DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8480 • Fax: (808) 768-4567
Web site: www.honolulu.gov

FILE COPY
FEB 08 2016

KIRK CALDWELL
MAYOR

ROBERT J. KRONING, P.E.
DIRECTOR

MARK YONAMINE, P.E.
DEPUTY DIRECTOR

CDD-B 16-639423

January 22, 2016

RECEIVED
'16 JAN 27 P3:36
OFC. OF ENVIRONMENTAL
QUALITY CONTROL

Virginia Pressler, M.D., Director of Health
Office of Environmental Quality Control
State Department of Health
235 South Beretania Street, Suite 702
Honolulu, Hawaii 96813

Dear Dr. Pressler:

SUBJECT: Draft Environmental Assessment for the Salt Lake Boulevard Widening, Phase 3 Project

With this letter, the City and County of Honolulu Department of Design and Construction hereby transmits the Draft Environmental Assessment and Anticipated Finding of No Significant Impact (DEA-AFONSI) for the Salt Lake Boulevard Widening, Phase 3 (Maluna Street to Ala Lilikoi Street), situated at TMKs (1) 1-11-10, 1-1-17, 1-1-18, 1-1-21, and 1-1-71 in the Honolulu District on the island of Oahu for publication in the next available edition of the Environmental Notice.

Enclosed is a completed OEQC Publication Form, two copies of the DEA-AFONSI, an Adobe Acrobat PDF file of the same, and an electronic copy of the publication form in MS Word. Simultaneous with this letter, we have submitted the summary of the action in a text file by electronic mail to your office.

If there are any questions, please contact Jeremy-Joel Lee at 768-8809 or our consultant, John Kirkpatrick of Belt Collins Hawaii LLC, at 521-5361.

Very truly yours,

Robert J. Kroning, P.E.
Director

JKL:HK:pto

Enclosures

FILE COPY
FEB 08 2016

July 2015 Revision

AGENCY ACTION SECTION 343-5(b), HRS PUBLICATION FORM

Project Name: Salt Lake Boulevard Widening, Phase 3 (Maluna Street to Ala Liliko'i Street)
HRS §343-5 Trigger(s): Use of government lands and funds
Island: **O'ahu**
District: **Honolulu**
TMK: **(1) 1-11-10, 1-1-17, 1-1-18, 1-1-21, and 1-1-71.**
Permits: National Environmental Policy Act (NEPA); Endangered Species Act (ESA), Section 7 consultation; National Historic Preservation Act (NHPA), Section 106 consultation; U.S. Navy authorization (for use of any Navy land); Chapter 6E, HRS review; Hawai'i Coastal Zone Management (CZM) federal consistency review; Clean Water Act (CWA), Section 402, NPDES Permit; Design Exception for Federal Highway Administration approval; Construction Permits

Proposing/Determination Agency:
Department of Design and Construction, City and County of Honolulu, 650 S. King Street, 11th Floor, Honolulu, HI 96813, Jeremy-Joel Lee, (808) 768-8809

Accepting Authority:
(for EIS submittals only)

Consultant:
Belt Collins Hawaii LLC, 2153 N. King Street, Suite 200, Honolulu, HI 96819, John Kirkpatrick (808) 521-5361

Status (check one only):

_x_DEA-AFNSI — Submit the proposing agency notice of determination/transmittal on agency letterhead, a hard copy of DEA, a completed OEQC publication form, along with an electronic word processing summary and a PDF copy (you may send both summary and PDF to oeqchawaii@doh.hawaii.gov); a 30-day comment period ensues upon publication in the periodic bulletin.

__FEA-FONSI — Submit the proposing agency notice of determination/transmittal on agency letterhead, a hard copy of the FEA, an OEQC publication form, along with an electronic word processing summary and a PDF copy (send both summary and PDF to oeqchawaii@doh.hawaii.gov); no comment period ensues upon publication in the periodic bulletin.

__FEA-EISPN — Submit the proposing agency notice of determination/transmittal on agency letterhead, a hard copy of the FEA, an OEQC publication form, along with an electronic word processing summary and PDF copy (you may send both summary and PDF to oeqchawaii@doh.hawaii.gov); a 30-day consultation period ensues upon publication in the periodic bulletin.

__Act 172-12 EISPN — Submit the proposing agency notice of determination on agency letterhead, an OEQC publication form, and an electronic word processing summary (you may send the summary to oeqchawaii@doh.hawaii.gov). NO environmental assessment is required and a 30-day consultation period upon publication in the periodic bulletin.

__DEIS — The proposing agency simultaneously transmits to both the OEQC and the accepting authority, a hard copy of the DEIS, a completed OEQC publication form, a distribution list, along with an electronic word processing summary and PDF copy of the DEIS (you may send both the summary and PDF to oeqchawaii@doh.hawaii.gov); a 45-day comment period ensues upon publication in the periodic bulletin.

__FEIS — The proposing agency simultaneously transmits to both the OEQC and the accepting authority, a hard copy of the FEIS, a completed OEQC publication form, a distribution list, along with an electronic word processing summary and PDF copy of the FEIS (you may send both the summary and PDF to oeqchawaii@doh.hawaii.gov); no comment period ensues upon publication in the periodic bulletin.

__ Section 11-200-23

Determination — The accepting authority simultaneously transmits its determination of acceptance or nonacceptance (pursuant to Section 11-200-23, HAR) of the FEIS to both OEQC and the proposing agency. No comment period ensues upon publication in the periodic bulletin.

__Section 11-200-27 Determination — The accepting authority simultaneously transmits its notice to both the proposing agency and the OEQC that it has reviewed (pursuant to Section 11-200-27, HAR) the previously accepted FEIS and determines that a supplemental EIS is not required. No EA is required and no comment period ensues upon publication in the periodic bulletin.

__Withdrawal (explain)

Summary (Provide proposed action and purpose/need in less than 200 words. Please keep the summary brief and on this one page)**:**

The City and County of Honolulu (City) is proposing to expand Salt Lake Boulevard between Maluna Street and Ala Liliko'i Street from two lanes to four lanes (2 eastbound, 2 westbound) and include a median, dedicated bike lanes, sidewalk, and on-street parking. This project would increase the capacity of the boulevard to accommodate existing and projected traffic volumes through the years ahead. It would complete the final segment section of the overall Salt Lake Boulevard widening project from Pu'uloa Road and Kahuā'paani Street that initially started in the late 1970s. Three alternative road widening concepts, plus a "no action" alternative, were considered for the project. Except for the "no action" alternative, all of the alternatives include basic design elements: widening from two travel lanes to four travel lanes with a median/left-turn storage lane, provision of on-street parking, addition of bike lanes and improved sidewalks, and installation of stormwater drainage systems.Alternatives A and B include underground detention basins to retain stormwater; Alternative C includes bioswales.The provision of dedicated bike lanes is consistent with the City's "complete streets" program to include public street facilities to accommodate all modes of transportation. The addition of a parking lane within the right-of-way would allow adjacent residents to continue on-street parking fronting their homes. The median could serve as a left-turn storage lane and allow eastbound vehicles to turn left into adjacent residential driveways or serve as a spatial buffer and landscaped feature between the eastbound lanes and the westbound lanes. All improvements would be constructed within the boulevard's existing right-of-way, except for some areas that require minor grading modifications at intersection approaches and drainage system connections, and, in one alternative, retaining walls in the adjacent downslope property,

RECEIVED
'16 JAN 27 P3:36
OFC. OF ENVIRONMENTAL
QUALITY CONTROL

DRAFT
ENVIRONMENTAL ASSESSMENT

SALT LAKE BOULEVARD WIDENING—PHASE 3
Maluna Street to Ala Liliko‘i Street

Prepared for:

Department of Design and Construction
City and County of Honolulu

Department of Transportation
Highways Division
State of Hawai‘i

Federal Highway Administration
U.S. Department of Transportation

DRAFT
ENVIRONMENTAL ASSESSMENT

SALT LAKE BOULEVARD WIDENING–PHASE 3
Maluna Street to Ala Liliko‘i Street

February 2016

For review by:

Department of Design and Construction
City and County of Honolulu

Department of Transportation
Highways Division
State of Hawai‘i

Federal Highway Administration
U.S. Department of Transportation

Table of Contents

Executive Summary ES-1

Chapter 1
Purpose and Need

1.1 Introduction and Background 1-1
1.2 Purpose And Need 1-1
1.3 Public Involvement 1-7

Chapter 2
Proposed Action And Alternatives

2.1 Introduction 2-1
2.2 Proposed Action 2-1
2.2.1 Alternative A–Limited On-Street Parking, Striped Median, And Overhead Utilities 2-1
2.2.1.1 Alternative A Proposed Improvements 2-1
2.2.1.2 Alternative A Construction Schedule and Cost 2-5
2.2.2 Alternative B–Limited On-Street Parking, Raised Landscaped Median, And Overhead Utilities 2-11
2.2.2.1 Alternative B Proposed Improvements 2-11
2.2.2.2 Alternative B Construction Schedule and Cost 2-12
2.2.3 Alternative C–Full On-Street Parking, Raised Landscaped Median, Underground Utilities, And Use Of U.S. Navy Land 2-19
2.2.3.1 Alternative C Proposed Improvements 2-19
2.2.3.2 Alternative C Construction Schedule and Cost 2-23
2.2.4 Alternative D–No Action 2-25
2.2.5 Summary Of Proposed Action Alternatives 2-25
2.3 Alternatives Considered But Not Carried Forward For Analyses 2-26
2.3.1 Alternative Designs/Road Features 2-27
2.3.2 Alternative Alignment 2-30
2.3.3 Alternative Transportation System 2-30
2.3.4 Alternative Traffic Management 2-31

Chapter 3
Affected Natural Environment,Potential Impacts, and Mitigation Measures

3.1 Introduction 3-1
3.2 Geology, Topography, And Soils 3-1
3.2.1 Affected Environment 3-1
3.2.2 Environmental Consequences 3-4
3.2.2.1 Alternative A 3-4
3.2.2.2 Alternative B 3-9
3.2.2.3 Alternative C 3-10
3.2.2.4 Alternative D–No Action 3-11
3.2.3 Mitigation Measures 3-11
3.3 Hydrology 3-11
3.3.1 Affected Environment 3-11
3.3.2 Environmental Consequences 3-12
3.3.2.1 Alternative A 3-12
3.3.2.2 Alternatives B and C 3-14
3.3.2.3 Alternative D–No Action 3-15
3.3.3 Mitigation Measures 3-15
3.4 Natural Hazards 3-15
3.4.1 Affected Environment 3-15
3.4.2 Environmental Consequences 3-16
3.4.2.1 Alternative A 3-16
3.4.2.2 Alternatives B and C 3-16
3.4.2.3 Alternative D–No Action 3-16
3.4.3 Mitigation Measures 3-17
3.5 Flora And Fauna 3-17
3.5.1 Affected Environment 3-17
3.5.2 Environmental Consequences 3-18
3.5.2.1 Alternative A 3-18
3.5.2.2 Alternatives B and C 3-19
3.5.2.3 Alternative D–No Action 3-19
3.5.3 Mitigation Measures 3-19

Chapter 4
Affected Man-Made Environment, Potential Impacts and Mitigation Measures

4.1 Introduction 4-1
4.2 Land Use And Land Tenure 4-1
4.2.1 Affected Environment 4-1
4.2.2 Environmental Consequences 4-2
4.2.2.1 Alternative A 4-2
4.2.2.2 Alternative B 4-4
4.2.2.3 Alternative C 4-4
4.2.2.4 Alternative D–No Action 4-5
4.2.3 Mitigation Measures 4-5
4.3 Transportation 4-5
4.3.1 Affected Environment 4-5
4.3.1.1 Public Roadways 4-5
4.3.1.2 Public Transit 4-9
4.3.1.3 Bicycle Travel 4-9
4.3.1.4 Pedestrian Travel 4-9
4.3.1.5 Parking Beside Salt Lake Boulevard 4-11
4.3.2 Environmental Consequences 4-11
4.3.2.1 Alternative A 4-11
4.3.2.2 Alternative B 4-14
4.3.2.3 Alternative C 4-14
4.3.2.4 Alternative D-No Action 4-15
4.3.3 Mitigation Measures 4-16
4.4 Air Quality 4-18
4.4.1 Affected Environment 4-18
4.4.2 Environmental Consequences 4-19
4.4.2.1 Alternative A 4-19
4.4.2.2 Alternative B 4-19
4.4.2.3 Alternative C 4-19
4.4.2.4 Alternative D–No Action 4-20

4.4.3 Mitigation Measures 4-20
4.5 Noise Environment 4-20
4.5.1 Affected Environment 4-20
4.5.2 Environmental Consequences 4-21
4.5.2.1 Alternative A 4-21
4.5.2.2 Alternative B 4-23
4.5.2.3 Alternative C 4-23
4.5.2.4 Alternative D–No Action 4-23
4.5.3 Mitigation Measures 4-23
4.6 Visual Resources 4-24
4.6.1 Affected Environment 4-24
4.6.2 Environmental Consequences 4-25
4.6.2.1 Alternative A 4-25
4.6.2.2 Alternative B 4-25
4.6.2.3 Alternative C 4-25
4.6.2.4 Alternative D–No Action 4-26
4.6.3 Mitigation Measures 4-26
4.7 Archaeological And Cultural Resources 4-26
4.7.1 Affected Archaeological Resources 4-26
4.7.2 Affected Cultural Resources 4-28
4.7.3 Environmental Consequences 4-29
4.7.3.1 Alternative A 4-29
4.7.3.2 Alternatives B and C 4-29
4.7.3.3 Alternative D–No Action 4-29
4.7.4 Mitigation Measures 4-29
4.8 Socio-economic 4-30
4.8.1 Affected Environment 4-30
4.8.2 Environmental Consequences 4-33
4.8.2.1 Alternative A 4-33
4.8.2.2 Alternative B 4-35
4.8.2.3 Alternative C 4-35
4.8.2.4 Alternative D–No Action 4-36

4.8.3 Mitigation Measures 4-36
4.9 Utilities 4-36
4.9.1 Affected Environment 4-36
4.9.1.1 Water 4-36
4.9.1.2 Sewer 4-37
4.9.1.3 Storm Drainage 4-37
4.9.1.4 Electricity/Telecommunications 4-40
4.9.1.5 Traffic Signals and Street Lighting 4-40
4.9.1.6 Fuel and Gas 4-40
4.9.2 Environmental Consequences 4-41
4.9.2.1 Water 4-41
4.9.2.2 Sewer 4-41
4.9.2.3 Storm Drainage 4-42
4.9.2.4 Electricity/Telecommunications 4-44
4.9.2.5 Fuel and Gas 4-45
4.9.3 Mitigation Measures 4-46
4.10 Public Facilities And Services 4-46
4.10.1 Affected Environment 4-46
4.10.1.1 Police, Fire and Medical Services 4-46
4.10.1.2 Schools 4-46
4.10.1.3 Public Parks 4-46
4.10.2 Environmental Consequences 4-46
4.10.3 Mitigation Measures 4-47

Chapter 5
Relationship to Public Policies and Programs

5.1 Introduction 5-1
5.2 Relationship To Federal Laws and Executive Orders 5-1
5.2.1 National Environmental Policy Act 5-1
5.2.2 National Historic Preservation Act 5-1
5.2.3 Coastal Zone Management Act 5-2
5.2.4 Clean Water Act 5-2

5.2.5 Clean Air Act ... 5-3
5.2.6 Endangered Species Act ... 5-3
5.2.7 Fish And Wildlife Coordination Act ... 5-4
5.2.8 Migratory Bird Treaty Act ... 5-4
5.2.9 Compliance With Executive Orders ... 5-4
5.2.9.1 EO 12898, Environmental Justice in Minority Populations and Low Income Populations ... 5-4
5.2.9.2 EO 13045, Protection of Children from Environmental Health Risks and Safety Risks ... 5-5
5.2.9.3 EO 13112, Invasive Species ... 5-5
5.2.10 U.S. Department Of Transportation Act, Section 4(F) ... 5-5
5.2.11 Environmental Protection Agency's Sole Source Aquifer ... 5-6
5.2.12 American Association of State Highway and Transportation Officials ... 5-6
5.3 Hawai'i Revised Statutes, Chapter 343 ... 5-6
5.4 Hawai'i State Plan ... 5-6
5.4.1 Overview ... 5-6
5.4.2 Hawai'i State Plan ... 5-7
5.4.3 Hawai'i 2050 Sustainability Plan ... 5-15
5.5 State Environmental Policy ... 5-16
5.6 Hawai'i Coastal Zone Management Program ... 5-17
5.7 Hawai'i Climate Change Initiative: Act 286 Of 2012 ... 5-21
5.8 Hawai'i State Functional Plans ... 5-21
5.8.1 State Transportation Functional Plan (1991) ... 5-22
5.8.1.1 Goals of the Plan ... 5-22
5.8.1.2 Conformance with the Plan ... 5-22
5.9 Hawai'i State Land Use Law ... 5-22
5.10 Hawai'i Revised Statutes, Chapter 6e, Historic Preservation ... 5-24
5.11 State "Complete Streets" Policy ... 5-24
5.12 City And County Of Honolulu ... 5-24
5.12.1 General Plan for O'ahu ... 5-25
5.12.2 Primary Urban Center Development Plan ... 5-29
5.12.3 Land Use Ordinance ... 5-29

5.12.4 Special Management Area 5-30
5.12.5 City "Complete Streets" Policy 5-33
5.13 List of Required Environmental Permits and Consultations 5-34

Chapter 6
Cumulative Analysis

6.1 Introduction 6-1
6.2 Salt Lake Boulevard Widening–Increments 1 And 2 6-1
6.3 Other City Projects In Project Area 6-1
6.3.1 Āliamanu Wastewater Pump Stations 6-1
6.3.2 City Wastewater System Upgrades 6-1
6.3.3 Honolulu Rail Transit Project 6-2
6.4 Other Independent Projects In Project Vicinity With Potential Impacts 6-2
6.4.1 Major Residential Projects 6-2
6.4.2 Major State Projects 6-3
6.5 Cumulative Impacts On The Construction Industry 6-4
6.6 Further Analysis Of Cumulative Impacts 6-4
6.6.1 Roadways And Transportation 6-5
6.6.2 Contributions To Climate Change 6-5

Chapter 7
Summary of Impacts

7.1 Summary of Impacts 7-1
7.2 Anticipated Determination 7-10

Chapter 8
ther Considerations

8.1 Relationships Between Short-Term Uses and Long-Term Productivity 8-1
8.2 Irreversible And Irretrievable Commitments Of Resources By The Proposed Action 8-1
8.3 Probable Adverse Environmental Impacts Which Cannot Be Avoided 8-2

Chapter 9
List of Preparers 9-1

Chapter 10
References 10-1

List of Tables

Table 1-1 Existing 2011 Peak Hour LOS at Intersections Along Salt Lake Boulevard–Phase 3 1-5
Table 1-2 Projected 2040 Peak Hour LOS at Intersections Along Salt Lake Boulevard–Phase 3 1-5
Table 2-1 Possible Shrubs and Groundcover in Shoulder Areas and Bioswale 2-4
Table 4-1 LOS Definitions 4-8
Table 4-2 Existing (2011) Conditions LOS 4-8
Table 4-3 Project Impact Summary 4-11
Table 4-4 Alternative A Traffic Operating Conditions (LOS) 4-13
Table 4-5 Alternatives A, B and C Traffic Operating Conditions (LOS) Comparison 4-15
Table 4-6 Alternative D (No Action Alternative) Traffic Operating Conditions (LOS) 4-17
Table 4-7 Noise Prediction Results for Locations Along Phase 3 4-21
Table 4-8 Typical Construction Equipment Noise Levels 4-22
Table 4-9 Demographic Information from the 2010 Census 4-32
Table 4-10 Economic Characteristics, from the 2006 to 2010 American Community Survey 4-32
Table 4-11 Construction Jobs and Wages 4-34
Table 5-1 Hawaii State Plan–HRS Chapter 226, Part I 5-8
Table 5-2 Coastal Zone management–HRS Chapter 205A 5-17
Table 5-3 Honolulu General Plan 5-25
Table 5-4 List of Consultations, Approvals, and Permits for the Salt Lake Boulevard Widening—Phase 3 Project 5-34
Table 7-1 Summary of Potential Impact by Proposed Action Alternatives 7-1

List of Figures

Figure 1-1 Location Map 1-2
Figure 1-2 Salt Lake Boulevard Widening Project 1-3
Figure 2-1 Salt Lake Boulevard Widening–Phase 3 2-6
Figure 2-2 Alternative A Typical Section 2-7
Figure 2-3 Alternative A Alignment Plan 2-8
Figure 2-4 Alternative A Alignment Plan 2-9
Figure 2-5 Alternative A Landscape Section 2-10
Figure 2-6 Alternative B Typical Section 2-13
Figure 2-7 Alternative B Typical Section (High Cut Area) 2-14
Figure 2-8 Alternative B Alignment Plan 2-15
Figure 2-9 Alternative B Alignment Plan 2-16
Figure 2-10 Alternative B Landscape Section 2-17
Figure 2-11 Alternative B Landscape Section (High Cut Areas) 2-18
Figure 2-12 Alternative C Typical Section 2-20
Figure 2-13 Alternative C Alignment Plan 2-21
Figure 2-14 Alternative C Alignment Plan 2-22
Figure 2-15 Alternative C Landscape Section 2-24
Figure 2-16 Typical Road Widening Concept with Multi-Use Pathway Option 2-28
Figure 3-1 General Topography 3-3
Figure 3-2 Soils 3-4
Figure 4-1 Existing Land Use 4-2
Figure 4-2 Major Land Owners 4-3
Figure 4-3 Traffic Count Locations 4-6
Figure 4-4 TheBus Transportation Routes UPDATED 4-10
Figure 4-5 Census Tracts along the Salt Lake Boulevard Corridor 4-31
Figure 4-6 Existing Utilities (Western Part of Phase 3) 4-38
Figure 4-7 Existing Utilities (Eastern Part of Phase 3) 4-39
Figure 5-1 State Land Use District 5-23
Figure 5-2 Primary Urban Center Development Plan Map Excerpt 5-31
Figure 5-3 City Zoning 5-32

Appendices

Appendix A Public Input
Appendix B Traffic Impact Assessment Report
Appendix C Air Quality Study
Appendix D Noise Study

Acronyms and Abbreviations

AAQS	Ambient Air Quality Standards
AASHTO	American Association of State Highway and Transportation Officials
ADA	American with Disabilities Act
BMP	best management practice
BWS	Honolulu Board of Water Supply
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
City	City and County of Honolulu
CO	carbon monoxide
CO_2	carbon dioxide
CPI	Consumer Price Index
CWA	Clean Water Act of 1977
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act of 1972
dBA	Decibels, A-weighted scale
DBEDT	Department of Business, Economic Development and Tourism (State of Hawai‘i)
DDC	Department of Design and Construction, City and County of Honolulu
DDC-MED	Department of Design and Construction–Mechanical/Electrical Division, City and County of Honolulu
DFM	Department of Facilities Maintenance, City and County of Honolulu
DLNR	Department of Land and Natural Resources, State of Hawai‘i
DOE	Department of Education, City and County of Honolulu

Acronyms and Abbreviations

DOH	Department of Health, State of Hawai‘i
DOT	Department of Transportation, State of Hawai‘i
DOT-H	Department of Transportation, Highways Division, State of Hawai‘i
DES	Department of Environmental Services, City and County of Honolulu
DPP	Department of Planning and Permitting, City and County of Honolulu
DTS	Department of Transportation Services, City and County of Honolulu
EA	Environmental Assessment
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
F	Fahrenheit
FEMA	Federal Emergency Management Agency
FEMP	Federal Energy Management Program
FHWA	Federal Highway Administration
FWCA	Fish and Wildlife Coordination Act
FIRM	Flood Insurance Rate Map
GHG	greenhouse gas
GHGRP	Greenhouse Gas Reporting Program
GWP	global warming potential
HAR	Hawai‘i Administrative Rules
HART	Honolulu Authority for Rapid Transit
HCDA	Hawai‘i Community Development Authority
HCM	Highway Capacity Manual
HDOT	State Department of Transportation–Highways Division
HECO	Hawaiian Electric Company
HFD	Honolulu Fire Department
HRS	Hawai‘i Revised Statutes
HTEL	Hawaiian Telcom
IPCC	Intergovernmental Panel on Climate Change
kV	kilovolt

Acronyms and Abbreviations

LID	Low Impact Development
LOS	Level of Service
LUC	Land Use Commission
MBTA	Migratory Bird Treaty Act
MED	Mechanical/Electrical Division
MG	million gallons
MMTCO2Eq	million metric tons of carbon dioxide equivalent
MSL	mean sea level
NAAQS	National Ambient Air Quality Standards
NAICS	North American Industrial Classification System
NEPA	National Environmental Policy Act
NHO	Native Hawaiian Organization
NHPA	National Historic Preservation Act
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resource Conservation Service
O_3	ozone
OEQC	Office of Environmental Quality Control
OMPO	Oʻahu Metropolitan Planning Organization
ORTP	Oʻahu Regional Transportation Plan
OTWC	Oceanic Time Warner Cable
PA	programmatic agreement
PER	Preliminary Engineering Report
$PM_{2.5}$	2.5 microns or less
PM_{10}	10 microns or less
PUC	Primary Urban Center Public Utilities Commission
PUC	Public Utilities Commission
ROW	right of way
SDOT	State Department of Transportation
SHPD	State Historic Preservation Division
SLUC	State Land Use Commission
SO_2	sulfur dioxide

Acronyms and Abbreviations

TCP	traffic control plan
TheBus	O‘ahu Transit Services Inc.
TNM 2.5	Traffic Noise Model
TSS	Total Suspended Solids
TWSC	two-way stop controlled
UBC	Uniform Building Code
UNFCCC	United Nations Framework Convention on Climate Change
USC	United States Code
USDOT	U.S. Department of Transportation
USFWS	U.S. Fish and Wildlife Service
WWPS	Waste Water Pump Station

Executive Summary

Executive Summary

DRAFT
ENVIRONMENTAL ASSESSMENT
Salt Lake Boulevard Widening–Phase 3

This Draft Environmental Assessment (EA) has been prepared to meet the requirements of Chapter 343, Hawai‘i Revised Statutes (HRS), as amended, and Hawai‘i Administrative Rules (HAR) Title 11, State of Hawai‘i Department of Health, Chapter 200, Environmental Impact Statement Rules. The Final EA would also be in compliance with the requirements of Chapter 343, HRS, and the National Environmental Policy Act (NEPA) of 1969, as amended (Pub. L. 91-190, 42 US Code 4321-4347), Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations 1500-1508), and 23 Code of Federal Regulations 771, Environmental Impact and Related Procedures.

PROJECT NAME
Salt Lake Boulevard Widening–Phase 3

PROPOSING AGENCY
City and County of Honolulu
Department of Design and Construction
650 South King Street, 15th Floor
Honolulu, Hawai‘i 96813

ACCEPTING AGENCY FOR THE DRAFT EA
City and County of Honolulu
Department of Design and Construction
650 South King Street, 15th Floor
Honolulu, Hawai‘i 96813

LOCATION
Salt Lake Boulevard between Maluna Street and Ala Liliko‘i Street
Honolulu District
Island of O‘ahu

TAX MAP KEY
First District: 1-11-10, 1-1-17, 1-1-18, 1-1-21, and 1-1-71.

PROPOSED ACTION

The City and County of Honolulu (City) is proposing to expand Salt Lake Boulevard between Maluna Street and Ala Liliko‘i Street from two lanes to four lanes (two eastbound, two westbound) and include a median, dedicated bike lanes, sidewalk, and on-street parking. This project would increase the capacity of the boulevard to accommodate existing and projected traffic volumes through the years ahead. It would complete the final section of the overall Salt Lake Boulevard widening project from Pu‘uloa Road and Kahuā‘paani Street that initially started in the late 1970s. Three alternative road widening concepts, plus a “no action” alternative, were considered for the project. Except for the “no action” alternative, all of the alternatives include five basic design elements: widening from two travel lanes to four travel lanes with a median/left-turn storage lane, provision of on-street parking, addition of bike lanes and improved sidewalks, and installation of stormwater drainage systems. Alternatives A and B include underground detention basins to retain stormwater; Alternative C includes bioswales.

The provision of dedicated bike lanes is consistent with the City’s “complete streets” program to include public street facilities to accommodate all modes of transportation. The addition of a parking lane within the right-of-way would allow adjacent residents to continue on-street parking fronting their homes. The median could serve as a left-turn storage lane and allow eastbound vehicles to turn left into adjacent residential driveways or serve as a spatial buffer and landscaped feature between the eastbound lanes and the westbound lanes. All improvements including shoulder improvements and retaining walls would be constructed within the boulevard’s existing right-of-way, except for some areas that require minor grading modifications at intersection approaches and drainage system connections, and in one alternative, retaining walls in the adjacent downslope property, as described in Chapter 2.

POTENTIAL IMPACTS

During construction, short-term temporary impacts are expected to be generated by construction vehicles, machinery, and tools and equipment involved in site preparation, road construction, landscaping, and cleanup. Probable impacts would include fugitive dust, construction noise, erosion and sedimentation, and traffic slowdowns and detours through the construction area.

Construction of the road improvements is not expected to displace any existing residences or community facilities. No impacts are anticipated on any archaeological or cultural resources nor any endangered or threatened flora or fauna species. Depending on the final road widening design, use of the adjacent Navy land might be necessary. In that case, Navy authorization would be required and a NEPA environmental review triggered by use of Federal land as well as Federal funds.

When construction is completed and the widened road is in full operation, potential impacts would include improved traffic flow through the Salt Lake Boulevard corridor, increased

traffic noise, improved street lighting, safer pathways for bicyclists and pedestrians, controlled on-street parking, and a visually enhanced roadway environment. The speed limit is expected to match the completed portions of the overall Salt Lake Boulevard widening project.

PROPOSED MITIGATION

During construction, best management practices (BMPs) would be employed to control fugitive dust. In compliance with state statutory and regulatory requirements, measures would be implemented to minimize noise generated from the construction site. For erosion and sedimentation control, BMPs would be applied as required under National Pollutant Discharge Elimination System (NPDES) permits. Net increases in storm water runoff would be contained on-site under City requirements.

A City-approved traffic control plan would be implemented to minimize construction impact on traffic through the project corridor. Should use of any Navy land be required for the road widening, approval from the proper federal authorities would be first obtained.

ANTICIPATED FINDING OF NO SIGNIFICANT IMPACT

Construction of the proposed action would be in compliance with federal, State, and City land use and environmental laws and regulations, and implementation of the project would occur with the above proposed mitigation measures. This EA is also being prepared to satisfy NEPA requirements. However, under Chapter 343 HRS, it is anticipated that a Finding of No Significant Impact would be determined for the proposed action.

REQUIRED PERMITS AND APPROVALS

The proposed action alternatives are consistent with State and City land use policies and plans. Reviews, permits, and approvals anticipated for this project (construction permits are not included) are listed below and described in Chapter 5 of this document.

- National Environmental Policy Act (NEPA)
- Endangered Species Act (ESA), Section 7 informal consultation
- National Historic Preservation Act (NHPA), Section 106 consultation
- U.S. Navy authorization for use of any Navy land
- Chapter 343, HRS
- Chapter 6E, HRS
- Hawaiʻi Coastal Zone Management (CZM) federal consistency review
- Clean Water Act (CWA), Section 402, NPDES Permit
- Design Exception for Federal Highway Administration approval

PARTIES CONSULTED DURING EARLY CONSULTATION

Federal Agencies

- Federal Highway Administration (FHWA)
- U.S. Fish and Wildlife Service (USFWS)
- U.S. Navy

State of Hawai'i

- Department of Transportation (DOT), Highways Division
- Department of Land and Natural Resources (DLNR), State Historic Preservation Division (SHPD)
- Department of Education (DOE), Āliamanu Intermediate School

City and County of Honolulu

- Department of Planning and Permitting (DPP)
- Department of Transportation Services (DTS)
- Department of Environmental Services (DES)
- Department of Facilities Maintenance (DFM)
- Department of Parks and Recreation
- Honolulu Board of Water Supply (BWS)
- Traffic Review Branch, DPP
- Police Department
- Honolulu Fire Department

Others

- Honolulu Authority for Rapid Transportation
- Utility and telecommunication companies
- Forest City Hawaii
- Livable Communities Hawaii
- Island Family Christian Church
- Chevron Hawaii
- AT&T

In addition, input was obtained from the community at a Neighborhood Board meeting in September 2011 and a public informational meeting on the project in April 2012 (see Appendix A).

Chapter 1

Purpose and Need

CHAPTER 1

Purpose and Need

1.1 INTRODUCTION AND BACKGROUND

This environmental assessment (EA) is being prepared for the final phase of the City and County of Honolulu's (City) Salt Lake Boulevard Widening Project (see Figure 1-1). Since City action and land are involved, a Chapter 343, Hawai'i Revised Statutes (HRS), environmental document is being prepared. Further, as Federal-aid highway funding would be sought for the project's implementation, this EA is designed to be in compliance with the National Environmental Policy Act (NEPA) (42 United States Code [USC] § 4321, et seq.) as administered by the national Council on Environmental Quality (CEQ).

The Environmental Impact Statement (EIS) for the original Salt Lake Boulevard Widening Project, from Pu'uloa Road to Kahuapā'ani Street, was approved by the FHWA on February 4, 1977. Since that date, construction on the project occurred in phases starting with Increment 1, Phases 1 and 2, which extended from Pu'uloa Road to Ala Liliko'i Street. Construction of that section was completed in the early 1980s. Construction of Increment 2, Phases 1 and 2, which extended from Kahuapā'ani Street to Maluna Street, was completed in 2005.

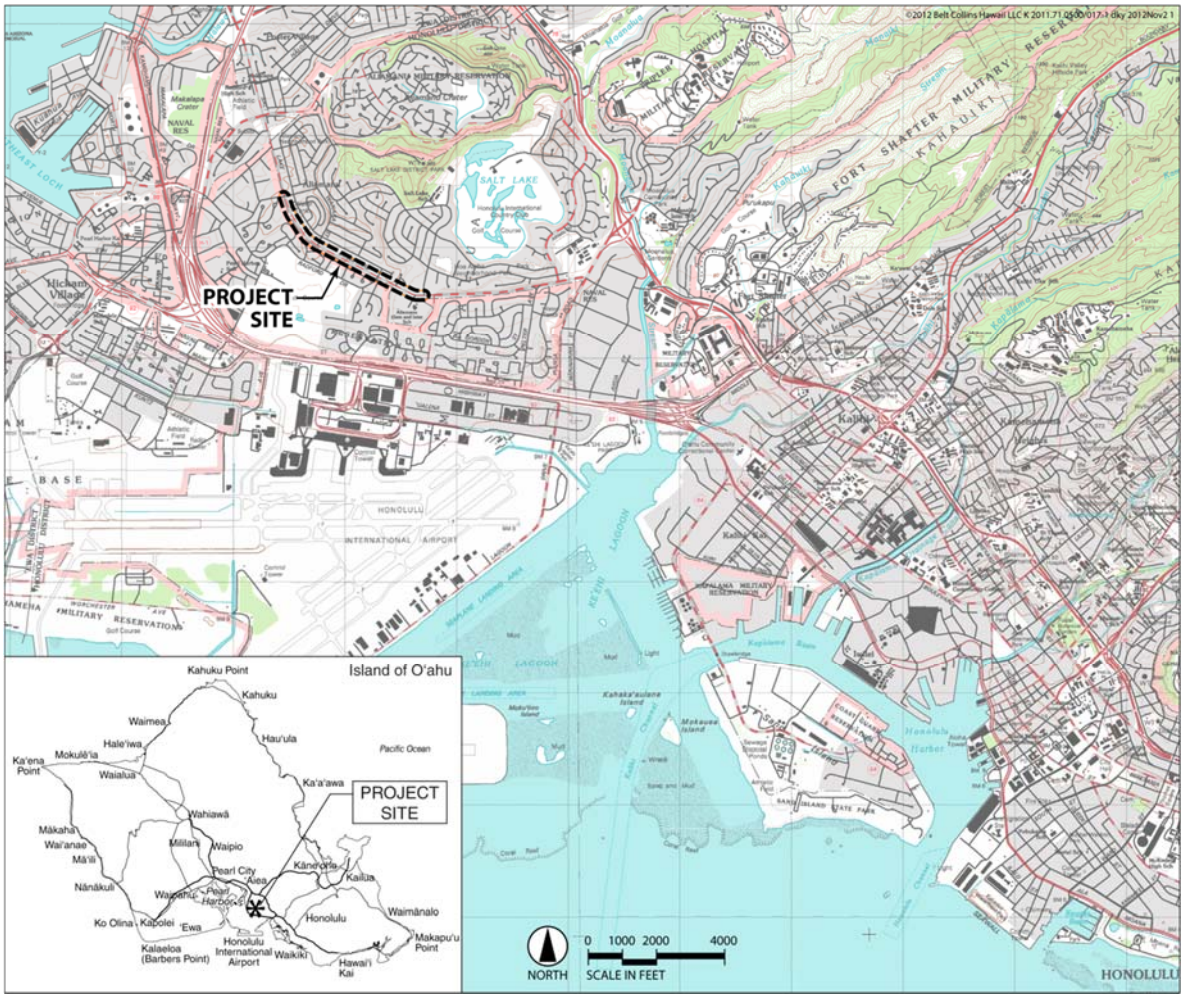
Salt Lake Boulevard Widening Project Increments and Phases (see Figure 1-2)

Increment 1	Phase 1	Pu'uloa Road to Peltier Avenue (constructed in late 1970s)
	Phase 2	Peltier Avenue to Ala Liliko'i Street (constructed in early 1980s)
Increment 2	Phase 1	Kahuapā'ani Street to Bougainville Drive (constructed in mid to late 1980s and 1990s)
	Phase 2	Bougainville Drive to Maluna Street (constructed in 2005)
	Phase 3	Maluna Street to Ala Liliko'i Street (proposed)

Since the start of the Salt Lake Boulevard Widening Project in the late 1970s, conditions in the community changed and new environmental review requirements evolved, requiring a re-evaluation of the impacts associated with subsequent phases. In 1996, the City prepared an EA for Increment 2, Phase 2, and a notice of its availability was published in the Office of Environmental Quality Control's (OEQC) The Environmental Notice. Since that publication, revisions were made to the design of the Phase 2 road section, and a revised EA was prepared and announced in the OEQC bulletin in 2001.

1.2 PURPOSE AND NEED

The purpose of the Salt Lake Boulevard Widening–Phase 3 project is to reduce traffic congestion and delays on the one-mile section of Salt Lake Boulevard between Maluna Street and Ala Liliko'i Street. The location of this Phase 3 section of the Salt Lake Boulevard Widening Project and its relationship to Increment 1, Phases 1 and 2 and Increment 2, Phases 1 and 2 are shown in Figure 1-2.



1 **Figure 1-1. Location Map**

1 **Figure 1-2. Salt Lake Boulevard Widening Project**

In preparation of the EA for the proposed Increment 2, Phase 3 (Phase 3) Salt Lake Boulevard Widening Project, findings of the earlier documents described above were reviewed for relevant background information. This EA document analyzes current alternative concepts for the proposed action in relation to present environmental conditions in compliance with current environmental requirements.

The full length of Salt Lake Boulevard is a collector road for traffic generated in the Salt Lake, Foster Village, Hālawa, Makalapa, and Navy housing communities located inland or north of the Honolulu International Airport. This boulevard also serves as a connector right-of-way for the adjacent neighborhoods, including Māpunapuna, Āliamanu, Moanalua, and Aloha Stadium areas.

The purpose and need for the original 2.8-mile Salt Lake Boulevard Widening Project, between Puʻuloa Road and Kahuapāʻani Street, stated:

> "The project is needed because the present facility is inadequate to serve the growing needs of the surrounding communities. With the ultimate development of the surrounding area, traffic conditions will become intolerable. The City and County elects to improve the existing roadway because of this necessity, its central location, existing wide right-of-way of 100-feet width which has been set aside for roadway purposes, and because other alignments or alternatives are either impractical or will cause much greater environmental impact on the surrounding communities."

In years prior to the 1977 Salt Lake Boulevard Widening Project EIS, development of nearby residential subdivisions, schools, shopping centers, churches, and recreational facilities generated increases in traffic volumes and a need to expand the then existing two-lane Salt Lake Boulevard to multiple lanes. In later years, results from a 1996 updated traffic study[1] confirmed the need to widen Salt Lake Boulevard as described in the 1977 EIS.

A 2012 traffic study was conducted for this EA (see Appendix B) to update the traffic study completed in 1996. This study reconfirmed the occurrence of congestion along Salt Lake Boulevard particularly at the intersections in Phase 3 (see Table 1-1). The study estimated that traffic volumes would continue to increase at a rate of 1.27 percent per year, and that current congestion would worsen if no improvements are made between Maluna Street and Ala Liliko'i Street. Projections in the 2012 Highway Capacity Manual study show that the signalized intersections at Salt Lake Boulevard and Wanaka Street and Salt Lake Boulevard

[1] City and County of Honolulu, Department of Design and Construction and U.S. Department of Transportation, Federal Highway Administration. May 2001. *Final Environmental Assessment for the Salt Lake Boulevard Widening Phase 2 – Bougainville Drive to Reeves Street.*

and Likini Place would reach Level of Service (LOS) F or overcapacity conditions (see Table 1-2).[2]

Table 1-1. Existing 2011 Peak Hour LOS at Intersections Along Salt Lake Boulevard–Phase 3

Salt Lake Boulevard—Phase 3 Intersections	Type of Intersection	Signalized/ Unsignalized	AM Peak Hour LOS	PM Peak Hour LOS
SLB and Wanaka St.	T-Intersection	Signalized	B	A
SLB and Likini St./Radford Dr.	Cross Intersection	Signalized	C	C
SLB and Kahikolu Pl.	T-Intersection	Unsignalized	F	F

Source: Austin Tsutsumi and Associates, 2012. Existing traffic counts taken in November and December 2011.

Table 1-2. Projected 2040 Peak Hour LOS at Intersections Along Salt Lake Boulevard–Phase 3

Salt Lake Boulevard—Phase 3 Intersections	Type of Intersection	Signalized/ Unsignalized	AM Peak Hour LOS	PM Peak Hour LOS
SLB and Wanaka St.	T-Intersection	Signalized	F	F
SLB and Likini St./Radford Dr.	Cross Intersection	Signalized	F	F
SLB and Kahikolu Pl.	T-Intersection	Unsignalized	F	F

Source: Austin Tsutsumi and Associates, 2012.

The year 2040 was identified as the end of the traffic analysis period as a result of funding requirements which dictate that the projected year should be 20 years from the anticipated completion of the project. The project may start construction as early as 2018 and may be completed in phases depending on funding. As Figure 1-2 shows, by 2040, the two remaining signalized intersections (Salt Lake Boulevard and Wanaka Street and Salt Lake Boulevard and Likini Street) along Salt Lake Boulevard (not yet widened) would each reach capacity.

The anticipated worsening of congestion along Phase 3 and its unsatisfactory LOS ratings at the intersections reinforce the need for completing the last phase of the Salt Lake Boulevard Widening Project.

The bottleneck created by the existing two-lane capacity of Phase 3 would be removed with the widening of the final phase to improve traffic flow through the entire roadway corridor from Puʻuloa Road to Kahuapāʻani Street.

[2] Level of Service (LOS), as defined in "The Highway Capacity Manual," dated 2000, is a qualitative measure used to describe the conditions of traffic flow at intersections. Values range from LOS A (minimal delay) to LOS F (congested).

One of the transportation objectives of the City's General Plan[3] is: "To create a transportation system which will enable people and goods to move safely, efficiently, and at a reasonable cost; serve all people, including the poor, the elderly, and the physically handicapped; and offer a variety of attractive and convenient modes of travel."

Policy 4 of this objective states: "Improve roads in existing communities to reduce congestion and eliminate unsafe conditions." This objective and policy of the City identify the need to improve transportation facilities for its residents to include adequate road systems for vehicles and for other modes of transportation for all residents.

The Primary Urban Center (PUC) Development Plan, which was adopted in 2004 to implement the policies of the General Plan, focuses on transportation policies to develop a "balanced transportation system" for Oʻahu.[4] The plan recognizes the need to increase roadway capacity to accommodate the high rate of growth in automobile traffic within the PUC. It notes that acquisition of right-of-ways to build new or to widen existing thoroughfares is severely constrained by high costs and limited space. For the Salt Lake Boulevard project, a 100-foot wide right-of-way already exists to accommodate the planned improvements.

To foster the development of a balanced transportation system, key objectives in the PUC Development Plan are to support transit and coordinate land use policies and regulations with transit development, generate interest and amenities for pedestrians along travel routes, manage transportation demand, and improve bicycling facilities. From these adopted public plans, the intent to accommodate multimodal travel along Salt Lake Boulevard and the need to install adequate pedestrian sidewalks and bicycle ways are evident.

The PUC Development Plan further states that Oʻahu's official long-range surface transportation strategy is documented in the Oʻahu Regional Transportation Plan, a federally mandated document that is updated every five years by the Oʻahu Metropolitan Planning Organization (OMPO). The most recent update, entitled Oʻahu Regional Transportation Plan 2035, was approved by the OMPO Policy Committee in April 2011. That plan identifies priority projects for its mid-range timeframe and long-range timeframe based on project needs and anticipated funding. Salt Lake Boulevard Widening between Maluna Street and Ala Lilikoʻi has been delegated Project No. 31 and listed under the Plan's mid-range projects. Implementation of the mid-range projects is anticipated between 2011 and 2020.

In 2009, the Hawaiʻi State Legislature amended state statutes to require the State Department of Transportation (DOT) and Hawaiʻi's four county transportation departments to adopt "complete streets" policies. The intent is to accommodate all users of roadways, including operators of motorized vehicles, transit users, as well as bicyclists and pedestrians. The Salt

---

[3] City and County of Honolulu. October 3, 2002. *General Plan: Objectives and Policies.* Posted at http://www.honoluludpp.org/Planning/GeneralPlan.aspx.

[4] City and County of Honolulu. *Primary Urban Center Development Plan.* 2004. (Ordinance 04-14). Posted at http://www.honoluludpp.org/Portals/0/pdfs/planning/PUC/PrimaryUrbanCenterDP.pdf.

Lake Boulevard—Phase 3 project is intended to conform to the State's and County's "complete streets" policies and provide safe sidewalks and bicycle ways. Additionally, the sidewalks would comply with requirements of the American with Disabilities Act (ADA).

Although Salt Lake Boulevard Widening–Phase 3 follows the completion of Increment 1, Phases 1 and 2 to the east and Increment 2, Phases 1 and 2 to the west, the DDC is incorporating for the first time for Salt Lake Boulevard in Phase 3 Low Impact Development (LID) design for the project's stormwater drainage system. An important principle behind the use of LID is the notion that surface runoff is not merely a waste product of stormwater to be disposed of, but rather it is a resource that can benefit the environment.[5] LID integrates a range of structural best management practices (BMPs) for road design and stormwater and wastewater management systems that minimizes environmental impacts.

1.3 PUBLIC INVOLVEMENT

NEPA and Chapter 343, HRS, require that potential impacts and issues be disclosed to affected agencies and the public. The implementing rules specify public notification and review periods during the environmental evaluation process. Public involvement starts with scoping and continues through mandated review and comment periods for the environmental document.

Major objectives under Chapter 343, HRS, are to identify the proposed action and alternatives, identify issues relating to the proposed action, analyze potential impacts and determine their significance, and provide for public participation. In particular, Chapter 343 calls for early consultation with stakeholders during the EA process, as well as public notification in The Environmental Notice published by OEQC.

The following activities were carried out to meet the above objectives:

- The Department of Design and Construction (DDC), City and County of Honolulu, transmitted letters of notification to federal and state agencies initiating the agency consultation process.
- Consultation meetings were held with FHWA, U.S. Navy, and Hawai'i State DOT-Highways Division. Consultation was initiated through correspondence with the U.S. Fish and Wildlife Service (USFWS) and the Hawai'i State Historic Preservation Division (SHPD) of the Department of Land and Natural Resources (DLNR).
- Scoping meetings were held or correspondence exchanged with local utility companies; City agencies (Department of Transportation Services [DTS], Department of

[5] State of Hawai'i, Office of Planning. Coastal Zone Management Program. June 2006. *Low Impact Development, A Practitioner's Guide.*

Environmental Services [DES], Department of Planning and Permitting [DPP]; and the principals of Āliamanu Elementary School and Āliamanu Intermediate School.

- DDC sent early consultation memoranda to other City and County agencies for input and comment on preparation of the EA.

- DDC reported the commencement of the project to the Āliamanu/Salt Lake/Foster Village Neighborhood Board on September 8, 2011 and presented a progress report with distribution of a fact sheet on the project at the neighborhood board meeting on November 8, 2012. A public informational meeting on the project was held at the Oʻahu Veterans Center in Foster Village, Oʻahu, on April 4, 2012. A second public informational meeting is expected to be scheduled in 2015.

- Consultation with special interest groups including Forest City Hawaii, Livable Communities Hawaii, and Island Family Christian Church.

Copies of memoranda from responding City agencies and a list of the comments received at the April 4, 2012 public meeting are included in Appendix A of this document. Comment letters on the Draft EA received during the Draft EA 30-day review period would be included in the Final EA.

Chapter 2

Proposed Action and Alternatives

CHAPTER 2
Proposed Action and Alternatives

2.1 INTRODUCTION

The City is proposing to widen Salt Lake Boulevard from two lanes to four lanes to reduce traffic congestion and delays and to accommodate the anticipated increase in traffic volumes over the coming years. Planning and traffic studies were conducted to determine the design requirements for the road improvements. Additional roadway elements such as parking lanes, bike lanes, sidewalks, and bioswales were included to comply with City General Plan, Development Plan, Complete Streets, and Low Impact Development (LID) policies. The year 2040 was selected as the planning horizon due to funding requirements which requires the project year to be 20 years from the anticipated completion year of the project. Depending on available project funding, the anticipated start of construction is as early as 2018. The duration of construction could be two years or, if phasing is necessary, somewhat longer.

2.2 PROPOSED ACTION

For the Phase 3 section of the Salt Lake Boulevard Widening Project, the City is proposing to add two new travel lanes (one in each direction), on-street parking, a median, bike lanes, pedestrian sidewalk, landscaping, and drainage improvements to the existing right-of-way to meet the project's purpose and need. Provision of the new roadway elements triggers a number of variations and options, each with different costs and benefits as well as different environmental impacts. In the remainder of this chapter, the EA will identify four proposed action alternatives comprised of a combination of different roadway elements that work well together. For the proposing agency, a preferred alternative may be selected at the end of the Draft EA review or a selection of roadway elements from the various alternatives may be combined to comprise the desired proposed action alternative. Chapters 3 and 4 of this document will present the evaluation of the four alternatives in terms of their impacts on the environment.

2.2.1 ALTERNATIVE A–LIMITED ON-STREET PARKING, STRIPED MEDIAN, AND OVERHEAD UTILITIES

2.2.1.1 Alternative A Proposed Improvements

Alternative A includes the addition of two new travel lanes (one in each direction), a striped median, dedicated bike lanes, and a pedestrian sidewalk primarily on the northern side of Salt Lake Boulevard (see Figure 2-1 through Figure 2-5). On-street parking would be provided in a parking lane along the northern side of the roadway where residences are located. No parking lane would be provided where steep high cuts in the hill side occur. The following items are the design features or roadway elements of Alternative A.

- **Eastbound.** One 10-foot-wide travel lane, one 12-foot-wide travel lane, and one 6-foot-wide bike lane.
- **Westbound.** One 10-foot-wide travel lane, one 12-foot-wide travel lane, one 5 to 6-foot-wide bike lane, and one 10-foot-wide parking lane, except at steep high cut areas.

- **Striped median/left-turn storage lane.** Twelve-foot-wide striped median with 10-foot-wide left-turn storage lane.
- **Sidewalk.** Eight-foot-wide sidewalk (with curb and gutter) on northern side of road and 8-foot-6-inch-wide between Radford Drive and Ala Liliko‘i Street on southern side of road.
- **Landscape strip.** Five-foot-wide landscape strip on northern side of road and 8-foot-6-inch-wide landscape strip on southern side of road.
- **Retaining walls.** Up to approximately 30 feet high on northern side at Honolulu Board of Water Supply (BWS) water tank site and 26 feet high near Wanaka Street intersection; up to approximately 15 feet high on the southern side (facing Navy property) with a total length of approximately 3,800 feet. A chain link fence, 2.5 to 6 feet high, atop the walls for safety purposes.
- **U-turns.** Limited to passenger cars at Wanaka Street, Radford Drive/ Likini Place, and Kahikolu Place intersections.
- **Utility lines.** Electrical lines for street lights to be relocated underground; all other electrical, telecommunications, and cable TV lines to remain overhead. Chevron fuel lines to be relocated.

The provision of an additional lane on the eastbound and westbound directions of this right-of-way would increase the capacity of Salt Lake Boulevard–Phase 3 to reduce existing traffic congestion and delays and meet the needs of future traffic demands. The proposed road widening project would maintain the consistency of the road capacity in Phase 3 with the road capacity in the adjacent Increment 2, Phases 1 and 2. The completed Increment 1, Phases 1 and 2 to the east has two westbound lanes and three eastbound lanes.

The addition of dedicated bike lanes on either side of the road is consistent with the City’s "complete streets" policy to plan for and accommodate all modes of transportation. Bike lanes or a designated bike route already occurs in the completed increments and phases of the widened boulevard. Further, the addition of a parking lane within the right-of-way would allow adjacent residents to continue on-street parking fronting their homes. No parking lane would be provided where steep high cuts occur in the adjacent hillside.

A sidewalk would be provided along the entire northern side of the right-of-way and on the southern side between Radford Drive and Ala Liliko‘i Street. There are no abutting land uses that require pedestrian access along the southern side of the boulevard west of Radford Drive. No public bus route occurs through the entire Phase 3 alignment which further negates the need, at least on the southern side, for a pedestrian walkway. Sloped ramps on the sidewalks at the intersections would be provided to accommodate wheelchair users and meet Americans with Disabilities Act (ADA) requirements.

All improvements including the shoulder features, landscape strips, and retaining walls would be constructed within the boulevard’s existing right-of-way. Exceptions would include the

potential encroachment of earthwork required at the Āliamanu Intermediate School property. The grade difference between the Salt Lake Boulevard and school site is substantial and would require a retaining wall or fill slope to support the edge of the widened road at that location. Present plans call for grading approximately 18,000 square feet of school land to create a fill slope or supporting embankment for the road improvement. This new fill slope would be the same for Alternatives B and C. Since the school property is owned by the City and County of Honolulu, no slope or landscape easement would be required for the long-term maintenance of the graded embankment. It is anticipated, however, that the State Department of Education would take over maintenance of the fill slope once completed.

Additionally, drainage lines from the road widening improvements would connect to approximately five existing drainage manholes or inlets in the adjacent Navy property. These manholes or inlets are situated within approximately 45 feet from the road widening right-of-way.

Another exception is there are two existing intersections (Salt Lake Boulevard-Maluna Street and Salt Lake Boulevard-Radford Drive) that would require modifications to the Navy approach lanes and sidewalks for a smooth transition from a grade and alignment standpoint to the widened boulevard. This would require construction work in a portion of the Navy land immediately adjacent to the intersection.

The striped median/left-turn storage lane contains a storage lane that allows eastbound vehicles to turn left into the road's northern side residential driveways as well as vehicles exiting the residential driveways to turn left into the storage lane before entering the main eastbound travel lanes.

Existing overhead utilities, including electrical, telephone, and cable TV, would remain overhead on utility poles, while power lines for the new street lights would be installed underground. Two 8-inch Chevron Corporation fuel lines run along the southern side of Salt Lake Boulevard. These lines would require relocation due to grade differences in the proposed road improvements.

In compliance with the City's LID practices, surface runoff from the roadway would be served by detention basins built underneath the roadway. Runoff from drainage areas above or north of the roadway corridor would be allowed to pass through and discharge via the basins to the drainage lines. No additional runoff would be permitted to flow into the adjacent downslope Navy property.

Landscaping would occur in the shoulder areas of the travelway and contain primarily ground cover and possibly shrubs (see Table 2-1 and Figure 2-5). Use of native plants would be the preference for this right-of-way. Trees are not being considered for this corridor with the presence of physical constraints. Low hanging existing utility lines would obstruct the growth of any mature trees on the northern side of the road and existing underground fuel lines and retaining wall structures would restrict location of trees on the southern side.

Table 2-1. Possible Shrubs and Groundcover in Shoulder Areas and Bioswale

Shrubs	
Crinum amabile or augustrum	Spider Lily
*Dodonaea viscose**	A'ali'i
*Hibiscus waimeae**	Koki'o ke'oke'o
Plumbago capensis	Plumbago
*Scaevola taccada**	Naupaka
Groundcovers	
Lantana montevidensis	Creeping Lantana
Liriope spicata	Variegated Liriope
*Osteomeles anthyllidifolia**	'Ulei
Pittosporum tobria 'Wheeleri'	Wheeler's dwarf pittosporum
Rhoeo discolor	Rhoeo
*Sida fallax**	'Ilima
*Wikstroemia uva-ursi**	'Akia
Bioswale (Alternative C only)	
*Bacopa monnieri**	Ae'ae
*Carex wahuensis**	Carex grass
*Dianella sandwicensis**	'Uki 'uki
*Fimbristylus cymosa**	Mau'u'aki'aki
*Sesuvium portulacastrum**	Akulikuli
*Sida fallax**	'Ilima

* Hawai'i native plant

Retaining walls would be required along some sections of the right-of-way to support grade differences between the road and adjacent properties. Some retaining walls along the northern border would be as high as approximately 30 feet, particularly at the BWS tank site and as high as 26 feet near the Wanaka Street intersection. On the southern side, retaining walls would be as high as approximately 15 feet (facing the Navy property). A chain link fence, 2.5 to 6 feet high, would be installed atop of the retaining wall or barrier. Where constructed, the retaining walls and chain-link fences would replace the existing Navy fence.

2.2.1.2 Alternative A Construction Schedule and Cost

Completion of the EA for Salt Lake Boulevard Widening–Phase 3 is scheduled to occur in the summer of 2016. Completion of design is expected in 2018. Depending on available project funding, construction may occur in phases. If construction occurs in one phase, projects of this size typically are completed within two years of commencement.

Construction of the project is anticipated to be financed by federal and City funds. Estimated cost of construction would depend on the final design and winning construction bid. Preliminary estimates indicate that the road construction would cost approximately $64 million.

Alternative A	Cost ($ million)*
Roadway Improvements	20.6
Retaining Walls and Landscaping	13.6
Storm Drainage	4.1
Utilities	7.6
Construction Management and Contingencies	18.4
TOTAL	64.3

* In 2014 dollars

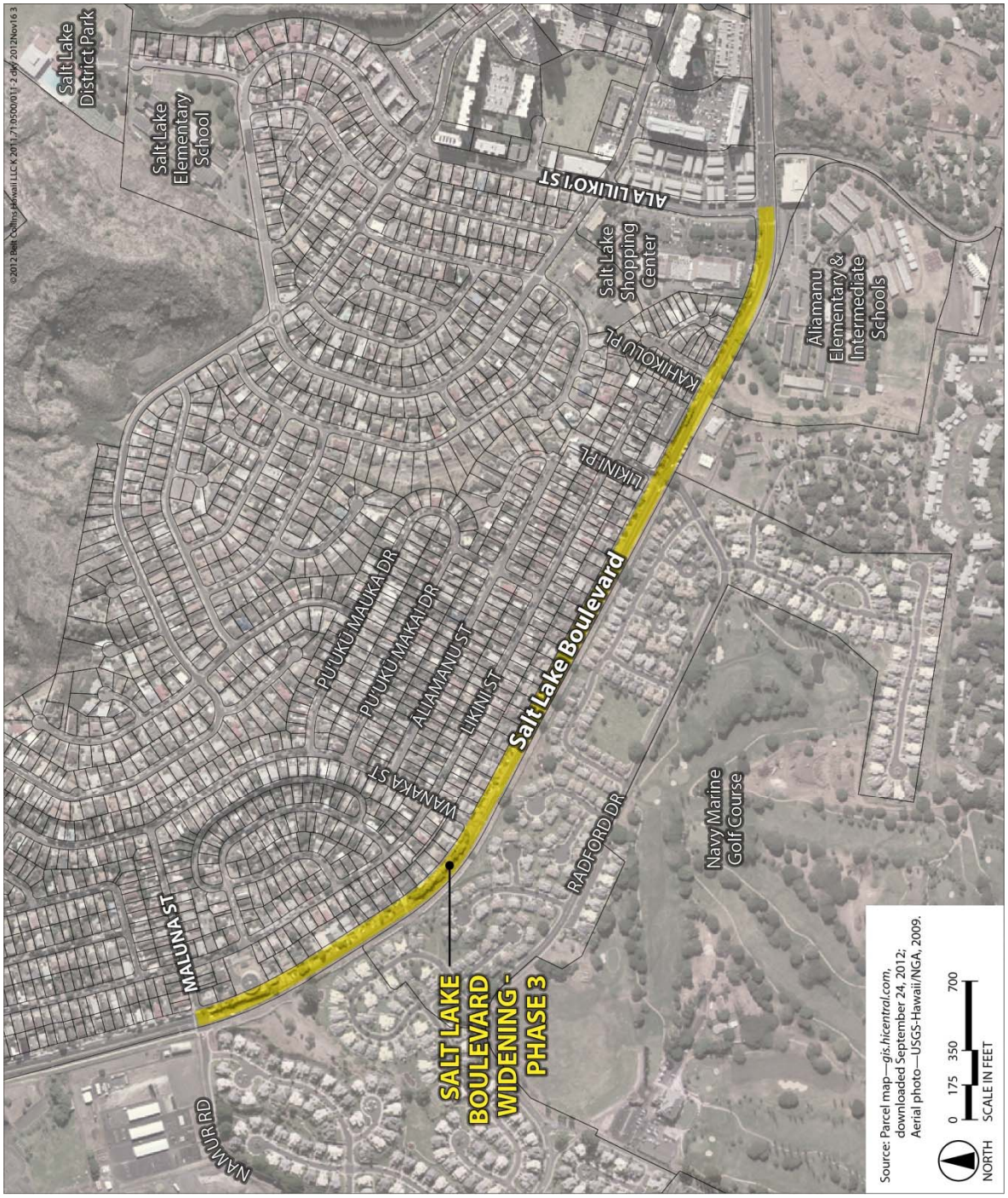
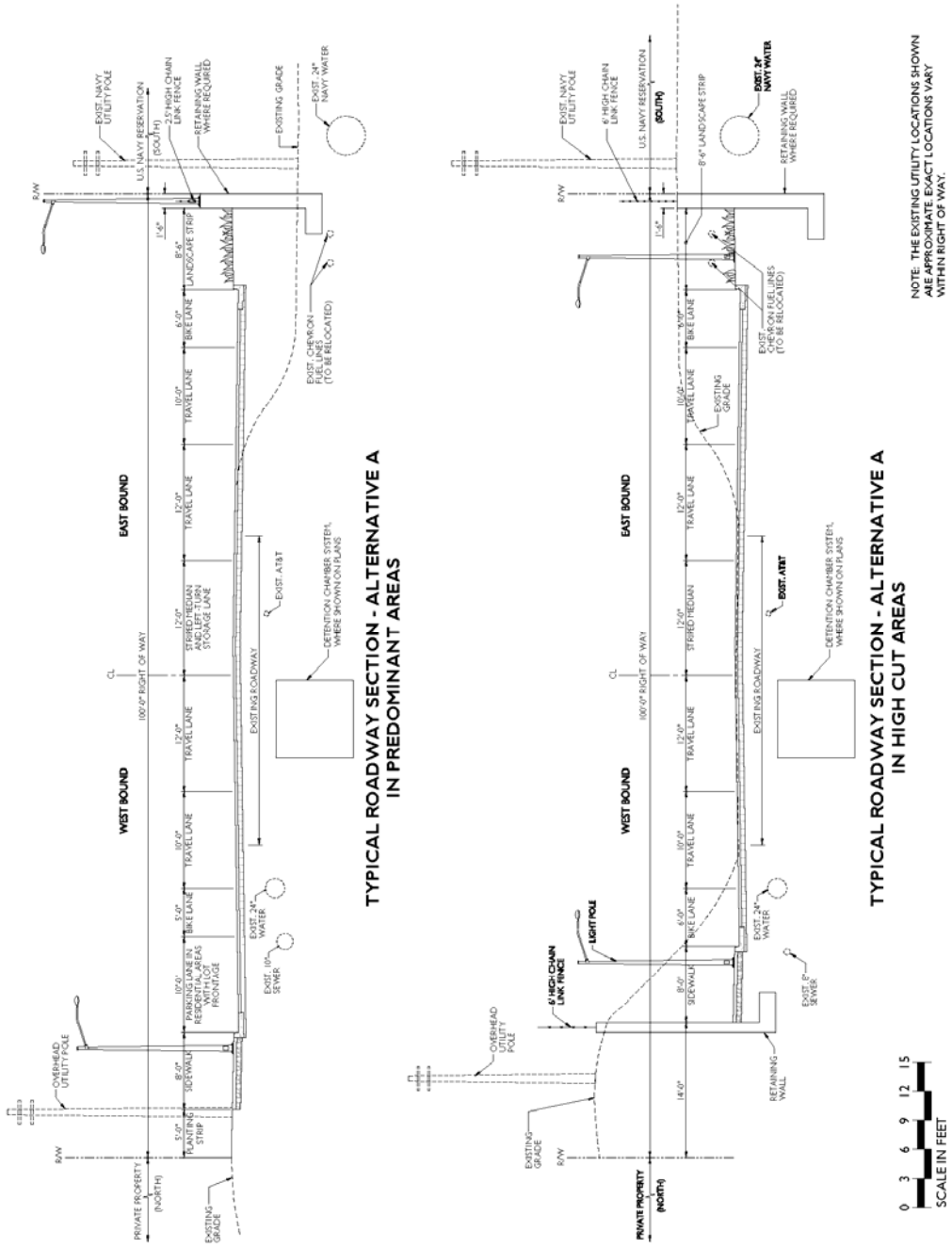
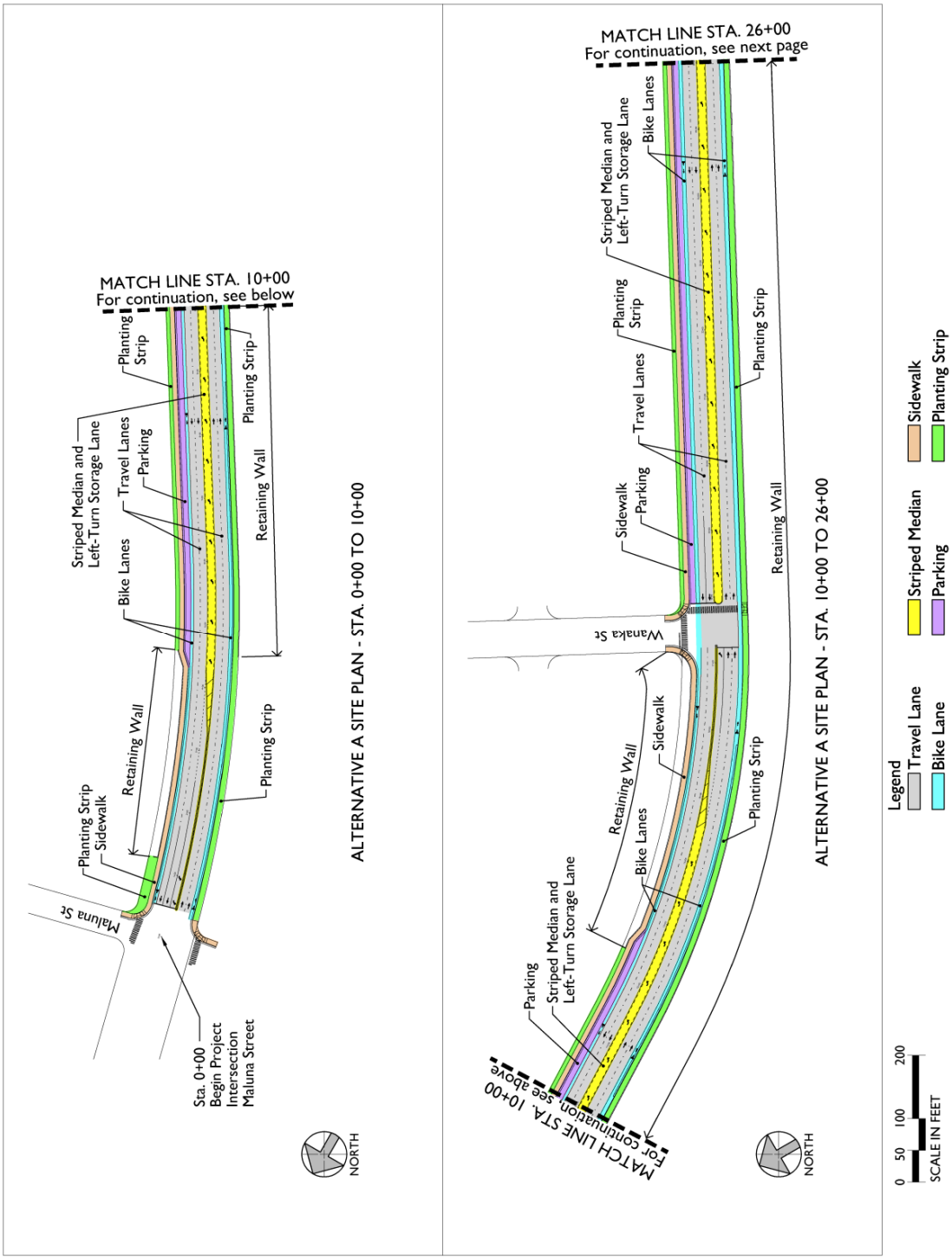


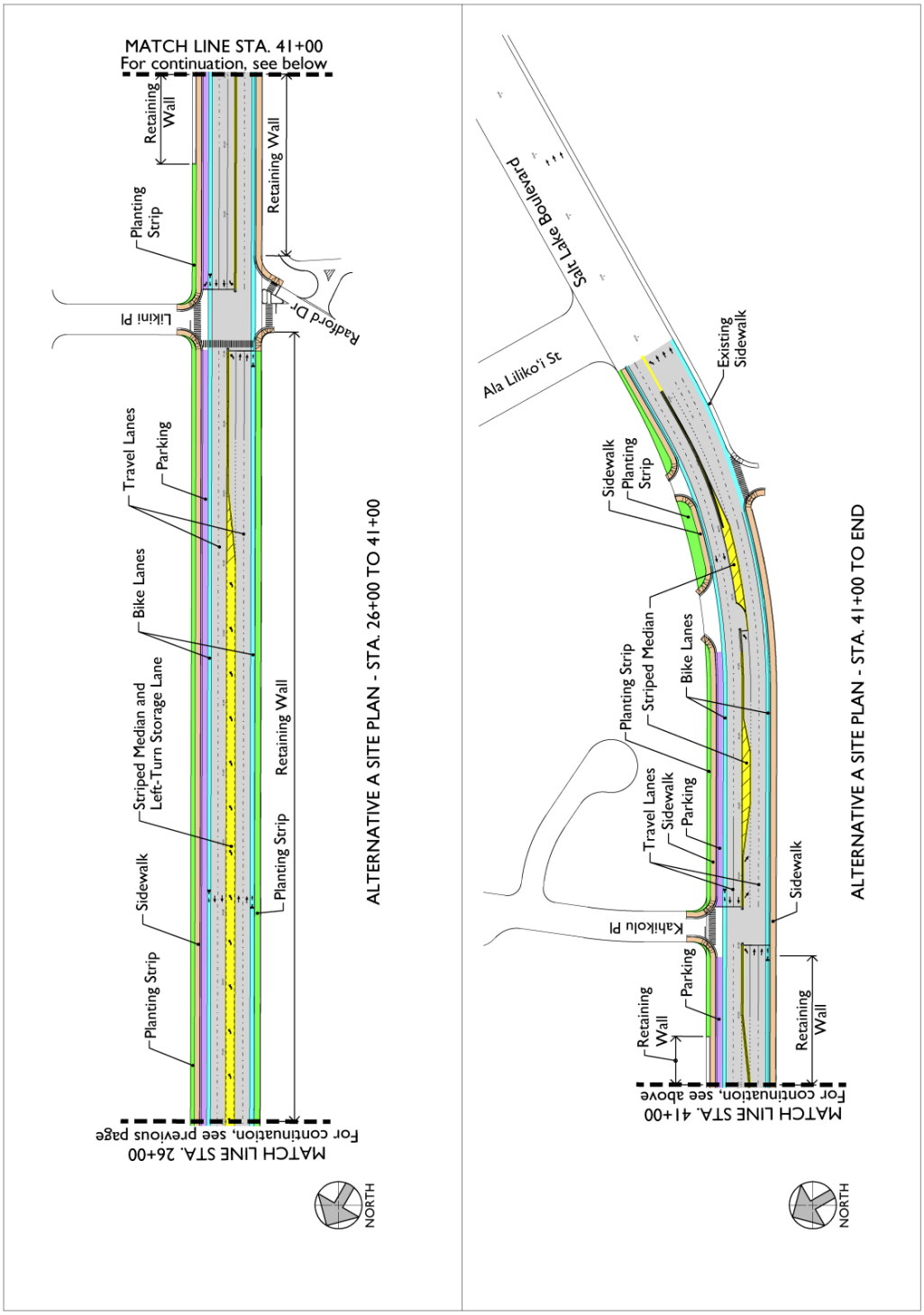
Figure 2-1. Salt Lake Boulevard Widening–Phase 3



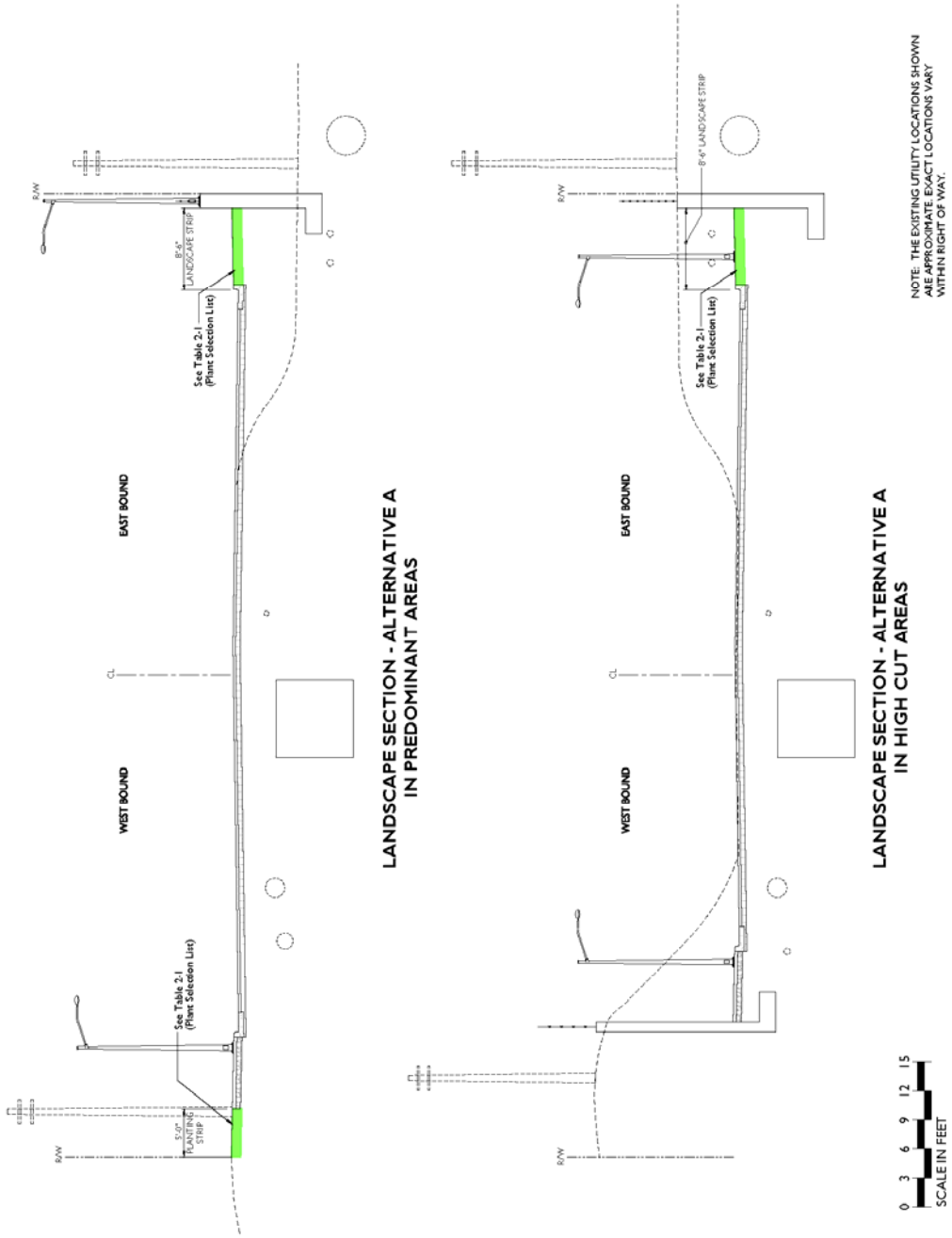
1 **Figure 2-2. Alternative A Typical Section**



1 **Figure 2-3. Alternative A Alignment Plan**



1 **Figure 2-4. Alternative A Alignment Plan**



1 **Figure 2-5. Alternative A Landscape Section**

2.2.2 ALTERNATIVE B–LIMITED ON-STREET PARKING, RAISED LANDSCAPED MEDIAN, AND OVERHEAD UTILITIES

2.2.2.1 Alternative B Proposed Improvements

As in Alternative A, this alternative includes two additional lanes, a parking lane on the northern side except at steep high cut areas, dedicated bike lanes, and sidewalk primarily on the northern side of the roadway (see Figure 2-6 through Figure 2-11). Unlike Alternative A, this alternative includes a raised landscaped median that creates a visual buffer between the eastbound traffic lanes and westbound traffic lanes. The following items are the design features or roadway elements of Alternative B.

- **Eastbound.** One 10-foot-wide travel lane, one 12-foot-wide travel lane, and one 6-foot-wide bike lane.
- **Westbound.** One 10-foot-wide travel lane, one 12-foot-wide travel land, one 5- to 6-foot-wide bike lane, and one 10-foot-wide parking lane, except at steep high cut areas.
- **Raised landscaped median.** Four to 12 feet wide, including 10-foot-wide turning lane at intersections.
- **Sidewalk.** Eight-foot-wide sidewalk (with curb and gutter) on northern side of road and 8-foot, 6-inch-wide between Radford Drive and Ala Liliko‘i Street on southern side of road.
- **Landscape strip.** Five-foot-wide landscape strip on northern side of road and 8-foot, 6-inch to 18-foot wide landscape strip on southern side of road.
- **Retaining wall.** Up to approximately 30 feet high on northern side at BWS water tank site and 26 feet high near Wanaka Street intersection, and lower retaining walls than Alternative A on southern side (facing Navy property) because narrower median (as narrow as 4 feet in comparison to Alternative A’s 12 feet) would bring the outer edge of the eastbound travel lanes closer to the center of the right-of-way and allow sloped shoulders (where the adjacent property is lower) to have lower walls. A chain-link fence, 2.5 to 6 feet high, atop the walls for safety purposes.
- **U-turns.** Limited to passenger cars at Wanaka Street, Radford Drive/Likini Place, and Kahikolu Place intersections.
- **Utility lines.** Electrical lines for street lights to be relocated underground; all other electrical, telecommunications, and cable TV lines to remain overhead. Chevron fuel lines to be relocated.

The raised median, which would vary in width from 4 to 12 feet, would also accommodate landscaping and create visual appeal for the roadway corridor. Sections of the road where the median is 4 feet wide would allow a tighter road pavement section and consequently wider landscaped shoulder area, especially on the southern side of the road. The landscaping on the median would be in addition to the shoulder areas where planting strips are planned. Consideration of the type of shrubs and groundcovers would be given to low-maintenance

varieties and indigenous species (see Table 2-1, Figure 2-10 and Figure 2-11). The planting strips in the northern shoulder areas may be restricted to groundcovers and limited shrubs in order to allow more driveway options for the residential properties. Existing low hanging utility lines are also expected to act as an obstruction to the growth of any large new trees.

With the installation of a raised median, a barrier, although relatively small, would be created along the road centerline disallowing left-turn maneuvers into the northern side residential driveways. Eastbound residents would be required to travel to the end of the block and, at the intersection, u-turn back to access their driveways. Conversely, the raised median would also disallow vehicles from the residential driveways to directly access the eastbound travel lanes that front their properties.

Sidewalks and the number of on-street parking spaces provided in Alternative B would be similar to Alternative A.

Similar to Alternative A, overhead utilities, including electrical, telephone, and cable TV, would continue to be located overhead on utility poles. Surface runoff from the roadway would be accommodated by bioswales along the southern side of the right-of-way as in Alternative A.

In compliance with the City's LID practices, surface runoff from the roadway would be served by detention basins built underneath the roadway. Runoff from drainage areas above or north of the roadway corridor would be allowed to pass through and discharge via the basins to the drainage lines. No additional runoff would be permitted to flow into the adjacent downslope Navy property.

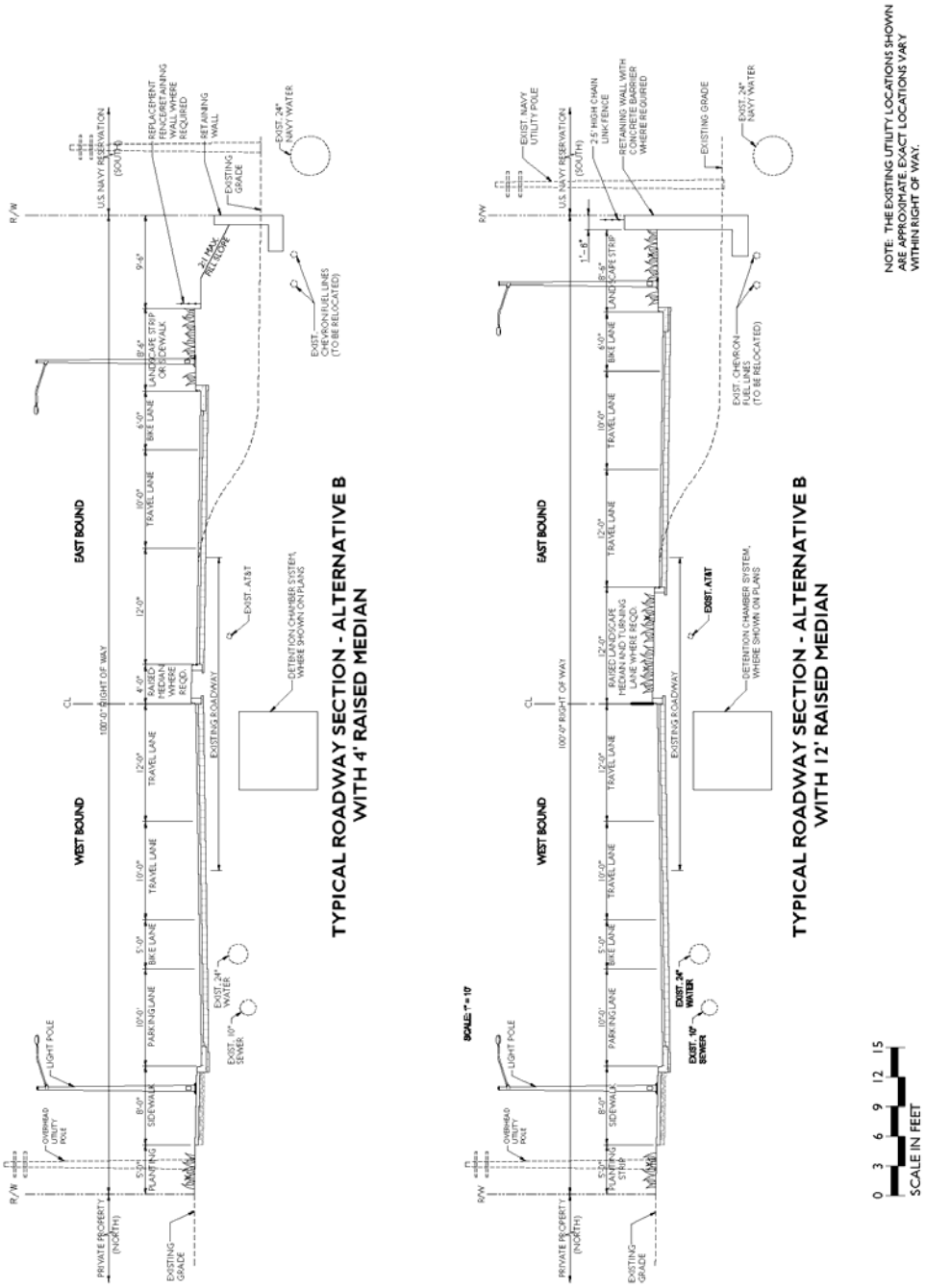
The proposed retaining walls along the southern boundary of Phase 3 adjacent to the Navy housing would be lower than Alternative A. The height of the walls may still be a visual concern to the residents of the Navy property but possibly not as much as in Alternative A.

2.2.2.2 Alternative B Construction Schedule and Cost

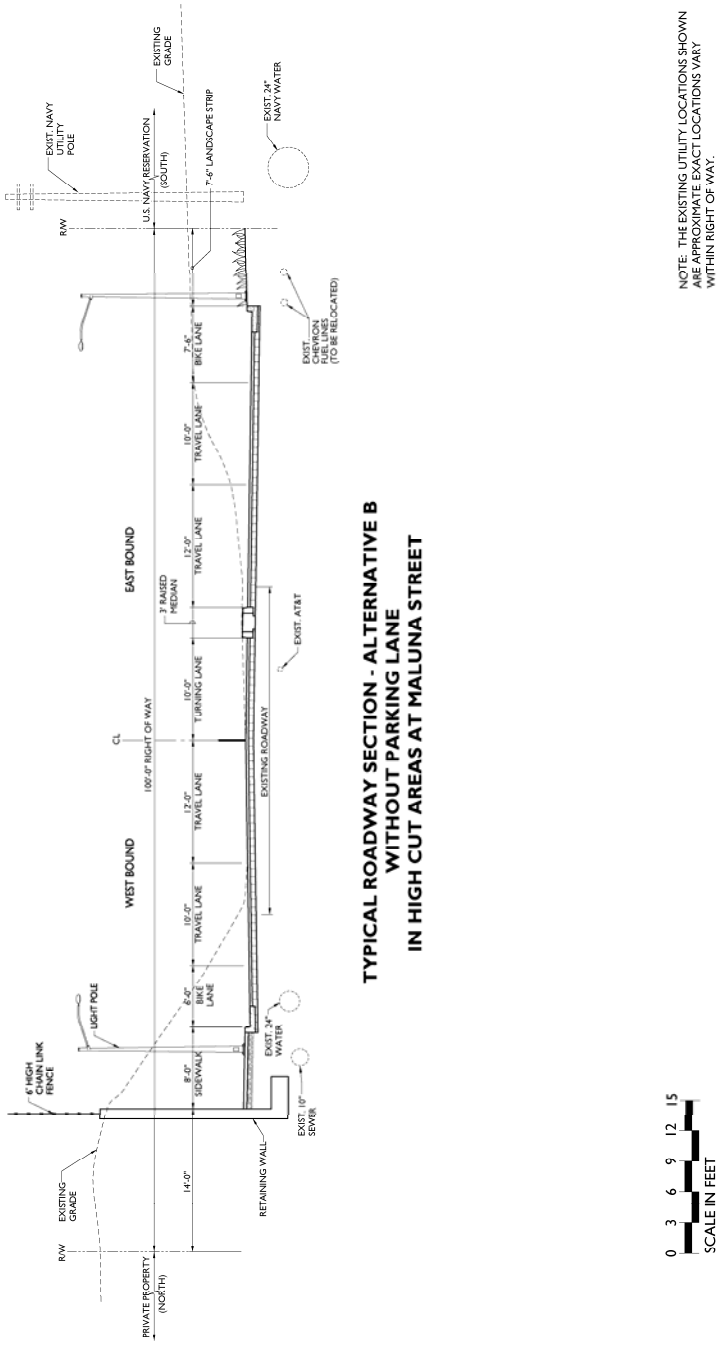
The preliminary cost for construction of Alternative B is estimated at approximately $55 million. Road construction is expected to occur over a similar timeframe as Alternative A.

Alternative B	Cost ($ million)*
Roadway Improvements	19.9
Retaining Walls and Landscaping	9.6
Storm Drainage	3.9
Utilities	6.0
Construction Management	15.8
TOTAL	55.3

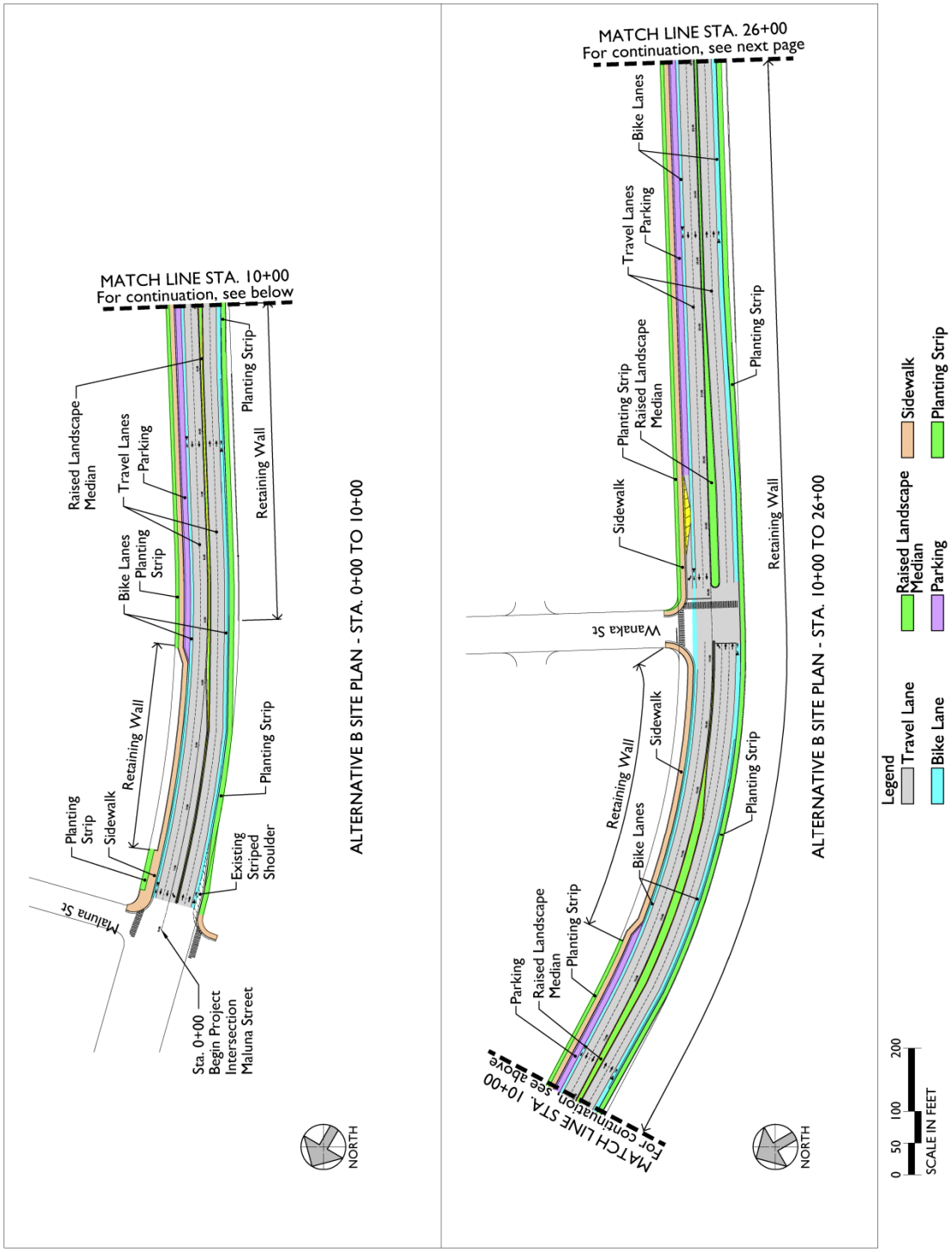
* In 2014 dollars. Listed items sum to less than the total because of rounding.



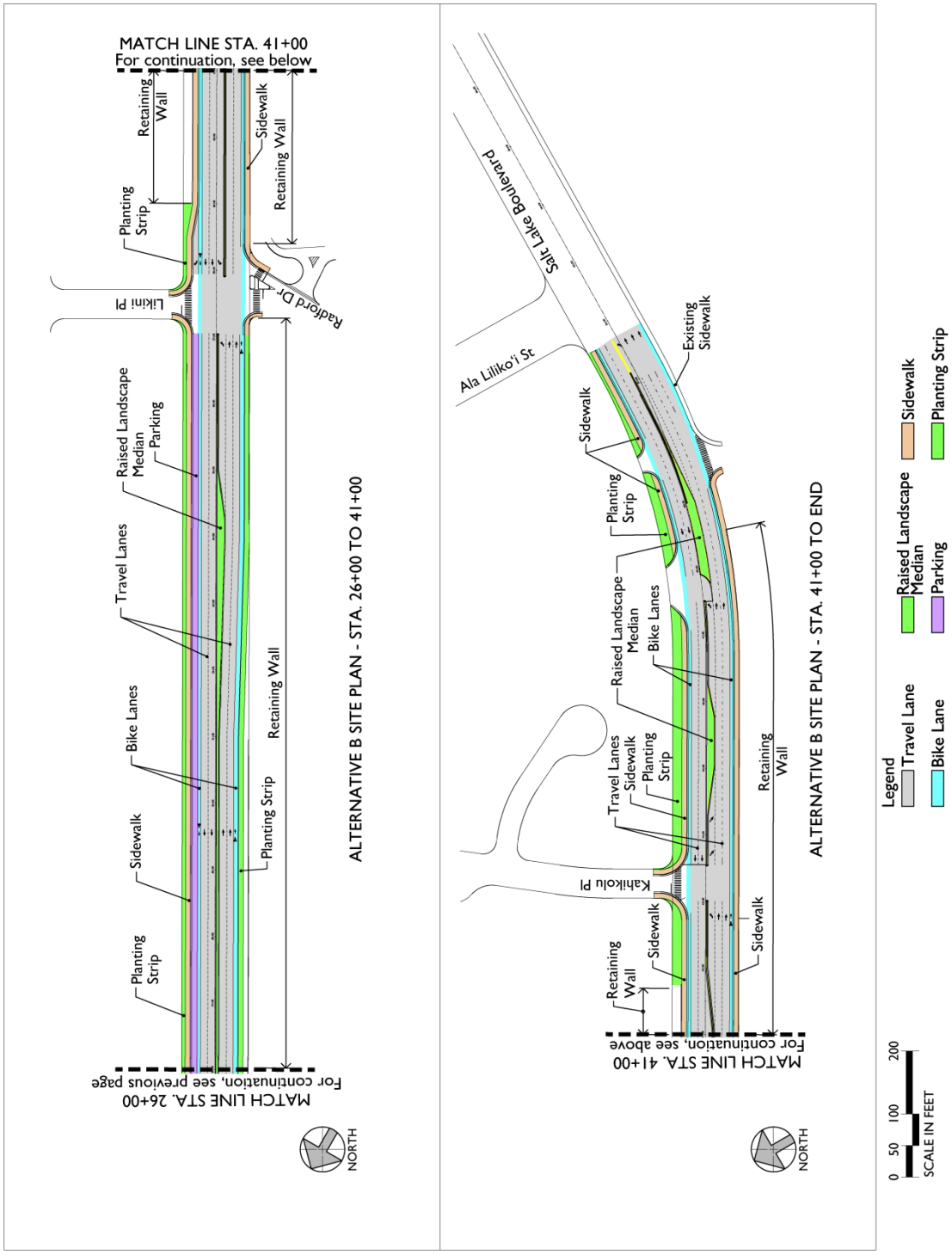
1 **Figure 2-6. Alternative B Typical Section**



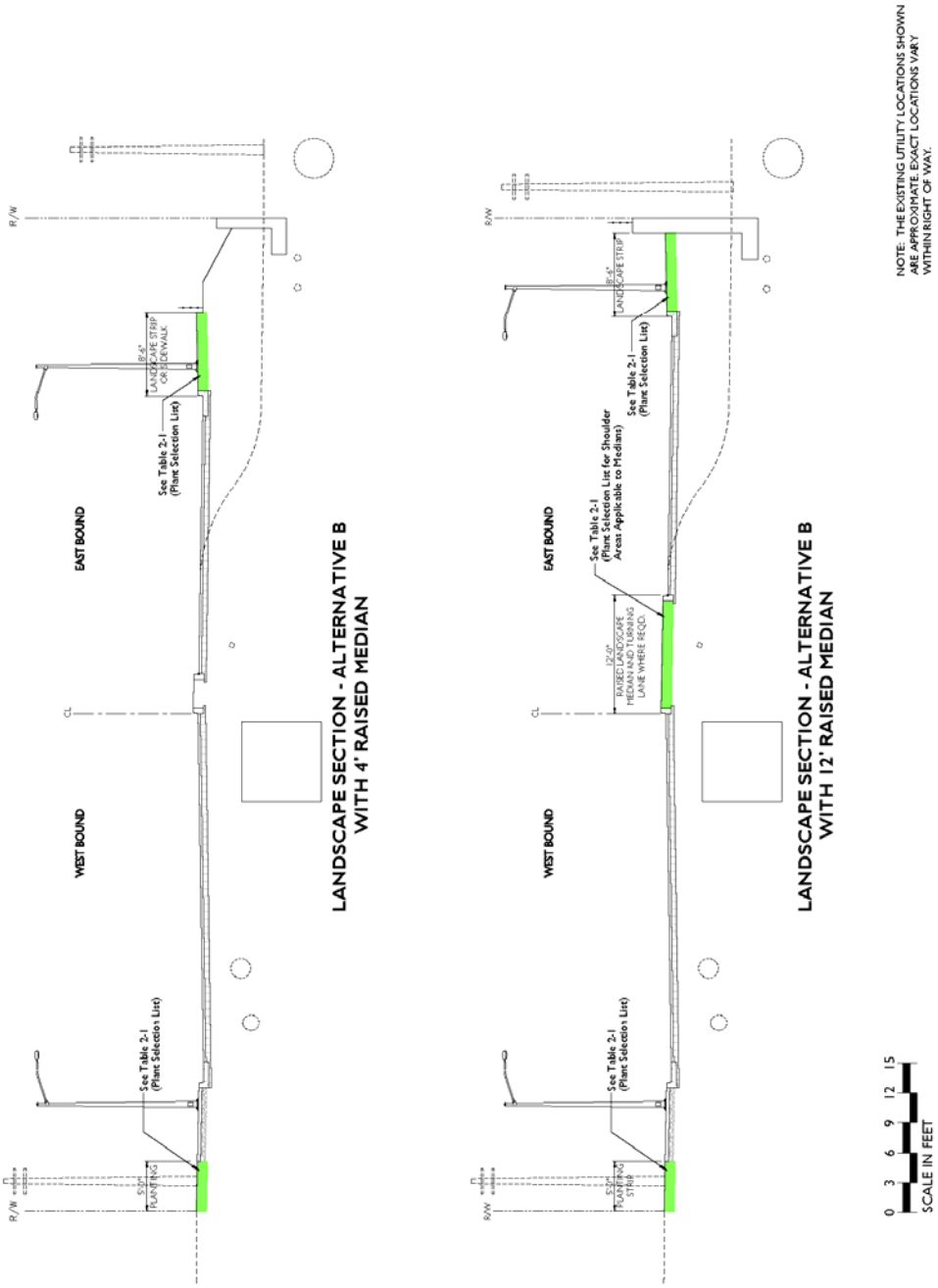
1 **Figure 2-7. Alternative B Typical Section (High Cut Area)**



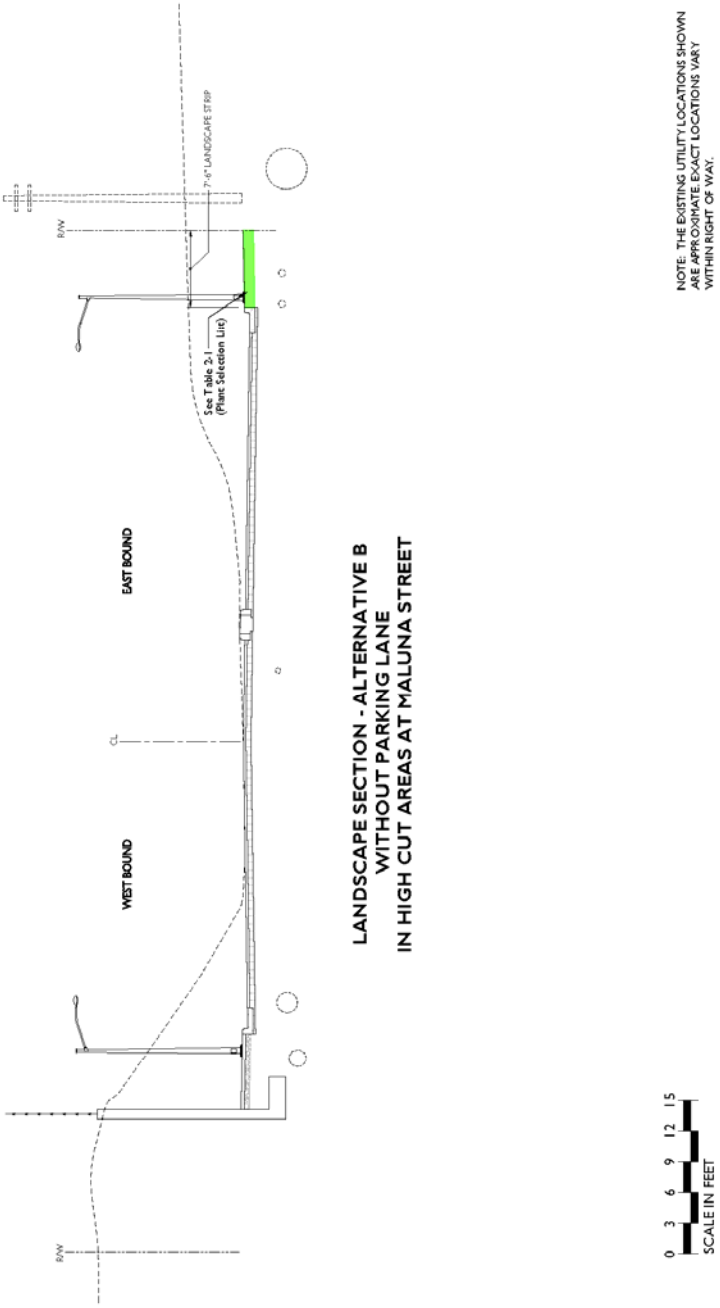
1 **Figure 2-8. Alternative B Alignment Plan**



1 **Figure 2-9. Alternative B Alignment Plan**



1 **Figure 2-10. Alternative B Landscape Section**



1 **Figure 2-11. Alternative B Landscape Section (High Cut Areas)**

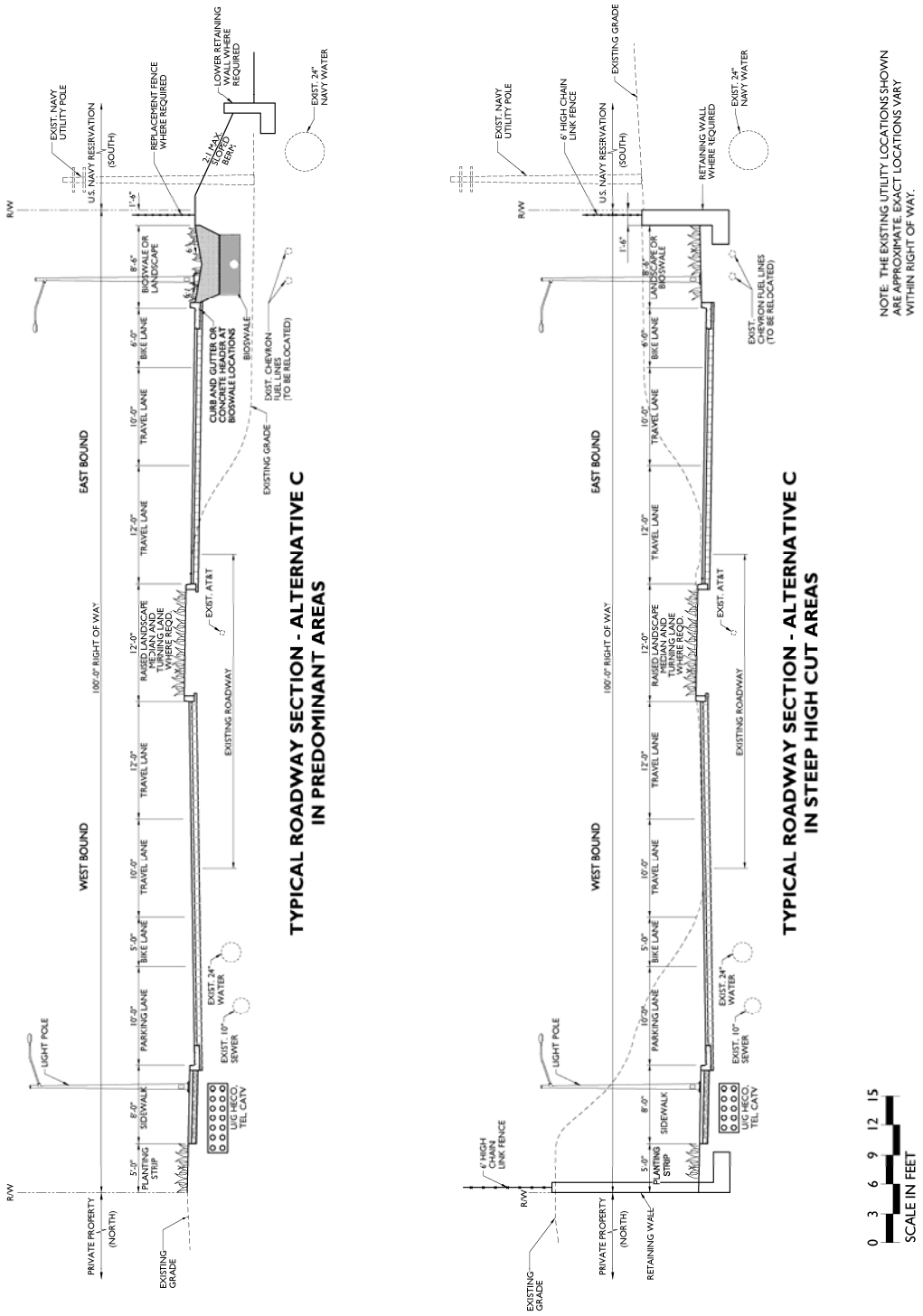
2.2.3 ALTERNATIVE C–FULL ON-STREET PARKING, RAISED LANDSCAPED MEDIAN, UNDERGROUND UTILITIES, AND USE OF U.S. NAVY LAND

2.2.3.1 Alternative C Proposed Improvements

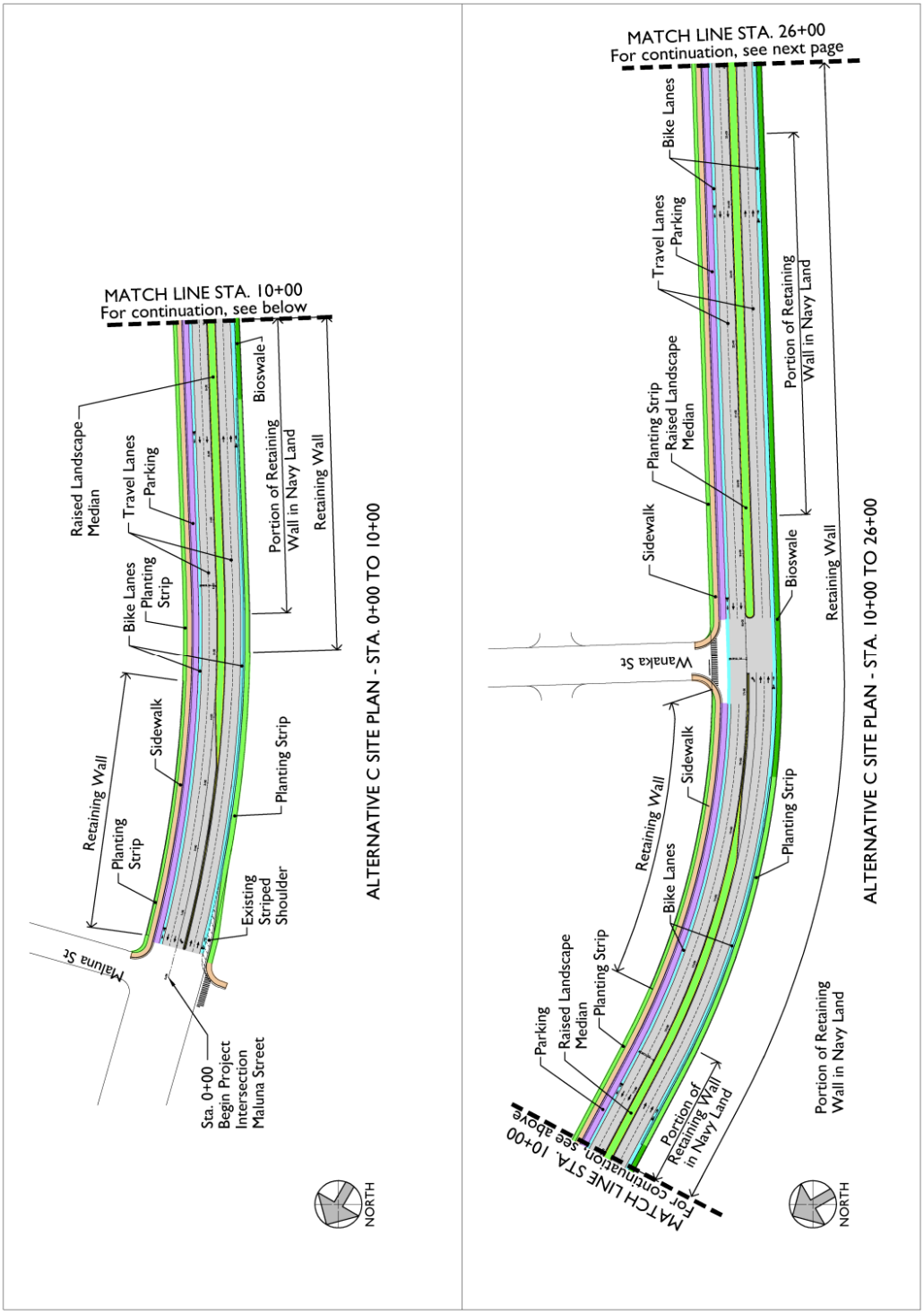
In addition to the two new travel lanes, this alternative includes a parking lane along the entire length of Phase 3 (Alternatives A and B exclude the steep high cut areas), a raised landscaped median as in Alternative B, underground utilities (Alternatives A and B include overhead utilities), and use of the adjacent U.S. Navy property (Alternatives A and B exclude use of Navy property) for sloped berm and retaining wall (see Figure 2-12 through Figure 2-15). The following items are the design features or roadway elements of Alternative C.

- **Eastbound.** One 10-foot-wide travel lane, one 12-foot-wide travel lane, and one 6-foot-wide bike lane.
- **Westbound.** One 10-foot-wide travel lane, one 12-foot-wide travel lane, one 5-foot-wide bike lane, and one 10-foot- wide parking lane predominantly throughout.
- **Raised landscaped median.** Twelve-foot-wide, including a 10-foot-wide turning lane at intersections.
- **Sidewalk.** Eight-foot-wide sidewalk (with curb and gutter) on northern side of road and 8-foot, 6-inch-wide between Radford Drive and Ala Liliko‘i Street on southern side of road.
- **Landscape strip.** Five-foot-wide landscape strip on northern side of road and 8-foot, 6-inch-wide landscape strip or bioswale/landscape strip on southern side of road.
- **Retaining walls.** Up to approximately 30 feet high on northern side at BWS water tank site and 26 feet high near Wanaka Street intersection, lower retaining walls than Alternative A on southern side, located in Navy property. A chain-link fence, approximately 2.5 to 6 feet high, atop the walls for safety purposes.
- **U-turns.** Limited to passenger cars at Wanaka Street, Radford Drive/Likini Place, and Kahikolu Place intersections.
- **Utility lines.** All utility lines to be located underground. Chevron fuel lines to be relocated.
- **Sloped berm and retaining wall.** Located on U.S. Navy property to avoid appearance of high wall.

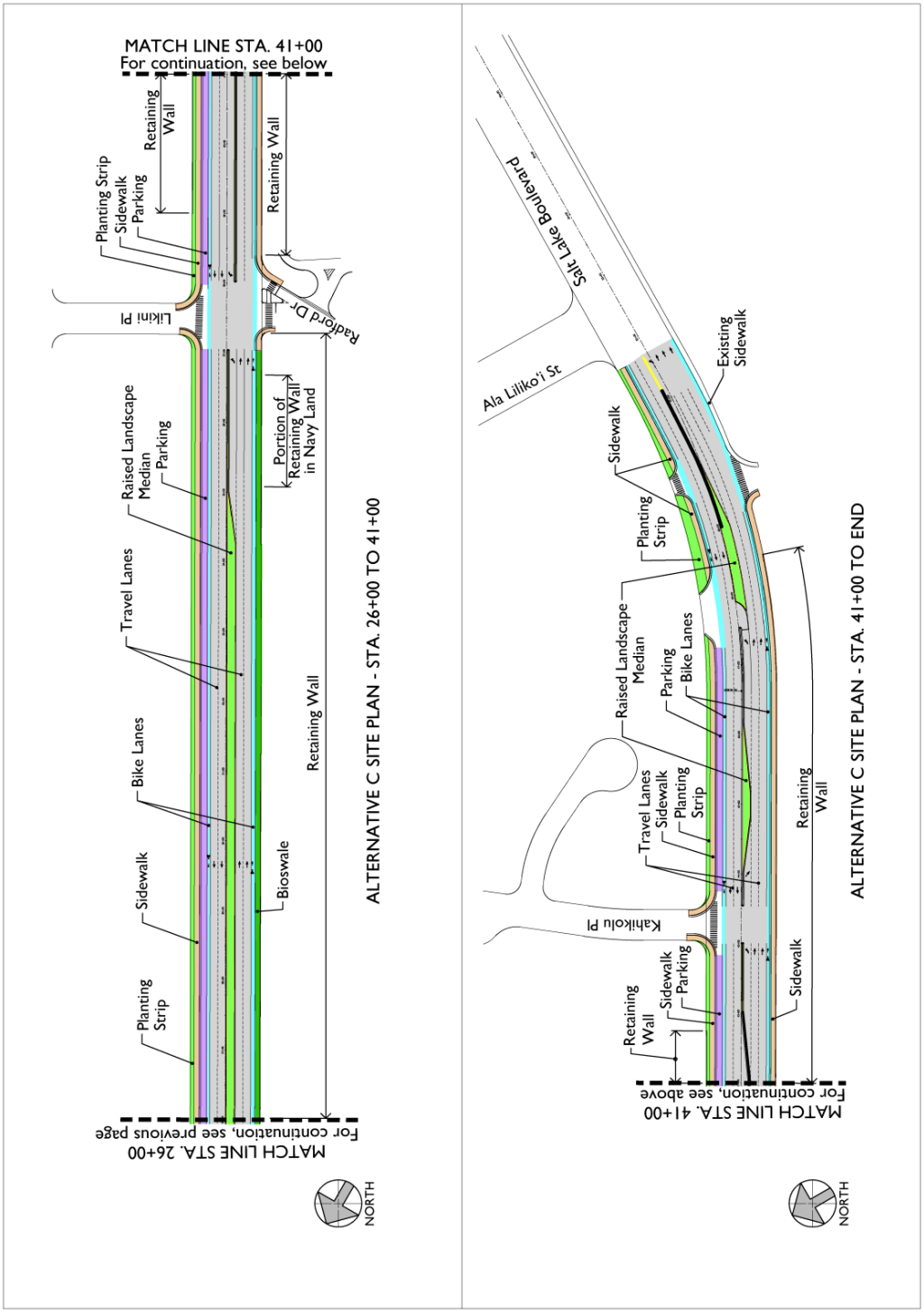
The provision of a parking lane along the predominant length of Phase 3 establishes a consistency and uniformity with Salt Lake Boulevard–Increment 2, Phases 1 and 2. It would include 41 more parking spaces than Alternative A, resulting in a total of 118 stalls or, on average, approximately 3 on-street parking spaces per street-frontage lot.



