM01).

All of the requested changes pertaining to MNI values and radiocarbon dating have been adequately addressed. With this final submission, the data recovery mitigation process is now complete. Based on our previous comments, it remains our understanding that Site 22514 will be preserved, and that a Preservation Plan will be prepared and submitted to our office for review and approval. A Burial Treatment Plan has been approved for Site 15033. Our office will recommend that these plans be implemented as a condition of any development permits.

Since this is a revision of the 2003 version, you will need to submit a new cover sheet and title page that references the 2005 revisions. Please send these pages for our library copies as soon as possible. The Data Recovery Report now meets with our approval and is considered final.

If you have any questions, please contact MaryAnne Maigret in the Hawaii Island office at (808) 327-3690 or Mr. David Brown in Kapolei at (808) 692-8025.

Aloha,

Melanie A. Chinen, Administrator
State Historic Preservation Division

MM:jen

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Appendix K

Archaeological Burial Treatment Plan/SHPD Correspondence
(Haun & Associates, February 2004)

Report 097-022504

BURIAL TREATMENT PLAN

SITE 15033

LAND OF WAIKOLOA , SOUTH KOHALA DISTRICT

ISLAND OF HAWAII (TMK: 6-8-01:37)

Haun & Associates

Archaeological, Cultural, and Historical Resource Management Services
HCR 1 Box 4730, Keaau, Hawaii 96749 Phone: 982-7755 Fax: 982-6343

01000105

Report 218-010203

BURIAL TREATMENT PLAN

SITE 15033

LAND OF WAIKOLOA, SOUTH KOHALA DISTRICT

ISLAND OF HAWAII (TMK: 6-8-01:37)

By:

Haun and Associates

Prepared for:

Bridge Aina Lea, LLC.
c/o THY Development Inc.
P.O. Box 6150
Kamuela, Hawaii
96743

February 2004

Haun & Associates

Archaeological, Cultural, and Historical Resource Management Services
HCR 1 Box 4730, Keaau, Hawaii 96749 Phone: 982-7755 Fax: 982-6343

01000106

INTRODUCTION

Project Identification

This Burial Treatment Plan (BTP) has been prepared for Bridge Aina Lea, LLC in conjunction with the proposed development of TMK: 6-8-01:25, 36-42, Land of Waikoloa, South Kohala District, Island of Hawaii. The project area consists of a c. 3000-acre parcel that is bounded on the west by the Queen Ka'ahumanu Highway and by undeveloped land to the north, south and east. The project area. ranges in elevation from 150-750 ft (*Figure 1*)

Bridge Aina Lea, LLC. is the applicant with regard to this proposed BTP. The mailing address of the applicant is as follows: Bridge Aina Lea, LLC, c/o THY Development Inc., p.O. Box 6150, Kamuela, Hawaii 96743.

Plan Purpose and Organization

The purpose of the BTP is to facilitate the proper treatment of human burial remains that have been identified at one site within the project area by achieving compliance with the applicable sections of Chapter 6E - Historic Preservation (Haw. Rev. St.; as amended), and the current administrative rules for the treatment of burial sites and human remains that were formally approved and adopted by the State of Hawai'i in September 1996 (DLNR 1996). More specifically, the purpose of the BTP is to provide the Hawaii Island Burial Council (HIBC) with the relevant information called for in Section 13-300-33: "Request for council determination to preserve or relocate Native Hawaiian burial sites". The information contained in this BTP is organized according to the following order of presentation: introduction; project background, identification of the burial sites, search for lineal and cultural descendants, proposed treatment of the burial site, and implementation of proposed BTP.

PROJECT BACKGROUND

An inventory survey of the project area (Schilz and Shun 1992) identified 13 sites with 34 features. Only one of the 13 sites, the burial covered by this plan, was assigned an SIHP Site number (Site 15033). The remaining 12 sites and 33 features consisted of modern military training features consisting of cairns, wall shelters, rock mounds and C-shapes. Site 15033 is a modified lava tube containing human remains. A survey conducted by Kennedy (1987) in the west-central portion of the project area identified a walled cave that was interpreted as recently utilized. This site was also not assigned a SIHP Site number.

In the survey report, only the Site 15033 cave was assessed as significant for information content under Criterion "d" and for its cultural value under Criterion "e" due to the presence of human remains. Schilz and Shun (1992) recommended the preservation of Site 15033.

On January 29, 2004, Dr. Alan Haun and Project Supervisor Dave Henry, B.S. inspected Site 15033 to verify the presence of the remains and to determine the extent of unmapped portions of the cave. The remains were identified and minor modifications to the previous site map were completed.

01000107

IDENTIFICATION OF THE BURIAL SITE

Site 15033

Site 15033 is a lava tube located at c. 580 ft elevation (see *Figure 1*). The entrance to the cave is located on the southwestern side of a large natural depression that is c. 30.0 m in diameter and 15.0 m deep (*Figure 2*). The entrance to the cave is 5.2 m long and opens onto a linear passage that is 13.75 m long (north-northwest by south-southeast), 3.5 to 5.0 m wide and 1.5 m in height. The skeleton of a goat is located just inside the entrance.

A collapsed wall remnant of piled cobbles and small boulders is located at the northern end of the entrance passage. Beyond the wall remnant is an oval-shaped chamber that is 15.5 m long (north-northwest by south-southeast), and 10.0 m wide with ceiling heights that range from 2.0 to 3.3 m. The floor is bare lava and a natural channel extends across the northern end in an east-west direction. A goat skeleton and a fragment of burned wood are located in the northwest corner of this chamber.

A passage extends to the west and southwest from the oval-chamber a distance of 38.0 m. This passage is 4.0 to 7.2 m wide and 1.0 to 3.0 m in height, with a bare lava floor. Several fragments of burnt and unburned wood, and a worked wooden stick were observed on the cave floor. A narrow chamber extends to the northwest at the western end of this passage. A human cranium is present at the southern end of this passage, resting on a pile of roof fall. Several rib bones and a mandible are situated 2.0 m to the northwest of the cranium. This passage was examined by Haun & Associates and was determined to terminate 6.2 m northwest of the cranium. This passage is choked with roof fall and a section of a wooden log is present along the northeastern side.

Haun & Associates also identified a previously unrecorded passage that extends to the south at the western end of the main cave. This passage could not be explored as it is only 0.2 m in height; however, light could be seen through the passage, and the area outside of the cave was examined. Three skylight openings leading to a linear passage were identified. This passage is 20.0 m long (east-west), 1.2 to 2.5 m wide and 1.0 to 1.2 m in height. The floor in this chamber is bare lava and no cultural remains were observed.

SEARCH FOR LINEAL AND CULTURAL DESCENDANTS

Documentary Research

It was not until 1867 that the current *ahupua'a* of Waikoloa was established, legally separated from the lands of Puako, Kalahuipua'a, and Anaeho'omalu. Supreme Court Justice G.M. Robertson states that, "...no cattle or sheep was in this country when the grant [of land from Kamehameha I to Issac Davis] was made, and land yielded what revenue could be derived from wild birds and *pili* grass" (Barrere (1971:112). He further states that Davis' land was "so bound to include scarcely and land fit for cultivation (Barrere 1971:112).

The Government Survey Map of 1901 indicates that Waikoloa was purchased by the Parker Ranch for cattle grazing (Barrere 1971:113). Portions of the Parker Ranch lands were subsequently used as training areas during World War II. In 1971, Waikoloa was subdivided and by 1972, the current project area was owned by Signal Properties (Schilz and Shun 1992).

Schilz and Shun indicate that the project area was likely of limited interest to Hawaiians likely due to the inhospitable terrain, arid conditions and general lack of soil (1992:10, 21). No pre-contact trails inland of the coast are present on maps of the area examined by Schilz and Shun (1992), suggesting that the project area was little used.

01000108

Publication of Legal Notices -

Legal notices were published in newspapers of local and statewide distribution. The notices contained (a) project name and location information, (b) identification of several contact persons, and (c) the landowner/applicant's intent to preserve the burial in place. Copies of each Affidavit of Publication are attached to this plan. Notices were published as follows:

1. *West Hawaii Today* – January 30, 2004 (Friday), February 1, 2004 (Sunday) and February 4, 2004 (Wednesday); and

2. *The Honolulu Advertiser* – January 30, 2004 (Friday), February 1, 2004 (Sunday) and February 4, 2004 (Wednesday).

The notices requested that any person having any information concerning the unmarked grave within the project area should contact Mrs. Ruby McDonald, Liaison, OHA (West Hawaii); Mr. Alan Haun, Haun & Associates; and/or Mr. Keola Lindsey, Burials Sites Program, DLNR-SHPD.

Consultations

No individuals claiming lineal descent have responded to the notices. Historic documentary evidence indicates that historic and pre-contact use of the project area was very limited and was likely comprised of the bird hunting and *pili* grass collection. Historic use was primarily for pasture.

PROPOSED TREATMENT OF THE BURIAL SITES

General Proposal: Preservation in Place

Preservation in place is the general treatment proposed for the burial that has been identified within the project area. In place preservation would be achieved through the establishment of a defined preservation buffer (described below).

Preservation Site Buffers

A buffer zone of 20 feet will be established around the perimeter of the cave interior on the ground surface. No land disturbing activity will occur within the buffer zone.

Short-Term Preservation

Short-term preservation will consist of the following general protective measures:

1. The site will be plotted accurately on grading plans and construction plans prior to the initiation of any grading, grubbing, and/or construction activities;

2. A temporary buffer zone of 50 ft shall be identified and marked around the site perimeter. The buffer zone boundary will be delineated with orange plastic fencing. An archaeologist will verify that the fencing is correctly in place prior to any land alteration. The verification will be documented in a letter to DLNR-SHPD. No activity will be allowed within the temporary buffer zone until the permanent buffer wall is constructed; and

3. Construction supervisors will be explicitly notified as to the nature and location of the site, the significance of the buffer zone, and the meaning of the buffer zone marking.

01000109

Preservation Buffers

Long term in place preservation of the identified burial site would be achieved through the establishment of a permanent preservation buffer zone of 20 ft surrounding the burial cave on all sides. With the exception of appropriate cultural activities and periodic maintenance, no land modification, or other activities of any type would be permitted to occur within the preservation buffer. The interior surface area of the buffers will be left in a natural state. The buffer boundary will be delineated by a low stone wall approximately 2 ft in height. The wall will be built to resemble traditional Hawaiian structures using local stone. The wall will have a dry stacked appearance with a concealed concrete core for stability. A narrow opening through the wall will provide access for recognized descendents and maintenance.

Signage

A small sign of durable material would be placed beside the site. The following signage text is suggested:

HE WAHI KAPU

This is a culturally sensitive native Hawaiian site.
Please do not disturb the site.

Damage to the site is punishable under
Chapter 6E, Hawai'i Revised Statutes.

Ownership, Maintenance, and Security

Responsibility for maintenance and security of the burial site would lie with the landowner. Long term/permanent in place preservation would be achieved by a restrictive covenant that would be incorporated into the deed of the property. The covenant would include the appropriate requirements and restrictions relating to physical improvements, maintenance, security, and access by recognized lineal and/or cultural descendants.

Access for Lineal and/or Cultural Descendants

Access to the burial site for appropriate cultural activities would be permitted to any lineal and/or cultural descendant formally recognized by the HIBC or DNLR-SHPD in accordance with the administration procedures contained within Section 13-300-35: "Recognition of lineal and cultural descendants" (DLNR 1996). Specific arrangements for access would be made by direct, mutual agreement between the landowner and recognized lineal and/or cultural descendants.

IMPLEMENTATION OF THE BURIAL TREATMENT PLAN

Preservation measures contained in the BTP would be implemented by the landowner within one year following receipt by the applicant of DLNR written confirmation of mutual agreement to these measures. All requirements and restrictions of the restrictive covenant including a metes and bounds description of the preservation buffer zones would be incorporated into the property deed and recorded with the Bureau of Conveyances.

REFERENCES CITED

Barrere, D.
1971 Appendix A. *Anaehoomalu – A Reconstruction of Its History. Anaehoomalu: A Hawaiian Oasis,* by W. Barrera Jr., Anthropological Trends No. 15. Dept. of Anthropology, B.P. Bishop Museum.

DLNR
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Kennedy, J.
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HISTORIC PRESERVATION DIVISION
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January 20, 2004

Mr. Jim Baldwin
Bridge Aina Lea LLC
2500 Kalakaua Ave. #2404
Honolulu, Hawaii 96815

LOG NO: 2004.0016
DOC NO: 0401PM01

Dear Mr. Baldwin:

SUBJECT: Chapter 6E-42 Historic Preservation Review of the Status of Archaeological Survey and Mitigation for the Bridge Aina Lea LLC Project Area [County/Planning]
Waikoloa, South Kohala, Hawaii Island
TMK: (3) 6-8-01: 25 (por.), 36, 37, 38, 39 and 40

Thank you for your letter of December 16, 2003 and attachments, which included a copy of the final archeological survey report for a portion of the subject area and a January 2002 report prepared by the US Army Corps of Engineers on the former Waikoloa Maneuver Area. This information was provided in response to the comments in our letter of October 30, 2003 (Log No. 2003.2223; Doc No. 0310PM11) regarding the status of historic preservation requirements related to the proposed development of the subject property.

As indicated in our previous letter, our office had no record that the 1991 archaeological inventory survey report entitled "Archaeological Survey and Evaluation Puako Residential Golf Community South Kohala, Hawaii Island" (Schilz and Shun 1991) had been approved by our office. It is now clear that the final revised report, dated August 1992, was in fact never submitted to our office. The final report, which has a slightly different title ("Archaeological Survey and Evaluation Puako Residential Golf Community South Kohala, Hawaii Island Golf Course Portion"), contains the information our office had previously requested regarding the amount of time and effort in conducting the survey. The final revised report meets with our approval.

In our previous letter we recommended additional archaeological survey to assess the adequacy of the 1991 survey and to collect more information about the twelve other "sites" (cairns and shelters that were described but not assigned State site numbers) that had been recorded in the 1991 survey and interpreted as modern features made by either the military during World War II training exercises or hunters. We now believe that additional survey is unnecessary. First,

survey coverage is no longer an issue now that we have a final report on the 1991 survey. Second, the January 2002 U.S. Army Corps of Engineers Report, entitled "Phase II Engineering Evaluation/Cost Analysis Former Waikoloa Maneuver Area and Nansay Sites Island of Hawai'i, Hawai'i," indicates that the subject area was used as an artillery firing range during the war. This information, though not as specific as we would like, adds credence to the view that the sites are modern and most probably related to military training exercises since the fractured and scarred boulders found in many of them are most likely the result of artillery firing. No further research on these "sites" will be required.

All of the historic preservation requirements for the subject parcels have now been fulfilled, except for the development and implementation of a Burial Treatment Plan for Site 50-10-11-15003. If you or your archaeological consultant should have any questions about the preparation of this plan please contact our Burials Program Director, Kai Markell, at (808) 587-0008.

Aloha,

P. Holly McEldowney

P. Holly McEldowney, Administrator
State Historic Preservation Division

c. Chris Yuen, County of Hawaii Planning Department
Kai Emler, County of Hawaii Department of Public Works
Kai Markell, SHPD Burial Sites Program
Chair, Hawai'i Island Burial Council

PM:ak

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Appendix L

Cultural Impact Assessment (Helen Wong Smith, August 2007)

CULTURAL IMPACT ASSESSMENT

FOR

VILLAGES OF ʻĀINA LEʻA

August 2007

Prepared by Helen Wong Smith

For

Bridge ʻĀina Leʻa, LLC

Abstract

At the request of Bridge Aina Lea LLC Helen Wong Smith was engaged to prepare a cultural impact assessment for the rezoning application for approximately 1,060 acres in the State Land Use Urban District for TMK Nos. 6-8-01:25, 36, 37, 38, 39, and 40.

This document provides a cultural assessment for a proposed multi-use development at Waikōloa, South Kohala, Hawai`i Island. The assessment is based on a review of a wide range of written material – archaeological reports, government and other historical records, Hawaiian language sources translated into English, and transcripts of a long series of interviews with native Hawaiians who resided and worked these lands.

Research took place between June 11 and July 26, 2007 and included resources of the Hawaii State Archives, University of Hawai`i at Hilo Mookini Library, and the Hilo Public Library as well as online resources, i.e. Ulukau and previous historical and cultural reports and interviews.

Based on the cultural and historical information gathered for this report no cultural resources with the exception of a single burial found within a natural lava cave were ascertained. Nor could any contemporary or continuing cultural practices be associated with the project area.

I. INTRODUCTION……..3

II. MO`OLELO `AINA: NATIVE TRADITIONS AND HISTORIC ACCOUNTS OF WAIKŌLOA
a. Kekāhi Mo`olelo Hawai`i (Selected Hawaiian Traditions)……4
b. Waikōloa Described in the Journals and Logs of Historic Visitors (1779 to 1902) ……..……7

III. CHRONOLOGICAL HISTORY OF RESIDENCY AND TRAVEL IN THE MA UKA LANDS OF WAIKOLOA……...8

IV. SELECTED DOCUMENTATION OF THE HISTORY AND ARCHAEOLOGY OF WAIKŌLOA……17

V. CULTURAL IMPACTS……19

VI. SUMMARY AND CONCLUSIONS……20

VII. RESOURCES REVIEWED……..21

INTRODUCTION

Although we refer to Waikōloa as an ahupua`a today older references classify it as an `*ili* of Waimea ahupua`a. The following excerpt is from testimony given by a native of the area:

> Waikoloa is an ili of Waimea ahupuaa; Waimea is an Okana - Kanehailua[1]

In her 1932 presentation on Waimea, Bernice Judd[2] Librarian of the Hawaiian Mission Children's Society, states, "In the early days Waimea meant all the plateau between the Kohala Mountains and Mauna Kea, inland from Kawaihae. This area is from eight to ten miles long and from three to five miles wide. There was no running water on Mauna Kea, so the inhabitants lived at the base of the Kohala Mountains, where three streams touched the plain on their way towards the sea….The middle stream, which was famous for wild ducks, was named Waikoloa, or Duckwater[3]. This and the most westerly stream, called Kohakohau, went towards Kawaihae, but neither reached the sea, except in times of flood[4].

Mahele recipient George Hu`eu Davis also referred to Waikōloa as an `*ili*[5]. Several early maps at the State Survey Office indicate this designation to be the most common. Marion Kelly's further distinguishes Waikōloa as an `*ili kūpono* (land division paying tribute to the ruling chief). She writes, "The other of these `ilikūpono, namely Waikoloa, was given by Kamehameha as a separate property to Isaac Davis….[6]" It must be noted the `*ili* of `Anaeho`omalu and Kalāhuipua`a were detached from Davis' award of Waikōloa and were awarded to Queen Kalama[7].

As recent as the 1940s, Waikōloa was still considered as part of Waimea as evidenced by G.S. Handy entry for the coastal bays, "The coastal section of Waimea, now called South Kohala…[8]

The landscape is formed by a series of overlapping lava flows from an ancient eruption of Mauna Kea and an even older one from Mauna Loa forming a broad delta area

---

[1] Boundary Commission Book No. 1:6-12
[2] The Judd and Ruggles families established a mission station shortly after 1830 on the banks of the Waikoloa Stream, near where it descended abruptly from the Kohala Mountains.
[3] On October 30, 1968 two *kōloa* (Anas wyvilliana) were observed in a small pool of Waikoloa stream within the Kohala Watershed for the first time in over twenty years.
[4] Judd 1932:14
[5] Hu`eu 1847
[6] Kelly 1956:119
[7] Boundary Commission Book No. 1:8
[8] Handy 1940:163

allowing occasional floods from the mountainside drainage making an inhospitable place for agricultural activities[9]. The project area encompasses the following flows from south to north: the Kanikū Lava Flow (Mauna Loa 1,500 – 3,000 years before present [bp]); another Mauna Loa flow (3,000 – 5,000 years bp); and two separate flows from Mauna Kea (>10,000 years bp)[10].

The project area ranges from 150 ft. to nearly 700 ft. in elevation and falls within McEldowney's Vegetation Zone III[11] of which grasses form the dominant vegetation. Buffelgrass and *pili* (*Heteropogon contortis*) predominate over other grasses, and shrubs are seen more often than at lower elevations. *Pili* was the preferred grass for thatching houses and was the primary material available in dry areas where alternate species were not found[12] .

MO`OLELO `AINA: NATIVE TRADITIONS AND HISTORIC ACCOUNTS OF WAIKŌLOA

Kekāhi Mo`olelo Hawai`i (Selected Hawaiian Traditions)

Traditions regarding Waikoloa usually focus on Kalāhuipua`a its coastal *`ili*. Kalāhuipua`a, compared to surrounding lands, is an oasis and since pre-contact times was valuable for fishing, aquaculture, and other shoreline activities. It includes a small strip of sand beach backed by brackish-water anchialine ponds which sustain a wide variety of marine life. Apparently, limited agriculture activities also took place here.

> The coastal section of Waimea, now called South Kohala, has a number of small bays with sandy shores where fishermen used to live, and where they probably cultivated potatoes in small patches. Anaehoomalu, Waialua, Honokaope, Kalahuipuaa and Puaoa all have sandy strips along the sea; and there is an area of black cinder in sections where sweet potatoes might be grown in rainy seasons[13].

Samuel Mānaiakalani Kamakau, the 19th century Hawaiian scholar and historian, cites the waters of Kalāhuipua`a as a favorite of the 16th century chief `Umi-a-Liloa, son of the first unifier of Hawai`i Island:

> He [`Umi-a-Liloa] was noted for his skill in fishing and was called Pu`ipu`i a kea lawai`a (a stalwart fisherman). Aku fishing was his favorite occupation, and it often took him to the beaches from

[9] Puako Historical Society 2000:6
[10] U.S.G.S. Miscellaneous Investigations Series Map I-2524-A
[11] 1983:410
[12] Handy & Handy 1972
[13] Handy 1940:163

> Kalahuipua`a to Makaula. He also fished for `ahi and for kala. He was accompanied by famed fishermen such as Pae, Kahuna, and all the chiefs of the kingdom[14].

A legend regarding the boundary between Kohala and Kona which lies some 3500 feet south from the project area refers to Lonoikamakahiki, grandson of `Umi. Lonoikamakahiki is credited with the erection of the boundary marker called Ahu-a-Lono, situated on this boundary and indicated on most survey maps. The story relays Lonoikamakahiki was deserted by his followers while on a visit on Kauai where he was befriended by a Kauai man by the name of Kapaihi-a-Hilina. Kapaihi accompanied Lono when the latter returned to Hawaii, and became the chief's closet advisor. In jealously the other chiefs poisoned Lono's mind against Kapaihi to whom Lono eventually denied admittance to his presence while at Kahalu`u, Kona. Kapaihi then left Kona to return to Kauai, and Lono, almost immediately repenting for his action, went in search for Kapaihi:

> When Lonoikamakahiki set sail on his search for his friend, Kapaihiahilina had already arrived at `Anaeho`omalu and soon afterwards was followed by Lonoikamakahiki and others. Lonoikamakahiki saw Kapaihiahilina sitting on the sand beach when the canoes were being hauled ashore…When they came together…Lonoikamakahiki made a covenant between them…built a temple of rocks (he wahi ahu pohaku) as a place for the offering of their prayers and the making of oaths to Lonoikamakahiki's god to fully seal the covenant[15].

According to Fornander, this mound [ke ahu] of rocks [pōhaku]) was also known as Keahualono[16].

Kamakau also mentions Kalāhuipua`a as he relays how Kamehameha I prevented lava flows from entering the fishpond at Kīholo:

> The fishpond at Kīholo, North Kona was constantly being threatened by lava flows when Kamehameha was the ruler of the kingdom of Hawaii. A flow came down close to the pond at Kīholo; Kamehameha brought a pig and cast it in: the "fires" stopped…It was a time, perhaps, when the fires had ears and would listen to the words of men. Today…Kalahuipua`a in South Kohala [is] covered with lava…and [in] lands that have never known the desolation of lava flows, there are places where lava has overrun the land[17].

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[14] Kamakau 1961
[15] Barrere 1971
[16] Fornander 1917:360-362
[17] Kamakau 1961:67

Cultural Resource Specialist Kepā Maly has spent years translating what he cites as "perhaps one of the most detailed native traditions which includes rich accounts of place names, practices…" the Ka`ao Ho`oniua Pu`uwai no Ka-Miki" (The Heart Stirring Tale of Ka-Miki) published in the Hawaiian language newspaper Ka Hōkū o Hawai`i[18]. Maly's translation of the following mo`olelo (tradition) and his comments for Waikoloa from Ka-Miki:

> Upon completing their training, Ka-uluhe sent Ka-Miki and Maka`iole to fetch `awa from Waipi`o water from a sacred spring on Mauna Kea, and other items needed to prepare the `awa for drinking. While traveling on the plain to Waikōloa, Ka-Miki and Maka-`iole gathered the sedge Ka-lau-o-ke-Kāhuli which was to be used for straining the ceremonial `awa drink. At Holoholokū, some of the sacred water of Kāne which Ka-Miki was carrying in the `awa bowl Hōkū`ula was lifted out by the wind, Waikōloa. The water was carried some distance, and where it fell a spring was formed. The deity Pōhaku-a-Kāne retrieved some of the water from the spring, and carried it to his companion deity Pōhakuloa at the base of Mauna Kea. The spring from where Pōhakukāne fetched the water came to be called Waiki`i (Water fetched)… (March 12, 1914)

While on their journey around the island, the brothers stopped at Kapalilua, South Kona, and Ka-Miki was described as the skilled `olohe (skilled one) from the lands of Nāpu`u (the Pu`u Anahulu – Kekaha region). In describing Nāpu`u, the wind Waikōloa is mentioned:

> Nāpu`u (pū) `Ala Kinikini I ku`ia e ke ao-lewa I ka makani I ke ho`ohae a ka Nāulu, I ka hōelo `ia e ka Waikōloa a me ke Kaumuku kuehu lepo I ke kula pili – The many gullied or folded hills where the wind borne Nāulu rain clouds appear, [land] moistened by the Waikōloa wind, with the Kaumuku winds which stir up the dust on the pili grass covered plain…(December 3, 1914)

Samuel Kamakau ascribes Waikōloa as one of several winds that came to Hawai`i from Kahiki when they were sent by Lonopele as he tried to destroy the priest Pā`ao and his companions (Kamakau 1991:5)[19].

> Kanakanaka was an expert lawai`a hi-`ahi (deep sea tuna lure fisherman), and his sister was the wind goddess Waikōloa[20]

[18] Maly 1999:23
[19] Maly 1999:25
[20] Ibid.:27

Waikoloa Described in the Journals and Logs of Historic Visitors (1774 to 1902)

A member of Captain Vancouver's crew was one of the few early foreigners to travel inland from the coast in February 1793. In this case, the area visited was *ma uka* of Kawaiahae, north of Waikōloa. The description of Waikōloa would no doubt be quite similar:

> I traveled a few mile back…through the most barren, scorching country I have ever walked over, composed of scorious dregs and black porous rocks, interspersed with dreary caverns and deep ravines….The herbs and grasses which the soil produced in the rainy seasons were now mostly in the shriveled state, thinly scattered and by no means sufficient to cover the surface from the sun's powerful heat, so that I met with very few plants in flower in this excursion[21].

Vancouver noted the relative absence of habitations immediately south of Kawaihae in contrast to the numerous houses and plantations on the slopes of Kohala to the north[22].

Captain Vancouver's gift of cattle and horses that year to the west coast of the island were allowed to roam free by Kamehameha I's decree so they could multiple. A wall was built between the King's and Davis' land in Waikoloa ca 1815 in an effort to keep the roaming cattle out of the King's cultivated lands. The wall was named after the King's konohiki, Kauliokamoa[23]. By the time Rev. William Ellis conducted his tour around the island in 1823 there were "immense herds of them, they do not attempt to tame any; and the only advantage they derive is by employing persons, principally foreigners, to shoot them, salt the meat in the mountains, and bring it down to the shore for the purpose of provisioning the native vessels[24]."

Barrère cites these "marauding cattle" as the cause of abandonment of agricultural plots, construction of stone walls, and the deforestation of certain areas[25]. By 1846 the majority of the Waimea area had been converted to pasture for herds of cattle, sheep, and horses[26]. Reverend Lyons reported that because of this, many people moved away and he was then living in a cattle pen[27].

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[21] Menzies 1920 IN Barrere 1981
[22] Vancouver 1801: vol. III:186, 190
[23] Barrere, 1983:30
[24] Ellis 1963:291
[25] Barrere 1983:48
[26] Ibid.:49
[27] Lyons n.d. IN Barrere 1983

Both Kawaiahe and Puakō were "considerable villages" in 1823 when Ellis toured the island. In Kawaihae he numbered one hundred houses[28], with a population somewhere between five and six hundred. Although Ellis gives no figure for Puakō, Lyons estimated it to be larger than Kawaihae in 1935[29]. Of the five to six miles of shore intervening, Lyons wrote: "I walked along the shore – alone. On one hand was the ocean; on the other a dreary, desolate waste – rocks, lava, coral[30]." He mentions no inhabitants along his route.

Two late 19th century references to Kalāhuipua`a have been found. The first in 1880 by George Bowser:

> From Puako to Kalahuipua`a is about four miles. The traveler cannot mistake the road in this district, as the paths are always plainly marked. The road to Kalahuipua`a is along the beach, and is in good order. A few shrubs are growing along the route, but on my left are several waterholes and two small groves of coconut trees[31].

The same year J.S. Emerson noted, while conducting a government surveying Kalāhuipua`a that Kamehameha I "had" a small village at Keawanui (in back of a small cove northeast of Lahuipuaa Pond. He writes the Keawanui Landing "…was the landing of Kamehameha I[32]. Emerson's map of Kalāhuipua`a was secured from the State Survey Office and is included in this report (Figure 1). Kamehameha is said to have rewarded Isaac Davis, one of his foreign advisors, for his services with a large tract of Waikoloa which had been previously held by the branch of Waimea chiefs represented by Papa, wife of Isaac's son George Hu`eu Davis. However, Kalāhuipua`a with its valuable fishponds was detached from the gift[33].

CHRONOLOGICAL HISTORY OF RESIDENCY AND TRAVEL IN THE MA UKA LANDS OF WAIKOLOA

Precontact land use pattern in the Waikōloa area was originally subsistence horticulture and a subsistence marine exploitation. By the later half of the 16th century changes in this pattern changed to what archaeologist William Bonk calls "subsistence-support" economy reaching its peak in the late 18th century[34]. Archaeologist Lloyd Soehren states, "In aboriginal times, before cattle, these lands [of Waikōloa] were marginal to

[28] Ellis 1963:300
[29] Doyle 1945:86
[30] Doyle 1945:85
[31] Bowser IN Clark 1985:127
[32] Hommon 1981
[33] Hommon 1981
[34] Bonk 1985:6

the Hawaiian economy, serving as a reservoir of material products such as *pili* grass and birds[35]."

Use of this zone was probably for the most part limited to transportation routes, with most habitation temporary. Barrère, however, names three permanent settlements of the early 1800s north of the project area:

> On the rising ground above the seacoast settlements, several main trails led past occasionally cultivated grounds to the uplands of Waimea where there were, in the early 1820s, three major settlements about two miles apart. One was a Keaalii, one at Waikoloa, and one at Pu`ukapu. All three were concentrated where a major stream emptied itself upon the plateau.

Kamehameha I played a role in the early history of Waikoloa. Barrère reports it is uncertain whether he gave Waikoloa Nui to John Young or Isaac Davis, his two *haole* advisors. Nevertheless, it was listed as one of John Young's lands at the time of the Mahele[36] by the Privy Council. This same Privy Council then found George Hueu, son of Davis, the heir of Waikōloa and awarded it to him with Land Commission Award 8521-B:1, Royal Patent 5671[37] referring to it as "An inheritance land, the ahupuaa of Waikoloa, Kalana of Waimea[38]. They were likely referring to the fact George's mother was Kahaanapilo, whose father was one of the Waimea chiefs who had previously held Waimea land[39].

Barrère gives a complete review of Davis' battle to settle the boundaries of his land[40]. This is due to the Crown having lands also known as "Waikoloa." The end result was calling those lands belonging to the Crown, "Lalamilo" or Waikoloa-iki" and those to Davis as Waikoloa Nui.

In his testimony regarding this boundary dispute, Ehu, a *kama`āina* of Puukapu, stated, "Waikoloa was the land that had the birds – the boundary as stated is the boundary from the time of Kamehameha first[41]."

During a cross-examination of Wahahee, another *kama`āina*, stated: "I heard Waikoloa was divided. –there are two Waikoloa's, they lie side by side….-all the pili belonged to Waikoloa[42]."

> A kamaaina of Waikoloa was I who stated, [Waikoloa] "The wall was built to keep off the cattle, and to mark the land. The church is on the King's land….-The boundary as I know it is from the English school

[35] 1984
[36] Privy Council Records 1848:3:98-99
[37] Board of Commissioners 1929:59
[38] Book 10:394-395
[39] Barrere 1983:25
[40] Barrere 1983:29
[41] Maly 1999:88
[42] Maly 1999:89

> house along a hollow, to the ditch near to Hoomaloo; thence to puu Makekeo; thence to hills outside of Ahuli, The church in a Paulama which joins Waikoloa[43].

Kuahine's testimony refers to the *pili* in the vicinity:

> Liuliu is an old road, forms the boundary between Waikoloa and the ahupuaa to Puuwaawaa, where the road divides, one goes to the sea shore,, and the other goes along the boundary, along the pili to Kepani; thence to Keahu a Lono – Waikoloa being mauka of the road[44].
>
> Kahanapilo (wahine) was Konohiki of Waikoloa – it descended from her parents, and from her husband, Hueu, this is from my knowledge. I know about the wall built, my father was the luna at the time. –I was large at the time, and could carry stones. –Kupapaulu and Keawekuloa were the Konohikis of the land[45].

Kanehailua's testimony provides the ma kai boundary of Waikōloa, closer to the project area:

In 1862 a Commission of Boundaries was established in the Kingdom to legally set the boundaries of all of the *ahupua`a* that had been awarded as part of the Mahele. Subsequently, in 1874, the Commissioners of Boundaries was authorized to certify the boundaries of lands brought before them[46]. Rufus A. Lyman served as the Commissioner of Boundaries for the Third Judicial Circuit Court. The primary informants for the boundary descriptions were old native residents of the areas being discussed[47].

As stated previously historical documents differ in regarding Waikōloa as an *ahupua`a* or an *`ili* of Waimea. During 1865 hearings to determine the boundaries between Waimea and Waikōloa a witness by the name of Kanehailua testified "Waikoloa is an `ili of Waimea ahupua`a….[48]" In addition, several maps at the Survey Office indicate this latter designation to be the most common.

The State Archives' Land Files include correspondence relating the lands of Waikoloa. The correspondence reveals those who held interest or were interested in land or land uses in this area and provides a method of monitoring land transactions. Note these entries concern both Davis' and the Crown's land and the battle Barrère mentioned.

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[43] Maly 1999:90
[44] Ibid.
[45] Ibid.
[46] W.D. Alexander IN Thrum 1891:117-118
[47] Maly 1999:81
[48] Barrere 1983

Interior Department, Land Matters Document 381

The following ahupuaas for konohikis in Waimea and Hamakua. Waikoloa Leleihoku heir. "Other lands for C. Carr ½ acres in Waikoloa."

Interior Department, Book 15, page 117

In list of konohiki lands, showing that the above place belong to Awane Leleiohoku & own a fishing right.

Interior Department, Land Matters Document 314

In list of lands, showing that Royal Patent 5671, was issued to Hueu, by name only on Land Claim No. 8521B, on above land Waimea, Hawaii.

Interior Department, Land Matters Document 364

In list showing that Leleiohoku is the owner of the above ahupuaa. Also in list showing that the school is the owner of the above land…

September 1, 1848

Kauikeaouli (Kamehameha III) approved equal division of lands of John Young (Olohana), between his heirs. In this division, John Young (Keoni Ana) received the ahupua`a of Kawaihae 2nd[49].

Public Instruction, December 23, 1851

L. Lyons to Minister of Public Instruction. Has sold 180 acres to J.P. Parker, Jr. &c.

Interior Department, January 1, 1852

In original lease from Kamehameha III to C. Carr on a piece of land situated at the above place containing 68 periods and 7 rods for the term of 50 years at a rental of $70 a year. Receipt of the payment of one year's rent, attached.

Public Instruction, April 23, 1852

L. Lyons to Minister of Public Instruction. Re. deed to Mr. Parker to above land, if ready to deliver same to his son Curtis. To consult with John Ii, re matter of surveying the followint lands, belonging to Leleihoku.

Interior Department, May 29, 1859

In letter from the Minister of Interior to the Chief Clerk of the Interior Department re. dispute between Mr. Davis & Mr. Parker over the boundaries of the above land.

Interior Department, June 26, 1866

[49] Privy Council Vol. 3-A:97-99

In letter from John P. Parker to J.O. Dominis informing him that Wiltse is now engaged in surveying the above land.

Interior Department, July 26, 1866
In letter from S.C. Wiltse to J.O. Dominis informing him that he completed the survey of the above land & Waimea.

Interior Department, September 19, 1866
In letter from George Davis to the Commissioners of Crown Lands informing them that he will commence the survey of the above ahupuaa on September 30, 1866 &c.

Interior Department, October 4, 1866
In petition by the Commissioner of Crown Lands to the Commissioner of Boundaries for the settlement of the boundaries of the ahupua`a of Waimea in South Kohala. Also protest by G.D. Hueu against the settlement of boundaries along the above ahupuaa. – Documents attached testimony notes of survey, protest &c.

Interior Department, December 6, 1893
Surveyor General to Commissioner of Crown Lands. That the above land was awarded to G.D. Hueu, under Land Claim 8251B &c.

Supreme Court Justice Robertson determined the land was rightfully Hueu's through direct inheritance from his father, Isaac. This portion of Judge Robertson's decision gives insight to the limited value of Waikōloa in 1867:

> The land…was granted by King Kamehameha I to his faithful friend and follower, Isaac Davis, the father of appellant [George Hueu Davis], about the beginning of the present century. We consider it clear that in making the grant the King intended to give, and did give to Isaac Davis, a tract of land of very great extent, although not of proportionate value. There were no cattle or sheep in this country when the grant was made, and the land given to Isaac Davis only yielded what revenue could be derived from wild birds and pili grass.
>
> By terms of the grant…the land given to Isaac Davis was expressly deprived of any rights in the sea, i.e. of fishery, and was so bounded as to include scarcely any land fit for cultivation; and, as some of the witnesses expressed it, all the pili land extending to the aa on the boundary of Kona, was given to Isaac Davis.
>
> There is one fact which we regard as clearly established…and that is the fact that for upwards of sixty years, the appellant and his father

> before him, exercised undisturbed lordship over the large tract of land which we feel bound to include in the boundaries of Waikoloa nui, as granted to Isaac Davis. No evidence has been given to contravene the fact of long and undisturbed control and occupancy[50].

In his extensive study of coastal trails of South Kohala, Kepā Maly accounts for nine smaller *kuleana* awarded in the uplands of Waikōloa, most in the vicinity of the present-day Waimea Town[51]. Like those awarded in `Ōuli, it is likely that the upland residents probably made seasonal trips to procure marine resources from the shore of South Kohala—the coastal lands were associated with larger district of Waimea[52].

An 1873 school report for South Kohala identifies school locations and the names of teachers living in the region. Two schools were identified within Waikōloa. The teacher for the school located at Puakō was Josepha who was paid a daily salary of $0.50 and taught 20 students in a mortar school house[53]

As noted in several of the entries above, rancher John Parker had interest in the lands of Waikōloa. The rise of John Parker and his ranch in Waimea will not be covered here. More relevant to this report is the ranch's acquisition of Waikōloa lands. This transaction was hindered by a dispute between Samuel Parker and his manager Alfred Carter.

> An example of the situation is Carter's effort in 1903 to add to the pasturage of the ranch. He found that the Waikoloa property owned by Lucy Peabody was essential to the Parker Ranch as important grazing land-and it could be acquired. When Carter finally convinced Sam of its importance, the latter concurred and agreed to the negotiations. Carter was in the midst of working out the transaction when Sam suddenly withdrew his consent.
>
> Carter then did the only thing that seemed feasible; he negotiated with Miss Peabody in order to get the land for his ward, Thelma. He was shortly shocked to learn that Sam was already bidding for the land in his own right and for his own purpose – excluding Thelma entirely. Carter immediately brought all his legal skills to bear on the problem and, in his astute way, soon had Sam agreeing to

[50] *Hawaiian Gazette* February 27, 1897
[51] Indices of Awards 1929; cf. Register Map No. 2756 – Waikoloa Water Rights Map IN Maly 1999
[52] Maly 1999:56
[53] Public Instruction Files (January 1 – July 1, 1873), Hawai`i State Archives

> purchase the land for the joint interest of himself and Thelma. The purchase was made[54].

Thelma was the mother of Richard Smart, the last direct owner of Parker Ranch. The Government Survey Map of 1901 indicates Waikōloa was purchased by the Parker Ranch for cattle grazing[55]. Portions of the Parker Ranch were subsequently used as training areas during World War II[56].

In his 1999 study of the coastal trails of South Kohala, Kepā Maly notes, "…it was found most of the early government communications pertaining to roads in South Kohala focus on travel from Kawaihae Harbor to Waimea[57]." The few references Maly provided regarding trails and roads continuing on to the Puakō vicinity and beyond are related here:

March 11, 1859
Isaac Y. Davis; to Minister of the Interior, Keoni Ana
Writing in reference to the progress of the 1859 lava flow which also cut off the Alanui Aupuni between Kawaihae and Kona.

> …There is nothing new, but, your red eyed woman is flowing once again, damaging the land of the King. It is here in the uplands of Puuwaawaa, and is perhaps going again to destroy the places that remain, such as Wainanalii.
>
> Won't you command your woman, Pele, not to go once again and destroy the land of my King, or you two shall be cut off from me…[58]

September 13, 1871
Jas. Smith, Road Supervisor, North Kona; to Chas. Gulick, Chief Clerk, Interior Department:
Reports that work has been under way on the áa of Kaniku[59]."

September 20, 1871
Samuel F. Chillingworth, Road Supervisor, South Kohala to F.W. Hutchinson, Minister of the Interior:

> Herewith I have the honor to hand your Excellency, a/c current vouchers etc. for work on Kawaihae & Kiholo road, also for money expended in the repairs of the Waimea road, in the part damaged by the recent storm.

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[54] Brennan 1974:124
[55] Barrere 1971:113
[56] Haun 2004:2
[57] Maly 1999:62
[58] Interior Department letters, Lands, Hawaii State Archives
[59] Subject File – Roads, Hawaii, Hawaii State Archives

> I have now made about two thirds of the road from the boundary where Mr. Smith commenced, leaving about one third more to finish the road over the "Clinkers." The portion I have worked, I have succeeded in making into quite a good road and have carefully gone over the remaining portion, which will take about two Hundred Dollars to complete. I find however that I have exceeded the limits of your Excellency's first instructions viz. (to expend $500)… I now await your Excellency's instructions as to continuing the work[60]…

December 18, 1871
R.A. Lyman, Lieut. Governor of Hawai`i to F.W. Hutchinson, Minister of the Interior:

> …The last time I was in Waimea, parties who came to Court from Kona, told me that the whole of the road between Kiholo and Kawaihae was being well made. I have written to several parties making inquiries in reference to the road and will send you the result of my inquiries, as soon as I hear from them…[61]

December 29, 1871
R.A. Lyman, Governor of Hawai`i to F.W. Hutchinson, Minister of the Interior:

> …I notice from your favor of the 18th inst., that you speak of the new flow of lava from Kiholo and Kawaiahe road. The only New flow of lava on that road, is the flow of 1859, on the north side of Kiholo, and is several miles south of the boundary of south Kohala and north Kona.
>
> Mr. Smith I am told commenced to work the road in Kona at the boundary of south Kohala and is working toward the New Lava flow at Kiholo. He has not yet got to it. Mr. C. [Chillingworth] commenced work at the boundary of his District, and is working towards Kawaihae. Judge Hoapili says that he has almost completed his portion of the road, and that you can canter a horse the whole length of it…[62]

March 8, 1888
J. Kaelemakule; Supervisor, North Kona Road Board; to L.A. Thurston, Minister of the Interior:
Provides Thurston with an over view of work on the road of North Kona, and described the Government road (Ala nui Aupuni or Ala loa) to Kiholo and the South Kohala bondary:

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[60] Subject File – Roads, Hawaii
[61] Subject File – Roads, Hawaii
[62] Subject File – Roads, Hawaii

> …3. The government road or ala loa from puland Kainaliu (that is the boundary between this district of South Kona), runs straight down to Kiholo and reaches the boundary of the district adjoining South Kohala, its length is 20 or 30 miles. With a troubled heart I explain to your Excellency that from the place called Kapalaoa next to South Kohala until Kiholo – this is a very bad section of about 8 miles; This place is always damaged by the animals of the people who travel along this road. The pahoehoe to the north of Kiholo called Ke A. hou, is a place that it is justified to work quickly without waiting[63].

December 1892
Petition to Geo. N. Wilcox, Minister of the Interior:
Signed by 160 residents of Kona. The petitioners note that the Kanikū (Kohala-Kona road) was built in 1871, and ask that S.B. Kaomea be appointed to position of Road Supervisor for unfinished work on Kealakehe Road:

A 1992 archaeological survey of the project area revealed no pre-contact trails inland of the coast[64].

Messers. William Akau and Clayton Bertleman, both lifetime residents of the area, were interviewed by Mr. Harvey Auna on February 23, 1991 regarding the project area. They relayed the northern portion of the area was used primarily for cattle grazing by Parker Ranch. During World War II the area was also used by the Marine Corps for maneuvers and training, as well as for a target and impact zone[65].

In a 1998 interview with knowledgeable *kama`āina* Robert Keakealani and his sister Leina`ala Lightner, Kepā Maly notated place names they learned from their kūpuna. Robert learned they used to travel from "Kapalaoa to a place inland of `Anaeho`omalu in Waikōloa. This place, known as Makahonu, was an old dryland planting ground—situated near the present day Waikōloa Road-Ka`ahumanu Highway intersection-which was still used through the turn of the century by native residents of the coast[66]." The project area is adjacent to this intersection and is it likely it was included in Makahonu and utilized for agricultural activities. Robert cites the elders planted sweet potatoes, pumpkins, and sugar cane at the kīpuka Makahonu by piling up stones into ahu [cairns or mounds][67].

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[63] Subject File – Roads, Hawaii; translated by K. Maly
[64] Schilz and Shun 1992:21
[65] Ibid.:13
[66] Maly 1999:Appendix A:15
[67] Maly 1999:Appendix A:23

Situate at a terminus of the Queen Ka`ahumanu Highway and the entry road to Puakō was a small group of houses was built on the hill. Several c-shaped shelters have been found there, together with two enclosures and some circular stone paving. Parts of these structures were recycled as cairns and grave markers in the early 20th century when the same area was used as a small cemetery[68].

A 1969 article outlines Boise-Cascade's planned development of its 31,000 acres running from the 3,000-foot level to the sea in Waikōloa[69]. Three wells were sunk for the anticipated community of 30,000 after Boise's $10 million purchase price.[70]

SELECTED DOCUMENTATION OF THE HISTORY AND ARCHAEOLOGY OF WAIKŌLOA

Very little archaeological work has been conducted for the uplands of Waikoloa. Previous archaeological and historical studies in the area have focused primarily the `ili of `Anaeho`omalu and Kalahuipuaa where the resorts are located. In addition, Waikōloa *ma uka* has been traditionally sparsely inhabited owing to its harsh terrain and rarely visited by foreigners. The verdant forest zone of which Waimea is a part of was cultivated extensively and goods exchanged with the coastal inhabitants. Barrère says this about the zone in which the project area is located:

> There appears to have been very little activity in the zone stretching from Kawaihae to the area of extensive agricultural and residential occupation in the uplands….So, while little has been reported of this less-desirable zone between the coast and the uplands, the true nature of land utilization of the area remains unclear[71].

One of the first archaeological surveys relevant to this project is by Bevacqua (1972). He notes the bulk of Waikōloa is composed of rough and broken *pāhoehoe* which resulted from ten different lava flows originating from Mauna Loa[72]. The general topography Bevacqua found in 1972 were rolling hills with occasional gullies and lava outcroppings, with fountain grass as the dominant ground over and *kiawe* trees scattered through the area, denser in the ravines and dry stream beds of the southern portion. Bevacqua's Survey Areas E and F fall nearest the present project area. In area F he recorded five sites:

- Site 17 – a roughly circular stone enclosure, 2.4 meters in diameter

[68] Puako Historical Society 2000:13
[69] *Hawaii Investor* December 1969:59.
[70] Ibid:60
[71] Barrere 1983:46
[72] Bevacqua 1972:1

- Site 18 – a C-shaped shelter measuring 1.5 meters across and 1.2 meters deep, with walls 0.6 meter high and 0.5 meter wide; 10 meters NE of the shelter a cairn, 0.7 meter high and 1.2 meters in base diameter
- Site 19 – a cairn, 0.8 meter high and 2.0 meters in base diameter
- Site 20 – a cairn, 0.9 meter high and 1.75 meters in base diameter
- Site 21 – a small, badly deteriorated cluster of four C-shaped shelters, a rectangular enclosure, four walls, and a cairn.

Bevacqua did not consider these sites worthy of excavation or preservation and stated no further archaeological work was necessary before development of the area[73].

Paul Rosendahl conducted a mitigation program at archaeological sites along the Queen Ka`ahumanu Highways corridor. The corridor abuts the present project area to the west. Rosendahl lists only one site along this stretch of the corridor, feature 843, consisting of a C-shape with cairn[74] without recommending further investigation.

An archaeological survey for a section north of Waikōloa Village and west of the northernmost end of Paniolo Drive (TMK 6-8-02:26) was conducted in December 1988 by William Bonk who "nothing found except scattered shrapnel fragments indicative of use as a military target area in recent past[75]."

Bonk characterizes land use patterns for the Waimea-Waikōloa area:

> The prehistoric land…was originally subsistence horticulture and a subsistence marine exploitation. By the later half of the 16th century, we see changes in this pattern with an increase, through time, of what I have called a "subsistence-support" economy. This reaches its peak in the late prehistoric of the second half of the 18th century (Bonk, 1985:6). As foreign ships increased in numbers at Kawaihae, in the early historic period, we see a further development to a "subsistence-trade" economy for the environs of Waimea. Through the 19th century, cattle became a greater and more important part of the economic base, the transporting of products, and a money-based economic system gradually substituted for that of a subsistence base[76].

Bonk quotes Soehren in regards to Waikōloa's pre-contact value in comparison to the fertile lands of Waimea, "In aboriginal times, before cattle, these lands (Waikoloa) were marginal to the Hawaiian economy, serving as a

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[73] Ibid.:12
[74] Rosendahl 1972:201
[75] R.M.Towill 1991
[76] Bonk 1988:2

reservoir of material products such as pili grass and birds[77]." Bonk supports Soehren's assessment by arguing "the midlands of Waikoloa were not able to support horticulture. A yearly rainfall of 10 inches would not allow permanent settlement at the time[78]." Bonk cites this as the reason for the "paucity of archaeological remains n the midlands of Waikoloa and explains as well why we found nothing of prehistoric cultural significance in the region we scrutinized[79]."

This broad statement was made for the areas near the Queen Ka`ahumanu Highway within Waikōloa and Pu`uanahulu, "At lower elevations near the Queen Kaahumanu Highway, the frequency of pre-Contact sites may be expected to increase. Abrader depression and scoria quarry areas might also occur[80]."

The Environmental Impact State for the Waikoloa Affordable Housing Project situate at the north end of the existing Waikōloa Village approximately four miles *ma uka* of Queen Ka`ahumanu Highway identified scattered shrapnel fragments and remains of field communication wire suggest the area may have been used for a military training area during World War II[81].

An archaeological survey of the project area conducted in 1991 and 1992 identified thirteen sites assessing only one (Site 50-10-11-15033), a burial cave, as significant and the other twelve as historically associated. The investigators were not surprised at the lack of indigenous archaeological sites as the terrain is "too rugged and inhospitable for human use and habitation[82]."

An archaeological survey of the project area in 2000 identified nineteen temporary features were identified, including c-shapes and *ahu*, a rock shelter, a quarry site, two hearths and a possible short trail which they postulate was likely a goat rather than a cultural trail[83].

CULTURAL IMPACTS

The cultural impacts to any locale in Hawai`i are not always readily evident. What is assessed by Western eyes as "barren land" may be a rich resource to Hawaiians for harvesting material i.e. *pili* grass; spiritual aspects, i.e. the wind; or for the trails on which to travel. References to these cultural features have been found for the general Waikōloa, but not specific to the project area. Most cultural sites in this section of South Kohala occur between 40 and 280 ft.

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[77] Bonk 1988:3
[78] Ibid.
[79] Ibid.
[80] DMT Consultant Engineers 1999
[81] R.M. Towill 1990:1-3
[82] Schilz & Shun 1992:21
[83] Kennedy 2000:3

elevation, with the highest density near gullies land gulches, dropping off at 160 ft[84].

The most direct reference to cultural practices in the vicinity is the dryland planting ground named Makahonu near the present day Waikōloa Road-Ka`ahumanu Highway intersection which may have included the project area[85]." Robert Keakealani cites the elders planted sweet potatoes, pumpkins, and sugar cane at the kīpuka Makahonu by piling up stones into *ahu* [cairns or mounds][86] as recent as the turn of the 20th century.

With the exception of one burial (Site 15033) archaeological surveys of the project area uncovered remains of what are likely temporary shelters or remnants of military operations from World War II. The burial found in a lava tube is located at c. 580 ft. elevation[87].

Based on the findings of *Archaeological Survey and Evaluation Puako Residential Golf Community South Kohala, Hawaii Island Golf Course Portion* and *Phase II Engineering Evaluation/Cost Analysis Former Waikoloa Maneuver Area and Nansay Sites Island of Hawaii* the State Historic Preservation Division concluded the project area was used as an artillery firing range during the war[88] and required no further investigations.

SUMMARY & RECOMMENDATIONS

Reviewing the information presented in this cultural impact review – historical documentation, archaeological surveys and research, and oral reminiscences – reveal no cultural sites in the project area save the lava tube burial. Based on the evidence gathered, no contemporary or continuing cultural practices occur within the project area.

Based on the findings of this assessment, Bridge `Aina Lea will have minimal impact on Hawaiian cultural resources, beliefs and practices. It should be noted, however remnants of Hawaiian practices, be it agricultural, temporary habitation sites, or additional burials may reveal themselves during development as they have been identified in other areas of Waikōloa. In the event such archaeological resources are encountered during land-altering activities associated with construction, work in the immediate area of the discovery should be halted and DLNR-SHPD contacted as outlined in *draft* Hawaii Administrative Rules 13§13-280.

[84] Clark and Kirch 1983
[85] Maly 1999:Appendix A:15
[86] Maly 1999:Appendix A:23
[87] Haun 2004:1
[88] Letter to Jim Baldwin from McEldowney, P. Holly, January 20, 2004

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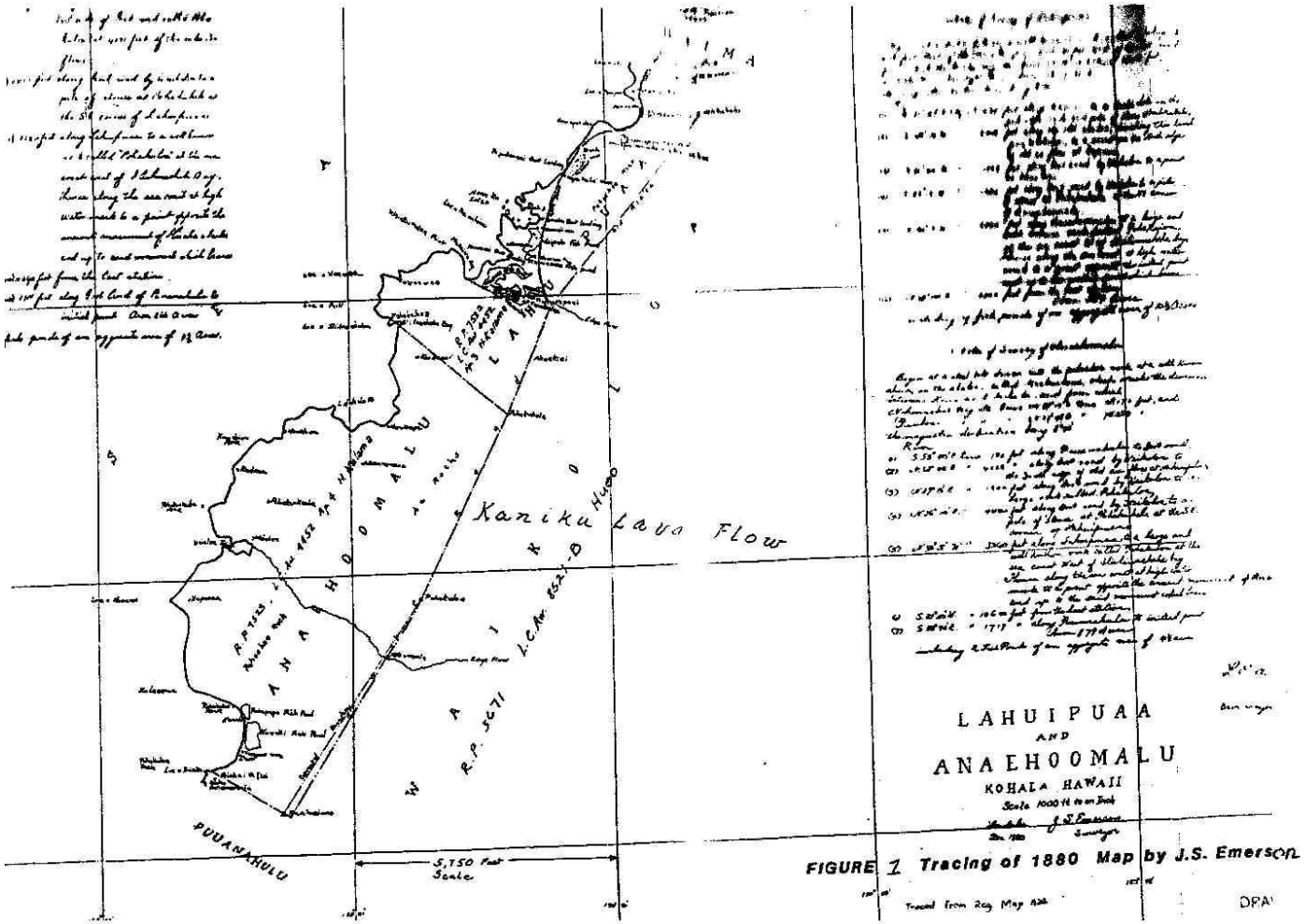


FIGURE 1 Tracing of 1880 Map by J.S. Emerson

Appendix L1

Cultural Impact Assessment, First Addendum–Cattle Trail

(Helen Wong Smith, July 2009)

Addendum to Cultural Impact Assessment for DW `Āina Le`a Development, LLC, Waikōloa, Hawai'i Island, TMK Nos. 6-8-01:25, 36, 37, 38, 39, and 40

Prepared by Helen Wong Smith, MLIS, CA
Archival/Historical Consultant
July 2009

Abstract

At the request of Makani Resources, identification and field inspection of a cattle trail was conducted to determine its impact on the project area. These tasks responded to comments made to the Cultural Impact Assessment prepared by Helen Wong Smith, this report's author, submitted August 2007. Deborah L. Chang, a planning consultant specializing in trails and access issues, wrote then owners Bridge Aina Le`a, LLC asking them to determine if a cattle trail from Pu`u Wa`awa`a Ranch to Puakō[1] she learned of from Robert "Sonny" Keakealani, Jr. impacted the subject properties.

On June 25, 2009 Wong Smith and archaeologist James Head accompanied Sonny Keakealani to the Puakō Gate near the Queen Ka`ahumanu Highway and then *ma uka* along Highway 19 to an flat area beneath Pu`u Ku`aīniho (Kuainiho on U.S.G.S. topographic maps) where cattle were rounded prior being driven to the Puakō Gate. A possible ahu (or cairn) which may have marked the cattle trail was also located in the area. After Keakealani's identifications, Wong Smith and Head returned to the Puakō Gate and hiked *ma uka* following Sonny's directions to follow remains of fence line to mark the trail.

The resulting report shows the location of this cattle trail as identified by Keakealani and its relation to the project area.

[1] Letter to John Baldwin, Managing Member of Bridge Aina Le`a, LLC, January 7, 2008

Background

In August 2007 Helen Wong Smith, Archival/Historical Consultant prepared a Cultural Impact Assessment (CIA) for Bridge `Āina Le`a, LLC as part of a rezoning application for approximately 1,060 acres in the State Land Use Urban District for TMK Nos. 6-8-01:25, 36, 37, 38, 39, and 40. In response to this CIA, Deborah Chang notified Bridge `Āina Le`a of a *ma uka – ma kai* trail located on the subject properties (Appendix A). In response, Connie Kiriu, Makani Resources, requested Wong Smith contact Robert "Sonny' Keakealani, Jr. of this trail's location. Uncle Sonny drew the approximate trail on a TMK map which indicated the trail did not impact the subject properties (Appendix B).

A 1992 letter from Don Hibbard, Administrator of the State Historic Preservation Division (SHPD) to Christine Barada of Nansay Hawaii, Inc. refers to this trail. A field investigation by SHPD archaeologist Marc Smith on September 11, 1992 concluded the trail as historic "from the ranching era or when the area was used for military training during the early part of this [20th] century[2]." This conclusion was reinforced by review of two maps, one from the late 1800s and the other 1928, neither which indicated this trail. Dr. Hibbard stated due to its "recent age, our office believes that it does not constitute a significant historic site and hence, not worthy of further recordation, data recovery, or preservation (Appendix C)."

Field Inspection

Wong Smith and archaeologist James Head accompanied Uncle Sonny on June 25, 2009 to identify the location of a cattle trail utilized by the cowboys of Pu`uwa`wa`a Ranch into the 1930s. The location of this trail was relayed by his father Robert Keakealani, Sr. and was never traversed by Uncle Sonny himself. The first point at the PuakŌ Gate is located *ma kai* some 120 yards off the Queen Ka`ahumanu Highway near the 72 mile marker

Figure 1 – PuakŌ Gate

[2] regarding the "Mauka-Makai Trail, Puako Residential Golf Community…TMK 6-8-01:25, 36-42"

Uncle Sonny recommended the remaining fence posts indicating the trail be followed as far as possible from this gate *ma uka.*

Figure 2 – Remains of fence post from PuakŌ Gate looking toward Queen Ka`ahumanu Highway

Figure 3 – Uncle Sonny near remains of fence post near the PuakŌ Gate

Figure 4 - Remains of stone wall on both sides of Puakō Gate

Crossing the Queen Ka`ahumanu Highway additional fence line remains were identified.

Figure 5 – Remains of fence lines *ma uka* of Queen Ka`ahumanu Hwy. indicating cattle trail

Traveling on the WaikŌloa by-pass road Uncle Sonny pointed out the *pu`u* to align to mark the trail. Arriving at Highway 19, the Hawai`i Belt Road we turned south to the 15 mile maker, near the base of Pu`u Ku`aīniho (828' U.S.G.S. topographic). *Ma kai* of the highway is a plain some 300 by 300 yards where Uncle Sonny learned this was where the cattle corralled prior the drive to PuakŌ.

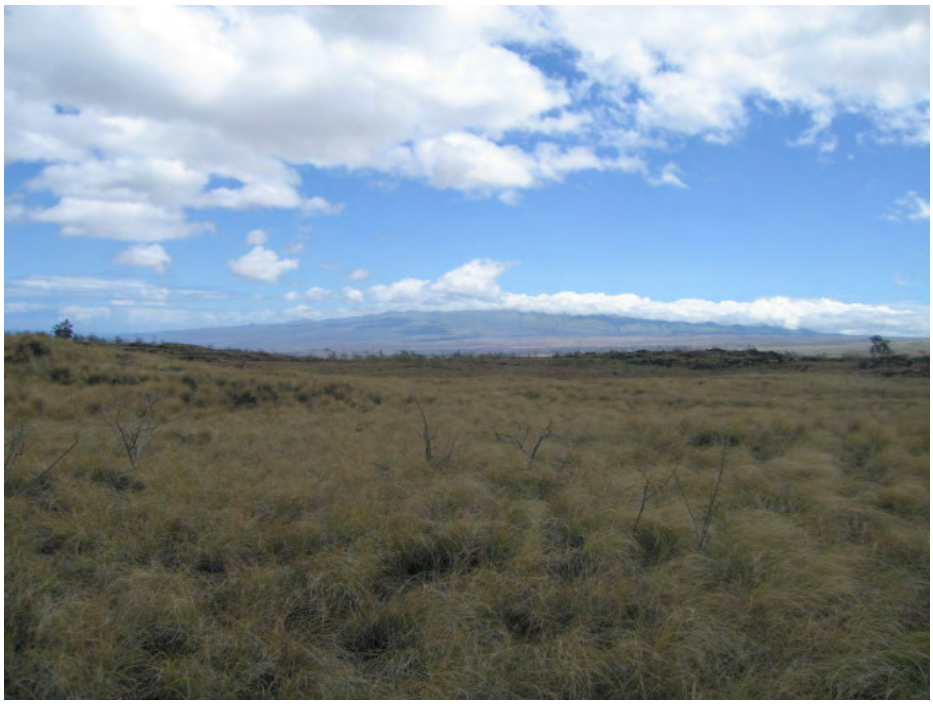


Figure 6 – Plain near Pu`u Ku`aīniho where cattle corralled prior drive

An *ahu* (cairn) was located by James Head in the plain interpreted by Uncle Sonny as a trail marker.

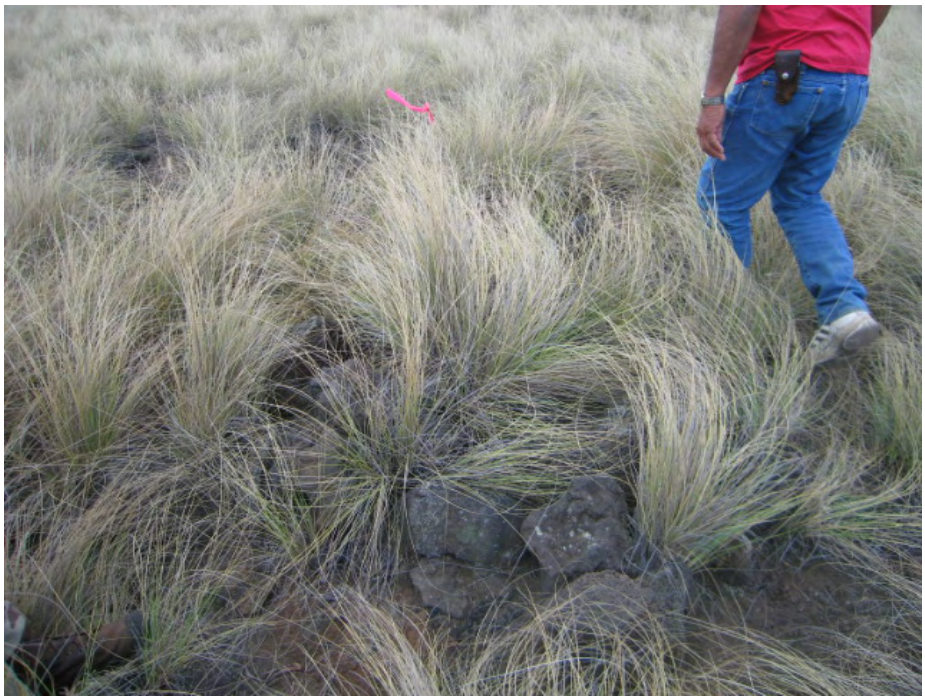


Figure 7 – Remains of *ahu* near Pu`u Ku`aīniho

Remains of the old Government Road between Highway 19 and the plane were intact.

Figure 8 – Uncle Sonny and James Head on old Government Road near Pu`u Ku`aīniho

Uncle Sonny recommended returning to this plain after a fire when the lack of grass may reveal the cattle trail. Until then, he suggested staring at the Puakō Gate and following the fence line from there. He believed this to be the best approach to determining the full extent of the cattle trail.

That afternoon Head and Wong Smith returned to Queen Ka`ahumanu Hwy. and searched for the fence line following a 4 wheel-drive road going *ma uka* parallel to `Auwaiakeakua[3] Gulch with Head taking GPS at several fence posts to maintain the trail. The following maps show the location of the trail in relation to the subject properties:

[3] watercourse of the god, Pukui, Elbert & Mookini 1974

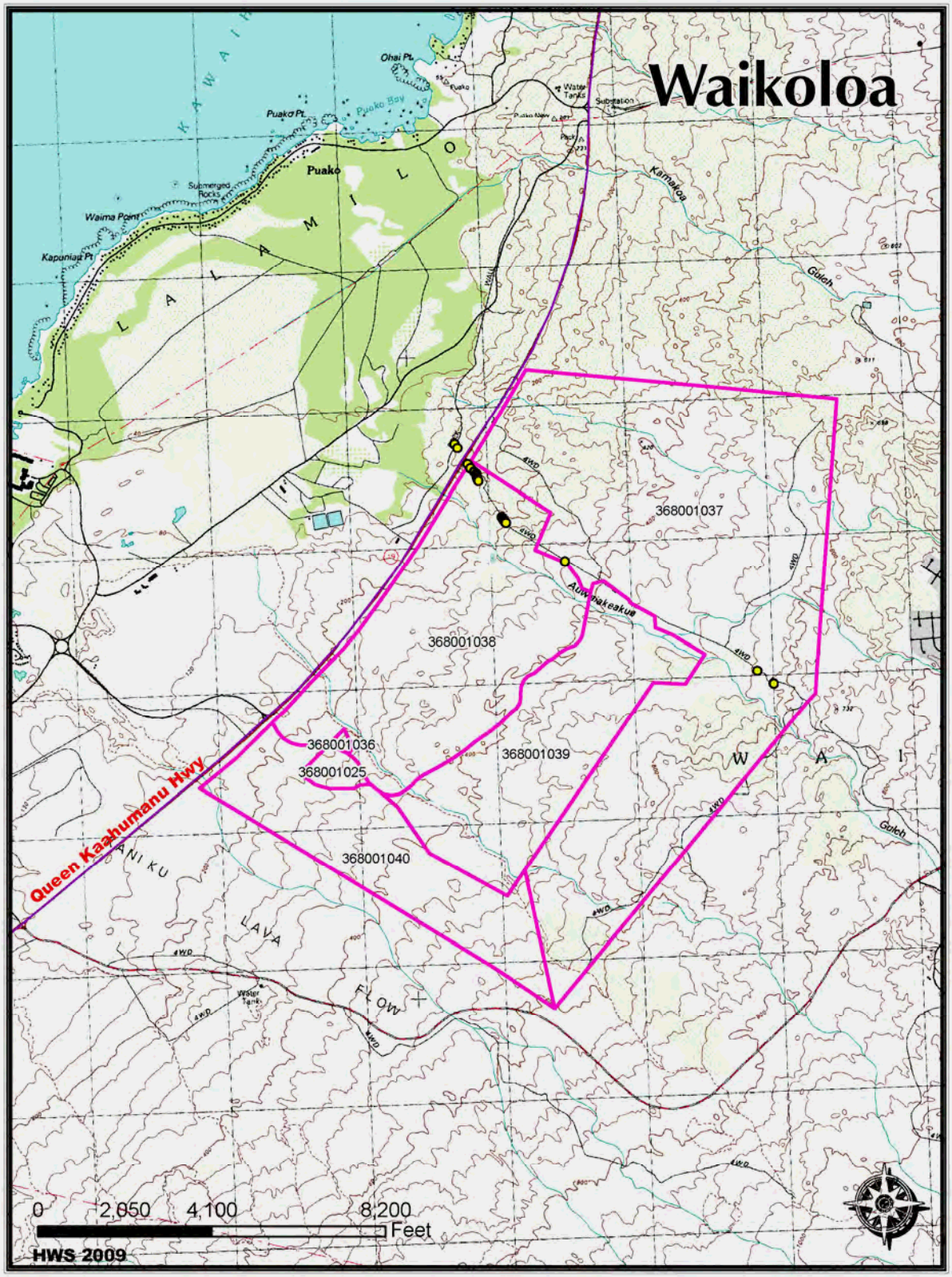


Figure 9 – Topographical map showing GPS points of fence line/trail in relation to subject properties

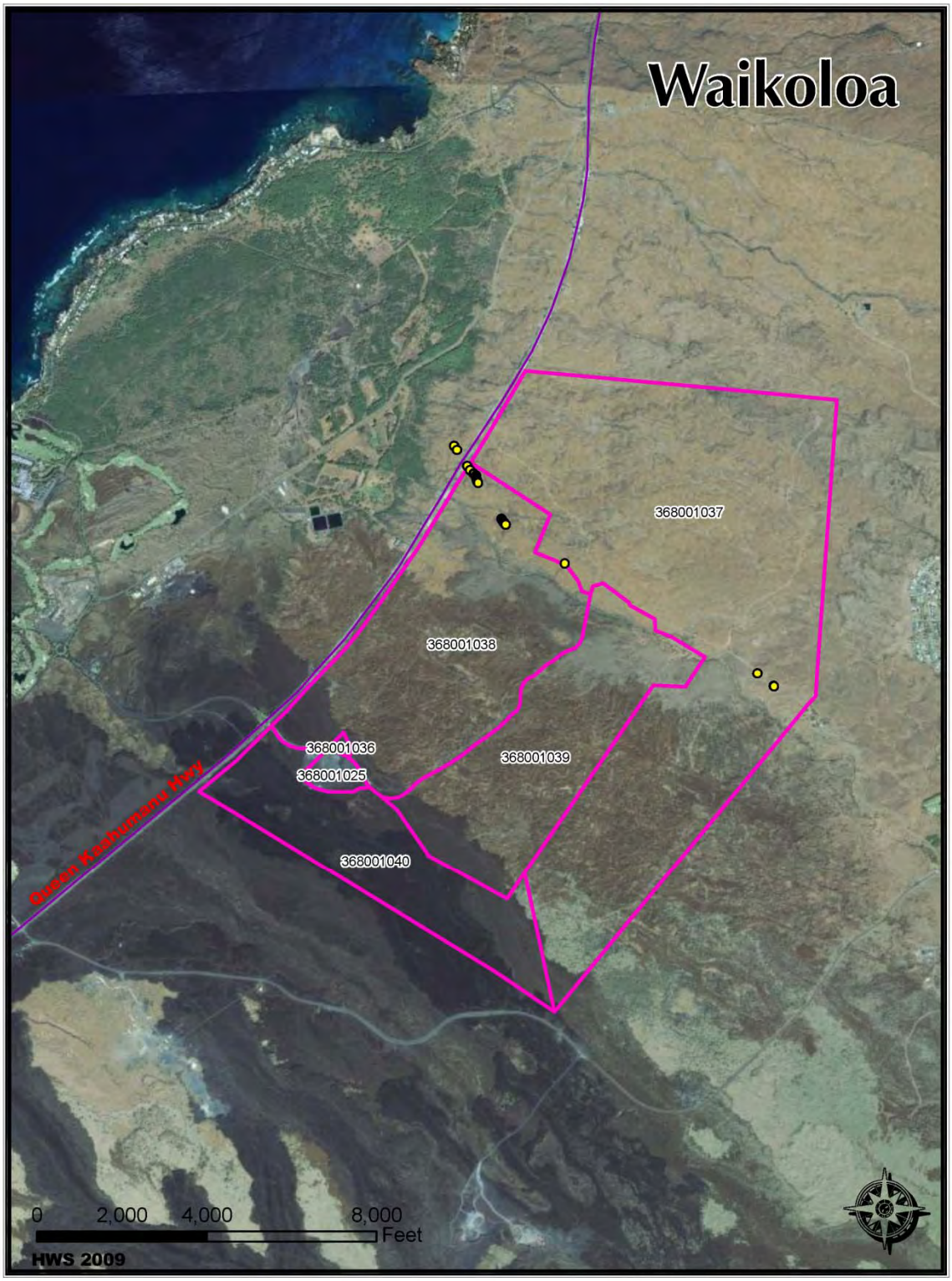


Figure 10 – Aerial image with GPS points of fence line/trail in relation to subject properties

While these two maps reflect the final point of the *ma kai* portion of the trail, the following map provides an overview of the trail's fullest extent from its commencement near Pu`u Ku`aīniho:

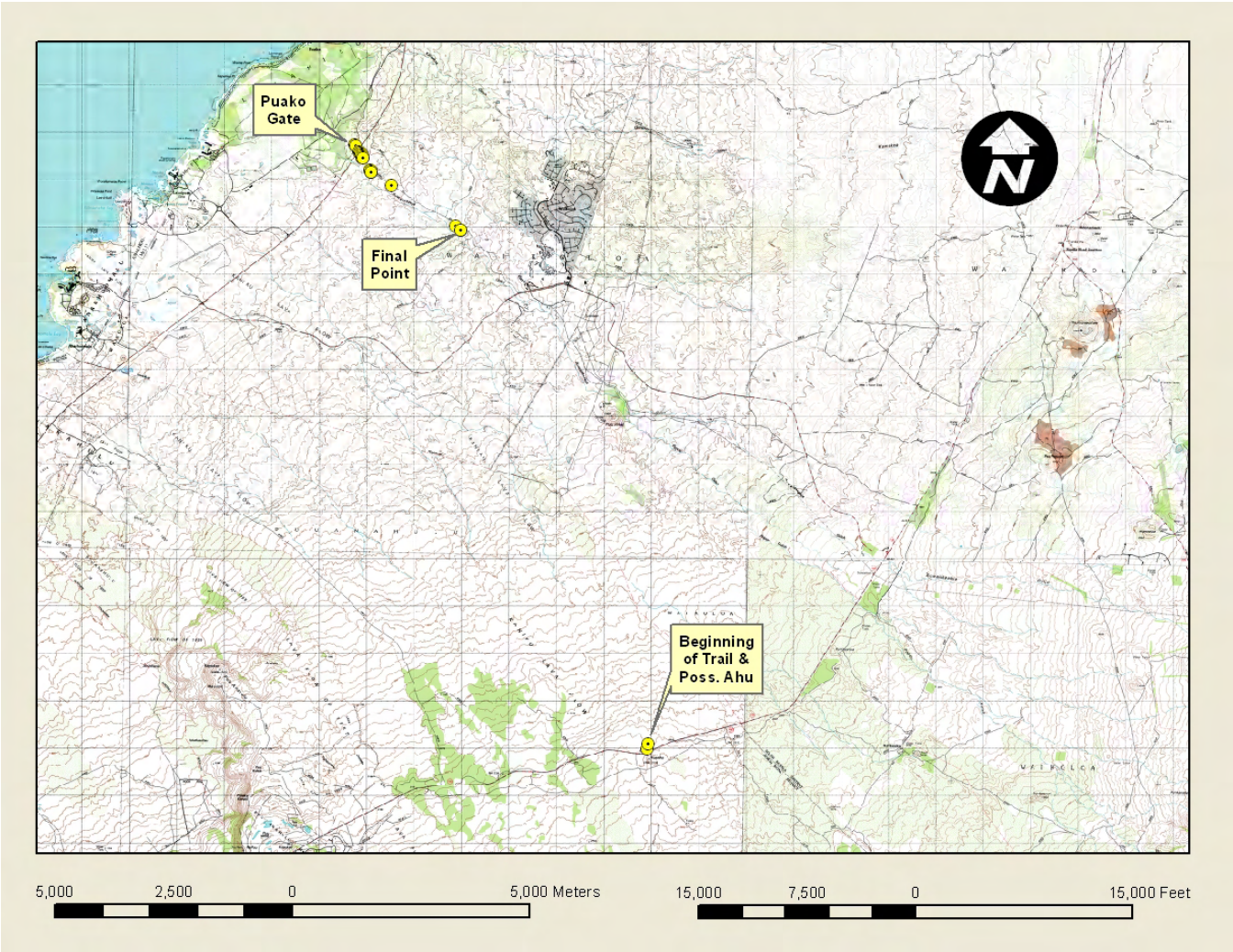


Figure 11 – Topographical map with all GPS trail points indicated

Conclusion

Uncle Sonny has never traveled this cattle trail but was informed of its location by his father Robert Keakealani, Sr. who relayed it was no longer utilized after the 1930s when cattle where shipped out of Kawaihae or Kailua instead of Puakō. According the markers shared by Uncle Sonny, the trail traverses the subject properties parallel to `Auwaiakeakua Gulch. The trail was identified within the boundaries of the subject properties. At a later date, the full extent of the trail can be determined from the plain near Pu`u Ku`aīniho to the last GPS point taken within the subject properties.

Appendix A

Letter from Deborah Chang to Bridge `Āina Le`a, LLC,
January 7, 2008

ISLAND
TRANSITIONS LLC

January 7, 2008

Mr. John K. Baldwin
Managing Member
Bridge Aina Le`a, LLC
2500 Kalākaua Ave., No. 2404
Hon., HI 96815

SUBJECT: EIS Preparation Notice for Villages of `Āina Le`a

Dear Mr. Baldwin:

As you prepare the above-referenced Draft Environmental Impact Statement, please research as part of your cultural resources assessment whether a portion of a major, historic *mauka-makai* trail is located on the subject properties. The trail was used to drive cattle from the ranch formerly in Pu`u Anahulu and Pu`u Wa`awa`a, North Kona District, all the way down to Puakō and Kawaihae. Mr. Sonny Keākealani, currently a resident of Waimea, has personally used that trail when he worked for that ranch and would be the most knowledgeable about the trail's location and historic use. You may contact me if you need assistance in contacting Mr. Keākealani.