1 **Figure 2-12. Alternative C Typical Section**



1 **Figure 2-13. Alternative C Alignment Plan**



1 **Figure 2-14. Alternative C Alignment Plan**

During construction, extensive excavation would be required in the steep high cut areas along some sections of the right-of-way to make room for the new parking lane. The cost to excavate deep into these steep rocky areas is substantial.

As in Alternative B, Alternative C would include a raised landscaped median between the eastbound travel lanes and westbound travel lanes. The landscaped median would be consistently 12 feet wide throughout the Phase 3 alignment, unlike Alternative B in which the width would vary between 4 feet and 12 feet.

Planting options for Alternative C are similar to Alternative A and B (see Table 2-1).

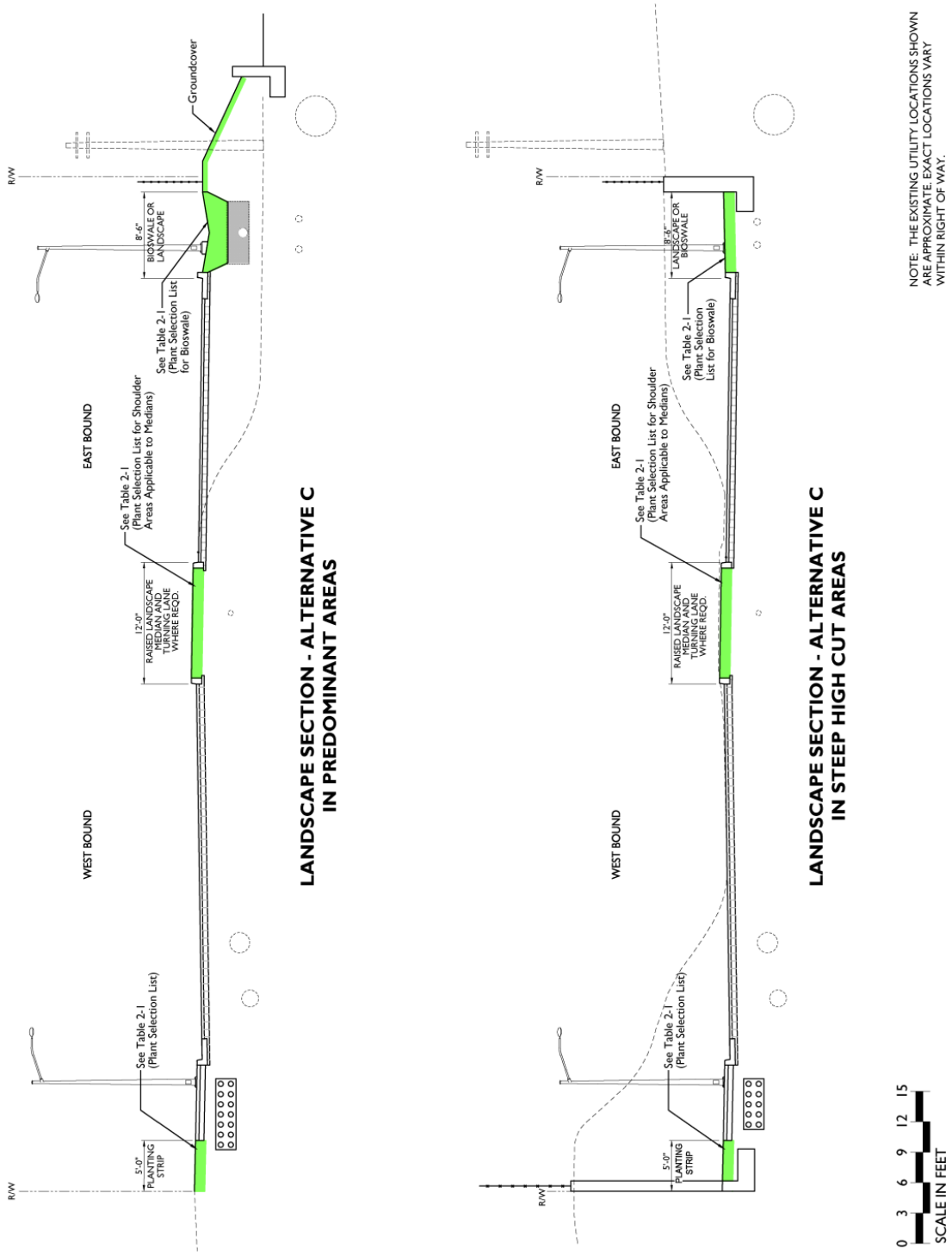
Unlike Alternatives A and B, all utilities in Alternative C would be located underground. This would establish a utility corridor consistent with the completed (widened) sections of Salt Lake Boulevard and result in improvements to the visual appearance of the roadway right-of-way. Undergrounding utility lines however, comes with a high installation cost. Private lateral utility connections may remain overhead.

In compliance with the City's LID practices, surface runoff from the roadway would be served by bioswales on the southern side of the roadway. Runoff from drainage areas above or north of the roadway corridor would be allowed to pass through and discharge via bioswales. The bioswales would be sized so that no additional runoff would flow into the adjacent downslope Navy property.

Retaining walls to support grade differences in the roadway corridor are a major element of the landscape areas. Retaining walls along the southern boundary of Alternative C are lower than Alternatives A and B and should be less of a visual concern to adjacent military residents. To allow for the sloped berms and lower retaining walls, the embankments would require extensions into the Navy land by approximately 8 to 12 feet over a total length of approximately 1,400 feet. The encroachment into the Navy housing area would occur in the common areas of the individual residences. Many of the residences, if not all, have an enclosed or fenced private yard at the rear of their units. None of the private yards would be affected by the extended retaining walls. Use of the Navy land for the City project would require U.S. government authorization and possibly an easement from the Navy.

2.2.3.2 Alternative C Construction Schedule and Cost

The preliminary cost for construction of Alternative C is estimated at approximately $79 million. Completion of the road construction is expected to occur over a longer period of time than Alternative A and B as additional earthwork is required and federal authorization must be obtained for use of Navy land.



1 **Figure 2-15. Alternative C Landscape Section**

Alternative C	Cost ($ million)*
Roadway Improvements	21.2
Retaining Walls and Landscaping	16.3
Storm Drainage	4.2
Utilities	14.7
Construction Management	22.6
TOTAL	79.1

* In 2014 dollars. Listed items sum to less than the total because of rounding.

2.2.4 ALTERNATIVE D–NO ACTION

Under the No Action alternative, Alternative A, B, or C would not occur. The roadway within the Salt Lake Boulevard right-of-way would remain in its existing configuration with two lanes, no bike lanes, no curbs and gutters, and no sidewalk.

Under the No Action alternative, there would be no construction and associated impacts and hence, no construction cost other than costs associated with periodic maintenance resurfacing.

The effects of "No Action" are that traffic volumes would continue to increase on Salt Lake Boulevard, further burdening the roadway's capacity to accommodate present and future traffic demands. The stretch of Salt Lake Boulevard between Ala Liliko'i Street and Maluna Street has and would continue to worsen as a bottleneck for traffic between Increment 1 and the completed portion of Increment 2. Since commercial vehicles also use this roadway for pick-ups and deliveries and as a transit route, delivery schedules and possibly businesses would be impacted by continued worsening of traffic through this corridor.

2.2.5 SUMMARY OF PROPOSED ACTION ALTERNATIVES

Table 2-2 summarizes the key roadway elements of each proposed action alternative. It also serves as a quick reference for comparison purposes.

Table 2-2. Summary of Road Widening Alternatives

Roadway Elements	Alternative A	Alternative B	Alternative C	Alternative D (No Action)
Four travel lanes, dedicated bike lanes, sidewalk, bioswale drainage, and landscaped strip	Included	Included	Included	No change
Median	Striped median including left-turn storage lane	Raised landscaped median, 4- to 12-foot width	Raised landscaped median, 12-foot width	No change
Parking lane	Limited	Limited	Full length	No change
Utilities	Overhead	Overhead	Underground	No change
Improvements within Right-of-Way	All*	All*	Partially in Navy land	No change
Management of drainage	Underground retention	Underground retention	Bioswales	No change
Estimated construction cost (in million 2014 dollars)	$64.3	$55.3	$79.1	No cost

* With some exceptions as described in Section 2.2.1.1.

2.3 ALTERNATIVES CONSIDERED BUT NOT CARRIED FORWARD FOR ANALYSES

The process used to determine the reasonable range of alternatives to be evaluated in this EA involved screening various alternatives based on the purpose of and need for the project as described in Chapter 1. In addition, alternatives were screened for factors such as compliance with current public policies and design standards, suitability to existing site, engineering feasibility, accessibility to proposed improvements, responsiveness to public concerns, safety and cost, all of which are criteria used by and are responsibilities of the City to provide needed safe and efficient transportation systems for the public. As a result of this screening process, only Alternatives A, B, and C were advanced for further analysis. Also, Chapter 343 HRS and NEPA environmental review requires analysis of a “No Action” alternative as a basis for comparison of the build alternatives. The “No Action” alternative is provided as Alternative D in this EA.

Alternatives which were considered but not carried forward for further evaluation in this EA are identified below.

2.3.1 ALTERNATIVE DESIGNS/ROAD FEATURES

No Parking Lane. This alternative includes no parking lane for Phase 3 of the Salt Lake Boulevard Widening Project. The non-inclusion of on-street parking would reduce potential traffic conflicts along the right-of-way. It would require less pavement area in the roadway than in Alternative A, hence, less grading, smaller retaining walls, and smaller drainage improvements. There would be larger grassed areas between the roadway and residential lots, and as a result improved aesthetics and transitions to the adjacent residential driveways.

The drawback would be no on-street parking for public use, a loss of potentially 118 parking spaces along Salt Lake Boulevard. Adjoining residents do not favor this alternative, as the provision of on-street parking has been in practice for as long as the residences have had frontage to the road. For that reason, this alternative was removed from further consideration.

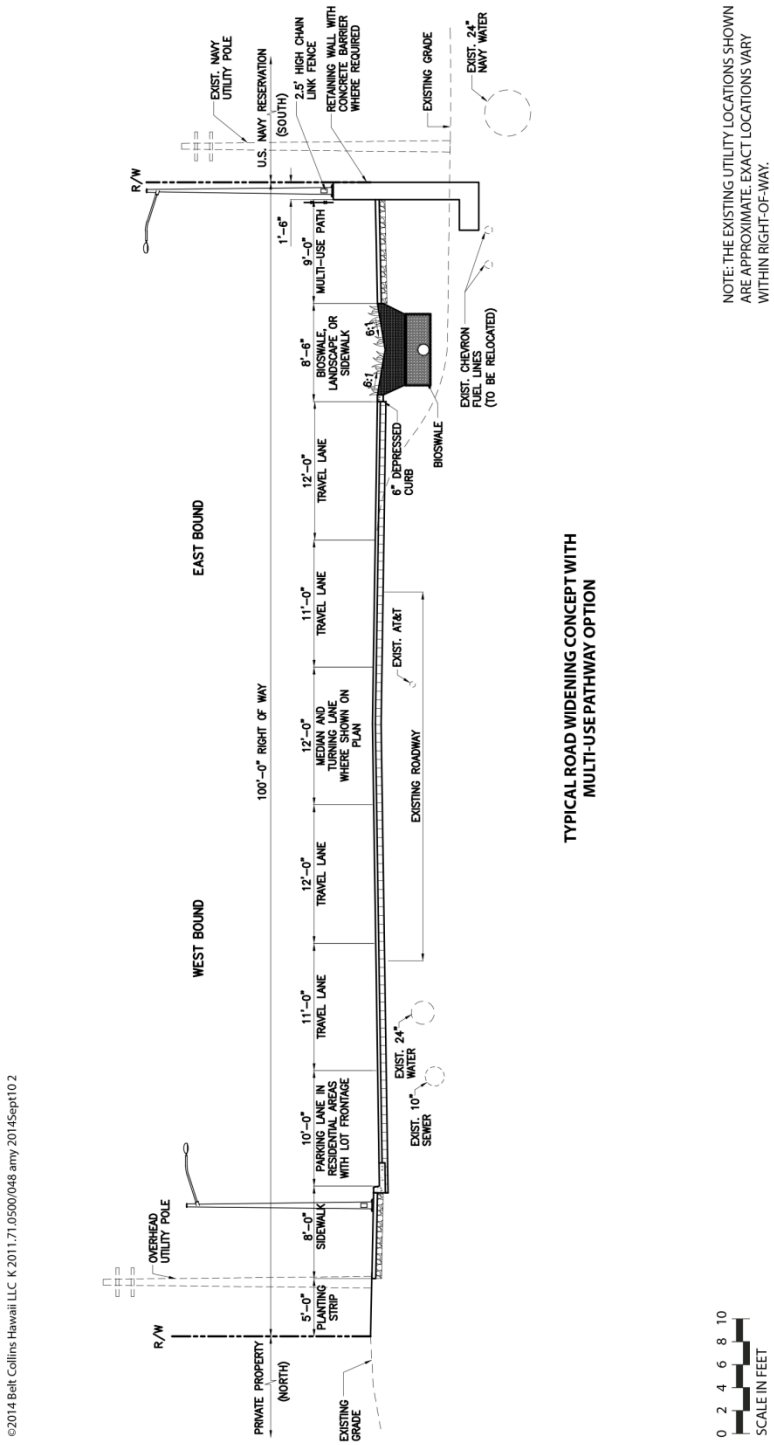
Shared Use Lane by Vehicles and Bicycles. This alternative considered the continuation of a shared use of a lane by vehicles and bicycles from Salt Lake Boulevard Widening – Increment 2, Phases 1 and 2 through Phase 3. Such a special lane would improve the efficiency of space within the right-of-way.

The drawback for this alternative is that there are some inherent dangers and risks in mixing different transportation modes on a particular lane or pathway. A wide shared use lane is not as safe as a dedicated lane for vehicles and a separate pathway for bicycles.

For safety reasons, this alternative was removed from further consideration.

Multi-Use Pathway for Bicycles and Pedestrians (Southern Shoulder). This alternative considered the use of a multi-use pathway for bicycles and pedestrians in the shoulder area outside of the vehicular travel lanes in lieu of dedicated bike lanes within the travel lanes and standard sidewalks in the typical shoulder areas (see Figure 2-16). The multi-use pathway would be located on the southern side of the road away from the potential hazards of the multiple driveways and on-street parking on the northern side. Combining the bike lanes and pedestrian sidewalk into a multi-use pathway eliminates the need to have separate bike lanes and sidewalks on both sides of the road. Since all of the residences that have direct access to Salt Lake Boulevard occupy the northern side of the road, an improved sidewalk would be beneficial there as well.

With all of the benefits this alternative would generate however, its suitability for the Salt Lake Boulevard–Phase 3 is not strong. Phase 3 of the Salt Lake Boulevard Widening Project is bordered at either end by the completed Increment 1 and Increment 2, Phases 1 and 2. These completed (widened) sections of Salt Lake Boulevard already have existing sidewalks and dedicated bike lanes or designated bike routes on either side of the road. Changing the bike paths to just one side of the road for the middle Phase 3 section would be disruptive and confusing to the cyclist.



1 **Figure 2-16. Typical Road Widening Concept with Multi-Use Pathway Option**

The U.S. Navy owns a large majority of the land on the southern side of the Salt Lake Boulevard right-of-way. Security for this property is a major consideration for the Navy. The Navy has expressed preference to prohibit shrub and trees on the side of the City right-of-way abutting the Navy Public Works Center in Phase 2, but since a property fence already occurs along the Navy housing area beside Phase 3, security concerns for that boundary by the military are not as intense.

With neither direct access from the housing units on the Navy property (except at Namur Road and Radford Drive) to the Salt Lake Boulevard nor any bus stops on the southern side of the travel lanes, use of a sidewalk in the multi-use pathway is not expected to be high, particularly if an improved walkway is to be provided on the northern side. This would raise the question whether a multi-use pathway with a pedestrian walkway is appropriate on the southern side.

In summary, , the provision of a multi-use pathway on the southern side of Salt Lake Boulevard–Phase 3 is not warranted at this time, and as a result, was removed from further consideration in this EA.

Multi-Use Pathway for Bicycles and Pedestrians (Northern Shoulder). This alternative is similar to the multi-use pathway on the southern shoulder, but instead is located on the northern shoulder. As with the multi-use pathway on the southern shoulder, this multi-use pathway would combine bike lanes and pedestrian walkway into a single multi-use pathway on the northern side and eliminate the need for separate bike lanes and sidewalks on either side of the road.. Consolidating the bike lanes and pedestrian sidewalk on the northern side of the roadway would decrease the amount of grading and retaining wall heights on the southern side of the road.

The drawbacks to this alternative are that this design would create more difficulties in a smooth grade transition between the roadway/multi-use path and the northern residential driveways/entrances. The numerous driveways on the northern side would also be disruptive and pose as a potential hazard for bicyclists on the multi-use pathway than if the pathway were to be located on the southern side.

Similar to the alternative that contains a multi-use pathway on the southern side, this alternative would create disconnects of bikeways at each end of Phase 3. The bike lanes would require cross-overs at the terminuses causing confusion and possible delays for the bike lane users. .

Given the design constraints from existing site conditions along the roadway's northern boundary and disconnects in roadway elements between the completed (widened) sections of Salt Lake Boulevard and Phase 3, this alternative was removed from further consideration.

Reduced Landscaped Strip on Northern Side. This alternative considered reducing the landscape strip width on the northern side of the road and providing an equivalent greenbelt

strip on the southern side of the road. The intent was to reduce the amount of grading and retaining wall heights, to some extent, and provide more space for appurtenant utilities on the southern side of the road.

The drawbacks for this alternative are that there would be more difficulties in transitioning from the pavement of the widened road to the existing residential driveways and accesses on the northern side due to elevation differences. Further, this alternative would require more coordination of overhead utility lines and pole relocations within a narrower landscaped strip in the northern shoulder area.. Given these design and accessibility constraints, this alternative was removed from further consideration.

2.3.2 ALTERNATIVE ALIGNMENT

The purpose and need for this project is to reduce traffic congestion and delays along the existing Salt Lake Boulevard corridor. This readily eliminated any consideration of an alternative route between Maluna Street and Ala Liliko‘i Street.

Meandering the road alignment outside of the existing road corridor to avoid severe physiographical conditions or to accommodate a more efficient transportation alignment would result in the displacement of existing residences. This option would be costly to construct and disruptive to the community and, as a result, was removed from further consideration.

2.3.3 ALTERNATIVE TRANSPORTATION SYSTEM

Public Transit System. Improving the City’s public transit service (TheBus) to increase public ridership through the Salt Lake community may take some vehicles off the road and improve traffic in the community. It is noted however, existing bus routes through the community serve only a portion of the homes in the area and do not run along the entire length of Salt Lake Boulevard. These limitations on the bus service may discourage riders from fully using the public transit system.

Improvements to make the system more attractive to residents, such as more frequent buses and revisions to the bus routes, would require further traffic and routing studies and additional marketing and implementation costs. Moreover, large portions of the traffic on Salt Lake Boulevard–Phase 3 are through-traffic to surrounding communities or traffic associated with commercial and industrial businesses in nearby Salt Lake, Hālawa, Makalapa and Māpunapuna districts. These users do not typically rely on bus service for transportation. As a result, improving the public transit system around the study area would not effectively accomplish the purpose and need for the project.

Rail Transit System. In the Hālawa, Āliamanu, and Honolulu International Airport area, the designated route for the Honolulu Rail Transit project is Nimitz Highway. Salt Lake Boulevard

was a considered alternative route in the 2010 Final EIS for the rail project.[1] Construction of the project is currently proceeding on the Nimitz Highway route which overall starts in ʻEwa and ends at Ala Moana Center. It is not clear that traffic on Salt Lake Boulevard would benefit from a rail system unless a transit station were located in the vicinity. If no station is located in the area, residents would not likely abandon their vehicles and use or access the system, and as result, there would be no consequence that reduces congestion and traffic delays on the local streets and no compliance with the purpose and need for the Salt Lake Boulevard project.

2.3.4 ALTERNATIVE TRAFFIC MANAGEMENT

Improvements to traffic light cycles/timing would provide marginal improvements to traffic flow through the Phase 3 section of Salt Lake Boulevard, as noted in a traffic study for the City (see Appendix B). For the future, increasing the number of travel lanes in the road right-of-way would be a more effective and long-term solution to improving the capacity of Salt Lake Boulevard between Maluna Street and Ala Liliko‘i Street and to accommodating the anticipated increase in traffic volumes along this corridor.

[1] City and County of Honolulu. June 2010. *Honolulu High-Capacity Transit Corridor Project Environmental Impact Statement.*

Chapter 3

Affected Natural Environment, Potential Impacts, and Mitigation Measures

CHAPTER 3

Affected Natural Environment, Potential Impacts, and Mitigation Measures

3.1 INTRODUCTION

This chapter, which describes the affected natural environment, potential environmental consequences of the project, and proposed mitigation measures, is organized by resource areas as follows: geology, topography, and soils; hydrology; natural hazards; and flora and fauna.

The discussion of environmental consequences includes both direct and indirect impacts. Direct impacts are those caused by the action which occurs at the same place and time. Indirect effects may occur later in time or farther in distance but are still reasonably foreseeable. Cumulative environmental impacts are addressed in Chapter 6, Cumulative Analysis. Cumulative impacts are defined as the results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Environmental consequences are examined in this chapter for the proposed action alternatives discussed in Chapter 2, including the No Action alternative.

3.2 GEOLOGY, TOPOGRAPHY, AND SOILS

3.2.1 AFFECTED ENVIRONMENT

Geology

The area of Oʻahu known as Salt Lake was formed through a series of volcanic eruptions, beginning about 500,000 years ago and terminating more than 100,000 years ago.[1] Three low profile, overlapping tuff cones or volcanic craters, known as Makalapa, Āliamanu and Āliapaʻakai, are clustered in the area. The Salt Lake Boulevard project lies to the southwest of Āliamanu and Āliapaʻakai craters. The three cones blocked the former water courses of Moanalua and Hālawa Streams and forced them to make wide detours to the sea (Macdonald et al.1983:445 in Cultural Surveys Hawaiʻi 2012).[2] The cones also formed a rain shadow in the lee of the Koʻolau mountain range creating dry conditions for the area.

Salt Lake was a shallow lake that formed in the bowl of Āliapaʻakai as a result of freshwater springs or possibly seawater seepages.[3] Because the lake had no outlet, water loss was largely by evaporation. Salt deposits formed around the shore, and the lake was known to Hawaiians as Āliapaʻakai, or "salt pond." In 1910, an artesian well was dug to bring the water level higher for use as a fishpond, and the inflow of water lowered the salt content of the lake. A tunnel, dug through the southwest rim of the crater, was constructed to control the water level and

---

1 Pankiwskyj, Kost A. 1972. "Geology of the Salt Lake Area, Oahu, Hawaii." Pacific Science. Volume 26, Number 2. http://scholarspace.manoa.hawaii.edu/handle/10125/404.

2 Macdonald, Gordon Andrew, Agatin T. Abbott, and Frank L. Peterson. January 1983. Volcanoes in the Sea: The Geology of Hawaii. Second Edition.

3 Alexander, A.C. 1926 in Maciolek, J. A. April 30, 1982. "Lakes and Lake-like Waters of the Hawaiian Archipelago." Occasional Papers of Bernice P. Bishop Museum. Volume 25, Number 1.

provide an outlet.[4] This act and later construction of a larger drainage outlet eventually removed the salt from the lake.

The community known as Salt Lake was developed during the building boom of the 1960s in Āliapaʻakai, the largest and easternmost of the three volcanic craters. By the mid-1960s, water quality in the lake and surrounding wetlands had been adversely affected by development in the surrounding areas, as well as from sewage pumped to the lake from the development in Āliamanu Crater. In 1966, the State filled in most of the lake and surrounding wetlands. Today, only remnants of the original lake remain, including ponds at the Honolulu Country Club golf course.

Topography

In the Salt Lake Boulevard–Phase 3 corridor, elevation ranges from around 132 feet above mean sea level (MSL) near the Board of Water Supply reservoir (at the west end) to approximately 23 feet MSL at the low point near Ala Liliko‘i Street (at the east end). The surrounding land generally slopes lower toward the south and perpendicular to the roadway (see Figure 3-1). Near the Ala Liliko‘i Street end of the project, the land reverses slope and drains north toward Salt Lake. The roadway itself is rolling with a series of high and low points. There are some retaining walls and exposed rock embankments along the roadway.

Soils

The National Resource Conservation Service (NRCS) Web Soil Survey identifies the general soil types of the area as Makalapa Clay (MdB and MdC) and Rock Land (rRK). Makalapa Clay is a typical soil found on O‘ahu near Salt Lake Crater, Diamond Head, and the Mōkapu Peninsula. A typical soil profile consists of roughly 38 inches of dark grayish brown clay underlain by weathered volcanic tuff. Makalapa soils are very sticky, very plastic, and have a high shrink-swell potential. These soils are well drained, with slow to medium runoff, and slow permeability. Erosion hazard is slight to moderate.

Rock Land has exposed rock covering 25 to 90 percent of the surface. Rock outcrops and very shallow soils are the main characteristics. Any soils found on Rock Land surfaces are also very sticky, very plastic, and have a high shrink-swell potential. The NRCS lists both soil types in Hydrologic Soil Group “D”. See Figure 3-2.

[4] Macdonald, Gordon Andrew, Agatin T. Abbott, and Frank L. Peterson. January 1983. *Volcanoes in the Sea: The Geology of Hawaii.* Second Edition.

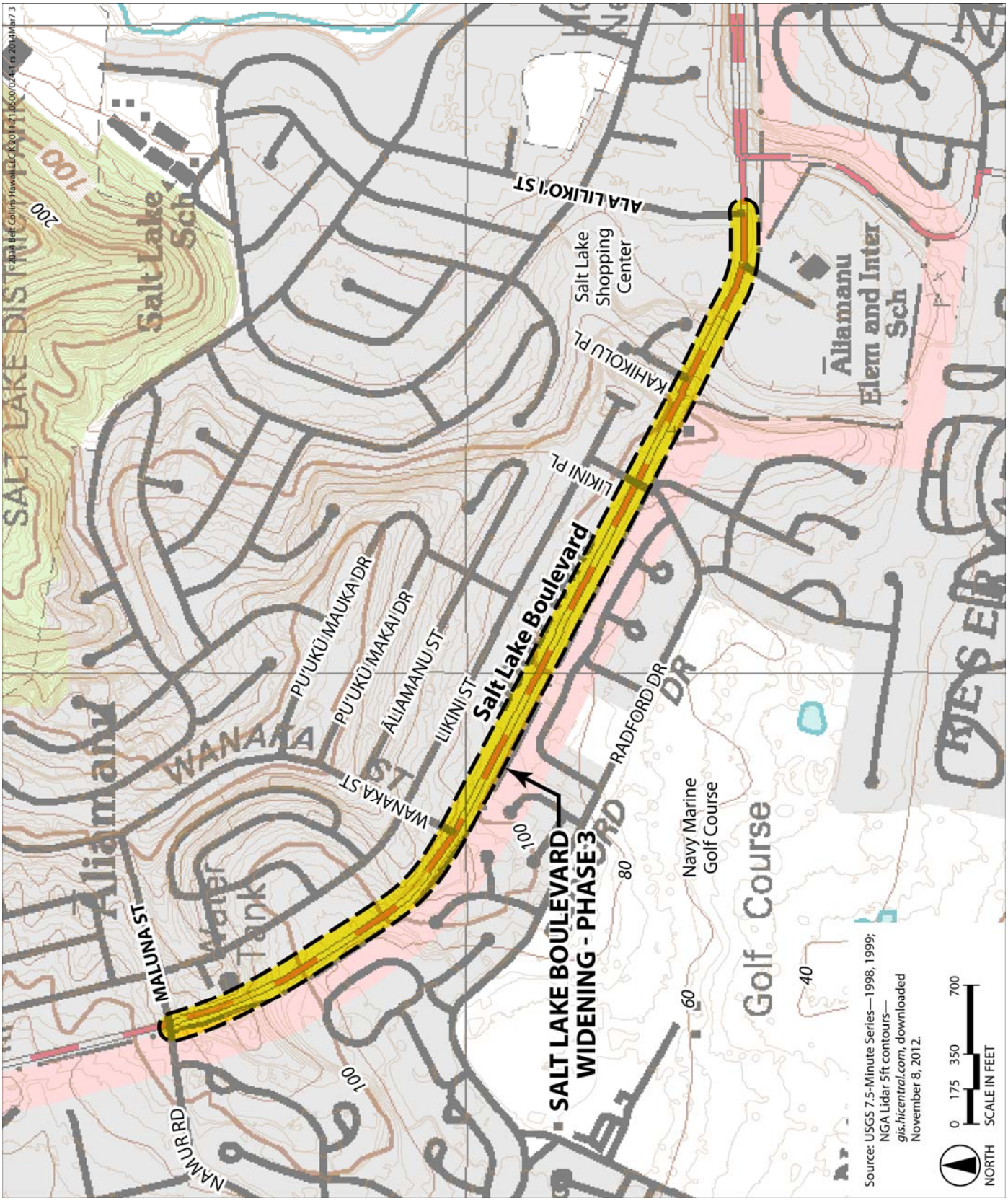


Figure 3-1. General Topography

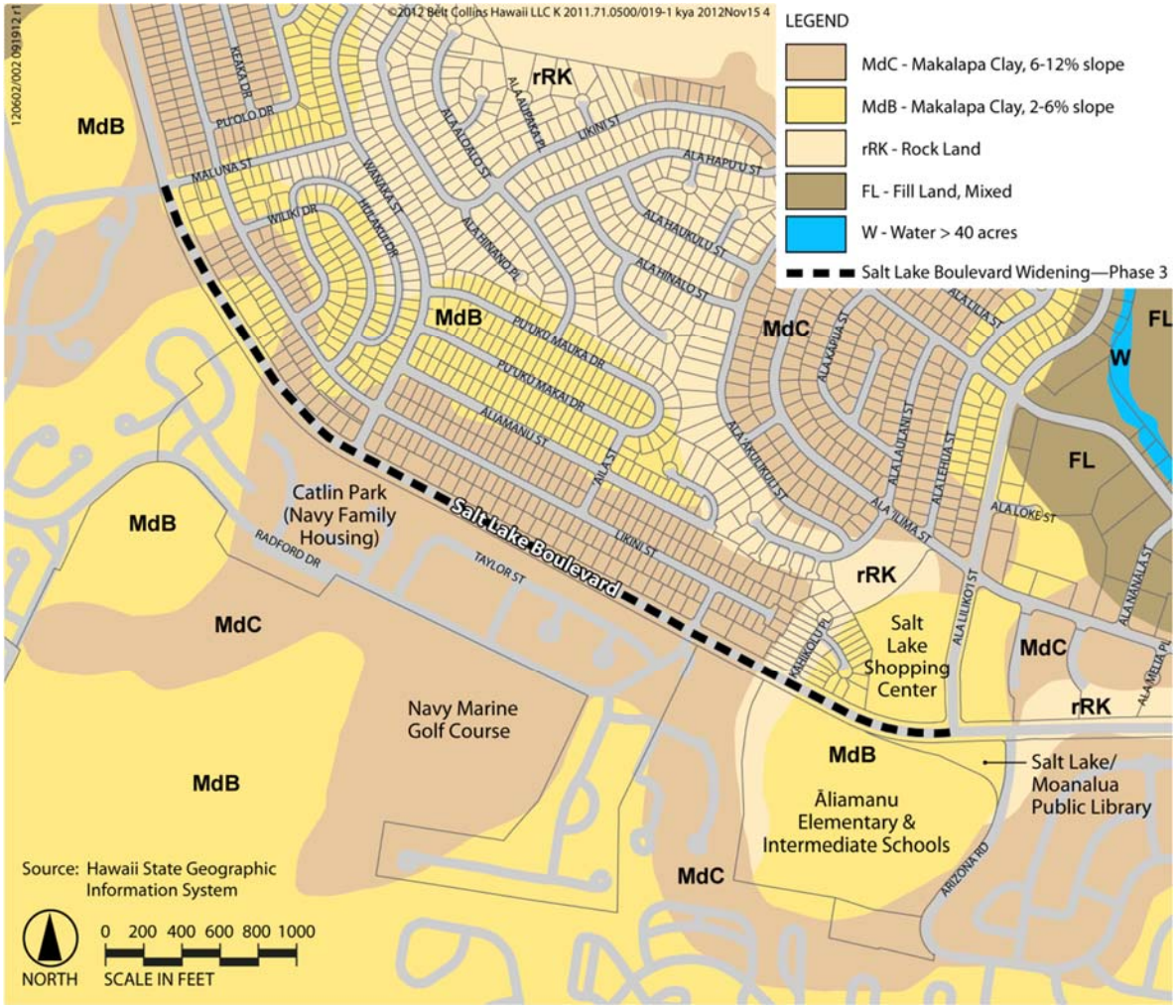


Figure 3-2. Soils

3.2.2 ENVIRONMENTAL CONSEQUENCES

3.2.2.1 Alternative A

Construction Impacts

During construction, impacts to soils and topography would be associated with grading within the road right-of-way and with site work, including a combination of excavation and embankment. Earthwork would include excavations of up to approximately 30 feet on the northern side of the road at the BWS water tank and approximately 26 feet high near the Wanaka Street intersection. On the southern side, earthwork would be required to extend the finished grade of the road to the right-of-way boundary resulting in a need at some locations for a retaining wall of up to approximately 15 feet high (facing Navy property). Overall, it is estimated that Alternative A would involve approximately 16,000 cubic yards of excavation or earthwork.

All improvements, including shoulder improvements and retaining walls, would be constructed within the City's existing right-of-way. An exception would occur at the Āliamanu Intermediate School property where current plans call for establishing a fill slope or graded embankment to support the edge of the proposed road widening improvements. Approximately 13,000 cubic yards of fill would be imported to the site and occupy approximately 18,000 square feet of the school property adjacent to the City right-of-way. A right-of-entry from the State would be sought for the construction of the new fill slope. The plan for the fill slope is similar for Alternatives B and C.

A detailed description of the four critical sections within the project corridor where retaining walls are needed is provided below.

Section 1- Northern Side - Station 3+00 (BWS Water Tank, near Maluna Street)

Just east of Maluna Street on the northern side of the roadway, the adjacent lots sit on a rocky bluff approximately 30 feet higher than the roadway. Under Alternative A, a retaining wall of up to approximately 30 feet high would be constructed. The wall would be approximately 31 feet from the water tank at its closest location. See Photograph 3-1.

Photograph 3-1. Section 1—Looking east. Retaining wall needed on northern (left) side near water tank.

Section 2 - Northern Side - Station 15+00

The second critical location is along the northern side of Salt Lake Boulevard just west of Wanaka Street, where a 450-foot-long retaining wall of up to approximately 26 feet high, would be required. For Alternative A, the retaining wall would be adjacent to the new sidewalk and located at the top of grade for the roadway, limiting the amount of slope cut required. See Photograph 3-2.

Photograph 3-2. Section 2—Looking east. Retaining wall needed on northern (left) side.

Section 3 - Southern Side - Maluna Street to Radford Drive

Section 3 is located between Maluna Street and Radford Drive on the southern side bordering the Navy's Catlin Park family housing. In this area, retaining walls with a total length of - approximately 3,800 feet, varying in height from approximately 0 feet to 15 feet,[5] would be constructed along the right-of-way boundary. See Photograph 3-3.

Photograph 3-3. Section 3—Looking east. Retaining wall needed on southern (right) side adjacent to Navy's Catlin Park family housing area.

[5] Includes height of wall for the grade difference in the area and height of wall serving as a barrier for the right-of-way. The retaining walls, in some instances, are in cut areas along the right-of-way and, in other instances, in fill areas of the right-of-way.

Section 4 - Southern Side - Radford Drive to Āliamanu Middle School Driveway

Section 4 is located on the southern side between Radford Drive and the Āliamanu Middle School driveway. This area near the Island Family Christian Church would require a retaining wall approximately 15 feet high to accommodate the higher elevation of the adjacent parcel. See Photograph 3-4.

Photograph 3-4. Section 4—Looking east. Retaining wall needed on southern (right) side of Salt Lake Boulevard near Island Family Christian Church.

Options for retaining walls include gravity walls, cantilever walls, piling walls, anchored walls, or segmental block walls. Soil nailing can also be investigated. In some locations where the cuts are into solid rock, the rock face alone may be able to remain without additional structural retaining measures. The structural design would be performed in accordance with soils investigations.

Operational Impacts

The completed roadway improvements would not have an adverse impact on soils, topography or geological conditions. Retaining walls would be designed appropriately for

existing soil conditions, and all design and construction would be done in accordance with applicable City and County of Honolulu and State of Hawai'i DOT design guidelines and standards and would be coordinated with the City and County of Honolulu, Department of Planning and Permitting.

3.2.2.2 Alternative B

Construction Impacts

Alternative B includes a raised landscaped median in lieu of a striped median as proposed in Alternative A to create a buffer and safety barrier and improve the visual appearance of the right-of-way. Similar to the Alternative A, Alternative B would have limited on-street parking and include retaining walls of up to approximately 30 feet and 26 feet high on the northern side at the western end of Salt Lake Boulevard. On the southern side, the retaining walls would be less as shoulder area would be tighter to the narrower median. As in Alternative A, all construction would be within the right-of-way and not require use of Navy land. Alternative B would involve an estimated 15,000 cubic yards of excavation or earthwork, a little less than the Alternative A. Specific differences by section are described below:

Section 1 - Northern Side - Station 3+00 (BWS Water Tank, near Maluna Street)

There would be no parking lane in this section and impacts would be similar to Alternative A.

Section 2 - Northern Side - Station 15+00

There would be no parking lane in this section, and impacts would be similar to Alternative A.

Section 3 - Southern Side – Maluna Street to Radford Drive

Alternative B has the least amount of retaining walls (with heights of up to approximately 14 feet high) in this section adjacent to the Navy housing. This alternative narrows the roadway median by 8 feet, allowing some of the grade differential to be accommodated with a 2:1 slope in lieu of a retaining wall at the right-of-way boundary.

Section 4 - Southern Side - Radford Drive to Āliamanu Middle School Driveway

Improvements are the same as Alternatives A and C, including a retaining wall of up to approximately 15 feet high at the right-of-way boundary.

Operational Impacts

Like Alternative A, Alternative B would not have a continuous parking lane along Salt Lake Boulevard. It would differ in appearance due to a raised landscape median and different heights retaining walls.

Similar to Alternatives A and C, there would be no long-term adverse impacts from Alternative B on topographical, geological, or soils conditions. All improvements would be properly designed and constructed in accordance with applicable design and engineering standards.

3.2.2.3 Alternative C

Construction Impacts

Alternative C includes a parking lane along the entire northern side of Phase 3. It would require the greatest quantity of earthwork of the three action alternatives. Alternative C would require approximately 24,000 cubic yards of excavation and embankment, including extensive excavation at the steep high cut areas. Along the Navy boundary, Alternative C would include fill in the military housing property to minimize the proposed retaining wall heights. The sloped berm and lower retaining wall would mitigate the visual impact of a single, high wall as proposed in Alternative A. As a result of this terraced design, construction of Alternative C would encroach into the Navy land, which would require approval from the federal government. Specific differences by sections are described below.

Section 1- Northern Side - Station 3+00 (BWS Water Tank, near Maluna Street)

In high cut areas, as in the section along the BWS water tank, higher retaining walls and more cut would be required to accommodate the new parking lane. The retaining wall in this area would be from 6 feet to approximately 30 feet high for a length of approximately 310 feet. The wall would be approximately 18 feet from the water tank at its closest location, which would make construction of the retaining wall more complicated than Alternative A.

Section 2 - Northern Side - Station 15+00

The retaining wall in this area would be approximately the same height as the retaining wall in Alternative A. The wall, however, would be at the right-of-way boundary where there are existing fences and homes as close as 5 feet from the edge of the right-of-way. The proximity of the existing homes to this high retaining wall would make construction of the retaining wall a challenge.

Section 3 - Southern Side - Maluna Street to Radford Drive

In this area adjacent to the Navy's Catlin Park family housing, the retaining walls would be located 8 to 12 feet into the Navy land. The southern shoulder of the widened road would be graded to reduce the height of the retaining wall in the Navy land to approximately 3 to 8 feet.

Section 4 - Southern Side - Radford Drive to Āliamanu Middle School Driveway

Improvements would be the same as Alternatives A and B, and the retaining wall would be up to approximately 14 feet high.

Operational Impacts

In the long-term, Alternative C would differ from Alternatives A and B with the presence of a continuous parking lane and lower retaining walls particularly along the Navy property line. Like Alternatives A and B, there would be no long-term adverse impact on topographical, geological, and soils conditions. All improvements would be properly designed and constructed in accordance with applicable design and engineering standards.

3.2.2.4 Alternative D–No Action

Under the No Action alternative, there would be no roadway improvements and no impact to area topography, geology, or soils. No earthwork would be involved and no retaining walls would be constructed.

3.2.3 Mitigation Measures

During construction, best management practices (BMPs) would be employed as part of the proposed action alternatives. Erosion and sediment control measures as prescribed under National Pollutant Discharge Elimination System (NPDES) permit requirements of the State of Hawaiʻi Department of Health (DOH) would be implemented including use of possible sediment control filters at drain inlets, catch basin openings, and along the limits of grading to capture sediment-laden runoff. Other possible measures include phased grading to reduce the amount and duration of soil exposed to erosion, preservation of existing plants that serve to control erosion, installation of vegetation and/or physical stabilization measures on slopes, and protection of stockpiles of gravel, topsoil, excavated materials, and imported materials.

To comply with State DOH requirements for dust control (Hawaiʻi Administrative Rules [HAR] 11-60.1), temporary measures could be applied to stabilize soil from wind erosion and reduce dust generated by construction activities. Examples for the latter include installation of temporary dust screens along the property lines of downwind properties, and use of water trucks to frequently sprinkle water over areas of exposed dirt or soil stockpiles.

3.3 Hydrology

3.3.1 Affected Environment

Surface Water Resources

There are no streams or other surface water resources within the immediate project corridor. The closest streams are Moanalua Stream, located to the east, which empties into Keʻehi Lagoon, and Hālawa Stream, located to the west, which empties into the east loch of Pearl Harbor.

Groundwater Resources

The project area is within the Moanalua groundwater unit of the Honolulu Aquifer, near the boundary of the Honolulu and Pearl Harbor Aquifers. These two aquifers are major sources of potable water for much of Oʻahu. They are regional, unconfined, basal groundwater aquifers composed of Koʻolau basalt except near the coast, where there are thick confining units of unconsolidated and consolidated sedimentary deposits.

The nearest municipal wells within the Honolulu Aquifer consist of a cluster of wells (Moanalua, Moanalua 1, 2 and 3) located near Moanalua Gardens, about a mile northwest of the project corridor. Groundwater levels for these wells range from about 18 to 21 feet above mean sea level (MSL). Another well about 0.3 miles north of the project corridor is in the

Waimalu unit of the Pearl Harbor Aquifer. This well is currently abandoned but was noted as having a groundwater level of 20 feet above MSL.

Based on information from these existing wells, the groundwater level within the project corridor is estimated to be approximately 21 feet above MSL. As noted above, current elevations along Salt Lake Boulevard range from 132 feet above MSL near the Board of Water Supply tank at Maluna Street to approximately 23 feet above MSL near Ala Liliko‘i Street. This seems to indicate that groundwater can be anywhere from over 100 feet below ground at the western end, to only a few feet below ground at the lower, eastern end.

Drainage

In general, residential areas on the northern side of the Salt Lake Boulevard corridor slope toward the project with drainage flowing across the roadway corridor. City and County of Honolulu storm drain systems are located within the present roadway and adjacent private properties. The storm drains run toward Salt Lake Boulevard where they cross the road, continue through the Navy’s housing area, and outlet at the Navy-Marine Golf Course. Drainage flows from these areas ultimately discharge into Pearl Harbor.

Although most of the runoff from the area north of Salt Lake Boulevard is intercepted by the City storm drain system, the existing system is inadequate and under capacity. As a result, during heavy rains, much of the storm water overflows onto Salt Lake Boulevard creating flooding and ponding conditions within the project corridor.

The Navy recently made improvements to roadways and storm drain systems in the Catlin Park housing area. While the system is better able to manage the Salt Lake Boulevard surface runoff and overflow, most of the Navy storm drain lines within its property remain undersized for even a 10-year storm runoff.

3.3.2 Environmental Consequences

3.3.2.1 Alternative A

Construction Impacts

Project construction would not have an adverse impact on hydrologic conditions on the site or on adjacent properties. The construction contractor would be required to obtain the required NPDES permits which include general permits for construction dewatering, stormwater runoff, and hydrotesting activities. Appropriate erosion control measures would be implemented during construction, including measures to prevent fuel, oil, and cement products from discharging or leaching into nearby surface waters or the ocean.

Operational Impacts

With appropriate drainage design and preventive measures, as described below, the proposed project would not have an adverse impact on existing hydrologic conditions on the site, the City’s drainage system, or on adjacent and downstream properties.

Increase in Impervious Areas

Since the vertical alignment (i.e., upward and downward slope) of Salt Lake Boulevard would not be modified, existing drainage patterns are not expected to change significantly. Widening of the existing roadway by two lanes, however, would increase the amount of impervious surface within the right-of-way, resulting in additional storm water runoff. This additional runoff would be channeled to bioswales on the southern side of the road. This LID feature is designed to receive ground percolation discharges of stormwater runoff from the road pavement.

Additionally, an existing open detention basin near Marshall Road would be used to capture runoff from upland areas near Maluna Street. The project drainage system is designed to ensure that the quantity of runoff leaving the project area does not exceed existing conditions, and therefore, roadway improvements would not increase drainage flow off-site.

Navy's Storm Drain System

Although the project is designed not to increase storm water flows off-site over present conditions, the Navy's existing storm drain system lacks adequate capacity for existing flows. Since the Navy has no immediate plans to upgrade the capacity of its existing storm drain lines, occasional flooding and surface overflows would continue in downstream areas. Hence, with or without the proposed improvements to Salt Lake Boulevard, the Navy land would experience overflows when storm water runoff exceeds the capacity of the Navy's drain system. This condition would not worsen as a result of the Salt Lake Boulevard Widening–Phase 3 project.

The detention basins included in Alternatives A and B would hold runoff so that it can be released over time, given the capacity of the downstream drain line system. A particular feature of the project's new drain system is, in areas where the detention basins plus downstream drain line capacity is insufficient, the road widening project, which would include new drain inlets and catch basins, would include a "release" for excessive storm water to discharge to downstream areas before it backs up and spreads into the roadway travel lanes.

All drainage improvements for the proposed action alternatives would conform to the City and County of Honolulu and State of Hawai'i DOT design guidelines and be coordinated with the City and County of Honolulu, Department of Planning and Permitting.

Water Quality

Pollutants associated with storm water runoff from the project would be reduced to the maximum extent practicable. Appropriate BMPs would be employed to comply with the State of Hawai'i DOT "Storm Water Permanent Best Management Practices Manual."

There is a potential for storm water runoff from developed areas, such as roadways, to contain pollutants such as suspended solids, hydrocarbons, trace metals, pesticides,

phosphorus, nitrogen, and trash and debris, which could degrade water quality. With implementation of pollution prevention measures as part of the project, the proposed widening of Salt Lake Boulevard would not have a negative impact on water quality in Hālawa or Moanalua Streams or in receiving waters of Pearl Harbor or Keʻehi Lagoon.

Water quality treatment devices would be installed at key locations in the underground drainage system to treat stormwater runoff and aid in removing pollutants. Debris containment traps would be used in catch basins to prevent trash and debris from entering the drainage system. Six underground hydrodynamic separation devices would be installed to treat runoff from the new storm drain system. The devices would be sized to remove at least 80 percent of Total Suspended Solids (TSS) of the size fraction typical for urban runoff. The selected treatment devices would have a small footprint, generally fitting inside an oversized drain manhole. Regular maintenance of the structures would be required for continued performance.

An existing detention basin provides water quality treatment for the western-most end of the project corridor. The basin has adequate capacity for retaining the required water quality volume.

Groundwater

The project would not adversely impact groundwater resources of the Pearl Harbor Aquifer. The potential for runoff infiltration into the underlying groundwater aquifer is low since groundwater in the area lies below an impervious layer. The project is not expected to increase infiltration into the groundwater aquifer.

3.3.2.2 Alternatives B and C

Construction Impacts

Both Alternatives B and C would have construction impacts similar to Alternative A. Alternative C, however, would require additional excavation in the steep high cut areas and grading in the adjacent Navy land. None of the alternatives would have an adverse impact on existing hydrological conditions. For Alternatives B and C, the construction contractor would be required to apply appropriate erosion control measures and utilize BMPs in accordance with NPDES permit requirements for construction dewatering, storm water runoff, and hydrotesting activities.

Operational Impacts

Both Alternatives B and C would have operational impacts similar to Alternative A. Both alternatives would improve existing conditions due to the construction of new drain inlets, catchment basins or bioswales, and underground drainage systems along the roadway.

A particular feature of the project's new drain system is, in areas where downstream drain line capacity is insufficient, the road widening project, which would include new drain inlets

and catch basins, would include a "release" for excessive storm water to discharge to downstream areas before it backs up and spreads into the roadway travel lanes.

For Alternatives B and C, downstream drainage conditions would remain unchanged. Neither Alternatives B or C would adversely affect groundwater resources.

3.3.2.3 Alternative D–No Action

The No Action alternative would have no environmental impacts associated with construction or operation. Existing drainage conditions would continue, with occasional flooding along Salt Lake Boulevard. There would be no drainage improvements or installation of pollution control devices, and unless drainage improvements are made by the Navy, there would be no change in downstream drainage conditions in the Navy housing area.

3.3.3 Mitigation Measures

With the construction of the planned drainage system improvements as part of the road widening project, no additional mitigation measures would be necessary. The planned improvements would minimize existing flooding from heavy rains across the boulevard. In compliance with City requirements, there would be no net increase in off-site runoff from the project area.

3.4 Natural Hazards

3.4.1 Affected Environment

Earthquake

The Uniform Building Code (UBC) provides minimum design criteria to address potential damage associated with seismic disturbance. The UBC includes six seismic zones ranging from 0 (no chance of severe ground shaking) to 4 (10% chance of severe shaking in a 50-year interval). The entire island of O'ahu is designated Zone 2a. The roadway improvements are being constructed to meet UBC standards appropriate for O'ahu.

Tsunami

Tsunami are most often generated by deep sea earthquakes or underwater landslides and are a year-round threat to coastal areas of Hawai'i. The City and County of Honolulu has produced maps showing tsunami evacuation areas, those coastal areas most vulnerable to potential tsunami damage. The Salt Lake Boulevard project area is not within a tsunami evacuation area.

Flooding

The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) for the project area are included in maps 15003C0332G and 15003C0334G. The FIRM indicates that the project corridor and vicinity lie within Flood Zone D, which are areas in which flood hazards are undetermined but possible. Sections 3.3.1 and 3.3.2 describe surface runoff and drainage conditions in the project area during storm events.

3.4.2 Environmental Consequences

3.4.2.1 Alternative A

Construction Impacts

Project construction would not increase the incidence or likelihood of any natural hazards. Access through the Salt Lake Boulevard Widening–Phase 3 corridor would remain open throughout project construction, but traffic flow would be temporarily disrupted, and delays can be anticipated without advance warnings. This situation could slow emergency access through the area in the event of any natural disaster. A traffic control plan would be in place to minimize construction impact on traffic.

Operational Impacts

The project would have no impact on the FIRM classification for the project area. Project drainage improvements, including new drain inlets, catch basins, bioswales, and underground drain line system would improve existing drainage conditions along Salt Lake Boulevard. By directing storm water through the new drainage system, the overflow of water onto the roadway would be minimized. Since the Navy has no immediate plans for drainage improvements on its property, flooding is likely to continue to occur there during periods of heavy rain.

The project would not affect the incidence or likelihood of other natural disasters. In the long-term, the project would have positive indirect impacts. An improved and widened Salt Lake Boulevard–Phase 3 would provide more efficient and safer vehicular movement and evacuation along this major thoroughfare in the event of a natural or manmade disaster. The addition of pedestrian sidewalks and bike lanes would provide additional transportation options through this busy corridor.

3.4.2.2 Alternatives B and C

Neither Alternative B nor C would impact risks to humans or properties associated with natural disasters. Both alternatives would provide similar drainage upgrades as Alternative A, alleviating existing, localized flooding problems during heavy rains.

Both alternatives would increase vehicle capacity and provide pedestrian and bicycle improvements that do not presently exist. Both alternatives would have positive indirect impacts on the community's overall emergency preparedness and ability to respond to a natural disaster.

3.4.2.3 Alternative D–No Action

The No Action alternative would not provide any drainage improvements through this section of Salt Lake Boulevard, and existing roadway flooding and ponding during heavy rains would continue. This section of Salt Lake Boulevard would continue to remain a two-lane road, with less carrying capacity in an emergency than the roadway sections to the east and west, which have already been upgraded.

3.4.3 Mitigation Measures

The project would not impact the occurrence of natural hazards or the risk of damage caused by natural hazards such as earthquakes, tsunami, or floods. Roadway drainage improvements would help alleviate current flooding along this section of Salt Lake Boulevard. There would be no adverse flooding impact on adjacent properties as a result of the project. No additional mitigation measures are required.

3.5 Flora And Fauna

3.5.1 Affected Environment

Improvements are proposed within an existing roadway right-of-way in an urbanized area where land on both sides has been extensively disturbed and developed. No water bodies, wetlands, or critical habitat designated under the Endangered Species Act (ESA) are located within the project limits.

According to a letter regarding Increment 2, Phase 2 of the Salt Lake Boulevard widening project from the U.S. Fish and Wildlife Service, dated October 25, 1999, no federally listed aquatic or terrestrial species were known to occur within the project area. Likewise, the State Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW) determined that no threatened or endangered species exist along the project route (letter dated June 24, 1999). The current Phase 3 area is within the same general area examined for the Increment 2, Phase 2 EA, and biological conditions have not substantially changed since that document was prepared and approved.

Within the Phase 3 project corridor, existing roadside vegetation along the southern shoulder include grasses, weeds, and occasional trees such as Chinese banyan (*Ficus nicrocarpa*), monkeypod (*Samanea saman*), kiawe (*Prosopis pallida*), and koa haole (*Leucaena leucocephala*). All are introduced species and none are listed as threatened or endangered under the Endangered Species Act (ESA) or designated as “exceptional trees” by the City and County of Honolulu.[6] Vegetation on the northern side of the street consists of landscaped plantings in the private residential lots and various introduced shrubs and weeds in the right-of-way.

Mammals within the project area are likely typical of urbanized areas, including rats, mice, mongoose, and feral cats. Birds found in the project area are also likely typical of urban Oʻahu, comprised primarily of common introduced species. No species listed under ESA are known to occur here. No critical habitat designated under ESA exists in the project vicinity.

[6] In 1975, the Hawai'i State Legislature found that rapid development had led to the destruction of many of the state's exceptional trees and passed Act 105 - The Exceptional Tree Act. The Act recognized that trees are valuable for their beauty and crucial ecological functions. It mandated each county to enact regulations to protect trees of exceptional stature. Each county has its own program, set of rules, and operating guidelines.

Between one-half to one mile north-east of the project area are the remains of the original Salt Lake and its adjoining wetlands (see description in section 3.2). This area is considered to be a waterbird "refuge" by DLNR, an area that is identified as a resource but not actively managed as a "sanctuary." Endemic or indigenous birds observed at Salt Lake include the Hawaiian duck, Hawaiian gallinule, Hawaiian coot, Hawaiian stilt, and black-crowned night heron. The first four species of these native waterbirds are federally listed as endangered.[7]

3.5.2 Environmental Consequences

In accordance with Section 7 of ESA, State DOT initiated consultation with the U.S. Fish and Wildlife Services (USFWS) for this project. The consultation was carried out partially within the context of a "Programmatic Informal Consultation with the Federal Highway Administration for Preventive Maintenance and Shoulder Guardrail Improvement Projects in the State of Hawaii," dated December 20, 2011. The proposed project involves improvements covered under the programmatic informal consultation, as well as improvements specifically excluded from the programmatic agreement (PA) process. Roadway widening within limits of the existing right-of-way is covered under the PA process. The project elements excluded from the PA process include grading and improvements of the drainage immediately adjacent to and outside the right-of-way, relocation of overhead transmission lines, relocation of underground utilities, and upgrading of the existing street lighting system.

The FHWA wrote to the U.S. Fish and Wildlife Service (USFWS), Pacific Islands Fish and Wildlife Office, to initiate consultation pursuant to Section 7 of the ESA. A letter, dated August 9, 2013, was subsequently received from that office indicating concurrence with FHWA's determination that the proposed project is not likely to adversely affect the federally endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*) or the threatened Newell's shearwater (*Puffinus auricularis newelli*).

The letter further noted that any future assessment on the project provide an evaluation of the potential for movement and dispersal of invasive species due to planned activities, and provide measures to prevent or reduce impacts from invasive species. Additionally, it was recommended that the project use Standard Fish and Wildlife Best Management Practices to avoid or minimize any project-related degradation of area water quality conditions and to use, if possible, native plants for any landscaping of the project. If it is not possible to use native plants due to the project's purpose and need, then it is recommended that plant species thought to have a low risk of becoming invasive be used.

3.5.2.1 Alternative A

Construction Impacts

No ESA-listed species are known to inhabit the areas where improvements are proposed. None of the trees within the right-of-way are ESA-listed species or designated by the City as

[7] U.S. Fish and Wildlife Service. Endangered Species Program website.

"exceptional trees." Listed waterbird species at Salt Lake are not within the immediate project vicinity.

The federally endangered Hawaiian hoary bat (Lasiurus cinereus semotus) is not known to inhabit this area.

Operational Impacts

No ESA-listed species are known to occur within the project corridor. Operations of the widened roadway would not adversely affect ESA-listed species or their habitats. Given the distance of the Salt Lake wetlands from the project area, impacts on listed waterbirds are highly unlikely.

Lighting for the widened roadway would include shielded street lights designed to minimize attraction to seabirds such as the threatened Newell's shearwaters (Puffinus auricularis newelli). Modern cut-off fixtures with flat lenses would be installed. These types of fixtures limit light emitted to the area below the horizontal plan of the flat lens and prevent the light source from being visible above the fixture.

3.5.2.2 Alternatives B and C

Neither Alternatives B nor Alternative C would have an adverse impact on ESA-listed plant or animal species or their habitat.

3.5.2.3 Alternative D–No Action

With no construction or change in operations, the No Action alternative would have no impact on ESA-listed species or their habitat.

3.5.3 Mitigation Measures

As described above, with implementation of conservation measures during construction and installation of special street lighting fixtures, the proposed project is not likely to adversely affect the threatened Newell's shearwater. No additional mitigation is required.

Chapter 4

Affected Man-Made Environment, Potential Impacts, and Mitigation Measures

CHAPTER 4

Affected Man-Made Environment, Potential Impacts, and Mitigation Measures

4.1 INTRODUCTION

This chapter, which describes the affected man-made environment, environmental consequences of the proposed action alternatives, and proposed mitigation measures, is organized by resource areas, including land use and land tenure, transportation, air quality, noise, visual resources, cultural resources, socio-economic environment, utilities, and public facilities and services.

See the introduction to Chapter 3 for a discussion of direct, indirect, and cumulative impacts.

4.2 LAND USE AND LAND TENURE

4.2.1 AFFECTED ENVIRONMENT

Salt Lake Boulevard is a major thoroughfare that runs along the southern perimeter of the Salt Lake suburban neighborhood located approximately six miles west of downtown Honolulu. The project corridor is a one-mile section between Maluna Street and Ala Liliko‘i Street. For most of the corridor, lands on either side of the right-of-way are in single- and multi-family residential use, except for the eastern end near Ala Liliko‘i Street (see Figure 4-1). The land to the north of the project corridor is occupied by single-family residences and low-rise, walk-up apartment buildings. These parcels are owned primarily by small private landowners. At the far east end of the project corridor is the Salt Lake Shopping Center.

On the southern side of Salt Lake Boulevard, there are two parcels near Ala Liliko‘i Street owned by the State of Hawai‘i and the City and County of Honolulu (City) (see Figure 4-2). The City-owned parcel, 26 aces in size, is the site of Āliamanu Elementary School and Āliamanu Intermediate School (see Figure 4-2). A smaller, triangular-shaped parcel, owned by the State of Hawai‘i, is the site of the Salt Lake/Moanalua Public Library.

The remainder of the land bordering the southern side of Salt Lake Boulevard is owned by the federal government. Other than a small site used by the Island Family Christian Church., most of this area is occupied by the Navy’s Catlin Park family housing. The Catlin Park residences were originally built in 1968 and reconstructed in 2008 with new townhouses and single-family homes for Navy enlisted personnel. Unlike the northern side of Salt Lake Boulevard, where the houses and apartment buildings are adjacent to the existing right-of-way, the Catlin Park housing is set back from the existing road and separated by a chain link fence. The shoulder area between the edge of the existing roadway up to the fence is open and grassy. Along flat stretches, it may be used informally for parking by surrounding residents.

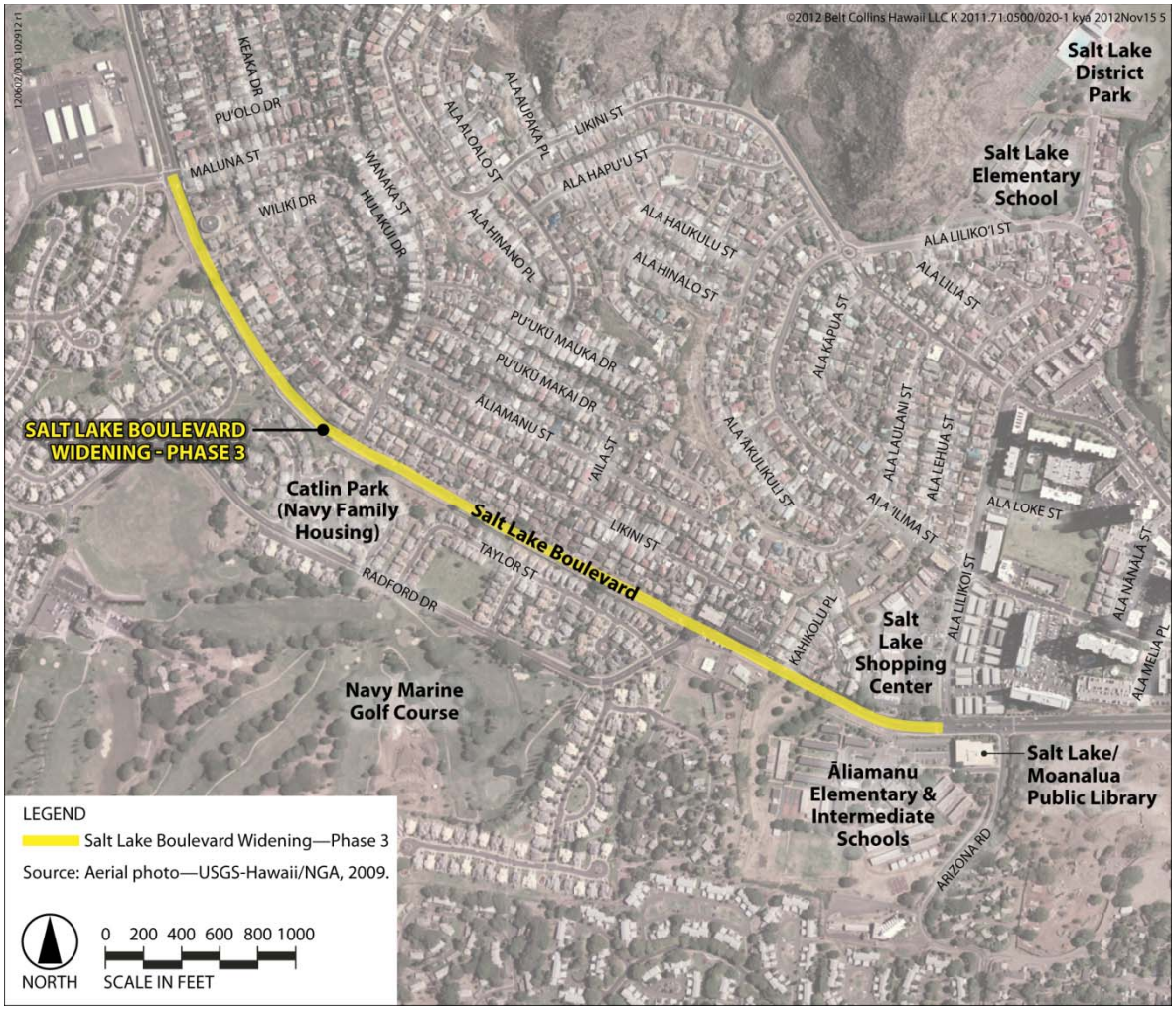


Figure 4-1. Existing Land Use

4.2.2 ENVIRONMENTAL CONSEQUENCES

4.2.2.1 Alternative A

Construction Impacts

There would be no land use or land ownership changes during construction. No buildings or structures would be displaced. Construction of the road improvements would occur within the existing City right-of-way. Construction on the retaining walls along the southern boundary of the road right-of-way would likely require temporary access over the adjacent Navy property. A right-of-entry would be sought from the Navy to use its land for construction access. Further, construction of the retaining walls would require removal of the Navy fences. When completed, the retaining walls would serve as a substitute replacement for the Navy fences as well as a structural embankment for the widened Salt Lake Boulevard.

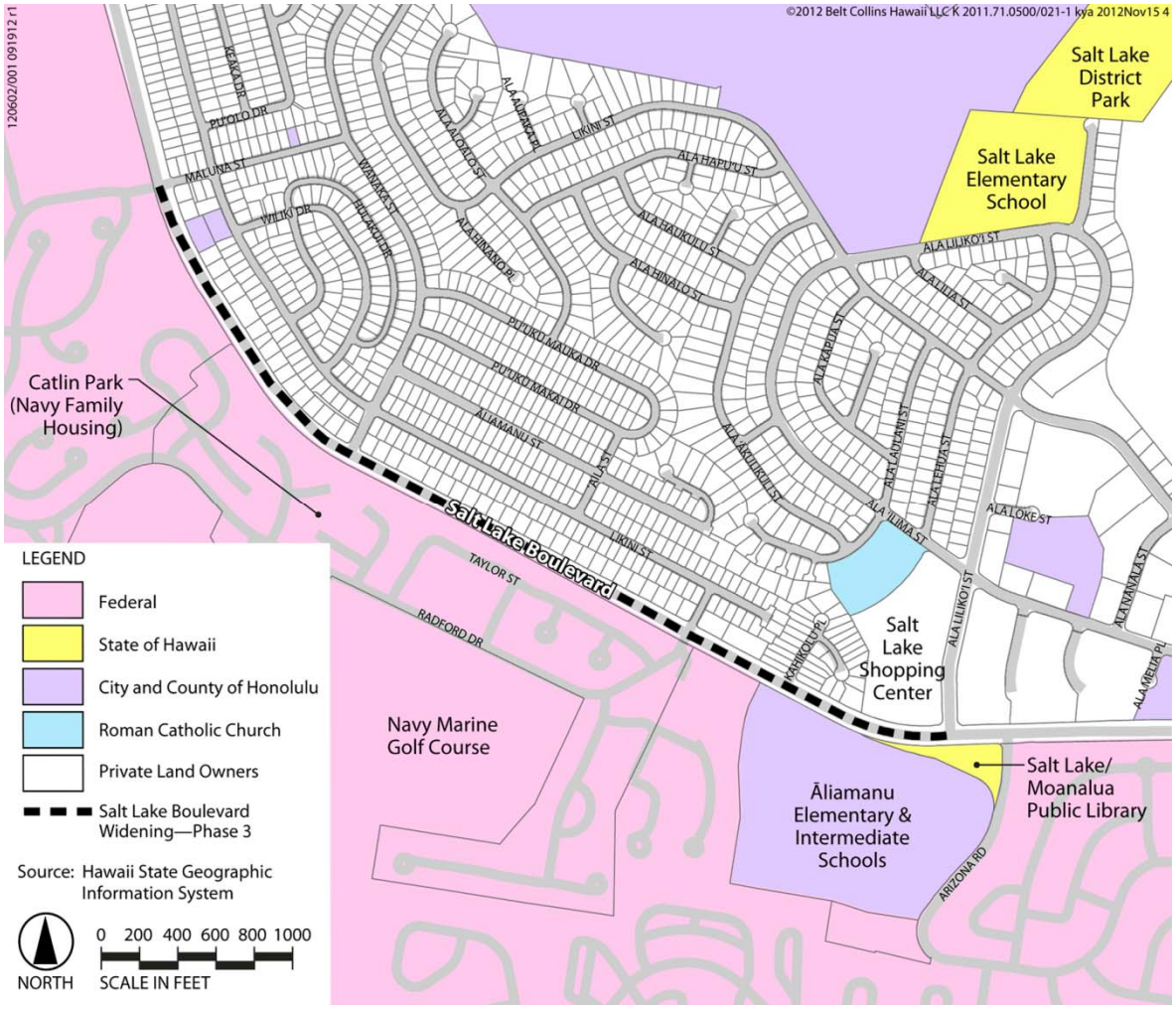


Figure 4-2. Major Land Owners

At Āliamanu Intermediate School, construction of a fill slope would be required as an embankment for the proposed road improvements. Although a State facility occupies the school site, the land is owned by the City. A right-of-entry would be required from the State for the construction of the graded embankment. Depending on concurrence from the State, it is assumed DOE would take responsibility for maintenance of the fill slope.

At the Radford Drive–Salt Lake Boulevard intersection, roadway modifications would be required to adapt the Navy's housing access road to the new widened boulevard. The modifications would include transitional grading and resurfacing of the Radford Drive approach to Salt Lake Boulevard, restriping pavement surfaces, modifying existing landscape island and curbs, and realigning existing and installing new connecting sidewalks. Use of approximately 2,800 square feet of Navy land may be necessary for these improvements. As

required, proper authorization would be sought from the Navy prior to the commencement of the modification work.

Once construction begins on the road widening improvements, the right-of-way areas along either side of the existing two-lane road (currently vacant or used for informal street parking) would become part of the construction zone. Parking of personal vehicles would not be allowed. Temporary traffic control measures via an approved traffic control plan would manage traffic through the construction zone and access to individual driveways and private residences. The construction contractor would be responsible for securing permission to use other properties for staging and equipment storage purposes. Construction traffic impacts and management measures are discussed in section 4.3.

Operational Impacts

Operations of the widened roadway would not change surrounding land uses or land ownership. A maintenance easement, however, may be required on the adjacent Navy land for long-term maintenance of the new retaining wall. Alternatively, a right-of-entry could be sought whenever maintenance work is required.

The proposed improvements of Alternative A are consistent with the adjoining sections of Salt Lake Boulevard (Increment 1, Phases 1 and 2 and Increment 2, Phases 1 and 2) which have already been widened and improved within their rights-of-way.

The inclusion of sidewalks and bicycle lanes would enhance connectivity between residential areas, schools, shopping center and churches. At the same time, the replacement of a two-lane road with a four-lane road would bifurcate the area, creating a physical and visual separation between the residential areas of the north and residential areas of the south. Although these changes do not directly change land use, in the long term, they may have indirect effects on visual and physical connections and interrelationships between various parts of the community.

4.2.2.2 Alternative B

Construction Impacts

As with Alternative A, construction of Alternative B would not change land use or land ownership.

Operational Impacts

As with Alternative A, Alternative B improvements are all located within the Salt Lake Boulevard right-of-way. There would be no change in land use or land ownership.

4.2.2.3 Alternative C

Construction Impacts

Construction of Alternative C would involve use of Navy land along sections of Salt Lake Boulevard right-of-way. A right-of-entry authorization would be required from the Navy for

the construction of the sloped berm and retaining wall within the Navy property. Alternatively, a construction and maintenance easement over the Navy land would be sought for the development and long-term maintenance of the shoulder improvement.

Operational Impacts

Placement of sloped berms and retaining walls within the Navy property would convert those areas from Navy residential yards to City road accessory use. Although acquisition of those areas may be an option for the City, it is likely that a maintenance or possibly landscape easement would be created. Alternatively, the City could forsake the easement and seek a right-of-entry whenever maintenance of the shoulder features is required.

4.2.2.4 Alternative D–No Action

The No Action alternative would not affect current land use or ownership.

4.2.3 MITIGATION MEASURES

With no changes in land use or ownership in Alternatives A and B, no mitigation is required. For Alternative C, appropriate approvals would be required for use of Navy land.

4.3 TRANSPORTATION

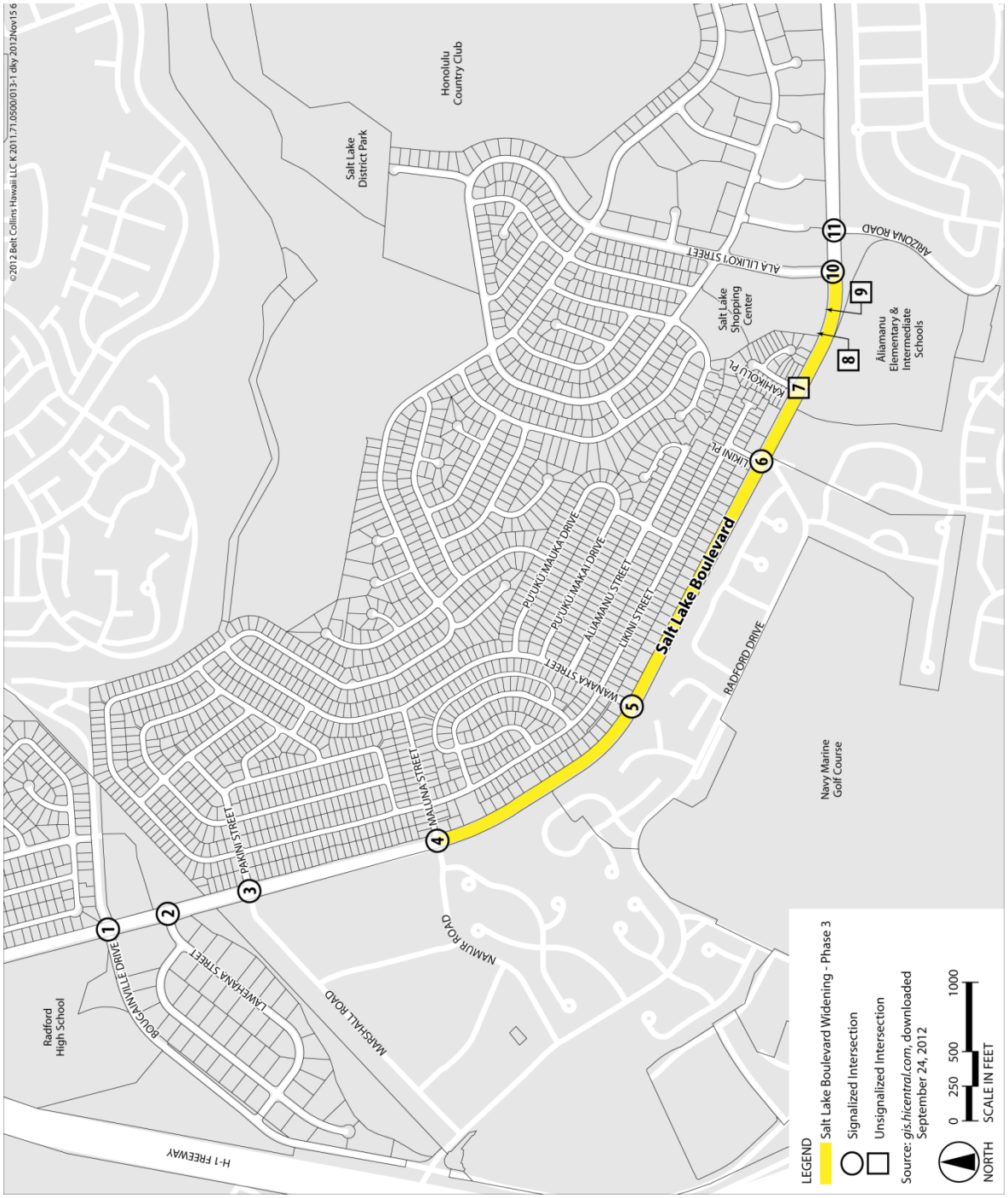
4.3.1 AFFECTED ENVIRONMENT

This section describes existing public roadways, public transit, and facilities for bicyclists and pedestrians.

4.3.1.1 Public Roadways

Salt Lake Boulevard extends approximately 3.4 miles from Pu‘uloa Road on the east to Kamehameha Highway at the Aloha Stadium on the west. Figure 4-1 shows the Phase 3 portion of Salt Lake Boulevard, adjacent land uses and connecting side streets. These streets include City as well as Navy streets.

As previously described, Phase 3 of the Salt Lake Boulevard widening project is located between Increment 1, Phases 1 and 2 and Increment 2, Phases 1 and 2, which is situated between Maluna Street and Ala Liliko‘i Street. A study assessing traffic impacts resulting from the Phase 3 widening of Salt Lake Boulevard is included in Appendix B and summarized in this section. Manual turning movement traffic counts and field observations were conducted on Tuesday, November 1, 2011; Wednesday, November 30, 2011; and Tuesday, December 13, 2011. Counts were taken at the following locations and are shown in Figure 4-3.



1 **Figure 4-3. Traffic Count Locations**

1. Bougainville Drive/Salt Lake Boulevard (signalized intersection, west of project area)
2. Lawehana Street/Salt Lake Boulevard (signalized intersection, west of project area)
3. Marshall Road/Pakini Street/Salt Lake Boulevard (signalized intersection, west of project area)
4. Maluna Street/Namur Road/Salt Lake Boulevard (signalized intersection, western edge of project area)
5. Wanaka Street/Salt Lake Boulevard (signalized intersection, in project area)
6. Radford Drive/Likini Place/Salt Lake Boulevard (signalized intersection, in project area)
7. Kahikolu Place/Salt Lake Boulevard (unsignalized intersection, in project area)
8. Salt Lake Shopping Center Driveway 1/Salt Lake Boulevard/Āliamanu School Parking Lot (unsignalized T-intersection, in project area)
9. Salt Lake Shopping Center Driveway 2/Āliamanu Elementary/Middle School Driveway/Salt Lake Boulevard (unsignalized access [right-turn in, right-turn out], in project area)
10. Ala Liliko‘i Street/Salt Lake Boulevard (signalized intersection, eastern edge of project area)
11. Arizona Road/Salt Lake Boulevard (signalized intersection, east of project area).

Level of service (LOS) is used to characterize traffic conditions and provide a quantitative measure to describe traffic flow conditions. The LOS methodology is based on the 2000 Highway Capacity Manual (HCM 2000), prepared by the Transportation Research Board. The different levels range from excellent free-flowing conditions (LOS A) to very congested conditions (LOS F). Table 4-1 defines each LOS. The accepted LOS in urban areas is typically considered to be a minimum LOS D.

Traffic analyses were done for peak hours (hours with highest volumes) during the morning (AM) and afternoon (PM). Both traffic counts and field observations were used to study current traffic conditions and estimate the LOS for the studied intersections.

Table 4-1. LOS Definitions

Level of Service	Average Delay Per Vehicle	
	At Unsignalized Intersections	At Signalized Intersections
A	Up to 10 seconds	Up to 10 seconds
B	>10 and ≤15 seconds	>10 and ≤20 seconds
C	>15 and ≤25 seconds	>20 and ≤35 seconds
D	>25 and ≤35 seconds	>35 and ≤55 seconds
E	>35 and ≤50 seconds	>55 and ≤80 seconds
F	>50 seconds	>80 seconds

Source: Highway Capacity Manual 2000

The weekday am peak hour of traffic occurs between 7:15AM, and 8:15AM, and the weekday PM peak hour of traffic occurs between 4:00PM and 5:00PM. Table 4-2 summarizes existing (2011) conditions at the study intersections during the AM and PM peak hours. The analysis indicate that 3 of the 11 intersections studied operated at LOS E or worse during at least one of the peak hours (as shown by gray highlighting in Table 4-2).

Table 4-2. Existing (2011) Conditions LOS

Intersection	Control[1]	LOS - AM Peak Hour	LOS - PM Peak Hour
1) Salt Lake Boulevard and Bougainville Drive	Signal	D	F
2) Salt Lake Boulevard and Lawehana Street	Signal	B	C
3) Salt Lake Boulevard, Marshall Road, and Pakini Street	Signal	B	B
4) Salt Lake Boulevard, Maluna Street, and Namur Road	Signal	C	C
5) Salt Lake Boulevard and Wanaka Street	Signal	B	A
6) Salt Lake Boulevard, Radford Drive, and Likini Place	Signal	C	C
7) Salt Lake Boulevard and Kahikolu Place	TWSC	F	F
8) Salt Lake Boulevard, Shopping Center DW1, and Āliamanu School Parking Lot	TWSC	F	F
9) Salt Lake Boulevard, Shopping Center DW2, and Āliamanu Elementary/Middle School Driveway	TWSC	D	D
10) Salt Lake Boulevard and Ala Liliko‘i Street	Signal	C	B
11) Salt Lake Boulevard and Arizona Road	Signal	C	B

Notes:

1 Intersection is controlled by a traffic signal or is unsignalized and two-way stop controlled (TWSC). For unsignalized intersections, the level of service for the worst movement is reported.

4.3.1.2 Public Transit

TheBus, the Honolulu public transit system, runs two routes through the project vicinity (see Figure 4-4). Bus Route 3 begins at Wanaka Street in the west, and extends to Kapiʻolani Community College in Kaimukī to the east. It runs mainly along Ala ʻIlima Street and does not travel through Salt Lake Boulevard—Phase 3. Route 32 runs from Pearl Ridge Shopping Center to Māpunapuna. It passes through a portion of the Phase 3 corridor from Likini Place to Ala Lilikoʻi Street. According to the current schedule, Route 32 accounts for approximately 21 eastbound and 24 westbound buses daily along Salt Lake Boulevard during each weekday.

No bus rider shelters are located along Salt Lake Boulevard–Phase 3.

4.3.1.3 Bicycle Travel

Currently, there is no separate provision for bicycles through the Phase 3 corridor. Along Increment 1 of Salt Lake Boulevard from Arizona Road to Puʻuhale Road, bike lanes are striped along both sides of the roadway. For Increment 2, Phase 2 of Salt Lake Boulevard from Bougainville Drive to Maluna Street, there is a dedicated bike lane in the westbound travel lanes and a bike route within the eastbound travel lanes.

The Oʻahu Bike Plan[1] shows a bike lane between Puʻuloa Road to Ala Lilikoʻi Street and a proposed lane along the remainder of the boulevard, from Ala Lilikoʻi Street to Kamehameha Highway. The proposed lane is a Priority 2 (#2-137), i.e., part of the overall plan for a bicycle-friendly community, but not of highest immediate benefit.

4.3.1.4 Pedestrian Travel

A continuous defined walkway does not exist along the northern side of the existing roadway. Space for pedestrian access is not clearly marked between Maluna Street to Likini Place since there are either areas with steep slopes or wide shoulders fronting residences that now accommodate parked cars and trash cans. Between Likini Place and the west end of the Salt Lake Shopping Center, a narrow path overgrown by weeds encroaches into the pedestrian-accessible area.

Along the southern side, a narrow asphalt concrete path provides access throughout the road corridor. This path is primarily adjacent to the travel lane and is only set back away from the roadway between Island Family Christian Church at Radford Drive and Āliamanu Elementary School.

[1] City and County of Honolulu, Department of Transportation Services. August 2012. *Oʻahu Bike Plan: A Bicycle Master Plan.* www.oahubikeplan.org/downloads/Oahu_Bike_Plan-August_2012.pdf.

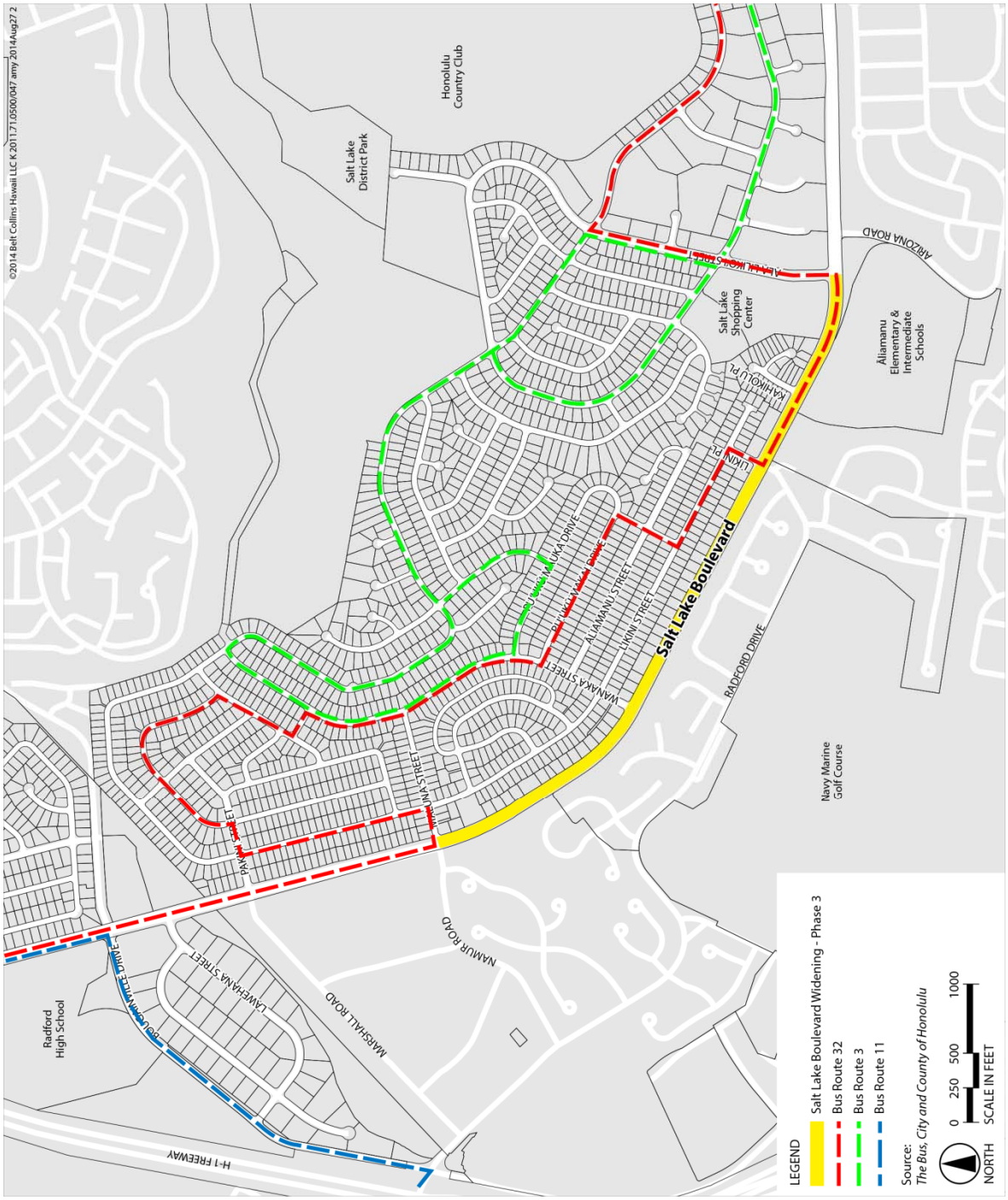


Figure 4-4. TheBus Transportation Routes UPDATED

4.3.1.5 Parking Beside Salt Lake Boulevard

Along much of the relatively flat area between Wanaka Street and Likini Street, cars are often parked on the northern side of the right of way, usually at an angle to the roadway. On the southern side, the grassy margin is sometimes used for parking. The drivers parking on the southern side presumably traverse the roadway to homes on the northern side, without benefit of crosswalks.

4.3.2 ENVIRONMENTAL CONSEQUENCES

The proposed action alternatives would widen Salt Lake Boulevard–Phase 3 to match in compatibility with the roadway improvements to the east (Increment 1) and to the west (Increment 2, Phases 1 and 2). The widened roadway of Phase 3 would provide two travel lanes along Salt Lake Boulevard in either direction, turning lanes, on-street parking, sidewalks and dedicated bike lanes.

To evaluate potential impacts from the proposed action alternatives, it is necessary to compare estimates of future (2040) traffic conditions from Alternatives A, B, and C ("Future Year 2040 with Project") with the No Action alternative ("Base Year 2040"). The incremental change in the LOS between future baseline conditions and future with project conditions represents the potential impacts of the proposed action alternatives. Table 4-3 summarizes the impacts of the various alternatives based on the listed criteria:

Table 4-3. Project Impact Summary

No Action alternative (Future Baseline)	Proposed Action Alternatives (Future with Project)	Project Impact
LOS D or better	LOS D or better	No
LOS D or better	LOS E or F	Yes
LOS E or F	LOS E or F	No

4.3.2.1 Alternative A

Construction Impacts

Construction impacts on Salt Lake Boulevard traffic would be short-term and occur primarily during off-peak hours. Implementation of a temporary traffic control plan (TCP), prepared by a licensed engineer and approved by the City Department of Planning and Permitting (DPP), would minimize such impacts. The TCP would include traffic control and management provisions designed to maintain safe vehicular and pedestrian passage through or around the project construction zones. Traffic cones, posted signs, and flashing arrows would be placed in advance of the construction area to provide adequate warning to motorists. Police officers would also be on duty to assist in the smooth passage of traffic through or around the construction area.

Work is expected to be conducted in phases in order that only portions of the roadway would be affected at any one time. The construction contractor would be required to provide access to homes in the area, as needed. In the event that construction (e.g., involving installation or relocation of road features) directly blocks a resident's access to his or her home, the construction contractor would immediately cease work, provide access through the work zone, and allow the owner to traverse the construction area. Once the owner is on his/her property, the contractor can then resume work.

Bus transit routes traverse a portion of the project area. Two weeks advance notice of the impending construction work would need to be provided to the Oʻahu Transit Services Inc. which operates TheBus.

Impacts from short-term construction-related trips on area traffic are not expected to be significant considering the relatively small number of construction vehicles that would be making trips to the site and their anticipated timing during non-peak hour periods.

Operational Impacts

Alternative A is anticipated to improve traffic conditions at the intersections where Salt Lake Boulevard would be widened (intersections 5 to 9). As shown in Table 4-4, no intersections or turning movements in the project area would be at LOS F. Only 2 of the 11 intersections would be operating below LOS D. All study intersections would operate at a LOS equal to or better than the No Action alternative LOS (2040).

The road widening improvements would eliminate the existing wide, paved shoulder, which currently provide direct access to an unpaved informal parking area south of the intersection of Salt Lake Boulevard - Shopping Center Driveway 1 - Āliamanu Elementary/Intermediate Schools driveway. As a result, trips entering and exiting the schools' parking lot would be re-assigned to the schools' driveway or Arizona Road, which also provides access to the schools.

Travel by bicycle and on foot would be improved as a result of the project. Mobility and safety would increase for bike riders, notably between the residential neighborhoods and the schools, library, and shopping center at the eastern end of Phase 3. The improved sidewalk on the northern side of the road would benefit the residents who have homes and parked vehicles along the right-of-way. The existing sidewalk on or near the southern side of the road between Radford Drive and Ala Lilikoʻi Street would benefit the parents and children who must walk to and from Āliamanu Elementary and Intermediate Schools at the eastern end of Phase 3.

With the widened roadway, unpaved shoulder areas on both sides of the roadway would no longer be available for parking. As a result, the total number of spaces where vehicles could be parked would decline.

Table 4-4. Alternative A Traffic Operating Conditions (LOS)

Intersection	Control[1]	LOS AM Peak Hour		LOS PM Peak Hour		Project impact?
		No Action	Alt. A	No Action	Alt. A	
1) Salt Lake Boulevard and Bougainville Drive	Signal	E	E	D	D	No
2) Salt Lake Boulevard and Lawehana Street	Signal	B	B	C	C	No
3) Salt Lake Boulevard, Marshall Road, and Pakini Street	Signal	C	C	C	C	No
4) Salt Lake Boulevard, Maluna Street, and Namur Road	Signal	B	C	B	B	No
5) Salt Lake Boulevard and Wanaka Street	Signal	F	A	F	A	No
6) Salt Lake Boulevard, Radford Drive, and Likini Place	Signal	F	C	F	C	No
7) Salt Lake Boulevard and Kahikolu Place	TWSC	F	D	F	E	No
8) Salt Lake Boulevard, Shopping Center DW1, and Āliamanu School Parking Lot	TWSC	F	B	F	B	No
9) Salt Lake Boulevard, Shopping Center DW2, and Āliamanu Elementary/ Middle School Driveway	TWSC	F	C	F	B	No
10) Salt Lake Boulevard and Ala Liliko'i Street	Signal	C	C	C	C	No
11) Salt Lake Boulevard and Arizona Road	Signal	C	C	B	C	No

Notes:

1 Intersection is controlled by a traffic signal or is unsignalized and two-way stop controlled (TWSC). For unsignalized intersections the level of service for the worst movement is reported.

Gray highlights mark LOS E or F, in either No Action or Alternative A Future conditions. The last column assesses Alt. A conditions as changing LOS from acceptable conditions to LOS E or F ("Yes") or not ("No").

4.3.2.2 Alternative B

Construction Impacts

As with Alternative A, traffic impacts during construction would be managed by implementation of a TCP (described above). Construction vehicle impacts would be minimal, similar to Alternative A.

Operational Impacts

The raised medians would prevent mid-block left-turn access to the boulevard-front residences. This is more of an inconvenience to the residents than a traffic operational impact since there are only a few locations that would experience sight distance issues without the median. For that reason, U-turns would be allowed at intersections for this alternative to ensure that mid-block left-turns are restricted and adds a few more turning movements at the intersections. The raised median also provides a measure of safety for two-directional traffic.

The impact on traffic congestion from Alternative A and Alternative B is similar. A slight reduction in LOS was calculated at Wanaka Street (Intersection 5) and Ala Liliko‘i Street (Intersection 10), but an improvement was calculated for Kahikolu Place (Intersection 7). Table 4-5 shows the differences between Alternative A and Alternative B operating conditions. The tan boxes show where a slight decrease in LOS would arise with Alternative B, and the green boxes show an improvement from Alternative A.

Impacts for bicycle and pedestrian travel would be similar to Alternative A.

4.3.2.3 Alternative C

Construction Impacts

Construction vehicle related impacts may be slightly greater than Alternatives A and B as more construction equipment may be required to work into the steep high cut areas of the right-of-way and adjacent Navy property. If the extra equipment is stored on-site, the daily transport of these items over public roads would be minimized.

Operational Impacts

This alternative action would have a raised median in the roadway section and create traffic conditions similar to Alternative B. Access points and U-turns would be similar to Alternative B. The LOS analysis described in Table 4-5 for Alternative B would also apply to this alternative.

The parking lane in Alternative C would occur along the entire length of Phase 3. In Alternatives A and B, no on-street parking would occur along steep high cut areas. Since additional on-street parking would be provided in Alternative C, more use of the sidewalk is anticipated for this alternative than under Alternatives A and B.

Table 4-5. Alternatives A, B and C Traffic Operating Conditions (LOS) Comparison

Intersection	Control[1]	LOS AM Peak Hour		LOS PM Peak hour	
		Alt A	Alt B or Alt C	Alt A	Alt B or Alt C
1) Salt Lake Boulevard and Bougainville Drive	Signal	E	E	D	D
2) Salt Lake Boulevard and Lawehana Street	Signal	B	B	C	C
3) Salt Lake Boulevard, Marshall Road, and Pakini Street	Signal	C	C	C	C
4) Salt Lake Boulevard, Maluna Street, and Namur Road	Signal	C	C	B	B
5) Salt Lake Boulevard and Wanaka Street	Signal	A	B	A	B
6) Salt Lake Boulevard, Radford Drive, and Likini Place	Signal	C	C	C	C
7) Salt Lake Boulevard and Kahikolu Place	TWSC	D	C	E	D
8) Salt Lake Boulevard, Shopping Center DW1, and Āliamanu School Parking Lot	TWSC	B	B	B	B
9) Salt Lake Boulevard, Shopping Center DW2, and Āliamanu Elementary/Middle School Driveway	TWSC	C	C	B	B
10) Salt Lake Boulevard and Ala Liliko'i Street	Signal	C	C	C	D
11) Salt Lake Boulevard and Arizona Road	Signal	C	C	C	C

Notes:

1 Intersection is controlled by a traffic signal or is unsignalized and two-way stop controlled (TWSC). For unsignalized intersections the level of service for the worst movement is reported.

Highlights show differences in LOS, between Alt A and Alts B or C, as discussed above in the text.

For westbound bicycle travel, the bike lane would be along a continuous parking lane as opposed to an intermittent parking lane as proposed under Alternatives A and B. The continuous parking lane adds additional parking along the right-of-way and generates more potential interferences with cyclists. As in Alternative A and B, sidewalk improvements would benefit the residents along the right-of-way, along with parents and students who walk to and from the elementary and intermediate schools at the eastern end of Phase 3.

4.3.2.4 Alternative D-No Action

The No Action alternative (2040) conditions were determined by applying growth factors projected by existing studies. An ambient growth rate was estimated based on population data obtained from the O'ahu Regional Transportation Plan (ORTP) 2035. The ORTP

forecasted population and employment growth within designated regions on O‘ahu from year 2007 to 2035. The rate obtained from the ORTP was then extrapolated to the project year 2040. The volumes obtained by applying the growth rate to the existing count data provided the future baseline conditions without the proposed action.

The analysis indicates that using the projected volumes, 6 of the 11 intersections would be operating under unacceptable conditions even with some mitigation measures, which could include:

- Re-stripe the northbound through lane into a left-turn lane to provide two northbound left-turn lanes at Salt Lake Boulevard/Bougainville Drive (Intersection 1).
- Provide traffic signal coordination between Bougainville Drive, Lawehana Street and Marshall Road/Pakini Street (Intersections 1, 2, and 3) along Salt Lake Boulevard.
- Provide traffic signal coordination between Radford Drive/Likini Place, Ala Liliko‘i Street and Arizona Road (Intersections 6, 10, and 11) along Salt Lake Boulevard.
- Create an access off Salt Lake Boulevard to the Island Family Christian Church, which restricts vehicle turning movements to right-in/right-out turns only.

Under No Action conditions, traffic flow would be highly congested, with LOS F experienced at the Wanaka Street and Radford Drive-Likini signalized intersections in both the morning and the afternoon peak hours. Table 4-6 compares the existing condition with the future baseline (2040) condition.

Under the No Action alternative, no provision would be made for bicycle travel through the Phase 3 corridor, and pedestrian movement would continue to depend on unpaved paths or shoulder areas used for parking and trash cans.

4.3.3 MITIGATION MEASURES

Without raised medians to prevent mid-block left-turn movements, use of some type of physical divider or separator, such as an 8-inch curb, is recommended where sight distances are limited and/or conflicts are anticipated. Based on field observations, it was determined that the location along Salt Lake Boulevard which most likely would need a divider is around the Radford Drive/Likini Place intersection.

The Island Family Christian Church is considering acquiring the Navy property it currently occupies. If this happens, the church may no longer be granted access to Salt Lake Boulevard via Radford Drive, which is a military right-of-way. Access to Salt Lake Boulevard would be directly from the church property and limited to right-in/right-out due to sight distance issues. The church is not anticipated to generate significant trips on Salt Lake Boulevard during the week’s AM and PM peak-hour traffic and as a result would not heavily disrupt its normal operations.

Table 4-6. Alternative D (No Action Alternative) Traffic Operating Conditions (LOS)

Intersection	Control[1]	LOS AM Peak Hour		LOS PM Peak hour	
		Existing	2040	Existing	2040
1) Salt Lake Boulevard and Bougainville Drive	Signal	D	E	F	D
2) Salt Lake Boulevard and Lawehana Street	Signal	B	B	C	C
3) Salt Lake Boulevard, Marshall Road, and Pakini Street	Signal	B	C	B	C
4) Salt Lake Boulevard, Maluna Street, and Namur Road	Signal	C	B	C	B
5) Salt Lake Boulevard and Wanaka Street	Signal	B	F	A	F
6) Salt Lake Boulevard, Radford Drive, and Likini Place	Signal	C	F	C	F
7) Salt Lake Boulevard and Kahikolu Place	TWSC	F	F	F	F
8) Salt Lake Boulevard, Shopping Center DW1, and Āliamanu School Parking Lot	TWSC	F	F	F	F
9) Salt Lake Boulevard, Shopping Center DW2, and Āliamanu Elementary/Middle School Driveway	TWSC	D	F	D	F
10) Salt Lake Boulevard and Ala Liliko'i Street	Signal	C	C	B	C
11) Salt Lake Boulevard and Arizona Road	Signal	C	C	B	B

Notes:

1 Intersection is controlled by a traffic signal or is unsignalized and two-way stop controlled (TWSC). For unsignalized intersections the level of service for the worst movement is reported.

Gray highlight is used to identify future conditions below LOS D, even with mitigations.

Additional considerations of possible U-turn movements at the following intersections apply to both Alternatives B and C:

- Salt Lake Boulevard/Wanaka Street – allow eastbound and westbound U-turn movements;
- Salt Lake Boulevard/Radford Drive/Likini Place – allow eastbound and westbound U-turn movements; and

- Salt Lake Boulevard/Kahikolu Place – signalize intersection, allow eastbound U-turn movements, and provide crosswalk on westbound approach.

Trucks most likely would not be able to perform U-turns; as a result, signs should be installed to prohibit this movement. At cross-streets where right-turn movement on red is allowed, a "Right Turn on Red Yield to U-turn" sign should be installed.

4.4 AIR QUALITY

4.4.1 AFFECTED ENVIRONMENT

Air quality modeling analysis was conducted for the proposed action by Environmental Resources Management (see Appendix C).

Carbon monoxide (CO) is the leading pollutant associated with automobile exhaust. Ambient CO concentrations have decreased in recent years due to improvements in fuel efficiency and reformulated gasoline. High CO concentrations can occur near congested intersections if a large number of vehicles move slowly or idle. The air quality analysis focused on three signalized intersections (Wanaka Street and Salt Lake Boulevard; Radford Drive – Likini Place and Salt Lake Boulevard; and Kahikolu Place and Salt Lake Boulevard) as most likely to be "hot spots" for emissions.

The model follows EPA guidelines for assumptions about wind speed and similar factors, and uses 2010 Honolulu monitoring data for CO concentrations gathered by the State of Hawai'i. The highest monitored local values were used. Emissions of other pollutants were also modeled based on traffic volumes and speeds in the traffic study report for the Salt Lake Boulevard Widening—Phase 3 project (see Appendix C).

Mobile, Stationary, and Natural Air Emissions. Sources of mobile emissions for Honolulu include: vehicles, material handling equipment such as forklifts, and airplanes at the airport. Power generators are a stationary source of emissions. The future Emergency Power Facility[2] would be located at the Honolulu International Airport.[3] Sources of natural emissions include the ocean, wind-blown dust, and sulfur dioxide (SO_2) from volcanoes on the island of Hawai'i.

Air Quality Monitoring. DOH maintains two monitoring stations in Honolulu. The closest is at 1039 Sand Island Access Parkway near the Sand Island State Recreation Area. This station monitors for particulate matter with a nominal aerodynamic diameter of 2.5 microns or less

[2] The 10-megawatt Emergency Power Facility will use biodiesel. Construction started in October 2011. (Associated Press. October 12, 2011. "Emergency power facility set to go up at airport." StarAdvertiser. www.staradvertiser.com/news/20111012_Emergency_power_facility_set_to_go_up_at_airport.html. Accessed February 2014.)

[3] In January 2014, HECO started the process of deactivating the Honolulu Power Plant. (Shimogawa, Duane. January 31, 2014. "Hawaiian Electric starts deactivating Downtown Honolulu power plant." Pacific Business News. www.bizjournals.com/pacific/news/2014/01/31/hawaiian-electric-starts-deactivating.html. Accessed February 2014.)

($PM_{2.5}$) and ozone (O_3) from vehicle traffic. A second air monitoring station is located two miles away at 1250 Punchbowl Street, on the roof of DOH's office building. This station monitors for SO_2, carbon dioxide (CO_2), particulate matter with a nominal aerodynamic diameter of 10 microns or less (PM_{10} and $PM_{2.5}$). Based on air quality data from these stations, all federal and state ambient air quality standards are being met, except during episodes of heavy vog.

4.4.2 Environmental Consequences

4.4.2.1 Alternative A

Construction Impacts

Construction-related air emissions, primarily fugitive dust and emissions from diesel-powered equipment and vehicles, would not be significant because they would be short term and controlled through implementation of regulatory controls. As required by HAR 11-60.1-33, fugitive dust would be controlled during demolition, earthmoving, and truck transport activities. As applicable, permits under HAR 11-60.1 would be obtained by the operator of the regulated stationary source equipment used for construction, e.g., portable diesel generators.

Operational Impacts

Alternative A would lead to improved traffic flow, so the Level of Service (LOS) in 2040 at the studied intersections would improve from F to C or better. Predicted CO concentrations are estimated to remain well below both national and state ambient air standards. Other modeled air quality indicators—volatile organic compounds, nitrous oxide, total particulate matter, and sulfur dioxide—are similarly expected to decrease with Alternative A. Therefore, no adverse air quality impacts would be associated with the project during operations.

4.4.2.2 Alternative B

Construction Impacts

As described above for Alternative A, construction-related impacts on air quality would be short-term and minimized effectively through management practices and adherence to HAR 11-60.1.

Operational Impacts

Air quality impacts would be similar to those described above for Alternative A. No adverse impacts on air quality would be associated with Alternative B during operations.

4.4.2.3 Alternative C

Construction Impact

As described above for the Alternative A, construction-related impacts on air quality would be minimized through management practices and adherence to HAR 11-60.1.

Operational Impacts

Air quality impacts would be similar to those described above for the Alternatives A and B. No adverse impacts on air quality would be associated with Alternative C during operation

4.4.2.4 Alternative D–No Action

Under this alternative, the intersections studied would regularly experience LOS F conditions. EPA guidelines indicate that air quality modeling may be required if LOS D to F conditions occur. No Action conditions would clearly involve a higher likelihood of adverse emissions concentrations than the other alternative cases modeled.

4.4.3 MITIGATION MEASURES

No mitigation measures are needed for Alternative A, B, or C, because federal and state ambient air quality standards would not be exceeded.

4.5 NOISE ENVIRONMENT

4.5.1 AFFECTED ENVIRONMENT

A noise analysis of the project was conducted by Censeo AV & Acoustics in September 2012. The findings of the analysis (see Appendix D) are summarized in this section.

Salt Lake Boulevard is a well-traveled roadway with homes on both sides. Measured noise levels at five locations along Salt Lake Boulevard—Phase 3 at afternoon peak traffic times ranged from 63 to 68 decibels (dBA). The major source of noise was vehicular traffic on the boulevard, although traffic on Wanaka Street and in Salt Lake Shopping Center also contributed to the noise level.

The HDOT Highway Noise Policy and Abatement Guidelines call for abatement measures to be considered (a) if noise levels reach 66 dBA or higher at noise-sensitive properties (including single-family or multi-family homes, playgrounds, recreation areas, schools, libraries, and hospitals), or (b) if predicted traffic noise exceeds existing noise levels by 15 dBA or more.

Using the Traffic Noise Model (TNM 2.5) developed by the FHWA, the consultant identified current noise levels for 15 sensitive locations along the Phase 3 corridor. These sites included homes, churches, and stores. The modeled existing noise ranged from 52 to 66 dBA, as shown in able 4-7. Existing noise reached 66 dBA at one site.

Table 4-7. Noise Prediction Results for Locations Along Phase 3

	Sensitive Receiver Location	Existing Noise Level (dBA)	Future No-Action Noise Level (dBA)	Future Noise Level with Road Widening (dBA)	Noise Criterion (dBA)
1	1009 Maluna Street	56	57	57	66
2	1205 Namur Road	58	59	59	66
3	2846 Salt Lake Blvd.	62	64	64	66
4	3819 Salt Lake Blvd.	56	57	57	66
5	3751 Salt Lake Blvd.	52	53	53	66
6	3817 Salt Lake Blvd.	63	65	65	66
7	3711 Salt Lake Blvd.	58	59	59	66
8	3669 Salt Lake Blvd.	57	59	59	66
9	3637 Salt Lake Blvd.	63	65	65	66
10	3583 Salt Lake Blvd.	60	61	61	66
11	3545 Salt Lake Blvd.	63	64	64	66
12	3515 Salt Lake Blvd.	61	62	62	66
13	3469 Salt Lake Blvd.	65	65	65	66
14	3409 Salt Lake Blvd.	62	59	59	66
15	3313 Salt Lake Blvd.	**66**	**67**	**67**	66

Notes: Numbers in bold exceed noise limits. Column headers translate the noise study's "No Build" and "Build" conditions into the terms used in this document.

Source: Calculations performed by Censeo using TNM 2.5.

4.5.2 Environmental Consequences

4.5.2.1 Alternative A

Construction Impacts

State DOH regulations do not permit loud construction noise (noise levels that exceed maximum permissible under Chapter 46, HAR) before 7AM or after 6PM on weekdays, or before 9AM or after 6PM on Saturdays, or at any time on Sundays and holidays. Especially loud equipment, such as jackhammers, may only be operated between 9AM and 5:30PM on weekdays.

Table 4-8 shows the noise levels produced by various types of construction equipment. The types of construction equipment to be used for this project typically generate noise levels of 80 to 90 dBA at a distance of 50 feet while the equipment is operating. Construction

equipment operations can vary from intermittent to fairly continuous, with multiple pieces of equipment operating concurrently.

Table 4-8. Typical Construction Equipment Noise Levels

Type of Equipment	Noise Level in dBA at 50 Feet
Bulldozer	80
Front Loader	72–84
Jack Hammer or Rock Drill	81–98
Backhoe	72–93
Scraper and Grader	80–93
Electrical Generator	71–82
Concrete Pump	81–83
Concrete and Dump Trucks	83–90
Air Compressor	74–87
Pneumatic Tools	81–98
Roller (Compactor)	73–75
Saws	73–82

Source: U.S. EPA, excerpted from Censeo AV and Acoustics 2012, Table 6.

Locations within about 1,650 feet of a construction site are expected to experience occasional episodes of noise levels greater than 60 dBA. Areas within about 500 feet of a construction site are expected to experience episodes with noise levels greater than 70 dBA. Such episodes of high noise levels would not be continuous throughout the day and would generally be restricted to daytime hours.

Operational Impacts

TNM 2.5 analysis of noise levels in 2040 was based on information about future traffic levels along the corridor. Those traffic levels would exist with or without the proposed road widening improvements. The modeled results in Table 4-6 show that noise levels under Alternative A would exceed 66 dBA at the eastern end of the Phase 3 corridor. At no point along the corridor would noise associated with future traffic increase by 15 dBA or more. Consequently, abatement measures would be considered only at the eastern end of the project area.

The receptor at 3313 Salt Lake Boulevard identified as “15” in able 4-7 is at the Salt Lake Shopping Center. To obtain more information on the extent of noise levels around receptor 15, nine additional receptors were set up at the east end of the road corridor. Analysis of the new receptors show that future noise levels from the inclined road section adjacent to the

Island Family Christian Church to the Salt Lake Shopping Center would be 66 to 68 dBA (at or higher than the HDOT noise limit of 66 dBA).

4.5.2.2 Alternative B

Construction Impacts

Construction noise would be similar to Alternative A; the regulatory and management measures identified in this section would apply to Alternative B as well as Alternative A.

Operational Impacts

Traffic volumes and noise would be similar to Alternative A.

4.5.2.3 Alternative C

Construction Impacts

Construction noise would be similar to Alternatives A and B, although slightly longer as more work would be required to excavate into the steep high cut areas and construct sloped berms and retaining walls in the adjacent Navy land. Regulatory and management measures identified above would apply to Alternative C.

Operational Impacts

Traffic volumes and noise would be similar to Alternatives A and B.

4.5.2.4 Alternative D–No Action

No construction and hence no construction noise would occur with the No Action alternative. Even without the roadway widening improvements, traffic noise associated with the natural increase in traffic over Salt Lake Boulevard would be similar to proposed action alternatives (see Appendix D).

4.5.3 MITIGATION MEASURES

During construction, the following management measures may be considered to reduce noise impacts. Not all measures may be feasible for the Salt Lake Boulevard project and would have to be further evaluated.

- Re-route truck traffic away from residential streets, if possible. Select streets with fewest homes if no other options are available.
- Locate equipment, including stationary equipment such as generators, on the construction lot as far away from noise sensitive receivers as possible.
- Combine noisy operations to occur in the same time period. The total noise would not increase significantly and the duration of the noise impact would be less.
- Avoid nighttime activities. Sensitivity to noise increases during nighttime hours at residential receivers.

- Use specially quieted equipment when possible, such as quieted and enclosed air compressors and residential or critical grade mufflers on all engines.

During the long-term operations of Salt Lake Boulevard—Phase 3, abatement measures for traffic noise may include modified roadway design, traffic management measures, or improvements at receptor sites. Neither modified roadway design nor wide berms could address noise levels on both sides of a busy roadway in an established right-of-way. Modified roadway design would require a wider right-of-way. Traffic management measures such as rules limiting truck traffic are a possibility. However, this measure would not be feasible since Salt Lake Boulevard links major industrial and commercial areas.

Noise barriers (noise attenuation walls) were considered for mitigating operational noise impacts but were found to be infeasible. In one case, a barrier would have to block the residence's driveway in order to be effective. In another, a barrier more than 15 feet high would be needed. The cost would be far more than is justified by HDOT guidance for the limited benefit potentially gained.

A possible management measure could include controlling noise at the receptor site. At sites where indoor noise reaches or exceeds 66 dBA, installation of air conditioning or forced ventilation could reduce interior noise by about 10 dBA. If the homes already have air conditioning, management could involve improving windows and walls to lessen noise levels by at least 7 dBA. Receptor-site noise management would involve an indoor analysis once external measures have been determined not to be feasible.

The noise abatement strategies discussed above are responses to increased traffic which would occur both with and without the project. These measures are considered as possible steps to manage existing and anticipated traffic noise.

4.6 VISUAL RESOURCES

4.6.1 AFFECTED ENVIRONMENT

Major visual resources in the region are panoramic views of the ocean, mountains, and urban center.[4] Drivers and passengers along Salt Lake Boulevard see little of the ocean or mountains because of the intervening landscape. Diamond Head and the urban center also do not come into view because of topography.

Currently, the easternmost section of Salt Lake Boulevard (Increment 1) is bounded by high walls on both sides. Moving west, the views widen just before the Phase 3 section. Along Phase 3, the views are mainly of residential areas, although fencing on the south side and slopes on the north side restrict visibility from street level along several stretches. In other

[4] Department of Planning and Permitting, City and County of Honolulu, *Primary Urban Center Development Plan.* Honolulu, HI, 2004. Revised Ordinances of Honolulu 04-14. Posted at http://dev.honoluludpp.org/Portals/0/pdfs/planning/PUC/PrimaryUrbanCenterDP.pdf.

areas, the roadway abuts shoulder sections used for parking and trash cans. Elsewhere, urban vistas are evident looking either east or west from the Phase 3 corridor.

4.6.2 Environmental Consequences

4.6.2.1 Alternative A

Construction Impacts

Visual impacts during construction would consist of the presence of construction equipment and delayed traffic due to construction activity. These are temporary and minor impacts.

Operational Impacts

Visual impacts from Alternative A would include the presence of a wider and improved roadway. Development of the median, bike lanes, parking lane, and sidewalks would give the right-of-way a more orderly and contemporary appearance than at present. Since there are no significant vistas (i.e., long-range view of landmarks) in or from the Phase 3 corridor, there would be no impact from the project on these resources.

4.6.2.2 Alternative B

Construction Impacts

Visual impacts during construction would be similar to Alternative A.

Operational Impacts

Visual impacts of Alternative B would be similar to Alternative A.

The raised, landscaped median proposed as part of Alternative B would break up the appearance of a continuous asphalt concrete pavement for motorists, cyclists, and pedestrians. Aesthetically, this median choice seems preferable to a striped median.

The addition of landscaping in the median would complement the landscaping in the shoulder areas of the road and provide a more pleasing overall appearance than Alternative A.

4.6.2.3 Alternative C

Construction Impacts

Visual impacts during construction would be similar to Alternatives A and B except construction equipment would be on the scene a little longer for Alternative C at the steep high cut areas and immediate adjacent Navy land.

Operational Impacts

Visual impacts of the completed improvements under Alternative C would include the appearance of a slightly wider roadway corridor than with Alternatives A and B, particularly at the steep high cut areas and road shoulder use of adjacent Navy lands for sloped berms and retaining walls.

4.6.2.4 Alternative D–No Action

The No Action alternative would generate no change in visual impacts.

4.6.3 MITIGATION MEASURES

Adverse visual impacts of the project would be minimal and do not need mitigation beyond the planned landscaping that is incorporated with the project.

4.7 ARCHAEOLOGICAL AND CULTURAL RESOURCES

4.7.1 AFFECTED ARCHAEOLOGICAL RESOURCES

Salt Lake Boulevard–Phase 3 lies within Moanalua Ahupuaʻa, in a dry rain shadow area of the Koʻolau mountain and overlapping tuff cones of Āliamanu and Āliapaʻakai. The dryness of this area limits its suitability for traditional agricultural and other cultural pursuits.

The nearby "salt pond" of Moanalua is Āliapaʻakai or Salt Lake, a storied place or "wahi pana" that once stretched across a crater of the same name (Āliapaʻakai) and which was filled during the 1970s to construct a golf course and residential homes.

Legends associated with Moanalua include one that associates the creation of Āliapaʻakai and the adjacent Āliamanu Crater with the goddess Pele.

> ...[Pele] left Kauai and went to Oahu, to a place near Honolulu, to Moanalua, a beautiful suburb. There she dug a fire pit. The earth, or rather the eruption of lava, was forced up into a hill which later bore the name Ke-alia-manu. The crater which she dug filled up with salt water and was named Ke-alia-paa-kai (the white bed of salt, or Salt Lake).[5]

Near Āliapaʻakai and Āliamanu was Leilono, an entrance to the netherworld.

> Leilono at Moanalua, Oahu, was close to the rock Kapukaki and easterly of it (a ma ka na'e aku), directly in line with the burial mound of Aliamanu and facing toward the right side of the north Star (a huli i ka ʻao ʻao ʻakau o ka Hokupaʻa). On the bank of the old trail there was a flat bed of pahoehoe lava, and on it there was a circular place about two feet in circumference. This was the entrance to go down...(ka puka o Leilono)...[6]

In 2012, Cultural Surveys Hawaiʻi, Inc. conducted an *Archaeological Literature Review and Field Inspection* of the Phase 3 corridor. The study describes the early 1800 activities that occurred in Moanalua which included a village, upland agriculture as well as aquaculture in

---

[5] Cultural Surveys Hawaii, Inc., Draft Archaeological Literature Review and Field Inspection for the Salt Lake Boulevard Widening Project Phase 3, July 2012, with reference to Westerveld, W.D., *Myths and Legends of Hawaiʻi*, 1987.

[6] Cultural Surveys Hawaii, Inc., Draft Archaeological Literature Review and Field Inspection for the Salt Lake Boulevard Widening Project Phase 3, July 2012, with reference to Samuel M. Kamakau, *Ka Poʻe Kahiko: The People of Old*, 1964.

coastal fish ponds. With the coming of missionaries and western settlers, large company operators brought big changes to the land division. According to literature research, the areas around the project site were in use by the sugar plantation. By the mid-1930s, the Honolulu Plantation Company had more than 23,000 acres of land leased in Moanalua for sugar cane cultivation. A few years earlier, it is believed the Rodgers Airport (which was to become Honolulu International Airport) was begun.

During the mid- and late-1930s and 1940s, build-up occurred in Pearl Harbor and Hickam Air Force Base. Substantial fill activities and airport construction were carried out in 1942 and 1943 with rapid development of roads and warehouse-like buildings in the surrounding areas. A 1943 map[7] shows the present Salt Lake Boulevard as having been established as a major roadway with major military housing development just to the east (Camp Catlin Naval Reservation). During the ensuing years, Naval facilities and housing continued to develop to the south of the Salt Lake Boulevard–Phase 3 and market residential homes began to fill the vacant lands to the north and above the boulevard and in the Salt Lake area. Today, the adjacent properties along Salt Lake Boulevard—Phase 3 are occupied by a mix of residential homes, apartments, schools, churches, neighborhood shopping center, and military housing.

For purposes of Section 106 of the Historic Preservation Act, Cultural Surveys Hawaiʻi, Inc. conducted an archaeological study of the Salt Lake Boulevard–Phase 3 corridor. Historic research was undertaken, including study of archival sources, historic maps, Land Commission Awards and previous archaeological reports to construct a history of land use and determine if archaeological sites have been recorded on or near the project site. A limited field inspection of the project site, which has undergone extensive urbanization, to identify any surface archaeological features and investigate and assess the potential for impacts to such sites.

Results of the study are presented in CSH's report entitled "Archaeological Literature Review and Field Inspection for the Salt Lake Boulevard Widening Project Phase 3, Maluna Street to Ala Lilikoʻi Street, Moanalua Ahupuaʻa, Kona District, Oʻahu, Hawaiʻi, TMK: [1] 1-1-plat 010 (Salt Lake Boulevard).

The study revealed no archaeological or buried sites that are known to occur within 400 feet of the Salt Lake Boulevard corridor. The *Archaeological Literature Review and Field Inspection* study recommends no further archaeological work on the roadway corridor.

The State Historic Preservation Division of the Department of Land and Natural Resources initiated Section 106 review of the project, but notified the proposing agency it would complete its review during the EA's 30-day public review period administered by the State Office of Environmental Quality Control.

[7] War Department Honolulu and Ewa quad map showing the Salt Lake area, Honolulu airport, Halawa district, and Naval housing of Pearl Harbor, 1943.

4.7.2 AFFECTED CULTURAL RESOURCES

The two *Wahi Pana* (storied places) in the general vicinity of the project are:

- Āliapaʻakai or Salt Lake was a 0.9-mile-wide body of water, a *wahi pana* that once stretched across a crater of the same name. The creation of Āliapaʻakai is variously attributed to the works of the gods Kū and Lono and to the volcano goddess Pele in her search for a new home. Āliapaʻakai was used as a fishpond and also as a source of salt. The closest point (southeast end) of the present Salt Lake Boulevard project area lies approximately a quarter mile southwest of the former salt lake at the base of the outer edge of the Āliapaʻakai tuff cone. Āliapaʻakai was filled during the 1970s to construct a golf course and residential homes.
- Leilono, an entrance to the netherworld, is understood to have been traditionally located in the present Āliamanu Military Reservation more than 1.25 miles to the northeast of the project area.

The immediate project vicinity is developed with single-family residences, apartment buildings, commercial uses, and public facilities. The project corridor is located far from the sea and any natural sources of fresh water. The actual corridor itself appears to have been almost entirely graded repeatedly. Vegetation consists of short exotic grasses and weeds, an occasional kiawe *(Prosopis pallida)* tree and small areas of koa haole *(Leucana glauca).* No resources for traditional Hawaiian gathering practices are believed to be present or on-going within the road corridor.

In its 2012 study, CSH indicated that a 1933 War Department ʻEwa Quad Map shows an approximately1.4-mile-long trail section crossing the Salt Lake Boulevard Widening–Phase 3 project corridor (near present day Kahikolu Place) and extending up to the north-northwest along a southern ridge of the Āliamanu and Āliapaʻakai tuff cones. This may be an early 20th century trail or a spur trail off of the main traditional Hawaiian south shore trail that runs southeast on the west side of the Āliamanu and Āliapaʻakai tuff cones towards the mouth of Moanalua and Kalihi Streams.

It seems clear that the former crossing of this 1933 documented trail through the present Salt Lake Boulevard corridor was on the summit of a perpendicular crossing ridge. This former trail crossing, in the immediate vicinity of 3370 Salt Lake Boulevard, was probably completely obliterated by construction of Salt Lake Boulevard and later by grading and grubbing on both sides of the travel lanes. The Phase 3 road widening project, hence, is not anticipated to have any adverse impact on the former trail alignment.

The 1933 War Department map also shows two irrigation ditches crossing Phase 3 at three different locations. Today, these locations are occupied by roads, residential homes, military housing, and commercial and public facilities.

Further, no makaʻāinana ("people that attend the land") Land Commission Awards are known to occur in this area.

Native Hawaiian Organizations (NHOs) were consulted for this project as part of the Section 106 review as well as the cultural resource provisions of the Chapter 343, HRS, environmental review. The Office of Hawaiian Affairs, Oʻahu Island Burial Council, as well as the Hawaiian Civic Club of Honolulu, Pearl Harbor Hawaiian Civic Club and Prince Kuhio Hawaiian Civic Club were requested by the State Department of Transportation to comment and provide input on the project. They were also requested to furnish the names of other resource groups or parties who might contribute information on the project area. To date, no response from these NHOs have been received.

Another opportunity for traditional cultural resource consultation would be made available in the EA's 30-day, Chapter 343, HRS, public review process. Comments received during the 30-day public review, will be included in Appendix A of the Final EA.

4.7.3 ENVIRONMENTAL CONSEQUENCES

4.7.3.1 Alternative A

Both Āliapaʻakai and Leilono are noted places for the Hawaiian people. The proposed improvements to Salt Lake Boulevard would not have any effect on these places.

There are no unique resources for traditional Hawaiian cultural practices present within the Salt Lake Boulevard corridor, and consequently, no traditional cultural practices would be adversely affected by Alternative A or any of the proposed action alternatives. There would be no impact on access to any cultural resources or practices beyond the project area. As this project goes through the consultation process in accordance with Section 106 of the National Historic Preservation Act (NHPA), there would be opportunity for input from potentially concerned parties.

4.7.3.2 Alternatives B and C

No impacts on cultural resources or practices are anticipated under either Alternatives B or C.

4.7.3.3 Alternative D–No Action

No impacts on cultural resources or practices are anticipated under the No Action alternative.

4.7.4 MITIGATION MEASURES

As this project completes its review under the NHPA Section 106 consultation process, there would be opportunity for further input from other concerned parties.

In the unlikely event of uncovering human skeletal remains or other significant archaeological deposits, all construction work in the immediate area of the find would cease and the State

Historic Preservation Division (SHPD) promptly notified. Construction work would not resume until proper treatment of the find is concluded as approved by the SHPD.

4.8 SOCIO-ECONOMIC

4.8.1 AFFECTED ENVIRONMENT

Salt Lake Boulevard passes between two types of communities—military family housing to the south, and civilian neighborhoods to the north. While the Salt Lake civilian residential area includes many high-rise apartment buildings, most of the homes near Phase 3 are single-family residences. Low-rise apartments are located near the Likini Street intersection.

Salt Lake Boulevard extends from an industrial area, Māpunapuna, to the east, to Aloha Stadium along Kamehameha Highway to the west. The roadway serves nearby residents as well as major industrial, commercial , schools, recreational, and military housing. These activities attract travelers from the entire island of Oʻahu. Two bus lines, Routes 3 and 32, serve the residential community above Salt Lake Boulevard.

The area surrounding the project was developed largely by the 1970s. The original Salt Lake Boulevard Widening Project EIS was approved in 1977. Since that time, nearby commercial uses increased with the development of the Bougainville Center along the Increment 2 section of Salt Lake Boulevard. Hawaiʻi's first Costco store was located in that area; it is now home to a Target store and other retail and service operations.

Socio-economic impacts can be anticipated at two levels. The immediate region of influence consists of the neighborhoods immediately adjacent to Phase 3. These fall within Census Tracts 68.02, 68.06, and 70 (as shown in Figure 4-5). The road's users come from a much wider area. The entire island of Oʻahu can be viewed as sending travelers through the corridor and as affected by the project.

The three Census Tracts adjoining the Phase 3 corridor differ in several ways, as indicated in Table 4-9 and Table 4-10:

- The Āliamanu Census Tract (#68.02) population distribution is much like that of the island as a whole, with a median age of 39.8 years and a racial mix in which Asians form the majority. Census respondents could identify with more than one racial identity in 2010. Household incomes tend to be well above the island median.
- To the east, the Ala Liliko'i Census Tract (# 68.06) has a much older population. Asians form the great majority of residents. Again, household incomes are high, but the share of the population living below the poverty line is well above the island average.

1 **Figure 4-5. Census Tracts along the Salt Lake Boulevard Corridor**

Table 4-9. Demographic Information from the 2010 Census

	City and County of Honolulu	Census Track 68.02 Āliamanu	Census Tract 68.06: Liliko'i	Census Tract 70: Navy-Marine
Population	953,207	6,842	1,704	4,041
Under 5	6.4%	5.6%	4.5%	18.9%
5 to 17	15.7%	16.6%	10.7%	16.6%
18 to 64	63.4%	62.1%	48.4%	64.2%
65 and over	14.5%	15.8%	36.4%	0.4%
Median Age	37.5	39.7	52.3	23.7
Race (Alone or in Combination)				
White	36.8%	18.5%	13.1%	69.5%
Asian	62.0%	78.5%	91.8%	15.9%
Native Hawaiian or Pacific Islander	24.5%	22.1%	11.1%	4.5%
Black	3.4%	1.9%	0.9%	15.9%
American Indian, Alaska Native	2.1%	1.2%	0.8%	2.9%
Other	2.3%	2.0%	1.2%	6.8%
Average Number of Race Identifications per Person	1.31	1.24	1.19	1.15
Hispanic Identification	8.1%	5.7%	3.0%	15.8%
Population in Households	917,907	6,725	1,690	4,041
Population in Group Quarters	35,300	117	14	—

1 Source: U.S. Bureau of the Census, 2010 Census, posted American FactFinder. www.census.gov.

Table 4-10. Economic Characteristics, from the 2006 to 2010 American Community Survey

	City and County of Honolulu	Census Track 68.02 Āliamanu	Census Tract 68.06: Liliko'i	Census Tract 70: Navy-Marine
Population Age 16 or more	752,343	6,194	1,609	2,405
In Labor Force	501,779	57.4%	43.2%	76.4%
Unemployment Rate	5.0%	5.9%	4.3%	4.4.%
Median Household Income	$70,093	$89,156	$86,413	$55,570
Share of Population in Poverty	8.8%	7.3%	12.1%	5.1%

2 All data from sample surveys drawn in 2006 through 2010. Dollar values are in 2009 $s.

3 Source: American Community Survey; data posted at American Fact Finder at www.census.gov.

- The Navy-Marine tract (#70) consists of housing for enlisted families. The population is young and includes far higher percentages of both Whites and Blacks than the island average. Household incomes are well below the island median, but the share of the population living below the poverty line is low. Navy housing has been extensively replaced or renovated since 1996. The housing is now managed by Forest City Military Communities under a long-term redevelopment and management agreement with the U.S. Navy.

Very few residents of the area adjoining the project corridor are in group quarters (such as dormitories or convalescent homes).

These demographic data indicate that the immediate area does not qualify as a minority or low-income area for the purposes of Executive Order No. 12898, Environmental Justice for Minority and Low-Income Communities.

Non-residential facilities next to the Phase 3 project corridor include:

- **Āliamanu Elementary School and Āliamanu Intermediate School** were established in the late 1950s and serve mainly children from military families. They are within the Radford Complex Area. With many military families moving to and from Hawaiʻi each year, the student populations change more quickly than in most Hawaiʻi public schools.
- **Salt Lake Shopping Center** has about 87,000 square feet of leasable area. It includes a Safeway grocery store and a Long's drug store, as well as fast food restaurants and other retail outlets. It was established in 1973.[8]
- **Island Family Christian Church** has occupied its site on Salt Lake Boulevard since the early 1960s. It took its present name in 1993 to underline the fact that it brings together military and local families (who had earlier formed separate congregations).[9] The church holds worship services, youth and adult group meetings, and after-school programs.

4.8.2 ENVIRONMENTAL CONSEQUENCES

4.8.2.1 Alternative A

The major socio-economic impact associated with construction is employment. After the project is built, the widened roadway would accommodate various transportation modes, including automobile riders, bus transit users, pedestrians, and bicyclists, shortening travel times and encouraging diverse modes of travel.

---

[8] Salt Lake Shopping Center. "About Salt Lake Shopping Center." http://saltlakeshoppingcenter.com/about-saltlakeshoppingcenter.php.

[9] Island Family Christian Church. "Church History." www.islandfamily.org/history.shtml.

Construction Impacts

Table 4-11 shows an estimated 268 person-years of direct construction work. Given the expected duration of construction (approximately 24 months), this suggests that, on average, 134 construction-industry workers would be employed full-time during the construction phase. This figure includes on-site jobs and jobs in baseyards and headquarters, so the on-site average job count would be lower.

The table also shows the jobs generated in the larger Hawai‘i economy by construction spending. “Indirect” jobs are associated with the purchase of materials and services by the firms actually engaged in construction. “Induced” jobs are supported by workforce spending (by direct and indirect workers). Since construction lasts for a limited period of time, all of these jobs are of limited duration. The total job impact (including direct, indirect, and induced jobs) would come to some 719 person-years.

Wages associated with construction are also shown in Table 4-11. The total wage impact of construction from Alternative A is estimated at $40.9 million (2011 dollars).

Table 4-11. Construction Jobs and Wages

	Alternative A	Alternative B	Alternative C	Alternative D
Construction Cost (million 2014 $)	$64.3	$55.3	$79.1	$0.0
Adjusted Cost (million 2011 $)	$61.5	$52.9	$75.7	$0.0
Jobs				
Direct Construction Jobs	268	231	330	0
Indirect and Induced Jobs	451	388	555	0
Total Jobs	**719**	**619**	**885**	**0**
Wages (millions $)				
Direct Wages	$21.4	$18.5	$26.4	$0.0
Indirect and Induced Wages	$19.5	$16.8	$24.0	$0.0
Total Wages	**$40.9**	**$35.2**	**$50.4**	**$0.0**

Notes:
Construction cost from estimates by Austin Tsutsumi Associates. Direct jobs based on average job count per million dollars in construction spending, 2011, adjusted for heavy construction. Indirect and induced jobs based on 2007 Input-Output analysis of the Hawai‘i economy. Wages from 2010 wages by industry, for heavy construction and (for indirect and induced) for all covered employment Wages escalated from 2010 to 2011 in line with changes in the Consumer Price Index (CPI). Early 2014 cost deflated to 2011 $s in line with changes in CPI from 2011 to the end of 2013.
Source: 2011, 2012a, 2012b, 2014; DLIR 2011.

During construction, traffic movement along the corridor would be limited from time to time. Access to driveways along work sites could be temporarily blocked, and parking along the roadside would be reduced. These impacts would be short-term. Implementation of a traffic control plan would minimize construction impact on traffic and accesses to affected residences and public facilities.

Operational Impacts

The widened Salt Lake Boulevard would serve both local and through traffic. For commuters and island businesses, it would improve mobility between Honolulu and the ʻAiea/Pearl City area. For local residents, it would provide a complete streets alternative to narrow side roads. The new bikeways and sidewalks would provide safer routes to schools, the public library, and the Salt Lake Shopping Center, contributing to the quality of life for nearby residents.

4.8.2.2 Alternative B

Construction Impacts

As shown in Table 4-11, the total job impact amounts to 619 person-years, and the associated wages come to $35.2 million.

Impacts on nearby residents and businesses would be the same as for Alternative A.

Operational Impacts

As with Alternative A, Alternative B would improve mobility and safety, having much the same impacts as described above.

The raised landscaped median in Alternative B would affect residents along Salt Lake Boulevard by ruling out left turns into and from their driveways. Instead of turning from the left-turn storage lane in the striped median, motorists would travel to the next intersection and make a U-turn to reach their mid-block destination. This travel pattern would likely be viewed as an inconvenience. However, the use of raised medians also tends to correlate with increased safety on four-lane urban roadways (with safety increasing as the total volume of traffic increases).

4.8.2.3 Alternative C

Construction Impacts

As shown in Table 4-11, the total job impact amounts to about 885 person-years, and the associated wages come to $50.4 million.

Impacts on nearby residents and businesses would be the same as for Alternatives A and B.

Operational Impacts

As with Alternatives A and B, the widening of Salt Lake Boulevard under Alternative C would improve mobility and safety within the right-of-way.

The raised landscaped median proposed as part of Alternative C would have impacts similar to those described for Alternative B.

The use of sloped berms and retaining walls on the southern side of the road in Navy land, as opposed to solely a retaining wall directly along the property line, would affect residents of the Navy housing area, by reducing their backyard space and increasing the visibility of their homes from the roadway. Security features would need to be built into the sloped berm and retaining walls for the Navy housing.

4.8.2.4 Alternative D–No Action

Construction Impacts

No construction and as a result no economic benefits would occur as part of the No Action alternative.

Operational Impacts

With the No Action alternative, Salt Lake Boulevard would still have two lanes through the Phase 3 corridor and no bike lanes or sidewalks. As shown in Table 4-6, traffic congestion would continue to increase and the LOS would reach unacceptable levels at peak-hour times.

4.8.3 MITIGATION MEASURES

The road widening project would create inconvenience for some area residents during construction but would not bring adverse socio-economic impacts over the long term. Construction-related impacts can be managed through communication with residents and businesses located along the route and by timely completion of the project. No further mitigation is necessary.

4.9 UTILITIES

4.9.1 AFFECTED ENVIRONMENT

4.9.1.1 Water

Multiple water lines are located in or adjacent to the project corridor. These are owned and operated by either the Board of Water Supply (BWS) or Navy Public Works Center.

The BWS has existing 36-inch, 24-inch, 6-inch, and 4-inch water mains within Salt Lake Boulevard (Figure 4-6). The 36-inch water line is a transmission main and has no fire hydrant or water meter connections. The 36-inch line extends from the west along Salt Lake Boulevard and ends just east of Maluna Street. On the eastern side of Phase 3, the 36-inch line starts at Likini Place and extends east along the road. The 24-inch water line is a service main which runs along the entire length of Salt Lake Boulevard on the northern side and includes fire hydrants and smaller water main branches. The 6-inch and 4-inch water lines service the water meters for the adjacent private properties. A 1.0 million gallon (MG) reinforced concrete reservoir is located immediately north of the boulevard, near the Maluna Street intersection. This reservoir or tank is used by BWS to fill upper reservoirs in the area.

Just outside of the road right-of-way and within Navy property are two water lines owned and operated by the Navy Public Works Center. The 24-inch line runs along the length of the project, while the 12-inch water line begins at Radford Drive and heads eastbound to Arizona Road.

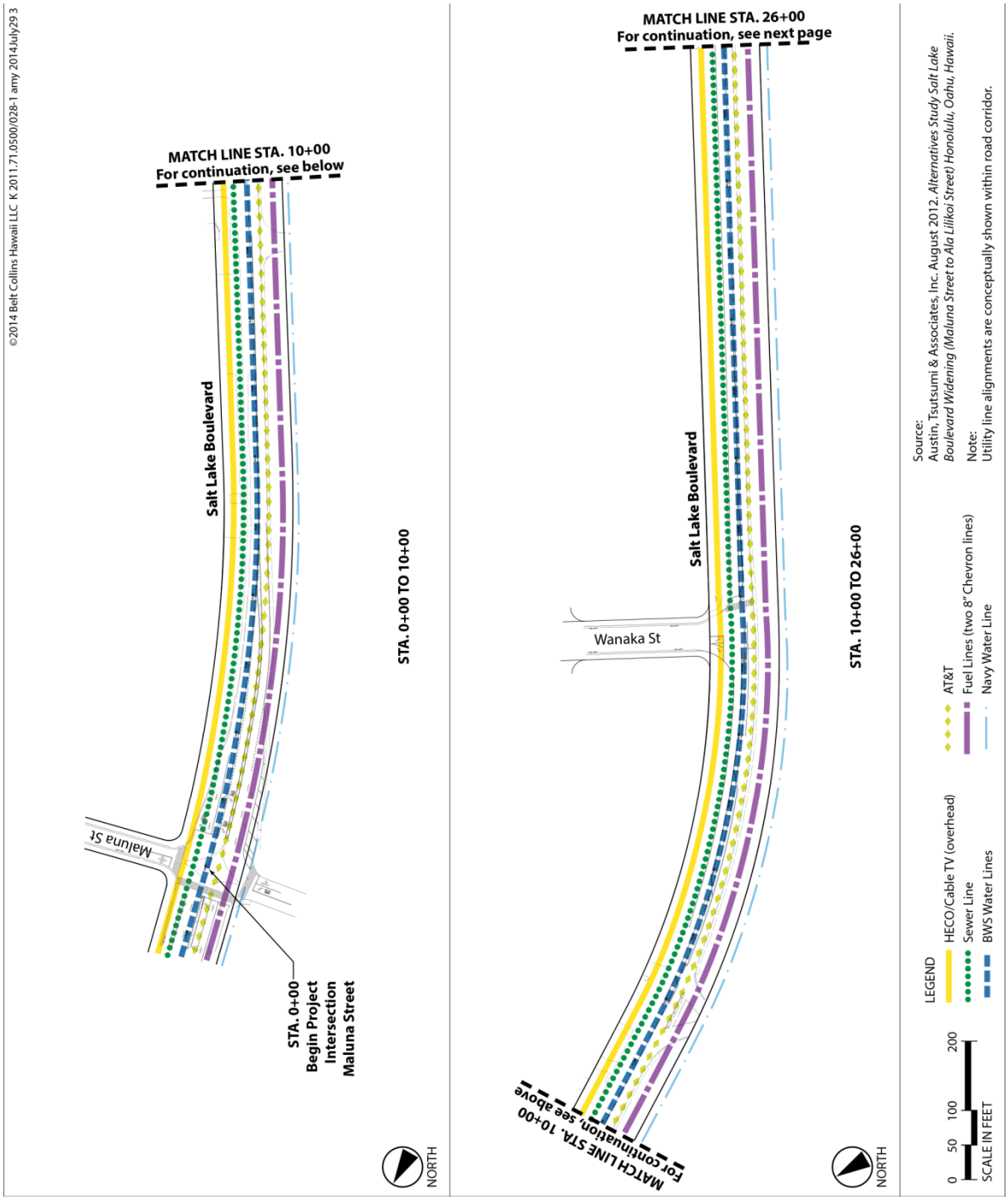
4.9.1.2 Sewer

There are both gravity and force main sewer lines within the Phase 3 right-of-way, which are owned and maintained by the City and County of Honolulu. Most of the 8-inch to 12-inch gravity sewer lines service the residential properties and are located on the north side of the roadway (see Figure 4-7). Two wastewater pump stations, Āliamanu WWPS No. 1 and Āliamanu WWPS No. 2, are located along Salt Lake Boulevard to convey the area wastewater to the City's Kamehameha Highway Waste Water Pump Station. Āliamanu WWPS No. 1 is located on the north side of Salt Lake Boulevard in Phase 3 and Āliamanu WWPS No. 2 is located on the north side near Āliamanu Playground in Increment 2.

4.9.1.3 Storm Drainage

The residential areas mauka of the Phase 3 corridor generally slope towards Salt Lake Boulevard. Surface runoff is collected in the City and County of Honolulu roadway drainage system that includes catchment basins and drain inlets. This system pipes storm water underground from the residential areas, across Salt Lake Boulevard, and connects to the Navy's drainage system, where it outlets in the Navy-Marine Golf Course. Within the project limits, only a few grated drain inlets collect runoff from the roadway and some of the residential areas. Portions of Salt Lake Boulevard that have already been widened to the east and west of the Phase 3 corridor have catch basins with curb inlets to collect storm water.

Under existing conditions, the drainage system is inadequate to accept runoff generated from the existing upland drainage basin. The deficiencies are largely due to inadequate quantity of drain inlets and undersized drain lines. The downstream Navy drainage system lacks capacity to accept runoff from an event greater than a 10-year storm. During such (over 10-year storm) events, the drainage system may back-up, forcing runoff to sheet flow across Navy land and eventually into the Navy-Marine Golf Course. Flooding problems within the roadway, at the drain inlets, and on Navy property are common during large storms.



1 **Figure 4-6. Existing Utilities (Western Part of Phase 3)**

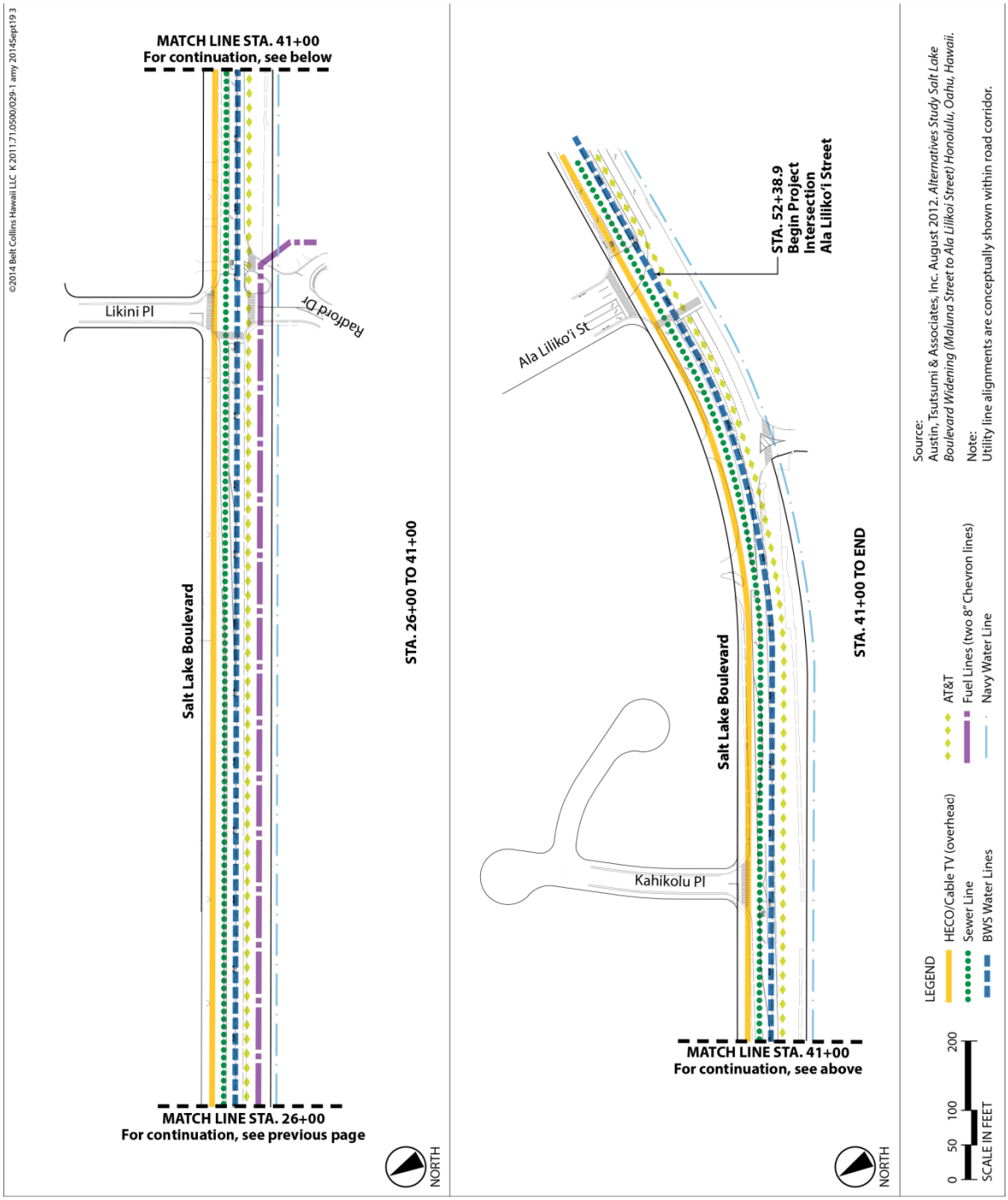


Figure 4-7. Existing Utilities (Eastern Part of Phase 3)

4.9.1.4 Electricity/Telecommunications

Hawaiian Electric Company (HECO), Hawaiian Telcom (HTEL), and Oceanic Time Warner Cable (OTWC) have overhead lines along Phase 3 of Salt Lake Boulevard (Figure 4-6 and Figure 4-7). An overhead joint utility pole system with alternating taller and shorter poles is routed along the northern side of the road. HECO's 46 kilo-Volt (kV) (transmission voltage) lines contact only the taller poles while its 12 kV (high voltage), HECO secondary (low voltage), HTEL, and OTWC lines contact all the poles.

Another overhead line is routed along the southern side of the roadway and supports the City's street lighting and traffic-signal interconnect systems. A third overhead Navy-owned pole line is aligned south of the City's lines and is located entirely within Navy property. Existing HTEL and OTWC cables also cross overhead Salt Lake Boulevard into the Navy's property to serve the Makalapa Housing Area.

The utility poles within the Salt Lake Boulevard right-of-way are owned by the Joint Pole Committee which consists of HECO, HTEL, City Department of Design and Construction-Mechanical/Electrical Division (DDC-MED), and the State Department of Transportation-Highways Division (HDOT).

AT&T Corporation owns and operates underground fiber-optic communication cables within the Salt Lake Boulevard right-of-way. These cables are routed through an underground ductline located generally south of the roadway centerline.

4.9.1.5 Traffic Signals and Street Lighting

Four intersections in the Phase 3 corridor have existing traffic signals: one at Maluna Street/Namur Road, one at Wanaka Street, one a Radford Drive/Likini Place, and one at Ala Liliko'i Street. Existing street lights and electrical lines which power the traffic lights and street lights are owned and maintained by the City Department of Facility Maintenance and are currently mounted on wood poles owned and maintained by the Joint Pole Committee. These wood poles are located on the south side of the road.

4.9.1.6 Fuel and Gas

Two 8-inch fuel lines with one heat tracing line runs along Salt Lake Boulevard, providing service to Chevron Marine Terminal (located at Pier 30 in Honolulu Harbor) and the Honolulu Fuel Facility (located on Sand Island Access Road). One of these lines carries jet fuel to both locations, and the other carries gasoline, diesel, and jet fuel to the Chevron Marine Terminal. A four-inch heat tracing line adjacent to the fuel lines is abandoned. No valves are located within the project limits.

4.9.2 ENVIRONMENTAL CONSEQUENCES

4.9.2.1 Water

Alternative A

Construction Impacts

Construction of Alternative A would require the relocation of some water meter boxes and valve boxes, along with certain grade adjustments for manholes and hydrants to match the new roadway section. The water lines would also be required to meet the minimum and maximum cover requirements, which are specified by BWS.

BWS has indicated that it would like to extend the 36-inch water main from Maluna Street to Likini Place. Construction of this water main would be coordinated with the project to minimize construction impacts. The project would be phased such that interruptions to water service would be limited to less than a day.

The new roadway section would also require relocating a portion of the existing 24-inch Navy water line near Radford Drive intersection where its alignment is within one foot from the Salt Lake Boulevard right-of-way and there is up to 11 feet of planned excavation on the south side of the road. If relocation is necessary, the line would be relocated in order that it is fully within the Navy property and has at least 5 feet minimum clearance from the Salt Lake Boulevard right-of-way.

Operational Impacts

During its long-term operation, Alternative A is not anticipated to impact the public water system.

Alternatives B and C

Construction Impacts

Construction activities and impacts of Alternative B and C would be similar to those under Alternative A. Additionally, under Alternative C, portions of the existing Navy 24-inch and 12-inch water lines that are run beneath the proposed retaining walls in the Navy property may need to be relocated.

Operational Impacts

Neither alternative would impact the public water system.

Alternative D – No Action

There would be no construction or operational impacts under the No Action alternative.

4.9.2.2 Sewer

Alternative A

Construction Impacts

Impacts to the sewer system would include adjusting the sewer manhole covers to the finished grade of the proposed improvements. Sewer lines and laterals are not expected to be

relocated; however, some sections may be relocated at cut areas or where they are in conflict with the new retaining walls or other new utilities. Existing sewer laterals servicing adjacent properties are not expected to be affected.

The City is also exploring the feasibility of replacing the Āliamanu Waste Water Pump Station (WWPS) No. 1 with a replacement gravity sewer line that would run parallel with the existing force main and gravity sewer of Salt Lake Boulevard–Phase 3. The proposed replacement gravity line, which would have a depth of 10 to 30 feet, would be installed using trenchless technology. Construction of the roadway would be coordinated with this project.

Operational Impacts

Alternative A is not anticipated to impact the public sewer system.

Alternatives B and C

Construction Impacts

Construction activities and impacts would be similar to those described for Alternative A.

Operational Impacts

Neither alternative would impact the public sewer system.

Alternative D - No Action

There would be no construction or operational impacts under the No Action alternative.

4.9.2.3 Storm Drainage

Alternative A

Construction Impacts

Runoff from the road pavement would be conveyed by new curb, gutters, and catch basins on the northern side of the road. Underground detention basins would be used to collect runoff on the majority of the southern side of the road. Drain inlets and underground pipes within the right-of-way would be used to convey and connect the existing runoff from the upland basins via the detention basins to the existing storm drainage line system.

The widened roadway would have additional impervious surface and as a result would generate additional storm water runoff. The additional runoff would be mitigated by existing detention systems and bioswales. The existing open detention basin near Marshall Road would be used to control runoff from the western end of the project site. Eight-foot, six-inch wide bioswales, which would decrease normal runoff from the road pavement to less than existing levels by retaining and filtering the storm water into the ground would occupy the southern side of the roadway. Runoff at the eastern end of Phase 3 roadway would increase by approximately 7.9 cubic feet per second. The existing 6-foot by 4-foot box culvert at Ala Liliko‘i Street has excess capacity to receive the additional flow.

To accommodate intense storm events larger than the design storms for the roadway, an emergency overflow release is being designed in the retaining walls at two locations along the roadway low points. The overflow release would consist of four 6-inch by 12-inch slots in the retaining walls situated at the sidewalk grade on the southern side of the road. In the event an intense storm event occurs and floods the roadway, the slots would provide a release for the ponding water.

Operational Impacts

As described above, the new drainage system for the Phase 3 road improvements is designed to contain the additional runoff from the widened road within the existing right-of-way and allow flows from the upland basins to pass through the road corridor to the existing drainage system below. All drainage improvements within the Phase 3 corridor would conform to HDOT guidelines, State and City LID policies, and coordinated with the City's DPP. Maintenance of drainage features would be the responsibility of the City's Department of Facilities Maintenance.

Alternatives B and C

Construction Impacts

With the replacement of the striped median with a raised landscape median, Alternative B would have slightly less impervious surface than Alternative A and hence, less generated runoff. Alternative C would have similar impervious surface to Alternative B as both would have a raised landscaped median. The difference in generated runoff volumes among the three alternatives would be small, and not a major concern in the design of the project's proposed drainage system.

For Alternative C, the use of bioswales is proposed, rather than underground detention basins. The bioswales would be sized to control runoff volumes to much the same level as the detention basins proposed for Alternatives A and B.

Operational Impacts

The difference in runoff volumes from the three alternatives would be minor and not call for notable changes in the proposed drainage system.

Maintenance of drainage features would be the responsibility of the City's Department of Facilities Maintenance. That Department has indicated that it views bioswale maintenance as more difficult than maintenance of underground basins. Bioswales may fail if maintenance is greatly deferred, so the risk that drainage features would need to be replaced is greater for Alternative C.

Alternative D - No Action

There would be no change in existing drainage conditions in the Phase 3 corridor.

4.9.2.4 Electricity/Telecommunications

Alternative A

Construction Impacts

Alternative A would require placing the existing overhead street light and traffic signal interconnect systems on the south side of the road underground and relocating any remaining overhead facilities to the existing north side pole lines. The existing utility poles on the north side, which carry electrical, telephone, and cable TV lines, would remain in place and shifted only where necessary to accommodate the road widening improvements.

Impacts to residents would occur only near the poles that require adjustment in their position. The utility companies typically conduct their construction without interruption of electric, telephone, and cable TV services. In the event a scheduled outage is required, the utility companies would coordinate with the affected area residents.

The AT&T duct system is not expected to be impacted by the road widening improvements.

Traffic signals at existing intersections would remain but would be upgraded and reconfigured to the recommendations outlined in the traffic impact report. The existing street lights would be upgraded to new luminaires on galvanized steel street light standards, in conformance with City DDC standards.

Operational Impacts

Under Alternative A, electrical, telecommunication, and cable TV services on overhead lines would be maintained, similar to existing conditions. The new underground location of the electrical lines servicing the street lights and traffic control lights would be protected from severe weather conditions.

Alternative B

Construction Impacts

Construction impacts would be similar to those described for Alternative A.

The existing traffic signals would be upgraded and reconfigured at the intersections per the traffic impact report recommendations, and when warranted, the intersection at Kahikolu Place would become signalized. Street lights would also be upgraded to new luminaires on galvanized street light standards, in conformance with City DDC-MED standards.

Operational Impacts

No operational impacts to the electrical and telecommunications system are anticipated.

Alternative C

Construction Impacts

Under this alternative, all of the electrical, telecommunications, and cable TV lines would be placed in a duct system under Salt Lake Boulevard's northern sidewalk. Construction impacts

to adjacent properties would include converting overhead service connections within the private properties to an underground connection with appropriate service boxes. Electrical metering equipment would also require upgrade to meet current standards.

Up to approximately eight Navy utility poles may be impacted by the extended retaining walls on Navy land and may require replacement at the same general location but repositioned on the final grade and retaining wall construction.

The existing traffic signals would be upgraded and repositioned at the intersections per the traffic impact report recommendations, and when warranted, the intersection at Kahikolu Place would become signalized. Street lights would also be upgraded to new luminaires on galvanized street light standards, in conformance with City DDC-MED standards and repositioned to accommodate the widened road.

Operational Impacts

The underground electrical, telecommunications, and cable TV systems along Phase 3 would be less vulnerable to damage from severe weather conditions than Alternatives A and B.

Alternative D - No Action

There would be no construction or operational impacts under the No Action alternative.

4.9.2.5 Fuel and Gas

Alternative A

Construction Impacts

Alternative A would require relocating the Chevron fuel lines throughout the entire Phase 3 corridor in order to be at a proper elevation and under a specified cover. Other utilities would not be allowed to locate over the fuel lines.

Operational Impacts

Alternative A would replace the existing Chevron fuel lines in-kind; therefore, no operational impacts are expected.

Alternatives B and C

Construction Impacts

Construction impacts would be similar to Alternative A.

Operational Impacts

Operational impacts would be similar to Alternative A.

Alternative D - No Action

There would be no construction or operational impacts under the No Action alternative.

4.9.3 MITIGATION MEASURES

No additional mitigation is required during construction or operations.

4.10 Public Facilities And Services

4.10.1 AFFECTED ENVIRONMENT

4.10.1.1 Police, Fire and Medical Services

Police and Fire Services. Police services are covered by the Honolulu Police Department District 5 (Kalihi). The Pearl Harbor end of Salt Lake Boulevard is within District 3 (Pearl City). Fire services are provided by the Honolulu Fire Department's (HFD's) Moanalua station (No. 30) on Ala 'Ilima Street, next to Salt Lake Boulevard, supported by station No. 8 at Nimitz and Valkenburgh and additional stations in Kalihi and 'Aiea/Pearl City.

Emergency Medical Services. The City's Department of Emergency Medical Services Division (EMS) serves the 'Aiea/Salt Lake area. EMS facilities are stationed at Kapiʻolani Medical Center, and a Rapid Response Unit for the area is stationed at Kuakini Medical Center. Private companies provide additional ambulance service. HFD also provides first responder services. Regional hospitals for the area include Kapiʻolani Medical Center, and Straub Clinic (Pali Momi), and Kaiser Permanente Moanalua Medical Center. Military hospitals, located approximately two miles from the project site, are Tripler Army Medical Center and the Spark M. Matsunaga VA Medical Center.

4.10.1.2 Schools

Several public and private schools are located within 0.5-miles of Salt Lake Boulevard. Public schools are Āliamanu Elementary School, Āliamanu Intermediate School, Salt Lake Elementary School, and Radford High School. Private schools include St. Philomena Early Learning Center, Tiny Tots Christian Preschool, and Salt Lake Preschool (Kamaʻaina Kids).

4.10.1.3 Public Parks

The City Department of Parks and Recreation has three parks within a mile of the project corridor. These are Salt Lake District Park, Hoaloha Park, and Āliamanu Playground.

4.10.2 ENVIRONMENTAL CONSEQUENCES

Alternative A

Construction Impacts

Existing public services and facilities would have the capacity to accommodate any changes generated by the construction of the road improvements. Construction impacts would include construction vehicles on the public roadways and possible lane closures and rerouting of traffic during construction. These actions could impact response times of emergency vehicles in the short-term, and may be avoided or minimized through implementation of a traffic control plan.

Operational Impacts

No operational impacts are anticipated.

Alternative B

Construction

Construction impacts would be similar to Alternative A.

Operational Impacts

Operational impacts would be similar to Alternative A.

Alternative C

Construction

Construction impacts would be similar to Alternatives A and B.

Operational Impacts

Operational impacts would be similar to Alternatives A and B.

Alternative C - No Action

No construction or operational impacts are anticipated under the No Action alternative.

4.10.3 MITIGATION MEASURES

No mitigation measures are required.

Chapter 5

Relationship to Public Policies and Programs

CHAPTER 5
Relationship to Public Policies and Programs

5.1 INTRODUCTION

This EA satisfies the requirements of Chapter 343, Hawai'i Revised Statutes (HRS), and its implementing regulations. In addition, several additional federal and state laws, Executive Orders (EO), permits and consultations, identified during the scoping/preconsultation process and in preparation of this document, are described in this section. This is not intended to be an exhaustive listing of required permits and approvals.

5.2 RELATIONSHIP TO FEDERAL LAWS AND EXECUTIVE ORDERS

5.2.1 NATIONAL ENVIRONMENTAL POLICY ACT

This EA was prepared under Section 343, HRS, but is designed to be in compliance with NEPA (42 United States Code [USC] § 4321, et seq.) as administered by the Council on Environmental Quality regulations (40 Code of Federal Regulations [CFR] Parts 1500 to 1508), since Federal-aid highway funding would be sought in the project's implementation. The EA discloses potential impacts of the proposed action alternatives and assesses the need for possible mitigation measures.

5.2.2 National Historic Preservation Act

The National Historic Preservation Act (NHPA) of 1966, as amended (16 USC §470) recognizes the nation's historic heritage and establishes a national policy for the preservation of historic properties as well as the National Register of Historic Places. Section 106 of the NHPA requires federal agencies to take into account the effects of federal undertakings on historic properties, and affords the Advisory Council on Historic Preservation a reasonable opportunity to comment on such undertakings. The Section 106 process, as defined in 36 CFR §800, provides for identification and evaluation of historic properties, for determining the effects of proposed undertakings, and for ways to resolve adverse effects in consultation with concerned parties.

Relationship of the Proposed Action Alternatives to NHPA. The Hawai'i State Department of Transportation (DOT), Highways Division corresponded on December 24, 2012 with the State Historic Preservation Division (SHPD) to initiate Section 106 consultation on the Salt Lake Boulevard project. SHPD commenced review of the project but indicated it would issue a formal response during the EA's State (Chapter 343, HRS) public review period.

On December 24, 2012, the Hawai'i State DOT also transmitted letters to Native Hawaiian Organizations (NHOs) in the project vicinity, including the Office of Hawaiian Affairs, O'ahu Island Burial Council, Hawaiian Civic Club of Honolulu, Pearl Harbor Hawaiian Civic Club, and Prince Kuhio Hawaiian Civic Club, requesting input and comment on the proposed project. These organizations were also requested to share the names of other sources or contacts who might provide input on the project. As of April 2015, no responses have been received.

5.2.3 COASTAL ZONE MANAGEMENT ACT

The purpose of the Coastal Zone Management Act (CZMA) of 1972 (16 USC §1451 et seq.) is to encourage coastal states to manage and conserve coastal areas as a unique, irreplaceable resource. The CZMA has objectives relating primarily to (1) protecting and preserving the coastal zone, (2) improving coastal scenic and open space resources; (3) ensuring that coastal developments are located, designed and built to minimize social, visual and environmental impacts; and (4) encouraging research and development of new technologies for exploring, using, or protecting marine and coastal resources.

The CZMA requires a consistency determination from the Department of Business, Economic Development and Tourism (DBEDT), State of Hawaiʻi, for actions subject to federal permits within the coastal zone, as defined by HRS §205A-1. Coastal zone management (CZM) consistency determinations are not required for actions on federal properties that would not have reasonably foreseeable direct or indirect effects on resources in the coastal zone.

Relationship of the Proposed Action Alternatives to the CZMA. All of Hawaiʻi is within the coastal zone. The CZMA consistency determination is undertaken on the basis of permit requests, and would be issued only after this EA is accepted and a permit request is made.

The City and State DOT standards for road construction follow applicable laws, regulations and best management practices (BMP), and are generally in conformity with the demands of the CZMA. A consistency determination would be requested before Federal-aid highway funds are spent on the project.

5.2.4 CLEAN WATER ACT

The Clean Water Act (CWA) of 1977, as amended (33 USC §1251 et seq.), is the major federal legislation concerning improvement of the nation's water resources. The CWA amended the Federal Water Pollution Control Act and requires federal agency consistency with state nonpoint source pollution abatement plans. Amended in 1987, the CWA strengthens enforcement mechanisms and regulations for stormwater runoff, provides for the development of industrial and municipal wastewater treatment standards, and establishes a permitting system to control wastewater discharges to surface waters.

CWA Section 402. Discharges of point source pollutants into surface waters of the U.S. are controlled under the National Pollutant Discharge Elimination System (NPDES) program, pursuant to Section 402 of the CWA. Pursuant to the CWA and amendments, states may be authorized to administer permit programs. In the State of Hawaiʻi, the State Department of Health (DOH), Clean Water Branch, under Hawaiʻi Administrative Rules (HAR) 11-55, administers the NPDES program. Requirements for NPDES permit coverage are triggered for construction activities of one acre or greater, construction dewatering, and hydrotesting.

Relationship of the Proposed Action Alternatives to the CWA. Before construction, the City would secure a NPDES permit for the project.

5.2.5 CLEAN AIR ACT

The Clean Air Act (CAA) and amendments (42 USC §7401 et seq.) comprise the comprehensive federal law that regulates air emissions from area, stationary, and mobile sources. This law authorizes the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment. Pursuant to the CAA and amendments, state-operated permit programs serve to control emissions. In Hawaiʻi, the state operating permit program is implemented by the DOH, and emissions of regulated air pollutants within the state may be subject to permitting as required under HAR 11-60.1.

Relationship of the Proposed Action Alternatives to the CAA. As noted in Chapter 4, the state is in attainment of the NAAQs and Hawaiʻi State AAQS. As the entire state is in attainment of the NAAQS, emissions from the project are not subject to the General Conformity Regulations, 40 CFR Parts 51 and 93, pursuant to section 176(c) of the CAA (FR 2010).

5.2.6 ENDANGERED SPECIES ACT

The Federal Endangered Species Act (ESA) of 1973 (16 USC §1531 et seq.) establishes a process for identifying and listing threatened and endangered species. It requires federal agencies to carry out programs for the conservation of federally-listed endangered and threatened plants and wildlife and designated critical habitats for such species. It also prohibits actions by federal agencies that would likely jeopardize the continued existence of those species or result in the destruction or adverse modification of designated critical habitat. Section 7 of the ESA requires consultations with federal wildlife management agencies, particularly U.S. Fish and Wildlife Service (USFWS), on actions that may affect listed species or designated critical habitats. Section 9 of the ESA prohibits the "taking" (through harm or harassment) of endangered species without an agency-issued permit.

Relationship of the Proposed Action Alternatives to the ESA. The project site is urbanized and not located in any recognized critical habitat for endangered species. No impact on endangered species is anticipated.

The City is aware of the potential impact of unshielded lighting on seabirds and would upgrade lighting along the Phase 3 corridor. Modern cut-off fixtures with flat lenses, similar to current State DOT highway lights, would be installed. These types of fixtures limit light emitted to the area below the horizontal plane of the flat lens and prevent the light source from being visible above the fixture.

The City through the State DOT and Federal Highway Administration (FHWA) wrote to the, USFWS, Pacific Islands Fish and Wildlife Office, to initiate consultation pursuant to Section 7 of the ESA. A letter, dated August 9, 2013, was subsequently received from that office indicating concurrence with FHWA's determination that the proposed project is not likely to adversely affect the federally endangered Hawaiian hoary bat and threatened Newell's shearwater due to the incorporation of proposed avoidance and minimization.

The letter further noted that any future assessment on the project provide an evaluation of the potential for movement and dispersal of invasive species due to planned activities, and provide measures to prevent or reduce impacts from invasive species. Additionally, it was recommended that the project use Standard Fish and Wildlife Best Management Practices to avoid or minimize any project-related degradation of area water quality conditions and to use, if possible, native plants for any landscaping of the project. If it is not possible to use native plants due to the project's purpose and need, then it is recommended that plant species thought to have a low risk of becoming invasive be used.

5.2.7 FISH AND WILDLIFE COORDINATION ACT

The Fish and Wildlife Coordination Act (FWCA), as amended (16 USC §661 et seq.), provides the USFWS the authority to evaluate impacts to fish and wildlife resources from new development and requires federal agencies implementing development projects to consult with the USFWS and appropriate resource management agencies regarding impacts and proposed mitigation measures.

Relationship of the Proposed Action Alternatives to the FWCA. As noted above, the City through the State DOT and FHWA consulted with the USFWS under the FWCA.

5.2.8 MIGRATORY BIRD TREATY ACT

The Migratory Bird Treaty Act (MBTA) of 1918 (16 USC §703 et seq.), as amended, establishes protections for migratory birds and prohibitions for activities involving migratory birds that "pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export…" unless permitted by regulations.

Relationship of the Proposed Action Alternatives to the MBTA. No proposed action alternatives are expected to fall under the MBTA's list of activities. As noted above, the replacement of existing roadway lighting with newer, shielded fixtures may help to protect seabirds from disorientation and harm.

5.2.9 COMPLIANCE WITH EXECUTIVE ORDERS

5.2.9.1 EO 12898, Environmental Justice in Minority Populations and Low Income Populations

EO 12898 (11 February 1994) requires federal agencies to identify and address the potential for disproportionately high adverse environmental effects on minority and low-income residents as a whole.

Relationship of the Proposed Action Alternatives to EO 12898. This EA has reviewed information about the residents living near the proposed action alternatives and finds they do not constitute a minority or low-income population.

5.2.9.2 EO 13045, Protection of Children from Environmental Health Risks and Safety Risks

EO 13045 (21 April 1997) requires federal agencies to identify and assess environmental health and safety risks that may disproportionately affect children.

Relationship of the Project to EO 13045. Factors that raise concerns about children's health and safety include:

- The project area is next to Āliamanu Elementary and Āliamanu Intermediate Schools;
- Island Family Christian Church runs after-school programs at its facility adjacent to Salt Lake Boulevard; and
- The Navy housing south of the project serves families of enlisted sailors, and is home to many children.

Construction activities associated with the project would temporarily increase ambient noise and fugitive dust, but would be controlled following best management practices. Traffic disruptions from the construction activities would be managed by the implementation of a City approved traffic control plan. When completed, the project would have sidewalks and dedicated bike lanes to promote safer travel for pedestrians and bicyclists. These features are expected to reduce safety risks for children along the route.

5.2.9.3 EO 13112, Invasive Species

EO 13112 (10 January 2001) requires federal agencies to identify those actions (and not authorize, fund, or carry out actions) that they believe would cause or promote the introduction or spread of invasive species.

Relationship of the Proposed Action Alternatives to EO 13112. No activity of the proposed action alternatives is expected to cause or promote the introduction or spread of invasive species.

5.2.10 U.S. DEPARTMENT OF TRANSPORTATION ACT, SECTION 4(F)

The USDOT Act of 1966 (49 USC §303, referred to as Section 4(f)) requires evaluation of federal transportation projects that use public parks, recreation areas, or historic sites. It subjects projects to USDOT policies on such resources as lands, wildlife and waterfowl refuges, and historic sites. Consideration must be given on avoidance, minimization, and mitigation or enhancement measures for impacts on those resources.

Relationship of the Proposed Action Alternatives to USDOT Act, Section 4(f). No parks, recreation areas, or historic sites are located along the project corridor.

5.2.11 ENVIRONMENTAL PROTECTION AGENCY'S SOLE SOURCE AQUIFER

EPA's Sole Source Aquifer Program was established under Section 1424(e) of the Safe Drinking Water Act. This program, which allows for EPA environmental review, has been used by communities since 1977 to help prevent contamination of groundwater by federally-funded or aided projects.

The Salt Lake Boulevard Widening-Phase 3 is located in the Southern Oʻahu Basal Aquifer, a designated sole source aquifer that extends from the Ewa Plains to Mānoa and Wahiawa on the island of Oʻahu.

5.2.12 AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS

AASHTO is a professional nonprofit organization that works to develop design guidelines for roads and bridges in United States' cities, towns, and countrysides. Part of these guidelines is the desire to ensure uniform safety throughout the nation – to have some standardization.

Design exceptions are documented approvals allowing a legal divergence from standard road designs and management policies thereby reducing claims of liability. These exceptions apply to specific features, such as a lane width or shoulder dimension, and not as a blanket exception for the whole road.

A design exception is reviewed by the State Department of Transportation and approved by the Federal Highway Administration (FHWA). A design exception would be required for the proposed Salt Lake Boulevard widening project because the roadway would not meet the minimum vertical sight distance requirement for the posted speed limit of the facility. Without a design exception approved by the FHWA, the federal agency would not participate in the construction funding for the project.

5.3 HAWAIʻI REVISED STATUTES, CHAPTER 343

This EA has been prepared to meet the requirements of Chapter 343, HRS, and its implementing regulations (Hawaiʻi Administrative Rules, Chapter 11-200). The proposing agency has reviewed the likely effects of the proposed action alternatives and finds none of the probable impacts would reach the level of significance. Accordingly, an EA has been prepared, and a Finding of No Significant Impact is anticipated.

5.4 HAWAIʻI STATE PLAN

5.4.1 OVERVIEW

The Hawaiʻi State Legislature in 1978 adopted the Hawaiʻi State Planning Act (Planning Act) as Chapter 226, HRS, to establish direction and provide long-range planning for the State. The

Planning Act called for the creation of 12 functional plans to set specific objectives, establish policies, and implement actions for various fields of activity.

The Legislature in 2005 enacted Act 8, which provided for the development of the Hawai‘i 2050 Sustainability Plan. The legislators felt that with the passage of time and new challenges facing the islands a thorough review of existing 30-year-old plans would be in the public interest. The legislators recognized that while many key initiatives were accomplished under the Hawai‘i State Plan and State functional plans, they were simply outdated and needed updating. The intent of the Hawai‘i 2050 Sustainability Plan, however, is not to replace existing State and County plans but to augment and complement them.

The following sections evaluate the proposed action alternatives in relation to the goals and policies of the (1) Hawai‘i State Planning Act; (2) State functional plans; and (3) Hawai‘i 2050 Sustainability Plan.

5.4.2 Hawai‘i State Plan

DBEDT (formerly known as the Department of Planning and Economic Development) completed in 1978 the Hawai‘i State Plan to: (1) improve the planning process; (2) increase the effectiveness of government and private actions; (3) improve coordination among agencies and levels of government; (4) provide for the wise use of Hawai‘i’s resources; and (5) guide the future development of the state.[1]

The Planning Act consists of a series of broad goals, objectives, and policies that serve as guidelines for future long-term growth and development. The Planning Act is divided into three sections: Part I - Overall Theme, Goals, Objectives and Policies; Part II - Planning Coordination and Implementation; and Part III - Priority Guidelines. Part I of the Planning Act consists of three overall themes: (1) individual and family self-sufficiency; (2) social and economic mobility; and (3) community or social well-being. These themes are considered “basic functions of society” and goals toward which government must strive (HRS Section 226-3).

Part II of the Planning Act primarily addresses internal government policies to help streamline, coordinate, and implement various plans and processes between governmental agencies. It seeks to eliminate or consolidate burdensome or duplicative governmental requirements imposed on business, where public health, safety, and welfare would not be adversely affected.

Part III of the Planning Act establishes overall priority guidelines to address areas of statewide concern (HRS Section 226-101). The overall direction and focus are on improving

[1] State of Hawai‘i Department of Planning and Economic Development, 1978, Revised 1989, 1991.

the quality of life for Hawai‘i’s present and future population through the pursuit of desirable courses of action (HRS Section 226-102).

Table 5-1 evaluates the proposed action alternatives’ conformance with the State’s goals and objectives of Part I of the Planning Act. Parts II and III are not presented as those sections pertain to internal government affairs and statewide concerns. Sections within Part I that do not pertain to the proposed action alternatives have been omitted.

Table 5-1. Hawaii State Plan–HRS Chapter 226, Part I

SECTION	CHAPTER 226 - PART I. OVERALL THEME, GOALS, OBJECTIVES AND POLICIES	RATING
A = ACTIVELY SUPPORTS C= CONFORMS F = FAILS TO MEET PLAN GOAL NA = GOAL IS NOT APPLICABLE		
226-3	OVERALL THEME	
226-4	STATE GOALS. In order to guarantee, for present and future generations, those elements of choice and mobility that insure that individuals and groups may approach their desired levels of self-reliance and self-determination, it shall be the goal of the State to achieve:	
(1)	A strong, viable economy, characterized by stability, diversity, and growth, that enables the fulfillment of the needs and expectations of Hawai‘i's present and future generations.	A
(2)	A desired physical environment, characterized by beauty, cleanliness, quiet, stable natural systems, and uniqueness, that enhances the mental and physical well being of the people.	C
(3)	Physical, social, and economic well being, for individuals and families in Hawai‘i, that nourishes a sense of community responsibility, of caring, and of participation in community life.	A
CONFORMANCE DETERMINATION: The proposed action alternatives appear to fully support HRS Section 226-4 since it would enable and encourage both economic activity and community life.		
226-5	OBJECTIVE AND POLICIES FOR POPULATION.	
(a)	It shall be the objective in planning for the State's population to guide population growth to be consistent with the achievement of physical, economic, and social objectives contained in this chapter;	
(b)	To achieve the population objective, it shall be the policy of this State to:	
(1)	Manage population growth statewide in a manner that provides increased opportunities for Hawai‘i’s people to pursue their physical, social, and economic aspirations while recognizing the unique needs of each county.	C
(2)	Encourage an increase in economic activities and employment opportunities on the neighbor islands consistent with community needs and desires.	NA
(3)	Promote increased opportunities for Hawai‘i’s people to pursue their socio-economic aspirations throughout the islands.	C
(4)	Encourage research activities and public awareness programs to foster an understanding of Hawai‘i’s limited capacity to accommodate population needs and to address concerns resulting from an increase in Hawai‘i’s population.	NA

Table 5-1. Hawaii State Plan–HRS Chapter 226, Part I

SECTION	CHAPTER 226 - PART I. OVERALL THEME, GOALS, OBJECTIVES AND POLICIES	RATING
A = ACTIVELY SUPPORTS C= CONFORMS F = FAILS TO MEET PLAN GOAL NA = GOAL IS NOT APPLICABLE		
(5)	Encourage federal actions and coordination among major governmental agencies to promote a more balanced distribution of immigrants among the states, provided that such actions do not prevent the reunion of immediate family members.	NA
(6)	Pursue an increase in federal assistance for states with a greater proportion of foreign immigrants relative to their state's population.	NA
(7)	Plan the development and availability of land and water resources in a coordinated manner so as to provide for the desired levels of growth in each geographic area.	NA
CONFORMANCE DETERMINATION: Completion of the Salt Lake Boulevard Widening—Phase 3 project promotes economic growth.		
226-6	OBJECTIVES AND POLICIES FOR THE ECONOMY - IN GENERAL.	
(a)	Planning for the State's economy in general shall be directed toward achievement of the following objectives:	
(1)	Increased and diversified employment opportunities to achieve full employment, increased income and job choice, and improved living standards for Hawai'i's people.	C
(2)	A steadily growing and diversified economic base that is not overly dependent on a few industries, and includes the development and expansion of industries on the neighbor islands.	C
(b)	To achieve the general economic objectives, it shall be the policy of this State to:	
(1)	Expand Hawai'i's national and international marketing, communication, and organizational ties, to increase the State's capacity to adjust to and capitalize upon economic changes and opportunities occurring outside the State.	NA
(2)	Promote Hawai'i as an attractive market for environmentally and socially sound investment activities that benefit Hawai'i's people.	NA
(3)	Seek broader outlets for new or expanded Hawai'i business investments.	NA
(4)	Expand existing markets and penetrate new markets for Hawai'i's products and services.	NA
(5)	Assure that the basic economic needs of Hawai'i's people are maintained in the event of disruptions in overseas transportation.	NA
(6)	Strive to achieve a level of construction activity responsive to, and consistent with, state growth objectives.	C
(7)	Encourage the formation of cooperatives and other favorable marketing arrangements at the local or regional level to assist Hawai'i's small-scale producers, manufacturers, and distributors.	NA
(8)	Encourage labor-intensive activities that are economically satisfying and which offer opportunities for upward mobility.	NA

Table 5-1. Hawaii State Plan–HRS Chapter 226, Part I

SECTION	CHAPTER 226 - PART I. OVERALL THEME, GOALS, OBJECTIVES AND POLICIES	RATING
A = ACTIVELY SUPPORTS C= CONFORMS F = FAILS TO MEET PLAN GOAL NA = GOAL IS NOT APPLICABLE		
(9)	Foster greater cooperation and coordination between the government and private sectors in developing Hawai'i's employment and economic growth opportunities.	C
(10)	Stimulate the development and expansion of economic activities which will benefit areas with substantial or expected employment problems.	C
(11)	Maintain acceptable working conditions and standards for Hawai'i's workers.	C
(13)	Provide equal employment opportunities for all segments of Hawai'i's population through affirmative action and nondiscrimination measures.	A
(14)	Encourage businesses that have favorable financial multiplier effects within Hawai'i's economy.	A
(15)	Promote and protect intangible resources in Hawai'i, such as scenic beauty and the aloha spirit, which are vital to a healthy economy.	C
(16)	Increase effective communication between the educational community and the private sector to develop relevant curricula and training programs to meet future employment needs in general, and requirements of new, potential growth industries in particular.	NA
(17)	Foster a business climate in Hawai'i - including attitudes, tax and regulatory policies, and financial and technical assistance programs - that is conducive to the expansion of existing enterprises and the creation and attraction of new business and industry.	C
CONFORMANCE DETERMINATION: The proposed action alternatives support orderly development of Hawai'i's industries.		
226-9	OBJECTIVE AND POLICIES FOR THE ECONOMY – FEDERAL EXPENDITURES.	
(a)	Planning for the State's economy with regard to federal expenditures shall be directed towards achievement of the objective of a stable federal investment base as an integral component of Hawai'i's economy;	
(b)	To achieve the federal expenditures objective, it shall be the policy of this State to:	
(1)	Encourage the sustained flow of federal expenditures in Hawai'i that generates long-term government civilian employment.	NA
(2)	Promote Hawai'i's supportive role in national defense.	A
(3)	Promote the development of federally supported activities in Hawai'i that respect state-wide economic concerns, are sensitive to community needs, and minimize adverse impacts on Hawai'i's environment.	C
(4)	Increase opportunities for entry and advancement of Hawai'i's people into federal government service.	NA
(5)	Promote federal use of local commodities, services, and facilities available in Hawai'i.	C
(6)	Strengthen federal-state-county communication and coordination in all federal activities that affect Hawai'i.	NA

Table 5-1. Hawaii State Plan–HRS Chapter 226, Part I

SECTION	CHAPTER 226 - PART I. OVERALL THEME, GOALS, OBJECTIVES AND POLICIES	RATING
A = ACTIVELY SUPPORTS C= CONFORMS F = FAILS TO MEET PLAN GOAL NA = GOAL IS NOT APPLICABLE		
(7)	Pursue the return of federally controlled lands in Hawai‘i that are not required for either the defense of the nation or for other purposes of national importance, and promote the mutually beneficial exchanges of land between federal agencies, the State, and the counties.	NA
CONFORMANCE DETERMINATION: Federal agencies, including the military branches, depend on Honolulu's roadways for transportation of personnel and equipment. Salt Lake Boulevard Widening—Phase 3 serves military housing areas and provides access to Joint Base Pearl Harbor-Hickam.		
226-10	OBJECTIVE AND POLICIES FOR THE ECONOMY – POTENTIAL GROWTH ACTIVITIES.	
(a)	Planning for the State's economy with regard to potential growth activities shall be directed towards achievement of the objective of development and expansion of potential growth activities that serve to increase and diversify Hawai‘i's economic base.	
(b)	To achieve the potential growth activity objective, it shall be the policy of this State to:	
(1)	Facilitate investment and employment in economic activities that have the potential for growth such as diversified agriculture, aquaculture, apparel and textile manufacturing, film and television production, and energy and marine-related industries.	C
(2)	Expand Hawai‘i's capacity to attract and service international programs and activities that generate employment for Hawai‘i's people.	NA
(3)	Enhance and promote Hawai‘i's role as a center for international relations, trade, finance, services, technology, education, culture, and the arts.	NA
(4)	Accelerate research and development of new energy- related industries based on wind, solar, ocean, and underground resources and solid waste.	NA
(5)	Promote Hawai‘i's geographic, environmental, social, and technological advantages to attract new economic activities into the State.	NA
(6)	Provide public incentives and encourage private initiative to attract new industries that best support Hawai‘i's social, economic, physical, and environmental objectives.	C
(7)	Increase research and the development of ocean-related economic activities such as mining, food production, and scientific research.	NA
(8)	Develop, promote, and support research and educational and training programs that will enhance Hawai‘i's ability to attract and develop economic activities of benefit to Hawai‘i.	NA
(9)	Foster a broader public recognition and understanding of the potential benefits of new, growth-oriented industry in Hawai‘i.	C
(10)	Encourage the development and implementation of joint federal and state initiatives to attract federal programs and projects that will support Hawai‘i's social, economic, physical, and environmental objectives.	NA
(11)	Increase research and development of businesses and services in the telecommunications and information industries.	NA

Table 5-1. Hawaii State Plan–HRS Chapter 226, Part I

SECTION	CHAPTER 226 - PART I. OVERALL THEME, GOALS, OBJECTIVES AND POLICIES	RATING
A = ACTIVELY SUPPORTS C= CONFORMS F = FAILS TO MEET PLAN GOAL NA = GOAL IS NOT APPLICABLE		
CONFORMANCE DETERMINATION: The project improves access to a major industrial area and reduces congestion that could affect Hawai'i's competitive position in economic growth activities.		
226-11	OBJECTIVES AND POLICIES FOR THE PHYSICAL ENVIRONMENT – LANDBASED, SHORELINE, AND MARINE RESOURCES.	
(a)	Planning for the State's physical environment with regard to land-based, shoreline, and marine resources shall be directed towards achievement of the following objectives:	
(1)	Prudent use of Hawai'i's land-based, shoreline, and marine resources.	C
(2)	Effective protection of Hawai'i's unique and fragile environmental resources.	C
(b)	To achieve the land-based, shoreline, and marine resources objectives, it shall be the policy of this State to:	
(1)	Exercise an overall conservation ethic in the use of Hawai'i's natural resources.	C
(2)	Ensure compatibility between land-based and water-based activities and natural resources and ecological systems.	C
(3)	Take into account the physical attributes of areas when planning and designing activities and facilities.	C
(4)	Manage natural resources and environs to encourage their beneficial and multiple use without generating costly or irreparable environmental damage.	C
(5)	Consider multiple uses in watershed areas, provided such uses do not detrimentally affect water quality and recharge functions.	NA
(6)	Encourage the protection of rare or endangered plant and animal species and habitats native to Hawai'i.	C
(7)	Provide public incentives that encourage private actions to protect significant natural resources from degradation or unnecessary depletion.	C
(8)	Pursue compatible relationships among activities, facilities, and natural resources.	C
(9)	Promote increased accessibility and prudent use of inland and shoreline areas for public recreational, educational, and scientific purposes.	A
CONFORMANCE DETERMINATION: The project would be built following best management practices for environmental impact management.		
226-13	OBJECTIVES AND POLICIES FOR THE PHYSICAL ENVIRONMENT – LAND, AIR, AND WATER QUALITY.	
(a)	Planning for the State's physical environment with regard to land, air, and water quality shall be directed towards achievement of the following objectives:	
(1)	Maintenance and pursuit of improved quality in Hawai'i's land, air, and water resources.	A
(2)	Greater public awareness and appreciation of Hawai'i's environmental resources.	C
(b)	To achieve the land, air, and water quality objectives, it shall be the policy of this State to:	

Table 5-1. Hawaii State Plan–HRS Chapter 226, Part I

SECTION	CHAPTER 226 - PART I. OVERALL THEME, GOALS, OBJECTIVES AND POLICIES	RATING
A = ACTIVELY SUPPORTS C= CONFORMS F = FAILS TO MEET PLAN GOAL NA = GOAL IS NOT APPLICABLE		
(1)	Foster educational activities that promote a better understanding of Hawai'i's limited environmental resources.	NA
(2)	Promote the proper management of Hawai'i's land and water resources.	C
(3)	Promote effective measures to achieve desired quality in Hawai'i's surface, ground, and coastal waters.	C
(4)	Encourage actions to maintain or improve aural and air quality levels to enhance the health and well-being of Hawai'i's people.	A
(5)	Reduce the threat to life and property from erosion, flooding, tsunamis, hurricanes, earthquakes, volcanic eruptions, and other natural or man-induced hazards and disasters.	C
(6)	Encourage design and construction practices that enhance the physical qualities of Hawai'i's communities.	C
(7)	Encourage urban developments in close proximity to existing services and facilities.	C
(8)	Foster recognition of the importance and value of the land, air, and water resources to Hawai'i's people, their cultures and visitors.	NA
CONFORMANCE DETERMINATION: The proposed action alternatives would be built following best management practices to minimize impacts on the environment. By reducing traffic congestion, they would reduce undesirable emissions.		
226-14	OBJECTIVE AND POLICIES FOR FACILITY SYSTEMS – IN GENERAL.	
(a)	Planning for the State's facility systems in general shall be directed towards achievement of the objective of water, transportation, waste disposal, and energy and telecommunication systems that support statewide social, economic, and physical objectives.	A
(b)	To achieve the general facility systems objective, it shall be the policy of this State to:	
(1)	Accommodate the needs of Hawai'i's people through coordination of facility systems and capital improvement priorities in consonance with state and county plans.	A
(2)	Encourage flexibility in the design and development of facility systems to promote prudent use of resources and accommodate changing public demands and priorities.	C
(3)	Ensure that required facility systems can be supported within resource capacities and at reasonable cost to the user.	C
(4)	Pursue alternative methods of financing programs and projects and cost-saving techniques in the planning, construction, and maintenance of facility systems.	NA
CONFORMANCE DETERMINATION: The project completes long-planned improvements to O'ahu's road system and supports the vitality of both industrial areas and residential communities nearby.		
226-17	OBJECTIVES AND POLICIES FOR FACILITY SYSTEMS – TRANSPORTATION.	

Table 5-1. Hawaii State Plan–HRS Chapter 226, Part I

SECTION	CHAPTER 226 - PART I. OVERALL THEME, GOALS, OBJECTIVES AND POLICIES	RATING
A = ACTIVELY SUPPORTS C= CONFORMS F = FAILS TO MEET PLAN GOAL NA = GOAL IS NOT APPLICABLE		
(a)	Planning for the State's facility systems with regard to transportation shall be directed towards the achievement of the following objectives:	
(1)	An integrated multi-modal transportation system that services statewide needs and promotes the efficient, economical, safe, and convenient movement of people and goods.	A
(2)	A statewide transportation system that is consistent with and will accommodate planned growth objectives throughout the State.	A
(b)	To achieve the transportation objectives, it shall be the policy of this State to:	
(1)	Design, program, and develop a multi-modal system in conformance with desired growth and physical development as stated in this chapter;	A
(2)	Coordinate state, county, federal, and private transportation activities and programs toward the achievement of statewide objectives;	A
(3)	Encourage a reasonable distribution of financial responsibilities for transportation among participating governmental and private parties;	A
(4)	Provide for improved accessibility to shipping, docking, and storage facilities;	A
(5)	Promote a reasonable level and variety of mass transportation services that adequately meet statewide and community needs;	A
(6)	Encourage transportation systems that serve to accommodate present and future development needs of communities;	A
(7)	Encourage a variety of carriers to offer increased opportunities and advantages to inter-island movement of people and goods;	NA
(8)	Increase the capacities of airport and harbor systems and support facilities to effectively accommodate transshipment and storage needs;	NA
(9)	Encourage the development of transportation systems and programs which would assist statewide economic growth and diversification;	A
(10)	Encourage the design and development of transportation systems sensitive to the needs of affected communities and the quality of Hawai'i's natural environment;	C
(11)	Encourage safe and convenient use of low-cost, energy-efficient, non-polluting means of transportation;	C
(12)	Coordinate intergovernmental land use and transportation planning activities to ensure the timely delivery of supporting transportation infrastructure in order to accommodate planned growth objectives; and	A
(13)	Encourage diversification of transportation modes and infrastructure to promote alternate fuels and energy efficiency.	NA
CONFORMANCE DETERMINATION: The proposed action alternatives are part of a long-planned process that support both economic growth and the movement of Hawai'i's people.		

Table 5-1. Hawaii State Plan–HRS Chapter 226, Part I

SECTION	CHAPTER 226 - PART I. OVERALL THEME, GOALS, OBJECTIVES AND POLICIES	RATING
A = ACTIVELY SUPPORTS C= CONFORMS F = FAILS TO MEET PLAN GOAL NA = GOAL IS NOT APPLICABLE		
226-26	SECTION 226-26 OBJECTIVES AND POLICIES FOR SOCIO – CULTURAL ADVANCEMENT – PUBLIC SAFETY.	
(a)	Planning for the State's socio-cultural advancement with regard to public safety shall be directed towards the achievement of the following objectives:	
(1)	Assurance of public safety and adequate protection of life and property for all people.	C
(2)	Optimum organizational readiness and capability in all phases of emergency management to maintain the strength, resources, and social and economic well-being of the community in the event of civil disruptions, wars, natural disasters, and other major disturbances.	C
(3)	Promotion of a sense of community responsibility for the welfare and safety of Hawai'i's people.	NA
(b)	To achieve the public safety objectives, it shall be the policy of this State to:	
(1)	Ensure that public safety programs are effective and responsive to community needs.	NA
(2)	Encourage increased community awareness and participation in public safety programs.	NA
(c)	To further achieve public safety objectives related to criminal justice, it shall be the policy of this State to:	
(1)	Support criminal justice programs aimed at preventing and curtailing criminal activities.	NA
(2)	Develop a coordinated, systematic approach to criminal justice administration among all criminal justice agencies.	NA
(3)	Provide a range of correctional resources which may include facilities and alternatives to traditional incarceration in order to address the varied security needs of the community and successfully reintegrate offenders into the community.	NA
(d)	To further achieve public safety objectives related to emergency management, it shall be the policy of this State to:	
(1)	Ensure that responsible organizations are in a proper state of readiness to respond to major war-related, natural, or technological disasters and civil disturbances at all times.	NA
(2)	Enhance the coordination between emergency management programs throughout the State.	NA
CONFORMANCE DETERMINATION: The proposed action alternatives increase the reliability of the roadway network in a sector important for emergency management.		

5.4.3 HAWAI'I 2050 SUSTAINABILITY PLAN

The Hawai'i State Legislature in 2005 sought answers to the long-term future of our state and the pressing issues facing our people. Under the Special Session Laws of Hawai'i 2005, the Legislature enacted Act 8, which provides for (1) the development of a sustainability plan to

address the vital needs of Hawai‘i through the year 2050, and (2) the establishment of the Hawai‘i Sustainability Task Force under the guidance of the Office of the State Auditor.[2]

Concerns over the “steady deterioration of public infrastructure, lack of affordable housing, continued reliance on a service-based economy, vulnerability of Hawai‘i in a volatile global energy market, possible interruptions in travel and critical food supplies, threats to our fragile island ecosystems, and ever increasing numbers of residents and visitors” were vital issues that needed to be addressed. Questions were raised about the direction, the long-term limits of growth, and the need to plan and act to assure a preferred future for the people of Hawai‘i. Moreover, the task force addressed a most basic question: What is the state’s carrying capacity?

The 2050 Plan recognized that tourism, defense, construction, and agriculture have been the foundation of our economy and are likely to continue to be economic drivers in the future. Tourism alone generates an estimated 20 percent of all economic activity and a quarter of the state’s tax revenue. While most residents support keeping the level of tourism and military activity the same, they also want a more diverse, sustainable, and resilient economy to expand our economic base beyond current industries.

The 2050 Plan recognized that diversified agriculture, knowledge- and innovation-based industries would offer quality employment and greater diversity to our economy, but that the replacement of one sector of the economy with another in the same way that the visitor industry supplanted agriculture would not be a solution. The creation of greater resiliency in the economy would mean buying locally produced goods and services. However, as an island state to become totally economically self-sufficient would not be a possibility. There are many products that residents could purchase locally to reduce dependence on outside sources.

The 2050 Plan called for a quality transportation system that links people to places and provides opportunities for social interaction, recreation, and community engagement. A system that enables the flow of commerce would ensure that businesses could transport their goods and services to their destination in a timely and cost-effective way.

Conformance with the Plan. The proposed action alternatives directly contribute to improving transportation infrastructure, helping move people and goods in a timely and cost-effective way.

5.5 STATE ENVIRONMENTAL POLICY

The State Environmental Policy under HRS Chapter 344, established a policy that: (1) encourages productive and enjoyable harmony between people and their environment; (2) promotes efforts that would prevent or eliminate damage to the environment and biosphere; (3) stimulates the health and welfare of humanity; and (4) enriches the

[2] The entire Hawai‘i 2050 Sustainability Plan can be found at http://www.hawaii2050.org/.

understanding of the ecological systems and natural resources important to the people of Hawai‘i.

HRS 344-3(2)(C) states that it shall be the policy of the State, through its programs, authorities, and resources to establish communities which provide a sense of identity, wise use of land, efficient transportation, and aesthetic and social satisfaction in harmony with the natural environment which is uniquely Hawaiian.

The Salt Lake Boulevard Widening—Phase 3 project is designed to meet the needs of the community. It would reduce traffic congestion to provide a safe and efficient transportation system not only for vehicles but bicyclists and pedestrians. Input from area residents have also been considered in the provision of aesthetic features for the right-of-way.

5.6 HAWAI‘I COASTAL ZONE MANAGEMENT PROGRAM

The Hawai‘i Coastal Zone Management (CZM) Program was established in 1977 as a result of the federal CZM Act of 1972 and consequent CZM Program. The objectives and policies of the Hawai‘i CZM Program, which are intended to manage, develop, and protect resources of the coastal zone, are set forth in HRS Chapter 205A. The CZM area is defined as all lands of the State and all waters extending to the limits of the State’s police power. The State DBEDT, Office of Planning is the lead agency responsible for conducting a continuing review of actions by State and County agencies for compliance with HRS 205A. The project’s relevance to key objectives and policies of the CZM program are summarized in Table 5-2.

Table 5-2. Coastal Zone management–HRS Chapter 205A

SECTION	CHAPTER 205A - 2 Objectives and Policies	PROJECT RELEVANCE
RELEVANCE CRITERIA: A = Actively Supports F = Fails to Meet Program Objective/Policy C = Conforms NA = Objective/Policy is Not Applicable		
(1)	Recreational Resources	
	Provide coastal recreational opportunities accessible to the public.	NA
	Improve coordination and funding of coastal recreational planning and management.	NA
	Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area.	NA
(2)	**Historic Resources**	
	Protect, preserve, and, where desirable, restore those natural and manmade historic and prehistoric resources in the coastal zone management area that are significant in Hawaiian and American history and culture.	C
	Identify and analyze significant archaeological resources.	A

Table 5-2. Coastal Zone management–HRS Chapter 205A

SECTION	CHAPTER 205A - 2 Objectives and Policies	PROJECT RELEVANCE
RELEVANCE CRITERIA:	A = Actively Supports F = Fails to Meet Program Objective/Policy C = Conforms NA = Objective/Policy is Not Applicable	
	Maximize information retention through preservation of remains and artifacts or salvage operations.	C
	Support state goals for protection, restoration, interpretation, and display of historic resources.	C
(3)	**Scenic and Open Space Resources**	
	Protect, preserve, and, where desirable, restore or improve the quality of coastal scenic and open space resources.	C
	Identify valued scenic resources in the coastal zone management area.	NA
	Ensure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline.	A
	Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources.	C
	Encourage those developments that are not coastal dependent to locate in inland areas.	NA
(4)	**Coastal Ecosystems**	
	Protect valuable coastal ecosystems, including reefs, from disruption and minimize adverse impacts on all coastal ecosystems.	A
	Exercise an overall conservation ethic, and practice stewardship in the protection, use, and development of marine and coastal resources.	C
	Improve the technical basis for natural resource management.	NA
	Preserve valuable coastal ecosystems, including reefs, of significant biological or economic importance.	C
	Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs.	NA
	Promote water quantity and quality planning and management practices that reflect the tolerance of fresh water and marine ecosystems and maintain and enhance water quality through the development and implementation of point and nonpoint source water pollution control measures.	NA
(5)	**Economic Uses**	
	Provide public or private facilities and improvements important to the State's economy in suitable locations.	A
	Concentrate coastal dependent development in appropriate areas.	C

Table 5-2. Coastal Zone management–HRS Chapter 205A

SECTION	CHAPTER 205A - 2 Objectives and Policies	PROJECT RELEVANCE
RELEVANCE CRITERIA:	A = Actively Supports F = Fails to Meet Program Objective/Policy C = Conforms NA = Objective/Policy is Not Applicable	
	Ensure that coastal dependent development such as harbors and ports, and coastal related development such as visitor industry facilities and energy generating facilities, are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area.	C
	Direct the location and expansion of coastal dependent developments to areas presently designated and used for such developments and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when: (i) Use of presently designated locations is not feasible; (ii) Adverse environmental effects are minimized; and (iii) The development is important to the State's economy.	C
(6)	**Coastal Hazards**	
	Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution.	A
	Develop and communicate adequate information about storm wave, tsunami, flood, erosion, subsidence, and point and nonpoint source pollution hazards.	NA
	Control development in areas subject to storm wave, tsunami, flood, erosion, hurricane, wind, subsidence, and point and nonpoint source pollution hazards.	C
	Ensure that developments comply with requirements of the Federal Flood Insurance Program.	C
	Prevent coastal flooding from inland projects.	A
(7)	**Managing Development**	
	Improve the development review process, communication, and public participation in the management of coastal resources and hazards.	NA
	Use, implement, and enforce existing laws effectively to the maximum extent possible in managing present and future coastal zone development.	NA
	Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements.	NA
	Communicate the potential short and long-term impacts of proposed significant coastal developments early in their life cycle and in terms understandable to the public to facilitate public participation in the planning and review process.	C
(8)	**Public Participation**	
	Stimulate public awareness, education, and participation in coastal management.	C

Table 5-2. Coastal Zone management–HRS Chapter 205A

SECTION	CHAPTER 205A - 2 Objectives and Policies	PROJECT RELEVANCE
RELEVANCE CRITERIA:	A = Actively Supports F = Fails to Meet Program Objective/Policy C = Conforms NA = Objective/Policy is Not Applicable	
	Promote public involvement in coastal zone management processes.	C
	Disseminate information on coastal management issues by means of educational materials, published reports, staff contact, and public workshops for persons and organizations concerned with coastal issues, developments, and government activities.	C
	Organize workshops, policy dialogues, and site-specific mediations to respond to coastal issues and conflicts.	NA
(9)	**Beach Protection**	
	Protect beaches for public use and recreation.	NA
	Locate new structures inland from the shoreline setback to conserve open space, minimize interference with natural shoreline processes, and minimize loss of improvements due to erosion.	C
	Prohibit construction of private erosion-protection structures seaward of the shoreline, except when they result in improved aesthetic and engineering solutions to erosion at the sites and do not interfere with existing recreational and waterline activities.	C
	Minimize the construction of public erosion-protection structures seaward of the shoreline.	C
	Prohibit private property owners from creating a public nuisance by inducing or cultivating the private property owner's vegetation in a beach transit corridor.	NA
	Prohibit private property owners from creating a public nuisance by allowing the private property owner's unmaintained vegetation to interfere or encroach upon a beach transit corridor.	NA
(10)	**Marine Resources**	
	Promote the protection, use, and development of marine and coastal resources to assure their sustainability.	NA
	Ensure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial.	C
	Coordinate the management of marine and coastal resources and activities to improve effectiveness and efficiency.	NA
	Assert and articulate the interests of the State as a partner with federal agencies in the sound management of ocean resources within the United States exclusive economic zone.	NA

Table 5-2. Coastal Zone management–HRS Chapter 205A

SECTION	CHAPTER 205A - 2 Objectives and Policies	PROJECT RELEVANCE
RELEVANCE CRITERIA: A = Actively Supports F = Fails to Meet Program Objective/Policy C = Conforms NA = Objective/Policy is Not Applicable		
	Promote research, study, and understanding of ocean processes, marine life, and other ocean resources in order to acquire and inventory information necessary to understand how ocean development activities relate to and impact upon ocean and coastal resources.	NA
	Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources.	NA
CONFORMANCE DETERMINATION: The proposed action alternatives conform with and support HRS Section 205A-2 as the road widening project would advance the economic uses' objectives and policies of the CZM program and would follow best management practices and other State environmental laws, rules, and regulations to protect O'ahu's coastal and marine environments. The proposed action alternatives would also conform extensively with the CZM's historic resources, scenic and open space, coastal hazards, and public participation policies. It is noted that many of those resources are not located in the project corridor.		

5.7 HAWAI'I CLIMATE CHANGE INITIATIVE: ACT 286 OF 2012

The State of Hawai'i recognizes the importance of climate change. Act 286 of 2012 amended the State Planning Law (HRS Chapter 226) to include climate change adaptation as one of seven areas of statewide concern crucial to the quality of life. Ten priority guidelines were adopted. These deal with outreach, stewardship, monitoring, and development of knowledge and strategies that integrate climate change adaptation into state activities.

Conformance with Act 286. Sea level rise is one aspect of climate change that is of concern to the State of Hawai'i. Salt Lake Boulevard runs inland of the Special Management Area, and may provide an alternative route to Nimitz Highway, which is nearer to the shoreline. In the event that coastal roadways are less reliably available than now, provisions of alternative inland routes is a strategy for accommodating climate change adaptation.

5.8 HAWAI'I STATE FUNCTIONAL PLANS

The Planning Act called for the creation of functional plans to set specific objectives, establish policies, and implement actions for various fields of activity. These functional plans further identified those organizations responsible for carrying out the actions, the implementing timeframe, and the proposed budgets. The specific areas covered by the functional plans include: (1) agriculture, (2) conservation lands, (3) education and higher education, (4) employment, (5) energy, (6) health, (7) historic preservation, (8) housing, (9) human services, (10) recreation, (11) tourism, (12) transportation, and (13) water resource development.

The State Transportation Functional Plan has been identified and is directly relevant to the proposed action alternatives. It is important to note that while this plan is considered to be the current "official" State functional plan for transportation, it was last updated in 1991. Hence, a deviation from the original goals of the plan may have occurred due to local, national, or world events or other unforeseeable factors.

5.8.1 STATE TRANSPORTATION FUNCTIONAL PLAN (1991)

5.8.1.1 Goals of the Plan

The 1991 State Transportation Functional Plan sought to: (1) construct facility and infrastructure improvements in support of Hawai'i's thriving economy and growing population base; (2) develop a transportation system balanced with an array of new alternatives; (3) implement Transportation Systems Management to maximize the use of existing facilities and systems; (4) foster innovation and use of new technology in transportation; (5) maximize joint efforts with the private sector; (6) pursue land use initiatives which help reduce travel demand; and (7) encourage resident quality-of-life improvements through improved mobility opportunities and travel reduction.

5.8.1.2 Conformance with the Plan

The proposed action alternatives fully support the State's Transportation Plan by contributing to a balanced transportation system and providing residents with quality-of-life improvements through improved mobility opportunities. The road widening improvements would include two additional travel lanes, new dedicated bike lanes, and wide sidewalks.

5.9 HAWAI'I STATE LAND USE LAW

The Hawai'i State Legislature determined in 1961 that a state-wide zoning system was needed to protect Hawai'i's valuable land from development that provided a short-term gain for a few and resulted in a long-term loss to the income and growth potential of the state's economy. Accordingly, the Legislature established an overall framework of land-use management and adopted the Land Use Law under Chapter 205, HRS. The law placed all lands in the state in one of four land-use districts: Urban, Agricultural, Conservation, or Rural (the Rural District was added in 1963), and established the Land Use Commission (LUC) under Section 205-1, HRS. The right-of-way for the Salt Lake Boulevard is located in the Urban district (see Figure 5-1).

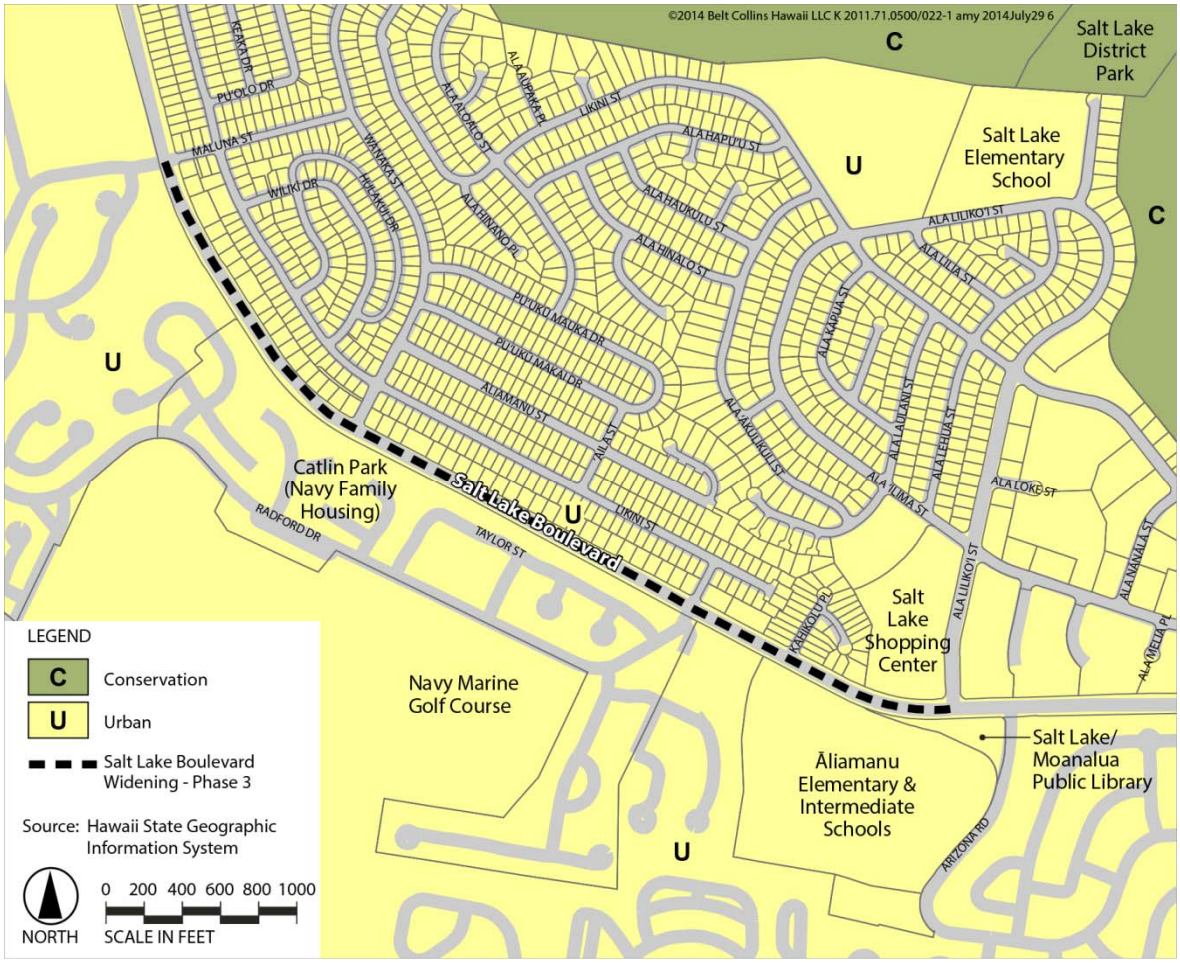


Figure 5-1. State Land Use District

Section 205-2 (b) of the Land Use Law states that "Urban districts shall include activities or uses as provided by ordinances or regulations of the county within which the urban district is situated."

Conformance with State Land Use Law. The current and planned use of the project area as a public roadway, and the use of nearby parcels (zoned as federal (F-1), residential (R-5), apartment (A-1) and commercial (B-1) are in line with the regulations of the City and County of Honolulu (Revised Ordinances of Honolulu, Chapter 21). These activities are appropriate within the urban district.

5.10 HAWAIʻI REVISED STATUTES, CHAPTER 6E, HISTORIC PRESERVATION

HRS Chapter 6E-8 states that "[b]efore any agency or officer of the state or its political subdivisions commences any project which may affect historic property, aviation artifact, or a burial site, the agency or officer shall advise the department [DLNR, SHPD] and allow the department an opportunity for review of the effect of the proposed project on historic properties, aviation artifacts, or burial sites… especially those listed on the Hawaiʻi register of historic places. The proposed project shall not be commenced, or in the event it has already begun, continued, until the department shall have given its written concurrence."

Conformance with the Law. An archaeological literature and field inspection of the Salt Lake Boulevard Widening - Phase 3 corridor was conducted. Its findings are presented in this document and included in a review by the Hawaiʻi SHPD as part of the HRS Chapter 343 agency and public review process.

5.11 STATE "COMPLETE STREETS" POLICY

The Statewide Complete Streets Policy (Act 54) was enacted in 2009 and requires the State Department of Transportation and four county transportation departments to adopt a Complete Streets policy of their own. For compliance, the City and County of Honolulu established its Complete Streets policy in May 2012.

Complete Streets is a comprehensive design approach to planning, design, and construction of transportation systems that accommodate all users of the road regardless of their age, ability, or preferred mode of transportation. Complete Streets features include sidewalks, crosswalks, traffic signals, bicycle lanes, street furniture, landscaping, and bicycle parking, among others. There are many community benefits to Complete Streets including improved quality of life, economic development, social equity, public health and safety, and ecological sustainability. The Salt Lake Boulevard Widening–Phase 3 has considered and includes provisions of the Complete Streets policy.

5.12 CITY AND COUNTY OF HONOLULU

State law and county charter require each county to prepare and adopt a long-range general plan to guide the overall future development of the county. HRS Chapter 46 grants the counties certain powers and responsibilities. Among them is the power to regulate land development through zoning, which must be based on a general plan.

5.12.1 GENERAL PLAN FOR O‘AHU

The *General Plan* (amended 2002) for O‘ahu has 11 topical sections:

1 - Population
2 - Economic Activity
3 - Natural Environment
4 - Housing
5 - Transportation and Utilities
6 - Energy
7 - Physical Development and Urban Design
8 - Public Safety
9 - Health and Education
10 - Culture and Recreation
11 - Government Operations and Fiscal Management

Relevant objectives of Section 2 - Economic Activity, and Section 5 - Transportation and Utilities are discussed in the following table. The City and County of Honolulu General Plan can be found at http://honoluludpp.org/planning/GeneralPlan/.

Table 5-3. Honolulu General Plan

HONOLULU GENERAL PLAN	Rating
A = ACTIVELY SUPPORTS C= CONFORMS F = FAILS TO MEET PLAN GOAL NA = GOAL IS NOT APPLICABLE	
ECONOMIC ACTIVITY	
OBJECTIVE A To promote employment opportunities that will enable all the people of O‘ahu to attain a decent standard of living.	
Policy 1: Encourage the growth and diversification of O‘ahu's economic base.	A
Policy 2: Encourage the development of small businesses and larger industries which will contribute to the economic and social well-being of O‘ahu residents.	C
Policy 3: Encourage the development in appropriate locations on O‘ahu of trade, communications, and other industries of a nonpolluting nature.	C
Policy 4: Encourage the development of local, national, and world markets for the products of O‘ahu-based industries.	NA
Policy 5: Encourage the wider distribution of available employment opportunities through such methods as shortening the work week and reducing the use of overtime.	NA
Policy 6: Encourage the continuation of a significant level of Federal employment on O‘ahu.	NA

Table 5-3. Honolulu General Plan

HONOLULU GENERAL PLAN	Rating
A = ACTIVELY SUPPORTS C= CONFORMS F = FAILS TO MEET PLAN GOAL NA = GOAL IS NOT APPLICABLE	
OBJECTIVE B To maintain the viability of O‘ahu's visitor industry.	NA
OBJECTIVE C To maintain the viability of agriculture on O‘ahu.	
Policy 1: Assist the agricultural industry to ensure the continuation of agriculture as an important source of income and employment.	C
Policy 2: Support agricultural diversification in all agricultural areas on O‘ahu.	C
Policy 3: Support the development of markets for local products, particularly those with the potential for economic growth.	A
Policy 4: Provide sufficient agricultural land in ‘Ewa, Central O‘ahu, and the North Shore to encourage the continuation of sugar and pineapple as viable industries.	NA
Policy 5: Maintain agricultural land along the Windward, North Shore, and Wai‘anae coasts for truck fanning, flower growing, aquaculture, livestock production, and other types of diversified agriculture.	NA
Policy 6: Encourage the more intensive use of productive agricultural land.	NA
Policy 7: Encourage the use of more efficient production practices by agriculture, including the efficient use of water.	NA
Policy 8: Encourage the more efficient use of non- potable water for agricultural use.	NA
OBJECTIVE D To make full use of the economic resources of the sea.	NA
OBJECTIVE E To prevent the occurrence of large scale unemployment.	NA
OBJECTIVE F To increase the amount of Federal spending on O‘ahu.	
Policy 1: Take full advantage of Federal programs and grants which will contribute to the economic and social well-being of O‘ahu's residents.	A
Policy 2: Encourage the Federal government to pay for the cost of public services used by Federal agencies.	C
Policy 3: Encourage the Federal government to lease new facilities rather than construct them on tax-exempt public land.	C
Policy 4: Encourage the military to purchase locally all needed services and supplies which are available on O‘ahu.	C

Table 5-3. Honolulu General Plan

HONOLULU GENERAL PLAN	Rating
A = ACTIVELY SUPPORTS C= CONFORMS F = FAILS TO MEET PLAN GOAL NA = GOAL IS NOT APPLICABLE	
OBJECTIVE G To bring about orderly economic growth on O‘ahu.	
Policy 1: Direct major economic activity and government services to the primary urban center and the secondary urban center at Kapolei.	C
Policy 2: Permit the moderate growth of business centers in the urban-fringe areas.	NA
Policy 3: Maintain sufficient land in appropriately located commercial and industrial areas to help ensure a favorable business climate on O‘ahu.	NA
Policy 4: Encourage the continuation of a high level of military-related employment in the Hickam-Pearl Harbor, Wahiawā, Kailua-Kanē‘ohe, and ‘Ewa areas.	C
TRANSPORTATION AND UTILITIES	
OBJECTIVE A To create a transportation system which will enable people and goods to move safely, efficiently, and at a reasonable cost; serve all people, including the poor, the elderly, and the physically handicapped; and offer a variety of attractive and convenient modes of travel.	
Policy 1: Develop and maintain an integrated ground-transportation system consisting of the following elements and their primary purposes:	
a. Public transportation-for travel to and from work, and travel within Central Honolulu;	NA
b. Roads and highways-for commercial traffic and travel in nonurban areas;	NA
c. Bikeways-for recreational activities and trips to work, schools, shopping centers, and community facilities; and	A
d. Pedestrian walkways-for getting around Downtown and Waikīkī, and for trips to schools, parks, and shopping centers.	A
Policy 2: Provide transportation services to people living within the ‘Ewa, Central O‘ahu, and Pearl City-Hawai‘i Kai corridors primarily through a mass transit system including exclusive right-of-way rapid transit and feeder-bus components as well as through the existing highway system with limited improvements as may be appropriate.	A
Policy 3: Provide transportation services outside the ‘Ewa, Central O‘ahu, and Pearl City-Hawai‘i Kai corridors primarily through a system of express- and feeder-buses as well as through the highway system with limited to moderate improvements sufficient to meet the needs of the communities being served.	NA
Policy 4: Improve transportation facilities and services in the ‘Ewa corridor and in the trans-Ko‘olau corridors to meet the needs of ‘Ewa and Windward communities.	NA
Policy 5: Improve roads in existing communities to reduce congestion and eliminate unsafe conditions.	A
Policy 6: Consider both environmental impact as well as construction and operating costs as important factors in planning alternative nodes of transportation.	C

Table 5-3. Honolulu General Plan

HONOLULU GENERAL PLAN	Rating
A = ACTIVELY SUPPORTS C= CONFORMS F = FAILS TO MEET PLAN GOAL NA = GOAL IS NOT APPLICABLE	
Policy 7: Promote the use of public transportation as a means of moving people quickly and efficiently, of conserving energy, and of guiding urban development.	C
Policy 8: Make available transportation services to people with limited mobility: the young, the elderly, the handicapped, and the poor.	C
Policy 9: Promote programs to reduce dependence on the use of automobiles.	NA
Policy 10: Discourage the inefficient use of the private automobile, especially in congested corridors and during peak-hours.	A
Policy 11: Make public, and encourage private, improvements to major walkway systems.	A
Policy 12: Encourage the provision of separate aviation facilities for small civilian aircraft.	NA
Policy 13: Facilitate the development of a second deep-water harbor to relieve congestion in Honolulu Harbor.	NA
OBJECTIVE B To meet the needs of the people of O‘ahu for an adequate supply of water and for environmentally sound systems of waste disposal.	NA
OBJECTIVE C To maintain a high level of service for all utilities.	
Policy 1: Maintain existing utility systems in order to avoid major breakdowns.	C
Policy 2: Provide improvements to utilities in existing neighborhoods to reduce substandard conditions.	NA
Policy 3: Plan for the timely and orderly expansion of utility systems.	NA
Policy 4: Increase the efficiency of public utilities by encouraging a mixture of uses with peak periods of demand occurring at different times of the day.	NA
OBJECTIVE D To maintain transportation and utility systems which will help O‘ahu continue to be a desirable place to live and visit.	
Policy 1: Give primary emphasis in the capital-improvement program to the maintenance and improvement of existing roads and utilities.	C
Policy 2: Use the transportation and utility systems as a means of guiding growth and the pattern of land use on O‘ahu.	C
Policy 3: Encourage the study and use of telecommunications as an alternative to conventional transportation facilities.	NA
Policy 4: Evaluate the social, economic, and environmental impact of additions to the transportation and utility systems before they are constructed.	C
Policy 5: Require the installation of underground utility lines wherever feasible.	C

Table 5-3. Honolulu General Plan

HONOLULU GENERAL PLAN	Rating
A = ACTIVELY SUPPORTS C= CONFORMS F = FAILS TO MEET PLAN GOAL NA = GOAL IS NOT APPLICABLE	
Policy 6: Seek improved taxing powers for the City and County in order to provide a more equitable means of financing transportation and utility services.	NA

The City Department of Planning and Permitting has begun a "focused update" process for the General Plan. The update would deal with objectives and policies related to O'ahu's overall growth, the economy, affordable housing, and sustainability. No specific changes in policy have been proposed.

5.12.2 PRIMARY URBAN CENTER DEVELOPMENT PLAN

The Primary Urban Center Development Plan (2004) is one of eight regional plans based on the O'ahu General Plan and establishes more detailed policies to shape growth in the urban core of the island. The Plan has a vision with five major themes for the Primary Urban Center (PUC):

- Honolulu's natural, cultural, and scenic resources are protected and enhanced;
- Livable neighborhoods have business districts, parks and plazas, and walkable streets;
- The PUC offers in-town housing choices for people of all ages and incomes;
- Honolulu is the Pacific's leading city and travel destination; and
- A balanced transportation system provides mobility.

Conformance with the Plan. Implementation of the proposed action alternatives in conformance with environmental laws and policies, as discussed above, responds to the first theme of the plan (see Figure 5-2). The proposed action alternatives respond to the last theme not only by improving vehicle mobility on a major route serving urban residents, but also by providing sidewalks and bike lanes for pedestrian and bicycle travel.

5.12.3 LAND USE ORDINANCE

The City's Land Use Ordinance (Revised Ordinances of Honolulu (ROH) Chapter 21) regulates land uses and structures throughout the urban areas of O'ahu. The proposed action alternatives are located within the existing Salt Lake Boulevard right-of-way, except Alternative C which would require some use of Navy land adjacent to the right-of-way boundary.

The LUO does not include land use regulations for existing right-of-ways. Approval of improvements within the City's rights-of-way are with the Department of Design and

Construction. Approval for use of the Navy land adjacent to the Salt Lake Boulevard–Phase 3 is with the U.S. Navy.

The use of retaining walls in Alternatives A, B, and C would be subject to zoning height restrictions. The requirements of the zoning (see Figure 5-3) may be waived by the Planning Director for public uses (ROH 212-2.130). This would be advantageous should the retaining walls require heights higher than allowed under the zoning ordinance for areas with steep grade differences. In the final design, the retaining wall heights would be dependent on the heights of the steep high-cut areas and required fill for the downslope side of the roadway, balanced by the need to maintain a visually pleasing corridor and to provide protection against uncontrolled vehicles from leaving the right-of-way.

5.12.4 SPECIAL MANAGEMENT AREA

Although the Special Management Areas (SMAs) originated under the federal CZM and Hawai‘i CZM Programs, the counties in Hawai‘i regulate and administer the SMAs in their respective jurisdictions. For the coastal area of O‘ahu south of the project site, the SMA extends from the shoreline around Keehi Lagoon to several hundred feet inland no further than the H-1 Freeway-Nimitz Highway at the Middle Street interchange. Phase 3 of the Salt Lake Boulevard widening project is located more than one mile from the inland boundary of the SMA and hence is not subject to the City’s SMA Rules and Regulations.

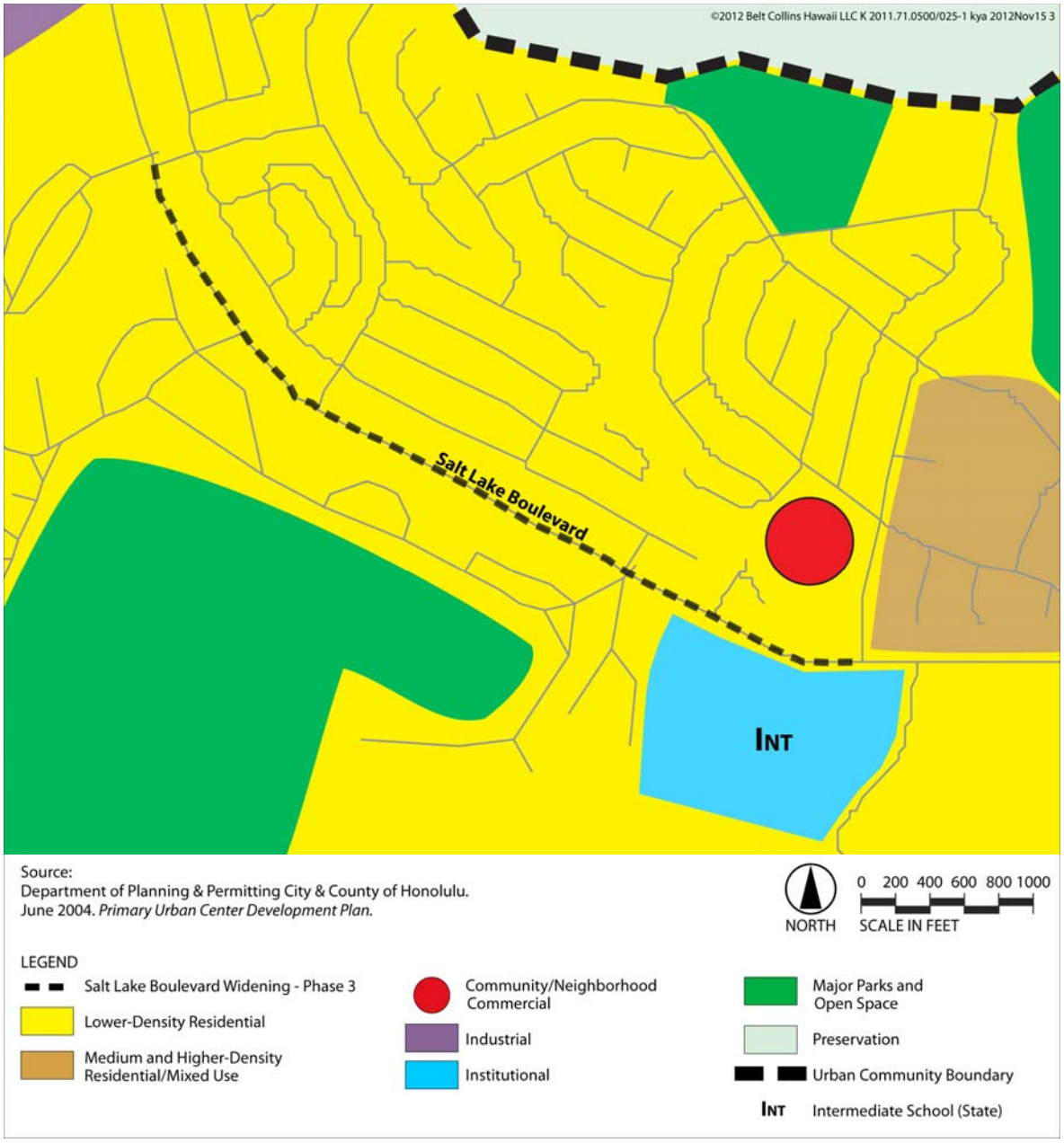


Figure 5-2. Primary Urban Center Development Plan Map Excerpt

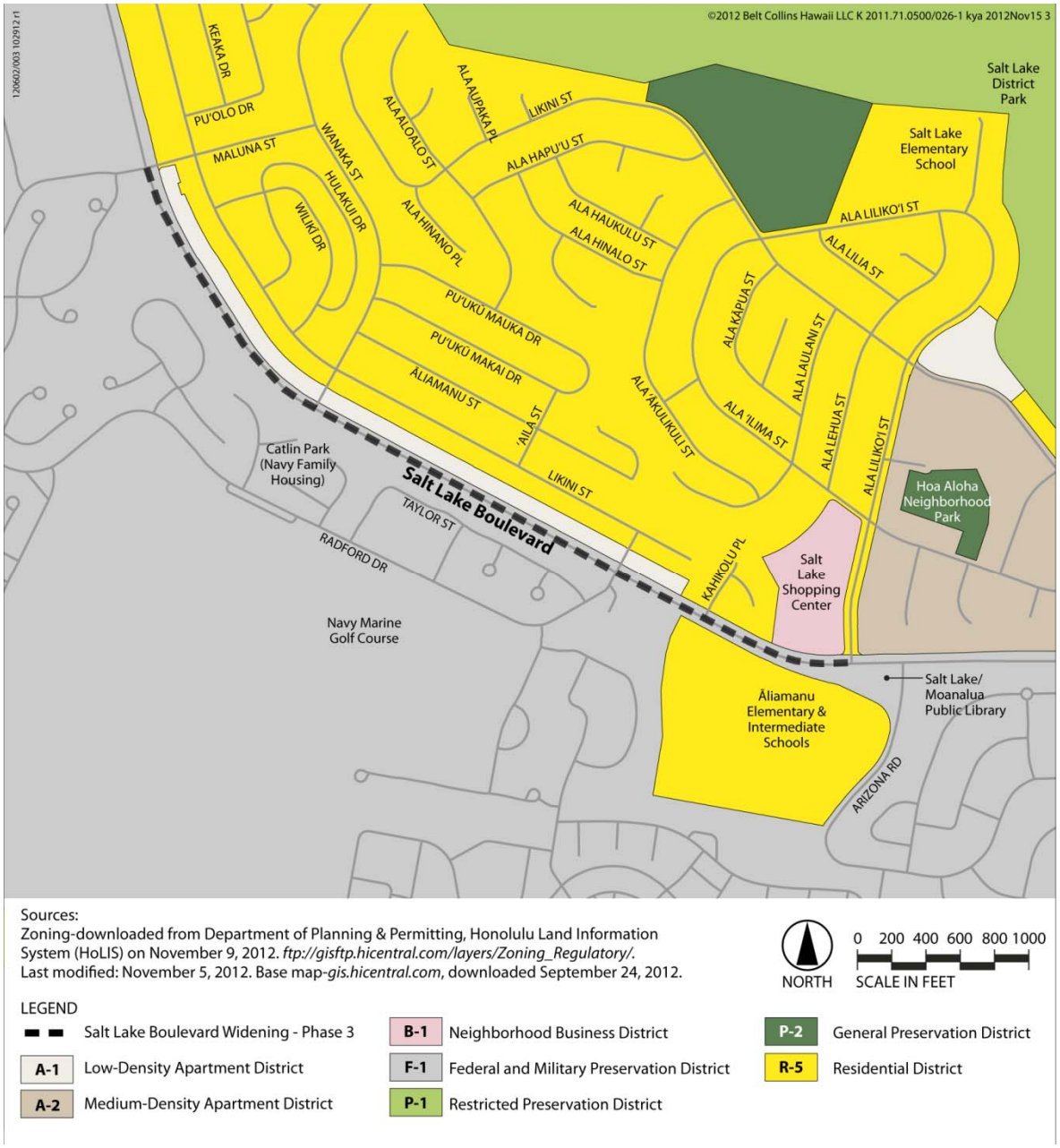


Figure 5-3. City Zoning

5.12.5 CITY "COMPLETE STREETS" POLICY

Ordinance 12-15, approved by the Mayor in 2012, establishes a "complete streets" policy to encourage the development of transportation facilities that provide safe mobility for all users. Every transportation facility or project, whether new construction, reconstruction, or maintenance, provides the opportunity to implement "complete streets" policies and principles.