The fascinating history of ranching on the island of Hawai`i includes a special legacy of long-distance trails that are worthy of preservation, interpretation, and use. Historic trails and routes can be successfully integrated into new developments, especially when identified early in the planning process.

Thank you for your consideration of my comments.

Sincerely,

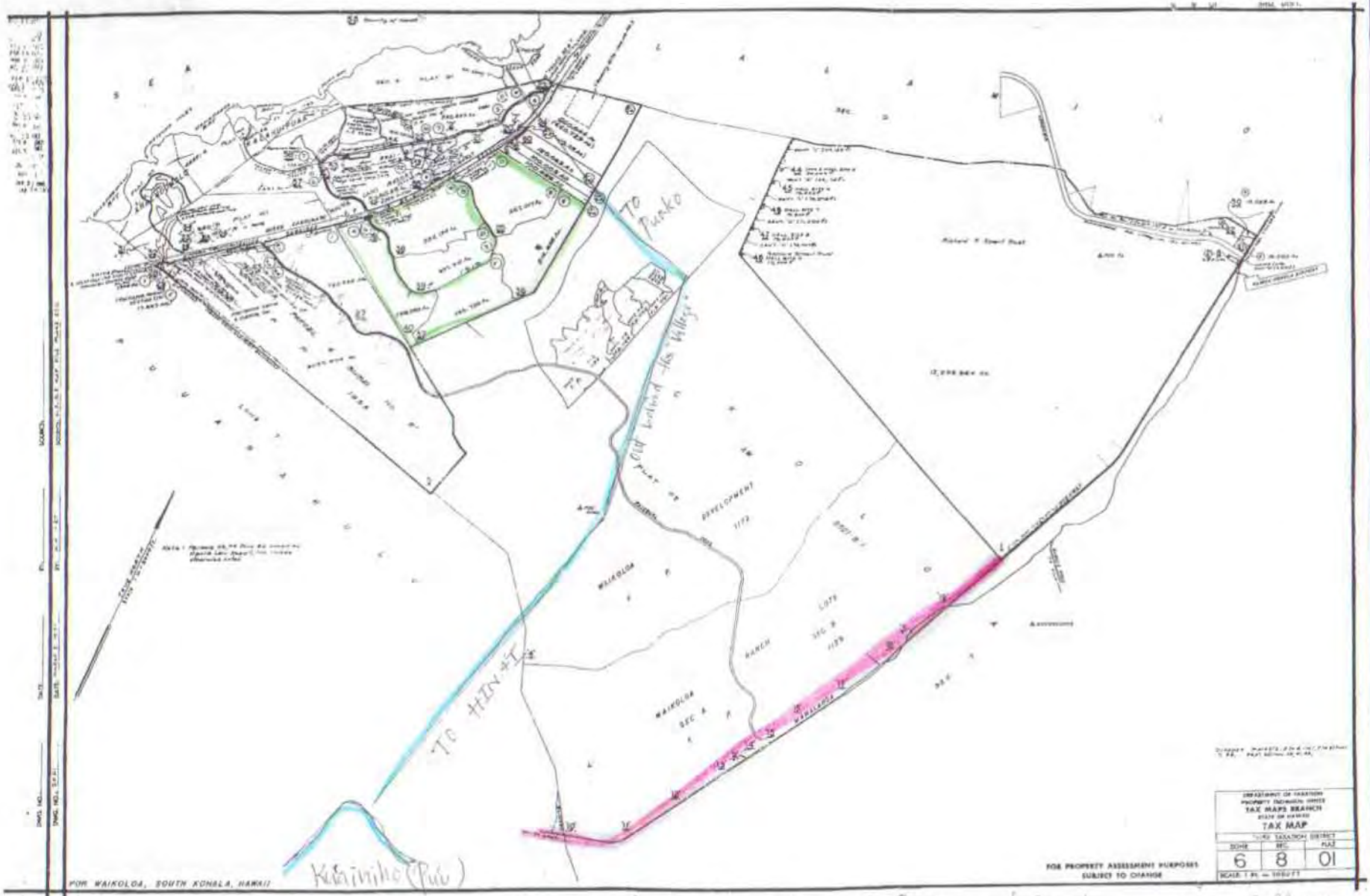
Deborah L. Chang

c: Hi. County Planning Dept.
Makani Resources
OEQC
Nā Ala Hele

Deborah L. Chang, LSW · *Principal Planner* · *Specializing In Trails & Access Issues*
P.O. Box 202 · Pa`auilo, Hi 96776-0202 · (808) 776-1516 · hkulaiwi@yahoo.com

APPENDIX B

TMK map with approximate route of cattle trail by Sonny Keakealani, February 2008



Note: This is Dad's approximation - He is willing to take us out in the field to actually show us where. Call us and we can look at possible dates/times. If that's a consideration, feel free to call 885-5045.

APPENDIX C

Letter from Don Hibbard to Nansay Hawaii, Inc., October 26, 1992

JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCE

DEPUTIES

JOHN P. KEPPELER, II
DONA L. HANAIKE

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION DIVISION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

October 26, 1992

LOG NO: 6556
DOC NO: 0339x

Ms. Christine Barada
Nansay Hawaii, Inc.
Kamuela Business Center
P.O. Box 111222, Suite 727
Kamuela, Hawaii 96743

Dear Ms. Barada:

SUBJECT: **Mauka-Makai Trail, Puako Residential Golf Community**
Waikoloa, South Kohala, Island of Hawaii
TMK: 6-8-01: 25, 36-42

Field check of the subject trail was conducted on September 11, 1992, by our Hilo Office Hawaii Island archaeologist, Marc Smith. Our Hawaii Island archaeologist, Kanalei Shun, in Honolulu is also very familiar with this project area as he was involved with the initial survey of the subject property. Both staff members conclude that the subject trail is historic, probably from the ranching era or when the area was used for military training during the early part of this century.

Our office also reviewed our records for the area and the results also support the conclusion that the trail is historic. An old map by L. L. Kaelemakulo from the late 1800s of Waikoloa and Waimea does not show the presence of any mauka-makai trail; the map does show the presence of a coastal trail, which it calls Alanui, heading from Kalahuipuaa to Puako and then mauka to Waikoloa iki and present-day Kamuela. A second map in our files, a 1928 map of the island of Hawaii by Walter E. Wall that shows all the major mauka-makai and north-south trails on the island, also fails to indicate any mauka-makai trail in the land unit of Waikoloa. Because the trail is recent in age, our office believes that it does not constitute a significant historic site and hence, not worthy of further recordation, data recovery, or preservation.

If you should have any further questions, please contact Kanalei Shun at 587-0007.

Sincerely,

DON HIBBARD, Administrator
State Historic Preservation Division

KS:sty

c: Allan Schilz, Ogden Environmental and Energy Services

Appendix L2

Cultural Impact Assessment, Second Addendum–Utility Corridors (Haun & Associates, January 2010)

Report 712-012910

SECOND ADDENDUM TO CULTURAL IMPACT ASSESSMENT
DW ‘AINA LE‘A DEVELOPMENT
LAND OF WAIKŌLOA
SOUTH KOHALA DISTRICT
ISLAND OF HAWAI‘I

By:

Alan E. Haun, Ph.D.,
Solomon H. Kailihiwa, III, B.A.
and
Dave Henry, B. S.

Prepared for:

D W ‘Aina Le‘a Development, LLC
P.O. Box 383129
Waikoloa, Hawai‘i 96738

January 2010

Haun & Associates
Archaeological, Cultural, and Historical Resource Management Services
73-1168 Kahuna A‘o Road, Kailua-Kona Hawai‘i 96740 Phone: 982-7755 Fax: 325-1520

Introduction

At the request of D W ʻAina Leʻa Development LLC, Haun & Associates prepared this second addendum to a Cultural Impact Assessment (CIA; Wong Smith 2007). The present project focused on ten specific locations within the Land of Waikōloa, South Kohala District, Island of Hawaiʻi (*Figure 1*). These locations consist of a proposed potable water easement, a portion of a Hawaiian Electric Light Company (HELCO) easement, seven stream crossings and a portion of ʻAuwaiakeakua Stream Gulch. These areas extend through portions of TMK: (3) 6-8-01: 37 and (3) 6-8-02:19 (*Figures 2, 3, 4* and *5*).

The objective of this assessment was to identify any culturally significant resources or traditional cultural practices that occurred within the project area and its vicinity. The study relied upon archival research that focused on historical documents, previous archaeological studies, and previous CIA studies prepared for the project area and adjacent lands (Wong Smith 2007, 2009).

In 2007, Wong Smith (2007) prepared a CIA for a rezoning application for a multi-use development within an area of approximately 1,060-acres in the State Land Use Urban District in Waikōloa (TMK:6-8-01: 25, 36, 37, 38, 39 and 40). The CIA was based on archival research including archaeological reports, government and historic documents, Hawaiian language documents that had been translated into English, and transcripts of previous interviews of individuals that lived and worked in the Waikōloa area. These transcripts included two individuals interviewed by Harvey Auna in 1991 (Schilz and Shun 1992), and two individuals interviewed by Maly in 1998 (Maly 1999).

According to Wong Smith (2007), traditional Hawaiian activity in the Waikōloa area mainly consisted of bird catching and harvesting *pili* grass (*Heteropogon contortus*). *Pili* was used as the main thatching material for *hale* (houses). Wong Smith cites informant testimony that there was a dryland garden area known as Makahonu near the intersection of Waikōloa Road and Queen Kaʻahumanu Highway where sweet potatoes, pumpkins, and sugar cane were cultivated until the early 1900s. Previous archaeological studies cited by Wong Smith indicate that historic and prehistoric use of the area was minimal and that the area was used for military training in the 1940s. Wong Smith's CIA concluded that there were no ongoing traditional cultural practices in the project area, and that there was only one site of cultural significance, State Inventory of Historic Places (SIHP) Site 15033, a burial cave (Wong Smith 2007).

In 2008, Deborah L. Chang wrote a letter to John K. Baldwin of Bridge ʻAina Leʻa, LLC in response to the Environmental Impact Statement (EIS) for the re-zoning application (Wong Smith 2009, Appendix A). Chang identified a *mauka-makai* (inland-seaward) trail that was utilized by cowboys to drive cattle from the upland ranch in Puʻu Anahulu and Puʻu Waʻawaʻa to the shores of Puakō and Kawaihae. The letter identified Sonny Keākealani as the source for the trail information and indicated that Sonny had personally used the trail when he worked for the ranch.

In response to Chang's letter, Wong Smith (2009) prepared an addendum to her original CIA (Wong Smith 2007). This addendum included a field inspection of the trail with Robert "Sonny" Keākealani, Jr. Mr. Keākealani drew the approximate location of the trail on a tax map and then led Wong Smith along portions of the trail. Mr. Keākealani indicated that he never traveled the trail, but that his father, Robert Keākealani, Sr. informed him of its location. Wong Smith mapped confirmed sections of the trail that follow a dirt road that parallels the north side of Auwaiakeakua Gulch .

The cattle drive trail was discussed in a 1992 letter from the State Historic Preservation Division (SHPD) Administrator Don Hibbard to Nansay Hawaii, Inc (Wong Smith 2009, Appendix C). Hibbard stated that the trail was inspected by SHPD staff who concluded that the trail was "probably from the ranching era or when the area was used for military training during the early part of [the 20th] century" (SHPD LOG NO: 6556, DOC NO: 0339x). Hibbard also stated that his office reviewed their records for the project area and the evidence that they found supports the staff conclusion. They were unable to find any evidence of the cattle trail on any historic maps of Waikōloa and Waimea pre-dating the 1930s. Hibbard concluded that because "the trail is recent in age, our office believes that it does not constitute a significant historic site and hence, not worthy of further recordation, data recovery, or preservation".

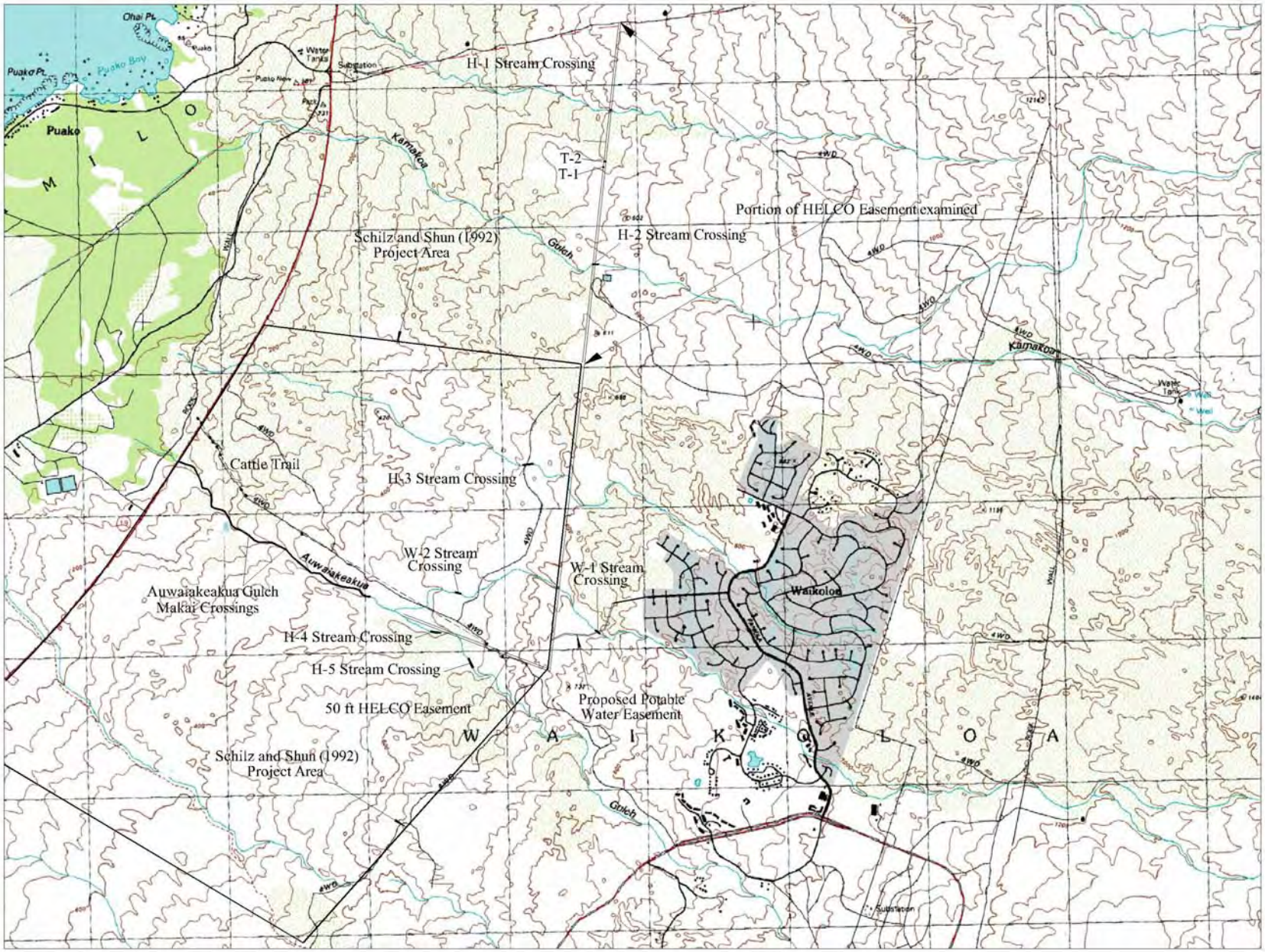


Figure 1. Portion of USGS Anaehoomalu Quadrangle showing Project Area Locations

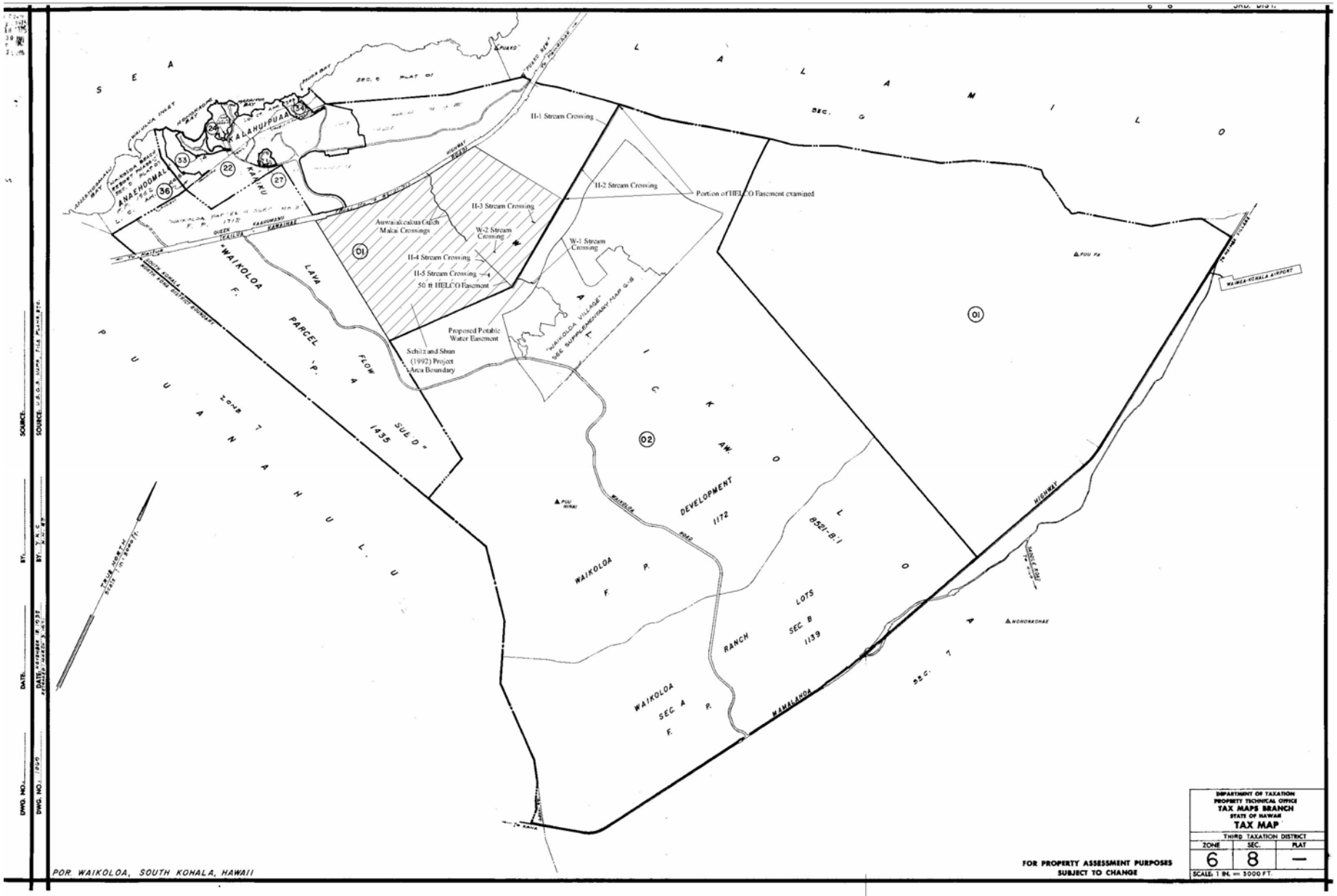


Figure 2. Tax Map Key 6-8 showing Project Area Locations

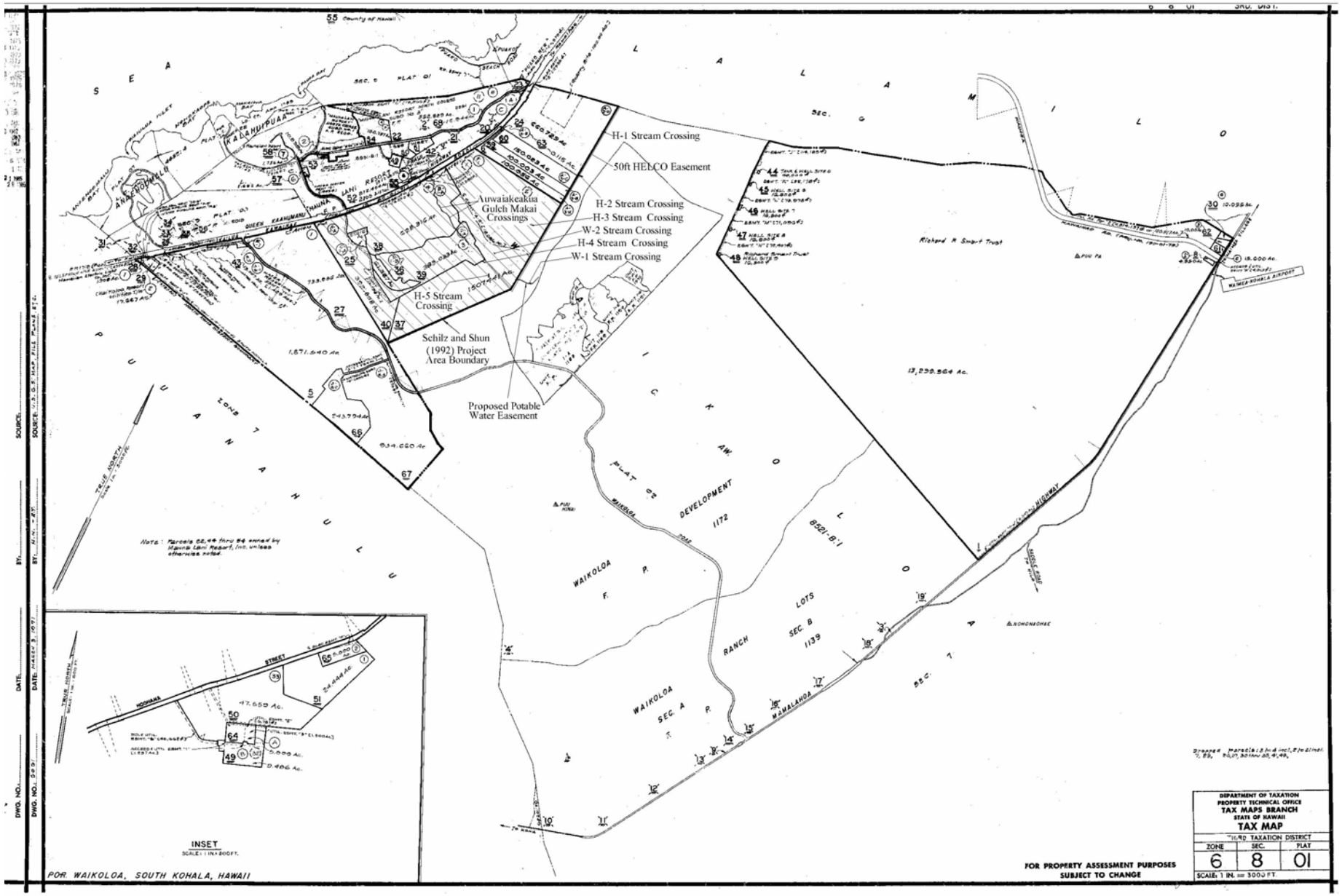


Figure 3. Tax Map Key 6-8-01 showing Project Area Locations

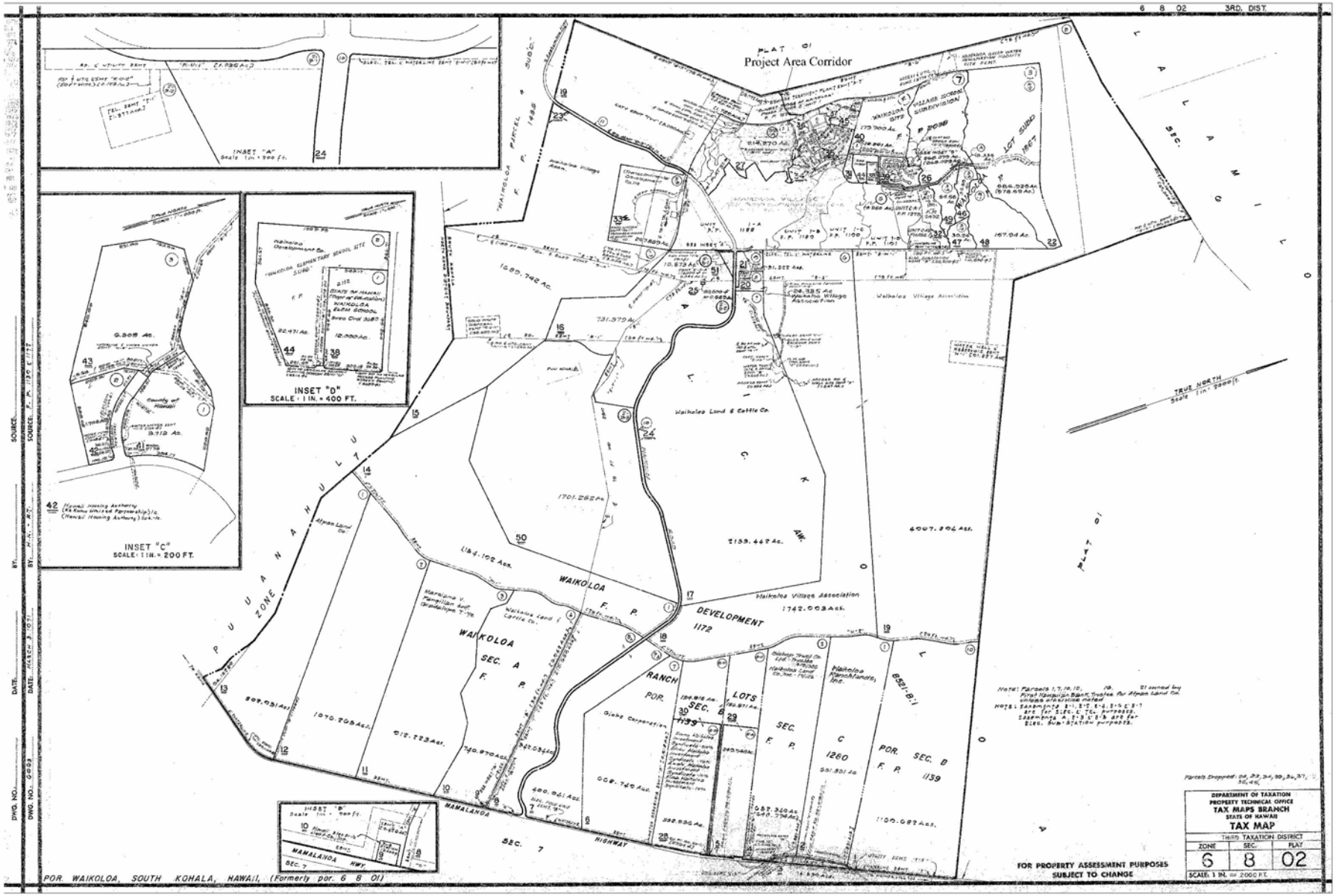


Figure 4. Tax Map Key 6-8-02 showing Project Area Locations

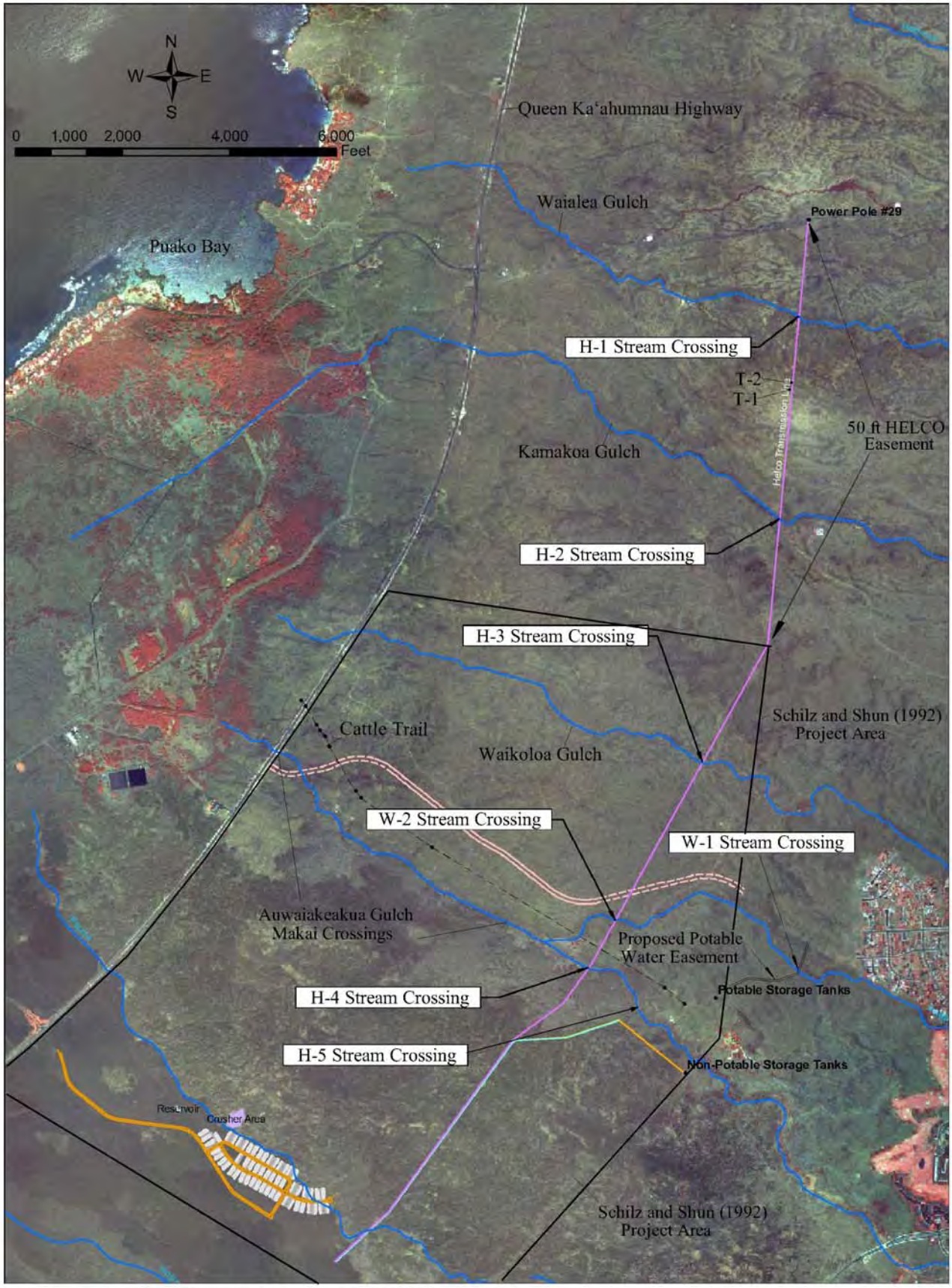


Figure 5. Aerial View showing Project Area Locations

The present second addendum CIA study was conducted because it includes areas that are outside the lands covered by the earlier CIA studies by Wong Smith. These areas consist of a potable water easement, a HELCO easement, and two stream crossings (H-1 and H-2). These areas are described in the following section. The remaining study areas are within the area covered by the original CIA (Wong Smith 2007). The previously and newly examined study areas were assessed to support applications for State and Federal stream crossing permits.

Project Area Description

As stated, ten areas were examined as part of this second CIA addendum study. These areas consist of a proposed potable water easement, a HELCO easement, seven stream crossings (Stream Crossings H-1 through H-5 and W-1 and W-2) and a portion of ʻAuwaiakeakua Stream Gulch (see *Figures 1-5*). These ten areas are located within or adjacent to a 3,000-acre parcel that was previously surveyed by Schilz and Shun (1992). The areas within the Schilz and Shun (1992) survey area consist of Stream Crossings H-3, H-4, H-5 and W-2 and the ʻAuwaiakeakua Stream Gulch area.

The five remaining locations (potable water easement, HELCO easement and Stream Crossings H-1, H-2 and W-1) are located outside the Schilz and Shun (1992) project area to the north and east. The HELCO easement portion of the project area, which includes the H-1 and part of the H-2 stream crossings, was previously surveyed by Moore et al. (2001). The results of these prior studies are discussed in more detail in the following section.

All of the stream gulches were dry at the time of the study. The vegetation within the areas consists of sparse *kiawe* (*Prosopis pallida*), *koa haole* (*Leucaena glauca*), *ilima (Sida fallax* Walp.*)* and low grasses. Rainfall in the vicinity averages less than 10 inches per year (Juvik and Juvik 1998:57). Field inspection of ʻAuwaiakeakua Stream Gulch and the seven stream crossings each extended between the tops of the banks on both sides of the drainages. The ten survey areas are described below.

The **Potable Water Easement** consists of a 30 ft wide corridor located within TMK: (3) 6-8-02:19 between c. 645 ft and 685 ft elevation. The corridor extends from the western end of Hulu Street in Waikoloa Village 1,959 ft to the west where it terminates at the inland boundary of TMK: (3) 6-8-01:37 (*Figures 6, 7, 8*). The corridor crosses a branch of ʻAuwaiakeakua Gulch. This crossing was examined as Stream Crossing W-1 (discussed below).

The **HELCO easement** portion of the project is located within TMK: (3) 6-8-02:19 at elevations ranging from c. 580 to 650 ft. It originates at the land division between Lalamilo and Waikōloa and extends approximately 1.6 miles to the south (see *Figure 5*). The easement is 50 feet in width and is bordered along the seaward side by a barbed wire fence. Stream Crossings H-1 and H-2 (discussed below) are located along the HELCO easement.

The **H-1 Stream Crossing** is located within TMK: (3) 6-8-02:19 on the Waialea Stream drainage at c. 475 ft elevation. This crossing is located along the 50 ft wide HELCO easement. The crossing consists only of the portion of the drainage that is located within the HELCO easement (*Figure* 9). The **H-2 Stream Crossing** is situated within TMK: (3) 6-8-02:19 on the Kamakoa Stream drainage at c. 530 ft elevation. This crossing is also located along the 50 ft HELCO easement, c. 5,723 ft south of the northern end. This stream crossing originated along the fence line on the seaward side of the HELCO easement and extends 150 ft upslope (*Figure 10*).

The **H-3 Stream Crossing** is situated within TMK: (3) 6-8-01:37 on the Waikōloa Stream drainage at c. 530 ft elevation. This crossing is located at the intersection of a dirt road and the drainage. It extended 125 ft inland and 125 ft seaward from the center of the road for a total of 250 linear feet (*Figure 11*). The **H-4 Stream Crossing** is situated within TMK: (3) 6-8-01:37 on the ʻAuwaiakeakua Stream Gulch at c. 475 ft elevation. This crossing area extends 125 ft inland and 125 ft seaward from the center of the gulch crossing, a total of 250 linear feet (*Figure 12*).

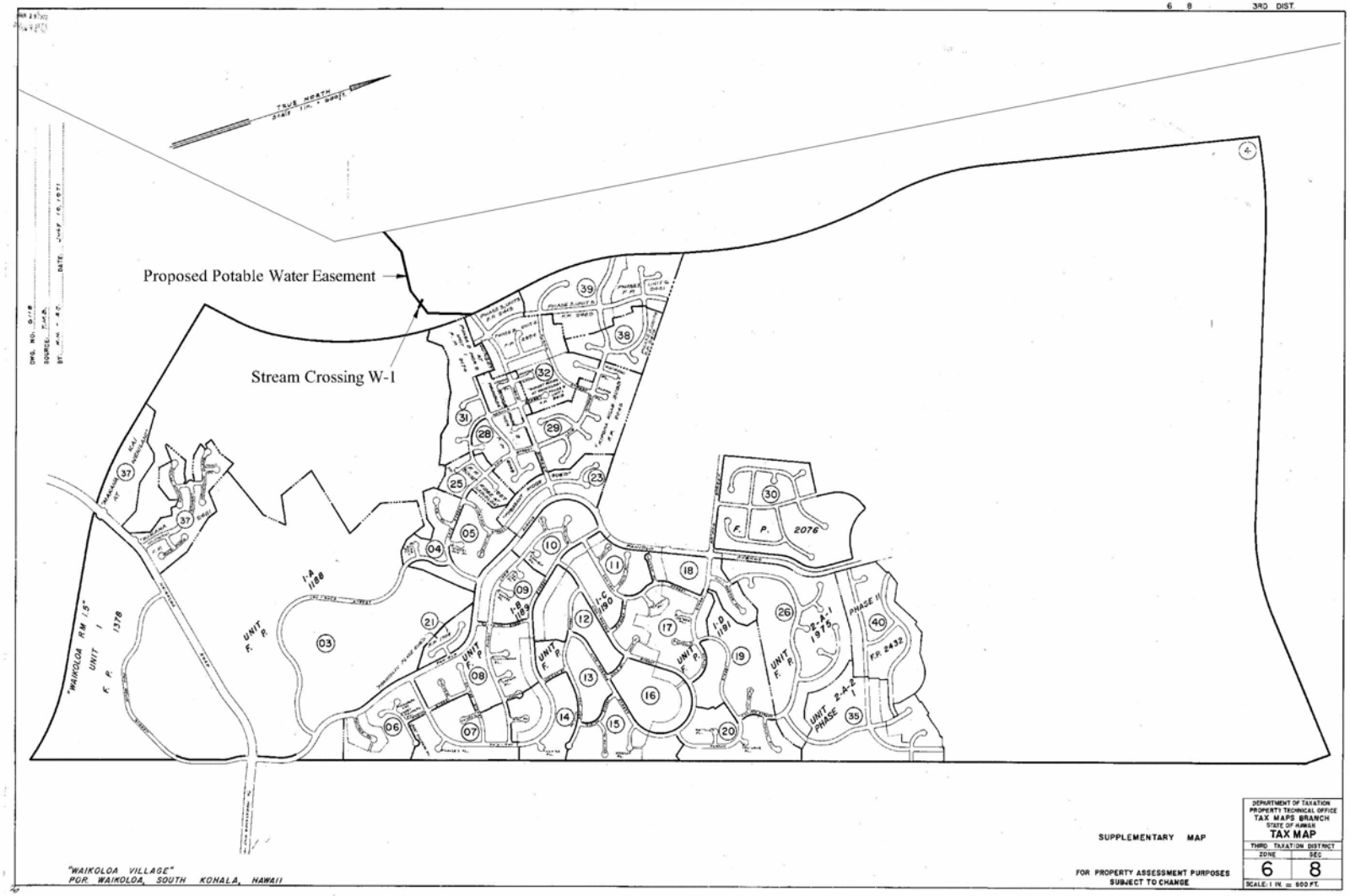


Figure 6. Tax Map Key Supplemental Map 6-8 showing Potable Water Ease,emt amd Stream Crossing W-1

Figure 7. Potable Water Easement, view to south

Figure 8. Potable Water Easement, view to southwest

Figure 9. H-1 Stream Crossing, view to northwest

Figure 10. H-2 Stream Crossing, view to northwest

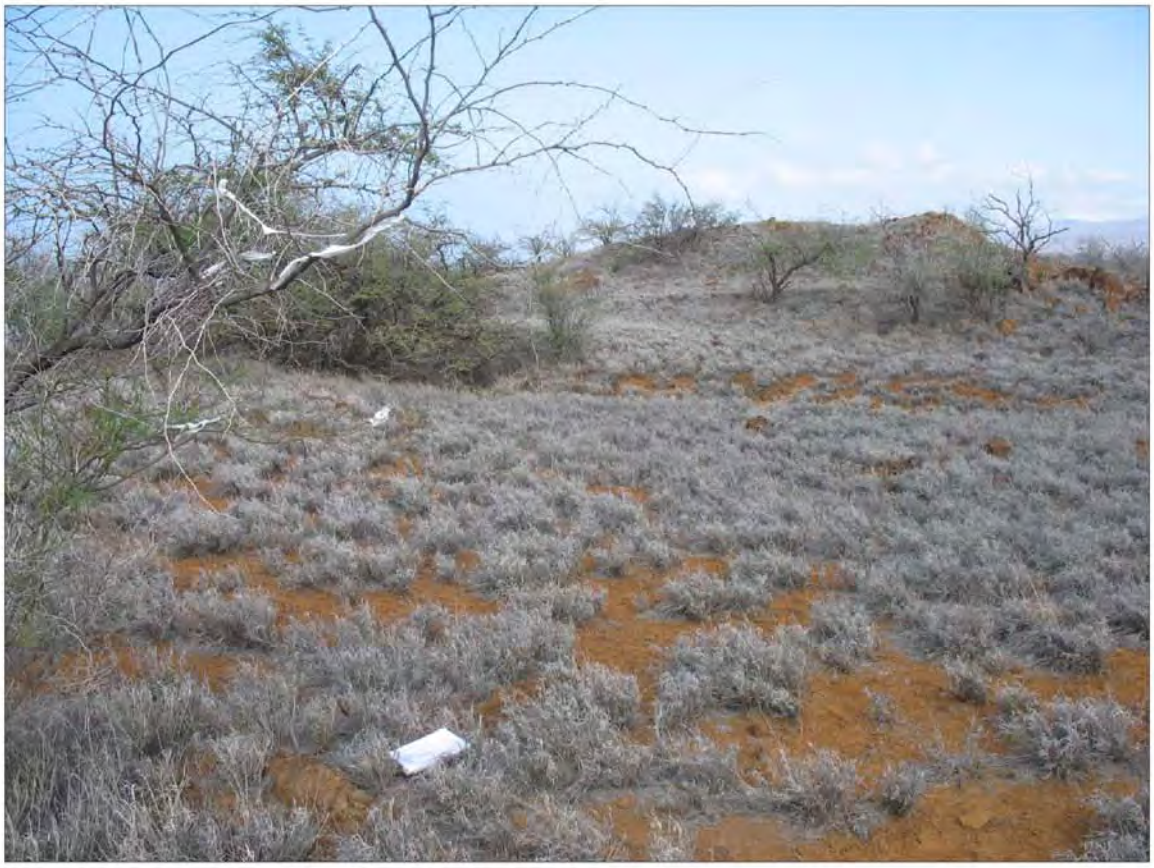


Figure 11. H-3 Stream Crossing, view to north-northwest

Figure 12. H-4 Stream Crossing, view to east

The **H-5 Stream Crossing** is situated within TMK: (3) 6-8-01:37 in ‘Auwaiakeakua Stream Gulch at c. 550 ft elevation, inland of the H-4 Crossing This crossing area also extends 125 ft inland and 125 ft seaward from the center of the gulch crossing, a total of 250 linear feet (*Figure 13*).

The **W-1 Stream Crossing** is situated within TMK: (3) 6-8-02:19 on a northern tributary of ‘Auwaiakeakua drainage at c. 675 ft elevation. This crossing is located along the proposed potable water corridor discussed above. The crossing area extends 75 ft inland and 75 ft seaward along the gulch for a total of 150 ft (see *Figure 6* and *Figure 14*).

The **W-2 Stream Crossing** is located within TMK: (3) 6-8-01:37 at c. 555 ft elevation. This crossing extends from the center of the proposed crossing 75 ft inland and 75 ft seaward for a total of 150 linear feet (*Figure 15*).

The **‘Auwaiakeakua Gulch Makai Crossings** area consists of a 5,000 ft section of the ‘Auwaiakeakua Gulch where an unspecified number of potential stream crossings are to be incorporated into future development plans. The specific locations of these crossings will be determined in the future. The ‘Auwaiakeakua Gulch Makai Crossings portion of the project originates on the inland side of Queen Ka‘ahumanu Highway at c. 115 ft elevation (*Figure 16*). It extends upslope 5,000 ft to c. 445 ft elevation. This portion of the project is located within an area previously surveyed by Moore et al. (2001), who reported no archaeological sites within the gulch.

Historical Documentary Research

Haun et al. (2003), Welch (1989) and Barrere (1971, 1983) discuss the traditional land divisions of Waikōloa and the adjacent lands of Kalahuipua‘a, and ‘Anaeho‘omalu (*Figure 17*). Their research focused on Land Commission Award (LCA) testimony, Boundary Commission testimony, and other historic documents. In earlier times, Waimea was a sub-district of Kohala that included all of the land in the district south of Waikōloa Stream. Waimea was composed of eight subdivisions with the majority of the district being composed of the *‘ili* of Waikōloa and Pu‘ukapu. The remainder consisted of the *‘ili* of Wai‘aka, Lālāmilo, ‘Anaeho‘omalu, Kalahuipua‘a, Puakō, and ‘Ōuli.

At the *Mahele*, Waikōloa was deemed Crown Land of which Isaac Davis received a large portion. Waikōloa (LCA 8521-B) was sometimes referred to as “Waikōloa Nui” and “Waikōloa Iki”, differentiating between the Crown Land and Davis’ land respectively. The Crown Land portion later became known as Lālāmilo and Davis’ portion simply as Waikōloa. The coastal lands of ‘Anaeho‘omalu and Kalahuipua‘a were retained by the Crown as *‘ili kupono*. Kamehameha III gave these lands to his wife Kalama (LCA 4452). ‘Anaeho‘omalu was claimed by Kahenehene (LCA 4100), but she relinquished it (Maly 2000:19).

Traditional and legendary references to ‘Anaeho‘omalu, located seaward of the project area, are presented in detail by Maly (2000) and Barrere (1971) and are summarized here. According to legendary accounts in about the Thirteenth Century, Kama‘iole, a cruel chief, was killed in a battle at ‘Anaeho‘omalu. During the same period, fishing and salt making are described.

In the Sixteenth Century, the Hawai‘i Island ruler Lono-i-ka-makahiki, the grandson of ‘Umi-a-Liloa, put down a revolt by a group of rebel chiefs who were encamped at ‘Anaeho‘omalu. Lono-i-ka-makahiki erected an altar, Ke-Ahu-a Lono, on the boundary between Kona and Kohala at ‘Anaeho‘omalu to consecrate a cooperative covenant between the chief and his trusted advisor, Kapaihiahilina, who had been slandered. The altar was built at the time Lono-i-ka-makahiki was preparing to battle the invading forces of the Maui king Kama-lala-walu.

Early historic accounts from Cook’s voyage in 1779 and Arago in 1819 describe the general vicinity as desolate and sparsely inhabited based on observations made from the ships (Maly 2000). Ellis traveled from Kawaihae to Kailua by canoe in 1823 stopping at Puakō, and at Kapalaoa, a small settlement a short distance south of ‘Anaeho‘omalu.

Figure 13. H-5 Stream Crossing, view to west

Figure 14. W-1 Stream Crossing, view to south

Figure 15. W-2 Stream Crossing, view to southeast

Figure 16. Auwaiakeakua Gulch, view to east

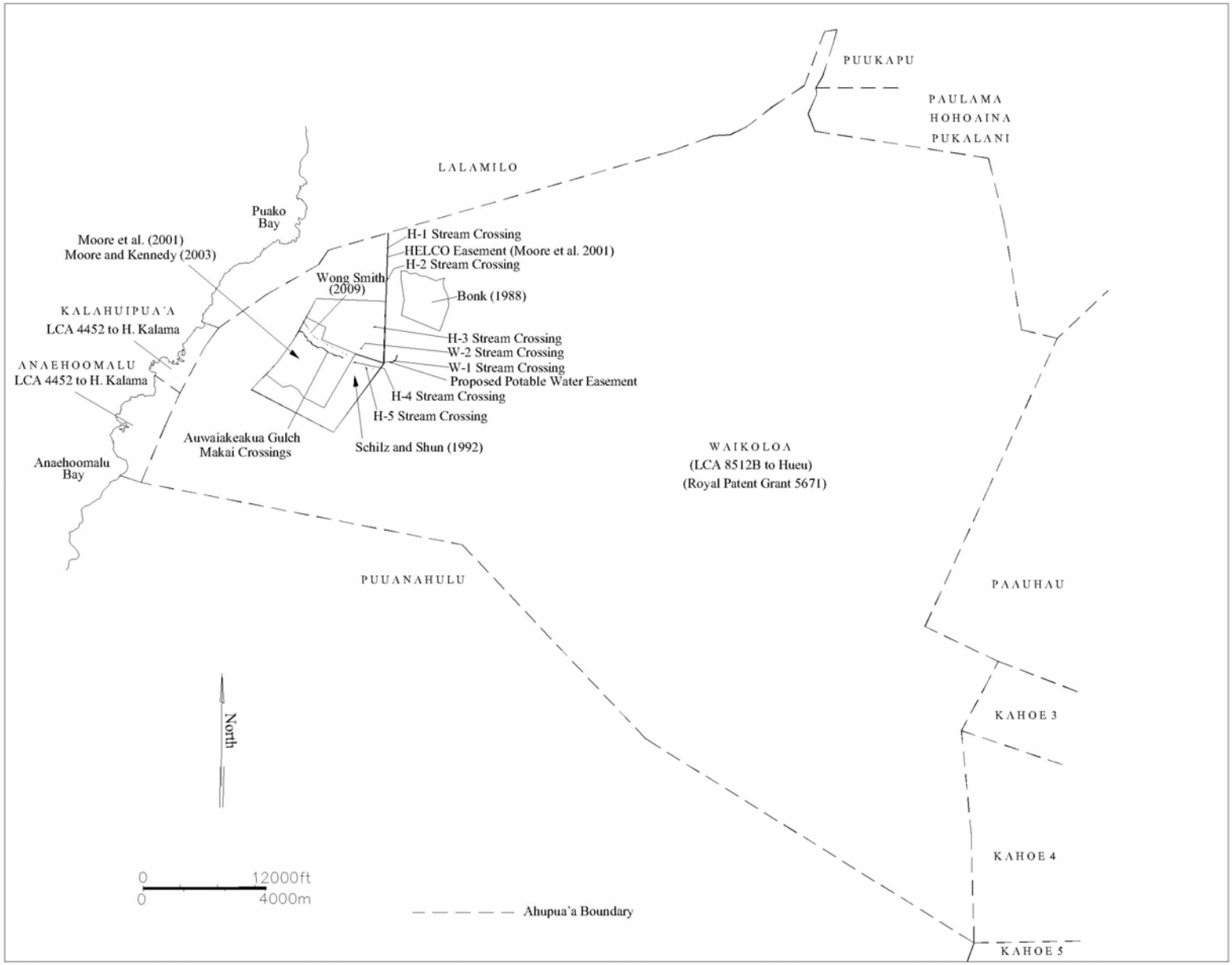


Figure 17. Ahupua`a Boundaries, Land Commission Awards and Previous Archaeological Studies in and near Project Area

Kahenehene's (LCA 4100) 1848 claim testimony for a parcel at ʻAnaehoʻomalu describes *kou* and coconut trees and salt making ponds (Maly 2000). The claim included four houses that were enclosed. Boundary Commission testimony from 1873 describes a small *heiau* called Hiakalaihi at the coast on the boundary between ʻAnaehoʻomalu and Puuanahulu. Ke-Ahu-a Lono was situated inland of the *heiau*. A large rock called Pohakuloa at the coast was described as marking the boundary between ʻAnaehoʻomalu and Kalahuipuaʻa.

John Palmer Parker settled in Hawaiʻi in 1815 and became a renowned bullock hunter (Haun et al. 2003). He became friends with John Young and spent much of his early years at Kealakekua, where Kamehameha held court. After the death of Kamehameha in 1819, Parker moved to Waiapuka in Kohala with his *aliʻi* wife, Kipikane and their new-born daughter (Wellmon 1970: 20-26).

In 1850, John Parker purchased 640 acres of land at Mana from the Hawaiian Government. The following year, Parker purchased an additional 1,000 acres. In 1852, Kamehameha III granted a lease to Parker for the lands of Waikōloa, giving Parker the competitive edge to control the developing ranching industry (Wellmon 1970:75). Parker's grandson, Samuel Parker, purchased ʻAnaehoʻomalu and Kalahuipuaʻa from the estate of Charles Kanaina, Queen Kalama's uncle, in 1878 (Barrere 1971). These lands were used by the ranch for recreation, fishing and aquaculture.

In the early 1900s, the Parker family acquired Waikōloa and ʻŌuli in fee-simple, giving them 100,000 acres of grazing land (Wellmon 1970: 75). Alfred W. Carter, guardian of Thelma Parker and manager of Parker Ranch, did much to aid ranching by improving cattle stock, conserving tree-less ranch lands by planting new and better grasses, and organizing the Hawaiʻi Meat Company to provide ranchers an outlet to market their beef and beef products (Brundage 1971:59, 28). The ranch sold Kalahuipuaʻa and ʻAnaehoʻomalu to Francis Iʻi Brown in 1936 (Maly 1999:126). Mr. Carter managed Parker Ranch until 1937 when his son, Hartwell Carter took over the position of ranch manager and remained in that capacity for the next twenty-five years.

As a major supplier of beef, Parker Ranch played a pivotal role in providing beef and mutton to the American military in Hawaiʻi during both WWI and WWII. The Waikōloa Maneuver Area, an area of 91,000 acres, was acquired by the U.S. Navy in December 1943 through a license agreement with Richard Smart of Parker Ranch for the sum of $1.00 (*ibid*.: 109). The training area extended from the ocean to the Pohakuloa Training Area, and from the Waimea-Kawaihae Road to south of the Waikōloa Road. The area was used for military exercises including the use of live ammunition and other explosives. The land was returned to Parker Ranch in September 1946. The project area is currently undeveloped.

Previous Archaeological Work

Several archaeological studies have been conducted within and in the immediate vicinity of the project area. The location of these investigations is depicted in *Figure 17*. A survey of c. 3,000-acres of Waikōloa was undertaken by Schilz and Shun (1992). The Schilz and Shun survey identified 13 sites with 34 features; however, only one was assigned a site number. The site consists of a burial cave designated SIHP Site 15033. The 12 remaining sites were designated as modern military features consisting of cairns, walled shelters, rock mounds and C-shaped enclosures. According to the authors, the paucity of archaeological sites was not surprising as the terrain was, "too rugged and inhospitable for human use and habitation" (*ibid*.:21).

A subsequent archaeological inventory survey of a c. 1000-acre portion of the Schilz and Shun (1992) study area and a 50 ft wide HELCO easement was conducted by Archaeological Consultants of the Pacific (Moore et al. 2001). The survey identified ten sites with 15 features consisting of a hearth, a trail segment leading to a small stone quarry, three *ahu* along a jeep trail, C-shaped walls with an associated *ahu*, a rock shelter, a large *ahu*, and a modern fire pit. All of these features are located in the seaward portion of their project area, below c. 400 ft elevation. The survey of the HELCO easement noted shrapnel and a piece of unexploded ordnance, none of which were assigned site numbers.

Data recovery excavations were subsequently undertaken at one of the ten sites identified within the 1000-acre survey area (Moore and Kennedy 2003). The excavations at the Site 22514-A rock shelter yielded food remains and stone tools along with a large number of seabird remains. The amount of seabird remains recovered suggested that the shelter was associated with the harvesting of seabirds in the immediate area. Moore and Kennedy speculated that the C-shapes with associated *ahu* noted during the inventory survey may have been used as hunting blinds for catching seabirds. Radiocarbon dating indicated utilization of this site as early as the AD 1300s.

As previously discussed, Wong Smith (2009) documented a trail used to drive cattle from the uplands to the coast at Puakō (see *Figures 1 and 5*). The trail parallels the north side of ʻAuwaiakeakua Gulch along the course of a dirt road that bisects the Schilz and Shun (1992) study area. Bonk (1988) conducted a reconnaissance survey of c. 580 acres just north of Waikōloa Village. This survey identified numerous modern military shrapnel fragments although no archaeological sites or features were identified.

Field Inspection Findings

No culturally significant sites or features were identified during the field inspection of the proposed potable water easement or the eight stream crossing areas. Two archaeological sites and exploded ordinance fragments were noted along the HELCO easement. These sites consist of a small enclosure and a mound interpreted as the probable remnants of World War II era military activities (see *Figures 1* and *5*). These sites are described below. No evidence of recent traditional cultural practices was observed during the inspection fieldwork.

Site T-1 is a low, circular enclosure that is constructed of roughly stacked boulders and cobbles measuring 7.5 ft long, 7.2 ft wide and 2 ft high (*Figure 18*). The fence line that serves as the *makai* (seaward) boundary of the HELCO easement, and a recent water line extend over the surface of the enclosure. This feature is very similar to military features described by Schilz and Shun (1992) and has a commanding view of a wide gulch to the north and east.

Site T-2 is a low, roughly rectangular mound of piled cobbles and small boulders that measures 3.28 ft long, 2.96 ft wide and 2 ft high (*Figure 19*). It is located approximately 138 ft to the north-northeast of T-1 at the top of a gulch bank. This mound also is similar to the military features described by Schilz and Shun (1992).

The general absence of archaeological sites throughout the other inspection areas examined is attributable to the rugged and arid conditions. As discussed above, the paucity of archaeological remains in this area has been well documented during previous studies and the findings of the present study are not unexpected.

Conclusion

The objective of this assessment was to identify any culturally significant resources or traditional cultural practices that occurred within the project area and its vicinity. The study relied upon archival research that focused on historical documents, previous archaeological studies, and previous CIA studies (Wong Smith 2007, 2009) prepared for the project area and adjacent lands.

The Waikōloa area was noted mainly for its seabird harvesting and *pili* harvesting. Evidence of seabird harvesting was documented during a previous archaeological study of the area (Moore et al. 2001). C-shaped structures with associated cairns were interpreted to be blinds constructed to hunt local seabirds. Seabird remains were recovered during data recovery excavations of a cave shelter situated in the vicinity of these “blinds” (Moore and Kennedy 2003).

Figure 18. Site T-1 Enclosure, view to north

Figure 19. Site T-2 Mound, view to northwest

During the current field investigations two sites were noted along the HELCO easement between crossings H-1 and H-2. The sites consist of a small circular enclosure and a small mound. Both sites are situated overlooking a gulch, approximately 138 ft apart. The sites are very similar to WWII military training-related sites described by Schilz and Shun (1992) and likely are the result the same episode of activity. Further signs of military training included fragments of exploded ordinance in the easement corridor.

The archival research and field inspection for this CIA addendum study did not identify any culturally significant resources or any evidence that the project areas are currently being used for any traditional cultural practices. The only culturally significant site identified during previous studies in the project area vicinity is a burial cave (SIHP Site 15033). A burial treatment plan (BTP) for the site was previously prepared by Haun & Associates (2004) and approved by the SHPD and Hawaii Island Burial Council (SHPD LOG NO: 2004.2992, DOC NO: 0410KL01). Adherence to this BTP will ensure that the burial site will not be impacted by development.

If human skeletal remains, or other culturally significant sites, are encountered during development activity, the remains will be treated following the procedures outlined in Hawai‘i Revised Statutes (HRS) Chapter 6E-43. Work in the area of the discovery will be halted, the remains stabilized if necessary, and DLNR-SHPD will be consulted for guidance.

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Appendix M
Traffic Impact Analysis Report (SSFM, September 2009)

TRAFFIC IMPACT ANALYSIS REPORT

September 2009

Project Managers, Planners and Engineers
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TRAFFIC IMPACT ANALYSIS REPORT

FOR

THE VILLAGES OF AINA LE‘A

WAIKOLOA, HAWAI‘I

July 15, 2009

PREPARED FOR:

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This work was prepared by
me or under my supervision

_____

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Licensed Professional Engineer
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TABLE OF CONTENTS

SECTION **PAGE**

I. PROJECT BACKGROUND AND DESCRIPTION 1

II. STUDY METHODOLOGY 7

III. EXISTING CONDITIONS 10

A. Roadways 10
B. Traffic Volumes 11

IV. TRAFFIC FORECASTS 15

A. Background Traffic Forecast 17
B. Project Generated Traffic 22
C. Trips Diverted to New Roadway 31
D. Total With Project Forecast Volumes 34

V. ANALYSIS OF FUTURE CONDITIONS 40

A. Level of Service Analysis 40
B. Mitigation Needed 46
C. Traffic Signal Warrants 49
D. Recommendations 55

VI. ANALYSIS OF OTHER ADJACENT PROPERTIES 57

A. Additional Projects 57
B. Supplemental Traffic Forecast 58
C. Supplemental Traffic Analysis 63

VII. CLOSING SUMMARY COMMENTS……..65

APPENDICES

APPENDIX A Traffic Count Data

APPENDIX B Trip Estimation and Wintass Outputs

APPENDIX C Highway Capacity Manual Analysis Reports

APPENDIX D Traffic Signal Warrant Analysis

LIST OF FIGURES

FIGURE **PAGE**

Figure 1 Project Location Map for Villages of Aina Le’a……...……2

Figure 2 Conceptual Study Network for the Villages of Aina Le’a 5

Figure 3 Conceptual Master Plan for Villages of Aina Le’a……..….6

Figure 4 2007 Existing Daily Traffic Volumes……...…..13

Figure 5 2007 Existing Peak Hour Traffic Volumes…….…14

Figure 6 Year 2009 Peak Hour Traffic Volumes……...…15

Figure 7 Predicted Year 2012 Traffic Volumes Added Due to Background Growth…...20

Figure 8 Predicted Year 2012 Traffic Volumes without Project……...…21

Figure 9 Predicted Year 2020 Traffic Volumes without Project……...…22

Figure 10 Trip Assignment Percentages for New Trips……28

Figure 11 Volume Added Due to New Trips Generated in Phase I of Project in Year 2020……...30

Figure 12 Volume Added Due to New Trips Generated at Full Buildout of Project in Year 2020 ……..….……...31

Figure 13 Predicted Year 2012 Traffic Volumes Diverted Due to New Connecting Roadway……33

Figure 14 Predicted Year 2020 Traffic Volumes Diverted Due to New Connecting Roadway……34

Figure 15 Predicted Year 2012 Traffic Volumes without Project in Place……...36

Figure 16 Predicted Year 2012 Traffic Volumes with Project in Place……37

Figure 17 Predicted Year 2020 Traffic Volumes without Project in Place……...38

Figure 18 Predicted Year 2020 Traffic Volumes with Project in Place……39

Figure 19 Application of Right Turn Lane Warrant Criteria to Intersection of Queen Ka’ahumanu Highway at Mauna Lani Drive Northbound with Project in Year 2012…..47

Figure 20 Application of Right Turn Lane Warrant Criteria to Intersection of Queen Ka’ahumanu Highway at New Villages of Aina Le’a Access Northbound with Project in Year 2012……...48

Figure 21 MUTCD Figure 4C-1 Four-Hour Vehicular Volume Warrant…….52

Figure 22 2020 Traffic Generated by Unscheduled Potential Developments……...61

Figure 23 Predicted Peak Hour Traffic Forecast with Other Potential Developments Year 2020……...…62

LIST OF TABLES

TABLE **PAGE**

Table 1 Land Use Summary (Land within Current Urban District)…….. 4

Table 2 Intersection Levels of Service from HCM……...…..8

Table 3 Daily Traffic Volumes on Queen Ka’ahumanu Highway ……...12

Table 4 Intersection Level of Service Analysis for Existing Conditions in 2009….16

Table 5 Predicted Development Projects in the Area of Villages of Aina Le’a……17

Table 6 Trip Generation for Kilohana Kai, Waikoloa Heights, Waikoloa Highlands and Lot 28……..18

Table 7 Trip Distribution Factors for Trips Using Queen Ka’ahumanu Highway for Trips in Table 6…….18

Table 8 Trip Generation for Villages of Aina Le’a Phase I in 2012……...…24

Table 9 Trip Generation for Villages of Aina Le’a Full Buildout in .2020……..…..24

Table 10 Trip Generation Summary for Villages of Aina Le’a Phase I in Year 2012…25

Table 11 Trip Generation Summary for Villages of Aina Le’a at Full Buildout in Year 2020……..…26

Table 12 External Trip Generation for Villages of Aina Le’a at Full Buildout in Year 2020…….27

Table 13 Intersection Level of Service Analysis for Year 2012 without Project…...….41

Table 14 Intersection Level of Service Analysis for Year 2020 without Project……42

Table 15 Intersection Level of Service Analysis for Year 2012 with Project……..…43

Table 16 Intersection Level of Service Analysis for Year 2020 with Project……..…44

Table 17 Summary of MUTCD Signal Warrants for Intersection of Queen Ka’ahumanu Highway at Mauna Lani Drive/Villages of Aina Le’a Access 1 (South End)……51

Table 18 Summary of MUTCD Signal Warrants for Intersection of Queen Ka’ahumanu Highway at Villages of Aina Le’a Access 2 (North End)……...…53

Table 19 Intersection Level of Service Analysis for Year 2020 with Project and Widening of Queen Ka’ahumanu Highway and All Mitigations in Place……55

Table 20 2020 Trip Generation Analysis for Other Adjacent Potential Developments……..….59

Table 21 Trip Distribution Analysis for Other Adjacent Potential Developments……..60

Table 22 Traffic Operations Analysis with Other Adjacent Potential Developments in Place in Year 2020……..….64

I. Project Background and Description

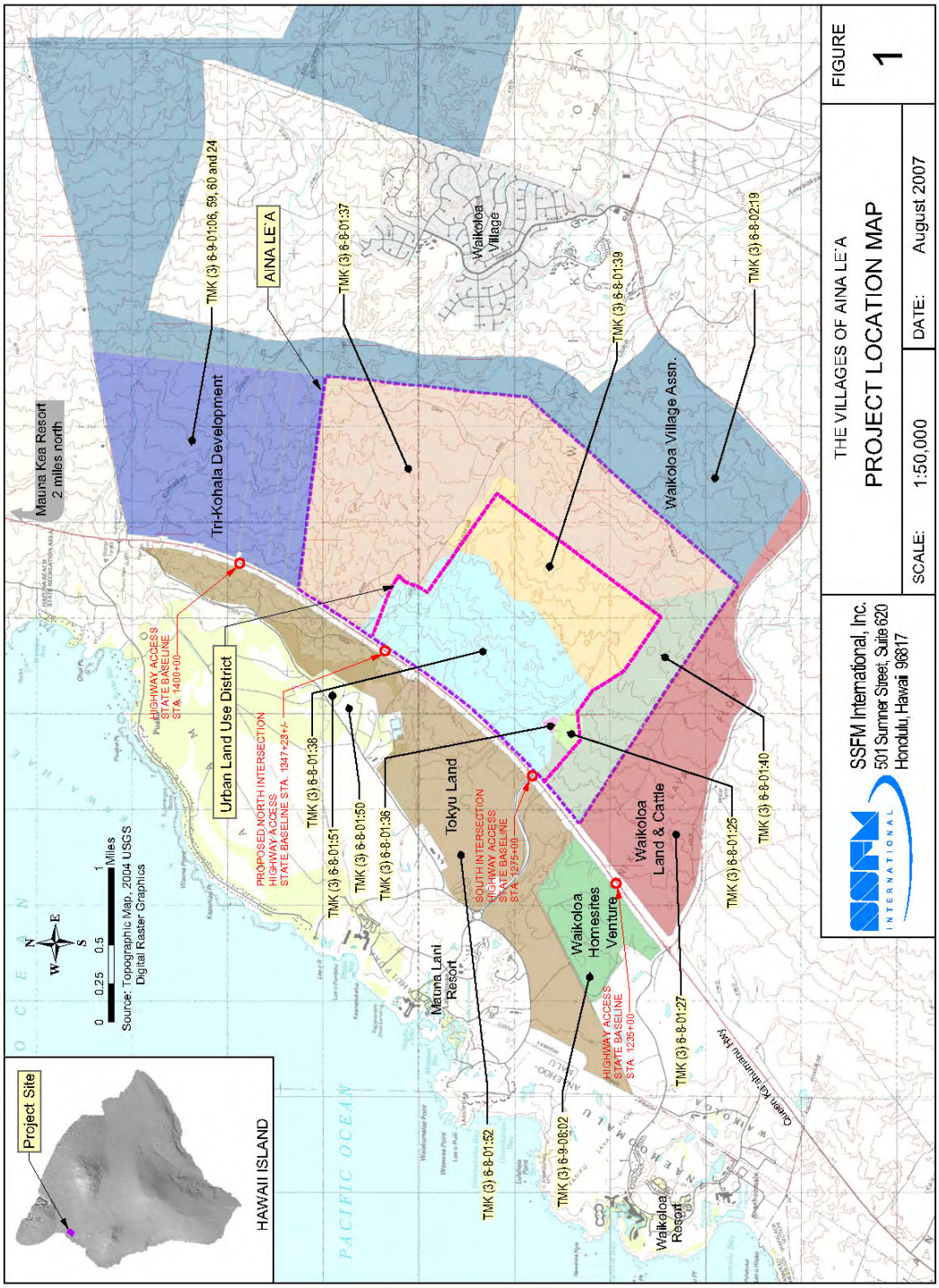
The Villages of Aina Leʻa is a proposed development located in Waikoloa, South Kohala District, Island of Hawaiʻi. This traffic impact analysis was conducted to determine traffic impacts and potential mitigation measures necessary to accommodate this new development.

The Villages of Aina Leʻa is a planned mixed-use community located on a 3,000-acre property made up of Tax Map Key (TMK) numbers 6-8-01: portion 25, 36, 37, 38, 39, and 40. The development planning is focused on the 1,060-acre urban area as designated by the State Land Use Commission and consists of commercial zones CV-10, and residential zones RM-4, RM-7, and RM-14.5. The remaining 1,940 acres are designated for agricultural land use.

The project site is located in Waikoloa, on the northwestern portion of the Island of Hawaiʻi in the South Kohala District (see Figure 1). Its western-most edge is approximately two miles inland from the coast. The site is bordered to the west by State Highway Route 19 (Queen Ka'ahumanu Highway). The Mauna Lani and Waikoloa Resorts and Golf Courses occupy large portions of the coastal zone immediately southwest of the site. One mile from the eastern border of the project site is the Waikoloa Village, a residential community. The land surrounding the property on the north and south boundaries is presently undeveloped.

Figure 1

Project Location Map for Villages of Aina Le’a



The Villages of Aina Le‘a development has two proposed access points to and from Queen Ka’ahumanu Highway as shown in Figure 2. The first phase of the project will include constructing the primary (southern) access from its connection at Queen Ka’ahumanu Highway at Mauna Lani Drive, to create a four-legged cross-type intersection. This intersection is noted as Aina Le’a Access 1 in Figure 2. This section is envisioned as a 100-foot wide right-of-way containing a four-lane roadway, landscaped median, and meandering bike/pedestrian path, extending northeasterly into the development to the entrance of the proposed commercial center. Once past the commercial area, the roadway section narrows to a two lane roadway with an adjacent bike/pedestrian path. This 80-foot wide road right-of-way extends through the urban core. Within the 18-hole golf course and surrounding residential community, 50- and 60-foot wide road rights-of-way are planned to extend from the 80-foot wide right-of-way.

The secondary (northern) entrance, located approximately 1.4 miles north of the intersection of and Queen Ka’ahumanu Highway at Mauna Lani Drive, is planned to be constructed by 2012. This new intersection is noted as Aina Le’a Access 2 on Figure 2. This new road will have an 80-foot wide right-of-way and will extend from Queen Ka’ahumanu Highway eastward to provide a connection to Waikoloa Village.

The master plan for the Villages of Aina Le‘a includes one 18-hole golf course surrounded by multiple “pods.” Each pod has been assigned specific land uses. The project will be constructed in two main phases. The initial phase includes the construction of a 340,000 square foot commercial center, 300 affordable housing units, and an 18-hole golf course with clubhouse. This phase is expected to be completed in the year 2012.

Table 1 lists the proposed land uses within the Villages of Aina Le‘a and the conceptual master plan for the project is shown in Figure 3.

Table 1

Land Use Summary (Land within Current Urban District)

Land Use	Proposed Approximate Acreage	Proposed Approximate Units	Gross Floor Area (sf)	Density (Units/Ac)
Single Family (SF)	227	790	-	2.6
Multi Family (MF)	169	1047	-	8.5
Mixed Use (MU) Commercial	25	-	80,000	-
Mixed Use (MU) Residential		125	-	-
Affordable Housing (AH)	32	500	-	12
Commercial (C)	36	-	340,000	-
Golf Course (GC)	251	1	-	-
Golf Course Club House	4	1	-	-
Highway Buffer	234	-	-	-
Parks/Open Space	37	-	-	-
Major Roadways	45	-	-	-
Total Commercial	49	-	420,000	-
Total Residential	1,060	2462	-	-
Total Other	571	-	-	-

The first phase of the project will involve construction of the main roadway that extends from the southern entrance at its intersection with Queen Ka’ahumanu Highway at Mauna Lani Drive. The initial development projects include the 345 affordable housing units, the golf course and clubhouse, as seen on the master conceptual plan. The roadway from the northern entrance that expands into Waikoloa Village will also be constructed simultaneously so that both roadways are expected to be completed by 2012. However, the two roadway systems will not initially connect, and both will have separate access to Queen Ka’ahumanu Highway. The balance of the project will be incrementally added with full build-out scheduled for about 2020. The two roadway systems are scheduled to connect in 2020.

Figure 2

Conceptual Study Network for the Villages of Aina Le’a

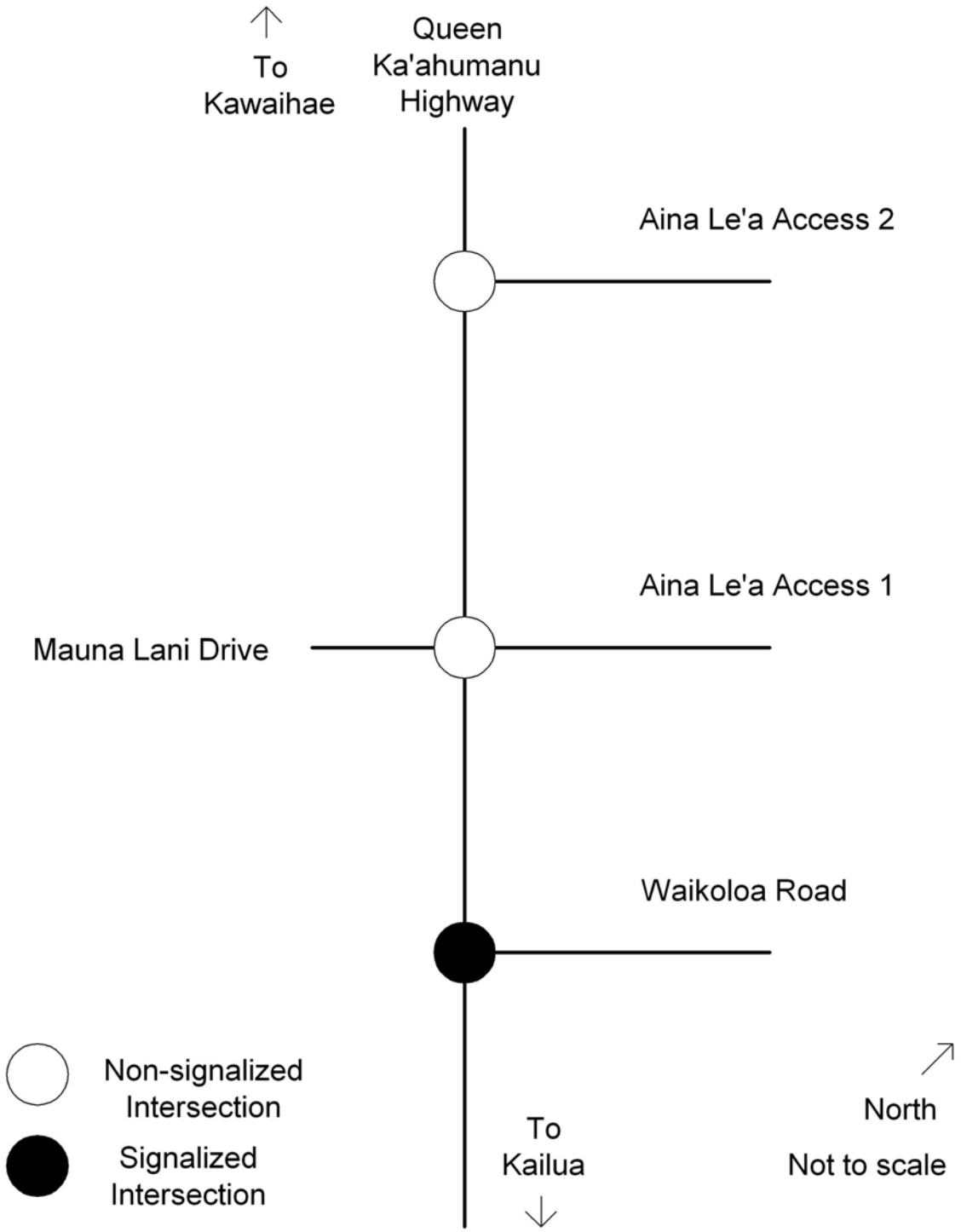
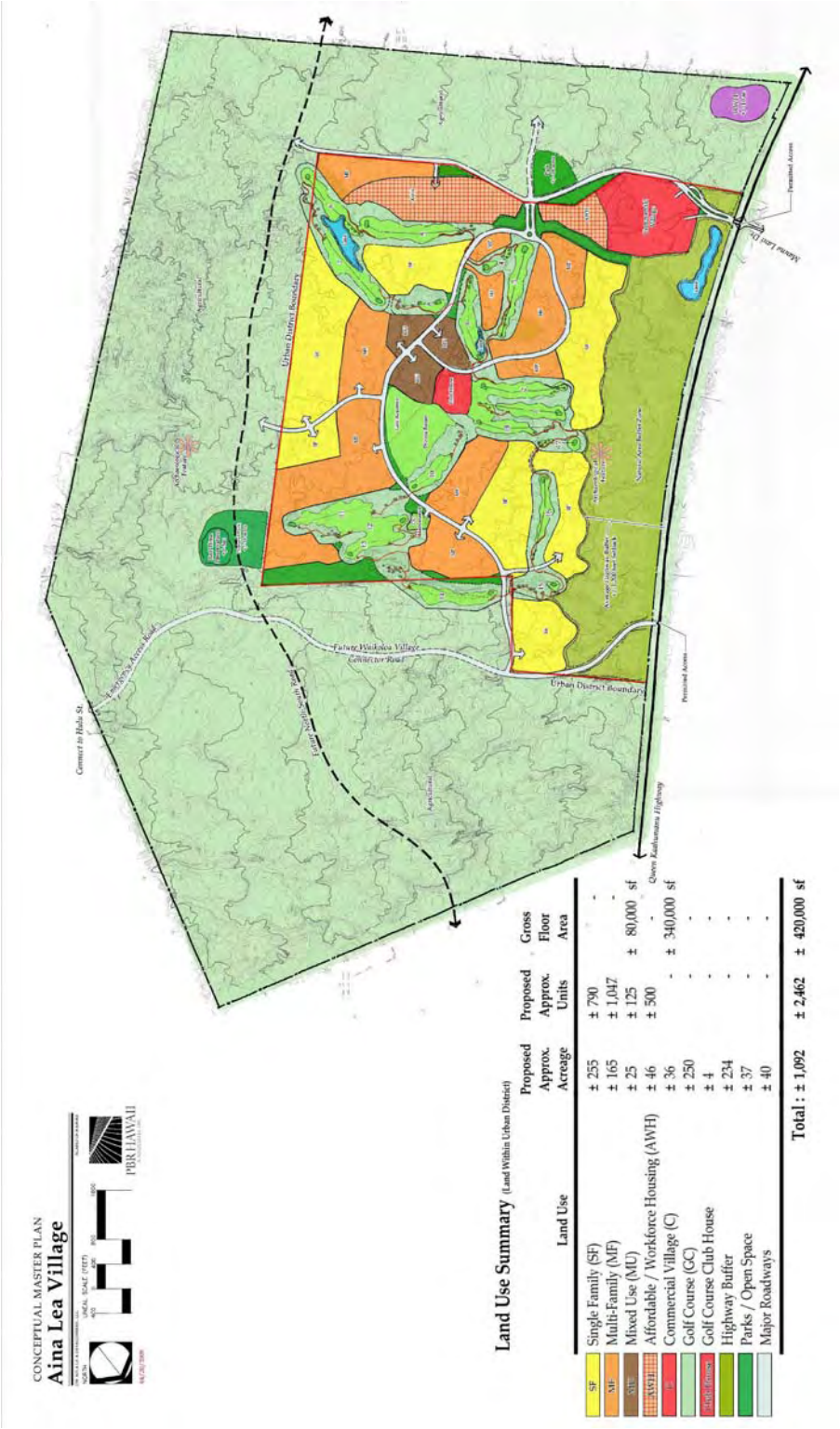


Figure 3

Conceptual Master Plan for Villages of Aina Le’a



II. Study Methodology

The traffic impact analysis study included the following procedures:

A. Identification of current traffic and roadway conditions

The morning and afternoon peak hours were identified for detailed study. The results of this analysis are discussed in the section on Existing Conditions.

B. Forecasting of future traffic conditions with and without the proposed project

The first forecast year (2012) is the scheduled completion of the project's first phase that will include a golf course, affordable housing and the mauka-makai roadway that extends to Waikoloa Village. The second forecast year (2020) is the scheduled completion of the entire project. Three intersections were analyzed on Queen Ka'ahumanu Highway as part of this study. The Queen Ka'ahumanu Highway/Waikoloa Road intersection is the closest major intersection to the project site. One of the two proposed project access roadways will add a fourth approach leg to the existing Queen Ka'ahumanu Highway/Mauna Lani Drive intersection, while the other will create a new major intersection (see Figure 2). The forecasting methodology and results are described in the section on Traffic Forecasts.

C. Analysis of existing and future traffic conditions

Existing and future year conditions with and without the project being built were developed. Mitigation measures were identified and recommended. Traffic signal warrant analyses are also included in the section on Analysis of Future Conditions. The traffic signal warrant study required the estimation of traffic for entire day from 7:00 a.m. to 6:00 p.m. using traffic counts and predicted new traffic volumes.

The concept of level of service is used to quantify the quality of traffic flow on roadway facilities. The Transportation Research Board (TRB) has developed procedures to calculate level of service value(s) by measuring traffic volumes against the capacities of different types of roadway facilities. The TRB Highway Capacity Manual 2000 (HCM) describes the various procedures developed for freeways, highways, signalized and non-signalized intersections, and other surface transportation facilities.