Complete streets principles consist of the following objectives:

1) Improve safety;

2) Apply a context sensitive solution process that integrates community context and the surrounding environment, including land use;

3) Protect and promote accessibility and mobility for all;

4) Balance the needs and comfort of all modes and users;

5) Encourage consistent use of national industry best practice guidelines to select complete streets design elements;

6) Improve energy efficiency in travel and mitigate vehicle emissions by providing non-motorized transportation options;

7) Encourage opportunities for physical activities and recognize the health benefits of an active lifestyle;

8) Recognize complete streets as a long-term investment that can save money over time;

9) Build partnerships with stakeholders and organizations statewide; and

10) Incorporate trees and landscaping as integral components of complete streets.

Phase 3 of the Salt Lake Boulevard Widening Project would include accommodations, not only for motorists but, for pedestrians, bicyclists, and individuals dependent on mobility devices. TheBus currently provide public bus service in the residential community above Salt Lake Boulevard, but its transit lines do follow a route accessible by a large number of residents in the community. No improvements for public transit riders are being proposed for this project at this time. The details in the road design include features such as a raised median (for two proposed alternative actions), sidewalks, dedicated bike lanes and safety barrier along various sections of the Navy housing property line.

Conducting scoping meetings and public information meetings and in preparation of this EA, an evaluation of the project is made in terms of context sensitive solutions. Moreover, with the purpose and need statement for the project, there is identification of objectives that work towards achieving some of the principles of complete streets.

5.13 LIST OF REQUIRED ENVIRONMENTAL PERMITS AND CONSULTATIONS

Table 5-4 identifies consultations, approvals, and permits required for implementation of the proposed action alternatives. Additional permits and approvals may be required as a result of available details in construction or of the environment, e.g., consultation would be required with SHPD and the Oʻahu Burial Council should an inadvertent discovery of human remains occur during construction. Table 5-4 does not include construction permits that may be required from the City.

Table 5-4. List of Consultations, Approvals, and Permits for the Salt Lake Boulevard Widening—Phase 3 Project

	Permit, Approval or Consultation	Alternative A	Alternative B	Alternative C	Alternative D
Federal					
USFWS	Consultation in accordance with Section 7, Endangered Species Act	√	√	√	
U.S. Navy	Right of Entry for construction or long-term maintenance of City facilities on Navy land (or easement as an option)			√	
FHWA	Design exception is needed for Federal-aided projects to meet minimum vertical sight distance requirements and is reviewed by SDOT and approved by FHWA.	√	√	√	
State of Hawaiʻi					
DBEDT, Office of Planning	Coastal Zone Management Federal Consistency Review	√	√	√	
DOH	National Pollutant Discharge Elimination System permit for discharge of storm water associated with construction activities	√	√	√	

Table 5-4. List of Consultations, Approvals, and Permits for the Salt Lake Boulevard Widening—Phase 3 Project

	Permit, Approval or Consultation	Alternative A	Alternative B	Alternative C	Alternative D
SHPD	Consultation in accordance with Section 106, National Historic Preservation Act	√	√	√	
DOE	Right of Entry for construction on school site.	√	√	√	
City & County of Honolulu					
DPP	Zoning land use compliance.	√	√	√	
DDC	Construction plans for City right-of-way improvements.	√	√	√	

NOTES:
USFWS = U.S. Fish and Wildlife Service
FHWA = Federal Highway Administration
DBEDT = Department of Business, Economic Development and Tourism
DOH = Department of Health
SHPD = State Historic Preservation Division
DOE = Department of Education
DPP = Department of Planning and Permitting
DDC = Department of Design and Construction
SDOT = State Department of Transportation

Chapter 6

Cumulative Analysis

CHAPTER 6

Cumulative Analysis

6.1 INTRODUCTION

Cumulative impacts are those that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. They can result from individually minor but collectively significant actions taking place over a period of time. [1]

Considering the resources affected by the Salt Lake Boulevard Widening-Phase 3 project, other projects (or actions) that could incrementally impact the same resources were identified. Such projects/actions include past and present actions on the Salt Lake Boulevard right-of-way, and past, present, and future actions not related to the project but with potential for cumulative impacts. Some of these projects are physically outside of the roadway corridor but affect a similar resource or resources.

6.2 SALT LAKE BOULEVARD WIDENING–INCREMENTS 1 AND 2

The original Salt Lake Boulevard Widening Project began in the 1970s with the first increment covering the eastern section between Puʻuloa Road and Ala Lilikoʻi Street. Improvements included construction of a five-lane collector road (two lanes westbound, three lanes eastbound) with median, curbs and gutters, sidewalks, and bike lanes. Increment 2, Phases 1 and 2, comprising the western section was completed in 2005. It included widening of the existing two-lane road to 4 lanes and installation of sidewalks, bicycle lanes, and landscaped median. The present Phase 3 of Increment 2 of the road widening project would occur between the completed Increment 1 and Increment 2, Phases 1 and 2. Impacts from Increment 1 and the completed portion of Increment 2 are being considered in the design and development of Phase 3.

6.3 OTHER CITY PROJECTS IN PROJECT AREA

6.3.1 ĀLIAMANU WASTEWATER PUMP STATIONS

Prior to the initiation of the Salt Lake Boulevard Widening—Phase 3 alternative concepts, the Department of Design and Construction explored various solutions to resolving flood issues with the City's two wastewater pump stations (one in Increment 2, Phase 2 and the other in Phase 3) along the existing boulevard. During the investigations, the City determined that it may need to upgrade the entire sewer system in the area. Evaluation of the sewer system is currently in progress and any improvements to that system would be coordinated with the proposed road widening improvements in Phase 3.

6.3.2 CITY WASTEWATER SYSTEM UPGRADES

The City entered into a Consent Decree filed in federal court on December 17, 2010 to upgrade major components of its wastewater collection and treatment system. The Consent Decree requires that the City install a valve system at the Hart Street sewage pump station by

[1] Hawaiʻi Administrative Rules (HAR) §11-200.

December 31, 2014 to facilitate the transfer of pumped flows to the backup force main if necessary. The Consent Decree also requires that the City upgrade the Sand Island Wastewater Treatment Plant to comply with secondary treatment standards, as defined in 40 Code of Federal Regulations (CFR) 133, by December 31, 2035.

Construction of the required improvements would involve the use of available labor, equipment, materials, and supplies. Major projects occurring at the same time would be competing for available construction resources. If the timetable for these projects is different, then there would be less of a supply and scheduling problem.

6.3.3 HONOLULU RAIL TRANSIT PROJECT

Construction on the City and County of Honolulu's 20-mile rail transit project started in May 2012. The first section of the project commenced from East Kapolei and would continue towards downtown Honolulu and Ala Moana. During construction, the project would involve approximately 10,000 total jobs on average in the State economy. As many as 6,000 of these could be directly in construction when work peaks, thus potentially affecting the availability of construction labor and materials islandwide.[2]

In August 2012, the Hawai'i State Supreme Court ruled that the City must conduct a complete archaeological study for the 20-mile line before the new rail system can be built. As a result, the Honolulu Authority for Rapid Transit (HART), which is responsible for managing the rail system, announced that no new construction on the project, including "ground-altering activity," would be done until the archaeological survey work is completed. Other challenges surfaced regarding whether all alternatives to the selected route were properly considered.

In February 2014, in separate rulings from the U.S. 9th Circuit Court of Appeals and the U.S. District Court, the multi-billion dollar rail transit project was given virtual clearance to continue construction on the 20-mile transit system. With the unexpected interruption in the project schedule, the estimated completion date for the project now may be delayed from the original date of 2019.

6.4 OTHER INDEPENDENT PROJECTS IN PROJECT VICINITY WITH POTENTIAL IMPACTS

6.4.1 MAJOR RESIDENTIAL PROJECTS

Koa Ridge, a planned residential community of 3,500 homes in Waipi'o, O'ahu, and Ho'opili, a planned residential community of 11,700 homes in 'Ewa, O'ahu, were approved by the State

[2] The Final EIS schedule for the rail project showed employment as highest in 2013 to 2014. The schedule has changed due to suspension of construction until completion of cultural assessments and submittal of a supplemental federal EIS. However, work has resumed, so the high rail employment period is likely to be well before construction of Salt Lake Boulevard Phase 3.

Land Use Commission (SLUC) in 2012.[3] In July 2013, the City Planning Commission approved zoning changes between Waipiʻo and Mililani which may allow Koa Ridge to continue to move forward with development. Meanwhile, the City Council approved the City's updated ʻEwa Development Plan which includes planned land use designations for the Hoʻopili project. Zoning for the Hoʻopili project was approved by Council in May 2015.

In the Kakaʻako district of urban Honolulu, the Hawaiʻi Community Development Authority (HCDA) has been reviewing and approving a number of new high-rise residential condominium projects. These include the development of luxury, affordable, and retirement units supplemented with convenience and entertainment facilities to support all of the activities for in-town living. With such a growth anticipated, a rail transit system station would be located in the center of the district. Current estimates show a population in Kakaʻako at 10,000, but by 2030, the population would reach 30,000.[4] During this highly active period, high-rise construction would contribute to the overall demand for construction workers of all trades and experience. Although Kakaʻako is located more than five miles from Salt Lake Boulevard, its impact could be far reaching and affect the island's as well as the state's economy as a whole.

Nearer to Salt Lake Boulevard, the Live Work Play ʻAiea mixed use development, proposed for the Kamehameha Drive-In site, would include up to 1,500 homes, up to 143,000 square feet of commercial space, and approximately 80,000 square feet of office space. Zoning approval was obtained from the City in May 2014. Construction was to begin in the summer of 2014 with completion of the first phase (commercial facilities portion) scheduled in 2015.

It is reasonable to expect that these projects would be constructed in phases and in response to market demand. Nonetheless, the volume of new residential construction, and hence demand for construction labor and materials, is likely to be greater than at present.

6.4.2 MAJOR STATE PROJECTS

Honolulu International Airport Terminal Modernization. This State DOT project involves $750 million in improvements for Honolulu International Airport including a new commuter terminal, new cargo facility, consolidated rental car facility, a new concourse and runway and taxiway improvements. Construction kicked-off in mid-2013 and would be completed in 3 to 4 years.

Kapālama Container Terminal. The State DOT, Harbors Division, is proposing to develop a new container terminal in Honolulu Harbor at the former Kapalama Military Reservation to handle

[3] In December 2013, the State Supreme Court invalided the LUC's 2010 decision to approve the Koa Ridge project. (Shimogawa, Duane. December 26, 2013. "Supreme Court nullifies LUC ruling on Koa Ridge, but project is going forward." Pacific Business News. www.bizjournals.com/pacific/news/2013/12/26/supreme-court-nullifies-luc-ruling-on.html. Accessed February 2014.)

[4] Creamer, Beverly. September 2012. "Kakaako's Building Boom." Hawaii Business. www.hawaiibusiness.com/Hawaii-Business/September-2012/Kakaakos-Building-Boom/index.php?cparticle=2&siarticle=1#artanc.

anticipated increases in cargo volumes. While this project could affect traffic volumes along Sand Island Access Road and local routes near the harbor, it would have no impact on Salt Lake Boulevard traffic. Construction was scheduled to begin in 2014. Construction or renovation of facilities for relocated maritime tenants and construction of the new terminal could continue into 2016.

Moanalua High School Performing Arts Center. The first phase of this project, including the development of rehearsal space, was completed in the fall of 2013. The much larger second phase, i.e., construction of a new auditorium, would occur when funding is secured. No change in enrollment is anticipated in association with the new Performing Arts Center.

6.5 CUMULATIVE IMPACTS ON THE CONSTRUCTION INDUSTRY

Cumulative impacts of a sudden, large increase in construction activity could include difficulties in finding skilled labor and increases in prices for labor and materials. However, many of the smaller projects listed above could be finished before the 2018 to 2020 time-frame for the Salt Lake Boulevard widening project. The rail project resumed construction in 2014 and would continue for several years thereafter.

Few or no problems in finding labor and materials are expected, because: (1) new developments and demand for labor can be anticipated, (2) the timing of the project would probably occur at different times around the high point of employment on the rail project, and (3) the current underemployment conditions of construction workers in Hawaiʻi would provide a deep pool of workers. The Hawaiʻi construction and related workforce reached a high of 39,100 employees in 2007. As of March 2015, some 32,100 people were employed in construction, only 82 percent of the highest employment count.[5] With the rail transit project and other projects listed above, construction employment could reach the 2007 level at times in the next few years. In the meantime, the population, including young entrants to the workforce, has grown and over thirty apprenticeship programs for the construction trades are now recognized in Hawaiʻi.[6] Consequently, the cumulative impact of construction employment for the project on the construction labor force does not appear significant.

6.6 FURTHER ANALYSIS OF CUMULATIVE IMPACTS

Resource areas in which potential cumulative impacts may occur are discussed below. Some resources/issues are not presented in this section as they are inherently cumulative and evaluated in Chapters 3 and 4, or because they are not affected by or affect other projects.

---

[5] State of Hawaiʻi, Department of Labor and Industrial Relations, Current Employment Statistics, https://www.hiwi.org/gsipub/index.asp?docid=421. Accessed on April 20, 2015).

[6] State of Hawaiʻi, Department of Business, Economic Development, and Tourism. List of apprenticeship programs at http://labor.hawaii.gov/wdd/home/job-seekers/apprenticeship/.

6.6.1 ROADWAYS AND TRANSPORTATION

The traffic analysis for the Salt Lake Boulevard – Phase 3 estimated future traffic volumes on Salt Lake Boulevard intersections to the year 2040. This analysis is inherently cumulative, including anticipated urban population growth and associated increases in traffic volumes in the project vicinity.

Construction of bike lanes along the length of Salt Lake Boulevard could lead to increased ridership beyond the Phase 3 area, and perhaps reduced ridership in the narrow roadways north of the boulevard near Phase 3. Both of these trends are beneficial.

The Honolulu rail transit project, which would run along Nimitz Highway near the Salt Lake Boulevard corridor, may affect traffic volumes on this and other nearby roadways. The impact from the rail project, however, would not be so great that there would be no need for the Phase 3 widening.

6.6.2 CONTRIBUTIONS TO CLIMATE CHANGE

This section analyzes cumulative impacts of the proposed action alternatives in the context of state and federal policies addressing climate change and greenhouse gases (GHGs). Climate change refers to changes in the mean and/or variability of climate properties that can be identified, e.g., using statistical tests to estimate changes likely to persist for an extended period, typically decades or longer.[7] The rise in global air temperatures and its association with the rise in anthropogenic (man-made) GHGs, primarily through the burning of fossil fuels, has led to the identification of climate change as an issue of great importance. As concluded by the Intergovernmental Panel on Climate Change (IPCC),[8] most of the warming in recent decades is very likely the result of human activities.[9] Since 1900, the earth's average surface temperature has increased by about 1.2 to 1.4 degrees Fahrenheit (F) (EPA 2012).

Without GHGs, it is estimated that temperatures would be about 60 degrees F cooler (EPA 2012). GHGs include carbon dioxide (CO_2), methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Each of these gases has its own global warming potential (GWP) to trap heat in the atmosphere relative to CO_2. Methane has 21 times the warming potential than CO_2, so it has a GWP of 21; CO_2's GWP is 1. Using these GWPs and the quantities of each gas, the gases can be aggregated and expressed in million metric tons of CO_2 equivalent ($MMTCO_2Eq$).

Projections of GHG concentrations and temperature over time suggest adverse effects of varying proportions due to alteration in the balance of energy transfers between the atmosphere, space, land, and oceans. In Hawai'i, the following changes have been observed: air temperature has risen; rainfall and stream flow have decreased; rain intensity has

---

7 Intergovernmental Panel on Climate Change. *Report on Climate Change – 2007.*

8 Intergovernmental Panel on Climate Change. *Report on Climate Change – 2007.*

9 U.S. Environmental Protection Agency. April 15, 2012. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010.*

increased; sea level and sea surface temperatures have increased; and the ocean is acidifying.[10] Sea level rise can accelerate and expand erosion along beaches. Certain research indicates that a rise of three feet above the 1990 level could occur by the end of the 21st century.[11] While geographic variability exists and more monitoring and studies are needed, sea level rise is expected to continue.

Initiatives are ongoing at both federal and state levels to address climate change. Initiatives regarding GHG inventories and climate change adaptation planning are described below.

GHG Inventories. In general, inventories provide the quantification needed to establish and identify target reductions to stabilize GHG concentrations and to prevent dangerous influences on climate.

The latest Hawai'i inventory indicates total GHG emissions in 2007 of 24.27 $MMTCO_2Eq$. Ground transportation contributed 20 percent of all GHGs (4.47 $MMTCO_2Eq$). This compares to 22 percent (4.83 $MMTCO_2Eq$) for aviation transportation and 40 percent (8.76 $MMTCO_2Eq$) for electric power.

No national, state, or local reporting or controls are imposed on GHG emissions from the sources considered in this cumulative impact analysis. However, federal and state directives and plans suggest that reporting and controls are likely to affect some of these sources under other requirements in the near future.

- With Executive Order (EO) 13514, October 5, 2009, the President established an integrated strategy toward sustainability in the federal government and made the reduction of GHG emissions a priority for federal agencies. The EO requires agencies to conduct and submit comprehensive inventories of GHG emissions, and to develop agency-wide targets for emissions reductions.[12]

- With the promulgation of 40 Code of Federal Regulations (CFR) Part 98, referred to as the Greenhouse Gas Reporting Program (GHGRP), on October 30, 2009, large GHG emissions sources in the U.S. were required to report GHGs. Reporting is at the facility level, except for certain suppliers of fossil fuels and industrial GHGs. The 2010 data set was released in January 2012 and is being evaluated by the U.S. EPA for use in improving the United Nations Framework Convention on Climate Change (UNFCCC) - compliant inventory.

- At the state level, the Global Warming Solutions Act (Act 234, Session Laws of Hawai'i 2007) established a policy to achieve statewide GHG emissions levels at or below those in

[10] Fletcher, Chip. 2010. *Hawaii's Changing Climate – Briefing Sheet, 2010.*

[11] Vermeer, M. and Rahmstorf, S. 2009. *Global sea level linked to global temperature,* and Fletcher, C.H. 2009. *Sea Level by the End of the 21st Century: A Review.*

[12] U.S. Department of Energy, Federal Energy Management Program (FEMP). June 4, 2012. *Federal GHG Accounting and Reporting Guidance.*

1990 by January 1, 2020. It also established a GHG emissions reduction task force to prepare a work plan and regulatory scheme to achieve the statewide GHG limits. The *Hawai'i Greenhouse Gas Inventory: 1990 and 2007,*[13] an update of previously estimated 1990 GHG emissions and inventory of 2007 GHGs, was a product of Act 234. New administrative rules were promulgated in mid-2014.[14]

Adaptation Planning. Federal and state governments have issued directives to manage the effects of climate change in both the short and long term.

- At the federal level, EO 13514 directs agencies to evaluate risks and vulnerabilities to manage climate change effects on the agency's operations and mission in the short and long term. EO 13514 charges agencies to actively participate in the Interagency Climate Change Adaptation Task Force and mandates the Task Force to develop recommendations for the President on how the policies and practices of federal agencies can be made compatible with and reinforce a national climate change adaptation strategy (Council on Environmental Quality, 2011).
- At the state level, Act 286, Session Laws of Hawai'i 2012, encourages collaboration and cooperation among county, state, and federal agencies, policy makers, businesses, and other community partners to plan for the impacts of climate change and avoid, minimize, or mitigate loss of life, land, and property of future generations. Act 286 amends the Hawai'i State Planning Act (Hawai'i Revised Statutes [HRS] Chapter 226) to include climate change adaptation priority guidelines.

No significant cumulative impacts on climate change would occur, as any GHG emissions from the Salt Lake Boulevard Widening—Phase 3 project would not be sufficient to have an appreciable impact on climate. Rather, global man-made activities would also need to be considered. Given the above, implementation of the project could reduce GHG emissions slightly, if any with less congestion on the roadway.

[13] State of Hawai'i Department of Business, Economic Development, and Tourism. December 31, 2008. *Hawaii Greenhouse Gas Inventory: 1990 and 2007.*

[14] The rules and responses to comments on the draft rules are posted at http://health.hawaii.gov/cab/final-amendments-to-hawaii-administrative-rules/

Chapter 7

Summary of Impacts

CHAPTER 7

Summary of Impacts

7.1 SUMMARY OF IMPACTS

Table 7-1 summarizes the potential impacts of the proposed action alternatives (including Alternatives A, B, C, and D) and possible mitigation measures, as disclosed in detail in this EA.

Table 7-1. Summary of Potential Impact by Proposed Action Alternatives

Impacts to Resource Area	Alternative A (Limited On-Street Parking, Striped Median, and Overhead Utilities) Potential Impacts	Alternative B (Limited On-Street Parking, Raised Landscaped Median, and Overhead Utilities) Potential Impacts	Alternative C (Full On-Street Parking, Raised Landscaped Median, Underground Utilities, and Use of U.S. Navy Land) Potential Impacts	Alternative D (No Action) Potential Impacts
Topography, Geology and Soils	Construction: No significant impact. Earthwork and grading would be conducted in compliance with applicable laws, regulations and NPDES permit requirements, thus avoiding or minimizing impacts. Operations: No adverse impact. During operations, no change to topography, geology, or soils is expected. Mitigation: No additional mitigation is required.	Construction: Slightly less quantity of required earthwork as Alternative A. Operations: Similar to Alternative A. Mitigation: No additional mitigation is required.	Construction: Greater quantity of earthwork would be required than in Alternatives A and B to accommodate continuous parking lane along Phase 3 including steep high cut areas and sloped berms/ retaining walls in adjacent Navy land. Operations: No adverse impact, except lower retaining walls than in Alternative A would occur along Navy property line. Mitigation: Approval required to use Navy land.	Construction: No impact. Operations: No impact. Mitigation: No mitigation is required.

Table 7-1. Summary of Potential Impact by Proposed Action Alternatives

Impacts to Resource Area	Alternative A (Limited On-Street Parking, Striped Median, and Overhead Utilities) Potential Impacts	Alternative B (Limited On-Street Parking, Raised Landscaped Median, and Overhead Utilities) Potential Impacts	Alternative C (Full On-Street Parking, Raised Landscaped Median, Underground Utilities, and Use of U.S. Navy Land) Potential Impacts	Alternative D (No Action) Potential Impacts
Hydrology	Construction: No significant impact. Runoff and sedimentation would be avoided or minimized through BMPs and compliance with NPDES permit requirements. Operations: The new drainage system is designed to contain additional surface runoff to within the existing roadway right-of-way. No net increase in runoff is expected to occur on downslope adjacent properties. Mitigation: No additional mitigation is required.	Construction: Similar to Alternatives A and C. Operations: Similar to Alternatives A and C. Mitigation: No additional mitigation is required.	Construction: Similar to Alternatives A and B, but some portions of the road improvements would occur in the adjacent Navy land. Operations: No significant difference from Alternatives A and B. Mitigation: No additional mitigation is required.	Construction: No impact. Operations: No impact. Mitigation: No mitigation is required.
Natural Hazards	Construction: No impact to natural, hazard-prone areas due to short-term, temporary construction activities. Early warning systems are in effect to implement avoidance procedures. Operations: Improved road conditions would benefit emergency responses to natural hazards. Mitigation: No additional mitigation is required.	Construction: Similar to Alternatives A and C. Operations: Similar to Alternatives A and C. Mitigation: No additional mitigation is required.	Construction: Similar to Alternatives A and B. Operations: Similar to Alternatives A and B. Mitigation: No additional mitigation is required.	Construction: No impact. Operations: No impact. Mitigation: No mitigation is required.

Table 7-1. Summary of Potential Impact by Proposed Action Alternatives

Impacts to Resource Area	Alternative A (Limited On-Street Parking, Striped Median, and Overhead Utilities) Potential Impacts	Alternative B (Limited On-Street Parking, Raised Landscaped Median, and Overhead Utilities) Potential Impacts	Alternative C (Full On-Street Parking, Raised Landscaped Median, Underground Utilities, and Use of U.S. Navy Land) Potential Impacts	Alternative D (No Action) Potential Impacts
Flora and Fauna	Construction: No impact on ESA-listed plant or animal species is anticipated. Operations: No adverse impact is anticipated. Installation of shielded lights would minimize adverse effect to seabirds, such as the threatened Newell's shearwater. Mitigation: No additional mitigation is required.	Construction: Similar to Alternatives A and C. Operations: Similar to Alternatives A and C. Mitigation: No additional mitigation is required.	Construction: Similar to Alternatives A and B. Operations: Similar to Alternatives A and B. Mitigation: No additional mitigation is required.	Construction: No impact. Operations: No impact. Mitigation: No mitigation is required.
Land Use and Land Tenure	Construction: No significant adverse impact. No displacement of existing structures or facilities. Construction work would occur within existing City right-of-way. Existing accesses to adjacent land uses would be maintained through implementation of a traffic control plan. Contractor would be responsible for securing permission for access from adjacent properties to construction site and use of other properties for staging and equipment storage purposes. Operations: Infrastructure improvement is consistent with existing and planned land uses in the community. Mitigation: No additional mitigation is required.	Construction: Similar to Alternative A. Operations: Similar to Alternative A. Mitigation: No additional mitigation is required.	Construction: Similar to Alternatives A and B, except Navy permission required to access and construct portion of road improvements in adjacent Navy land. Operations: Similar to Alternatives A and B, but an easement, right-of-entry, or coordination of maintenance would be required for portion of road improvements on Navy land. Mitigation: No additional mitigation is required.	Construction: No impact. Operations: No impact. Mitigation: No mitigation is required.

Table 7-1. Summary of Potential Impact by Proposed Action Alternatives

Impacts to Resource Area	Alternative A (Limited On-Street Parking, Striped Median, and Overhead Utilities) Potential Impacts	Alternative B (Limited On-Street Parking, Raised Landscaped Median, and Overhead Utilities) Potential Impacts	Alternative C (Full On-Street Parking, Raised Landscaped Median, Underground Utilities, and Use of U.S. Navy Land) Potential Impacts	Alternative D (No Action) Potential Impacts
Transportation	Construction: Construction-related traffic would be short-term and minor. A traffic control plan would be implemented during construction to minimize traffic impact. Operations: Traffic conditions are anticipated to be improved. No more informal, haphazard parking in road shoulders. Widened roadway with on-street parking, bike lanes and sidewalks would provide "complete street" facilities for the community. Mitigation: No additional mitigation is required.	Construction: Similar to Alternatives A and C. Operations: No striped median and left-turn storage lane. Raised landscaped median would provide buffer benefits along road corridor. Raised median however would disallow eastbound motorists to turn left into north side residential driveways as well as disallow residents to exit their properties turning left onto the eastbound lanes. Similar to Alternative A, there would be limited on-street parking. Overall, the widened roadway with on-street parking, bike lanes and sidewalks would provide "complete street" facilities for the community. Mitigation: No additional mitigation is required.	Construction: Similar to Alternatives A and B, except an easement or right-of-entry required from Navy to construct portion of road improvements in adjacent Navy land. Operations: Similar to Alternative B, the raised landscaped median would provide buffer benefits, but limit access between the road and adjacent properties. Unlike Alternatives A and B, Alternative C would have full on-street parking along the entire north side of the road. Overall, the widened roadway with on-street parking, bike lanes and sidewalks would provide "complete street" facilities for the community. Mitigation: No additional mitigation is required.	Construction: No impact. Operations: Traffic at three intersections already reaches LOS F during peak hours; with anticipated increase in traffic over time, conditions would further deteriorate. Mitigation: Alternatives A, B and C would provide improvements to worsening traffic.

Table 7-1. Summary of Potential Impact by Proposed Action Alternatives

Impacts to Resource Area	Alternative A (Limited On-Street Parking, Striped Median, and Overhead Utilities) Potential Impacts	Alternative B (Limited On-Street Parking, Raised Landscaped Median, and Overhead Utilities) Potential Impacts	Alternative C (Full On-Street Parking, Raised Landscaped Median, Underground Utilities, and Use of U.S. Navy Land) Potential Impacts	Alternative D (No Action) Potential Impacts
Air Quality	Construction: No significant impact from temporary fugitive dust and diesel-powered vehicle/equipment emissions. Adherence to DOH regulatory controls and permit requirements would minimize impacts. Operations: With improved traffic flow, predicted CO concentrations are estimated to remain well below both national and state ambient air quality standards. Mitigation: No additional mitigation is required.	Construction: Similar to Alternative A. Operations: Similar to Alternative A and C. Mitigation: No additional mitigation is required.	Construction: Although construction dust would extend over a slightly longer period at the steep high cut areas and Navy lands, fugitive dust would still be short-term and temporary and mitigated by adherence to DOH requirements. Operations: Similar to Alternatives A and B. Mitigation: No additional mitigation is required.	Construction: No impact. Operations: No change in impacts. Mitigation: No mitigation is required.

Table 7-1. Summary of Potential Impact by Proposed Action Alternatives

Impacts to Resource Area	Alternative A (Limited On-Street Parking, Striped Median, and Overhead Utilities) Potential Impacts	Alternative B (Limited On-Street Parking, Raised Landscaped Median, and Overhead Utilities) Potential Impacts	Alternative C (Full On-Street Parking, Raised Landscaped Median, Underground Utilities, and Use of U.S. Navy Land) Potential Impacts	Alternative D (No Action) Potential Impacts
Noise Environment	Construction: Temporary noise impacts would occur. The construction contractor would be required to obtain a noise permit from the State DOH for any anticipated excessive noise generated at the construction site. Operations: For the long-term, traffic noise levels are expected to increase with growth, with or without the project. The difference in noise levels, with or without the project, is expected to be insignificant. Noise levels would reach 66 dBA or more (which would call for abatement measures) only at the eastern end (shopping center area) of Phase 3. Mitigation: Additional mitigation, beyond management of construction noise through DOH regulations, includes supplemental management procedures as described in Section 4.5.3 of this EA. Available traffic management measures, also describe in Section 4.5.3, provide mitigation for long-term operational noise.	Construction: Similar to Alternatives A and C. Operations: Similar to Alternatives A and C. Mitigation: Similar to Alternatives A and C.	Construction: For Alternative C, although construction noise would extend over a slightly longer period at the steep high cut areas and Navy lands, the noise would still be short-term and temporary. As in Alternative A, compliance with DOH regulations on noise would minimize impacts. Operations: Similar to Alternatives A and B. Mitigation: Similar to Alternatives A and B.	Construction: No impact. Operations: No impact (i.e., existing conditions). Mitigation: No mitigation is required.

Table 7-1. Summary of Potential Impact by Proposed Action Alternatives

Impacts to Resource Area	Alternative A (Limited On-Street Parking, Striped Median, and Overhead Utilities) Potential Impacts	Alternative B (Limited On-Street Parking, Raised Landscaped Median, and Overhead Utilities) Potential Impacts	Alternative C (Full On-Street Parking, Raised Landscaped Median, Underground Utilities, and Use of U.S. Navy Land) Potential Impacts	Alternative D (No Action) Potential Impacts
Visual Resources	Construction: Visual impacts from construction would be temporary and not significant. Operations: The visual quality of the road corridor would be improved. Mitigation: No additional mitigation is required.	Construction: Similar to Alternatives A and C. Operations: Similar to Alternative A, with the inclusion of a raised landscaped median. Mitigation: No additional mitigation is required.	Construction: Similar to Alternatives A and B, but including removal of overhead utilities. Operations: Similar to Alternative A, with the inclusion of a raised landscaped median, no overhead utilities, and wider visual appearance of road corridor at steep high cut areas. Mitigation: No additional mitigation is required.	Construction: No impact. Operations: No impact. Mitigation: No mitigation is required.
Cultural Resources	Construction: No adverse impact. If human remains or other subsurface archaeological resources are encountered during construction, work would stop and SHPD contacted in accordance with State laws. Operations: No impact. Mitigation: No additional mitigation is required.	Construction: Similar to Alternatives A and C. Operations: Similar to Alternatives A and C. Mitigation: Similar to Alternatives A and C.	Construction: Similar to Alternatives A and B. Operations: Similar to Alternatives A and B. Mitigation: Similar to Alternatives A and B.	Construction: No impact. Operations: No impact. Mitigation: No mitigation is required.

Table 7-1. Summary of Potential Impact by Proposed Action Alternatives

Impacts to Resource Area	Alternative A (Limited On-Street Parking, Striped Median, and Overhead Utilities) Potential Impacts	Alternative B (Limited On-Street Parking, Raised Landscaped Median, and Overhead Utilities) Potential Impacts	Alternative C (Full On-Street Parking, Raised Landscaped Median, Underground Utilities, and Use of U.S. Navy Land) Potential Impacts	Alternative D (No Action) Potential Impacts
Socio-economics	Construction: Construction work, jobs, and income would be generated. Implementation of a traffic control plan would minimize construction impacts on adjacent businesses and community activities. Operations: Improved traffic movement would benefit many roadway users, as by "complete streets" policies, and the quality of life along the corridor. Mitigation: No additional mitigation is required beyond management activities noted as part of the project.	Construction: Similar to Alternative A, but with a slightly lower construction cost. Operations: Similar to Alternative A, but with a raised landscaped median, left-turn movements between the driveways and the road could create inconveniences to the residents. The raised median would create a buffer between the travel lanes in different directions. Mitigation: No additional mitigation is required.	Construction: Similar to Alternatives A and B, but with larger economic benefits from higher construction costs. Operations: Similar to Alternative B with raised landscaped median (left-turn movements between the driveways and the road could create inconvenience to residents). The raised median would create a buffer between the travel lanes in different directions. For Alternative C, sloped berms/retaining walls in the Navy land may decrease some backyard space in the Navy housing area. Security fences along Navy property line would need to be modified. Mitigation: No additional mitigation is required.	Construction: No impact. Operations: No impact. Mitigation: No mitigation is required.

Table 7-1. Summary of Potential Impact by Proposed Action Alternatives

Impacts to Resource Area	Alternative A (Limited On-Street Parking, Striped Median, and Overhead Utilities) Potential Impacts	Alternative B (Limited On-Street Parking, Raised Landscaped Median, and Overhead Utilities) Potential Impacts	Alternative C (Full On-Street Parking, Raised Landscaped Median, Underground Utilities, and Use of U.S. Navy Land) Potential Impacts	Alternative D (No Action) Potential Impacts
Utilities	Construction: No significant impact. Construction would be coordinated with the affected utility companies and Navy utilities and accomplished in compliance with agency reviews and applicable approval requirements. Portions of Chevron fuel lines would be relocated. All drainage improvements would comply with HDOT guidelines, City policies and standards, and Navy consultation. Operations: No impact to public utilities, electrical/ telecommunications and fuel/gas systems. With the proposed drainage improvements, increased runoff due to increased impervious surfaces would be controlled on-site. Mitigation: No additional mitigation is required.	Construction: Similar to Alternative A. Operations: Similar to Alternative A. Mitigation: additional No mitigation is required.	Construction: Similar to Alternatives A and B, except overhead electrical, telecommunications, and cable TV lines would be relocated underground. Operations: Unlike Alternatives A and B, underground utilities would be less vulnerable to severe weather conditions. With the proposed bioswale improvements, runoff due to increased impervious surfaces on-site would be controlled. Mitigation: No additional mitigation is required.	Construction: No impact. Operations: No impact. Mitigation: No mitigation is required.
Public Facilities and Services	Construction: No significant impacts. Lane closures could impact response times of emergency vehicles. A traffic control plan will be in place to reduce impact. Operations: No impact. Mitigation: No additional mitigation is required.	Construction: Similar to Alternatives A and C. Operations: Similar to Alternatives A, except slightly more maintenance required for landscaped median. Mitigation: No additional mitigation is required.	Construction: Similar to Alternatives A and B. Operations: Similar to Alternatives B and possible maintenance of road improvements in Navy land. Mitigation: No additional mitigation is required.	Construction: No impact. Operations: No change in impacts. Mitigation: No mitigation is required.

7.2 ANTICIPATED DETERMINATION

The following findings and reasons demonstrate that the project would have no significant adverse impact on the environment based on the 13 significance criteria included in HAR 11-200-12, and as a result, support the anticipated Finding of No Significant Impact (FONSI) determination, as provided under HAR 11-200-12.

1. *Involves an irrevocable commitment to loss or destruction of any natural or cultural resource.* Botanical, fauna, and cultural assessments have been performed and determined that there are no significant, endangered, threatened, or sensitive resources in the project area.
2. *Curtails the range of beneficial uses of the environment.* The proposed action alternatives call for improvements to a roadway within an existing right-of-way. No existing buildings or structures would be displaced. No change in adjacent land uses is anticipated. The project would not adversely affect the range of beneficial uses of the surrounding areas.
3. *Conflicts with the state's long-term environmental policies or goals and guidelines as expressed in Chapter 344, HRS, and any revisions thereof and amendments thereto, court decisions, or executive orders.* As demonstrated in Chapter 5 of this document, the proposed action alternatives are consistent with the State's long-term environmental policies and guidelines as expressed in Chapter 344, HRS.
4. *Substantially affects the economic or social welfare of the community or state.* The proposed action alternatives are expected to sustain and improve the positive economic effect that a transportation facility provides to a community. Moreover, the construction activity associated with the project would mobilize jobs and infuse business and personal income into the local economy. No negative effects are anticipated on the social welfare of the local community.
5. *Substantially affects public health.* The proposed action alternatives would not result in the use of hazardous materials or employ a construction methodology that would be detrimental to the public health and safety of the area residents. Existing State DOH regulations are in effect to protect air and water quality in Hawai'i. Construction noise would be minimized through compliance with HAR, Chapter 11-46, Community Noise Control requirements and implementation of BMPs and recommended noise abatement measures.
6. *Involves substantial secondary impacts, such as population changes or effects on public facilities.* There would be no significant adverse social impact generated by the proposed action alternatives. The improved transportation corridor would not change existing land uses nor generate direct increase in resident population. It would not result in significant long-term negative impacts on traffic nor overburden existing public facilities and services.

7. *Involves a substantial degradation of environmental quality.* The proposed action alternatives would not involve massive grading over substantial areas, clearing and removing of substantial existing vegetation, and significantly altering natural drainage patterns in the area. No long-term degradation of the natural environment is anticipated.
8. *Is individually limited but cumulatively has considerable effect upon the environment or involves a commitment for larger actions.* The proposed action alternatives are being planned and designed as a complete construction project. Evaluation of the project's probable impacts considers its total build-out. Scheduling and constructing the project would depend on available funding. Previous phases of the road widening project have long been completed.
9. *Substantially affects a rare, threatened, or endangered species, or its habitat.* In a heavily urbanized environment within a completely altered site, no federal- or State-listed rare, threatened, or endangered fauna or flora species is likely to occur or be negatively affected. The USFWS has concurred with this assessment.
10. *Detrimentally affects air or water quality or ambient noise levels.* The anticipated impacts associated with the construction of the proposed action alternatives, such as fugitive dust and noise, are short-term and temporary. These impacts would be minimized by the implementation of mitigation measures in accordance with applicable laws, statutes, ordinances, and rules and regulations of the federal, state, and county governments. Additionally, erosion and sedimentation control measures and BMPs would be implemented to prevent construction-related runoff from impacting adjacent properties and water resources.
11. *Affects or is likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters.* The proposed action alternatives are located more than 1.3 miles from the shoreline. Coastal hazards are not expected to impact the project area. Although the project site is subject to periodic heavy rainfall, severe stormwater runoff is not likely to be detrimental to the roadway improvements.
12. *Substantially affects scenic vistas and viewplanes identified in county or state plans or studies.* The proposed action alternatives would consist primarily of transportation corridor improvements within an existing right-of-way. There would be no buildings, structures, or topographic modifications to interfere with existing vistas and viewplanes.
13. *Requires substantial energy consumption.* Traffic movements through the widened roadway are expected to occur more efficiently. Hence, fuel consumption would be reduced. Improved street lighting is not expected to significantly increase the demand for electrical power from the local utility company.

Chapter 8

Other Considerations

CHAPTER 8

Other Considerations

8.1 RELATIONSHIPS BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Section 11-200-17, HAR requires discussion of the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity. Short-term and long-term do not necessarily refer to fixed time periods but are viewed relative to environmentally significant consequences of the proposed action. This section discusses the extent to which the proposed action involves trade-offs among short-term and long-term gains and losses, as well as the extent to which the proposed action foreclose future options and/or narrows the range of beneficial uses of the environment.

Short-term impacts from the Salt Lake Boulevard Widening–Phase 3 project would result from construction activities on land within an existing road right-of-way. Short-term construction-related traffic, noise, and air quality impacts described in this document would not be significant given implementation of required BMPs to avoid or minimize impacts. Further, the potential for short-term impacts on ESA-listed fauna during construction activities was assessed during the ESA Section 7 consultation process and has been determined to have no impact. Cultural research of Phase 3 reveals no cultural resource within the road corridor.

Additionally, construction of the proposed action alternative would involve removal of common vegetation as well as excavation and fill within the existing right-of-way. Modification of the physical terrain would occur primarily where the road cross section must maintain a smooth alignment across severe grade differences. This impact represents a trade-off between loss of natural gradients in the terrain and enhancing the long-term productivity of the transportation corridor for the community. It is recognized that failing to accommodate future growth in transportation demand (Alternative D–No Action) could lead to negative socioeconomic impacts on the community and the region.

8.2 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES BY THE PROPOSED ACTION

A commitment of resources is considered irreversible when it precludes restoration of those resources to their pre-project condition. Use, consumption, destruction, or degradation of resources resulting from implementation of the Salt Lake Boulevard Widening–Phase 3 project, such that those resources cannot be retrieved or replaced in any form, is considered an irretrievable commitment of resources.

Irreversible and irretrievable commitments of resources during construction include:

- Use of resources for construction materials used on the project;
- Excavation and disposal of soil and sediment;
- Use of available space in the construction and demolition landfill;

- Expenditure of funds to finance construction;
- Construction manpower; and
- Use of energy in the form of direct consumption of fossil fuel for vehicles and equipment.

With the construction of the right-of-way improvements to achieve adequate transportation capacity along Salt Lake Boulevard–Phase 3, open space would be irreversibly or irretrievably lost. The loss of open space, however, would be mitigated with the retention of view corridors and inclusion of landscaped strips through the road right-of-way.

Fossil fuel would be irreversibly and irretrievably committed during project construction to provide electrical power for certain construction machinery and equipment. The amount to be committed, however, is expected to be temporary and nominal compared to what is being committed to total users on the rest of the island.

8.3 PROBABLE ADVERSE ENVIRONMENTAL IMPACTS WHICH CANNOT BE AVOIDED

Over the long-term operations of Salt Lake Boulevard between Maluna Street and Ala Liliko‘i Street, traffic noise would increase with increased use of the road with or without the proposed action alternative. The increase in noise may affect adjacent residents. Mitigation measures are available to reduce these impacts to levels that are not significant.

During construction of the project, there would be short-term impacts such as noise, fugitive dust, emissions from vehicles and equipment, traffic congestion, and sedimentation. These temporary impacts cannot be avoided but would be limited to the immediate construction vicinity and managed through implementations of BMPs in accordance with applicable government regulations.

Chapter 9

List of Preparers

CHAPTER 9

List of Preparers

This Environmental Assessment (EA) for the Salt Lake Boulevard Widening–Phase 3 project was prepared for the Department of Design and Construction, City and County of Honolulu, Department of Transportation, Highways Division, State of Hawaii, and Federal Highways Administration. The prime consultant for this EA is Belt Collins Hawaii LLC. The following list identifies the organizations and individuals involved in the preparation of this document.

Name	Title	Education	Project Participation
Belt Collins Hawaii LLC			
John Chung	Vice President	B.S., Civil Engineering	Principal-in-Charge
Joanne Hiramatsu	Director of Planning	B.A., Environmental Planning	Principal Planner
Glen Koyama	Senior Project Manager	M.U.P., Planning B.F.A., Urban and Regional Design	Associate Project Manager
John Kirkpatrick	Senior Socioeconomic Analyst	Ph.D., Anthropology	Socioeconomics, Cultural Impact Analysis
Ed Kuniyoshi	Senior Planner	M., Urban Planning B.F.A., Urban and Regional Design	Land Use Planning
Michael Lim	Planning Technician	B.S. Music Education	Technical Planning
Dawn Easterday	Landscape Architect	B.S., Landscape Architecture	Landscape Design
Robin Matsunaga	Civil Engineer	B.S., Civil Engineering B.S., Geology	Infrastructure
Lindsay Nakashima	Civil Engineer	B.S., Civil Engineering M.B.A.	Traffic
Carolyn Ancheta	Civil Engineer	B.S., Civil Engineering	Infrastructure
Karon Aoki	Graphic Designer	B.F.A., Graphic Design	Graphics Documentation
Rania Sawyer	Graphic Designer	M.L.A., Landscape Architecture B. END., Environmental Design	Graphics Documentation
Amy Yamakawa	Graphic Designer	B.F.A., Graphic Design	Graphics Documentation
Albert Rivera	CADD Manager	A.S. Drafting Technology	Graphics Documentation

Name	Title	Education	Project Participation
Austin, Tsutsumi & Assoc., Inc.			
Terrance Arashiro	President	M.S., Civil Engineering	Civil Engineering
Censeo AV & Acoustics LLC			
Todd Beiler	President	M.S., Mechanical Engineering	Noise
Environmental Resources Management			
John Koehler	Program Director	Sc.D., Environmental Health Science	Air Quality
Cultural Surveys Hawai‘i, Inc.			
Hallett Hammatt	President	Ph.D., Archaeology	Cultural Resources

Chapter 10

References

CHAPTER 10

References

A.C. Alexander, 1926 in J. A. Maciolek. 1982. *Lakes and Lake-like Waters Of the Hawaiian Archipelago.*

Associated Press. October 12, 2011. "Emergency power facility set to go up at airport." *StarAdvertiser.* www.staradvertiser.com/news/20111012_Emergency_power_facility_set_to_go_up_at_airport.html. Accessed February 2014.

Chun, Noelle. November 2006. "The Real Salt Lake, this area has a flavorful past." *Honolulu Magazine.* www.honolulumagazine.com/Honolulu-Magazine/November-2006/The-Real-Salt-Lake

City and County of Honolulu. October 3, 2002. *General Plan: Objectives and Policies.*

City and County of Honolulu, Department of Design and Construction (DDC). August 17, 1998. *Draft Finding of Suitability for Easement (FOSE) for Salt Lake Boulevard Phase II, Salt Lake, Oahu, Hawaii.* Prepared by Masa Fujioka & Associates.

City and County of Honolulu, Department of Design and Construction. April 2003. *Final Environmental Assessment, Salt Lake District Park Master Plan Update, Honolulu, Oahu.*

City and County of Honolulu, Department of Design and Construction and U.S. Department of Transportation, Federal Highway Administration. May 2001. *Final Environmental Assessment for the Salt Lake Boulevard Widening Phase 2 – Bougainville Drive to Reeves Street.*

City and County of Honolulu, Department of Planning and Permitting. June 2004. Primary Urban Center Development Plan. www.honoluludpp.org/Portals/0/pdfs/planning/PUC/PrimaryUrbanCenterDP.pdf.

City and County of Honolulu, Department of Public Works. July 1992 (revised January 1993). *Planning Study – Salt Lake Boulevard Improvements, Kahuapaani Street to Ala Lilikoi Street.* Prepared by Akinaka & Associates, Ltd.

City and County of Honolulu, Department of Transportation Services. August 2012. O'ahu Bike Plan: A Bicycle Master Plan. www.oahubikeplan.org/downloads/Oahu_Bike_Plan-August_2012.pdf.

City and County of Honolulu, Division of Environmental Quality, Storm Water Quality Branch. September 13, 2012. *Low-Impact Development and Sustainable Stormwater Management.* PowerPoint presentation by Gerald Takayesu, P.E., Head, Storm Water Quality Branch.

City and County of Honolulu. Land Use Ordinance (Revised Ordinance of Honolulu (ROH), Chapter 21).

City and County of Honolulu Council. Ordinance 12-15, City "Complete Streets" law.

Council on Environmental Quality (CEQ). March 4, 2011. Federal Agency Climate Change Adaptation Planning Support Document.

Creamer, Beverly. September 2012. "Kakaako's Building Boom." Hawaii Business. www.hawaiibusiness.com/Hawaii-Business/September-2012/Kakaakos-Building-Boom/index.php?cparticle=2&siarticle=1#artanc.

Federal Emergency Management Agency. Flood Insurance Rate Maps, City and County of Honolulu, Hawaii, Map Nos. 15003C0332G and 15003C0334G.

Fletcher, C.H. 2009. "Sea Level by the End of the 21st Century: A Review" Shore and Beach, 77.4: 1-9.

Fletcher, Chip. 2010. *Hawai'i's Changing Climate – Briefing Sheet, 2010.* University of Hawai'i Sea Grant College Program Center for Island Climate Adaptation and Policy.

Hawai'i Revised Statutes. Chapter 6E-2.

Hawai'i 2050 Sustainability Task Force. January 2008. Hawai'i 2050 Sustainability Plan.

Honolulu Authority for Rapid Transport (HART). www.honolulutransit.org. Accessed February 2014.

Intergovernmental Panel on Climate Change (IPCC) Report on Climate Change - 2007

Island Family Christian Church. "Church History." www.islandfamily.org/history.shtml.

Macdonald, Gordon Andrew, Agatin T. Abbott, and Frank L. Peterson. January 1983. *Volcanoes in the Sea: The Geology of Hawaii.* Second Edition.

Maciolek, J. A. April 30, 1982. "Lakes and Lake-like Waters of the Hawaiian Archipelago." Occasional Papers of Bernice P. Bishop Museum. Volume 25, Number 1.

Masa Fujioka & Associates. August 14, 1998. *Draft Environmental Baseline Survey, Salt Lake Boulevard Easement Phase II, Salt Lake, Oahu, Hawaii.*

Memorandum from HART to City Department of Design and Construction, October 11, 2012.

Oahu Metropolitan Planning Organization (OMPO). April 2011. Oahu Regional Transportation Plan 2035.

Pankiwskyj, Kost A. 1972. "Geology of the Salt Lake Area, Oahu, Hawaii." *Pacific Science.* Volume 26, Number 2. http://scholarspace.manoa.hawaii.edu/handle/10125/404.

Personal communication between Mr. Nolan Hirai, Clean Air Branch Acting Manager of the State of Hawaiʻi Department of Health and Ms. Lesley Matsumoto, Belt Collins Hawaii. August 21, 2012.

Salt Lake Shopping Center. "About Salt Lake Shopping Center." http://saltlakeshoppingcenter.com/about-saltlakeshoppingcenter.php.

Shimogawa, Duane. December 26, 2013. "Supreme Court nullifies LUC ruling on Koa Ridge, but project is going forward." *Pacific Business News.* www.bizjournals.com/pacific/news/2013/12/26/supreme-court-nullifies-luc-ruling-on.html. Accessed February 2014.

_____. January 31, 2014. "Hawaiian Electric starts deactivating Downtown Honolulu power plant." *Pacific Business News.* www.bizjournals.com/pacific/news/2014/01/31/hawaiian-electric-starts-deactivating.html. Accessed February 2014.

State of Hawaiʻi, Act 54, Session Laws of Hawaiʻi 2009. Statewide "Complete Streets" Policy

State of Hawaiʻi, Act 286, Session Laws of Hawaiʻi 2012, amended Hawaiʻi Revised Statutes, Chapter 226, State Planning Law.

State of Hawaiʻi, Hawaii Revised Statutes.

_____. 1974a. HRS, Chapter 343, Environmental Impact Statements.

_____. 1974b. HRS, Chapter 344, Environmental Policy Act.

_____. 1970. HRS, Chapter 341, Environmental Quality Control

State of Hawaiʻi. 2003. Hawaiʻi Administrative Rules (HAR) Title 11, Chapter 60.1, Air Pollution Control.

_____. 1996. HAR, Title 11, Chapter 46, Community Noise Control

_____. 2009. HAR, Title 11, Chapter 55 Water Pollution Control

_____. 2007(amended). HAR, Title 11, Chapter 200, Environmental Impact Statement Rules.

State of Hawai‘i, Department of Business, Economic Development, and Tourism (DBEDT). December 31, 2008. *Hawaii Greenhouse Gas Inventory: 1990 and 2007.* Prepared by ICF International.

State of Hawai‘i, Office of Governor. *The Hawai‘i State Plan.*

State of Hawai‘i, Office of Planning, Coastal Zone Management Program. June 2006. *Low Impact Development, A Practitioner's Guide.*

State of Hawai‘i, Office of Planning. Hawaii Statewide GIS Program. Available at http://planning.hawaii.gov/gis/.

State of Hawai‘i, State Functional Plans, 1984, 1989, 1990, and 1991.

State of Hawai‘i, State Land Use Commission. No date. State Land Use District Maps.

Transportation Research Board (TRB), 2000. *Highway Capacity Manual.*

U.S., 40 Code of Federal Regulations (CFR) 133 Secondary Treatment Regulations

U.S. Bureau of the Census. American FactFinder. 2010 Census. www.census.gov

U.S. Department of Agriculture Soil Conservation Service (SCS). 1972. Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii.

U.S. Department of Energy, Federal Energy Management Program (FEMP). June 4, 2012. *Federal GHG Accounting and Reporting Guidance.*

U.S. Department of the Navy. April 2001. *Environmental Assessment for the Granting of U.S. Navy Easements and License.*

U.S. Department of Transportation, Federal Highway Administration and City and County of Honolulu, Department of Design and Construction. May 2001. *Final Environmental Assessment for the Salt Lake Boulevard Widening Phase 2 – Bougainville Drive to Reeves Street.*

U.S. Department of Transportation, Federal Highway Administration; State of Hawai‘i, Department of Transportation; and City and County of Honolulu, Department of Public Works. February 4, 1977 *Final Environmental Impact Statement, Salt Lake Boulevard – Puuloa Road to Halawa Heights Road Extension, City and County of Honolulu, Honolulu, Hawaii.*

U.S. Environmental Protection Agency (EPA). April 15, 2012. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2010.*

U.S. Federal Highways Administration. March 14, 2001. *Design Exception Report - Salt Lake Boulevard Widening, Bougainville Drive to Reeves Street, Federal-Aid Project No. STP-7311(2).* Submitted by City and County of Honolulu, Department of Design and Construction.

U.S. Fish and Wildlife Service. 2013. Endangered Species Program website. Available at http://www.fws.gov/endangered/.

Vermeer, M., Rahmstorf, S. 2009. "Global sea level linked to global temperature." Proceedings of the National Academy of Science, 106.51:21527-21532.

Appendices

Appendix A

Public Input

Salt Lake Boulevard Widening – Phase 3

Public Informational Meeting
April 4, 2012

MEETING AGENDA

Salt Lake Boulevard Widening – Phase 3

April 4, 2012
Oahu Veterans Center
7:00 pm to 9:00 pm

Welcome and Opening Statement

Project Introduction and Background

Environmental Assessment

Proposed Road Widening Concepts and Options

Questions and Answers

Overall Public Review

Adjournment

List of Attendees

Informational Meeting
Salt Lake Boulevard Widening – Phase 3
Oahu Veterans Center
Date: April 4, 2012
7:00 pm to 9:00 pm

Attendees	Address
Howard Shima	Salt Lake
Bob Cunningham	Foster Village
Melecio Corpuz	Salt Lake
Joseph Cheng	Salt Lake
Philomena Cheng	Salt Lake
Lucinda Matsui	Salt Lake
Ruth Boyette	Foster Village
Carole Kaapu	Attending for State Representative Aaron Johanson
Ken & Tina Humphries	Salt Lake
Ethel Shima	Salt Lake
Marcos Carinio	Salt Lake
Thelma Carinio	Salt Lake
Dennis Galolo	Attending for District 7 Council Member
Dennis Egge	Salt Lake
Johng Kyun Ko	Salt Lake
Jane & Les Au	Salt Lake
Lorene Godfrey	Stadium-Halawa
Carl Miura	Attending for Senator Glenn Wakai
Bill and Barb Troegner	Salt Lake
Charmaine Tadjvar	County Agency
Rodney Kawamoto	Foster Village
Chi Ching Chan	Salt Lake
Kathy Dombrigues	Salt Lake
Gregory Raap	Business Representative
Ruguine Aspiras	Salt Lake
Bob Jordan	Kapolei
Margaret Leong	Salt Lake
Kevin & Margaret Yee	Salt Lake
Dong Soo Ko	Salt Lake
L. Nauka	Salt Lake
D. L. Davis-Brown	Salt Lake
Doris Tamayose	Salt Lake
Glenn Wakai	State Senator (15th District)
Aaron Ling Johanson	State Representative (31st District)
Jared Stokes	Salt Lake
Mike Holland	Kailua
Maurice Morita	Salt Lake
Tatiana Quong	Stadium-Halawa

FACT SHEET

SALT LAKE BOULEVARD WIDENING – PHASE 3

MALUNA STREET TO ALA LILIKOI STREET
Honolulu, Hawaii

Proposing Agency
City and County of Honolulu, Department of Design and Construction

Primary Consultants
Belt Collins Hawaii LLC – Planning and Environmental
Austin, Tsutsumi & Associates, Inc. – Preliminary Engineering Studies

Proposed Action
Preliminary engineering and environmental studies are currently underway on the third and final phase of the City and County of Honolulu's (City) Salt Lake Boulevard Widening Project (see attachment 1). This City road widening project, which began in the 1970s, is intended to improve the capacity of Salt Lake Boulevard from Puuloa Road to Kahuapaani Street to accommodate increased traffic volume. With the development of new homes and businesses and the increase in population in the Salt Lake, Halawa, and Mapunapuna areas in the 1960s and 70s, the two-lane Salt Lake Boulevard was experiencing traffic congestion. Future projections showed that traffic would worsen if no improvements were made to the right-of-way.

Implementation of the Salt Lake Boulevard Widening Project in the ensuing years was undertaken in phases. The section of the Boulevard between Puuloa Road and Ala Lilikoi Street comprised the first phase of the project. Improvements included construction of a five-lane collector road with median, curbs and gutters, sidewalks, and bikeways. Phase 2 of the project, located between Kahuapaani Street and Maluna Road, was completed in 2005 and included widening of the Boulevard from 2 lanes to 4 lanes. The current project or Phase 3, which encompasses the section between Phases 1 and 2, will complete the overall road improvement project and finally provide multi-lanes of roadway capacity for the entire length of Salt Lake Boulevard.

Alternative design concepts for the final road section are presently being considered by the City (see attached exhibit 3). They include:

Concept 1: Expansion from 2 lanes to 4 lanes: 2 lanes east-bound/2 lanes west-bound
Bike Lane: dedicated bike lane on both sides (mauka and makai of travel lanes)
Median: 14' wide median and turning lane
Sidewalk: 8' wide sidewalk on both sides
Landscape: 5' wide planting strip on mauka side
On-Street Parking: parking lane on mauka side

Concept 2: Expansion from 2 lanes to 4 lanes: 2 lanes east-bound/2 lanes west-bound
Bike Lane: dedicated bike lane on both sides
Median: 4' to 14' wide median
Sidewalk: 8' wide sidewalk on both sides
Landscape: 5' wide planting strip mauka side/sloped area on makai side
On-Street Parking: parking on mauka side only at existing residences

Concept 3: Expansion from 2 lanes to 4 lanes: 2 lanes east-bound/2 lanes west-bound
Bike Lane: dedicated bike lane on both sides
Median: 14' wide median and turning lane
Sidewalk: 8' wide sidewalk on both sides
Landscape: 13' wide planting strip mauka side
On-Street Parking: no parking

An Environmental Assessment (EA) is being prepared for Phase 3 of the Salt Lake Boulevard Widening Project. This informational document will be in compliance with Chapter 343, Hawaii Revised Statutes, and the National Environmental Policy Act. It will include updated information from the Environmental Impact Statement (EIS) prepared in 1977 for the overall Salt Lake Boulevard Widening Project and the EA prepared in 2001 for the project's Phase 2 section. This updated EA is expected to re-evaluate the various environmental conditions affected by Phase 3 and the current relevant environmental policies and regulation applicable to the project area.

Key Stages in Project Planning Process

Consultation with Agency and Stakeholders (in progress)
Preliminary Engineering and Environmental Studies (in progress)
Preparation of Road Widening Concept Options (in progress)
Public Informational Meeting (April 4, 2012)
Draft Environmental Assessment Review
Final Environmental Assessment
Design and Construction

Construction Budget

Construction is expected to be financed by Federal and City and County of Honolulu funds. Estimated cost of construction will depend of the final design of the road widening improvements.

Key Reviewing and Approving Agencies

Federal Highways Administration
State Department of Transportation, Highways Division
State Department of Health, Clean Water Branch
Department of Design and Construction
Department of Planning and Permitting

Contacts:

Mr. Glen Koyama
Belt Collins Hawaii LLC
2153 N. King Street, Ste 200
Honolulu, Hawaii 96819-4554
Ph. (808) 521-5361

Mr. Jeremy Lee
Department of Design and Construction
City and County of Honolulu
650 S. King Street, 11th Floor
Honolulu, Hawaii 96813
Ph. (808) 768-8809

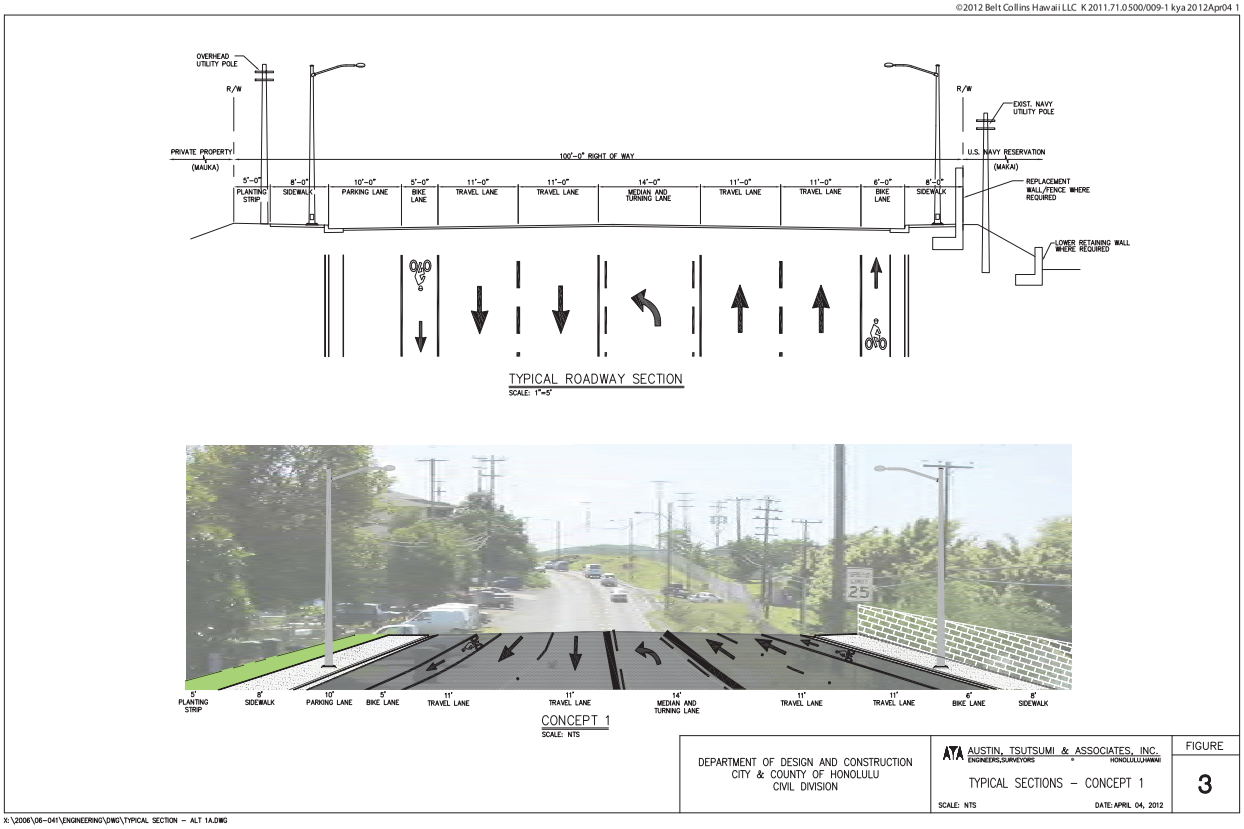
April 2012

BELT COLLINS
NORTH
SCALE IN FEET
0 350 700 1400

Figure 1
SALT LAKE BOULEVARD WIDENING – PHASE 3
City and County of Honolulu

©2012 Belt Collins Hawaii LLC K 2011.71.0500/003-1 kya 2012Mar30 3

©2012 Belt Collins Hawaii LLC K 2011.71.0500/009-1 kya 2012Apr04 1



©2012 Belt Collins Hawaii LLC K 2011.71.0500/007-1 kya 2012Mar30 1

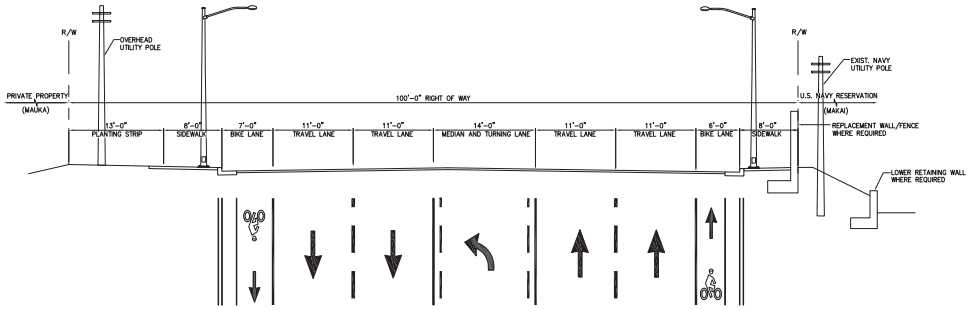
Figure 2
AERIAL PHOTOGRAPH OF SALT LAKE BOULEVARD – PHASE 3
City and County of Honolulu

BELT COLLINS

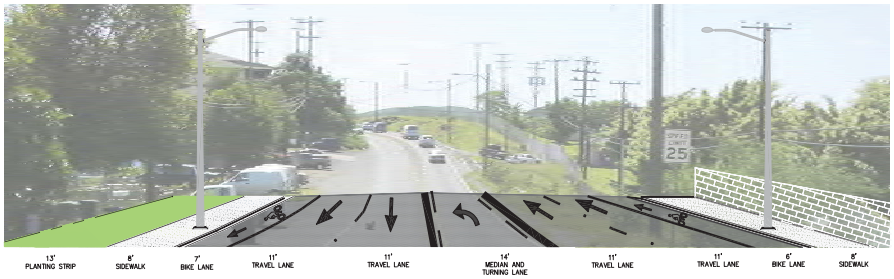
NORTH

0 175 350 700
SCALE IN FEET

©2012 Belt Collins Hawaii LLC K 2011.71.0500/009-3 kya 2012Apr04 1



TYPICAL ROADWAY SECTION
SCALE: 1"=5'

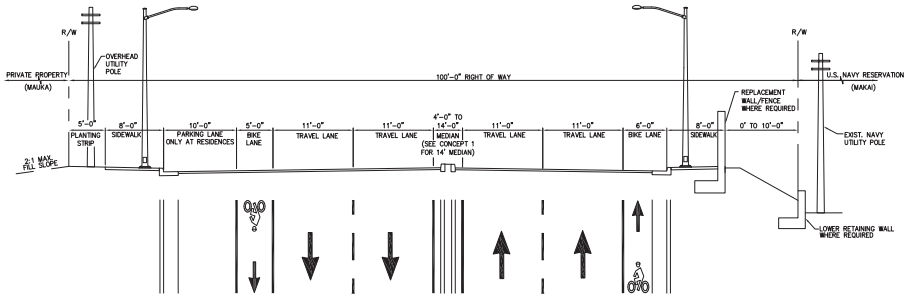


CONCEPT 3
SCALE: NTS

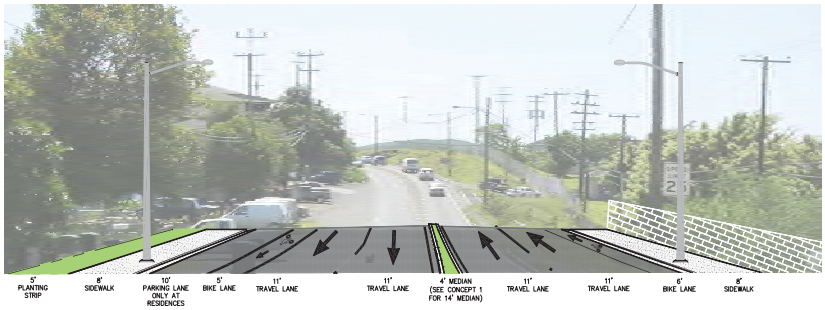
DEPARTMENT OF DESIGN AND CONSTRUCTION CITY & COUNTY OF HONOLULU CIVIL DIVISION	AUSTIN, TSUTSUMI & ASSOCIATES, INC. ENGINEERS, SURVEYORS * HONOLULU, HAWAII TYPICAL SECTIONS – CONCEPT 3 SCALE: NTS DATE: APRIL 04, 2012	FIGURE 5

X:\2006\06-041\ENGINEERING\DWG\TYPICAL SECTION – ALT 3A.DWG

©2012 Belt Collins Hawaii LLC K 2011.71.0500/009-2 kya 2012Apr04 1



TYPICAL ROADWAY SECTION
SCALE: 1"=5'



CONCEPT 2
SCALE: NTS

DEPARTMENT OF DESIGN AND CONSTRUCTION CITY & COUNTY OF HONOLULU CIVIL DIVISION	AUSTIN, TSUTSUMI & ASSOCIATES, INC. ENGINEERS, SURVEYORS * HONOLULU, HAWAII TYPICAL SECTIONS – CONCEPT 2 SCALE: NTS DATE: APRIL 04, 2012	FIGURE 4

X:\2006\06-041\ENGINEERING\DWG\TYPICAL SECTION – ALT 2A.DWG

Public Comments and Input From Question and Answer Session

Salt Lake Boulevard Widening - Phase 3 Public Meeting
Oahu Veterans Center, 1298 Kukila Street
April 4, 2012, 7:00 p.m. to 9:00 p.m.

Question/Comment 1: Will there be walls on both sides of Salt Lake Boulevard? Will the previous walls be continued? Will there be any walls at Kahikolu Way?

Response 1: The majority of the walls are going to be on the makai side of Salt Lake Boulevard. New retaining wall locations and heights will depend on the earthwork that is required to construct the road and sidewalk. The location and design of noise walls will depend upon the results of the noise study and the locations of driveways and walkways.

There will need to be a retaining wall across the street from Kahikolu Way due to the steep slope fronting Aliamanu Elementary School. On the mauka side adjacent to the Kahikolu Way residences, there are existing retaining walls built on the mauka slope. Some of those existing walls may be affected by the project.

Question/Comment 2: The light pole near Kahikolu Way has been hit and repaired multiple times. About ten years ago two people died after crashing into the pole.

Response 2: The comment was acknowledged. The City will take into consideration the location of the utility poles and sight distances in its design of Salt Lake Boulevard.

Question/Comment 3: The area near Kahikolu Way is a high density, low-rise area. Residents are having difficulty making left turns onto Salt Lake Boulevard. A request was made to have a median storage lane along the entire length of Phase 3, to not affect the flow of traffic. Almost all utilities can be moved back except traffic lights.

Response 3: The comment was acknowledged. The City will take into consideration the vehicular access to residences in its design of Salt Lake Boulevard.

Question/Comment 4: Is speed limit remaining at 25 MPH?

Response 4: There are currently no plans to adjust the speed limit along Salt Lake Boulevard under this project.

Question/Comment 5: Has there been a count taken of the number of cars parked along this stretch of Salt Lake Boulevard? How many parking spaces will be available when the road improvements are completed?

Response 5: A visual count of the vehicles parked along Salt Lake Boulevard had been performed. The actual number of vehicles parked within the City right-of-way is very difficult to assess due to how the vehicles are irregularly parked. For instance, many cars are doubled parked. On any given evening, the City estimates that there may be approximately 80 to 100 vehicles parked within the City right-of-way. The City also noted that vehicles are parking on the grass area fronting the Navy housing on the makai side of the street, and that parking is increased on Sundays during church services.

Based on the existing driveway locations, the City estimates that there will be available parking spaces for 60 cars after the completion of the project.

Question/Comment 6: The City's estimate of 100 cars is low. Many cars park along Salt Lake Boulevard to attend church services at the Island Family Christian Church. 400 people attended the most recent Sunday services. The church has been informed by the Navy that the church will not have access to their property from Radford Drive.

Response 6: The comments were acknowledged. The City recognizes that there will be a shortage of parking spaces. The City asked to meet with a church representative following the meeting to discuss the relocation of their driveway.

Question/Comment 7: Pertaining to the retaining walls on makai side where there are hills and valleys. Will there be a lot of cut and fill? Will the Navy fence be eliminated or replaced with the retaining walls?

Response 7: Since the majority of the Navy housing lies below Salt Lake Boulevard, there is quite a bit of fill on the Navy side. The existing fence may remain in locations where there will be no earthwork, however in majority of locations, the fence will likely be replaced by new walls or a new fence.

Question/Comment 8: What is the estimated project schedule?

Response 8: The project's planning and environmental assessment is anticipated to be completed in 2013. The design and preparation of the final construction documents is approximately a 2 year process. Given these durations, the construction of the project could potentially start in 2015, if no delays occur in the other stages in the project and the project is fully funded.

The project has major drainage issues that need to be addressed and any drainage improvements will need to be coordinated with the Navy. Also, the Board of Water Supply is planning to include the installation of a new 36-inch water main under this widening project.

The City currently estimates that the construction work may last 2 years. However the actual construction time will depend on the phasing of the project and the extent of the improvements.

Question/Comment 9: Three design concepts were presented. Who decides which concept will be chosen?

Response 9: The decision will be made collectively with public input through processes like the public meeting. The final concept is typically a hybrid of various concepts, developed with several things in mind, including cost and safety aspects.

Question/Comment 10: Is there construction funding for the project?

Response 10: At this time there are no construction funds released. The project is on City's CIP 6-year cycle and the Oahu Metropolitan Planning Organization (OMPO) Statewide Transportation Improvement Plan list which will allow the City to receive federal funds.

Question/Comment 11: Years ago, the City's estimate to complete the project was approximately $65 million. Since there are a limited amount of federal funds for the entire state, how can the project be built in one phase? It is doubtful that the Federal Highway Administration can give the City $65 million at one time. Does this mean multiple phases for the project?

Response 11: Under the past Statewide Transportation Improvement Program, the Federal Highway Administration granted approximately $150 to $160 million per year to the State. Oahu received about two-thirds of the federal funds (approximately $100 million) with the neighbor islands getting the remainder. For the federal funds going to Oahu, the State government received about 70 percent for Oahu projects and the City received about 30 percent. The City matches 20% or more of the federal funds.

Although it is preferable to have the project constructed in one phase it may be necessary to have 2 or 3 phases to stay within budgetary limits.

Question/Comment 12: It is possible for the construction of the project would go beyond 2018?

Response 12: This may be considered a "worst case scenario" depending on the total costs for the improvements. The City's goal is to focus on preparing a full project, rather than phasing the project. The intent is to complete the project in this single, last phase. The Federal Highway Administration will be looking for "project-ready" plans. Other projects may fall out of their budget if those projects are not ready which may allow additional funds to be allocated to Salt Lake Boulevard.

Question/Comment 13: Do any of the concepts lend themselves to separation of pedestrians and bicyclists from vehicular traffic?

Response 13: Currently, the concepts include bike lanes in the roadway. It may be possible to use the mauka landscaped strip as a shared bike/pedestrian use however the bike lanes are already in the roadway at the both ends of the project. It would be difficult to transition the bicyclists from the roadway to the mauka landscaped strip for this portion of Salt Lake Boulevard.

Question/Comment 14: Previous commenter clarified that there is a greater concern about separating pedestrians from vehicles.

Response 14: The comment was acknowledged. The City plans to construct raised sidewalks on both sides of the roadway.

Question/Comment 15: Will vehicles be forced to go right and perform a U-turn in order to go left at Kahikolu Place?

Response 15: The City's current plan is to retain the refuge area in the median, where vehicles can come out of Kahikolu before merging into traffic on Salt Lake Boulevard.

Question/Comment 16: Will there be a new traffic light at Kahikolu? Vehicles on Kahikolu wait a long time to turn onto Salt Lake Boulevard.

Response 16: The intersection will be examined and vehicle counts will be conducted to determine if traffic signals will be warranted at the intersection.

Question/Comment 17: Regarding the undergrounding of utilities, will consideration be given to relocate the utilities underground for continuity? What will determine whether the utilities are placed underground?

Response 17: As the conceptual plan is further developed, the City will evaluate the total project and cost of undergrounding the utilities. The City will have to determine what improvements are most important and cost effective to undertake. Community input will be sought by the City.

Question/Comment 18: Will there be any cost incurred by residents? What will be the financial impact on homeowners? Will there be an assessment?

Response 18: Any necessary property adjustments due to the construction of the project within private property will be made at the City's cost with no cost to the homeowners. For storm drain connections from homes lower than the finished roadway,

there will be a drainage connection agreement which property owners will be required to sign before the City completes the drainage connection.

In the case of undergrounding of the utilities, there will be riser poles between every other house to drop the utility wires down to the homes as currently occurs. There may be an assessment to the property owners if the riser poles are removed and utilities are run underground to the homes.

Question/Comment 19: Is the 8-foot walkway needed on the makai side of the roadway? Consider eliminating the sidewalk or making it less wide.

Response 19: The Americans with Disabilities Act (ADA) requires that access be provided on sidewalks. The City is expecting additional changes to the ADA in the near future and the current City standards are the basis for the 8-foot sidewalk width. The City will check to see if some adjustments can be made.

Question/Comment 20: A concern was raised about the amount of grading required on the mauka side of Salt Lake Boulevard near Kahikolu Place. The commenter recalled that a previous study mentioned approximately 14 feet of cut was needed and expressed concern about access to properties and steep driveways.

Response 20: The City currently has no plans to significantly alter the grade of the mauka side of Salt Lake Boulevard fronting Kahikolu Place. There may be some grading to improve sight distances, but the City is not planning major cuts in that area.

Question/Comment 21: There are stair steps serving Aliamanu School. How will the City provide pedestrian access?

Response 21: The City's current plan is to replace the stairs with the sidewalk which will run on the makai side of Salt Lake Boulevard.

Question/Comment 22: Do the Chevron pipe lines run the entire length of the project? Are there any safety concerns with the lines? Who pays for the relocation of the pipe lines?

Response 22: Two Chevron fuel lines run along the makai side of the road in the sloped area. The Chevron lines are in the City's right-of-way on the Ewa end of the project but turn south near Radford Drive. The project is being coordinated with Chevron. Chevron is responsible for the maintenance of their lines. The City does not anticipate impacting the lines.

Question/Comment 23: Is there a website for the project?

Response 23: The City has no plans to develop a website for this planning phase.

Question/Comment 24: Will project decisions be made behind closed doors?

Response 24: Several factors will be considered in making decisions, including: engineering feasibility, safety, environmental impacts, costs, funding, public input, compliance with laws, and politics. The findings and decisions will be disclosed in the final environmental assessment documents.

Prepared by: Belt Collins Hawaii
Austin Tsutsumi & Associates
Date: April 6, 2012

Agency Letters Received

During Early Consultation Process

DEPARTMENT OF DESIGN AND CONSTRUCTION

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
PHONE: (808) 768-8480 • FAX: (808) 768-4567
WEB SITE: www.honolulu.gov

PETER B. CARLISLE
MAYOR

LORI M. K. KAHIKINA, P.E.
DIRECTOR

CHRIS TAKASHIGE, P.E.
DEPUTY DIRECTOR

CDD-B 12-469371

June 13, 2012

MEMORANDUM

TO: TIM STEINBERGER, P.E., DIRECTOR
DEPARTMENT OF ENVIRONMENTAL SERVICES

WESTLEY K. C. CHUN, Ph.D, P.E., DIRECTOR
DEPARTMENT OF FACILITY MAINTENANCE

DAVID K. TANOUE, DIRECTOR
DEPARTMENT OF PLANNING AND PERMITTING

GARY B. CABATO, DIRECTOR
DEPARTMENT OF PARKS AND RECREATION

WAYNE Y. YOSHIOKA, DIRECTOR
DIRECTOR OF TRANSPORTATION SERVICES

DANIEL GRABAUSKAS, EXECUTIVE DIRECTOR AND CEO
HONOLULU AUTHORITY FOR RAPID TRANSPORTATION

ERNEST Y. W. LAU, P.E., MANAGER AND CHIEF ENGINEER
HONOLULU BOARD OF WATER SUPPLY

LOUIS M. KEALOHA, CHIEF OF POLICE
HONOLULU POLICE DEPARTMENT

KENNETH G. SILVA, FIRE CHIEF
HONOLULU FIRE DEPARTMENT

JAMES H. E. IRELAND, M.D., DIRECTOR
HONOLULU EMERGENCY SERVICES DEPARTMENT

'12 JUN 18 P1:44

DEPARTMENT OF ENVIRONMENTAL SVCS

FROM: LORI M. K. KAHIKINA, P.E., DIRECTOR
DEPARTMENT OF DESIGN AND CONSTRUCTION

SUBJECT: SALT LAKE BOULEVARD WIDENING – PHASE 3
ENVIRONMENTAL ASSESSMENT

Tim Steinberger
Westley K. C. Chun
David K. Tanoue
Gary B. Cabato
Wayne Y. Yoshioka
Daniel Grabauskas
Ernest Y. W. Lau
Louis M. Kealoha
Kenneth G. Silva
James H. E. Ireland

We wish to inform you that the Department of Design and Construction (DDC) is proposing to widen the remaining segment of the Salt Lake Boulevard in Honolulu, Hawaii. The widening will increase the number of traffic lanes between Maluna Street and Ala Lilikoi Street from two lanes to four lanes. Improvements to be considered include a median strip, sidewalks, a bikeway, and on-street parking. These proposed improvements are intended to relieve traffic congestion along the route and accommodate safer travel for pedestrians and bicyclists. The Board of Water Supply is also considering installing a 36-inch waterline concurrently with the widening project.

As the City will be pursuing federal-aid funding, an Environmental Assessment (EA) will be prepared in compliance with Chapter 343, Hawaii Revised Statutes, and the National Environmental Policy Act. DDC has engaged the consulting firms of Belt Collins Hawaii (BCH) to provide planning, community outreach, and environmental services, and Austin Tsutsumi & Associates (ATA) to provide preliminary engineering services and develop road improvement concepts for the project. Glen Koyama, senior project manager, is the lead contact for BCH [(808) 521-5361], and Terrance Arashiro, chief engineer, is the point of contact for ATA [(808) 533-3646].

As part of the scoping process for the EA, early consultation with affected agencies is required to define environmental evaluation requirements for the Salt Lake Boulevard Widening-Phase 3. Your agency has been identified as an early contact for this project.

As a result, we have been or will be contacting you or your staff to consult with your agency on the proposed road improvements.

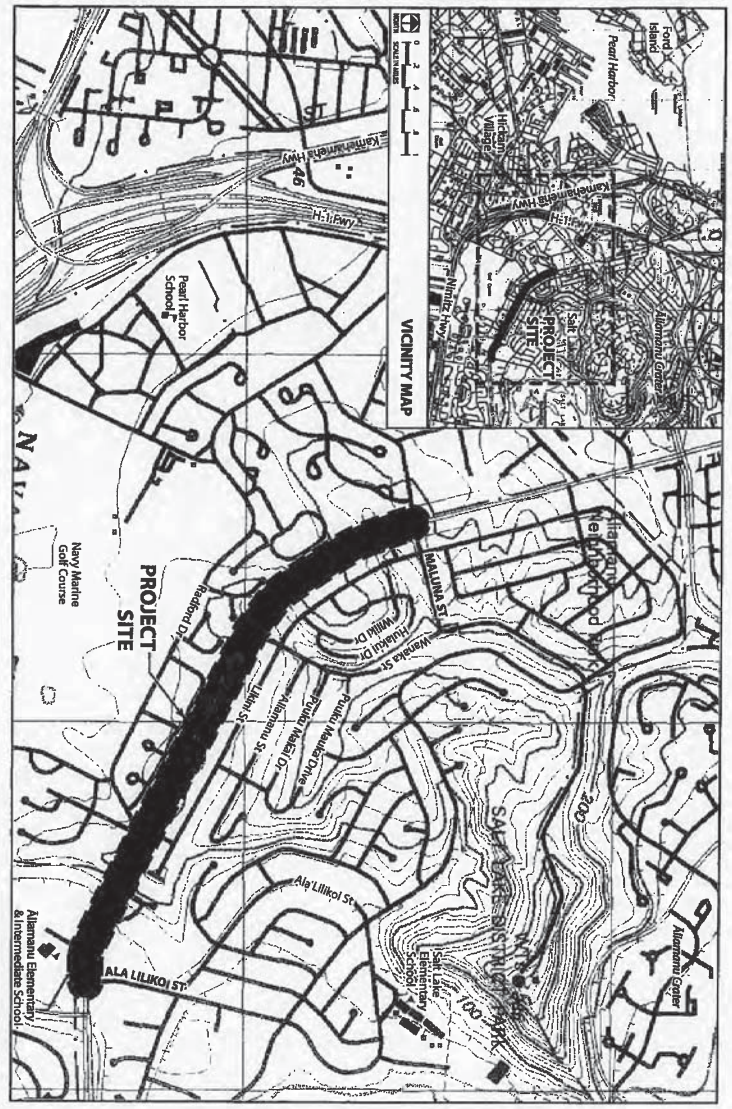
Thank you for your cooperation and we look forward to discussing this project with you.

If you have any questions, please contact Jeremy Lee with the Civil Division at Extension 88809.

JKL:LC:lal

✓Enclosure (Location Map)

c: Belt Collins (w/enclosure)
Austin, Tsutsumi & Associates (w/enclosure)



PROJECT LOCATION MAP
Salt Lake Boulevard Widening—Phase 3
Maluna Street to Ala Lilikoi Street
Honolulu, Hawaii

HONOLULU FIRE DEPARTMENT
CITY AND COUNTY OF HONOLULU
636 South Street
Honolulu, Hawaii 96813-5007
Phone: 808-723-7139 Fax: 808-723-7111 Internet: www.honolulu.gov/hfd

PETER B. CARLISLE
MAYOR

KENNETH G. SILVA
FIRE CHIEF

EMMIT A. KANE
DEPUTY FIRE CHIEF

DEPT OF DESIGN & CONSTR
C & C OF HONOLULU
'12 SEP 25 PM 2:20

September 24, 2012

DDC
RECEIVED
SEP 26 2012
CDD

'12 SEP 26 A11:34
RECEIVED
DDC-CIVIL DIVISION
C & C OF HONOLULU

TO: LORI KAHIKINA, P.E., DIRECTOR
DEPARTMENT OF DESIGN AND CONSTRUCTION

FROM: KENNETH G. SILVA, FIRE CHIEF

SUBJECT: SALT LAKE BOULEVARD WIDENING - PHASE 3
ENVIRONMENTAL ASSESSMENT

In response to your memorandum of September 10, 2012, regarding the above-mentioned subject, the Honolulu Fire Department has determined that there will be no significant impact to our services during this project.

Should you have questions, please contact Battalion Chief Socrates Bratakos of our Fire Prevention Bureau at 723-7151 or at sbratakos@honolulu.gov.

KENNETH G. SILVA
Fire Chief

KGS/SY:bh

POLICE DEPARTMENT
CITY AND COUNTY OF HONOLULU
801 SOUTH BERETANIA STREET · HONOLULU, HAWAII 96813
TELEPHONE: (808) 529-3111 · INTERNET: www.honolulupd.org

PETER B. CARLISLE
MAYOR

LOUIS M. KEALOHA
CHIEF

DAVE M. KAJIHIRO
MARIE A. McCAULEY
DEPUTY CHIEFS

12 SEP 28 AM 8:10
DDC
RECEIVED
SEP 28 2012
CDD
12X485643

OUR REFERENCE EO-WS

September 26, 2012

'12 SEP 28 A8:26
RECEIVED
DDC-CIVIL DIVISION
C & C OF HONOLULU

TO: LORI KAHIKINA, P.E., DIRECTOR
DEPARTMENT OF DESIGN AND CONSTRUCTION

ATTENTION: JEREMY LEE, CIVIL ENGINEER

FROM: LOUIS M. KEALOHA, CHIEF OF POLICE
HONOLULU POLICE DEPARTMENT

SUBJECT: SALT LAKE BOULEVARD WIDENING – PHASE 3 ENVIRONMENTAL ASSESSMENT

Thank you for the opportunity to review the subject project.

This project may cause an increase in the calls for police service due to the anticipated pedestrian and vehicle traffic congestion during the construction phase. However, once the project is completed, it should have no significant impact on the facilities or operations of the Honolulu Police Department.

If there are any questions, please call Major William Chur of District 5 (Kalihi) at 723-8202.

LOUIS M. KEALOHA
Chief of Police

By
BART S. HUBER
Assistant Chief
Support Services Bureau

Serving and Protecting With Aloha

Appendix B

Traffic Impact Analysis Report

TRAFFIC IMPACT ANALYSIS REPORT
SALT LAKE BOULEVARD WIDENING
Salt Lake, Oahu, Hawaii

DRAFT

July 12, 2012

Prepared for:

City and County of Honolulu
Department of Planning and Permitting
Civil Engineering Branch
650 S. King Street, 8th Floor
Honolulu, Hawaii 96813

Austin, Tsutsumi & Associates, Inc.
Civil Engineers • Surveyors
501 Sumner Street, Suite 521
Honolulu, Hawaii 96817-5031
Telephone: (808) 533-3646
Facsimile: (808) 526-1267
E-mail: atahnl@atahawaii.com
Honolulu • Wailuku • Hilo, Hawaii

TRAFFIC IMPACT ANALYSIS REPORT
Salt Lake Boulevard Widening
Salt Lake, Oahu, Hawaii

DRAFT

Prepared for

City and County of Honolulu
Department of Planning and Permitting
Civil Engineering Branch

Prepared by
Austin, Tsutsumi & Associates, Inc.
Civil Engineers • Surveyors
Honolulu • Wailuku • Hilo, Hawaii

July 12, 2012

TABLE OF CONTENTS

		Page
I.	INTRODUCTION	1-3
	A. Background and Location	1
	B. Study Methodology	3
	C. Definitions	3
II.	EXISTING CONDITIONS	3-18
	A. Roadway System	3
	B. Existing Traffic Volumes	7
	C. Existing Traffic Conditions	8
III.	BASE YEAR 2040 SCENARIO	19-25
	A. Ambient Growth Rate	19
	B. Other Known Developments	19
	C. Base Year 2040 Analysis	20
IV.	COMPLETE STREETS CONSIDERATIONS	26-27
V.	ROUNDABOUT CONSIDERATION	27-28
VI.	YEAR 2040 TRAFFIC CONDITIONS WITH PROJECT	31-40
	A. Year 2040 with Project and Raised Medians	32
	B. Future Year 2040 with Project without Raised Medians	33
VII.	RECOMMENDATIONS	41
VIII.	CONCLUSION	41-42
IX.	REFERENCES	43

TABLE OF CONTENTS
Cont'd

TABLES

		Page
1.	EXISTING INTERSECTION LEVEL OF SERVICE SUMMARY	17
2.	EXISTING, BASE YEAR 2040 AND BASE YEAR 2040 WITH MITIGATIONS INTERSECTION LEVEL OF SERVICE SUMMARY	24
3.	YEAR 2040 SINGLE AND DOUBLE LANE ROUNDABOUT ANALYSIS	30
4.	BASE YEAR 2040 WITH MITIGATION, YEAR 2040 WITH PROJECT AND RAISED MEDIAN AND YEAR 2040 WITH PROJECT INTERSECTION LEVEL OF SERVICE SUMMARY	39

TABLE OF CONTENTS
Cont'd

Page

FIGURES

1. LOCATION MAP 2

2. EXISTING LANE CONFIGURATION, VOLUME AND LEVEL OF SERVICE 16

3. BASE YEAR 2040 VOLUME AND LEVEL OF SERVICE 22

4. BASE YEAR 2040 WITH MITIGATION VOLUME AND LEVEL OF SERVICE..... 23

5. DOUBLE LANE ROUNDABOUT IMPACT AT INTERSECTIONS .. 29

6. YEAR 2040 WITH PROJECT LANE CONFIGURATION WITH RAISED MEDIAN VOLUME AND LEVEL OF SERVICE 37

7. YEAR 2040 WITH PROJECT LANE CONFIGURATION VOLUME AND LEVEL OF SERVICE..... 38

TABLE OF CONTENTS
Cont'd

APPENDICES

A. TRAFFIC COUNT DATA

B. LEVEL OF SERVICE CRITERIA

C. LEVEL OF SERVICE CALCULATIONS

D. CHURCH DRIVEWAY ANALYSIS

AUSTIN, TSUTSUMI & ASSOCIATES, INC. CIVIL ENGINEERS • SURVEYORS
CONTINUING THE ENGINEERING PRACTICE FOUNDED BY H. A. R. AUSTIN IN 1934

KENNETH K. KUROKAWA, P.E.
TERRANCE S. ARASHIRO, P.E.
STANLEY T. WATANABE
IVAN K. NAKATSUKA, P.E.
ADRIENNE W.L.H. WONG, P.E., LEED AP
KEITH K. NIIYA, P.E.

DRAFT

TRAFFIC IMPACT ASSESSMENT REPORT
Salt Lake Boulevard Widening

Salt Lake, Oahu, Hawaii

I. INTRODUCTION

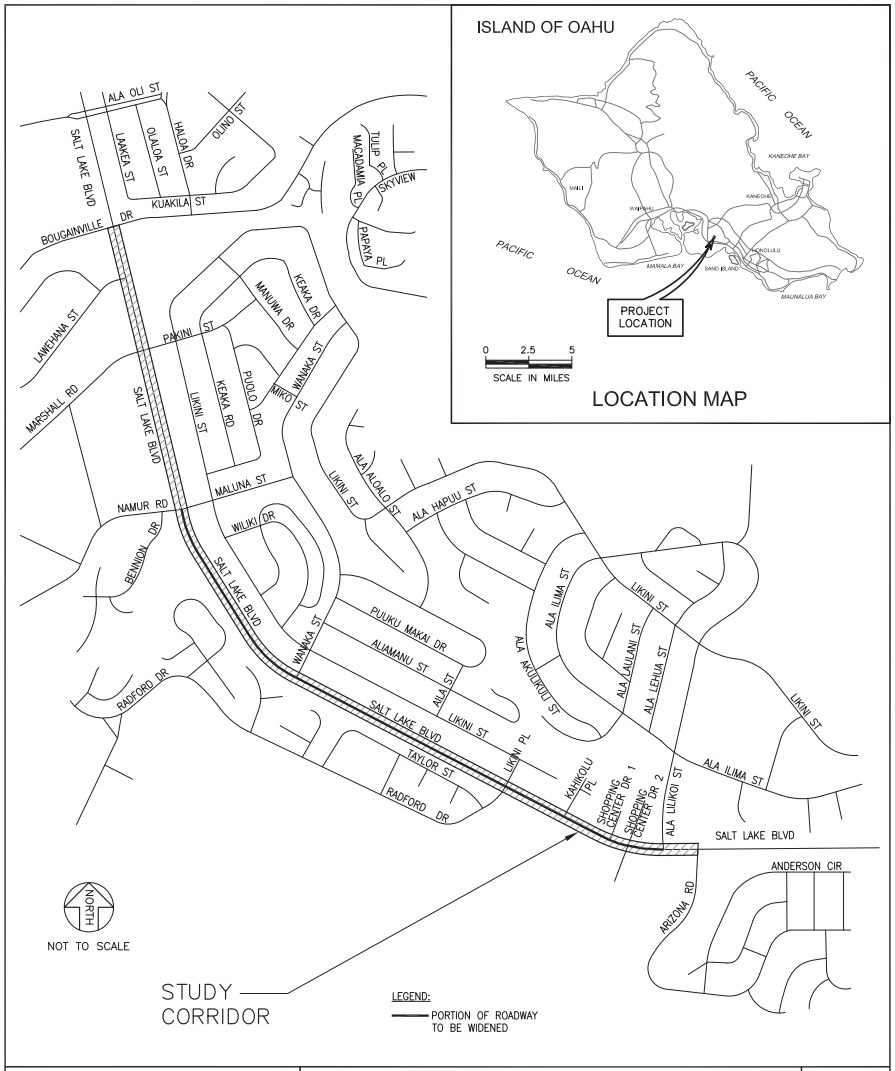
This report documents the findings of a traffic study conducted by Austin, Tsutsumi, and Associates, Inc. (ATA) to evaluate the traffic impact of the proposed Salt Lake Boulevard Widening between Ala Lilikoi Street and Maluna Street to two lanes in each direction.

A. Background and Location

The City and County of Honolulu Department of Design and Construction (DDC) has requested that traffic analyses be performed to provide a traffic impact analysis to assess the impact of the proposed continued widening of Salt Lake Boulevard. The roadway portion between Maluna Street and Ala Lilikoi Street along Salt Lake Boulevard will be widened and is the continuation of roadway improvements along Salt Lake Boulevard. Hereinafter, "Project" shall refer to the proposed widening of Salt Lake Boulevard.

REPLY TO:
501 SUMNER STREET, SUITE 521 • HONOLULU, HAWAII 96817-5031
PHONE (808) 533-3646 • FAX (808) 526-1267
EMAIL : atahnl@atahawaii.com

OFFICES IN:
HONOLULU, HAWAII
WAILUKU, MAUI, HAWAII
HILO, HAWAII



SALT LAKE BLVD WIDENING	AUSTIN, TSUTSUMI & ASSOCIATES, INC. ENGINEERS,SURVEYORS • HONOLULU,HAWAII	FIGURE
	LOCATION MAP	1

B. Study Methodology

This study will address the following:

1. Assess existing traffic operating conditions at key locations within the study area.
2. Recommend roadway improvements or other mitigative measures, as appropriate to minimize existing congestion and/or safety issues.
3. Determine the impacts of a raised median, which would prevent direct access to residential driveways and would impact movements at intersections.

C. Definitions

- **High, or Heavy Turning Movement Volume –** a subjective term that for this report, shall be used to describe conditions where the turning movement volume forms a significant component of the traffic processed through the intersection, and noticeably reduces capacity along the main arterial. This term can apply to a single heavy turning movement, or the collective effect of all turning movements.
- **Level-of-Service (LOS)** – as based on The Highway Capacity Manual – Special Report 209 (HCM), dated 2000, LOS is a qualitative measure used to describe the conditions of traffic flow at intersections. Values range from LOS A (minimal delay) to LOS F (congested).

II. EXISTING CONDITIONS

A. Roadway System

Bougainville Drive

Is an east-west, four-lane, two-way, undivided major collector roadway. This roadway begins to the west at its intersection with Valkenburgh Street and terminates to the east at its intersection with Bougainville Loop and Aliamanu Drive. This intersection is signalized at its intersection with Salt Lake Boulevard.

This roadway provides access to residential homes to the east including Aliamanu Military Reservation and schools and a commercial area to the west.

Lawehana Street

Is an east-west, two-lane, two-way, undivided minor collector roadway beginning to the west at its intersection with Bougainville Drive and terminating to the east at a signalized intersection with Salt Lake Boulevard. This roadway provides access to commercial areas.

Marshall Road

Is an east-west, two-lane, two-way, undivided restricted military minor collector roadway. This roadway begins to the west at its intersection with Radford Drive and terminates to the east at a signalized intersection with Salt Lake Boulevard across Pakini Street. Access off of Salt Lake Boulevard to the Navy Compound is currently closed off.

Pakini Street

Is an east-west, two-lane, two-way, undivided minor collector roadway beginning to the west at a signalized intersection with Salt Lake Boulevard across Marshall Road and terminating to the east at its intersection with Manuwa Drive. This roadway provides access to residential homes.

Maluna Street

Is an east-west, two-lane, two-way, undivided minor collector roadway beginning to the west at a signalized intersection with Salt Lake Boulevard across Namur Road and terminating to the east at its intersection with Wanaka Street. This roadway provides access to residential homes.

Namur Road

Is an east-west, two-lane, two-way, undivided minor collector roadway providing access to residential homes and commercial sites. This roadway begins to the west at its intersection with Radford Drive and terminates to the east at a signalized intersection with Salt Lake Boulevard across Maluna Street.

Wanaka Street

Is a north-south, two-lane, two-way, undivided minor collector roadway beginning to the south at a signalized intersection with Salt Lake Boulevard and terminating to the north at its intersection with Likini Street. This roadway provides access to residential homes.

Likini Place

Is a north-south, two-lane, two-way, undivided minor collector roadway beginning to the south at a signalized intersection with Salt Lake Boulevard across Radford Drive and terminating to the north at its intersection with Likini Street across. This roadway provides access to residential homes.

Radford Drive

Is a north-south, two-lane, two-way, divided major collector roadway beginning to the south at its intersection with Makalapa Road/Kamehameha Highway and terminating to the north at a signalized intersection with Salt Lake Boulevard across Likini Place. This roadway primarily provides access to military residential homes, the Navy Exchange Shopping Plaza, and Moanalua Shopping Center, Pearl Harbor Elementary, and Navy Marine Golf Course via Valkenburgh Street.

Kahikolu Place

Is a north-south, two-lane, two-way, undivided local roadway. This cul-de-sac begins to the south at an unsignalized intersection with Salt Lake Boulevard. This roadway provides access to residential homes.

Salt Lake Shopping Center Driveway 1

Is a north-south, two-lane, two-way, driveway. This driveway provides right-in access to the Salt Lake Shopping Center from westbound Salt Lake Boulevard and left-in access to the Salt Lake Shopping Center from eastbound Salt Lake Boulevard. Only right turn out are allowed out of Driveway 1. This driveway is unsignalized at its intersection with Salt Lake Boulevard.

Salt Lake Shopping Center Driveway 2

Is a north-south, two-lane, two-way, driveway. At its intersection with Salt Lake Boulevard, this driveway is limited to right-in/right-out.

Aliamanu Elementary/Middle School Driveway

Is a north-south, two-lane, two-way, driveway. This driveway is unsignalized and provides right-in and right-out access for Aliamanu Elementary/Middle School. There is a wide paved shoulder that runs parallel to eastbound Salt Lake Boulevard which begins near the Salt Lake Boulevard/Salt Lake Shopping Center Driveway 1 intersection and terminates at the Salt Lake Boulevard/Aliamanu Elementary/Middle School Driveway intersection. This shoulder is used frequently for school drop off's during the AM peak hour of traffic. Adjacent to the shoulder is a dirt area used as a parking lot by the Aliamanu Elementary/Middle School users. From this dirt area, direct access is provided onto eastbound Salt Lake Boulevard.

Ala Lilikoi Street

Is a north-south, four-lane, two-way, undivided major collector roadway beginning to the south at a signalized intersection with Salt Lake Boulevard and terminates to the north at its intersection with Likini Street/Ala Ilima Street. This roadway primarily provides access to residences and commercial sites.

Arizona Road

Is a north-south, two-lane, two-way, undivided minor collector roadway beginning to the south at its intersection with Camp Catlin Road and terminates to the north at a signalized intersection with Salt Lake Boulevard. This roadway provides access to the Salt Lake/Moanalua Public Library and residential homes, as well as access to Nimitz Highway via Camp Catlin Road.

Salt Lake Boulevard

Begins as a north-south, two-way, major collector roadway to the west at its intersection with Kamehameha Highway and then curves to become an east-west roadway and terminates at its intersection with Puuloa Road/Pukoloa

Street. For the purpose of this study, Salt Lake Boulevard will be considered an east-west roadway.

Between its intersections with Ala Oli Street and Marshall Road, this roadway is a five-lane divided roadway with three (3) westbound lanes and two (2) eastbound lanes. Between its intersection with Marshall Road and Maluna Street, this roadway is a four-lane divided roadway with two (2) westbound lanes and two (2) eastbound lanes. Between its intersection with Maluna Street and with Salt Lake Shopping Center Driveway 2, this roadway is a two-lane undivided roadway with one (1) westbound lane and one (1) eastbound lane. Between its intersection with Salt Lake Shopping Center Driveway 2 and Ala Lilikoi Street, this roadway is a five-lane divided roadway with two westbound lanes and three eastbound lanes. Between its intersection with Ala Lilikoi Street and Arizona Road, this roadway is a four-lane divided roadway with two (2) westbound lanes and two (2) eastbound lanes. East of its intersection with Arizona Road, this roadway is a five-lane divided roadway with two (2) westbound lanes and three (3) eastbound lanes.

B. Existing Traffic Volumes

Manual turning movement traffic counts and field observations were conducted at the following study intersections on Tuesday, November 1, 2011, Wednesday, November 30, 2011 and Tuesday, December 13, 2011:

- Bougainville Drive/Salt Lake Boulevard (Signalized)
- Lawehana Street/Salt Lake Boulevard (Signalized)
- Marshall Road/Pakini Street/Salt Lake Boulevard (Signalized) – Dec. 13, AM & PM
- Maluna Street/Namur Road/Salt Lake Boulevard (Signalized)
- Wanaka Street/Salt Lake Boulevard (Signalized)
- Radford Drive/Likini Place/Salt Lake Boulevard (Signalized)
- Kahikolu Place/Salt Lake Boulevard (Unsignalized)

- Salt Lake Shopping Center Driveway 1/Salt Lake Boulevard/ Aliamanu School Parking Lot (Unsignalized)
- Salt Lake Shopping Center Driveway 2/Aliamanu Elementary/Middle School Driveway/Salt Lake Boulevard (Unsignalized)
- Ala Lilikoi Street/Salt Lake Boulevard (Signalized)
- Arizona Road/Salt Lake Boulevard (Signalized) – Nov. 30, AM

Based on the count data, it was determined that the weekday AM peak hour of traffic occurs between 7:15 AM and 8:15 AM and the weekday PM peak hour of traffic occurs between 4:00 PM and 5:00 PM. The turning movement count data is included in Appendix A.

Overall, it was found that the traffic volume at the study intersections increased[1] by approximately 1.5 percent during the PM peak hour of traffic while it decreased by approximately 1.1 percent during the AM peak hour of traffic when compared to the original Salt Lake Boulevard Widening TIAR dated March 19, 1998.

C. Existing Traffic Conditions

Level of Service (LOS) is a qualitative measure used to describe the conditions of traffic flow at intersections, with values ranging from free-flow conditions at LOS A to congested conditions at LOS F. The Highway Capacity Manual – Special Report 209 (HCM), dated 2000, methods for calculating volume to capacity ratios, delays and corresponding Levels of Service were utilized in this study. LOS Definitions for signalized and unsignalized intersections are provided in Appendix B.

Methodology

Analysis for the study intersections was performed using Synchro. Synchro is an analysis program that is capable of preparing reports consistent with HCM methodology. These reports contain control delay results, based on intersection lane geometry, signal timing inputs, and hourly traffic volume.

[1] Volume comparison is based on intersection volume average for the AM and PM peak hour of traffic.

This program assigns a LOS Based on delay (see Appendix B) as a qualitative measure of performance. These results, as confirmed or refined by field observations, constitute the technical analysis that will form the basis for the recommendations outlined in this report.

Observations and Intersection Analysis – Existing Conditions

AM Weekday Peak Hour of Traffic

During the weekday AM peak hour of traffic Salt Lake Boulevard was observed to carry heavier volumes in the eastbound direction, towards Honolulu.

The studied intersections were observed to operate relatively smoothly during the AM peak hour of traffic. Below is a description of the individual intersections:

See Figure 2 for the intersections lane configuration, volumes and LOS.

Salt Lake Boulevard/Bougainville Drive

This signalized intersection was observed to operate with some congestion during the AM peak hour of traffic. This observation is consistent with the overall LOS D analysis result. The eastbound through and westbound through major movements operate relatively smoothly at LOS D and C, respectively.

The northbound and southbound minor street approaches and eastbound and westbound left-turn movements operate with longer delays at LOS E and F. Those long delays are due to the long cycle length which gives preference to the major through movements along Salt Lake Boulevard as well as the heavy volumes. Although long delays were observed on those movements, the queues were typically able to clear during each cycle length of the traffic signal.

Salt Lake Boulevard/Lawehana Street

This signalized "tee"-intersection was observed to operate relatively smoothly during the AM peak hour of traffic. This observation is consistent with the overall LOS B analysis result. The eastbound and westbound through movements along Salt Lake Boulevard were observed to operate with small delays at LOS A. The westbound left-turn and minor northbound approach

operate at LOS E most likely due to the long cycle length which gives preference to the major eastbound and westbound through movement. Although long delays were observed on those movements, the queues were able to clear during each cycle length of the traffic signal.

Salt Lake Boulevard/Pakini Street/Marshall Road

This signalized intersection operates as a "tee"-intersection due to the closure of Marshall Road and was observed to operate relatively smoothly during the AM peak hour of traffic. This observation is consistent with the overall LOS B analysis result. The eastbound left-turn, westbound left-turn and the minor southbound movements operate at LOS F, LOS E and LOS C respectively - likely due to the long cycle length which gives preference to the major eastbound and westbound through movement. Although long delays were observed on those movements, the queues were able to clear after each cycle length.

Salt Lake Boulevard/Maluna Street/Namur Road

This signalized intersection was observed to operate relatively smoothly during the AM peak hour of traffic. This observation is consistent with the overall LOS C analysis result. All movements operate at LOS D or better.

Salt Lake Boulevard/Wanaka Street

This signalized "tee"-intersection was observed to operate relatively smoothly during the AM peak hour of traffic. This observation is consistent with the overall LOS B analysis result. All movements operate at LOS D or better.

Salt Lake Boulevard/Likini Place/Radford Drive

This signalized intersection was observed to operate relatively smoothly during the AM peak hour of traffic. This observation is consistent with the overall LOS C analysis result. The permissive westbound left-turn operates at LOS E due to the 214 vehicles having to wait for a gap in eastbound traffic. All other movements operate at LOS D or better.

Salt Lake Boulevard/Kahikolu Place

This unsignalized "tee"-intersection was observed to operate relatively smoothly during the AM peak hour of traffic along Salt Lake Boulevard. Delay

was observed on the southbound stopped control approach at LOS F. However, vehicles were not observed to queue along Kahikolu Place.

Salt Lake Boulevard/Salt Lake Shopping Center Driveway 1/ Aliamanu School Parking Lot

This signalized intersection was observed to operate relatively smoothly during the AM peak hour of traffic. The eastbound left-turn would occasionally experience delays while waiting for a gap in traffic between westbound vehicles. This result is supported by the analysis result of the eastbound left-turn operating at LOS B and the westbound movements operating at LOS A.

Although not an actual paved access the northbound approach was analyzed since vehicles were observed to perform those movements. The northbound vehicles originate from the dirt/gravel parking lot fronting Aliamanu Elementary/Middle School. This lot is used for parking and for school drop offs.

At this intersection, northbound and southbound left-turn and through movements are not permitted; however, vehicles were observed to perform those movements, which operate at LOS F.

Salt Lake Boulevard/Salt Lake Shopping Center Driveway 2/Aliamanu Elementary/Middle School Driveway

This unsignalized intersection operates like two “tee”-intersections since a raised median along Salt Lake Boulevard separates the eastbound and westbound lanes. The intersection was observed to operate smoothly and all movements operate at LOS D or better.

Salt Lake Boulevard/Ala Lilikoi Street

This intersection was observed to operate relatively smoothly during the AM peak hour of traffic. This observation is consistent with the overall LOS C analysis result. The eastbound left-turn operates at LOS E while all the other movements operate at LOS D or better.

Due to the short stacking distance along Salt Lake Boulevard (approximately 200 feet) between Ala Lilikoi Street and Arizona Road, eastbound

queues from the Arizona Road intersection would sometimes extend into the intersection. However, queues were observed to clear after each cycle length.

Salt Lake Boulevard/Arizona Road

This intersection was observed to operate relatively smoothly during the AM peak hour of traffic. This observation is consistent with the overall LOS C analysis result. All movements operate at LOS D or better.

PM Weekday Peak Hour of Traffic

During the weekday PM peak hour of traffic Salt Lake Boulevard was observed to carry heavier volumes in the westbound direction due to commuters returning home from work. Queues in the westbound direction at the intersection of Salt Lake Boulevard/Likini Place/Radford Drive were observed to extend to the Kahikolu Street intersection regularly and sometimes extended to the Ala Lilikoi intersection. Additionally, left-turn queues at the Salt Lake Boulevard/Likini Place/Radford Drive intersection were also observed to occasionally extend into the through lane causing additional delays to the through movement. However, beyond this intersection, the westbound traffic flows relatively smoothly.

Below is a description of the individual intersections.

Salt Lake Boulevard/Bougainville Drive

This signalized intersection was observed to operate with some congestion during the PM peak hour of traffic. This result is supported by the overall LOS F analysis result.

The eastbound through and westbound through major movements operate relatively smoothly at LOS C.

The southbound minor approach as well as the eastbound and westbound left-turn movements operate with longer delays at LOS E due to the long cycle length which gives preference to the major through movement along Salt Lake Boulevard. Although long delays were observed on those movements, the queues were typically able to clear during each cycle length of the traffic signal. However, the heavy northbound left-turn movement (418 vehicles)

operates at LOS F and overcapacity conditions; the queues sometimes clear after two (2) cycle lengths.

Salt Lake Boulevard/Lawehana Street

This signalized "tee"-intersection was observed to operate relatively smoothly during the PM peak hour of traffic. This result is supported by the overall LOS C analysis result. The major eastbound and westbound through movements were observed to operate with small delays at LOS B and A, respectively. The westbound left-turn and minor northbound approach operate with longer delays at LOS E and F most likely due to the long cycle length which gives preference to the major eastbound and westbound through movement. Although long delays were observed on those movements, the queues were able to clear during each cycle length of the traffic signal.

Salt Lake Boulevard/Pakini Street/Marshall Road

This signalized intersection was observed to operate relatively smoothly during the PM peak hour of traffic. This observation is consistent with the overall LOS B analysis result. The eastbound left-turn and westbound left-turn movements operate at LOS D while the minor southbound approach operates at LOS C, likely due to the long cycle length which gives preference to the major eastbound and westbound through movements. Although long delays were observed on those movements, the queues were able to clear during each cycle length of the traffic signal.

Salt Lake Boulevard/Maluna Street/Namur Road

This signalized intersection was observed to operate relatively smoothly during the PM peak hour of traffic. This observation is consistent with the overall LOS C analysis result. The minor northbound and southbound movements operate at LOS D. The eastbound and westbound left-turn movements operate at LOS F, likely due to the long cycle length which gives preference to the major eastbound and westbound through movements. Although long delays were observed on those movements, the queues were typically able to clear during each cycle length of the traffic signal.

Salt Lake Boulevard/Wanaka Street

This signalized "tee"-intersection was observed to operate relatively smoothly during the PM peak hour of traffic. This observation is consistent with the overall LOS A analysis result. All movements operate at LOS D or better.

Salt Lake Boulevard/Likini Place/Radford Drive

All the movements at this signalized intersection operate at LOS D or better. However, the westbound through queue was observed to extend to the Ala Lilikoi intersection. This would sometimes block the westbound left-turn vehicles from entering the left-turn pocket.

Salt Lake Boulevard/Kahikolu Place

At this unsignalized "tee"-intersection, the eastbound approach was observed to operate relatively smoothly while the westbound approach was observed to queue as described above. The southbound stopped controlled approach operates at LOS F due to the heavy volume along Salt Lake Boulevard.

Salt Lake Boulevard/Salt Lake Shopping Center Driveway 1/Aliamanu School Parking Lot

This unsignalized intersection was observed to operate with some congestion during the PM peak hour of traffic. The eastbound left-turn would occasionally experience delays while waiting for a gap in traffic between the westbound vehicles. Vehicles were observed to be slow moving in the westbound direction, most likely attributed to the high vehicle volume in this direction and operations at the signal at the Radford Drive/Likini Place/Salt Lake Boulevard intersection.

Although the analysis shows the eastbound left-turn to operate at LOS B, at times, this movement was observed to operate with longer delays. The northbound approach originates from a gravel parking lot for Aliamanu Elementary/Middle School. The left-turn and through movements are not permitted for the northbound and southbound approaches; however, some vehicles were observed to perform those movements. The analysis shows that the minor northbound left-turn and southbound movements operate at LOS F and

LOS D respectively, likely attributed to the limited amount of usable gaps between eastbound and westbound vehicles.