The methodology for analyzing signalized intersections calculates the levels of service for individual movements, approaches and the intersection as a whole based on the average stopped delay per vehicle. The results range from level of service A (best, with average delays less than ten seconds) to F (worst, with average delays longer than 80 seconds).

The procedure used for analyzing non-signalized intersections calculates vehicle delays and levels of service based on the distribution of gaps in traffic on the major street and driver judgment in selecting gaps through which to execute turns. For two-way stop intersections where only the minor street traffic is controlled by a stop sign, levels of service are calculated for the critical turning movements including outbound movements from the stop-controlled approach and left turns from the major street to the minor street. The procedure does not calculate an overall intersection level of service.

The thresholds for level of service for signalized and non-signalized intersections are shown in the Table 2 below:

Table 2

Intersection Levels of Service from HCM

Level Of Service	Signalized Intersection Control Delay (Seconds/Vehicle)	Non-signalized Intersection Delay (Seconds/Vehicle)
A	< 10	< 10
B	10 to 20	10 to 15
C	20 to 35	15 to 25
D	35 to 55	25 to 35
E	55 to 80	35 to 50
F	> 80	> 50

Many jurisdictions consider levels of service A to D as acceptable for areas like Hawai‘i Island, with levels of service E and F indicating the need for mitigating measures. The County of Hawai‘i has previously recommended a minimum level of service C for proposed projects, while recognizing that many of their signalized intersections are already at level of service D. For signalized intersections, the major streets can be designed to have a higher level of service than the side streets or turning lanes. Lower levels of service on the latter approaches can be tolerated if they permit the main approaches to have acceptable levels of service. In many areas of the state, the traffic signal cycle lengths are increased to improve traffic flow on the main street while increasing delays on the minor side streets. For non-signalized intersections, level of service F conditions are not acceptable but could be tolerated if the delays are not much higher than 60 seconds, traffic queues are short, and there are no reasonable mitigating measures available. The HCM procedures for arterial streets and highways were not applied in this study since the study network intersections are over one mile away from each other.

D. Forecasting and analysis of future traffic conditions with traffic generated by other adjacent properties

Section IV provides an analysis of the potential traffic impacts assuming that adjacent land parcels were to be developed by 2020, the year the Villages of Aina Le‘a is scheduled for full build out. Research with the landowners as well as the County of Hawaii verified the adjacent land parcels currently have no definite development schedules. Therefore, there is a significant amount of speculation in the prediction of traffic volumes that may result from these potential developments. Nonetheless a subsequent section of this report does attempt to analyze the general expectations of the future conditions if all the potential projects do materialize. These projects will add traffic to Queen Ka’ahumanu Highway and some of the trips to and from these new developments will likely also have trip ends within the Villages of Aina Le’a.

III. Existing Conditions

The existing roadway and traffic conditions in the study area were surveyed on June 26, and 27, 2007 as part of this analysis. Based on historical traffic growth records the 2007 data was adjusted to estimate expected traffic volumes for the existing conditions in the year 2009.

A. Roadways

The main roadways currently in the study include Queen Ka’ahumanu Highway, Waikoloa Road, and Mauna Lani Drive, as shown in Figure 2.

Queen Ka’ahumanu Highway is the primary arterial highway on the west side of the island of Hawai‘i. The highway passes through the North Kona and South Kohala districts and connects Kailua Village with the Kona International Airport, the Kohala resort areas, and Kawaihae. It is a two lane Class I State Highway with limited access and a posted speed limit of 55 miles per hour. The roadway is within a 350 foot right-of-way at the Waikoloa Road intersection and is in a 425-foot wide right-of-way at the Mauna Lani Drive intersection. Intersections on this highway are fully channelized and signalized where warranted, including the intersection of Queen Ka’ahumanu Highway at Waikoloa Road.

Waikoloa Road is a two-lane undivided County roadway that runs between the Queen Ka’ahumanu Highway to the west and Mamalahoa Highway to the east. The three-legged intersection of Waikoloa Road at Queen Ka’ahumanu Highway is signalized. This intersection serves as an access point to the Waikoloa Village, mauka of Queen Ka’ahumanu Highway. Waikoloa Road is presently the only roadway running between Mamalahoa Highway and Queen Ka’ahumanu Highway for many miles. The posted speed limit is 55 miles per hour except the span within the Waikoloa Village urban district. In this area, Waikoloa Road becomes a four lane divided roadway with posted speed limits of 35 miles per hour.

Mauna Lani Drive is a two lane private roadway providing access to the Mauna Lani Resort area. There are separate turning lanes on all approaches of the non-signalized three-legged intersection at Queen Ka’ahumanu Highway. This is the only entrance/exit to the Mauna Lani area. The posted speed limit is 35 miles per hour to the security gate where the speed limit decreases to 25 miles per hour.

B. Traffic Volumes

Traffic meter counts were taken at the two existing study intersections from 1:00 PM on Tuesday, June 26 to 1:00 PM on Wednesday, June 27, 2007. The meter counts were used in lieu of manual traffic counts because the channelized design of the intersections made it possible to count individual turning movements into and out of the intersections separately. Two meters with two road tube connections were used at each intersection to count inbound and outbound movements. A separate meter was used to count northbound and southbound movements on Queen Ka’ahumanu Highway north of the Mauna Lani Drive intersection. A total of five meters were used. The worksheets from these traffic counts are included in appendix A.

Daily traffic volumes were derived from the 24-hour meter counts as shown on Figure 4. On a daily basis, most of the turning movements into and from both intersections are oriented to the south (towards Kona). Waikoloa Road has about 10,000 vehicles per day, while Mauna Lani Drive has about 8100 total vehicles per day.

Turning movement counts were made during the peak periods of 6:00 to 8:30 a.m. and 3:00 to 5:30 p.m. and the raw data is provided in appendix A. The individual turning movements for the peak morning and afternoon peak hours are shown in Figure 5. Waikoloa Road, which generally serves residential traffic, shows a higher outbound flow in the morning peak hour and a higher inbound flow in the afternoon peak. In contrast, Mauna Lani Drive which serves an employment center has higher inbound flow in the morning and higher outbound flow in the afternoon. The existing traffic operations are discussed in the Analysis of Future Conditions section.

The Hawaii Department of Transportation has taken metered traffic counts at selected locations on Big Island roadways every two years. One station is at the Queen Ka’ahumanu Highway intersection with Kawaihae Road about seven miles north of the project site. The daily traffic volumes on Queen Ka’ahumanu Highway have been increasing from 10,698 in 1996 to 12,012 in 2004. At the time of the data collection in 2007, no additional traffic counts were available. The daily traffic counts from 1998 through 2004 are shown in tabular form in Table 3. As seen in Table 3, there has been an increase of approximately 12.2% over the eight-year period for an average annual increase of about 1.5% per year. Traffic volumes for the existing year of 2009 were derived by inflating the traffic counts from 2007 by 3% which reflects the annual increase of 1.5%.

Table 3

Daily Traffic Volumes on Queen Ka’ahumanu Highway

Month & Year of Count	Southbound	Northbound	Total
January 1996	5448	5250	10,698
September 1998	4663	4566	9,229
May 2000	5032	5333	10,365
May 2002	5320	5638	10,958
May 2004	6272	5740	12,012
Increase from 1996 - 2004			12.2%
Average annual increase			1.5%

No attempt was made to analyze seasonal variations in the daily traffic volumes. However, it is felt that the data available provides a reasonable assessment of historical traffic volume growth on the section of Queen Ka’ahumanu Highway at the Villages of Aina Le’a project site.

Figure 4

2007 Existing Daily Traffic Volumes

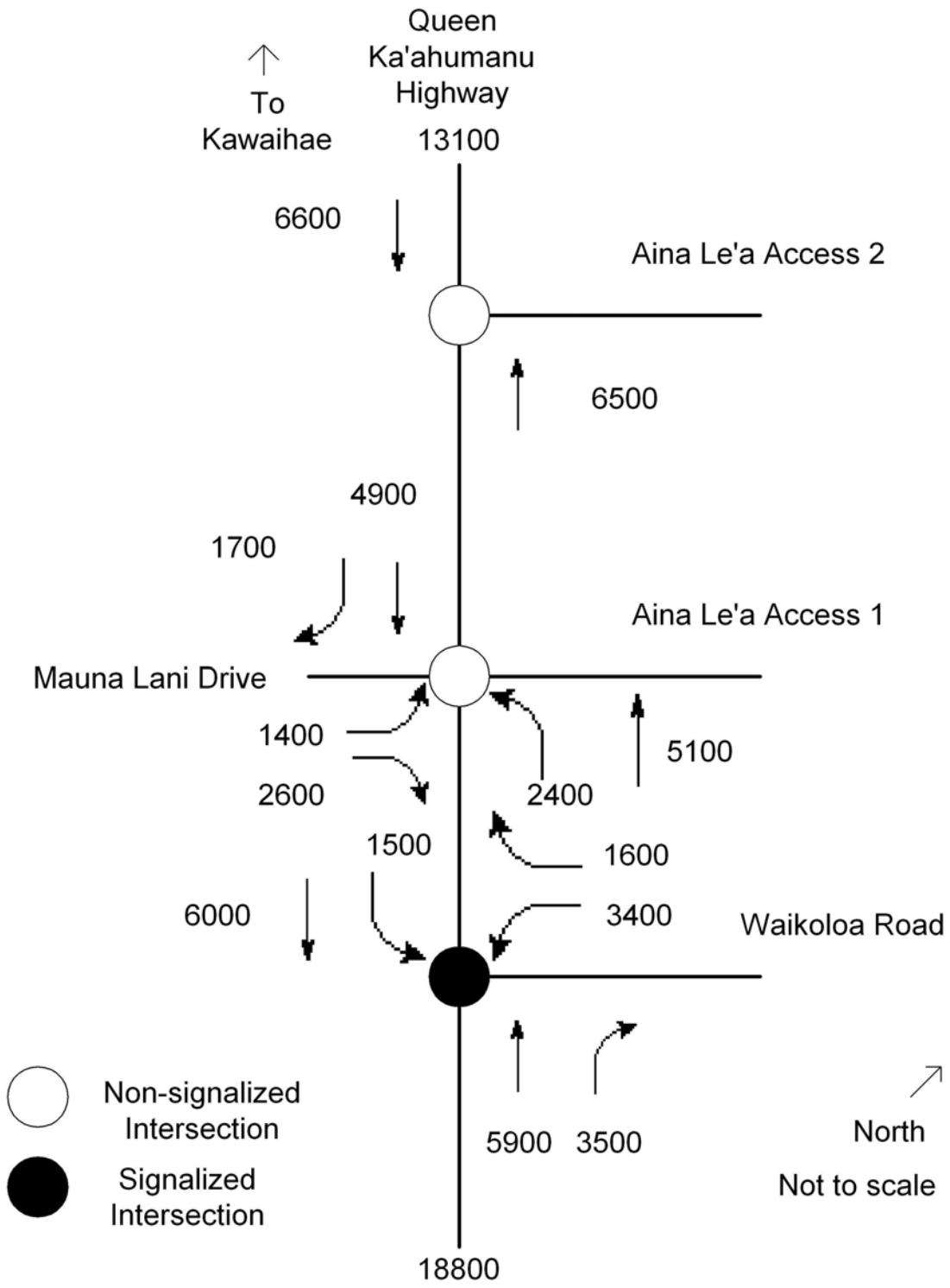


Figure 5

2007 Existing Peak Hour Traffic Volumes

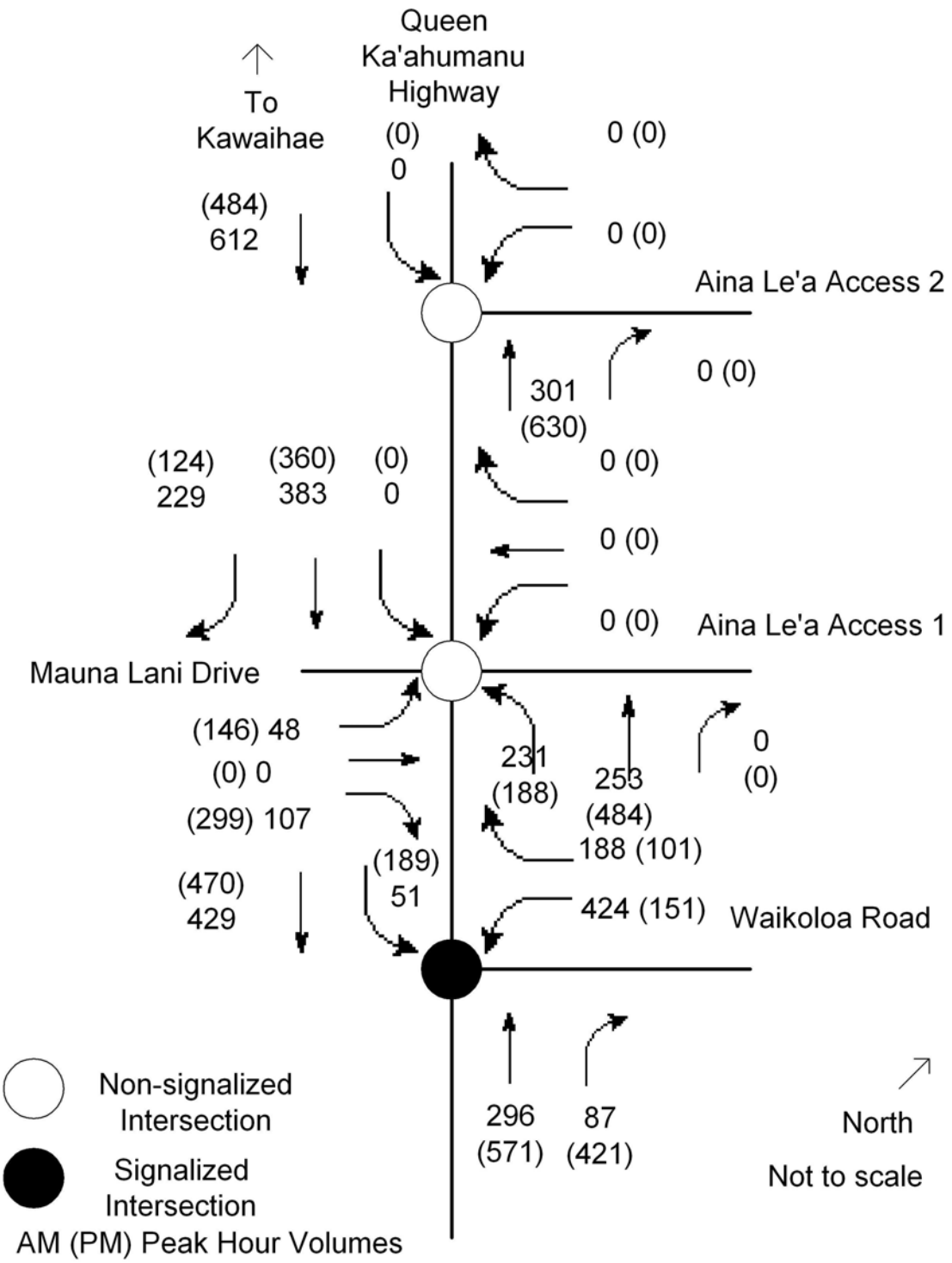


Figure 6

Year 2009 Peak Hour Traffic Volumes

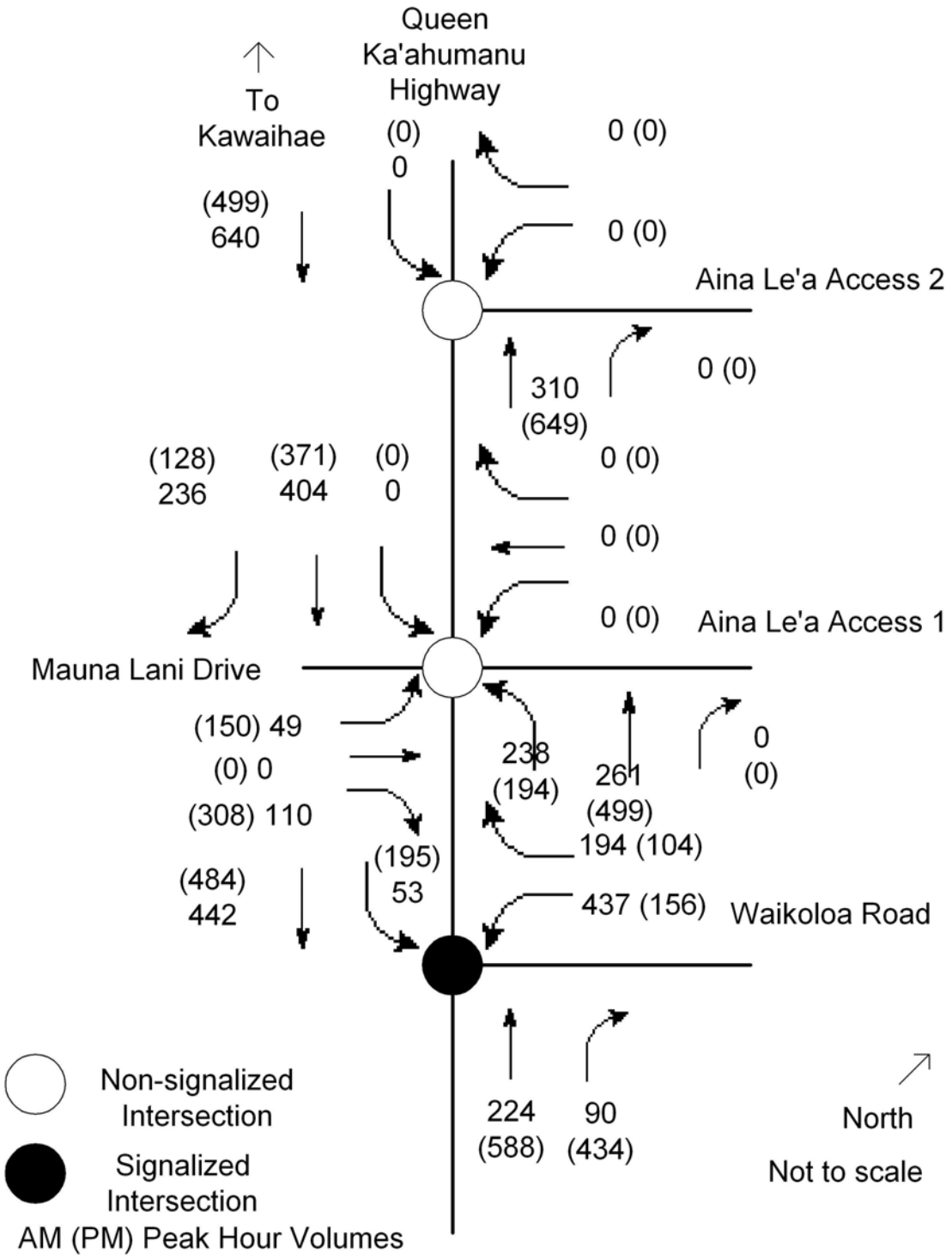


Table 4

Intersection Level of Service Analysis for Existing Conditions in 2009

Intersection	Movement	Morning Peak Hour			Afternoon Peak Hour		
		v/c Ratio	Delay (sec)	LOS	v/c Ratio	Delay (sec)	LOS
Queen Ka’ahumanu Highway at Waikoloa Road	Northbound Thru	.44	17	B	.82	23	C
	Northbound Right	.06	14	B	.30	12	B
	Southbound Thru	.56	12	B	.43	5	A
	Southbound Left	.13	9	A	.48	9	A
	Westbound Left	.72	19	B	.45	22	C
	Westbound Right	.14	12	B	.07	20	B
Queen Ka’ahumanu Highway at Mauna Lani Drive	Northbound Thru	.17	0	NA	.32	0	NA
	Northbound Left	.30	11	B	.20	9	A
	Southbound Thru	.27	0	NA	.24	0	NA
	Southbound Right	.16	0	NA	.08	0	NA
	Eastbound Left	.23	24	C	.75	58	F
	Eastbound Right	.20	12	B	.52	16	C

Table 4 shows that the existing traffic conditions at the morning and afternoon peak hours are generally good. The only movement with an LOS worse than D is the left turn from Mauna Lani Drive onto Queen Ka’ahumanu Highway in the afternoon peak hour. This is a result of the apparent difficulty in making the left turn versus the total through traffic on Queen Ka’ahumanu Highway.

IV. TRAFFIC FORECASTS

The first phase of the proposed project is scheduled for occupancy by 2012, with final completion of the entire project by 2020. During the interim, background traffic on the area roadways can be expected to increase due to regional growth and new projects in the area. The traffic that would be generated from the proposed project was added to the background traffic forecast to obtain the total with project traffic forecast.

A. Background Traffic Forecast

There are several development projects planned in the study area at Waikoloa Village and Mauna Lani Resort. The July 2007 issue of the *Breeze*, the monthly newsletter for the Waikoloa Village Association, lists the projects being planned or built in Waikoloa Village. This information was used to identify the number of residential units that could be expected by 2012 and 2020 as follows in Table 5.

Table 5

Predicted Development Projects in the Area of Villages of Aina Le’a

Project	Number of Residences (SF or MF*) planned	
	By 2012	2012 to 2020
Castle and Cooke	582 SF & 173 MF	None
Sunset Ridge	210 SF	None
Kilohana Kai	130 SF	100 SF
Waikoloa Heights	268 SF	1251 SF
Waikoloa Highlands	149 SF	249 SF
Lot 28	106 MF	None
Totals	1445 SF & 173 MF	1600 SF

*SF=Single Family; MF=Multifamily Units

Trips generated by these developments can be expected to use Waikoloa Road and Queen Ka’ahumanu Highway.

The proposed commercial projects listed in the newsletter were not included in this tabulation because they would tend to attract trips from within Waikoloa Village and not attract many trips from outside the Village. Although the Waikoloa Heights project has entitlement to build 3,000 residential units, 268 are scheduled to be constructed starting in 2008 and an additional 1,251 are estimated to be constructed by 2020.

Traffic forecasts were available for the Waikoloa Highlands project from the *Traffic Impact Analysis Report Waikoloa Highlands Subdivision* (July 2005 draft) by Julian Ng, Inc.

The ‘*Auwaiakeakua Gulch Bridge Crossing Traffic Study Update* (April 2004) by M&E Pacific, Inc. included the traffic generated for the Castle and Cooke, and Sunset Ridge projects by 2011.

The trips generated by the Kilohana Kai, Waikoloa Heights, Waikoloa Highlands, and Lot 28 were calculated using the following trip generation factors from the Institute of Transportation Engineers' Trip Generation Handbook (Seventh Edition, 2003) as shown in Table 6.

Table 6

Trip Generation for Kilohana Kai, Waikoloa Heights, Waikoloa Highlands and Lot 28

Land Use	AM Peak Hour Trips Per Dwelling Unit		PM Peak Hour Trips Per Dwelling Unit	
	Entering	Exiting	Entering	Exiting
Single Family	0.19	0.56	0.64	0.37
Multi Family	0.10	0.36	0.38	0.20

The resulting trips were also multiplied by a trip distribution factor to account for the portion of trips that travel to Queen Ka’ahumanu Highway as shown in Table 7.

Table 7

Trip Distribution Factors for Trips Using Queen Ka’ahumanu Highway for Trips in Table 6

Direction	AM Peak Hour	PM Peak Hour
Inbound	0.35	0.40
Outbound	0.52	0.36

These trip distribution factors were derived in the M&E Pacific, Inc., report for the ‘Auwaiakeakua Gulch Bridge Crossing Traffic Study and were based on actual 2004 traffic counts. The forecast trips were added to the 2011 forecast of traffic on Waikoloa Road by M&E Pacific, Inc., and are illustrated in Figures 4 and 5 for 2012 and 2020, respectively. These increases in volume are anticipated by the development of the projects discussed above.

Traffic forecast for trips generated by new projects within the Mauna Lani Resort were obtained from the *Traffic Impact Report for the Mauna Lani Site Development* (February 2007) prepared by Wilson Okamoto Corporation. The traffic forecast was for year 2015; therefore, half the new trips were added to this 2012 forecast and the balance added for the 2020 forecast. The results of this analysis are included on Figures 7 and 8 for 2012 and 2020, respectively.

Traffic increases can also be expected on the roadways due to general growth in other areas of the island. As indicated earlier, the historical growth rate for Queen Ka’ahumanu Highway has been approximately 1.5% per year. Using this annual growth rate compounded for the seven-year period from 2007 to 2012 results in an increase in through traffic of 11%. So, this 11% factor was applied to existing through volumes on Queen Ka’ahumanu Highway for the morning and afternoon peak hours. Turning movement volumes were not increased with this factor. The resulting increases in traffic volume due to this background growth are shown in Figure 4.

It is assumed that the incremental increases in traffic from other areas of the island were omitted from the projections for the development projects listed above.

The final background (without project) traffic forecasts for the Villages of Aina Le‘a are shown on Figures 7 and 8. The background traffic forecasts show high volumes traveling between Waikoloa Road and the south leg of Queen Ka’ahumanu Highway. The traffic operations for the background forecast conditions are discussed in the Analysis of Future Conditions section.

Figure 7

Predicted Year 2012 Traffic Volumes Added Due to Background Growth

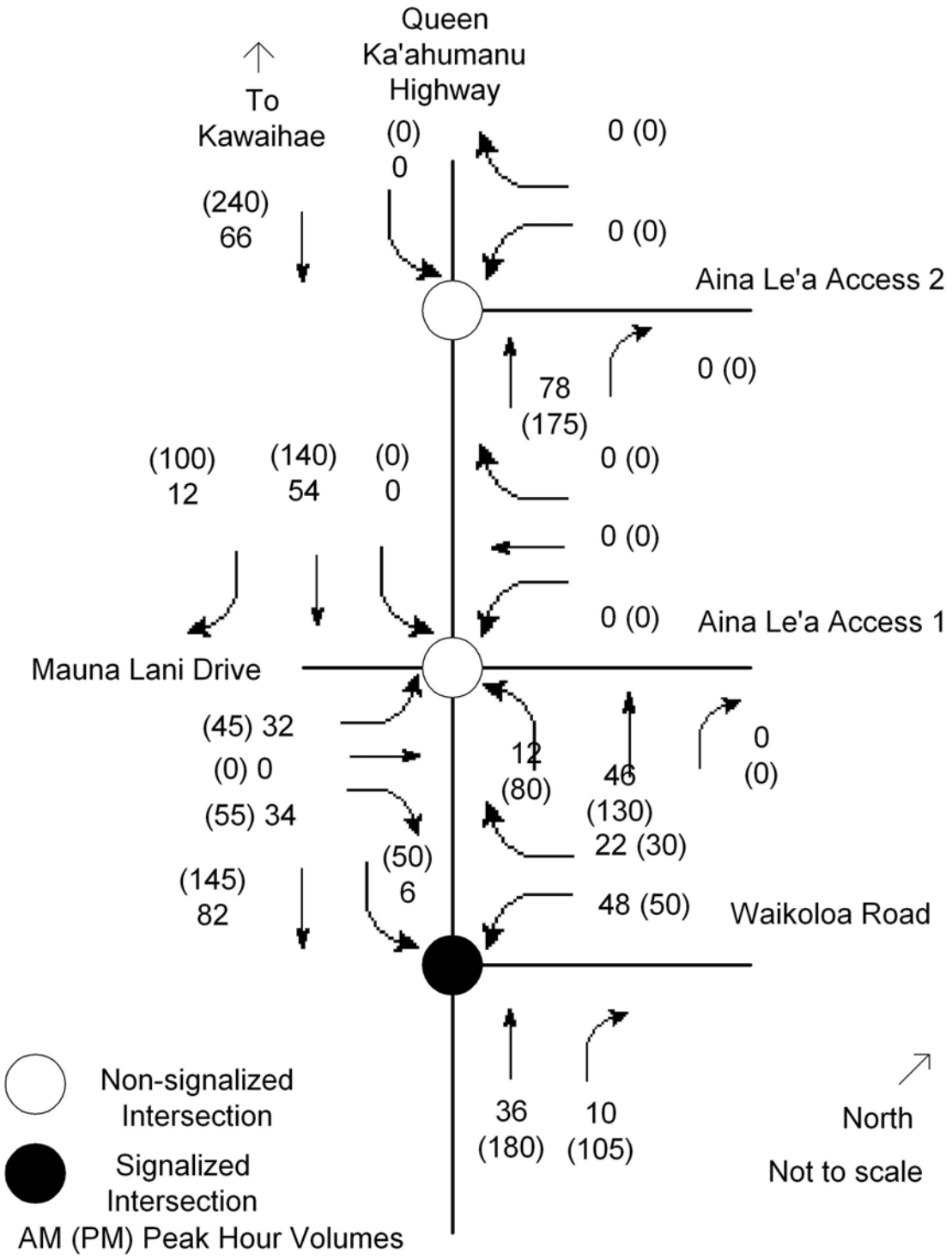


Figure 8

Predicted Year 2012 Traffic Volumes without Project

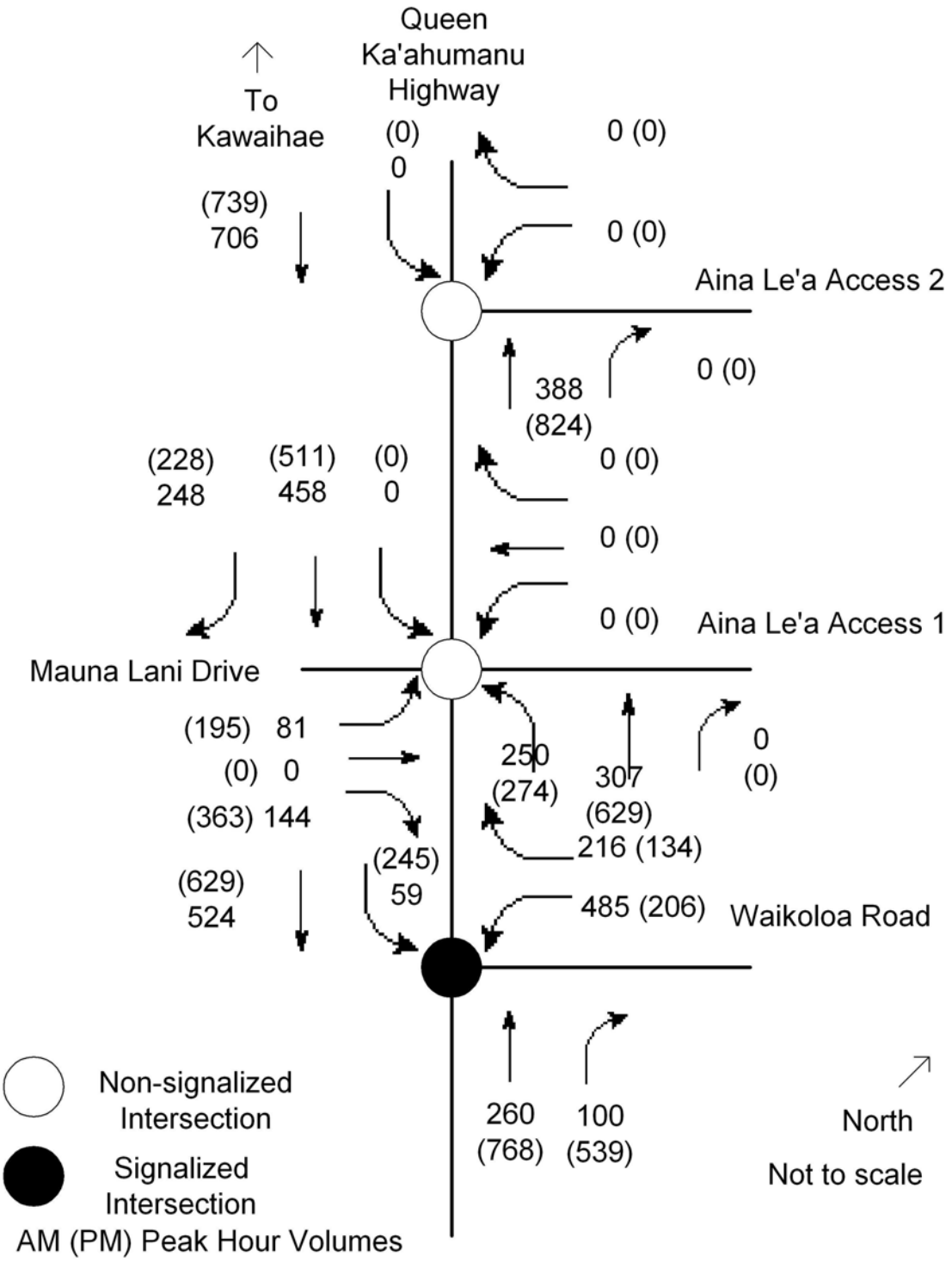
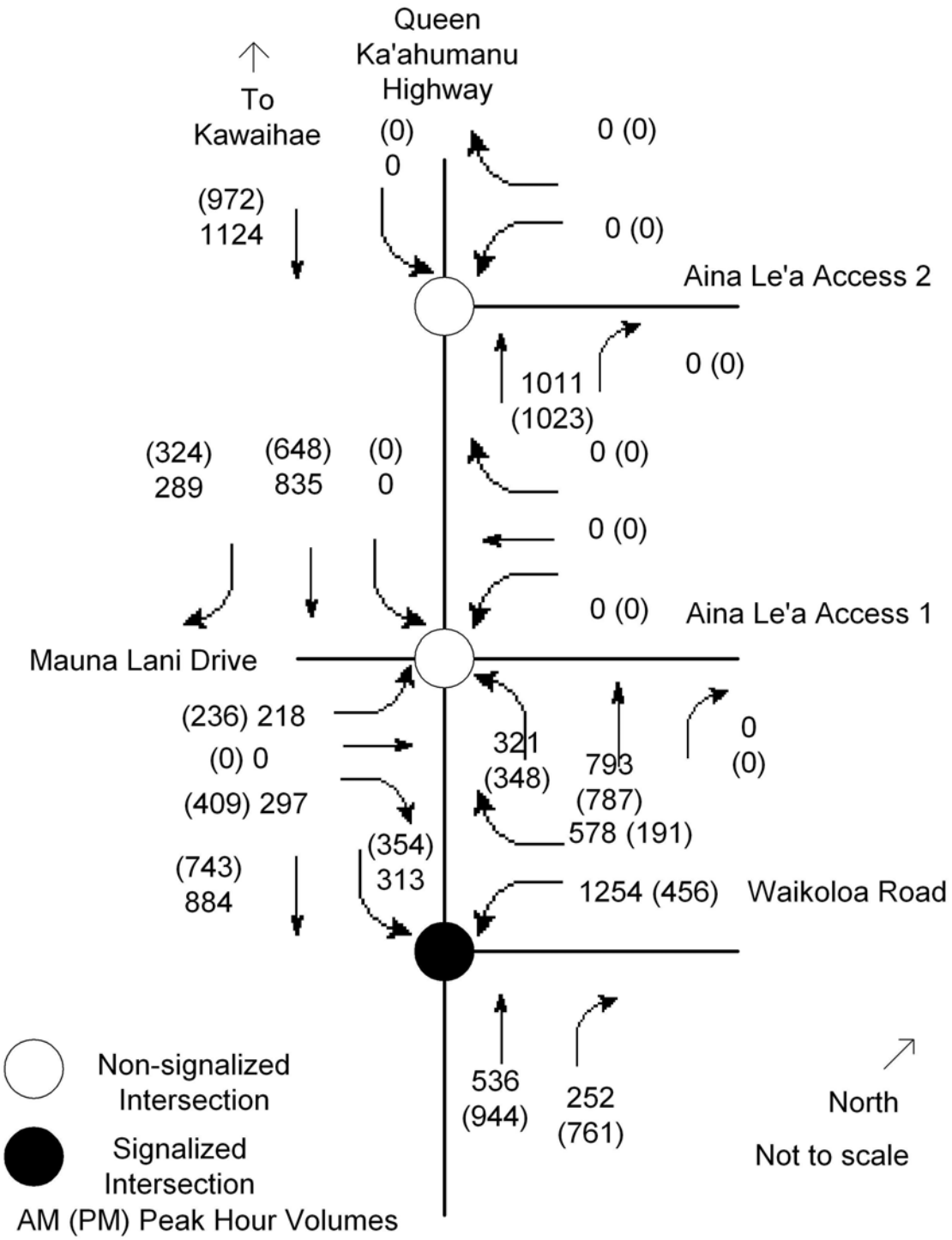


Figure 9

Predicted Year 2020 Traffic Volumes without Project



B. Project Generated Traffic

The traditional three-step process of trip generation, trip distribution and trip assignment was used to forecast future traffic that would be generated by the proposed project. The trip generation step forecasts the number of new trips that would be produced in each of the two study periods. The trip distribution step allocates these new trips by direction of travel. Finally, the trip assignment step assigns the trips to the specific turning movements at the study intersections.

The trip generation step forecasts the volume of vehicle trips that would be generated by the proposed project during the weekday mornings and afternoons. The trip generation rates from the Institute of Transportation Engineers Trip Generation Report (Seventh Edition, 2003) were used to forecast the peak hour trips. The trip generation analysis and rates utilized are shown in Tables 8 and 9. Detailed calculations are provided in the appendices.

The trip generation rates for the Golf Course Clubhouse and Academy was obtained from the *Traffic Impact Study, Villages of Hokukano* (November 1995) prepared by Parsons Brinckerhoff Quade & Douglas, Inc., for a similar proposed project in South Kona.

As shown in Table 10, the proposed project is expected to generate 216 trips in the morning peak and 263 trips in the afternoon peak in year 2012.

With full development in 2020, the proposed project is expected to generate 1612 total trips in the morning peak and 3078 trips in the afternoon peak. Because of the large size of the development and the mixed use of the site with both residential and commercial retail land uses, it is expected that there will be a number of trips that are created within the development between the on-site land uses. This is referred to as internal capture and it essentially reduces the expected number of trips external to the site on the adjacent street network. To estimate the extent of internal capture, a spreadsheet developed by the Florida Department of Transportation (DFOT) was used. The details of the calculations from this FDOT spreadsheet are provided in the appendices. This spreadsheet uses methods and data from ITE and studies done in the state of Florida. As a result of the application of this methodology it is estimated that 9% of the total daily trips generated by the site will be internally generated with the remaining 91% entering or leaving the site on a daily basis. For the morning peak hour, it was estimated that the internal capture would be 4% and the afternoon peak hour internal capture was estimated to be 19%. The internal capture methodology was used to develop Table 13, which shows total new external trips to and from the site.

Table 8

Trip Generation for Villages of Aina Le’a Phase I in 2012

Land Use/ ITE Land Use Code	Unit	Number	Daily		A.M. Peak Hour					P.M. Peak Hour				
			Trips Per Unit	Total Trips	Trips Per Unit	% Entry	% Exit	Total Entry	Total Exit	Trips Per Unit	% Entry	% Exit	Total Entry	Total Exit
Affordable Housing LU 220	Dwelling Unit	340	6.72	2318	0.51	20%	80%	35	141	0.62	65%	35%	139	75
Golf Course	Hole	18	40	720	2.22	80%	20%	32	8	2.61	45%	55%	22	27
Totals	-		-	3038	-	-	-	67	149	-	-	-	161	102

Table 9

Trip Generation for Villages of Aina Le’a Full Buildout in 2020

Land Use/ ITE Land Use Code	Unit	Number	Daily		A.M. Peak Hour					P.M. Peak Hour				
			Trips Per Unit	Total Trips	Trips Per Unit	% Entry	% Exit	Total Entry	Total Exit	Trips Per Unit	% Entry	% Exit	Total Entry	Total Exit
Affordable Housing 220	Dwelling Unit	340	6.72	2318	0.51	20%	80%	35	141	0.62	65%	35%	139	75
Golf Course	Hole	18	40	720	2.22	80%	20%	32	8	2.61	45%	55%	22	27
Single Family Housing 210	Dwelling Unit	790	9.57	6962	.75	25%	75%	347	204	.79	64%	36%	347	204
Commercial Retail New 820	TSF	420	See eq’n (1)	11,283	See eq’n	61%	39%	134	82	See eq’n	48%	52%	421	416
Commercial Retail Passby 820	TSF	420	25% total	3761	See eq’n	61%	39%	45	27	See eq’n	48%	52%	141	139
Multifamily Housing 220	Dwelling Unit	1047	6.72	7882	0.51	20%	80%	118	542	0.62	65%	35%	308	156
Totals	-	-	-	32,850	-	-	-	533	1205	-	-	-	1738	1340

(1) See detailed information in appendices.

Table 10

Trip Generation Summary for Villages of Aina Le’a Phase I in Year 2012

Land Use	Units	Number	Daily Trips	A.M. Trips		P.M. Trips	
				In	Out	In	Out
Single Family	DU	0	0	0	0	0	0
Multi Family	DU	0	2318	35	141	139	75
Mixed Use Residential	DU	0					
Affordable Housing	DU	340					
Total Multi-unit Housing	DU	340					
Mixed Use Commercial Retail	TSF	0	0	0	0	0	0
Commercial Retail	TSF	0					
Total Commercial Retail	TSF	0					
Golf Course (GC)	Holes	18	644	32	8	22	27
Totals	-	-	2962	67	149	161	102

Table 11

Trip Generation Summary for Villages of Aina Le’a at Full Buildout in Year 2020

Land Use	Units	Number	Daily Trips	A.M. Trips		P.M. Trips	
				In	Out	In	Out
Single Family	DU	790	6962	140	422	434	255
Multi Family	DU	1047	10,200	162	648	608	328
Mixed Use Residential	DU	125					
Affordable Housing	DU	500					
Total Multi-unit Housing	DU	1672					
Mixed Use Commercial Retail	TSF	80	15,044	199	127	674	730
Commercial Retail	TSF	340					
Total Commercial Retail	TSF	420					
Golf Course (GC)	Holes	18	644	32	8	22	27
Totals	-	-	32,850	533	1205	1738	1340

As seen in Table 11, the entire project at full buildout in the year 2020 would generate a very large number of new trips at 32,850 per day. The morning peak hour would generate 1738 while the afternoon peak hour would generate 3078. However, as indicated earlier some of these trips would be made to and from the residential portions of the development and the commercial retail portions. The FDOT methodology does not provide an assessment of potential internal capture for the trips to be generated by the golf course. However, the numbers for the golf course are very small in comparison to the total, so, not including these trips in the calculation is likely not a major consideration. Table 12 shows the trips expected to be created external to and from the new Villages at Aina Lea at full buildout in the year 2020. As seen in Table 12, the total morning hour external trips will be 1662 while the afternoon peak hour external trips will be estimated to be 2504. Again, the difference between the total trips and the external trips would be those generated within the development which use internal street connections and do not travel to or from Queen Ka’ahumanu Highway.

Table 12

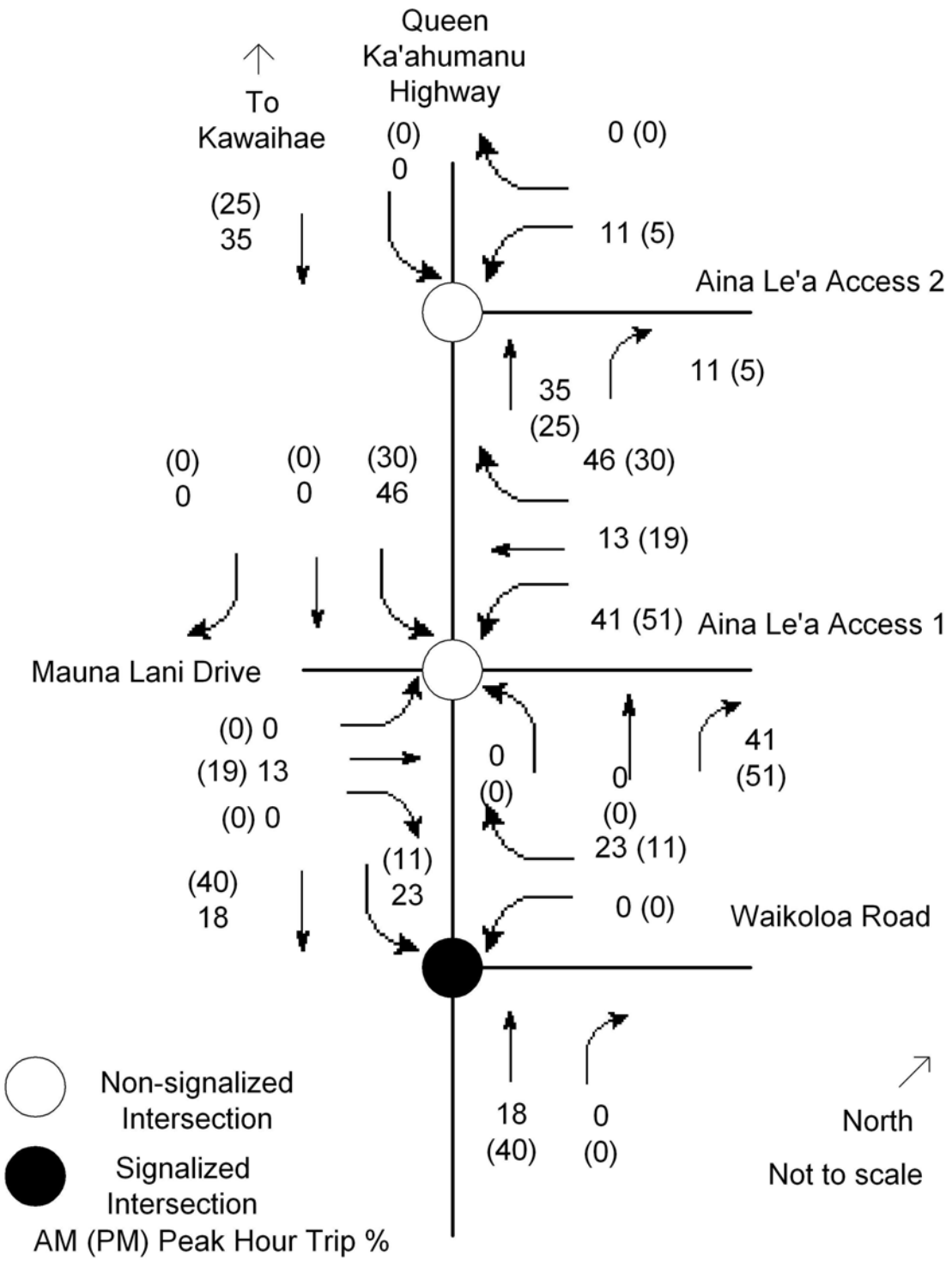
External Trip Generation for Villages of Aina Le’a at Full Buildout in Year 2020

Land Use	Units	Number	Daily Trips	A.M. Trips		P.M. Trips	
				In	Out	In	Out
Single Family	DU	790	6266	131	412	347	204
Multi Family	DU	1047	9448	153	638	520	267
Mixed Use Residential	DU	125					
Affordable Housing	DU	500					
Total Multi-unit Housing	DU	1672					
Mixed Use Commercial Retail	TSF	80	13,596	179	109	562	555
Commercial Retail	TSF	340					
Total Commercial Retail	TSF	420					
Golf Course (GC)	Holes	18	644	32	8	22	27
Totals	-	-	29,954	495	1167	1451	1053

The trip distribution analysis was done to develop a basis for prediction of the direction of travel of trips to and from the new development. Generally, it was assumed that trips would be distributed in proportions matching current traffic patterns. The major directions of travel for this study included north and south via Queen Ka’ahumanu Highway, Waikoloa Village, and internal to the project site. Figure 8 shows the pattern of traffic assignment for new external trips to and from the site. A unique aspect of trips generated by commercial centers is that a large portion is pass-by and diverted trips. Pass-by trips are attracted from traffic passing the site on an adjacent roadway and have direct access to the commercial center. Therefore, these trips do not add to the through volumes on the roadway. They are added to the turning movements but are subtracted from the through movements where they turn off to access the commercial center. Diverted trips are attracted from the roadways in the vicinity of, but not adjacent to, the commercial center. They require a diversion from that roadway and add traffic to streets adjacent to the site. The proposed commercial center can expect pass-by trips from Queen Ka’ahumanu Highway and diverted trips from Waikoloa Road. The ITE Trip Generation Handbook (Second Edition, 2004) provides a list of average pass-by trip factors for various types of commercial land uses. A commercial center of the size proposed for this project can expect about 25 percent pass-by trips. Passby trips were assumed to follow the pattern of traffic flows for the morning and afternoon peak hours based on total approach volumes to each intersection. Departing passby trips were assumed to travel in the same direction as they would have had they not stopped at the site.

Figure 10

Trip Assignment Percentages for New Trips



The trip assignment step assigns the generated trips to the specific turning movements at the study intersections. The project-generated trips were then assigned to the study network. The results are shown on Figure 11 for 2012 and Figure 12 for 2020. The diverted trips are shown as negative traffic volumes on the through movements of Queen Ka’ahumanu Highway. It was assumed that trips would be distributed in the same manner in the year 2020 as in the year 2012. It was assumed that passby trips were to be assigned based on the proportional approach volumes from the roadways in the study network.

Figure 11

Volume Added Due to New Trips Generated in Phase I of Project in Year 2012

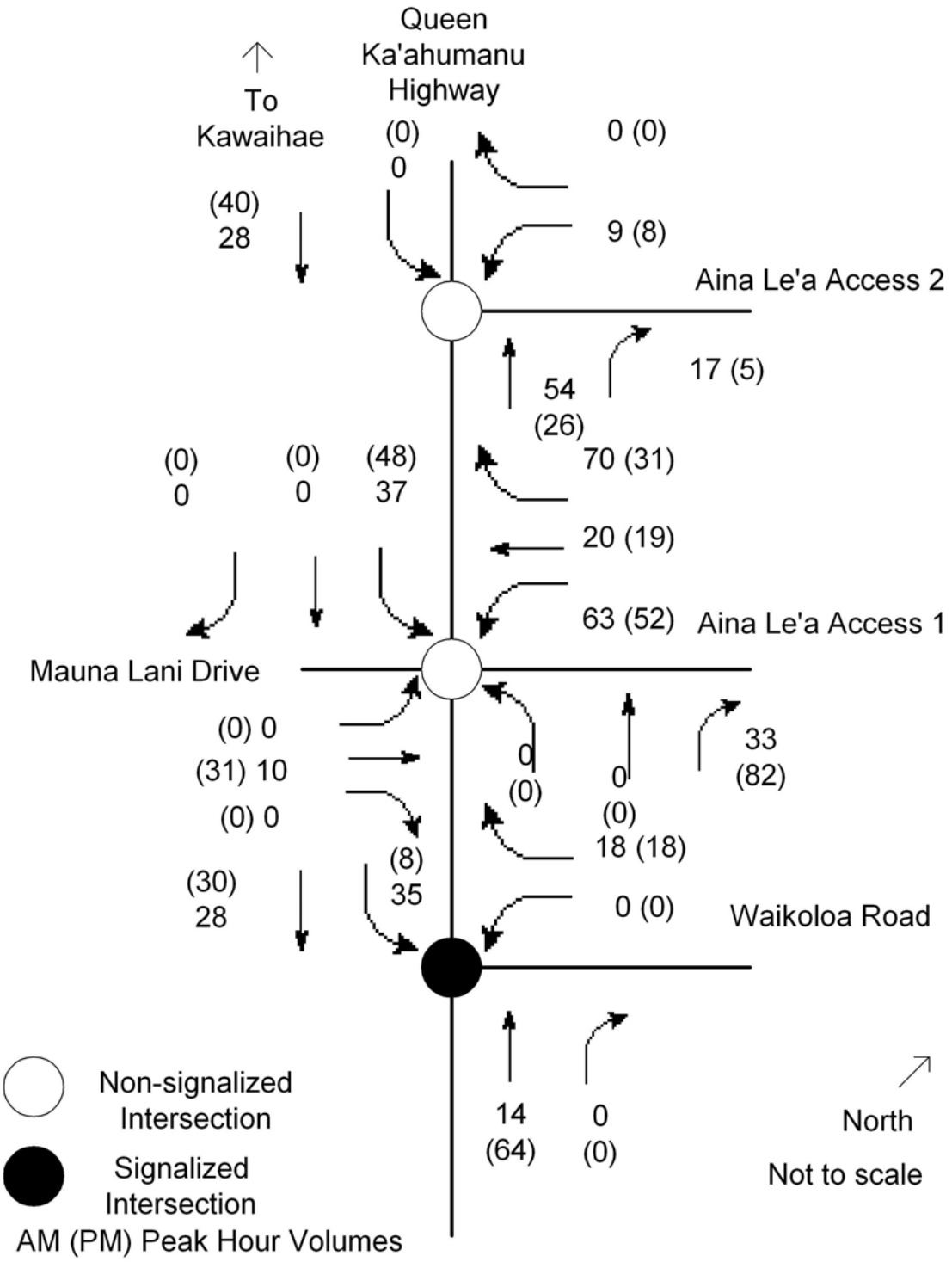
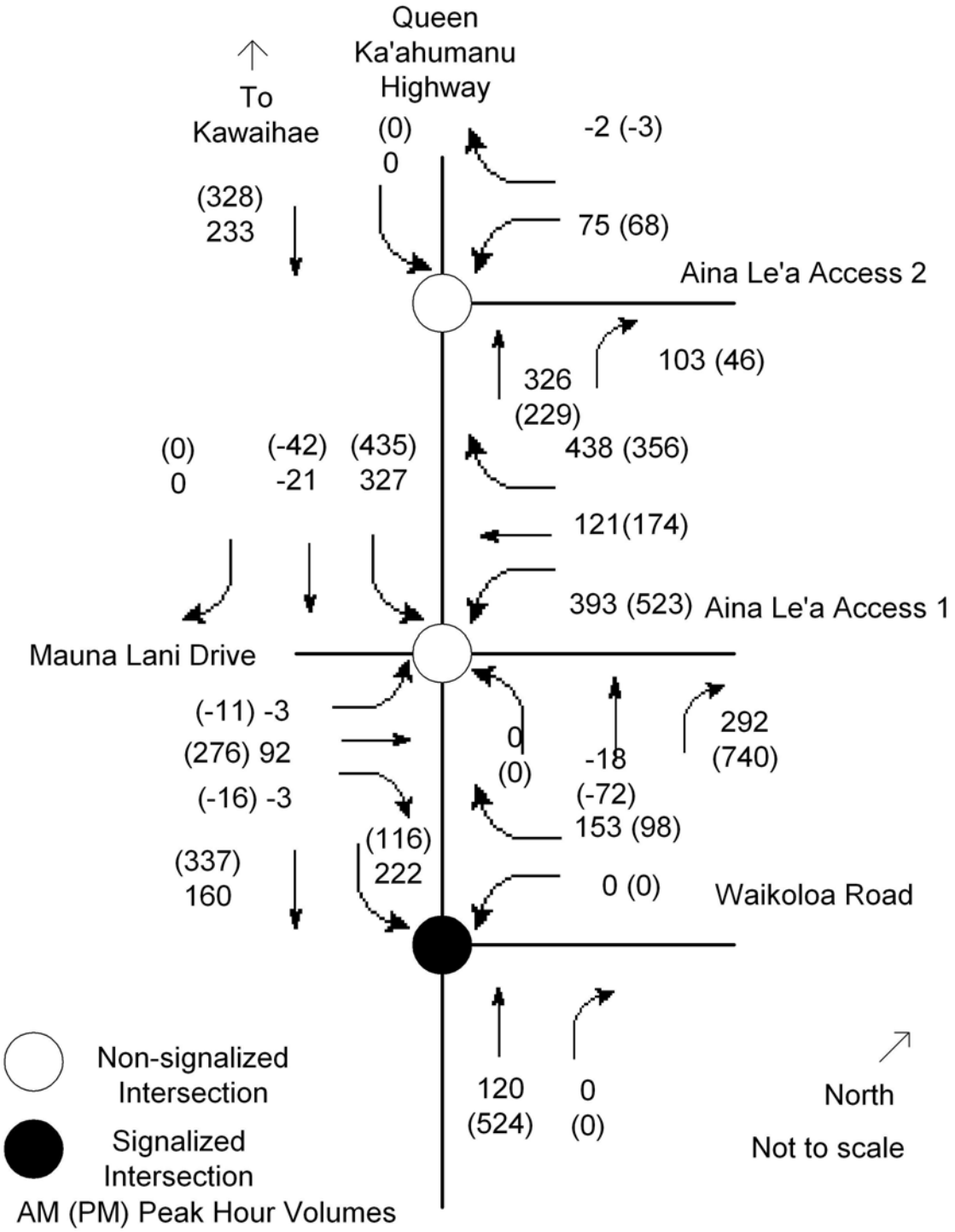


Figure 12

Volume Added Due to New Trips Generated at Full Buildout of Project in Year 2020



C. Trips Diverted to New Roadway

The proposed project includes making a new roadway connection from the Villages of Aina Le‘a to Hulu Street in Waikoloa Village that will allow Waikoloa Village residents a second route to Queen Ka’ahumanu Highway. Several factors will determine the extent to which this roadway is used by Waikoloa Village residents: 1) the location of the residence in relation to the new roadway; 2) trips to Kawaihae will be more apt to use the roadway; and 3) traffic conditions on Waikoloa Road.

The M&E Pacific, Inc. study summarized traffic counts and the level of traffic north of Hulu Street because several large development projects are proposed in this area. Future residents would be candidates for using the new roadway through the Villages of Aina Le‘a to connect to Queen Ka’ahumanu Highway.

These factors were considered in preparing the trip diversion figures shown on Figure 13 for 2012 and on Figure 14 for 2020. A higher diversion is forecast for 2020 when Waikoloa Road is expected to be more congested. The makai bound diversion was higher in the morning peak while the mauka bound diversion was higher in the afternoon peak.

Figure 13

Predicted Year 2012 Traffic Volumes Diverted Due to New Connecting Roadway

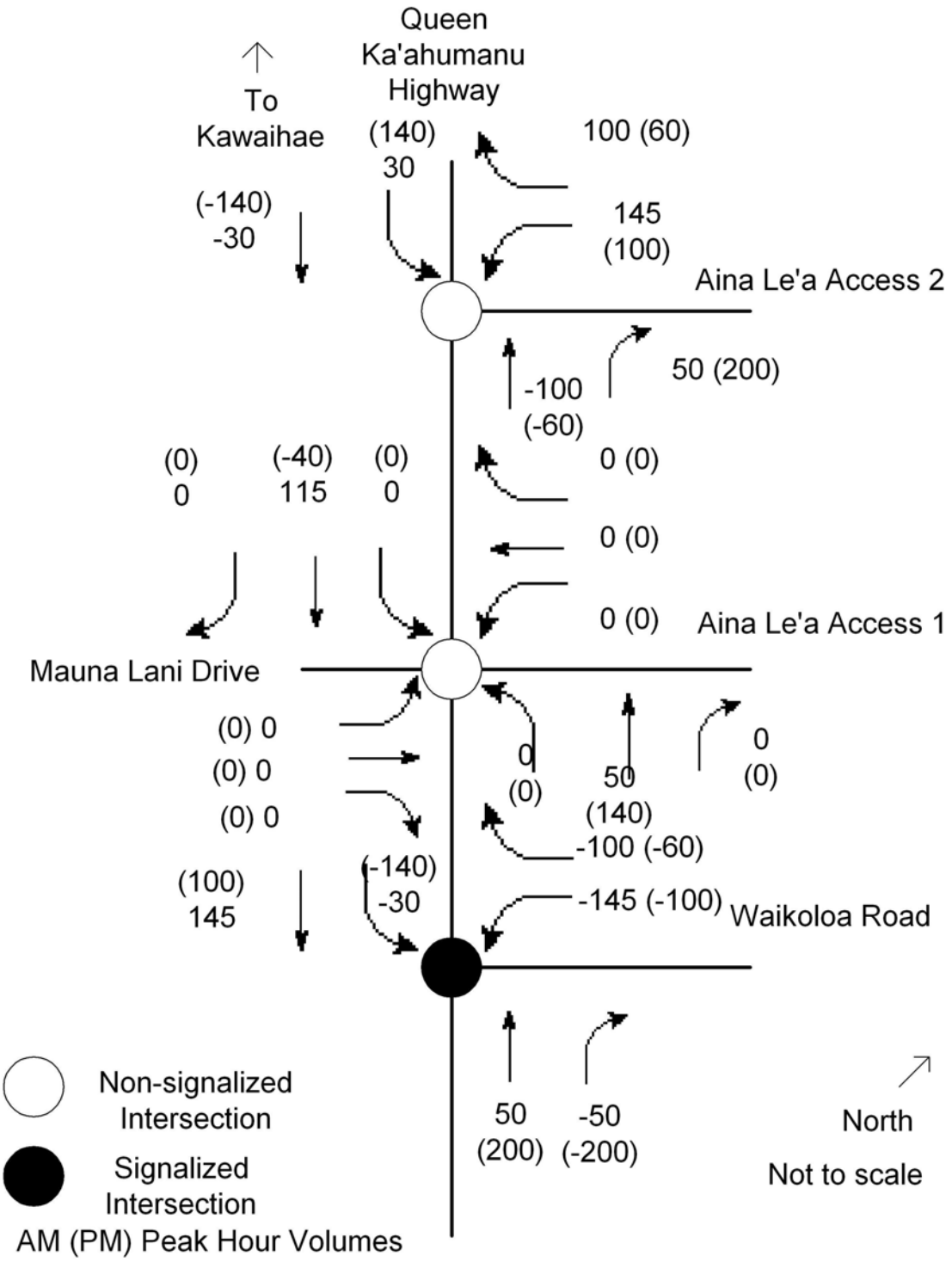
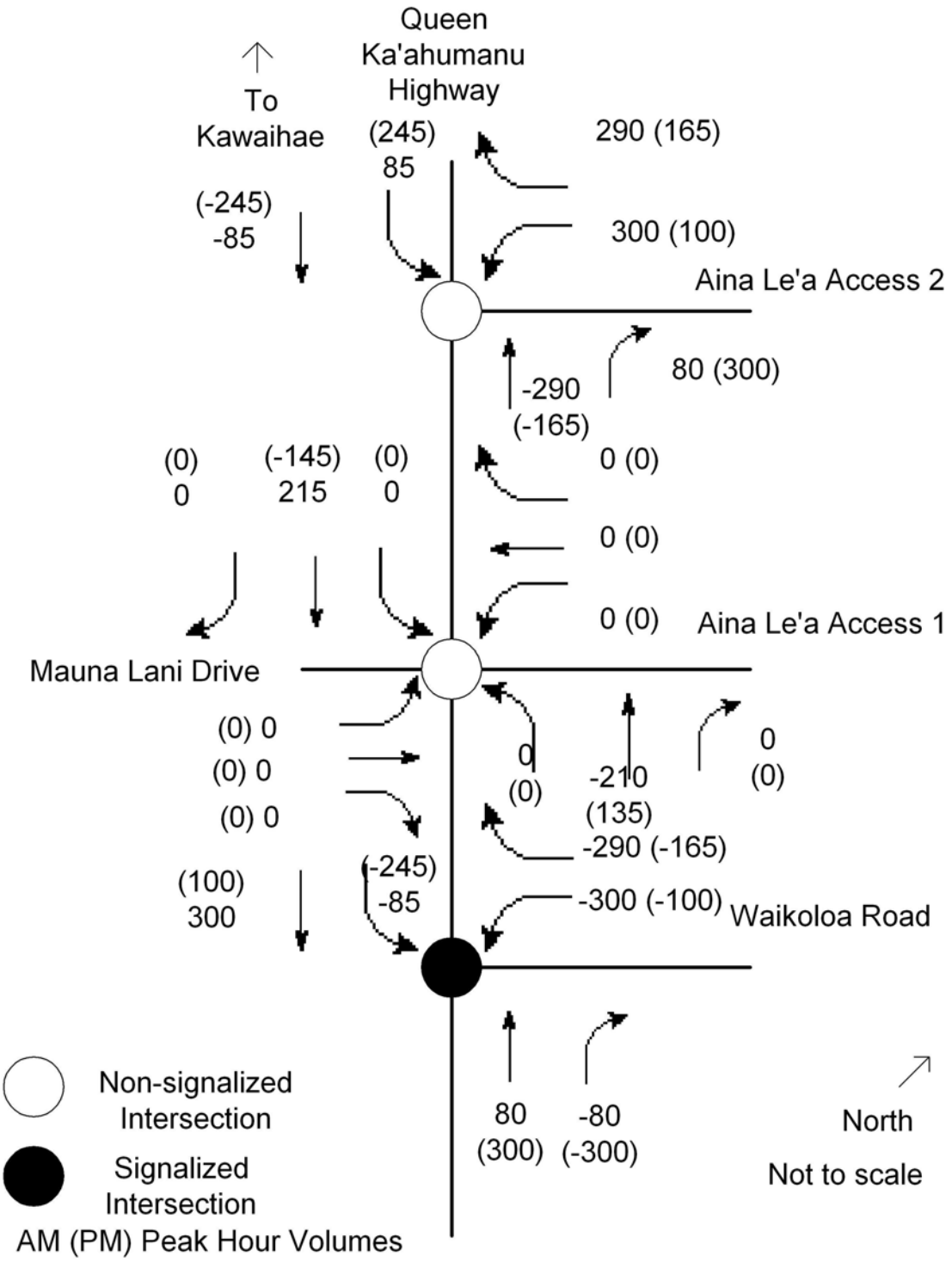


Figure 14

Predicted Year 2020 Traffic Volumes Diverted Due to New Connecting Roadway



D. Total with Project Forecast Volumes

Total with project traffic assignments were prepared for 2012 and 2020. For 2012, the project generated traffic assignment volumes from Figure 9 and the diverted trips from figure 11 were added to the background traffic forecasts from Figure 7 to obtain the 2012 total with project traffic forecasts shown on Figure 16.

Similarly, the traffic forecasts on Figures 8, 10 and 12 were added together to obtain the total with project traffic forecasts for 2020 shown on Figure 18.

Figure 15

Predicted Year 2012 Traffic Volumes without Project in Place

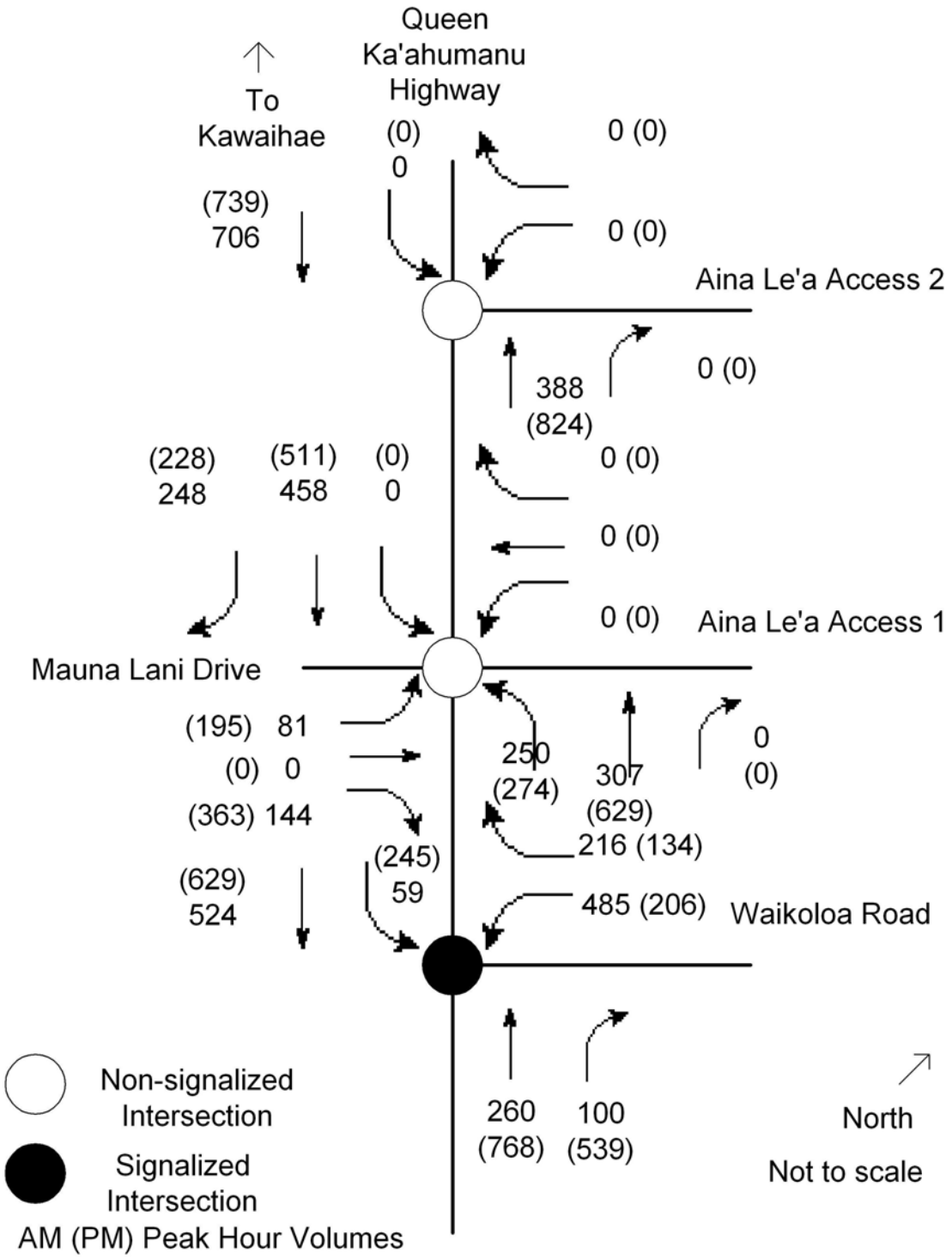


Figure 16

Predicted Year 2012 Traffic Volumes with Project in Place

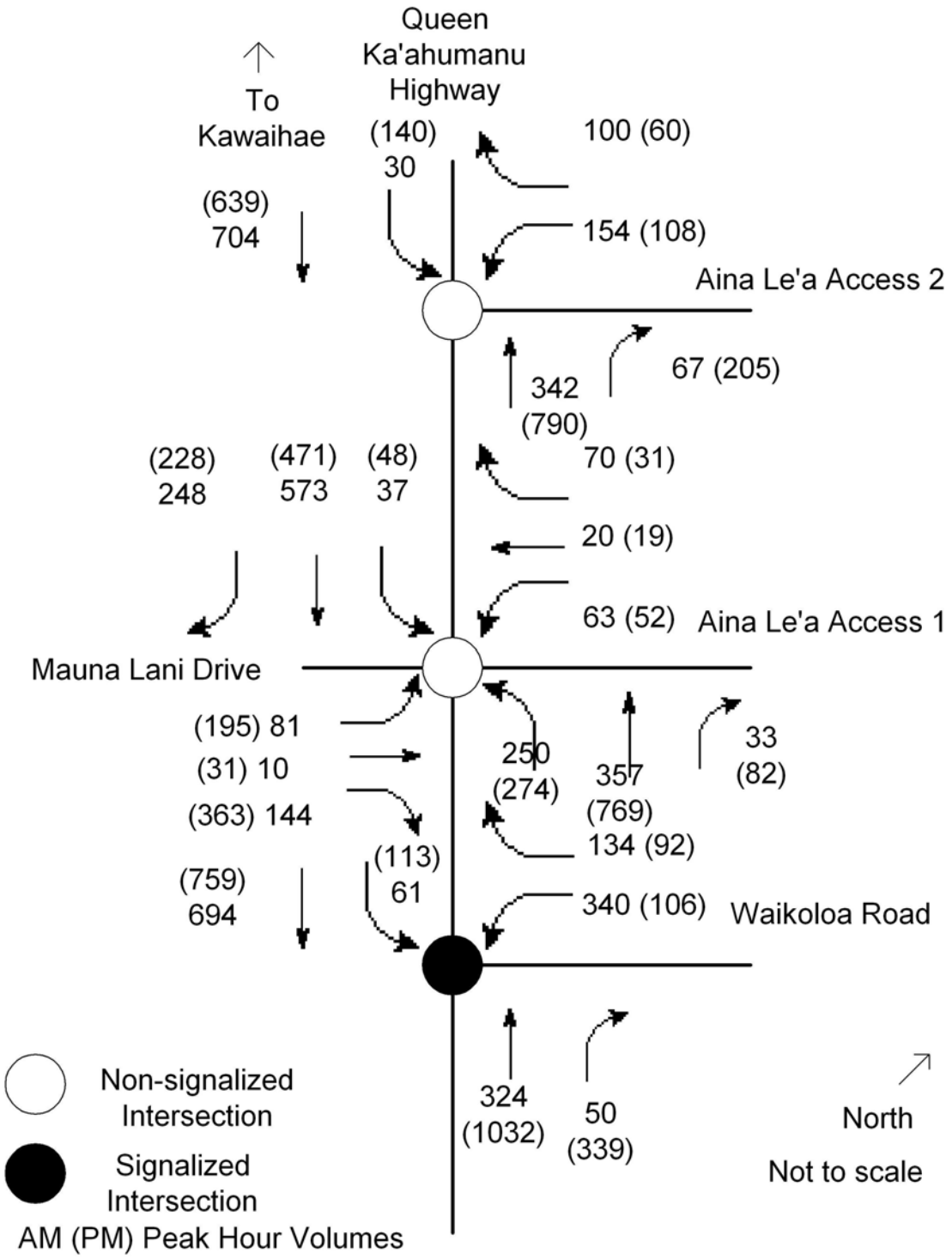


Figure 17

Predicted Year 2020 Traffic Volumes without Project in Place

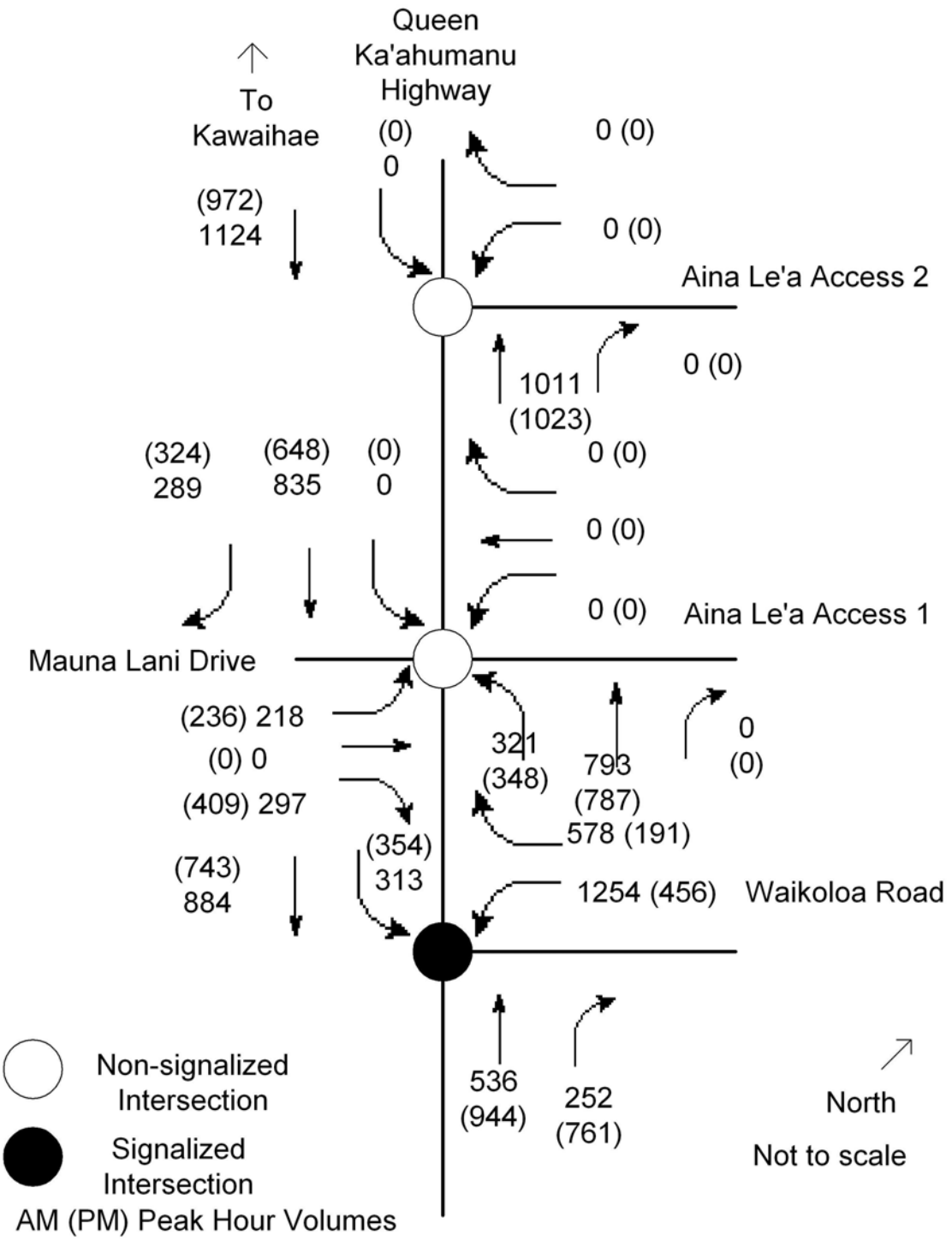
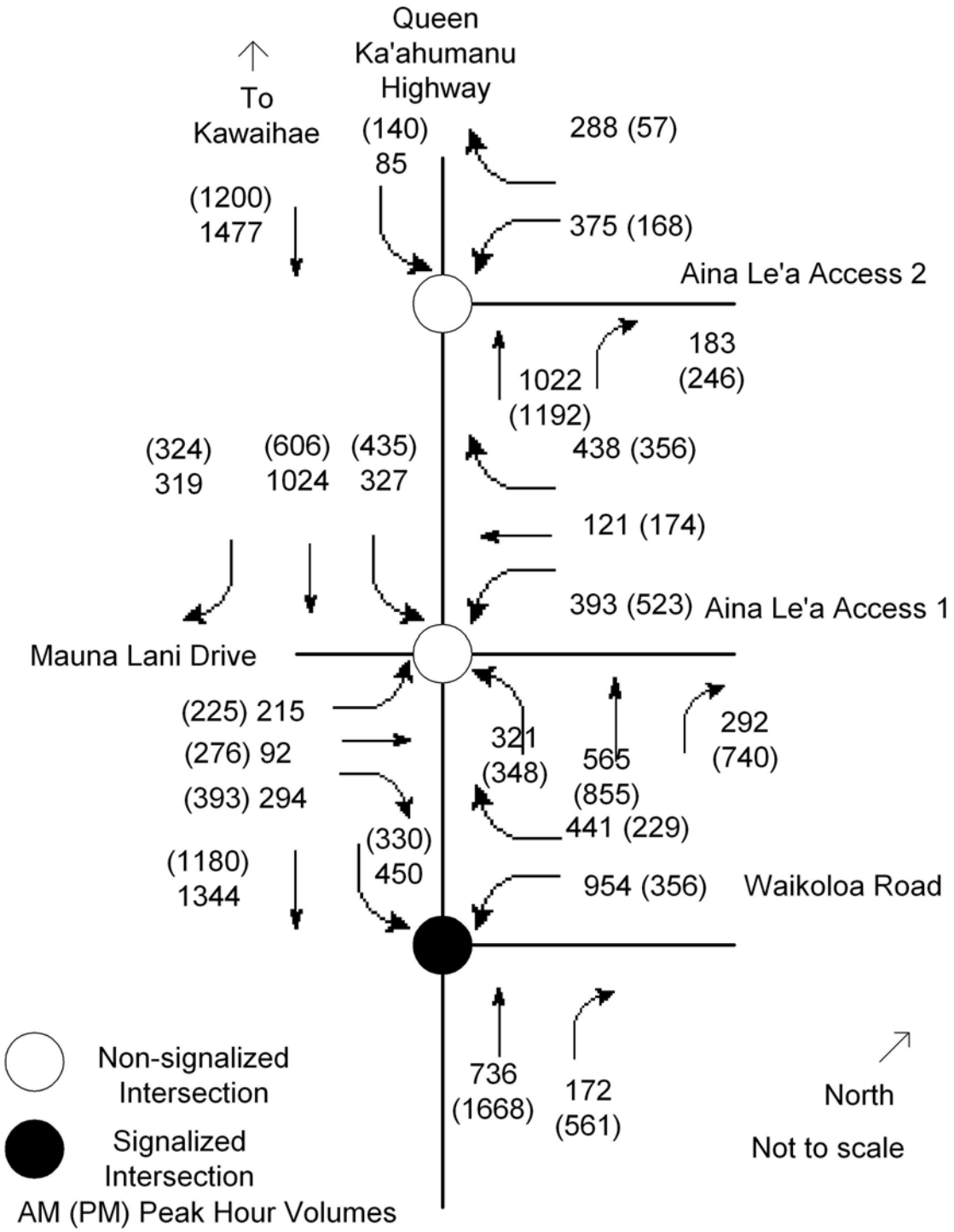


Figure 18

Predicted Year 2020 Traffic Volumes with Project in Place



V. ANALYSIS OF FUTURE CONDITIONS

A. Level of Service Analysis

The existing and forecast traffic volumes described in the previous sections were analyzed to identify acceptable and unacceptable traffic conditions. Measures to mitigate the unacceptable conditions are then recommended.

Table 13 shows the predicted v/c ratios, delay and LOS for the year 2012 without the project in place. Table 14 shows the same predicted traffic operational data for the year 2020 without the project in place. Table 15 shows the predicted traffic operational data for the year 2012 with the project in place and Table 16 shows the same data for the year 2020 with the project in place.

As seen in Table 13, there are predicted to be some deterioration in traffic conditions by the year 2012 even without the Villages of Aina Le’a project. At the current traffic signal at Waikoloa Road, the LOS for the left turn off Waikoloa Road shows an LOS F for the morning peak hour and an LOS F for the northbound through movement on Queen Ka’ahumanu Highway for the afternoon peak hour. These values reflect the increases in traffic volume on the highway and the side street as well as the operations of the existing traffic signal. At the existing non-signalized intersection at Mauna Lani Drive, there is a predicted LOS F for the left turn from Mauna Lani Drive for the both the morning and afternoon peak hours. And, the right turn from Mauna Lani Drive also shows an LOS F for the afternoon peak hour. These results indicate that the background growth of traffic on Queen Ka’ahumanu Highway is a factor in the review of the impacts of the Villages of Aina Le’a.

Table 13

Intersection Level of Service Analysis for Year 2012 without Project

Intersection	Movement	Morning Peak Hour			Afternoon Peak Hour		
		v/c Ratio	Delay (sec)	LOS	v/c Ratio	Delay (sec)	LOS
Queen Ka’ahumanu Highway at Waikoloa Road	Northbound Thru	.48	15.0	B	.95	35.9	D
	Northbound Right	.07	12.5	B	.37	10.9	B
	Southbound Thru	.65	12.1	B	.58	7.5	A
	Southbound Left	.15	8.2	A	.92	46.9	D
	Westbound Left	.80	21.2	C	.52	21.7	C
	Westbound Right	.15	11.0	B	.09	18.4	B
Queen Ka’ahumanu Highway at Mauna Lani Drive	Northbound Thru	.20	0	NA	.40	0	NA
	Northbound Left	.25	4.3	A	.29	31	B
	Southbound Thru	.29	0	NA	.33	0	NA
	Southbound Right	.16	0	NA	.15	0	NA
	Eastbound Left	.89	141.2	F	> 2.0	> 200	F
	Eastbound Right	.27	13.6	B	.74	28.9	F

Table 14

Intersection Level of Service Analysis for Year 2020 without Project

Intersection	Movement	Morning Peak Hour			Afternoon Peak Hour		
		v/c Ratio	Delay (sec)	LOS	v/c Ratio	Delay (sec)	LOS
Queen Ka’ahumanu Highway at Waikoloa Road	Northbound Thru	1.18	154	F	1.47	250	F
	Northbound Right	.17	40	D	.83	38	D
	Southbound Thru	1.29	183	F	.77	20	B
	Southbound Left	1.40	245	F	1.12	117	F
	Westbound Left	1.42	226	F	.79	36	D
	Westbound Right	.57	13	B	.24	12	B
Queen Ka’ahumanu Highway at Mauna Lani Drive	Northbound Thru	.52	NA	B	.21	NA	NA
	Northbound Left	.49	14.5	B	.52	NA	NA
	Southbound Thru	.55	NA	NA	.45	NA	NA
	Southbound Right	.21	NA	NA	.21	NA	NA
	Eastbound Left	2.81	>400	F	3.03	> 400	F
	Eastbound Right	1.04	97.2	F	1.15	123	F

For the year 2020, it is seen in Table 14 that the intersection of Queen Ka’ahumanu Highway at Waikoloa Road will have more deteriorated traffic conditions. The northbound through movement will have LOS F for the morning and afternoon peak hours while the southbound direction will have LOS F for the morning peak hour. The southbound left turn will have LOS F for the afternoon peak hour. For the intersection of Queen Ka’ahumanu Highway at Mauna Lani Drive, the LOS will be F for the Mauna Lani Drive approach for both the morning and afternoon peak hours without the project. Again, this analysis points out that the background growth of traffic resulting from new developments in the area as well as through traffic from afar is a significant factor in future traffic conditions.

Tables 15 and 16 show that conditions will continue to deteriorate with the construction of the Villages of Aina Le’a in both years 2012 and 2020.

Table 15

Intersection Level of Service Analysis for Year 2012 with Project

Intersection	Movement	Morning Peak Hour			Afternoon Peak Hour		
		v/c Ratio	Delay (sec)	LOS	v/c Ratio	Delay (sec)	LOS
Queen Ka’ahumanu Highway at Waikoloa Road	Nbd Thru	.49	13.1	B	1.17	100.6	F
	Nbd Right	.03	10.4	B	.26	8.5	A
	Sbd Thru	.76	13.2	B	.65	6.7	A
	Sbd Left	.15	6.9	A	.41	14.7	B
	Wbd Left	.66	18.8	B	.35	22.4	C
	Wbd Right	.09	13.2	B	.06	20.7	C
Queen Ka’ahumanu Highway at Mauna Lani Drive & New Aina Le’a Access (Access 1)	Nbd Thru/Right	.23	0	NA	.49	0	NA
	Nbd Left	.28	10.2	B	.28	9.8	A
	Sbd Thru	.37	0	NA	.30	0	NA
	Sbd Left	.03	8.2	A	.11	13.1	B
	Sbd Right	.16	0	NA	.15	0	NA
	Ebd Left/Thru	> 1.0	>100	F	> 1	> 100	F
	Ebd Right	.32	15.9	C	.70	25.1	D
	Wbd Left	1.87	> 100	F	> 1	> 100	F
	Wbd Thru	0.31	78.3	F	> 1	> 100	F
	Wbd Right	0.12	11.2	B	.14	22.3	C
Queen Ka’ahumanu Highway at New Aina Le’a Access (Access 2)	Nbd Thru	.26	0	NA	.64	0	NA
	Nbd Right	.26	0	NA	.64	0	NA
	Sbd Thru	.45	0	NA	.41	0	NA
	Sbd Left	.03	8.3	A	.24	12.3	B
	Wbd Left	.89	90.3	F	> 1	> 100	F
	Wbd Right	.17	11.7	B	.21	19.9	C

As seen in Table 15, there are several traffic movements that will have LOS E or F in the year 2012 with the Villages of Aina Le’a project in place.

Table 16

Intersection Level of Service Analysis for Year 2020 with Project

Intersection	Movement	Morning Peak Hour			Afternoon Peak Hour		
		v/c Ratio	Delay (sec)	LOS	v/c Ratio	Delay (sec)	LOS
Queen Ka’ahumanu Highway at Waikoloa Road	Nbd Thru	1.32	183	F	2.75	> 800	F
	Nbd Right	.18	20	B	.86	35	C
	Sbd Thru	1.39	201	F	1.15	93	F
	Sbd Left	1.15	114	F	.83	31	C
	Wbd Left	1.74	365	F	.73	25	C
	Wbd Right	.47	22	C	.16	20	B
Queen Ka’ahumanu Highway at Mauna Lani Drive & New Aina Le’a Access (Access 1)	Nbd Thru	.57	0	NA	1.05	0	NA
	Nbd Right	.57	0	NA	1.05	0	NA
	Nbd Left	.81	39	E	.58	18	C
	Sbd Thru	.68	0	NA	.40	0	NA
	Sbd Left	.60	19	C	2.46	> 400	F
	Sbd Right	.21	0	NA	.21	0	NA
	Ebd Left	> 1.0	> 100	F	> 1.0	> 100	F
	Ebd Thru	> 1.0	> 100	F	> 1.0	> 100	F
	Ebd Right	> 1.0	> 100	F	> 1.0	> 100	F
	Wbd Left	> 1.0	> 100	F	> 1.0	> 100	F
	Wbd Thru	> 1.0	> 100	F	> 1.0	> 100	F
	Wbd Right	1.22	> 100	F	3.13	> 100	F
Queen Ka’ahumanu Highway at New Aina Le’a Access (Access 2)	Nbd Thru	.80	0	NA	.95	0	NA
	Nbd Right	.80	0	NA	.95	0	NA
	Sbd Thru	.98	0	NA	.79	0	NA
	Sbd Left	.19	14	B	.39	20	C
	Wbd Left	> 1.0	> 100	E	2.13	> 600	F
	Wbd Right	1.54	> 300	F	.42	44	E

As seen in Table 16, there are expected to be several traffic movements which will have congestion problems at the full buildout of the Villages of Aina Le’a in the year 2020. At the new access point on the northern end it is predicted that the exiting traffic will have great difficulty with only stop sign control. Table 16 shows that there would be v/c ratios exceeded 1.0 along with LOS E or F for both the left turns and right turns exiting the site. The v/c ratio for the northbound through traffic on Queen Ka’ahumanu Highway would be very close to 1.0. These data generally indicate that stop sign control will likely not be sufficient for the intersection. Signal warrants are addressed in the next section of this report. At the intersection at Aina Le’a opposite the existing Mauna Lani Drive, it is also sent that there are traffic congestion problems at full buildout in the year 2020. Table 16 shows that the eastbound and westbound side street approaches will have LOS F and v/c ratios exceeding 1.0 for all movements for both the morning and afternoon peak hours. This result would tend to indicate that the intersection cannot function properly without a traffic signal in the year 2020. Signal warrants are addressed in the next section of this report. Also, Table 16 shows that there will be a problem with the northbound left turn in the morning peak hour and the southbound left turn in the afternoon peak hour. This tends to indicate the need for separable left turn phases and this will be addressed later in this report. Finally, the v/c ratio for the northbound through and right turn movements indicates the likely need for a right turn lane. Again, this will be addressed later in the report. For the intersection at Waikoloa Road, it is seen that the northbound and southbound through movements would have v/c ratios exceeding 1.0 and LOS of F for both peak hours. The LOS for the left turn out of the Villages of Aina Le’a would be at F for the morning peak hour. Again, this would tend to indicate that a traffic signal would be needed at the intersection and this will be addressed in a subsequent section of this report.

The new intersection of the north access roadway and Queen Ka’ahumanu Highway is predicted to operate at acceptable levels of service in 2012 with two lanes and 2020 with four lanes. Double left turn lanes on the new access roadway approach would be desirable by 2020. The intersection is forecast to operate at an unacceptable level of service E in the afternoon peak in 2020 with a two lane highway. Providing two southbound left turn lanes by 2020 would be desirable. Potential mitigations needs for the years 2012 and 2020 are discussed further in the next section of this report.

The three study intersections are spaced about 1.4 miles from each other. Therefore, traffic signal coordination is not likely necessary unless and until there may become new addition points of access between Waikoloa Road and Mauna Lani Drive or between Mauna Lani Drive and the new Aina Le’a access.

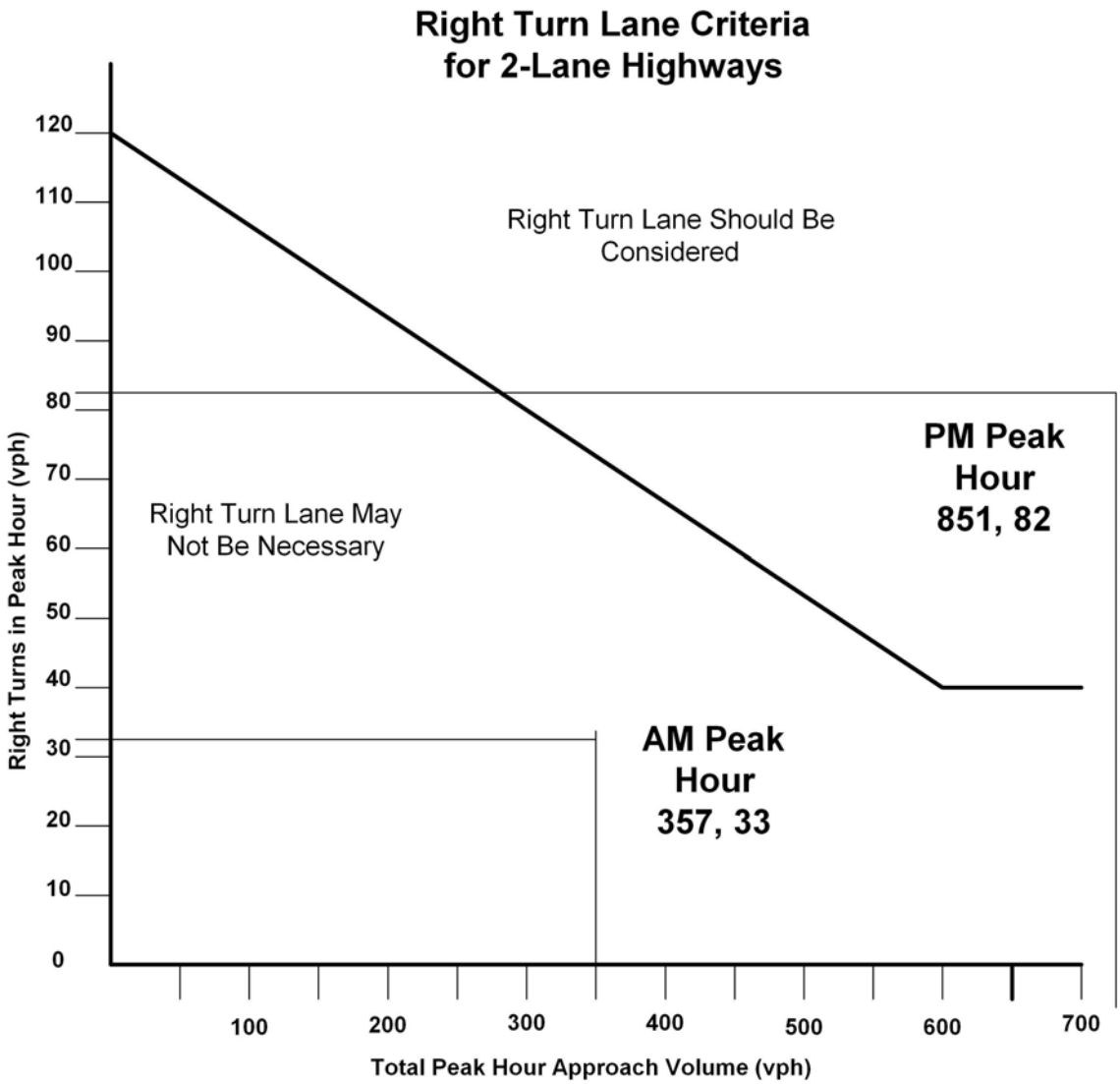
B. Mitigation Needed

The two proposed access points from Queen Ka’ahumanu Highway will require intersection design which conforms to State and local standards. Queen Ka’ahumanu Highway is classified as a primary arterial. The nominal design features will need to meet Hawaii DOT standards, based on A Policy on Geometric Design of Highways and Streets 2004, the Green Book, published by the American Association of State Highway and Transportation Officials (AASHTO).

A review was made to determine whether right turn lanes will be needed for the two intersections at the completion of Phase I in the year 2012 and at the full buildout in the year 2020. At the proposed access to the Villages at Aina Le’a opposite Mauna Lani Drive, there will have to be a left turn lane added for safety reasons, regardless of traffic control for turns southbound into the new development. The criteria for addition of right turn lanes is contained in the Green Book and consists of a chart that relates the need for a turn lane to the total volume of traffic on the roadway and the amount of right turns. The predicted year 2012 traffic volumes with application of this criteria for the intersection of Queen Ka’ahumanu Highway at Mauna Lani Drive for the peak hours are shown in Figure 19. As seen in Figure 19, the volumes indicate that a right turn lane should be considered for this intersection at the completion of Phase I in the year 2012. Based on this review, a right turn lane is recommended.

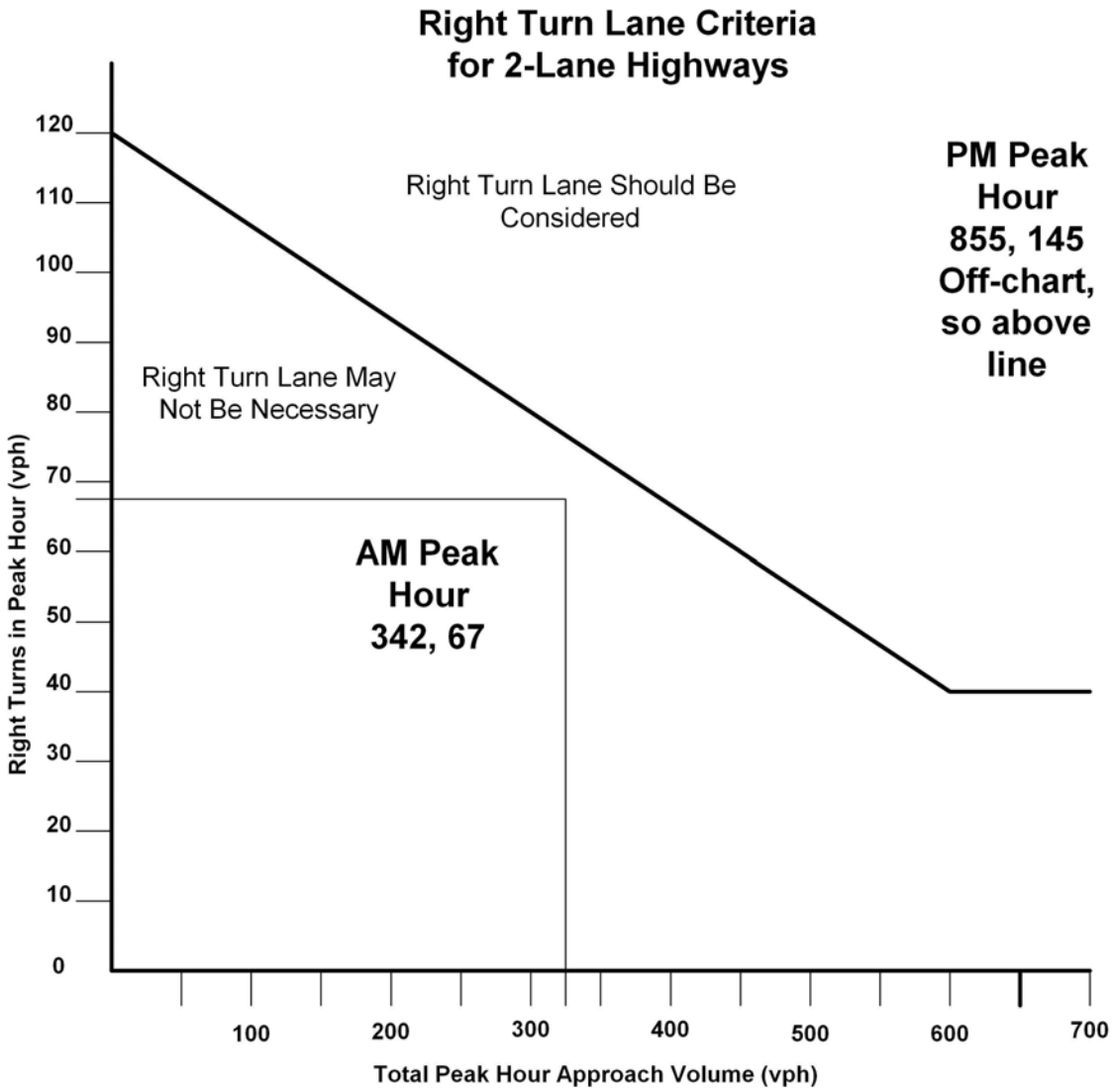
Figure 19

Application of Right Turn Lane Warrant Criteria to Intersection of Queen Ka’ahumanu Highway at Mauna Lani Drive Northbound with Project in Year 2012



As seen in Figure 19, a right turn lane should be considered for this intersection for the northbound direction based on the predicted traffic volumes for the afternoon peak hour. Design of the turn lane as to its length should be based on predicted traffic volumes for the full buildout of the project in the year 2020. This will be discussed in a subsequent section of this report. Figure 20 shows the application of the criteria for right turn lanes as applied to the intersection of Queen Ka’ahumanu Highway at the second or northern access to the Villages of Aina Le’a. As seen in Figure 20, a right turn lane will be needed in the afternoon peak hour at this intersection in the year 2012.

Figure 20
Application of Right Turn Lane Warrant Criteria to Intersection of Queen Ka’ahumanu Highway at New Villages of Aina Le’a Access Northbound with Project in Year 2012



Design of the turn lane as to its length should be based on predicted traffic volumes for the full buildout of the project in the year 2020. This will be discussed in a subsequent section of this report.

Since both intersection show the need for right turn lanes in 2012, they would also be needed in the year 2020.

C. Traffic Signal Warrants

The level of service analysis indicated that the Mauna Lani Drive and new north access roadway intersections would not operate at acceptable levels of service without traffic signals, and traffic signals were recommended as mitigating measures. However, unacceptable levels of service in themselves do not justify the installation of traffic signals. An engineering study must be conducted to determine whether or not a traffic signal is justified at a particular location. Traffic signal warrants are contained in the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD 2003 Edition), and are listed below:

- Warrant 1, Eight-Hour Vehicular Volume (includes conditions A and B)
- Warrant 2, Four-Hour Vehicular Volume
- Warrant 3, Peak Hour
- Warrant 4, Pedestrian Volume
- Warrant 5, School Crossings
- Warrant 6, Coordinated Signal System
- Warrant 7, Crash Experience
- Warrant 8, Roadway Network.

The MUTCD also notes that the “satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic signal.”

A traffic signal warrant analysis was conducted for the intersections of Queen Ka’ahumanu Highway at Mauna Lani Drive and at the new north access roadway intersection with predicted year 2012 traffic volumes. Of the eight warrants shown above, the first two warrants, Warrant 1, Eight-Hour Vehicular Volume, and Warrant 2, Four-Hour Vehicular Volume, are most applicable to this study. The data collected in the 24 hour traffic counts were used to describe the traffic characteristics for the busiest 13 hours of the day, from which the peak eight and four hours which satisfied the warrants were identified.

The other warrants are not generally applicable to the two intersections for the following reasons:

- Warrant 3, Peak Hour, is intended for locations with high peak hour traffic such as an industrial or major employment site, which does not apply here;
- Warrant 4, Pedestrian Volume, is intended at crosswalks with 100 or more pedestrians an hour for each of any four hours, which does not apply here;
- Warrant 5, School Crossings, does not apply since there are no school crossings.
- Warrant 6, Coordinated Signal System, is used where adjacent traffic signals do not provide the necessary degree of platooning, which does not apply here;
- Warrant 7, Crash Experience, could not be analyzed since traffic accident data was not made available to this study; and
- Warrant 8, Roadway Network, is used at the intersection of two major routes and does not apply here.

In applying the traffic signal warrants, it is necessary to establish the number of lanes on the major street which in our case is Queen Ka’ahumanu Highway and the minor streets, which in our case are the Mauna Lani Drive/Villages of Aina Le’a Access 1 and the proposed new Villages of Aina Le’a Access 2. Since Queen Ka’ahumanu Highway currently has one lane for through traffic in each direction, it was assumed that the major street had only one approach lane. This essentially means that the left turn lanes and right turn lanes on the major street are ignored, along with the corresponding traffic volumes. In addition, the minor street traffic was review to include only the left turn volume, ignoring the right turn volume and any through traffic across the major street. Since each intersection is expected to have only one left turn lane in the year 2012, it was therefore assumed that the traffic signal warrants would be analyzed using one approach lane in each direction on the major street and one approach lane on the minor street. Also, the high-speed reduction factor which is provided in the MUTCD was not used. Most highway agencies do not use this reduction factor except in rare cases. Based on the application of the criteria discussed above, the thresholds for the application of the warrants were then selected.

The Warrant 1, Eight-Hour Vehicular Volume, has two parts. Condition A, the minimum vehicular volume warrant, is "intended for application where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal." The criteria for Condition A of Warrant 1 requires a total of at least 500 vehicles per hour (vph) on the major street and at least 150 vph on the higher volume approach of the minor street for the same eight hours.Condition B, the interruption of continuous traffic warrant, is "intended for application where the traffic volume on a major street is so heavy that traffic on a minor street suffers excessive delay or conflict in entering of crossing the major street." The criteria for Condition A of Warrant 1 require a total of at least 750 vehicles per hour (vph) on the major street and at least 75 vph on the higher volume approach of the minor street for the same eight hours.The Warrant 2, Four-Hour Vehicular Volume analysis utilizes the charts identified as Figure 4C-1 in the MUTCD. The threshold value decreases as the major street volume increases. Hourly traffic volumes were developed for the 11-hour period from 7:00 a.m. to 6:00 p.m. Traffic generation values for the 11 hours were estimated using the predicted daily traffic volumes for the new development. The distribution of traffic throughout the day was estimated using information from the NCHRP report 387 for residential developments. This report provides estimated average percentages of residential trips for the hours of the day for entering and exiting trips. For the golf course, the hourly percentages of daily trips were estimated assuming the trips were distributed in the same manner as commercial retail trips. This estimate uses data taken from the Institute of Transportation Engineers (ITE) publication *Trip Generation Handbook*. The trip distribution and assignments for each hour of the day were estimated using the Wintass program and the results of the application of this program are provided in the Appendix B.

The detailed calculations for the Mauna Lani Drive intersection Warrant 1 and Warrant 2 analyses are included in Appendix D. The results of application of the signal warrants are shown in Table 17 for the intersection of Queen Ka’ahumanu Highway at Mauna Lani Drive and the new access to the Villages of Aina Le’a Access 1 (south end).

Table 17

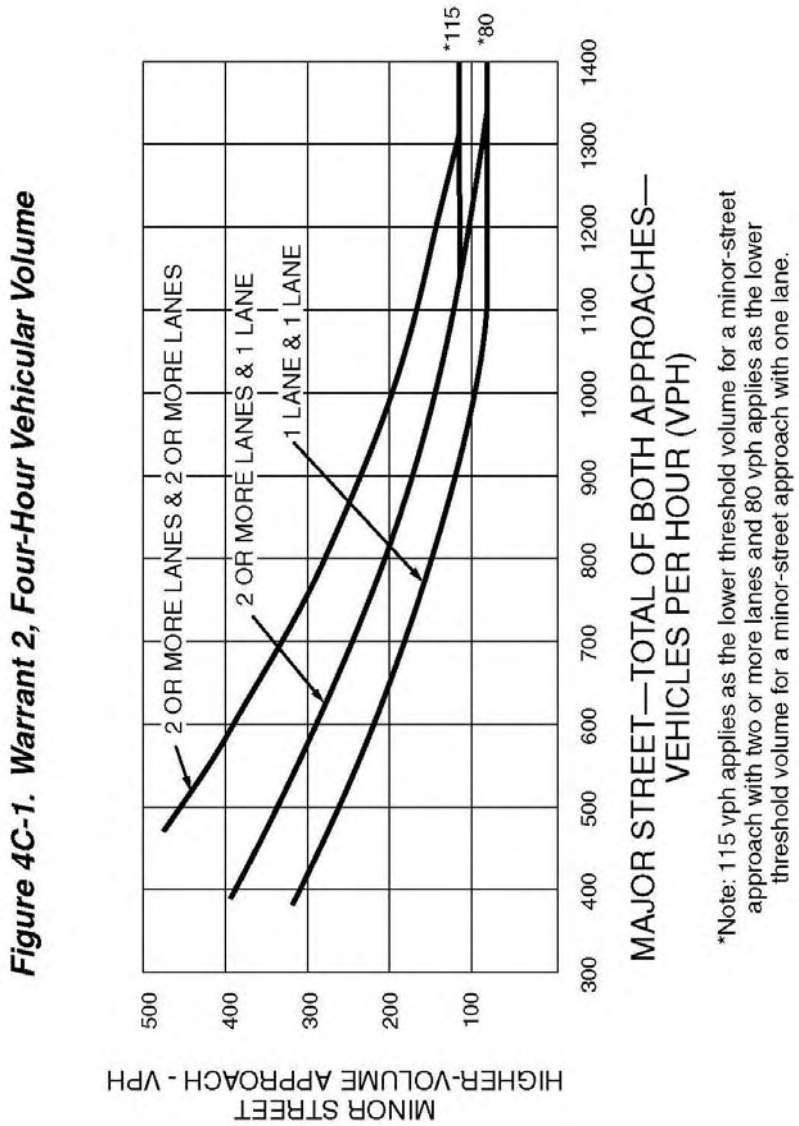
Summary of MUTCD Signal Warrants for Intersection of Queen Ka’ahumanu Highway at Mauna Lani Drive/Villages of Aina Le’a Access 1 (South End)

Begin Time	Total volume on major street (1)	Left turn volume on minor street (2)	Warrant 1		Warrant 2
			Condition A	Condition B	
			Are thresholds exceeded? (500 req’d on major street, 150 req’d on minor street)	Are thresholds exceeded? (750 req’d on major street, 75 req’d on minor street)	Do volumes meet criteria in Figure 4C-1 of MUTCD? (3)
0700	895	84	No	Yes	No
0800	842	97	No	Yes	No
0900	773	101	No	Yes	No
1000	828	109	No	Yes	No
1100	836	104	No	Yes	No
1200	888	124	No	Yes	No
1300	889	124	No	Yes	No
1400	971	142	No	Yes	Yes
1500	1146	165	Yes	Yes	Yes
1600	1317	160	Yes	Yes	Yes
1700	930	132	No	Yes	Yes
Number of hours exceeded			2	11	4
Number of hours required			8	8	4
Is warrant met?			No	Yes	Yes

(1) Queen Ka’ahumanu Highway
(2) Higher of side street approaches for each hour of the day
(3) See Figure 21 for MUTCD Figure 4C-1 for Warrant 2.

Figure 21

MUTCD Figure 4C-1 Four-Hour Vehicular Volume Warrant



As seen in Table 17, the intersection of Queen Ka’ahumanu Highway at the intersection with Mauni Lani Drive and the new access to the Villages of Aina Le’a (south end) will meet the criteria of warrant 1 (condition B) and warrant 2 for the Phase I buildout year of 2012.

The detailed calculations for predicted traffic volumes for the new intersection of Queen Ka’ahumanu Highway at the new northern access to the Villages of Aina Le’a are included in Appendix B. Warrant 1 and Warrant 2 analyses are included in Appendix D. The results of application of the signal warrants are shown in Table 18 for the intersection of Queen Ka’ahumanu Highway at the new access to the Villages of Aina Le’a Access 2 (north end).

Table 18

Summary of MUTCD Signal Warrants for Intersection of Queen Ka’ahumanu Highway at Villages of Aina Le’a Access 2 (North End)

Begin Time	Total volume on major street (1)	Left turn volume on minor street (2)	Warrant 1		Warrant 2
			Condition A	Condition B	
			Are thresholds exceeded? (500 req’d on major street, 150 req’d on minor street)	Are thresholds exceeded? (750 req’d on major street, 75 req’d on minor street)	Do volumes meet criteria in Figure 4C-1 of MUTCD? (3)
0700	940	145	No	Yes	Yes
0800	894	134	No	Yes	No
0900	802	119	No	Yes	No
1000	832	124	No	Yes	No
1100	839	126	No	Yes	No
1200	941	118	No	Yes	Yes
1300	929	121	No	Yes	Yes
1400	1044	126	No	Yes	Yes
1500	1197	149	No	Yes	Yes
1600	1529	140	No	Yes	Yes
1700	972	118	No	Yes	Yes
Number of hours exceeded			0	11	6
Number of hours required			8	8	4
Is warrant met?			No	Yes	Yes

1. Queen Ka’ahumanu Highway
2. Higher of side street approaches for each hour of the day
3. See Figure 21 for MUTCD Figure 4C-1 for Warrant 2.

As seen in Table 18, the intersection of Queen Ka’ahumanu Highway at the new access to the Villages of Aina Le’a (south end) will meet the criteria of warrant 1 (condition B) and warrant 2 for the Phase I buildout year of 2012. As indicated in earlier discussion in the text there will be substantial diversion of traffic to this intersection as a result of the construction of the connector road.

Summary of Mitigations for Project for Phase I

Based on the review of the study intersections with completion of Phase I in the year 2012, it will likely be necessary to provide the following items to mitigate the effects on traffic flow:

1. Add a right turn lane on Queen Ka’ahaumanu Highway at Mauna Lani Drive northbound
2. Add a right turn lane on Queen Ka’ahaumanu Highway at the northern access to the Villages of Aina Le’a in the northbound direction
3. Install a traffic signal at the intersection of Queen Ka’ahaumanu Highway at Mauna Lani Drive and the new access to the Villages of Aina Le’a
4. Install a traffic signal at the intersection of Queen Ka’ahaumanu Highway at the northern access to the Villages of Aina Le’a
5. The access to the Villages of Aina Le’a opposite Mauna Lani Drive should have three approach lanes with lanes for left turns and through movements and a channelized right turn lane
6. The northern access to the Villages of Aina Le’a should have two approach lanes with a lanes for left turns and a channelized right turn lane

Review of Traffic Operations at Full Buildout of Project in Year 2020

It was assumed that the above mitigation items would be in place at the completion of Phase I and therefore would be in place for the full buildout in the year 2020. It was also assumed that at some point before 2020 there would be one through lane added in each direction on Queen Ka’ahumanu Highway. A review was made assuming the above mitigations and the additional lanes would be in place in 2020 with the additional traffic generated by the site. Since the signal warrant analysis for the year 2012 indicated that traffic signals would be needed, no warrant analysis was done for the year 2020. The results from the HCM analysis for the year 2020 are shown in Table 19. As seen in Table 19, there will still be traffic congestion issues in a few locations. In the morning peak hour, the v/c ratios would all be below 1.0. For the afternoon peak hour, there are some movements shown with v/c ratios above 1.0 including the eastbound through and westbound left turn movements. However, it is likely that these movements can be improved with traffic signal timing adjustments.

Table 19

Intersection Level of Service Analysis for Year 2020 with Project and Widening of Queen Ka’ahumanu Highway and All Mitigations in Place

Intersection	Movement	Morning Peak Hour			Afternoon Peak Hour		
		v/c Ratio	Delay (sec)	LOS	v/c Ratio	Delay (sec)	LOS
Queen Ka’ahumanu Highway at Waikoloa Road	Nbd Thru	.76	25	C	.74	16	B
	Nbd Right	.13	2	A	.19	2	A
	Sbd Thru	.86	22	C	.58	8	A
	Sbd Left	.51	17	B	.60	15	B
	Wbd Left	.74	33	C	.57	31	C
	Wbd Right	.43	25	C	.04	26	C
Queen Ka’ahumanu Highway at Mauna Lani Drive & New Aina Le’a Access (Access 1)	Nbd Thru	.41	28	C	.65	34	C
	Nbd Left	.90	78	E	.94	84	F
	Nbd Right	.27	13	B	.85	30	C
	Sbd Left	.75	66	E	.90	78	E
	Sbd Thru	.92	55	D	.56	39	D
	Sbd Right	.40	35	D	.25	34	C
	Ebd Left	.83	83	F	.88	90	F
	Ebd Thru	.48	62	E	1.47	299	F
	Ebd Right	.53	36	D	.65	39	D
	Wbd Left	.90	78	E	1.16	155	F
	Wbd Thru	.41	28	D	.59	58	E
	Wbd Right	.27	13	D	.77	46	D
Queen Ka’ahumanu Highway at New Aina Le’a Access (Access 2)	Nbd Thru	.72	39	D	.74	16	B
	Nbd Right	.12	30	C	.20	2	A
	Sbd Thru	.76	24	C	.58	8	A
	Sbd Left	.73	50	D	.70	20	C
	Wbd Left	.77	35	C	.57	31	C
	Wbd Right	.47	13	B	.04	26	C

D. Recommendations

The following recommendations are made based on the results of the analyses in this report.

1. Install a traffic signal at the intersection of Queen Ka’ahumanu Highway and Mauna Lani Drive to coincide with the completion of the proposed project’s Phase 1 completion date. This signal should be fully actuated and should be operational with the occupation of the proposed project and the connection of the internal access road.

2. Install a traffic signal at the intersection of Queen Ka’ahumanu Highway and the new north access roadway to the Villages of Aina Le’a when it is opened to traffic flow in the year 2012. This signal should be fully actuated. Due to its distance from the other proposed signal, coordination will not be necessary at this time.

3. Queen Ka’ahumanu Highway will need to be widened to have four lanes by 2020 to accommodate the projected growth of Waikoloa Village, the Mauna Lani Resort, and general traffic, as well as the Villages of Aina Le’a. Two through lanes in each direction are needed to accommodate the volume of through traffic and to receive the traffic from double left turns on Waikoloa Road. The length of this widening was not analyzed in this study specifically, but in general, it should extend from a point south of Waikoloa Road to a point north of the new proposed Aina Le’a access on its north end.

5. The proposed north-south roadway from the north access roadway that extends to Waikoloa Village should be connected to the primary (southern) roadway at the earliest possible time. Without this connection, vehicles traveling between Waikoloa Village and the primary roadway within the Villages of Aina Le‘a must enter Queen Ka’ahumanu Highway. Providing this connection will take many trips off Queen Ka’ahumanu Highway and the three study intersections, and may help to defer the need to widen the highway.

6. Geometric design of the new intersections should comply with the AASHTO Green Book and Hawaii DOT standards. They should include consideration of acceleration lanes for entry onto Queen Ka’ahumanu Highway and a review of the design of any proposed median treatments. Pedestrian features should be included for the proposed signalized intersections.

VI. ANALYSIS OF POTENTIAL TRAFFIC IMPACT OF OTHER ADJACENT PROPERTIES

There are properties with development potential adjacent to the Villages of Aina Le‘a project site that were not included in previous chapters of this report because they have no specific construction timetable. Although the adjacent parcels are currently unscheduled, this section addresses the potential traffic impacts as if these unscheduled developments were to be constructed by 2020, the year the Villages of Aina Le‘a is scheduled for full build-out.

Preliminary engineering for the Villages of Aina Le‘a indicated the need to relocate the north access road further north to avoid a water body and major ground work. Although the relocation of the north access road (from highway station 1340+00 to 1347+23) has no affect on traffic volumes; the Villages of Aina Le‘a will coordinate with Tokyu Land Corporation in its request for this change from the Hawaii Department of Transportation.

A. Additional Projects

Several land potential developments adjacent to the Villages of Aina Le‘a project have been identified. These potential development projects are summarily listed below by property owner. Each property is depicted on figure 1 in relation to the proposed Villages of Aina Le‘a project site.

- Waikoloa Homesite Venture - This 252-acre property is located on the makai side of Queen Ka’ahumanu Highway between Mauna Lani Drive and Waikoloa Road. The land owners indicated that they are revising their plans to include a golf course and 300 to 400 single- and multi-family units. No specific completion/occupancy date was given. The assumed highway access point to the Waikoloa Homesite Venture and the Waikoloa Land and Cattle property is at Queen Ka’ahumanu Highway station 1235+00, about midway between Waikoloa Road and the Villages of Aina Le‘a project’s south-access roadway, about three-fourths mile south of the latter access. Waikoloa Homesite Venture is classified as unimproved residential land as indicated by the Hawai‘i County Real Property Tax website.
- Waikoloa Land and Cattle - This 740-acre parcel is mauka of and immediately across the Queen Ka’ahumanu Highway from the Waikoloa Homestead Venture property, and is north of the Queen Ka’ahumanu Highway intersection with Waikoloa Road. The Hawai‘i County Real Property Tax website indicates that the Waikoloa Land and Cattle parcel is classified as agricultural land.
- Tokyu Land Corporation - This 816-acre property extends along the makai side of Queen Ka’ahumanu Highway from Mauna Lani Drive north to about the same northern boundary as the Tri-Kohala property. The long length of the property means it has the potential to incorporate two access points: Mauna Lani Drive and a new north access point at station 1347+23, directly across Queen Ka’ahumanu Highway from the Villages of Aina Le‘a proposed

project’s north access road. Two smaller parcels (TMK (3)6-8-001:050 and 051) totaling approximately 67 acres have been sold and are not included in the total 816 acre Tokyu Land Corporation property. The landowners and County have both stated that there are currently no development plans for the property. If the highway access point for the proposed Villages of Aina Le‘a project’s north access road is relocated, then the north access for a potential Tokyu development project would also be expected to be relocated so that the two access points to Queen Ka’ahumanu Highway are opposite one another. The Tokyu Land Corporation property is zoned as Ag-5 as indicated by Hawai‘i County Planning Department.

- Tri-Kohala - This 1,011-acre property is immediately north of the Villages of Aina Le‘a project site and mauka of Queen Ka’ahumanu Highway. The County of Hawai‘i has confirmed that there are no development plans for this property. The highway access point to this property is at Queen Ka’ahumanu Highway station 1400+00, about one mile north of the Villages of Aina Le‘a north access road. The Tri-Kohala property is zoned as Ag-5 as indicated by Hawai‘i County Planning Department.
- Waikoloa Village Association - This 4,900+ acre parcel forms a buffer around the existing Waikoloa Village. The Hawai‘i County Real Property Tax website indicates that the land is classified as agricultural and appears to have very low development potential due to its topography. There is no known development plan for it.

Based on the uncertain development schedules for the above projects, a supplemental analysis was conduct for the 2020 analysis year, assuming the Waikoloa Homesite Venture, Waikoloa Land and Cattle, Tokyu Land Corporation and Tri-Kohala projects were developed according to their current zoning or classification. The Waikoloa Village Association property was not included in the supplemental analysis because of its low development potential due to the rugged terrain.

B. Supplemental Traffic Forecast

The same procedures and assumptions used in the primary analysis were used for this supplemental traffic forecast. The type and quantity of land uses assumed for each of the four properties are shown on table 6. The same trip generation rates used for the background and project-generated traffic forecasts on table 2 were used and are shown on table 6. The four adjacent unscheduled, potential developments are forecasted to generate almost 900 trips in the morning peak hour and 1,200 trips in the afternoon peak hour.

Table 20

2020 Trip Generation Analysis for Other Adjacent Potential Developments

Land Development Project	AM Peak Hour						PM Peak Hour					
	Total		% Internal		External		Total		% Internal		External	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Waikoloa Homesite Venture	88	194	34	35	58	126	224	143	61	60	87	57
Waikoloa Land & Cattle	38	113	8	11	35	101	127	75	19	18	103	62
Tokyu Land Corporation	77	231	29	30	55	162	262	154	65	65	92	54
Tri-Kohala	38	113	8	18	35	93	127	75	19	18	103	62
Total	241	651	-	-	183	481	740	447	-	-	385	234

The same trip distribution factors used for the background and project-generated traffic forecasts were also utilized. The trip distribution factors for Mauna Lani Drive were used for the two adjacent properties makai of Queen Ka’ahumanu Highway. Similarly, the trip distribution factors for Waikoloa Village and the proposed Villages of Aina Le‘a project were used for the two adjacent developments mauka of Queen Ka’ahumanu Highway.

Table 21

Trip Distribution Analysis for Other Adjacent Potential Developments

AM Peak Hour												
Land Development	To/From North		To/From South		To/From Waikoloa		To/From Mauna Lani		To/From Internal		Total	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Waikoloa Homesite Venture	27	72	19	45	9	23	0	0	34	35	89	175
Waikoloa Land & Cattle	8	25	11	51	11	25	1	1	8	11	39	113
Tokyu Land Corporation	23	104	17	65	8	32	0	0	29	30	77	231
Tri-Kohala	8	25	11	51	11	25	1	1	8	11	39	113
Total	66	226	58	212	39	105	2	2	79	87	244	632
PM Peak Hour												
Land	To/From North		To/From South		To/From Waikoloa		To/From Mauna Lani		To/From Internal		Total	
Development	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Waikoloa Homesite Venture	90	37	43	31	29	14	0	0	61	60	223	142
Waikoloa Land & Cattle	22	14	51	22	34	19	3	1	19	18	129	74
Tokyu Land Corporation	107	40	50	34	34	15	0	0	65	65	256	154
Tri-Kohala	22	51	51	22	34	19	3	1	19	18	129	111
Total	241	142	195	109	131	67	6	2	164	161	737	481

The results for the trips generated by the four adjacent property’s potential development are shown on Figure 15. These trips were then added to the total with project traffic assignments for 2020 from figure 14 to obtain the total traffic with other adjacent potential developments forecasts shown on figure 16. The north access for the Tokyu Land Corporation development was assumed to be across the north access roadway for the proposed Villages of Aina Le‘a project.

Figure 22

2020 Traffic Generated by Unscheduled Potential Developments

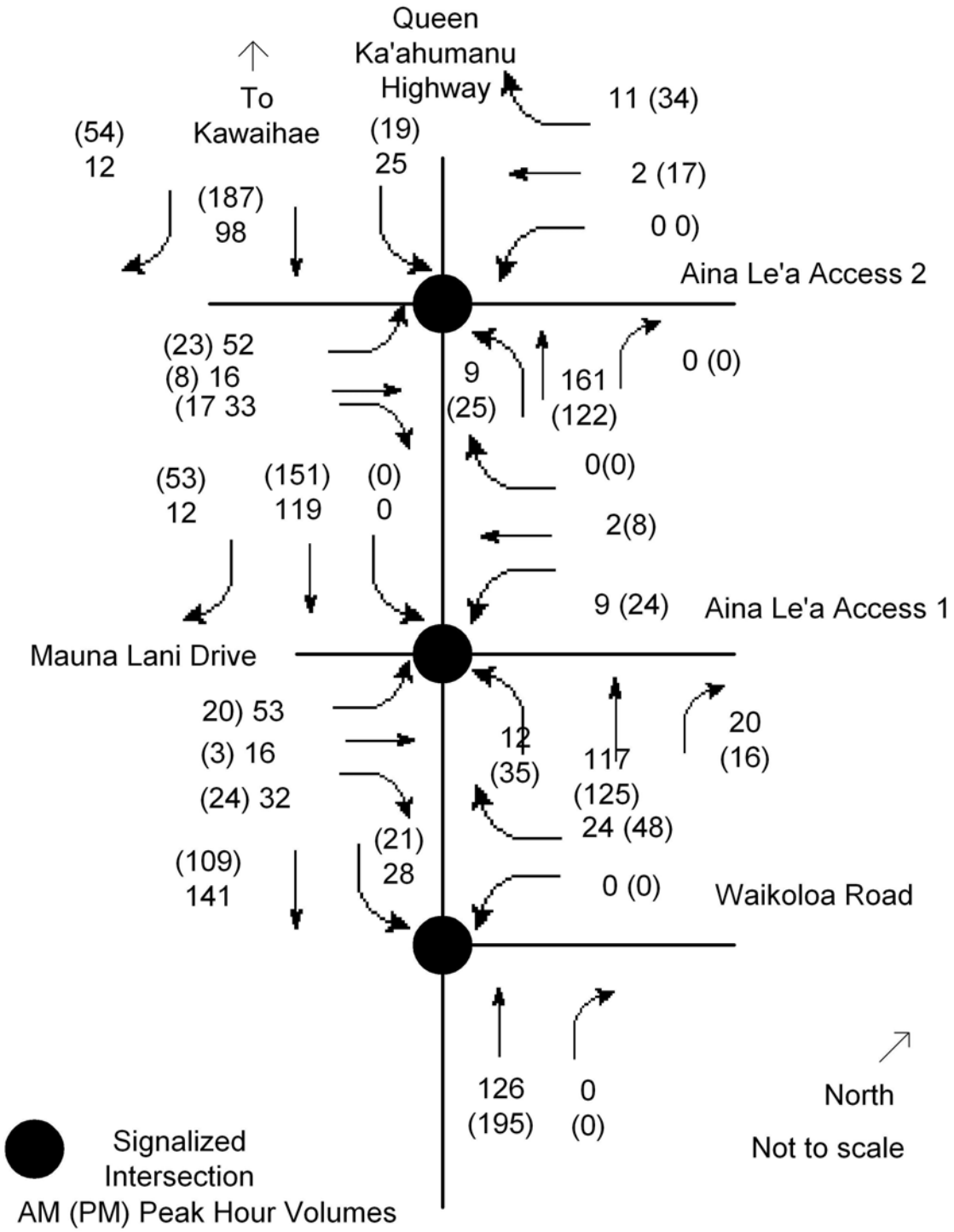
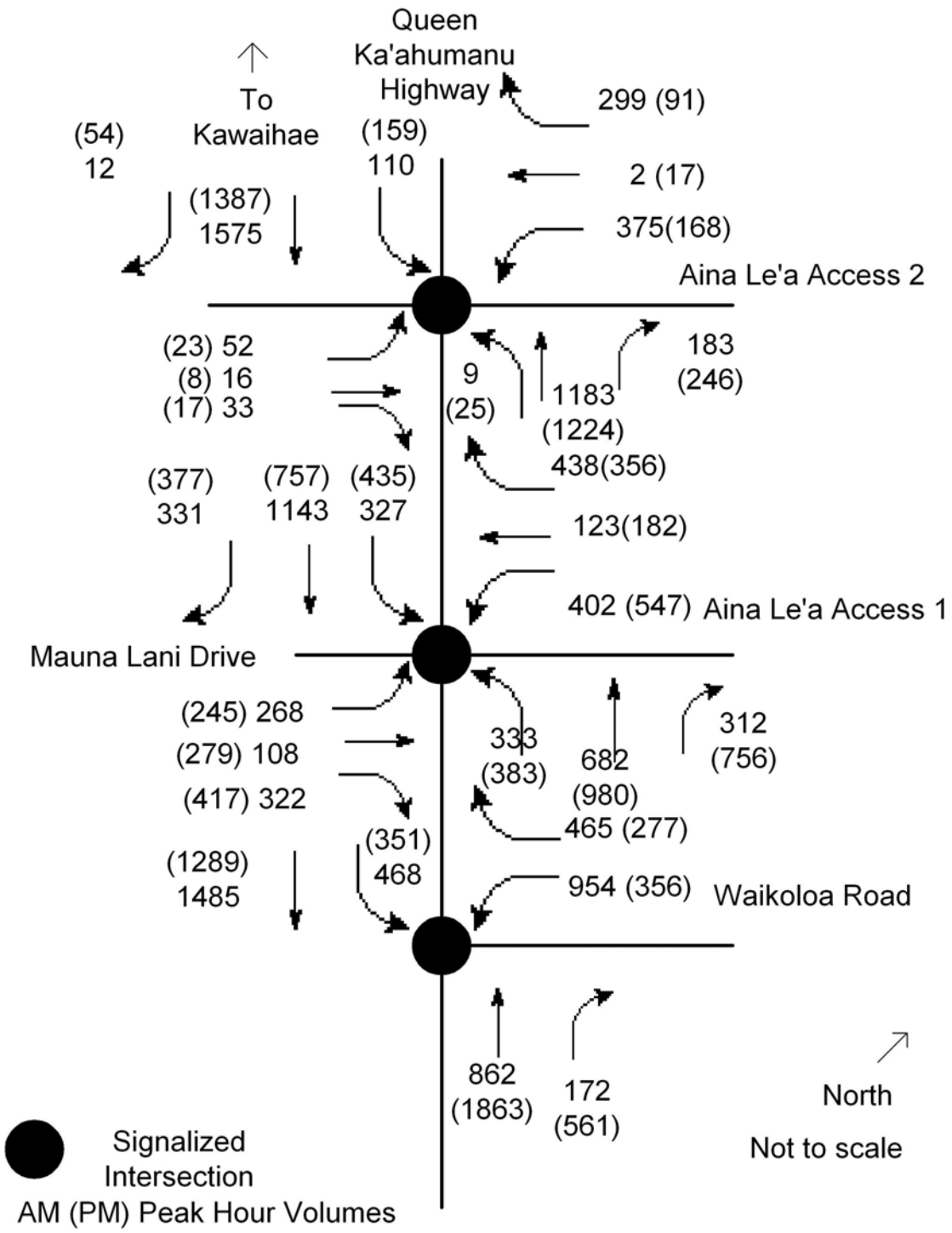


Figure 23

Predicted Peak Hour Traffic Forecast with Other Potential Developments
Year 2020



C. Supplemental Traffic Analysis

The HCM methodology for analyzing intersections was applied to the traffic volumes shown on Figure 23. The results of this supplemental analysis are shown on Table 22. A comparison of the results indicates that the additional traffic generated by the other adjacent developments would not have an adverse traffic impact. The levels of service for the intersection, approaches and movements are forecast to remain the same, although there would be increases in delay. As discussed earlier in this report, there will be a need to add through lanes on Queen Ka’ahumanu Highway by the year 2020.

Preliminary engineering for the proposed project indicated the need to move the north access road from Queen Ka’ahumanu Highway station 1340+00 further north to station 1347+23; however, moving the north access road has no affect on traffic volumes. The Villages of Aina Le‘a will coordinate with Tokyu Land Corporation to obtain permission to relocation both access points to station 1347+23.

As seen in Table 22, in the year 2020 at full buildout of the Villages of Aina Le’a and with all the potential projects in the immediate area fully developed, there will be some small issues with the v/c ratio and LOS for the mainline traffic flow on Queen Ka’ahumanu Highway. For the morning peak hour, the predicted v/c ratio for the southbound through movement at the intersection with Mauna Lani Drive and the access to the Villages of Aina Le’a is shown to be 1.03. This value is so close to 1.0 and the relative certainty of the future projects is so unknown, that this is not considered to be a significant issue. It is likely this situation, should it occur, could be remedied with traffic signal retiming adjustments. For the afternoon peak hour, the northbound through movement is shown to have an LOS of E but a v/c ratio of 0.88. Again, the LOS may be improved with adjustments to signal timing. There are several side street and mainline left turn movements shown to be at LOS E or with a v/c ratio slightly over 1.0 in both the morning and afternoon peak hours at full buildout of the Villages of Aina Le’a and all the potential projects in the area. Again, with the relative uncertainty of the additional potential area projects, this is not considered to be a significant issue. It is likely these v/c and LOS concerns could be alleviated if they develop in the future with adjustments to the traffic signal timing.

Table 22

Traffic Operations Analysis with Other Adjacent Potential Developments in Place in Year 2020

Intersection	Movement	Morning Peak Hour			Afternoon Peak Hour		
		v/c Ratio	Delay (sec)	LOS	v/c Ratio	Delay (sec)	LOS
Queen Ka’ahumanu Highway at Waikoloa Road	Nbd Thru	.86	35	D	.97	34	C
	Nbd Right	.12	22	C	.39	12	B
	Sbd Thru	.85	20	C	.53	6	A
	Sbd Left	.80	41	D	.94	73	E
	Wbd Left	.88	35	C	.65	41	D
	Wbd Right	.55	12	B	.56	29	C
Queen Ka’ahumanu Highway at Mauna Lani Drive & New Aina Le’a Access (Access 1)	Nbd Thru	.68	40	D	.89	78	E
	Nbd Left	1.0	105	F	.86	48	D
	Nbd Right	.22	19	B	.88	38	D
	Sbd Left	.75	60	E	1.11	139	F
	Sbd Thru	1.03	74	E	.69	41	D
	Sbd Right	.23	30	C	.26	33	C
	Ebd Left	1.07	124	F	1.15	160	F
	Ebd Thru	.29	42	D	.82	67	E
	Ebd Right	.59	34	C	.73	42	D
	Wbd Left	1.0	34	F	1.08	121	F
	Wbd Thru	.18	25	C	.26	28	C
	Wbd Right	.51	16	B	.42	18	B
Queen Ka’ahumanu Highway at New Aina Le’a Access (Access 2)	Nbd Left	.12	17	B	.16	13	B
	Nbd Thru	.90	32	C	.62	18	B
	Nbd Right	.13	16	B	.17	12	B
	Sbd Thru	.95	32	C	.56	15	B
	Sbd Left	.77	38	D	.60	9	A
	Sbd Right	.77	38	D	.60	9	A
	Wbd Left	.89	47	D	.78	66	E
	Wbd Thru	0	20	B	.06	46	D
	Wbd Right	.49	24	C	.06	46	D
	Ebd Left	.12	21	C	.11	46	D
	Ebd Thru	.03	20	C	.03	45	D
	Ebd Right	.06	20	C	.01	45	D

VII. CLOSING SUMMARY COMMENTS

The following summary comments are made regarding the predicted traffic impacts of the Villages of Aina Le’a.

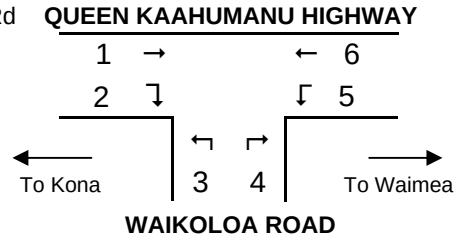
1. The proposed general access plan with two major points of access onto Queen Ka’ahumanu Highway and the internal connecting roadway should be adequate to serve the new develop without adverse impacts. The two new intersections will require traffic signals to be in place and operational at the completion of Phase I in the year 2012. The intersections will need a high-type design with double left turn lanes, right turn channelization and acceleration and deceleration lanes. The proposed two signals will be about 1.4 miles apart so that coordination will not likely be necessary. However, should other developments in the area, such as the ones envisioned and discussed earlier in this report come to fruition, there may be additional access points onto the highway. In that case, more traffic signals may be needed and coordination might become necessary. It would be wise to consider the communication needs for a coordinated signal system should this event occur in the future.
2. There will be a need for one additional through lane in each direction on Queen Ka’ahumanu Highway before the year 2020. Additional study will be needed to determine the starting and ending points of this widening. Further, much of the need for this widening will be derived from the background growth and from the potential new projects in the area. The Villages of Aina Le’a project will not be the single source of new traffic that helps to cause the need for widening of Queen Ka’ahumanu Highway. It is suggested that the county and HDOT review the needs for widening of Queen Ka’ahumanu Highway and develop a staged plan for its implementation.
3. Should the potential projects in the area change significantly in scope, additional review will be needed to determine traffic access and highway needs. This report made certain assumptions about the likely access points for the new projects in the immediate area. If land use changes are made to the proposed new developments, a significant review and revision of this report may be needed.

APPENDIX A

24-Hour Traffic Count Raw Data

TRAFFIC TURNING MOVEMENT COUNT
THE VILLAGES OF AINA L`EA

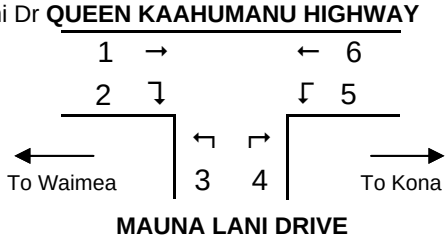
LOCATION: Queen Kaahumanu Hwy/Waikoloa Rd
DATE: June 26-27, 2007, Wed/Thursday
TIME: 6:00a-8:30a / 3:00p-5:30p
WEATHER: Clear
RECORDER: Metered count



TIME PERIOD	MOVEMENT NUMBER 1	2	3	4	5	6	TOTAL
6:00-6:15a	30	8	60	14	6	79	197
6:15-6:30a	26	26	94	26	8	143	323
6:30-6:45a	45	23	104	44	7	149	372
6:45-7:00a	43	16	124	68	12	125	388
7:00-7:15a	63	20	86	48	16	52	285
7:15-7:30a	66	28	110	28	16	103	351
7:30-7:45a	54	25	97	53	19	95	343
7:45-8:00a	67	39	96	56	14	69	341
8:00-8:15a	60	43	87	39	14	63	306
8:15-8:30a	54	41	70	38	13	53	269
6:00-8:30a	508	269	928	414	125	931	3175
6:30-7:30a	217	87	424	188	51	429	1396
PHF	0.81		0.80		0.88		
3:00-3:15p	101	76	41	26	20	130	394
3:15-3:30p	128	88	49	33	30	109	437
3:30-3:45p	154	92	39	23	52	127	487
3:45-4:00p	153	127	38	20	45	165	548
4:00-4:15p	104	100	54	42	44	71	415
4:15-4:30p	160	102	20	16	48	107	453
4:30-4:45p	95	81	39	43	48	97	403
4:45-5:00p	129	72	39	23	42	104	409
5:00-5:15p	87	78	48	25	40	116	394
5:15-5:30p	96	92	37	28	34	66	353
3:30-5:30p	1207	744	314	220	353	853	3691
3:30-4:30p	571	421	151	101	189	470	1903
PHF	0.89		0.66		0.78		

TRAFFIC TURNING MOVEMENT COUNT
THE VILLAGES OF AINA L`EA

LOCATION: Queen Kaahumanu Hwy/Mauna Lani Dr
DATE: June 26-27, 2007, Wed/Thursday
TIME: 6:00a-8:30a / 3:00p-5:30p
WEATHER: Clear
RECORDER: Metered count



TIME PERIOD	MOVEMENT NUMBER 1	2	3	4	5	6	TOTAL
6:00-6:15a	72	30	4	10	21	20	157
6:15-6:30a	143	19	4	11	15	40	232
6:30-6:45a	142	44	2	16	32	59	295
6:45-7:00a	142	72	6	16	83	49	368
7:00-7:15a	56	66	12	30	66	63	293
7:15-7:30a	108	39	17	24	45	62	295
7:30-7:45a	86	52	13	37	37	79	304
7:45-8:00a	81	53	10	34	61	94	333
8:00-8:15a	72	46	11	27	52	69	277
8:15-8:30a	64	36	18	20	52	58	248
6:00-8:30a	966	457	97	225	464	593	2802
6:45-7:45a	392	229	48	107	231	253	1260
PHF	0.73				0.94		
3:00-3:15p	93	21	37	57	40	87	335
3:15-3:30p	75	18	26	64	36	125	344
3:30-3:45p	101	26	48	78	54	123	430
3:45-4:00p	124	40	22	86	44	129	445
4:00-4:15p	47	34	41	68	52	94	336
4:15-4:30p	88	24	35	67	38	138	390
4:30-4:45p	79	26	32	66	36	102	341
4:45-5:00p	96	22	38	50	46	106	358
5:00-5:15p	96	20	26	60	33	79	314
5:15-5:30p	61	19	33	39	41	83	276
3:00-5:30p	860	250	338	635	420	1066	3569
3:30-4:30p	360	124	146	299	188	484	1601
PHF	0.74				0.95		

24-Hour Count Raw Data

Time	North Bound (to Kawaihae)	South Bound (to Kona)	South Bound (to Kona)	Right Turn into Mauna Lani Drive from Queen K Hwy	South Bound Through at ML (to Kona)	North Bound (to Kawaihae)	Left Turn onto Queen K Hwy from Mauna Lani Drive	North Bound Through at ML(to Kawaihae)
26-Jun-07								
01:00 PM	124	100	100	22	78	124	21	103
01:15 PM	106	110	110	32	78	106	19	87
01:30 PM	110	106	106	24	82	110	28	82
01:45 PM	103	106	106	36	70	103	20	83
02:00 PM	108	96	96	19	77	108	32	76
02:15 PM	120	107	107	36	71	120	28	92
02:30 PM	110	130	130	35	95	110	24	86
02:45 PM	129	122	122	24	98	129	26	103
03:00 PM	124	114	114	21	93	124	37	87
03:15 PM	151	93	93	18	75	151	26	125
03:30 PM	171	127	127	26	101	171	48	123
03:45 PM	151	164	164	40	124	151	22	129
04:00 PM	135	81	81	34	47	135	41	94
04:15 PM	173	112	112	24	88	173	35	138
04:30 PM	134	105	105	26	79	134	32	102
04:45 PM	144	118	118	22	96	144	38	106
05:00 PM	105	116	116	20	96	105	26	79
05:15 PM	116	80	80	19	61	116	33	83
05:30 PM	116	96	96	20	76	116	18	98
05:45 PM	121	89	89	18	71	121	23	98
06:00 PM	92	92	92	25	67	92	23	69
06:15 PM	80	60	60	20	40	80	30	50
06:30 PM	90	58	58	13	45	90	27	63
06:45 PM	67	57	57	13	44	67	15	52
07:00 PM	70	48	48	14	34	70	13	57
07:15 PM	58	64	64	9	55	58	14	44
07:30 PM	43	57	57	18	39	43	16	27
07:45 PM	59	62	62	10	52	59	9	50
08:00 PM	49	36	36	13	23	49	10	39
08:15 PM	50	52	52	5	47	50	10	40
08:30 PM	47	37	37	15	22	47	14	33
08:45 PM	60	38	38	11	27	60	6	54
09:00 PM	45	32	32	10	22	45	21	24
09:15 PM	78	33	33	5	28	78	25	53
09:30 PM	52	40	40	9	31	52	18	34
09:45 PM	76	20	20	6	14	76	14	62
10:00 PM	54	18	18	3	15	54	18	36
10:15 PM	66	20	20	6	14	66	28	38
10:30 PM	62	32	32	7	25	62	17	45
10:45 PM	58	16	16	4	12	58	11	47
11:00 PM	43	13	13	8	5	43	23	20
11:15 PM	50	14	14	1	13	50	9	41
11:30 PM	41	1	1	1	0	41	7	34
11:45 PM	16	2	2	0	2	16	2	14

Time	North Bound (to Kawaihae)	South Bound (to Kona)	South Bound (to Kona)	Right Turn into Mauna Lani Drive from Queen K Hwy	South Bound Through at ML (to Kona)	North Bound (to Kawaihae)	Left Turn onto Queen K Hwy from Mauna Lani Drive	North Bound Through at ML(to Kawaihae)
27-Jun-07								
12:00 AM	20	4	4	0	4	20	12	8
12:15 AM	23	0	0	0	0	23	14	9
12:30 AM	19	2	2	0	2	19	2	17
12:45 AM	10	3	3	1	2	10	2	8
01:00 AM	5	2	2	1	1	5	3	2
01:15 AM	7	3	3	0	3	7	4	3
01:30 AM	6	2	2	0	2	6	0	6
01:45 AM	3	2	2	0	2	3	0	3
02:00 AM	2	5	5	0	5	2	0	2
02:15 AM	1	2	2	1	1	1	0	1
02:30 AM	1	6	6	1	5	1	0	1
02:45 AM	2	2	2	0	2	2	0	2
03:00 AM	6	6	6	1	5	6	1	5
03:15 AM	0	9	9	2	7	0	0	0
03:30 AM	4	10	10	0	10	4	0	4
03:45 AM	1	10	10	1	9	1	0	1
04:00 AM	2	12	12	5	7	2	0	2
04:15 AM	4	30	30	4	26	4	0	4
04:30 AM	2	29	29	11	18	2	0	2
04:45 AM	3	41	41	10	31	3	0	3
05:00 AM	5	48	48	18	30	5	3	2
05:15 AM	12	60	60	14	46	12	5	7
05:30 AM	16	88	88	26	62	16	2	14
05:45 AM	22	102	102	20	82	22	1	21
06:00 AM	24	102	102	30	72	24	4	20
06:15 AM	44	162	162	19	143	44	4	40
06:30 AM	61	186	186	44	142	61	2	59
06:45 AM	55	214	214	72	142	55	6	49
07:00 AM	75	122	122	66	56	75	12	63
07:15 AM	79	147	147	39	108	79	17	62
07:30 AM	92	138	138	52	86	92	13	79
07:45 AM	104	134	134	53	81	104	10	94
08:00 AM	80	118	118	46	72	80	11	69
08:15 AM	76	100	100	36	64	76	18	58
08:30 AM	94	92	92	25	67	94	13	81
08:45 AM	113	93	93	32	61	113	18	95
09:00 AM	87	95	95	42	53	87	13	74
09:15 AM	71	83	83	21	62	71	16	55
09:30 AM	88	80	80	17	63	88	20	68
09:45 AM	91	108	108	30	78	91	20	71
10:00 AM	97	89	89	28	61	97	20	77
10:15 AM	88	78	78	13	65	88	18	70
10:30 AM	84	90	90	14	76	84	21	63
10:45 AM	96	102	102	24	78	96	18	78
11:00 AM	81	94	94	20	74	81	20	61
11:15 AM	98	87	87	22	65	98	22	76
11:30 AM	90	82	82	21	61	90	15	75
11:45 AM	90	102	102	22	80	90	15	75
12:00 PM	114	102	102	21	81	114	25	89
12:15 PM	87	87	87	20	67	87	20	67
12:30 PM	115	87	87	24	63	115	18	97
12:45 PM	112	92	92	22	70	112	29	83

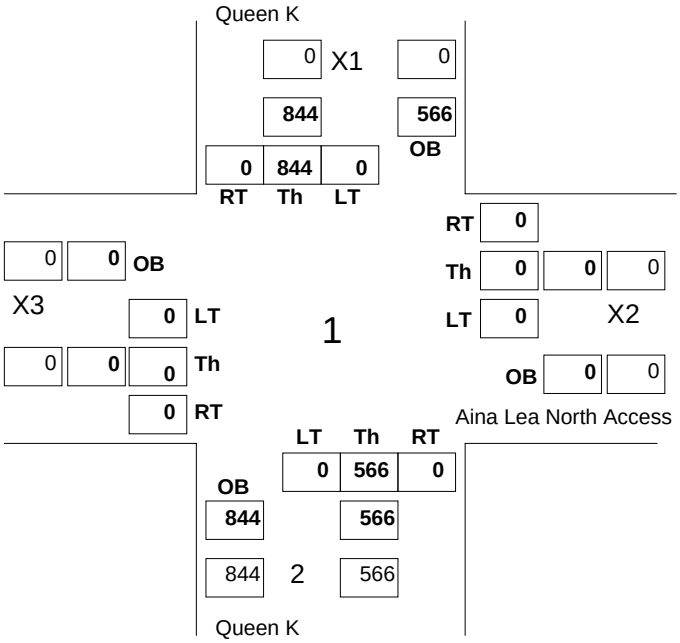
APPENDIX B

Intersection Turning Movements

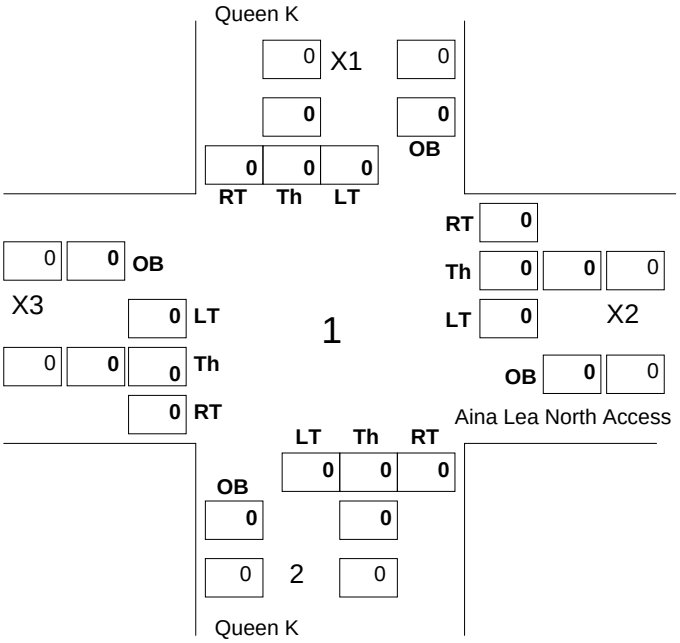
Project: Aina Lea
Scenario: 2012 With Background and Diverted and New Trips and Addl SF and Golf
Time Period: AM

Intersection Name: Queen K at North Entrance
Intersection ID: 1

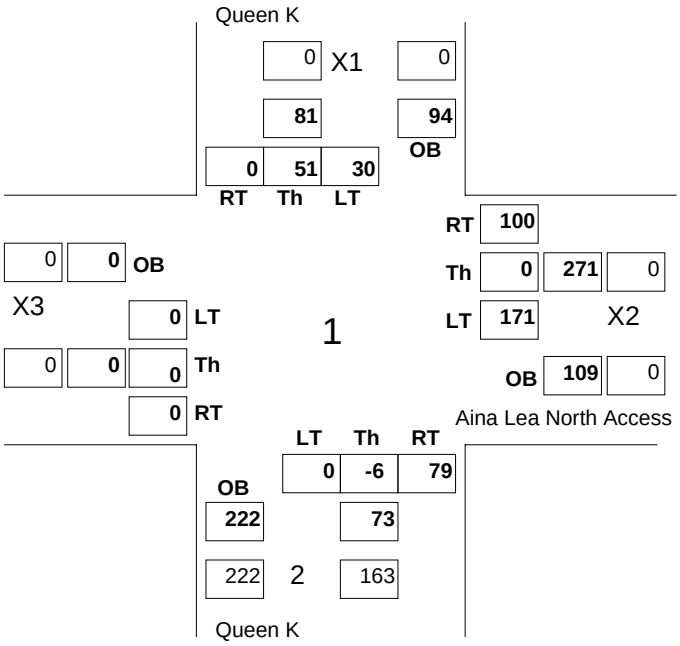
Existing



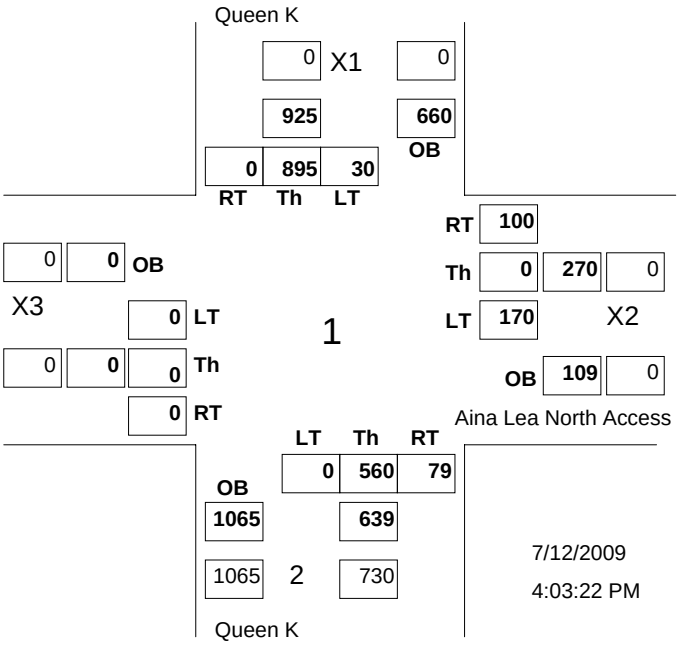
Growth



Site



Future



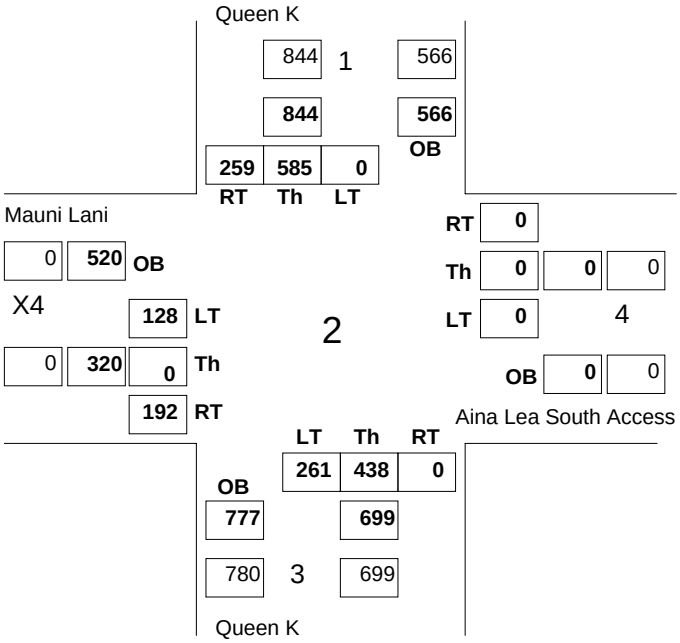
7/12/2009
4:03:22 PM

Intersection Turning Movements

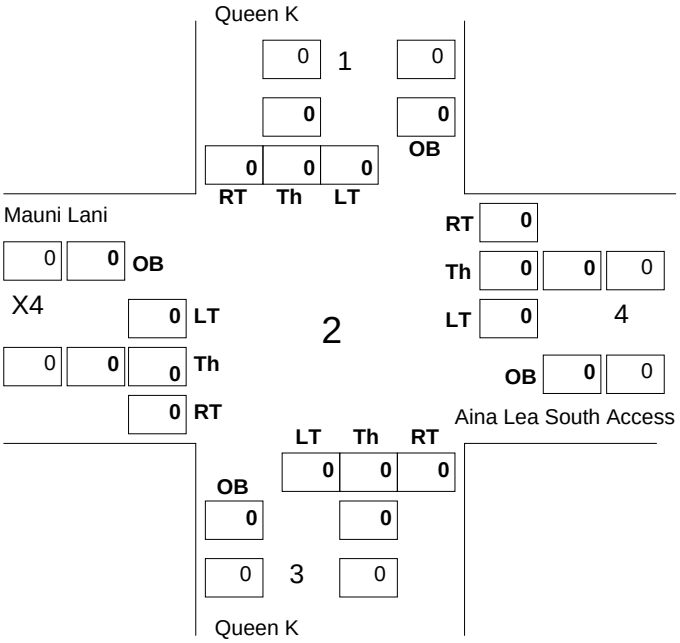
Project: Aina Lea
Scenario: 2012 With Background and Diverted and New Trips and Addl SF and Golf
Time Period: AM

Intersection Name: Queen K at Mauni Lani/New Access to Aina Lea
Intersection ID: 2

Existing



Growth



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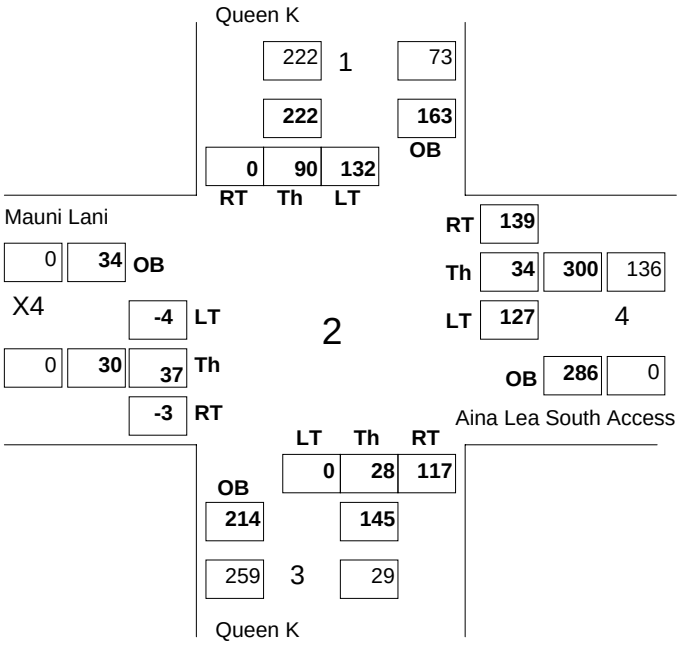

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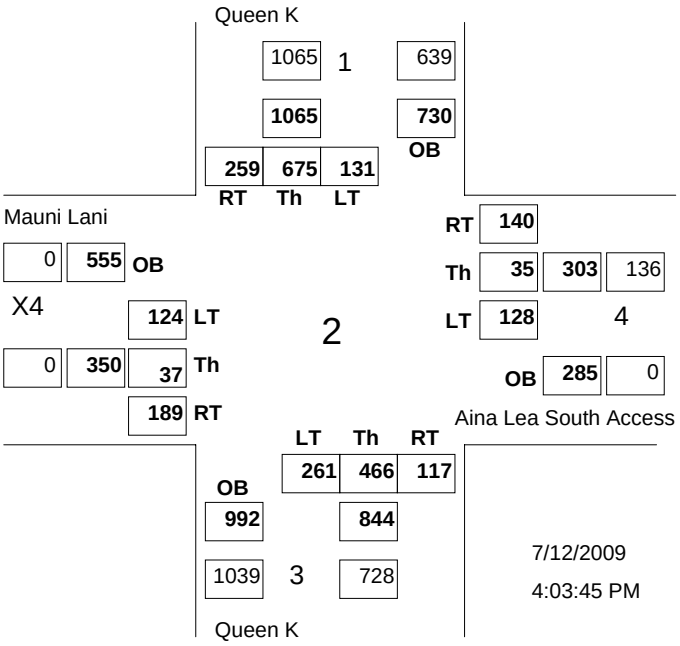

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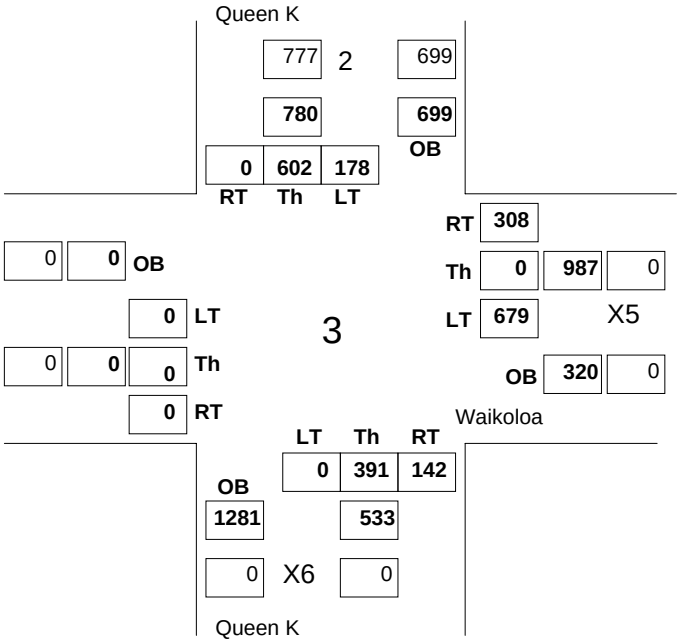
Intersection Turning Movements

Project: Aina Lea
Scenario: 2012 With Background and Diverted and New Trips and Addl SF and Golf
Time Period: AM

Intersection Name: Queen K at Waikoloa
Intersection ID: 3

Existing



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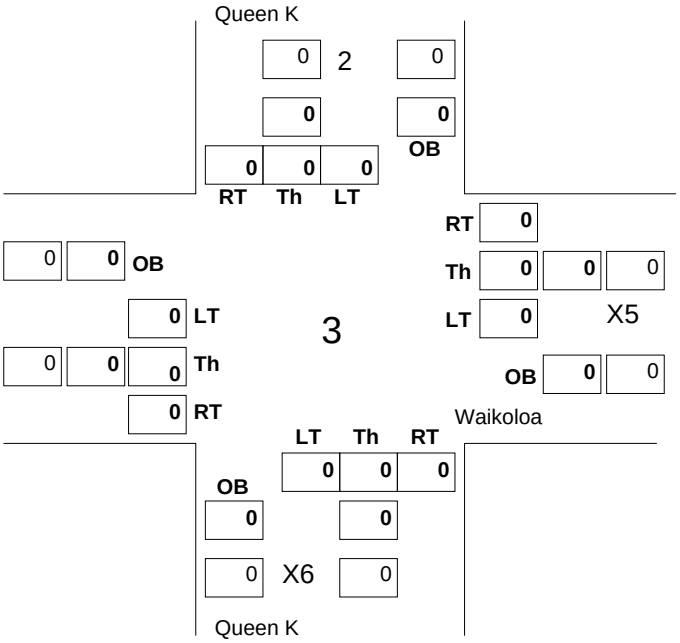