Salt Lake Boulevard/Salt Lake Shopping Center Driveway 2/Aliamanu Elementary/Middle School Driveway

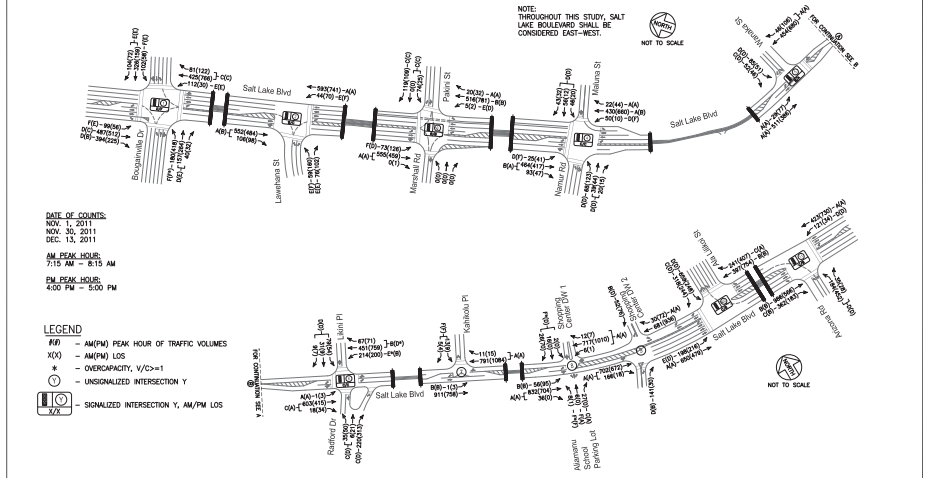
This unsignalized intersection was observed to operate relatively smoothly in the eastbound direction. In the westbound direction along Salt Lake Boulevard, queues originating from the intersection with Radford Drive/Likini Place were observed to extend to this intersection.

Salt Lake Boulevard/Ala Lilikoi Street

This intersection was observed to operate relatively smoothly during the PM peak hour of traffic. This observation is consistent with the overall LOS B analysis result. The analysis shows that the eastbound left-turn along with the southbound left-turn and right-turn movements operate at LOS D, likely due to the long cycle length which gives preference to the major eastbound and westbound through movement.

Salt Lake Boulevard/Arizona Road

This intersection was observed to operate relatively smoothly during the PM peak hour of traffic. This observation is consistent with the overall LOS B analysis result. All movements operate at LOS D or better.



SALT LAKE BLVD WIDENING

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
ENGINEERS,SURVEYORS · HONOLULU,HAWAII

EXISTING LANE CONFIGURATION, VOLUME AND LEVEL OF SERVICE

FIGURE 2

Table 1: Existing Intersection Level of Service Summary

Intersection	Existing 2011 Conditions					
	AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1 Salt Lake Boulevard/Bougainville Drive						
EB LT	91	0.80	F	78	0.59	E
EB TH	37	0.42	D	20	0.32	C
EB RT	50	0.67	D	18	0.17	B
WB LT	74	0.81	E	77	0.48	E
WB TH/RT	28	0.33	C	23	0.36	C
NB LT	89	0.84	F	357	1.61	F*
NB TH/RT	51	0.33	D	56	0.47	E
SB LT	82	0.73	F	77	0.58	E
SB TH/RT	72	0.85	E	72	0.67	E
Overall	54	0.76	D	81	0.67	F
2 Salt Lake Boulevard/Lawehana Street						
EB TH/RT	3	0.34	A	11	0.29	B
WB LT	79	0.63	E	82	0.66	F
WB TH	3	0.18	A	5	0.19	A
NB LT	78	0.63	E	83	0.79	F
NB RT	67	0.09	E	60	0.09	E
Overall	14	0.39	B	23	0.40	C
3 Salt Lake Boulevard/Marshall Road/Pakini Street						
EB LT	80	0.87	F	53	0.78	D
EB TH/RT	8	0.29	A	6	0.21	A
WB LT	79	0.63	E	41	0.20	D
WB TH	11	0.37	B	11	0.41	B
WB RT	9	0.02	A	8	0.03	A
SB LT/TH	30	0.51	C	32	0.23	C
SB RT	26	0.09	C	31	0.08	C
Overall	17	0.47	B	15	0.43	B
4 Salt Lake Boulevard/Maluna Street/Namur Road						
EB LT	51	0.42	D	101	0.83	F
EB TH/RT	12	0.36	B	8	0.23	A
WB LT	53	0.61	D	182	0.80	F
WB TH	10	0.24	A	10	0.32	B
WB RT	8	0.02	A	8	0.05	A
NB LT	43	0.56	D	52	0.68	D
NB TH/RT	37	0.24	D	41	0.33	D
SB LT/TH/RT	47	0.70	D	41	0.25	D
Overall	21	0.49	C	21	0.45	C
5 Salt Lake Boulevard/Wanaka Street						
EB LT	3	0.11	A	5	0.32	A
EB TH	7	0.61	A	4	0.39	A
WB TH/RT	7	0.59	A	4	0.85	A
SB LT	43	0.67	D	44	0.58	D
SB RT	32	0.06	C	38	0.05	D
Overall	11	0.62	B	7	0.82	A
6 Salt Lake Boulevard/Radford Drive/Likini Place						
EB LT	5	0.01	A	3	0.02	A
EB TH/RT	21	0.85	C	6	0.53	A
WB LT	71	1.00	E*	12	0.61	B
WB TH/RT	13	0.65	B	40	1.00	D*
NB LT/TH	32	0.38	C	46	0.65	D
NB RT	35	0.55	C	36	0.31	D
SB LT/TH/RT	47	0.75	D	44	0.63	D
Overall	29	0.94	C	29	0.94	C

Note:
* = over-capacity, v/c > 1
Err = applies to unsignalized intersection and usually operates better than shown in the analysis

Table 1: Existing Intersection Level of Service Summary Continued

Intersection	Existing 2011 Conditions					
	AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
7 Salt Lake Boulevard/Kahikolu Place						
EB LT	10	0.01	B	13	0.02	B
WB TH/RT	0	0.51	A	0	0.71	A
SB LT/RT	63	0.37	F	134	0.53	F
8 Salt Lake Boulevard/Shopping Center DW 1/Aliamanu School Parking Lot						
EB LT	10	0.08	B	13	0.20	B
EB TH/RT	0	0.59	A	0	0.46	A
WB LT/TH/RT	1	0.03	A	0	0.00	A
NB LT	Err	Err	F*	696	0.51	F
NB TH	69	0.13	F	0	0.00	A
NB RT	20	0.17	C	0	0.00	A
SB LT/TH/RT	314	1.36	F*	32	0.47	D
9 Salt Lake Boulevard/Shopping Center DW 2/Aliamanu Elementary/Middle School Driveway						
EB TH/RT	0	0.57	A	0	0.44	A
WB RT	0	0.02	A	0	0.05	A
NB RT	30	0.62	D	15	0.11	B
SB RT	15	0.14	B	28	0.39	D
10 Salt Lake Boulevard/Ala Lilikoi Street						
EB LT	55	0.79	E	52	0.73	D
EB TH	10	0.23	A	4	0.13	A
WB TH	18	0.31	B	11	0.44	B
WB RT	25	0.25	C	6	0.32	A
SB LT	39	0.74	D	44	0.52	D
SB RT	32	0.33	C	41	0.19	D
Overall	27	0.56	C	19	0.52	B
11 Salt Lake Boulevard/ Arizona Road						
EB TH	17	0.60	B	10	0.31	B
EB RT	27	0.31	C	17	0.14	B
WB LT	52	0.70	D	52	0.39	D
WB TH	5	0.17	A	7	0.32	A
NB LT/RT	45	0.63	D	46	0.76	D
Overall	23	0.63	C	19	0.42	B

Note:
* = over-capacity, v/c > 1
Err = applies to unsignalized intersection and usually operates better than shown in the analysis

III. BASE YEAR 2040 SCENARIO

The year 2040 was selected as the project build out year due to funding requirements which requires the projected year to be 20 years from the anticipated completion year of the Project. The Project is anticipated to be completed by year 2017.

A. Ambient Growth Rate

An ambient growth rate was estimated based on population data obtained from the Oahu Regional Transportation Plan (ORTP) 2035. The ORTP forecasts population and employment growth within designated regions around Oahu from year 2007 to a baseline year of 2035. Projections to year 2040 do not currently exist; therefore, the rate obtained from the ORTP was extrapolated to project to year 2040.

The majority of the Salt Lake area has already been built out to full development; thus traffic growth will be minimal. However, due to Salt Lake Boulevard's connectivity between Aiea and freeway on/off ramps, an average population growth was taken from these regions and forecasted to conservatively yield an ambient growth rate of about 1 percent between 2011 and 2040.

B. Other Known Developments

In addition to the ambient growth rate, projected traffic volumes for known developments which are anticipated to be completed and occupied by the year 2040 are added to the projected Base Year 2040 traffic volumes.

The only known project in the area is a Navy commercial/industrial development on a 18.5 acre lot located on the Joint Base Pearl Harbor-Hickam NAVFAC compound site between Radford Drive to the south, Salt Lake Boulevard to the north, Lawehana Street to the west and Namur Road to the east. However, due to the lack of information and uncertainty regarding this project, it was not included in the analysis for this report.

C. Base Year 2040 Analysis

As discussed above, year 2040 traffic volume was derived using a growth factor of 1.33. Base Year 2040 assumes that existing geometric conditions prevail.

For the purpose of this study, it was assumed that the currently closed access to the Navy compound at Marshall Road would be open by year 2040. Access to this compound is currently provided via two gates, one off of Radford Drive and the second one off of Namur Road. Since Namur Road provides similar accessibility to Salt Lake Boulevard as Marshall Road, it was assumed that some of the trips currently using Namur Road would divert onto Marshall Road with the opening of this access.

The Island Family Christian Church is located just east of Radford Drive along Salt Lake Boulevard and is currently on Navy land. It is possible that in the future this land will be sold and the Navy will restrict its access off of Radford Drive to military use only. Given that possibility, the new property owner would need to provide its own access off of Salt Lake Boulevard.

Based on preliminary geometric assessments, the access to the church would have to be limited to right-in/right-out only due to sight distance issues. However, the church is not anticipated to generate more than 15 trips during the AM and PM peak hours of traffic. Therefore, the relocated driveway would not significantly impact traffic conditions along Salt Lake Boulevard. See Appendix D for a summary of findings.

Analysis

Since no roadway improvements are planned and traffic volume is expected to increase, all the intersections traffic operations would increase in delay. The following signalized intersections would experience LOS F and/or overcapacity conditions overall as a result:

- Salt Lake Boulevard/Bougainville Drive – AM and PM peak hours of traffic

Mitigation:

Re-stripe the northbound through movement into a left-turn lane. With this lane configuration, the minor approaches would improve. The northbound left-turn movement would improve from 425 seconds delay to 87 seconds and the intersection would improve from LOS F to LOS D during the PM peak hour of traffic. During the AM peak hour of traffic, the delays would remain relatively the same.

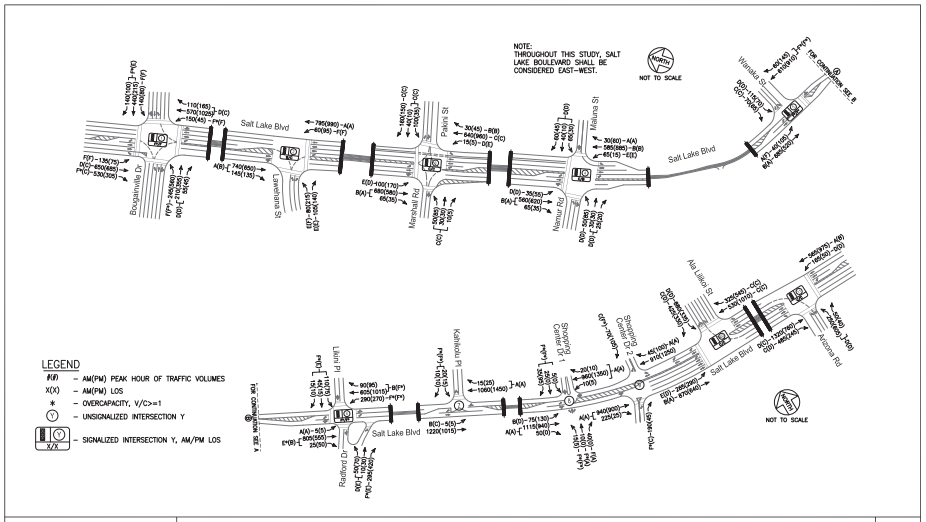
- Salt Lake Boulevard/Wanaka Street – PM peak hour of traffic
- Salt Lake Boulevard/Radford Drive/Likini Place – AM and PM peak hours of traffic

In addition to the increase in traffic volume, the long delays on the minor approaches and eastbound and westbound turning movements are also due to traffic signal coordination and/or preference given to the major thoroughfare, Salt Lake Boulevard. Therefore, it is recommended that certain intersections be coordinated during both peak hours of traffic:

- Lawehana Street and Marshsall/ Road/Pakini Street with Bougainville Drive
- Radford Drive/Likini Place with Ala Lilikoi Street.

At unsignalized intersections, the delays would be on the stop controlled approaches. In general, the delays represented in the analysis are much greater than would actually occur; this is due to gaps in traffic and other field conditions such as the presence of refuge lanes which are not taken into account in the analysis.

See Figure 3 and 4 for the Base Year 2040 and Base Year 2040 with Mitigations volume and LOS. See Table 2 for a summary of the Existing, Base Year 2040 and Base Year 2040 with Mitigations LOS.

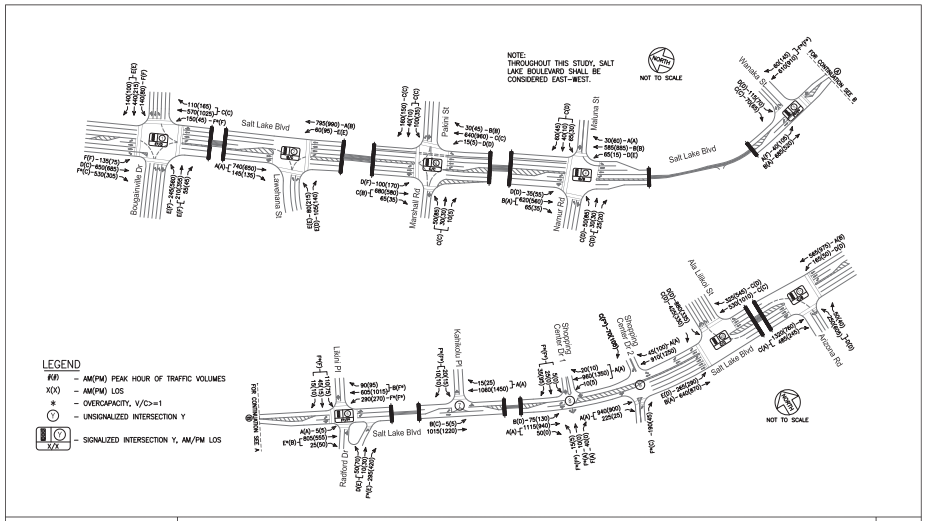


SALT LAKE BLVD WIDENING

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
ENGINEERS,SURVEYORS · HONOLULU,HAWAII

BASE YEAR 2040 VOLUME AND LEVEL OF SERVICE

FIGURE 3



SALT LAKE BLVD WIDENING	AUSTIN, TSUTSUMI & ASSOCIATES, INC. ENGINEERS,SURVEYORS • HONOLULU,HAWAII
	BASE YEAR 2040 WITH MITIGATION VOLUME AND LEVEL OF SERVICE
	FIGURE 4

Table 2: Existing, Base Year 2040 and Base Year 2040 with Mitigations Intersection Level of Service Summary

	Existing Conditions						Base Year 2040						Base Year 2040 with Mitigation					
	AM			PM			AM			PM			AM			PM		
Intersection	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
Salt Lake Boulevard/Bougainville Drive																		
EB LT	91	0.80	F	78	0.59	E	101	0.88	F	87	0.72	F	101	0.88	F	95	0.76	F
EB TH	37	0.42	D	20	0.32	C	46	0.62	D	28	0.48	C	46	0.62	D	31	0.51	C
EB RT	50	0.67	D	18	0.17	B	149	1.15	F*	24	0.22	C	149	1.15	F*	27	0.22	C
WB LT	74	0.81	E	77	0.48	E	134	1.07	F*	82	0.61	F	148	1.07	F*	101	0.61	F
WB TH/RT	28	0.33	C	23	0.36	C	37	0.51	D	31	0.54	C	35	0.52	C	21	0.58	C
NB LT	89	0.84	F	357	1.61	F*	105	0.95	F	461	1.85	F*	76	0.75	E	92	0.96	F
NB TH/RT	51	0.33	D	56	0.47	E	52	0.44	D	53	0.55	D	75	0.86	E	82	0.94	F
SB LT	82	0.73	F	77	0.58	E	83	0.79	F	81	0.67	F	83	0.79	F	81	0.67	F
SB TH/RT	72	0.85	E	72	0.67	E	135	1.12	F*	74	0.78	E	67	0.88	E	63	0.64	E
Overall	54	0.76	D	81	0.67	F	89	1.09	F*	100	0.91	F	78	1.03	E*	49	0.76	D
Salt Lake Boulevard/Lanikuhana Street																		
EB TH/RT	3	0.34	A	11	0.29	B	4	0.48	A	17	0.42	B	6	0.48	A	5	0.43	A
WB LT	79	0.63	E	82	0.66	F	81	0.71	F	89	0.73	F	71	0.71	E	75	0.71	E
WB TH	3	0.18	A	5	0.19	A	4	0.31	A	8	0.34	A	1	0.31	A	13	0.35	B
NB LT	78	0.63	E	83	0.79	F	80	0.69	E	91	0.88	F	80	0.69	E	77	0.82	E
NB RT	67	0.09	E	60	0.09	E	65	0.12	E	58	0.12	E	65	0.12	E	53	0.12	D
Overall	14	0.39	B	23	0.40	C	15	0.53	B	27	0.54	C	14	0.53	B	23	0.55	C
Salt Lake Boulevard/Marshall Road/Pakini Street																		
EB LT	80	0.87	F	53	0.78	D	75	0.89	E	43	0.73	D	52	0.75	D	100	0.96	F
EB TH/RT	8	0.29	A	6	0.21	A	13	0.45	B	8	0.35	A	21	0.46	C	13	0.37	B
WB LT	79	0.63	E	41	0.20	D	39	0.47	D	71	0.59	E	42	0.54	D	45	0.45	D
WB TH	11	0.37	B	11	0.41	B	22	0.75	C	27	0.85	C	26	0.80	C	25	0.84	C
WB RT	9	0.02	A	8	0.03	A	12	0.03	B	12	0.04	B	13	0.03	B	11	0.04	B
NB LT/TH/RT	0	0.00	0	0	0.00	0	26	0.32	C	34	0.54	C	25	0.29	C	30	0.49	C
SB LT/TH	30	0.51	C	32	0.23	C	33	0.67	C	31	0.29	C	31	0.64	C	28	0.26	C
SB RT	26	0.09	C	31	0.08	C	24	0.12	C	29	0.10	C	24	0.12	C	27	0.10	C
Overall	17	0.47	B	15	0.43	B	24	0.81	C	23	0.76	C	26	0.74	C	28	0.77	C
Salt Lake Boulevard/Moluna Street/Namu'u Road																		
EB LT	51	0.42	D	101	0.83	F	52	0.52	D	54	0.65	D	42	0.48	D	54	0.65	D
EB TH/RT	12	0.36	B	8	0.23	A	14	0.46	B	8	0.29	A	16	0.52	B	8	0.29	A
WB LT	53	0.61	D	182	0.80	F	61	0.71	E	63	0.56	E	45	0.64	D	63	0.56	E
WB TH	10	0.24	A	10	0.32	B	13	0.49	B	16	0.65	B	14	0.55	B	16	0.65	B
WB RT	8	0.02	A	8	0.05	A	9	0.03	A	9	0.07	A	10	0.03	A	9	0.07	A
NB LT	43	0.56	D	52	0.68	D	38	0.36	D	45	0.57	D	29	0.30	C	45	0.57	D
NB TH/RT	37	0.24	D	41	0.33	D	36	0.18	D	39	0.26	D	28	0.16	C	39	0.26	D
SB LT/TH/RT	47	0.70	D	41	0.25	D	47	0.72	D	41	0.38	D	34	0.64	C	41	0.38	D
Overall	21	0.49	C	21	0.45	C	22	0.58	C	19	0.64	B	20	0.61	B	19	0.64	B
Salt Lake Boulevard/Wanaka Street																		
EB LT	3	0.11	A	5	0.32	A	4	0.22	A	85	0.99	F	4	0.22	A	85	0.99	F
EB TH	7	0.61	A	4	0.39	A	16	0.86	B	5	0.56	A	16	0.86	B	5	0.56	A
WB TH/RT	7	0.59	A	4	0.85	A	506	2.08	F*	927	3.02	F*	506	2.08	F*	927	3.02	F*
SB LT	43	0.67	D	44	0.58	D	43	0.71	D	40	0.64	D	43	0.71	D	40	0.64	D
SB RT	32	0.06	C	38	0.05	D	29	0.08	C	31	0.07	C	29	0.08	C	31	0.07	C
Overall	11	0.62	B	7	0.82	A	221	1.85	F*	545	2.71	F*	221	1.85	F*	545	2.71	F*
Salt Lake Boulevard/Radford Drive/Lilikoi Place																		
EB LT	5	0.01	A	3	0.02	A	5	0.08	A	10	0.13	A	5	0.07	A	9	0.13	A
EB TH/RT	21	0.85	C	6	0.53	A	71	1.09	E*	14	0.73	B	62	1.06	E*	13	0.72	B
WB LT	71	1.00	E*	12	0.61	B	639	2.34	F*	108	1.14	F*	537	2.12	F*	86	1.09	F*
WB TH/RT	13	0.65	B	40	1.00	D*	19	0.83	B	190	1.37	F*	15	0.81	B	173	1.34	F*
NB LT/TH	32	0.38	C	46	0.65	D	46	0.65	D	62	0.80	E	53	0.68	D	75	0.84	E
NB RT	35	0.55	C	36	0.31	D	165	1.19	F*	73	0.88	E	178	1.21	F*	71	0.84	E
SB LT/TH/RT	47	0.75	D	44	0.63	D	191	1.25	F*	74	0.86	E	236	1.35	F*	102	0.95	F
Overall	29	0.94	C	29	0.94	C	143	2.11	F*	111	1.27	F*	132	1.97	F*	103	1.27	F*

Note:
* = over-capacity, v/c > 1
Err = applies to unsignalized intersection. Intersections usually operate better than shown in the analysis

Table 2: Existing, Base Year 2040 and Base Year 2040 with Mitigations Intersection Level of Service Summary Continued

	Existing Conditions						Base Year 2040						Base Year 2040 with Mitigation					
	AM			PM			AM			PM			AM			PM		
Intersection	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
Salt Lake Boulevard/Kahikolu Place																		
EB LT	10	0.01	B	13	0.02	B	12	0.04	B	24	0.06	C	12	0.04	B	24	0.06	C
WB TH/RT	0	0.51	A	0	0.71	A	0	0.68	A	0	0.95	A	0	0.68	A	0	0.95	A
NB LT/RT	63	0.37	F	134	0.53	F	Err	4.85	F*	1059	2.49	F*	Err	5.52	F*	1155	2.66	F*
Salt Lake Boulevard/Shopping Center Driveway 1																		
EB LT	10	0.08	B	13	0.20	B	13	0.16	B	33	0.55	D	13	0.16	B	33	0.55	D
EB TH/RT	0	0.59	A	0	0.46	A	0	0.79	A	0	0.61	A	0	0.79	A	0	0.61	A
WB LT/TH/RT	1	0.03	A	0	0.00	A	6	0.10	A	2	0.03	A	7	0.10	A	2	0.03	A
NB LT	Err	Err	F*	696	0.51	F	Err	Err	F*	Err	Err	F*	Err	Err	F*	Err	Err	F*
NB TH	69	0.13	F	0	0.00	A	1496	1.99	F*	0	0.00	A	1709	2.23	F*	0	0.00	A
NB RT	20	0.17	C	0	0.00	A	73	0.60	F	0	0.00	A	75	0.61	F	0	0.00	A
SB LT/TH/RT	314	1.36	F*	32	0.47	D	Err	Err	F*	363	1.54	F*	Err	Err	F*	363	1.54	F*
Salt Lake Boulevard/Shopping Center Driveway 2/Alamanu Intermediate																		
EB TH/RT	0	0.57	A	0	0.44	A	0	0.77	A	0	0.59	A	0	0.77	A	0	0.59	A
WB RT	0	0.02	A	0	0.05	A	0	0.04	A	0	0.07	A	0	0.04	A	0	0.07	A
NB RT	30	0.62	D	15	0.11	B	298	1.51	F*	20	0.22	C	300	1.51	F*	20	0.22	C
SB RT	15	0.14	B	28	0.39	D	22	0.27	C	247	1.26	F*	22	0.27	C	247	1.26	F*
Salt Lake Boulevard/Ala Lilikoi Street																		
EB LT	55	0.79	E	52	0.73	D	69	0.92	E	48	0.76	D	61	0.92	E	42	0.76	D
EB TH	10	0.23	A	4	0.13	A	13	0.33	B	5	0.19	A	12	0.33	B	5	0.19	A
WB TH	18	0.31	B	11	0.44	B	22	0.51	C	23	0.70	C	23	0.51	C	28	0.70	C
WB RT	25	0.25	C	6	0.32	A	27	0.33	C	33	0.45	C	30	0.33	C	50	0.45	D
SB LT	39	0.74	D	44	0.52	D	41	0.86	D	43	0.59	D	41	0.86	D	43	0.59	D
SB RT	32	0.33	C	41	0.19	D	31	0.50	C	39	0.27	D	31	0.50	C	39	0.27	D
Overall	27	0.56	C	19	0.52	B	31	0.74	C	27	0.69	C	30	0.74	C	32	0.69	C
Salt Lake Boulevard/ Arizona Road																		
EB TH	17	0.60	B	10	0.31	B	36	0.93	D	21	0.45	C	34	0.94	C	9	0.42	A
EB TH/RT																		
EB RT	27	0.31	C	17	0.14	B	27	0.54	C	40	0.18	D						
WB LT	52	0.70	D	52	0.39	D	53	0.78	D	52	0.50	D	53	0.78	D	52	0.50	D
WB TH	5	0.17	A	7	0.32	A	6	0.23	A	10	0.45	B	6	0.23	A	10	0.45	B
NB LT/RT	45	0.63	D	46	0.76	D	45	0.73	D	46	0.85	D	45	0.73	D	46	0.85	D
Overall	23	0.63	C	19	0.42	B	32	0.85	C	26	0.56	C	33	0.86	C	20	0.56	B

Note:
* = over-capacity, v/c > 1
Err = applies to unsignalized intersection. Intersections usually operate better than shown in the analysis

IV. COMPLETE STREETS CONSIDERATIONS

"Complete Streets" is a concept which aims at providing opportunities for safe and comfortable facilities for motorists, transit users, pedestrians and bicyclists. This includes, but is not limited to aesthetic improvements such as planter strips, buffers between the different uses, pedestrian connectivity to various attractions and narrower travel ways for shorter pedestrian crossing distances. However, in most cases, the extent to which "Complete Streets" can be achieved relies heavily on the right-of-way (ROW) available and the type of funding available. Other factors include but are not limited to the following:

- Existing traffic conditions
- Community needs and desires
- Number and types of users
- Existing and planned land uses
- Utilities
- Parking needs

Based on the Alternative Alignment Study Summary for Salt Lake Boulevard Widening, conducted by Austin, Tsutsumi & Associates, Inc. in 2012, three (3) main alternatives were considered and consisted of various combinations of:

- Exclusive bike lanes/shared travel lane (vehicles and bikes)
- Parking lanes
- Multi-use path (pedestrian and bike path)
- Landscape strip/furnishings

Pros and cons of each alternative were considered which led to the recommendation of Alternative A which is the alternative used in this report. Alternative A was selected because of its minimal impact to the existing corridor, requiring the least amount of pavement, providing street parking along residential lots and provision of better transition to existing residential driveways.

The Project is in a fully developed area which already provides transit opportunities. The existing bus route does not go through Salt Lake Boulevard where the widening is planned to occur. It instead goes though the residential area via Likini Place and travels roughly parallel to Salt Lake Boulevard before reconnecting with Salt Lake Boulevard at Maluna Street.

The Project is proposing the following:

- Eastbound: one (1) 11 foot-travel lane and one (1) 17–foot shared travel lane and bike lane
- Westbound: two (2) 11-foot travel lanes and one (1) 5-foot bike lane, with no parking lane
- 14-foot wide median which includes 10-foot turning lanes where needed
- 8-foot sidewalk on the north side and 6-foot sidewalk on the south side
- 15-foot landscape strip on the north side

Although not all of the ideal elements of Complete Streets are present, the Project would provide for all forms of transportation.

Although the general design elements were determined from the Alternative Alignment Study Summary for Salt Lake Boulevard Widening, this report also took into considerations other factors that would further provide for a "Complete Street" concept and were discussed in the report where applicable.

V. ROUNDABOUT CONSIDERATION

The Hawaii Department of Transportation's (HDOT) December 2008 "Modern Roundabouts Policy Guideline" currently only allows modern single-lane roundabouts. However, operational analysis would indicate that double-lane roundabouts would be required at Salt Lake Boulevard's intersection with Wanaka Street, Radford Drive/Likini Place, and Kahikolu Place.

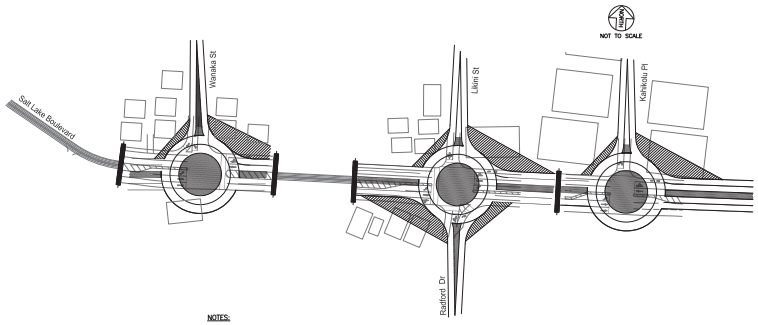
However, Salt Lake Boulevard traffic volume is much higher than on its intersecting side streets; therefore, the flow will not be balanced. As stated in the "Roundabouts: An Informational Guide" (2010), where "intersections of a major arterial

and a minor arterial or local road […] roundabouts delay and deflect all traffic entering the intersection and could introduce excessive delay or speed inconsistencies to flow on the major arterial." In addition, physical requirements for double-lane roundabouts at the proposed intersections would be:

- Right-of-way (ROW) acquisition:
  - Additional ROW would be necessary to accommodate the space needed for a double-lane roundabout.
  - Sight easements would be necessary due to sight distance requirements which would affect existing structures at the corners of the intersections.
- Driveway access:
  - Due to the close proximity of some of the driveways to the proposed roundabout, some driveway accesses may need to be restricted and/or relocated.
- Roadway alignment:
  - Approaches into a roundabout should ideally be at 90-degree angles. However, Salt Lake Boulevard at its intersection with Wanaka Street and Radford Drive at its intersection with Salt Lake Boulevard and Likini Place are skewed and may need to be re-aligned.

Therefore, due to the physical requirements of double-lane roundabouts and the fact that only single lane roundabouts are allowed, roundabouts at the intersections of Salt Lake Boulevard with Wanaka Street, Radford Drive/Likini Place and Kahikolu Place are not recommended.

See Figure 5 for an illustration of the physical impacts of double-lane roundabouts at the intersections, See Table 3 for a summary of the LOS.



NOTES:

1. THE DOUBLE-LANE ROUNDABOUTS DEPICTED HEREIN DO NOT REPRESENT ACTUAL STRIPING PATTERNS AND CURVES; THEY HAVE BEEN INCLUDED FOR ILLUSTRATIVE PURPOSES, PRIMARILY TO DEMONSTRATE THE ESTIMATED RIGHT-OF-WAY AND SIGHT EASEMENT IMPACTS UPON EXISTING STRUCTURES.
2. SIGHT EASEMENT BOUNDARIES ARE ONLY APPROXIMATE AND WOULD BE AFFECTED BY THE GEOMETRICS OF THE ROUNDABOUT.
3. CAPACITY ANALYSIS WOULD INDICATE THAT SINGLE-LANE ROUNDABOUTS WOULD OPERATE OVER-CAPACITY AND AT LOS F AT ANY OF THESE THREE INTERSECTIONS DURING THE AM AND/OR PM PEAK HOUR OF TRAFFIC.
4. THE ROUNDABOUT FOOTPRINT WOULD ALSO SEVER AND/OR RESTRICT ACCESS TO EXISTING DRIVEWAYS.

LEGEND

▭ – EXISTING STRUCTURE

▨ – ESTIMATED SIGHT DISTANCE EASEMENT

FOR ILLUSTRATIVE PURPOSES ONLY; NOT FOR CONSTRUCTION PURPOSES

SALT LAKE BLVD WIDENING

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
ENGINEERS,SURVEYORS • HONOLULU,HAWAII

FIGURE 5

DOUBLE LANE ROUNDABOUT IMPACT AT INTERSECTIONS

Table 3: Year 2040 Single and Double Lane Roundabout Analysis

Intersection	Signle Lane Roundabout						Double Lane Roundabout					
	AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
Salt Lake Boulevard/Wanaka Street												
EB LT/TH	24	0.84	C	14	0.67	B	8	0.41	A	7	0.32	A
EB TH/RT							9	0.46	A	7	0.35	A
WB LT/TH							7	0.35	A	11	0.55	B
WB TH/RT	14	0.69	B	109	1.18	F*	8	0.39	A	12	0.61	B
SB LT/TH/RT	12	0.38	B	17	0.41	C						
SB LT/RT							8	0.20	A	11	0.31	B
Salt Lake Boulevard/Radford Drive/Likini Place												
EB LT/TH							20	0.71	C	11	0.44	B
EB TH/RT							24	0.78	C	11	0.49	B
EB LT/TH/RT	275	1.56	F*	63	1.02	F*						
WB LT/TH							11	0.56	B	19	0.78	C
WB TH/RT							13	0.62	B	27	0.87	D
WB LT/TH/RT	83	1.11	F*	320	1.67	F*						
NB LT/TH							12	0.26	B	8	0.22	A
NB LT/TH/RT	181	1.29	F*	99	1.11	F*						
NB RT							35	0.79	D	21	0.71	C
SB LT/TH/RT	26	0.61	D	49	0.68	E	17	0.50	C	20	0.43	C
Salt Lake Boulevard/Kahikolu Place												
EB LT/TH	154	1.29	F*	70	1.08	F*	13	0.65	B	10	0.52	A
EB TH/RT							11	0.73	C	11	0.58	B
WB LT/TH							9	0.51	A	15	0.71	B
WB TH/RT	52	1.02	F*	237	1.49	F*	11	0.58	B	19	0.80	C
SB LT/RT	13	0.17	B	22	0.24	C						
SB LT/RT							9	0.13	A	13	0.15	B

Note:
* = over-capacity, v/c > 1

VI. YEAR 2040 TRAFFIC CONDITIONS WITH PROJECT

The Project would widen the remainder of Salt Lake Boulevard between its intersection with Maluna Street/Namur Road and Ala Lilikoi Street. The widened roadway would provide two travel lanes along Salt Lake Boulevard in either direction as well as turning lanes where necessary and a bike lane on the north and south side of the roadway.

At the intersection of Salt Lake Boulevard/Shopping Center Driveway 1/Aliamanu Elementary/Middle School Parking Lot, the roadway widening would eliminate the existing wide paved shoulder which currently provides direct access to the unpaved parking lot. As a result, the exiting trips entering/exiting this parking lot were re-assigned to the Aliamanu Elementary/Middle School Driveway or Arizona Road which also provides access to the schools.

The Project is not anticipated to significantly impact traffic operations at the intersections where Salt Lake Boulevard has already been widened. Therefore, the following intersections along Salt Lake Boulevard would operate at conditions similar to Base Year 2040 with Mitigations:

- Bougainville Drive
- Lawehana Street
- Marshall Road/Pakini Street
- Maluna Street/Namur Road
- Ala Lilikoi Street
- Arizona Road

Therefore, only intersections where Salt Lake Boulevard is widened will be discussed. Two (2) scenarios were analyzed:

- Year 2040 with Project and raised medians between intersections
- Year 2040 with Project without raised medians

Below is a summary of the analysis for each scenario.

A. Year 2040 with Project and Raised Medians

Several driveways north of Salt Lake Boulevard currently provide access to residential areas. The raised medians would eliminate mid-block left-turn access into those residential areas. Therefore, to allow access to those sites, U-turn movements would be necessary at the following intersections along Salt Lake Boulevard:

- Wanaka Street
- Radford Drive/Likini Place
- Kahikolu Place

Due to the limited sight distance[2] provided for U-turn movements at the intersections of Salt Lake Boulevard/Radford Drive/Likini Place and Salt Lake Boulevard/Wanaka Street, the shared left-turn/U-turn movements would operate with a protected phase. Similarly, since the unsignalized intersection of Salt Lake Boulevard/Kahikolu Place has limited sight distance[3] for U-turns a traffic signal would need to be installed at this intersection even though the traffic volume would not warrant a traffic signal. Trucks would not be allowed to make U-turns and the cross street should have a “Right-Turn on Red Yield to U-turn” sign to avoid potential conflicts.

In order to determine the number of U-turns at each intersection, the number of dwellings was estimated and trips generated using the Institute of Transportation Engineers (ITE), Trip Generation, 8th Edition for single detached dwellings and apartments. It was assumed that approximately 50 percent of the trips generated would be making U-turns.

Analysis

The Project would improve traffic progression along Salt Lake Boulevard due to the additional lanes and as a result also improve traffic operations along the minor approaches.

---

[2] Based on AASHTO “Decision Sight Distance” criteria for a design speed of 35 MPH and suburban road.

[3] See footnote 2.

Salt Lake Boulevard/Wanaka Street

With the Project the intersection would operate at LOS D or better on all the movements during both AM and PM peak hours of traffic.

Salt Lake Boulevard/Radford Drive/Likini Place

The intersection would significantly improve over Base Year conditions from LOS F and overcapacity conditions to LOS C during both AM and PM peak hours of traffic. However, the heavy westbound shared U-turn/left-turn movement and southbound approach would continue to experience long delays, LOS E, during the AM peak hour of traffic. All other movements would operate at LOS D or better during the AM and PM peak hours of traffic.

Salt Lake Boulevard/Kahikolu Place

This intersection should be coordinated with the intersection of Salt Lake Boulevard/Ala Lilikoi Street. With this signal configuration, the intersection would operate at LOS D or better on all movements during the AM and PM peak hour of traffic.

As a "Complete Streets" element, a crosswalk should be provided on the westbound approach to allow pedestrians coming from the north and west to access the Aliamanu Schools located approximately 600-feet to the south east of the intersection. Without this crosswalk, pedestrians would have to cross at the intersection of Salt Lake Boulevard/Ala Lilikoi intersection then back track to the Aliamanu School driveway.

B. Future Year 2040 with Project without Raised Medians

Without the raised medians the residential area can be accessed through mid-block left-turn movements. Where wide medians are provided, they would act as a storage/refuge lane.

Mid-block left-turn movements would require vehicles to cross two lanes of traffic, in some cases three (3) lanes. Due to queuing from the nearby signal these mid-block left-turn vehicles may experience sight distance issues. Similarly, the close proximity of residential driveways may result in potential queuing and sight distance issues for left-turn movements in and out of those

driveways. For those reasons, U-turns are recommended at the following intersections with Salt Lake Boulevard:

- Wanaka Street
- Radford Drive/Likini Place
- Kahikolu Place

Analysis

Overall, the intersections would operate at conditions similar or better than the alternative with the raised medians since mid-block left-turn movements would be allowed and would reduce the traffic volume at the intersections. Analysis for this alternative was performed without U-turns as a means of comparison with the previous alternative. However, with U-turns allowed, the intersections would operate similar to the alternative with the raised medians.

Salt Lake Boulevard/Wanaka Street

All movements would operate at LOS D or better during both peak hours of traffic. The wide medians would provide some storage for the mid-block left-turn vehicles.

However, U-turns are recommended at this intersection due to some anticipated sight distance issues.

Salt Lake Boulevard/Radford Drive/Likini Place

This intersection should be coordinated with the intersection of Salt Lake Boulevard/Ala Lilikoi Street. The intersection would significantly improve over base year conditions. The minor southbound approach would operate at LOS E during the AM peak hour of traffic. All other movements would operate at LOS D or better during the AM and PM peak hour of traffic.

The analysis shows the intersection without any U-turn. However, U-turns are recommended due to the fact that some mid-block left-turn movements will have to occur in close proximity to the intersection. Therefore, with U-turns the intersection would operate similar to the alternative with the raised medians.

Salt Lake Boulevard/Kahikolu Place

Without a signal, the intersection southbound approach would operate at LOS E and F during the AM and PM peak hour of traffic, respectively. All other movements would operate at LOS D or better.

However, an eastbound U-turn movement is recommended at this intersection due to the westbound left-turn queue from the Salt Lake Boulevard/Radford Drive/Likini Place intersection. During the peak hours of traffic it is possible that this queue could block access to the residential driveways. Additionally, mid-block left-turn vehicles would have to cross three lanes of traffic.

The U-turn would require a signal at the intersection as well as a protected eastbound left-turn phasing. With this configuration, the intersection would operate similar to the alternative with the raised medians.

Both alternatives would accommodate the Year 2040 traffic volume demand along Salt Lake Boulevard. Some delays are expected on the major approach turning movement due to the heavy demand and on the minor approaches due to preference given to the major thoroughfare. However, the projected volume would likely be lower since the growth used is deemed conservative for the following reasons:

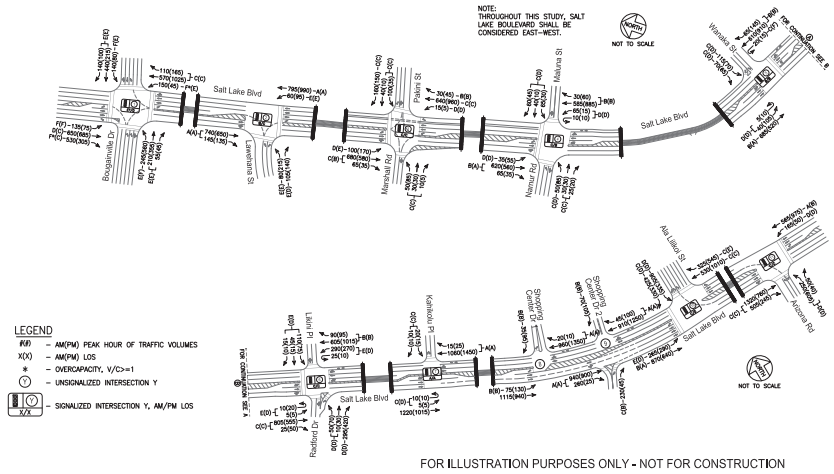
- Traffic volume has not significantly increased over the past 13 years
- The ORTP does not project a significant growth in the area (under one (1) percent)
- Salt Lake Boulevard is not a regional roadway, therefore the widening is not anticipated to attract regional trips

Without raised medians to prevent mid-block left-turn movements, it is recommended that some type of barrier such as an eight (8) inch curb be implemented where sight distances will be limited and/or conflicts are anticipated. Based on field observations it was determined that the location that would most likely need a barrier is:

- Salt Lake Boulevard at Radford Drive/Likini Place

The raised medians would prevent mid-block left-turn access, which is more of an inconvenience to the residents than a traffic operational impact. From an operational standpoint, mid-block left-turns at certain locations would experience sight distance issues. For that reason U-turns should be allowed at intersections to provide options and barriers installed where deemed necessary to ensure that mid-block left-turn are restricted.

As previously mentioned the Island Family Christian Church will potentially be able to buy the land it sits on and therefore no longer granted access via Radford Drive which is a military access. An exclusive access to the church site of off Salt Lake Boulevard would have to be limited to a right-in/right-out only due to sight distance issues. The church is not anticipated to generate significant trips during the AM and PM peak hours of traffic and therefore would operate satisfactorily.



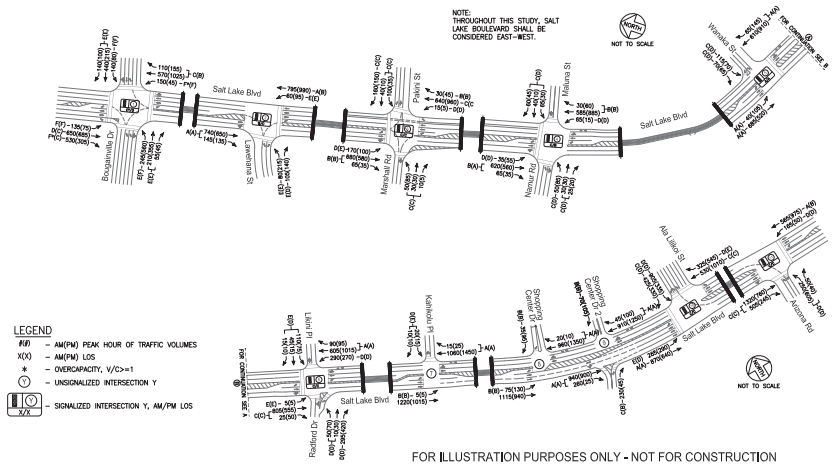
FOR ILLUSTRATION PURPOSES ONLY - NOT FOR CONSTRUCTION

SALT LAKE BLVD WIDENING

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
ENGINEERS, SURVEYORS • HONOLULU, HAWAII

FIGURE 6

YEAR 2040 WITH PROJECT LANE CONFIGURATION WITH RAISED MEDIAN VOLUME AND LEVEL OF SERVICE



FOR ILLUSTRATION PURPOSES ONLY - NOT FOR CONSTRUCTION

SALT LAKE BLVD WIDENING

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
ENGINEERS, SURVEYORS • HONOLULU, HAWAII

FIGURE 7

YEAR 2040 WITH PROJECT LANE CONFIGURATION VOLUME AND LEVEL OF SERVICE

Table 4: Base Year 2040 with Mitigation, Year 2040 with Project and Raised Median and Year 2040 with Project Intersection Level of Service Summary

Intersection	Base Year 2040 with Mitigation						Year 2040 with Project and Raised Medians						Year 2040 with Project					
	AM			PM			AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1 Salt Lake Boulevard/Bougainville Drive																		
EB LT	101	0.88	F	95	0.76	F	101	0.88	F	95	0.76	F	101	0.88	F	95	0.76	F
EB TH	46	0.62	D	31	0.51	C	46	0.62	D	34	0.53	C	46	0.62	D	30	0.50	C
EB RT	149	1.15	F*	27	0.22	C	149	1.15	F*	28	0.23	C	149	1.15	F*	26	0.23	C
WB LT	148	1.07	F*	101	0.61	F	131	1.07	F*	73	0.61	E	136	1.07	F*	103	0.61	F
WB TH/RT	35	0.52	C	21	0.58	C	26	0.52	C	29	0.60	C	28	0.52	C	19	0.57	B
NB LT	76	0.75	E	92	0.96	F	76	0.75	E	81	0.91	F	76	0.75	E	81	0.91	F
NB TH/RT	75	0.86	E	82	0.94	F	75	0.86	E	69	0.88	E	75	0.86	E	80	0.93	E
SB LT	83	0.79	F	81	0.67	F	83	0.79	F	80	0.66	E	83	0.79	F	95	0.76	F
SB TH/RT	67	0.88	E	63	0.64	E	67	0.88	E	62	0.61	E	67	0.88	E	68	0.71	E
Overall	78	1.03	E*	49	0.76	D	75	1.03	E*	48	0.76	D	75	1.03	E*	47	0.77	D
2 Salt Lake Boulevard/Lawehana Street																		
EB TH/RT	6	0.48	A	5	0.43	A	5	0.48	A	7	0.43	A	5	0.48	A	4	0.43	A
WB LT	71	0.71	E	75	0.71	E	72	0.71	E	68	0.71	E	77	0.71	E	77	0.71	E
WB TH	1	0.31	A	13	0.35	B	8	0.31	A	8	0.35	A	8	0.31	A	13	0.35	B
NB LT	80	0.69	E	77	0.82	E	80	0.69	E	77	0.82	E	80	0.69	E	77	0.82	E
NB RT	65	0.12	E	53	0.12	D	65	0.12	E	53	0.12	D	65	0.12	E	53	0.12	D
Overall	14	0.53	B	23	0.55	C	17	0.53	B	21	0.55	C	17	0.53	B	22	0.55	C
3 Salt Lake Boulevard/Marshall Road/Pakini Street																		
EB LT	52	0.75	D	100	0.96	F	52	0.75	D	80	0.87	E	50	0.75	D	64	0.82	E
EB TH/RT	21	0.46	C	13	0.37	B	21	0.46	C	13	0.37	B	17	0.46	B	14	0.36	B
WB LT	42	0.54	D	45	0.45	D	42	0.54	D	45	0.45	D	42	0.54	D	42	0.37	D
WB TH	26	0.80	C	25	0.84	C	26	0.80	C	27	0.86	C	26	0.80	C	26	0.85	C
WB RT	13	0.03	B	11	0.04	B	13	0.03	B	11	0.04	B	13	0.03	B	11	0.04	B
NB LT/TH/RT	25	0.29	C	30	0.49	C	25	0.29	C	30	0.49	C	25	0.29	C	30	0.49	C
SB LT/TH	31	0.64	C	28	0.26	C	31	0.64	C	28	0.26	C	31	0.64	C	28	0.26	C
SB RT	24	0.12	C	27	0.10	C	24	0.12	C	27	0.10	C	24	0.12	C	27	0.10	C
Overall	26	0.74	C	28	0.77	C	26	0.74	C	27	0.77	C	25	0.74	C	25	0.76	C
4 Salt Lake Boulevard/Maluna Street/Namur Road																		
EB LT	42	0.48	D	54	0.65	D	42	0.48	D	49	0.63	D	42	0.48	D	52	0.63	D
EB TH/RT	16	0.52	B	8	0.29	A	16	0.53	B	9	0.31	A	16	0.53	B	8	0.29	A
WB U/LT							43	0.63	D	45	0.39	D						
WB LT	45	0.64	D	63	0.56	E							42	0.60	D	53	0.49	D
WB TH	14	0.55	B	16	0.65	B												
WB TH/RT							15	0.58	B	18	0.74	B	15	0.58	B	18	0.71	B
WB RT	10	0.03	A	9	0.07	A												
NB LT	29	0.30	C	45	0.57	D	29	0.29	C	38	0.51	D	29	0.29	C	45	0.57	D
NB TH/RT	28	0.16	C	39	0.26	D	28	0.16	C	35	0.25	C	27	0.16	C	39	0.26	D
SB LT/TH/RT	34	0.64	C	41	0.38	D	34	0.63	C	36	0.35	D	34	0.63	C	40	0.38	D
Overall	20	0.61	B	19	0.64	B	21	0.63	C	20	0.75	B	20	0.63	C	20	0.68	B
5 Salt Lake Boulevard/Wanaka Street																		
EB U/LT							39	0.62	D	41	0.65	D						
EB LT	4	0.22	A	85	0.99	F							3	0.14	A	6	0.40	A
EB TH	16	0.86	B	5	0.56	A	11	0.50	B	4	0.23	A	4	0.35	A	3	0.20	A
WB U							25	0.10	C	86	0.64	F						
WB TH/RT	506	2.08	F*	927	3.02	F*	11	0.62	B	19	0.84	B	5	0.49	A	5	0.62	A
SB LT	43	0.71	D	40	0.64	D	25	0.51	C	42	0.60	D	25	0.56	C	51	0.57	D
SB RT	29	0.08	C	31	0.07	C	23	0.06	C	35	0.05	D	21	0.06	C	45	0.05	D
Overall	221	1.85	F*	545	2.71	F*	14	0.59	B	19	0.78	B	7	0.50	A	8	0.62	A

Note:
* = over-capacity, v/c > 1
Err = applies to unsignalized intersection. Intersections usually operate better than shown in the analysis

Table 4: Base Year 2040 with Mitigation, Year 2040 with Project and Raised Median and Year 2040 with Project Intersection Level of Service Summary Continued

Intersection	Base Year 2040 with Mitigation						Year 2040 with Project and Raised Medians						Year 2040 with Project					
	AM			PM			AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
6 Salt Lake Boulevard/Radford Drive/Likini Place																		
EB U/LT							57	0.47	E	55	0.39	D						
EB LT	5	0.07	A	9	0.13	A							66	0.53	E	69	0.32	E
EB TH/RT	62	1.06	E*	13	0.72	B	30	0.72	C	21	0.43	C	28	0.68	C	24	0.45	C
WB U/LT							59	0.88	E	54	0.85	D						
WB LT	537	2.12	F*	86	1.09	F*							51	0.86	D	53	0.74	D
WB TH/RT	15	0.81	B	173	1.34	F*	12	0.37	B	11	0.54	B	6	0.36	A	4	0.52	A
NB LT/TH	53	0.68	D	75	0.84	E	39	0.43	D	49	0.64	D	39	0.43	D	49	0.64	D
NB RT	178	1.21	F*	71	0.84	E	39	0.44	D	42	0.40	D	36	0.24	D	44	0.54	D
SB LT/TH/RT	236	1.35	F*	102	0.95	F	60	0.84	E	55	0.72	D	60	0.84	E	55	0.72	D
Overall	132	1.97	F*	103	1.27	F*	33	0.79	C	27	0.63	C	29	0.76	C	25	0.60	C
7 Salt Lake Boulevard/Kahikolu Place																		
EB U/LT							32	0.41	C	48	0.53	D						
EB LT	12	0.04	B	24	0.06	C							11	0.03	B	14	0.03	B
WB TH/RT	0	0.68	A	0	0.95	A	7	0.54	A	7	0.67	A	0	0.24	0	0	0.34	0
SB LT/RT	Err	5.52	F*	1155	2.66	F*	27	0.23	C	34	0.27	C	30	0.31	D	48	0.39	E
8 Salt Lake Boulevard/Shopping Center DW 1																		
EB LT	13	0.16	B	33	0.55	D	11	0.13	B	14	0.28	B	11	0.13	B	14	0.28	B
WB TH/RT							0	0.23	A	0	0.29	A	0	0.23	A	0	0.29	A
WB LT/TH/RT	7	0.10	A	2	0.03	A												
NB LT	Err	Err	F*	Err	Err	F*												
NB TH	1709	2.23	F*	0	0.00	A												
NB RT	75	0.61	F	0	0.00	A												
SB LT/TH/RT	Err	Err	F*	363	1.54	F*												
SB RT							11	0.08	B	11	0.19	B	11	0.08	B	11	0.19	B
9 Salt Lake Boulevard/Shopping Center DW 2/Alamanu Intermediate																		
EB TH/RT	0	0.77	0	0	0.59	0	0	0.42	A	0	0.21	A	0	0.42	A	0	0.21	A
WB TH/RT							0	0.23	A	0	0.34	A	0	0.23	A	0	0.34	A
NB RT	300	1.51	F*	20	0.22	C	20	0.60	C	12	0.12	B	19	0.59	C	13	0.13	B
SB RT	22	0.27	C	247	1.26	F*	10	0.11	B	10	0.17	B	10	0.11	B	10	0.17	B
10 Salt Lake Boulevard/Ala Lilikoi Street																		
EB LT	61	0.92	E	42	0.76	D	55	0.85	E	48	0.76	D	61	0.85	E	43	0.76	D
EB TH	12	0.33	B	5	0.19	A	13	0.33	B	5	0.19	A	9	0.33	A	3	0.19	A
WB TH	23	0.51	C	28	0.70	C	26	0.56	C	32	0.70	C	27	0.56	C	28	0.70	C
WB RT	30	0.33	C	50	0.45	D	33	0.33	C	75	0.45	E	42	0.33	D	60	0.45	E
SB LT	41	0.86	D	43	0.59	D	40	0.86	D	43	0.59	D	40	0.86	D	43	0.59	D
SB RT	31	0.50	C	39	0.27	D	29	0.44	C	39	0.27	D	29	0.44	C	39	0.27	D
Overall	30	0.74	C	32	0.69	C	30	0.75	C	38	0.69	D	31	0.75	C	33	0.69	C
11 Salt Lake Boulevard/ Arizona Road																		
EB TH/RT	34	0.94	C	9	0.42	A	34	0.94	C	21	0.42	C	32	0.94	C	23	0.42	C
WB LT	53	0.78	D	52	0.50	D	55	0.80	D	52	0.50	D	55	0.80	D	52	0.50	D
WB TH	6	0.23	A	10	0.45	B	6	0.23	A	10	0.45	B	6	0.23	A	10	0.45	B
NB LT/RT	45	0.73	D	46	0.85	D	45	0.73	D	46	0.85	D	45	0.73	D	46	0.85	D
Overall	33	0.86	C	20	0.56	B	32	0.86	C	24	0.56	C	31	0.86	C	25	0.56	C

Note:
* = over-capacity, v/c > 1
Err = applies to unsignalized intersection. Intersections usually operate better than shown in the analysis

VII. RECOMMENDATIONS

Base Year 2040

- *Salt Lake Boulevard/Bougainville* Drive - re-stripe the northbound through lane into a left-turn lane providing two northbound left-turn lanes.
- Provide traffic signal coordination between Bougainville Drive, Lawehana Street and Marshall Road/Pakini Street along Salt Lake Boulevard
- Provide traffic signal coordination between Radford Drive/Likini Place, Ala Lilikoi Street and Arizona Road along Salt Lake Boulevard
- With a separate access to the Island Family Christian Church, restrict access to right-in/right-out only

Year 2040 with Project with or without raised medians

- *Salt Lake Boulevard/Wanaka Street* – allow eastbound and westbound U-turn movements
- *Salt Lake Boulevard/Radford Drive/Likini Place* – allow eastbound and westbound U-turn movements
- *Salt Lake Boulevard/Kahikolu Place* – signalize the intersection, allow eastbound U-turn movements and provide a crosswalk on the westbound approach

Most likely trucks would not be able to perform U-turns therefore; a sign should indicate this prohibition. On cross-streets where right-turn on red are allowed a "Right Turn on Red Yield to U-turn" sign should be installed.

Without raised medians, it is also recommended that barriers be installed to restrict mid-block left-turn movements where sight distances would be an issue.

VIII. CONCLUSION

Base Year 2040

Salt Lake Boulevard is not expected to undergo a significant increase in traffic by year 2040. The widening of the remaining portion of Salt Lake Boulevard is also not

expected to attract a significant amount of regional traffic. Therefore, the growth factor of 1.33 used was deemed conservative.

Without the Project, traffic operation along Salt Lake Boulevard between Namur Road/Maluna Street and Ala Lilikoi Street would experience long delays especially at the intersection of Radford Drive/Likini Place.

Year 2040 with Project

Roundabouts were considered at the Project intersections; however, it was found that single-lane roundabouts would operate at LOS F and overcapacity conditions – and that double-lane roundabouts would be required to accommodate the traffic volume. However, the physical requirements – ROW acquisition, impacts to existing structures and driveways – would make the roundabout option undesirable.

Therefore, the Project would complete the Salt Lake Boulevard roadway widening while maintaining the existing operations at the Project intersections. The Project is expected to improve traffic operations at the intersections where Salt Lake Boulevard is being widened, while also providing enhanced access to pedestrians and bicyclists. However, some movements – primarily minor approaches and turning movements off of Salt Lake Boulevard – would continue to experience delays of LOS E or F.

With the proper measures taken at the critical locations (i.e. barriers where sight distances are an issue), the alternative without the raised medians would be the preferred alternative as it would allow vehicles to access their homes more directly thereby reducing the demand at the intersections.

IX. REFERENCES

1. American Association of State Highway and Transportation Officials, A Policy on Geometric Design of Highways and Streets, 6th Edition, 2011
2. American Association of State Highway and Transportation Officials, Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2004
3. Austin, Tsutsumi & Associates, Inc., Alternative Alignment Study Summary for Salt Lake Boulevard Widening Draft, 2011
4. NCHRP Report 672, Roundabouts: An Informational Guide, 2010
5. Institute of Transportation Engineers, Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities, 2005
6. Institute of Transportation Engineers, Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, 2010
7. Institute of Transportation Engineers, Trip Generation, 8th Edition, 2008
8. Federal Highway Administration (FHWA), Manual on Uniform Transportation Devices (MUTCD), 2009
9. Gresham Smith and Partners, Complete Streets Design Guidelines, 2009
10. Transportation Research Board, Highway Capacity Manual – HCM 2000.

Z:\2006\06-041\Salt Lake Blvd Widen\TIAR\submittal 071212\SL Blvd Report.doc

APPENDICES

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS · SURVEYORS

APPENDIX A

TRAFFIC COUNT DATA

Austin Tsutsumi & Asscociates
501 Sumner St. Ste. 521
Honolulu, HI 96817
(808) 533-3646

File Name : AM_Salt Lake - Bougainville
Site Code : 00000000
Start Date : 11/1/2011
Page No : 1

Groups Printed- Unshifted

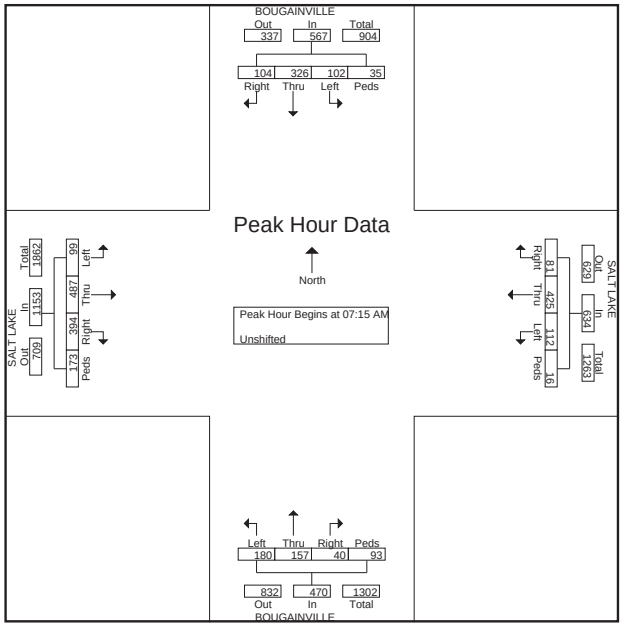
	BOUGAINVILLE From North					SALT LAKE From East					BOUGAINVILLE From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
06:30 AM	2	48	16	0	66	2	75	5	0	82	1	10	28	2	41	77	99	6	2	184	373
06:45 AM	12	71	21	0	104	15	83	8	0	106	2	12	16	2	32	97	97	2	1	197	439
Total	14	119	37	0	170	17	158	13	0	188	3	22	44	4	73	174	196	8	3	381	812
07:00 AM	14	80	26	3	123	19	100	8	1	128	5	21	25	7	58	91	117	11	8	227	536
07:15 AM	34	104	31	0	169	10	89	16	1	116	8	25	42	17	92	89	104	20	27	240	617
07:30 AM	29	99	33	9	170	11	136	31	10	188	14	32	46	39	131	116	140	29	40	325	814
07:45 AM	26	73	22	25	146	45	116	56	3	220	11	53	50	34	148	124	128	34	100	386	900
Total	103	356	112	37	608	85	441	111	15	652	38	131	163	97	429	420	489	94	175	1178	2867
08:00 AM	15	50	16	1	82	15	84	9	2	110	7	47	42	3	99	65	115	16	6	202	493
08:15 AM	10	31	16	1	58	20	118	3	2	143	1	20	34	2	57	52	96	12	1	161	419
Grand Total	142	556	181	39	918	137	801	136	19	1093	49	220	283	106	658	711	896	130	185	1922	4591
Apprch %	15.5	60.6	19.7	4.2		12.5	73.3	12.4	1.7		7.4	33.4	43	16.1		37	46.6	6.8	9.6		
Total %	3.1	12.1	3.9	0.8	20	3	17.4	3	0.4	23.8	1.1	4.8	6.2	2.3	14.3	15.5	19.5	2.8	4	41.9	

Austin Tsutsumi & Asscociates

501 Sumner St. Ste. 521
Honolulu, HI 96817
(808) 533-3646

File Name : AM_Salt Lake - Bougainville
Site Code : 00000000
Start Date : 11/1/2011
Page No : 2

	BOUGAINVILLE From North					SALT LAKE From East					BOUGAINVILLE From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:15 AM to 08:00 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:15 AM																					
07:15 AM	**34**	**104**	31	0	169	10	89	16	1	116	8	25	42	17	92	89	104	20	27	240	617
07:30 AM	29	99	**33**	9	**170**	11	**136**	31	**10**	188	**14**	32	46	**39**	131	116	**140**	29	40	325	814
07:45 AM	26	73	22	**25**	146	**45**	116	**56**	3	**220**	11	**53**	**50**	34	**148**	**124**	128	**34**	**100**	**386**	**900**
08:00 AM	15	50	16	1	82	15	84	9	2	110	7	47	42	3	99	65	115	16	6	202	493
Total Volume	104	326	102	35	567	81	425	112	16	634	40	157	180	93	470	394	487	99	173	1153	2824
% App. Total	18.3	57.5	18	6.2		12.8	67	17.7	2.5		8.5	33.4	38.3	19.8		34.2	42.2	8.6	15		
PHF	.765	.784	.773	.350	.834	.450	.781	.500	.400	.720	.714	.741	.900	.596	.794	.794	.870	.728	.433	.747	.784



Austin Tsutsumi & Asscociates

501 Sumner St. Ste. 521
Honolulu, HI 96817
(808) 533-3646

File Name : AM_Lawehana - Salt Lake (recount)
Site Code : 00000000
Start Date : 11/1/2011
Page No : 1

Groups Printed- Unshifted

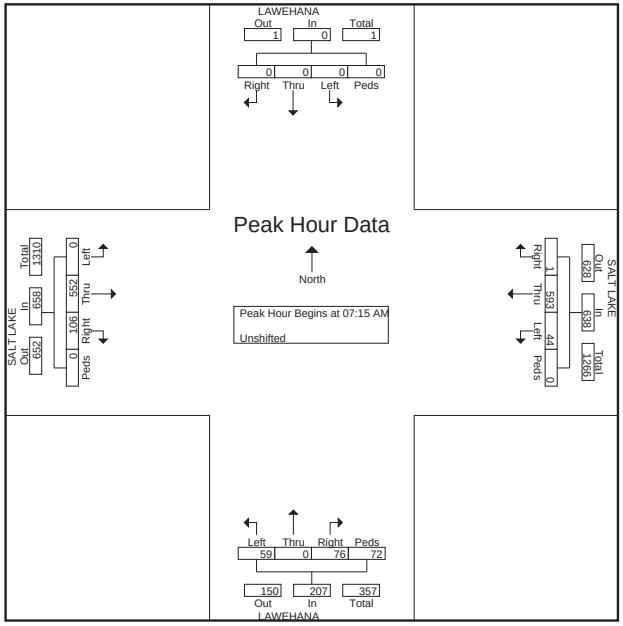
	LAWEHANA From North					SALT LAKE From East					LAWEHANA From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
07:15 AM	0	0	0	0	0	0	117	3	0	120	11	0	11	16	38	17	138	0	0	155	313
07:30 AM	0	0	0	0	0	1	179	6	0	186	21	0	7	30	58	24	169	0	0	193	437
07:45 AM	0	0	0	0	0	0	192	21	0	213	29	0	23	25	77	28	129	0	0	157	447
Total	0	0	0	0	0	1	488	30	0	519	61	0	41	71	173	69	436	0	0	505	1197
08:00 AM	0	0	0	0	0	0	105	14	0	119	15	0	18	1	34	37	116	0	0	153	306
Grand Total	0	0	0	0	0	1	593	44	0	638	76	0	59	72	207	106	552	0	0	658	1503
Apprch %	0	0	0	0		0.2	92.9	6.9	0		36.7	0	28.5	34.8		16.1	83.9	0	0		
Total %	0	0	0	0	0	0.1	39.5	2.9	0	42.4	5.1	0	3.9	4.8	13.8	7.1	36.7	0	0	43.8	

Austin Tsutsumi & Asscociates

501 Sumner St. Ste. 521
Honolulu, HI 96817
(808) 533-3646

File Name : AM_Lawehana - Salt Lake (recount)
Site Code : 00000000
Start Date : 11/1/2011
Page No : 2

	LAWEHANA From North					SALT LAKE From East					LAWEHANA From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:15 AM to 08:00 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:15 AM																					
07:15 AM	0	0	0	0	0	0	117	3	0	120	11	0	11	16	38	17	138	0	0	155	313
07:30 AM	0	0	0	0	0	**1**	179	6	0	186	21	0	7	**30**	58	24	**169**	0	0	**193**	437
07:45 AM	0	0	0	0	0	0	**192**	**21**	0	**213**	**29**	0	**23**	25	**77**	28	129	0	0	157	**447**
08:00 AM	0	0	0	0	0	0	105	14	0	119	15	0	18	1	34	**37**	116	0	0	153	306
Total Volume	0	0	0	0	0	1	593	44	0	638	76	0	59	72	207	106	552	0	0	658	1503
% App. Total	0	0	0	0		0.2	92.9	6.9	0		36.7	0	28.5	34.8		16.1	83.9	0	0		
PHF	.000	.000	.000	.000	.000	.250	.772	.524	.000	.749	.655	.000	.641	.600	.672	.716	.817	.000	.000	.852	.841



Austin, Tsutsumi & Associates

501 Sumner Street Suite 521
Honolulu, HI, Zip 96817
(808) 533-3646

File Name : AM_Pakini-Marshall - Salt Lake
Site Code : 00000000
Start Date : 12/13/2011
Page No : 1

Groups Printed- Unshifted

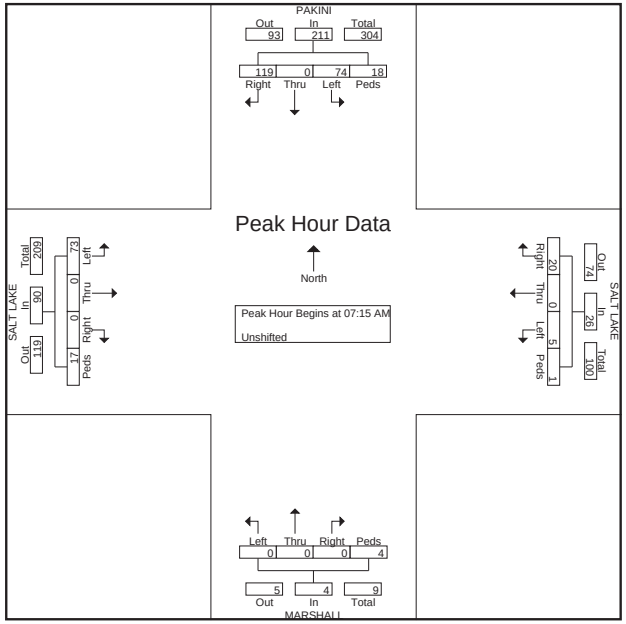
	PAKINI From North					SALT LAKE From East					MARSHALL From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
07:15 AM	24	0	33	1	58	4	0	1	0	5	0	0	0	0	0	0	0	15	2	17	80
07:30 AM	36	0	21	9	66	7	0	1	1	9	0	0	0	2	2	0	0	17	12	29	106
07:45 AM	36	0	8	4	48	6	0	3	0	9	0	0	0	0	0	0	0	26	2	28	85
Total	96	0	62	14	172	17	0	5	1	23	0	0	0	2	2	0	0	58	16	74	271
08:00 AM	23	0	12	4	39	3	0	0	0	3	0	0	0	2	2	0	0	15	1	16	60
08:15 AM	21	0	5	0	26	2	0	0	0	2	0	0	1	0	1	1	0	13	2	16	45
Grand Total	140	0	79	18	237	22	0	5	1	28	0	0	1	4	5	1	0	86	19	106	376
Apprch %	59.1	0	33.3	7.6		78.6	0	17.9	3.6		0	0	20	80		0.9	0	81.1	17.9		
Total %	37.2	0	21	4.8	63	5.9	0	1.3	0.3	7.4	0	0	0.3	1.1	1.3	0.3	0	22.9	5.1	28.2	

Austin, Tsutsumi & Associates

501 Sumner Street Suite 521
Honolulu, HI, Zip 96817
(808) 533-3646

File Name : AM_Pakini-Marshall - Salt Lake
Site Code : 00000000
Start Date : 12/13/2011
Page No : 2

	PAKINI From North					SALT LAKE From East					MARSHALL From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:15 AM to 08:00 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:15 AM																					
07:15 AM	24	0	**33**	1	58	4	0	1	0	5	0	0	0	0	0	0	0	15	2	17	80
07:30 AM	**36**	0	21	**9**	**66**	**7**	0	1	**1**	**9**	0	0	0	**2**	**2**	0	0	17	**12**	**29**	**106**
07:45 AM	36	0	8	4	48	6	0	**3**	0	9	0	0	0	0	0	0	0	**26**	2	28	85
08:00 AM	23	0	12	4	39	3	0	0	0	3	0	0	0	2	2	0	0	15	1	16	60
Total Volume	119	0	74	18	211	20	0	5	1	26	0	0	0	4	4	0	0	73	17	90	331
% App. Total	56.4	0	35.1	8.5		76.9	0	19.2	3.8		0	0	0	100		0	0	81.1	18.9		
PHF	.826	.000	.561	.500	.799	.714	.000	.417	.250	.722	.000	.000	.000	.500	.500	.000	.000	.702	.354	.776	.781



Austin, Tsutsumi & Associates

501 Sumner Street Suite 521
Honolulu, HI, Zip 96817
(808) 533-3646

File Name : AM_Salt Lake - Namur - Maluna
Site Code : 00000000
Start Date : 11/1/2011
Page No : 1

Groups Printed- Unshifted

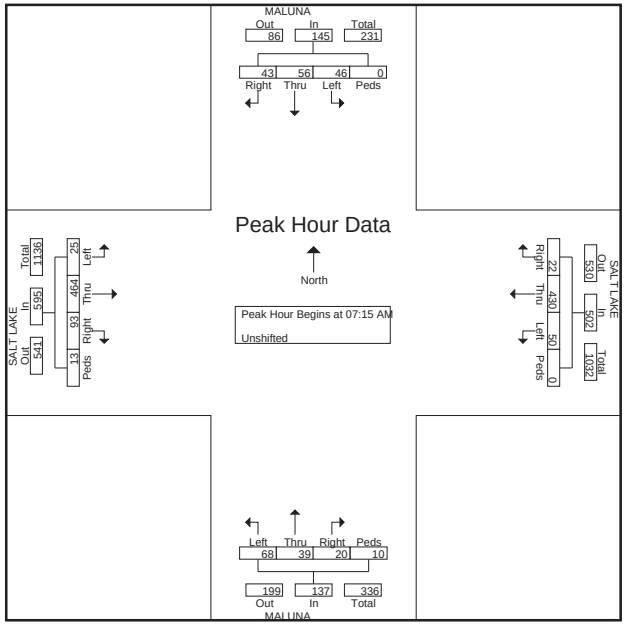
	MALUNA From North					SALT LAKE From East					MALUNA From South					SALT LAKE From West						
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	U-Turns	Peds	App. Total	Int. Total
07:15 AM	8	27	11	0	46	7	85	19	0	111	2	5	14	4	25	28	107	6	1	2	144	326
07:30 AM	10	16	10	0	36	2	135	15	0	152	9	9	21	2	41	32	144	7	3	1	187	416
07:45 AM	15	9	11	0	35	7	116	8	0	131	6	15	18	2	41	17	134	5	2	1	159	366
Total	33	52	32	0	117	16	336	42	0	394	17	29	53	8	107	77	385	18	6	4	490	1108
08:00 AM	10	4	14	0	28	6	94	8	0	108	3	10	15	2	30	16	79	7	0	3	105	271
Grand Total	43	56	46	0	145	22	430	50	0	502	20	39	68	10	137	93	464	25	6	7	595	1379
Apprch %	29.7	38.6	31.7	0		4.4	85.7	10	0		14.6	28.5	49.6	7.3		15.6	78	4.2	1	1.2		
Total %	3.1	4.1	3.3	0	10.5	1.6	31.2	3.6	0	36.4	1.5	2.8	4.9	0.7	9.9	6.7	33.6	1.8	0.4	0.5	43.1	

Austin, Tsutsumi & Associates

501 Sumner Street Suite 521
Honolulu, HI, Zip 96817
(808) 533-3646

File Name : AM_Salt Lake - Namur - Maluna
Site Code : 00000000
Start Date : 11/1/2011
Page No : 2

	MALUNA From North					SALT LAKE From East					MALUNA From South					SALT LAKE From West						
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	U-Turns	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:15 AM to 08:00 AM - Peak 1 of 1																						
Peak Hour for Entire Intersection Begins at 07:15 AM																						
07:15 AM	8	**27**	11	0	**46**	**7**	85	**19**	0	111	2	5	14	**4**	25	28	107	6	1	2	144	326
07:30 AM	10	16	10	0	36	2	**135**	15	0	**152**	**9**	9	**21**	2	**41**	**32**	**144**	**7**	**3**	1	**187**	**416**
07:45 AM	**15**	9	11	0	35	7	116	8	0	131	6	**15**	18	2	41	17	134	5	2	1	159	366
08:00 AM	10	4	**14**	0	28	6	94	8	0	108	3	10	15	2	30	16	79	7	0	**3**	105	271
Total Volume	43	56	46	0	145	22	430	50	0	502	20	39	68	10	137	93	464	25	6	7	595	1379
% App. Total	29.7	38.6	31.7	0		4.4	85.7	10	0		14.6	28.5	49.6	7.3		15.6	78	4.2	1	1.2		
PHF	.717	.519	.821	.000	.788	.786	.796	.658	.000	.826	.556	.650	.810	.625	.835	.727	.806	.893	.500	.583	.795	.829



Austin, Tsutsumi & Associates

501 Sumner Street Suite 521
Honolulu, HI, Zip 96817
(808) 533-3646

File Name : AM_Salt Lake - Wanaka
Site Code : 00000000
Start Date : 11/1/2011
Page No : 1

Groups Printed- Unshifted

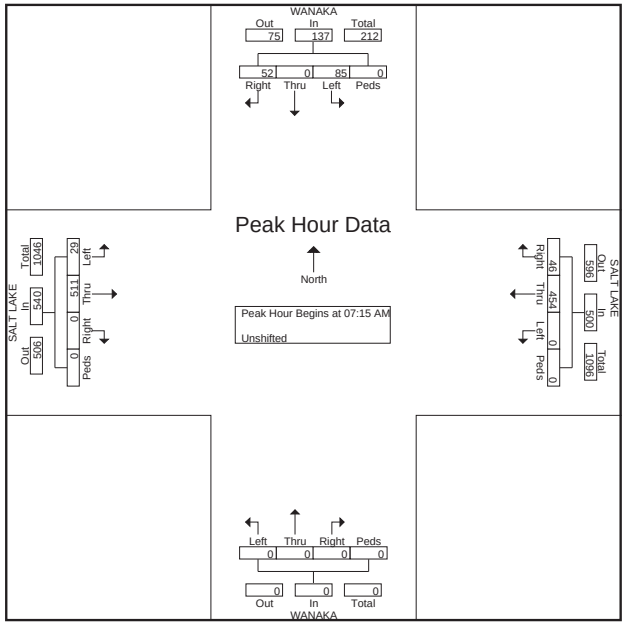
	WANAKA From North					SALT LAKE From East					WANAKA From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
07:15 AM	13	0	25	0	38	10	95	0	0	105	0	0	0	0	0	0	128	3	0	131	274
07:30 AM	16	0	22	0	38	12	126	0	0	138	0	0	0	0	0	0	148	11	0	159	335
07:45 AM	15	0	20	0	35	9	123	0	0	132	0	0	0	0	0	0	140	7	0	147	314
Total	44	0	67	0	111	31	344	0	0	375	0	0	0	0	0	0	416	21	0	437	923
08:00 AM	8	0	18	0	26	15	110	0	0	125	0	0	0	0	0	0	95	8	0	103	254
Grand Total	52	0	85	0	137	46	454	0	0	500	0	0	0	0	0	0	511	29	0	540	1177
Apprch %	38	0	62	0		9.2	90.8	0	0		0	0	0	0		0	94.6	5.4	0		
Total %	4.4	0	7.2	0	11.6	3.9	38.6	0	0	42.5	0	0	0	0	0	0	43.4	2.5	0	45.9	

Austin, Tsutsumi & Associates

501 Sumner Street Suite 521
Honolulu, HI, Zip 96817
(808) 533-3646

File Name : AM_Salt Lake - Wanaka
Site Code : 00000000
Start Date : 11/1/2011
Page No : 2

	WANAKA From North					SALT LAKE From East					WANAKA From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:15 AM to 08:00 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:15 AM																					
07:15 AM	13	0	**25**	0	**38**	10	95	0	0	105	0	0	0	0	0	0	128	3	0	131	274
07:30 AM	**16**	0	22	0	38	12	**126**	0	0	**138**	0	0	0	0	0	0	**148**	**11**	0	**159**	**335**
07:45 AM	15	0	20	0	35	9	123	0	0	132	0	0	0	0	0	0	140	7	0	147	314
08:00 AM	8	0	18	0	26	**15**	110	0	0	125	0	0	0	0	0	0	95	8	0	103	254
Total Volume	52	0	85	0	137	46	454	0	0	500	0	0	0	0	0	0	511	29	0	540	1177
% App. Total	38	0	62	0		9.2	90.8	0	0		0	0	0	0		0	94.6	5.4	0		
PHF	.813	.000	.850	.000	.901	.767	.901	.000	.000	.906	.000	.000	.000	.000	.000	.000	.863	.659	.000	.849	.878



Austin, Tsutsumi, & Associates

501 Sumner Street Honolulu, Hawaii 96817 suite 521
1-808-533-3646

File Name : AM_Salt Lake - Radford
Site Code : 00000000
Start Date : 11/1/2011
Page No : 1

Groups Printed- Unshifted - Bank 1

	RADFORD From North					SALT LAKE From East					RADFORD From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
06:30 AM	1	6	18	1	26	6	82	57	0	145	17	2	1	2	22	5	128	0	4	137	330
06:45 AM	0	7	32	2	41	4	73	60	0	137	26	0	4	3	33	5	141	1	4	151	362
Total	1	13	50	3	67	10	155	117	0	282	43	2	5	5	55	10	269	1	8	288	692
07:00 AM	1	6	20	3	30	10	73	65	0	148	36	0	13	3	52	8	131	0	6	145	375
07:15 AM	2	8	28	0	38	18	96	62	0	176	44	0	5	7	56	4	150	0	7	161	431
07:30 AM	0	10	20	3	33	19	129	36	0	184	67	1	14	5	87	7	186	1	13	207	511
07:45 AM	4	10	14	0	28	17	111	59	0	187	69	4	15	0	88	5	140	0	1	146	449
Total	7	34	82	6	129	64	409	222	0	695	216	5	47	15	283	24	607	1	27	659	1766
08:00 AM	3	3	17	0	23	13	115	57	0	185	40	1	1	0	42	2	127	0	0	129	379
08:15 AM	0	1	17	1	19	9	96	49	0	154	41	1	3	0	45	4	120	1	1	126	344
Grand Total	11	51	166	10	238	96	775	445	0	1316	340	9	56	20	425	40	1123	3	36	1202	3181
Apprch %	4.6	21.4	69.7	4.2		7.3	58.9	33.8	0		80	2.1	13.2	4.7		3.3	93.4	0.2	3		
Total %	0.3	1.6	5.2	0.3	7.5	3	24.4	14	0	41.4	10.7	0.3	1.8	0.6	13.4	1.3	35.3	0.1	1.1	37.8	
Unshifted	11	51	166	10	238	96	775	445	0	1316	340	9	56	20	425	40	1123	3	36	1202	3181
% Unshifted	100	100	100	100	100	100	100	100	0	100	100	100	100	100	100	100	100	100	100	100	100
Bank 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Bank 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

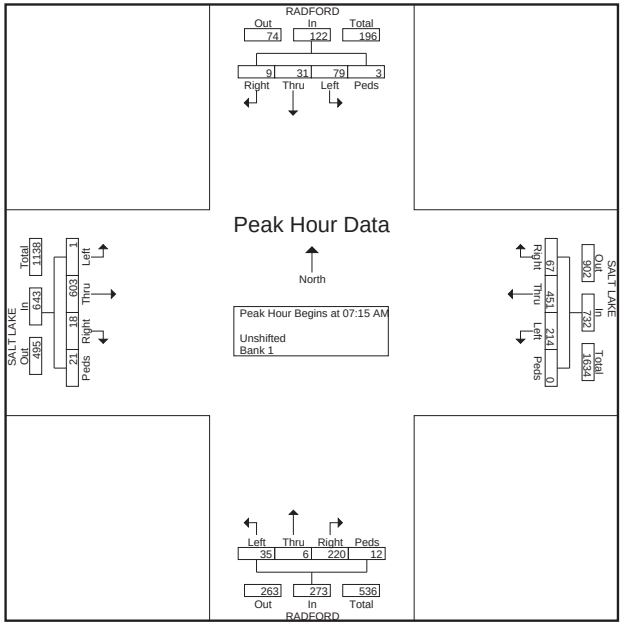
Austin, Tsutsumi, & Associates

501 Sumner Street Honolulu, Hawaii 96817 suite 521

1-808-533-3646

File Name : AM_Salt Lake - Radford
Site Code : 00000000
Start Date : 11/1/2011
Page No : 2

	RADFORD From North					SALT LAKE From East					RADFORD From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 06:30 AM to 08:15 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:15 AM																					
07:15 AM	2	8	**28**	0	**38**	18	96	**62**	0	176	44	0	5	**7**	56	4	150	0	7	161	431
07:30 AM	0	**10**	20	**3**	33	**19**	**129**	36	0	184	67	1	14	5	87	**7**	**186**	**1**	**13**	**207**	**511**
07:45 AM	**4**	10	14	0	28	17	111	59	0	**187**	**69**	**4**	**15**	0	**88**	5	140	0	1	146	449
08:00 AM	3	3	17	0	23	13	115	57	0	185	40	1	1	0	42	2	127	0	0	129	379
Total Volume	9	31	79	3	122	67	451	214	0	732	220	6	35	12	273	18	603	1	21	643	1770
% App. Total	7.4	25.4	64.8	2.5		9.2	61.6	29.2	0		80.6	2.2	12.8	4.4		2.8	93.8	0.2	3.3		
PHF	.563	.775	.705	.250	.803	.882	.874	.863	.000	.979	.797	.375	.583	.429	.776	.643	.810	.250	.404	.777	.866



Austin, Tsutsumi & Associates

501 Sumner Street Suite 521
Honolulu, HI, Zip 96817
(808) 533-3646

File Name : AM_Kahikolu - Salt Lake
Site Code : 00000000
Start Date : 11/1/2011
Page No : 1

Groups Printed- Class 1

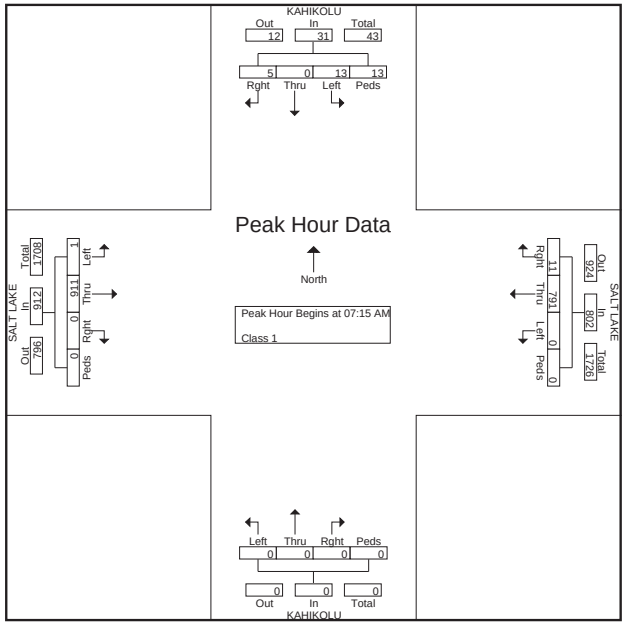
	KAHIKOLU From North					SALT LAKE From East					KAHIKOLU From South					SALT LAKE From West					
Start Time	Rght	Thru	Left	Peds	App. Total	Rght	Thru	Left	Peds	App. Total	Rght	Thru	Left	Peds	App. Total	Rght	Thru	Left	Peds	App. Total	Int. Total
06:30 AM	2	0	3	1	6	2	149	0	0	151	0	0	0	0	0	0	155	0	0	155	312
06:45 AM	0	0	4	0	4	0	148	0	0	148	0	0	0	0	0	0	196	0	0	196	348
Total	2	0	7	1	10	2	297	0	0	299	0	0	0	0	0	0	351	0	0	351	660
07:00 AM	0	0	3	2	5	2	151	0	1	154	0	0	0	0	0	0	190	0	0	190	349
07:15 AM	0	0	5	3	8	4	184	0	0	188	0	0	0	0	0	0	225	0	0	225	421
07:30 AM	4	0	3	5	12	2	212	0	0	214	0	0	0	0	0	0	269	1	0	270	496
07:45 AM	1	0	2	0	3	2	187	0	0	189	0	0	0	0	0	0	235	0	0	235	427
Total	5	0	13	10	28	10	734	0	1	745	0	0	0	0	0	0	919	1	0	920	1693
08:00 AM	0	0	3	5	8	3	208	0	0	211	0	0	0	0	0	0	182	0	0	182	401
08:15 AM	1	0	3	0	4	1	106	0	0	107	0	0	0	0	0	0	100	0	0	100	211
Grand Total	8	0	26	16	50	16	1345	0	1	1362	0	0	0	0	0	0	1552	1	0	1553	2965
Apprch %	16	0	52	32		1.2	98.8	0	0.1		0	0	0	0		0	99.9	0.1	0		
Total %	0.3	0	0.9	0.5	1.7	0.5	45.4	0	0	45.9	0	0	0	0	0	0	52.3	0	0	52.4	

Austin, Tsutsumi & Associates

501 Sumner Street Suite 521
Honolulu, HI, Zip 96817
(808) 533-3646

File Name : AM_Kahikolu - Salt Lake
Site Code : 00000000
Start Date : 11/1/2011
Page No : 2

	KAHIKOLU From North					SALT LAKE From East					KAHIKOLU From South					SALT LAKE From West					
Start Time	Rght	Thru	Left	Peds	App. Total	Rght	Thru	Left	Peds	App. Total	Rght	Thru	Left	Peds	App. Total	Rght	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 06:30 AM to 08:15 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:15 AM																					
07:15 AM	0	0	**5**	3	8	**4**	184	0	0	188	0	0	0	0	0	0	225	0	0	225	421
07:30 AM	**4**	0	3	**5**	**12**	2	**212**	0	0	**214**	0	0	0	0	0	0	**269**	**1**	0	**270**	**496**
07:45 AM	1	0	2	0	3	2	187	0	0	189	0	0	0	0	0	0	235	0	0	235	427
08:00 AM	0	0	3	5	8	3	208	0	0	211	0	0	0	0	0	0	182	0	0	182	401
Total Volume	5	0	13	13	31	11	791	0	0	802	0	0	0	0	0	0	911	1	0	912	1745
% App. Total	16.1	0	41.9	41.9		1.4	98.6	0	0		0	0	0	0		0	99.9	0.1	0		
PHF	.313	.000	.650	.650	.646	.688	.933	.000	.000	.937	.000	.000	.000	.000	.000	.000	.847	.250	.000	.844	.880

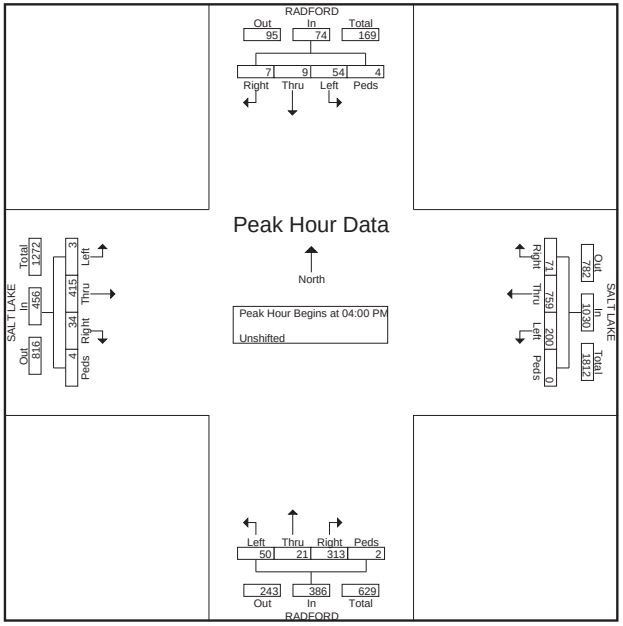


Austin Tsutsumi & Associates

501 Sumner St. Ste. 521
Honolulu, HI 96817
(808) 533-3646

File Name : PM_Radford - Salt Lake (recount)
Site Code : 00000000
Start Date : 11/1/2011
Page No : 2

	RADFORD From North					SALT LAKE From East					RADFORD From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	0	1	13	1	15	19	191	46	0	256	71	5	7	0	83	**12**	107	0	1	**120**	474
04:15 PM	1	1	**16**	**2**	20	10	182	38	0	230	82	**7**	12	**1**	102	4	**114**	**1**	1	120	472
04:30 PM	2	**6**	12	1	**21**	**22**	**210**	**66**	0	**298**	**86**	3	**17**	1	**107**	7	107	1	0	115	**541**
04:45 PM	**4**	1	13	0	18	20	176	50	0	246	74	6	14	0	94	11	87	1	**2**	101	459
Total Volume	7	9	54	4	74	71	759	200	0	1030	313	21	50	2	386	34	415	3	4	456	1946
% App. Total	9.5	12.2	73	5.4		6.9	73.7	19.4	0		81.1	5.4	13	0.5		7.5	91	0.7	0.9		
PHF	.438	.375	.844	.500	.881	.807	.904	.758	.000	.864	.910	.750	.735	.500	.902	.708	.910	.750	.500	.950	.899



Austin, Tsutsumi & Associates

501 Sumner Street Suite 521
Honolulu, HI, Zip 96817
(808) 533-3646

File Name : PM_Salt Lake - Kahikolu
Site Code : 00000000
Start Date : 11/1/2011
Page No : 1

Groups Printed- Unshifted

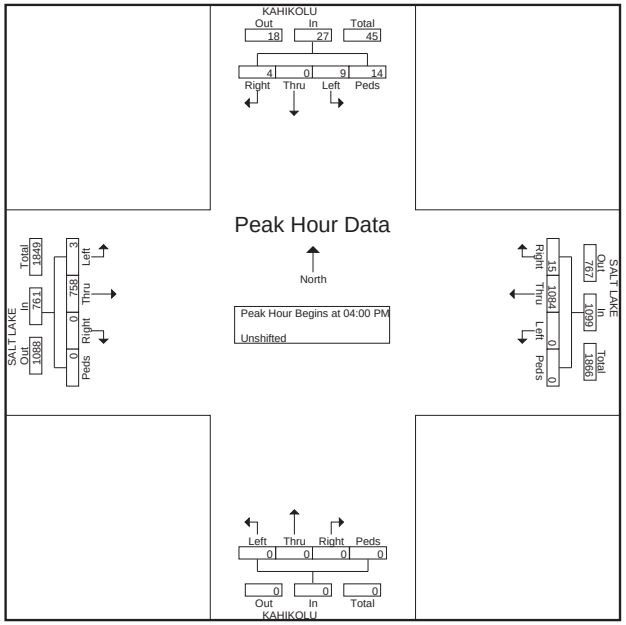
	KAHIKOLU From North					SALT LAKE From East					KAHIKOLU From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
04:00 PM	0	0	2	2	4	2	264	0	0	266	0	0	0	0	0	0	181	0	0	181	451
04:15 PM	1	0	2	7	10	7	249	0	0	256	0	0	0	0	0	0	214	0	0	214	480
04:30 PM	2	0	5	3	10	3	295	0	0	298	0	0	0	0	0	0	196	2	0	198	506
04:45 PM	1	0	0	2	3	3	276	0	0	279	0	0	0	0	0	0	167	1	0	168	450
Total	4	0	9	14	27	15	1084	0	0	1099	0	0	0	0	0	0	758	3	0	761	1887
Grand Total	4	0	9	14	27	15	1084	0	0	1099	0	0	0	0	0	0	758	3	0	761	1887
Apprch %	14.8	0	33.3	51.9		1.4	98.6	0	0		0	0	0	0		0	99.6	0.4	0		
Total %	0.2	0	0.5	0.7	1.4	0.8	57.4	0	0	58.2	0	0	0	0	0	0	40.2	0.2	0	40.3	

Austin, Tsutsumi & Associates

501 Sumner Street Suite 521
Honolulu, HI, Zip 96817
(808) 533-3646

File Name : PM_Salt Lake - Kahikolu
Site Code : 00000000
Start Date : 11/1/2011
Page No : 2

	KAHIKOLU From North					SALT LAKE From East					KAHIKOLU From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	0	0	2	2	4	2	264	0	0	266	0	0	0	0	0	0	181	0	0	181	451
04:15 PM	1	0	2	**7**	**10**	**7**	249	0	0	256	0	0	0	0	0	0	**214**	0	0	**214**	480
04:30 PM	**2**	0	**5**	3	10	3	**295**	0	0	**298**	0	0	0	0	0	0	196	**2**	0	198	**506**
04:45 PM	1	0	0	2	3	3	276	0	0	279	0	0	0	0	0	0	167	1	0	168	450
Total Volume	4	0	9	14	27	15	1084	0	0	1099	0	0	0	0	0	0	758	3	0	761	1887
% App. Total	14.8	0	33.3	51.9		1.4	98.6	0	0		0	0	0	0		0	99.6	0.4	0		
PHF	.500	.000	.450	.500	.675	.536	.919	.000	.000	.922	.000	.000	.000	.000	.000	.000	.886	.375	.000	.889	.932



Austin, Tsutsumi & Associates

501 Sumner Street Suite 521
Honolulu, HI, Zip 96817
(808) 533-3646

File Name : PM_Driveway #1 - Salt Lake
Site Code : 00000000
Start Date : 11/1/2011
Page No : 1

Groups Printed- Unshifted

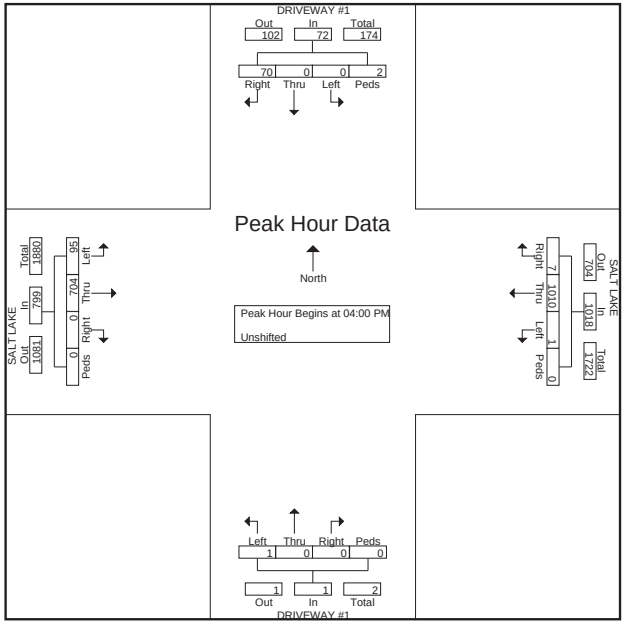
	DRIVEWAY #1 From North					SALT LAKE From East					DRIVEWAY #1 From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
04:00 PM	28	0	0	0	28	4	241	0	0	245	0	0	0	0	0	0	177	24	0	201	474
04:15 PM	21	0	0	0	21	1	240	1	0	242	0	0	0	0	0	0	193	28	0	221	484
04:30 PM	11	0	0	2	13	2	266	0	0	268	0	0	1	0	1	0	169	16	0	185	467
04:45 PM	10	0	0	0	10	0	263	0	0	263	0	0	0	0	0	0	165	27	0	192	465
Total	70	0	0	2	72	7	1010	1	0	1018	0	0	1	0	1	0	704	95	0	799	1890
Grand Total	70	0	0	2	72	7	1010	1	0	1018	0	0	1	0	1	0	704	95	0	799	1890
Apprch %	97.2	0	0	2.8		0.7	99.2	0.1	0		0	0	100	0		0	88.1	11.9	0		
Total %	3.7	0	0	0.1	3.8	0.4	53.4	0.1	0	53.9	0	0	0.1	0	0.1	0	37.2	5	0	42.3	

Austin, Tsutsumi & Associates

501 Sumner Street Suite 521
Honolulu, HI, Zip 96817
(808) 533-3646

File Name : PM_Driveway #1 - Salt Lake
Site Code : 00000000
Start Date : 11/1/2011
Page No : 2

	DRIVEWAY #1 From North					SALT LAKE From East					DRIVEWAY #1 From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	**28**	0	0	0	**28**	**4**	241	0	0	245	0	0	0	0	0	0	177	24	0	201	474
04:15 PM	21	0	0	0	21	1	240	**1**	0	242	0	0	0	0	0	0	**193**	**28**	0	**221**	**484**
04:30 PM	11	0	0	**2**	13	2	**266**	0	0	**268**	0	0	**1**	0	**1**	0	169	16	0	185	467
04:45 PM	10	0	0	0	10	0	263	0	0	263	0	0	0	0	0	0	165	27	0	192	465
Total Volume	70	0	0	2	72	7	1010	1	0	1018	0	0	1	0	1	0	704	95	0	799	1890
% App. Total	97.2	0	0	2.8		0.7	99.2	0.1	0		0	0	100	0		0	88.1	11.9	0		
PHF	.625	.000	.000	.250	.643	.438	.949	.250	.000	.950	.000	.000	.250	.000	.250	.000	.912	.848	.000	.904	.976



Austin Tsutsumi & Asscociates

501 Sumner St. Ste. 521
Honolulu, HI 96817
(808) 538-3646

File Name : PM_SL Shopping Center - Salt Lake (recount)
Site Code : 00000000
Start Date : 11/1/2011
Page No : 1

Groups Printed- Unshifted

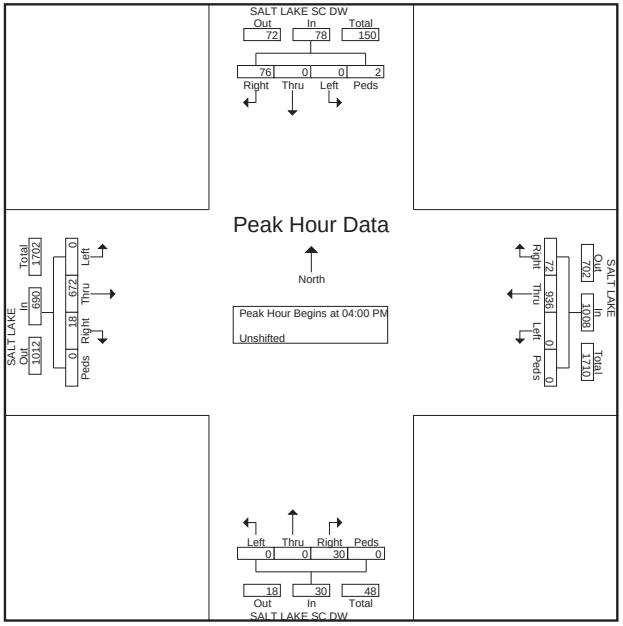
	SALT LAKE SC DW From North					SALT LAKE From East					SALT LAKE SC DW From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
04:00 PM	25	0	0	0	25	20	205	0	0	225	11	0	0	0	11	4	167	0	0	171	432
04:15 PM	14	0	0	0	14	14	226	0	0	240	8	0	0	0	8	7	176	0	0	183	445
04:30 PM	14	0	0	2	16	21	259	0	0	280	4	0	0	0	4	3	181	0	0	184	484
04:45 PM	23	0	0	0	23	17	246	0	0	263	7	0	0	0	7	4	148	0	0	152	445
Total	76	0	0	2	78	72	936	0	0	1008	30	0	0	0	30	18	672	0	0	690	1806
Grand Total	76	0	0	2	78	72	936	0	0	1008	30	0	0	0	30	18	672	0	0	690	1806
Apprch %	97.4	0	0	2.6		7.1	92.9	0	0		100	0	0	0		2.6	97.4	0	0		
Total %	4.2	0	0	0.1	4.3	4	51.8	0	0	55.8	1.7	0	0	0	1.7	1	37.2	0	0	38.2	

Austin Tsutsumi & Asscociates

501 Sumner St. Ste. 521
Honolulu, HI 96817
(808) 538-3646

File Name : PM_SL Shopping Center - Salt Lake (recount)
Site Code : 00000000
Start Date : 11/1/2011
Page No : 2

	SALT LAKE SC DW From North					SALT LAKE From East					SALT LAKE SC DW From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	**25**	0	0	0	**25**	20	205	0	0	225	**11**	0	0	0	**11**	4	167	0	0	171	432
04:15 PM	14	0	0	0	14	14	226	0	0	240	8	0	0	0	8	**7**	176	0	0	183	445
04:30 PM	14	0	0	**2**	16	**21**	**259**	0	0	**280**	4	0	0	0	4	3	**181**	0	0	**184**	**484**
04:45 PM	23	0	0	0	23	17	246	0	0	263	7	0	0	0	7	4	148	0	0	152	445
Total Volume	76	0	0	2	78	72	936	0	0	1008	30	0	0	0	30	18	672	0	0	690	1806
% App. Total	97.4	0	0	2.6		7.1	92.9	0	0		100	0	0	0		2.6	97.4	0	0		
PHF	.760	.000	.000	.250	.780	.857	.903	.000	.000	.900	.682	.000	.000	.000	.682	.643	.928	.000	.000	.938	.933



Austin Tsutsumi & Asscociates

501 Sumner St. Ste. 521
Honolulu, HI 96817
(808) 533-3646

File Name : PM_Salt Lake - Ala Lilikoi
Site Code : 00000000
Start Date : 11/1/2011
Page No : 1

Groups Printed- Unshifted

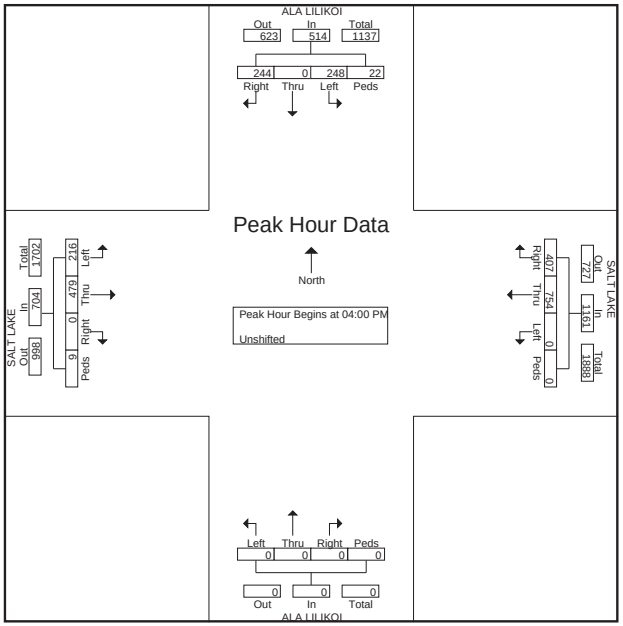
	ALA LILIKOI From North					SALT LAKE From East					ALA LILIKOI From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
03:45 PM	43	0	69	8	120	83	183	0	0	266	0	0	0	0	0	0	130	65	10	205	591
Total	43	0	69	8	120	83	183	0	0	266	0	0	0	0	0	0	130	65	10	205	591
04:00 PM	51	0	68	8	127	88	184	0	0	272	0	0	0	0	0	0	124	56	4	184	583
04:15 PM	58	0	65	6	129	93	171	0	0	264	0	0	0	0	0	0	121	57	1	179	572
04:30 PM	71	0	66	4	141	121	208	0	0	329	0	0	0	0	0	0	127	51	2	180	650
04:45 PM	64	0	49	4	117	105	191	0	0	296	0	0	0	0	0	0	107	52	2	161	574
Total	244	0	248	22	514	407	754	0	0	1161	0	0	0	0	0	0	479	216	9	704	2379
05:00 PM	64	0	60	3	127	123	165	0	0	288	0	0	0	0	0	0	83	50	1	134	549
05:15 PM	59	0	53	6	118	110	171	0	0	281	0	0	0	0	0	0	121	54	3	178	577
05:30 PM	65	0	64	1	130	86	140	0	0	226	0	0	0	0	0	0	96	49	1	146	502
Grand Total	475	0	494	40	1009	809	1413	0	0	2222	0	0	0	0	0	0	909	434	24	1367	4598
Apprch %	47.1	0	49	4		36.4	63.6	0	0		0	0	0	0		0	66.5	31.7	1.8		
Total %	10.3	0	10.7	0.9	21.9	17.6	30.7	0	0	48.3	0	0	0	0	0	0	19.8	9.4	0.5	29.7	

Austin Tsutsumi & Asscociates

501 Sumner St. Ste. 521
Honolulu, HI 96817
(808) 533-3646

File Name : PM_Salt Lake - Ala Lilikoi
Site Code : 00000000
Start Date : 11/1/2011
Page No : 2

	ALA LILIKOI From North					SALT LAKE From East					ALA LILIKOI From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	51	0	**68**	**8**	127	88	184	0	0	272	0	0	0	0	0	0	124	56	**4**	**184**	583
04:15 PM	58	0	65	6	129	93	171	0	0	264	0	0	0	0	0	0	121	**57**	1	179	572
04:30 PM	**71**	0	66	4	**141**	**121**	**208**	0	0	**329**	0	0	0	0	0	0	**127**	51	2	180	**650**
04:45 PM	64	0	49	4	117	105	191	0	0	296	0	0	0	0	0	0	107	52	2	161	574
Total Volume	244	0	248	22	514	407	754	0	0	1161	0	0	0	0	0	0	479	216	9	704	2379
% App. Total	47.5	0	48.2	4.3		35.1	64.9	0	0		0	0	0	0		0	68	30.7	1.3		
PHF	.859	.000	.912	.688	.911	.841	.906	.000	.000	.882	.000	.000	.000	.000	.000	.000	.943	.947	.563	.957	.915



Austin Tsutsumi & Asscociates

501 Sumner St. Ste. 521
Honolulu, HI 96817
(808) 533-3646

File Name : PM_Arizona - Salt Lake (recount)
Site Code : 00000000
Start Date : 11/1/2011
Page No : 1

Groups Printed- Unshifted

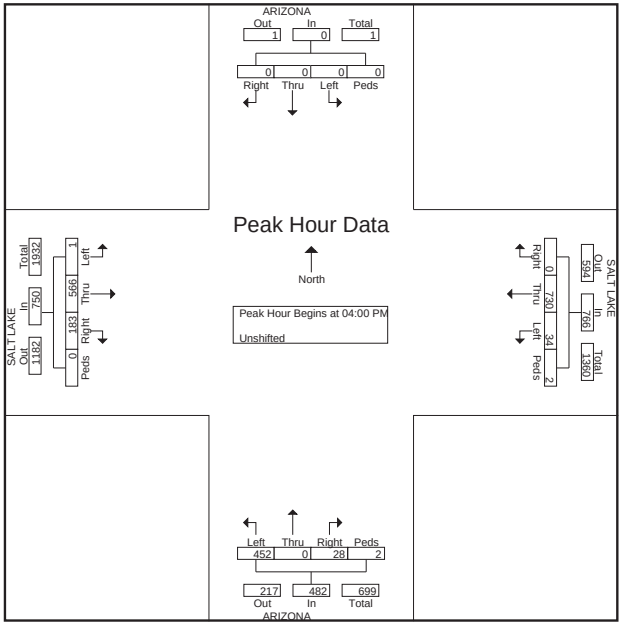
	ARIZONA From North					SALT LAKE From East					ARIZONA From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
04:00 PM	0	0	0	0	0	0	159	7	0	166	11	0	103	0	114	48	148	0	0	196	476
04:15 PM	0	0	0	0	0	0	178	9	0	187	6	0	103	0	109	49	150	1	0	200	496
04:30 PM	0	0	0	0	0	0	203	11	2	216	9	0	117	2	128	51	145	0	0	196	540
04:45 PM	0	0	0	0	0	0	190	7	0	197	2	0	129	0	131	35	123	0	0	158	486
Total	0	0	0	0	0	0	730	34	2	766	28	0	452	2	482	183	566	1	0	750	1998
Grand Total	0	0	0	0	0	0	730	34	2	766	28	0	452	2	482	183	566	1	0	750	1998
Apprch %	0	0	0	0		0	95.3	4.4	0.3		5.8	0	93.8	0.4		24.4	75.5	0.1	0		
Total %	0	0	0	0	0	0	36.5	1.7	0.1	38.3	1.4	0	22.6	0.1	24.1	9.2	28.3	0.1	0	37.5	

Austin Tsutsumi & Asscociates

501 Sumner St. Ste. 521
Honolulu, HI 96817
(808) 533-3646

File Name : PM_Arizona - Salt Lake (recount)
Site Code : 00000000
Start Date : 11/1/2011
Page No : 2

	ARIZONA From North					SALT LAKE From East					ARIZONA From South					SALT LAKE From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	0	0	0	0	0	0	159	7	0	166	**11**	0	103	0	114	48	148	0	0	196	476
04:15 PM	0	0	0	0	0	0	178	9	0	187	6	0	103	0	109	49	**150**	**1**	0	**200**	496
04:30 PM	0	0	0	0	0	0	**203**	**11**	**2**	**216**	9	0	117	**2**	128	**51**	145	0	0	196	**540**
04:45 PM	0	0	0	0	0	0	190	7	0	197	2	0	**129**	0	**131**	35	123	0	0	158	486
Total Volume	0	0	0	0	0	0	730	34	2	766	28	0	452	2	482	183	566	1	0	750	1998
% App. Total	0	0	0	0		0	95.3	4.4	0.3		5.8	0	93.8	0.4		24.4	75.5	0.1	0		
PHF	.000	.000	.000	.000	.000	.000	.899	.773	.250	.887	.636	.000	.876	.250	.920	.897	.943	.250	.000	.938	.925



AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX B

LEVEL OF SERVICE CRITERIA

APPENDIX B – LEVEL OF SERVICE (LOS) CRITERIA

LEVEL OF SERVICE FOR SIGNALIZED INTERSECTIONS (HCM 2000)

Level of service for signalized intersections is directly related to delay values and is assigned on that basis. Level of Service is a measure of the acceptability of delay values to motorists at a given intersection. The criteria are given in table below.

Level-of Service Criteria for Signalized Intersections

Level of Service	Control Delay per Vehicle (sec./veh.)
A	< 10.0
B	>10.0 and ≤ 20.0
C	>20.0 and ≤ 35.0
D	>35.0 and ≤ 55.0
E	>55.0 and ≤ 80.0
F	> 80.0

Delay is a complex measure, and is dependent on a number of variables, including the quality of progression, the cycle length, the green ratio, and the v/c ratio for the lane group or approach in question.

LEVEL OF SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS (HCM 2000)

The level of service criteria for unsignalized intersections is defined as the average control delay, in seconds per vehicle.

LOS delay threshold values are lower for two-way stop-controlled (TWSC) and all-way stop-controlled (AWSC) intersections than those of signalized intersections. This is because more vehicles pass through signalized intersections, and therefore, drivers expect and tolerate greater delays. While the criteria for level of service for TWSC and AWSC intersections are the same, procedures to calculate the average total delay may differ.