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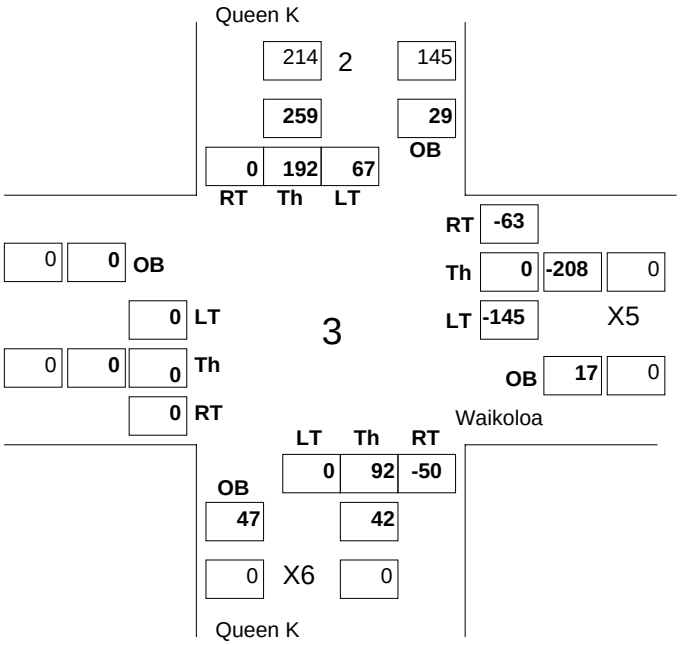

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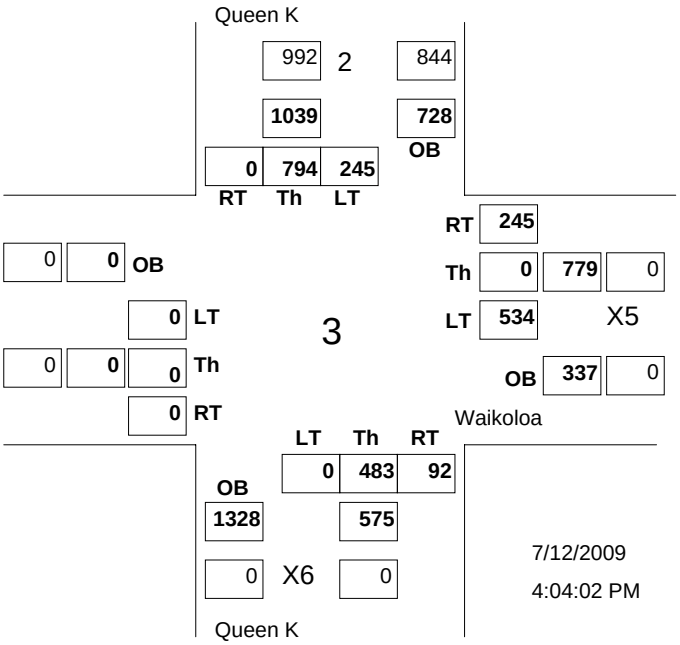

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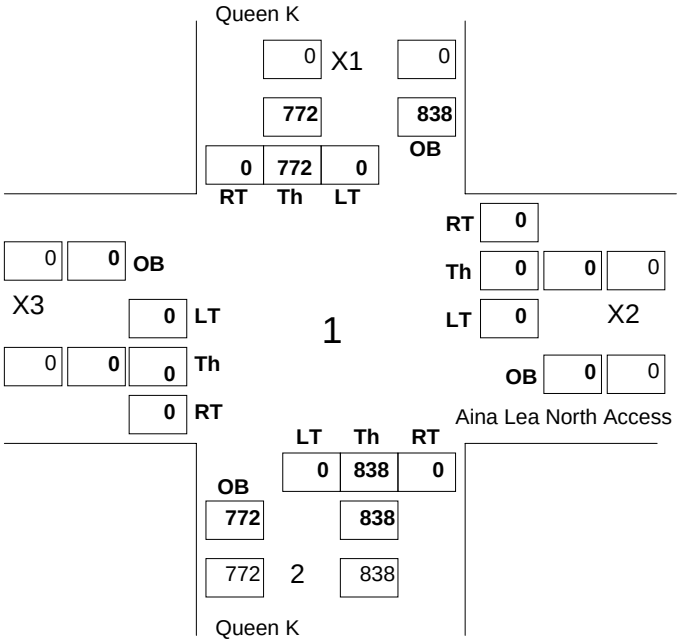
4:04:02 PM

Intersection Turning Movements

Project: Aina Lea
Scenario: 2012 With Background and Diverted and New Trips
Time Period: PM

Intersection Name: Queen K at North Entrance
Intersection ID: 1

Existing



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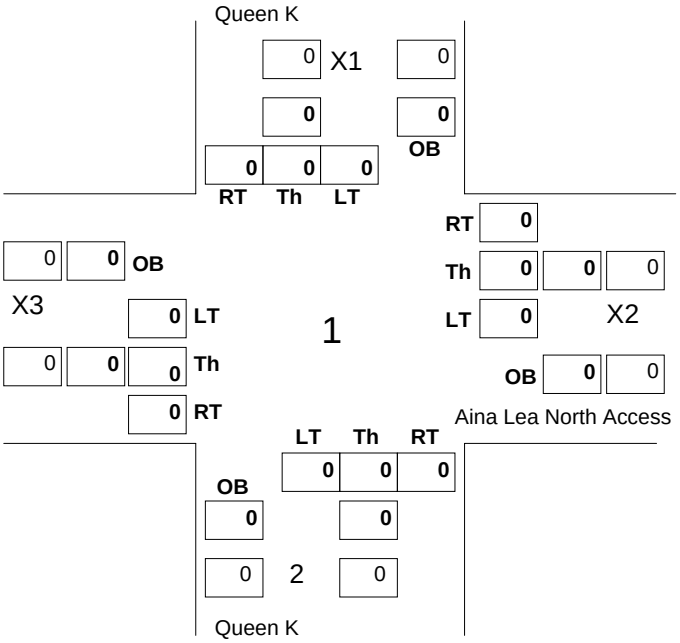

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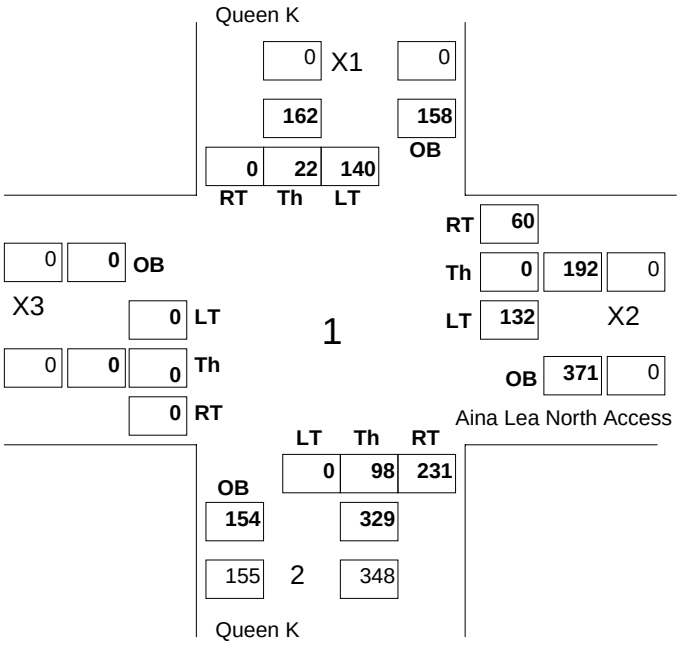

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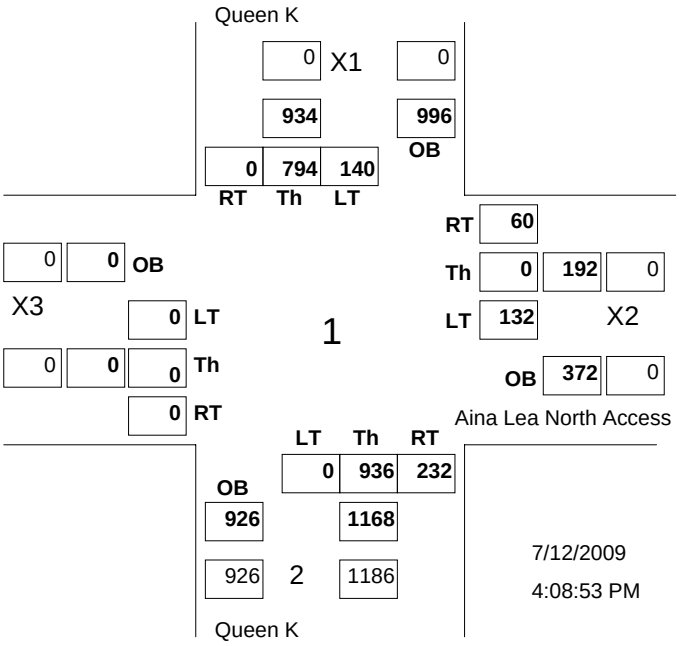

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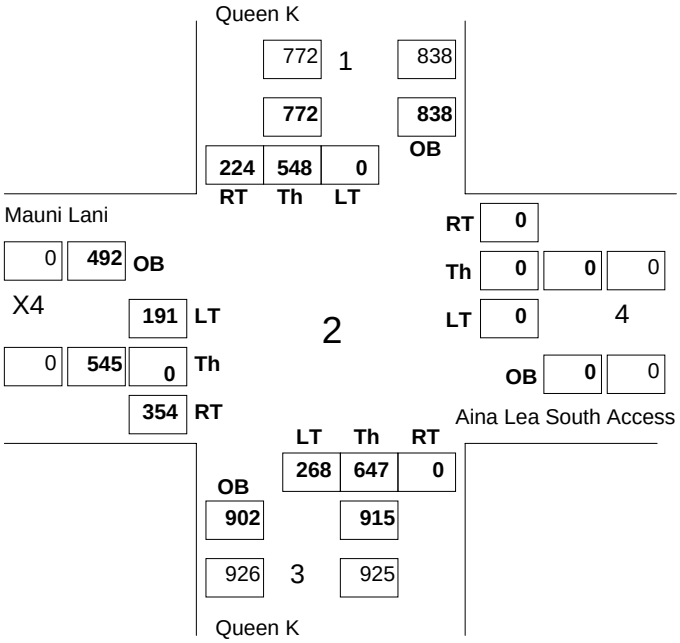
4:08:53 PM

Intersection Turning Movements

Project: Aina Lea
Scenario: 2012 With Background and Diverted and New Trips
Time Period: PM

Intersection Name: Queen K at Mauni Lani/New Access to Aina Lea
Intersection ID: 2

Existing



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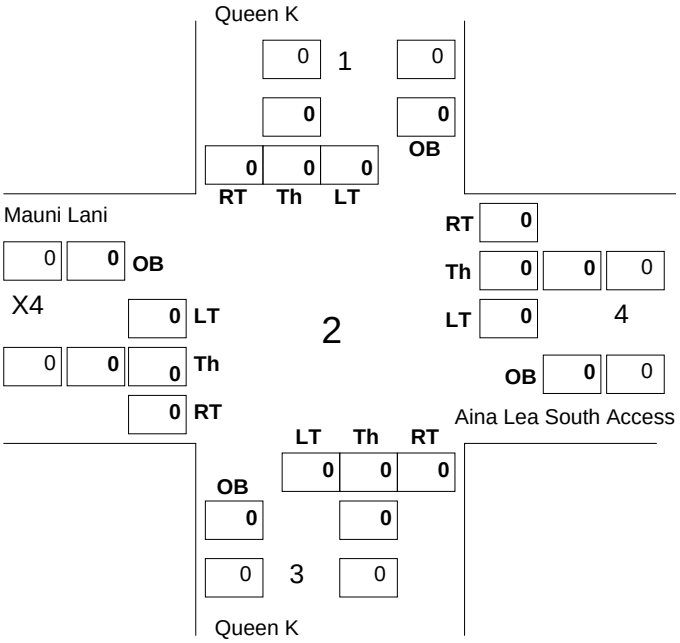

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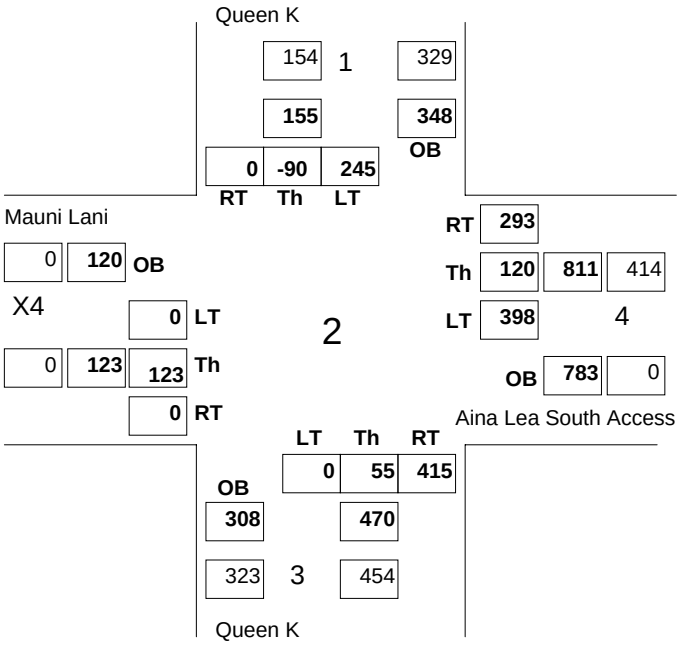

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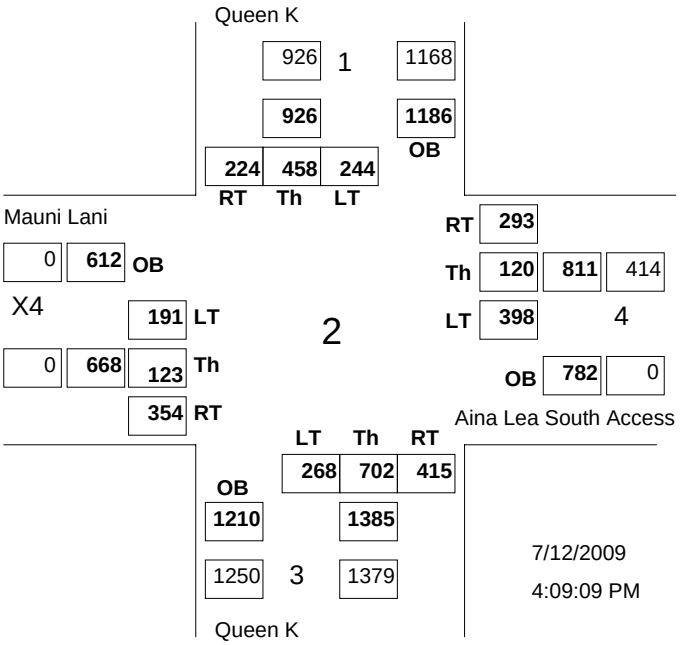


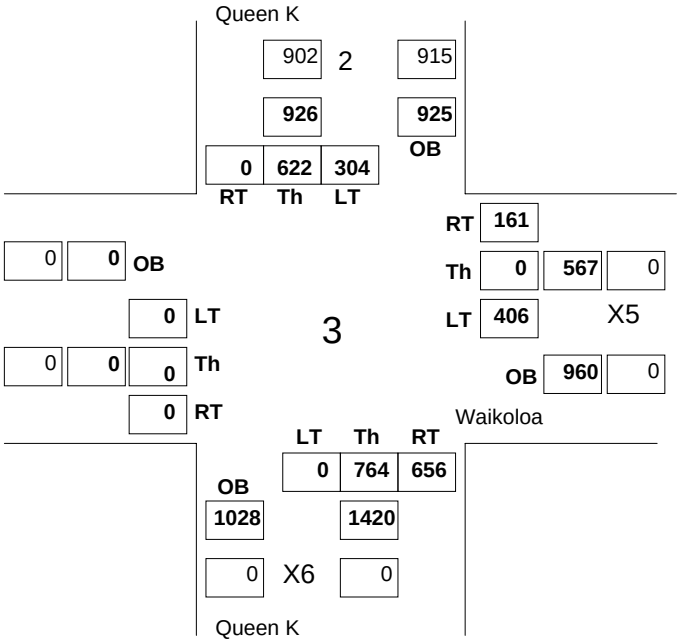
7/12/2009
4:09:09 PM

Intersection Turning Movements

Project: Aina Lea
Scenario: 2012 With Background and Diverted and New Trips
Time Period: PM

Intersection Name: Queen K at Waikoloa
Intersection ID: 3

Existing



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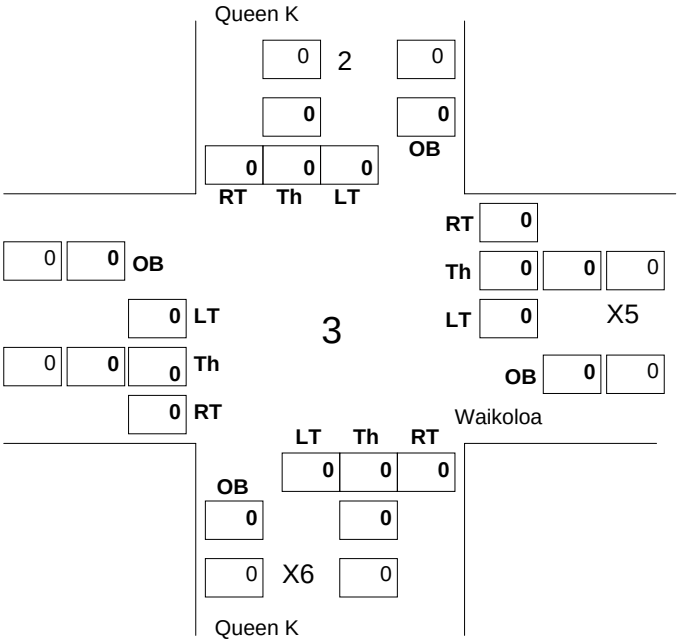

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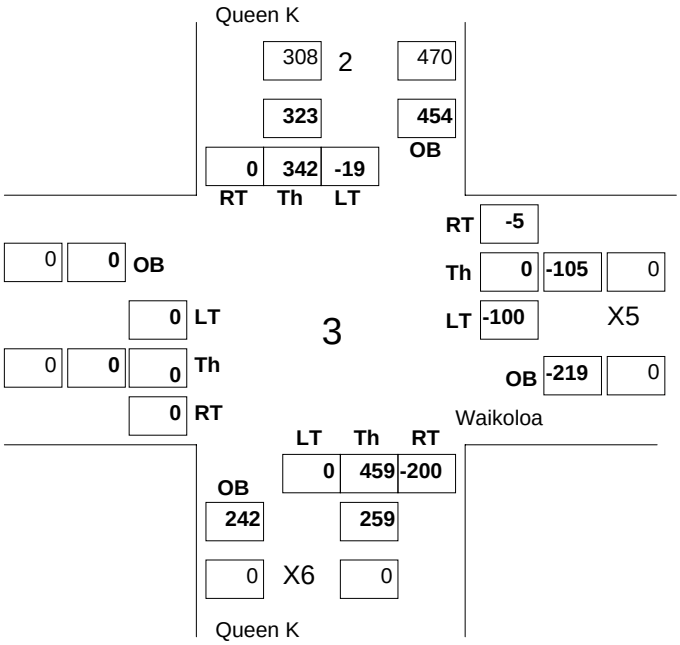

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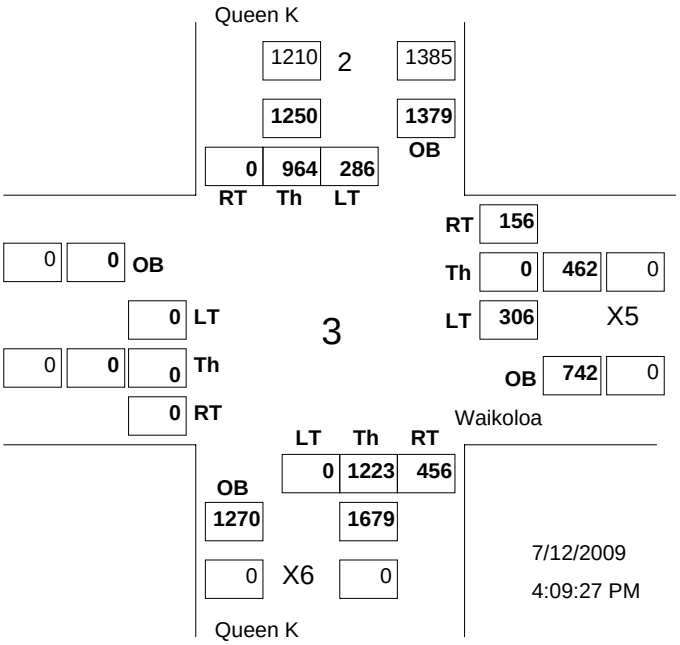


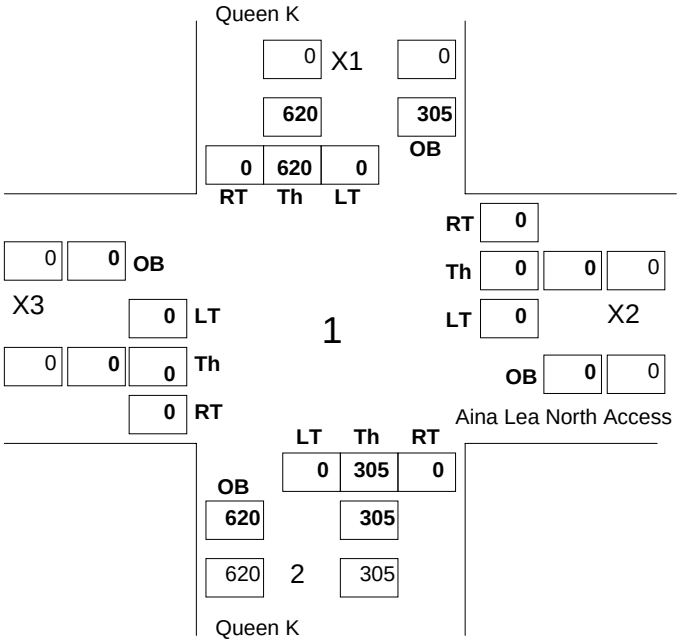
7/12/2009
4:09:27 PM

Intersection Turning Movements

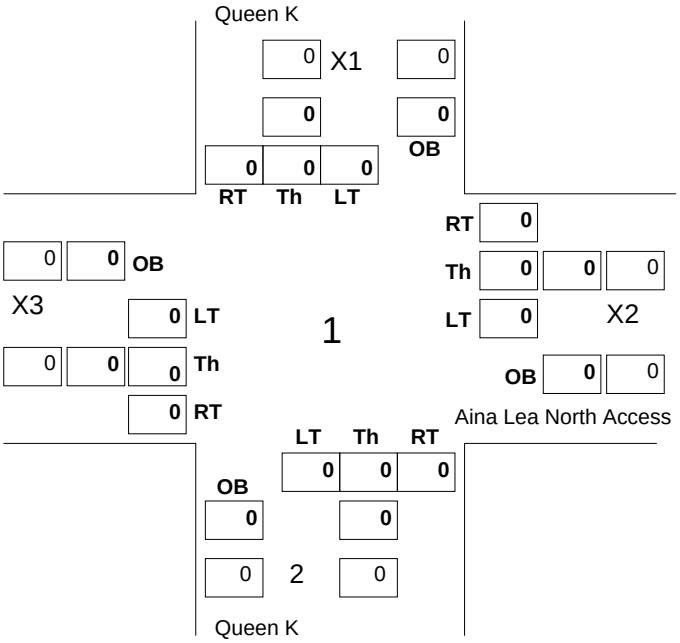
Project: Aina Lea
Scenario: 2020 With Background and Diverted and New Trips and Addl SF and Golf
Time Period: AM

Intersection Name: Queen K at North Entrance
Intersection ID: 1

Existing



Growth



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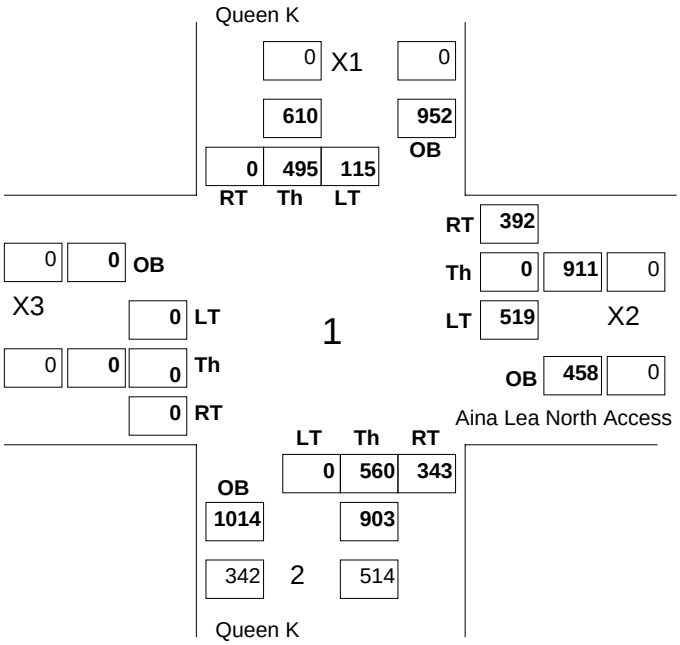

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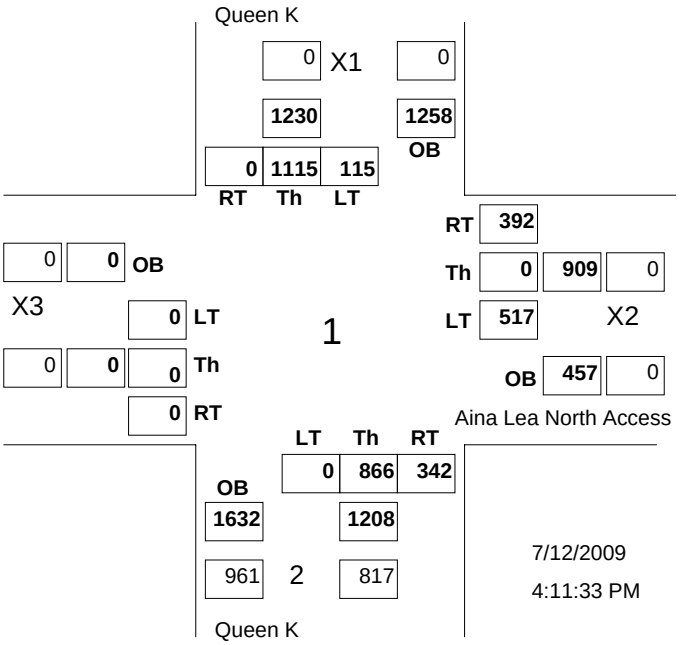


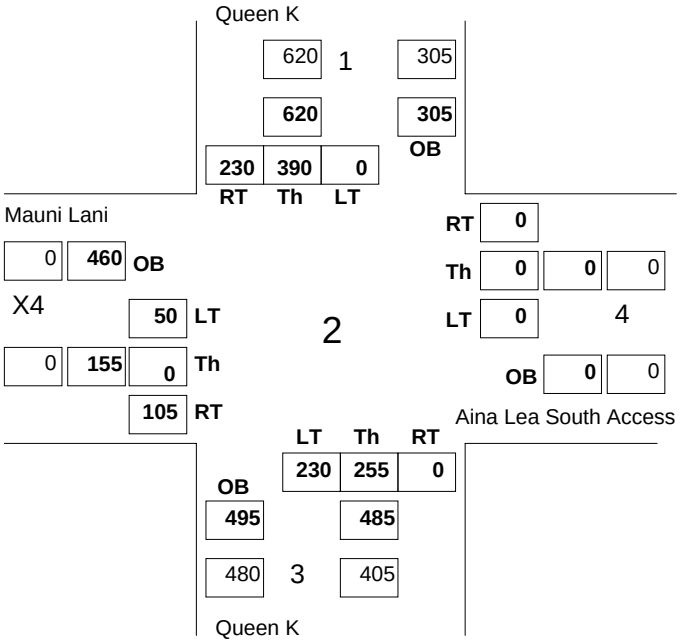
7/12/2009
4:11:33 PM

Intersection Turning Movements

Project: Aina Lea
Scenario: 2020 With Background and Diverted and New Trips and Addl SF and Golf
Time Period: AM

Intersection Name: Queen K at Mauni Lani/New Access to Aina Lea
Intersection ID: 2

Existing



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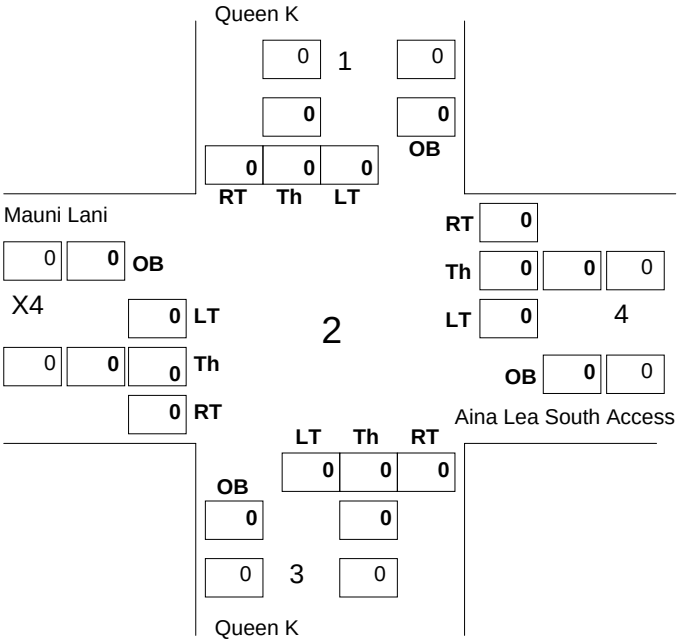

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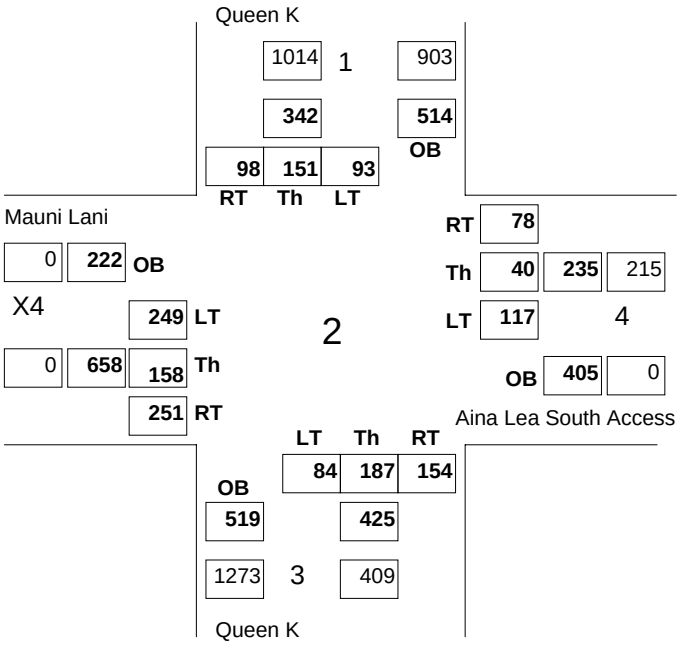

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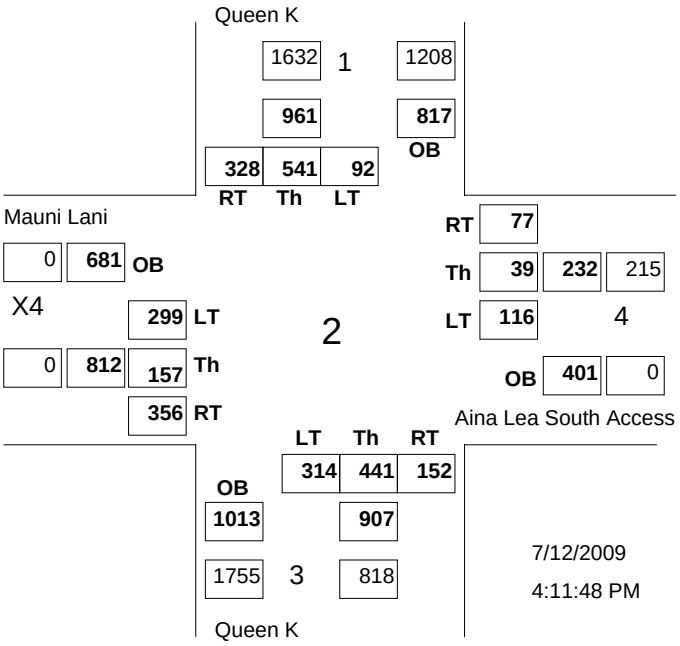


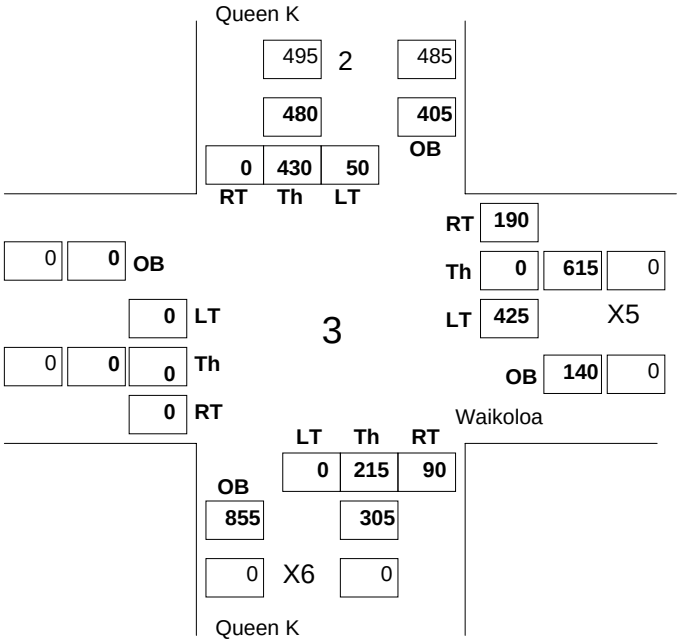
7/12/2009
4:11:48 PM

Intersection Turning Movements

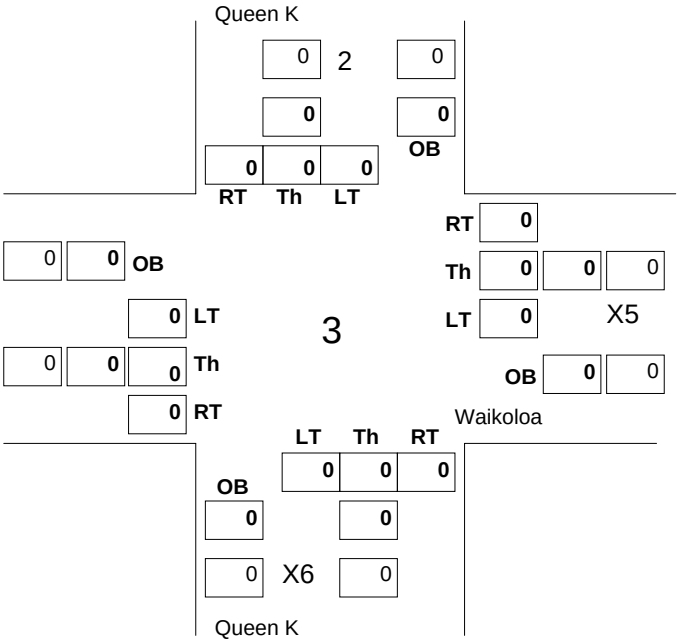
Project: Aina Lea
Scenario: 2020 With Background and Diverted and New Trips and Addl SF and Golf
Time Period: AM

Intersection Name: Queen K at Waikoloa
Intersection ID: 3

Existing



Growth



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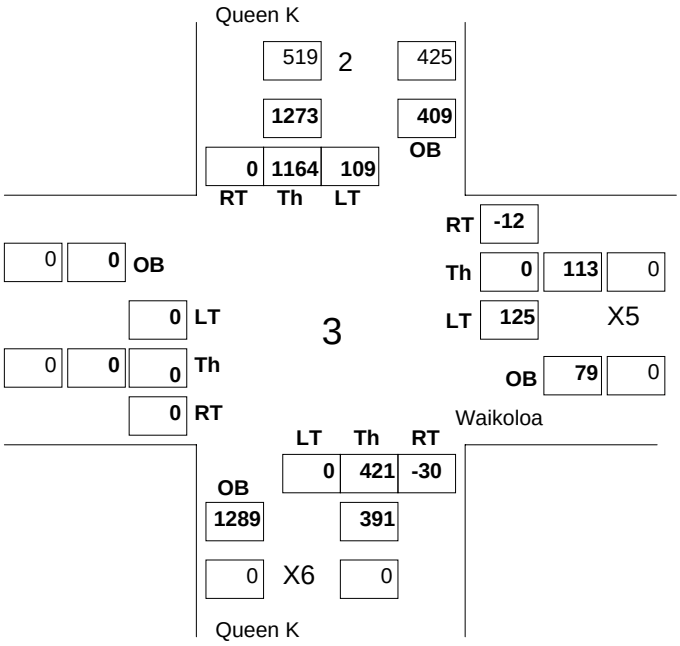

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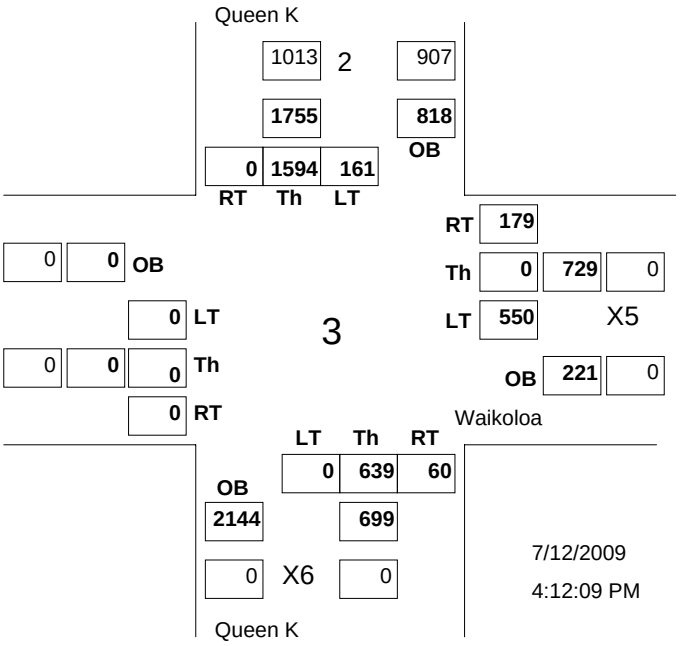


7/12/2009
4:12:09 PM

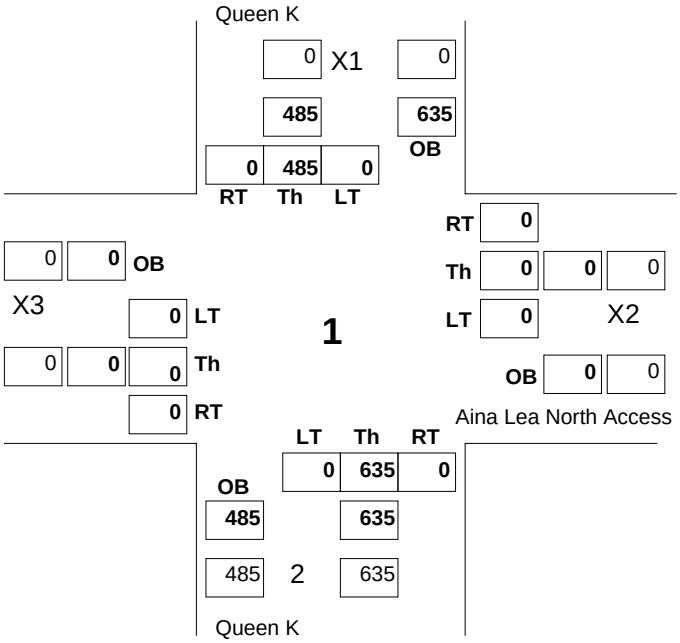
Intersection Turning Movements

Project: Aina Lea
Scenario: 2020 With Background and Diverted and New Trips
Time Period: PM

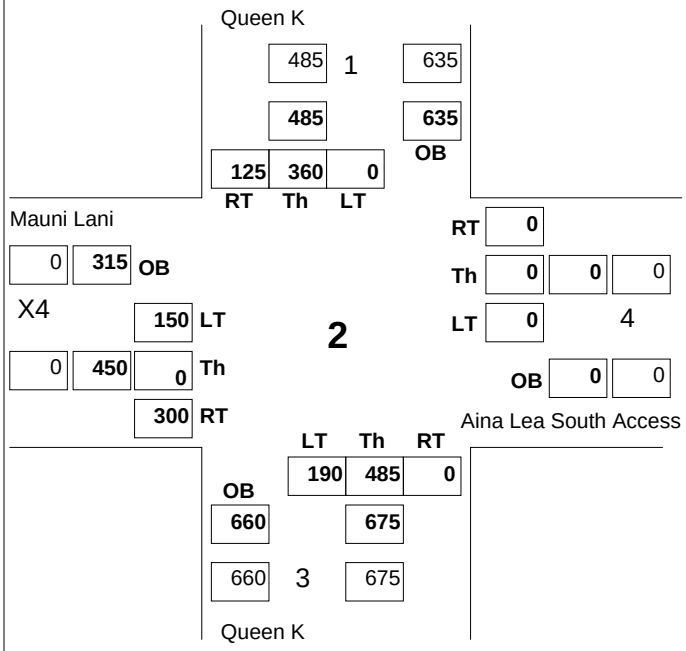
Type: Existing Plus Growth

Displayed: Volumes

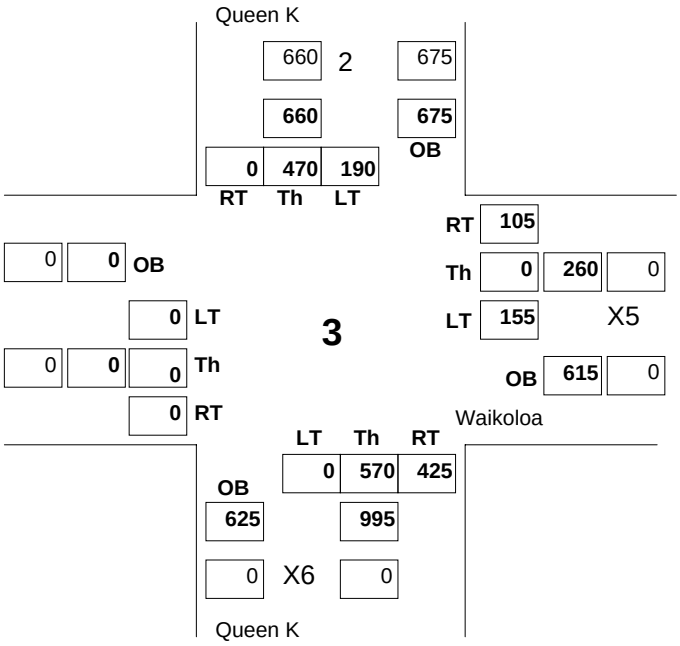
Queen K at North Entrance

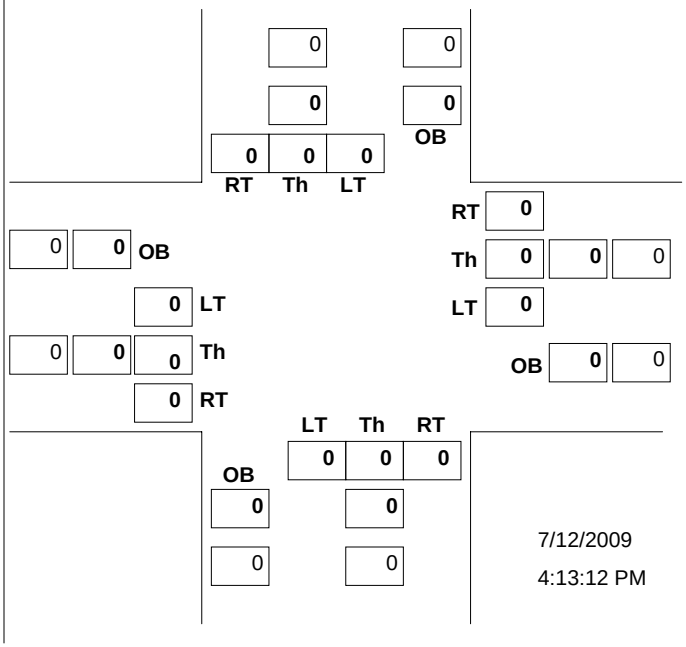


Queen K at Mauni Lani/New Access to Aina Lea



Queen K at Waikoloa





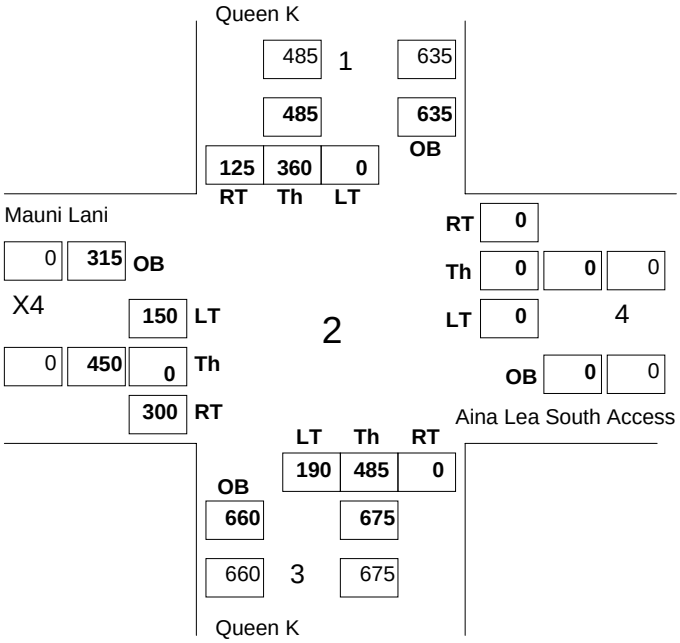
7/12/2009
4:13:12 PM

Intersection Turning Movements

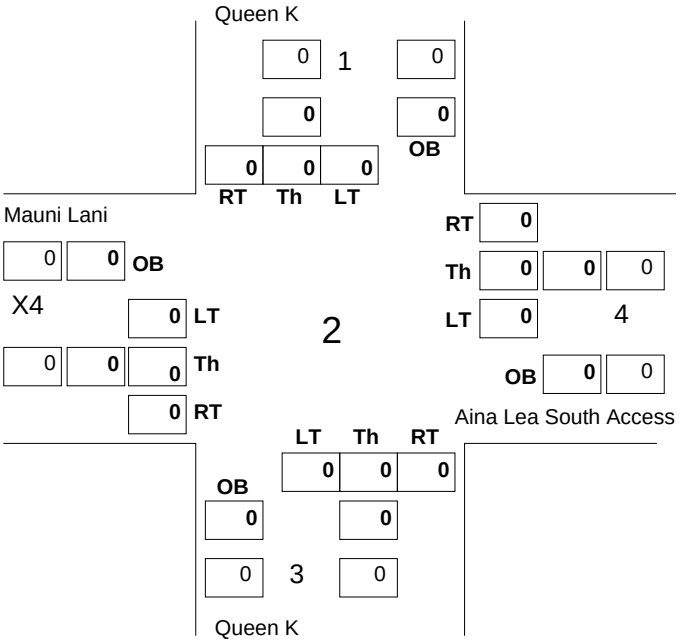
Project: Aina Lea
Scenario: 2020 With Background and Diverted and New Trips
Time Period: PM

Intersection Name: Queen K at Mauni Lani/New Access to Aina Lea
Intersection ID: 2

Existing



Growth



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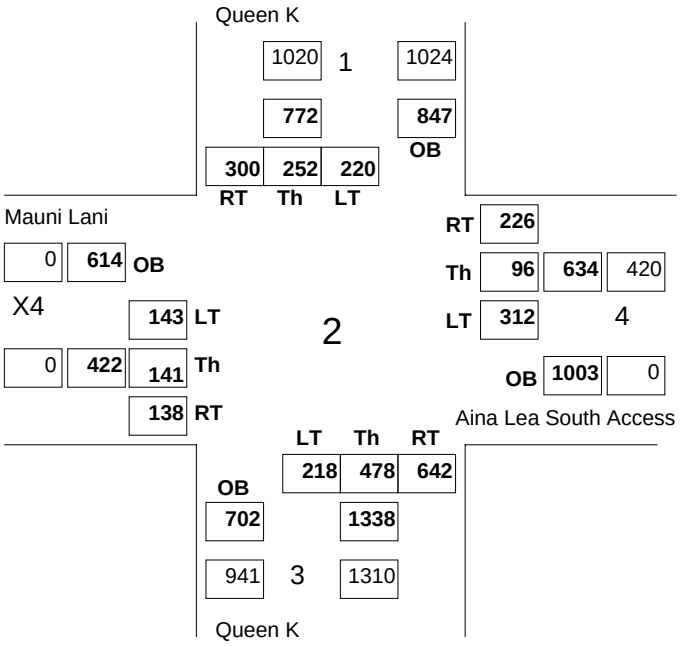
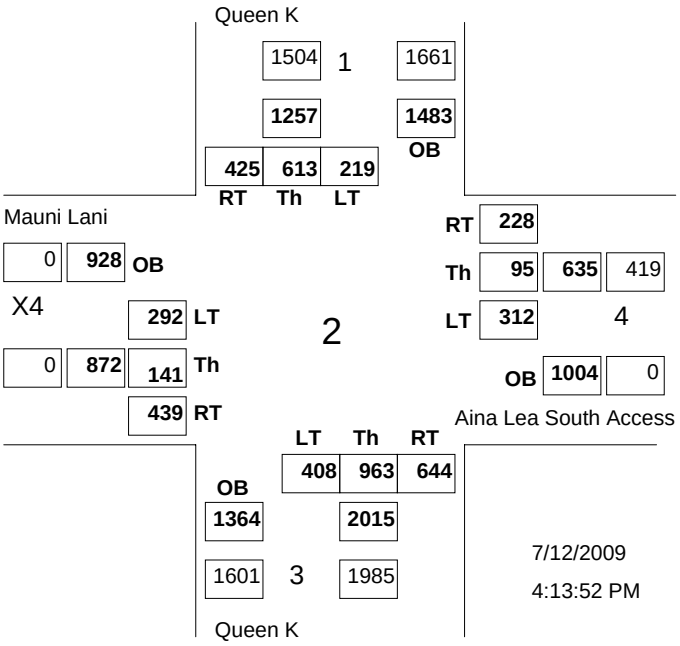


Future



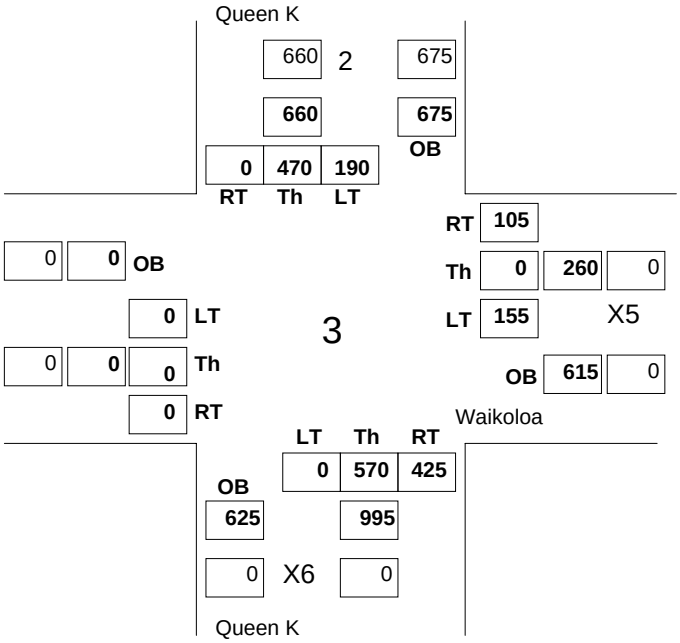
7/12/2009
4:13:52 PM

Intersection Turning Movements

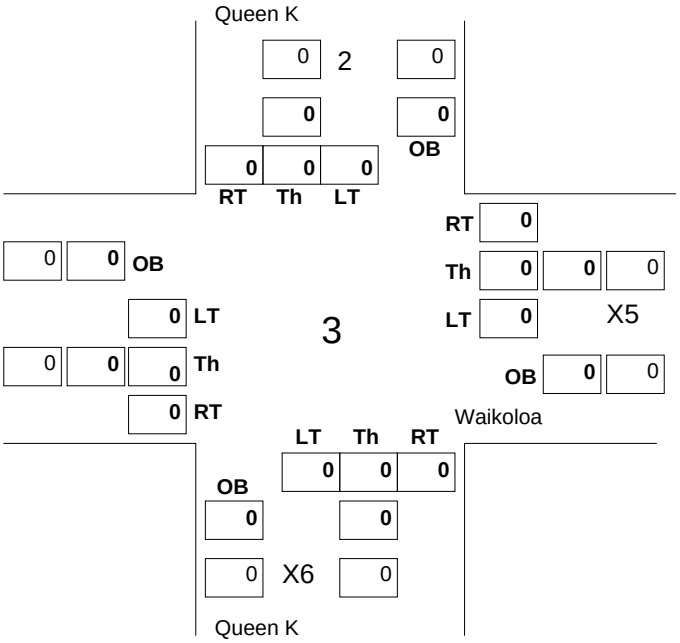
Project: Aina Lea
Scenario: 2020 With Background and Diverted and New Trips
Time Period: PM

Intersection Name: Queen K at Waikoloa
Intersection ID: 3

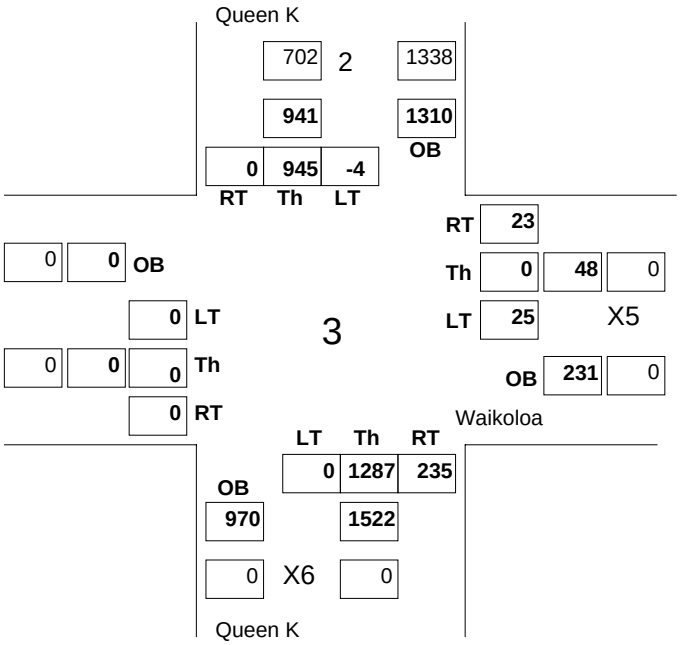
Existing



Growth



Site



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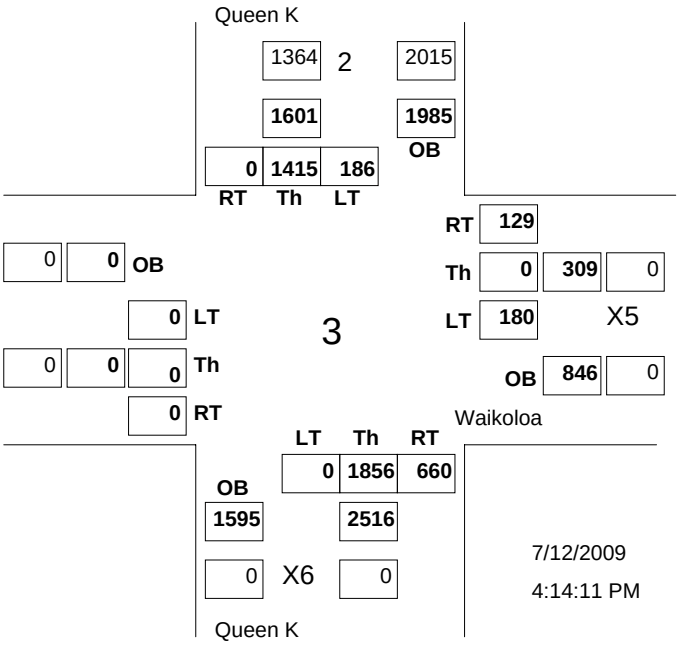

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APPENDIX C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	49	0	110	0	0	0	238	261	0	0	404	236
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	55	0	124	0	0	0	267	293	0	0	454	265
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								TWLTL			TWLTL	
Median storage veh)								2			2	
Upstream signal (ft)								1266				
pX, platoon unblocked												
vC, conflicting volume	1282	1282	454	1406	1547	293	719			293		
vC1, stage 1 conf vol	454	454		828	828							
vC2, stage 2 conf vol	828	828		578	719							
vCu, unblocked vol	1282	1282	454	1406	1547	293	719			293		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)	6.1	5.5		6.1	5.5							
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	77	100	80	100	100	100	70			100		
cM capacity (veh/h)	240	253	608	126	153	748	887			1274		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	55	124	0	0	0	267	293	0	454	265
Volume Left	55	0	0	0	0	267	0	0	0	0
Volume Right	0	124	0	0	0	0	0	0	0	265
cSH	240	608	1700	1700	1700	887	1700	1700	1700	1700
Volume to Capacity	0.23	0.20	0.00	0.00	0.00	0.30	0.17	0.00	0.27	0.16
Queue Length 95th (ft)	21	19	0	0	0	32	0	0	0	0
Control Delay (s)	24.4	12.4	0.0	0.0	0.0	10.8	0.0	0.0	0.0	0.0
Lane LOS	C	B	A	A	A	B				
Approach Delay (s)	16.1		0.0			5.2		0.0		
Approach LOS	C		A							

Intersection Summary				
Average Delay	4.0			
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												
Volume (veh/h)	150	0	308	0	0	0	194	499	0	0	371	128
Sign Control		Stop			Stop			Free			Free	
Grade		0%			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)	163	0	335	0	0	0	211	542	0	0	403	139
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								TWLTL			TWLTL	
Median storage veh)								2			2	
Upstream signal (ft)								1266				
pX, platoon unblocked	0.77	0.77		0.77	0.77	0.77				0.77		
vC, conflicting volume	1367	1367	403	1702	1507	542	542			542		
vC1, stage 1 conf vol	403	403		964	964							
vC2, stage 2 conf vol	964	964		738	542							
vCu, unblocked vol	1328	1328	403	1763	1508	256	542			256		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)	6.1	5.5		6.1	5.5							
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	25	100	48	100	100	100	80			100		
cM capacity (veh/h)	218	229	649	21	200	604	1031			1012		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	163	335	0	0	0	211	542	0	403	139
Volume Left	163	0	0	0	0	211	0	0	0	0
Volume Right	0	335	0	0	0	0	0	0	0	139
cSH	218	649	1700	1700	1700	1031	1700	1700	1700	1700
Volume to Capacity	0.75	0.52	0.00	0.00	0.00	0.20	0.32	0.00	0.24	0.08
Queue Length 95th (ft)	127	74	0	0	0	19	0	0	0	0
Control Delay (s)	58.2	16.3	0.0	0.0	0.0	9.4	0.0	0.0	0.0	0.0
Lane LOS	F	C	A	A	A	A				
Approach Delay (s)	30.0		0.0			2.6		0.0		
Approach LOS	D		A							

Intersection Summary				
Average Delay	9.4			
Intersection Capacity Utilization	59.3%	ICU Level of Service	B	
Analysis Period (min)	15			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	437	194	224	90	53	442
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	1.00	1.00	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	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.42	1.00
Satd. Flow (perm)	1770	1583	1863	1583	791	1863
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	491	218	252	101	60	497
RTOR Reduction (vph)	0	134	0	70	0	0
Lane Group Flow (vph)	491	84	252	31	60	497
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	20.4	20.4	16.1	16.1	25.8	25.8
Effective Green, g (s)	22.4	22.4	18.1	18.1	27.8	27.8
Actuated g/C Ratio	0.38	0.38	0.31	0.31	0.48	0.48
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	681	609	579	492	474	890
v/s Ratio Prot	c0.28		0.14		0.01	c0.27
v/s Ratio Perm		0.05		0.02	0.05	
v/c Ratio	0.72	0.14	0.44	0.06	0.13	0.56
Uniform Delay, d1	15.2	11.6	16.0	14.1	8.6	10.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.8	0.1	0.5	0.1	0.1	0.8
Delay (s)	19.0	11.7	16.5	14.1	8.7	11.6
Level of Service	B	B	B	B	A	B
Approach Delay (s)	16.8		15.8			11.3
Approach LOS	B		B			B

Intersection Summary

HCM Average Control Delay	14.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	58.2	Sum of lost time (s)	8.0
Intersection Capacity Utilization	54.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	156	104	588	434	195	484
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	1.00	1.00	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	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.14	1.00
Satd. Flow (perm)	1770	1583	1863	1583	268	1863
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	170	113	639	472	212	526
RTOR Reduction (vph)	0	89	0	274	0	0
Lane Group Flow (vph)	170	24	639	198	212	526
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	11.3	11.3	24.2	24.2	39.1	39.1
Effective Green, g (s)	13.3	13.3	26.2	26.2	41.1	41.1
Actuated g/C Ratio	0.21	0.21	0.42	0.42	0.66	0.66
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	377	337	782	665	439	1227
v/s Ratio Prot	c0.10		c0.34		c0.08	0.28
v/s Ratio Perm		0.02		0.13	0.23	
v/c Ratio	0.45	0.07	0.82	0.30	0.48	0.43
Uniform Delay, d1	21.4	19.6	16.0	12.0	8.5	5.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.9	0.1	6.6	0.3	0.8	0.2
Delay (s)	22.2	19.7	22.6	12.3	9.3	5.3
Level of Service	C	B	C	B	A	A
Approach Delay (s)	21.2		18.2			6.5
Approach LOS	C		B			A

Intersection Summary

HCM Average Control Delay	14.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	62.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	60.4%	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												
Volume (veh/h)	160	0	226	0	0	0	273	484	0	0	639	271
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	180	0	254	0	0	0	307	544	0	0	718	304
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								TWLTL			TWLTL	
Median storage veh)								2			2	
Upstream signal (ft)								1266				
pX, platoon unblocked	0.87	0.87		0.87	0.87	0.87				0.87		
vC, conflicting volume	1875	1875	718	2129	2180	544	1022			544		
vC1, stage 1 conf vol	718	718		1157	1157							
vC2, stage 2 conf vol	1157	1157		972	1022							
vCu, unblocked vol	1931	1931	718	2222	2280	402	1022			402		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)	6.1	5.5		6.1	5.5							
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	41	100	100	100	55			100		
cM capacity (veh/h)	116	130	431	7	19	566	683			1012		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	180	254	0	0	0	307	544	0	718	304
Volume Left	180	0	0	0	0	307	0	0	0	0
Volume Right	0	254	0	0	0	0	0	0	0	304
cSH	116	431	1700	1700	1700	683	1700	1700	1700	1700
Volume to Capacity	1.55	0.59	0.00	0.00	0.00	0.45	0.32	0.00	0.42	0.18
Queue Length 95th (ft)	328	92	0	0	0	58	0	0	0	0
Control Delay (s)	352.3	24.7	0.0	0.0	0.0	14.5	0.0	0.0	0.0	0.0
Lane LOS	F	C	A	A	A	B				
Approach Delay (s)	160.5		0.0			5.2		0.0		
Approach LOS	F		A							

Intersection Summary			
Average Delay	32.1		
Intersection Capacity Utilization	72.8%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	236	0	409	0	0	0	348	787	0	0	688	324
Sign Control		Stop			Stop			Free			Free	
Grade		0%			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)	257	0	445	0	0	0	378	855	0	0	748	352
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								TWLTL			TWLTL	
Median storage veh)								2			2	
Upstream signal (ft)								1266				
pX, platoon unblocked	0.68	0.68		0.68	0.68	0.68				0.68		
vC, conflicting volume	2360	2360	748	2804	2712	855	1100			855		
vC1, stage 1 conf vol	748	748		1612	1612							
vC2, stage 2 conf vol	1612	1612		1192	1100							
vCu, unblocked vol	2767	2767	748	3423	3286	550	1100			550		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)	6.1	5.5		6.1	5.5							
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	100	0	0	100	100	41			100		
cM capacity (veh/h)	33	42	414	0	2	364	638			695		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	257	445	0	0	0	378	855	0	748	352
Volume Left	257	0	0	0	0	378	0	0	0	0
Volume Right	0	445	0	0	0	0	0	0	0	352
cSH	33	414	1700	1700	1700	638	1700	1700	1700	1700
Volume to Capacity	7.77	1.07	0.00	0.00	0.00	0.59	0.50	0.00	0.44	0.21
Queue Length 95th (ft)	Err	374	0	0	0	97	0	0	0	0
Control Delay (s)	Err	97.1	0.0	0.0	0.0	18.5	0.0	0.0	0.0	0.0
Lane LOS	F	F	A	A	A	C				
Approach Delay (s)	3720.1		0.0			5.7		0.0		
Approach LOS	F		A							

Intersection Summary			
Average Delay	861.7		
Intersection Capacity Utilization	90.8%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	727	330	427	152	184	681
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	1.00	1.00	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	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.16	1.00
Satd. Flow (perm)	1770	1583	1863	1583	302	1863
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	817	371	480	171	207	765
RTOR Reduction (vph)	0	237	0	117	0	0
Lane Group Flow (vph)	817	134	480	54	207	765
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	25.1	25.1	21.8	21.8	37.8	37.8
Effective Green, g (s)	27.1	27.1	23.8	23.8	39.8	39.8
Actuated g/C Ratio	0.36	0.36	0.32	0.32	0.53	0.53
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	640	573	592	503	396	990
v/s Ratio Prot	c0.46		0.26		0.08	c0.41
v/s Ratio Perm		0.08		0.03	0.19	
v/c Ratio	1.28	0.23	0.81	0.11	0.52	0.77
Uniform Delay, d1	23.9	16.7	23.5	18.1	12.3	14.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	136.3	0.2	8.3	0.1	1.2	3.8
Delay (s)	160.2	16.9	31.7	18.1	13.5	17.8
Level of Service	F	B	C	B	B	B
Approach Delay (s)	115.4		28.2			16.9
Approach LOS	F		C			B

Intersection Summary

HCM Average Control Delay	61.1	HCM Level of Service	E
HCM Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	74.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	82.9%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	456	191	944	761	354	743
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	1.00	1.00	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	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.13	1.00
Satd. Flow (perm)	1770	1583	1863	1583	248	1863
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	496	208	1026	827	385	808
RTOR Reduction (vph)	0	140	0	510	0	0
Lane Group Flow (vph)	496	68	1026	317	385	808
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	23.6	23.6	24.0	24.0	42.9	42.9
Effective Green, g (s)	25.6	25.6	26.0	26.0	44.9	44.9
Actuated g/C Ratio	0.33	0.33	0.33	0.33	0.57	0.57
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	577	516	617	524	431	1066
v/s Ratio Prot	c0.28		c0.55		c0.17	0.43
v/s Ratio Perm		0.04		0.20	0.34	
v/c Ratio	0.86	0.13	1.66	0.60	0.89	0.76
Uniform Delay, d1	24.8	18.6	26.2	21.9	20.5	12.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	12.2	0.1	305.4	2.0	20.3	3.1
Delay (s)	36.9	18.7	331.7	23.9	40.7	15.8
Level of Service	D	B	F	C	D	B
Approach Delay (s)	31.6		194.3			23.9
Approach LOS	C		F			C

Intersection Summary

HCM Average Control Delay	109.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.18		
Actuated Cycle Length (s)	78.5	Sum of lost time (s)	12.0
Intersection Capacity Utilization	104.6%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	154	100	715	67	30	1007
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	173	112	803	75	34	1131
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			TWLTL			TWLTL
Median storage veh)			2			2
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2040	841			879	
vC1, stage 1 conf vol	841					
vC2, stage 2 conf vol	1199					
vCu, unblocked vol	2040	841			879	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	25	69			96	
cM capacity (veh/h)	229	365			769	

Direction, Lane #	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total	173	112	879	34	1131
Volume Left	173	0	0	34	0
Volume Right	0	112	75	0	0
cSH	229	365	1700	769	1700
Volume to Capacity	0.75	0.31	0.52	0.04	0.67
Queue Length 95th (ft)	132	32	0	3	0
Control Delay (s)	57.0	19.2	0.0	9.9	0.0
Lane LOS	F	C		A	
Approach Delay (s)	42.1		0.0	0.3	
Approach LOS	E				

Intersection Summary			
Average Delay	5.3		
Intersection Capacity Utilization	68.2%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	108	60	989	205	140	912
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	117	65	1075	223	152	991
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			TWLTL			TWLTL
Median storage veh)			2			2
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2482	1186			1298	
vC1, stage 1 conf vol	1186					
vC2, stage 2 conf vol	1296					
vCu, unblocked vol	2482	1186			1298	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	22	72			71	
cM capacity (veh/h)	150	230			534	

Direction, Lane #	WB 1	WB 2	NB 1	SB 1	SB 2
Volume Total	117	65	1298	152	991
Volume Left	117	0	0	152	0
Volume Right	0	65	223	0	0
cSH	150	230	1700	534	1700
Volume to Capacity	0.78	0.28	0.76	0.29	0.58
Queue Length 95th (ft)	122	28	0	29	0
Control Delay (s)	83.9	26.8	0.0	14.4	0.0
Lane LOS	F	D		B	
Approach Delay (s)	63.5		0.0	1.9	
Approach LOS	F				

Intersection Summary			
Average Delay	5.3		
Intersection Capacity Utilization	88.2%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	208	10	277	63	20	70	291	603	33	37	835	289
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	234	11	311	71	22	79	327	678	37	42	938	325
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								TWLTL			TWLTL	
Median storage veh)								2			2	
Upstream signal (ft)								1266				
pX, platoon unblocked	0.76	0.76		0.76	0.76	0.76				0.76		
vC, conflicting volume	2443	2390	938	2688	2696	696	1263			715		
vC1, stage 1 conf vol	1021	1021		1350	1350							
vC2, stage 2 conf vol	1421	1369		1338	1346							
vCu, unblocked vol	2746	2676	938	3070	3081	437	1263			462		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)	6.1	5.5		6.1	5.5							
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	60	3	0	0	83	41			95		
cM capacity (veh/h)	0	28	322	0	4	470	554			836		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	234	322	71	22	79	327	715	42	938	325
Volume Left	234	0	71	0	0	327	0	42	0	0
Volume Right	0	311	0	0	79	0	37	0	0	325
cSH	0	235	0	4	470	554	1700	836	1700	1700
Volume to Capacity	Err	1.37	1025.52	6.24	0.17	0.59	0.42	0.05	0.55	0.19
Queue Length 95th (ft)	Err	443	Err	Err	15	95	0	4	0	0
Control Delay (s)	Err	231.2	Err	Err	14.2	20.4	0.0	9.5	0.0	0.0
Lane LOS	F	F	F	F	B	C		A		
Approach Delay (s)	Err		5430.8			6.4		0.3		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	94.6%	ICU Level of Service	F
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	236	31	409	52	19	31	348	927	82	48	648	324
Sign Control		Stop			Stop			Free			Free	
Grade		0%			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)	257	34	445	57	21	34	378	1008	89	52	704	352
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								TWLTL			TWLTL	
Median storage veh)								2			2	
Upstream signal (ft)								1266				
pX, platoon unblocked	0.64	0.64		0.64	0.64	0.64				0.64		
vC, conflicting volume	2617	2662	704	3079	2970	1052	1057			1097		
vC1, stage 1 conf vol	809	809		1809	1809							
vC2, stage 2 conf vol	1808	1853		1270	1161							
vCu, unblocked vol	3232	3302	704	3949	3780	805	1057			874		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)	6.1	5.5		6.1	5.5							
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	0	0	0	0	0	86	43			90		
cM capacity (veh/h)	0	2	438	0	1	247	663			500		

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	NB 2	SB 1	SB 2	SB 3
Volume Total	257	478	57	21	34	378	1097	52	704	352
Volume Left	257	0	57	0	0	378	0	52	0	0
Volume Right	0	445	0	0	34	0	89	0	0	352
cSH	0	29	0	1	247	663	1700	500	1700	1700
Volume to Capacity	Err	16.60	Err	19.97	0.14	0.57	0.65	0.10	0.41	0.21
Queue Length 95th (ft)	Err	Err	Err	Err	12	90	0	9	0	0
Control Delay (s)	Err	Err	Err	Err	21.8	17.4	0.0	13.0	0.0	0.0
Lane LOS	F	F	F	F	C	C		B		
Approach Delay (s)	Err		Err			4.5		0.6		
Approach LOS	F		F							

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	100.7%	ICU Level of Service	G
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	654	281	545	117	195	974
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	1.00	1.00	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	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.12	1.00
Satd. Flow (perm)	1770	1583	1863	1583	229	1863
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	735	316	612	131	219	1094
RTOR Reduction (vph)	0	209	0	84	0	0
Lane Group Flow (vph)	735	107	612	47	219	1094
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	25.0	25.0	26.6	26.6	43.0	43.0
Effective Green, g (s)	27.0	27.0	28.6	28.6	45.0	45.0
Actuated g/C Ratio	0.34	0.34	0.36	0.36	0.56	0.56
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	597	534	666	566	368	1048
v/s Ratio Prot	c0.42		0.33		0.09	c0.59
v/s Ratio Perm		0.07		0.03	0.24	
v/c Ratio	1.23	0.20	0.92	0.08	0.60	1.04
Uniform Delay, d1	26.5	18.8	24.6	17.0	14.1	17.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	118.2	0.2	17.7	0.1	2.6	39.9
Delay (s)	144.7	19.0	42.3	17.1	16.7	57.4
Level of Service	F	B	D	B	B	E
Approach Delay (s)	106.9		37.8			50.6
Approach LOS	F		D			D

Intersection Summary

HCM Average Control Delay	66.6	HCM Level of Service	E
HCM Volume to Capacity ratio	1.11		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	8.0
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						
Volume (vph)	356	149	1208	561	222	873
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	1.00	1.00	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	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.13	1.00
Satd. Flow (perm)	1770	1583	1863	1583	242	1863
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	387	162	1313	610	241	949
RTOR Reduction (vph)	0	113	0	334	0	0
Lane Group Flow (vph)	387	49	1313	276	241	949
Turn Type		Perm		Perm	pm+pt	
Protected Phases	8		2		1	6
Permitted Phases		8		2	6	
Actuated Green, G (s)	20.2	20.2	24.8	24.8	41.1	41.1
Effective Green, g (s)	22.2	22.2	26.8	26.8	43.1	43.1
Actuated g/C Ratio	0.30	0.30	0.37	0.37	0.59	0.59
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	536	479	681	579	399	1095
v/s Ratio Prot	c0.22		c0.70		0.10	c0.51
v/s Ratio Perm		0.03		0.17	0.25	
v/c Ratio	0.72	0.10	1.93	0.48	0.60	0.87
Uniform Delay, d1	22.8	18.4	23.2	17.9	12.8	12.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	4.8	0.1	423.0	0.6	2.6	7.4
Delay (s)	27.6	18.5	446.3	18.5	15.4	20.1
Level of Service	C	B	F	B	B	C
Approach Delay (s)	24.9		310.6			19.1
Approach LOS	C		F			B

Intersection Summary

HCM Average Control Delay	173.0	HCM Level of Service	F
HCM Volume to Capacity ratio	1.30		
Actuated Cycle Length (s)	73.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	105.6%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	218	297	321	793	835	319
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	245	334	361	891	938	358
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	TWLTL	
Median storage veh)					2	
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2551	938	938			
vC1, stage 1 conf vol	938					
vC2, stage 2 conf vol	1612					
vCu, unblocked vol	2551	938	938			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3	2.2			
p0 queue free %	0	0	51			
cM capacity (veh/h)	87	322	734			

Direction, Lane #	EB 1	EB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	245	334	361	891	938	358
Volume Left	245	0	361	0	0	0
Volume Right	0	334	0	0	0	358
cSH	87	322	734	1700	1700	1700
Volume to Capacity	2.81	1.04	0.49	0.52	0.55	0.21
Queue Length 95th (ft)	591	299	68	0	0	0
Control Delay (s)	922.8	97.2	14.5	0.0	0.0	0.0
Lane LOS	F	F	B			
Approach Delay (s)	446.7		4.2		0.0	
Approach LOS	F					

Intersection Summary			
Average Delay	84.3		
Intersection Capacity Utilization	83.8%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	236	409	348	787	688	324
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	265	460	391	884	773	364
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	TWLTL	
Median storage veh)					2	
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	2439	773	773			
vC1, stage 1 conf vol	773					
vC2, stage 2 conf vol	1666					
vCu, unblocked vol	2439	773	773			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3	2.2			
p0 queue free %	0	0	54			
cM capacity (veh/h)	88	401	847			

Direction, Lane #	EB 1	EB 2	NB 1	NB 2	SB 1	SB 2
Volume Total	265	460	391	884	773	364
Volume Left	265	0	391	0	0	0
Volume Right	0	460	0	0	0	364
cSH	88	401	847	1700	1700	1700
Volume to Capacity	3.03	1.15	0.46	0.52	0.45	0.21
Queue Length 95th (ft)	Err	433	62	0	0	0
Control Delay (s)	Err	122.9	12.8	0.0	0.0	0.0
Lane LOS	F	F	B			
Approach Delay (s)	3736.5		3.9		0.0	
Approach LOS	F					

Intersection Summary			
Average Delay	864.8		
Intersection Capacity Utilization	78.6%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	1254	578	536	252	313	884
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	1.00	1.00	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	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.10	1.00
Satd. Flow (perm)	1770	1583	1863	1583	182	1863
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1363	628	583	274	340	961
RTOR Reduction (vph)	0	18	0	202	0	0
Lane Group Flow (vph)	1363	610	583	72	340	961
Turn Type		pt+ov		Perm	pm+pt	
Protected Phases	8	8 1	2		1	6
Permitted Phases				2	6	
Actuated Green, G (s)	74.0	93.0	35.0	35.0	54.0	54.0
Effective Green, g (s)	76.0	95.0	37.0	37.0	56.0	56.0
Actuated g/C Ratio	0.54	0.68	0.26	0.26	0.40	0.40
Clearance Time (s)	6.0		6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	961	1074	492	418	243	745
v/s Ratio Prot	c0.77	0.39	0.31		0.15	c0.52
v/s Ratio Perm				0.05	c0.41	
v/c Ratio	1.42	0.57	1.18	0.17	1.40	1.29
Uniform Delay, d1	32.0	11.8	51.5	39.7	42.0	42.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	194.4	0.7	102.3	0.2	202.6	140.5
Delay (s)	226.4	12.5	153.8	39.9	244.7	182.5
Level of Service	F	B	F	D	F	F
Approach Delay (s)	158.9		117.4			198.7
Approach LOS	F		F			F

Intersection Summary

HCM Average Control Delay	162.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.40		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	125.0%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	456	191	944	761	354	743
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	1.00	1.00	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	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.10	1.00
Satd. Flow (perm)	1770	1583	1863	1583	180	1863
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	496	208	1026	827	385	808
RTOR Reduction (vph)	0	2	0	335	0	0
Lane Group Flow (vph)	496	206	1026	492	385	808
Turn Type		pt+ov		Perm	pm+pt	
Protected Phases	8	8 1	2		1	6
Permitted Phases				2	6	
Actuated Green, G (s)	33.2	52.3	35.3	35.3	54.4	54.4
Effective Green, g (s)	35.2	54.3	37.3	37.3	56.4	56.4
Actuated g/C Ratio	0.35	0.55	0.37	0.37	0.57	0.57
Clearance Time (s)	6.0		6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	626	863	698	593	343	1055
v/s Ratio Prot	c0.28	0.13	c0.55		c0.17	0.43
v/s Ratio Perm				0.31	0.46	
v/c Ratio	0.79	0.24	1.47	0.83	1.12	0.77
Uniform Delay, d1	28.9	11.8	31.1	28.3	30.7	16.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	6.8	0.1	219.2	9.6	85.9	3.4
Delay (s)	35.7	12.0	250.4	37.9	116.7	19.9
Level of Service	D	B	F	D	F	B
Approach Delay (s)	28.7		155.5			51.1
Approach LOS	C		F			D

Intersection Summary

HCM Average Control Delay	98.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.14		
Actuated Cycle Length (s)	99.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	104.6%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	375	288	1022	183	85	1477
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	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	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.04	1.00
Satd. Flow (perm)	1770	1583	1863	1583	72	1863
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	421	324	1148	206	96	1660
RTOR Reduction (vph)	0	124	0	16	0	0
Lane Group Flow (vph)	421	200	1148	190	96	1660
Turn Type		Perm		pt+ov	pm+pt	
Protected Phases	8		2	2 8	1	6
Permitted Phases		8			6	
Actuated Green, G (s)	29.0	29.0	98.0	133.0	109.0	109.0
Effective Green, g (s)	29.0	29.0	98.0	133.0	109.0	109.0
Actuated g/C Ratio	0.19	0.19	0.65	0.89	0.73	0.73
Clearance Time (s)	6.0	6.0	6.0		6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	342	306	1217	1404	109	1354
v/s Ratio Prot	c0.24		0.62	0.12	0.03	c0.89
v/s Ratio Perm		0.13			0.61	
v/c Ratio	1.23	0.65	0.94	0.14	0.88	1.23
Uniform Delay, d1	60.5	55.9	23.5	1.1	46.5	20.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	126.9	4.9	14.3	0.0	50.7	108.5
Delay (s)	187.4	60.8	37.8	1.1	97.2	129.0
Level of Service	F	E	D	A	F	F
Approach Delay (s)	132.3		32.2			127.2
Approach LOS	F		C			F

Intersection Summary

HCM Average Control Delay	94.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.23		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	108.5%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	168	57	1192	246	140	1200
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	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	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.04	1.00
Satd. Flow (perm)	1770	1583	1863	1583	72	1863
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	183	62	1296	267	152	1304
RTOR Reduction (vph)	0	53	0	5	0	0
Lane Group Flow (vph)	183	9	1296	262	152	1304
Turn Type		Perm		pt+ov	pm+pt	
Protected Phases	8		2	2 8	1	6
Permitted Phases		8			6	
Actuated Green, G (s)	20.1	20.1	98.2	124.3	109.2	109.2
Effective Green, g (s)	20.1	20.1	98.2	124.3	109.2	109.2
Actuated g/C Ratio	0.14	0.14	0.69	0.88	0.77	0.77
Clearance Time (s)	6.0	6.0	6.0		6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	252	225	1295	1393	116	1440
v/s Ratio Prot	c0.10		0.70	0.17	0.05	c0.70
v/s Ratio Perm		0.01			c0.98	
v/c Ratio	0.73	0.04	1.00	0.19	1.31	0.91
Uniform Delay, d1	58.0	52.3	21.6	1.2	51.5	12.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	10.0	0.1	25.2	0.1	188.3	8.4
Delay (s)	67.9	52.3	46.7	1.3	239.8	20.6
Level of Service	E	D	D	A	F	C
Approach Delay (s)	64.0		39.0			43.4
Approach LOS	E		D			D

Intersection Summary

HCM Average Control Delay	42.8	HCM Level of Service	D
HCM Volume to Capacity ratio	1.20		
Actuated Cycle Length (s)	141.3	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												
Volume (vph)	215	92	294	393	121	438	321	565	292	327	1024	319
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.89		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1787	1670		1787	1900	1599	1787	1863	1599	1787	1863	1599
Flt Permitted	0.67	1.00		0.14	1.00	1.00	0.06	1.00	1.00	0.14	1.00	1.00
Satd. Flow (perm)	1261	1670		269	1900	1599	118	1863	1599	267	1863	1599
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	242	103	330	442	136	492	361	635	328	367	1151	358
RTOR Reduction (vph)	0	77	0	0	0	78	0	0	136	0	0	67
Lane Group Flow (vph)	242	356	0	442	136	414	361	635	192	367	1151	291
Heavy Vehicles (%)	1%	0%	1%	1%	0%	1%	1%	2%	1%	1%	2%	1%
Turn Type	Perm			pm+pt		pt+ov	pm+pt		Prot	pm+pt		Prot
Protected Phases		4		3	8	8 1	5	2	2	1	6	6
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	22.0	22.0		48.0	48.0	74.0	79.0	64.0	64.0	89.0	69.0	69.0
Effective Green, g (s)	22.0	22.0		48.0	48.0	74.0	79.0	64.0	64.0	89.0	69.0	69.0
Actuated g/C Ratio	0.15	0.15		0.32	0.32	0.49	0.53	0.43	0.43	0.59	0.46	0.46
Clearance Time (s)	6.0	6.0		6.0	6.0		6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	185	245		288	608	789	229	795	682	361	857	736
v/s Ratio Prot		0.21		c0.20	0.07	0.26	c0.16	0.34	0.12	0.14	c0.62	0.18
v/s Ratio Perm	0.19			c0.29			c0.67			0.47		
v/c Ratio	1.31	1.45		1.53	0.22	0.52	1.58	0.80	0.28	1.02	1.34	0.40
Uniform Delay, d1	64.0	64.0		45.1	37.4	26.0	49.9	37.4	28.0	36.9	40.5	26.7
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	172.0	225.6		257.4	0.2	0.6	279.3	5.6	0.2	51.6	162.2	0.4
Delay (s)	236.0	289.6		302.5	37.5	26.6	329.2	43.0	28.2	88.5	202.7	27.1
Level of Service	F	F		F	D	C	F	D	C	F	F	C
Approach Delay (s)		270.3			142.0			117.4			146.9	
Approach LOS		F			F			F			F	

Intersection Summary

HCM Average Control Delay	154.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.56		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	136.4%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	225	276	393	523	174	356	348	855	740	435	606	324
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.91		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1787	1722		1787	1900	1599	1787	1863	1599	1787	1863	1599
Flt Permitted	0.64	1.00		0.14	1.00	1.00	0.18	1.00	1.00	0.06	1.00	1.00
Satd. Flow (perm)	1201	1722		269	1900	1599	344	1863	1599	109	1863	1599
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)	245	300	427	568	189	387	378	929	804	473	659	352
RTOR Reduction (vph)	0	34	0	0	0	30	0	0	229	0	0	116
Lane Group Flow (vph)	245	693	0	568	189	357	378	929	575	473	659	236
Heavy Vehicles (%)	1%	0%	1%	1%	0%	1%	1%	2%	1%	1%	2%	1%
Turn Type	Perm			pm+pt		pt+ov	pm+pt		Prot	pm+pt		Prot
Protected Phases		4		3	8	8 1	5	2	2	1	6	6
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	22.0	22.0		48.0	48.0	74.0	79.0	64.0	64.0	89.0	69.0	69.0
Effective Green, g (s)	22.0	22.0		48.0	48.0	74.0	79.0	64.0	64.0	89.0	69.0	69.0
Actuated g/C Ratio	0.15	0.15		0.32	0.32	0.49	0.53	0.43	0.43	0.59	0.46	0.46
Clearance Time (s)	6.0	6.0		6.0	6.0		6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	176	253		288	608	789	325	795	682	288	857	736
v/s Ratio Prot		c0.40		c0.26	0.10	0.22	0.12	0.50	0.36	c0.22	0.35	0.15
v/s Ratio Perm	0.20			0.37			0.50			c0.75		
v/c Ratio	1.39	2.74		1.97	0.31	0.45	1.16	1.17	0.84	1.64	0.77	0.32
Uniform Delay, d1	64.0	64.0		45.1	38.5	24.8	29.3	43.0	38.5	52.3	33.8	25.7
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	207.3	793.4		449.8	0.3	0.4	101.8	89.2	9.3	304.2	4.2	0.3
Delay (s)	271.3	857.4		495.0	38.8	25.2	131.2	132.2	47.9	356.5	38.0	25.9
Level of Service	F	F		F	D	C	F	F	D	F	D	C
Approach Delay (s)		709.7			260.7			99.9			136.7	
Approach LOS		F			F			F			F	

Intersection Summary

HCM Average Control Delay	245.4	HCM Level of Service	F
HCM Volume to Capacity ratio	1.93		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	156.7%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	954	441	736	172	450	1344
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	1.00	1.00	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	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.07	1.00
Satd. Flow (perm)	1770	1583	1863	1583	131	1863
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1037	479	800	187	489	1461
RTOR Reduction (vph)	0	21	0	50	0	0
Lane Group Flow (vph)	1037	458	800	137	489	1461
Turn Type		pt+ov		Perm	pm+pt	
Protected Phases	8	8 1	2		1	6
Permitted Phases				2	6	
Actuated Green, G (s)	59.0	87.0	51.0	51.0	79.0	79.0
Effective Green, g (s)	61.0	89.0	53.0	53.0	81.0	81.0
Actuated g/C Ratio	0.41	0.59	0.35	0.35	0.54	0.54
Clearance Time (s)	6.0		6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	720	939	658	559	333	1006
v/s Ratio Prot	c0.59	0.29	0.43		0.24	c0.78
v/s Ratio Perm				0.09	c0.56	
v/c Ratio	1.44	0.49	1.22	0.24	1.47	1.45
Uniform Delay, d1	44.5	17.5	48.5	34.3	50.6	34.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	206.0	0.4	110.6	0.2	226.6	209.1
Delay (s)	250.5	17.9	159.1	34.6	277.2	243.6
Level of Service	F	B	F	C	F	F
Approach Delay (s)	177.0		135.5			252.0
Approach LOS	F		F			F

Intersection Summary

HCM Average Control Delay	200.7	HCM Level of Service	F
HCM Volume to Capacity ratio	1.45		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	130.3%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	356	229	1668	561	330	1180
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	1.00	1.00	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	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.07	1.00
Satd. Flow (perm)	1770	1583	1863	1583	130	1863
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	387	249	1813	610	359	1283
RTOR Reduction (vph)	0	0	0	64	0	0
Lane Group Flow (vph)	387	249	1813	546	359	1283
Turn Type		pt+ov		Perm	pm+pt	
Protected Phases	8	8 1	2		1	6
Permitted Phases				2	6	
Actuated Green, G (s)	32.5	60.6	51.2	51.2	79.3	79.3
Effective Green, g (s)	34.5	62.6	53.2	53.2	81.3	81.3
Actuated g/C Ratio	0.28	0.51	0.43	0.43	0.66	0.66
Clearance Time (s)	6.0		6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	493	800	801	680	405	1223
v/s Ratio Prot	c0.22	0.16	c0.97		0.17	c0.69
v/s Ratio Perm				0.34	0.41	
v/c Ratio	0.78	0.31	2.26	0.80	0.89	1.05
Uniform Delay, d1	41.2	17.9	35.3	30.7	39.1	21.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	8.0	0.2	572.5	6.8	20.1	39.6
Delay (s)	49.3	18.2	607.8	37.6	59.2	60.9
Level of Service	D	B	F	D	E	E
Approach Delay (s)	37.1		464.3			60.5
Approach LOS	D		F			E

Intersection Summary

HCM Average Control Delay	265.4	HCM Level of Service	F
HCM Volume to Capacity ratio	1.56		
Actuated Cycle Length (s)	123.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	135.8%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	375	288	1022	183	85	1477
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
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	1583	3539	1583	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.10	1.00
Satd. Flow (perm)	1770	1583	3539	1583	189	3539
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	421	324	1148	206	96	1660
RTOR Reduction (vph)	0	104	0	38	0	0
Lane Group Flow (vph)	421	220	1148	168	96	1660
Turn Type		Perm		pt+ov	pm+pt	
Protected Phases	8		2	2 8	1	6
Permitted Phases		8			6	
Actuated Green, G (s)	29.3	29.3	38.8	74.1	49.8	49.8
Effective Green, g (s)	29.3	29.3	38.8	74.1	49.8	49.8
Actuated g/C Ratio	0.32	0.32	0.43	0.81	0.55	0.55
Clearance Time (s)	6.0	6.0	6.0		6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	569	509	1507	1288	190	1935
v/s Ratio Prot	c0.24		0.32	0.11	0.03	c0.47
v/s Ratio Perm		0.14			0.25	
v/c Ratio	0.74	0.43	0.76	0.13	0.51	0.86
Uniform Delay, d1	27.5	24.3	22.2	1.8	14.7	17.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	5.0	0.6	2.3	0.0	2.1	4.0
Delay (s)	32.5	24.9	24.6	1.8	16.8	21.6
Level of Service	C	C	C	A	B	C
Approach Delay (s)	29.2		21.1			21.4
Approach LOS	C		C			C

Intersection Summary

HCM Average Control Delay	22.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	91.1	Sum of lost time (s)	12.0
Intersection Capacity Utilization	71.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	168	57	1192	246	140	1200
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	1.00	1.00	0.95	1.00	1.00	0.95
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	1583	3539	1583	1770	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.10	1.00
Satd. Flow (perm)	1770	1583	3539	1583	179	3539
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	189	64	1339	276	157	1348
RTOR Reduction (vph)	0	52	0	33	0	0
Lane Group Flow (vph)	189	12	1339	243	157	1348
Turn Type		Perm		pt+ov	pm+pt	
Protected Phases	8		2	2 8	1	6
Permitted Phases		8			6	
Actuated Green, G (s)	14.3	14.3	39.5	59.8	50.7	50.7
Effective Green, g (s)	14.3	14.3	39.5	59.8	50.7	50.7
Actuated g/C Ratio	0.19	0.19	0.51	0.78	0.66	0.66
Clearance Time (s)	6.0	6.0	6.0		6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	329	294	1815	1229	225	2330
v/s Ratio Prot	c0.11		0.38	0.15	0.05	c0.38
v/s Ratio Perm		0.01			c0.41	
v/c Ratio	0.57	0.04	0.74	0.20	0.70	0.58
Uniform Delay, d1	28.6	25.7	14.7	2.3	11.4	7.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.4	0.1	1.6	0.1	9.1	0.4
Delay (s)	31.0	25.8	16.3	2.3	20.4	7.6
Level of Service	C	C	B	A	C	A
Approach Delay (s)	29.7		13.9			8.9
Approach LOS	C		B			A

Intersection Summary

HCM Average Control Delay	12.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	77.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	65.0%	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												
Volume (vph)	215	92	294	393	121	438	321	565	292	327	1024	319
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	0.97	1.00	1.00	0.97	1.00	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3467	1900	1599	3467	1900	1599	1787	3539	1599	3467	3539	1599
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3467	1900	1599	3467	1900	1599	1787	3539	1599	3467	3539	1599
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	242	103	330	442	136	492	361	635	328	367	1151	358
RTOR Reduction (vph)	0	0	9	0	0	90	0	0	58	0	0	128
Lane Group Flow (vph)	242	103	321	442	136	402	361	635	270	367	1151	230
Heavy Vehicles (%)	1%	0%	1%	1%	0%	1%	1%	2%	1%	1%	2%	1%
Turn Type	Prot		pt+ov	Prot		pt+ov	Prot		pt+ov	Prot		Prot
Protected Phases	7	4	4 5	3	8	8 1	5	2	2 3	1	6	6
Permitted Phases												
Actuated Green, G (s)	12.0	16.1	54.2	20.5	24.6	51.0	32.1	62.7	89.2	20.4	51.0	51.0
Effective Green, g (s)	12.0	16.1	54.2	20.5	24.6	51.0	32.1	62.7	89.2	20.4	51.0	51.0
Actuated g/C Ratio	0.08	0.11	0.38	0.14	0.17	0.35	0.22	0.44	0.62	0.14	0.35	0.35
Clearance Time (s)	6.0	6.0		6.0	6.0		6.0	6.0		6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	290	213	603	495	325	567	399	1544	993	492	1256	567
v/s Ratio Prot	0.07	0.05	0.20	c0.13	0.07	c0.25	c0.20	0.18	0.17	0.11	c0.33	0.14
v/s Ratio Perm												
v/c Ratio	0.83	0.48	0.53	0.89	0.42	0.71	0.90	0.41	0.27	0.75	0.92	0.40
Uniform Delay, d1	64.9	59.9	34.9	60.5	53.2	40.0	54.3	27.8	12.4	59.2	44.3	34.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	18.3	1.7	0.9	18.2	0.9	4.1	23.3	0.2	0.1	6.1	10.5	0.5
Delay (s)	83.2	61.6	35.8	78.7	54.0	44.0	77.6	28.0	12.6	65.2	54.8	35.4
Level of Service	F	E	D	E	D	D	E	C	B	E	D	D
Approach Delay (s)		56.7			59.6			37.7			53.2	
Approach LOS		E			E			D			D	

Intersection Summary

HCM Average Control Delay	50.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	143.7	Sum of lost time (s)	18.0
Intersection Capacity Utilization	82.1%	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												
Volume (vph)	245	279	417	547	182	356	383	980	756	435	757	377
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1787	1900	1599	3467	1900	1599	3467	3539	1599	3467	3539	1599
Flt Permitted	0.63	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1191	1900	1599	3467	1900	1599	3467	3539	1599	3467	3539	1599
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	303	453	595	198	387	416	1065	822	473	823	410
RTOR Reduction (vph)	0	0	19	0	0	8	0	0	39	0	0	271
Lane Group Flow (vph)	266	303	434	595	198	379	416	1065	783	473	823	139
Heavy Vehicles (%)	1%	0%	1%	1%	0%	1%	1%	2%	1%	1%	2%	1%
Turn Type	Perm		pt+ov	Prot		pt+ov	Prot		pt+ov	Prot		Prot
Protected Phases		4	4 5	3	8	8 1	5	2	2 3	1	6	6
Permitted Phases	4											
Actuated Green, G (s)	27.0	27.0	51.7	22.0	55.0	78.0	18.7	48.8	76.8	17.0	47.1	47.1
Effective Green, g (s)	27.0	27.0	51.7	22.0	55.0	78.0	18.7	48.8	76.8	17.0	47.1	47.1
Actuated g/C Ratio	0.19	0.19	0.37	0.16	0.40	0.56	0.13	0.35	0.55	0.12	0.34	0.34
Clearance Time (s)	6.0	6.0		6.0	6.0		6.0	6.0		6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	232	370	596	550	753	899	467	1244	885	425	1201	543
v/s Ratio Prot		0.16	0.27	c0.17	0.10	0.24	0.12	0.30	c0.49	c0.14	0.23	0.09
v/s Ratio Perm	c0.22											
v/c Ratio	1.15	0.82	0.73	1.08	0.26	0.42	0.89	0.86	0.88	1.11	0.69	0.26
Uniform Delay, d1	55.9	53.6	37.5	58.4	28.2	17.5	59.0	41.7	27.1	60.9	39.5	33.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	104.3	13.2	4.4	62.4	0.2	0.3	18.8	6.0	10.5	78.0	1.6	0.3
Delay (s)	160.2	66.7	41.9	120.8	28.4	17.8	77.8	47.7	37.6	138.9	41.1	33.4
Level of Service	F	E	D	F	C	B	E	D	D	F	D	C
Approach Delay (s)		80.1			71.5			49.5			66.4	
Approach LOS		F			E			D			E	

Intersection Summary

HCM Average Control Delay	63.4	HCM Level of Service	E
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	138.8	Sum of lost time (s)	18.0
Intersection Capacity Utilization	89.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	954	441	736	172	450	1344
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	0.97	1.00	0.95	1.00	0.97	0.95
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)	3433	1583	3539	1583	3433	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	3433	1583	3539	1583	3433	3539
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	1037	479	800	187	489	1461
RTOR Reduction (vph)	0	20	0	129	0	0
Lane Group Flow (vph)	1037	459	800	58	489	1461
Turn Type		pt+ov		Perm	Prot	
Protected Phases	8	8 1	2		1	6
Permitted Phases				2		
Actuated Green, G (s)	45.4	72.9	35.6	35.6	21.5	63.1
Effective Green, g (s)	47.4	74.9	37.6	37.6	23.5	65.1
Actuated g/C Ratio	0.39	0.62	0.31	0.31	0.20	0.54
Clearance Time (s)	6.0		6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	1350	984	1104	494	670	1912
v/s Ratio Prot	c0.30	0.29	0.23		0.14	c0.41
v/s Ratio Perm				0.04		
v/c Ratio	0.77	0.47	0.72	0.12	0.73	0.76
Uniform Delay, d1	31.8	12.2	36.8	29.6	45.5	21.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.7	0.4	2.4	0.1	4.0	1.9
Delay (s)	34.5	12.5	39.2	29.7	49.5	23.6
Level of Service	C	B	D	C	D	C
Approach Delay (s)	27.5		37.4			30.1
Approach LOS	C		D			C

Intersection Summary

HCM Average Control Delay	30.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	120.5	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	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	356	229	1668	561	330	1180
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	0.97	1.00	0.95	1.00	0.97	0.95
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)	3433	1583	3539	1583	3433	3539
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	3433	1583	3539	1583	3433	3539
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	387	249	1813	610	359	1283
RTOR Reduction (vph)	0	1	0	242	0	0
Lane Group Flow (vph)	387	248	1813	368	359	1283
Turn Type		pt+ov		Perm	Prot	
Protected Phases	8	8 1	2		1	6
Permitted Phases				2		
Actuated Green, G (s)	18.0	40.5	51.4	51.4	16.5	73.9
Effective Green, g (s)	20.0	42.5	53.4	53.4	18.5	75.9
Actuated g/C Ratio	0.19	0.41	0.51	0.51	0.18	0.73
Clearance Time (s)	6.0		6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	661	648	1819	814	611	2585
v/s Ratio Prot	c0.11	0.16	c0.51		c0.10	0.36
v/s Ratio Perm				0.23		
v/c Ratio	0.59	0.38	1.00	0.45	0.59	0.50
Uniform Delay, d1	38.2	21.5	25.2	16.0	39.2	5.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.3	0.4	20.2	0.4	1.4	0.2
Delay (s)	39.5	21.9	45.3	16.4	40.6	6.1
Level of Service	D	C	D	B	D	A
Approach Delay (s)	32.6		38.0			13.6
Approach LOS	C		D			B

Intersection Summary

HCM Average Control Delay	28.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	103.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	75.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

APPENDIX D

Appendix C-2
Warrant 2 for Traffic Signals

2007 QUEEN KA'AHUMANU HIGHWAY AT MAUNA LANI DRIVE

						Warrant 2, Basic 4 Hour Vehicular Warrant			Warrant 2, (70%) 4 Hour Vehicular Warrant		
	Queen Ka'ahumanu Highway			Mauna Lani Access Road		Standard required Minor Street volume	Is Highest Minor Street Volume> standard		Standard required Minor Street volume	Is Highest Minor Street Volume> standard	
TIME PERIOD	South bound	North bound	Two Way	Left Turns	Right Turns		Left turns only	Left & right turns		Left turns only	Left & right turns
5:00-6:00 AM	298	91	389	11	11	300	NO	NO	170	NO	NO
6:00-7:00 AM	664	319	983	16	53	100	NO	NO	60	NO	YES
7:00-8:00 AM	541	507	1048	52	125	80	NO	YES	60	NO	YES
8:00-9:00 AM	403	496	899	60	106	110	NO	YES	60	NO	YES
9:00-10:00 AM	366	442	808	69	124	150	NO	YES	60	YES	YES
10:00-11:00 AM	359	418	777	77	137	160	NO	YES	60	YES	YES
11:00-12:00 AM	365	418	783	72	177	150	NO	YES	60	YES	YES
12:00-1:00 PM	368	485	853	92	158	130	NO	YES	60	YES	YES
1:00-2:00 PM	422	509	931	88	169	110	YES	YES	60	YES	YES
2:00-3:00 PM	455	508	963	110	198	100	YES	YES	60	YES	YES
3:00-4:00 PM	498	638	1136	133	285	80	YES	YES	60	YES	YES
4:00-5:00 PM	416	612	1028	146	251	80	YES	YES	60	YES	YES
5:00-6:00 PM	381	506	887	100	203	120	NO	YES	60	YES	YES
						Do minor street volumes exceed standards for 4 hours of the day? **YES/YES**			Do minor street volumes exceed standards for 4 hours of the day? **YES/YES**		

CHAPTER 4C. TRAFFIC CONTROL SIGNAL NEEDS STUDIES

Section 4C.01 Studies and Factors for Justifying Traffic Control Signals

Standard:

An engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at a particular location.

The investigation of the need for a traffic control signal shall include an analysis of the applicable factors contained in the following traffic signal warrants and other factors related to existing operation and safety at the study location:

Warrant 1, Eight-Hour Vehicular Volume.
Warrant 2, Four-Hour Vehicular Volume.
Warrant 3, Peak Hour.
Warrant 4, Pedestrian Volume.
Warrant 5, School Crossing.
Warrant 6, Coordinated Signal System.
Warrant 7, Crash Experience.
Warrant 8, Roadway Network.

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

Support:

Sections 8D.07 and 10D.05 contain information regarding the use of traffic control signals instead of gates and/or flashing light signals at highway-railroad grade crossings and highway-light rail transit grade crossings, respectively.

Guidance:

A traffic control signal should not be installed unless one or more of the factors described in this Chapter are met.

A traffic control signal should not be installed unless an engineering study indicates that installing a traffic control signal will improve the overall safety and/or operation of the intersection.

A traffic control signal should not be installed if it will seriously disrupt progressive traffic flow.

The study should consider the effects of the right-turn vehicles from the minor-street approaches. Engineering judgment should be used to determine what, if any, portion of the right-turn traffic is subtracted from the minor-street traffic count when evaluating the count against the above signal warrants.

Engineering judgment should also be used in applying various traffic signal warrants to cases where approaches consist of one lane plus one left-turn or right-turn lane. The site-specific traffic characteristics dictate whether an approach should be considered as one lane or two lanes. For example, for an approach with one lane for through and right-turning traffic plus a left-turn lane, engineering judgment could indicate that it should be considered a one-lane approach if the traffic using the left-turn lane is minor. In such a case, the total traffic volume approaching the intersection should be applied against the signal warrants as a one-lane approach. The approach should be considered two lanes if approximately half of the traffic on the approach turns left and the left-turn lane is of sufficient length to accommodate all left-turn vehicles.

Similar engineering judgment and rationale should be applied to a street approach with one lane plus a right-turn lane. In this case, the degree of conflict of minor-street right-turn traffic with traffic on the major street should be considered. Thus, right-turn traffic should not be included in the minor-street volume if the movement enters the major street with minimal conflict. The approach should be evaluated as a one-lane approach with only the traffic volume in the through/left-turn lane considered.

At a location that is under development or construction and where it is not possible to obtain a traffic count that would represent future traffic conditions, hourly volumes should be estimated as part of an engineering study for comparison with traffic signal warrants. Except for locations where the engineering study uses the satisfaction of Warrant 8 to justify a signal, a traffic control signal installed under projected conditions should have an engineering study done within 1 year of putting the signal into stop-and-go operation to determine if the signal is justified. If not justified, the signal should be taken out of stop-and-go operation or removed.

For signal warrant analysis, a location with a wide median, even if the median width is greater than 9 m (30 ft), should be considered as one intersection.

Option:

At an intersection with a high volume of left-turn traffic from the major street, the signal warrant analysis may be performed in a manner that considers the higher of the major-street left-turn volumes as the "minor-street" volume and the corresponding single direction of opposing traffic on the major street as the "major-street" volume.

For signal warrant analysis, bicyclists may be counted as either vehicles or pedestrians.

Support:

When performing a signal warrant analysis, bicyclists riding in the street with other vehicular traffic are usually counted as vehicles and bicyclists who are clearly using pedestrian facilities are usually counted as pedestrians.

Option:

Engineering study data may include the following:

A. The number of vehicles entering the intersection in each hour from each approach during 12 hours of an average day. It is desirable that the hours selected contain the greatest percentage of the 24-hour traffic volume.
B. Vehicular volumes for each traffic movement from each approach, classified by vehicle type (heavy trucks, passenger cars and light trucks, public-transit vehicles, and, in some locations, bicycles), during each 15-minute period of the 2 hours in the morning and 2 hours in the afternoon during which total traffic entering the intersection is greatest.
C. Pedestrian volume counts on each crosswalk during the same periods as the vehicular counts in Item B above and during hours of highest pedestrian volume. Where young, elderly, and/or persons with physical or visual disabilities need special consideration, the pedestrians and their crossing times may be classified by general observation.
D. Information about nearby facilities and activity centers that serve the young, elderly, and/or persons with disabilities, including requests from persons with disabilities for accessible crossing improvements at the location under study. These persons might not be adequately reflected in the pedestrian volume count if the absence of a signal restrains their mobility.
E. The posted or statutory speed limit or the 85th-percentile speed on the uncontrolled approaches to the location.
F. A condition diagram showing details of the physical layout, including such features as intersection geometrics, channelization, grades, sight-distance restrictions, transit stops and routes, parking conditions, pavement markings, roadway lighting, driveways, nearby railroad crossings, distance to nearest traffic control signals, utility poles and fixtures, and adjacent land use.
G. A collision diagram showing crash experience by type, location, direction of movement, severity, weather, time of day, date, and day of week for at least 1 year.

The following data, which are desirable for a more precise understanding of the operation of the intersection, may be obtained during the periods specified in Item B of the preceding paragraph:

A. Vehicle-hours of stopped time delay determined separately for each approach.
B. The number and distribution of acceptable gaps in vehicular traffic on the major street for entrance from the minor street.
C. The posted or statutory speed limit or the 85th-percentile speed on controlled approaches at a point near to the intersection but unaffected by the control.
D. Pedestrian delay time for at least two 30-minute peak pedestrian delay periods of an average weekday or like periods of a Saturday or Sunday.
E. Queue length on stop-controlled approaches.

Section 4C.02 Warrant 1, Eight-Hour Vehicular Volume

Support:

The Minimum Vehicular Volume, Condition A, is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

It is intended that Warrant 1 be treated as a single warrant. If Condition A is satisfied, then the criteria for Warrant 1 is satisfied and Condition B and the combination of Conditions A and B are not needed. Similarly, if Condition B is satisfied, then the criteria for Warrant 1 is satisfied and the combination of Conditions A and B is not needed.

Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume

Condition A—Minimum Vehicular Volume									
Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1.....	1.....	500	400	350	280	150	120	105	84
2 or more...	1.....	600	480	420	336	150	120	105	84
2 or more...	2 or more...	600	480	420	336	200	160	140	112
1.....	2 or more....	500	400	350	280	200	160	140	112

Condition B—Interruption of Continuous Traffic									
Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1.....	1.....	750	600	525	420	75	60	53	42
2 or more...	1.....	900	720	630	504	75	60	53	42
2 or more...	2 or more...	900	720	630	504	100	80	70	56
1.....	2 or more....	750	600	525	420	100	80	70	56

[a] Basic minimum hourly volume.
[b] Used for combination of Conditions A and B after adequate trial of other remedial measures.
[c] May be used when the major-street speed exceeds 70 km/h or exceeds 40 mph or in an isolated community with a population of less than 10,000.
[d] May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major-street speed exceeds 70 km/h or exceeds 40 mph or in an isolated community with a population of less than 10,000.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that one of the following conditions exist for each of any 8 hours of an average day:

A. The vehicles per hour given in both of the 100 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; or

B. The vehicles per hour given in both of the 100 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

In applying each condition the major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of these 8 hours.

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 70 percent columns in Table 4C-1 may be used in place of the 100 percent columns.

Guidance:

The combination of Conditions A and B is intended for application at locations where Condition A is not satisfied and Condition B is not satisfied and should be applied only after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that both of the following conditions exist for each of any 8 hours of an average day:

A. The vehicles per hour given in both of the 80 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; and

B. The vehicles per hour given in both of the 80 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

These major-street and minor-street volumes shall be for the same 8 hours for each condition; however, the 8 hours satisfied in Condition A shall not be required to be the same 8 hours satisfied in Condition B. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

Section 4C.03 Warrant 2, Four-Hour Vehicular Volume

Support:

The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all fall above the applicable curve in Figure 4C-1 for the existing combination of approach lanes. On the minor street, the higher volume shall not be required to be on the same approach during each of these 4 hours.

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-2 may be used in place of Figure 4C-1.

Section 4C.04 Warrant 3, Peak Hour

Support:

The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

Standard:

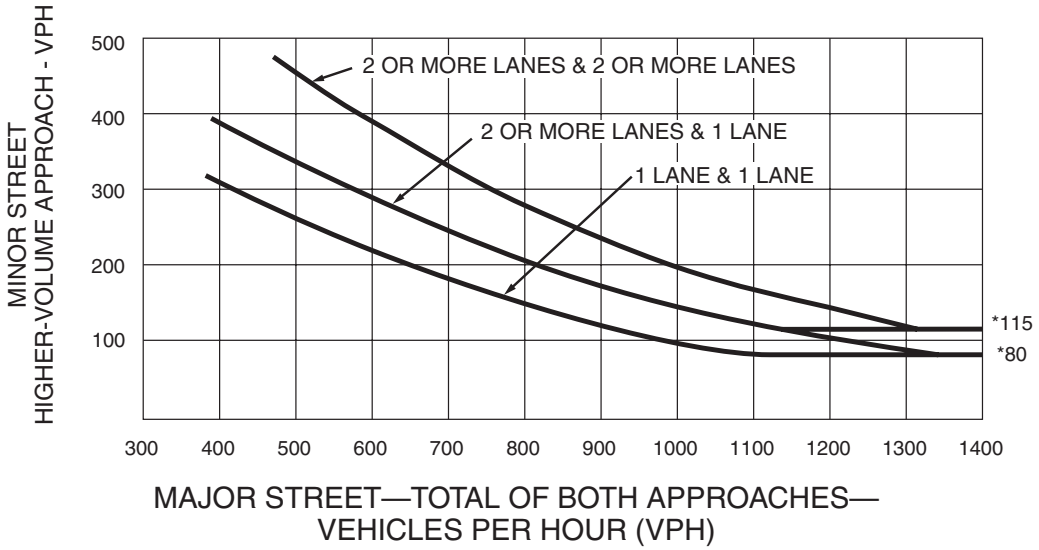
This signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.

The need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of the following two categories are met:

A. If all three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:

1. The total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane approach; or 5 vehicle-hours for a two-lane approach, and

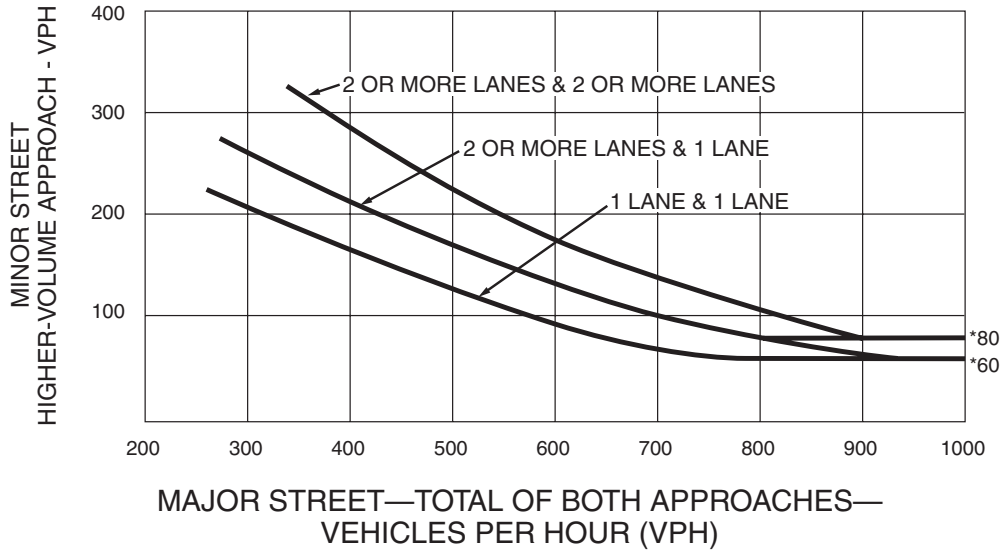
Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume



*Note: 115 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-2. Warrant 2, Four-Hour Vehicular Volume (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 70 km/h OR ABOVE 40 mph ON MAJOR STREET)



*Note: 80 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 60 vph applies as the lower threshold volume for a minor-street approach with one lane.

2. **The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes, and**
3. **The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.**

B. **The plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4C-3 for the existing combination of approach lanes.**

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-4 may be used in place of Figure 4C-3 to satisfy the criteria in the second category of the Standard.

Section 4C.05 Warrant 4, Pedestrian Volume

Support:

The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

Standard:

The need for a traffic control signal at an intersection or midblock crossing shall be considered if an engineering study finds that both of the following criteria are met:

A. **The pedestrian volume crossing the major street at an intersection or midblock location during an average day is 100 or more for each of any 4 hours or 190 or more during any 1 hour; and**
B. **There are fewer than 60 gaps per hour in the traffic stream of adequate length to allow pedestrians to cross during the same period when the pedestrian volume criterion is satisfied. Where there is a divided street having a median of sufficient width for pedestrians to wait, the requirement applies separately to each direction of vehicular traffic.**

The Pedestrian Volume signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 90 m (300 ft), unless the proposed traffic control signal will not restrict the progressive movement of traffic.

If this warrant is met and a traffic control signal is justified by an engineering study, the traffic control signal shall be equipped with pedestrian signal heads conforming to requirements set forth in Chapter 4E.

Guidance:

If this warrant is met and a traffic control signal is justified by an engineering study, then:

A. If at an intersection, the traffic control signal should be traffic-actuated and should include pedestrian detectors.
B. If at a nonintersection crossing, the traffic control signal should be pedestrian-actuated, parking and other sight obstructions should be prohibited for at least 30 m (100 ft) in advance of and at least 6.1 m (20 ft) beyond the crosswalk, and the installation should include suitable standard signs and pavement markings.
C. Furthermore, if installed within a signal system, the traffic control signal should be coordinated.

Option:

The criterion for the pedestrian volume crossing the major roadway may be reduced as much as 50 percent if the average crossing speed of pedestrians is less than 1.2 m/sec (4 ft/sec).

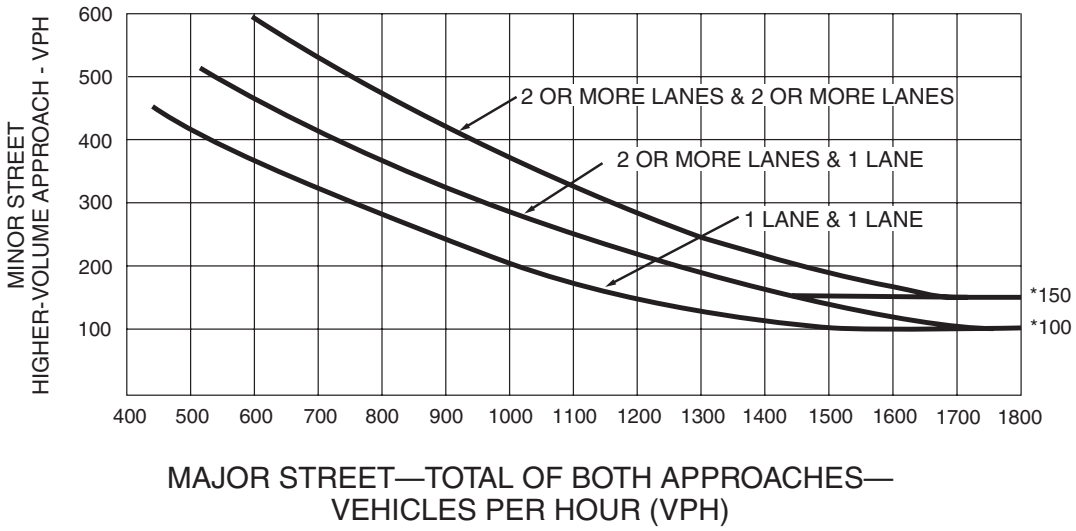
A traffic control signal may not be needed at the study location if adjacent coordinated traffic control signals consistently provide gaps of adequate length for pedestrians to cross the street, even if the rate of gap occurrence is less than one per minute.

Section 4C.06 Warrant 5, School Crossing

Support:

The School Crossing signal warrant is intended for application where the fact that school children cross the major street is the principal reason to consider installing a traffic control signal.

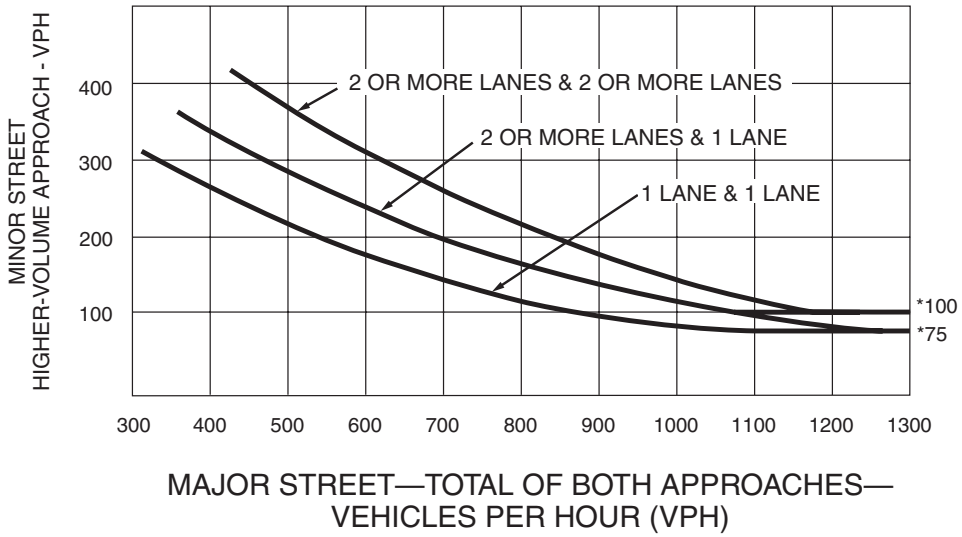
Figure 4C-3. Warrant 3, Peak Hour



*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 approach with one lane.

Figure 4C-4. Warrant 3, Peak Hour (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 70 km/h OR ABOVE 40 mph ON MAJOR STREET)



*Note: 100 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 75 vph applies as the lower threshold volume for a minor-street approach with one lane.

Standard:

The need for a traffic control signal shall be considered when an engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of school children at an established school crossing across the major street shows that the number of adequate gaps in the traffic stream during the period when the children are using the crossing is less than the number of minutes in the same period (see Section 7A.03) and there are a minimum of 20 students during the highest crossing hour.

Before a decision is made to install a traffic control signal, consideration shall be given to the implementation of other remedial measures, such as warning signs and flashers, school speed zones, school crossing guards, or a grade-separated crossing.

The School Crossing signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 90 m (300 ft), unless the proposed traffic control signal will not restrict the progressive movement of traffic.

Guidance:

If this warrant is met and a traffic control signal is justified by an engineering study, then:

A. If at an intersection, the traffic control signal should be traffic-actuated and should include pedestrian detectors.
B. If at a nonintersection crossing, the traffic control signal should be pedestrian-actuated, parking and other sight obstructions should be prohibited for at least 30 m (100 ft) in advance of and at least 6.1 m (20 ft) beyond the crosswalk, and the installation should include suitable standard signs and pavement markings.
C. Furthermore, if installed within a signal system, the traffic control signal should be coordinated.

Section 4C.07 Warrant 6, Coordinated Signal System

Support:

Progressive movement in a coordinated signal system sometimes necessitates installing traffic control signals at intersections where they would not otherwise be needed in order to maintain proper platooning of vehicles.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that one of the following criteria is met:

A. On a one-way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning.
B. On a two-way street, adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.

Guidance:

The Coordinated Signal System signal warrant should not be applied where the resultant spacing of traffic control signals would be less than 300 m (1,000 ft).

Section 4C.08 Warrant 7, Crash Experience

Support:

The Crash Experience signal warrant conditions are intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that all of the following criteria are met:

A. Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and
B. Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for a reportable crash; and
C. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in Table 4C-1 (see Section 4C.02), or the vph in both of the 80 percent columns of Condition B in Table 4C-1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not

less than 80 percent of the requirements specified in the Pedestrian Volume warrant. These major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h or exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

Section 4C.09 Warrant 8, Roadway Network

Support:

Installing a traffic control signal at some intersections might be justified to encourage concentration and organization of traffic flow on a roadway network.

Standard:

The need for a traffic control signal shall be considered if an engineering study finds that the common intersection of two or more major routes meets one or both of the following criteria:

A. The intersection has a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic volumes, based on an engineering study, that meet one or more of Warrants 1, 2, and 3 during an average weekday; or

B. The intersection has a total existing or immediately projected entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a nonnormal business day (Saturday or Sunday).

A major route as used in this signal warrant shall have one or more of the following characteristics:

A. It is part of the street or highway system that serves as the principal roadway network for through traffic flow; or

B. It includes rural or suburban highways outside, entering, or traversing a City; or

C. It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.

SCMUTCD Section 4-3.08 Accident Types Correctable by Signalization

A traffic control signal, when obeyed by drivers and pedestrians, can be expected to eliminate or reduce materially the number and seriousness of the following types of accidents:

1. Those involving substantially right-angle collisions or conflicts, such as occur between vehicles on intersecting streets.
2. Those involving conflicts between straight -moving vehicles and crossing pedestrians.
3. Those between straight-moving and left-turning vehicles approaching from opposite directions, if an independent time interval is allowed during the signal cycle for the left-turn movement.
4. Those involving excessive speed, in cases where signal coordination will restrict speed to a reasonable rate.

On the other hand, traffic control signals cannot be expected to reduce the following types of accidents:

1. Rear-end collisions, which often increase after signalization.
2. Collisions between vehicles proceeding in the same or opposite directions, one of which makes a turn across the path of the other, particularly in no independent signal interval is provided for these turn movements.
3. Accidents involving pedestrians and turning vehicles when both move during the same interval.
4. Other types of pedestrian accidents, if pedestrians or drivers do not obey the signals

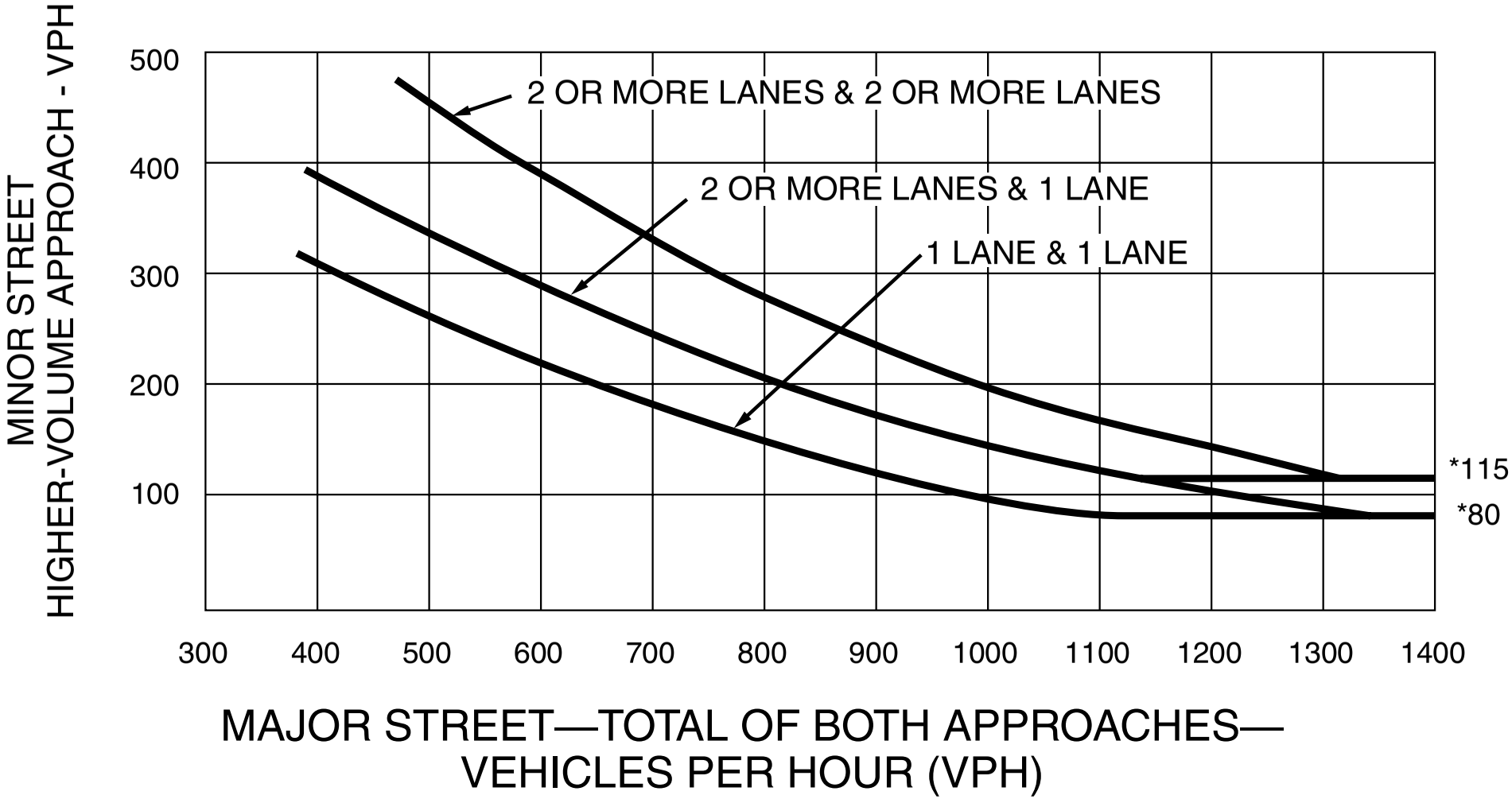
Signal Warrant Calculations
Aina Lea and Mauna Lani 2012

	Northbound			Southbound			Eastbound			Westbound			Major	Minor	Minor
	L	T	R	L	T	R	L	T	R	L	T	R	Total	Left/thru	Less 1/2 R
700	221	394	1	1	500	222	84	0	159	4	1	5	895	84	164
800	205	387	34	38	417	151	97	11	140	48	15	53	842	108	178
900	186	354	16	18	401	122	101	5	158	23	7	26	773	106	185
1000	142	375	23	26	427	89	109	7	171	30	9	34	828	116	202
1100	143	374	31	35	427	97	104	10	211	31	10	35	836	114	220
1200	153	419	45	50	419	99	124	14	192	42	13	47	888	138	234
1300	153	422	70	41	426	99	124	26	49	68	25	40	889	150	175
1400	163	445	61	36	490	126	142	23	232	63	23	37	971	165	281
1500	186	560	41	24	562	117	165	15	319	78	29	46	1146	180	340
1600	273	530	71	42	745	271	160	26	226	65	24	38	1317	186	299
1700	160	443	68	40	447	89	132	25	237	67	25	40	930	157	276

Traffic Signal Warrant Analysis Aina Lea North Access 2012

	Northbound			Southbound			Eastbound			Westbound			Major	Minor	Minor
	L	T	R	L	T	R	L	T	R	L	T	R	Total	Left/thru	Less 1/2 Rights
700	0	332	51	30	578	0	0	0	0	145	0	100	940	145	195
800	0	396	56	26	472	0	0	0	0	134	0	86	894	134	177
900	0	356	46	24	422	0	0	0	0	119	0	79	802	119	159
1000	0	388	49	24	420	0	0	0	0	124	0	81	832	124	165
1100	0	382	49	24	433	0	0	0	0	126	0	81	839	126	167
1200	0	469	48	22	450	0	0	0	0	118	0	73	941	118	155
1300	0	460	47	24	445	0	0	0	0	121	0	79	929	121	161
1400	0	493	48	25	526	0	0	0	0	126	0	83	1044	126	168
1500	0	613	58	30	554	0	0	0	0	149	0	100	1197	149	199
1600	0	584	52	28	917	0	0	0	0	140	0	92	1529	140	186
1700	0	492	46	23	457	0	0	0	0	118	0	77	972	118	157

Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume



*Note: 115 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor-street approach with one lane.

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Appendix N

Noise Quality Impact Report (Y. Ebisu & Associates, December 2009)

ACOUSTIC STUDY FOR THE PROPOSED VILLAGES OF AINA LE`A

SOUTH KOHALA, HAWAII

Prepared for:

DW AINA LE`A DEVELOPMENT, LLC

Prepared by:

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DECEMBER 2009

TABLE OF CONTENTS

CHAPTER	CHAPTER TITLE	PAGE NO.
	List of Figures	ii
	List of Tables	iii
I.	SUMMARY	1
II.	PURPOSE	3
III.	NOISE DESCRIPTORS AND THEIR RELATIONSHIP TO LAND USE COMPATIBILITY	4
IV.	GENERAL STUDY METHODOLOGY	10
V.	EXISTING NOISE ENVIRONMENT	15
VI.	FUTURE NOISE ENVIRONMENT	18
VII.	DISCUSSION OF PROJECT RELATED NOISE IMPACTS AND POSSIBLE NOISE MITIGATION MEASURES	23
	Traffic Noise	23
	Construction Noise	23
APPENDICES:		
A	REFERENCES	27
B	EXCERPTS FROM EPA'S ACOUSTIC TERMINOLOGY GUIDE	28
C	SUMMARY OF BASE YEAR AND FUTURE YEAR TRAFFIC VOLUMES	31

LIST OF FIGURES

NUMBER	FIGURE TITLE	PAGE NO.
1	PROJECT LOCATION MAP AND NOISE MEASUREMENT LOCATIONS	2
2	LAND USE COMPATIBILITY WITH YEARLY DAY-NIGHT AVERAGE SOUND LEVEL AT A SITE FOR BUILDINGS AS COMMONLY CONSTRUCTED	7
3	HOURLY VARIATIONS OF TRAFFIC NOISE AT 100 FT SETBACK DISTANCE FROM THE CENTERLINE OF QUEEN KAAHUMANU HIGHWAY AT 74 MILEPOST (STA. B71001907334, 10/10-11/06)	14
4	RECEPTOR LOCATIONS WHERE FUTURE TRAFFIC NOISE LEVELS WERE CALCULATED	22
5	ANTICIPATED RANGE OF CONSTRUCTION NOISE LEVELS VS. DISTANCE	24
6	AVAILABLE WORK HOURS UNDER DOH PERMIT PROCEDURES FOR CONSTRUCTION NOISE	26

LIST OF TABLES

NUMBER	TABLE TITLE	PAGE NO.
1	EXTERIOR NOISE EXPOSURE CLASSIFICATION (RESIDENTIAL LAND USE)	5
2	EFFECTS OF NOISE ON PEOPLE (RESIDENTIAL LAND USES ONLY)	6
3	TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS	11
4	SPOT TRAFFIC NOISE MEASUREMENT RESULTS	13
5	EXISTING (CY 2007) TRAFFIC VOLUMES AND NOISE LEVELS ALONG VARIOUS ROADWAY SECTIONS (AM OR PM PEAK HOUR)	16
6	YEAR 2007 AND 2020 DISTANCES TO 55 AND 65 DNL CONTOURS	17
7	FUTURE (CY 2020) TRAFFIC VOLUMES AND NOISE LEVELS ALONG VARIOUS ROADWAY SECTIONS (AM OR PM PEAK HOUR, WITH PROJECT)	19
8	CALCULATIONS OF PROJECT AND NON-PROJECT TRAFFIC NOISE CONTRIBUTIONS (CY 2020) (DNL)	20
9	PREDICTIONS OF FUTURE TRAFFIC NOISE LEVELS (DNL) AT VARIOUS LOCATIONS ON THE PROJECT SITE	21

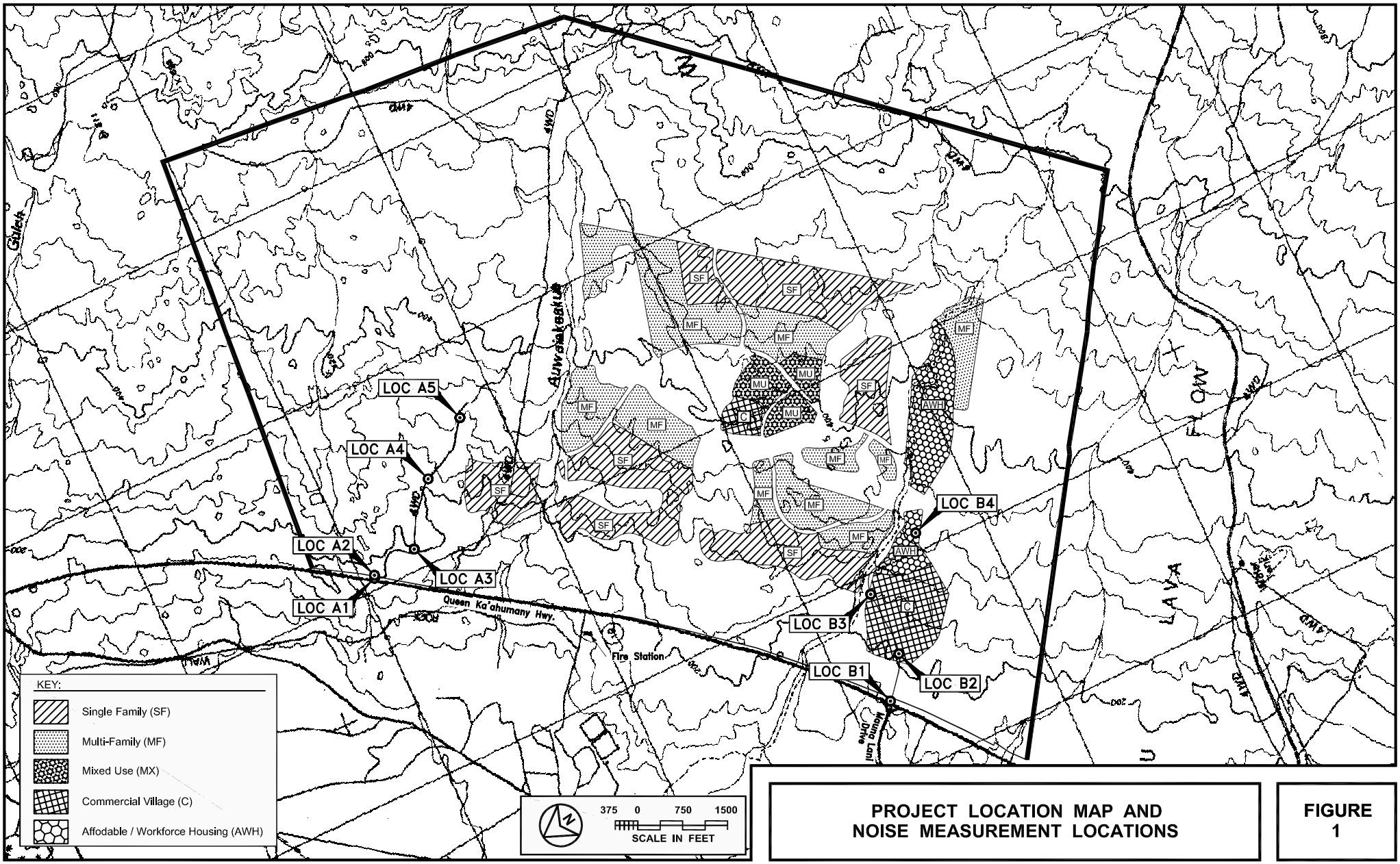
CHAPTER I. SUMMARY

The existing and future traffic noise levels in the vicinity of the proposed Villages of Aina Le`a Project in South Kohala, Hawaii were evaluated for their potential impact on present and future noise sensitive areas. Figure 1 depicts the location of the project site. The future traffic noise levels along the primary access roadways to the project were calculated for the year 2020.

Along the existing Queen Kaahumanu Highway, traffic noise levels are expected to increase by 4.1 to 4.3 DNL between CY 2007 and CY 2020 as a result of both project and non-project traffic. Traffic noise increases due to project traffic are predicted to range from 1.2 to 1.8 DNL which is below the range of the noise increases caused by non-project traffic (2.3 to 2.9 DNL) on Queen Kaahumanu Highway. These increases in traffic noise levels associated with project traffic range from the insignificant to the moderately significant. Fortunately, these increases in traffic noise levels are expected to occur along Queen Kaahumanu Highway, where the lands adjacent to and along the highway Rights-of-Way are generally undeveloped.

Project residents should not be impacted by traffic noise from Queen Kaahumanu Highway since adequate setback distances have been provided from the highway. Adequate setbacks from the two new access roads within the project boundaries or sound attenuating berms or walls should also be provided so as to minimize traffic noise impacts at planned residences within the Villages of Aina Le`a project.

Unavoidable, but temporary, noise impacts may occur during the construction of the proposed project. Because construction activities may be audible at the closest developed properties of the Fire Station, Mauna Lani Resort, and Waikoloa Village, the acoustic environment from construction of the project may be degraded during periods of construction. Mitigation measures to reduce construction noise to inaudible levels will not be practical in all cases. For this reason, the use of quiet equipment and construction curfew periods as required under the State Department of Health noise regulations are recommended to minimize construction noise impacts.



PROJECT LOCATION MAP AND NOISE MEASUREMENT LOCATIONS

FIGURE 1

CHAPTER II. PURPOSE

The objectives of this study were to describe the existing and future noise environment in the environs of the proposed Villages of Aina Le`a Project in South Kohala on the island of Hawaii. Traffic noise level increases and impacts associated with the proposed development were to be determined within the project site as well as along the public roadways expected to service the project traffic. A specific objective was to determine the future traffic noise level increases associated with both project and non-project traffic, and the potential noise impacts associated with these increases. Assessments of possible impacts from short term construction noise at the project site were also included in the noise study objectives. Recommendations for minimizing these noise impacts were also to be provided as required.

CHAPTER III. NOISE DESCRIPTORS AND THEIR RELATIONSHIP TO LAND USE COMPATIBILITY

The noise descriptor currently used by federal agencies to assess environmental noise is the Day-Night Average Sound Level (DNL or Ldn). This descriptor incorporates a 24-hour average of instantaneous A-Weighted sound levels as read on a standard Sound Level Meter. The maximum A-Weighted sound level occurring while a noise source such as a heavy truck or aircraft is moving past a listener (i.e., the maximum sound level from a "single event") is referred to as the "Lmax value". The mathematical product (or integral) of the instantaneous sound level times the duration of the event is known as the "Sound Exposure Level", or Lse, which is analogous to the energy of the time-varying sound levels associated with a single event.

The DNL values represent the average noise during a typical day of the year. DNL exposure levels of 55 or less are typical of quiet rural or suburban areas. DNL exposure levels of 55 to 65 are typical of urbanized areas with medium to high levels of activity and street traffic. DNL exposure levels above 65 are representative of densely developed urban areas and areas fronting high volume roadways.

By definition, the minimum averaging period for the DNL descriptor is 24 hours. Additionally, sound levels which occur during the nighttime hours of 10:00 PM to 7:00 AM are increased by 10 decibels (dB) prior to computing the 24-hour average by the DNL descriptor. Because of the averaging used, DNL values in urbanized areas typically range between 50 and 75 DNL. In comparison, the typical range of intermittent noise events may have maximum Sound Level Meter readings between 75 and 105 dBA. A more complete list of noise descriptors is provided in Appendix B to this report. In Appendix B, the Ldn descriptor symbol is used in place of the DNL descriptor symbol.

Table 1, extracted from Reference 1, categorizes the various DNL levels of outdoor noise exposure with severity classifications. Table 2, also extracted from Reference 1, presents the general effects of noise on people in residential use situations. Figure 2, extracted from Reference 2, presents suggested land use compatibility guidelines for residential and nonresidential land uses. A general consensus among federal agencies has developed whereby residential housing development is considered acceptable in areas where exterior noise does not exceed 65 DNL. This value of 65 DNL is used as a federal regulatory threshold for determining the necessity for special noise abatement measures when applications for federal funding assistance are made.

As a general rule, noise levels of 55 DNL or less occur in rural areas, or in areas which are removed from high volume roadways. In urbanized areas which are shielded from high volume streets, DNL levels generally range from 55 to 65 DNL, and are usually controlled by motor vehicle traffic noise. Residences which front major roadways are generally exposed to levels of 65 DNL, and as high as 75 DNL when the

TABLE 1

EXTERIOR NOISE EXPOSURE CLASSIFICATION (RESIDENTIAL LAND USE)

NOISE EXPOSURE CLASS	DAY–NIGHT SOUND LEVEL	EQUIVALENT SOUND LEVEL	FEDERAL (1) STANDARD
Minimal Exposure	Not Exceeding 55 DNL	Not Exceeding 55 Leq	Unconditionally Acceptable
Moderate Exposure	Above 55 DNL But Not Above 65 DNL	Above 55 Leq But Not Above 65 Leq	Acceptable(2)
Significant Exposure	Above 65 DNL But Not Above 75 DNL	Above 65 Leq But Not Above 75 Leq	Normally Unacceptable
Severe Exposure	Above 75 DNL	Above 75 Leq	Unacceptable

Notes: (1) Federal Housing Administration, Veterans Administration, Department of Defense, and Department of Transportation.

(2) FHWA uses the Leq instead of the Ldn descriptor. For planning purposes, both are equivalent if: (a) heavy trucks do not exceed 10 percent of total traffic flow in vehicles per 24 hours, and (b) traffic between 10:00 PM and 7:00 AM does not exceed 15 percent of average daily traffic flow in vehicles per 24 hours. The noise mitigation threshold used by FHWA for residences is 67 Leq.

TABLE 2

EFFECTS OF NOISE ON PEOPLE
(Residential Land Uses Only)

EFFECTS[1] / DAY-NIGHT AVERAGE SOUND LEVEL IN DECIBELS	Hearing Loss	Speech Interference		Annoyance[2]	Average Community Reaction[4]	General Community Attitude Towards Area
		Indoor	Outdoor			
	Qualitative Description	%Sentence Intelligibility	Distance in Meters for 95% Sentence Intelligibility	% of Population Highly Annoyed[3]		
75 and above	May Begin to Occur	98%	0.5	37%	Very Severe	Noise is likely to be the most important of all adverse aspects of the community environment.
70	Will Not Likely Occur	99%	0.9	25%	Severe	Noise is one of the most important adverse aspects of the community environment.
65	Will Not Occur	100%	1.5	15%	Significant	Noise is one of the important adverse aspects of the community environment.
60	Will Not Occur	100%	2.0	9%	Moderate to Slight	Noise may be considered an adverse aspect of the community environment.
55 and below	Will Not Occur	100%	3.5	4%		Noise considered no more important than various other environmental factors.

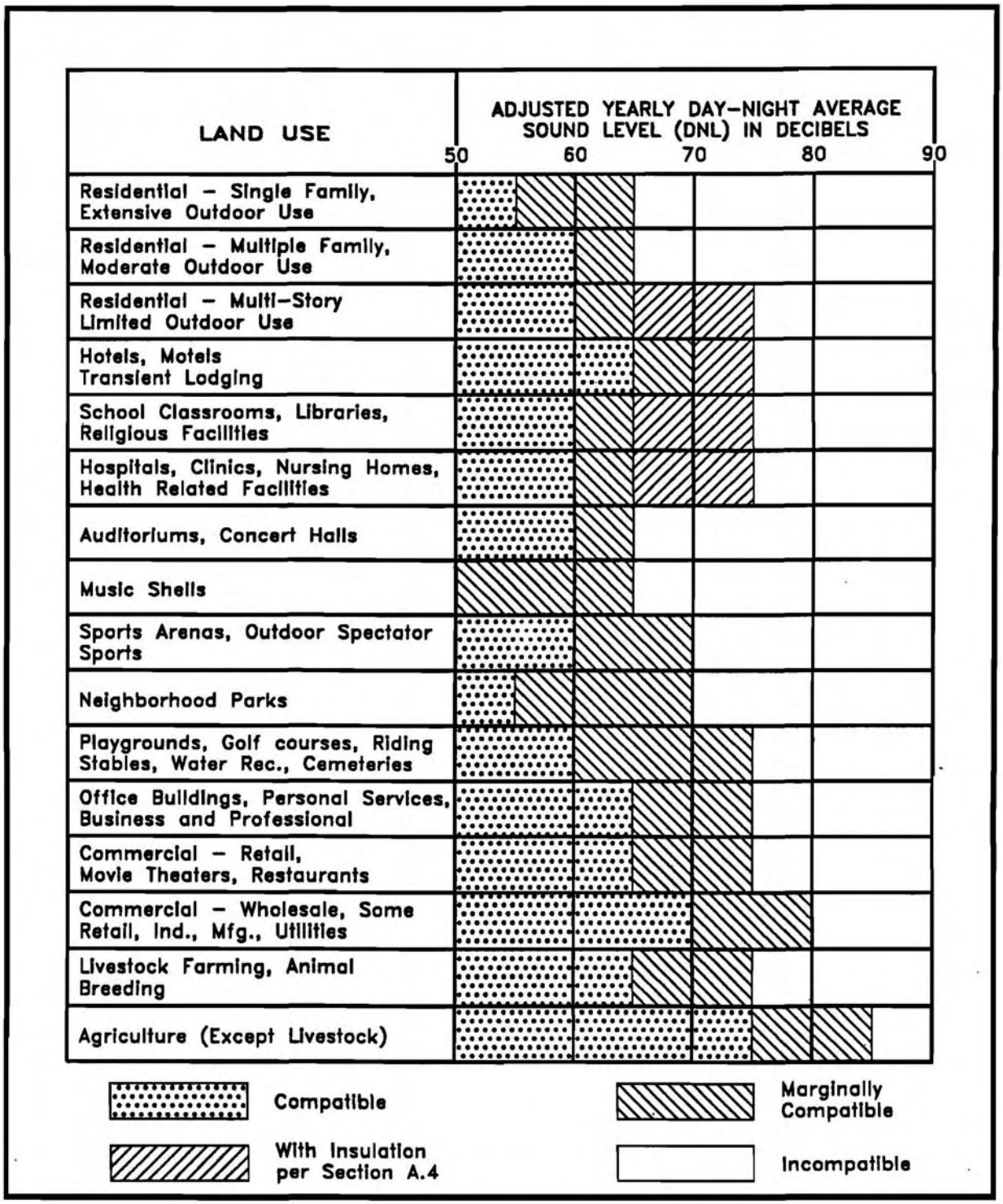
1. "Speech Interference" data are drawn from the following tables in EPA's "Levels Document": Table 3, Fig. D-1, Fig. D-2, Fig. D-3. All other data from National Academy of Science 1977 report "Guidelines for Preparing Environmental Impact Statements on Noise, Report of Working Group 69 on Evaluation of Environmental Impact of Noise."

2. Depends on attitudes and other factors.

3. The percentages of people reporting annoyance to lesser extents are higher in each case. An unknown small percentage of people will report being "highly annoyed" even in the quietest surroundings. One reason is the difficulty all people have in integrating annoyance over a very long time.

4. Attitudes or other non-acoustic factors can modify this. Noise at low levels can still be an important problem, particularly when it intrudes into a quiet environment.

NOTE: Research implicates noise as a factor producing stress-related health effects such as heart disease, high-blood pressure and stroke, ulcers and other digestive disorders. The relationships between noise and these effects, however, have not as yet been quantified.



LAND USE COMPATIBILITY WITH YEARLY AVERAGE DAY-NIGHT AVERAGE SOUND LEVEL (DNL) AT A SITE FOR BUILDINGS AS COMMONLY CONSTRUCTED.
(Source: American National Standards Institute S12.9-1998/Part 5)

FIGURE 2

roadway is a high speed freeway. Due to noise shielding effects from intervening structures, interior lots are usually exposed to 3 to 10 DNL lower noise levels than the front lots which are not shielded from the traffic noise.

For the purposes of determining noise acceptability for funding assistance from federal agencies, an exterior noise level of 65 DNL or lower is considered acceptable. These federal agencies include the Federal Aviation Administration (FAA), Department of Defense (DOD); Federal Housing Administration, Housing and Urban Development (FHA/HUD), and Veterans Administration (VA). This standard is applied nationally (see Reference 3), including Hawaii.

Because of our open-living conditions, the predominant use of naturally ventilated dwellings, and the relatively low exterior-to-interior sound attenuation afforded by these naturally ventilated structures, an exterior noise level of 65 DNL does not eliminate all risks of noise impacts. Because of these factors, a lower level of 55 DNL is considered as the "Unconditionally Acceptable" (or "Near-Zero Risk") level of exterior noise (see Reference 4). For typical, naturally ventilated structures in Hawaii, an exterior noise level of 55 DNL results in an interior level of approximately 45 DNL, which is considered to be the "Unconditionally Acceptable" (or "Near-Zero Risk") level of interior noise. However, after considering the cost and feasibility of applying the lower level of 55 DNL, government agencies such as FHA/HUD and VA have selected 65 DNL as a more appropriate regulatory standard.

For commercial, industrial, and other non-noise sensitive land uses, exterior noise levels as high as 75 DNL are generally considered acceptable. Exceptions to this occur when naturally ventilated office and other commercial establishments are exposed to exterior levels which exceed 65 DNL.

In the State of Hawaii, the State Department of Health (DOH) regulates noise from on-site activities. State DOH noise regulations are expressed in maximum allowable property line noise limits rather than DNL (see Reference 5). The noise limits apply on all islands of the State, including Hawaii. Although they are not directly comparable to noise criteria expressed in DNL, State DOH noise limits for preservation/residential, apartment/commercial, and agricultural/industrial lands equate to approximately 55, 60, and 76 DNL, respectively.

Because the proposed project site is located on lands designated for single family and multifamily residential, and commercial uses, various DOH noise limits would be applicable along the lot boundary lines or receptor locations for any stationary machinery, or equipment related to commercial or construction activities. These property line limits are 60 dBA and 50 dBA during the daytime and nighttime periods, respectively, for commercial lots or receptors. For multifamily or apartment use, the State DOH limits are also 60 dBA and 50 dBA during the daytime and nighttime periods, respectively. For single family residential and public facility uses, the State DOH limits are 55 dBA and 45 dBA during the daytime and nighttime periods, respectively. These

noise limits cannot be exceeded for more than 2 minutes in any 20-minute time period under the State DOH noise regulations. The State DOH noise regulations do not apply to aircraft or motor vehicles.

CHAPTER IV. GENERAL STUDY METHODOLOGY

Existing traffic and background ambient noise levels were measured at nine locations in the project environs to provide a basis for developing the traffic noise contours along Queen Kaahumanu Highway; and for determining the existing background ambient noise levels in the project area. The locations of the measurement sites are shown in Figure 1. Noise measurements were performed during March and August 2009. The traffic noise measurement results, and their comparisons with computer model predictions of existing traffic noise levels are summarized in Tables 3 and 4. The results of the traffic noise measurements were compared with calculations of existing traffic noise levels to validate the computer model used.

Traffic noise calculations for the existing conditions as well as noise predictions for the future conditions with and without the project were performed using the Federal Highway Administration (FHWA) Noise Prediction Model (Reference 6). Traffic data entered into the noise prediction model were: hourly traffic volumes, average vehicle speeds, estimates of traffic mix, and loose soil propagation loss factor. The traffic assignments for the project (Reference 7) and Hawaii State Department of Transportation counts on Queen Kaahumanu Highway (Reference 8) were the primary sources of data inputs to the model. For existing and future traffic, it was assumed that the average noise levels, or Leq(h), during the AM or PM peak hours were 1.0 dB less than the 24-hour DNL along any roadway segment in the project environs. This assumption was based on computations of both the hourly Leq and the 24-hour DNL of traffic noise on Queen Kaahumanu Highway (see Figure 3).

Traffic noise calculations for both the existing and future conditions in the project environs were developed for ground level receptors without the benefit of shielding effects. Traffic assignments with and without the project were obtained from the project's traffic turning movements (Reference 7). The forecasted increases in traffic noise levels over existing levels were calculated for both scenarios, and noise impact risks evaluated. The relative contributions of non-project and project related traffic to the total noise levels were also calculated, and an evaluation was made of possible traffic noise impacts resulting from the project.

TABLE 3
TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS

	LOCATION	Time of Day (HRS)	Ave. Speed (MPH)	Hourly Traffic Volume AUTO	M.TRUCK	H.TRUCK	Measured Leq (dB)	Predicted Leq (dB)
A1	50 FT from centerline of Q. Kaahumanu Hwy. (3/9/09)	0952 TO 1052	64	603	20	46	71.3	71.7
A2	100 FT from centerline of Q. Kaahumanu Hwy. (3/9/09)	0952 TO 1052	64	603	20	46	66.1	66.1
A1	50 FT from centerline of Q. Kaahumanu Hwy. (8/10/09)	0645 TO 0745	65	600	8	32	70.8	70.9
B1	50 FT from centerline of Q. Kaahumanu Hwy. (8/10/09)	1003 TO 1139	65	592	18	34	71.2	71.4
A1	50 FT from centerline of Q. Kaahumanu Hwy. (8/10/09)	1203 TO 1303	61	671	17	25	70.4	70.4
A1	50 FT from centerline of Q. Kaahumanu Hwy. (8/10/09)	1603 TO 1703	60	838	6	9	70.1	70.3

TABLE 3 (CONTINUED)
TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS

	LOCATION	Time of Day (HRS)	Ave. Speed (MPH)	Hourly Traffic Volume AUTO	M.TRUCK	H.TRUCK	Measured Leq (dB)	Predicted Leq (dB)
B1	50 FT from centerline of Q. Kaahumanu Hwy. (8/10/09)	1603 TO 1703	63	838	6	9	71.2	71.1
A1	50 FT from centerline of Q. Kaahumanu Hwy. (8/11/09)	0638 TO 0738	65	637	9	27	70.5	70.8
B1	50 FT from centerline of Q. Kaahumanu Hwy. (8/11/09)	0638 TO 0738	65	637	9	27	71.0	71.0

TABLE 4

SPOT TRAFFIC NOISE MEASUREMENT RESULTS

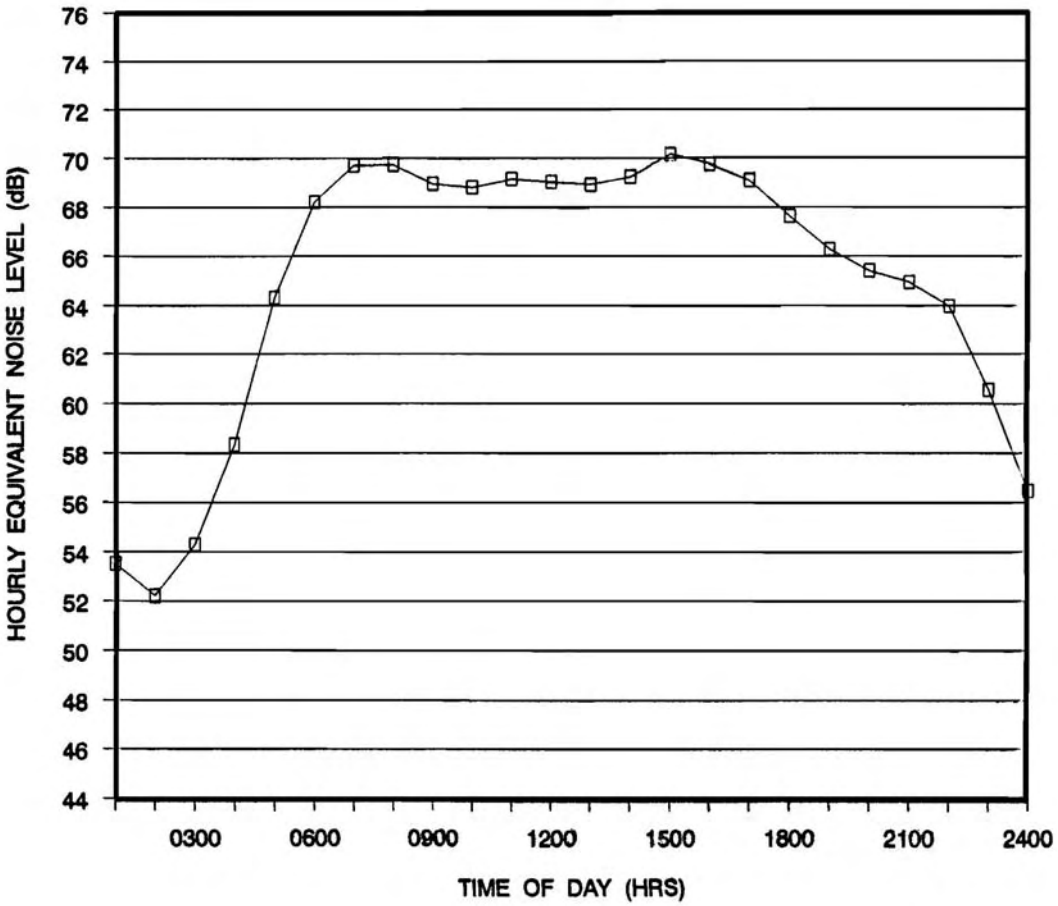
LOCATION	Time of Day (HRS)	Measured at "B1" or "A1" Leq (dB) (b	Measured at Loc. Leq (dB) (a)	Meas. Difference Leq (dB) (c) = (b)-(a	Predicted at Loc. Leq (dB)
B1. 50 FT from the center-line of Queen Kaahuma Highway (8/10/09)	1030 TO 1040	71.9	"B2" 45.1	26.8	"B2" 47.1
B1. 50 FT from the center-line of Queen Kaahuma Highway (8/10/09)	1105 TO 1115	70.1	"B3" 50.6	19.5	"B3" 43.4
B1. 50 FT from the center-line of Queen Kaahuma Highway (8/10/09)	1130 TO 1139	71.0	"B4" 44.3	26.7	"B4" 41.6
A1. 50 FT from the center-line of Queen Kaahuma Highway (8/10/09)	1230 TO 1240	70.8	"A3" 46.4	24.4	"A3" 47.1
A1. 50 FT from the center-line of Queen Kaahuma Highway (8/10/09)	1245 TO 1250	69.3	"A4" 45.3	24.0	"A4" 42.3
A1. 50 FT from the center-line of Queen Kaahuma Highway (8/10/09)	1255 TO 1305	71.4	"A5" 45.3	26.1	"A5" 41.7

Notes:

1. Measured differences are between interior locations and locations at 50 feet distance from the centerline of Queen Kaahumanu Highway.
2. See Figure 1 for noise measurement locations.
3. Predicted sound levels at interior locations based on FHWA Traffic Noise Model, Version 2.5

FIGURE 3

HOURLY VARIATIONS OF TRAFFIC NOISE AT 100 FT SETBACK DISTANCE FROM THE CENTERLINE OF QUEEN KA'AHUMANU HIGHWAY AT 74 MILEPOST (STA. B71001907334; OCTOBER 10–11, 2006)



□ 100 FT from Roadway Centerline (71.3 DNL)

CHAPTER V. EXISTING NOISE ENVIRONMENT

The existing traffic noise levels in the project environs vary from levels of approximately 74 DNL along the makai (west) property boundary, to less than 45 DNL at the mauka (east) property boundary and interior locations of the project site. Traffic noise levels along Queen Kaahumanu Highway are less than 65 DNL at 152 FT or greater setback distances from the highway centerline under unobstructed visual line-of-sight conditions. At the east boundary of the project which is currently undeveloped, existing background ambient noise levels are very low and less than 45 DNL.