Level of Service Criteria for Two-Way Stop-Controlled Intersections

Level of Service	Average Control Delay (sec/veh)
A	≤ 10
B	>10 and ≤15
C	>15 and ≤25
D	>25 and ≤35
E	>35 and ≤50
F	> 50

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

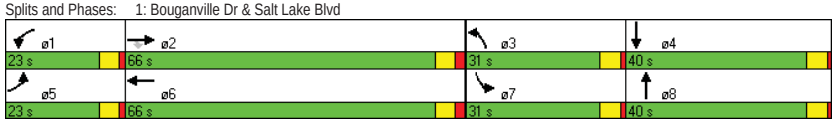
LEVEL OF SERVICE CALCULATIONS

- Existing Conditions AM

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	99	487	394	112	425	180	157	102	326
Turn Type	Prot	NA	Perm	Prot	NA	Prot	NA	Prot	NA
Protected Phases	5	2		1	6	3	8	7	4
Permitted Phases			2						
Detector Phase	5	2	2	1	6	3	8	7	4
Switch Phase									
Minimum Initial (s)	5.0	20.0	20.0	5.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	34.0	34.0	10.0	34.0	10.0	33.0	10.0	33.0
Total Split (s)	23.0	66.0	66.0	23.0	66.0	31.0	40.0	31.0	40.0
Total Split (%)	14.4%	41.3%	41.3%	14.4%	41.3%	19.4%	25.0%	19.4%	25.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	5.0	6.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?									
Recall Mode	None	C-Max	C-Max	None	C-Max	None	None	None	None
Act Effct Green (s)	15.7	61.1	61.1	24.5	69.9	21.7	37.2	16.2	31.7
Actuated g/C Ratio	0.10	0.38	0.38	0.15	0.44	0.14	0.23	0.10	0.20
v/c Ratio	0.80	0.42	0.79	0.81	0.34	0.84	0.35	0.73	0.85
Control Delay	100.6	37.9	20.8	81.0	27.3	95.9	48.4	91.6	72.2
Queue Delay	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Total Delay	100.6	37.9	20.8	81.0	27.5	95.9	48.4	91.6	72.2
LOS	F	D	C	F	C	F	D	F	E
Approach Delay		37.9			40.1		68.7		75.9
Approach LOS		D			D		E		E

Intersection Summary	
Cycle Length: 160	
Actuated Cycle Length: 160	
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow, Master Intersection	
Natural Cycle: 90	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.85	
Intersection Signal Delay: 50.8	Intersection LOS: D
Intersection Capacity Utilization 80.3%	ICU Level of Service D
Analysis Period (min) 15	

Splits and Phases: 1: Bouganville Dr & Salt Lake Blvd



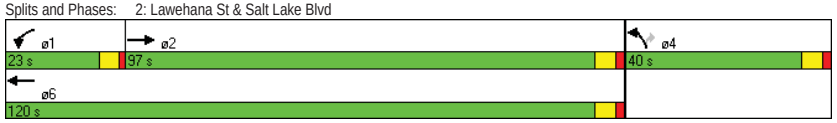
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	99	487	394	112	425	81	180	157	40	102	326	104
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		3%			-3%			2%			-2%	
Total Lost time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.66	1.00	0.98		1.00	0.96		1.00	0.92	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.97		1.00	0.96	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1743	3486	1035	1796	4849		1752	3256		1787	3177	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1743	3486	1035	1796	4849		1752	3256		1787	3177	
Peak-hour factor, PHF	0.73	0.87	0.79	0.50	0.78	0.45	0.90	0.74	0.71	0.77	0.78	0.77
Adj. Flow (vph)	136	560	499	224	545	180	200	212	56	132	418	135
RTOR Reduction (vph)	0	0	234	0	33	0	0	15	0	0	20	0
Lane Group Flow (vph)	136	560	265	224	692	0	200	253	0	132	533	0
Confl. Peds. (#/hr)			266			51			109			208
Turn Type	Prot	NA	Perm	Prot	NA		Prot	NA		Prot	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2									
Actuated Green, G (s)	15.7	61.1	61.1	24.5	69.9		21.7	37.2		16.2	31.7	
Effective Green, g (s)	15.7	61.1	61.1	24.5	69.9		21.7	37.2		16.2	31.7	
Actuated g/C Ratio	0.10	0.38	0.38	0.15	0.44		0.14	0.23		0.10	0.20	
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	5.0	5.0	2.0	5.0		2.0	3.0		2.0	3.0	
Lane Grp Cap (vph)	171	1331	395	275	2118		238	757		181	629	
v/s Ratio Prot	0.08	0.16		c0.12	0.14		c0.11	0.08		0.07	c0.17	
v/s Ratio Perm			c0.26									
v/c Ratio	0.80	0.42	0.67	0.81	0.33		0.84	0.33		0.73	0.85	
Uniform Delay, d1	70.6	36.4	41.1	65.6	29.6		67.5	51.1		69.8	61.8	
Progression Factor	1.00	1.00	1.00	0.89	0.94		1.00	1.00		1.00	1.00	
Incremental Delay, d2	20.7	1.0	8.7	15.8	0.4		21.8	0.3		11.7	10.3	
Delay (s)	91.3	37.4	49.8	74.3	28.2		89.2	51.4		81.5	72.1	
Level of Service	F	D	D	E	C		F	D		F	E	
Approach Delay (s)		48.7			39.1			67.5			73.9	
Approach LOS		D			D			E			E	

Intersection Summary			
HCM Average Control Delay	53.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	80.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Configurations					
Volume (vph)	552	44	593	59	76
Turn Type	NA	Prot	NA	NA	Perm
Protected Phases	2	1	6	4	
Permitted Phases					4
Detector Phase	2	1	6	4	4
Switch Phase					
Minimum Initial (s)	20.0	5.0	20.0	5.0	5.0
Minimum Split (s)	28.0	10.0	26.0	37.0	37.0
Total Split (s)	97.0	23.0	120.0	40.0	40.0
Total Split (%)	60.6%	14.4%	75.0%	25.0%	25.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	6.0	6.0
Lead/Lag	Lag	Lead			
Lead-Lag Optimize?					
Recall Mode	C-Max	None	C-Max	None	None
Act Effct Green (s)	116.8	11.9	133.8	14.2	14.2
Actuated g/C Ratio	0.73	0.07	0.84	0.09	0.09
v/c Ratio	0.34	0.63	0.18	0.63	0.52
Control Delay	2.8	91.7	2.8	87.8	18.9
Queue Delay	0.1	0.0	0.0	0.0	0.0
Total Delay	2.9	91.7	2.8	87.8	18.9
LOS	A	F	A	F	B
Approach Delay	2.9		11.6	49.6	
Approach LOS	A		B	D	

Intersection Summary	
Cycle Length: 160	
Actuated Cycle Length: 160	
Offset: 44 (28%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow	
Natural Cycle: 75	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.63	
Intersection Signal Delay: 12.0	Intersection LOS: B
Intersection Capacity Utilization 61.6%	ICU Level of Service B
Analysis Period (min) 15	

Splits and Phases: 2: Lawehana St & Salt Lake Blvd



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	552	106	44	593	59	76
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	10	10
Grade (%)	-1%			-3%	-1%	
Total Lost time (s)	6.0		5.0	6.0	6.0	6.0
Lane Util. Factor	0.95		1.00	0.91	1.00	1.00
Frpb, ped/bikes	0.95		1.00	1.00	1.00	0.88
Flpb, ped/bikes	1.00		1.00	1.00	1.00	1.00
Frt	0.97		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	3290		1796	5162	1660	1305
Flt Permitted	1.00		0.95	1.00	0.95	1.00
Satd. Flow (perm)	3290		1796	5162	1660	1305
Peak-hour factor, PHF	0.82	0.72	0.52	0.77	0.64	0.66
Adj. Flow (vph)	673	147	85	770	92	115
RTOR Reduction (vph)	7	0	0	0	0	105
Lane Group Flow (vph)	813	0	85	770	92	10
Confl. Peds. (#/hr)		72				72
Turn Type	NA		Prot	NA	NA	Perm
Protected Phases	2		1	6	4	
Permitted Phases						4
Actuated Green, G (s)	116.9		11.9	133.8	14.2	14.2
Effective Green, g (s)	116.9		11.9	133.8	14.2	14.2
Actuated g/C Ratio	0.73		0.07	0.84	0.09	0.09
Clearance Time (s)	6.0		5.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0		2.0	5.0	3.0	3.0
Lane Grp Cap (vph)	2404		134	4317	147	116
v/s Ratio Prot	c0.25		c0.05	0.15	c0.06	
v/s Ratio Perm						0.01
v/c Ratio	0.34		0.63	0.18	0.63	0.09
Uniform Delay, d1	7.7		71.9	2.5	70.3	67.0
Progression Factor	0.29		1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4		7.0	0.1	8.1	0.3
Delay (s)	2.6		79.0	2.6	78.4	67.3
Level of Service	A		E	A	E	E
Approach Delay (s)	2.6			10.2	72.2	
Approach LOS	A			B	E	

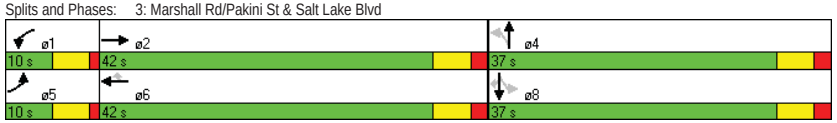
Intersection Summary			
HCM Average Control Delay	13.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	61.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	WBR	SBL	SBT	SBR	ø4
Lane Configurations									
Volume (vph)	73	555	5	516	20	74	0	119	
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	
Protected Phases	5	2	1	6			8		4
Permitted Phases					6	8		8	
Detector Phase	5	2	1	6	6	8	8	8	
Switch Phase									
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	28.0	10.0	28.0	28.0	37.0	37.0	37.0	11.0
Total Split (s)	10.0	42.0	10.0	42.0	42.0	37.0	37.0	37.0	37.0
Total Split (%)	11.2%	47.2%	11.2%	47.2%	47.2%	41.6%	41.6%	41.6%	42%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Total Lost Time (s)	5.0	6.0	5.0	6.0	6.0		6.0	6.0	
Lead/Lag	Lead	Lag	Lead	Lag	Lag				
Lead-Lag Optimize?									
Recall Mode	None	Max	None	Max	Max	None	None	None	None
Act Effct Green (s)	5.1	45.1	5.1	36.7	36.7		13.9	13.9	
Actuated g/C Ratio	0.07	0.62	0.07	0.50	0.50		0.19	0.19	
v/c Ratio	0.84	0.28	0.10	0.39	0.04		0.48	0.35	
Control Delay	85.8	9.2	37.4	13.4	5.8		31.1	6.7	
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Total Delay	85.8	9.2	37.4	13.4	5.8		31.1	6.7	
LOS	F	A	D	B	A		C	A	
Approach Delay		20.3		13.5			18.4		
Approach LOS		C		B			B		

Intersection Summary	
Cycle Length: 89	
Actuated Cycle Length: 72.8	
Natural Cycle: 75	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.84	
Intersection Signal Delay: 17.1	Intersection LOS: B
Intersection Capacity Utilization 56.7%	ICU Level of Service B
Analysis Period (min) 15	

Splits and Phases: 3: Marshall Rd/Pakini St & Salt Lake Blvd



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	73	555	0	5	516	20	0	0	0	74	0	119
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			1%			-4%	
Total Lost time (s)	5.0	6.0		5.0	6.0	6.0					6.0	6.0
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00					1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.95					1.00	0.96
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00					1.00	1.00
Frt	1.00	1.00		1.00	1.00	0.85					1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00					0.95	1.00
Satd. Flow (prot)	1787	3575		1787	3575	1515					1804	1554
Flt Permitted	0.95	1.00		0.95	1.00	1.00					0.76	1.00
Satd. Flow (perm)	1787	3575		1787	3575	1515					1438	1554
Peak-hour factor, PHF	0.70	0.91	0.92	0.42	0.74	0.71	0.92	0.92	0.92	0.56	0.92	0.83
Adj. Flow (vph)	104	610	0	12	697	28	0	0	0	132	0	143
RTOR Reduction (vph)	0	0	0	0	0	13	0	0	0	0	0	117
Lane Group Flow (vph)	104	610	0	12	697	15	0	0	0	0	132	26
Confl. Peds. (#/hr)			21			19	17		5	1		35
Parking (#/hr)									0			
Turn Type	Prot	NA		Prot	NA	Perm	Perm			Perm	NA	Perm
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		8
Actuated Green, G (s)	5.1	45.1		0.8	40.8	40.8					13.9	13.9
Effective Green, g (s)	5.1	45.1		0.8	40.8	40.8					13.9	13.9
Actuated g/C Ratio	0.07	0.59		0.01	0.53	0.53					0.18	0.18
Clearance Time (s)	5.0	6.0		5.0	6.0	6.0					6.0	6.0
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0					3.0	3.0
Lane Grp Cap (vph)	119	2099		19	1899	805					260	281
v/s Ratio Prot	c0.06	c0.17		0.01	c0.19							
v/s Ratio Perm						0.01					c0.09	0.02
v/c Ratio	0.87	0.29		0.63	0.37	0.02					0.51	0.09
Uniform Delay, d1	35.5	7.9		37.9	10.5	8.5					28.4	26.2
Progression Factor	1.00	1.00		1.00	1.00	1.00					1.00	1.00
Incremental Delay, d2	44.9	0.4		40.9	0.5	0.0					1.6	0.1
Delay (s)	80.4	8.2		78.8	11.0	8.6					29.9	26.3
Level of Service	F	A		E	B	A					C	C
Approach Delay (s)		18.7			12.0			0.0			28.1	
Approach LOS		B			B			A			C	

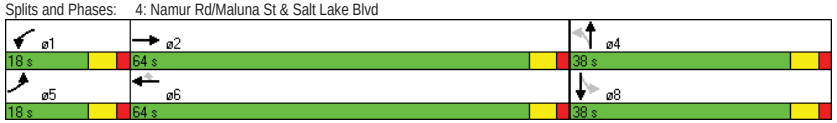
Intersection Summary			
HCM Average Control Delay	17.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	76.8	Sum of lost time (s)	23.0
Intersection Capacity Utilization	56.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	25	464	50	430	22	68	39	46	56
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	NA
Protected Phases	5	2	1	6			4		8
Permitted Phases					6	4		8	
Detector Phase	5	2	1	6	6	4	4	8	8
Switch Phase									
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	11.0	26.0	11.0	26.0	26.0	11.0	11.0	40.0	40.0
Total Split (s)	18.0	64.0	18.0	64.0	64.0	38.0	38.0	38.0	38.0
Total Split (%)	15.0%	53.3%	15.0%	53.3%	53.3%	31.7%	31.7%	31.7%	31.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0		6.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag				
Lead-Lag Optimize?									
Recall Mode	None	Max	None	Max	Max	None	None	None	None
Act Effct Green (s)	6.4	59.2	8.5	63.5	63.5	19.0	19.0		19.0
Actuated g/C Ratio	0.06	0.58	0.08	0.62	0.62	0.19	0.19		0.19
v/c Ratio	0.26	0.37	0.50	0.24	0.03	0.54	0.28		0.69
Control Delay	56.0	13.9	59.8	11.2	7.6	51.7	29.1		48.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Delay	56.0	13.9	59.8	11.2	7.6	51.7	29.1		48.0
LOS	E	B	E	B	A	D	C		D
Approach Delay		15.5		16.8			39.6		48.0
Approach LOS		B		B			D		D

Intersection Summary	
Cycle Length: 120	
Actuated Cycle Length: 102.2	
Natural Cycle: 80	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.69	
Intersection Signal Delay: 22.5	Intersection LOS: C
Intersection Capacity Utilization 55.6%	ICU Level of Service B
Analysis Period (min) 15	

Splits and Phases: 4: Namur Rd/Maluna St & Salt Lake Blvd



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	25	464	93	50	430	22	68	39	20	46	56	43
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		7%			-6%			0%			-12%	
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0	6.0	6.0			6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	1.00			1.00	
Frpb, ped/bikes	1.00	0.99		1.00	1.00	1.00	1.00	0.99			0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	0.99	1.00			1.00	
Frt	1.00	0.97		1.00	1.00	0.85	1.00	0.94			0.96	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00			0.99	
Satd. Flow (prot)	1708	3275		1823	3645	1631	1756	1739			1868	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.45	1.00			0.88	
Satd. Flow (perm)	1708	3275		1823	3645	1631	832	1739			1672	
Peak-hour factor, PHF	0.89	0.81	0.73	0.66	0.80	0.79	0.81	0.65	0.56	0.82	0.52	0.72
Adj. Flow (vph)	28	573	127	76	538	28	84	60	36	56	108	60
RTOR Reduction (vph)	0	13	0	0	0	7	0	20	0	0	12	0
Lane Group Flow (vph)	28	687	0	76	538	21	84	76	0	0	212	0
Confl. Peds. (#/hr)			23				13		10			13
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		
Actuated Green, G (s)	4.1	60.5		7.2	63.6	63.6	19.0	19.0			19.0	
Effective Green, g (s)	4.1	60.5		7.2	63.6	63.6	19.0	19.0			19.0	
Actuated g/C Ratio	0.04	0.58		0.07	0.61	0.61	0.18	0.18			0.18	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0	6.0	6.0			6.0	
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0	3.0	3.0			3.0	
Lane Grp Cap (vph)	67	1892		125	2214	991	151	316			303	
v/s Ratio Prot	0.02	c0.21		c0.04	c0.15			0.04				
v/s Ratio Perm						0.01	0.10				c0.13	
v/c Ratio	0.42	0.36		0.61	0.24	0.02	0.56	0.24			0.70	
Uniform Delay, d1	49.1	11.8		47.4	9.5	8.2	39.0	36.7			40.2	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00			1.00	
Incremental Delay, d2	1.5	0.5		5.6	0.3	0.0	4.4	0.4			6.9	
Delay (s)	50.7	12.3		53.0	9.7	8.2	43.4	37.1			47.0	
Level of Service	D	B		D	A	A	D	D			D	
Approach Delay (s)		13.8			14.8			40.0			47.0	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	21.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	104.7	Sum of lost time (s)	24.0
Intersection Capacity Utilization	55.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations					
Volume (vph)	29	511	454	85	52
Turn Type	Perm	NA	NA	NA	Perm
Protected Phases		2	2	4	
Permitted Phases	2				4
Detector Phase	2	2	2	4	4
Switch Phase					
Minimum Initial (s)	25.0	25.0	25.0	4.0	4.0
Minimum Split (s)	30.0	30.0	30.0	20.0	20.0
Total Split (s)	64.0	64.0	64.0	22.0	22.0
Total Split (%)	74.4%	74.4%	74.4%	25.6%	25.6%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	Max	Max	Max	None	None
Act Effct Green (s)	63.1	63.1	63.1	10.9	10.9
Actuated g/C Ratio	0.78	0.78	0.78	0.13	0.13
v/c Ratio	0.10	0.59	0.57	0.59	0.31
Control Delay	4.5	8.8	8.2	46.5	12.5
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	4.5	8.8	8.2	46.5	12.5
LOS	A	A	A	D	B
Approach Delay		8.5	8.2	33.2	
Approach LOS		A	A	C	

Intersection Summary	
Cycle Length: 86	
Actuated Cycle Length: 80.8	
Natural Cycle: 60	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.59	
Intersection Signal Delay: 11.3	Intersection LOS: B
Intersection Capacity Utilization 51.2%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 5: Salt Lake Blvd & Wanaka St

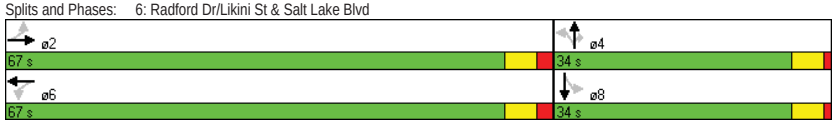
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	29	511	454	46	85	52
Ideal Flow (vphpl)	1400	1400	1400	1400	1400	1400
Lane Width	10	10	10	12	10	10
Grade (%)		0%	1%		-8%	
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.99		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1217	1281	1256		1266	1132
Flt Permitted	0.42	1.00	1.00		0.95	1.00
Satd. Flow (perm)	543	1281	1256		1266	1132
Peak-hour factor, PHF	0.66	0.86	0.90	0.77	0.85	0.81
Adj. Flow (vph)	44	594	504	60	100	64
RTOR Reduction (vph)	0	0	4	0	0	56
Lane Group Flow (vph)	44	594	560	0	100	8
Turn Type	Perm	NA	NA		NA	Perm
Protected Phases		2	2		4	
Permitted Phases	2					4
Actuated Green, G (s)	62.1	62.1	62.1		9.7	9.7
Effective Green, g (s)	62.1	62.1	62.1		9.7	9.7
Actuated g/C Ratio	0.76	0.76	0.76		0.12	0.12
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	4.0	4.0	4.0		2.2	2.2
Lane Grp Cap (vph)	412	972	954		150	134
v/s Ratio Prot		c0.46	0.45		c0.08	
v/s Ratio Perm	0.08					0.01
v/c Ratio	0.11	0.61	0.59		0.67	0.06
Uniform Delay, d1	2.6	4.4	4.3		34.5	32.0
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.5	2.9	2.6		8.9	0.1
Delay (s)	3.1	7.3	6.9		43.4	32.1
Level of Service	A	A	A		D	C
Approach Delay (s)		7.0	6.9		39.0	
Approach LOS		A	A		D	

Intersection Summary			
HCM Average Control Delay	10.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	81.8	Sum of lost time (s)	10.0
Intersection Capacity Utilization	51.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Configurations									
Volume (vph)	1	603	214	451	35	6	220	79	31
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	Perm	NA
Protected Phases		2		6		4			8
Permitted Phases	2		6		4		4	8	
Detector Phase	2	2	6	6	4	4	4	8	8
Switch Phase									
Minimum Initial (s)	5.0	5.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	46.0	46.0	46.0	46.0	9.0	9.0	9.0	24.0	24.0
Total Split (s)	67.0	67.0	67.0	67.0	34.0	34.0	34.0	34.0	34.0
Total Split (%)	66.3%	66.3%	66.3%	66.3%	33.7%	33.7%	33.7%	33.7%	33.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0		0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0		5.0	5.0		5.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	Max	Max	Max	Max	None	None	None	None	None
Act Effct Green (s)	61.3	61.3	61.3	61.3		19.3	19.3		19.3
Actuated g/C Ratio	0.67	0.67	0.67	0.67		0.21	0.21		0.21
v/c Ratio	0.01	0.85	1.00	0.65		0.39	0.72		0.76
Control Delay	7.0	24.9	77.3	14.5		36.2	22.5		53.9
Queue Delay	0.0	0.0	0.0	0.0		0.0	0.0		0.0
Total Delay	7.0	24.9	77.3	14.5		36.2	22.5		53.9
LOS	A	C	E	B		D	C		D
Approach Delay		24.8		33.1		25.4			53.9
Approach LOS		C		C		C			D

Intersection Summary	
Cycle Length: 101	
Actuated Cycle Length: 91.6	
Natural Cycle: 90	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 1.00	
Intersection Signal Delay: 30.5	Intersection LOS: C
Intersection Capacity Utilization 90.7%	ICU Level of Service E
Analysis Period (min) 15	

Splits and Phases: 6: Radford Dr/Likini St & Salt Lake Blvd



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1	603	18	214	451	67	35	6	220	79	31	9
Ideal Flow (vphpl)	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
Grade (%)		1%			-2%			2%			-6%	
Total Lost time (s)	6.0	6.0		6.0	6.0			5.0	5.0		5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	0.95		0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			0.97	1.00		1.00	
Frt	1.00	0.99		1.00	0.98			1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.97	
Satd. Flow (prot)	1296	1355		1312	1356			1273	1100		1341	
Flt Permitted	0.38	1.00		0.27	1.00			0.71	1.00		0.75	
Satd. Flow (perm)	513	1355		374	1356			940	1100		1043	
Peak-hour factor, PHF	0.25	0.81	0.64	0.86	0.87	0.88	0.58	0.38	0.80	0.70	0.78	0.56
Adj. Flow (vph)	4	744	28	249	518	76	60	16	275	113	40	16
RTOR Reduction (vph)	0	1	0	0	4	0	0	0	148	0	4	0
Lane Group Flow (vph)	4	771	0	249	590	0	0	76	127	0	165	0
Confl. Peds. (#/hr)	3		33	12		3	21		12			24
Turn Type	Perm	NA		Perm	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		2			6			4			8	
Permitted Phases	2			6			4		4	8		
Actuated Green, G (s)	61.3	61.3		61.3	61.3			19.3	19.3		19.3	
Effective Green, g (s)	61.3	61.3		61.3	61.3			19.3	19.3		19.3	
Actuated g/C Ratio	0.67	0.67		0.67	0.67			0.21	0.21		0.21	
Clearance Time (s)	6.0	6.0		6.0	6.0			5.0	5.0		5.0	
Vehicle Extension (s)	5.0	5.0		5.0	5.0			3.0	3.0		3.0	
Lane Grp Cap (vph)	343	907		250	907			198	232		220	
v/s Ratio Prot		0.57			0.44							
v/s Ratio Perm	0.01			c0.67				0.08	0.12		c0.16	
v/c Ratio	0.01	0.85		1.00	0.65			0.38	0.55		0.75	
Uniform Delay, d1	5.1	11.6		15.0	8.9			31.0	32.2		33.9	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.1	9.8		55.9	3.6			1.2	2.6		13.4	
Delay (s)	5.1	21.4		70.9	12.5			32.3	34.9		47.3	
Level of Service	A	C		E	B			C	C		D	
Approach Delay (s)		21.4			29.7			34.3			47.3	
Approach LOS		C			C			C			D	

Intersection Summary			
HCM Average Control Delay	28.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	91.6	Sum of lost time (s)	11.0
Intersection Capacity Utilization	90.7%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Exist AM PHF
7: Salt Lake Blvd & Kahikolu Pl 1/3/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	1	911	791	11	13	5
Sign Control		Free	Free		Stop	
Grade		0%	-2%		0%	
Peak Hour Factor	0.25	0.85	0.93	0.69	0.65	0.31
Hourly flow rate (vph)	4	1072	851	16	20	16
Pedestrians		13	13		13	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		1	1		1	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		534	907			
pX, platoon unblocked	0.88				0.69	0.88
vC, conflicting volume	879				1964	885
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	792				1770	798
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				67	95
cM capacity (veh/h)	718				61	331

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	4	1072	866	36
Volume Left	4	0	0	20
Volume Right	0	0	16	16
cSH	718	1700	1700	97
Volume to Capacity	0.01	0.63	0.51	0.37
Queue Length 95th (ft)	0	0	0	37
Control Delay (s)	10.0	0.0	0.0	63.0
Lane LOS	B			F
Approach Delay (s)	0.0		0.0	63.0
Approach LOS				F

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	78.6%	ICU Level of Service	D
Analysis Period (min)	15		

Exist AM PHF
8: Salt Lake Blvd & Shopping Center Entrance 1 1/3/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	56	832	36	6	717	12	8	6	27	2	16	26
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.64	0.38	0.87	0.75	1.00	0.75	0.56	0.25	0.25	0.65
Hourly flow rate (vph)	64	945	56	16	824	16	8	8	48	8	64	40
Pedestrians		1			1						1	
Lane Width (ft)		12.0			12.0						12.0	
Walking Speed (ft/s)		4.0			4.0						4.0	
Percent Blockage		0			0						0	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		888			553							
pX, platoon unblocked	0.87			0.75			0.81	0.81	0.75	0.81	0.81	0.87
vC, conflicting volume	841			1002			2038	1974	975	1991	1994	834
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	744			832			1807	1728	796	1750	1753	736
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	92			97			0	87	83	79	0	89
cM capacity (veh/h)	752			597			0	64	289	37	62	365

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	NB 3	SB 1
Volume Total	64	1002	856	8	8	48	112
Volume Left	64	0	16	8	0	0	8
Volume Right	0	56	16	0	0	48	40
cSH	752	1700	597	0	64	289	82
Volume to Capacity	0.08	0.59	0.03	Err	0.13	0.17	1.36
Queue Length 95th (ft)	7	0	2	Err	10	15	215
Control Delay (s)	10.2	0.0	0.8	Err	69.4	20.0	313.8
Lane LOS	B		A	F	F	C	F
Approach Delay (s)	0.6		0.8	Err			313.8
Approach LOS				F			F

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	79.6%	ICU Level of Service	D
Analysis Period (min)	15		

Exist AM PHF
9: Aliamanu School /Shopping Center Entrance 2 & Salt Lake Blvd 1/3/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	702	166	0	681	30	0	0	141	0	0	52
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.96	0.68	0.92	0.94	0.75	0.92	0.92	0.64	0.92	0.92	0.87
Hourly flow rate (vph)	0	731	244	0	724	40	0	0	220	0	0	60
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		1105			336							
pX, platoon unblocked	0.88			0.95			0.91	0.91	0.95	0.91	0.91	0.88
vC, conflicting volume	764			731			1638	1618	853	1578	1456	724
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	666			689			1524	1502	818	1458	1324	621
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	38	100	100	86
cM capacity (veh/h)	814			858			76	110	356	37	142	430

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	975	724	40	220	60
Volume Left	0	0	0	0	0
Volume Right	244	0	40	220	60
cSH	1700	1700	1700	356	430
Volume to Capacity	0.57	0.43	0.02	0.62	0.14
Queue Length 95th (ft)	0	0	0	99	12
Control Delay (s)	0.0	0.0	0.0	30.1	14.7
Lane LOS				D	B
Approach Delay (s)	0.0	0.0		30.1	14.7
Approach LOS				D	B

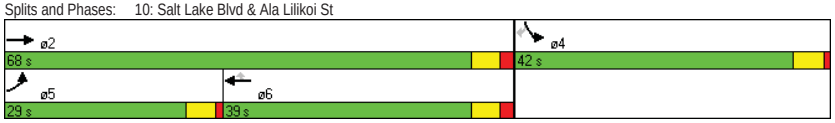
Intersection Summary				
Average Delay		3.7		
Intersection Capacity Utilization		82.3%	ICU Level of Service	E
Analysis Period (min)		15		

Exist AM PHF
10: Salt Lake Blvd & Ala Lilikoi St 1/3/2012

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	198	650	397	241	659	318
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	20.0	20.0	20.0	6.0	6.0
Minimum Split (s)	10.0	26.0	29.0	29.0	35.0	35.0
Total Split (s)	29.0	68.0	39.0	39.0	42.0	42.0
Total Split (%)	26.4%	61.8%	35.5%	35.5%	38.2%	38.2%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	C-Max	C-Max	C-Max	None	None
Act Effct Green (s)	20.2	67.6	42.4	42.4	31.4	31.4
Actuated g/C Ratio	0.18	0.61	0.39	0.39	0.29	0.29
v/c Ratio	0.79	0.23	0.31	0.46	0.74	0.63
Control Delay	60.0	10.2	19.6	5.5	40.1	7.9
Queue Delay	0.0	0.0	0.6	0.6	0.0	0.0
Total Delay	60.0	10.3	20.2	6.1	40.2	7.9
LOS	E	B	C	A	D	A
Approach Delay		23.5	14.0		28.9	
Approach LOS		C	B		C	

Intersection Summary	
Cycle Length: 110	
Actuated Cycle Length: 110	
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow, Master Intersection	
Natural Cycle: 80	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.79	
Intersection Signal Delay: 23.1	Intersection LOS: C
Intersection Capacity Utilization 68.5%	ICU Level of Service C
Analysis Period (min) 15	

Splits and Phases: 10: Salt Lake Blvd & Ala Lilikoi St



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	198	650	397	241	659	318
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lane Util. Factor	1.00	0.91	0.95	1.00	0.97	1.00
Frpb, ped/bikes	1.00	1.00	1.00	0.84	1.00	0.75
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	5085	3539	1337	3433	1189
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	5085	3539	1337	3433	1189
Peak-hour factor, PHF	0.77	0.92	0.94	0.73	0.91	0.82
Adj. Flow (vph)	257	707	422	330	724	388
RTOR Reduction (vph)	0	0	0	203	0	277
Lane Group Flow (vph)	257	707	422	127	724	111
Confl. Peds. (#/hr)				102		220
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Actuated Green, G (s)	20.2	67.6	42.4	42.4	31.4	31.4
Effective Green, g (s)	20.2	67.6	42.4	42.4	31.4	31.4
Actuated g/C Ratio	0.18	0.61	0.39	0.39	0.29	0.29
Clearance Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Vehicle Extension (s)	3.0	4.0	4.0	4.0	3.0	3.0
Lane Grp Cap (vph)	325	3125	1364	515	980	339
v/s Ratio Prot	c0.15	0.14	c0.12		c0.21	
v/s Ratio Perm				0.10		0.09
v/c Ratio	0.79	0.23	0.31	0.25	0.74	0.33
Uniform Delay, d1	42.9	9.5	23.6	23.0	35.6	31.0
Progression Factor	1.00	1.00	0.74	1.02	1.00	1.00
Incremental Delay, d2	12.3	0.2	0.6	1.1	2.9	0.6
Delay (s)	55.2	9.7	18.0	24.6	38.5	31.5
Level of Service	E	A	B	C	D	C
Approach Delay (s)		21.8	20.9		36.1	
Approach LOS		C	C		D	

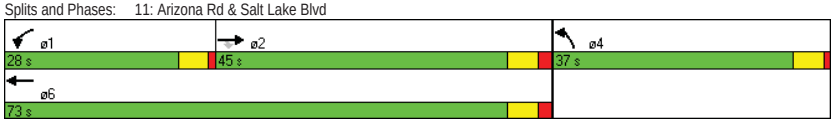
Intersection Summary			
HCM Average Control Delay	27.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	68.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBT	EBR	WBL	WBT	NBL
Lane Configurations					
Volume (vph)	986	362	121	423	184
Turn Type	NA	Perm	Prot	NA	NA
Protected Phases	2		1	6	4
Permitted Phases		2			
Detector Phase	2	2	1	6	4
Switch Phase					
Minimum Initial (s)	20.0	20.0	5.0	20.0	5.0
Minimum Split (s)	28.0	28.0	10.0	26.0	34.0
Total Split (s)	45.0	45.0	28.0	73.0	37.0
Total Split (%)	40.9%	40.9%	25.5%	66.4%	33.6%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	1.0	2.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0	5.0	6.0	5.0
Lead/Lag	Lag	Lag	Lead		
Lead-Lag Optimize?					
Recall Mode	C-Max	C-Max	None	C-Max	None
Act Effct Green (s)	58.1	58.1	17.6	80.7	18.3
Actuated g/C Ratio	0.53	0.53	0.16	0.73	0.17
v/c Ratio	0.60	0.46	0.70	0.17	0.64
Control Delay	19.5	5.6	57.1	5.3	44.2
Queue Delay	1.1	0.5	0.0	0.0	0.0
Total Delay	20.6	6.1	57.1	5.3	44.2
LOS	C	A	E	A	D
Approach Delay	16.3			20.8	44.2
Approach LOS	B			C	D

Intersection Summary	
Cycle Length: 110	
Actuated Cycle Length: 110	
Offset: 41 (37%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow	
Natural Cycle: 90	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.70	
Intersection Signal Delay: 21.6	Intersection LOS: C
Intersection Capacity Utilization 56.4%	ICU Level of Service B
Analysis Period (min) 15	

Splits and Phases: 11: Arizona Rd & Salt Lake Blvd



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	986	362	121	423	184	35
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	10	12	12	12
Grade (%)	8%			-10%	-2%	
Total Lost time (s)	6.0	6.0	5.0	6.0	5.0	
Lane Util. Factor	0.95	1.00	1.00	0.95	0.97	
Frpb, ped/bikes	1.00	0.97	1.00	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	0.85	1.00	1.00	0.97	
Flt Protected	1.00	1.00	0.95	1.00	0.96	
Satd. Flow (prot)	3398	1475	1734	3716	3397	
Flt Permitted	1.00	1.00	0.95	1.00	0.96	
Satd. Flow (perm)	3398	1475	1734	3716	3397	
Peak-hour factor, PHF	0.91	0.80	0.62	0.93	0.60	0.49
Adj. Flow (vph)	1084	452	195	455	307	71
RTOR Reduction (vph)	0	209	0	0	22	0
Lane Group Flow (vph)	1084	243	195	455	356	0
Confl. Peds. (#/hr)		4				5
Turn Type	NA	Perm	Prot	NA	NA	
Protected Phases	2		1	6	4	
Permitted Phases		2				
Actuated Green, G (s)	58.1	58.1	17.6	80.7	18.3	
Effective Green, g (s)	58.1	58.1	17.6	80.7	18.3	
Actuated g/C Ratio	0.53	0.53	0.16	0.73	0.17	
Clearance Time (s)	6.0	6.0	5.0	6.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	1795	779	277	2726	565	
v/s Ratio Prot	c0.32		c0.11	0.12	c0.10	
v/s Ratio Perm		0.17				
v/c Ratio	0.60	0.31	0.70	0.17	0.63	
Uniform Delay, d1	18.0	14.7	43.7	4.4	42.7	
Progression Factor	0.88	1.74	1.00	1.00	1.00	
Incremental Delay, d2	1.4	1.0	7.9	0.1	2.3	
Delay (s)	17.2	26.5	51.6	4.6	45.0	
Level of Service	B	C	D	A	D	
Approach Delay (s)	19.9			18.7	45.0	
Approach LOS	B			B	D	

Intersection Summary			
HCM Average Control Delay	23.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	56.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

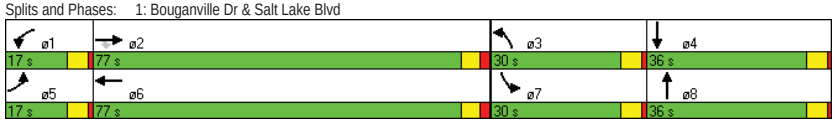
LEVEL OF SERVICE CALCULATIONS

- Existing Conditions PM

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	56	512	225	30	766	418	264	58	159
Turn Type	Prot	NA	Perm	Prot	NA	Prot	NA	Prot	NA
Protected Phases	5	2		1	6	3	8	7	4
Permitted Phases			2						
Detector Phase	5	2	2	1	6	3	8	7	4
Switch Phase									
Minimum Initial (s)	5.0	20.0	20.0	5.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	34.0	34.0	10.0	34.0	10.0	33.0	10.0	33.0
Total Split (s)	17.0	77.0	77.0	17.0	77.0	30.0	36.0	30.0	36.0
Total Split (%)	10.6%	48.1%	48.1%	10.6%	48.1%	18.8%	22.5%	18.8%	22.5%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	5.0	6.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?									
Recall Mode	None	C-Max	C-Max	None	C-Max	None	None	None	None
Act Effct Green (s)	10.6	89.2	89.2	7.7	84.4	25.0	33.6	10.5	19.1
Actuated g/C Ratio	0.07	0.56	0.56	0.05	0.53	0.16	0.21	0.07	0.12
v/c Ratio	0.59	0.32	0.26	0.41	0.36	1.61	0.48	0.58	0.69
Control Delay	92.2	21.0	3.2	87.3	22.8	329.3	56.1	91.3	68.4
Queue Delay	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0
Total Delay	92.2	21.0	3.2	87.3	23.6	329.3	56.1	91.3	68.4
LOS	F	C	A	F	C	F	E	F	E
Approach Delay		21.5			25.9		208.7		72.6
Approach LOS		C			C		F		E

Intersection Summary	
Cycle Length: 160	
Actuated Cycle Length: 160	
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow	
Natural Cycle: 100	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 1.61	
Intersection Signal Delay: 76.8	Intersection LOS: E
Intersection Capacity Utilization 82.7%	ICU Level of Service E
Analysis Period (min) 15	

Splits and Phases: 1: Bouganville Dr & Salt Lake Blvd



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	56	512	225	30	766	122	418	264	32	58	159	72
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		3%			-3%			2%			-2%	
Total Lost time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.95	1.00	1.00		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.98		1.00	0.96	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1743	3486	1478	1796	5021		1752	3415		1787	3383	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1743	3486	1478	1796	5021		1752	3415		1787	3383	
Peak-hour factor, PHF	0.82	0.83	0.92	0.83	0.94	0.80	0.95	0.88	0.67	0.85	0.74	0.86
Adj. Flow (vph)	68	617	245	36	815	152	440	300	48	68	215	84
RTOR Reduction (vph)	0	0	110	0	14	0	0	8	0	0	28	0
Lane Group Flow (vph)	68	617	135	36	953	0	440	340	0	68	271	0
Confl. Peds. (#/hr)			24			7			13			18
Turn Type	Prot	NA	Perm	Prot	NA		Prot	NA		Prot	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2									
Actuated Green, G (s)	10.6	88.2	88.2	6.7	84.3		25.0	33.6		10.5	19.1	
Effective Green, g (s)	10.6	88.2	88.2	6.7	84.3		25.0	33.6		10.5	19.1	
Actuated g/C Ratio	0.07	0.55	0.55	0.04	0.53		0.16	0.21		0.07	0.12	
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	5.0	5.0	2.0	5.0		2.0	3.0		2.0	3.0	
Lane Grp Cap (vph)	115	1922	815	75	2645		274	717		117	404	
v/s Ratio Prot	c0.04	c0.18		0.02	c0.19		c0.25	0.10		0.04	c0.08	
v/s Ratio Perm			0.09									
v/c Ratio	0.59	0.32	0.17	0.48	0.36		1.61	0.47		0.58	0.67	
Uniform Delay, d1	72.6	19.6	17.7	74.9	22.1		67.5	55.5		72.6	67.4	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	5.3	0.4	0.4	1.8	0.4		289.1	0.5		4.7	4.3	
Delay (s)	77.9	20.0	18.2	76.7	22.5		356.6	55.9		77.3	71.8	
Level of Service	E	C	B	E	C		F	E		E	E	
Approach Delay (s)		23.8			24.4			223.8			72.8	
Approach LOS		C			C			F			E	

Intersection Summary			
HCM Average Control Delay	80.9	HCM Level of Service	F
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	27.0
Intersection Capacity Utilization	82.7%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Configurations					
Volume (vph)	484	70	741	160	102
Turn Type	NA	Prot	NA	NA	Perm
Protected Phases	2	1	6	4	
Permitted Phases					4
Detector Phase	2	1	6	4	4
Switch Phase					
Minimum Initial (s)	20.0	5.0	20.0	5.0	5.0
Minimum Split (s)	28.0	10.0	26.0	37.0	37.0
Total Split (s)	111.0	22.0	133.0	43.0	43.0
Total Split (%)	63.1%	12.5%	75.6%	24.4%	24.4%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	6.0	6.0
Lead/Lag	Lag	Lead			
Lead-Lag Optimize?					
Recall Mode	Max	None	Max	None	None
Act Effct Green (s)	110.0	12.2	127.2	24.9	24.9
Actuated g/C Ratio	0.67	0.07	0.78	0.15	0.15
v/c Ratio	0.29	0.66	0.19	0.79	0.38
Control Delay	12.0	97.3	5.4	89.3	12.2
Queue Delay	0.9	0.0	0.0	0.0	0.0
Total Delay	12.8	97.3	5.4	89.3	12.2
LOS	B	F	A	F	B
Approach Delay	12.8		14.7	59.8	
Approach LOS	B		B	E	

Intersection Summary	
Cycle Length: 176	
Actuated Cycle Length: 164.1	
Natural Cycle: 75	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.79	
Intersection Signal Delay: 21.9	Intersection LOS: C
Intersection Capacity Utilization 51.1%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 2: Lawehana St & Salt Lake Blvd

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	484	98	70	741	160	102
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	10	10
Grade (%)	-1%			-3%	-1%	
Total Lost time (s)	6.0		5.0	6.0	6.0	6.0
Lane Util. Factor	0.95		1.00	0.91	1.00	1.00
Frpb, ped/bikes	0.99		1.00	1.00	1.00	0.97
Flpb, ped/bikes	1.00		1.00	1.00	1.00	1.00
Frt	0.97		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	3431		1796	5162	1660	1440
Flt Permitted	1.00		0.95	1.00	0.95	1.00
Satd. Flow (perm)	3431		1796	5162	1660	1440
Peak-hour factor, PHF	0.88	0.82	0.80	0.95	0.80	0.82
Adj. Flow (vph)	550	120	88	780	200	124
RTOR Reduction (vph)	9	0	0	0	0	105
Lane Group Flow (vph)	661	0	88	780	200	19
Confl. Peds. (#/hr)		8				12
Turn Type	NA		Prot	NA	NA	Perm
Protected Phases	2		1	6	4	
Permitted Phases						4
Actuated Green, G (s)	110.0		12.2	127.2	24.9	24.9
Effective Green, g (s)	110.0		12.2	127.2	24.9	24.9
Actuated g/C Ratio	0.67		0.07	0.78	0.15	0.15
Clearance Time (s)	6.0		5.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0		2.0	5.0	3.0	3.0
Lane Grp Cap (vph)	2300		134	4001	252	219
v/s Ratio Prot	c0.19		c0.05	0.15	c0.12	
v/s Ratio Perm						0.01
v/c Ratio	0.29		0.66	0.19	0.79	0.09
Uniform Delay, d1	11.0		73.9	4.9	67.1	59.8
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	0.3		8.5	0.1	15.7	0.2
Delay (s)	11.4		82.4	5.0	82.8	60.0
Level of Service	B		F	A	F	E
Approach Delay (s)	11.4			12.8	74.1	
Approach LOS	B			B	E	

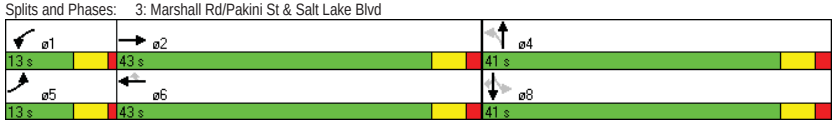
Intersection Summary			
HCM Average Control Delay	23.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	164.1	Sum of lost time (s)	17.0
Intersection Capacity Utilization	51.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	WBR	SBL	SBT	SBR	ø4
Lane Configurations									
Volume (vph)	126	459	2	781	32	25	0	109	
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	
Protected Phases	5	2	1	6			8		4
Permitted Phases					6	8		8	
Detector Phase	5	2	1	6	6	8	8	8	
Switch Phase									
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	28.0	10.0	28.0	28.0	37.0	37.0	37.0	11.0
Total Split (s)	13.0	43.0	13.0	43.0	43.0	41.0	41.0	41.0	41.0
Total Split (%)	13.4%	44.3%	13.4%	44.3%	44.3%	42.3%	42.3%	42.3%	42%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Total Lost Time (s)	5.0	6.0	5.0	6.0	6.0		6.0	6.0	
Lead/Lag	Lead	Lag	Lead	Lag	Lag				
Lead-Lag Optimize?									
Recall Mode	None	Max	None	Max	Max	None	None	None	None
Act Effct Green (s)	8.1	53.0	5.2	40.2	40.2		10.8	10.8	
Actuated g/C Ratio	0.11	0.72	0.07	0.54	0.54		0.15	0.15	
v/c Ratio	0.73	0.19	0.03	0.43	0.05		0.19	0.36	
Control Delay	57.1	7.3	37.0	13.3	5.0		27.8	8.2	
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Total Delay	57.1	7.3	37.0	13.3	5.0		27.8	8.2	
LOS	E	A	D	B	A		C	A	
Approach Delay		18.4		13.0			13.1		
Approach LOS		B		B			B		

Intersection Summary	
Cycle Length: 97	
Actuated Cycle Length: 73.9	
Natural Cycle: 75	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.73	
Intersection Signal Delay: 15.1	Intersection LOS: B
Intersection Capacity Utilization 50.2%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 3: Marshall Rd/Pakini St & Salt Lake Blvd



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	126	459	1	2	781	32	0	0	0	25	0	109
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			1%			-4%	
Total Lost time (s)	5.0	6.0		5.0	6.0	6.0					6.0	6.0
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00					1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.98					1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00					1.00	1.00
Frt	1.00	1.00		1.00	1.00	0.85					1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00					0.95	1.00
Satd. Flow (prot)	1787	3569		1787	3575	1562					1805	1590
Flt Permitted	0.95	1.00		0.95	1.00	1.00					0.76	1.00
Satd. Flow (perm)	1787	3569		1787	3575	1562					1439	1590
Peak-hour factor, PHF	0.88	0.93	0.25	0.50	0.94	0.73	0.92	0.92	0.92	0.62	0.92	0.91
Adj. Flow (vph)	143	494	4	4	831	44	0	0	0	40	0	120
RTOR Reduction (vph)	0	0	0	0	0	19	0	0	0	0	0	105
Lane Group Flow (vph)	143	498	0	4	831	25	0	0	0	0	40	15
Confl. Peds. (#/hr)			8			2	3		5			5
Parking (#/hr)									0			
Turn Type	Prot	NA		Prot	NA	Perm	Perm			Perm	NA	Perm
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		8
Actuated Green, G (s)	8.1	51.7		0.9	44.5	44.5					9.6	9.6
Effective Green, g (s)	8.1	51.7		0.9	44.5	44.5					9.6	9.6
Actuated g/C Ratio	0.10	0.65		0.01	0.56	0.56					0.12	0.12
Clearance Time (s)	5.0	6.0		5.0	6.0	6.0					6.0	6.0
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0					3.0	3.0
Lane Grp Cap (vph)	183	2330		20	2009	878					174	193
v/s Ratio Prot	c0.08	0.14		0.00	c0.23							
v/s Ratio Perm						0.02					c0.03	0.01
v/c Ratio	0.78	0.21		0.20	0.41	0.03					0.23	0.08
Uniform Delay, d1	34.7	5.5		38.8	9.9	7.7					31.5	30.9
Progression Factor	1.00	1.00		1.00	1.00	1.00					1.00	1.00
Incremental Delay, d2	17.9	0.2		1.8	0.6	0.1					0.7	0.2
Delay (s)	52.5	5.8		40.6	10.5	7.8					32.1	31.0
Level of Service	D	A		D	B	A					C	C
Approach Delay (s)		16.2			10.5			0.0			31.3	
Approach LOS		B			B			A			C	

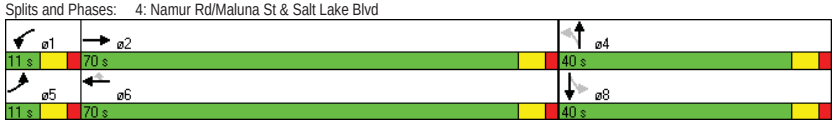
Intersection Summary			
HCM Average Control Delay	14.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	79.2	Sum of lost time (s)	17.0
Intersection Capacity Utilization	50.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	41	417	10	660	44	123	44	20	12
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	NA
Protected Phases	5	2	1	6			4		8
Permitted Phases					6	4		8	
Detector Phase	5	2	1	6	6	4	4	8	8
Switch Phase									
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	11.0	26.0	11.0	26.0	26.0	11.0	11.0	40.0	40.0
Total Split (s)	11.0	70.0	11.0	70.0	70.0	40.0	40.0	40.0	40.0
Total Split (%)	9.1%	57.9%	9.1%	57.9%	57.9%	33.1%	33.1%	33.1%	33.1%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0		6.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag				
Lead-Lag Optimize?									
Recall Mode	None	Max	None	Max	Max	None	None	None	None
Act Effct Green (s)	5.0	73.5	5.0	64.4	64.4	18.3	18.3		18.3
Actuated g/C Ratio	0.05	0.69	0.05	0.61	0.61	0.17	0.17		0.17
v/c Ratio	0.79	0.22	0.14	0.33	0.06	0.66	0.34		0.31
Control Delay	106.1	7.6	55.8	11.7	6.9	54.3	35.0		26.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Delay	106.1	7.6	55.8	11.7	6.9	54.3	35.0		26.6
LOS	F	A	E	B	A	D	D		C
Approach Delay		18.6		12.1			46.1		26.6
Approach LOS		B		B			D		C

Intersection Summary	
Cycle Length: 121	
Actuated Cycle Length: 105.8	
Natural Cycle: 80	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.79	
Intersection Signal Delay: 20.0	Intersection LOS: C
Intersection Capacity Utilization 51.8%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 4: Namur Rd/Maluna St & Salt Lake Blvd



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	41	417	47	10	660	44	123	44	15	20	12	32
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		7%			-6%			0%			-12%	
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0	6.0	6.0			6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	1.00			1.00	
Frpb, ped/bikes	1.00	0.99		1.00	1.00	0.97	1.00	0.99			0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00			1.00	
Frt	1.00	0.98		1.00	1.00	0.85	1.00	0.96			0.94	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00			0.99	
Satd. Flow (prot)	1708	3329		1823	3645	1589	1762	1779			1810	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.69	1.00			0.88	
Satd. Flow (perm)	1708	3329		1823	3645	1589	1281	1779			1618	
Peak-hour factor, PHF	0.64	0.94	0.73	0.83	0.89	0.79	0.85	0.55	0.54	0.71	0.50	0.73
Adj. Flow (vph)	64	444	64	12	742	56	145	80	28	28	24	44
RTOR Reduction (vph)	0	7	0	0	0	10	0	12	0	0	29	0
Lane Group Flow (vph)	64	501	0	12	742	46	145	96	0	0	67	0
Confl. Peds. (#/hr)			12			2	5		7			7
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		
Actuated Green, G (s)	5.0	73.5		0.9	69.4	69.4	18.3	18.3			18.3	
Effective Green, g (s)	5.0	73.5		0.9	69.4	69.4	18.3	18.3			18.3	
Actuated g/C Ratio	0.05	0.66		0.01	0.63	0.63	0.17	0.17			0.17	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0	6.0	6.0			6.0	
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0	3.0	3.0			3.0	
Lane Grp Cap (vph)	77	2210		15	2285	996	212	294			267	
v/s Ratio Prot	c0.04	c0.15		0.01	c0.20			0.05				
v/s Ratio Perm						0.03	c0.11				0.04	
v/c Ratio	0.83	0.23		0.80	0.32	0.05	0.68	0.33			0.25	
Uniform Delay, d1	52.4	7.4		54.8	9.7	7.9	43.5	40.8			40.2	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00			1.00	
Incremental Delay, d2	48.7	0.2		127.3	0.4	0.1	8.8	0.7			0.5	
Delay (s)	101.1	7.6		182.1	10.1	8.0	52.3	41.4			40.7	
Level of Service	F	A		F	B	A	D	D			D	
Approach Delay (s)		18.1			12.5			47.6			40.7	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	21.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	110.7	Sum of lost time (s)	24.0
Intersection Capacity Utilization	51.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations					
Volume (vph)	77	386	680	51	46
Turn Type	Perm	NA	NA	NA	Perm
Protected Phases		2	2	4	
Permitted Phases	2				4
Detector Phase	2	2	2	4	4
Switch Phase					
Minimum Initial (s)	25.0	25.0	25.0	4.0	4.0
Minimum Split (s)	30.0	30.0	30.0	20.0	20.0
Total Split (s)	67.0	67.0	67.0	24.0	24.0
Total Split (%)	73.6%	73.6%	73.6%	26.4%	26.4%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	1.5	1.5	1.5	1.5	1.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	C-Max	C-Max	C-Max	None	None
Act Effct Green (s)	74.5	74.5	74.5	9.5	9.5
Actuated g/C Ratio	0.82	0.82	0.82	0.10	0.10
v/c Ratio	0.31	0.38	0.83	0.52	0.32
Control Delay	6.7	4.6	6.0	51.3	15.9
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	6.7	4.6	6.0	51.3	15.9
LOS	A	A	A	D	B
Approach Delay		5.0	6.0	36.0	
Approach LOS		A	A	D	

Intersection Summary	
Cycle Length: 91	
Actuated Cycle Length: 91	
Offset: 83 (91%), Referenced to phase 2:EBWB, Start of Green	
Natural Cycle: 90	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.83	
Intersection Signal Delay: 8.1	Intersection LOS: A
Intersection Capacity Utilization 94.8%	ICU Level of Service F
Analysis Period (min) 15	

Splits and Phases: 5: Salt Lake Blvd & Wanaka St

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	77	386	680	106	51	46
Ideal Flow (vphpl)	1400	1400	1400	1400	1400	1400
Lane Width	10	10	10	12	10	10
Grade (%)		0%	1%		-8%	
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.98		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1217	1281	1247		1266	1106
Flt Permitted	0.29	1.00	1.00		0.95	1.00
Satd. Flow (perm)	373	1281	1247		1266	1106
Peak-hour factor, PHF	0.80	0.96	0.93	0.88	0.75	0.89
Adj. Flow (vph)	96	402	731	120	68	52
RTOR Reduction (vph)	0	0	4	0	0	47
Lane Group Flow (vph)	96	402	847	0	68	5
Confl. Peds. (#/hr)	1			1		1
Turn Type	Perm	NA	NA		NA	Perm
Protected Phases		2	2		4	
Permitted Phases	2					4
Actuated Green, G (s)	72.5	72.5	72.5		8.5	8.5
Effective Green, g (s)	72.5	72.5	72.5		8.5	8.5
Actuated g/C Ratio	0.80	0.80	0.80		0.09	0.09
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	4.0	4.0	4.0		2.2	2.2
Lane Grp Cap (vph)	297	1021	993		118	103
v/s Ratio Prot		0.31	c0.68		c0.05	
v/s Ratio Perm	0.26					0.00
v/c Ratio	0.32	0.39	0.85		0.58	0.05
Uniform Delay, d1	2.5	2.7	5.9		39.5	37.6
Progression Factor	1.00	1.00	0.14		1.00	1.00
Incremental Delay, d2	2.9	1.1	3.3		4.7	0.1
Delay (s)	5.4	3.9	4.1		44.2	37.7
Level of Service	A	A	A		D	D
Approach Delay (s)		4.2	4.1		41.4	
Approach LOS		A	A		D	

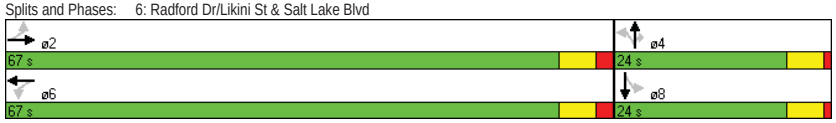
Intersection Summary			
HCM Average Control Delay	7.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	91.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	94.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Configurations									
Volume (vph)	3	415	200	759	50	21	313	54	9
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	Perm	NA
Protected Phases		2		6		4			8
Permitted Phases	2		6		4		4	8	
Detector Phase	2	2	6	6	4	4	4	8	8
Switch Phase									
Minimum Initial (s)	5.0	5.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	46.0	46.0	46.0	46.0	9.0	9.0	9.0	24.0	24.0
Total Split (s)	67.0	67.0	67.0	67.0	24.0	24.0	24.0	24.0	24.0
Total Split (%)	73.6%	73.6%	73.6%	73.6%	26.4%	26.4%	26.4%	26.4%	26.4%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0		0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0		5.0	5.0		5.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	C-Max	C-Max	C-Max	C-Max	None	None	None	None	None
Act Effct Green (s)	66.6	66.6	66.6	66.6		13.4	13.4		13.4
Actuated g/C Ratio	0.73	0.73	0.73	0.73		0.15	0.15		0.15
v/c Ratio	0.02	0.53	0.61	1.00		0.64	0.75		0.65
Control Delay	4.0	7.0	15.2	44.0		55.2	14.9		50.6
Queue Delay	0.0	0.0	0.0	0.0		0.0	0.0		0.0
Total Delay	4.0	7.0	15.2	44.0		55.2	14.9		50.6
LOS	A	A	B	D		E	B		D
Approach Delay		7.0		37.7		23.7			50.6
Approach LOS		A		D		C			D

Intersection Summary	
Cycle Length: 91	
Actuated Cycle Length: 91	
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBTL, Start of Yellow, Master Intersection	
Natural Cycle: 100	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 1.00	
Intersection Signal Delay: 28.6	Intersection LOS: C
Intersection Capacity Utilization 91.3%	ICU Level of Service F
Analysis Period (min) 15	

Splits and Phases: 6: Radford Dr/Likini St & Salt Lake Blvd



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	3	415	34	200	759	71	50	21	313	54	9	7
Ideal Flow (vphpl)	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
Lane Width	11	11	11	10	10	10	12	12	12	12	12	12
Grade (%)		1%			-2%			2%			-6%	
Total Lost time (s)	6.0	6.0		6.0	6.0			5.0	5.0		5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	0.97		0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			0.99	1.00		1.00	
Frt	1.00	0.99		1.00	0.99			1.00	0.85		0.98	
Flt Protected	0.95	1.00		0.95	1.00			0.97	1.00		0.97	
Satd. Flow (prot)	1253	1298		1228	1273			1305	1124		1335	
Flt Permitted	0.22	1.00		0.45	1.00			0.75	1.00		0.76	
Satd. Flow (perm)	296	1298		586	1273			1008	1124		1041	
Peak-hour factor, PHF	0.75	0.91	0.71	0.76	0.90	0.81	0.73	0.75	0.91	0.84	0.38	0.44
Adj. Flow (vph)	4	456	48	263	843	88	68	28	344	64	24	16
RTOR Reduction (vph)	0	3	0	0	3	0	0	0	293	0	8	0
Lane Group Flow (vph)	4	501	0	263	928	0	0	96	51	0	96	0
Confl. Peds. (#/hr)	4		6	2		4	4		2			8
Turn Type	Perm	NA		Perm	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		2			6			4			8	
Permitted Phases	2			6			4		4	8		
Actuated Green, G (s)	66.6	66.6		66.6	66.6			13.4	13.4		13.4	
Effective Green, g (s)	66.6	66.6		66.6	66.6			13.4	13.4		13.4	
Actuated g/C Ratio	0.73	0.73		0.73	0.73			0.15	0.15		0.15	
Clearance Time (s)	6.0	6.0		6.0	6.0			5.0	5.0		5.0	
Vehicle Extension (s)	5.0	5.0		5.0	5.0			3.0	3.0		3.0	
Lane Grp Cap (vph)	217	950		429	932			148	166		153	
v/s Ratio Prot		0.39			c0.73							
v/s Ratio Perm	0.01			0.45				c0.10	0.05		0.09	
v/c Ratio	0.02	0.53		0.61	1.00			0.65	0.31		0.63	
Uniform Delay, d1	3.3	5.3		5.9	12.0			36.6	34.6		36.5	
Progression Factor	0.80	0.78		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.1	2.0		6.4	28.3			9.4	1.0		7.9	
Delay (s)	2.8	6.2		12.3	40.4			46.0	35.7		44.3	
Level of Service	A	A		B	D			D	D		D	
Approach Delay (s)		6.1			34.2			37.9			44.3	
Approach LOS		A			C			D			D	

Intersection Summary			
HCM Average Control Delay	29.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	91.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	91.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Exist PM PHF
7: Salt Lake Blvd & Kahikolu Pl 1/3/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	3	758	1084	15	9	4
Sign Control		Free	Free		Stop	
Grade		0%	2%		0%	
Peak Hour Factor	0.38	0.89	0.92	0.54	0.45	0.50
Hourly flow rate (vph)	8	852	1178	28	20	8
Pedestrians		14	14		14	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		1	1		1	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		534	907			
pX, platoon unblocked	0.73				0.76	0.73
vC, conflicting volume	1220				2088	1220
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1118				2110	1118
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	98				51	96
cM capacity (veh/h)	453				41	180

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	8	852	1206	28
Volume Left	8	0	0	20
Volume Right	0	0	28	8
cSH	453	1700	1700	53
Volume to Capacity	0.02	0.50	0.71	0.53
Queue Length 95th (ft)	1	0	0	51
Control Delay (s)	13.1	0.0	0.0	133.9
Lane LOS	B			F
Approach Delay (s)	0.1		0.0	133.9
Approach LOS				F

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	92.4%	ICU Level of Service	F
Analysis Period (min)	15		

Exist PM PHF
8: Salt Lake Blvd & Shopping Center Entrance 1 1/3/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	95	704	0	1	1010	7	1	0	0	0	0	70
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.85	0.91	0.92	0.25	0.95	0.44	0.25	0.92	0.92	0.92	0.92	0.62
Hourly flow rate (vph)	112	774	0	4	1063	16	4	0	0	0	0	113
Pedestrians		2			2						2	
Lane Width (ft)		12.0			12.0						12.0	
Walking Speed (ft/s)		4.0			4.0						4.0	
Percent Blockage		0			0						0	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		888			553							
pX, platoon unblocked	0.77						0.77	0.77		0.77	0.77	0.77
vC, conflicting volume	1081			774			2191	2086	776	2080	2078	1075
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	952			774			2403	2266	776	2258	2256	945
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	80			100			49	100	100	100	100	53
cM capacity (veh/h)	551			842			8	25	397	19	25	242

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	NB 3	SB 1
Volume Total	112	774	1083	4	0	0	113
Volume Left	112	0	4	4	0	0	0
Volume Right	0	0	16	0	0	0	113
cSH	551	1700	842	8	1700	1700	242
Volume to Capacity	0.20	0.46	0.00	0.51	0.00	0.00	0.47
Queue Length 95th (ft)	19	0	0	25	0	0	57
Control Delay (s)	13.2	0.0	0.2	696.1	0.0	0.0	32.2
Lane LOS	B		A	F	A	A	D
Approach Delay (s)	1.7		0.2	696.1			32.2
Approach LOS				F			D

Intersection Summary			
Average Delay	3.9		
Intersection Capacity Utilization	118.8%	ICU Level of Service	H
Analysis Period (min)	15		

Exist PM PHF
9: Aliamanu School /Shopping Center Entrance 2 & Salt Lake Blvd 1/3/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	672	18	0	936	72	0	0	30	0	0	76
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.93	0.64	0.92	0.90	0.86	0.92	0.92	0.68	0.92	0.92	0.76
Hourly flow rate (vph)	0	723	28	0	1040	84	0	0	44	0	0	100
Pedestrians		2									2	
Lane Width (ft)		12.0									12.0	
Walking Speed (ft/s)		4.0									4.0	
Percent Blockage		0									0	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		1105			336							
pX, platoon unblocked	0.79						0.79	0.79		0.79	0.79	0.79
vC, conflicting volume	1126			723			1879	1862	737	1779	1765	1044
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1025			723			1981	1960	737	1854	1836	921
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	89	100	100	61
cM capacity (veh/h)	533			880			22	50	419	40	60	257

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	751	1040	84	44	100
Volume Left	0	0	0	0	0
Volume Right	28	0	84	44	100
cSH	1700	1700	1700	419	257
Volume to Capacity	0.44	0.61	0.05	0.11	0.39
Queue Length 95th (ft)	0	0	0	9	44
Control Delay (s)	0.0	0.0	0.0	14.6	27.6
Lane LOS				B	D
Approach Delay (s)	0.0	0.0		14.6	27.6
Approach LOS				B	D

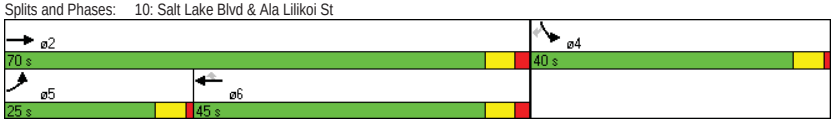
Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	80.6%	ICU Level of Service	D
Analysis Period (min)	15		

Exist PM PHF
10: Salt Lake Blvd & Ala Lilikoi St 1/3/2012

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	216	479	754	407	248	244
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	20.0	20.0	20.0	6.0	6.0
Minimum Split (s)	10.0	26.0	29.0	29.0	35.0	35.0
Total Split (s)	25.0	70.0	45.0	45.0	40.0	40.0
Total Split (%)	22.7%	63.6%	40.9%	40.9%	36.4%	36.4%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	C-Max	C-Max	C-Max	None	None
Act Effct Green (s)	19.2	82.1	57.9	57.9	16.9	16.9
Actuated g/C Ratio	0.17	0.75	0.53	0.53	0.15	0.15
v/c Ratio	0.73	0.13	0.44	0.47	0.52	0.60
Control Delay	56.7	4.7	12.4	2.2	45.2	9.9
Queue Delay	0.0	0.0	0.9	0.5	0.0	0.0
Total Delay	56.7	4.7	13.2	2.8	45.2	9.9
LOS	E	A	B	A	D	A
Approach Delay		20.8	9.4		27.2	
Approach LOS		C	A		C	

Intersection Summary	
Cycle Length: 110	
Actuated Cycle Length: 110	
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow, Master Intersection	
Natural Cycle: 80	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.73	
Intersection Signal Delay: 16.4	Intersection LOS: B
Intersection Capacity Utilization 64.8%	ICU Level of Service C
Analysis Period (min) 15	

Splits and Phases: 10: Salt Lake Blvd & Ala Lilikoi St



Exist PM PHF
10: Salt Lake Blvd & Ala Lilikoi St 1/3/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	216	479	754	407	248	244
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lane Util. Factor	1.00	0.91	0.95	1.00	0.97	1.00
Frpb, ped/bikes	1.00	1.00	1.00	0.96	1.00	0.95
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	5085	3539	1515	3433	1511
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	5085	3539	1515	3433	1511
Peak-hour factor, PHF	0.95	0.94	0.91	0.84	0.91	0.86
Adj. Flow (vph)	227	510	829	485	273	284
RTOR Reduction (vph)	0	0	0	230	0	240
Lane Group Flow (vph)	227	510	829	255	273	44
Confl. Peds. (#/hr)				22		31
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Actuated Green, G (s)	19.2	82.1	57.9	57.9	16.9	16.9
Effective Green, g (s)	19.2	82.1	57.9	57.9	16.9	16.9
Actuated g/C Ratio	0.17	0.75	0.53	0.53	0.15	0.15
Clearance Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Vehicle Extension (s)	3.0	4.0	4.0	4.0	3.0	3.0
Lane Grp Cap (vph)	309	3795	1863	797	527	232
v/s Ratio Prot	c0.13	0.10	c0.23		c0.08	
v/s Ratio Perm				0.17		0.03
v/c Ratio	0.73	0.13	0.44	0.32	0.52	0.19
Uniform Delay, d1	43.0	3.9	16.1	14.8	42.8	40.6
Progression Factor	1.00	1.00	0.63	0.35	1.00	1.00
Incremental Delay, d2	8.7	0.1	0.7	1.0	0.9	0.4
Delay (s)	51.7	4.0	10.8	6.2	43.7	41.0
Level of Service	D	A	B	A	D	D
Approach Delay (s)		18.7	9.1		42.3	
Approach LOS		B	A		D	

Intersection Summary			
HCM Average Control Delay	18.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		

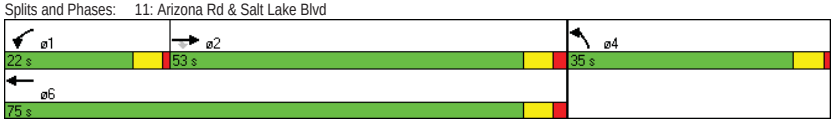
c Critical Lane Group

Exist PM PHF
11: Arizona Rd & Salt Lake Blvd 1/3/2012

Lane Group	EBT	EBR	WBL	WBT	NBL
Lane Configurations					
Volume (vph)	566	183	34	730	452
Turn Type	NA	Perm	Prot	NA	NA
Protected Phases	2		1	6	4
Permitted Phases		2			
Detector Phase	2	2	1	6	4
Switch Phase					
Minimum Initial (s)	20.0	20.0	5.0	20.0	5.0
Minimum Split (s)	28.0	28.0	10.0	26.0	34.0
Total Split (s)	53.0	53.0	22.0	75.0	35.0
Total Split (%)	48.2%	48.2%	20.0%	68.2%	31.8%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	1.0	2.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0	5.0	6.0	5.0
Lead/Lag	Lag	Lag	Lead		
Lead-Lag Optimize?					
Recall Mode	C-Max	C-Max	None	C-Max	None
Act Effct Green (s)	64.7	64.7	8.2	75.9	23.1
Actuated g/C Ratio	0.59	0.59	0.07	0.69	0.21
v/c Ratio	0.30	0.21	0.34	0.32	0.76
Control Delay	11.4	3.8	54.5	7.6	47.2
Queue Delay	0.4	0.4	0.0	0.0	0.5
Total Delay	11.8	4.1	54.5	7.6	47.7
LOS	B	A	D	A	D
Approach Delay	9.9			10.0	47.7
Approach LOS	A			B	D

Intersection Summary	
Cycle Length: 110	
Actuated Cycle Length: 110	
Offset: 39 (35%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow	
Natural Cycle: 75	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.76	
Intersection Signal Delay: 19.5	Intersection LOS: B
Intersection Capacity Utilization 50.9%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 11: Arizona Rd & Salt Lake Blvd



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	566	183	34	730	452	28
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	10	12	12	12
Grade (%)	8%			-10%	-2%	
Total Lost time (s)	6.0	6.0	5.0	6.0	5.0	
Lane Util. Factor	0.95	1.00	1.00	0.95	0.97	
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	0.85	1.00	1.00	0.99	
Flt Protected	1.00	1.00	0.95	1.00	0.96	
Satd. Flow (prot)	3398	1482	1734	3716	3443	
Flt Permitted	1.00	1.00	0.95	1.00	0.96	
Satd. Flow (perm)	3398	1482	1734	3716	3443	
Peak-hour factor, PHF	0.94	0.90	0.77	0.90	0.88	0.64
Adj. Flow (vph)	602	203	44	811	514	44
RTOR Reduction (vph)	0	85	0	0	6	0
Lane Group Flow (vph)	602	118	44	811	552	0
Confl. Peds. (#/hr)		2				4
Turn Type	NA	Perm	Prot	NA	NA	
Protected Phases	2		1	6	4	
Permitted Phases		2				
Actuated Green, G (s)	63.8	63.8	7.1	75.9	23.1	
Effective Green, g (s)	63.8	63.8	7.1	75.9	23.1	
Actuated g/C Ratio	0.58	0.58	0.06	0.69	0.21	
Clearance Time (s)	6.0	6.0	5.0	6.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	1971	860	112	2564	723	
v/s Ratio Prot	0.18		0.03	c0.22	c0.16	
v/s Ratio Perm		0.08				
v/c Ratio	0.31	0.14	0.39	0.32	0.76	
Uniform Delay, d1	11.8	10.5	49.4	6.8	40.9	
Progression Factor	0.85	1.54	1.00	1.00	1.00	
Incremental Delay, d2	0.4	0.3	2.3	0.3	4.8	
Delay (s)	10.4	16.6	51.7	7.1	45.7	
Level of Service	B	B	D	A	D	
Approach Delay (s)	12.0			9.4	45.7	
Approach LOS	B			A	D	

Intersection Summary			
HCM Average Control Delay	19.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	50.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Base Year 2040 AM

Timings
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	135	650	530	150	570	245	210	140	440
Turn Type	Prot	NA	Perm	Prot	NA	Prot	NA	Prot	NA
Protected Phases	5	2		1	6	3	8	7	4
Permitted Phases			2						
Detector Phase	5	2	2	1	6	3	8	7	4
Switch Phase									
Minimum Initial (s)	5.0	20.0	20.0	5.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	34.0	34.0	10.0	34.0	10.0	33.0	10.0	33.0
Total Split (s)	26.0	61.0	61.0	30.0	65.0	32.0	36.0	33.0	37.0
Total Split (%)	16.3%	38.1%	38.1%	18.8%	40.6%	20.0%	22.5%	20.6%	23.1%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	5.0	6.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?									
Recall Mode	None	C-Max	C-Max	None	C-Max	None	None	None	None

Intersection Summary
Cycle Length: 160
Actuated Cycle Length: 160
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow, Master Intersection
Natural Cycle: 130
Control Type: Actuated-Coordinated

Splits and Phases: 1: Bouganville Dr & Salt Lake Blvd

HCM Signalized Intersection Capacity Analysis
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	135	650	530	150	570	110	245	210	55	140	440	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		3%			-3%			2%			-2%	
Total Lost time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.66	1.00	0.98		1.00	0.96		1.00	0.92	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.97		1.00	0.96	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1743	3486	1035	1796	4846		1752	3251		1787	3177	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1743	3486	1035	1796	4846		1752	3251		1787	3177	
Peak-hour factor, PHF	0.73	0.87	0.79	0.50	0.78	0.45	0.90	0.74	0.71	0.77	0.78	0.77
Adj. Flow (vph)	185	747	671	300	731	244	272	284	77	182	564	182
RTOR Reduction (vph)	0	0	260	0	37	0	0	14	0	0	19	0
Lane Group Flow (vph)	185	747	411	300	938	0	272	347	0	182	727	0
Confl. Peds. (#/hr)			266			51			109			208
Turn Type	Prot	NA	Perm	Prot	NA		Prot	NA		Prot	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2									
Actuated Green, G (s)	19.3	55.0	55.0	25.0	60.7		26.2	38.4		20.6	32.8	
Effective Green, g (s)	19.3	55.0	55.0	25.0	60.7		26.2	38.4		20.6	32.8	
Actuated g/C Ratio	0.12	0.34	0.34	0.16	0.38		0.16	0.24		0.13	0.20	
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	5.0	5.0	2.0	5.0		2.0	3.0		2.0	3.0	
Lane Grp Cap (vph)	210	1198	356	281	1838		287	780		230	651	
v/s Ratio Prot	0.11	0.21		c0.17	0.19		c0.16	0.11		0.10	c0.23	
v/s Ratio Perm			c0.40									
v/c Ratio	0.88	0.62	1.15	1.07	0.51		0.95	0.44		0.79	1.12	
Uniform Delay, d1	69.2	43.9	52.5	67.5	38.2		66.2	51.7		67.6	63.6	
Progression Factor	1.00	1.00	1.00	0.92	0.94		1.00	1.00		1.00	1.00	
Incremental Delay, d2	31.4	2.5	96.8	72.1	1.0		38.5	0.4		15.8	71.8	
Delay (s)	100.6	46.3	149.3	134.4	36.7		104.7	52.1		83.4	135.4	
Level of Service	F	D	F	F	D		F	D		F	F	
Approach Delay (s)		95.7			59.7			74.7			125.2	
Approach LOS		F			E			E			F	

Intersection Summary			
HCM Average Control Delay	88.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	86.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Timings
2: Lawehana St & Salt Lake Blvd

7/19/2012

Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Configurations					
Volume (vph)	740	60	795	80	105
Turn Type	NA	Prot	NA	NA	Perm
Protected Phases	2	1	6	4	
Permitted Phases					4
Detector Phase	2	1	6	4	4
Switch Phase					
Minimum Initial (s)	20.0	5.0	20.0	5.0	5.0
Minimum Split (s)	28.0	10.0	26.0	37.0	37.0
Total Split (s)	90.0	25.0	115.0	45.0	45.0
Total Split (%)	56.3%	15.6%	71.9%	28.1%	28.1%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	6.0	6.0
Lead/Lag	Lag	Lead			
Lead-Lag Optimize?					
Recall Mode	C-Max	None	C-Max	None	None

Intersection Summary
Cycle Length: 160
Actuated Cycle Length: 160
Offset: 43 (27%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 80
Control Type: Actuated-Coordinated

Splits and Phases: 2: Lawehana St & Salt Lake Blvd

HCM Signalized Intersection Capacity Analysis
2: Lawehana St & Salt Lake Blvd

7/19/2012

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	740	145	60	795	80	105
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	10	10
Grade (%)	-1%			-3%	-1%	
Total Lost time (s)	6.0		5.0	6.0	6.0	6.0
Lane Util. Factor	0.95		1.00	0.91	1.00	1.00
Frpb, ped/bikes	0.95		1.00	1.00	1.00	0.88
Flpb, ped/bikes	1.00		1.00	1.00	1.00	1.00
Frt	0.97		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	3285		1796	4129	1660	1305
Flt Permitted	1.00		0.95	1.00	0.95	1.00
Satd. Flow (perm)	3285		1796	4129	1660	1305
Peak-hour factor, PHF	0.82	0.72	0.52	0.77	0.64	0.66
Adj. Flow (vph)	902	201	115	1032	125	159
RTOR Reduction (vph)	8	0	0	0	0	142
Lane Group Flow (vph)	1095	0	115	1032	125	17
Confl. Peds. (#/hr)		72				72
Parking (#/hr)				100		
Turn Type	NA		Prot	NA	NA	Perm
Protected Phases	2		1	6	4	
Permitted Phases						4
Actuated Green, G (s)	111.1		14.5	130.6	17.4	17.4
Effective Green, g (s)	111.1		14.5	130.6	17.4	17.4
Actuated g/C Ratio	0.69		0.09	0.82	0.11	0.11
Clearance Time (s)	6.0		5.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0		2.0	5.0	3.0	3.0
Lane Grp Cap (vph)	2281		163	3370	181	142
v/s Ratio Prot	c0.33		c0.06	0.25	c0.08	
v/s Ratio Perm						0.01
v/c Ratio	0.48		0.71	0.31	0.69	0.12
Uniform Delay, d1	11.2		70.7	3.6	68.7	64.4
Progression Factor	0.31		1.00	1.00	1.00	1.00
Incremental Delay, d2	0.6		10.8	0.2	10.8	0.4
Delay (s)	4.1		81.4	3.8	79.5	64.8
Level of Service	A		F	A	E	E
Approach Delay (s)	4.1			11.6	71.3	
Approach LOS	A			B	E	

Intersection Summary			
HCM Average Control Delay	15.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	68.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

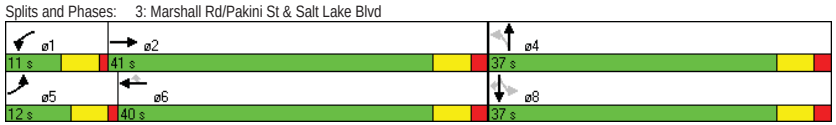
Timings
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT	SBR
Lane Configurations										
Volume (vph)	100	680	15	640	30	50	30	100	40	160
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	NA	Perm
Protected Phases	5	2	1	6			4		8	
Permitted Phases					6	4		8		8
Detector Phase	5	2	1	6	6	4	4	8	8	8
Switch Phase										
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	28.0	10.0	28.0	28.0	11.0	11.0	37.0	37.0	37.0
Total Split (s)	12.0	41.0	11.0	40.0	40.0	37.0	37.0	37.0	37.0	37.0
Total Split (%)	13.5%	46.1%	12.4%	44.9%	44.9%	41.6%	41.6%	41.6%	41.6%	41.6%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0		0.0	0.0
Total Lost Time (s)	5.0	6.0	5.0	6.0	6.0		6.0		6.0	6.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag					
Lead-Lag Optimize?										
Recall Mode	None	Max	None	Max	Max	None	None	None	None	None

Intersection Summary
Cycle Length: 89
Actuated Cycle Length: 76.9
Natural Cycle: 90
Control Type: Actuated-Uncoordinated

Splits and Phases: 3: Marshall Rd/Pakini St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	100	680	65	15	640	30	50	30	10	100	40	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			1%			-4%	
Total Lost time (s)	5.0	6.0		5.0	6.0	6.0		6.0			6.0	6.0
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00			1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.95		1.00			1.00	0.96
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00		0.99			1.00	1.00
Frt	1.00	0.99		1.00	1.00	0.85		0.98			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.97			0.96	1.00
Satd. Flow (prot)	1787	3511		1787	2502	1514		1764			1825	1553
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.67			0.74	1.00
Satd. Flow (perm)	1787	3511		1787	2502	1514		1219			1413	1553
Peak-hour factor, PHF	0.70	0.91	0.92	0.42	0.74	0.71	0.92	0.92	0.92	0.56	0.92	0.83
Adj. Flow (vph)	143	747	71	36	865	42	54	33	11	179	43	193
RTOR Reduction (vph)	0	6	0	0	0	23	0	6	0	0	0	148
Lane Group Flow (vph)	143	812	0	36	865	19	0	92	0	0	222	45
Confl. Peds. (#/hr)			21			19	17		5	1		35
Parking (#/hr)					100				0			
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		8
Actuated Green, G (s)	7.1	40.1		3.4	36.4	36.4		18.4			18.4	18.4
Effective Green, g (s)	7.1	40.1		3.4	36.4	36.4		18.4			18.4	18.4
Actuated g/C Ratio	0.09	0.51		0.04	0.46	0.46		0.23			0.23	0.23
Clearance Time (s)	5.0	6.0		5.0	6.0	6.0		6.0			6.0	6.0
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0		3.0			3.0	3.0
Lane Grp Cap (vph)	161	1784		77	1154	698		284			330	362
v/s Ratio Prot	c0.08	c0.23		0.02	c0.35							
v/s Ratio Perm						0.01		0.08			c0.16	0.03
v/c Ratio	0.89	0.45		0.47	0.75	0.03		0.32			0.67	0.12
Uniform Delay, d1	35.5	12.4		36.9	17.5	11.6		25.1			27.5	23.9
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00			1.00	1.00
Incremental Delay, d2	39.2	0.8		1.6	4.5	0.1		0.7			5.3	0.2
Delay (s)	74.7	13.2		38.5	22.0	11.7		25.8			32.8	24.0
Level of Service	E	B		D	C	B		C			C	C
Approach Delay (s)		22.4			22.2			25.8			28.7	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	23.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	78.9	Sum of lost time (s)	23.0
Intersection Capacity Utilization	60.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

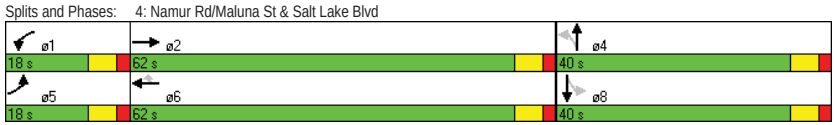
Timings
4: Namur Rd/Maluna St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	35	620	65	585	30	50	30	65	40
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	NA
Protected Phases	5	2	1	6			4		8
Permitted Phases					6	4		8	
Detector Phase	5	2	1	6	6	4	4	8	8
Switch Phase									
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	11.0	26.0	11.0	26.0	26.0	11.0	11.0	40.0	40.0
Total Split (s)	18.0	62.0	18.0	62.0	62.0	40.0	40.0	40.0	40.0
Total Split (%)	15.0%	51.7%	15.0%	51.7%	51.7%	33.3%	33.3%	33.3%	33.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0		6.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag				
Lead-Lag Optimize?									
Recall Mode	None	Max	None	Max	Max	None	None	None	None

Intersection Summary
Cycle Length: 120
Actuated Cycle Length: 102
Natural Cycle: 80
Control Type: Actuated-Uncoordinated

Splits and Phases: 4: Namur Rd/Maluna St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
4: Namur Rd/Maluna St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	35	620	65	65	585	30	50	30	25	65	40	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		7%			-6%			0%			-12%	
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0	6.0	6.0			6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	1.00			1.00	
Frpb, ped/bikes	1.00	0.99		1.00	1.00	1.00	1.00	0.99			0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	0.99	1.00			1.00	
Frt	1.00	0.98		1.00	1.00	0.85	1.00	0.93			0.95	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00			0.98	
Satd. Flow (prot)	1708	3334		1823	2552	1631	1757	1701			1836	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.48	1.00			0.85	
Satd. Flow (perm)	1708	3334		1823	2552	1631	881	1701			1595	
Peak-hour factor, PHF	0.89	0.81	0.73	0.66	0.80	0.79	0.81	0.65	0.56	0.82	0.52	0.72
Adj. Flow (vph)	39	765	89	98	731	38	62	46	45	79	77	83
RTOR Reduction (vph)	0	6	0	0	0	7	0	33	0	0	18	0
Lane Group Flow (vph)	39	848	0	98	731	31	62	58	0	0	221	0
Confl. Peds. (#/hr)			23				13		10			13
Parking (#/hr)					100							
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		
Actuated Green, G (s)	4.6	58.4		7.9	61.7	61.7	20.2	20.2			20.2	
Effective Green, g (s)	4.6	58.4		7.9	61.7	61.7	20.2	20.2			20.2	
Actuated g/C Ratio	0.04	0.56		0.08	0.59	0.59	0.19	0.19			0.19	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0	6.0	6.0			6.0	
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0	3.0	3.0			3.0	
Lane Grp Cap (vph)	75	1863		138	1507	963	170	329			308	
v/s Ratio Prot	0.02	0.25		c0.05	c0.29			0.03				
v/s Ratio Perm						0.02	0.07				c0.14	
v/c Ratio	0.52	0.46		0.71	0.49	0.03	0.36	0.18			0.72	
Uniform Delay, d1	48.9	13.6		47.2	12.3	8.9	36.6	35.2			39.5	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00			1.00	
Incremental Delay, d2	3.0	0.8		13.3	1.1	0.1	1.3	0.3			7.8	
Delay (s)	51.8	14.4		60.5	13.4	9.0	37.9	35.5			47.3	
Level of Service	D	B		E	B	A	D	D			D	
Approach Delay (s)		16.1			18.5			36.5			47.3	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	22.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	104.5	Sum of lost time (s)	18.0
Intersection Capacity Utilization	59.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

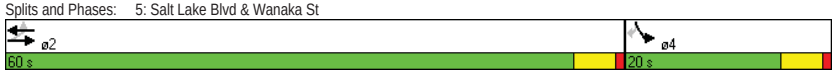
Timings
5: Salt Lake Blvd & Wanaka St

7/19/2012

Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations					
Volume (vph)	40	685	610	115	70
Turn Type	Perm	NA	NA	NA	Perm
Protected Phases		2	2	4	
Permitted Phases	2				4
Detector Phase	2	2	2	4	4
Switch Phase					
Minimum Initial (s)	25.0	25.0	25.0	4.0	4.0
Minimum Split (s)	30.0	30.0	30.0	20.0	20.0
Total Split (s)	60.0	60.0	60.0	20.0	20.0
Total Split (%)	75.0%	75.0%	75.0%	25.0%	25.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	Min	Min	Min	None	None

Intersection Summary
Cycle Length: 80
Actuated Cycle Length: 80
Natural Cycle: 150
Control Type: Actuated-Uncoordinated

Splits and Phases: 5: Salt Lake Blvd & Wanaka St



HCM Signalized Intersection Capacity Analysis
5: Salt Lake Blvd & Wanaka St

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	40	685	610	65	115	70
Ideal Flow (vphpl)	1400	1400	1400	1400	1400	1400
Lane Width	10	10	10	12	10	10
Grade (%)		0%	1%		-8%	
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.99		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1217	1281	502		1266	1132
Flt Permitted	0.30	1.00	1.00		0.95	1.00
Satd. Flow (perm)	389	1281	502		1266	1132
Peak-hour factor, PHF	0.66	0.86	0.90	0.77	0.85	0.81
Adj. Flow (vph)	61	797	678	84	135	86
RTOR Reduction (vph)	0	0	5	0	0	73
Lane Group Flow (vph)	61	797	757	0	135	13
Parking (#/hr)			100			
Turn Type	Perm	NA	NA		NA	Perm
Protected Phases		2	2		4	
Permitted Phases	2					4
Actuated Green, G (s)	57.9	57.9	57.9		12.0	12.0
Effective Green, g (s)	57.9	57.9	57.9		12.0	12.0
Actuated g/C Ratio	0.72	0.72	0.72		0.15	0.15
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	4.0	4.0	4.0		2.2	2.2
Lane Grp Cap (vph)	282	928	364		190	170
v/s Ratio Prot		0.62	c1.51		c0.11	
v/s Ratio Perm	0.16					0.01
v/c Ratio	0.22	0.86	2.08		0.71	0.08
Uniform Delay, d1	3.6	8.0	11.0		32.3	29.2
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.5	8.3	495.3		10.4	0.1
Delay (s)	4.1	16.3	506.3		42.7	29.3
Level of Service	A	B	F		D	C
Approach Delay (s)		15.4	506.3		37.5	
Approach LOS		B	F		D	

Intersection Summary			
HCM Average Control Delay	221.2	HCM Level of Service	F
HCM Volume to Capacity ratio	1.85		
Actuated Cycle Length (s)	79.9	Sum of lost time (s)	10.0
Intersection Capacity Utilization	65.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

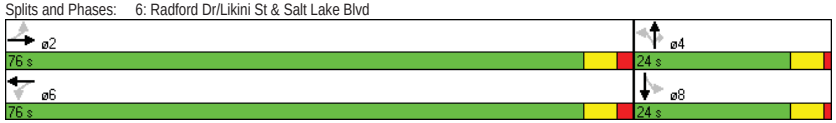
Timings
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Configurations									
Volume (vph)	5	805	290	605	50	10	295	110	45
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	Perm	NA
Protected Phases		2		6		4			8
Permitted Phases	2		6		4		4	8	
Detector Phase	2	2	6	6	4	4	4	8	8
Switch Phase									
Minimum Initial (s)	5.0	5.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	46.0	46.0	46.0	46.0	9.0	9.0	9.0	24.0	24.0
Total Split (s)	76.0	76.0	76.0	76.0	24.0	24.0	24.0	24.0	24.0
Total Split (%)	76.0%	76.0%	76.0%	76.0%	24.0%	24.0%	24.0%	24.0%	24.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0		0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0		5.0	5.0		5.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	Max	Max	Max	Max	None	None	None	None	None

Intersection Summary
Cycle Length: 100
Actuated Cycle Length: 100
Natural Cycle: 140
Control Type: Actuated-Uncoordinated

Splits and Phases: 6: Radford Dr/Likini St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	5	805	25	290	605	90	50	10	295	110	45	15
Ideal Flow (vphpl)	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
Grade (%)		1%			-2%			2%			-6%	
Total Lost time (s)	6.0	6.0		6.0	6.0			5.0	5.0		5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	0.95		0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			0.98	1.00		1.00	
Frt	1.00	0.99		1.00	0.98			1.00	0.85		0.98	
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.97	
Satd. Flow (prot)	1296	1355		1314	1356			1281	1096		1336	
Flt Permitted	0.27	1.00		0.15	1.00			0.68	1.00		0.72	
Satd. Flow (perm)	370	1355		205	1356			901	1096		997	
Peak-hour factor, PHF	0.25	0.81	0.64	0.86	0.87	0.88	0.58	0.38	0.80	0.70	0.78	0.56
Adj. Flow (vph)	20	994	39	337	695	102	86	26	369	157	58	27
RTOR Reduction (vph)	0	2	0	0	5	0	0	0	121	0	5	0
Lane Group Flow (vph)	20	1032	0	337	792	0	0	112	248	0	237	0
Confl. Peds. (#/hr)	3		33	12		3	21		12			24
Turn Type	Perm	NA		Perm	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		2			6			4			8	
Permitted Phases	2			6			4		4	8		
Actuated Green, G (s)	70.0	70.0		70.0	70.0			19.0	19.0		19.0	
Effective Green, g (s)	70.0	70.0		70.0	70.0			19.0	19.0		19.0	
Actuated g/C Ratio	0.70	0.70		0.70	0.70			0.19	0.19		0.19	
Clearance Time (s)	6.0	6.0		6.0	6.0			5.0	5.0		5.0	
Vehicle Extension (s)	5.0	5.0		5.0	5.0			3.0	3.0		3.0	
Lane Grp Cap (vph)	259	949		144	949			171	208		189	
v/s Ratio Prot		0.76			0.58							
v/s Ratio Perm	0.05			c1.64				0.12	0.23		c0.24	
v/c Ratio	0.08	1.09		2.34	0.83			0.65	1.19		1.25	
Uniform Delay, d1	4.8	15.0		15.0	10.8			37.5	40.5		40.5	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.6	55.8		624.2	8.6			8.7	124.5		150.4	
Delay (s)	5.3	70.8		639.2	19.4			46.2	165.0		190.9	
Level of Service	A	E		F	B			D	F		F	
Approach Delay (s)		69.5			203.6			137.4			190.9	
Approach LOS		E			F			F			F	

Intersection Summary			
HCM Average Control Delay	143.1	HCM Level of Service	F
HCM Volume to Capacity ratio	2.11		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	115.2%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
7: Salt Lake Blvd & Kahikolu Pl

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	1220	1060	15	20	10
Sign Control		Free	Free		Stop	
Grade		0%	-2%		0%	
Peak Hour Factor	0.25	0.85	0.93	0.69	0.65	0.31
Hourly flow rate (vph)	20	1435	1140	22	31	32
Pedestrians		13	13		13	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		1	1		1	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		534	907			
pX, platoon unblocked	0.80				0.46	0.80
vC, conflicting volume	1175				2652	1177
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1091				2998	1094
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	96				0	84
cM capacity (veh/h)	504				7	203

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	20	1435	1162	63
Volume Left	20	0	0	31
Volume Right	0	0	22	32
cSH	504	1700	1700	13
Volume to Capacity	0.04	0.84	0.68	4.85
Queue Length 95th (ft)	3	0	0	Err
Control Delay (s)	12.4	0.0	0.0	Err
Lane LOS	B			F
Approach Delay (s)	0.2		0.0	Err
Approach LOS				F

Intersection Summary			
Average Delay	235.3		
Intersection Capacity Utilization	100.7%	ICU Level of Service	G
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
8: Salt Lake Blvd & Shopping Center Entrance 1

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	75	1115	50	10	960	20	15	10	40	5	25	35
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.64	0.38	0.87	0.75	1.00	0.75	0.56	0.25	0.25	0.65
Hourly flow rate (vph)	85	1267	78	26	1103	27	15	13	71	20	100	54
Pedestrians		1			1						1	
Lane Width (ft)		12.0			12.0						12.0	
Walking Speed (ft/s)		4.0			4.0						4.0	
Percent Blockage		0			0						0	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		888			553							
pX, platoon unblocked	0.81			0.43			0.53	0.53	0.43	0.53	0.53	0.81
vC, conflicting volume	1131			1345			2751	2660	1307	2687	2686	1119
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1043			1143			3036	2866	1056	2916	2914	1027
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	84			90			0	0	40	0	0	76
cM capacity (veh/h)	538			265			0	7	119	0	6	229

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	NB 3	SB 1
Volume Total	85	1345	1156	15	13	71	174
Volume Left	85	0	26	15	0	0	20
Volume Right	0	78	27	0	0	71	54
cSH	538	1700	265	0	7	119	0
Volume to Capacity	0.16	0.79	0.10	Err	1.99	0.60	Err
Queue Length 95th (ft)	14	0	8	Err	67	75	Err
Control Delay (s)	13.0	0.0	6.3	Err	1496.0	73.1	Err
Lane LOS	B		A	F	F	F	F
Approach Delay (s)	0.8		6.3	Err			Err
Approach LOS				F			F

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	102.5%	ICU Level of Service	G
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
9: Aliamanu School /Shopping Center Entrance 2 & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	940	225	0	910	45	0	0	190	0	0	70
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.96	0.68	0.92	0.94	0.75	0.92	0.92	0.64	0.92	0.92	0.87
Hourly flow rate (vph)	0	979	331	0	968	60	0	0	297	0	0	80
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		1105			336							
pX, platoon unblocked	0.83			0.54			0.63	0.63	0.54	0.63	0.63	0.83
vC, conflicting volume	1028			979			2193	2173	1145	2113	1947	968
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	929			535			1983	1950	842	1855	1591	856
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	0	0	100	73
cM capacity (veh/h)	608			558			21	40	197	0	67	295

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	1310	968	60	297	80
Volume Left	0	0	0	0	0
Volume Right	331	0	60	297	80
cSH	1700	1700	1700	197	295
Volume to Capacity	0.77	0.57	0.04	1.51	0.27
Queue Length 95th (ft)	0	0	0	463	27
Control Delay (s)	0.0	0.0	0.0	297.8	21.7
Lane LOS				F	C
Approach Delay (s)	0.0	0.0		297.8	21.7
Approach LOS				F	C

Intersection Summary				
Average Delay		33.2		
Intersection Capacity Utilization		108.3%	ICU Level of Service	G
Analysis Period (min)		15		

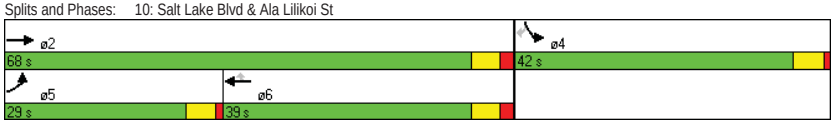
Timings
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	265	870	530	325	880	425
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	20.0	20.0	20.0	6.0	6.0
Minimum Split (s)	10.0	26.0	29.0	29.0	35.0	35.0
Total Split (s)	29.0	68.0	39.0	39.0	42.0	42.0
Total Split (%)	26.4%	61.8%	35.5%	35.5%	38.2%	38.2%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	C-Max	C-Max	C-Max	None	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow, Master Intersection
Natural Cycle: 80
Control Type: Actuated-Coordinated

Splits and Phases: 10: Salt Lake Blvd & Ala Lilikoi St



HCM Signalized Intersection Capacity Analysis
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	265	870	530	325	880	425
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lane Util. Factor	1.00	0.91	0.95	1.00	0.97	1.00
Frpb, ped/bikes	1.00	1.00	1.00	0.84	1.00	0.75
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	5085	3539	1337	3433	1189
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	5085	3539	1337	3433	1189
Peak-hour factor, PHF	0.77	0.92	0.94	0.73	0.91	0.82
Adj. Flow (vph)	344	946	564	445	967	518
RTOR Reduction (vph)	0	0	0	305	0	321
Lane Group Flow (vph)	344	946	564	140	967	197
Confl. Peds. (#/hr)				102		220
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Actuated Green, G (s)	23.3	62.8	34.5	34.5	36.2	36.2
Effective Green, g (s)	23.3	62.8	34.5	34.5	36.2	36.2
Actuated g/C Ratio	0.21	0.57	0.31	0.31	0.33	0.33
Clearance Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Vehicle Extension (s)	3.0	4.0	4.0	4.0	3.0	3.0
Lane Grp Cap (vph)	375	2903	1110	419	1130	391
v/s Ratio Prot	c0.19	0.19	c0.16		c0.28	
v/s Ratio Perm				0.10		0.17
v/c Ratio	0.92	0.33	0.51	0.33	0.86	0.50
Uniform Delay, d1	42.4	12.4	30.8	28.9	34.5	29.7
Progression Factor	1.00	1.00	0.67	0.85	1.00	1.00
Incremental Delay, d2	26.6	0.3	1.6	2.0	6.5	1.0
Delay (s)	69.0	12.7	22.3	26.5	41.0	30.7
Level of Service	E	B	C	C	D	C
Approach Delay (s)		27.7	24.2		37.4	
Approach LOS		C	C		D	

Intersection Summary			
HCM Average Control Delay	30.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	72.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Timings
11: Arizona Rd & Salt Lake Blvd

7/19/2012

Lane Group	EBT	EBR	WBL	WBT	NBL
Lane Configurations					
Volume (vph)	1320	485	165	565	250
Turn Type	NA	Perm	Prot	NA	NA
Protected Phases	2		1	6	4
Permitted Phases		2			
Detector Phase	2	2	1	6	4
Switch Phase					
Minimum Initial (s)	20.0	20.0	5.0	20.0	5.0
Minimum Split (s)	28.0	28.0	10.0	26.0	34.0
Total Split (s)	45.0	45.0	28.0	73.0	37.0
Total Split (%)	40.9%	40.9%	25.5%	66.4%	33.6%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	1.0	2.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0	5.0	6.0	5.0
Lead/Lag	Lag	Lag	Lead		
Lead-Lag Optimize?					
Recall Mode	C-Max	C-Max	None	C-Max	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 50 (45%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 100
Control Type: Actuated-Coordinated

Splits and Phases: 11: Arizona Rd & Salt Lake Blvd

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	1320	485	165	565	250	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	10	12	12	12
Grade (%)	8%			-10%	-2%	
Total Lost time (s)	6.0	6.0	5.0	6.0	5.0	
Lane Util. Factor	0.95	1.00	1.00	0.95	0.97	
Frpb, ped/bikes	1.00	0.97	1.00	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	0.85	1.00	1.00	0.97	
Flt Protected	1.00	1.00	0.95	1.00	0.96	
Satd. Flow (prot)	3398	1475	1734	3716	3394	
Flt Permitted	1.00	1.00	0.95	1.00	0.96	
Satd. Flow (perm)	3398	1475	1734	3716	3394	
Peak-hour factor, PHF	0.91	0.80	0.62	0.93	0.60	0.49
Adj. Flow (vph)	1451	606	266	608	417	102
RTOR Reduction (vph)	0	239	0	0	22	0
Lane Group Flow (vph)	1451	367	266	608	497	0
Confl. Peds. (#/hr)		4				5
Turn Type	NA	Perm	Prot	NA	NA	
Protected Phases	2		1	6	4	
Permitted Phases		2				
Actuated Green, G (s)	50.4	50.4	21.5	76.9	22.1	
Effective Green, g (s)	50.4	50.4	21.5	76.9	22.1	
Actuated g/C Ratio	0.46	0.46	0.20	0.70	0.20	
Clearance Time (s)	6.0	6.0	5.0	6.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	1557	676	339	2598	682	
v/s Ratio Prot	c0.43		c0.15	0.16	c0.15	
v/s Ratio Perm		0.25				
v/c Ratio	0.93	0.54	0.78	0.23	0.73	
Uniform Delay, d1	28.2	21.5	42.1	6.0	41.1	
Progression Factor	0.92	1.14	1.00	1.00	1.00	
Incremental Delay, d2	10.1	2.6	11.3	0.2	3.9	
Delay (s)	36.1	27.1	53.3	6.2	45.0	
Level of Service	D	C	D	A	D	
Approach Delay (s)	33.5			20.5	45.0	
Approach LOS	C			C	D	

Intersection Summary			
HCM Average Control Delay	31.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	70.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Base Year 2040 PM

Timings
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	75	685	305	45	1025	560	355	80	215
Turn Type	Prot	NA	Perm	Prot	NA	Prot	NA	Prot	NA
Protected Phases	5	2		1	6	3	8	7	4
Permitted Phases			2						
Detector Phase	5	2	2	1	6	3	8	7	4
Switch Phase									
Minimum Initial (s)	5.0	20.0	20.0	5.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	34.0	34.0	10.0	34.0	10.0	33.0	10.0	33.0
Total Split (s)	17.0	76.0	76.0	17.0	76.0	34.0	45.0	22.0	33.0
Total Split (%)	10.6%	47.5%	47.5%	10.6%	47.5%	21.3%	28.1%	13.8%	20.6%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	5.0	6.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?									
Recall Mode	None	C-Max	C-Max	None	C-Max	None	None	None	None

Intersection Summary
Cycle Length: 160
Actuated Cycle Length: 160
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 130
Control Type: Actuated-Coordinated

Splits and Phases: 1: Bouganville Dr & Salt Lake Blvd

HCM Signalized Intersection Capacity Analysis
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	75	685	305	45	1025	165	560	355	45	80	215	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		3%			-3%			2%			-2%	
Total Lost time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.95	1.00	1.00		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.98		1.00	0.96	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1743	3486	1478	1796	5019		1752	3412		1787	3381	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1743	3486	1478	1796	5019		1752	3412		1787	3381	
Peak-hour factor, PHF	0.82	0.83	0.92	0.83	0.94	0.80	0.95	0.88	0.67	0.85	0.74	0.86
Adj. Flow (vph)	91	825	332	54	1090	206	589	403	67	94	291	116
RTOR Reduction (vph)	0	0	168	0	16	0	0	8	0	0	27	0
Lane Group Flow (vph)	91	825	164	54	1280	0	589	462	0	94	380	0
Confl. Peds. (#/hr)			24			7			13			18
Turn Type	Prot	NA	Perm	Prot	NA		Prot	NA		Prot	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2									
Actuated Green, G (s)	11.7	79.2	79.2	7.9	75.4		29.0	39.3		12.6	22.9	
Effective Green, g (s)	11.7	79.2	79.2	7.9	75.4		29.0	39.3		12.6	22.9	
Actuated g/C Ratio	0.07	0.50	0.50	0.05	0.47		0.18	0.25		0.08	0.14	
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	5.0	5.0	2.0	5.0		2.0	3.0		2.0	3.0	
Lane Grp Cap (vph)	127	1726	732	89	2365		318	838		141	484	
v/s Ratio Prot	c0.05	c0.24		0.03	c0.25		c0.34	0.14		0.05	c0.11	
v/s Ratio Perm			0.11									
v/c Ratio	0.72	0.48	0.22	0.61	0.54		1.85	0.55		0.67	0.78	
Uniform Delay, d1	72.5	26.7	23.0	74.5	30.0		65.5	52.7		71.7	66.2	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	14.8	1.0	0.7	7.8	0.9		395.4	0.8		8.9	8.1	
Delay (s)	87.3	27.7	23.7	82.3	30.9		460.9	53.4		80.5	74.3	
Level of Service	F	C	C	F	C		F	D		F	E	
Approach Delay (s)		31.0			33.0			280.1			75.5	
Approach LOS		C			C			F			E	

Intersection Summary			
HCM Average Control Delay	100.4	HCM Level of Service	F
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	27.0
Intersection Capacity Utilization	92.1%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Timings
2: Lawehana St & Salt Lake Blvd

7/19/2012

Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Configurations					
Volume (vph)	650	95	990	215	140
Turn Type	NA	Prot	NA	NA	Perm
Protected Phases	2	1	6	4	
Permitted Phases					4
Detector Phase	2	1	6	4	4
Switch Phase					
Minimum Initial (s)	20.0	5.0	20.0	5.0	5.0
Minimum Split (s)	28.0	10.0	26.0	37.0	37.0
Total Split (s)	107.0	26.0	133.0	43.0	43.0
Total Split (%)	60.8%	14.8%	75.6%	24.4%	24.4%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	6.0	6.0
Lead/Lag	Lag	Lead			
Lead-Lag Optimize?					
Recall Mode	Max	None	Max	None	None

Intersection Summary
Cycle Length: 176
Actuated Cycle Length: 170.7
Natural Cycle: 75
Control Type: Actuated-Uncoordinated

Splits and Phases: 2: Lawehana St & Salt Lake Blvd

HCM Signalized Intersection Capacity Analysis
2: Lawehana St & Salt Lake Blvd

7/19/2012

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	650	135	95	990	215	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	10	10
Grade (%)	-1%			-3%	-1%	
Total Lost time (s)	6.0		5.0	6.0	6.0	6.0
Lane Util. Factor	0.95		1.00	0.91	1.00	1.00
Frpb, ped/bikes	0.99		1.00	1.00	1.00	0.97
Flpb, ped/bikes	1.00		1.00	1.00	1.00	1.00
Frt	0.97		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	3428		1796	4129	1660	1438
Flt Permitted	1.00		0.95	1.00	0.95	1.00
Satd. Flow (perm)	3428		1796	4129	1660	1438
Peak-hour factor, PHF	0.88	0.82	0.80	0.95	0.80	0.82
Adj. Flow (vph)	739	165	119	1042	269	171
RTOR Reduction (vph)	9	0	0	0	0	139
Lane Group Flow (vph)	895	0	119	1042	269	32
Confl. Peds. (#/hr)		8				12
Parking (#/hr)				100		
Turn Type	NA		Prot	NA	NA	Perm
Protected Phases	2		1	6	4	
Permitted Phases						4
Actuated Green, G (s)	106.7		15.4	127.1	31.6	31.6
Effective Green, g (s)	106.7		15.4	127.1	31.6	31.6
Actuated g/C Ratio	0.63		0.09	0.74	0.19	0.19
Clearance Time (s)	6.0		5.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0		2.0	5.0	3.0	3.0
Lane Grp Cap (vph)	2143		162	3074	307	266
v/s Ratio Prot	c0.26		c0.07	0.25	c0.16	
v/s Ratio Perm						0.02
v/c Ratio	0.42		0.73	0.34	0.88	0.12
Uniform Delay, d1	16.2		75.7	7.4	67.6	58.0
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	0.6		13.8	0.3	23.2	0.2
Delay (s)	16.8		89.4	7.7	90.9	58.2
Level of Service	B		F	A	F	E
Approach Delay (s)	16.8			16.1	78.1	
Approach LOS	B			B	E	

Intersection Summary			
HCM Average Control Delay	27.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	170.7	Sum of lost time (s)	17.0
Intersection Capacity Utilization	58.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

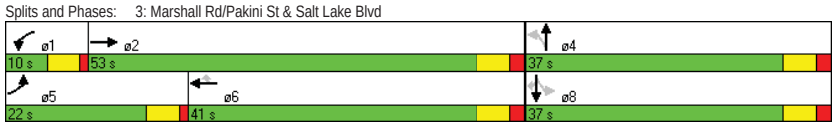
Timings
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT	SBR
Lane Configurations										
Volume (vph)	170	580	5	960	45	85	30	35	10	150
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	NA	Perm
Protected Phases	5	2	1	6			4		8	
Permitted Phases					6	4		8		8
Detector Phase	5	2	1	6	6	4	4	8	8	8
Switch Phase										
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	28.0	10.0	28.0	28.0	11.0	11.0	37.0	37.0	37.0
Total Split (s)	22.0	53.0	10.0	41.0	41.0	37.0	37.0	37.0	37.0	37.0
Total Split (%)	22.0%	53.0%	10.0%	41.0%	41.0%	37.0%	37.0%	37.0%	37.0%	37.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0		0.0	0.0
Total Lost Time (s)	5.0	6.0	5.0	6.0	6.0		6.0		6.0	6.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag					
Lead-Lag Optimize?										
Recall Mode	None	Max	None	Max	Max	None	None	None	None	None

Intersection Summary
Cycle Length: 100
Actuated Cycle Length: 79.8
Natural Cycle: 90
Control Type: Actuated-Uncoordinated

Splits and Phases: 3: Marshall Rd/Pakini St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	580	35	5	960	45	85	30	5	35	10	150
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			1%			-4%	
Total Lost time (s)	5.0	6.0		5.0	6.0	6.0		6.0			6.0	6.0
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00			1.00	1.00
Frpb, ped/bikes	1.00	0.99		1.00	1.00	0.98		1.00			1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00		1.00			1.00	1.00
Frt	1.00	0.97		1.00	1.00	0.85		0.99			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.97			0.96	1.00
Satd. Flow (prot)	1787	3454		1787	2502	1561		1777			1824	1589
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.75			0.71	1.00
Satd. Flow (perm)	1787	3454		1787	2502	1561		1375			1352	1589
Peak-hour factor, PHF	0.88	0.93	0.25	0.50	0.94	0.73	0.92	0.92	0.92	0.62	0.92	0.91
Adj. Flow (vph)	193	624	140	10	1021	62	92	33	5	56	11	165
RTOR Reduction (vph)	0	14	0	0	0	30	0	2	0	0	0	137
Lane Group Flow (vph)	193	750	0	10	1021	32	0	128	0	0	67	28
Confl. Peds. (#/hr)			8			2	3		5			5
Parking (#/hr)					100				0			
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		8
Actuated Green, G (s)	12.3	51.5		0.8	40.0	40.0		14.4			14.4	14.4
Effective Green, g (s)	12.3	51.5		0.8	40.0	40.0		14.4			14.4	14.4
Actuated g/C Ratio	0.15	0.62		0.01	0.48	0.48		0.17			0.17	0.17
Clearance Time (s)	5.0	6.0		5.0	6.0	6.0		6.0			6.0	6.0
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0		3.0			3.0	3.0
Lane Grp Cap (vph)	263	2125		17	1196	746		237			233	273
v/s Ratio Prot	c0.11	0.22		0.01	c0.41							
v/s Ratio Perm						0.02		c0.09			0.05	0.02
v/c Ratio	0.73	0.35		0.59	0.85	0.04		0.54			0.29	0.10
Uniform Delay, d1	34.1	7.9		41.3	19.3	11.6		31.6			30.2	29.2
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00			1.00	1.00
Incremental Delay, d2	8.8	0.5		29.3	7.8	0.1		2.5			0.7	0.2
Delay (s)	42.9	8.4		70.5	27.1	11.8		34.2			30.9	29.4
Level of Service	D	A		E	C	B		C			C	C
Approach Delay (s)		15.3			26.6			34.2			29.8	
Approach LOS		B			C			C			C	

Intersection Summary			
HCM Average Control Delay	22.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	83.7	Sum of lost time (s)	17.0
Intersection Capacity Utilization	63.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

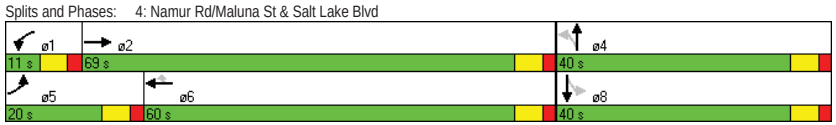
Timings
4: Namur Rd/Maluna St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	55	560	15	885	60	85	30	30	10
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	NA
Protected Phases	5	2	1	6			4		8
Permitted Phases					6	4		8	
Detector Phase	5	2	1	6	6	4	4	8	8
Switch Phase									
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	11.0	26.0	11.0	26.0	26.0	11.0	11.0	40.0	40.0
Total Split (s)	20.0	69.0	11.0	60.0	60.0	40.0	40.0	40.0	40.0
Total Split (%)	16.7%	57.5%	9.2%	50.0%	50.0%	33.3%	33.3%	33.3%	33.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0		6.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag				
Lead-Lag Optimize?									
Recall Mode	None	Max	None	Max	Max	None	None	None	None

Intersection Summary
Cycle Length: 120
Actuated Cycle Length: 99.2
Natural Cycle: 90
Control Type: Actuated-Uncoordinated

Splits and Phases: 4: Namur Rd/Maluna St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
4: Namur Rd/Maluna St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	55	560	35	15	885	60	85	30	20	30	10	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		7%			-6%			0%			-12%	
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0	6.0	6.0			6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.97	1.00	0.99			0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00			1.00	
Frt	1.00	0.99		1.00	1.00	0.85	1.00	0.94			0.93	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00			0.98	
Satd. Flow (prot)	1708	3365		1823	2552	1590	1763	1732			1794	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.63	1.00			0.85	
Satd. Flow (perm)	1708	3365		1823	2552	1590	1171	1732			1553	
Peak-hour factor, PHF	0.64	0.94	0.73	0.83	0.89	0.79	0.85	0.55	0.54	0.71	0.50	0.73
Adj. Flow (vph)	86	596	48	18	994	76	100	55	37	42	20	62
RTOR Reduction (vph)	0	3	0	0	0	10	0	24	0	0	36	0
Lane Group Flow (vph)	86	641	0	18	994	66	100	68	0	0	88	0
Confl. Peds. (#/hr)			12			2	5		7			7
Parking (#/hr)					100							
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		
Actuated Green, G (s)	8.0	67.7		1.8	61.5	61.5	15.4	15.4			15.4	
Effective Green, g (s)	8.0	67.7		1.8	61.5	61.5	15.4	15.4			15.4	
Actuated g/C Ratio	0.08	0.66		0.02	0.60	0.60	0.15	0.15			0.15	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0	6.0	6.0			6.0	
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0	3.0	3.0			3.0	
Lane Grp Cap (vph)	133	2214		32	1525	950	175	259			232	
v/s Ratio Prot	c0.05	0.19		0.01	c0.39			0.04				
v/s Ratio Perm						0.04	c0.09				0.06	
v/c Ratio	0.65	0.29		0.56	0.65	0.07	0.57	0.26			0.38	
Uniform Delay, d1	46.1	7.4		50.2	13.6	8.7	40.7	38.7			39.4	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00			1.00	
Incremental Delay, d2	7.8	0.3		12.8	2.2	0.1	4.5	0.5			1.0	
Delay (s)	53.9	7.8		62.9	15.8	8.8	45.1	39.3			40.5	
Level of Service	D	A		E	B	A	D	D			D	
Approach Delay (s)		13.2			16.1			42.3			40.5	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	18.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	102.9	Sum of lost time (s)	18.0
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