Calculations of existing traffic noise levels during the AM or PM peak traffic hour are presented in Table 5. The hourly Leq (or Equivalent Sound Level) contribution from each roadway section in the project environs was calculated for comparison with forecasted traffic noise levels with and without the project. The existing setback distances from the roadways' centerlines to their associated 55 and 65 DNL contours were also calculated as shown in Table 6. The contour line setback distances do not take into account noise shielding effects or the additive contributions of traffic noise from intersecting street sections. Based on the results of Table 6, it was concluded that the existing 65 DNL traffic noise contour is located approximately 152 FT from the centerline of Queen Kaahumanu Highway north of Mauna Lani Drive, and approximately 167 FT from the centerline of Queen Kaahumanu Highway south of Mauna Lani Drive.

Existing traffic noise levels at the interior portions of the project site are low (between 45 and 50 DNL) due to their large setback distances from Queen Kaahumanu Highway. At these interior locations on the project site, distant traffic, aircraft noise, and the natural sounds of birds and winds in foliage are the dominant noise sources. Between traffic, aircraft, or wind noise events, background ambient noise levels drop to a range of 25 to 35 dB. During calm wind periods, background ambient noise levels decrease to levels less than 30 dB at the interior locations removed from Queen Kaahumanu Highway. The minimum background ambient noise levels at these interior locations are controlled by distant traffic and wind noise.

TABLE 5

EXISTING (CY 2007) TRAFFIC VOLUMES AND NOISE LEVELS ALONG VARIOUS ROADWAY SECTIONS (AM OR PM PEAK HOUR)

LOCATION	SPEED (MPH)	TOTAL VPH	********* VOLUMES (VPH) ********** AUTOS	M TRUCKS	H TRUCKS	50' Leq	100' Leq	200' Leq
Q. Kaahumanu Hwy. - N. of Access Rd. #2	65	1,114	1,036	22	56	73.7	67.7	61.6
Q. Kaahumanu Hwy. - N. of Access Rd. #1	65	1,114	1,036	22	56	73.7	67.7	61.6
Q. Kaahumanu Hwy. - S. of Access Rd. #1	65	1,331	1,237	27	67	74.5	68.5	62.4
Aina Le`a Access Road #1 (South)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aina Le`a Access Road #2 (North)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

TABLE 6

YEAR 2007 AND 2020 DISTANCES TO 55 AND 65 DNL CONTOURS

STREET SECTION	55 DNL SETBACK (FT)		65 DNL SETBACK (FT)	
	CY 2007	CY 2020	CY 2007	CY 2020
Q. Kaahumanu Hwy. - N. of Access Rd. #2	474	756	152	243
Q. Kaahumanu Hwy. - N. of Access Rd. #1	474	748	152	245
Q. Kaahumanu Hwy. - S. of Access Rd. #1	519	828	167	266
Aina Le`a Access Road #1 (South)	N/A	440	N/A	133
Aina Le`a Access Road #2 (North)	N/A	263	N/A	79

Notes:

(1) All setback distances are from the roadways' centerlines.
(2) See TABLES 5 and 7 for traffic volume, speed, and mix assumptions.
(3) Setback distances are for unobstructed line-of-sight conditions.

CHAPTER VI. FUTURE NOISE ENVIRONMENT

Predictions of future traffic noise levels were made using the traffic volume assignments of Reference 7 for CY 2020 with and without the proposed project. The future assignments of project plus non-project traffic on the roadway sections which would service the project are shown in Table 7 for the AM or PM peak hour of traffic. As indicated in Table 8, by CY 2020 and following complete project build-out, traffic noise levels on Queen Kaahumanu Highway in the areas fronting the project are predicted to increase by 4.1 to 4.3 DNL. The traffic noise increases due to project traffic range from 1.2 to 1.8 DNL. These increases in traffic noise levels are considered to be low to moderate, and reflect the growth in forecasted project and non-project traffic in the project environs by CY 2020.

Table 6 summarizes the predicted increases in the future setback distances to the 55 and 65 DNL traffic noise contour lines along the roadways in the project environs and attributable to both project plus non-project traffic in CY 2020. The setback distances in Table 6 do not include the beneficial effects of noise shielding from terrain features and highway cuts, or the detrimental effects of additive contributions of noise from intersecting streets. As indicated in Table 6, the setback distances to the 65 DNL contour are predicted to range from 243 to 266 FT from the centerline of Queen Kaahumanu Highway following project build-out in CY 2020. The setback distances to the 55 DNL contour are predicted to range from 748 to 828 FT from the centerline of Queen Kaahumanu Highway following project build-out in CY 2020. Along the two new access roads through the project site, the setback distances to the 65 DNL contour are predicted to range from 79 to 133 FT from their centerlines, and the setback distances to the 55 DNL contour are predicted to range from 263 to 440 FT from their centerlines

Table 9 presents the predicted traffic noise levels resulting from both non-project and project traffic on Queen Kaahumanu Highway and the two access roads by CY 2020 at various locations on the project site, and as measured by the DNL descriptor system. The applicable locations on the project site are shown in Figure 4. As indicated in Table 9, future traffic noise levels at planned noise sensitive locations on the project site from Queen Kaahumanu Highway and the two access roads should remain below 60 DNL due to the very large buffer distances provided between the highway and the closest residences.

Because of the very large buffer distances provided between Queen Kaahumanu Highway and the planned noise sensitive locations of the project, the dominant traffic noise sources at some locations within the developed areas of the project site could be the two planned access roads. The use of large setback distances (140 FT and 80 FT from the south and north access roads, respectively), are recommended for noise sensitive properties located along these two roads. In addition, the use of berms or sound attenuating walls between the access roads and the noise sensitive properties are also recommended to achieve the lower traffic noise level of 55 DNL.

TABLE 7

FUTURE (CY 2020) TRAFFIC VOLUMES AND NOISE LEVELS ALONG VARIOUS ROADWAY SECTIONS (AM OR PM PEAK HOUR, WITH PROJECT)

LOCATION	SPEED (MPH)	TOTAL VPH	********* VOLUMES (VPH) ********** AUTOS	M TRUCKS	H TRUCKS	50' Leq	100' Leq	200' Leq
Q. Kaahumanu Hwy. - N. of Access Rd. #2	65	2,872	2,671	57	144	77.8	71.8	65.7
Q. Kaahumanu Hwy. - N. of Access Rd. #1	65	2,973	2,765	59	149	77.9	72.0	65.8
Q. Kaahumanu Hwy. - S. of Access Rd. #1	65	3,436	3,195	69	172	78.6	72.6	66.5
Aina Le`a Access Road #1 (South)	45	2,504	2,354	75	75	72.1	66.4	60.6
Aina Le`a Access Road #2 (North)	45	931	875	28	28	67.8	62.1	56.3

TABLE 8

CALCULATIONS OF PROJECT AND NON-PROJECT TRAFFIC NOISE CONTRIBUTIONS (CY 2020) (DNL)

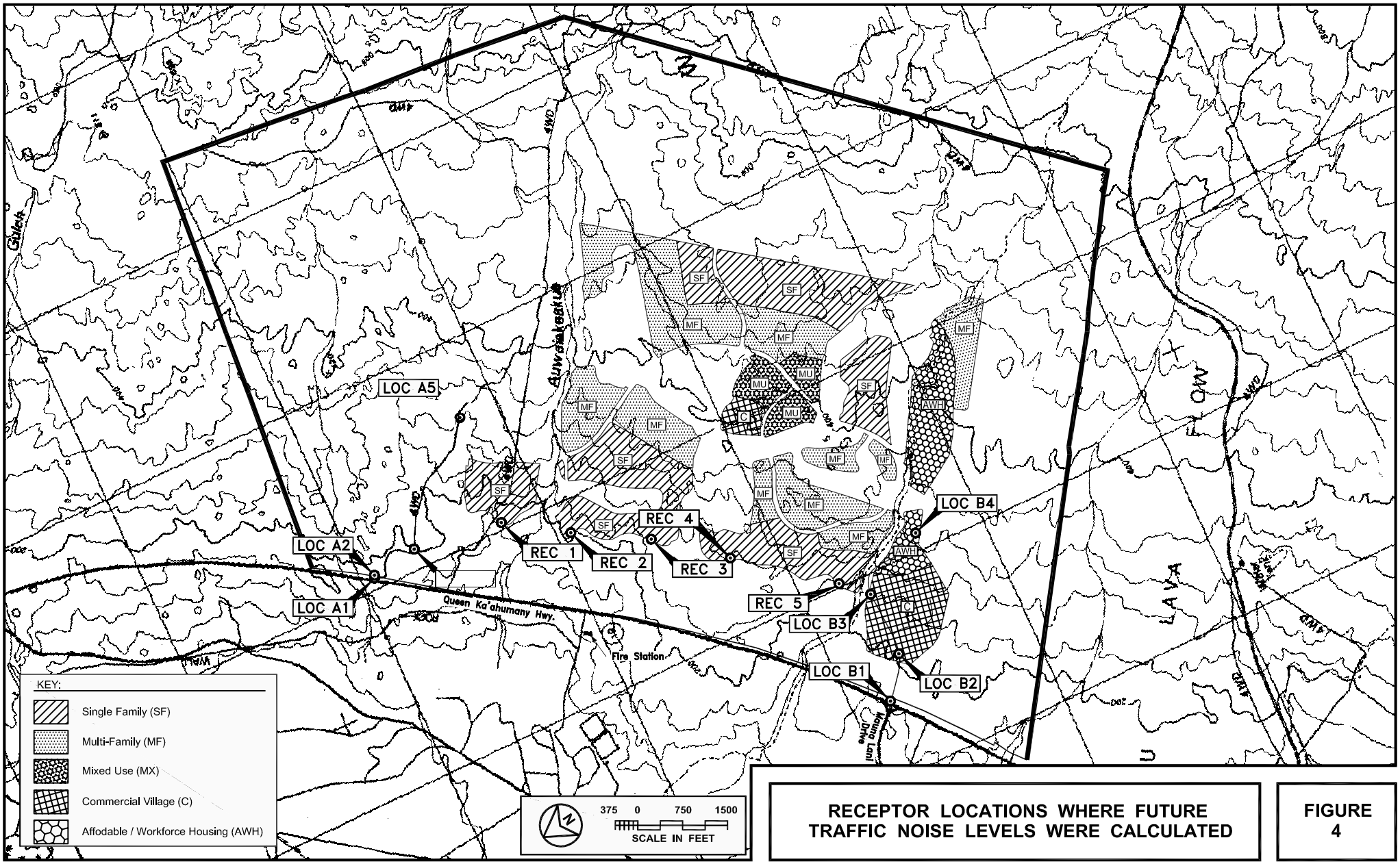
STREET SECTION	NOISE LEVEL (DB) INCREASE DUE TO: NON-PROJECT TRAFFIC	PROJECT TRAFFIC
Q. Kaahumanu Hwy. - N. of Access Rd. #	2.9	1.2
Q. Kaahumanu Hwy. - N. of Access Rd. #	2.9	1.4
Q. Kaahumanu Hwy. - S. of Access Rd. #	2.3	1.8
Aina Le`a Access Road #1 (South)	N/A	21.4
Aina Le`a Access Road #2 (North)	N/A	17.1

Note:

1. Traffic noise level increases along Aina Le`a Access Roads measured at 100 ft. from centerlines.
2. Traffic noise level increases along Aina Le`a Access Roads result from Aina Le`a project.

TABLE 9
PREDICTIONS OF FUTURE TRAFFIC NOISE LEVELS (DNL) AT VARIOUS LOCATIONS ON THE PROJECT SITI

Location	From Q. Kaahumanu Highway	From Access Road #2	From Access Road #1	From All Roads
A1	78	43	N/A	78
A2	73	42	N/A	73
A3	57	48	N/A	57
A4	52	53	N/A	55
A5	49	57	N/A	57
B1	79	N/A	65	79
B2	54	N/A	54	57
B3	52	N/A	41	52
B4	50	N/A	55	56
REC 1	55	53	N/A	57
REC 2	56	44	N/A	56
REC 3	53	N/A	N/A	53
REC 4	52	N/A	N/A	52
REC 5	52	N/A	37	52



RECEPTOR LOCATIONS WHERE FUTURE TRAFFIC NOISE LEVELS WERE CALCULATED

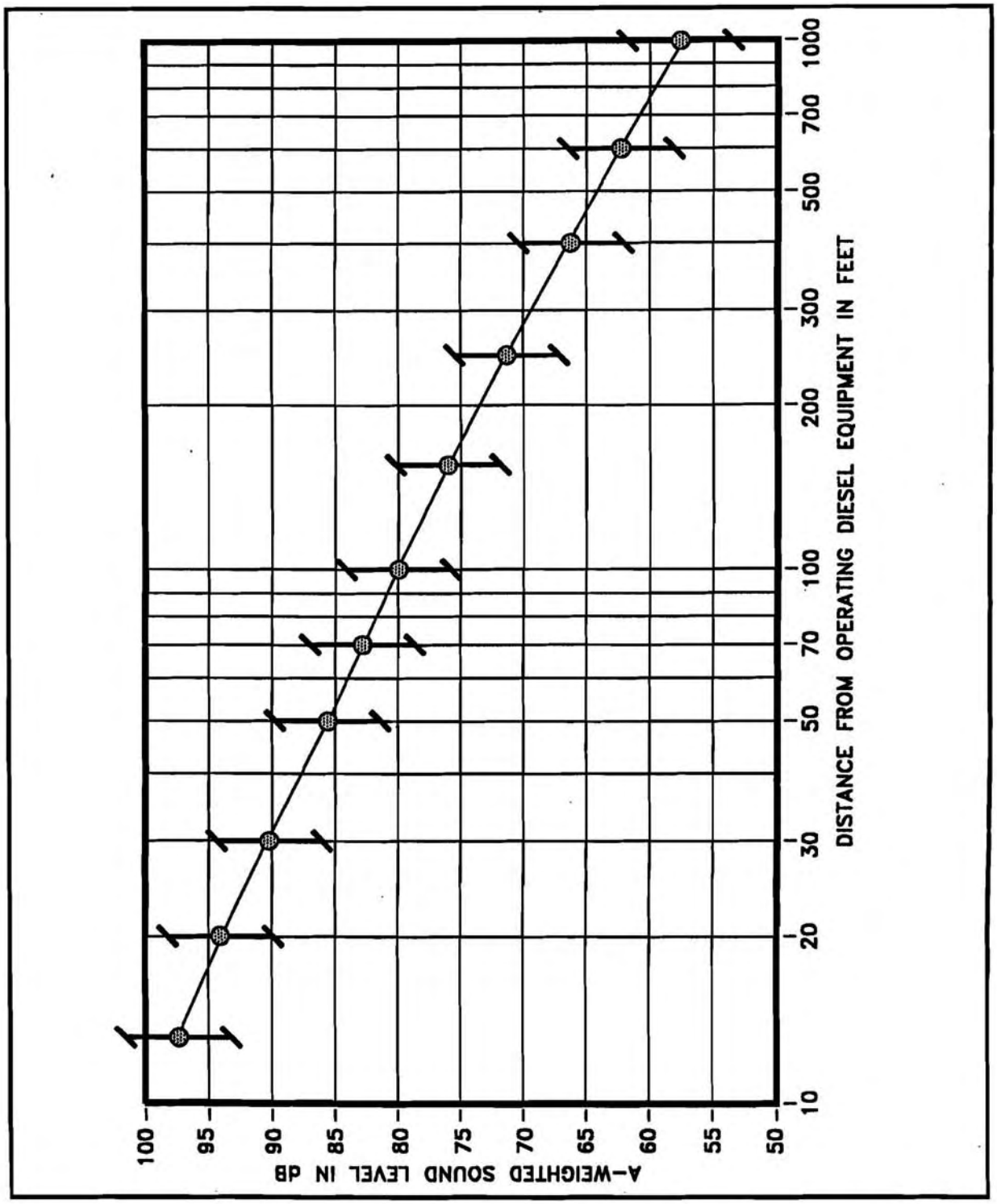
FIGURE 4

CHAPTER VII. DISCUSSION OF PROJECT RELATED NOISE IMPACTS AND POSSIBLE NOISE MITIGATION MEASURES

Traffic Noise. The increases in traffic noise levels attributable to the project from the present to CY 2020 are predicted to range from 1.2 to 1.8 DNL along Queen Kaahumanu Highway, where traffic noise levels are expected to continue to be above 65 DNL along the highway Right-of-Way. These increases in traffic noise levels along Queen Kaahumanu Highway which are attributable to the project are considered to be in the low to moderate category, and are lower than the traffic noise increases expected as a result of non-project traffic. In addition, the lands along the highway Rights-of-Way are generally vacant in the project environs. For these reasons, traffic noise impacts along Queen Kaahumanu Highway and resulting from project traffic are not considered to be serious. However, setback distances to the 65 DNL contour are expected to increase as a result of both project and non-project traffic.

An existing Fire Station is located on the west (makai) side of Queen Kaahumanu Highway in the project area. Existing traffic noise levels are less than 65 DNL at the Fire Station, and CY 2020 traffic noise levels are predicted to remain below 65 DNL with or without the Villages of Aina Le`a project. Normally, traffic noise mitigation measures at existing developments are undertaken by individual property owners along the roadways' Rights-of-Way or by public agencies during roadway improvement projects. These mitigation measures generally take the form of increased setbacks, sound attenuating walls, total closure and air conditioning, or the use of sound attenuating windows. Where adequate setbacks beyond the 65 DNL noise contour are not available, the construction of 6 FT high sound walls is generally effective for attenuating traffic noise at single story structures, or at the ground floors of multistory structures. Whenever mitigation of traffic noise at the upper floors are required, the use of closure and air conditioning, or the use of sound attenuating windows are the more appropriate sound attenuation measures. Along Queen Kaahumanu Highway in the immediate vicinity of the Villages of Aina Le`a project, the noise sensitive developments are generally located at more than adequate setback distances from the highway, so risks of adverse traffic noise impacts have been minimized.

Construction Noise. Audible construction noise will probably be unavoidable during the entire project construction period. The total time period for construction is unknown, but it is anticipated that the actual work will be moving from one location on the project site to another during that period. Actual length of exposure to construction noise at any receptor location will probably be less than the total construction period for the entire project. Typical levels of noise from construction activity (excluding pile driving activity) are shown in Figure 5. The existing Fire Station on the west side of Queen Kaahumanu Highway will experience the highest noise levels during

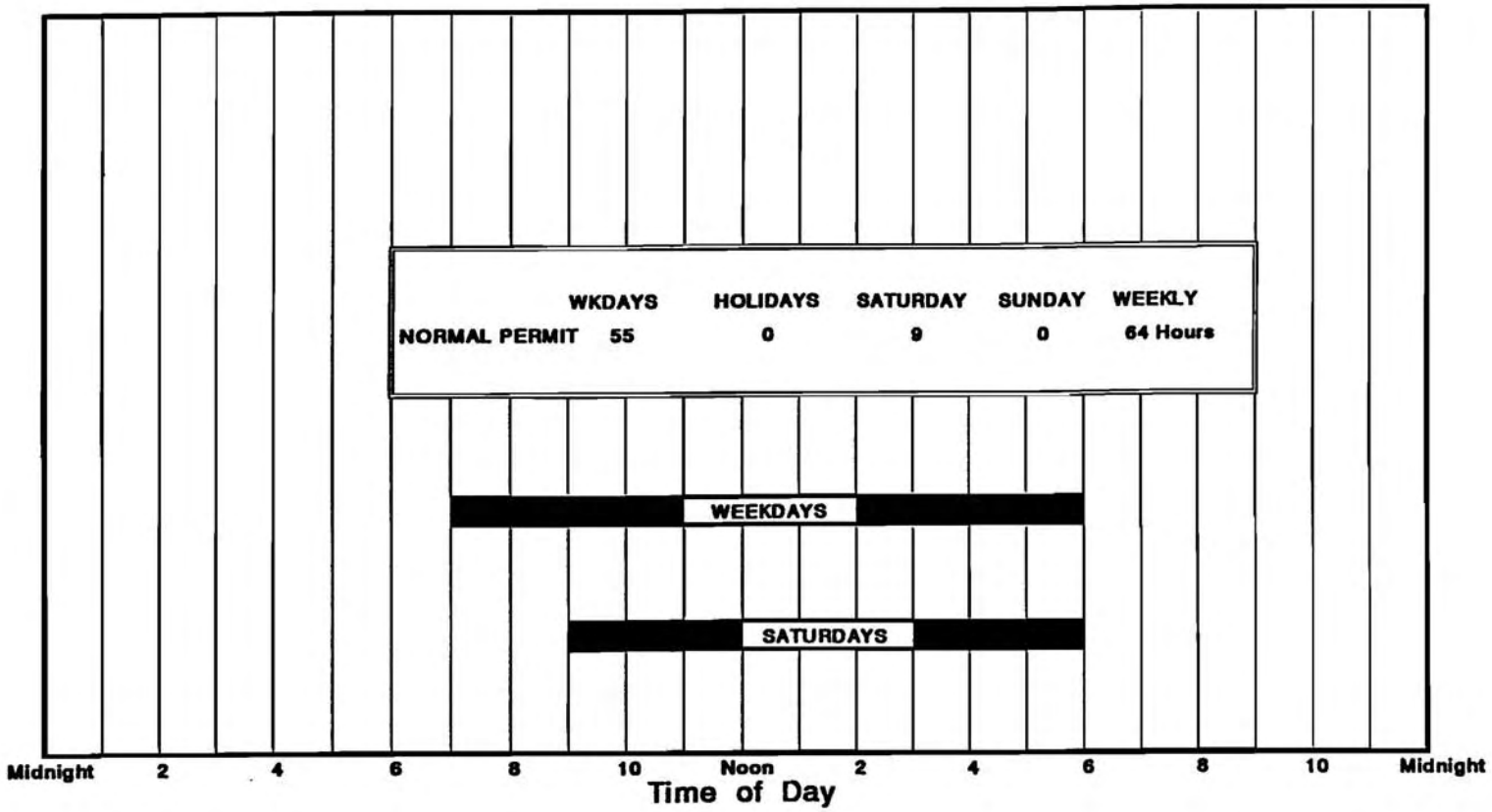


ANTICIPATED RANGE OF CONSTRUCTION NOISE LEVELS VS. DISTANCE

FIGURE 5

construction activities on the project site. However, construction noise levels from the project site should not exceed existing traffic noise levels of approximately 60 dBA from Queen Kaahumanu Highway at the existing Fire Station. The other noise sensitive developments of Waikoloa Village and Mauna Lani Resort are at least a mile from the project site. Adverse impacts from construction noise are not expected to be in the "public health and welfare" category due to the temporary nature of the work and due to the administrative controls available for its regulation. Instead, these impacts will probably be limited to the temporary degradation of the quality of the acoustic environment in the immediate vicinity of the project site.

Elimination of construction noise to inaudible levels will not be practical in all cases due to the intensity of construction noise sources (80 to 90+ dB at 50 FT distance), and due to the exterior nature of the work (grading and earth moving, trenching, concrete pouring, hammering, etc.). The use of properly muffled construction equipment should be required on the job site. The incorporation of State Department of Health construction noise limits and curfew times, which are applicable on the island of Hawaii (Reference 5), is another noise mitigation measure which can be applied to this project. Figure 6 depicts the normally permitted hours of construction for normal construction noise as well as the curfew periods for construction noise. Noisy construction activities are not allowed on Sundays and holidays under the DOH permit procedures.



AVAILABLE WORK HOURS UNDER DOH PERMIT PROCEDURES FOR CONSTRUCTION NOISE

FIGURE 6

APPENDIX A. REFERENCES

(1) "Guidelines for Considering Noise in Land Use Planning and Control;" Federal Interagency Committee on Urban Noise; June 1980.

(2) American National Standard, "Sound Level Descriptors for Determination of Compatible Land Use," ANSI S12.9-1998/ Part 5; Acoustical Society of America.

(3) "Environmental Criteria and Standards, Noise Abatement and Control, 24 CFR, Part 51, Subpart B;" U.S. Department of Housing and Urban Development; July 12, 1979.

(4) "Information on Levels of Environmental Noise Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety;" U.S. Environmental Protection Agency; EPA 550/9-74- 004; March 1974.

(5) "Title 11, Administrative Rules, Chapter 46, Community Noise Control;" Hawaii State Department of Health; September 23, 1996.

(6) "FHWA Highway Traffic Noise Model User's Guide;" FHWA-PD-96-009, Federal Highway Administration; Washington, D.C.; January 1998 and Version 2.5 Upgrade (April 14, 2004).

(7) "Traffic Impact Analysis Report for The Villages of Aina Le`a;" SSFM International; September 2009.

(8) 24-Hour Traffic Counts, Station B71001907334, Queen Kaahumanu Highway at 74 Milepost; State Department of Transportation; October 10-11, 2006.

APPENDIX B

EXCERPTS FROM EPA'S ACOUSTIC TERMINOLOGY GUIDE

Descriptor Symbol Usage

The recommended symbols for the commonly used acoustic descriptors based on A-weighting are contained in Table I. As most acoustic criteria and standards used by EPA are derived from the A-weighted sound level, almost all descriptor symbol usage guidance is contained in Table I.

Since acoustic nomenclature includes weighting networks other than "A" and measurements other than pressure, an expansion of Table I was developed (Table II). The group adopted the ANSI descriptor-symbol scheme which is structured into three stages. The first stage indicates that the descriptor is a level (i.e., based upon the logarithm of a ratio), the second stage indicates the type of quantity (power, pressure, or sound exposure), and the third stage indicates the weighting network (A, B, C, D, E.....). If no weighting network is specified, "A" weighting is understood. Exceptions are the A-weighted sound level and the A-weighted peak sound level which require that the "A" be specified. For convenience in those situations in which an A-weighted descriptor is being compared to that of another weighting, the alternative column in Table II permits the inclusion of the "A". For example, a report on blast noise might wish to contrast the LCdn with the LAdn.

Although not included in the tables, it is also recommended that "Lpn" and "LepN" be used as symbols for perceived noise levels and effective perceived noise levels, respectively.

It is recommended that in their initial use within a report, such terms be written in full, rather than abbreviated. An example of preferred usage is as follows:

The A-weighted sound level (LA) was measured before and after the installation of acoustical treatment. The measured LA values were 85 and 75 dB respectively.

Descriptor Nomenclature

With regard to energy averaging over time, the term "average" should be discouraged in favor of the term "equivalent". Hence, Leq, is designated the "equivalent sound level". For Ld, Ln, and Ldn, "equivalent" need not be stated since the concept of day, night, or day-night averaging is by definition understood. Therefore, the designations are "day sound level", "night sound level", and "day-night sound level", respectively.

The peak sound level is the logarithmic ratio of peak sound pressure to a reference pressure and not the maximum root mean square pressure. While the latter is the maximum sound pressure level, it is often incorrectly labelled peak. In that sound level meters have "peak" settings, this distinction is most important.

"Background ambient" should be used in lieu of "background", "ambient", "residual", or "indigenous" to describe the level characteristics of the general background noise due to the contribution of many unidentifiable noise sources near and far.

With regard to units, it is recommended that the unit decibel (abbreviated dB) be used without modification. Hence, DBA, PNdB, and EPNdB are not to be used. Examples of this preferred usage are: the Perceived Noise Level (Lpn was found to be 75 dB. Lpn = 75 dB). This decision was based upon the recommendation of the National Bureau of Standards, and the policies of ANSI and the Acoustical Society of America, all of which disallow any modification of bel except for prefixes indicating its multiples or submultiples (e.g., deci).

Noise Impact

In discussing noise impact, it is recommended that "Level Weighted Population" (LWP) replace "Equivalent Noise Impact" (ENI). The term "Relative Change of Impact" (RCI) shall be used for comparing the relative differences in LWP between two alternatives.

Further, when appropriate, "Noise Impact Index" (NII) and "Population Weighed Loss of Hearing" (PHL) shall be used consistent with CHABA Working Group 69 Report Guidelines for Preparing Environmental Impact Statements (1977).

APPENDIX B (CONTINUED)

TABLE I

A-WEIGHTED RECOMMENDED DESCRIPTOR LIST

TERM	SYMBOL
1. A-Weighted Sound Level	L_A
2. A-Weighted Sound Power Level	L_{WA}
3. Maximum A-Weighted Sound Level	L_{max}
4. Peak A-Weighted Sound Level	L_{Apk}
5. Level Exceeded x% of the Time	L_x
6. Equivalent Sound Level	L_{eq}
7. Equivalent Sound Level over Time (T) (1)	$L_{eq(T)}$
8. Day Sound Level	L_d
9. Night Sound Level	L_n
10. Day-Night Sound Level	L_{dn}
11. Yearly Day-Night Sound Level	$L_{dn(Y)}$
12. Sound Exposure Level	L_{SE}

(1) Unless otherwise specified, time is in hours (e.g. the hourly equivalent level is $L_{eq(1)}$). Time may be specified in non-quantitative terms (e.g., could be specified a $L_{eq(WASH)}$ to mean the washing cycle noise for a washing machine).

SOURCE: EPA ACOUSTIC TERMINOLOGY GUIDE, BNA 8-14-78,

APPENDIX B (CONTINUED)

TABLE II

RECOMMENDED DESCRIPTOR LIST

TERM	A-WEIGHTING	ALTERNATIVE[1] A-WEIGHTING	OTHER[2] WEIGHTING	UNWEIGHTED
1. Sound (Pressure)[3] Level	L_A	L_{pA}	L_B, L_{pB}	L_p
2. Sound Power Level	L_{WA}		L_{WB}	L_W
3. Max. Sound Level	L_{max}	L_{Amax}	L_{Bmax}	L_{pmax}
4. Peak Sound (Pressure) Level	L_{Apk}		L_{Bpk}	L_{pk}
5. Level Exceeded x% of the Time	L_x	L_{Ax}	L_{Bx}	L_{px}
6. Equivalent Sound Level	L_{eq}	L_{Aeq}	L_{Beq}	L_{peq}
7. Equivalent Sound Level[4] Over Time(T)	$L_{eq(T)}$	$L_{Aeq(T)}$	$L_{Beq(T)}$	$L_{peq(T)}$
8. Day Sound Level	L_d	L_{Ad}	L_{Bd}	L_{pd}
9. Night Sound Level	L_n	L_{An}	L_{Bn}	L_{pn}
10. Day-Night Sound Level	L_{dn}	L_{Adn}	L_{Bdn}	L_{pdn}
11. Yearly Day-Night Sound Level	$L_{dn(Y)}$	$L_{Adn(Y)}$	$L_{Bdn(Y)}$	$L_{pdn(Y)}$
12. Sound Exposure Level	L_S	L_{SA}	L_{SB}	L_{Sp}
13. Energy Average Value Over (Non-Time Domain) Set of Observations	$L_{eq(e)}$	$L_{Aeq(e)}$	$L_{Beq(e)}$	$L_{peq(e)}$
14. Level Exceeded x% of the Total Set of (Non-Time Domain) Observations	$L_{x(e)}$	$L_{Ax(e)}$	$L_{Bx(e)}$	$L_{px(e)}$
15. Average L_x Value	L_x	L_{Ax}	L_{Bx}	L_{px}

(1) "Alternative" symbols may be used to assure clarity or consistency.

(2) Only B-weighting shown. Applies also to C,D,E,.....weighting.

(3) The term "pressure" is used only for the unweighted level.

(4) Unless otherwise specified, time is in hours (e.g., the hourly equivalent level is Leq(1). Time may be specified in non-quantitative terms (e.g., could be specified as Leq(WASH) to mean the washing cycle noise for a washing machine.

APPENDIX C

SUMMARY OF BASE YEAR AND FUTURE YEAR TRAFFIC VOLUMES

ROADWAY LANES	**** CY 2007 *****		CY 2020 (NO BUILD)		CY 2020 (BUILD)	
	AM VPH	PM VPH	AM VPH	PM VPH	AM VPH	PM VPH
Q. Kaahumanu Hwy. - N. of Proj. Access 2 (NB)	301	630	1,011	1,023	1,310	1,249
Q. Kaahumanu Hwy. - N. of Proj. Access 2 (SB)	612	484	1,124	972	1,562	1,340
Two-Way	913	1,114	2,135	1,995	2,872	2,589
Q. Kaahumanu Hwy. - N. of Proj. Access 1 (NB)	301	630	1,011	1,023	1,212	1,437
Q. Kaahumanu Hwy. - N. of Proj. Access 1 (SB)	612	484	1,124	972	1,761	1,367
Two-Way	913	1,114	2,135	1,995	2,973	2,804
Q. Kaahumanu Hwy. - S. of Proj. Access 1 (NB)	484	672	1,114	1,135	1,178	1,920
Q. Kaahumanu Hwy. - S. of Proj. Access 1 (SB)	490	659	1,165	1,077	1,753	1,516
Two-Way	974	1,331	2,279	2,212	2,930	3,436
Aina Le`a Access 1 (South) (EB)	N/A	N/A	N/A	N/A	711	1,451
Aina Le`a Access 1 (South) (WB)	N/A	N/A	N/A	N/A	952	1,053
Two-Way	N/A	N/A	N/A	N/A	1,663	2,504
Aina Le`a Access 2 (North) (EB)	N/A	N/A	N/A	N/A	268	386
Aina Le`a Access 2 (North) (WB)	N/A	N/A	N/A	N/A	663	225
Two-Way	N/A	N/A	N/A	N/A	931	611

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Appendix O

Air Quality Impact Report (B.D. Neal & Associates, February 2010)

AIR QUALITY STUDY

FOR THE PROPOSED

VILLAGES OF AINA LE'A PROJECT

WAIKOLOA, SOUTH KOHALA, HAWAII

Prepared for:

D.W. Aina Le'a

February 2010

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CONTENTS

Section		Page
1.0	Summary	1
2.0	Introduction	4
3.0	Ambient Air Quality Standards	5
4.0	Regional and Local Climatology	7
5.0	Present Air Quality	11
6.0	Short-Term Impacts of Project	14
7.0	Long-Term Impacts of Project	17
7.1	Roadway Traffic	17
7.2	Electrical Demand	28
7.3	Solid Waste Disposal	29
8.0	Conclusions and Recommendations	29
References		32

FIGURES

Figure	
1	Project Location Map

TABLES

Table	
1	Summary of State of Hawaii and National Ambient Air Quality Standards

TABLES(cont.)

Table

2 Air Pollution Emissions Inventory for Island of Hawaii, 1993

3 Annual Summaries of Ambient Air Quality Measurements for Monitoring Stations Nearest Villages of Aina Le'a Project

4 Estimated Worst-Case 1-Hour Carbon Monoxide Concentrations Along Roadways Near Villages of Aina Le'a Project

5 Estimated Worst-Case 8-Hour Carbon Monoxide Concentrations Along Roadways Near Villages of Aina Le'a Project

6 Estimated Indirect Air Pollution Emissions from Villages of Aina Le'a Project Electrical Demand

1.0 SUMMARY

D.W. Aina Le'a is proposing to develop the Villages of Aina Le'a Project in the South Kohala District on the island of Hawaii. The proposed project will include up to 2,462 residential/mixed-use residential/affordable housing units, a golf course, commercial space, a park and other associated amenities and facilities. Development of the project is expected to commence in 2010 and be completed and fully occupied by 2020. This study examines the potential short- and long-term air quality impacts that could occur as a result of construction and use of the proposed facilities and suggests mitigative measures to reduce any potential air quality impacts where possible and appropriate.

Both federal and state standards have been established to maintain ambient air quality. At the present time, seven parameters are regulated including: particulate matter, sulfur dioxide, hydrogen sulfide, nitrogen dioxide, carbon monoxide, ozone and lead. Hawaii air quality standards are comparable to the national standards except those for nitrogen dioxide and carbon monoxide which are more stringent than the national standards.

Regional and local climate together with the amount and type of human activity generally dictate the air quality of a given location. The climate of the project area is very much affected by its near coastal situation and by nearby mountains. Winds are predominantly light and variable, although kona storms generate occasional strong winds from the south or southwest during winter.

Temperatures in the project area are generally very consistent and moderate with average daily temperatures ranging from about 65°F to 85°F. The extreme minimum temperature recorded at the nearby Old Kona Airport is 47°F, while the extreme maximum temperature is 93°F. Average annual rainfall in the area amounts to about 25 inches with each month typically contributing about 2 inches.

Except for periodic impacts from volcanic emissions (vog) and possibly occasional localized impacts from traffic congestion, the present air quality of the project area is believed to be relatively good. The limited air quality data that are available for the area from the Department of Health indicate that (despite the vog) concentrations are well within state and national air quality standards.

If the proposed project is given the necessary approvals to proceed, it may be inevitable that some short- and/or long-term impacts on air quality will occur either directly or indirectly as a consequence of project construction and use. Short-term impacts from fugitive dust will likely occur during the project construction phase. To a lesser extent, exhaust emissions from stationary and mobile construction equipment, from the disruption of traffic, and from workers' vehicles may also affect air quality during the period of construction. State air pollution control regulations require that there be no visible fugitive dust emissions at the property line. Hence, an effective dust control plan must be implemented to ensure compliance with state regulations. Fugitive dust emissions can be controlled to a large extent by watering of

active work areas, using wind screens, keeping adjacent paved roads clean, and by covering of open-bodied trucks. Other dust control measures could include limiting the area that can be disturbed at any given time and/or mulching or chemically stabilizing inactive areas that have been worked. Paving and landscaping of project areas early in the construction schedule will also reduce dust emissions. Monitoring dust at the project boundary during the period of construction could be considered as a means to evaluate the effectiveness of the project dust control program. Exhaust emissions can be mitigated by moving construction equipment and workers to and from the project site during off-peak traffic hours.

After construction, motor vehicles coming to and from the proposed development will result in a long-term increase in air pollution emissions in the project area. To assess the impact of emissions from these vehicles, a computerized air quality modeling study was undertaken to estimate current ambient concentrations of carbon monoxide at roadway intersections in the project vicinity and to predict future levels both with and without the proposed project. During worst-case conditions, model results indicated that present 1-hour and 8-hour carbon monoxide concentrations are within both the state and the national ambient air quality standards. In the year 2020 without the project, carbon monoxide concentrations were predicted to increase in the project area, but concentrations should remain within state and federal standards. With the project in the year 2020, carbon monoxide concentrations were estimated to increase at the intersection of Queen Kaahumanu Highway and Mauna Lani Drive compared to the without-project

case, but worst-case concentrations should remain within both national and state standards. Implementing mitigation measures for traffic-related air quality impacts is probably unnecessary and unwarranted.

Depending on the demand levels, long-term impacts on air quality are also possible due to indirect emissions associated with a development's electrical power and solid waste disposal requirements. Quantitative estimates of these potential impacts were not made, but based on the estimated demand levels and emission rates involved, any significant impacts are unlikely. Nevertheless, incorporating energy conservation design features and promoting conservation and recycling programs within the proposed development could serve to further reduce any associated impacts and conserve the island's resources.

2.0 INTRODUCTION

D.W. Aina Le’a is proposing to develop the Villages of Aina Le’a Project on approximately 1,060 acres of undeveloped lands in the South Kohala District on the island of Hawaii (see Figure 1 for project location). The project site is along the mauka side of Queen Kaahumanu Highway near the access road for the Mauni Lani Resort. The proposed development includes 1,837 multi- and single-family residential units, 125 mixed-use residential units, 500 affordable housing units, an 18-hole golf course and golf club house, commercial space for stores and services, park and open-space areas, a wastewater treatment plant, and other associated facilities and infrastructure. Full development and occupancy of

the development is planned by 2020.

The purpose of this study is to describe existing air quality in the project area and to assess the potential short- and long-term direct and indirect air quality impacts that could result from construction and use of the proposed facilities as planned. Measures to mitigate project impacts are suggested where possible and appropriate.

3.0 AMBIENT AIR QUALITY STANDARDS

Ambient concentrations of air pollution are regulated by both national and state ambient air quality standards (AAQS). National AAQS are specified in Section 40, Part 50 of the Code of Federal Regulations (CFR), while State of Hawaii AAQS are defined in Chapter 11-59 of the Hawaii Administrative Rules. Table 1 summarizes both the national and the state AAQS that are specified in the cited documents. As indicated in the table, national and state AAQS have been established for particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead. The state has also set a standard for hydrogen sulfide. National AAQS are stated in terms of both primary and secondary standards for most of the regulated air pollutants. National primary standards are designed to protect the public health with an "adequate margin of safety". National secondary standards, on the other hand, define levels of air quality necessary to protect the public welfare from "any known or anticipated adverse effects of a pollutant". Secondary public welfare impacts may include such effects as decreased

visibility, diminished comfort levels, or other potential injury to the natural or man-made environment, e.g., soiling of materials, damage to vegetation or other economic damage. In contrast to the national AAQS, Hawaii State AAQS are given in terms of a single standard that is designed "to protect public health and welfare and to prevent the significant deterioration of air quality".

Each of the regulated air pollutants has the potential to create or exacerbate some form of adverse health effect or to produce environmental degradation when present in sufficiently high concentration for prolonged periods of time. The AAQS specify a maximum allowable concentration for a given air pollutant for one or more averaging times to prevent harmful effects. Averaging times vary from one hour to one year depending on the pollutant and type of exposure necessary to cause adverse effects. In the case of the short-term (i.e., 1- to 24-hour) AAQS, both national and state standards allow a specified number of exceedances each year.

The Hawaii AAQS are in some cases considerably more stringent than the comparable national AAQS. In particular, the Hawaii 1-hour AAQS for carbon monoxide is four times more stringent than the comparable national limit. The U.S. Environmental Protection Agency (EPA) is currently working on a plan to phase out the national 1-hour ozone standard in favor of the new (and more stringent) 8-hour standard.

The Hawaii AAQS for sulfur dioxide were relaxed in 1986 to make the state standards essentially the same as the national limits. In 1993, the state also revised its particulate standards to follow those set by the federal government. During 1997, the federal government again revised its standards for particulate, but the new standards were challenged in federal court. A Supreme Court ruling was issued during February 2001, and as a result, the new standards for particulate were implemented during 2005. To date, the Hawaii Department of Health has not updated the state particulate standards. In September 2001, the state vacated the state 1-hour standard for ozone and an 8-hour standard was adopted.

4.0 REGIONAL AND LOCAL CLIMATOLOGY

Regional and local climatology significantly affect the air quality of a given location. Wind, temperature, atmospheric turbulence, mixing height and rainfall all influence air quality. Although the climate of Hawaii is relatively moderate throughout most of the state, significant differences in these parameters may occur from one location to another. Most differences in regional and local climates within the state are caused by the mountainous topography.

The site of the proposed project is located in the northern portion and along the western coast of the island of Hawaii. The topography of Hawaii Island is dominated by the great volcanic masses of Mauna Loa (13,653 feet), Mauna Kea (13,796 feet), and of Hualalai, the Kohala Mountains and Kilauea. The island

consists entirely of the slopes of these mountains and of the broad saddles between them. Mauna Loa and Kilauea, located on the southern half of the island, are still active volcanoes.

Hawaii lies well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high pressure cell to the north and east. Nearly the entire western coast of the island of Hawaii, however, is sheltered from the trade winds by high mountains, except when unusually strong trade winds sweep through the saddle between the Kohala Mountains and Mauna Kea and reach some areas to the lee. Due to wind shadow effects caused by the terrain, winds in the project area are often light and variable, but strong trade winds sweeping through the saddle do affect the project area at times. Local winds such as land/sea breezes and/or upslope/downslope winds may tend to dominate the wind pattern for the area. During the daytime, winds typically move onshore because of seabreeze and/or upslope effects. At night, winds generally are land breezes and/or drainage winds that move downslope and out to sea. During winter, occasional strong winds from the south or southwest occur in association with the passage of winter storm systems.

Air pollution emissions from motor vehicles, the formation of photochemical smog and smoke plume rise all depend in part on air temperature. Colder temperatures tend to result in higher emissions of contaminants from automobiles but lower concentrations of photochemical smog and ground-level concentrations of air pollution from elevated plumes. In Hawaii, the annual and daily variation of temperature depends to a large

degree on elevation above sea level, distance inland and exposure to the trade winds. Average temperatures at locations near sea level generally are warmer than those at higher elevations. Areas exposed to the trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. The project site's leeward location results in a larger temperature profile compared to windward locations at the same elevation. At Keahole Point (Kona Airport), located about 15 miles south of the project site, average daily minimum and maximum temperatures are 70°F and 83°F, respectively [1]. Temperatures at the project site are similar but may be slightly warmer.

Small scale, random motions in the atmosphere (turbulence) cause air pollutants to be dispersed as a function of distance or time from the point of emission. Turbulence is caused by both mechanical and thermal forces in the atmosphere. It is often measured and described in terms of Pasquill-Gifford stability class. Stability class 1 is the most turbulent and class 6 is the least. Thus, air pollution dissipates the best during stability class 1 conditions and the worst when stability class 6 prevails. In the South Kohala area, stability classes 5 or 6 typically occur during the nighttime or early morning hours when temperature inversions form due to radiation cooling or to drainage flow from the mountainous interior of the island. Stability classes 1 through 4 occur during the daytime, depending mainly on the amount of cloud cover and incoming solar radiation and the onset and extent of the sea breeze.

Mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Low mixing heights can result in high ground-level air pollution concentrations because contaminants emitted from or near the surface can become trapped within the mixing layer. In Hawaii, minimum mixing heights tend to be high because of mechanical mixing caused by the trade winds and because of the temperature moderating effect of the surrounding ocean. Low mixing heights may sometimes occur, however, at inland locations and even at times along coastal areas early in the morning following a clear, cool, windless night. Coastal areas also may experience low mixing levels during sea breeze conditions when cooler ocean air rushes in over warmer land. Mixing heights in Hawaii typically are above 3000 feet (1000 meters).

Rainfall can have a beneficial affect on the air quality of an area in that it helps to suppress fugitive dust emissions, and it also may "washout" gaseous contaminants that are water soluble. Rainfall in Hawaii is highly variable depending on elevation and on location with respect to the trade wind. The climate of the project area is relatively dry due to the leeward location. At Puako located a few miles to the north, average annual rainfall amounts to only about 9 inches with the winter months being the wettest [2]. Rainfall at the project site is probably about the same.

5.0 PRESENT AIR QUALITY

Present air quality in the project area is mostly affected by air

pollutants from vehicular, industrial, natural and/or agricultural sources. Table 2 presents an air pollutant emission summary for the island of Hawaii for calendar year 1993. The emission rates shown in the table pertain to manmade emissions only, i.e., emissions from natural sources are not included. As suggested in the table, much of the manmade particulate emissions on Hawaii originate from area sources, such as the mineral products industry and agriculture. Manmade sulfur oxides are emitted almost exclusively by point sources, such as power plants and other fuel-burning industries. Nitrogen oxides emissions emanate predominantly from area sources (mostly motor vehicle traffic), although industrial point sources contribute a significant share. The majority of carbon monoxide emissions occur from area sources (motor vehicle traffic), while hydrocarbons are emitted mainly from point sources.

It should be noted that Hawaii Island is unique from the other islands in the state in terms of the natural volcanic air pollution emissions that occur. Volcanic emissions periodically plague the project area. This is especially so since the latest eruption phase of the Kilauea Volcano began in 1983. Air pollution emissions from the Hawaiian volcanoes consist primarily of sulfur dioxide. After entering the atmosphere, these sulfur dioxide emissions are carried away by the wind and either washed out as acid rain or gradually transformed into particulate sulfates or acid aerosols. Although emissions from Kilauea are vented on the other side of a mountain barrier more than 50 miles from the project site, the prevailing wind patterns eventually carry some of the emissions into the South Kohala area. These emissions can be seen in the form of the volcanic haze (vog)

which persistently hangs over the area.

There are no major industrial sources of air pollution in the immediate project area. The nearest major industrial source of air pollution is Hawaii Electric Light Company's Keahole Power Plant, which is located about 15 miles to the south. Air pollution emissions from Keahole Power Plant consist mostly of sulfur dioxide and oxides of nitrogen.

The project site is situated adjacent to Queen Kaahumanu Highway on the mauka side. Queen Kaahumanu Highway is a regional arterial roadway that often carries substantial volumes of traffic. Downslope winds during the evening and nighttime hours or during strong tradewind conditions will tend to carry emissions from motor vehicles traversing this roadway away from the project site. Onshore wind conditions will tend to carry emissions from the roadway toward the project site.

The State Department of Health operates a network of air quality monitoring stations at various locations around the state. Unfortunately, very limited data are available for Hawaii Island, and even less data are available for the South Kohala area specifically. During the most recent 5-year period for which data have been reported (2002-2006), the Department of Health operated an air quality monitoring station in the Kealakekua area (about 30 miles south of the project site) for measuring sulfur dioxide. Particulate was also monitored at this site, but monitoring for this parameter was discontinued during 2000. As

indicated in Table 3, measurements of sulfur dioxide concentrations at this location during the 2002-2006 monitoring period were consistently low (despite the vog) with annual average concentrations of 8 to 13 $\mu g/m^3$, which represents about 10 to 15 percent of the state and national standard. The highest annual second-highest 3-hour and 24-hour concentrations (which are most relevant to the standards) for these five years were 90 and 42 $\mu g/m^3$, respectively; these are about 7 to 12 percent of the applicable standards. No exceedances of the state/national 3-hour and 24-hour AAQS for sulfur dioxide were recorded. These measurements may only be partially representative of conditions in the project area due to the distance to the air quality station.

Although not shown in the table, the annual average particulate concentration for the year 2000 was 18 $\mu g/m^3$, which equates to about 36 percent of the state/national standard. The second-highest 24-hour concentration of particulate matter, 23 $\mu g/m^3$, was about 15 percent of the state/national standard, and there were no violations of the state/national AAQS during the 2000 monitoring period. Monitoring of particulate matter was discontinued at this site during June 2000.

At this time, there are no reported measurements of lead, ozone, nitrogen dioxide or carbon monoxide in the project vicinity. These are primarily motor vehicle related air pollutants. Lead, ozone and nitrogen dioxide typically are regional scale problems. Concentrations of lead and nitrogen dioxide generally have not

been found to exceed AAQS elsewhere in the state. Ozone concentrations, on the other hand, have been found to exceed the state standard at times at Sand Island on Oahu. Carbon monoxide air pollution typically is a microscale problem caused by congested motor vehicular traffic. In traffic congested areas such as urban Honolulu, carbon monoxide concentrations have been found to occasionally exceed the state AAQS. Present concentrations of carbon monoxide in the project area are estimated later in this study based on computer modeling of motor vehicle emissions.

6.0 SHORT-TERM IMPACTS OF PROJECT

Short-term direct and indirect impacts on air quality could potentially occur due to project construction. For a project of this nature, there are two potential types of air pollution emissions that could directly result in short-term air quality impacts during project construction: (1) fugitive dust from vehicle movement and soil excavation; and (2) exhaust emissions from on-site construction equipment. Indirectly, there also could be short-term impacts from slow-moving construction equipment traveling to and from the project site, from a temporary increase in local traffic caused by commuting construction workers, and from the disruption of normal traffic flow caused by lane closures of adjacent roadways.

Fugitive dust emissions may arise from the grading and dirt-moving activities associated with site clearing and preparation work. The emission rate for fugitive dust emissions from construction

activities is difficult to estimate accurately. This is because of its elusive nature of emission and because the potential for its generation varies greatly depending upon the type of soil at the construction site, the amount and type of dirt-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The EPA [3] has provided a rough estimate for uncontrolled fugitive dust emissions from construction activity of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and precipitation/evaporation (P/E) index of 50. Uncontrolled fugitive dust emissions at the project site would likely be somewhere near that level, depending on the amount of rainfall that occurs. In any case, State of Hawaii Air Pollution Control Regulations [4] prohibit visible emissions of fugitive dust from construction activities at the property line. Thus, an effective dust control plan for the project construction phase is essential.

Adequate fugitive dust control can usually be accomplished by the establishment of a frequent watering program to keep bare-dirt surfaces in construction areas from becoming significant sources of dust. In dust-prone or dust-sensitive areas, other control measures such as limiting the area that can be disturbed at any given time, applying chemical soil stabilizers, mulching and/or using wind screens may be necessary. Control regulations further stipulate that open-bodied trucks be covered at all times when in motion if they are transporting materials that could be blown away. Haul trucks tracking dirt onto paved streets from unpaved areas is often a significant source of dust in construction areas. Some means to alleviate this problem, such as road cleaning or tire washing, may be appropriate. Paving of parking areas and/or

establishment of landscaping as early in the construction schedule as possible can also lower the potential for fugitive dust emissions. Monitoring dust at the project property line could be considered to quantify and document the effectiveness of dust control measures.

On-site mobile and stationary construction equipment also will emit air pollutants from engine exhausts. The largest of this equipment is usually diesel-powered. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment, but the standard for nitrogen dioxide is set on an annual basis and is not likely to be violated by short-term construction equipment emissions. Carbon monoxide emissions from

diesel engines, on the other hand, are low and should be relatively insignificant compared to vehicular emissions on nearby roadways.

Project construction activities will also likely obstruct the normal flow of traffic at times to such an extent that overall vehicular emissions in the project area will temporarily increase. The only means to alleviate this problem will be to attempt to keep roadways open during peak traffic hours and to move heavy construction equipment and workers to and from construction areas during periods of low traffic volume. Thus, most potential short-term air quality impacts from project construction can be mitigated.

7.0 LONG-TERM IMPACTS OF PROJECT

7.1 Roadway Traffic

After construction is completed, use of the proposed facilities will result in increased motor vehicle traffic in the project area, potentially causing long-term impacts on ambient air quality. Motor vehicles with gasoline-powered engines are significant sources of carbon monoxide. They also emit nitrogen oxides and other contaminates.

Federal air pollution control regulations require that new motor vehicles be equipped with emission control devices that reduce emissions significantly compared to a few years ago. In 1990, the

President signed into law the Clean Air Act Amendments. This legislation requires further emission reductions, which have been phased in since 1994. More recently, additional restrictions were signed into law during the Clinton administration, which will begin to take effect during the next decade. The added restrictions on emissions from new motor vehicles will lower average emissions each year as more and more older vehicles leave the state's roadways. It is estimated that carbon monoxide emissions, for example, will go down by an average of about 30 to 40 percent per vehicle during the next 10 years due to the replacement of older vehicles with newer models.

To evaluate the potential long-term indirect ambient air quality impact of increased roadway traffic associated with a project such as this, computerized emission and atmospheric dispersion models can be used to estimate ambient carbon monoxide concentrations along roadways leading to and from the project. Carbon monoxide is selected for modeling because it is both the most stable and the most abundant of the pollutants generated by motor vehicles. Furthermore, carbon monoxide air pollution is generally considered to be a microscale problem that can be addressed locally to some extent, whereas nitrogen oxides air pollution most often is a regional issue that cannot be addressed by a single new development.

For this project, three scenarios were selected for the carbon monoxide modeling study: (1) year 2009 with present conditions, (2) year 2020 without the project, and (3) year 2020 with the project. To begin the modeling study of the three scenarios, critical receptor areas in the vicinity of the project were identified for analysis. Generally speaking, roadway intersections are the primary concern because of traffic congestion and because of the increase in vehicular emissions associated with traffic queuing. For this study, the same key intersections identified in the traffic study were also selected for air quality analysis. These included the following intersections:

- Queen Kaahumanu Highway at Waikoloa Road
- Queen Kaahumanu Highway at Mauna Lani Drive
- Queen Kaahumanu Highway at New Aina Le’a Access 2

The traffic impact report for the project [5] describes the projected future traffic conditions and laneage configurations of these intersections in detail. In performing the air quality impact analysis, it was assumed that all recommended traffic mitigation measures would be implemented.

The main objective of the modeling study was to estimate maximum 1-hour average carbon monoxide concentrations for each of the three scenarios studied. To evaluate the significance of the estimated concentrations, a comparison of the predicted values for each scenario can be made. Comparison of the estimated values to

the national and state AAQS was also used to provide another measure of significance.

Maximum carbon monoxide concentrations typically coincide with peak traffic periods. The traffic impact assessment report evaluated morning and afternoon peak traffic periods. These same periods were evaluated in the air quality impact assessment.

The EPA computer model MOBILE6 [6] was used to calculate vehicular carbon monoxide emissions for each year studied. One of the key inputs to MOBILE6 is vehicle mix. Unless very detailed information is available, national average values are typically assumed, which is what was used for the present study. Based on national average vehicle mix figures, the present vehicle mix in the project area was estimated to be 40.9% light-duty gasoline-powered automobiles, 46.2% light-duty gasoline-powered trucks and vans, 3.6% heavy-duty gasoline-powered vehicles, 0.2% light-duty diesel-powered vehicles, 8.5% heavy-duty diesel-powered trucks and buses, and 0.6% motorcycles. For the future scenarios studied, the vehicle mix was estimated to change slightly with fewer light-duty gasoline-powered automobiles and more light-duty gasoline-powered trucks and vans.

Ambient temperatures of 59 and 68 degrees F were used for morning and afternoon peak-hour emission computations, respectively. These are conservative assumptions since morning/afternoon ambient temperatures will generally be warmer than this, and emission estimates given by MOBILE6 generally have an inverse relationship

to the ambient temperature.

After computing vehicular carbon monoxide emissions through the use of MOBILE6, these data were then input to an atmospheric dispersion model. EPA air quality modeling guidelines [7] currently recommend that the computer model CAL3QHC [8] be used to assess carbon monoxide concentrations at roadway intersections, or in areas where its use has previously been established, CALINE4 [9] may be used. Until a few years ago, CALINE4 was used extensively in Hawaii to assess air quality impacts at roadway intersections. In December 1997, the California Department of Transportation recommended that the intersection mode of CALINE4 no longer be used because it was thought the model has become outdated. Studies have shown that CALINE4 may tend to over-predict maximum concentrations in some situations. Therefore, CAL3QHC was used for the subject analysis.

CAL3QHC was developed for the U.S. EPA to simulate vehicular movement, vehicle queuing and atmospheric dispersion of vehicular emissions near roadway intersections. It is designed to predict 1-hour average pollutant concentrations near roadway intersections based on input traffic and emission data, roadway/receptor geometry and meteorological conditions.

Although CAL3QHC is intended primarily for use in assessing atmospheric dispersion near signalized roadway intersections, it can also be used to evaluate unsignalized intersections. This is accomplished by manually estimating queue lengths and then applying the same techniques used by the model for signalized intersections. Currently, one of the study intersections, Queen Kaahumanu Highway at Mauna Lani Drive, is unsignalized. In the future, in accordance with the traffic report, this intersection was assumed to be signalized.

Input peak-hour traffic data were obtained from the traffic study cited previously. This included vehicle approach volumes, saturation capacity estimates, intersection laneage and signal timings (where applicable). All emission factors that were input to CAL3QHC for free-flow traffic on roadways were obtained from MOBILE6 based on assumed free-flow vehicle speeds corresponding to the posted speed limits.

Model roadways were set up to reflect roadway geometry, physical dimensions and operating characteristics. Concentrations predicted by air quality models generally are not considered valid within the roadway-mixing zone. The roadway-mixing zone is usually taken to include 3 meters on either side of the traveled portion of the roadway and the turbulent area within 10 meters of a cross street. Model receptor sites were thus located at the edges of the mixing zones near all intersections that were studied for all three scenarios. This implies that pedestrian sidewalks either already exist or are assumed to exist in the future. All receptor heights were placed at 1.8 meters above ground to

simulate levels within the normal human breathing zone.

Input meteorological conditions for this study were defined to provide "worst-case" results. One of the key meteorological inputs is atmospheric stability category. For these analyses, atmospheric stability category 6 was assumed for the morning cases, while atmospheric stability category 4 was assumed for the afternoon cases. These are the most conservative stability categories that are generally used for estimating worst-case pollutant dispersion within suburban areas for these periods. A surface roughness length of 100 cm and a mixing height of 1000 meters were used in all cases. Worst-case wind conditions were defined as a wind speed of 1 meter per second with a wind direction resulting in the highest predicted concentration. Concentration estimates were calculated at wind directions of every 5 degrees.

Existing background concentrations of carbon monoxide in the project vicinity are believed to be at low levels. Thus, background contributions of carbon monoxide from sources or roadways not directly considered in the analysis were accounted for by adding a background concentration of 0.5 ppm to all predicted concentrations for 2009. Although increased traffic is expected to occur within the project area during the next several years with or without the project, background carbon monoxide concentrations may not change significantly since individual emissions from motor vehicles are forecast to decrease with time. Hence, a background value of 0.5 ppm was assumed to persist for the future scenarios studied.

Predicted Worst-Case 1-Hour Concentrations

Table 4 summarizes the final results of the modeling study in the form of the estimated worst-case 1-hour morning and afternoon ambient carbon monoxide concentrations. These results can be compared directly to the state and the national AAQS. Estimated worst-case carbon monoxide concentrations are presented in the table for three scenarios: year 2009 with existing traffic, year 2020 without the project and year 2020 with the project. The locations of these estimated worst-case 1-hour concentrations all occurred at or very near the indicated intersections.

As indicated in the table, the highest estimated 1-hour concentration within the project vicinity for the present (2009) case was 3.8 mg/m^3. This was projected to occur during the morning peak traffic hour near the intersection of Queen Kaahumanu Highway and Waikoloa Road. Concentrations at other locations and times studied were 3.2 mg/m^3 or lower. All predicted worst-case 1-hour concentrations for the 2009 scenario were within both the national AAQS of 40 mg/m^3 and the state standard of 10 mg/m^3.

In the year 2020 without the proposed project, the highest worst-case 1-hour concentration was predicted to continue to occur during the morning at the intersection of Queen Kaahumanu Highway and Waikoloa Road. A value of 6.4 mg/m^3 was predicted to occur at

this location and time. Peak-hour worst-case values at the other locations and times studied for the 2020 without project scenario ranged between 3.1 and 5.8 mg/m^3. Compared to the existing case, concentrations increased, but all projected worst-case concentrations for this scenario remained within the state and national standards.

In the year 2020 with the proposed project and with the recommended traffic mitigation measures, the predicted highest worst-case 1-hour concentration occurred during the morning at the intersection of Queen Kaahumanu Highway and Mauna Lani Drive with a value of 6.9 mg/m^3, which is about 19 percent higher compared to the without project case. Other concentrations for this scenario ranged between 2.6 and 6.0 mg/m^3. All concentrations would remain within the state and federal standards.

Predicted Worst-Case 8-Hour Concentrations

Worst-case 8-hour carbon monoxide concentrations were estimated by multiplying the worst-case 1-hour values by a persistence factor of 0.5. This accounts for two factors: (1) traffic volumes averaged over eight hours are lower than peak 1-hour values, and (2) meteorological conditions are more variable (and hence more favorable for dispersion) over an 8-hour period than they are for a single hour. Based on monitoring data, 1-hour to 8-hour persistence factors for most locations generally vary from 0.4 to 0.8 with 0.6 being the most typical. One study based on modeling [10] concluded that 1-hour to 8-hour persistence factors could

typically be expected to range from 0.4 to 0.5. EPA guidelines [11] recommend using a value of 0.7 unless a locally derived persistence factor is available. Recent monitoring data for locations on Oahu reported by the Department of Health [12] suggest that this factor may range between about 0.2 and 0.6 depending on location and traffic variability. Considering the location of the project and the traffic pattern for the area, a 1-hour to 8-hour persistence factor of 0.5 will likely yield reasonable estimates of worst-case 8-hour concentrations.

The resulting estimated worst-case 8-hour concentrations are indicated in Table 5. For the 2009 scenario, the estimated worst-case 8-hour carbon monoxide concentrations for the two locations studied ranged from 1.6 mg/m^3 at Queen Kaahumanu Highway and Mauna Lani Drive to 1.9 mg/m^3 at Queen Kaahumanu Highway and Waikoloa Road. The estimated worst-case concentrations were within both the state standard of 5 mg/m^3 and the national limit of 10 mg/m^3.

For the year 2020 without project scenario, worst-case concentrations ranged between 2.9 and 3.2 mg/m^3, with the highest concentration at the Queen Kaahumanu Highway and Waikoloa Road intersection. Concentrations at the two locations studied increased compared to the existing case, but all predicted concentrations were within the standards.

For the 2020 with project scenario (assuming traffic mitigation measures), concentrations ranged from 2.7 mg/m^3 at Queen Kaahumanu

Highway and Aina Le'a Access 2 to 3.4 mg/m^3 at Queen Kaahumanu Highway and Mauna Lani Drive. All predicted 8-hour concentrations for this scenario were well within both the national and the state AAQS.

Conservativeness of Estimates

The results of this study reflect several assumptions that were made concerning both traffic movement and worst-case meteorological conditions. One such assumption concerning worst-case meteorological conditions is that a wind speed of 1 meter per second with a steady direction for 1 hour will occur. A steady wind of 1 meter per second blowing from a single direction for an hour is extremely unlikely and may occur only once a year or less. With wind speeds of 2 meters per second, for example, computed carbon monoxide concentrations would be only about half the values given above. The 8-hour estimates are also conservative in that it is unlikely that anyone would occupy the assumed receptor sites (within 3 m of the roadways) for a period of 8 hours.

7.2 Electrical Demand

The proposed project also will cause indirect air pollution emissions from power generating facilities as a consequence of electrical power usage. The peak power demand of the project (excluding commercial uses) at full build out is expected to reach approximately 7.4 megawatts [13]. Assuming the average demand is approximately one-half the peak demand, the annual electrical demand of the project (excluding commercial uses) when fully developed is expected to reach a maximum of approximately 32 million kilowatt-hours. Electrical power for the project will most probably be provided mostly by oil-fired generating facilities, but some of the project power may also be derived from geothermal energy, wind power or other sources. In order to meet the electrical power needs of the proposed project, power generating facilities will likely be required to burn more fuel and hence more air pollution will be emitted at these facilities. Given in Table 6 are estimates of the indirect air pollution emissions that would result from the project electrical demand assuming all power is provided by burning more fuel oil at local power plants. These values can be compared to the island-wide emission estimates for 1993 given in Table 2. The estimated indirect emissions from project electrical demand amount to about 1 percent or less of the present (manmade) air pollution emissions occurring on Hawaii Island even if all power is assumed to be derived from oil.

7.3 Solid Waste Disposal

Solid waste generated by the proposed development when fully completed and occupied is not expected to exceed about 10 tons per day or 3,650 tons per year [13]. Currently, all solid waste on the island is buried at solid waste landfills. Thus, assuming this continues to be the method for solid waste disposal, the only associated air pollution emissions that will occur will be from trucking the waste to the landfill and burying it. These emissions should be relatively minor.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The major potential short-term air quality impact of the project will occur from the emission of fugitive dust during construction. Uncontrolled fugitive dust emissions from construction activities are estimated to amount to about 1.2 tons per acre per month, depending on rainfall. To control dust, active work areas and any temporary unpaved work roads should be watered at least twice daily on days without rainfall. Use of wind screens and/or limiting the area that is disturbed at any given time will also help to contain fugitive dust emissions. Wind erosion of inactive areas of the site that have been disturbed could be controlled by mulching or by the use of chemical soil stabilizers. Dirt-hauling trucks should be covered when traveling on roadways to prevent windage. A routine road cleaning and/or tire washing program will also help to reduce fugitive dust emissions that may occur as a result of trucks tracking dirt onto paved roadways in the project area. Paving of parking areas and establishment of landscaping early in the construction schedule will also help to control dust. Monitoring dust at the project boundary during the period of

construction could be considered as a means to evaluate the effectiveness of the project dust control program and to adjust the program if necessary.

During construction phases, emissions from engine exhausts (primarily consisting of carbon monoxide and nitrogen oxides) will also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

After construction of the proposed project is completed and it is fully occupied, carbon monoxide concentrations in the project area due to motor vehicle emissions will likely increase, but worst-case concentrations should remain within both the state and the national ambient air quality standards. Implementing any air quality mitigation measures for long-term traffic-related impacts is probably unnecessary and unwarranted.

Any long-term impacts on air quality due to indirect emissions from supplying the project with electricity and from the disposal of solid waste materials generated by the project will likely be small based on the relatively small magnitudes of these emissions. Nevertheless, indirect emissions from project electrical demand could likely be reduced somewhat by incorporating energy-saving features into project design requirements. This might include the use of solar water heaters; designing building space so that window positions maximize indoor light

without unduly increasing indoor heat; using landscaping where feasible to provide afternoon shade to cut down on the use of air conditioning; installation of insulation and double-glazed doors to reduce the effects of the sun and heat; providing movable, controlled openings for ventilation at opportune times; and possibly installing automated room occupancy sensors.

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Figure 1 - Location Map

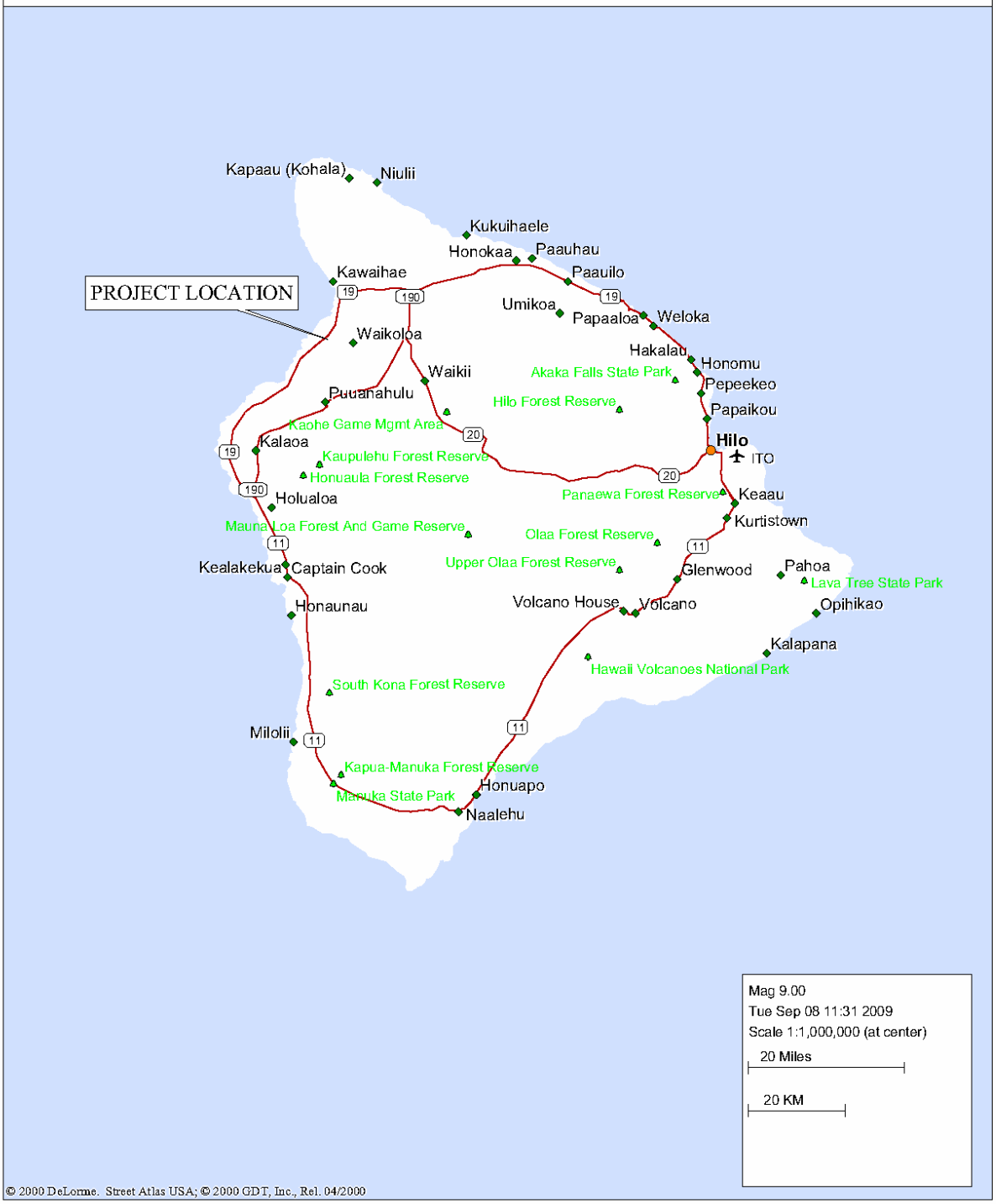

Table 1

SUMMARY OF STATE OF HAWAII AND NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Units	Averaging Time	Maximum Allowable Concentration		
			National Primary	**National Secondary**	**State of Hawaii**
Particulate Matter (<10 microns)	$\mu g/m^3$	Annual 24 Hours	50[a] 150[b]	50[a] 150[b]	50 150[c]
Particulate Matter (<2.5 microns)	$\mu g/m^3$	Annual 24 Hours	15[a] 35[d]	15[a] 35[d]	- -
Sulfur Dioxide	$\mu g/m^3$	Annual 24 Hours 3 Hours	80 365[c] -	- - 1300[c]	80 365[c] 1300[c]
Nitrogen Dioxide	$\mu g/m^3$	Annual	100	100	70
Carbon Monoxide	mg/m^3	8 Hours 1 Hour	10[c] 40[c]	- -	5[c] 10[c]
Ozone	$\mu g/m^3$	8 Hours 1 Hour	157[e] 235[f]	157[e] 235[f]	157[e] -
Lead	$\mu g/m^3$	Calendar Quarter	1.5	1.5	1.5
Hydrogen Sulfide	$\mu g/m^3$	1 Hour	-	-	35[c]

[a] Three-year average of annual arithmetic mean.

[b] 99th percentile value averaged over three years.

[c] Not to be exceeded more than once per year.

[d] 98th percentile value averaged over three years.

[e] Three-year average of fourth-highest daily 8-hour maximum.

[f] Standard is attained when the expected number of annual exceedances is less than or equal to 1.

Table 2

AIR POLLUTION EMISSIONS INVENTORY FOR ISLAND OF HAWAII, 1993

Air Pollutant	Point Sources (tons/year)	Area Sources (tons/year)	Total (tons/year)
Particulate	30,311	9,157	39,468
Sulfur Oxides	9,345	nil	9,345
Nitrogen Oxides	4,054	8,858	12,912
Carbon Monoxide	3,357	23,934	27,291
Hydrocarbons	1,477	203	1,680

Source: Final Report, “Review, Revise and Update of the Hawaii Emissions Inventory Systems for the State of Hawaii”, prepared for Hawaii Department of Health by J.L. Shoemaker & Associates, Inc., 1996

Table 3

ANNUAL SUMMARIES OF AIR QUALITY MEASUREMENTS FOR MONITORING STATIONS NEAREST VILLAGES OF AINA LE'A PROJECT

Parameter / Location	2002	2003	2004	2005	2006
Sulfur Dioxide / Kealakekua, Kona					
3-Hour Averaging Period:					
No. of Samples	2877	2886	2513	2341	2697
Highest Concentration ($\mu g/m^3$)	50	91	55	83	119
2nd Highest Concentration ($\mu g/m^3$)	37	58	54	82	90
No. of State AAQS Exceedances	0	0	0	0	0
24-Hour Averaging Period:					
No. of Samples	362	364	317	296	341
Highest Concentration ($\mu g/m^3$)	19	39	21	47	31
2nd Highest Concentration ($\mu g/m^3$)	18	22	19	42	29
No. of State AAQS Exceedances	0	0	0	0	0
Annual Average Concentration ($\mu g/m^3$)	8	10	8	13	11

Source: State of Hawaii Department of Health, "Annual Summaries, Hawaii Air Quality Data, 2002 - 2006"

Table 4

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR VILLAGES OF AINA LE'A PROJECT (milligrams per cubic meter)

Roadway Intersection	Year/Scenario					
	2009/Present		2020/Without Project		2020/With Project[a]	
	AM	PM	AM	PM	AM	PM
Queen Kaahumanu Hwy at Waikoloa Road	3.8	2.9	6.4	3.3	6.0	3.8
Queen Kaahumanu Hwy at Mauna Lani Drive	3.2	2.9	5.8	3.1	6.9	4.6
Queen Kaahumanu Hwy at Aina Le'a Access 2	-	-	-	-	5.4	2.6

Hawaii State AAQS: 10
National AAQS: 40

[a]Includes mitigation measures given in project traffic report.

Table 5

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR VILLAGES OF AINA LE'A PROJECT (milligrams per cubic meter)

Roadway Intersection	Year/Scenario		
	2009/Present	2020/Without Project	2020/With Project[a]
Queen Kaahumanu Hwy at Waikoloa Road	1.9	3.2	3.0
Queen Kaahumanu Hwy at Mauna Lani Drive	1.6	2.9	3.4
Queen Kaahumanu Hwy at Aina Le'a Access 2	-	-	2.7

Hawaii State AAQS: 5
National AAQS: 10

[a]Includes mitigation measures given in project traffic report.

Table 6

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM VILLAGES OF AINA LE'A PROJECT ELECTRICAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	8
Sulfur Dioxide	83
Carbon Monoxide	8
Volatile Organics	<1
Nitrogen Oxides	36

[a]Based on U.S. EPA emission factors for utility boilers [3]. Assumes demand of 32 million kw-hrs per year of electrical power use. Estimated emission rates assume low-sulfur oil used to generate power.

Appendix P
Socio-Economic Assessment (SMS, August 2009)

Beyond Information. Intelligence.

Consulting

Database Marketing

Economic & Social Impact Studies

Research

Training

SOCIAL IMPACT ASSESSMENT OF THE VILLAGES OF ʻĀina Lea

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August 2009

CONTENTS

1. INTRODUCTION 1

2. THE SOCIO-ECONOMIC CONTEXT 2

2.1 ECONOMIC CONTEXT 3
2.2 POPULATION CONTEXT 9
2.3 SOCIAL CONTEXT 14

3. SOCIAL IMPACTS 16

3.1 REGIONAL SOCIAL IMPACTS 16
3.2 COMMUNITY PERCEPTIONS AND ATTITUDES 17
3.3 PUBLIC SERVICE IMPACTS 19

4. ECONOMIC IMPACT 24

4.1 EMPLOYMENT 24
4.2 TAX IMPACT 27

5. MITIGATION MEASURES 28

Exhibits

EXHIBIT 2: DW `AINA LE`A DEVELOPMENT PROJECT 2

EXHIBIT 2.1: PREDICTED JOB GROWTH, STATE OF HAWAI`I, 2007-2012 4

EXHIBIT 2.2: JOB GROWTH, STATE OF HAWAI`I AND HAWAI`I COUNTY, 1991-2008 4

EXHIBIT 2.3: UNEMPLOYMENT RATE, STATE OF HAWAI`I AND HAWAI`I COUNTY, 1991-2008 5

EXHIBIT 2.4: JOB COUNT, HAWAI`I COUNTY, 2008 4TH QUARTER 5

EXHIBIT 2.5: AVERAGE VISITOR CENSUS, STATE OF HAWAI`I, 1990-2008 6

EXHIBIT 2.6: AVERAGE DAILY VISITOR CENSUS, HAWAI`I COUNTY, 1990-2008 6

EXHIBIT 2.8: HOTEL OCCUPANCY RATE, STATE AND COUNTY OF HAWAI`I, 1990-2008 7

EXHIBIT 2.9: HAWAI`I COUNTY POPULATION, 1990-2008 9

EXHIBIT 2.10: POPULATION GROWTH RATE, STATE AND COUNTIES OF HAWAI`I, 1990-2007 10

EXHIBIT 2.11: ACTUAL POPULATION GROWTH, STATE AND COUNTIES OF HAWAI`I, 2000-2007 10

EXHIBIT 2.12: PROJECTED POPULATION GROWTH RATE, HAWAI`I COUNTY, 2005-2035 11

EXHIBIT 2.13: POPULATION OF HAWAI`I COUNTY DISTRICTS, 2008 12

EXHIBIT 2.14: AGE DISTRIBUTION, COUNTY OF HAWAI`I AND SOUTH KOHALA, 2007 13

EXHIBIT 2.15: RACIAL DISTRIBUTION, HAWAI`I COUNTY AND SOUTH KOHALA, 2007 13

EXHIBIT 2.16: HOUSEHOLD AND PER CAPITA INCOME, HAWAI`I COUNTY AND SOUTH KOHALA, 2007 14

EXHIBIT 4.1: ECONOMIC SUMMARY 23

EXHIBIT 4.2: CONSTRUCTION EMPLOYMENT 25

EXHIBIT 4.3: CONSTRUCTION WORKERS' EARNINGS 25

EXHIBIT 4.4: CONSTRUCTION EMPLOYMENT 26

EXHIBIT 4.5: TOTAL STATE TAX REVENUES 27

EXHIBIT 4.6: INCOME TAX REVENUES 28

SOCIAL IMPACT ASSESSMENT OF THE VILLAGES OF `AINA LE`A

1. INTRODUCTION

The Villages of `Aina Le`a is a proposed residential golf-community development by DW `Aina Le`a Development, LLC in the Waikoloa area of the County of Hawai`i. The Villages are currently zoned to include multi-family residential, village commercial, residential-agriculture, and agriculture areas. The total project area consists of 1,092 acres; the development is capable of producing a total of 2,230 units, including 1,945 market-rate residential units and 385 affordable units. Recreational amenities are presently scheduled to include one golf course and a golf academy.