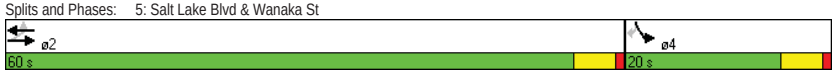
Timings
5: Salt Lake Blvd & Wanaka St

7/19/2012

Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations					
Volume (vph)	105	520	910	70	65
Turn Type	Perm	NA	NA	NA	Perm
Protected Phases		2	2	4	
Permitted Phases	2				4
Detector Phase	2	2	2	4	4
Switch Phase					
Minimum Initial (s)	25.0	25.0	25.0	4.0	4.0
Minimum Split (s)	30.0	30.0	30.0	20.0	20.0
Total Split (s)	60.0	60.0	60.0	20.0	20.0
Total Split (%)	75.0%	75.0%	75.0%	25.0%	25.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	Min	Min	Min	None	None

Intersection Summary
Cycle Length: 80
Actuated Cycle Length: 76
Natural Cycle: 150
Control Type: Actuated-Uncoordinated

Splits and Phases: 5: Salt Lake Blvd & Wanaka St



HCM Signalized Intersection Capacity Analysis
5: Salt Lake Blvd & Wanaka St

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	105	520	910	145	70	65
Ideal Flow (vphpl)	1400	1400	1400	1400	1400	1400
Lane Width	10	10	10	12	10	10
Grade (%)		0%	1%		-8%	
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.98		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1217	1281	498		1266	1107
Flt Permitted	0.14	1.00	1.00		0.95	1.00
Satd. Flow (perm)	175	1281	498		1266	1107
Peak-hour factor, PHF	0.80	0.96	0.93	0.88	0.75	0.89
Adj. Flow (vph)	131	542	978	165	93	73
RTOR Reduction (vph)	0	0	6	0	0	65
Lane Group Flow (vph)	131	542	1137	0	93	8
Confl. Peds. (#/hr)	1			1		1
Parking (#/hr)			100			
Turn Type	Perm	NA	NA		NA	Perm
Protected Phases		2	2		4	
Permitted Phases	2					4
Actuated Green, G (s)	58.1	58.1	58.1		8.9	8.9
Effective Green, g (s)	58.1	58.1	58.1		8.9	8.9
Actuated g/C Ratio	0.75	0.75	0.75		0.12	0.12
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	4.0	4.0	4.0		2.2	2.2
Lane Grp Cap (vph)	132	967	376		146	128
v/s Ratio Prot		0.42	c2.28		c0.07	
v/s Ratio Perm	0.75					0.01
v/c Ratio	0.99	0.56	3.02		0.64	0.07
Uniform Delay, d1	9.2	4.0	9.4		32.5	30.3
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	75.8	0.9	918.0		7.0	0.1
Delay (s)	85.0	4.9	927.4		39.5	30.5
Level of Service	F	A	F		D	C
Approach Delay (s)		20.5	927.4		35.5	
Approach LOS		C	F		D	

Intersection Summary			
HCM Average Control Delay	544.8	HCM Level of Service	F
HCM Volume to Capacity ratio	2.71		
Actuated Cycle Length (s)	77.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	115.8%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

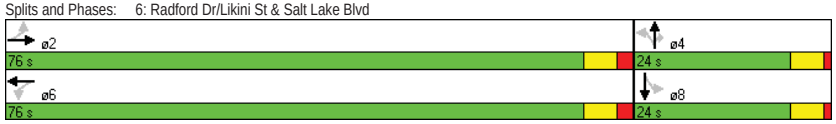
Timings
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Configurations									
Volume (vph)	5	555	270	1015	70	30	420	75	15
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	Perm	NA
Protected Phases		2		6		4			8
Permitted Phases	2		6		4		4	8	
Detector Phase	2	2	6	6	4	4	4	8	8
Switch Phase									
Minimum Initial (s)	5.0	5.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	46.0	46.0	46.0	46.0	9.0	9.0	9.0	24.0	24.0
Total Split (s)	76.0	76.0	76.0	76.0	24.0	24.0	24.0	24.0	24.0
Total Split (%)	76.0%	76.0%	76.0%	76.0%	24.0%	24.0%	24.0%	24.0%	24.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0		0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0		5.0	5.0		5.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	C-Max	C-Max	C-Max	C-Max	None	None	None	None	None

Intersection Summary
Cycle Length: 100
Actuated Cycle Length: 100
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBTL, Start of Yellow, Master Intersection
Natural Cycle: 150
Control Type: Actuated-Coordinated

Splits and Phases: 6: Radford Dr/Likini St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	5	555	50	270	1015	95	70	30	420	75	15	10
Ideal Flow (vphpl)	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
Lane Width	11	11	11	10	10	10	12	12	12	12	12	12
Grade (%)		1%			-2%			2%			-6%	
Total Lost time (s)	6.0	6.0		6.0	6.0			5.0	5.0		5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	0.97		0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Frt	1.00	0.98		1.00	0.99			1.00	0.85		0.98	
Flt Protected	0.95	1.00		0.95	1.00			0.97	1.00		0.97	
Satd. Flow (prot)	1254	1296		1228	1273			1306	1126		1337	
Flt Permitted	0.06	1.00		0.34	1.00			0.70	1.00		0.67	
Satd. Flow (perm)	74	1296		440	1273			942	1126		925	
Peak-hour factor, PHF	0.75	0.91	0.71	0.76	0.90	0.81	0.73	0.75	0.91	0.84	0.38	0.44
Adj. Flow (vph)	7	610	70	355	1128	117	96	40	462	89	39	23
RTOR Reduction (vph)	0	4	0	0	3	0	0	0	283	0	7	0
Lane Group Flow (vph)	7	676	0	355	1242	0	0	136	179	0	144	0
Confl. Peds. (#/hr)	4		6	2		4	4		2			8
Turn Type	Perm	NA		Perm	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		2			6			4			8	
Permitted Phases	2			6			4		4	8		
Actuated Green, G (s)	71.0	71.0		71.0	71.0			18.0	18.0		18.0	
Effective Green, g (s)	71.0	71.0		71.0	71.0			18.0	18.0		18.0	
Actuated g/C Ratio	0.71	0.71		0.71	0.71			0.18	0.18		0.18	
Clearance Time (s)	6.0	6.0		6.0	6.0			5.0	5.0		5.0	
Vehicle Extension (s)	5.0	5.0		5.0	5.0			3.0	3.0		3.0	
Lane Grp Cap (vph)	53	920		312	904			170	203		167	
v/s Ratio Prot		0.52			c0.98							
v/s Ratio Perm	0.09			0.81				0.14	c0.16		0.16	
v/c Ratio	0.13	0.73		1.14	1.37			0.80	0.88		0.86	
Uniform Delay, d1	4.6	8.8		14.5	14.5			39.3	40.0		39.8	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	5.1	5.2		93.6	175.0			22.9	33.1		34.3	
Delay (s)	9.7	14.0		108.1	189.5			62.2	73.0		74.1	
Level of Service	A	B		F	F			E	E		E	
Approach Delay (s)		13.9			171.5			70.6			74.1	
Approach LOS		B			F			E			E	

Intersection Summary			
HCM Average Control Delay	111.1	HCM Level of Service	F
HCM Volume to Capacity ratio	1.27		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	113.3%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
7: Salt Lake Blvd & Kahikolu Pl

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	1015	1450	25	15	10
Sign Control		Free	Free		Stop	
Grade		0%	2%		0%	
Peak Hour Factor	0.38	0.89	0.92	0.54	0.45	0.50
Hourly flow rate (vph)	13	1140	1576	46	33	20
Pedestrians		14	14		14	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		1	1		1	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		534	907			
pX, platoon unblocked	0.57				0.68	0.57
vC, conflicting volume	1636				2794	1627
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1737				2673	1721
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	94				0	68
cM capacity (veh/h)	206				15	62

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	13	1140	1622	53
Volume Left	13	0	0	33
Volume Right	0	0	46	20
cSH	206	1700	1700	21
Volume to Capacity	0.06	0.67	0.95	2.49
Queue Length 95th (ft)	5	0	0	172
Control Delay (s)	23.7	0.0	0.0	1058.8
Lane LOS	C			F
Approach Delay (s)	0.3		0.0	1058.8
Approach LOS				F

Intersection Summary			
Average Delay	20.1		
Intersection Capacity Utilization	119.4%	ICU Level of Service	H
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
8: Salt Lake Blvd & Shopping Center Entrance 1

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	130	940	0	5	1350	10	5	0	0	0	0	95
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.85	0.91	0.92	0.25	0.95	0.44	0.25	0.92	0.92	0.92	0.92	0.62
Hourly flow rate (vph)	153	1033	0	20	1421	23	20	0	0	0	0	153
Pedestrians		2			2						2	
Lane Width (ft)		12.0			12.0						12.0	
Walking Speed (ft/s)		4.0			4.0						4.0	
Percent Blockage		0			0						0	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		888			553							
pX, platoon unblocked	0.57						0.57	0.57		0.57	0.57	0.57
vC, conflicting volume	1446			1033			2966	2825	1035	2815	2813	1436
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1405			1033			4067	3819	1035	3802	3799	1389
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	45			97			0	100	100	100	100	0
cM capacity (veh/h)	277			673			0	1	281	1	1	99

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	NB 3	SB 1
Volume Total	153	1033	1464	20	0	0	153
Volume Left	153	0	20	20	0	0	0
Volume Right	0	0	23	0	0	0	153
cSH	277	1700	673	0	1700	1700	99
Volume to Capacity	0.55	0.61	0.03	Err	0.00	0.00	1.54
Queue Length 95th (ft)	77	0	2	Err	0	0	291
Control Delay (s)	32.9	0.0	2.2	Err	0.0	0.0	362.9
Lane LOS	D		A	F	A	A	F
Approach Delay (s)	4.2		2.2	Err			362.9
Approach LOS				F			F

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	154.2%	ICU Level of Service	H
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
9: Aliamanu School /Shopping Center Entrance 2 & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	900	25	0	1250	100	0	0	45	0	0	105
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.93	0.64	0.92	0.90	0.86	0.92	0.92	0.68	0.92	0.92	0.76
Hourly flow rate (vph)	0	968	39	0	1389	116	0	0	66	0	0	138
Pedestrians		2									2	
Lane Width (ft)		12.0									12.0	
Walking Speed (ft/s)		4.0									4.0	
Percent Blockage		0									0	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		1105			336							
pX, platoon unblocked	0.56						0.56	0.56		0.56	0.56	0.56
vC, conflicting volume	1507			968			2516	2494	987	2378	2359	1393
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1513			968			3302	3263	987	3057	3022	1310
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			0	100	78	100	100	0
cM capacity (veh/h)	249			712			0	5	300	3	7	109

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	1007	1389	116	66	138
Volume Left	0	0	0	0	0
Volume Right	39	0	116	66	138
cSH	1700	1700	1700	300	109
Volume to Capacity	0.59	0.82	0.07	0.22	1.26
Queue Length 95th (ft)	0	0	0	21	231
Control Delay (s)	0.0	0.0	0.0	20.4	246.8
Lane LOS				C	F
Approach Delay (s)	0.0	0.0		20.4	246.8
Approach LOS				C	F

Intersection Summary				
Average Delay	13.1			
Intersection Capacity Utilization	105.3%	ICU Level of Service	G	
Analysis Period (min)	15			

Timings
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	290	640	1010	545	335	330
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	20.0	20.0	20.0	6.0	6.0
Minimum Split (s)	10.0	26.0	29.0	29.0	35.0	35.0
Total Split (s)	25.0	70.0	45.0	45.0	40.0	40.0
Total Split (%)	22.7%	63.6%	40.9%	40.9%	36.4%	36.4%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	C-Max	C-Max	C-Max	None	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow, Master Intersection
Natural Cycle: 90
Control Type: Actuated-Coordinated

Splits and Phases: 10: Salt Lake Blvd & Ala Lilikoi St

HCM Signalized Intersection Capacity Analysis
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	290	640	1010	545	335	330
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lane Util. Factor	1.00	0.91	0.95	1.00	0.97	1.00
Frpb, ped/bikes	1.00	1.00	1.00	0.96	1.00	0.95
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	5085	3539	1515	3433	1511
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	5085	3539	1515	3433	1511
Peak-hour factor, PHF	0.95	0.94	0.91	0.84	0.91	0.86
Adj. Flow (vph)	305	681	1110	649	368	384
RTOR Reduction (vph)	0	0	0	343	0	310
Lane Group Flow (vph)	305	681	1110	306	368	74
Confl. Peds. (#/hr)				22		31
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Actuated Green, G (s)	24.9	79.1	49.2	49.2	19.9	19.9
Effective Green, g (s)	24.9	79.1	49.2	49.2	19.9	19.9
Actuated g/C Ratio	0.23	0.72	0.45	0.45	0.18	0.18
Clearance Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Vehicle Extension (s)	3.0	4.0	4.0	4.0	3.0	3.0
Lane Grp Cap (vph)	401	3657	1583	678	621	273
v/s Ratio Prot	c0.17	0.13	c0.31		c0.11	
v/s Ratio Perm				0.20		0.05
v/c Ratio	0.76	0.19	0.70	0.45	0.59	0.27
Uniform Delay, d1	39.8	5.0	24.5	21.1	41.3	38.8
Progression Factor	1.00	1.00	0.84	1.49	1.00	1.00
Incremental Delay, d2	8.3	0.1	2.1	1.8	1.5	0.5
Delay (s)	48.0	5.1	22.7	33.1	42.9	39.4
Level of Service	D	A	C	C	D	D
Approach Delay (s)		18.4	26.5		41.1	
Approach LOS		B	C		D	

Intersection Summary			
HCM Average Control Delay	27.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	76.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Timings
11: Arizona Rd & Salt Lake Blvd

7/19/2012

Lane Group	EBT	EBR	WBL	WBT	NBL
Lane Configurations					
Volume (vph)	760	245	50	975	605
Turn Type	NA	Perm	Prot	NA	NA
Protected Phases	2		1	6	4
Permitted Phases		2			
Detector Phase	2	2	1	6	4
Switch Phase					
Minimum Initial (s)	20.0	20.0	5.0	20.0	5.0
Minimum Split (s)	28.0	28.0	10.0	26.0	34.0
Total Split (s)	53.0	53.0	22.0	75.0	35.0
Total Split (%)	48.2%	48.2%	20.0%	68.2%	31.8%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	1.0	2.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	6.0	5.0	6.0	5.0
Lead/Lag	Lag	Lag	Lead		
Lead-Lag Optimize?					
Recall Mode	C-Max	C-Max	None	C-Max	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 21 (19%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated

Splits and Phases: 11: Arizona Rd & Salt Lake Blvd

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	760	245	50	975	605	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	10	12	12	12
Grade (%)	8%			-10%	-2%	
Total Lost time (s)	6.0	6.0	5.0	6.0	5.0	
Lane Util. Factor	0.95	1.00	1.00	0.95	0.97	
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	0.85	1.00	1.00	0.99	
Flt Protected	1.00	1.00	0.95	1.00	0.96	
Satd. Flow (prot)	3398	1482	1734	3716	3442	
Flt Permitted	1.00	1.00	0.95	1.00	0.96	
Satd. Flow (perm)	3398	1482	1734	3716	3442	
Peak-hour factor, PHF	0.94	0.90	0.77	0.90	0.88	0.64
Adj. Flow (vph)	809	272	65	1083	688	62
RTOR Reduction (vph)	0	130	0	0	7	0
Lane Group Flow (vph)	809	142	65	1083	743	0
Confl. Peds. (#/hr)		2				4
Turn Type	NA	Perm	Prot	NA	NA	
Protected Phases	2		1	6	4	
Permitted Phases		2				
Actuated Green, G (s)	57.6	57.6	8.3	70.9	28.1	
Effective Green, g (s)	57.6	57.6	8.3	70.9	28.1	
Actuated g/C Ratio	0.52	0.52	0.08	0.64	0.26	
Clearance Time (s)	6.0	6.0	5.0	6.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	1779	776	131	2395	879	
v/s Ratio Prot	0.24		0.04	c0.29	c0.22	
v/s Ratio Perm		0.10				
v/c Ratio	0.45	0.18	0.50	0.45	0.85	
Uniform Delay, d1	16.4	13.8	48.8	9.8	38.9	
Progression Factor	1.22	2.84	1.00	1.00	1.00	
Incremental Delay, d2	0.8	0.5	2.9	0.6	7.5	
Delay (s)	20.9	39.7	51.8	10.4	46.4	
Level of Service	C	D	D	B	D	
Approach Delay (s)	25.6			12.8	46.4	
Approach LOS	C			B	D	

Intersection Summary			
HCM Average Control Delay	25.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	57.8%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Base Year 2040 with Mitigation AM

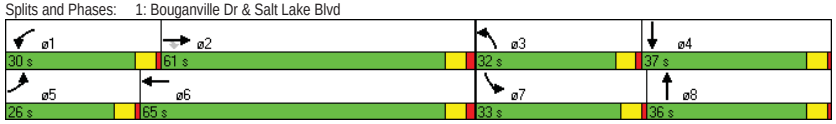
Timings
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	135	650	530	150	570	245	210	140	440
Turn Type	Prot	NA	Perm	Prot	NA	Prot	NA	Prot	NA
Protected Phases	5	2		1	6	3	8	7	4
Permitted Phases			2						
Detector Phase	5	2	2	1	6	3	8	7	4
Switch Phase									
Minimum Initial (s)	5.0	20.0	20.0	5.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	34.0	34.0	10.0	34.0	10.0	33.0	10.0	33.0
Total Split (s)	26.0	61.0	61.0	30.0	65.0	32.0	36.0	33.0	37.0
Total Split (%)	16.3%	38.1%	38.1%	18.8%	40.6%	20.0%	22.5%	20.6%	23.1%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	5.0	6.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?									
Recall Mode	None	C-Max	C-Max	None	C-Max	None	None	None	None

Intersection Summary
Cycle Length: 160
Actuated Cycle Length: 160
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow, Master Intersection
Natural Cycle: 120
Control Type: Actuated-Coordinated

Splits and Phases: 1: Bouganville Dr & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	135	650	530	150	570	110	245	210	55	140	440	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		3%			-3%			2%			-2%	
Total Lost time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91		0.97	1.00		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.66	1.00	0.96		1.00	0.96		1.00	0.92	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.97		1.00	0.96	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1743	3486	1035	1796	4765		3399	1711		1787	3177	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1743	3486	1035	1796	4765		3399	1711		1787	3177	
Peak-hour factor, PHF	0.73	0.87	0.79	0.50	0.78	0.45	0.90	0.74	0.71	0.77	0.78	0.77
Adj. Flow (vph)	185	747	671	300	731	244	272	284	77	182	564	182
RTOR Reduction (vph)	0	0	260	0	37	0	0	6	0	0	18	0
Lane Group Flow (vph)	185	747	411	300	938	0	272	355	0	182	728	0
Confl. Peds. (#/hr)			266			51			109			208
Turn Type	Prot	NA	Perm	Prot	NA		Prot	NA		Prot	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2									
Actuated Green, G (s)	19.3	55.0	55.0	25.0	60.7		17.2	38.4		20.6	41.8	
Effective Green, g (s)	19.3	55.0	55.0	25.0	60.7		17.2	38.4		20.6	41.8	
Actuated g/C Ratio	0.12	0.34	0.34	0.16	0.38		0.11	0.24		0.13	0.26	
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	5.0	5.0	2.0	5.0		2.0	3.0		2.0	3.0	
Lane Grp Cap (vph)	210	1198	356	281	1808		365	411		230	830	
v/s Ratio Prot	0.11	0.21		c0.17	0.20		0.08	0.21		c0.10	c0.23	
v/s Ratio Perm			c0.40									
v/c Ratio	0.88	0.62	1.15	1.07	0.52		0.75	0.86		0.79	0.88	
Uniform Delay, d1	69.2	43.9	52.5	67.5	38.4		69.3	58.3		67.6	56.6	
Progression Factor	1.00	1.00	1.00	1.13	0.87		1.00	1.00		1.00	1.00	
Incremental Delay, d2	31.4	2.5	96.8	72.1	1.0		7.1	16.9		15.8	10.4	
Delay (s)	100.6	46.3	149.3	148.2	34.5		76.3	75.2		83.4	67.0	
Level of Service	F	D	F	F	C		E	E		F	E	
Approach Delay (s)		95.7			61.2			75.7			70.2	
Approach LOS		F			E			E			E	

Intersection Summary			
HCM Average Control Delay	77.6	HCM Level of Service	E
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	86.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Timings
2: Lawehana St & Salt Lake Blvd

7/19/2012

Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Configurations					
Volume (vph)	740	60	795	80	105
Turn Type	NA	Prot	NA	NA	Perm
Protected Phases	2	1	6	4	
Permitted Phases					4
Detector Phase	2	1	6	4	4
Switch Phase					
Minimum Initial (s)	20.0	5.0	20.0	5.0	5.0
Minimum Split (s)	28.0	10.0	26.0	37.0	37.0
Total Split (s)	90.0	25.0	115.0	45.0	45.0
Total Split (%)	56.3%	15.6%	71.9%	28.1%	28.1%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	6.0	6.0
Lead/Lag	Lag	Lead			
Lead-Lag Optimize?					
Recall Mode	C-Max	None	C-Max	None	None

Intersection Summary
Cycle Length: 160
Actuated Cycle Length: 160
Offset: 67 (42%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 80
Control Type: Actuated-Coordinated

Splits and Phases: 2: Lawehana St & Salt Lake Blvd

HCM Signalized Intersection Capacity Analysis
2: Lawehana St & Salt Lake Blvd

7/19/2012

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	740	145	60	795	80	105
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	10	10
Grade (%)	-1%			-3%	-1%	
Total Lost time (s)	6.0		5.0	6.0	6.0	6.0
Lane Util. Factor	0.95		1.00	0.91	1.00	1.00
Frpb, ped/bikes	0.95		1.00	1.00	1.00	0.88
Flpb, ped/bikes	1.00		1.00	1.00	1.00	1.00
Frt	0.97		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	3285		1796	4129	1660	1305
Flt Permitted	1.00		0.95	1.00	0.95	1.00
Satd. Flow (perm)	3285		1796	4129	1660	1305
Peak-hour factor, PHF	0.82	0.72	0.52	0.77	0.64	0.66
Adj. Flow (vph)	902	201	115	1032	125	159
RTOR Reduction (vph)	8	0	0	0	0	142
Lane Group Flow (vph)	1095	0	115	1032	125	17
Confl. Peds. (#/hr)		72				72
Parking (#/hr)				100		
Turn Type	NA		Prot	NA	NA	Perm
Protected Phases	2		1	6	4	
Permitted Phases						4
Actuated Green, G (s)	111.1		14.5	130.6	17.4	17.4
Effective Green, g (s)	111.1		14.5	130.6	17.4	17.4
Actuated g/C Ratio	0.69		0.09	0.82	0.11	0.11
Clearance Time (s)	6.0		5.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0		2.0	5.0	3.0	3.0
Lane Grp Cap (vph)	2281		163	3370	181	142
v/s Ratio Prot	c0.33		c0.06	0.25	c0.08	
v/s Ratio Perm						0.01
v/c Ratio	0.48		0.71	0.31	0.69	0.12
Uniform Delay, d1	11.2		70.7	3.6	68.7	64.4
Progression Factor	0.48		0.89	0.32	1.00	1.00
Incremental Delay, d2	0.6		8.2	0.2	10.8	0.4
Delay (s)	5.9		70.9	1.3	79.5	64.8
Level of Service	A		E	A	E	E
Approach Delay (s)	5.9			8.3	71.3	
Approach LOS	A			A	E	

Intersection Summary			
HCM Average Control Delay	14.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	68.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

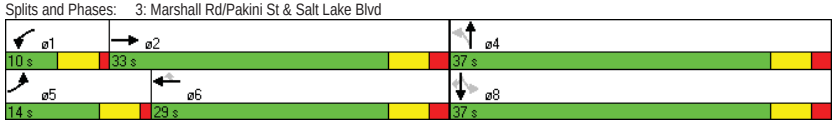
Timings
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT	SBR
Lane Configurations										
Volume (vph)	100	680	15	640	30	50	30	100	40	160
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	NA	Perm
Protected Phases	5	2	1	6			4		8	
Permitted Phases					6	4		8		8
Detector Phase	5	2	1	6	6	4	4	8	8	8
Switch Phase										
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	28.0	10.0	28.0	28.0	11.0	11.0	37.0	37.0	37.0
Total Split (s)	14.0	33.0	10.0	29.0	29.0	37.0	37.0	37.0	37.0	37.0
Total Split (%)	17.5%	41.3%	12.5%	36.3%	36.3%	46.3%	46.3%	46.3%	46.3%	46.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0		0.0	0.0
Total Lost Time (s)	5.0	6.0	5.0	6.0	6.0		6.0		6.0	6.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag					
Lead-Lag Optimize?										
Recall Mode	None	C-Max	None	C-Max	C-Max	None	None	None	None	None

Intersection Summary
Cycle Length: 80
Actuated Cycle Length: 80
Offset: 7 (9%), Referenced to phase 2:EBT and 6:WBT, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated

Splits and Phases: 3: Marshall Rd/Pakini St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	100	680	65	15	640	30	50	30	10	100	40	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			1%			-4%	
Total Lost time (s)	5.0	6.0		5.0	6.0	6.0		6.0			6.0	6.0
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00			1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.95		1.00			1.00	0.96
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00		0.99			1.00	1.00
Frt	1.00	0.99		1.00	1.00	0.85		0.98			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.97			0.96	1.00
Satd. Flow (prot)	1787	3510		1787	2502	1513		1764			1825	1553
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.70			0.74	1.00
Satd. Flow (perm)	1787	3510		1787	2502	1513		1270			1407	1553
Peak-hour factor, PHF	0.70	0.91	0.92	0.42	0.74	0.71	0.92	0.92	0.92	0.56	0.92	0.83
Adj. Flow (vph)	143	747	71	36	865	42	54	33	11	179	43	193
RTOR Reduction (vph)	0	6	0	0	0	24	0	7	0	0	0	145
Lane Group Flow (vph)	143	812	0	36	865	18	0	91	0	0	222	48
Confl. Peds. (#/hr)			21			19	17		5	1		35
Parking (#/hr)					100				0			
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		8
Actuated Green, G (s)	8.5	40.2		3.0	34.7	34.7		19.8			19.8	19.8
Effective Green, g (s)	8.5	40.2		3.0	34.7	34.7		19.8			19.8	19.8
Actuated g/C Ratio	0.11	0.50		0.04	0.43	0.43		0.25			0.25	0.25
Clearance Time (s)	5.0	6.0		5.0	6.0	6.0		6.0			6.0	6.0
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0		3.0			3.0	3.0
Lane Grp Cap (vph)	190	1764		67	1085	656		314			348	384
v/s Ratio Prot	c0.08	0.23		0.02	c0.35							
v/s Ratio Perm						0.01		0.07			c0.16	0.03
v/c Ratio	0.75	0.46		0.54	0.80	0.03		0.29			0.64	0.12
Uniform Delay, d1	34.7	12.9		37.8	19.6	13.0		24.4			26.9	23.4
Progression Factor	1.21	0.90		1.00	1.00	1.00		1.00			1.00	1.00
Incremental Delay, d2	12.6	0.8		4.1	6.1	0.1		0.5			3.8	0.1
Delay (s)	54.8	12.3		41.9	25.7	13.1		24.9			30.7	23.5
Level of Service	D	B		D	C	B		C			C	C
Approach Delay (s)		18.6			25.8			24.9			27.4	
Approach LOS		B			C			C			C	

Intersection Summary			
HCM Average Control Delay	23.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	60.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

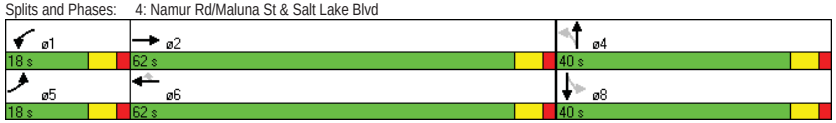
Timings
4: Namur Rd/Maluna St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	35	620	65	585	30	50	30	65	40
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	NA
Protected Phases	5	2	1	6			4		8
Permitted Phases					6	4		8	
Detector Phase	5	2	1	6	6	4	4	8	8
Switch Phase									
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	11.0	26.0	11.0	26.0	26.0	11.0	11.0	40.0	40.0
Total Split (s)	18.0	62.0	18.0	62.0	62.0	40.0	40.0	40.0	40.0
Total Split (%)	15.0%	51.7%	15.0%	51.7%	51.7%	33.3%	33.3%	33.3%	33.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0		6.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag				
Lead-Lag Optimize?									
Recall Mode	None	Min	None	Min	Min	None	None	None	None

Intersection Summary
Cycle Length: 120
Actuated Cycle Length: 84.8
Natural Cycle: 80
Control Type: Actuated-Uncoordinated

Splits and Phases: 4: Namur Rd/Maluna St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
4: Namur Rd/Maluna St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	35	620	65	65	585	30	50	30	25	65	40	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		7%			-6%			0%			-12%	
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0	6.0	6.0			6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	1.00			1.00	
Frpb, ped/bikes	1.00	0.99		1.00	1.00	1.00	1.00	0.99			0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	0.99	1.00			1.00	
Frt	1.00	0.98		1.00	1.00	0.85	1.00	0.93			0.95	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00			0.98	
Satd. Flow (prot)	1708	3338		1823	2552	1631	1759	1703			1837	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.52	1.00			0.85	
Satd. Flow (perm)	1708	3338		1823	2552	1631	961	1703			1596	
Peak-hour factor, PHF	0.89	0.81	0.73	0.66	0.80	0.79	0.81	0.65	0.56	0.82	0.52	0.72
Adj. Flow (vph)	39	765	89	98	731	38	62	46	45	79	77	83
RTOR Reduction (vph)	0	7	0	0	0	8	0	32	0	0	17	0
Lane Group Flow (vph)	39	847	0	98	731	30	62	59	0	0	222	0
Confl. Peds. (#/hr)			23				13		10			13
Parking (#/hr)					100							
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		
Actuated Green, G (s)	4.1	42.2		7.3	45.4	45.4	18.9	18.9			18.9	
Effective Green, g (s)	4.1	42.2		7.3	45.4	45.4	18.9	18.9			18.9	
Actuated g/C Ratio	0.05	0.49		0.08	0.53	0.53	0.22	0.22			0.22	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0	6.0	6.0			6.0	
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0	3.0	3.0			3.0	
Lane Grp Cap (vph)	81	1630		154	1341	857	210	373			349	
v/s Ratio Prot	0.02	0.25		c0.05	c0.29			0.03				
v/s Ratio Perm						0.02	0.06				c0.14	
v/c Ratio	0.48	0.52		0.64	0.55	0.03	0.30	0.16			0.64	
Uniform Delay, d1	40.1	15.2		38.3	13.6	9.9	28.2	27.3			30.6	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00			1.00	
Incremental Delay, d2	1.6	0.6		6.2	0.8	0.0	0.8	0.2			3.8	
Delay (s)	41.8	15.7		44.5	14.4	9.9	29.0	27.5			34.4	
Level of Service	D	B		D	B	A	C	C			C	
Approach Delay (s)		16.8			17.6			28.1			34.4	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM Average Control Delay	19.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	86.4	Sum of lost time (s)	18.0
Intersection Capacity Utilization	59.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

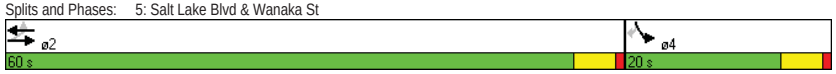
Timings
5: Salt Lake Blvd & Wanaka St

7/19/2012

Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations					
Volume (vph)	40	685	610	115	70
Turn Type	Perm	NA	NA	NA	Perm
Protected Phases		2	2	4	
Permitted Phases	2				4
Detector Phase	2	2	2	4	4
Switch Phase					
Minimum Initial (s)	25.0	25.0	25.0	4.0	4.0
Minimum Split (s)	30.0	30.0	30.0	20.0	20.0
Total Split (s)	60.0	60.0	60.0	20.0	20.0
Total Split (%)	75.0%	75.0%	75.0%	25.0%	25.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	Min	Min	Min	None	None

Intersection Summary
Cycle Length: 80
Actuated Cycle Length: 80
Natural Cycle: 150
Control Type: Actuated-Uncoordinated

Splits and Phases: 5: Salt Lake Blvd & Wanaka St



HCM Signalized Intersection Capacity Analysis
5: Salt Lake Blvd & Wanaka St

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	40	685	610	65	115	70
Ideal Flow (vphpl)	1400	1400	1400	1400	1400	1400
Lane Width	10	10	10	12	10	10
Grade (%)		0%	1%		-8%	
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.99		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1217	1281	502		1266	1132
Flt Permitted	0.30	1.00	1.00		0.95	1.00
Satd. Flow (perm)	389	1281	502		1266	1132
Peak-hour factor, PHF	0.66	0.86	0.90	0.77	0.85	0.81
Adj. Flow (vph)	61	797	678	84	135	86
RTOR Reduction (vph)	0	0	5	0	0	73
Lane Group Flow (vph)	61	797	757	0	135	13
Parking (#/hr)			100			
Turn Type	Perm	NA	NA		NA	Perm
Protected Phases		2	2		4	
Permitted Phases	2					4
Actuated Green, G (s)	57.9	57.9	57.9		12.0	12.0
Effective Green, g (s)	57.9	57.9	57.9		12.0	12.0
Actuated g/C Ratio	0.72	0.72	0.72		0.15	0.15
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	4.0	4.0	4.0		2.2	2.2
Lane Grp Cap (vph)	282	928	364		190	170
v/s Ratio Prot		0.62	c1.51		c0.11	
v/s Ratio Perm	0.16					0.01
v/c Ratio	0.22	0.86	2.08		0.71	0.08
Uniform Delay, d1	3.6	8.0	11.0		32.3	29.2
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.5	8.3	495.3		10.4	0.1
Delay (s)	4.1	16.3	506.3		42.7	29.3
Level of Service	A	B	F		D	C
Approach Delay (s)		15.4	506.3		37.5	
Approach LOS		B	F		D	

Intersection Summary			
HCM Average Control Delay	221.2	HCM Level of Service	F
HCM Volume to Capacity ratio	1.85		
Actuated Cycle Length (s)	79.9	Sum of lost time (s)	10.0
Intersection Capacity Utilization	65.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

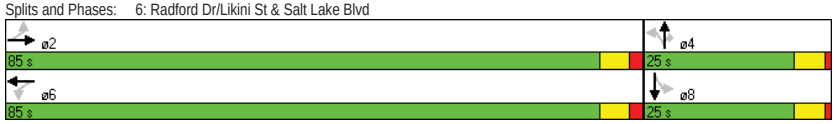
Timings
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Configurations									
Volume (vph)	5	805	290	605	50	10	295	110	45
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	Perm	NA
Protected Phases		2		6		4			8
Permitted Phases	2		6		4		4	8	
Detector Phase	2	2	6	6	4	4	4	8	8
Switch Phase									
Minimum Initial (s)	5.0	5.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	46.0	46.0	46.0	46.0	9.0	9.0	9.0	24.0	24.0
Total Split (s)	85.0	85.0	85.0	85.0	25.0	25.0	25.0	25.0	25.0
Total Split (%)	77.3%	77.3%	77.3%	77.3%	22.7%	22.7%	22.7%	22.7%	22.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0		0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0		5.0	5.0		5.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	C-Max	C-Max	C-Max	C-Max	None	None	None	None	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 70 (64%), Referenced to phase 2:EBTL and 6:WBTL, Start of Yellow
Natural Cycle: 140
Control Type: Actuated-Coordinated

Splits and Phases: 6: Radford Dr/Likini St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	5	805	25	290	605	90	50	10	295	110	45	15
Ideal Flow (vphpl)	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
Grade (%)		1%			-2%			2%			-6%	
Total Lost time (s)	6.0	6.0		6.0	6.0			5.0	5.0		5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	0.95		0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			0.98	1.00		1.00	
Frt	1.00	0.99		1.00	0.98			1.00	0.85		0.98	
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.97	
Satd. Flow (prot)	1296	1355		1314	1355			1280	1095		1335	
Flt Permitted	0.28	1.00		0.16	1.00			0.68	1.00		0.70	
Satd. Flow (perm)	380	1355		221	1355			905	1095		967	
Peak-hour factor, PHF	0.25	0.81	0.64	0.86	0.87	0.88	0.58	0.38	0.80	0.70	0.78	0.56
Adj. Flow (vph)	20	994	39	337	695	102	86	26	369	157	58	27
RTOR Reduction (vph)	0	1	0	0	5	0	0	0	128	0	4	0
Lane Group Flow (vph)	20	1032	0	337	792	0	0	112	241	0	238	0
Confl. Peds. (#/hr)	3		33	12		3	21		12			24
Turn Type	Perm	NA		Perm	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		2			6			4			8	
Permitted Phases	2			6			4		4	8		
Actuated Green, G (s)	79.0	79.0		79.0	79.0			20.0	20.0		20.0	
Effective Green, g (s)	79.0	79.0		79.0	79.0			20.0	20.0		20.0	
Actuated g/C Ratio	0.72	0.72		0.72	0.72			0.18	0.18		0.18	
Clearance Time (s)	6.0	6.0		6.0	6.0			5.0	5.0		5.0	
Vehicle Extension (s)	5.0	5.0		5.0	5.0			3.0	3.0		3.0	
Lane Grp Cap (vph)	273	973		159	973			165	199		176	
v/s Ratio Prot		0.76			0.58							
v/s Ratio Perm	0.05			c1.52				0.12	0.22		c0.25	
v/c Ratio	0.07	1.06		2.12	0.81			0.68	1.21		1.35	
Uniform Delay, d1	4.6	15.5		15.5	10.5			42.0	45.0		45.0	
Progression Factor	1.00	1.00		0.93	0.75			1.00	1.00		1.00	
Incremental Delay, d2	0.5	46.2		522.4	6.7			10.6	132.9		190.9	
Delay (s)	5.1	61.7		536.8	14.6			52.6	177.9		235.9	
Level of Service	A	E		F	B			D	F		F	
Approach Delay (s)		60.6			169.8			148.7			235.9	
Approach LOS		E			F			F			F	

Intersection Summary			
HCM Average Control Delay	132.3	HCM Level of Service	F
HCM Volume to Capacity ratio	1.97		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	115.2%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
7: Salt Lake Blvd & Kahikolu Pl

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	1220	1060	15	20	10
Sign Control		Free	Free		Stop	
Grade		0%	-2%		0%	
Peak Hour Factor	0.25	0.85	0.93	0.69	0.65	0.31
Hourly flow rate (vph)	20	1435	1140	22	31	32
Pedestrians		13	13		13	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		1	1		1	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		534	907			
pX, platoon unblocked	0.80				0.44	0.80
vC, conflicting volume	1175				2652	1177
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1091				3060	1094
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	96				0	84
cM capacity (veh/h)	504				6	203

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	20	1435	1162	63
Volume Left	20	0	0	31
Volume Right	0	0	22	32
cSH	504	1700	1700	11
Volume to Capacity	0.04	0.84	0.68	5.52
Queue Length 95th (ft)	3	0	0	Err
Control Delay (s)	12.4	0.0	0.0	Err
Lane LOS	B			F
Approach Delay (s)	0.2		0.0	Err
Approach LOS				F

Intersection Summary			
Average Delay	235.3		
Intersection Capacity Utilization	100.7%	ICU Level of Service	G
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
8: Salt Lake Blvd & Shopping Center Entrance 1

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	75	1115	50	10	960	20	15	10	40	5	25	35
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.64	0.38	0.87	0.75	1.00	0.75	0.56	0.25	0.25	0.65
Hourly flow rate (vph)	85	1267	78	26	1103	27	15	13	71	20	100	54
Pedestrians		1			1						1	
Lane Width (ft)		12.0			12.0						12.0	
Walking Speed (ft/s)		4.0			4.0						4.0	
Percent Blockage		0			0						0	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		888			553							
pX, platoon unblocked	0.81			0.42			0.51	0.51	0.42	0.51	0.51	0.81
vC, conflicting volume	1131			1345			2751	2660	1307	2687	2686	1119
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1043			1128			3091	2915	1036	2967	2965	1027
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	84			90			0	0	39	0	0	76
cM capacity (veh/h)	538			258			0	6	117	0	6	229

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	NB 3	SB 1
Volume Total	85	1345	1156	15	13	71	174
Volume Left	85	0	26	15	0	0	20
Volume Right	0	78	27	0	0	71	54
cSH	538	1700	258	0	6	117	0
Volume to Capacity	0.16	0.79	0.10	Err	2.23	0.61	Err
Queue Length 95th (ft)	14	0	8	Err	69	77	Err
Control Delay (s)	13.0	0.0	6.6	Err	1708.5	75.4	Err
Lane LOS	B		A	F	F	F	F
Approach Delay (s)	0.8		6.6	Err			Err
Approach LOS				F			F

Intersection Summary			
Average Delay	Err		
Intersection Capacity Utilization	102.5%	ICU Level of Service	G
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
9: Aliamanu School /Shopping Center Entrance 2 & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	940	225	0	910	45	0	0	190	0	0	70
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.96	0.68	0.92	0.94	0.75	0.92	0.92	0.64	0.92	0.92	0.87
Hourly flow rate (vph)	0	979	331	0	968	60	0	0	297	0	0	80
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		1105			336							
pX, platoon unblocked	0.83			0.53			0.61	0.61	0.53	0.61	0.61	0.83
vC, conflicting volume	1028			979			2193	2173	1145	2113	1947	968
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	929			513			1993	1959	827	1862	1592	856
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	0	0	100	73
cM capacity (veh/h)	608			555			20	39	196	0	66	295

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	1310	968	60	297	80
Volume Left	0	0	0	0	0
Volume Right	331	0	60	297	80
cSH	1700	1700	1700	196	295
Volume to Capacity	0.77	0.57	0.04	1.51	0.27
Queue Length 95th (ft)	0	0	0	465	27
Control Delay (s)	0.0	0.0	0.0	299.7	21.7
Lane LOS				F	C
Approach Delay (s)	0.0	0.0		299.7	21.7
Approach LOS				F	C

Intersection Summary				
Average Delay	33.4			
Intersection Capacity Utilization	108.3%	ICU Level of Service	G	
Analysis Period (min)	15			

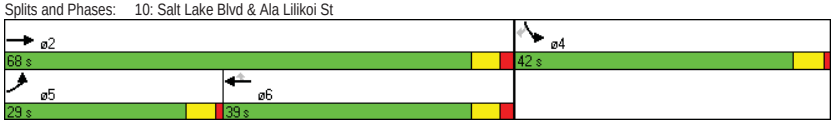
Timings
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	265	870	530	325	880	425
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	20.0	20.0	20.0	6.0	6.0
Minimum Split (s)	10.0	26.0	29.0	29.0	35.0	35.0
Total Split (s)	29.0	68.0	39.0	39.0	42.0	42.0
Total Split (%)	26.4%	61.8%	35.5%	35.5%	38.2%	38.2%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	C-Max	C-Max	C-Max	None	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow, Master Intersection
Natural Cycle: 80
Control Type: Actuated-Coordinated

Splits and Phases: 10: Salt Lake Blvd & Ala Lilikoi St



HCM Signalized Intersection Capacity Analysis
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	265	870	530	325	880	425
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lane Util. Factor	1.00	0.91	0.95	1.00	0.97	1.00
Frpb, ped/bikes	1.00	1.00	1.00	0.84	1.00	0.75
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	5085	3539	1337	3433	1189
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	5085	3539	1337	3433	1189
Peak-hour factor, PHF	0.77	0.92	0.94	0.73	0.91	0.82
Adj. Flow (vph)	344	946	564	445	967	518
RTOR Reduction (vph)	0	0	0	305	0	321
Lane Group Flow (vph)	344	946	564	140	967	197
Confl. Peds. (#/hr)				102		220
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Actuated Green, G (s)	23.3	62.8	34.5	34.5	36.2	36.2
Effective Green, g (s)	23.3	62.8	34.5	34.5	36.2	36.2
Actuated g/C Ratio	0.21	0.57	0.31	0.31	0.33	0.33
Clearance Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Vehicle Extension (s)	3.0	4.0	4.0	4.0	3.0	3.0
Lane Grp Cap (vph)	375	2903	1110	419	1130	391
v/s Ratio Prot	c0.19	0.19	c0.16		c0.28	
v/s Ratio Perm				0.10		0.17
v/c Ratio	0.92	0.33	0.51	0.33	0.86	0.50
Uniform Delay, d1	42.4	12.4	30.8	28.9	34.5	29.7
Progression Factor	0.99	0.97	0.69	0.97	1.00	1.00
Incremental Delay, d2	18.8	0.2	1.6	2.0	6.5	1.0
Delay (s)	60.8	12.2	23.0	30.0	41.0	30.7
Level of Service	E	B	C	C	D	C
Approach Delay (s)		25.2	26.1		37.4	
Approach LOS		C	C		D	

Intersection Summary			
HCM Average Control Delay	30.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	72.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Timings
11: Arizona Rd & Salt Lake Blvd

7/19/2012

Lane Group	EBT	WBL	WBT	NBL
Lane Configurations				
Volume (vph)	1320	165	565	250
Turn Type	NA	Prot	NA	NA
Protected Phases	2	1	6	4
Permitted Phases				
Detector Phase	2	1	6	4
Switch Phase				
Minimum Initial (s)	20.0	5.0	20.0	5.0
Minimum Split (s)	28.0	10.0	26.0	34.0
Total Split (s)	45.0	28.0	73.0	37.0
Total Split (%)	40.9%	25.5%	66.4%	33.6%
Yellow Time (s)	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	5.0
Lead/Lag	Lag	Lead		
Lead-Lag Optimize?				
Recall Mode	C-Max	None	C-Max	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 47 (43%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 100
Control Type: Actuated-Coordinated

Splits and Phases: 11: Arizona Rd & Salt Lake Blvd

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	1320	485	165	565	250	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	10	12	12	12
Grade (%)	8%			-10%	-2%	
Total Lost time (s)	6.0		5.0	6.0	5.0	
Lane Util. Factor	0.91		1.00	0.95	0.97	
Frpb, ped/bikes	0.99		1.00	1.00	1.00	
Flpb, ped/bikes	1.00		1.00	1.00	1.00	
Frt	0.96		1.00	1.00	0.97	
Flt Protected	1.00		0.95	1.00	0.96	
Satd. Flow (prot)	4625		1734	3716	3394	
Flt Permitted	1.00		0.95	1.00	0.96	
Satd. Flow (perm)	4625		1734	3716	3394	
Peak-hour factor, PHF	0.91	0.80	0.62	0.93	0.60	0.49
Adj. Flow (vph)	1451	606	266	608	417	102
RTOR Reduction (vph)	57	0	0	0	22	0
Lane Group Flow (vph)	2000	0	266	608	497	0
Confl. Peds. (#/hr)		4				5
Turn Type	NA		Prot	NA	NA	
Protected Phases	2		1	6	4	
Permitted Phases						
Actuated Green, G (s)	50.4		21.5	76.9	22.1	
Effective Green, g (s)	50.4		21.5	76.9	22.1	
Actuated g/C Ratio	0.46		0.20	0.70	0.20	
Clearance Time (s)	6.0		5.0	6.0	5.0	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)	2119		339	2598	682	
v/s Ratio Prot	c0.43		c0.15	0.16	c0.15	
v/s Ratio Perm						
v/c Ratio	0.94		0.78	0.23	0.73	
Uniform Delay, d1	28.4		42.1	6.0	41.1	
Progression Factor	0.90		1.00	1.00	1.00	
Incremental Delay, d2	8.9		11.3	0.2	3.9	
Delay (s)	34.4		53.3	6.2	45.0	
Level of Service	C		D	A	D	
Approach Delay (s)	34.4			20.5	45.0	
Approach LOS	C			C	D	

Intersection Summary			
HCM Average Control Delay	32.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	70.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Base Year 2040 with Mitigation PM

Timings
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	75	685	305	45	1025	560	355	80	215
Turn Type	Prot	NA	Perm	Prot	NA	Prot	NA	Prot	NA
Protected Phases	5	2		1	6	3	8	7	4
Permitted Phases			2						
Detector Phase	5	2	2	1	6	3	8	7	4
Switch Phase									
Minimum Initial (s)	5.0	20.0	20.0	5.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	34.0	34.0	10.0	34.0	10.0	33.0	10.0	33.0
Total Split (s)	17.0	76.0	76.0	17.0	76.0	34.0	45.0	22.0	33.0
Total Split (%)	10.6%	47.5%	47.5%	10.6%	47.5%	21.3%	28.1%	13.8%	20.6%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	5.0	6.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?									
Recall Mode	None	C-Max	C-Max	None	C-Max	None	None	None	None

Intersection Summary
Cycle Length: 160
Actuated Cycle Length: 160
Offset: 135 (84%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 90
Control Type: Actuated-Coordinated

Splits and Phases: 1: Bouganville Dr & Salt Lake Blvd

HCM Signalized Intersection Capacity Analysis
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	75	685	305	45	1025	165	560	355	45	80	215	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		3%			-3%			2%			-2%	
Total Lost time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91		0.97	1.00		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.95	1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.98		1.00	0.96	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1743	3486	1478	1796	5007		3399	1796		1787	3381	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1743	3486	1478	1796	5007		3399	1796		1787	3381	
Peak-hour factor, PHF	0.82	0.83	0.92	0.83	0.94	0.80	0.95	0.88	0.67	0.85	0.74	0.86
Adj. Flow (vph)	91	825	332	54	1090	206	589	403	67	94	291	116
RTOR Reduction (vph)	0	0	178	0	17	0	0	4	0	0	26	0
Lane Group Flow (vph)	91	825	154	54	1279	0	589	466	0	94	381	0
Confl. Peds. (#/hr)			24			7			13			18
Turn Type	Prot	NA	Perm	Prot	NA		Prot	NA		Prot	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2									
Actuated Green, G (s)	11.0	74.1	74.1	7.9	71.0		28.8	44.4		12.6	28.2	
Effective Green, g (s)	11.0	74.1	74.1	7.9	71.0		28.8	44.4		12.6	28.2	
Actuated g/C Ratio	0.07	0.46	0.46	0.05	0.44		0.18	0.28		0.08	0.18	
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	5.0	5.0	2.0	5.0		2.0	3.0		2.0	3.0	
Lane Grp Cap (vph)	120	1614	684	89	2222		612	498		141	596	
v/s Ratio Prot	c0.05	c0.24		0.03	c0.26		c0.17	c0.26		0.05	0.11	
v/s Ratio Perm			0.10									
v/c Ratio	0.76	0.51	0.22	0.61	0.58		0.96	0.94		0.67	0.64	
Uniform Delay, d1	73.2	30.2	25.7	74.5	33.2		65.1	56.4		71.7	61.2	
Progression Factor	1.00	1.00	1.00	1.25	0.60		1.00	1.00		1.00	1.00	
Incremental Delay, d2	21.3	1.2	0.8	7.4	1.0		27.0	25.2		8.9	2.3	
Delay (s)	94.5	31.4	26.5	100.5	20.8		92.0	81.6		80.5	63.4	
Level of Service	F	C	C	F	C		F	F		F	E	
Approach Delay (s)		34.7			24.0			87.4			66.6	
Approach LOS		C			C			F			E	

Intersection Summary			
HCM Average Control Delay	48.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	77.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Timings
2: Lawehana St & Salt Lake Blvd

7/19/2012

Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Configurations					
Volume (vph)	650	95	990	215	140
Turn Type	NA	Prot	NA	NA	Perm
Protected Phases	2	1	6	4	
Permitted Phases					4
Detector Phase	2	1	6	4	4
Switch Phase					
Minimum Initial (s)	20.0	5.0	20.0	5.0	5.0
Minimum Split (s)	28.0	10.0	26.0	37.0	37.0
Total Split (s)	75.0	29.0	104.0	56.0	56.0
Total Split (%)	46.9%	18.1%	65.0%	35.0%	35.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	6.0	6.0
Lead/Lag	Lag	Lead			
Lead-Lag Optimize?					
Recall Mode	C-Max	None	C-Max	None	None

Intersection Summary
Cycle Length: 160
Actuated Cycle Length: 160
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated

Splits and Phases: 2: Lawehana St & Salt Lake Blvd

HCM Signalized Intersection Capacity Analysis
2: Lawehana St & Salt Lake Blvd

7/19/2012

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	650	135	95	990	215	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	10	10
Grade (%)	-1%			-3%	-1%	
Total Lost time (s)	6.0		5.0	6.0	6.0	6.0
Lane Util. Factor	0.95		1.00	0.91	1.00	1.00
Frpb, ped/bikes	0.99		1.00	1.00	1.00	0.97
Flpb, ped/bikes	1.00		1.00	1.00	1.00	1.00
Frt	0.97		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	3429		1796	4129	1660	1440
Flt Permitted	1.00		0.95	1.00	0.95	1.00
Satd. Flow (perm)	3429		1796	4129	1660	1440
Peak-hour factor, PHF	0.88	0.82	0.80	0.95	0.80	0.82
Adj. Flow (vph)	739	165	119	1042	269	171
RTOR Reduction (vph)	8	0	0	0	0	137
Lane Group Flow (vph)	896	0	119	1042	269	34
Confl. Peds. (#/hr)		8				12
Parking (#/hr)				100		
Turn Type	NA		Prot	NA	NA	Perm
Protected Phases	2		1	6	4	
Permitted Phases						4
Actuated Green, G (s)	96.5		15.0	116.5	31.5	31.5
Effective Green, g (s)	96.5		15.0	116.5	31.5	31.5
Actuated g/C Ratio	0.60		0.09	0.73	0.20	0.20
Clearance Time (s)	6.0		5.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0		2.0	5.0	3.0	3.0
Lane Grp Cap (vph)	2068		168	3006	327	284
v/s Ratio Prot	c0.26		c0.07	0.25	c0.16	
v/s Ratio Perm						0.02
v/c Ratio	0.43		0.71	0.35	0.82	0.12
Uniform Delay, d1	17.1		70.4	7.9	61.6	52.8
Progression Factor	0.25		0.96	1.58	1.00	1.00
Incremental Delay, d2	0.6		7.4	0.2	15.3	0.2
Delay (s)	4.9		75.2	12.7	76.8	53.0
Level of Service	A		E	B	E	D
Approach Delay (s)	4.9			19.1	67.6	
Approach LOS	A			B	E	

Intersection Summary			
HCM Average Control Delay	22.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	58.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

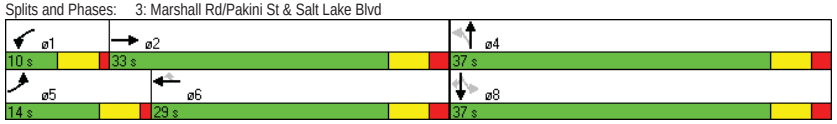
Timings
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT	SBR
Lane Configurations										
Volume (vph)	170	580	5	960	45	85	30	35	10	150
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	NA	Perm
Protected Phases	5	2	1	6			4		8	
Permitted Phases					6	4		8		8
Detector Phase	5	2	1	6	6	4	4	8	8	8
Switch Phase										
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	28.0	10.0	28.0	28.0	11.0	11.0	37.0	37.0	37.0
Total Split (s)	14.0	33.0	10.0	29.0	29.0	37.0	37.0	37.0	37.0	37.0
Total Split (%)	17.5%	41.3%	12.5%	36.3%	36.3%	46.3%	46.3%	46.3%	46.3%	46.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0		0.0	0.0
Total Lost Time (s)	5.0	6.0	5.0	6.0	6.0		6.0		6.0	6.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag					
Lead-Lag Optimize?										
Recall Mode	None	C-Max	None	C-Max	C-Max	None	None	None	None	None

Intersection Summary
Cycle Length: 80
Actuated Cycle Length: 80
Offset: 4 (5%), Referenced to phase 2:EBT and 6:WBT, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated

Splits and Phases: 3: Marshall Rd/Pakini St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	580	35	5	960	45	85	30	5	35	10	150
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			1%			-4%	
Total Lost time (s)	5.0	6.0		5.0	6.0	6.0		6.0			6.0	6.0
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00			1.00	1.00
Frpb, ped/bikes	1.00	0.99		1.00	1.00	0.98		1.00			1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00		1.00			1.00	1.00
Frt	1.00	0.97		1.00	1.00	0.85		0.99			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.97			0.96	1.00
Satd. Flow (prot)	1787	3455		1787	2502	1561		1777			1824	1589
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.75			0.71	1.00
Satd. Flow (perm)	1787	3455		1787	2502	1561		1375			1353	1589
Peak-hour factor, PHF	0.88	0.93	0.25	0.50	0.94	0.73	0.92	0.92	0.92	0.62	0.92	0.91
Adj. Flow (vph)	193	624	140	10	1021	62	92	33	5	56	11	165
RTOR Reduction (vph)	0	15	0	0	0	32	0	2	0	0	0	134
Lane Group Flow (vph)	193	749	0	10	1021	30	0	128	0	0	67	31
Confl. Peds. (#/hr)			8			2	3		5			5
Parking (#/hr)					100				0			
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		8
Actuated Green, G (s)	9.0	46.8		1.0	38.8	38.8		15.2			15.2	15.2
Effective Green, g (s)	9.0	46.8		1.0	38.8	38.8		15.2			15.2	15.2
Actuated g/C Ratio	0.11	0.58		0.01	0.48	0.48		0.19			0.19	0.19
Clearance Time (s)	5.0	6.0		5.0	6.0	6.0		6.0			6.0	6.0
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0		3.0			3.0	3.0
Lane Grp Cap (vph)	201	2021		22	1213	757		261			257	302
v/s Ratio Prot	c0.11	0.22		0.01	c0.41							
v/s Ratio Perm						0.02		c0.09			0.05	0.02
v/c Ratio	0.96	0.37		0.45	0.84	0.04		0.49			0.26	0.10
Uniform Delay, d1	35.3	8.8		39.2	17.9	10.8		28.9			27.6	26.8
Progression Factor	1.43	1.45		1.00	1.00	1.00		1.00			1.00	1.00
Incremental Delay, d2	49.8	0.5		5.3	7.2	0.1		1.4			0.5	0.2
Delay (s)	100.2	13.2		44.6	25.1	10.9		30.4			28.2	26.9
Level of Service	F	B		D	C	B		C			C	C
Approach Delay (s)		30.8			24.5			30.4			27.3	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	27.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	63.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

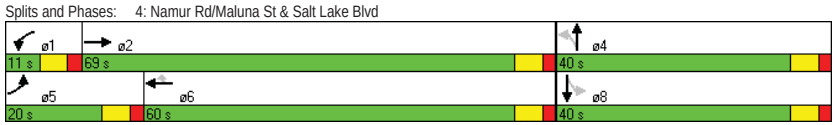
Timings
4: Namur Rd/Maluna St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	55	560	15	885	60	85	30	30	10
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	NA
Protected Phases	5	2	1	6			4		8
Permitted Phases					6	4		8	
Detector Phase	5	2	1	6	6	4	4	8	8
Switch Phase									
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	11.0	26.0	11.0	26.0	26.0	11.0	11.0	40.0	40.0
Total Split (s)	20.0	69.0	11.0	60.0	60.0	40.0	40.0	40.0	40.0
Total Split (%)	16.7%	57.5%	9.2%	50.0%	50.0%	33.3%	33.3%	33.3%	33.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0		6.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag				
Lead-Lag Optimize?									
Recall Mode	None	Max	None	Max	Max	None	None	None	None

Intersection Summary
Cycle Length: 120
Actuated Cycle Length: 99.2
Natural Cycle: 90
Control Type: Actuated-Uncoordinated

Splits and Phases: 4: Namur Rd/Maluna St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
4: Namur Rd/Maluna St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	55	560	35	15	885	60	85	30	20	30	10	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		7%			-6%			0%			-12%	
Total Lost time (s)	6.0	6.0		6.0	6.0	6.0	6.0	6.0			6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.97	1.00	0.99			0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	1.00	1.00			1.00	
Frt	1.00	0.99		1.00	1.00	0.85	1.00	0.94			0.93	
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00			0.98	
Satd. Flow (prot)	1708	3365		1823	2552	1590	1763	1732			1794	
Flt Permitted	0.95	1.00		0.95	1.00	1.00	0.63	1.00			0.85	
Satd. Flow (perm)	1708	3365		1823	2552	1590	1171	1732			1553	
Peak-hour factor, PHF	0.64	0.94	0.73	0.83	0.89	0.79	0.85	0.55	0.54	0.71	0.50	0.73
Adj. Flow (vph)	86	596	48	18	994	76	100	55	37	42	20	62
RTOR Reduction (vph)	0	3	0	0	0	10	0	24	0	0	36	0
Lane Group Flow (vph)	86	641	0	18	994	66	100	68	0	0	88	0
Confl. Peds. (#/hr)			12			2	5		7			7
Parking (#/hr)					100							
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		
Actuated Green, G (s)	8.0	67.7		1.8	61.5	61.5	15.4	15.4			15.4	
Effective Green, g (s)	8.0	67.7		1.8	61.5	61.5	15.4	15.4			15.4	
Actuated g/C Ratio	0.08	0.66		0.02	0.60	0.60	0.15	0.15			0.15	
Clearance Time (s)	6.0	6.0		6.0	6.0	6.0	6.0	6.0			6.0	
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0	3.0	3.0			3.0	
Lane Grp Cap (vph)	133	2214		32	1525	950	175	259			232	
v/s Ratio Prot	c0.05	0.19		0.01	c0.39			0.04				
v/s Ratio Perm						0.04	c0.09				0.06	
v/c Ratio	0.65	0.29		0.56	0.65	0.07	0.57	0.26			0.38	
Uniform Delay, d1	46.1	7.4		50.2	13.6	8.7	40.7	38.7			39.4	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00			1.00	
Incremental Delay, d2	7.8	0.3		12.8	2.2	0.1	4.5	0.5			1.0	
Delay (s)	53.9	7.8		62.9	15.8	8.8	45.1	39.3			40.5	
Level of Service	D	A		E	B	A	D	D			D	
Approach Delay (s)		13.2			16.1			42.3			40.5	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	18.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	102.9	Sum of lost time (s)	18.0
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Timings
5: Salt Lake Blvd & Wanaka St

7/19/2012

Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations					
Volume (vph)	105	520	910	70	65
Turn Type	Perm	NA	NA	NA	Perm
Protected Phases		2	2	4	
Permitted Phases	2				4
Detector Phase	2	2	2	4	4
Switch Phase					
Minimum Initial (s)	25.0	25.0	25.0	4.0	4.0
Minimum Split (s)	30.0	30.0	30.0	20.0	20.0
Total Split (s)	60.0	60.0	60.0	20.0	20.0
Total Split (%)	75.0%	75.0%	75.0%	25.0%	25.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	Min	Min	Min	None	None

Intersection Summary
Cycle Length: 80
Actuated Cycle Length: 76
Natural Cycle: 150
Control Type: Actuated-Uncoordinated

Splits and Phases: 5: Salt Lake Blvd & Wanaka St

HCM Signalized Intersection Capacity Analysis
5: Salt Lake Blvd & Wanaka St

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	105	520	910	145	70	65
Ideal Flow (vphpl)	1400	1400	1400	1400	1400	1400
Lane Width	10	10	10	12	10	10
Grade (%)		0%	1%		-8%	
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.98		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1217	1281	498		1266	1107
Flt Permitted	0.14	1.00	1.00		0.95	1.00
Satd. Flow (perm)	175	1281	498		1266	1107
Peak-hour factor, PHF	0.80	0.96	0.93	0.88	0.75	0.89
Adj. Flow (vph)	131	542	978	165	93	73
RTOR Reduction (vph)	0	0	6	0	0	65
Lane Group Flow (vph)	131	542	1137	0	93	8
Confl. Peds. (#/hr)	1			1		1
Parking (#/hr)			100			
Turn Type	Perm	NA	NA		NA	Perm
Protected Phases		2	2		4	
Permitted Phases	2					4
Actuated Green, G (s)	58.1	58.1	58.1		8.9	8.9
Effective Green, g (s)	58.1	58.1	58.1		8.9	8.9
Actuated g/C Ratio	0.75	0.75	0.75		0.12	0.12
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	4.0	4.0	4.0		2.2	2.2
Lane Grp Cap (vph)	132	967	376		146	128
v/s Ratio Prot		0.42	c2.28		c0.07	
v/s Ratio Perm	0.75					0.01
v/c Ratio	0.99	0.56	3.02		0.64	0.07
Uniform Delay, d1	9.2	4.0	9.4		32.5	30.3
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	75.8	0.9	918.0		7.0	0.1
Delay (s)	85.0	4.9	927.4		39.5	30.5
Level of Service	F	A	F		D	C
Approach Delay (s)		20.5	927.4		35.5	
Approach LOS		C	F		D	

Intersection Summary			
HCM Average Control Delay	544.8	HCM Level of Service	F
HCM Volume to Capacity ratio	2.71		
Actuated Cycle Length (s)	77.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	115.8%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

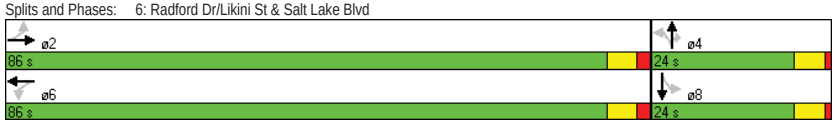
Timings
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Configurations									
Volume (vph)	5	555	270	1015	70	30	420	75	15
Turn Type	Perm	NA	Perm	NA	Perm	NA	Perm	Perm	NA
Protected Phases		2		6		4			8
Permitted Phases	2		6		4		4	8	
Detector Phase	2	2	6	6	4	4	4	8	8
Switch Phase									
Minimum Initial (s)	5.0	5.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	46.0	46.0	46.0	46.0	9.0	9.0	9.0	24.0	24.0
Total Split (s)	86.0	86.0	86.0	86.0	24.0	24.0	24.0	24.0	24.0
Total Split (%)	78.2%	78.2%	78.2%	78.2%	21.8%	21.8%	21.8%	21.8%	21.8%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0		0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0		5.0	5.0		5.0
Lead/Lag									
Lead-Lag Optimize?									
Recall Mode	C-Max	C-Max	C-Max	C-Max	None	None	None	None	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 57 (52%), Referenced to phase 2:EBTL and 6:WBTL, Start of Yellow
Natural Cycle: 150
Control Type: Actuated-Coordinated

Splits and Phases: 6: Radford Dr/Likini St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	5	555	50	270	1015	95	70	30	420	75	15	10
Ideal Flow (vphpl)	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400
Lane Width	11	11	11	10	10	10	12	12	12	12	12	12
Grade (%)		1%			-2%			2%			-6%	
Total Lost time (s)	6.0	6.0		6.0	6.0			5.0	5.0		5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	0.97		0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			0.99	1.00		1.00	
Frt	1.00	0.98		1.00	0.99			1.00	0.85		0.98	
Flt Protected	0.95	1.00		0.95	1.00			0.97	1.00		0.97	
Satd. Flow (prot)	1254	1296		1228	1273			1306	1125		1336	
Flt Permitted	0.06	1.00		0.34	1.00			0.69	1.00		0.65	
Satd. Flow (perm)	75	1296		446	1273			936	1125		889	
Peak-hour factor, PHF	0.75	0.91	0.71	0.76	0.90	0.81	0.73	0.75	0.91	0.84	0.38	0.44
Adj. Flow (vph)	7	610	70	355	1128	117	96	40	462	89	39	23
RTOR Reduction (vph)	0	4	0	0	3	0	0	0	299	0	6	0
Lane Group Flow (vph)	7	676	0	355	1242	0	0	136	163	0	145	0
Confl. Peds. (#/hr)	4		6	2		4	4		2			8
Turn Type	Perm	NA		Perm	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		2			6			4			8	
Permitted Phases	2			6			4		4	8		
Actuated Green, G (s)	80.1	80.1		80.1	80.1			18.9	18.9		18.9	
Effective Green, g (s)	80.1	80.1		80.1	80.1			18.9	18.9		18.9	
Actuated g/C Ratio	0.73	0.73		0.73	0.73			0.17	0.17		0.17	
Clearance Time (s)	6.0	6.0		6.0	6.0			5.0	5.0		5.0	
Vehicle Extension (s)	5.0	5.0		5.0	5.0			3.0	3.0		3.0	
Lane Grp Cap (vph)	55	944		325	927			161	193		153	
v/s Ratio Prot		0.52			c0.98							
v/s Ratio Perm	0.09			0.80				0.15	0.14		c0.16	
v/c Ratio	0.13	0.72		1.09	1.34			0.84	0.84		0.95	
Uniform Delay, d1	4.5	8.5		15.0	15.0			44.1	44.1		45.1	
Progression Factor	1.00	1.00		0.83	0.91			1.00	1.00		1.00	
Incremental Delay, d2	4.7	4.6		73.7	159.2			31.3	27.2		56.9	
Delay (s)	9.2	13.1		86.1	172.8			75.4	71.3		102.0	
Level of Service	A	B		F	F			E	E		F	
Approach Delay (s)		13.1			153.6			72.2			102.0	
Approach LOS		B			F			E			F	

Intersection Summary			
HCM Average Control Delay	103.2	HCM Level of Service	F
HCM Volume to Capacity ratio	1.27		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	113.3%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
7: Salt Lake Blvd & Kahikolu Pl

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	1015	1450	25	15	10
Sign Control		Free	Free		Stop	
Grade		0%	2%		0%	
Peak Hour Factor	0.38	0.89	0.92	0.54	0.45	0.50
Hourly flow rate (vph)	13	1140	1576	46	33	20
Pedestrians		14	14		14	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		1	1		1	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		534	907			
pX, platoon unblocked	0.57				0.68	0.57
vC, conflicting volume	1636				2794	1627
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1737				2718	1721
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	94				0	68
cM capacity (veh/h)	206				14	62

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	13	1140	1622	53
Volume Left	13	0	0	33
Volume Right	0	0	46	20
cSH	206	1700	1700	20
Volume to Capacity	0.06	0.67	0.95	2.66
Queue Length 95th (ft)	5	0	0	175
Control Delay (s)	23.7	0.0	0.0	1154.9
Lane LOS	C			F
Approach Delay (s)	0.3		0.0	1154.9
Approach LOS				F

Intersection Summary			
Average Delay		21.9	
Intersection Capacity Utilization		119.4%	ICU Level of Service H
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
8: Salt Lake Blvd & Shopping Center Entrance 1

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	130	940	0	5	1350	10	5	0	0	0	0	95
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.85	0.91	0.92	0.25	0.95	0.44	0.25	0.92	0.92	0.92	0.92	0.62
Hourly flow rate (vph)	153	1033	0	20	1421	23	20	0	0	0	0	153
Pedestrians		2			2						2	
Lane Width (ft)		12.0			12.0						12.0	
Walking Speed (ft/s)		4.0			4.0						4.0	
Percent Blockage		0			0						0	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		888			553							
pX, platoon unblocked	0.57						0.57	0.57		0.57	0.57	0.57
vC, conflicting volume	1446			1033			2966	2825	1035	2815	2813	1436
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1405			1033			4067	3819	1035	3802	3799	1389
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	45			97			0	100	100	100	100	0
cM capacity (veh/h)	277			673			0	1	281	1	1	99

Direction, Lane #	EB 1	EB 2	WB 1	NB 1	NB 2	NB 3	SB 1
Volume Total	153	1033	1464	20	0	0	153
Volume Left	153	0	20	20	0	0	0
Volume Right	0	0	23	0	0	0	153
cSH	277	1700	673	0	1700	1700	99
Volume to Capacity	0.55	0.61	0.03	Err	0.00	0.00	1.54
Queue Length 95th (ft)	77	0	2	Err	0	0	291
Control Delay (s)	32.9	0.0	2.2	Err	0.0	0.0	362.9
Lane LOS	D		A	F	A	A	F
Approach Delay (s)	4.2		2.2	Err			362.9
Approach LOS				F			F

Intersection Summary			
Average Delay		Err	
Intersection Capacity Utilization		154.2%	ICU Level of Service H
Analysis Period (min)		15	

HCM Unsignalized Intersection Capacity Analysis
9: Aliamanu School /Shopping Center Entrance 2 & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	900	25	0	1250	100	0	0	45	0	0	105
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.93	0.64	0.92	0.90	0.86	0.92	0.92	0.68	0.92	0.92	0.76
Hourly flow rate (vph)	0	968	39	0	1389	116	0	0	66	0	0	138
Pedestrians		2									2	
Lane Width (ft)		12.0									12.0	
Walking Speed (ft/s)		4.0									4.0	
Percent Blockage		0									0	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		1105			336							
pX, platoon unblocked	0.56						0.56	0.56		0.56	0.56	0.56
vC, conflicting volume	1507			968			2516	2494	987	2378	2359	1393
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1513			968			3302	3263	987	3057	3022	1310
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			0	100	78	100	100	0
cM capacity (veh/h)	249			712			0	5	300	3	7	109

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	1007	1389	116	66	138
Volume Left	0	0	0	0	0
Volume Right	39	0	116	66	138
cSH	1700	1700	1700	300	109
Volume to Capacity	0.59	0.82	0.07	0.22	1.26
Queue Length 95th (ft)	0	0	0	21	231
Control Delay (s)	0.0	0.0	0.0	20.4	246.8
Lane LOS				C	F
Approach Delay (s)	0.0	0.0		20.4	246.8
Approach LOS				C	F

Intersection Summary				
Average Delay	13.1			
Intersection Capacity Utilization	105.3%	ICU Level of Service	G	
Analysis Period (min)	15			

Timings
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	290	640	1010	545	335	330
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	20.0	20.0	20.0	6.0	6.0
Minimum Split (s)	10.0	26.0	29.0	29.0	35.0	35.0
Total Split (s)	25.0	70.0	45.0	45.0	40.0	40.0
Total Split (%)	22.7%	63.6%	40.9%	40.9%	36.4%	36.4%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	C-Max	C-Max	C-Max	None	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow, Master Intersection
Natural Cycle: 90
Control Type: Actuated-Coordinated

Splits and Phases: 10: Salt Lake Blvd & Ala Lilikoi St

HCM Signalized Intersection Capacity Analysis
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	290	640	1010	545	335	330
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lane Util. Factor	1.00	0.91	0.95	1.00	0.97	1.00
Frpb, ped/bikes	1.00	1.00	1.00	0.96	1.00	0.95
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	5085	3539	1515	3433	1511
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	5085	3539	1515	3433	1511
Peak-hour factor, PHF	0.95	0.94	0.91	0.84	0.91	0.86
Adj. Flow (vph)	305	681	1110	649	368	384
RTOR Reduction (vph)	0	0	0	343	0	310
Lane Group Flow (vph)	305	681	1110	306	368	74
Confl. Peds. (#/hr)				22		31
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Actuated Green, G (s)	24.9	79.1	49.2	49.2	19.9	19.9
Effective Green, g (s)	24.9	79.1	49.2	49.2	19.9	19.9
Actuated g/C Ratio	0.23	0.72	0.45	0.45	0.18	0.18
Clearance Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Vehicle Extension (s)	3.0	4.0	4.0	4.0	3.0	3.0
Lane Grp Cap (vph)	401	3657	1583	678	621	273
v/s Ratio Prot	c0.17	0.13	c0.31		c0.11	
v/s Ratio Perm				0.20		0.05
v/c Ratio	0.76	0.19	0.70	0.45	0.59	0.27
Uniform Delay, d1	39.8	5.0	24.5	21.1	41.3	38.8
Progression Factor	0.92	1.03	1.04	2.29	1.00	1.00
Incremental Delay, d2	5.5	0.1	2.1	1.8	1.5	0.5
Delay (s)	42.1	5.2	27.6	50.1	42.9	39.4
Level of Service	D	A	C	D	D	D
Approach Delay (s)		16.6	35.9		41.1	
Approach LOS		B	D		D	

Intersection Summary			
HCM Average Control Delay	31.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	76.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Timings
11: Arizona Rd & Salt Lake Blvd

7/19/2012

Lane Group	EBT	WBL	WBT	NBL
Lane Configurations				
Volume (vph)	760	50	975	605
Turn Type	NA	Prot	NA	NA
Protected Phases	2	1	6	4
Permitted Phases				
Detector Phase	2	1	6	4
Switch Phase				
Minimum Initial (s)	20.0	5.0	20.0	5.0
Minimum Split (s)	28.0	10.0	26.0	34.0
Total Split (s)	53.0	22.0	75.0	35.0
Total Split (%)	48.2%	20.0%	68.2%	31.8%
Yellow Time (s)	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	5.0
Lead/Lag	Lag	Lead		
Lead-Lag Optimize?				
Recall Mode	C-Max	None	C-Max	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 67 (61%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated

Splits and Phases: 11: Arizona Rd & Salt Lake Blvd

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	760	245	50	975	605	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	10	12	12	12
Grade (%)	8%			-10%	-2%	
Total Lost time (s)	6.0		5.0	6.0	5.0	
Lane Util. Factor	0.91		1.00	0.95	0.97	
Frpb, ped/bikes	0.99		1.00	1.00	1.00	
Flpb, ped/bikes	1.00		1.00	1.00	1.00	
Frt	0.96		1.00	1.00	0.99	
Flt Protected	1.00		0.95	1.00	0.96	
Satd. Flow (prot)	4668		1734	3716	3442	
Flt Permitted	1.00		0.95	1.00	0.96	
Satd. Flow (perm)	4668		1734	3716	3442	
Peak-hour factor, PHF	0.94	0.90	0.77	0.90	0.88	0.64
Adj. Flow (vph)	809	272	65	1083	688	62
RTOR Reduction (vph)	46	0	0	0	7	0
Lane Group Flow (vph)	1035	0	65	1083	743	0
Confl. Peds. (#/hr)		2				4
Turn Type	NA		Prot	NA	NA	
Protected Phases	2		1	6	4	
Permitted Phases						
Actuated Green, G (s)	57.6		8.3	70.9	28.1	
Effective Green, g (s)	57.6		8.3	70.9	28.1	
Actuated g/C Ratio	0.52		0.08	0.64	0.26	
Clearance Time (s)	6.0		5.0	6.0	5.0	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)	2444		131	2395	879	
v/s Ratio Prot	0.22		0.04	c0.29	c0.22	
v/s Ratio Perm						
v/c Ratio	0.42		0.50	0.45	0.85	
Uniform Delay, d1	16.0		48.8	9.8	38.9	
Progression Factor	0.54		1.00	1.00	1.00	
Incremental Delay, d2	0.5		2.9	0.6	7.5	
Delay (s)	9.1		51.8	10.4	46.4	
Level of Service	A		D	B	D	
Approach Delay (s)	9.1			12.8	46.4	
Approach LOS	A			B	D	

Intersection Summary			
HCM Average Control Delay	19.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	57.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2040 Single-Lane Roundabout AM

HCM 2010 Roundabout
5: Salt Lake Blvd & Wanaka St

6/28/2012

Intersection	
Intersection Delay (sec/veh)	18.5
Intersection LOS	C

Approach	EB	WB	SB
Entry Lanes	1	1	1
Conflicting Circle Lanes	1	1	1
Adjusted Approach Flow (vph)	817	722	215
Demand Flow Rate (pc/h)	833	737	220
Vehicles Circulating (pc/h)	132	62	657
Vehicles Exiting (pc/h)	745	903	142
Follow-Up Headway (s)	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	0	0	0
Ped Capacity Adjustment	1.000	1.000	1.000
Approach Delay (sec/veh)	24.0	14.4	11.9
Approach LOS	C	B	B

Lane	Left	Left	Left
Designated moves	LT	TR	LR
Assumed Moves	LT	TR	LR
Right Turn Channelized			
Lane Utilization	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193
Entry Flow Rate (pc/h)	833	737	220
Capacity, Entry Lane (pc/h)	990	1062	586
Entry HV Adjustment Factor	0.981	0.980	0.977
Flow Rate, Entry (vph)	817	722	215
Capacity, Entry (vph)	971	1041	572
Volume to Capacity Ratio	0.841	0.694	0.376
Control Delay (sec/veh)	24.0	14.4	11.9
Level of Service	C	B	B
95th-Percentile Queue (veh)	10	6	2

HCM 2010 Roundabout
6: Radford Dr/Likini St & Salt Lake Blvd

6/28/2012

Intersection	
Intersection Delay (sec/veh)	164.4
Intersection LOS	F

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adjusted Approach Flow (vph)	1010	1083	454	228
Demand Flow Rate (pc/h)	1030	1104	464	233
Vehicles Circulating (pc/h)	531	127	1143	1080
Vehicles Exiting (pc/h)	782	1480	418	151
Follow-Up Headway (s)	3.186	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	24	12	33	3
Ped Capacity Adjustment	0.997	0.998	1.000	1.000
Approach Delay (sec/veh)	275.1	83.4	180.5	26.4
Approach LOS	F	F	F	D

Lane	Left	Left	Left	Left
Designated moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
Right Turn Channelized				
Lane Utilization	1.000	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193	5.193
Entry Flow Rate (pc/h)	1030	1104	464	233
Capacity, Entry Lane (pc/h)	664	995	360	384
Entry HV Adjustment Factor	0.981	0.981	0.979	0.978
Flow Rate, Entry (vph)	1010	1083	454	228
Capacity, Entry (vph)	649	974	353	375
Volume to Capacity Ratio	1.555	1.111	1.288	0.607
Control Delay (sec/veh)	275.1	83.4	180.5	26.4
Level of Service	F	F	F	D
95th-Percentile Queue (veh)	52	28	21	4

Intersection			
Intersection Delay (sec/veh)	105.9		
Intersection LOS	F		

Approach	EB	WB	SB
Entry Lanes	1	1	1
Conflicting Circle Lanes	1	1	1
Adjusted Approach Flow (vph)	1385	1103	63
Demand Flow Rate (pc/h)	1412	1125	65
Vehicles Circulating (pc/h)	32	20	1103
Vehicles Exiting (pc/h)	1136	1424	42
Follow-Up Headway (s)	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	13	13	13
Ped Capacity Adjustment	0.998	0.998	1.000
Approach Delay (sec/veh)	153.5	51.5	12.8
Approach LOS	F	F	B

Lane	Left	Left	Left
Designated moves	LT	TR	LR
Assumed Moves	LT	TR	LR
Right Turn Channelized			
Lane Utilization	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193
Entry Flow Rate (pc/h)	1412	1125	65
Capacity, Entry Lane (pc/h)	1094	1108	375
Entry HV Adjustment Factor	0.981	0.981	0.969
Flow Rate, Entry (vph)	1385	1103	63
Capacity, Entry (vph)	1071	1084	363
Volume to Capacity Ratio	1.293	1.018	0.173
Control Delay (sec/veh)	153.5	51.5	12.8
Level of Service	F	F	B
95th-Percentile Queue (veh)	50	22	1

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2040 Single-Lane Roundabout PM

Intersection	
Intersection Delay (sec/veh)	69.1
Intersection LOS	F

Approach	EB	WB	SB
Entry Lanes	1	1	1
Conflicting Circle Lanes	1	1	1
Adjusted Approach Flow (vph)	673	1143	166
Demand Flow Rate (pc/h)	687	1166	169
Vehicles Circulating (pc/h)	95	134	998
Vehicles Exiting (pc/h)	1072	648	302
Follow-Up Headway (s)	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	1	0	1
Ped Capacity Adjustment	1.000	1.000	1.000
Approach Delay (sec/veh)	13.8	109.3	16.7
Approach LOS	B	F	C

Lane	Left	Left	Left
Designated moves	LT	TR	LR
Assumed Moves	LT	TR	LR
Right Turn Channelized			
Lane Utilization	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193
Entry Flow Rate (pc/h)	687	1166	169
Capacity, Entry Lane (pc/h)	1028	988	417
Entry HV Adjustment Factor	0.980	0.981	0.982
Flow Rate, Entry (vph)	673	1143	166
Capacity, Entry (vph)	1007	969	409
Volume to Capacity Ratio	0.669	1.180	0.406
Control Delay (sec/veh)	13.8	109.3	16.7
Level of Service	B	F	C
95th-Percentile Queue (veh)	5	34	2

Intersection	
Intersection Delay (sec/veh)	205.0
Intersection LOS	F

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adjusted Approach Flow (vph)	687	1600	598	151
Demand Flow Rate (pc/h)	700	1632	610	154
Vehicles Circulating (pc/h)	493	146	720	1611
Vehicles Exiting (pc/h)	1272	1184	473	167
Follow-Up Headway (s)	3.186	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	8	2	6	4
Ped Capacity Adjustment	0.999	1.000	0.999	1.000
Approach Delay (sec/veh)	63.2	320.2	99.3	48.7
Approach LOS	F	F	F	E

Lane	Left	Left	Left	Left
Designated moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
Right Turn Channelized				
Lane Utilization	1.000	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193	5.193
Entry Flow Rate (pc/h)	700	1632	610	154
Capacity, Entry Lane (pc/h)	690	976	550	226
Entry HV Adjustment Factor	0.981	0.981	0.981	0.982
Flow Rate, Entry (vph)	687	1600	598	151
Capacity, Entry (vph)	676	957	539	222
Volume to Capacity Ratio	1.015	1.672	1.110	0.683
Control Delay (sec/veh)	63.2	320.2	99.3	48.7
Level of Service	F	F	F	E
95th-Percentile Queue (veh)	17	87	19	4

Intersection			
Intersection Delay (sec/veh)	165.0		
Intersection LOS	F		

Approach	EB	WB	SB
Entry Lanes	1	1	1
Conflicting Circle Lanes	1	1	1
Adjusted Approach Flow (vph)	1153	1622	53
Demand Flow Rate (pc/h)	1176	1655	54
Vehicles Circulating (pc/h)	34	13	1608
Vehicles Exiting (pc/h)	1628	1197	60
Follow-Up Headway (s)	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	14	14	14
Ped Capacity Adjustment	0.998	0.998	1.000
Approach Delay (sec/veh)	70.3	237.0	22.4
Approach LOS	F	F	C

Lane	Left	Left	Left
Designated moves	LT	TR	LR
Assumed Moves	LT	TR	LR
Right Turn Channelized			
Lane Utilization	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193
Entry Flow Rate (pc/h)	1176	1655	54
Capacity, Entry Lane (pc/h)	1092	1115	226
Entry HV Adjustment Factor	0.981	0.980	0.981
Flow Rate, Entry (vph)	1153	1622	53
Capacity, Entry (vph)	1069	1091	222
Volume to Capacity Ratio	1.079	1.487	0.239
Control Delay (sec/veh)	70.3	237.0	22.4
Level of Service	F	F	C
95th-Percentile Queue (veh)	27	75	1

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2040 Double-Lane Roundabout AM

HCM 2010 Roundabout
5: Salt Lake Blvd & Wanaka St

7/11/2012

Intersection	
Intersection Delay (sec/veh)	8.0
Intersection LOS	A

Approach	EB	WB	SB
Entry Lanes	2	2	1
Conflicting Circle Lanes	2	2	2
Adjusted Approach Flow (vph)	863	784	221
Demand Flow Rate (pc/h)	880	800	226
Vehicles Circulating (pc/h)	160	67	719
Vehicles Exiting (pc/h)	697	973	148
Follow-Up Headway (s)	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	0	0	0
Ped Capacity Adjustment	1.000	1.000	1.000
Approach Delay (sec/veh)	8.7	7.3	8.0
Approach LOS	A	A	A

Lane	Left	Right	Left	Right	Left	Bypass
Designated moves	LT	TR	LT	TR	L	R
Assumed Moves	LT	TR	LT	TR	L	R
Right Turn Channelized						Yield
Lane Utilization	0.470	0.530	0.470	0.530	1.000	
Critical Headway (s)	4.293	4.113	4.293	4.113	4.113	
Entry Flow Rate (pc/h)	414	466	376	424	138	88
Capacity, Entry Lane (pc/h)	1002	1010	1075	1078	683	563
Entry HV Adjustment Factor	0.980	0.981	0.980	0.980	0.978	0.980
Flow Rate, Entry (vph)	406	457	368	416	135	86
Capacity, Entry (vph)	982	992	1053	1057	668	552
Volume to Capacity Ratio	0.413	0.461	0.350	0.393	0.202	0.156
Control Delay (sec/veh)	8.3	9.0	7.0	7.6	7.8	8.5
Level of Service	A	A	A	A	A	A
95th-Percentile Queue (veh)	2	2	2	2	1	1

HCM 2010 Roundabout
6: Radford Dr/Likini St & Salt Lake Blvd

7/11/2012

Intersection	
Intersection Delay (sec/veh)	18.9
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	2	2	2	1
Conflicting Circle Lanes	2	2	2	2
Adjusted Approach Flow (vph)	1064	1161	481	242
Demand Flow Rate (pc/h)	1085	1185	491	247
Vehicles Circulating (pc/h)	591	146	1233	1180
Vehicles Exiting (pc/h)	836	1578	443	151
Follow-Up Headway (s)	3.186	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	24	12	33	3
Ped Capacity Adjustment	0.988	0.988	1.000	1.000
Approach Delay (sec/veh)	22.3	11.8	29.5	17.1
Approach LOS	C	B	D	C

Lane	Left	Right	Left	Right	Left	Right	Left
Designated moves	LT	TR	LT	TR	LT	R	LTR
Assumed Moves	LT	TR	LT	TR	LT	R	LTR
Right Turn Channelized							
Lane Utilization	0.470	0.530	0.470	0.530	0.234	0.766	1.000
Critical Headway (s)	4.293	4.113	4.293	4.113	4.293	4.113	4.113
Entry Flow Rate (pc/h)	510	575	557	628	115	376	247
Capacity, Entry Lane (pc/h)	725	747	1013	1020	448	477	495
Entry HV Adjustment Factor	0.980	0.981	0.980	0.980	0.978	0.981	0.979
Flow Rate, Entry (vph)	500	564	546	616	112	369	242
Capacity, Entry (vph)	702	724	981	988	438	468	484
Volume to Capacity Ratio	0.712	0.779	0.557	0.623	0.257	0.789	0.499
Control Delay (sec/veh)	20.3	24.1	11.0	12.6	12.3	34.8	17.1
Level of Service	C	C	B	B	B	D	C
95th-Percentile Queue (veh)	6	8	4	5	1	7	3

Intersection						
Intersection Delay (sec/veh)	12.3					
Intersection LOS	B					

Approach		EB		WB		SB
Entry Lanes		2		2		1
Conflicting Circle Lanes		2		2		2
Adjusted Approach Flow (vph)		1466		1162		63
Demand Flow Rate (pc/h)		1495		1185		65
Vehicles Circulating (pc/h)		32		31		1174
Vehicles Exiting (pc/h)		1207		1496		42
Follow-Up Headway (s)		3.186		3.186		3.186
Ped Vol. Crossing Leg (#/hr)		13		13		13
Ped Capacity Adjustment		0.986		0.985		1.000
Approach Delay (sec/veh)		14.1		10.1		9.3
Approach LOS		B		B		A
Lane	Left	Right	Left	Right	Left	
Designated moves	LT	TR	LT	TR	LR	
Assumed Moves	LT	TR	LT	TR	LR	
Right Turn Channelized						
Lane Utilization	0.470	0.530	0.470	0.530	1.000	
Critical Headway (s)	4.293	4.113	4.293	4.113	4.113	
Entry Flow Rate (pc/h)	703	792	557	628	65	
Capacity, Entry Lane (pc/h)	1103	1105	1104	1106	497	
Entry HV Adjustment Factor	0.980	0.981	0.981	0.981	0.969	
Flow Rate, Entry (vph)	689	777	546	616	63	
Capacity, Entry (vph)	1066	1068	1067	1069	481	
Volume to Capacity Ratio	0.647	0.727	0.512	0.576	0.131	
Control Delay (sec/veh)	12.6	15.4	9.4	10.7	9.3	
Level of Service	B	C	A	B	A	
95th-Percentile Queue (veh)	5	7	3	4	0	

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2040 Double-Lane Roundabout PM

HCM 2010 Roundabout
5: Salt Lake Blvd & Wanaka St

7/11/2012

Intersection	
Intersection Delay (sec/veh)	9.9
Intersection LOS	A

Approach	EB	WB	SB
Entry Lanes	2	2	1
Conflicting Circle Lanes	2	2	2
Adjusted Approach Flow (vph)	684	1159	166
Demand Flow Rate (pc/h)	698	1182	169
Vehicles Circulating (pc/h)	111	145	1025
Vehicles Exiting (pc/h)	1083	664	302
Follow-Up Headway (s)	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	1	0	1
Ped Capacity Adjustment	0.999	1.000	1.000
Approach Delay (sec/veh)	7.0	11.5	11.1
Approach LOS	A	B	B

Lane	Left	Right	Left	Right	Left
Designated moves	LT	TR	LT	TR	LR
Assumed Moves	LT	TR	LT	TR	LR
Right Turn Channelized					
Lane Utilization	0.470	0.530	0.470	0.530	1.000
Critical Headway (s)	4.293	4.113	4.293	4.113	4.113
Entry Flow Rate (pc/h)	328	370	556	626	169
Capacity, Entry Lane (pc/h)	1040	1045	1014	1021	551
Entry HV Adjustment Factor	0.980	0.980	0.980	0.981	0.982
Flow Rate, Entry (vph)	321	362	545	614	166
Capacity, Entry (vph)	1018	1023	993	1002	542
Volume to Capacity Ratio	0.316	0.354	0.549	0.613	0.307
Control Delay (sec/veh)	6.7	7.2	10.7	12.2	11.1
Level of Service	A	A	B	B	B
95th-Percentile Queue (veh)	1	2	3	4	1

HCM 2010 Roundabout
6: Radford Dr/Likini St & Salt Lake Blvd

7/11/2012

Intersection	
Intersection Delay (sec/veh)	19.2
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	2	2	2	1
Conflicting Circle Lanes	2	2	2	2
Adjusted Approach Flow (vph)	709	1611	598	151
Demand Flow Rate (pc/h)	722	1643	610	154
Vehicles Circulating (pc/h)	504	168	753	1644
Vehicles Exiting (pc/h)	1294	1195	473	167
Follow-Up Headway (s)	3.186	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	8	2	6	4
Ped Capacity Adjustment	0.995	0.998	0.998	1.000
Approach Delay (sec/veh)	11.0	23.0	18.3	19.9
Approach LOS	B	C	C	C

Lane	Left	Right	Left	Right	Left	Right	Left
Designated moves	LT	TR	LT	TR	LT	R	LTR
Assumed Moves	LT	TR	LT	TR	LT	R	LTR
Right Turn Channelized							
Lane Utilization	0.470	0.530	0.470	0.530	0.228	0.772	1.000
Critical Headway (s)	4.293	4.113	4.293	4.113	4.293	4.113	4.113
Entry Flow Rate (pc/h)	339	383	772	871	139	471	154
Capacity, Entry Lane (pc/h)	774	794	996	1005	642	667	357
Entry HV Adjustment Factor	0.982	0.980	0.981	0.980	0.980	0.981	0.982
Flow Rate, Entry (vph)	333	375	757	854	136	462	151
Capacity, Entry (vph)	757	774	975	983	628	653	351
Volume to Capacity Ratio	0.440	0.485	0.777	0.869	0.217	0.707	0.431
Control Delay (sec/veh)	10.6	11.4	19.1	26.5	8.4	21.2	19.9
Level of Service	B	B	C	D	A	C	C
95th-Percentile Queue (veh)	2	3	8	12	1	6	2

Intersection						
Intersection Delay (sec/veh)	14.2					
Intersection LOS	B					

Approach		EB		WB		SB
Entry Lanes		2		2		1
Conflicting Circle Lanes		2		2		2
Adjusted Approach Flow (vph)		1164		1622		53
Demand Flow Rate (pc/h)		1187		1655		54
Vehicles Circulating (pc/h)		34		24		1619
Vehicles Exiting (pc/h)		1639		1197		60
Follow-Up Headway (s)		3.186		3.186		3.186
Ped Vol. Crossing Leg (#/hr)		14		14		14
Ped Capacity Adjustment		0.984		0.984		1.000
Approach Delay (sec/veh)		10.2		17.2		12.6
Approach LOS		B		C		B

Lane	Left	Right	Left	Right	Left
Designated moves	LT	TR	LT	TR	LR
Assumed Moves	LT	TR	LT	TR	LR
Right Turn Channelized					
Lane Utilization	0.470	0.530	0.470	0.530	1.000
Critical Headway (s)	4.293	4.113	4.293	4.113	4.113
Entry Flow Rate (pc/h)	558	629	778	877	54
Capacity, Entry Lane (pc/h)	1101	1103	1110	1111	364
Entry HV Adjustment Factor	0.980	0.981	0.980	0.981	0.981
Flow Rate, Entry (vph)	547	617	763	860	53
Capacity, Entry (vph)	1063	1065	1071	1072	357
Volume to Capacity Ratio	0.515	0.579	0.712	0.802	0.148
Control Delay (sec/veh)	9.5	10.8	14.8	19.3	12.6
Level of Service	A	B	B	C	B
95th-Percentile Queue (veh)	3	4	6	9	1

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2040 with Raised Median AM

Timings
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	135	650	530	150	570	245	210	140	440
Turn Type	Prot	NA	Perm	Prot	NA	Prot	NA	Prot	NA
Protected Phases	5	2		1	6	3	8	7	4
Permitted Phases			2						
Detector Phase	5	2	2	1	6	3	8	7	4
Switch Phase									
Minimum Initial (s)	5.0	20.0	20.0	5.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	34.0	34.0	10.0	34.0	10.0	33.0	10.0	33.0
Total Split (s)	26.0	61.0	61.0	30.0	65.0	32.0	36.0	33.0	37.0
Total Split (%)	16.3%	38.1%	38.1%	18.8%	40.6%	20.0%	22.5%	20.6%	23.1%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	5.0	6.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?									
Recall Mode	None	C-Max	C-Max	None	C-Max	None	None	None	None

Intersection Summary
Cycle Length: 160
Actuated Cycle Length: 160
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow, Master Intersection
Natural Cycle: 120
Control Type: Actuated-Coordinated

Splits and Phases: 1: Bouganville Dr & Salt Lake Blvd

HCM Signalized Intersection Capacity Analysis
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	135	650	530	150	570	110	245	210	55	140	440	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		3%			-3%			2%			-2%	
Total Lost time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91		0.97	1.00		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.66	1.00	0.96		1.00	0.96		1.00	0.92	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.97		1.00	0.96	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1743	3486	1035	1796	4765		3399	1711		1787	3177	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1743	3486	1035	1796	4765		3399	1711		1787	3177	
Peak-hour factor, PHF	0.73	0.87	0.79	0.50	0.78	0.45	0.90	0.74	0.71	0.77	0.78	0.77
Adj. Flow (vph)	185	747	671	300	731	244	272	284	77	182	564	182
RTOR Reduction (vph)	0	0	260	0	37	0	0	6	0	0	18	0
Lane Group Flow (vph)	185	747	411	300	938	0	272	355	0	182	728	0
Confl. Peds. (#/hr)			266			51			109			208
Turn Type	Prot	NA	Perm	Prot	NA		Prot	NA		Prot	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2									
Actuated Green, G (s)	19.3	55.0	55.0	25.0	60.7		17.2	38.4		20.6	41.8	
Effective Green, g (s)	19.3	55.0	55.0	25.0	60.7		17.2	38.4		20.6	41.8	
Actuated g/C Ratio	0.12	0.34	0.34	0.16	0.38		0.11	0.24		0.13	0.26	
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	5.0	5.0	2.0	5.0		2.0	3.0		2.0	3.0	
Lane Grp Cap (vph)	210	1198	356	281	1808		365	411		230	830	
v/s Ratio Prot	0.11	0.21		c0.17	0.20		0.08	0.21		c0.10	c0.23	
v/s Ratio Perm			c0.40									
v/c Ratio	0.88	0.62	1.15	1.07	0.52		0.75	0.86		0.79	0.88	
Uniform Delay, d1	69.2	43.9	52.5	67.5	38.4		69.3	58.3		67.6	56.6	
Progression Factor	1.00	1.00	1.00	0.87	0.64		1.00	1.00		1.00	1.00	
Incremental Delay, d2	31.4	2.5	96.8	72.1	1.0		7.1	16.9		15.8	10.4	
Delay (s)	100.6	46.3	149.3	130.9	25.5		76.3	75.2		83.4	67.0	
Level of Service	F	D	F	F	C		E	E		F	E	
Approach Delay (s)		95.7			50.3			75.7			70.2	
Approach LOS		F			D			E			E	

Intersection Summary			
HCM Average Control Delay	74.5	HCM Level of Service	E
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	86.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Timings
2: Lawehana St & Salt Lake Blvd

7/19/2012

Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Configurations					
Volume (vph)	740	60	795	80	105
Turn Type	NA	Prot	NA	NA	Perm
Protected Phases	2	1	6	4	
Permitted Phases					4
Detector Phase	2	1	6	4	4
Switch Phase					
Minimum Initial (s)	20.0	5.0	20.0	5.0	5.0
Minimum Split (s)	28.0	10.0	26.0	37.0	37.0
Total Split (s)	90.0	25.0	115.0	45.0	45.0
Total Split (%)	56.3%	15.6%	71.9%	28.1%	28.1%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	6.0	6.0
Lead/Lag	Lag	Lead			
Lead-Lag Optimize?					
Recall Mode	C-Max	None	C-Max	None	None

Intersection Summary
Cycle Length: 160
Actuated Cycle Length: 160
Offset: 34 (21%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 80
Control Type: Actuated-Coordinated

Splits and Phases: 2: Lawehana St & Salt Lake Blvd

HCM Signalized Intersection Capacity Analysis
2: Lawehana St & Salt Lake Blvd

7/19/2012

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	740	145	60	795	80	105
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	10	10
Grade (%)	-1%			-3%	-1%	
Total Lost time (s)	6.0		5.0	6.0	6.0	6.0
Lane Util. Factor	0.95		1.00	0.91	1.00	1.00
Frpb, ped/bikes	0.95		1.00	1.00	1.00	0.88
Flpb, ped/bikes	1.00		1.00	1.00	1.00	1.00
Frt	0.97		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	3285		1796	4129	1660	1305
Flt Permitted	1.00		0.95	1.00	0.95	1.00
Satd. Flow (perm)	3285		1796	4129	1660	1305
Peak-hour factor, PHF	0.82	0.72	0.52	0.77	0.64	0.66
Adj. Flow (vph)	902	201	115	1032	125	159
RTOR Reduction (vph)	8	0	0	0	0	142
Lane Group Flow (vph)	1095	0	115	1032	125	17
Confl. Peds. (#/hr)		72				72
Parking (#/hr)				100		
Turn Type	NA		Prot	NA	NA	Perm
Protected Phases	2		1	6	4	
Permitted Phases						4
Actuated Green, G (s)	111.1		14.5	130.6	17.4	17.4
Effective Green, g (s)	111.1		14.5	130.6	17.4	17.4
Actuated g/C Ratio	0.69		0.09	0.82	0.11	0.11
Clearance Time (s)	6.0		5.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0		2.0	5.0	3.0	3.0
Lane Grp Cap (vph)	2281		163	3370	181	142
v/s Ratio Prot	c0.33		c0.06	0.25	c0.08	
v/s Ratio Perm						0.01
v/c Ratio	0.48		0.71	0.31	0.69	0.12
Uniform Delay, d1	11.2		70.7	3.6	68.7	64.4
Progression Factor	0.37		0.90	2.11	1.00	1.00
Incremental Delay, d2	0.6		8.2	0.2	10.8	0.4
Delay (s)	4.7		72.0	7.8	79.5	64.8
Level of Service	A		E	A	E	E
Approach Delay (s)	4.7			14.2	71.3	
Approach LOS	A			B	E	

Intersection Summary			
HCM Average Control Delay	16.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	68.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

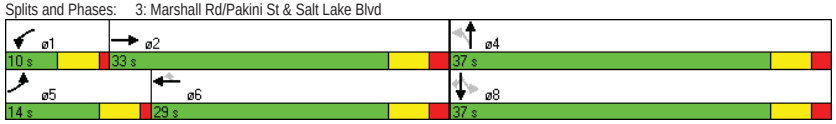
Timings
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT	SBR
Lane Configurations										
Volume (vph)	100	680	15	640	30	50	30	100	40	160
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	NA	Perm
Protected Phases	5	2	1	6			4		8	
Permitted Phases					6	4		8		8
Detector Phase	5	2	1	6	6	4	4	8	8	8
Switch Phase										
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	28.0	10.0	28.0	28.0	11.0	11.0	37.0	37.0	37.0
Total Split (s)	14.0	33.0	10.0	29.0	29.0	37.0	37.0	37.0	37.0	37.0
Total Split (%)	17.5%	41.3%	12.5%	36.3%	36.3%	46.3%	46.3%	46.3%	46.3%	46.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0		0.0	0.0
Total Lost Time (s)	5.0	6.0	5.0	6.0	6.0		6.0		6.0	6.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag					
Lead-Lag Optimize?										
Recall Mode	None	C-Max	None	C-Max	C-Max	None	None	None	None	None

Intersection Summary
Cycle Length: 80
Actuated Cycle Length: 80
Offset: 27 (34%), Referenced to phase 2:EBT and 6:WBT, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated

Splits and Phases: 3: Marshall Rd/Pakini St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	100	680	65	15	640	30	50	30	10	100	40	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			1%			-4%	
Total Lost time (s)	5.0	6.0		5.0	6.0	6.0		6.0			6.0	6.0
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00			1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.95		1.00			1.00	0.96
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00		0.99			1.00	1.00
Frt	1.00	0.99		1.00	1.00	0.85		0.98			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.97			0.96	1.00
Satd. Flow (prot)	1787	3510		1787	2502	1513		1764			1825	1553
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.70			0.74	1.00
Satd. Flow (perm)	1787	3510		1787	2502	1513		1270			1407	1553
Peak-hour factor, PHF	0.70	0.91	0.92	0.42	0.74	0.71	0.92	0.92	0.92	0.56	0.92	0.83
Adj. Flow (vph)	143	747	71	36	865	42	54	33	11	179	43	193
RTOR Reduction (vph)	0	6	0	0	0	24	0	7	0	0	0	145
Lane Group Flow (vph)	143	812	0	36	865	18	0	91	0	0	222	48
Confl. Peds. (#/hr)			21			19	17		5	1		35
Parking (#/hr)					100				0			
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		8
Actuated Green, G (s)	8.5	40.2		3.0	34.7	34.7		19.8			19.8	19.8
Effective Green, g (s)	8.5	40.2		3.0	34.7	34.7		19.8			19.8	19.8
Actuated g/C Ratio	0.11	0.50		0.04	0.43	0.43		0.25			0.25	0.25
Clearance Time (s)	5.0	6.0		5.0	6.0	6.0		6.0			6.0	6.0
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0		3.0			3.0	3.0
Lane Grp Cap (vph)	190	1764		67	1085	656		314			348	384
v/s Ratio Prot	c0.08	0.23		0.02	c0.35							
v/s Ratio Perm						0.01		0.07			c0.16	0.03
v/c Ratio	0.75	0.46		0.54	0.80	0.03		0.29			0.64	0.12
Uniform Delay, d1	34.7	12.9		37.8	19.6	13.0		24.4			26.9	23.4
Progression Factor	1.13	1.57		1.00	1.00	1.00		1.00			1.00	1.00
Incremental Delay, d2	12.6	0.8		4.1	6.1	0.1		0.5			3.8	0.1
Delay (s)	51.9	21.0		41.9	25.7	13.1		24.9			30.7	23.5
Level of Service	D	C		D	C	B		C			C	C
Approach Delay (s)		25.6			25.8			24.9			27.4	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	25.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	60.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

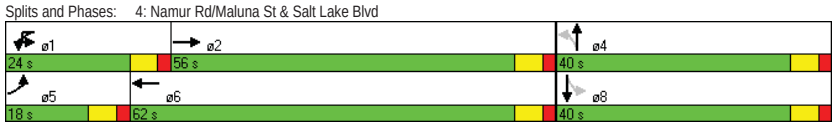
Timings
4: Namur Rd/Maluna St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Volume (vph)	35	620	65	585	50	30	65	40
Turn Type	Prot	NA	Prot	NA	Perm	NA	Perm	NA
Protected Phases	5	2	1	6		4		8
Permitted Phases					4		8	
Detector Phase	5	2	1	6	4	4	8	8
Switch Phase								
Minimum Initial (s)	5.0	20.0	5.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	11.0	26.0	11.0	26.0	11.0	11.0	40.0	40.0
Total Split (s)	18.0	56.0	24.0	62.0	40.0	40.0	40.0	40.0
Total Split (%)	15.0%	46.7%	20.0%	51.7%	33.3%	33.3%	33.3%	33.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0		6.0
Lead/Lag	Lead	Lag	Lead	Lag				
Lead-Lag Optimize?								
Recall Mode	None	Min	None	Min	None	None	None	None

Intersection Summary
Cycle Length: 120
Actuated Cycle Length: 85.1
Natural Cycle: 80
Control Type: Actuated-Uncoordinated

Splits and Phases: 4: Namur Rd/Maluna St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
4: Namur Rd/Maluna St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Volume (vph)	35	620	65	10	65	585	30	50	30	25	65	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		7%				-6%			0%			-12%
Total Lost time (s)	6.0	6.0			6.0	6.0		6.0	6.0			6.0
Lane Util. Factor	1.00	0.95			1.00	0.95		1.00	1.00			1.00
Frpb, ped/bikes	1.00	0.99			1.00	1.00		1.00	0.99			0.99
Flpb, ped/bikes	1.00	1.00			1.00	1.00		0.99	1.00			1.00
Frt	1.00	0.98			1.00	0.99		1.00	0.93			0.95
Flt Protected	0.95	1.00			0.95	1.00		0.95	1.00			0.98
Satd. Flow (prot)	1708	3338			1823	2533		1759	1703			1837
Flt Permitted	0.95	1.00			0.95	1.00		0.52	1.00			0.85
Satd. Flow (perm)	1708	3338			1823	2533		961	1703			1596
Peak-hour factor, PHF	0.89	0.81	0.73	0.92	0.66	0.80	0.79	0.81	0.65	0.56	0.82	0.52
Adj. Flow (vph)	39	765	89	11	98	731	38	62	46	45	79	77
RTOR Reduction (vph)	0	7	0	0	0	3	0	0	32	0	0	17
Lane Group Flow (vph)	39	847	0	0	109	766	0	62	59	0	0	222
Confl. Peds. (#/hr)			23					13		10		
Parking (#/hr)						100						
Turn Type	Prot	NA		Prot	Prot	NA		Perm	NA		Perm	NA
Protected Phases	5	2		1	1	6			4			8
Permitted Phases								4			8	
Actuated Green, G (s)	4.1	41.5			8.2	45.6		19.0	19.0			19.0
Effective Green, g (s)	4.1	41.5			8.2	45.6		19.0	19.0			19.0
Actuated g/C Ratio	0.05	0.48			0.09	0.53		0.22	0.22			0.22
Clearance Time (s)	6.0	6.0			6.0	6.0		6.0	6.0			6.0
Vehicle Extension (s)	2.0	5.0			2.0	5.0		3.0	3.0			3.0
Lane Grp Cap (vph)	81	1598			172	1332		211	373			350
v/s Ratio Prot	0.02	0.25			c0.06	c0.30			0.03			
v/s Ratio Perm								0.06				c0.14
v/c Ratio	0.48	0.53			0.63	0.58		0.29	0.16			0.63
Uniform Delay, d1	40.3	15.8			37.8	14.0		28.3	27.4			30.7
Progression Factor	1.00	1.00			1.00	1.00		1.00	1.00			1.00
Incremental Delay, d2	1.6	0.6			5.5	1.0		0.8	0.2			3.7
Delay (s)	41.9	16.4			43.3	14.9		29.0	27.6			34.4
Level of Service	D	B			D	B		C	C			C
Approach Delay (s)		17.5				18.5			28.2			34.4
Approach LOS		B				B			C			C

Intersection Summary			
HCM Average Control Delay	20.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	86.7	Sum of lost time (s)	18.0
Intersection Capacity Utilization	59.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR
Lane Configurations	
Volume (vph)	60
Ideal Flow (vphpl)	1900
Grade (%)	
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.72
Adj. Flow (vph)	83
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	13
Parking (#/hr)	
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Lane Group	EBL	EBT	WBU	WBT	SBL	SBR
Lane Configurations						
Volume (vph)	40	685	20	610	115	70
Turn Type	Prot	NA	Prot	NA	NA	Perm
Protected Phases	5	2	1	6	4	
Permitted Phases						4
Detector Phase	5	2	1	6	4	4
Switch Phase						
Minimum Initial (s)	4.0	25.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	30.0	9.0	21.0	31.0	31.0
Total Split (s)	12.0	45.0	14.0	47.0	31.0	31.0
Total Split (%)	13.3%	50.0%	15.6%	52.2%	34.4%	34.4%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead	Lag	Lead	Lag		
Lead-Lag Optimize?						
Recall Mode	None	Min	Min	None	None	None

Intersection Summary

Cycle Length: 90
Actuated Cycle Length: 60.2
Natural Cycle: 70
Control Type: Actuated-Uncoordinated

Splits and Phases: 5: Salt Lake Blvd & Wanaka St

HCM Signalized Intersection Capacity Analysis
5: Salt Lake Blvd & Wanaka St

7/19/2012

Movement	EBU	EBL	EBT	WBU	WBT	WBR	SBL	SBR
Lane Configurations								
Volume (vph)	5	40	685	20	610	65	115	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	10	10	12	10	12	10	10
Grade (%)			0%		1%		-8%	
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor		1.00	0.95	1.00	0.95		1.00	1.00
Frt		1.00	1.00	1.00	0.98		1.00	0.85
Flt Protected		0.95	1.00	0.95	1.00		0.95	1.00
Satd. Flow (prot)		1652	3303	1761	2263		1718	1537
Flt Permitted		0.95	1.00	0.95	1.00		0.95	1.00
Satd. Flow (perm)		1652	3303	1761	2263		1718	1537
Peak-hour factor, PHF	0.92	0.66	0.86	0.92	0.90	0.77	0.85	0.81
Adj. Flow (vph)	5	61	797	22	678	84	135	86
RTOR Reduction (vph)	0	0	0	0	9	0	0	73
Lane Group Flow (vph)	0	66	797	22	753	0	135	13
Parking (#/hr)					100			
Turn Type	Prot	Prot	NA	Prot	NA		NA	Perm
Protected Phases	5	5	2	1	6		4	
Permitted Phases								4
Actuated Green, G (s)		4.0	30.1	7.5	33.6		9.7	9.7
Effective Green, g (s)		4.0	30.1	7.5	33.6		9.7	9.7
Actuated g/C Ratio		0.06	0.48	0.12	0.54		0.16	0.16
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)		3.0	4.0	4.0	3.0		2.2	2.2
Lane Grp Cap (vph)		106	1596	212	1220		267	239
v/s Ratio Prot		c0.04	0.24	0.01	c0.33		c0.08	
v/s Ratio Perm								0.01
v/c Ratio		0.62	0.50	0.10	0.62		0.51	0.06
Uniform Delay, d1		28.4	11.0	24.4	9.9		24.1	22.4
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2		10.9	0.3	0.3	0.9		0.8	0.1
Delay (s)		39.3	11.3	24.7	10.8		24.9	22.5
Level of Service		D	B	C	B		C	C
Approach Delay (s)			13.4		11.2		23.9	
Approach LOS			B		B		C	

Intersection Summary			
HCM Average Control Delay	13.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	62.3	Sum of lost time (s)	15.0
Intersection Capacity Utilization	43.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