This report describes the social and economic context for the development; specifically, the South Kohala region and Hawai`i Island as a whole. Additional social impacts that the project may have on residents of neighboring communities are also identified. These impacts are drawn from our experience on Hawai`i Island, a literature search, a review of `Aina Le`a development plans, and interviews with community representatives and public officials in the area. The report concludes with a discussion of several measures that might be taken to address possible adverse social impacts of the development.

Some of the social impacts discussed in this report, like traffic, emergency services, and commercial opportunities in the Villages of `Aina Le`a, overlap the work of other economic and technical consultants to the project. We have limited our investigation to the social and economic impact of those issues and refer the reader to the associated consultant reports for further information.

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2. THE SOCIO-ECONOMIC CONTEXT

The Villages of `Aina Le'a is bordered on its makai (seaward) side by the Queen Ka'ahumanu Highway and on the mauka (upland) side by Waikoloa Village. Between those two borders it extends from the entrance to the Mauna Lani Resort north to the Village of Puako. Along the beach, the Mauna Lani Resort consists predominantly of time-share and vacation rental units. Waikoloa Village is a middle-class residential community developed over the course of the last decade. `Aina Le`a will be a complex community linking the two existing areas.

DW `Aina Le`a's project will be one of the County's largest single developments, eventually housing as many as 5,780 people[1] and serving them with commercial centers, a civic center, a community center, and substantial recreational amenities. There is little doubt this development will have major impacts on the people who currently live in the area and those who will eventually work and reside there.

Exhibit 2 shows the Villages of `Aina Le`a project map showing the location of the proposed project and planned developments.

Exhibit 2: DW `Aina Le`a Development Project

	Land Use	Proposed Approx. Acreage	Proposed Approx. Units	Gross Floor Area
SF	Single Family (SF)	± 255	± 790	-
MF	Multi-Family (MF)	± 165	± 1,047	-
MU	Mixed Use (MU)	± 25	± 125	± 80,000 sf
AWH	Affordable / Workforce Housing (AWH)	± 46	± 500	-
C	Commercial Village (C)	± 36	-	± 340,000 sf
	Golf Course (GC)	± 218	-	-
GC	Golf Course Club House	± 4	-	-
	Highway Buffer	± 234	-	-
	Parks / Open Space	± 37	-	-
	Major Roadways	± 40	-	-
	Total :	± 1,060*	± 2,462	± 420,000 sf

* Note: DW Aina Lea Development, LLC owns an additional 32 acres in the Agricultural District for a total project area of 1,092 acres.

[1] Based on DW `Aina Le`a's estimates for permanent residents.

It is clear that `Aina Le`a's position between the Waikoloa and Mauna Lani Resort areas (the "gold coast") on one side and Waikoloa Village on the other will affect the character of the Waikoloa region. The development of the gold coast brought the first era of rapid development in South Kohala. Since then the visitor plant along the coast has expanded continuously and enjoys a record business in this decade. The local economy, fueled by the success of the resort areas, has resulted in record low unemployment rates, record low residential vacancy rates, and record high housing costs throughout South Kohala.

In Waikoloa Village the tight housing market felt a resurgence in residential development proposals and an increase in development activity. Projects that have progressed far beyond the talking stages include Waikoloa Heights (1,000 units), the County's Affordable Housing Project (1,000 units) and Waikoloa Highlands (398 units). Given that there are only 1,750 units in Waikoloa today, these three projects alone will more than double the size of the Village.

2.1 Economic Context

2.1.1 Hawai`i Island

From the early 1980's to 1990 the State's economy grew quickly. In the 1990's that growth began to stagnate and the first seven years of the last decade witnessed very slow growth. By 2000, the State economy had returned to a healthier and stable growth rate and in 2007, the State's unemployment rate reached 2.6 percent (the lowest in the United States). However, in 2008 the state unemployment rate increased by 1.4 percent. Experts are predicting that there will be a decline in job growth in 2009, with a stabilization of the growth rate to 2008 levels by the year 2012 (Exhibit 2.1).

Like the rest of the State, Hawai`i County's economy also experienced wide scale growth from 2002 to 2006. In 2007, however, State job growth declined and the unemployment rate began to increase. Job growth fell by 3.3 percentage points from 2006 to 2007 (Exhibit 2.2), and the unemployment rate edged up a few tenths of a point in 2007, with a larger 2.2 point increase in 2008 (Exhibit 2.3) above the statewide level. The dramatic slow of the local economy has been affected by several sources, perhaps most predominantly the fallout from the mortgage-backed securities situation. Most experts have adjusted their predictions of the State's economy for an upward recovery period during 2010 and a stabilization of the economy as a whole in 2011.[2]

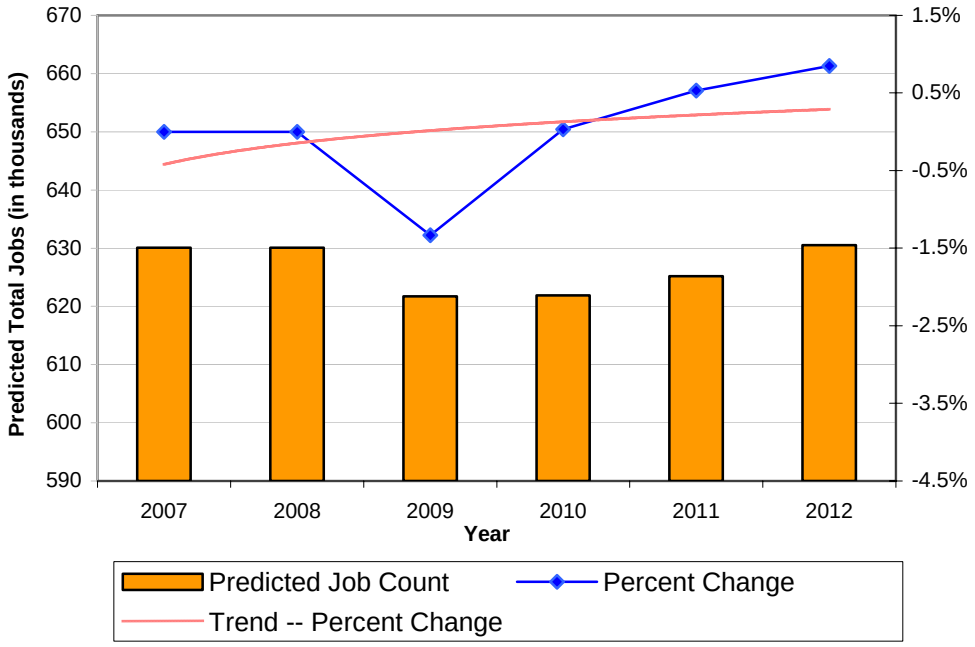
The leisure and hospitality industry in Hawai`i County accounts for the largest proportion of jobs; 22 percent, followed by government, which accounts for 20 percent (see Exhibit 2.4). County officials believe that diversifying the economy is crucial to the economic health of the county and have been working at accomplishing that objective. In fact, since the early 1990's (and up until 2007), Hawai`i County has witnessed annual job growth in virtually every industry. They have not, however, achieved the economic diversification they seek.

The visitor industry has been the backbone of both the State and Hawai`i County's economic growth. Visitor arrivals and hotel occupancy rates have risen steadily from the beginning of the decade to 2005 and have remained steady up until 2007(Exhibits 2.5, 2.6, 2.8). However, the number of average visitors across the State dropped by 10.6 percent in 2008 (Exhibit 2.6). In addition, the number of visitors that visited the Big Island dropped by 18.4 from 2007 to 2008. Hawai`i County's share of the statewide visitor count also declined slightly in the past two years; between 2007 and 2008, there was a 1.8 percent decrease (Exhibit 2.6).

The South Kohala visitor plant is the Big Island's most valuable travel infrastructure and its leading role in industry growth in this decade has contributed notably to the local Kohala economy (Exhibit 2.7).

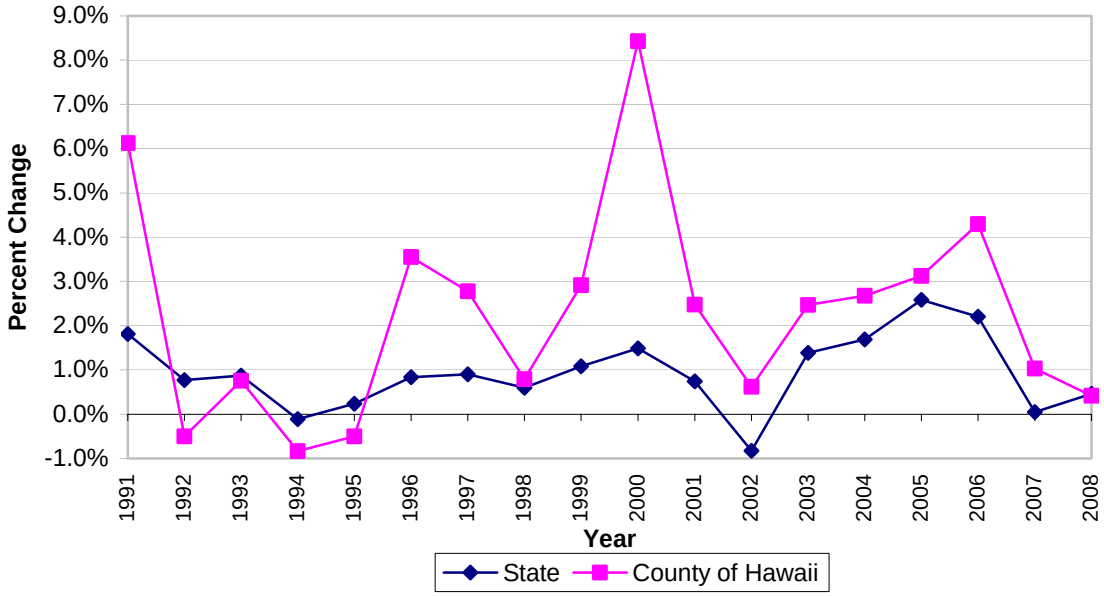
[2] FHB Economic Forecast 2008-2009

Exhibit 2.1: Predicted Job Growth, State of Hawai`i, 2007-2012



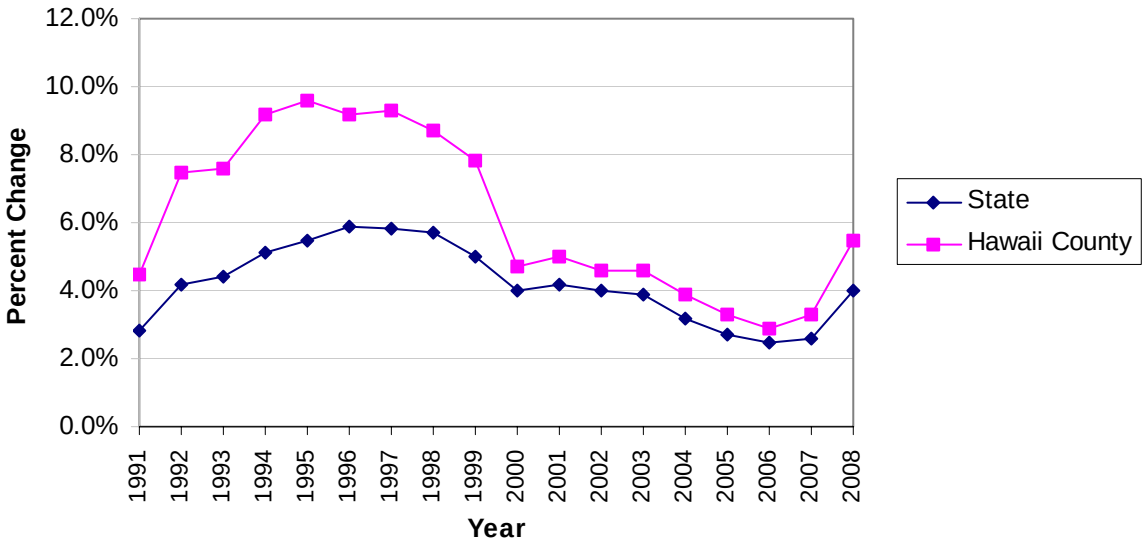
Source: DBEDT Outlook for the Economy 2009 (1st *QTR*)

Exhibit 2.2: Job Growth, State of Hawai`i and Hawai`i County, 1991-2008



Source: DBEDT Quarterly Statistical and Economic Report 2009 (1st *QTR*)

Exhibit 2.3: Unemployment Rate, State of Hawai`i and Hawai`i County, 1991-2008



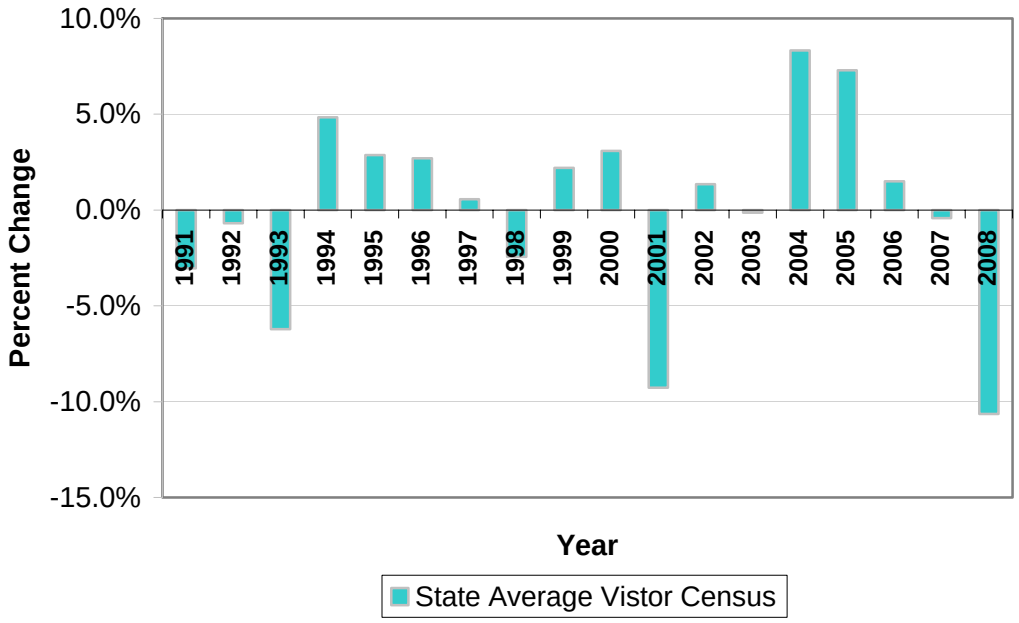
Source: DBEDT Quarterly Statistical and Economic Report 2009 (1st *QTR*)

Exhibit 2.4: Job Count, Hawai`i County, 2008 4th Quarter

	Hawai`i County		***State***	
	Job Count	**Percent**	**Job Count**	**Percent**
Total wage and salary jobs	68,150		628,550	
Total non-agriculture wage and salary jobs	65,950	97%	622,700	99%
Natural Resources, Mining, Constr.	5,200	7%	37,600	6%
Manufacturing	1,600	2%	14,950	2%
Wholesale Trade	1,650	2%	18,500	3%
Retail Trade	9,600	14%	71,100	11%
Transp., Warehousing, Util.	2,800	4%	28,700	5%
Information	650	1%	10,200	2%
Financial Activities	2,900	4%	29,450	5%
Professional & Business Services	4,850	7%	75,350	12%
Educational Services	1,150	2%	14,850	2%
Health Care & Social Services	6,400	9%	59,800	10%
Leisure and Hospitality	15800	22%	132,550	21%
Arts, Entertainment & Recreation	1,750	3%	11,000	2%
Accommodation	6,200	9%	36,550	6%
Food Services & Drinking Places	5,550	8%	57,550	9%
Other Services	2,300	3%	27,450	4%
Government	13,300	20%	129,650	21%
Federal	1,350	2%	32,700	5%
State	9,200	13%	78,400	12%
Local	2,800	4%	18,550	3%
Agricultural wage and Salary jobs	2,250	3%	5,850	1%

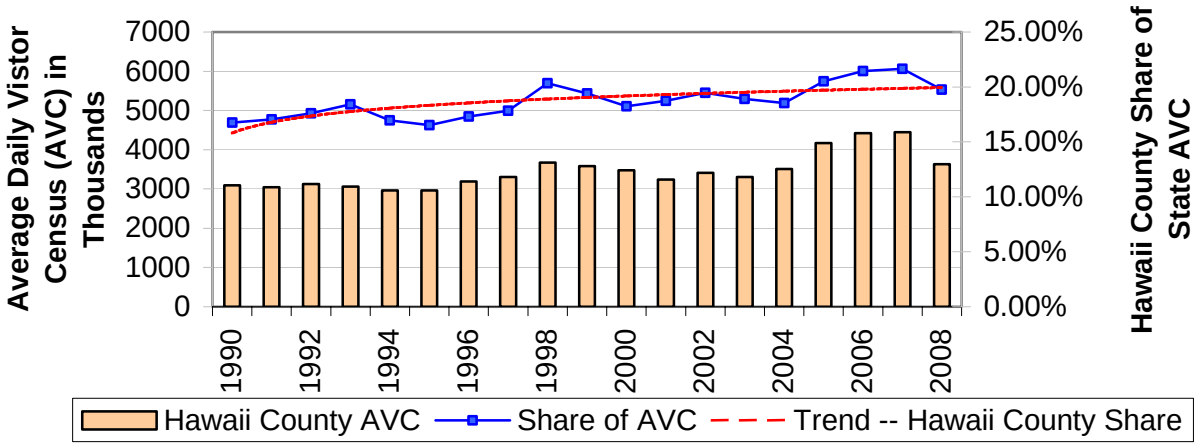
Source: DBEDT Quarterly Statistical and Economic Report, 1st Quarter 2009

Exhibit 2.5: Average Visitor Census, State of Hawai`i, 1990-2008



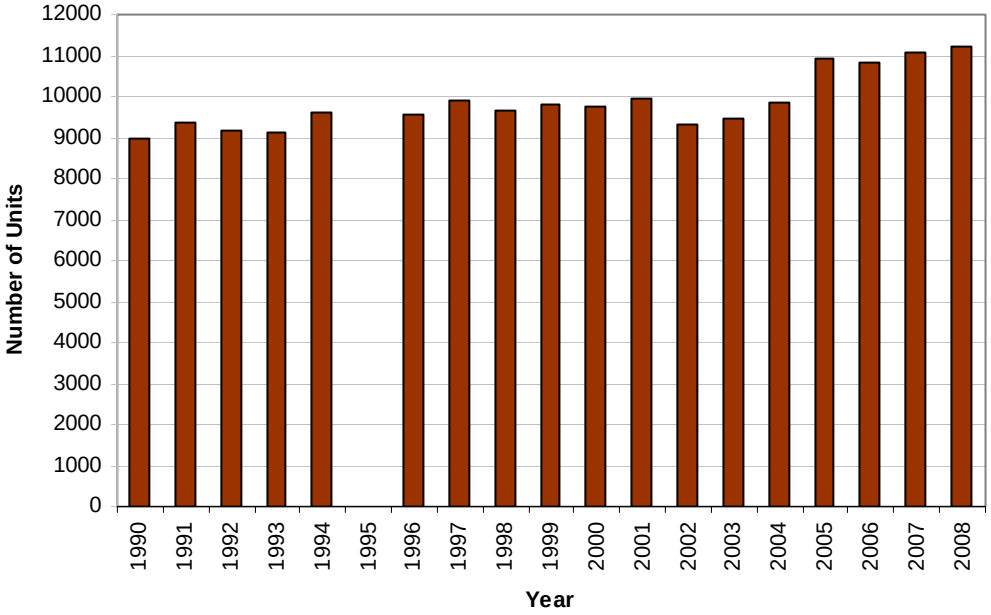
Source: UHERO Total Visitor Arrivals, 2008

Exhibit 2.6: Average Daily Visitor Census, Hawai`i County, 1990-2008



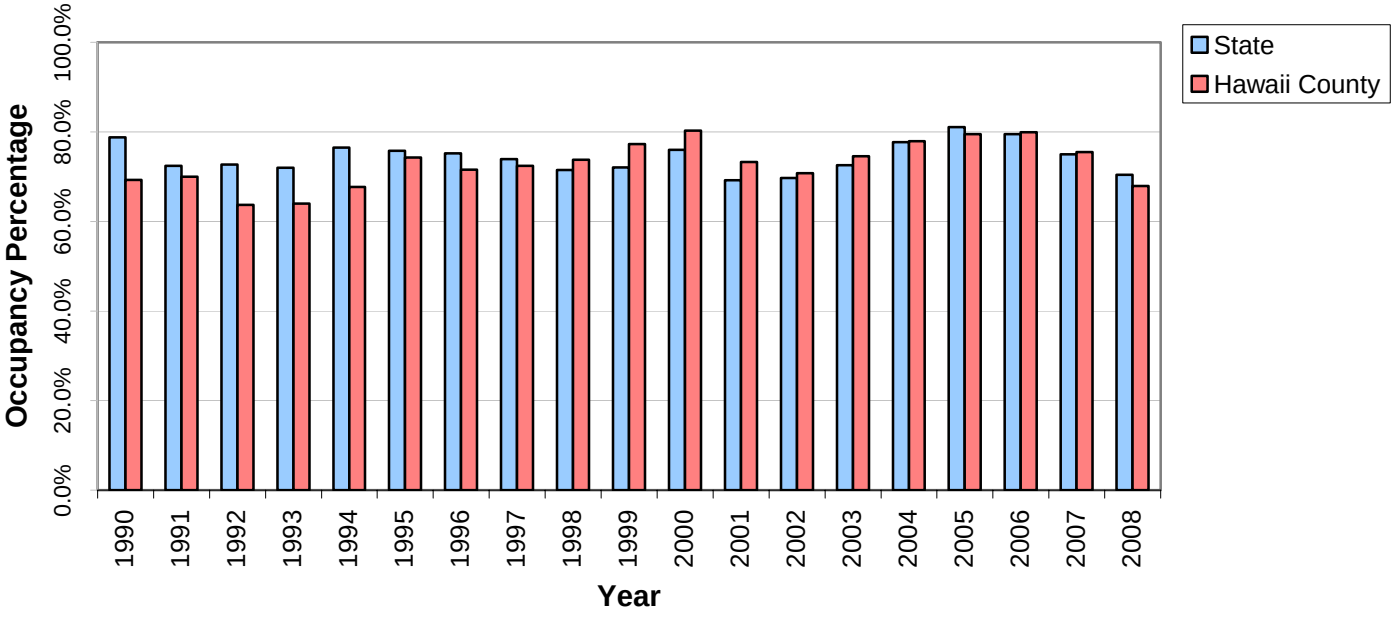
Source: UHERO Total Visitor Arrivals, 2008

Exhibit 2.7: Visitor Plant Inventory, Hawai`i County, 1990-2008



Source: DBEDT Visitor Plant Inventory 2008[3]

Exhibit 2.8: Hotel Occupancy Rate, State and County of Hawai`i, 1990-2008



Source: DBEDT Quarterly Statistical and Economic Report, 1st Quarter 2009

[3] Data for 1995 is not available.

2.1.2 South Kohala

South Kohala's economy has seen dramatic changes since the completion of Queen Ka'ahumanu Highway in the late 1970's. This two-lane highway made the South Kohala area accessible to visitors and residents alike. The roadway improvement resulted in increases in population, visitation, and the local job count. Since the completion of the Highway, many resorts, including the Hilton Waikoloa Village and the Marriott Waikoloa Beach Resort, have been added to the visitor plant along South Kohala coastline. Recent trends suggest that the South Kohala region will soon surpass other West Hawai`i areas in terms of its economic contribution.

Unfortunately, except for employment associated with the Kawaihae Harbor, employment in South Kohala is still dominated by and dependent upon the visitor industry. With the possible exception of construction employment, this imbalance is not expected to change in the years ahead.

South Kohala is made up of two larger villages, Waimea and Waikoloa, the port town of Kawaihae, and the rural areas in between. The social make-up of the areas is therefore mixed, including newer residents concentrated in along the coast, younger families in Waikoloa, and more traditional residents in the rural areas.

2.1.3 Waikoloa

In the early 1970's the Waikoloa Village Golf Course was opened and development of the surrounding community, Waikoloa Village, commenced. Since that time, Waikoloa Village has grown to house over 4,800 residents in about 1,750 homes. It is the only village of comparable size in the region for at least 15 miles. In part because it is a very new community, Waikoloa is also somewhat isolated with respect to public service access.

The Waikoloa Village community offers commercial and recreational amenities in addition to its golf course. Within the Waikoloa community there is a shopping center with a gas station, grocery store, and other retail and service businesses. The Village has a community park, tennis courts and other recreational facilities to serve its growing population. The retail and commercial areas serve its residential population well, but have not added significantly to the job count in the area.

Unlike recently completed homes along the coast, which cater to second homeowners and tourists, Waikoloa homes are primarily built for long term, local residency. Villagers are somewhat younger and more likely to have children than other areas in South Kohala. Their interests tend to center around children and family life, recreation and schools, and transportation as it affects those issues.

2.1.4 Waimea

Waimea is located to the north of the `Aina Le`a site. The village is also known as Kamuela after Samuel Parker, the founder of the Parker Ranch, one of the largest in the United States. Parker Ranch is based in Waimea and owns much of the lands around the town. Unlike plantation towns, which cluster around mills and nearby commercial areas, Waimea spreads along its major roadways.

As a ranch town, Waimea was relatively small until the 1980s. The population grew quickly from 1,179 in 1980 to 5,972 in 1990 and to approximately 8,600 residents in 2006. In the present decade, population growth continued, but at a slower pace. Today, Waimea is still the headquarters for the Parker Ranch, and also for two of the observatories on Mauna Kea. Waimea is a center of retail, health, and government facilities for the surrounding region.

All areas of the County of Hawai`i have experienced significant population growth in recent years. But Waimea's growth has not been as rapid as other areas in South Kohala. The town has maintained much of its traditional character, unique in Hawai`i for its ranch-based or paniolo flavor. We might expect residents there to be somewhat more conservative in the reactions to rapid growth, over development, and cultural change.

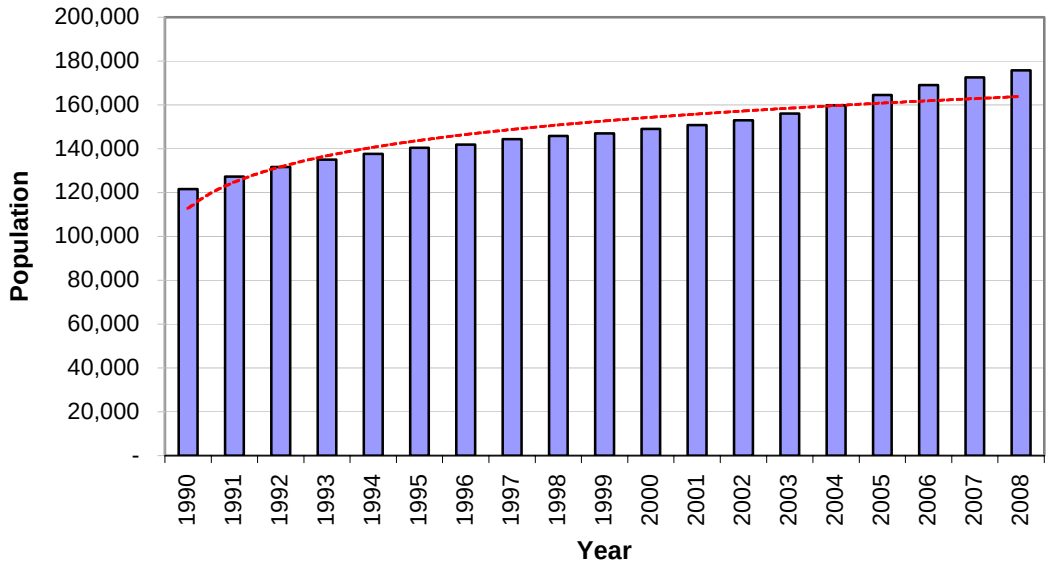
2.2 Population Context

2.2.1 Hawai`i County

Hawai`i Island is the largest of the Hawaiian Island with approximately 4,028 square miles of land area. Despite its size, it is only the second most populous county with a population of over 170,000 residents, 13.6 percent of the state population. Exhibits 2.9, 2.10 and 2.11 show the data of State's- and Hawai`i County's population growth. The 2005-2007 American Community Survey shows the estimated growth for the state and counties of Hawai`i (Exhibit 2.11). During the last six years, Hawai`i County population has increased by 17.1 percent, the largest growth rate of all the counties during this period.

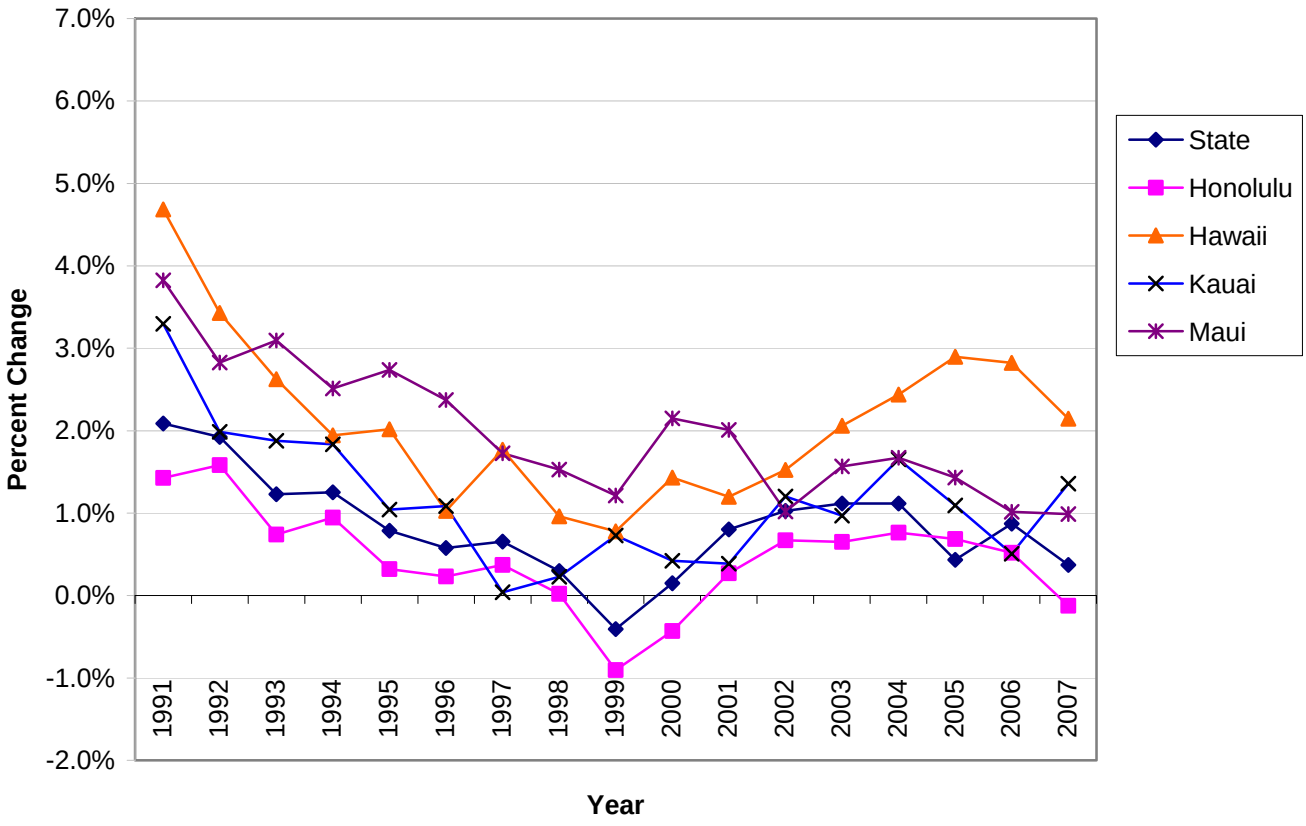
It is also important to note that the population growth rate of Hawai`i County is higher than both the State and the other Counties' growth rates (Exhibit 2.10, 2.11); in addition, predicted population projections estimate about 279,000 people by 2035 (Exhibit 2.12). With these population increases will come increases in the demand for housing and public services.

Exhibit 2.9: Hawai`i County Population, 1990-2008



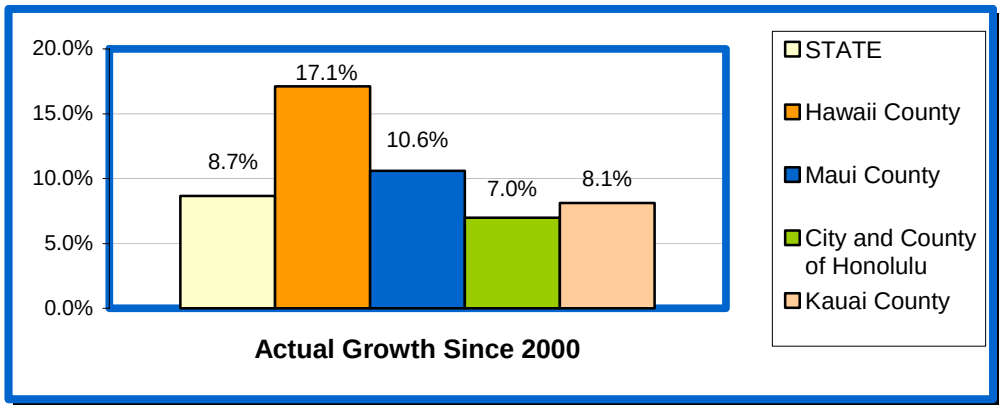
Source: UHERO Resident Population, Hawai`i County, 2008

Exhibit 2.10: Population Growth Rate, State and Counties of Hawai`i, 1990-2007



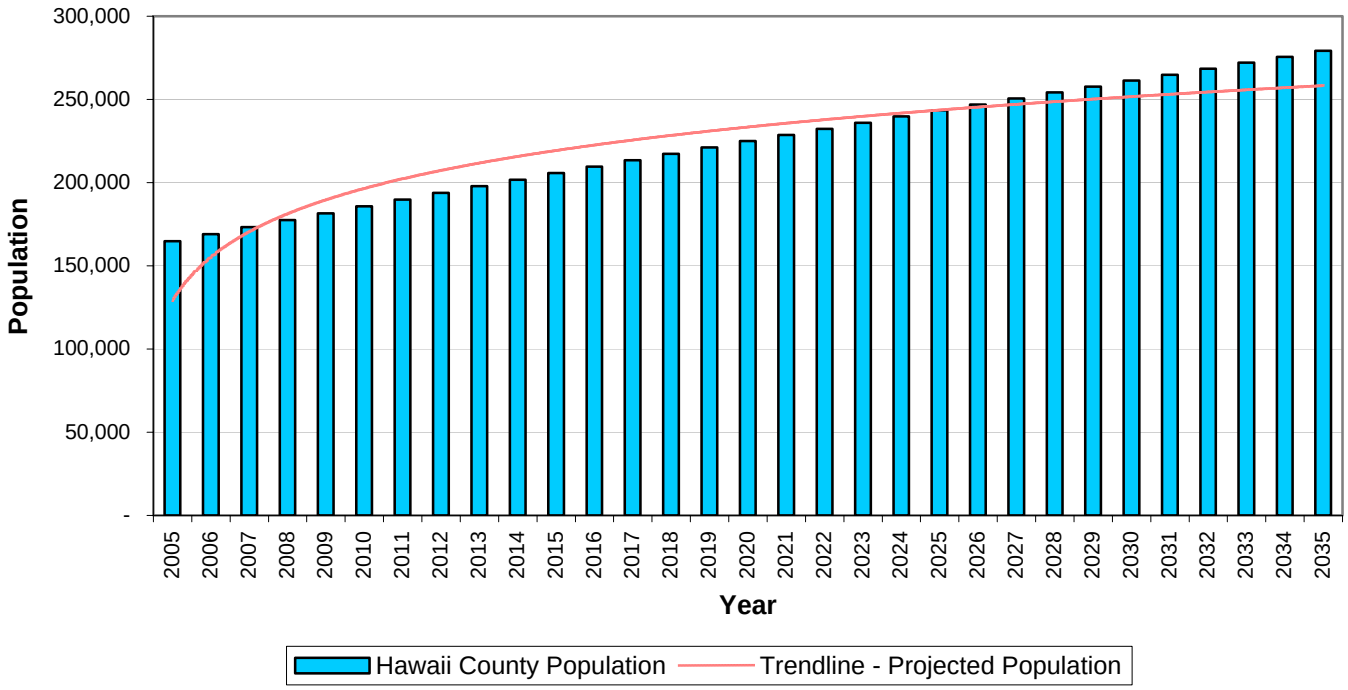
Source: DBEDT; State of Hawai`i Data Book, 2007

Exhibit 2.11: Actual Population Growth, State and Counties of Hawai`i, 2000-2007



Source: US Census Bureau, 2005-2007 American Community Survey

Exhibit 2.12: Projected Population Growth Rate, Hawai`i County, 2005-2035



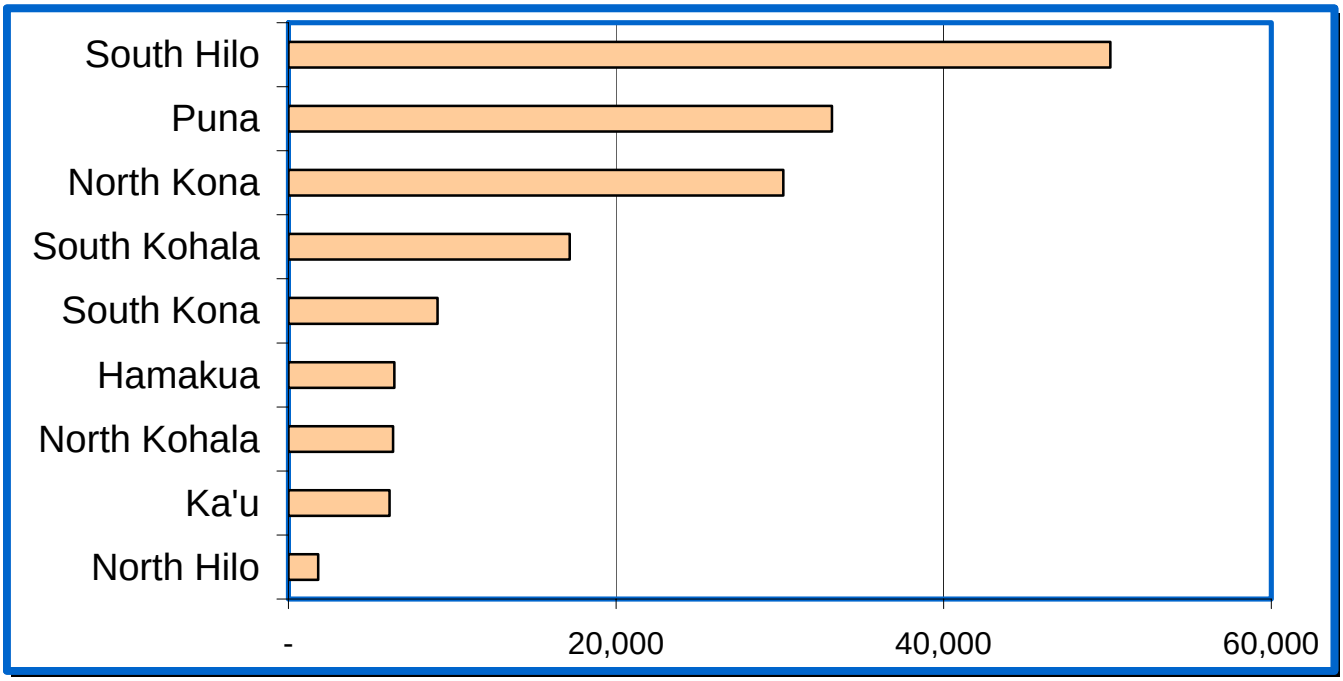
Source: Hawai`i County Data Book, Resident Population Projections, 2009

2.2.2 South Kohala

South Kohala is one of nine districts that make up Hawai`i County. The major residential areas in South Kohala include Waimea, Puako, and Waikoloa. Census figures show South Kohala with a total resident population of 13,079 in 4,648 households in 2000; and more than 17,600 estimated residents in 2009. Of those residents, approximately 4,000 are school-age children between the ages of 5 and 17.

As seen in Exhibit 2.13, South Kohala is the fourth most populous district in Hawai`i County, accounting for approximately ten percent of the County population. South Kohala experienced the greatest population growth since 1980. Its population increased by more than 140 percent over that period of time.

Exhibit 2.13: Population of Hawai`i County Districts, 2008

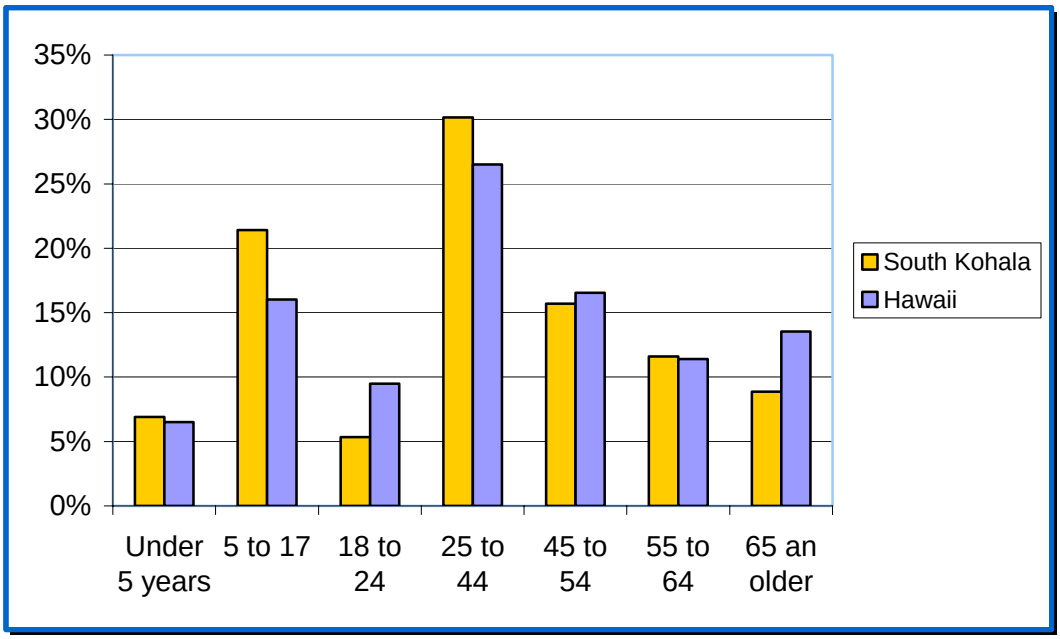


Source: U.S. Census Bureau, County of Hawai`i Data Book, 2008; SMS Estimation

The resident population of South Kohala is comprised of approximately 50 percent males and 50 percent females, which is similar to the distribution in the County and State. There is a slightly higher concentration of children under the age of 18 in South Kohala, with 33 percent compared to 23 percent in Hawai`i County (see Exhibit 2.11). Furthermore, only 24 percent of Kohala residents are seniors, compared with 25 percent Countywide.

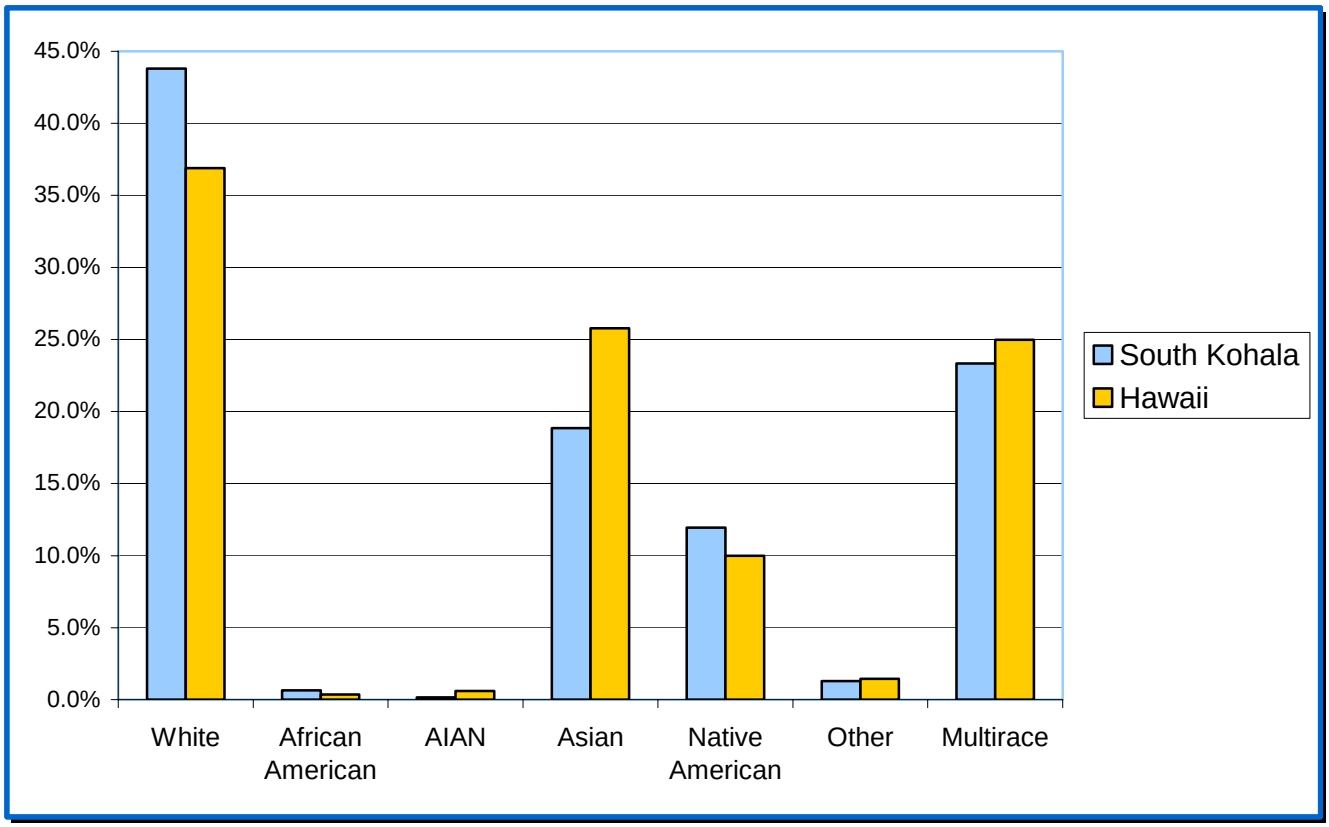
Hawai`i is one of the most racially diverse states in the U.S. Exhibit 2.12 shows that Hawai`i County and South Kohala contribute greatly to this diversity. More than 25 percent of County and South Kohala residents classify themselves as multi-racial. South Kohala has a higher concentration of Caucasians than the County (44 percent compared with 36 percent), and fewer Asians (19 percent compared with 26 percent). The increase in the Caucasian segment has been a relatively recent phenomenon.

Exhibit 2.14: Age Distribution, County of Hawai`i and South Kohala, 2007



Source: Hawai`i County Data Book (Table 1.11a) 2007; SMS Estimation

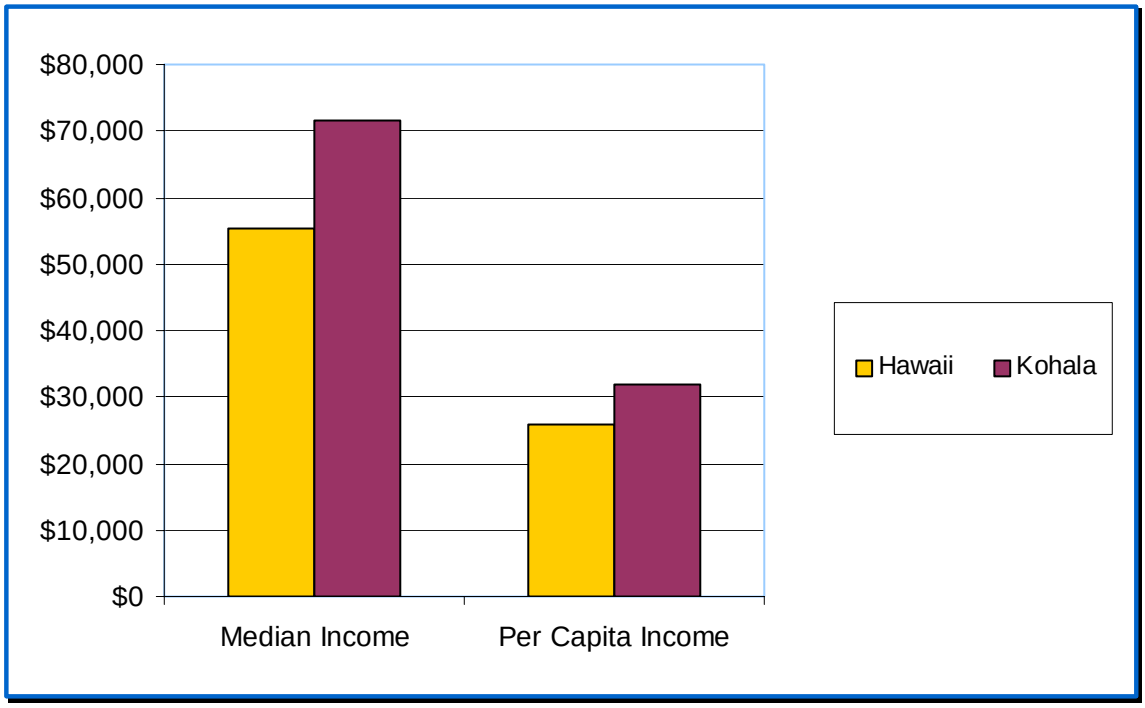
Exhibit 2.15: Racial Distribution, Hawai`i County and South Kohala, 2007



Source: U.S. Census Bureau 2007; SMS Estimation

From an economic perspective, South Kohala has higher income indicators than Hawai`i County as a whole. South Kohala residents have the highest median income at $71,548 and their per capita income, at $31,808, is second only to the North Kona District. Exhibit 2.16 presents the data for median and per capita income.

Exhibit 2.16: Household and Per Capita Income, Hawai`i County and South Kohala, 2007



Source: U.S. Census Bureau American Community Survey 2005-2007; SMS Estimation

2.3 Social Context

People in the County of Hawai`i are concerned about the pace of development in their communities and its effect on local infrastructure. This opinion was expressed repeatedly in our interviews with community leaders and public officials. It has been voiced in community meetings throughout the island, and also shows up in numerous public opinion surveys.[4]

Hawai`i County residents are pleased with recent progress and concerned about the future. During interviews SMS conducted with community leaders, the most critical problems that were expressed were the lack of affordable housing and traffic congestion. Residential development of any kind can be expected to alleviate the first and exacerbate the second of those concerns. Not everyone felt that was true. The concern over rapid development was fueled at least to some extent by the development of high-end properties in North Kona and South Kohala in recent years. As a result, many believe that "development" does not necessarily produce a solution to the affordable housing problem. It does, however, worsen the prospects for traffic into and out of the Waikoloa area, and brings up problems with access to social services and the current state of West Hawai`i infrastructure.

[4] Community meetings minutes, plans and additional information can be found on various websites dedicated to South Kohala, such as: http://www.waimeaplan.org/ or http://www.waikoloa.org.

2.3.1 Hawai`i County Overview

The Big Island is twice the size of the other Hawaiian Islands combined. Size creates a problem, not from providing basic services but from the ability to get to them. For example, there are certainly enough schools on the Island to serve a population of 32,000 school children. But families with school-age children who live in the county's rural communities may spend hours every day getting children to and from school. Their individual communities are too small to justify a new school. Similar problems affect health care, police, emergency medical facilities and in other public services, especially in West Hawai`i.

With the notable exceptions of Hilo, Kailua-Kona and Kamuela, Hawai`i Island is characterized by small towns built around rural, agrarian communities. In the past, there has been an evolving balance between the economies and populations of those communities, such that there was a sufficient population to provide workers for businesses in the area. That is no longer the case. Especially on the west side of the island, visitor industry growth now exceeds the capacity of the local population to fill the job slots. Long commutes from other areas of the island replace unemployment with turnover problems, increase traffic, and damage roadways. Development expected to provide homes for workers are filled with long-term visitors and second-home owners. South Kohala residents still have to travel significant distances for health care, shopping, schools, and other basic services. Local infrastructure, including roads and medical services are sorely taxed.

3. SOCIAL IMPACTS

3.1 Regional Social Impacts

The `Aina Le`a project, with its 2,330 units on 1,092 acres is large enough to generate an impact on the social character of the region. Nearby Waikoloa Village will certainly feel the impact, but Puako in the west and Kawaihae and Waimea in the north, will feel the effects of this large-scale development project.

3.1.1 South Kohala

On its own, the `Aina Le`a project will significantly impact the community fabric of South Kohala. If homes built there have the same average household size as the rest of the County (2.66 in 2000), `Aina Le`a will increase the population of South Kohala by 34 percent.

Considering the other development plans for South Kohala (See Exhibit 4.1 in Appendix 1), there is little doubt that the area will undergo tremendous changes over the next 10 to 15 years. The growth and its concomitant change are not directly attributable to the `Aina Le`a itself. Development of South Kohala has been a central element of County plans for decades; furthermore, it has been incorporated in the area's community plans, and has been known to local residents for many years. According to the community plan, this project will be consistent with the regional pattern of growth.

The type of units to be added will be less disruptive than their number. The lots of `Aina Le`a are not a unique product in the region. Similar lots have been and are available in various parts of Kamuela and along the coast.

3.1.2 `Aina Le`a

As a community significantly off the coastline, it is unlikely that `Aina Le`a will develop into a community dominated by tourists. Some visitors will use the commercial and recreational amenities, and second homeowners may purchase some of its high-end residences. `Aina Le`a's 385[5] affordable housing residences will serve to expand housing opportunities for South Kohala's burgeoning local population.

In all likelihood, 'Aina Le'a will develop into a diverse community whose members work throughout the region, from Kamuela to Kailua-Kona, both in and out of the visitor industry. They will be the new residents of the Waikoloa region as perceived by Hawai`i County planners two decades ago. As such, 'Aina Le'a will probably develop a character somewhere between that of Mauna Lani and Waikoloa Village. The community will have a more defined town center and will offer a wider array of commercial, recreational, and public services.

[5] The exact number of affordable units is undefined. State land use law requires `Aina Le`a to build 385 affordable residential units. County regulations specify that 20 percent of the residential units must be affordable (654 units). Furthermore, State law requires that affordable units must be built by the end of the development period, otherwise an in lieu fee is assessed. County regulations makes no specific requirement for completion dates, but begin to assess an in lieu fee for 20 percent of all units as they come online. The in lieu fee is high enough that few developers would consider delayed construction of affordable units to be an acceptable development alternative. Specifically, for completed dwellings the in lieu fee is 25 percent of the actual sales price minus the affordable price for households earning 125 percent of the median. For finished lots the in lieu fee is 25 percent of the actual sales price minus the affordable price for households earning 100 percent of the median. See also Chapter 11 of the Hawai'i County Code, section 11-4 and 11-5.

The major social impact of `Aina Le`a will be felt by the people of Waikoloa, the nearest neighbor. Waikoloa was developed in open fields just as is planned for `Aina Le`a. The development of a social character from nothing, as it were, may provide a model for the proposed development on its makai side. Regardless, the social life in the area may be negatively affected if the new development is not accompanied by increased public services like safety and security, education, and health services. If those improvements accompany new development, the people of Waikoloa Villages will benefit greatly.

Waikoloa and the rest of South Kohala can benefit from DW 'Aina Le'a's plan to connect the development with Waikoloa. The long-anticipated second town exit could be built through 'Aina Le'a to Queen Kaahumanu Highway. The proposed Community Center can serve both communities. The commercial and civic centers will be large and provide many more services and amenities than could be expected in Waikoloa Village alone.

3.2 Community Perceptions and Attitudes

Between December 10, 2007 and January 3, 2008, SMS executives interviewed 13 community leaders in the Waikoloa and South Kohala areas. In addition, between March 16 and March 27, 2009, 8 follow-up interviews were conducted with community leaders (with 5 of the 8 having been interviewed previously during the last meeting). Community leaders were very aware of the DW `Aina Le`a development and showed substantial support for the project. They were pleased at the opportunity to have commercial and public services at closer reach to their communities and generally positive about new housing the project would bring.

The community leaders identified three perceived needs[6]: The first need is a secondary access road for Waikoloa Village. The community perceives the existing single access road to Waikoloa Village to be inconvenient and a threat to public safety in times of emergency. Several informants said the situation made Waikoloa "the most dangerous cul-de-sac on the Big Island". They recounted their experience in the 2007 fire season as evidence of the danger that faces people in the area. They recalled DW `Aina Le`a's presentation of an attractive roundabout with a connection to Hulu Street, and all agreed with the proposal.

The second need is a community center. All respondents indicated that a community center is a major need in the existing community and imperative for the combined communities as `Aina Le`a is developed. Community leaders have worked with a number of developers and the County to find a suitable location and resources to fund a community center. So far, while some progress has been made, many feel they are not much closer to starting construction. Nearly all of our informants expect that the DW `Aina Le`a project will be the most appropriate champion of a Waikoloa Community Center.

The third need is for better access to public services. Again, nearly all informants felt that the DW `Aina Le`a project would provide opportunities to improve that situation. Some went beyond public services to include expanded commercial and light industrial services as well. Residents must drive to Waimea or Kona for much of their food, household goods, and hardware. An additional 14 acres of commercial space is planned by Metric Holdings for Waikoloa Village, but our informants felt still more was needed. `Aina Le`a, many felt, would contribute to the solution to these problems by: (1) providing space and infrastructure for the new services; and (2) providing political leverage to secure public service outlets in the area.

[6] Community needs are not listed in order of importance.

They expressed a belief that this development would generate a critical mass that will bring about a strong community capable of solving its own problems

In addition to the three concerns that we heard from just about all informants, a long list of comments, interests, and concerns were gathered. Not all of them represent social impacts generated by the proposed development. All of them are part of the community reaction to `Aina Le`a development plans and addressing them may be a community relation's opportunity.

The attitudes within the South Kohala Community include:

- **Confusion**: Respondents are keenly aware of the `Aina Le`a development and generally support it. However there is no consistent perspective on just what it involves. We heard many different estimates of the number of units, unit mix, and timing. All of these, we were told, came from presentations by the developer, that is, "from the horse's mouth". Some respondents "knew" there would be five golf courses, some said two golf courses, and one was certain there would be only one golf course. Consistent communication on the final objectives and the details of the project may be needed to fix community support and understanding of the development.

- **Skepticism**: A majority of the people we spoke with felt the project has been talked about for so many years that they were beginning to doubt it would ever come to fruition. The most cynical of these people expressed a belief that the owners are simply turning the wheels of the planning process without any real commitment to the project's completion.

- **Size is Not Important**: Their concern with the pace of development notwithstanding, most community leaders felt its size was not a problem for them. They know that major growth is scheduled for South Kohala and expect `Aina Le`a to be a multi-decade project. The area needs housing, especially affordable housing, in what is believed to be very large numbers. As long as this development is coordinated with other planned developments in the area, it will meet community needs. Many respondents told us that the market would determine the size and pace of development, and a few believe market demand may never justify the entire scope of `Aina Le`a.

- **Sense of Community**: South Kohala community leaders would like the development to be undertaken with a "sense of community". For some that meant adopting design and architectural elements that reflect the Hawai`i Island way of life. For others it meant that `Aina Le`a should be a place where everyone could feel that they belonged. None would be willing to accept any gated communities.

- **Golf Courses:** In the latest meeting, there was a strong shared-belief that the development cannot support and should not develop more than two golf courses. Financial difficulties at the course in Waikoloa Village were cited as evidence that the market isn't there, and the extra space could be devoted to parks and recreation areas that will better serve the community.

- **Commercial Center:** There was significant concern that the new development might not include enough commercial space. Some said simply that there was not enough commercial space to support even the basic needs of a larger population in the Waikoloa region. Others tied the issue to traffic. Without more commercial space, new residents should expect greatly increased travel times to shop for daily needs. Traffic congestion, especially traffic along Queen Kaahumanu Highway, could become critical.

- **School Traffic:** Most of our informants understood that the size of the proposed development would signal the need for at least one additional middle school and a high school. They felt that `Aina Le`a would be an ideal location for those schools. Again the issue was tied to traffic. The average trip to middle and high schools is about 30 miles from what we were told. The additional households at `Aina Le`a would add as many as 1,000 new students. If 40 percent of those students were on the road to Kona or Waimea twice a day, the impact on traffic would be significant. Most informants felt that DOE and the County would certainly understand and address the issue, and that the developers would provide the land and infrastructure for new schools.

- **Public Services**: As with other major developments, the community is concerned about safety. The topic includes the second access road, adequate police service, fire protection, and EMS or a clinic in the community. It was the informants' opinion that planning for these services were proceeding well.

- **Water Supply**: Our informants volunteered most of the issues discussed. We brought up water as an issue in all of our interviews. There is consensus that adequate water can be brought to the area from wells and no one was seriously concerned about water quality.

- **The Environment**: Community leaders were concerned about the environmental quality of the natural surroundings, especially the beaches and the ocean waters. Some were concerned about runoff during construction or pollution from golf courses. Specifically, during the most recent meeting, there were concerns expressed regarding sewage and run-off water during storms and how it would affect those who own septic tanks. There was also a concern for the people who live in Puako, in that they could be the unwilling recipients of the run-off water. Furthermore, there were others who were concerned about crowding at the beaches and overuse of ocean waters.

3.3 Public Service Impacts

3.3.1 Education

There are three public schools serving students in the Waikoloa region: Waikoloa Elementary and Intermediate School (K-8) located in Waikoloa Village, Waimea Elementary School (K-5) and Waimea Middle School (6-8) located in Kamuela, Kealakehe Elementary School (K-5) and Kealakehe High School (9-12) located just north of Kailua-Kona. The Department of Education (DOE) class size policy states that for grades K-3, schools must maintain a 20:1 ratio with a maximum of 25:1. The optimum class size for grades 4-12 is 26:1. According to the DOE's School Status and Improvement Report for 2007-08, Waikoloa public schools have an average of 15 students per classroom, well in line with DOE standards. In addition to the three public schools, there are six private schools in the region ranging from church daycare to private high schools.

The number of students in the region will rise dramatically as new residents move in. Data from the November 20, 2007 South Kohala Community Profile show that Waikoloa Elementary School will reach maximum capacity with an increase of 210 students. Waimea Middle School will reach maximum capacity with an additional 400 students.

The estimated 1,000 students[7] that `Aina Le`a will potentially add to the area cannot be accommodated by local schools without exceeding the maximum optimal class sizes. However, the developers of `Aina Le`a are evaluating whether development of a school site, an active park and community center is necessary. The revenue the state will receive in taxes from the development will aid the funding for these facilities. In addition, DOE policy requires that all new developments contribute to a school expansion fund and negotiations are underway at present to determine `Aina Le`a's fair share.

DW `Aina Le`a has set aside 32 acres outside the Urban Land Use District for a school to be developed by the Department of Education. The area is large enough to develop a middle or high school. Without extensive grading, the terrain throughout the entire development will not support the large athletic fields usually required by a high school. It would be notably less expensive to locate the area's new high school on lands to the north of `Aina Le`a that have less acute slopes.

3.3.2 Police

South Kohala's Police Main Station is in Waimea. From that station, a staff of 32 officers covers an area of 688 square miles -- an area larger than the Island of Oahu. The main station is currently 4-to-5 officers short of a full complement. They believe that with appropriate overtime, the staff can adequately handle the service area. There are two substations in the service area, one at the Mauna Lani Resort and one at the Waikoloa Golf Club. The Waikoloa substation is typically unmanned.

All indications are that the Waikoloa region will continue to be served from the South Kohala Main Station. Responses from the Police Department indicate that with some additional staff, `Aina Le`a can be adequately served. The need for additional staff was estimated to be about six full-time police officers for every 3,000 residents in the area. Additional revenue the state will receive in the form of taxes will benefit this need for additional policemen. Community leaders we interviewed are hopeful that the development at `Aina Le`a will lead to full staffing of the Waikoloa substation on a permanent basis.

DW `Aina Le`a recently proposed to designate 25 acres of land adjacent to the commercial center for a proposed civic center. The civic center would accommodate several public services identified by the community. Services might include a police substation, a fire station, or an EMS unit. Other services such as license and car registration could be included in the civic center as well.

3.3.3 Fire

There is currently a Fire Station located on Waikoloa Road near the entrance to Waikoloa Village and the South Kohala Fire Station is located just across Queen Ka`ahumanu Highway in Mauna Lani. According to the Regular Meeting Minutes of the Fire Commission for June 14, 2006, the Waikoloa Fire Station, which opened as a one-man station, recently became a two-man station. With the added support of the volunteer firemen in the region, the area is currently adequately serviced. The current station will not be able to handle the additional 2,230 new homes in `Aina Le`a and local fire stations may have to be expanded. Again, state revenues from development taxes will greatly aid in this expansion. Furthermore, a new fire station could be located in the proposed civic center, if needed.

3.3.4 EMS

Emergency Medical Services are currently located at the Waikoloa Fire Station and an emergency service helicopter is located on Queen Ka`ahumanu Highway about one mile from its intersection with Waikoloa Road. These services are more than adequate to meet current requirements for the Waikoloa region.

[7] The estimate assumes that the population of the new development will have a demographic profile similar to the population that currently resides there. We might also consider a profile with fewer children that would result from larger percentages of the units being used by second homeowners. In either case, it is likely that `Aina Le`a's new residents will place enough pressure on the school system to require substantial contributions to education.

EMS Services and the emergency service helicopter may not be sufficient to meet the needs of the area when `Aina Le`a and other developments are completed. No fixed standards are available that would suggest a requirement that DW `Aina Le`a supply additional EMS services. If they are needed in the area, EMS might be located in the proposed civic-center.

3.3.5 Parks

There is one County maintained park and one undeveloped park located in Waikoloa Village. The County maintains the larger park. It is more than two acres in size and is used primarily for baseball and soccer, with a small jungle gym for tots. There are numerous beach park locations within five miles of the intersection of Queen Ka`ahumanu Highway and Waikoloa Road. There is considerable open space surrounding the Village. Furthermore, there is approximately 20 acres of active park areas (grass play areas) within the affordable housing area, as well as over 250[8] acres of active park area within the entire development.

According to the present DW `Aina Le`a development plan, two parks are planned, one 17-acre active park and one 10-acre passive park. Together with the five-to-seven mile hiking and biking paths, and 225 acres of buffer zone between the highway and the developed area, there will be adequate park area at 'Aina Le'a. Depending on the population profile of new residents, `Aina Le`a will have as many as 5,780 new residents at build-out. County standards would therefore require about 29 acres of park space. Negotiations with the County may require the additional developed park space be delivered.

3.3.6 Road Network

South Kohala's road network consists of two main north-south highways; Queen Ka`ahumanu Highway in the west and Mamalahoa Highway in the east. Kawaihae Road connects the highways in the north and Waikoloa Road in the south. Most communities in South Kohala are located along those roads or use connector roads to access the main roadways.

The most serious issue affecting the road network is the need for a second road between Waikoloa Village and Queen Ka`ahumanu Highway. This long-awaited second access road will improve community safety and reduce traffic congestion in the area. If the roadway passes through DW `Aina Le`a's development, it will also serve to unite the two communities socially and economically; provide access to `Aina Le`a's planned community, commercial, and civic centers; and remove inter-community traffic from the main roadways.

Negotiations involving DW `Aina Le`a, Waikoloa Community representatives, and the County have been going on for some time. Technical and design problems are significant, and there is as yet to decide on the location of the second access road. All parties share a strong interest in having the second access road run through the subject development, and three possible alignments have been identified.

When the negotiations are completed the design plan for `Aina Le`a can be finalized and the developer can begin work on this important piece of infrastructure. The improvement of South Kohala's road network by adding the second access road will then stand as one of the most significant positive social impacts of the `Aina Le`a development.

[8] This includes walking trails, exercise stations, and other self-directed exercise areas.

3.3.7 Hospitals

There are no hospitals or community clinics located in Waikoloa Village or its immediate surrounding area. The nearest emergency medical facility, North Hawai`i Community Hospital, is located 18 miles away in Kamuela. Three other hospitals within 40 miles of the Waikoloa region offer emergency and urgent care services, acute care, and long-term care. Those are the Kona Community Hospital (40 miles), Kohala Hospital (35 miles) and Hale Ho'ola Hamakua (32 miles). Across the County critical care hospitalization decreased 17 percent between 1995 and 2005. Long-term care admissions more than doubled between 1993 and 2005. In 2006, there was an average of 2.3 beds per 1,000 people. No new facilities are planned, but zoning has been approved for the North Hawai`i Community Hospital in Waimea to expand their medical facilities.

South Kohala community leaders and their fellow residents are not concerned with the number of acute and long-term care beds in the County. They are worried about access to hospitals. On one hand that shifts their interest to emergency medical services. On the other there is interest in an urgent care clinic and basic health care services within the Waikoloa region.

DW `Aina Le`a has recently been interviewing several clinics which serve both local residents and special tourist services to build into this project. In addition, DW has also proposed that a privately operated urgent care medical services be located in the commercial center. That would serve the important medical needs of local residents and alleviate some of the burden on hospitals in the area.

Exhibit 4.1: Economic Summary

Economic Impact – Summary		
Overview		
Project Size	1,092 Acres	
Project Location	South Kohala (County of Hawaii)	
Total Number of Units (Affordable Housing + Market Rate Units)	2,330 units	
	First Year	**First Five Years**
Affordable Housing	385	-
Market Rate Units	-	1763
Costs and Earnings		
Construction Costs (DW Aina Lea Estimate)	$40,700,000	$2,562,600,000
Construction Worker Earnings (Estimation)	$11,688,057	$1,285,647,125
Employment		
Projected Employment (Estimation)		
Direct Employment[9]	164	5578
Indirect Employment	83	2877
Induced Employment	103	3558
Taxes		
Total Taxes (Estimation)	$1,667,717	$189,714,780
Income Taxes	$792,456	$36,505,918
Property Taxes	$662,296	$75,716,875
General Excise Taxes	$212,965	$77,491,987

[9] Measured in Person-Years of Employment

4. ECONOMIC IMPACT

The economic impact of the DW `Aina Le`a development project will have a significant positive effect on Hawaii's economy. The entire development project will add approximately $429 million[10] in taxes to the state's revenue. In addition to other taxes, about $74 million will be derived from income taxes, $12.8 million will be derived from property taxes, and $102 million will be derived from general excise taxes. Approximately 44,000 person-years of employment will be created during the eight year development plan, resulting in a decrease in the unemployment rate of Hawaii County, as well as an increase in local spending from the developers (for materials, subcontractors, etc) and from the individual workers.

This section of the report will highlight the extent of these impacts, and will provide estimates utilizing both information obtained through state sources, as well as in-house economic models developed by SMS. The technical terms used in this section are to distinguish impacts of several sorts. First, in economic analysis, a distinction is made between impacts of the actual construction and operations of a project, and the effects of project-related spending throughout the local economy. In discussions of jobs and revenue, three broad types are distinguished:

- *Direct* effects are immediately involved with construction of a project or with its operations. For example, in the context of job creation, direct employment would be created with the apportioned labor costs.
- *Indirect* effects are created as businesses directly involved with a project purchase goods and services in the local economy.
- *Induced* effects are created as workers spend their income for goods and services.

It is important to note that direct employment is not necessarily located at the site of a project. As a rule of thumb, about 20% of direct construction jobs are off-site (in base yards, offices, and the like). Indirect and induced jobs are created throughout the state. These are likely to be concentrated in commercial and/or industrial centers, rather than near a job site.

4.1 Employment

For this project, estimates are made on a 10-year full build out schedule with 5 years allocated toward infrastructure construction and 6 years allocated toward the construction of new homes.

Total Construction for this project is estimated at $5.3 billion. This construction spending will have a positive impact on the local economy by creating jobs and spending in related industries. Exhibit 4.1 shows that the direct workforce (as a result of this project) will include some 8,054 person-years of employment[11]. Using multipliers from the State Input-Output model, direct, indirect, and induced effects of the Aina Lea development spending were computed.

Indirect and induced jobs will also be created throughout the state. SMS estimates that this project will support some 9,189 indirect and induced person-years of employment. Both indirect and induced employment is produced through the flow of revenue through the local economy. That is, as a result of the construction spending for the `Aina Le`a development project, additional jobs will be created both indirectly (e.g. through subcontractors) and also in an induced fashion (e.g. through retail-service jobs that are created from additional spending of the construction workers). In total, approximately 17,243 person-years of employment will be created through infrastructure and home construction.

[10] Computed using the state's 2005 Input-Output model.

[11] Person-years of employment are the number of full time equivalent positions required to complete the work defined by the estimated cost of construction during the specific period of time.

Not all of these indirect and induced jobs will be created on the island of Hawai`i. Many industries that support Hawai`i-based construction efforts are not located in the islands or on the Big Island. However, SMS' experience suggests that approximately 14,567 person-years will be located on the Big Island[12].

Construction workers' earnings are shown in Exhibit 4.2. These earnings will also boost the local economy, as many of these dollars will be used to purchase goods and services from other industries.

Exhibit 4.2: Construction Employment

Job Types	*Person-Years of Employment*
Direct Employment	8,054
Indirect & Induced Employment	9,189
Subtotal	17,243
On-island	14,567

Exhibit 4.3: Construction Workers' Earnings

Construction Workers' Earnings	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Cumulative
Direct earnings[13]	6.0	13.4	84.9	178.2	388.1	209.7	179.6	175.7	0.0	0.0	1235.5
Indirect earnings	2.8	6.1	38.0	79.5	172.9	93.4	80.0	78.2	0.0	0.0	550.8
Induced earnings	2.9	6.3	40.0	83.9	182.7	98.7	84.5	82.7	0.0	0.0	581.9
Total	**11.7**	**25.8**	**162.8**	**341.6**	**743.7**	**401.8**	**344.1**	**336.7**	**0.0**	**0.0**	**2368.2**

[12] Includes direct construction work and 75 percent of indirect and induced work.
[13] In millions of 2009 constant $
Source: DBEDT, State Input-Output Study, 2005

Exhibit 4.4: Construction Employment

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Cumulative
Phase 1 - Infrastructure											
Construction spending[14]	19.7	9.5	-	-	-	-	-	-	-	-	29
Direct workforce	140	67									207
Indirect workforce	71	34									106
Induced workforce	88	42									131
Phase 2 - Infrastructure											
Construction spending	-	-	11.0	11.0	3.0	-	-	-	-	-	25
Direct workforce			78	78	21						177
Indirect workforce			40	40	11						91
Induced workforce			49	49	13						112
Townhouses											
Construction spending	3.4	3.8	5.8	-	-	-	-	-	-	-	13
Direct workforce	24	27	41								92
Indirect workforce	12	14	21								47
Induced workforce	15	17	26								58
Golf Course											
Construction spending	-	-	6.0	7.5	-	-	-	-	-	-	14
Direct workforce			58	73							131
Indirect workforce			6	8							14
Induced workforce			27	34							60
Shopping Center											
Construction spending	-	-	45.0	-	-	-	-	-	-	-	45
Direct workforce			243								243
Indirect workforce			151								151
Induced workforce			196								196
RM-4											
Construction spending	-	-	-	97	65.16	-	-	70.80	-	-	233
Direct workforce				688	462			502			1,653
Indirect workforce				351	236			257			844
Induced workforce				433	291			317			1,041
RM-7											
Construction spending	-	-	-	-	129	-	53.40	-	-	-	182
Direct workforce					915		379				1,294
Indirect workforce					468		194				661
Induced workforce					577		239				816
RM-14.5											
Construction spending	-	-	40	15	89	259.20	115.20	75.60	-	-	594
Direct workforce			284	106	632	1,839	818	537			4,216
Indirect workforce			145	54	323	940	418	274			2,153
Induced workforce			179	67	398	1,159	515	338			2,657
Total (Employment)	**374**	**215**	**1,745**	**2,112**	**4,634**	**4,197**	**2,730**	**2,371**	**-**	**-**	**17,150**

[14] In Millions of 2009 constant $

Source: DBEDT, State Input-Output Study, 2005

4.2 Tax Impact

The total area of development for this project is estimated at 1,092 acres. The level of construction is estimated at $5.3 billion and this level of construction will result in $196.5 million in direct state tax revenues. The indirect and induced impact of this project will result in $233.3 million in state tax revenues. In total, this project will result in an estimated $429.8 million[15] in state tax revenues. These state tax revenues will stimulate the state economy. Furthermore, the new residential units that will be developed will result in County tax revenues via property taxes. Some of these property taxes will come from new residents of Hawaii County and the resultant in-migration while other tax revenues will come from residents' relocation from other Big Island areas. For this reason, it should not be assumed that 100 percent of these property taxes represent new tax revenues.

In total, the estimated 2,230 new homes could result in approximately $12.8 million in property tax revenues. These estimates are based on KBCG's estimates[16] of potential unit sizing and pricing, in combination with the value per square foot of neighboring Waikoloa Village homes applied to the different-sized units. This amount of property taxes would represent approximately nine percent of the total property taxes collected.[17] The `Aina Le`a development project will result in property taxes that will be assessed on land and home that overall are more valuable than the surrounding Waikoloa Village homes. The trend is that property taxes are higher for more valuable units. As a result, the amount of property taxes could be even higher than the figures estimated here.

In addition to property taxes, the state will receive approximately $102 million in general excise taxes from the sales of all homes planned by the development project; consequently, this will be a further boon to the local Hawaiian economy. Furthermore, the revenue obtained through construction workers' income taxes (approximately $74 million over the entire scope of the project), will provide the state with additional positive income and will be especially welcomed during this current economic recession. Exhibit 4.5 shows a breakdown of estimated income tax revenues by year for the entire project. Other tax revenues will also be generated via taxes on utilities and other taxable services provided to local residents by the local government. This project requires no significant government contribution to complete and will have a positive fiscal impact on both the State and Hawaii County.

Exhibit 4.5: Total State Tax Revenues

State Taxes	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Cumulative
Direct[18]	0.56	1.74	13.14	28.13	62.14	33.68	28.85	28.22			196.47
Indirect	0.54	1.26	8.15	17.15	37.43	20.23	17.33	16.95			119.04
Induced	0.56	1.25	7.86	16.48	35.88	19.38	16.60	16.24			114.25
Total	**1.67**	**4.25**	**29.15**	**61.76**	**135.45**	**73.29**	**62.78**	**61.42**			**429.75**

[15] See Exhibit 4.4
[16] See Knowledge Based Consulting Group's `Aina Le`a marketing study
[17] Based on fiscal year 2008
Source: County of Hawaii, Comprehensive Annual Financial Report 2008
[18] In millions of 2009 constant $
Source: DBEDT, State Input-Output Study, 2005

Exhibit 4.6: Income Tax Revenues

Construction Type	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Cumulative
Phase 1 - Infrastr.[19]	0.62	0.62									1.24
Phase 2 - Infrastr.			0.72	0.72	0.20						1.63
Townhouses	0.17	0.82	0.38								1.37
Golf Course			0.39	0.49							0.88
Shopping Center			2.94								2.94
RM-4				6.33	4.26			4.63			15.22
RM-7					8.43		3.49				11.92
RM-14.5			2.61	0.98	5.82	16.94	7.53	4.94			38.82
Grand Totals	**0.79**	**1.44**	**7.04**	**8.52**	**18.70**	**16.94**	**11.02**	**9.57**			**74.03**

In sum, the development at Aina Lea will affect both the economy on the Big Island, as well as in the larger state economy in a very positive fashion. Many jobs will be generated through direct funding by developers, and additional employment will also be created as those funds flow through the local economy. The state will also benefit from the approximate $429 million in total taxes; this total tax figure is composed of many sources, including (but not limited to): income taxes, general excise taxes, and property taxes. Thus, there can be little doubt that the Aina Lea development project will have a significant positive impact on employment, workers' earnings, and state revenue on the island of Hawaii.

5. MITIGATION MEASURES

As part of this social impact assessment, SMS met with DW `Aina Le`a to review project impacts and discuss mitigations. The developer has considered and acted upon virtually all of the issues we discovered during our assessment. Many of those social impacts and associated mitigating actions have been presented throughout the report. Summary statements are presented below.

Local community leaders understand the social impacts of the DW `Aina Le`a residential development in South Kohala. Very few of those impacts cause them serious concern. The community seems to support the proposed development; to accept it as part of planned growth for South Kohala; and to welcome the added housing, commercial and recreational benefits it will bring. We hasten to add that their support is based on their expectation that the development will begin soon, be phased over several years, will be consistent with the North Hawai`i lifestyle and design, and will bring the promised benefits.

In some cases, planning or negotiations on mitigations are in progress, and the details of mitigating actions have not been finalized. Those areas are summarized below.

Golf Courses: The study has concluded that many residents in the area are concerned that too many golf courses will not be economically feasible or socially acceptable to the community. Evaluation of the economic feasibility of golf courses is outside the scope of this report. It is clear, however, that the community would prefer that the number of golf courses be minimized

Second Access Road: As we finalize this report, discussions of the most appropriate and effective route for the second access road are continuing. In our judgment the problems are more technical than political or economic. The developer, the county, and the community need to continue their efforts to find a feasible and mutually acceptable route.

[19] In millions of 2009 constant $

Schools: Further negotiations will have to be conducted to reach a final agreement on the location of schools. Locating elementary and intermediate schools do not seem to be a serious issue. It appears, however that locating a high school within the proposed development at `Aina Le`a may not be the best option for the community.

Parks: The developer has made provision for sufficient park area. It may require some additional negotiations for county and community to determine exactly where as which types of parks will be more effective for the residents in the area.

Continued negotiations for some social service areas may also produce changes in the current mitigation plans for services such as police, fire, and emergency medical services.