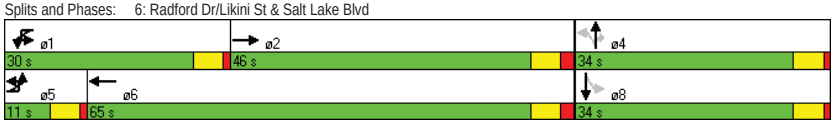
Timings
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Configurations									
Volume (vph)	5	805	290	605	50	10	295	110	45
Turn Type	Prot	NA	Prot	NA	Perm	NA	Perm	Perm	NA
Protected Phases	5	2	1	6		4			8
Permitted Phases					4		4	8	
Detector Phase	5	2	1	6	4	4	4	8	8
Switch Phase									
Minimum Initial (s)	4.0	5.0	4.0	5.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	46.0	9.0	46.0	9.0	9.0	9.0	34.0	34.0
Total Split (s)	11.0	46.0	30.0	65.0	34.0	34.0	34.0	34.0	34.0
Total Split (%)	10.0%	41.8%	27.3%	59.1%	30.9%	30.9%	30.9%	30.9%	30.9%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0		0.0	0.0		0.0
Total Lost Time (s)	5.0	6.0	5.0	6.0		5.0	5.0		5.0
Lead/Lag	Lead	Lag	Lead	Lag					
Lead-Lag Optimize?									
Recall Mode	None	C-Max	None	C-Max	None	None	None	None	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 100
Control Type: Actuated-Coordinated

Splits and Phases: 6: Radford Dr/Likini St & Salt Lake Blvd



Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Volume (vph)	10	5	805	25	25	290	605	90	50	10	295	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)			1%				-2%			2%		
Total Lost time (s)		5.0	6.0			5.0	6.0			5.0	5.0	
Lane Util. Factor		1.00	0.95			1.00	0.95			1.00	1.00	
Frpb, ped/bikes		1.00	1.00			1.00	1.00			1.00	0.97	
Flpb, ped/bikes		1.00	1.00			1.00	1.00			0.99	1.00	
Frt		1.00	0.99			1.00	0.98			1.00	0.85	
Flt Protected		0.95	1.00			0.95	1.00			0.96	1.00	
Satd. Flow (prot)		1761	3493			1787	3495			1758	1523	
Flt Permitted		0.95	1.00			0.95	1.00			0.67	1.00	
Satd. Flow (perm)		1761	3493			1787	3495			1224	1523	
Peak-hour factor, PHF	0.92	0.25	0.81	0.64	0.92	0.86	0.87	0.88	0.58	0.38	0.80	0.70
Adj. Flow (vph)	11	20	994	39	27	337	695	102	86	26	369	157
RTOR Reduction (vph)	0	0	2	0	0	0	9	0	0	0	226	0
Lane Group Flow (vph)	0	31	1031	0	0	364	788	0	0	112	143	0
Confl. Peds. (#/hr)		3		33		12		3	21		12	
Turn Type	Prot	Prot	NA		Prot	Prot	NA		Perm	NA	Perm	Perm
Protected Phases	5	5	2		1	1	6			4		
Permitted Phases									4		4	8
Actuated Green, G (s)		4.1	45.1			25.6	66.6			23.3	23.3	
Effective Green, g (s)		4.1	45.1			25.6	66.6			23.3	23.3	
Actuated g/C Ratio		0.04	0.41			0.23	0.61			0.21	0.21	
Clearance Time (s)		5.0	6.0			5.0	6.0			5.0	5.0	
Vehicle Extension (s)		3.0	5.0			3.0	5.0			3.0	3.0	
Lane Grp Cap (vph)		66	1432			416	2116			259	323	
v/s Ratio Prot		0.02	c0.30			c0.20	0.23					
v/s Ratio Perm										0.09	0.09	
v/c Ratio		0.47	0.72			0.88	0.37			0.43	0.44	
Uniform Delay, d1		51.9	27.2			40.7	11.1			37.6	37.7	
Progression Factor		1.00	1.00			1.00	1.00			1.00	1.00	
Incremental Delay, d2		5.2	3.1			18.1	0.5			1.2	1.0	
Delay (s)		57.1	30.3			58.8	11.6			38.8	38.7	
Level of Service		E	C			E	B			D	D	
Approach Delay (s)			31.1				26.4			38.7		
Approach LOS			C				C			D		

Intersection Summary			
HCM Average Control Delay	32.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	105.4%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	SBT	SBR
Lane Configurations		
Volume (vph)	45	15
Ideal Flow (vphpl)	1900	1900
Grade (%)	-6%	
Total Lost time (s)	5.0	
Lane Util. Factor	1.00	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.98	
Flt Protected	0.97	
Satd. Flow (prot)	1822	
Flt Permitted	0.71	
Satd. Flow (perm)	1342	
Peak-hour factor, PHF	0.78	0.56
Adj. Flow (vph)	58	27
RTOR Reduction (vph)	5	0
Lane Group Flow (vph)	237	0
Confl. Peds. (#/hr)		24
Turn Type	NA	
Protected Phases	8	
Permitted Phases		
Actuated Green, G (s)	23.3	
Effective Green, g (s)	23.3	
Actuated g/C Ratio	0.21	
Clearance Time (s)	5.0	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	284	
v/s Ratio Prot		
v/s Ratio Perm	c0.18	
v/c Ratio	0.84	
Uniform Delay, d1	41.5	
Progression Factor	1.00	
Incremental Delay, d2	18.7	
Delay (s)	60.2	
Level of Service	E	
Approach Delay (s)	60.2	
Approach LOS	E	

Intersection Summary

Timings
7: Salt Lake Blvd & Kahikolu Pl

7/19/2012

Lane Group	EBL	EBT	WBT	SBL
Lane Configurations				
Volume (vph)	5	1220	1060	20
Turn Type	Prot	NA	NA	NA
Protected Phases	1	6	2	8
Permitted Phases				
Detector Phase	1	6	2	8
Switch Phase				
Minimum Initial (s)	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	10.0	25.0	32.0
Total Split (s)	13.0	78.0	65.0	32.0
Total Split (%)	11.8%	70.9%	59.1%	29.1%
Yellow Time (s)	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	5.0
Lead/Lag	Lead		Lag	
Lead-Lag Optimize?	Yes		Yes	
Recall Mode	None	Min	Min	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 57.2
Natural Cycle: 70
Control Type: Actuated-Uncoordinated

Splits and Phases: 7: Salt Lake Blvd & Kahikolu Pl

HCM Signalized Intersection Capacity Analysis
7: Salt Lake Blvd & Kahikolu Pl

7/19/2012

Movement	EBU	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations							
Volume (vph)	10	5	1220	1060	15	20	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900
Grade (%)			0%	-2%		0%	
Total Lost time (s)		5.0	6.0	6.0		5.0	
Lane Util. Factor		1.00	0.95	0.95		1.00	
Frpb, ped/bikes		1.00	1.00	1.00		0.99	
Flpb, ped/bikes		1.00	1.00	1.00		1.00	
Frt		1.00	1.00	1.00		0.93	
Flt Protected		0.95	1.00	1.00		0.98	
Satd. Flow (prot)		1770	3539	3562		1676	
Flt Permitted		0.95	1.00	1.00		0.98	
Satd. Flow (perm)		1770	3539	3562		1676	
Peak-hour factor, PHF	0.92	0.25	0.85	0.93	0.69	0.65	0.31
Adj. Flow (vph)	11	20	1435	1140	22	31	32
RTOR Reduction (vph)	0	0	0	1	0	29	0
Lane Group Flow (vph)	0	31	1435	1161	0	34	0
Confl. Peds. (#/hr)		13			13	13	13
Turn Type	Prot	Prot	NA	NA		NA	
Protected Phases	1	1	6	2		8	
Permitted Phases							
Actuated Green, G (s)		2.6	45.0	37.4		5.5	
Effective Green, g (s)		2.6	45.0	37.4		5.5	
Actuated g/C Ratio		0.04	0.73	0.61		0.09	
Clearance Time (s)		5.0	6.0	6.0		5.0	
Vehicle Extension (s)		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)		75	2590	2166		150	
v/s Ratio Prot		0.02	c0.41	0.33		c0.02	
v/s Ratio Perm							
v/c Ratio		0.41	0.55	0.54		0.23	
Uniform Delay, d1		28.7	3.7	7.0		26.0	
Progression Factor		1.00	1.00	1.00		1.00	
Incremental Delay, d2		3.7	0.3	0.3		0.8	
Delay (s)		32.4	4.0	7.3		26.8	
Level of Service		C	A	A		C	
Approach Delay (s)			4.6	7.3		26.8	
Approach LOS			A	A		C	

Intersection Summary			
HCM Average Control Delay	6.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	61.5	Sum of lost time (s)	11.0
Intersection Capacity Utilization	53.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
8: Salt Lake Blvd & Shopping Center Entrance 1

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	75	1115	960	20	0	35
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.88	0.88	0.87	0.75	0.25	0.65
Hourly flow rate (vph)	85	1267	1103	27	0	54
Pedestrians		1	1		1	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		354	553			
pX, platoon unblocked	0.89				0.89	0.89
vC, conflicting volume	1131				1923	567
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	900				1231	267
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	87				100	92
cM capacity (veh/h)	667				131	650

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	SB 1
Volume Total	85	634	634	736	394	54
Volume Left	85	0	0	0	0	0
Volume Right	0	0	0	0	27	54
cSH	667	1700	1700	1700	1700	650
Volume to Capacity	0.13	0.37	0.37	0.43	0.23	0.08
Queue Length 95th (ft)	11	0	0	0	0	7
Control Delay (s)	11.2	0.0	0.0	0.0	0.0	11.0
Lane LOS	B					B
Approach Delay (s)	0.7			0.0		11.0
Approach LOS						B

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	45.0%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
9: Aliamanu School /Shopping Center Entrance 2 & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	940	260	0	910	45	0	0	230	0	0	70
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.96	0.68	0.92	0.94	0.75	0.92	0.92	0.64	0.92	0.92	0.87
Hourly flow rate (vph)	0	979	382	0	968	60	0	0	359	0	0	80
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		571			336							
pX, platoon unblocked	0.87			0.86			0.92	0.92	0.86	0.92	0.92	0.87
vC, conflicting volume	1028			979			1735	2198	681	1488	1977	514
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	742			647			1010	1512	300	742	1272	153
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	40	100	100	89
cM capacity (veh/h)	752			803			160	110	598	112	153	756

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	653	709	645	383	359	80
Volume Left	0	0	0	0	0	0
Volume Right	0	382	0	60	359	80
cSH	1700	1700	1700	1700	598	756
Volume to Capacity	0.38	0.42	0.38	0.23	0.60	0.11
Queue Length 95th (ft)	0	0	0	0	100	9
Control Delay (s)	0.0	0.0	0.0	0.0	19.7	10.3
Lane LOS					C	B
Approach Delay (s)	0.0		0.0		19.7	10.3
Approach LOS					C	B

Intersection Summary			
Average Delay	2.8		
Intersection Capacity Utilization	55.2%	ICU Level of Service	B
Analysis Period (min)	15		

Timings
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	265	870	530	325	905	425
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	20.0	20.0	20.0	6.0	6.0
Minimum Split (s)	10.0	26.0	29.0	29.0	35.0	35.0
Total Split (s)	34.0	67.0	33.0	33.0	43.0	43.0
Total Split (%)	30.9%	60.9%	30.0%	30.0%	39.1%	39.1%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	C-Max	C-Max	C-Max	None	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow, Master Intersection
Natural Cycle: 80
Control Type: Actuated-Coordinated

Splits and Phases: 10: Salt Lake Blvd & Ala Lilikoi St

HCM Signalized Intersection Capacity Analysis
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	265	870	530	325	905	425
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lane Util. Factor	1.00	0.91	0.95	1.00	0.97	1.00
Frpb, ped/bikes	1.00	1.00	1.00	0.84	1.00	0.75
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	5085	3539	1337	3433	1189
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	5085	3539	1337	3433	1189
Peak-hour factor, PHF	0.77	0.92	0.94	0.73	0.91	0.82
Adj. Flow (vph)	344	946	564	445	995	518
RTOR Reduction (vph)	0	0	0	318	0	343
Lane Group Flow (vph)	344	946	564	127	995	175
Confl. Peds. (#/hr)				102		220
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Actuated Green, G (s)	25.3	61.8	31.5	31.5	37.2	37.2
Effective Green, g (s)	25.3	61.8	31.5	31.5	37.2	37.2
Actuated g/C Ratio	0.23	0.56	0.29	0.29	0.34	0.34
Clearance Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Vehicle Extension (s)	3.0	4.0	4.0	4.0	3.0	3.0
Lane Grp Cap (vph)	407	2857	1013	383	1161	402
v/s Ratio Prot	c0.19	0.19	c0.16		c0.29	
v/s Ratio Perm				0.10		0.15
v/c Ratio	0.85	0.33	0.56	0.33	0.86	0.44
Uniform Delay, d1	40.5	13.0	33.3	31.0	33.9	28.3
Progression Factor	1.00	1.00	0.71	0.98	1.00	1.00
Incremental Delay, d2	14.8	0.3	2.1	2.2	6.4	0.8
Delay (s)	55.3	13.3	25.6	32.5	40.3	29.0
Level of Service	E	B	C	C	D	C
Approach Delay (s)		24.5	28.7		36.5	
Approach LOS		C	C		D	

Intersection Summary			
HCM Average Control Delay	30.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	73.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Timings
11: Arizona Rd & Salt Lake Blvd

7/19/2012

Lane Group	EBT	WBL	WBT	NBL
Lane Configurations				
Volume (vph)	1320	165	565	250
Turn Type	NA	Prot	NA	NA
Protected Phases	2	1	6	4
Permitted Phases				
Detector Phase	2	1	6	4
Switch Phase				
Minimum Initial (s)	20.0	5.0	20.0	5.0
Minimum Split (s)	28.0	10.0	26.0	34.0
Total Split (s)	53.0	23.0	76.0	34.0
Total Split (%)	48.2%	20.9%	69.1%	30.9%
Yellow Time (s)	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	5.0
Lead/Lag	Lag	Lead		
Lead-Lag Optimize?				
Recall Mode	C-Max	None	C-Max	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 48 (44%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 100
Control Type: Actuated-Coordinated

Splits and Phases: 11: Arizona Rd & Salt Lake Blvd

HCM Signalized Intersection Capacity Analysis
11: Arizona Rd & Salt Lake Blvd

7/19/2012

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	1320	505	165	565	250	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	10	12	12	12
Grade (%)	8%			-10%	-2%	
Total Lost time (s)	6.0		5.0	6.0	5.0	
Lane Util. Factor	0.91		1.00	0.95	0.97	
Frpb, ped/bikes	0.99		1.00	1.00	1.00	
Flpb, ped/bikes	1.00		1.00	1.00	1.00	
Frt	0.95		1.00	1.00	0.97	
Flt Protected	1.00		0.95	1.00	0.96	
Satd. Flow (prot)	4618		1734	3716	3394	
Flt Permitted	1.00		0.95	1.00	0.96	
Satd. Flow (perm)	4618		1734	3716	3394	
Peak-hour factor, PHF	0.91	0.80	0.62	0.93	0.60	0.49
Adj. Flow (vph)	1451	631	266	608	417	102
RTOR Reduction (vph)	67	0	0	0	22	0
Lane Group Flow (vph)	2015	0	266	608	497	0
Confl. Peds. (#/hr)		4				5
Turn Type	NA		Prot	NA	NA	
Protected Phases	2		1	6	4	
Permitted Phases						
Actuated Green, G (s)	50.8		21.1	76.9	22.1	
Effective Green, g (s)	50.8		21.1	76.9	22.1	
Actuated g/C Ratio	0.46		0.19	0.70	0.20	
Clearance Time (s)	6.0		5.0	6.0	5.0	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)	2133		333	2598	682	
v/s Ratio Prot	c0.44		c0.15	0.16	c0.15	
v/s Ratio Perm						
v/c Ratio	0.94		0.80	0.23	0.73	
Uniform Delay, d1	28.3		42.4	6.0	41.1	
Progression Factor	0.89		1.00	1.00	1.00	
Incremental Delay, d2	8.9		12.6	0.2	3.9	
Delay (s)	34.0		55.0	6.2	45.1	
Level of Service	C		D	A	D	
Approach Delay (s)	34.0			21.0	45.1	
Approach LOS	C			C	D	

Intersection Summary			
HCM Average Control Delay	32.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	70.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2040 with Raised Median PM

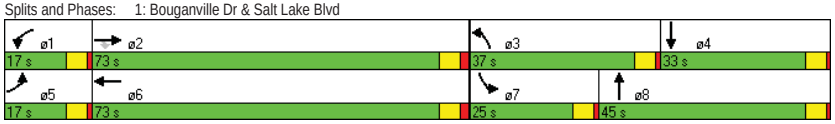
Timings
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	75	685	305	45	1025	560	355	80	215
Turn Type	Prot	NA	Perm	Prot	NA	Prot	NA	Prot	NA
Protected Phases	5	2		1	6	3	8	7	4
Permitted Phases			2						
Detector Phase	5	2	2	1	6	3	8	7	4
Switch Phase									
Minimum Initial (s)	5.0	20.0	20.0	5.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	34.0	34.0	10.0	34.0	10.0	33.0	10.0	33.0
Total Split (s)	17.0	73.0	73.0	17.0	73.0	37.0	45.0	25.0	33.0
Total Split (%)	10.6%	45.6%	45.6%	10.6%	45.6%	23.1%	28.1%	15.6%	20.6%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	5.0	6.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?									
Recall Mode	None	C-Max	C-Max	None	C-Max	None	None	None	None

Intersection Summary
Cycle Length: 160
Actuated Cycle Length: 160
Offset: 129 (81%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 90
Control Type: Actuated-Coordinated

Splits and Phases: 1: Bouganville Dr & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	75	685	305	45	1025	165	560	355	45	80	215	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		3%			-3%			2%			-2%	
Total Lost time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91		0.97	1.00		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.95	1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.98		1.00	0.96	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1743	3486	1478	1796	5007		3399	1796		1787	3381	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1743	3486	1478	1796	5007		3399	1796		1787	3381	
Peak-hour factor, PHF	0.82	0.83	0.92	0.83	0.94	0.80	0.95	0.88	0.67	0.85	0.74	0.86
Adj. Flow (vph)	91	825	332	54	1090	206	589	403	67	94	291	116
RTOR Reduction (vph)	0	0	181	0	17	0	0	4	0	0	26	0
Lane Group Flow (vph)	91	825	151	54	1279	0	589	466	0	94	381	0
Confl. Peds. (#/hr)			24			7			13			18
Turn Type	Prot	NA	Perm	Prot	NA		Prot	NA		Prot	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2									
Actuated Green, G (s)	11.0	71.1	71.1	7.9	68.0		30.3	47.2		12.8	29.7	
Effective Green, g (s)	11.0	71.1	71.1	7.9	68.0		30.3	47.2		12.8	29.7	
Actuated g/C Ratio	0.07	0.44	0.44	0.05	0.42		0.19	0.30		0.08	0.19	
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	5.0	5.0	2.0	5.0		2.0	3.0		2.0	3.0	
Lane Grp Cap (vph)	120	1549	657	89	2128		644	530		143	628	
v/s Ratio Prot	c0.05	c0.24		0.03	c0.26		c0.17	c0.26		0.05	0.11	
v/s Ratio Perm			0.10									
v/c Ratio	0.76	0.53	0.23	0.61	0.60		0.91	0.88		0.66	0.61	
Uniform Delay, d1	73.2	32.4	27.5	74.5	35.5		63.6	53.7		71.5	59.8	
Progression Factor	1.00	1.00	1.00	0.88	0.78		1.00	1.00		1.00	1.00	
Incremental Delay, d2	21.3	1.3	0.8	7.4	1.2		17.3	15.6		8.0	1.7	
Delay (s)	94.5	33.7	28.3	73.1	28.8		80.9	69.3		79.5	61.5	
Level of Service	F	C	C	E	C		F	E		E	E	
Approach Delay (s)		36.7			30.6			75.8			64.8	
Approach LOS		D			C			E			E	

Intersection Summary			
HCM Average Control Delay	48.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	77.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Timings
2: Lawehana St & Salt Lake Blvd

7/19/2012

Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Configurations					
Volume (vph)	650	95	990	215	140
Turn Type	NA	Prot	NA	NA	Perm
Protected Phases	2	1	6	4	
Permitted Phases					4
Detector Phase	2	1	6	4	4
Switch Phase					
Minimum Initial (s)	20.0	5.0	20.0	5.0	5.0
Minimum Split (s)	28.0	10.0	26.0	37.0	37.0
Total Split (s)	75.0	29.0	104.0	56.0	56.0
Total Split (%)	46.9%	18.1%	65.0%	35.0%	35.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	6.0	6.0
Lead/Lag	Lag	Lead			
Lead-Lag Optimize?					
Recall Mode	C-Max	None	C-Max	None	None

Intersection Summary
Cycle Length: 160
Actuated Cycle Length: 160
Offset: 141 (88%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated

Splits and Phases: 2: Lawehana St & Salt Lake Blvd

HCM Signalized Intersection Capacity Analysis
2: Lawehana St & Salt Lake Blvd

7/19/2012

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	650	135	95	990	215	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	10	10
Grade (%)	-1%			-3%	-1%	
Total Lost time (s)	6.0		5.0	6.0	6.0	6.0
Lane Util. Factor	0.95		1.00	0.91	1.00	1.00
Frpb, ped/bikes	0.99		1.00	1.00	1.00	0.97
Flpb, ped/bikes	1.00		1.00	1.00	1.00	1.00
Frt	0.97		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	3429		1796	4129	1660	1440
Flt Permitted	1.00		0.95	1.00	0.95	1.00
Satd. Flow (perm)	3429		1796	4129	1660	1440
Peak-hour factor, PHF	0.88	0.82	0.80	0.95	0.80	0.82
Adj. Flow (vph)	739	165	119	1042	269	171
RTOR Reduction (vph)	8	0	0	0	0	137
Lane Group Flow (vph)	896	0	119	1042	269	34
Confl. Peds. (#/hr)		8				12
Parking (#/hr)				100		
Turn Type	NA		Prot	NA	NA	Perm
Protected Phases	2		1	6	4	
Permitted Phases						4
Actuated Green, G (s)	96.5		15.0	116.5	31.5	31.5
Effective Green, g (s)	96.5		15.0	116.5	31.5	31.5
Actuated g/C Ratio	0.60		0.09	0.73	0.20	0.20
Clearance Time (s)	6.0		5.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0		2.0	5.0	3.0	3.0
Lane Grp Cap (vph)	2068		168	3006	327	284
v/s Ratio Prot	c0.26		c0.07	0.25	c0.16	
v/s Ratio Perm						0.02
v/c Ratio	0.43		0.71	0.35	0.82	0.12
Uniform Delay, d1	17.1		70.4	7.9	61.6	52.8
Progression Factor	0.37		0.86	1.01	1.00	1.00
Incremental Delay, d2	0.6		7.2	0.2	15.3	0.2
Delay (s)	7.0		68.0	8.2	76.8	53.0
Level of Service	A		E	A	E	D
Approach Delay (s)	7.0			14.4	67.6	
Approach LOS	A			B	E	

Intersection Summary			
HCM Average Control Delay	21.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	58.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

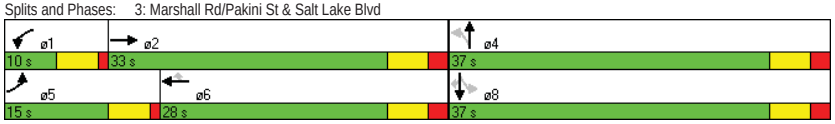
Timings
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT	SBR
Lane Configurations										
Volume (vph)	170	580	5	960	45	85	30	35	10	150
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	NA	Perm
Protected Phases	5	2	1	6			4		8	
Permitted Phases					6	4		8		8
Detector Phase	5	2	1	6	6	4	4	8	8	8
Switch Phase										
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	28.0	10.0	28.0	28.0	11.0	11.0	37.0	37.0	37.0
Total Split (s)	15.0	33.0	10.0	28.0	28.0	37.0	37.0	37.0	37.0	37.0
Total Split (%)	18.8%	41.3%	12.5%	35.0%	35.0%	46.3%	46.3%	46.3%	46.3%	46.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0		0.0	0.0
Total Lost Time (s)	5.0	6.0	5.0	6.0	6.0		6.0		6.0	6.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag					
Lead-Lag Optimize?										
Recall Mode	None	C-Max	None	C-Max	C-Max	None	None	None	None	None

Intersection Summary
Cycle Length: 80
Actuated Cycle Length: 80
Offset: 78 (98%), Referenced to phase 2:EBT and 6:WBT, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated

Splits and Phases: 3: Marshall Rd/Pakini St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	580	35	5	960	45	85	30	5	35	10	150
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			1%			-4%	
Total Lost time (s)	5.0	6.0		5.0	6.0	6.0		6.0			6.0	6.0
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00			1.00	1.00
Frpb, ped/bikes	1.00	0.99		1.00	1.00	0.98		1.00			1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00		1.00			1.00	1.00
Frt	1.00	0.97		1.00	1.00	0.85		0.99			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.97			0.96	1.00
Satd. Flow (prot)	1787	3455		1787	2502	1561		1777			1824	1589
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.75			0.71	1.00
Satd. Flow (perm)	1787	3455		1787	2502	1561		1375			1353	1589
Peak-hour factor, PHF	0.88	0.93	0.25	0.50	0.94	0.73	0.92	0.92	0.92	0.62	0.92	0.91
Adj. Flow (vph)	193	624	140	10	1021	62	92	33	5	56	11	165
RTOR Reduction (vph)	0	15	0	0	0	33	0	2	0	0	0	134
Lane Group Flow (vph)	193	749	0	10	1021	29	0	128	0	0	67	31
Confl. Peds. (#/hr)			8			2	3		5			5
Parking (#/hr)					100				0			
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		8
Actuated Green, G (s)	9.9	46.8		1.0	37.9	37.9		15.2			15.2	15.2
Effective Green, g (s)	9.9	46.8		1.0	37.9	37.9		15.2			15.2	15.2
Actuated g/C Ratio	0.12	0.58		0.01	0.47	0.47		0.19			0.19	0.19
Clearance Time (s)	5.0	6.0		5.0	6.0	6.0		6.0			6.0	6.0
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0		3.0			3.0	3.0
Lane Grp Cap (vph)	221	2021		22	1185	740		261			257	302
v/s Ratio Prot	c0.11	0.22		0.01	c0.41							
v/s Ratio Perm						0.02		c0.09			0.05	0.02
v/c Ratio	0.87	0.37		0.45	0.86	0.04		0.49			0.26	0.10
Uniform Delay, d1	34.4	8.8		39.2	18.7	11.3		28.9			27.6	26.8
Progression Factor	1.52	1.37		1.00	1.00	1.00		1.00			1.00	1.00
Incremental Delay, d2	27.3	0.5		5.3	8.3	0.1		1.4			0.5	0.2
Delay (s)	79.8	12.5		44.6	27.1	11.4		30.4			28.2	26.9
Level of Service	E	B		D	C	B		C			C	C
Approach Delay (s)		26.1			26.3			30.4			27.3	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	26.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	63.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

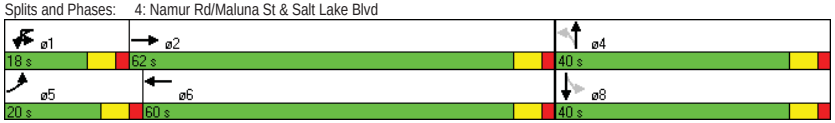
Timings
4: Namur Rd/Maluna St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Volume (vph)	55	560	15	885	85	30	30	10
Turn Type	Prot	NA	Prot	NA	Perm	NA	Perm	NA
Protected Phases	5	2	1	6		4		8
Permitted Phases					4		8	
Detector Phase	5	2	1	6	4	4	8	8
Switch Phase								
Minimum Initial (s)	5.0	20.0	5.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	11.0	26.0	11.0	26.0	11.0	11.0	40.0	40.0
Total Split (s)	20.0	62.0	18.0	60.0	40.0	40.0	40.0	40.0
Total Split (%)	16.7%	51.7%	15.0%	50.0%	33.3%	33.3%	33.3%	33.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0		6.0
Lead/Lag	Lead	Lag	Lead	Lag				
Lead-Lag Optimize?								
Recall Mode	None	Min	None	Min	None	None	None	None

Intersection Summary
Cycle Length: 120
Actuated Cycle Length: 91.9
Natural Cycle: 90
Control Type: Actuated-Uncoordinated

Splits and Phases: 4: Namur Rd/Maluna St & Salt Lake Blvd



Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Volume (vph)	55	560	35	10	15	885	60	85	30	20	30	10
Ideal Flow (vphpl)	1900	1900	1900	1400	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		7%				-6%			0%			-12%
Total Lost time (s)	6.0	6.0			6.0	6.0		6.0	6.0			6.0
Lane Util. Factor	1.00	0.95			1.00	0.95		1.00	1.00			1.00
Frpb, ped/bikes	1.00	1.00			1.00	1.00		1.00	0.99			0.99
Flpb, ped/bikes	1.00	1.00			1.00	1.00		1.00	1.00			1.00
Frt	1.00	0.99			1.00	0.99		1.00	0.94			0.93
Flt Protected	0.95	1.00			0.95	1.00		0.95	1.00			0.98
Satd. Flow (prot)	1708	3365			1823	2520		1764	1733			1795
Flt Permitted	0.95	1.00			0.95	1.00		0.66	1.00			0.85
Satd. Flow (perm)	1708	3365			1823	2520		1218	1733			1554
Peak-hour factor, PHF	0.64	0.94	0.73	0.92	0.83	0.89	0.79	0.85	0.55	0.54	0.71	0.50
Adj. Flow (vph)	86	596	48	11	18	994	76	100	55	37	42	20
RTOR Reduction (vph)	0	4	0	0	0	4	0	0	24	0	0	35
Lane Group Flow (vph)	86	640	0	0	29	1066	0	100	68	0	0	89
Confl. Peds. (#/hr)			12				2	5		7		
Parking (#/hr)						100						
Turn Type	Prot	NA		Prot	Prot	NA		Perm	NA		Perm	NA
Protected Phases	5	2		1	1	6			4			8
Permitted Phases								4			8	
Actuated Green, G (s)	7.5	57.1			3.8	53.4		15.1	15.1			15.1
Effective Green, g (s)	7.5	57.1			3.8	53.4		15.1	15.1			15.1
Actuated g/C Ratio	0.08	0.61			0.04	0.57		0.16	0.16			0.16
Clearance Time (s)	6.0	6.0			6.0	6.0		6.0	6.0			6.0
Vehicle Extension (s)	2.0	5.0			2.0	5.0		3.0	3.0			3.0
Lane Grp Cap (vph)	136	2044			74	1432		196	278			250
v/s Ratio Prot	c0.05	c0.19			0.02	c0.42			0.04			
v/s Ratio Perm								c0.08				0.06
v/c Ratio	0.63	0.31			0.39	0.74		0.51	0.25			0.35
Uniform Delay, d1	41.9	8.9			44.0	15.2		36.1	34.5			35.1
Progression Factor	1.00	1.00			1.00	1.00		1.00	1.00			1.00
Incremental Delay, d2	6.9	0.2			1.2	2.6		2.2	0.5			0.9
Delay (s)	48.8	9.1			45.2	17.8		38.3	34.9			36.0
Level of Service	D	A			D	B		D	C			D
Approach Delay (s)		13.8				18.5			36.7			36.0
Approach LOS		B				B			D			D

Intersection Summary			
HCM Average Control Delay	19.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	94.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	61.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR
Lane Configurations	
Volume (vph)	45
Ideal Flow (vphpl)	1900
Grade (%)	
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Peak-hour factor, PHF	0.73
Adj. Flow (vph)	62
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	7
Parking (#/hr)	
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	

Intersection Summary

Timings
5: Salt Lake Blvd & Wanaka St

7/19/2012

Lane Group	EBL	EBT	WBU	WBT	SBL	SBR
Lane Configurations						
Volume (vph)	105	520	15	910	70	65
Turn Type	Prot	NA	Prot	NA	NA	Perm
Protected Phases	5	2	1	6	4	
Permitted Phases						4
Detector Phase	5	2	1	6	4	4
Switch Phase						
Minimum Initial (s)	4.0	25.0	4.0	25.0	4.0	4.0
Minimum Split (s)	9.0	30.0	9.0	30.0	31.0	31.0
Total Split (s)	18.0	51.0	18.0	51.0	31.0	31.0
Total Split (%)	18.0%	51.0%	18.0%	51.0%	31.0%	31.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead	Lag	Lead	Lag		
Lead-Lag Optimize?	Yes	Yes	Yes	Yes		
Recall Mode	None	Min	None	Min	None	None

Intersection Summary
Cycle Length: 100
Actuated Cycle Length: 79.3
Natural Cycle: 90
Control Type: Actuated-Uncoordinated

Splits and Phases: 5: Salt Lake Blvd & Wanaka St

HCM Signalized Intersection Capacity Analysis
5: Salt Lake Blvd & Wanaka St

7/19/2012

Movement	EBU	EBL	EBT	WBU	WBT	WBR	SBL	SBR
Lane Configurations								
Volume (vph)	10	105	520	15	910	145	70	65
Ideal Flow (vphpl)	1400	1900	1900	1400	1900	1900	1900	1900
Lane Width	12	10	10	12	10	12	10	10
Grade (%)			0%		1%		-8%	
Total Lost time (s)		5.0	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor		1.00	0.95	1.00	0.95		1.00	1.00
Frpb, ped/bikes		1.00	1.00	1.00	1.00		1.00	0.99
Flpb, ped/bikes		1.00	1.00	1.00	1.00		1.00	1.00
Frt		1.00	1.00	1.00	0.98		1.00	0.85
Flt Protected		0.95	1.00	0.95	1.00		0.95	1.00
Satd. Flow (prot)		1652	3303	1297	2244		1718	1517
Flt Permitted		0.95	1.00	0.95	1.00		0.95	1.00
Satd. Flow (perm)		1652	3303	1297	2244		1718	1517
Peak-hour factor, PHF	0.92	0.80	0.96	0.92	0.93	0.88	0.75	0.89
Adj. Flow (vph)	11	131	542	16	978	165	93	73
RTOR Reduction (vph)	0	0	0	0	10	0	0	66
Lane Group Flow (vph)	0	142	542	16	1133	0	93	7
Confl. Peds. (#/hr)		1				1		1
Parking (#/hr)					100			
Turn Type	Prot	Prot	NA	Prot	NA		NA	Perm
Protected Phases	5	5	2	1	6		4	
Permitted Phases								4
Actuated Green, G (s)		11.2	60.4	1.6	50.8		7.6	7.6
Effective Green, g (s)		11.2	60.4	1.6	50.8		7.6	7.6
Actuated g/C Ratio		0.13	0.71	0.02	0.60		0.09	0.09
Clearance Time (s)		5.0	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)		3.0	4.0	3.0	4.0		2.2	2.2
Lane Grp Cap (vph)		219	2358	25	1347		154	136
v/s Ratio Prot		c0.09	0.16	0.01	c0.50		c0.05	
v/s Ratio Perm								0.00
v/c Ratio		0.65	0.23	0.64	0.84		0.60	0.05
Uniform Delay, d1		34.8	4.1	41.2	13.6		37.1	35.2
Progression Factor		1.00	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2		6.5	0.1	44.6	5.1		4.9	0.1
Delay (s)		41.3	4.2	85.8	18.8		42.0	35.3
Level of Service		D	A	F	B		D	D
Approach Delay (s)			11.9		19.7		39.0	
Approach LOS			B		B		D	

Intersection Summary			
HCM Average Control Delay	18.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	84.6	Sum of lost time (s)	15.0
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

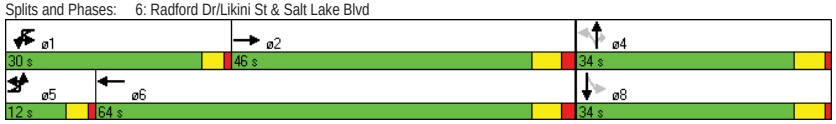
Timings
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Configurations									
Volume (vph)	5	555	270	1015	70	30	420	75	15
Turn Type	Prot	NA	Prot	NA	Perm	NA	Perm	Perm	NA
Protected Phases	5	2	1	6		4			8
Permitted Phases					4		4	8	
Detector Phase	5	2	1	6	4	4	4	8	8
Switch Phase									
Minimum Initial (s)	4.0	5.0	4.0	5.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	46.0	9.0	46.0	9.0	9.0	9.0	34.0	34.0
Total Split (s)	12.0	46.0	30.0	64.0	34.0	34.0	34.0	34.0	34.0
Total Split (%)	10.9%	41.8%	27.3%	58.2%	30.9%	30.9%	30.9%	30.9%	30.9%
Yellow Time (s)	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0		0.0	0.0		0.0
Total Lost Time (s)	4.0	6.0	4.0	6.0		5.0	5.0		5.0
Lead/Lag	Lead	Lag	Lead	Lag					
Lead-Lag Optimize?									
Recall Mode	None	C-Max	None	C-Max	None	None	None	None	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 2 (2%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 100
Control Type: Actuated-Coordinated

Splits and Phases: 6: Radford Dr/Likini St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL
Lane Configurations												
Volume (vph)	20	5	555	50	10	270	1015	95	70	30	420	75
Ideal Flow (vphpl)	1400	1900	1900	1900	1400	1900	1900	1900	1900	1900	1900	1900
Grade (%)			1%				-2%			2%		
Total Lost time (s)		4.0	6.0			4.0	6.0			5.0	5.0	
Lane Util. Factor		1.00	0.95			1.00	0.95			1.00	1.00	
Frpb, ped/bikes		1.00	1.00			1.00	1.00			1.00	0.98	
Flpb, ped/bikes		1.00	1.00			1.00	1.00			1.00	1.00	
Frt		1.00	0.98			1.00	0.99			1.00	0.85	
Flt Protected		0.95	1.00			0.95	1.00			0.97	1.00	
Satd. Flow (prot)		1761	3457			1787	3516			1777	1543	
Flt Permitted		0.95	1.00			0.95	1.00			0.69	1.00	
Satd. Flow (perm)		1761	3457			1787	3516			1274	1543	
Peak-hour factor, PHF	0.92	0.75	0.91	0.71	0.92	0.76	0.90	0.81	0.73	0.75	0.91	0.84
Adj. Flow (vph)	22	7	610	70	11	355	1128	117	96	40	462	89
RTOR Reduction (vph)	0	0	7	0	0	0	5	0	0	0	359	0
Lane Group Flow (vph)	0	29	673	0	0	366	1240	0	0	136	103	0
Confl. Peds. (#/hr)		4		6		2		4	4		2	
Turn Type	Prot	Prot	NA		Prot	Prot	NA		Perm	NA	Perm	Perm
Protected Phases	5	5	2		1	1	6			4		
Permitted Phases									4		4	8
Actuated Green, G (s)		4.7	50.0			26.6	71.9			18.4	18.4	
Effective Green, g (s)		4.7	50.0			26.6	71.9			18.4	18.4	
Actuated g/C Ratio		0.04	0.45			0.24	0.65			0.17	0.17	
Clearance Time (s)		4.0	6.0			4.0	6.0			5.0	5.0	
Vehicle Extension (s)		3.0	5.0			3.0	5.0			3.0	3.0	
Lane Grp Cap (vph)		75	1571			432	2298			213	258	
v/s Ratio Prot		0.02	0.19			c0.20	c0.35					
v/s Ratio Perm										0.11	0.07	
v/c Ratio		0.39	0.43			0.85	0.54			0.64	0.40	
Uniform Delay, d1		51.2	20.3			39.8	10.2			42.7	40.9	
Progression Factor		1.00	1.00			1.00	1.00			1.00	1.00	
Incremental Delay, d2		3.3	0.9			14.2	0.9			6.2	1.0	
Delay (s)		54.5	21.2			54.0	11.1			48.9	41.9	
Level of Service		D	C			D	B			D	D	
Approach Delay (s)			22.5				20.9			43.5		
Approach LOS			C				C			D		

Intersection Summary			
HCM Average Control Delay	27.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	101.7%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Movement	SBT	SBR
Lane Configurations		
Volume (vph)	15	10
Ideal Flow (vphpl)	1900	1900
Grade (%)	-6%	
Total Lost time (s)	5.0	
Lane Util. Factor	1.00	
Frpb, ped/bikes	1.00	
Flpb, ped/bikes	1.00	
Frt	0.98	
Flt Protected	0.97	
Satd. Flow (prot)	1820	
Flt Permitted	0.64	
Satd. Flow (perm)	1203	
Peak-hour factor, PHF	0.38	0.44
Adj. Flow (vph)	39	23
RTOR Reduction (vph)	7	0
Lane Group Flow (vph)	144	0
Confl. Peds. (#/hr)		8
Turn Type	NA	
Protected Phases	8	
Permitted Phases		
Actuated Green, G (s)	18.4	
Effective Green, g (s)	18.4	
Actuated g/C Ratio	0.17	
Clearance Time (s)	5.0	
Vehicle Extension (s)	3.0	
Lane Grp Cap (vph)	201	
v/s Ratio Prot		
v/s Ratio Perm	c0.12	
v/c Ratio	0.72	
Uniform Delay, d1	43.3	
Progression Factor	1.00	
Incremental Delay, d2	11.6	
Delay (s)	54.9	
Level of Service	D	
Approach Delay (s)	54.9	
Approach LOS	D	

Intersection Summary

Timings
7: Salt Lake Blvd & Kahikolu Pl

7/19/2012

Lane Group	EBL	EBT	WBT	SBL
Lane Configurations				
Volume (vph)	5	1015	1450	15
Turn Type	Prot	NA	NA	NA
Protected Phases	1	6	2	8
Permitted Phases				
Detector Phase	1	6	2	8
Switch Phase				
Minimum Initial (s)	4.0	4.0	4.0	4.0
Minimum Split (s)	9.0	9.0	24.0	32.0
Total Split (s)	11.0	78.0	67.0	32.0
Total Split (%)	10.0%	70.9%	60.9%	29.1%
Yellow Time (s)	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0
Lead/Lag	Lead		Lag	
Lead-Lag Optimize?	Yes		Yes	
Recall Mode	None	Min	Min	None

Intersection Summary

Cycle Length: 110
Actuated Cycle Length: 70.4
Natural Cycle: 90
Control Type: Actuated-Uncoordinated

Splits and Phases: 7: Salt Lake Blvd & Kahikolu Pl

HCM Signalized Intersection Capacity Analysis
7: Salt Lake Blvd & Kahikolu Pl

7/19/2012

Movement	EBU	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations							
Volume (vph)	10	5	1015	1450	25	15	10
Ideal Flow (vphpl)	1400	1900	1900	1900	1900	1900	1900
Grade (%)			0%	2%		0%	
Total Lost time (s)		5.0	5.0	5.0		5.0	
Lane Util. Factor		1.00	0.95	0.95		1.00	
Frpb, ped/bikes		1.00	1.00	1.00		0.99	
Flpb, ped/bikes		1.00	1.00	1.00		1.00	
Frt		1.00	1.00	1.00		0.95	
Flt Protected		0.95	1.00	1.00		0.97	
Satd. Flow (prot)		1770	3539	3484		1699	
Flt Permitted		0.95	1.00	1.00		0.97	
Satd. Flow (perm)		1770	3539	3484		1699	
Peak-hour factor, PHF	0.92	0.38	0.89	0.92	0.54	0.45	0.50
Adj. Flow (vph)	11	13	1140	1576	46	33	20
RTOR Reduction (vph)	0	0	0	1	0	18	0
Lane Group Flow (vph)	0	24	1140	1621	0	35	0
Confl. Peds. (#/hr)		14			14	14	14
Turn Type	Prot	Prot	NA	NA		NA	
Protected Phases	1	1	6	2		8	
Permitted Phases							
Actuated Green, G (s)		1.9	58.9	52.0		5.7	
Effective Green, g (s)		1.9	58.9	52.0		5.7	
Actuated g/C Ratio		0.03	0.79	0.70		0.08	
Clearance Time (s)		5.0	5.0	5.0		5.0	
Vehicle Extension (s)		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)		45	2794	2429		130	
v/s Ratio Prot		0.01	c0.32	c0.47		c0.02	
v/s Ratio Perm							
v/c Ratio		0.53	0.41	0.67		0.27	
Uniform Delay, d1		35.9	2.4	6.4		32.5	
Progression Factor		1.00	1.00	1.00		1.00	
Incremental Delay, d2		11.6	0.1	0.7		1.1	
Delay (s)		47.5	2.5	7.1		33.6	
Level of Service		D	A	A		C	
Approach Delay (s)			3.5	7.1		33.6	
Approach LOS			A	A		C	

Intersection Summary			
HCM Average Control Delay	6.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	74.6	Sum of lost time (s)	15.0
Intersection Capacity Utilization	59.7%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
8: Salt Lake Blvd & Shopping Center Entrance 1

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	130	940	1350	10	0	95
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.85	0.91	0.95	0.44	0.92	0.62
Hourly flow rate (vph)	153	1033	1421	23	0	153
Pedestrians		2	2		2	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		354	553			
pX, platoon unblocked	0.76				0.80	0.76
vC, conflicting volume	1446				2259	726
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	966				1662	24
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	72				100	81
cM capacity (veh/h)	541				50	798

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	SB 1
Volume Total	153	516	516	947	496	153
Volume Left	153	0	0	0	0	0
Volume Right	0	0	0	0	23	153
cSH	541	1700	1700	1700	1700	798
Volume to Capacity	0.28	0.30	0.30	0.56	0.29	0.19
Queue Length 95th (ft)	29	0	0	0	0	18
Control Delay (s)	14.3	0.0	0.0	0.0	0.0	10.6
Lane LOS	B					B
Approach Delay (s)	1.8			0.0		10.6
Approach LOS						B

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	58.8%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
9: Aliamanu School /Shopping Center Entrance 2 & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	900	25	0	1250	100	0	0	45	0	0	105
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.93	0.64	0.92	0.90	0.86	0.92	0.92	0.68	0.92	0.92	0.76
Hourly flow rate (vph)	0	968	39	0	1389	116	0	0	66	0	0	138
Pedestrians		2									2	
Lane Width (ft)		12.0									12.0	
Walking Speed (ft/s)		4.0									4.0	
Percent Blockage		0									0	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		571			336							
pX, platoon unblocked	0.74			0.97			0.76	0.76	0.97	0.76	0.76	0.74
vC, conflicting volume	1507			968			1822	2494	503	1933	2417	757
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	988			905			1266	2155	427	1413	2052	0
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	88	100	100	83
cM capacity (veh/h)	515			725			79	36	559	65	41	802

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	645	362	926	579	66	138
Volume Left	0	0	0	0	0	0
Volume Right	0	39	0	116	66	138
cSH	1700	1700	1700	1700	559	802
Volume to Capacity	0.38	0.21	0.54	0.34	0.12	0.17
Queue Length 95th (ft)	0	0	0	0	10	15
Control Delay (s)	0.0	0.0	0.0	0.0	12.3	10.4
Lane LOS					B	B
Approach Delay (s)	0.0		0.0		12.3	10.4
Approach LOS					B	B

Intersection Summary				
Average Delay		0.8		
Intersection Capacity Utilization		51.6%	ICU Level of Service	A
Analysis Period (min)		15		

Timings
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	290	640	1010	545	335	330
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	20.0	20.0	20.0	6.0	6.0
Minimum Split (s)	10.0	26.0	29.0	29.0	35.0	35.0
Total Split (s)	25.0	70.0	45.0	45.0	40.0	40.0
Total Split (%)	22.7%	63.6%	40.9%	40.9%	36.4%	36.4%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	C-Max	C-Max	C-Max	None	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow, Master Intersection
Natural Cycle: 90
Control Type: Actuated-Coordinated

Splits and Phases: 10: Salt Lake Blvd & Ala Lilikoi St

HCM Signalized Intersection Capacity Analysis
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	290	640	1010	545	335	330
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lane Util. Factor	1.00	0.91	0.95	1.00	0.97	1.00
Frpb, ped/bikes	1.00	1.00	1.00	0.96	1.00	0.95
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	5085	3539	1515	3433	1511
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	5085	3539	1515	3433	1511
Peak-hour factor, PHF	0.95	0.94	0.91	0.84	0.91	0.86
Adj. Flow (vph)	305	681	1110	649	368	384
RTOR Reduction (vph)	0	0	0	343	0	310
Lane Group Flow (vph)	305	681	1110	306	368	74
Confl. Peds. (#/hr)				22		31
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Actuated Green, G (s)	24.9	79.1	49.2	49.2	19.9	19.9
Effective Green, g (s)	24.9	79.1	49.2	49.2	19.9	19.9
Actuated g/C Ratio	0.23	0.72	0.45	0.45	0.18	0.18
Clearance Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Vehicle Extension (s)	3.0	4.0	4.0	4.0	3.0	3.0
Lane Grp Cap (vph)	401	3657	1583	678	621	273
v/s Ratio Prot	c0.17	0.13	c0.31		c0.11	
v/s Ratio Perm				0.20		0.05
v/c Ratio	0.76	0.19	0.70	0.45	0.59	0.27
Uniform Delay, d1	39.8	5.0	24.5	21.1	41.3	38.8
Progression Factor	1.00	1.00	1.21	3.48	1.00	1.00
Incremental Delay, d2	8.3	0.1	2.1	1.8	1.5	0.5
Delay (s)	48.0	5.1	31.7	75.0	42.9	39.4
Level of Service	D	A	C	E	D	D
Approach Delay (s)		18.4	47.7		41.1	
Approach LOS		B	D		D	

Intersection Summary			
HCM Average Control Delay	38.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	76.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Timings
11: Arizona Rd & Salt Lake Blvd

7/19/2012

Lane Group	EBT	WBL	WBT	NBL
Lane Configurations				
Volume (vph)	760	50	975	605
Turn Type	NA	Prot	NA	NA
Protected Phases	2	1	6	4
Permitted Phases				
Detector Phase	2	1	6	4
Switch Phase				
Minimum Initial (s)	20.0	5.0	20.0	5.0
Minimum Split (s)	28.0	10.0	26.0	34.0
Total Split (s)	53.0	22.0	75.0	35.0
Total Split (%)	48.2%	20.0%	68.2%	31.8%
Yellow Time (s)	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	5.0
Lead/Lag	Lag	Lead		
Lead-Lag Optimize?				
Recall Mode	C-Max	None	C-Max	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 106 (96%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated

Splits and Phases: 11: Arizona Rd & Salt Lake Blvd

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	760	245	50	975	605	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	10	12	12	12
Grade (%)	8%			-10%	-2%	
Total Lost time (s)	6.0		5.0	6.0	5.0	
Lane Util. Factor	0.91		1.00	0.95	0.97	
Frpb, ped/bikes	0.99		1.00	1.00	1.00	
Flpb, ped/bikes	1.00		1.00	1.00	1.00	
Frt	0.96		1.00	1.00	0.99	
Flt Protected	1.00		0.95	1.00	0.96	
Satd. Flow (prot)	4668		1734	3716	3442	
Flt Permitted	1.00		0.95	1.00	0.96	
Satd. Flow (perm)	4668		1734	3716	3442	
Peak-hour factor, PHF	0.94	0.90	0.77	0.90	0.88	0.64
Adj. Flow (vph)	809	272	65	1083	688	62
RTOR Reduction (vph)	46	0	0	0	7	0
Lane Group Flow (vph)	1035	0	65	1083	743	0
Confl. Peds. (#/hr)		2				4
Turn Type	NA		Prot	NA	NA	
Protected Phases	2		1	6	4	
Permitted Phases						
Actuated Green, G (s)	57.6		8.3	70.9	28.1	
Effective Green, g (s)	57.6		8.3	70.9	28.1	
Actuated g/C Ratio	0.52		0.08	0.64	0.26	
Clearance Time (s)	6.0		5.0	6.0	5.0	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)	2444		131	2395	879	
v/s Ratio Prot	0.22		0.04	c0.29	c0.22	
v/s Ratio Perm						
v/c Ratio	0.42		0.50	0.45	0.85	
Uniform Delay, d1	16.0		48.8	9.8	38.9	
Progression Factor	1.27		1.00	1.00	1.00	
Incremental Delay, d2	0.5		2.9	0.6	7.5	
Delay (s)	20.9		51.8	10.4	46.4	
Level of Service	C		D	B	D	
Approach Delay (s)	20.9			12.8	46.4	
Approach LOS	C			B	D	

Intersection Summary			
HCM Average Control Delay	24.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	57.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2040 AM

Timings
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	135	650	530	150	570	245	210	140	440
Turn Type	Prot	NA	Perm	Prot	NA	Prot	NA	Prot	NA
Protected Phases	5	2		1	6	3	8	7	4
Permitted Phases			2						
Detector Phase	5	2	2	1	6	3	8	7	4
Switch Phase									
Minimum Initial (s)	5.0	20.0	20.0	5.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	34.0	34.0	10.0	34.0	10.0	33.0	10.0	33.0
Total Split (s)	26.0	61.0	61.0	30.0	65.0	32.0	36.0	33.0	37.0
Total Split (%)	16.3%	38.1%	38.1%	18.8%	40.6%	20.0%	22.5%	20.6%	23.1%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	5.0	6.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?									
Recall Mode	None	C-Max	C-Max	None	C-Max	None	None	None	None

Intersection Summary
Cycle Length: 160
Actuated Cycle Length: 160
Offset: 154 (96%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 120
Control Type: Actuated-Coordinated

Splits and Phases: 1: Bouganville Dr & Salt Lake Blvd

HCM Signalized Intersection Capacity Analysis
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	135	650	530	150	570	110	245	210	55	140	440	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		3%			-3%			2%			-2%	
Total Lost time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91		0.97	1.00		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.66	1.00	0.96		1.00	0.96		1.00	0.92	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.97		1.00	0.96	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1743	3486	1035	1796	4765		3399	1711		1787	3177	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1743	3486	1035	1796	4765		3399	1711		1787	3177	
Peak-hour factor, PHF	0.73	0.87	0.79	0.50	0.78	0.45	0.90	0.74	0.71	0.77	0.78	0.77
Adj. Flow (vph)	185	747	671	300	731	244	272	284	77	182	564	182
RTOR Reduction (vph)	0	0	260	0	37	0	0	6	0	0	18	0
Lane Group Flow (vph)	185	747	411	300	938	0	272	355	0	182	728	0
Confl. Peds. (#/hr)			266			51			109			208
Turn Type	Prot	NA	Perm	Prot	NA		Prot	NA		Prot	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2									
Actuated Green, G (s)	19.3	55.0	55.0	25.0	60.7		17.2	38.4		20.6	41.8	
Effective Green, g (s)	19.3	55.0	55.0	25.0	60.7		17.2	38.4		20.6	41.8	
Actuated g/C Ratio	0.12	0.34	0.34	0.16	0.38		0.11	0.24		0.13	0.26	
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	5.0	5.0	2.0	5.0		2.0	3.0		2.0	3.0	
Lane Grp Cap (vph)	210	1198	356	281	1808		365	411		230	830	
v/s Ratio Prot	0.11	0.21		c0.17	0.20		0.08	0.21		c0.10	c0.23	
v/s Ratio Perm			c0.40									
v/c Ratio	0.88	0.62	1.15	1.07	0.52		0.75	0.86		0.79	0.88	
Uniform Delay, d1	69.2	43.9	52.5	67.5	38.4		69.3	58.3		67.6	56.6	
Progression Factor	1.00	1.00	1.00	0.95	0.69		1.00	1.00		1.00	1.00	
Incremental Delay, d2	31.4	2.5	96.8	72.1	1.0		7.1	16.9		15.8	10.4	
Delay (s)	100.6	46.3	149.3	136.2	27.5		76.3	75.2		83.4	67.0	
Level of Service	F	D	F	F	C		E	E		F	E	
Approach Delay (s)		95.7			53.1			75.7			70.2	
Approach LOS		F			D			E			E	

Intersection Summary			
HCM Average Control Delay	75.3	HCM Level of Service	E
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	86.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Timings
2: Lawehana St & Salt Lake Blvd

7/19/2012

Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Configurations					
Volume (vph)	740	60	795	80	105
Turn Type	NA	Prot	NA	NA	Perm
Protected Phases	2	1	6	4	
Permitted Phases					4
Detector Phase	2	1	6	4	4
Switch Phase					
Minimum Initial (s)	20.0	5.0	20.0	5.0	5.0
Minimum Split (s)	28.0	10.0	26.0	37.0	37.0
Total Split (s)	90.0	25.0	115.0	45.0	45.0
Total Split (%)	56.3%	15.6%	71.9%	28.1%	28.1%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	6.0	6.0
Lead/Lag	Lag	Lead			
Lead-Lag Optimize?					
Recall Mode	C-Max	None	C-Max	None	None

Intersection Summary
Cycle Length: 160
Actuated Cycle Length: 160
Offset: 26 (16%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 80
Control Type: Actuated-Coordinated

Splits and Phases: 2: Lawehana St & Salt Lake Blvd

HCM Signalized Intersection Capacity Analysis
2: Lawehana St & Salt Lake Blvd

7/19/2012

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	740	145	60	795	80	105
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	10	10
Grade (%)	-1%			-3%	-1%	
Total Lost time (s)	6.0		5.0	6.0	6.0	6.0
Lane Util. Factor	0.95		1.00	0.91	1.00	1.00
Frpb, ped/bikes	0.95		1.00	1.00	1.00	0.88
Flpb, ped/bikes	1.00		1.00	1.00	1.00	1.00
Frt	0.97		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	3285		1796	4129	1660	1305
Flt Permitted	1.00		0.95	1.00	0.95	1.00
Satd. Flow (perm)	3285		1796	4129	1660	1305
Peak-hour factor, PHF	0.82	0.72	0.52	0.77	0.64	0.66
Adj. Flow (vph)	902	201	115	1032	125	159
RTOR Reduction (vph)	8	0	0	0	0	142
Lane Group Flow (vph)	1095	0	115	1032	125	17
Confl. Peds. (#/hr)		72				72
Parking (#/hr)				100		
Turn Type	NA		Prot	NA	NA	Perm
Protected Phases	2		1	6	4	
Permitted Phases						4
Actuated Green, G (s)	111.1		14.5	130.6	17.4	17.4
Effective Green, g (s)	111.1		14.5	130.6	17.4	17.4
Actuated g/C Ratio	0.69		0.09	0.82	0.11	0.11
Clearance Time (s)	6.0		5.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0		2.0	5.0	3.0	3.0
Lane Grp Cap (vph)	2281		163	3370	181	142
v/s Ratio Prot	c0.33		c0.06	0.25	c0.08	
v/s Ratio Perm						0.01
v/c Ratio	0.48		0.71	0.31	0.69	0.12
Uniform Delay, d1	11.2		70.7	3.6	68.7	64.4
Progression Factor	0.41		0.97	2.05	1.00	1.00
Incremental Delay, d2	0.6		8.2	0.2	10.8	0.4
Delay (s)	5.2		76.9	7.6	79.5	64.8
Level of Service	A		E	A	E	E
Approach Delay (s)	5.2			14.5	71.3	
Approach LOS	A			B	E	

Intersection Summary			
HCM Average Control Delay	16.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	68.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

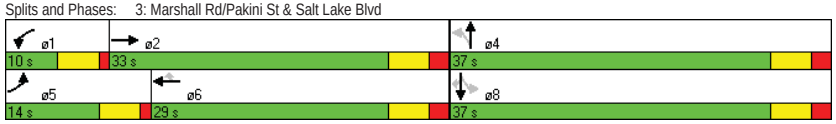
Timings
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT	SBR
Lane Configurations										
Volume (vph)	100	680	15	640	30	50	30	100	40	160
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	NA	Perm
Protected Phases	5	2	1	6			4		8	
Permitted Phases					6	4		8		8
Detector Phase	5	2	1	6	6	4	4	8	8	8
Switch Phase										
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	28.0	10.0	28.0	28.0	11.0	11.0	37.0	37.0	37.0
Total Split (s)	14.0	33.0	10.0	29.0	29.0	37.0	37.0	37.0	37.0	37.0
Total Split (%)	17.5%	41.3%	12.5%	36.3%	36.3%	46.3%	46.3%	46.3%	46.3%	46.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0		0.0	0.0
Total Lost Time (s)	5.0	6.0	5.0	6.0	6.0		6.0		6.0	6.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag					
Lead-Lag Optimize?										
Recall Mode	None	C-Max	None	C-Max	C-Max	None	None	None	None	None

Intersection Summary
Cycle Length: 80
Actuated Cycle Length: 80
Offset: 12 (15%), Referenced to phase 2:EBT and 6:WBT, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated

Splits and Phases: 3: Marshall Rd/Pakini St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	100	680	65	15	640	30	50	30	10	100	40	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			1%			-4%	
Total Lost time (s)	5.0	6.0		5.0	6.0	6.0		6.0			6.0	6.0
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00			1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.95		1.00			1.00	0.96
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00		0.99			1.00	1.00
Frt	1.00	0.99		1.00	1.00	0.85		0.98			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.97			0.96	1.00
Satd. Flow (prot)	1787	3510		1787	2502	1513		1764			1825	1553
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.70			0.74	1.00
Satd. Flow (perm)	1787	3510		1787	2502	1513		1270			1407	1553
Peak-hour factor, PHF	0.70	0.91	0.92	0.42	0.74	0.71	0.92	0.92	0.92	0.56	0.92	0.83
Adj. Flow (vph)	143	747	71	36	865	42	54	33	11	179	43	193
RTOR Reduction (vph)	0	6	0	0	0	24	0	7	0	0	0	145
Lane Group Flow (vph)	143	812	0	36	865	18	0	91	0	0	222	48
Confl. Peds. (#/hr)			21			19	17		5	1		35
Parking (#/hr)					100				0			
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		8
Actuated Green, G (s)	8.5	40.2		3.0	34.7	34.7		19.8			19.8	19.8
Effective Green, g (s)	8.5	40.2		3.0	34.7	34.7		19.8			19.8	19.8
Actuated g/C Ratio	0.11	0.50		0.04	0.43	0.43		0.25			0.25	0.25
Clearance Time (s)	5.0	6.0		5.0	6.0	6.0		6.0			6.0	6.0
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0		3.0			3.0	3.0
Lane Grp Cap (vph)	190	1764		67	1085	656		314			348	384
v/s Ratio Prot	c0.08	0.23		0.02	c0.35							
v/s Ratio Perm						0.01		0.07			c0.16	0.03
v/c Ratio	0.75	0.46		0.54	0.80	0.03		0.29			0.64	0.12
Uniform Delay, d1	34.7	12.9		37.8	19.6	13.0		24.4			26.9	23.4
Progression Factor	1.06	1.28		1.00	1.00	1.00		1.00			1.00	1.00
Incremental Delay, d2	12.6	0.8		4.1	6.1	0.1		0.5			3.8	0.1
Delay (s)	49.5	17.3		41.9	25.7	13.1		24.9			30.7	23.5
Level of Service	D	B		D	C	B		C			C	C
Approach Delay (s)		22.1			25.8			24.9			27.4	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	60.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

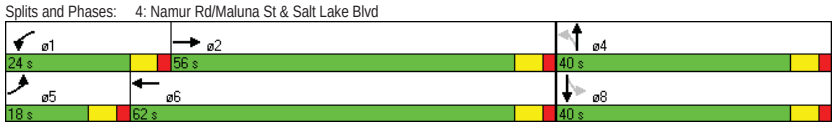
Timings
4: Namur Rd/Maluna St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Volume (vph)	35	620	65	585	50	30	65	40
Turn Type	Prot	NA	Prot	NA	Perm	NA	Perm	NA
Protected Phases	5	2	1	6		4		8
Permitted Phases					4		8	
Detector Phase	5	2	1	6	4	4	8	8
Switch Phase								
Minimum Initial (s)	5.0	20.0	5.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	11.0	26.0	11.0	26.0	11.0	11.0	40.0	40.0
Total Split (s)	18.0	56.0	24.0	62.0	40.0	40.0	40.0	40.0
Total Split (%)	15.0%	46.7%	20.0%	51.7%	33.3%	33.3%	33.3%	33.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0		6.0
Lead/Lag	Lead	Lag	Lead	Lag				
Lead-Lag Optimize?								
Recall Mode	None	Min	None	Min	None	None	None	None

Intersection Summary
Cycle Length: 120
Actuated Cycle Length: 84.5
Natural Cycle: 80
Control Type: Actuated-Uncoordinated

Splits and Phases: 4: Namur Rd/Maluna St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
4: Namur Rd/Maluna St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	35	620	65	65	585	30	50	30	25	65	40	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		7%			-6%			0%			-12%	
Total Lost time (s)	6.0	6.0		6.0	6.0		6.0	6.0			6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00			1.00	
Frpb, ped/bikes	1.00	0.99		1.00	1.00		1.00	0.99			0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.99	1.00			1.00	
Frt	1.00	0.98		1.00	0.99		1.00	0.93			0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.98	
Satd. Flow (prot)	1708	3338		1823	2533		1759	1703			1837	
Flt Permitted	0.95	1.00		0.95	1.00		0.52	1.00			0.85	
Satd. Flow (perm)	1708	3338		1823	2533		964	1703			1596	
Peak-hour factor, PHF	0.89	0.81	0.73	0.66	0.80	0.79	0.81	0.65	0.56	0.82	0.52	0.72
Adj. Flow (vph)	39	765	89	98	731	38	62	46	45	79	77	83
RTOR Reduction (vph)	0	7	0	0	3	0	0	32	0	0	17	0
Lane Group Flow (vph)	39	847	0	98	766	0	62	59	0	0	222	0
Confl. Peds. (#/hr)			23				13		10			13
Parking (#/hr)					100							
Turn Type	Prot	NA		Prot	NA		Perm	NA		Perm	NA	
Protected Phases	5	2		1	6			4			8	
Permitted Phases							4			8		
Actuated Green, G (s)	4.1	41.5		7.7	45.1		19.0	19.0			19.0	
Effective Green, g (s)	4.1	41.5		7.7	45.1		19.0	19.0			19.0	
Actuated g/C Ratio	0.05	0.48		0.09	0.52		0.22	0.22			0.22	
Clearance Time (s)	6.0	6.0		6.0	6.0		6.0	6.0			6.0	
Vehicle Extension (s)	2.0	5.0		2.0	5.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	81	1607		163	1325		212	375			352	
v/s Ratio Prot	0.02	0.25		c0.05	c0.30			0.03				
v/s Ratio Perm							0.06				c0.14	
v/c Ratio	0.48	0.53		0.60	0.58		0.29	0.16			0.63	
Uniform Delay, d1	40.0	15.5		37.8	14.0		28.0	27.1			30.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	1.6	0.6		4.2	1.0		0.8	0.2			3.7	
Delay (s)	41.7	16.1		42.0	15.0		28.8	27.3			34.1	
Level of Service	D	B		D	B		C	C			C	
Approach Delay (s)		17.2			18.1			27.9			34.1	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM Average Control Delay	20.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	86.2	Sum of lost time (s)	18.0
Intersection Capacity Utilization	59.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

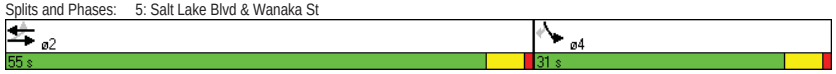
Timings
5: Salt Lake Blvd & Wanaka St

7/19/2012

Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations					
Volume (vph)	40	685	610	115	70
Turn Type	Perm	NA	NA	NA	Perm
Protected Phases		2	2	4	
Permitted Phases	2				4
Detector Phase	2	2	2	4	4
Switch Phase					
Minimum Initial (s)	25.0	25.0	25.0	4.0	4.0
Minimum Split (s)	30.0	30.0	30.0	31.0	31.0
Total Split (s)	55.0	55.0	55.0	31.0	31.0
Total Split (%)	64.0%	64.0%	64.0%	36.0%	36.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	Min	Min	Min	None	None

Intersection Summary
Cycle Length: 86
Actuated Cycle Length: 56.3
Natural Cycle: 65
Control Type: Actuated-Uncoordinated

Splits and Phases: 5: Salt Lake Blvd & Wanaka St



HCM Signalized Intersection Capacity Analysis
5: Salt Lake Blvd & Wanaka St

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	40	685	610	65	115	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	12	10	10
Grade (%)		0%	1%		-8%	
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	0.95	0.95		1.00	1.00
Frt	1.00	1.00	0.98		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1652	3303	2263		1718	1537
Flt Permitted	0.36	1.00	1.00		0.95	1.00
Satd. Flow (perm)	628	3303	2263		1718	1537
Peak-hour factor, PHF	0.66	0.86	0.90	0.77	0.85	0.81
Adj. Flow (vph)	61	797	678	84	135	86
RTOR Reduction (vph)	0	0	8	0	0	74
Lane Group Flow (vph)	61	797	754	0	135	12
Parking (#/hr)			100			
Turn Type	Perm	NA	NA		NA	Perm
Protected Phases		2	2		4	
Permitted Phases	2					4
Actuated Green, G (s)	39.1	39.1	39.1		8.0	8.0
Effective Green, g (s)	39.1	39.1	39.1		8.0	8.0
Actuated g/C Ratio	0.68	0.68	0.68		0.14	0.14
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	4.0	4.0	4.0		2.2	2.2
Lane Grp Cap (vph)	430	2262	1550		241	215
v/s Ratio Prot		0.24	c0.33		c0.08	
v/s Ratio Perm	0.10					0.01
v/c Ratio	0.14	0.35	0.49		0.56	0.06
Uniform Delay, d1	3.1	3.7	4.3		22.9	21.3
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.2	0.1	0.3		2.0	0.1
Delay (s)	3.3	3.9	4.6		24.9	21.3
Level of Service	A	A	A		C	C
Approach Delay (s)		3.8	4.6		23.5	
Approach LOS		A	A		C	

Intersection Summary			
HCM Average Control Delay	6.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	57.1	Sum of lost time (s)	10.0
Intersection Capacity Utilization	47.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

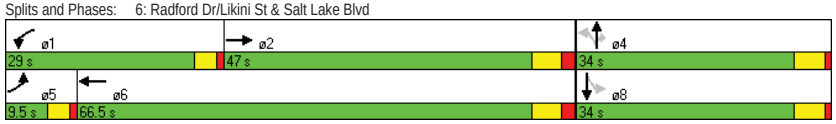
Timings
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Configurations									
Volume (vph)	5	805	290	605	50	10	295	110	45
Turn Type	Prot	NA	Prot	NA	Perm	NA	Perm	Perm	NA
Protected Phases	5	2	1	6		4			8
Permitted Phases					4		4	8	
Detector Phase	5	2	1	6	4	4	4	8	8
Switch Phase									
Minimum Initial (s)	4.0	5.0	4.0	5.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	8.5	46.0	8.0	46.0	9.0	9.0	9.0	34.0	34.0
Total Split (s)	9.5	47.0	29.0	66.5	34.0	34.0	34.0	34.0	34.0
Total Split (%)	8.6%	42.7%	26.4%	60.5%	30.9%	30.9%	30.9%	30.9%	30.9%
Yellow Time (s)	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0		0.0	0.0		0.0
Total Lost Time (s)	4.0	6.0	4.0	6.0		5.0	5.0		5.0
Lead/Lag	Lead	Lag	Lead	Lag					
Lead-Lag Optimize?	Yes			Yes					
Recall Mode	None	C-Max	None	C-Max	None	None	None	None	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 28 (25%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 100
Control Type: Actuated-Coordinated

Splits and Phases: 6: Radford Dr/Likini St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	5	805	25	290	605	90	50	10	295	110	45	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		1%			-2%			2%			-6%	
Total Lost time (s)	4.0	6.0		4.0	6.0			5.0	5.0		5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	0.97		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			0.99	1.00		1.00	
Frt	1.00	0.99		1.00	0.98			1.00	0.85		0.98	
Flt Protected	0.95	1.00		0.95	1.00			0.96	1.00		0.97	
Satd. Flow (prot)	1761	3493		1787	3495			1758	1523		1822	
Flt Permitted	0.95	1.00		0.95	1.00			0.67	1.00		0.71	
Satd. Flow (perm)	1761	3493		1787	3495			1224	1523		1342	
Peak-hour factor, PHF	0.25	0.81	0.64	0.86	0.87	0.88	0.58	0.38	0.80	0.70	0.78	0.56
Adj. Flow (vph)	20	994	39	337	695	102	86	26	369	157	58	27
RTOR Reduction (vph)	0	2	0	0	9	0	0	0	291	0	5	0
Lane Group Flow (vph)	20	1031	0	337	788	0	0	112	78	0	237	0
Confl. Peds. (#/hr)	3		33	12		3	21		12			24
Turn Type	Prot	NA		Prot	NA		Perm	NA	Perm	Perm	NA	
Protected Phases	5	2		1	6			4			8	
Permitted Phases							4		4	8		
Actuated Green, G (s)	2.4	47.7		24.0	69.3			23.3	23.3		23.3	
Effective Green, g (s)	2.4	47.7		24.0	69.3			23.3	23.3		23.3	
Actuated g/C Ratio	0.02	0.43		0.22	0.63			0.21	0.21		0.21	
Clearance Time (s)	4.0	6.0		4.0	6.0			5.0	5.0		5.0	
Vehicle Extension (s)	3.0	5.0		3.0	5.0			3.0	3.0		3.0	
Lane Grp Cap (vph)	38	1515		390	2202			259	323		284	
v/s Ratio Prot	0.01	c0.30		c0.19	0.23							
v/s Ratio Perm								0.09	0.05		c0.18	
v/c Ratio	0.53	0.68		0.86	0.36			0.43	0.24		0.84	
Uniform Delay, d1	53.2	25.0		41.4	9.7			37.6	36.0		41.5	
Progression Factor	1.00	1.00		0.84	0.54			1.00	1.00		1.00	
Incremental Delay, d2	12.5	2.5		16.0	0.4			1.2	0.4		18.7	
Delay (s)	65.8	27.5		50.7	5.7			38.8	36.4		60.2	
Level of Service	E	C		D	A			D	D		E	
Approach Delay (s)		28.2			19.0			37.0			60.2	
Approach LOS		C			B			D			E	

Intersection Summary			
HCM Average Control Delay	28.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	83.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
7: Salt Lake Blvd & Kahikolu Pl

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	1220	1060	15	20	10
Sign Control		Free	Free		Stop	
Grade		0%	-2%		0%	
Peak Hour Factor	0.25	0.85	0.93	0.69	0.65	0.31
Hourly flow rate (vph)	20	1435	1140	22	31	32
Pedestrians		13	13		13	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		1	1		1	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		534	907			
pX, platoon unblocked	0.92				0.81	0.92
vC, conflicting volume	1175				1934	607
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1024				1268	410
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				75	94
cM capacity (veh/h)	616				124	534

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	SB 1
Volume Total	20	718	718	760	402	63
Volume Left	20	0	0	0	0	31
Volume Right	0	0	0	0	22	32
cSH	616	1700	1700	1700	1700	204
Volume to Capacity	0.03	0.42	0.42	0.45	0.24	0.31
Queue Length 95th (ft)	3	0	0	0	0	31
Control Delay (s)	11.0	0.0	0.0	0.0	0.0	30.4
Lane LOS	B					D
Approach Delay (s)	0.2			0.0		30.4
Approach LOS						D

Intersection Summary			
Average Delay	0.8		
Intersection Capacity Utilization	47.2%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
8: Salt Lake Blvd & Shopping Center Entrance 1

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	75	1115	960	20	0	35
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.88	0.88	0.87	0.75	0.25	0.65
Hourly flow rate (vph)	85	1267	1103	27	0	54
Pedestrians		1	1		1	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		888	553			
pX, platoon unblocked	0.89				0.89	0.89
vC, conflicting volume	1131				1923	567
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	900				1227	267
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	87				100	92
cM capacity (veh/h)	667				132	650

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	SB 1
Volume Total	85	634	634	736	394	54
Volume Left	85	0	0	0	0	0
Volume Right	0	0	0	0	27	54
cSH	667	1700	1700	1700	1700	650
Volume to Capacity	0.13	0.37	0.37	0.43	0.23	0.08
Queue Length 95th (ft)	11	0	0	0	0	7
Control Delay (s)	11.2	0.0	0.0	0.0	0.0	11.0
Lane LOS	B					B
Approach Delay (s)	0.7			0.0		11.0
Approach LOS						B

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	45.0%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
9: Aliamanu School /Shopping Center Entrance 2 & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	940	260	0	910	45	0	0	230	0	0	70
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.96	0.68	0.92	0.94	0.75	0.92	0.92	0.64	0.92	0.92	0.87
Hourly flow rate (vph)	0	979	382	0	968	60	0	0	359	0	0	80
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		1105			336							
pX, platoon unblocked	0.87			0.85			0.92	0.92	0.85	0.92	0.92	0.87
vC, conflicting volume	1028			979			1735	2198	681	1488	1977	514
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	742			632			997	1503	282	728	1262	153
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	41	100	100	89
cM capacity (veh/h)	752			808			162	110	610	117	155	756

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	653	709	645	383	359	80
Volume Left	0	0	0	0	0	0
Volume Right	0	382	0	60	359	80
cSH	1700	1700	1700	1700	610	756
Volume to Capacity	0.38	0.42	0.38	0.23	0.59	0.11
Queue Length 95th (ft)	0	0	0	0	96	9
Control Delay (s)	0.0	0.0	0.0	0.0	19.0	10.3
Lane LOS					C	B
Approach Delay (s)	0.0		0.0		19.0	10.3
Approach LOS					C	B

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	55.2%	ICU Level of Service	B
Analysis Period (min)	15		

Timings
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	265	870	530	325	905	425
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	20.0	20.0	20.0	6.0	6.0
Minimum Split (s)	10.0	26.0	29.0	29.0	35.0	35.0
Total Split (s)	34.0	67.0	33.0	33.0	43.0	43.0
Total Split (%)	30.9%	60.9%	30.0%	30.0%	39.1%	39.1%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	C-Max	C-Max	C-Max	None	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 66 (60%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 80
Control Type: Actuated-Coordinated

Splits and Phases: 10: Salt Lake Blvd & Ala Lilikoi St

HCM Signalized Intersection Capacity Analysis
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	265	870	530	325	905	425
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lane Util. Factor	1.00	0.91	0.95	1.00	0.97	1.00
Frpb, ped/bikes	1.00	1.00	1.00	0.84	1.00	0.75
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	5085	3539	1337	3433	1189
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	5085	3539	1337	3433	1189
Peak-hour factor, PHF	0.77	0.92	0.94	0.73	0.91	0.82
Adj. Flow (vph)	344	946	564	445	995	518
RTOR Reduction (vph)	0	0	0	318	0	343
Lane Group Flow (vph)	344	946	564	127	995	175
Confl. Peds. (#/hr)				102		220
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Actuated Green, G (s)	25.3	61.8	31.5	31.5	37.2	37.2
Effective Green, g (s)	25.3	61.8	31.5	31.5	37.2	37.2
Actuated g/C Ratio	0.23	0.56	0.29	0.29	0.34	0.34
Clearance Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Vehicle Extension (s)	3.0	4.0	4.0	4.0	3.0	3.0
Lane Grp Cap (vph)	407	2857	1013	383	1161	402
v/s Ratio Prot	c0.19	0.19	c0.16		c0.29	
v/s Ratio Perm				0.10		0.15
v/c Ratio	0.85	0.33	0.56	0.33	0.86	0.44
Uniform Delay, d1	40.5	13.0	33.3	31.0	33.9	28.3
Progression Factor	1.16	0.69	0.75	1.27	1.00	1.00
Incremental Delay, d2	13.8	0.3	2.1	2.2	6.4	0.8
Delay (s)	60.9	9.2	27.0	41.5	40.3	29.0
Level of Service	E	A	C	D	D	C
Approach Delay (s)		23.0	33.4		36.5	
Approach LOS		C	C		D	

Intersection Summary			
HCM Average Control Delay	31.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	73.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Timings
11: Arizona Rd & Salt Lake Blvd

7/19/2012

Lane Group	EBT	WBL	WBT	NBL
Lane Configurations				
Volume (vph)	1320	165	565	250
Turn Type	NA	Prot	NA	NA
Protected Phases	2	1	6	4
Permitted Phases				
Detector Phase	2	1	6	4
Switch Phase				
Minimum Initial (s)	20.0	5.0	20.0	5.0
Minimum Split (s)	28.0	10.0	26.0	34.0
Total Split (s)	53.0	23.0	76.0	34.0
Total Split (%)	48.2%	20.9%	69.1%	30.9%
Yellow Time (s)	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	5.0
Lead/Lag	Lag	Lead		
Lead-Lag Optimize?				
Recall Mode	C-Max	None	C-Max	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 100
Control Type: Actuated-Coordinated

Splits and Phases: 11: Arizona Rd & Salt Lake Blvd

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	1320	505	165	565	250	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	10	12	12	12
Grade (%)	8%			-10%	-2%	
Total Lost time (s)	6.0		5.0	6.0	5.0	
Lane Util. Factor	0.91		1.00	0.95	0.97	
Frpb, ped/bikes	0.99		1.00	1.00	1.00	
Flpb, ped/bikes	1.00		1.00	1.00	1.00	
Frt	0.95		1.00	1.00	0.97	
Flt Protected	1.00		0.95	1.00	0.96	
Satd. Flow (prot)	4618		1734	3716	3394	
Flt Permitted	1.00		0.95	1.00	0.96	
Satd. Flow (perm)	4618		1734	3716	3394	
Peak-hour factor, PHF	0.91	0.80	0.62	0.93	0.60	0.49
Adj. Flow (vph)	1451	631	266	608	417	102
RTOR Reduction (vph)	67	0	0	0	22	0
Lane Group Flow (vph)	2015	0	266	608	497	0
Confl. Peds. (#/hr)		4				5
Turn Type	NA		Prot	NA	NA	
Protected Phases	2		1	6	4	
Permitted Phases						
Actuated Green, G (s)	50.8		21.1	76.9	22.1	
Effective Green, g (s)	50.8		21.1	76.9	22.1	
Actuated g/C Ratio	0.46		0.19	0.70	0.20	
Clearance Time (s)	6.0		5.0	6.0	5.0	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)	2133		333	2598	682	
v/s Ratio Prot	c0.44		c0.15	0.16	c0.15	
v/s Ratio Perm						
v/c Ratio	0.94		0.80	0.23	0.73	
Uniform Delay, d1	28.3		42.4	6.0	41.1	
Progression Factor	0.81		1.00	1.00	1.00	
Incremental Delay, d2	8.9		12.6	0.2	3.9	
Delay (s)	31.9		55.0	6.2	45.1	
Level of Service	C		D	A	D	
Approach Delay (s)	31.9			21.0	45.1	
Approach LOS	C			C	D	

Intersection Summary			
HCM Average Control Delay	31.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	70.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2040 PM

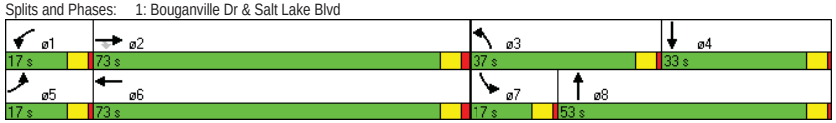
Timings
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations									
Volume (vph)	75	685	305	45	1025	560	355	80	215
Turn Type	Prot	NA	Perm	Prot	NA	Prot	NA	Prot	NA
Protected Phases	5	2		1	6	3	8	7	4
Permitted Phases			2						
Detector Phase	5	2	2	1	6	3	8	7	4
Switch Phase									
Minimum Initial (s)	5.0	20.0	20.0	5.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	34.0	34.0	10.0	34.0	10.0	33.0	10.0	33.0
Total Split (s)	17.0	73.0	73.0	17.0	73.0	37.0	53.0	17.0	33.0
Total Split (%)	10.6%	45.6%	45.6%	10.6%	45.6%	23.1%	33.1%	10.6%	20.6%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	5.0	6.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag	Lead	Lag
Lead-Lag Optimize?									
Recall Mode	None	C-Max	C-Max	None	C-Max	None	None	None	None

Intersection Summary
Cycle Length: 160
Actuated Cycle Length: 160
Offset: 126 (79%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 90
Control Type: Actuated-Coordinated

Splits and Phases: 1: Bouganville Dr & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
1: Bouganville Dr & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	75	685	305	45	1025	165	560	355	45	80	215	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		3%			-3%			2%			-2%	
Total Lost time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91		0.97	1.00		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.95	1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.98		1.00	0.96	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1743	3486	1478	1796	5007		3399	1796		1787	3381	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1743	3486	1478	1796	5007		3399	1796		1787	3381	
Peak-hour factor, PHF	0.82	0.83	0.92	0.83	0.94	0.80	0.95	0.88	0.67	0.85	0.74	0.86
Adj. Flow (vph)	91	825	332	54	1090	206	589	403	67	94	291	116
RTOR Reduction (vph)	0	0	172	0	16	0	0	4	0	0	27	0
Lane Group Flow (vph)	91	825	160	54	1280	0	589	466	0	94	380	0
Confl. Peds. (#/hr)			24			7			13			18
Turn Type	Prot	NA	Perm	Prot	NA		Prot	NA		Prot	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2									
Actuated Green, G (s)	11.0	75.4	75.4	7.9	72.3		30.3	44.7		11.0	25.4	
Effective Green, g (s)	11.0	75.4	75.4	7.9	72.3		30.3	44.7		11.0	25.4	
Actuated g/C Ratio	0.07	0.47	0.47	0.05	0.45		0.19	0.28		0.07	0.16	
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	5.0	5.0	2.0	5.0		2.0	3.0		2.0	3.0	
Lane Grp Cap (vph)	120	1643	697	89	2263		644	502		123	537	
v/s Ratio Prot	c0.05	c0.24		0.03	c0.26		c0.17	c0.26		0.05	0.11	
v/s Ratio Perm			0.11									
v/c Ratio	0.76	0.50	0.23	0.61	0.57		0.91	0.93		0.76	0.71	
Uniform Delay, d1	73.2	29.3	25.1	74.5	32.3		63.6	56.1		73.2	63.8	
Progression Factor	1.00	1.00	1.00	1.28	0.55		1.00	1.00		1.00	1.00	
Incremental Delay, d2	21.3	1.1	0.8	7.4	1.0		17.3	23.6		22.0	4.2	
Delay (s)	94.5	30.4	25.8	102.7	18.8		80.9	79.7		95.2	68.0	
Level of Service	F	C	C	F	B		F	E		F	E	
Approach Delay (s)		33.9			22.2			80.3			73.1	
Approach LOS		C			C			F			E	

Intersection Summary			
HCM Average Control Delay	46.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	27.0
Intersection Capacity Utilization	77.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Timings
2: Lawehana St & Salt Lake Blvd

7/19/2012

Lane Group	EBT	WBL	WBT	NBL	NBR
Lane Configurations					
Volume (vph)	650	95	990	215	140
Turn Type	NA	Prot	NA	NA	Perm
Protected Phases	2	1	6	4	
Permitted Phases					4
Detector Phase	2	1	6	4	4
Switch Phase					
Minimum Initial (s)	20.0	5.0	20.0	5.0	5.0
Minimum Split (s)	28.0	10.0	26.0	37.0	37.0
Total Split (s)	75.0	29.0	104.0	56.0	56.0
Total Split (%)	46.9%	18.1%	65.0%	35.0%	35.0%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	6.0	6.0
Lead/Lag	Lag	Lead			
Lead-Lag Optimize?					
Recall Mode	C-Max	None	C-Max	None	None

Intersection Summary
Cycle Length: 160
Actuated Cycle Length: 160
Offset: 153 (96%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated

Splits and Phases: 2: Lawehana St & Salt Lake Blvd

HCM Signalized Intersection Capacity Analysis
2: Lawehana St & Salt Lake Blvd

7/19/2012

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	650	135	95	990	215	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	10	10
Grade (%)	-1%			-3%	-1%	
Total Lost time (s)	6.0		5.0	6.0	6.0	6.0
Lane Util. Factor	0.95		1.00	0.91	1.00	1.00
Frpb, ped/bikes	0.99		1.00	1.00	1.00	0.97
Flpb, ped/bikes	1.00		1.00	1.00	1.00	1.00
Frt	0.97		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	3429		1796	4129	1660	1440
Flt Permitted	1.00		0.95	1.00	0.95	1.00
Satd. Flow (perm)	3429		1796	4129	1660	1440
Peak-hour factor, PHF	0.88	0.82	0.80	0.95	0.80	0.82
Adj. Flow (vph)	739	165	119	1042	269	171
RTOR Reduction (vph)	8	0	0	0	0	137
Lane Group Flow (vph)	896	0	119	1042	269	34
Confl. Peds. (#/hr)		8				12
Parking (#/hr)				100		
Turn Type	NA		Prot	NA	NA	Perm
Protected Phases	2		1	6	4	
Permitted Phases						4
Actuated Green, G (s)	96.5		15.0	116.5	31.5	31.5
Effective Green, g (s)	96.5		15.0	116.5	31.5	31.5
Actuated g/C Ratio	0.60		0.09	0.73	0.20	0.20
Clearance Time (s)	6.0		5.0	6.0	6.0	6.0
Vehicle Extension (s)	5.0		2.0	5.0	3.0	3.0
Lane Grp Cap (vph)	2068		168	3006	327	284
v/s Ratio Prot	c0.26		c0.07	0.25	c0.16	
v/s Ratio Perm						0.02
v/c Ratio	0.43		0.71	0.35	0.82	0.12
Uniform Delay, d1	17.1		70.4	7.9	61.6	52.8
Progression Factor	0.21		0.99	1.61	1.00	1.00
Incremental Delay, d2	0.6		7.2	0.2	15.3	0.2
Delay (s)	4.1		76.6	13.0	76.8	53.0
Level of Service	A		E	B	E	D
Approach Delay (s)	4.1			19.5	67.6	
Approach LOS	A			B	E	

Intersection Summary			
HCM Average Control Delay	22.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	160.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	58.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

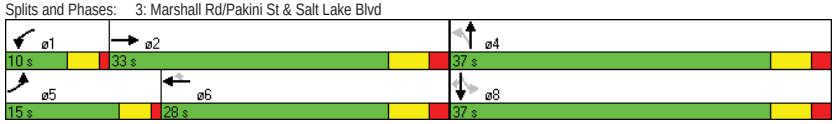
Timings
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT	SBR
Lane Configurations										
Volume (vph)	170	580	5	960	45	85	30	35	10	150
Turn Type	Prot	NA	Prot	NA	Perm	Perm	NA	Perm	NA	Perm
Protected Phases	5	2	1	6			4		8	
Permitted Phases					6	4		8		8
Detector Phase	5	2	1	6	6	4	4	8	8	8
Switch Phase										
Minimum Initial (s)	5.0	20.0	5.0	20.0	20.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	10.0	28.0	10.0	28.0	28.0	11.0	11.0	37.0	37.0	37.0
Total Split (s)	15.0	33.0	10.0	28.0	28.0	37.0	37.0	37.0	37.0	37.0
Total Split (%)	18.8%	41.3%	12.5%	35.0%	35.0%	46.3%	46.3%	46.3%	46.3%	46.3%
Yellow Time (s)	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0		0.0	0.0
Total Lost Time (s)	4.0	6.0	4.0	6.0	6.0		6.0		6.0	6.0
Lead/Lag	Lead	Lag	Lead	Lag	Lag					
Lead-Lag Optimize?										
Recall Mode	None	C-Max	None	C-Max	C-Max	None	None	None	None	None

Intersection Summary
Cycle Length: 80
Actuated Cycle Length: 80
Offset: 75 (94%), Referenced to phase 2:EBT and 6:WBT, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated

Splits and Phases: 3: Marshall Rd/Pakini St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
3: Marshall Rd/Pakini St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	580	35	5	960	45	85	30	5	35	10	150
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		-2%			-2%			1%			-4%	
Total Lost time (s)	4.0	6.0		4.0	6.0	6.0		6.0			6.0	6.0
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00		1.00			1.00	1.00
Frpb, ped/bikes	1.00	0.99		1.00	1.00	0.98		1.00			1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00		1.00			1.00	1.00
Frt	1.00	0.97		1.00	1.00	0.85		0.99			1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.97			0.96	1.00
Satd. Flow (prot)	1787	3455		1787	2502	1561		1777			1824	1589
Flt Permitted	0.95	1.00		0.95	1.00	1.00		0.75			0.71	1.00
Satd. Flow (perm)	1787	3455		1787	2502	1561		1375			1353	1589
Peak-hour factor, PHF	0.88	0.93	0.25	0.50	0.94	0.73	0.92	0.92	0.92	0.62	0.92	0.91
Adj. Flow (vph)	193	624	140	10	1021	62	92	33	5	56	11	165
RTOR Reduction (vph)	0	15	0	0	0	32	0	2	0	0	0	134
Lane Group Flow (vph)	193	749	0	10	1021	30	0	128	0	0	67	31
Confl. Peds. (#/hr)			8			2	3		5			5
Parking (#/hr)					100				0			
Turn Type	Prot	NA		Prot	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	5	2		1	6			4			8	
Permitted Phases						6	4			8		8
Actuated Green, G (s)	10.5	47.6		1.2	38.3	38.3		15.2			15.2	15.2
Effective Green, g (s)	10.5	47.6		1.2	38.3	38.3		15.2			15.2	15.2
Actuated g/C Ratio	0.13	0.60		0.01	0.48	0.48		0.19			0.19	0.19
Clearance Time (s)	4.0	6.0		4.0	6.0	6.0		6.0			6.0	6.0
Vehicle Extension (s)	2.0	5.0		2.0	5.0	5.0		3.0			3.0	3.0
Lane Grp Cap (vph)	235	2056		27	1198	747		261			257	302
v/s Ratio Prot	c0.11	0.22		0.01	c0.41							
v/s Ratio Perm						0.02		c0.09			0.05	0.02
v/c Ratio	0.82	0.36		0.37	0.85	0.04		0.49			0.26	0.10
Uniform Delay, d1	33.8	8.4		39.0	18.4	11.1		28.9			27.6	26.8
Progression Factor	1.34	1.62		1.00	1.00	1.00		1.00			1.00	1.00
Incremental Delay, d2	18.2	0.5		3.1	7.8	0.1		1.4			0.5	0.2
Delay (s)	63.5	14.1		42.1	26.1	11.2		30.4			28.2	26.9
Level of Service	E	B		D	C	B		C			C	C
Approach Delay (s)		24.0			25.4			30.4			27.3	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	25.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	62.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

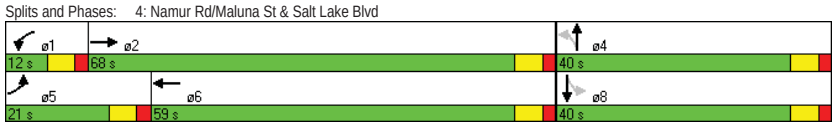
Timings
4: Namur Rd/Maluna St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Volume (vph)	55	560	15	885	85	30	30	10
Turn Type	Prot	NA	Prot	NA	Perm	NA	Perm	NA
Protected Phases	5	2	1	6		4		8
Permitted Phases					4		8	
Detector Phase	5	2	1	6	4	4	8	8
Switch Phase								
Minimum Initial (s)	5.0	20.0	5.0	20.0	5.0	5.0	5.0	5.0
Minimum Split (s)	11.0	26.0	11.0	26.0	11.0	11.0	40.0	40.0
Total Split (s)	21.0	68.0	12.0	59.0	40.0	40.0	40.0	40.0
Total Split (%)	17.5%	56.7%	10.0%	49.2%	33.3%	33.3%	33.3%	33.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0		6.0
Lead/Lag	Lead	Lag	Lead	Lag				
Lead-Lag Optimize?								
Recall Mode	None	Max	None	Max	None	None	None	None

Intersection Summary
Cycle Length: 120
Actuated Cycle Length: 98.5
Natural Cycle: 90
Control Type: Actuated-Uncoordinated

Splits and Phases: 4: Namur Rd/Maluna St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
4: Namur Rd/Maluna St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	55	560	35	15	885	60	85	30	20	30	10	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		7%			-6%			0%			-12%	
Total Lost time (s)	6.0	6.0		6.0	6.0		6.0	6.0			6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.99			0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.99		1.00	0.99		1.00	0.94			0.93	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.98	
Satd. Flow (prot)	1708	3365		1823	2520		1763	1732			1794	
Flt Permitted	0.95	1.00		0.95	1.00		0.63	1.00			0.85	
Satd. Flow (perm)	1708	3365		1823	2520		1173	1732			1553	
Peak-hour factor, PHF	0.64	0.94	0.73	0.83	0.89	0.79	0.85	0.55	0.54	0.71	0.50	0.73
Adj. Flow (vph)	86	596	48	18	994	76	100	55	37	42	20	62
RTOR Reduction (vph)	0	3	0	0	3	0	0	24	0	0	36	0
Lane Group Flow (vph)	86	641	0	18	1067	0	100	68	0	0	88	0
Confl. Peds. (#/hr)			12			2	5		7			7
Parking (#/hr)					100							
Turn Type	Prot	NA		Prot	NA		Perm	NA		Perm	NA	
Protected Phases	5	2		1	6			4			8	
Permitted Phases							4			8		
Actuated Green, G (s)	8.2	66.8		2.1	60.7		15.3	15.3			15.3	
Effective Green, g (s)	8.2	66.8		2.1	60.7		15.3	15.3			15.3	
Actuated g/C Ratio	0.08	0.65		0.02	0.59		0.15	0.15			0.15	
Clearance Time (s)	6.0	6.0		6.0	6.0		6.0	6.0			6.0	
Vehicle Extension (s)	2.0	5.0		2.0	5.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	137	2199		37	1497		176	259			232	
v/s Ratio Prot	c0.05	0.19		0.01	c0.42			0.04				
v/s Ratio Perm							c0.09				0.06	
v/c Ratio	0.63	0.29		0.49	0.71		0.57	0.26			0.38	
Uniform Delay, d1	45.5	7.6		49.5	14.6		40.4	38.5			39.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	6.3	0.3		3.6	2.9		4.2	0.5			1.0	
Delay (s)	51.8	7.9		53.1	17.5		44.5	39.0			40.2	
Level of Service	D	A		D	B		D	D			D	
Approach Delay (s)		13.1			18.1			41.9			40.2	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM Average Control Delay	19.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	102.2	Sum of lost time (s)	18.0
Intersection Capacity Utilization	61.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Timings
5: Salt Lake Blvd & Wanaka St

7/19/2012

Lane Group	EBL	EBT	WBT	SBL	SBR
Lane Configurations					
Volume (vph)	105	520	910	70	65
Turn Type	Perm	NA	NA	NA	Perm
Protected Phases		2	2	4	
Permitted Phases	2				4
Detector Phase	2	2	2	4	4
Switch Phase					
Minimum Initial (s)	25.0	25.0	25.0	4.0	4.0
Minimum Split (s)	30.0	30.0	30.0	31.0	31.0
Total Split (s)	79.0	79.0	79.0	31.0	31.0
Total Split (%)	71.8%	71.8%	71.8%	28.2%	28.2%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	C-Max	C-Max	C-Max	None	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 52 (47%), Referenced to phase 2:EBWB, Start of Green
Natural Cycle: 80
Control Type: Actuated-Coordinated

Splits and Phases: 5: Salt Lake Blvd & Wanaka St

HCM Signalized Intersection Capacity Analysis
5: Salt Lake Blvd & Wanaka St

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	105	520	910	145	70	65
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	10	10	10	12	10	10
Grade (%)		0%	1%		-8%	
Total Lost time (s)	5.0	5.0	5.0		5.0	5.0
Lane Util. Factor	1.00	0.95	0.95		1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00		1.00	0.99
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00
Frt	1.00	1.00	0.98		1.00	0.85
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1651	3303	2244		1718	1517
Flt Permitted	0.23	1.00	1.00		0.95	1.00
Satd. Flow (perm)	406	3303	2244		1718	1517
Peak-hour factor, PHF	0.80	0.96	0.93	0.88	0.75	0.89
Adj. Flow (vph)	131	542	978	165	93	73
RTOR Reduction (vph)	0	0	7	0	0	66
Lane Group Flow (vph)	131	542	1136	0	93	7
Confl. Peds. (#/hr)	1			1		1
Parking (#/hr)			100			
Turn Type	Perm	NA	NA		NA	Perm
Protected Phases		2	2		4	
Permitted Phases	2					4
Actuated Green, G (s)	89.5	89.5	89.5		10.5	10.5
Effective Green, g (s)	89.5	89.5	89.5		10.5	10.5
Actuated g/C Ratio	0.81	0.81	0.81		0.10	0.10
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	4.0	4.0	4.0		2.2	2.2
Lane Grp Cap (vph)	330	2687	1826		164	145
v/s Ratio Prot		0.16	c0.51		c0.05	
v/s Ratio Perm	0.32					0.00
v/c Ratio	0.40	0.20	0.62		0.57	0.05
Uniform Delay, d1	2.8	2.3	3.9		47.6	45.2
Progression Factor	1.00	1.00	0.89		1.00	1.00
Incremental Delay, d2	3.5	0.2	1.4		3.0	0.1
Delay (s)	6.4	2.5	4.9		50.6	45.3
Level of Service	A	A	A		D	D
Approach Delay (s)		3.2	4.9		48.3	
Approach LOS		A	A		D	

Intersection Summary			
HCM Average Control Delay	8.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	67.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

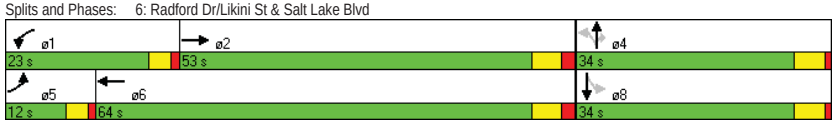
Timings
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	NBR	SBL	SBT
Lane Configurations									
Volume (vph)	5	555	270	1015	70	30	420	75	15
Turn Type	Prot	NA	Prot	NA	Perm	NA	Perm	Perm	NA
Protected Phases	5	2	1	6		4			8
Permitted Phases					4		4	8	
Detector Phase	5	2	1	6	4	4	4	8	8
Switch Phase									
Minimum Initial (s)	4.0	5.0	4.0	5.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	8.5	46.0	8.0	46.0	9.0	9.0	9.0	34.0	34.0
Total Split (s)	12.0	53.0	23.0	64.0	34.0	34.0	34.0	34.0	34.0
Total Split (%)	10.9%	48.2%	20.9%	58.2%	30.9%	30.9%	30.9%	30.9%	30.9%
Yellow Time (s)	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0		0.0	0.0		0.0
Total Lost Time (s)	4.0	6.0	4.0	6.0		5.0	5.0		5.0
Lead/Lag	Lead	Lag	Lead	Lag					
Lead-Lag Optimize?									
Recall Mode	None	C-Max	None	C-Max	None	None	None	None	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 50 (45%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 100
Control Type: Actuated-Coordinated

Splits and Phases: 6: Radford Dr/Likini St & Salt Lake Blvd



HCM Signalized Intersection Capacity Analysis
6: Radford Dr/Likini St & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	5	555	50	270	1015	95	70	30	420	75	15	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Grade (%)		1%			-2%			2%			-6%	
Total Lost time (s)	4.0	6.0		4.0	6.0			5.0	5.0		5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	0.98		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Frt	1.00	0.98		1.00	0.99			1.00	0.85		0.98	
Flt Protected	0.95	1.00		0.95	1.00			0.97	1.00		0.97	
Satd. Flow (prot)	1761	3457		1787	3516			1777	1543		1820	
Flt Permitted	0.95	1.00		0.95	1.00			0.69	1.00		0.64	
Satd. Flow (perm)	1761	3457		1787	3516			1274	1543		1203	
Peak-hour factor, PHF	0.75	0.91	0.71	0.76	0.90	0.81	0.73	0.75	0.91	0.84	0.38	0.44
Adj. Flow (vph)	7	610	70	355	1128	117	96	40	462	89	39	23
RTOR Reduction (vph)	0	8	0	0	5	0	0	0	321	0	7	0
Lane Group Flow (vph)	7	672	0	355	1240	0	0	136	141	0	144	0
Confl. Peds. (#/hr)	4		6	2		4	4		2			8
Turn Type	Prot	NA		Prot	NA		Perm	NA	Perm	Perm	NA	
Protected Phases	5	2		1	6			4			8	
Permitted Phases							4		4	8		
Actuated Green, G (s)	1.4	47.2		29.4	75.2			18.4	18.4		18.4	
Effective Green, g (s)	1.4	47.2		29.4	75.2			18.4	18.4		18.4	
Actuated g/C Ratio	0.01	0.43		0.27	0.68			0.17	0.17		0.17	
Clearance Time (s)	4.0	6.0		4.0	6.0			5.0	5.0		5.0	
Vehicle Extension (s)	3.0	5.0		3.0	5.0			3.0	3.0		3.0	
Lane Grp Cap (vph)	22	1483		478	2404			213	258		201	
v/s Ratio Prot	0.00	0.19		c0.20	c0.35							
v/s Ratio Perm								0.11	0.09		c0.12	
v/c Ratio	0.32	0.45		0.74	0.52			0.64	0.54		0.72	
Uniform Delay, d1	53.8	22.3		36.8	8.5			42.7	42.0		43.3	
Progression Factor	1.13	1.04		1.27	0.37			1.00	1.00		1.00	
Incremental Delay, d2	8.1	1.0		5.5	0.7			6.2	2.3		11.6	
Delay (s)	69.0	24.2		52.5	3.8			48.9	44.3		54.9	
Level of Service	E	C		D	A			D	D		D	
Approach Delay (s)		24.7			14.6			45.3			54.9	
Approach LOS		C			B			D			D	

Intersection Summary			
HCM Average Control Delay	25.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	82.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
7: Salt Lake Blvd & Kahikolu Pl

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	1015	1450	25	15	10
Sign Control		Free	Free		Stop	
Grade		0%	2%		0%	
Peak Hour Factor	0.38	0.89	0.92	0.54	0.45	0.50
Hourly flow rate (vph)	13	1140	1576	46	33	20
Pedestrians		14	14		14	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		1	1		1	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		534	907			
pX, platoon unblocked	0.78				0.84	0.78
vC, conflicting volume	1636				2224	839
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1258				1486	240
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				64	97
cM capacity (veh/h)	424				91	582

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	SB 1
Volume Total	13	570	570	1051	572	53
Volume Left	13	0	0	0	0	33
Volume Right	0	0	0	0	46	20
cSH	424	1700	1700	1700	1700	134
Volume to Capacity	0.03	0.34	0.34	0.62	0.34	0.40
Queue Length 95th (ft)	2	0	0	0	0	43
Control Delay (s)	13.8	0.0	0.0	0.0	0.0	48.8
Lane LOS	B					E
Approach Delay (s)	0.2			0.0		48.8
Approach LOS						E

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	54.6%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
8: Salt Lake Blvd & Shopping Center Entrance 1

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	130	940	1350	10	0	95
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.85	0.91	0.95	0.44	0.92	0.62
Hourly flow rate (vph)	153	1033	1421	23	0	153
Pedestrians		2	2		2	
Lane Width (ft)		12.0	12.0		12.0	
Walking Speed (ft/s)		4.0	4.0		4.0	
Percent Blockage		0	0		0	
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)		888	553			
pX, platoon unblocked	0.76				0.78	0.76
vC, conflicting volume	1446				2259	726
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	966				1844	24
tC, single (s)	4.1				6.8	6.9
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	72				100	81
cM capacity (veh/h)	541				37	798

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	SB 1
Volume Total	153	516	516	947	496	153
Volume Left	153	0	0	0	0	0
Volume Right	0	0	0	0	23	153
cSH	541	1700	1700	1700	1700	798
Volume to Capacity	0.28	0.30	0.30	0.56	0.29	0.19
Queue Length 95th (ft)	29	0	0	0	0	18
Control Delay (s)	14.3	0.0	0.0	0.0	0.0	10.6
Lane LOS	B					B
Approach Delay (s)	1.8			0.0		10.6
Approach LOS						B

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	58.8%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
9: Aliamanu School /Shopping Center Entrance 2 & Salt Lake Blvd

7/19/2012

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	900	25	0	1250	100	0	0	45	0	0	105
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.93	0.64	0.92	0.90	0.86	0.92	0.92	0.68	0.92	0.92	0.76
Hourly flow rate (vph)	0	968	39	0	1389	116	0	0	66	0	0	138
Pedestrians		2									2	
Lane Width (ft)		12.0									12.0	
Walking Speed (ft/s)		4.0									4.0	
Percent Blockage		0									0	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)		1105			336							
pX, platoon unblocked	0.74						0.74	0.74		0.74	0.74	0.74
vC, conflicting volume	1507			968			1822	2494	503	1933	2417	757
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	988			968			1412	2319	503	1562	2214	0
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			100	100	87	100	100	83
cM capacity (veh/h)	515			708			60	28	514	49	32	802

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	SB 1
Volume Total	645	362	926	579	66	138
Volume Left	0	0	0	0	0	0
Volume Right	0	39	0	116	66	138
cSH	1700	1700	1700	1700	514	802
Volume to Capacity	0.38	0.21	0.54	0.34	0.13	0.17
Queue Length 95th (ft)	0	0	0	0	11	15
Control Delay (s)	0.0	0.0	0.0	0.0	13.0	10.4
Lane LOS					B	B
Approach Delay (s)	0.0		0.0		13.0	10.4
Approach LOS					B	B

Intersection Summary				
Average Delay		0.8		
Intersection Capacity Utilization		51.6%	ICU Level of Service	A
Analysis Period (min)		15		

Timings
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	290	640	1010	545	335	330
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	20.0	20.0	20.0	6.0	6.0
Minimum Split (s)	10.0	26.0	29.0	29.0	35.0	35.0
Total Split (s)	25.0	70.0	45.0	45.0	40.0	40.0
Total Split (%)	22.7%	63.6%	40.9%	40.9%	36.4%	36.4%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	2.0	2.0	2.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?						
Recall Mode	None	C-Max	C-Max	C-Max	None	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 0 (0%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow, Master Intersection
Natural Cycle: 90
Control Type: Actuated-Coordinated

Splits and Phases: 10: Salt Lake Blvd & Ala Lilikoi St

HCM Signalized Intersection Capacity Analysis
10: Salt Lake Blvd & Ala Lilikoi St

7/19/2012

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	290	640	1010	545	335	330
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Lane Util. Factor	1.00	0.91	0.95	1.00	0.97	1.00
Frpb, ped/bikes	1.00	1.00	1.00	0.96	1.00	0.95
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	5085	3539	1515	3433	1511
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	5085	3539	1515	3433	1511
Peak-hour factor, PHF	0.95	0.94	0.91	0.84	0.91	0.86
Adj. Flow (vph)	305	681	1110	649	368	384
RTOR Reduction (vph)	0	0	0	343	0	310
Lane Group Flow (vph)	305	681	1110	306	368	74
Confl. Peds. (#/hr)				22		31
Turn Type	Prot	NA	NA	Perm	NA	Perm
Protected Phases	5	2	6		4	
Permitted Phases				6		4
Actuated Green, G (s)	24.9	79.1	49.2	49.2	19.9	19.9
Effective Green, g (s)	24.9	79.1	49.2	49.2	19.9	19.9
Actuated g/C Ratio	0.23	0.72	0.45	0.45	0.18	0.18
Clearance Time (s)	5.0	6.0	6.0	6.0	5.0	5.0
Vehicle Extension (s)	3.0	4.0	4.0	4.0	3.0	3.0
Lane Grp Cap (vph)	401	3657	1583	678	621	273
v/s Ratio Prot	c0.17	0.13	c0.31		c0.11	
v/s Ratio Perm				0.20		0.05
v/c Ratio	0.76	0.19	0.70	0.45	0.59	0.27
Uniform Delay, d1	39.8	5.0	24.5	21.1	41.3	38.8
Progression Factor	0.88	0.50	1.07	2.75	1.00	1.00
Incremental Delay, d2	7.4	0.1	2.1	1.8	1.5	0.5
Delay (s)	42.6	2.6	28.4	59.7	42.9	39.4
Level of Service	D	A	C	E	D	D
Approach Delay (s)		15.0	40.0		41.1	
Approach LOS		B	D		D	

Intersection Summary			
HCM Average Control Delay	33.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	76.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Timings
11: Arizona Rd & Salt Lake Blvd

7/19/2012

Lane Group	EBT	WBL	WBT	NBL
Lane Configurations				
Volume (vph)	760	50	975	605
Turn Type	NA	Prot	NA	NA
Protected Phases	2	1	6	4
Permitted Phases				
Detector Phase	2	1	6	4
Switch Phase				
Minimum Initial (s)	20.0	5.0	20.0	5.0
Minimum Split (s)	28.0	10.0	26.0	34.0
Total Split (s)	53.0	22.0	75.0	35.0
Total Split (%)	48.2%	20.0%	68.2%	31.8%
Yellow Time (s)	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	1.0	2.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0
Total Lost Time (s)	6.0	5.0	6.0	5.0
Lead/Lag	Lag	Lead		
Lead-Lag Optimize?				
Recall Mode	C-Max	None	C-Max	None

Intersection Summary
Cycle Length: 110
Actuated Cycle Length: 110
Offset: 5 (5%), Referenced to phase 2:EBT and 6:WBT, Start of Yellow
Natural Cycle: 75
Control Type: Actuated-Coordinated

Splits and Phases: 11: Arizona Rd & Salt Lake Blvd

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	760	245	50	975	605	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Width	12	12	10	12	12	12
Grade (%)	8%			-10%	-2%	
Total Lost time (s)	6.0		5.0	6.0	5.0	
Lane Util. Factor	0.91		1.00	0.95	0.97	
Frpb, ped/bikes	0.99		1.00	1.00	1.00	
Flpb, ped/bikes	1.00		1.00	1.00	1.00	
Frt	0.96		1.00	1.00	0.99	
Flt Protected	1.00		0.95	1.00	0.96	
Satd. Flow (prot)	4668		1734	3716	3442	
Flt Permitted	1.00		0.95	1.00	0.96	
Satd. Flow (perm)	4668		1734	3716	3442	
Peak-hour factor, PHF	0.94	0.90	0.77	0.90	0.88	0.64
Adj. Flow (vph)	809	272	65	1083	688	62
RTOR Reduction (vph)	46	0	0	0	7	0
Lane Group Flow (vph)	1035	0	65	1083	743	0
Confl. Peds. (#/hr)		2				4
Turn Type	NA		Prot	NA	NA	
Protected Phases	2		1	6	4	
Permitted Phases						
Actuated Green, G (s)	57.6		8.3	70.9	28.1	
Effective Green, g (s)	57.6		8.3	70.9	28.1	
Actuated g/C Ratio	0.52		0.08	0.64	0.26	
Clearance Time (s)	6.0		5.0	6.0	5.0	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)	2444		131	2395	879	
v/s Ratio Prot	0.22		0.04	c0.29	c0.22	
v/s Ratio Perm						
v/c Ratio	0.42		0.50	0.45	0.85	
Uniform Delay, d1	16.0		48.8	9.8	38.9	
Progression Factor	1.38		1.00	1.00	1.00	
Incremental Delay, d2	0.5		2.9	0.6	7.5	
Delay (s)	22.6		51.8	10.4	46.4	
Level of Service	C		D	B	D	
Approach Delay (s)	22.6			12.8	46.4	
Approach LOS	C			B	D	

Intersection Summary			
HCM Average Control Delay	24.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	11.0
Intersection Capacity Utilization	57.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
CIVIL ENGINEERS • SURVEYORS

APPENDIX D

Church Driveway Analysis

SUMMARY OF TRIP GENERATION RATES

Land Use or Bldg. Type: **Church** ITE CODE: 560
Project Name: Island Family Christian Church
Location:

Independent Variable: 1000 SF GFA UNITS: **20** Assumed gross leasable area

			TRIP RATE	VOLUME (TRIP RATE)	VOLUME (BEST FIT EQUATION)	VARIABLE CORRELATION	%
AVERAGE WEEKDAY VEHICLE TRIP ENDS			9.11	183	N/A	R^2 = ****	
PEAK	A.M.	ENTER	0.37	**7**	N/A	R^2 = ****	62%
HOUR	between	EXIT	0.23	**5**	N/A		38%
OF	7 and 9	TOTAL	0.56	**12**	N/A		
ADJACENT	P.M.	ENTER	0.26	**5**	N/A	R^2 = ****	48%
STREET	Between	EXIT	0.29	**6**	N/A		52%
TRAFFIC	4 and 6	TOTAL	0.55	**11**	N/A		
PEAK	A.M.	ENTER	0.50	10	N/A	R^2 = ****	55%
HOUR		EXIT	0.41	8	N/A		45%
OF		TOTAL	0.87	18	N/A		
GENERATOR	P.M.	ENTER	0.51	10	15	R^2 = 0.63	54%
		EXIT	0.44	9	12		46%
		TOTAL	0.94	19	27		
SATURDAY VEHICLE TRIP ENDS			10.37	208	N/A	R^2 = ****	
PEAK		ENTER	2.52	50	N/A	R^2 = ****	71%
HOUR OF		EXIT	1.03	21	N/A		29%
GENERATOR		TOTAL	3.54	71	N/A		
SUNDAY VEHICLE TRIP ENDS			36.63	733	691	R^2 = 0.51	
PEAK		ENTER	5.90	118	133	R^2 = 0.71	50%
HOUR OF		EXIT	5.90	118	133		50%
GENERATOR		TOTAL	11.76	236	266		

Reference: ITE "Trip Generation," 8th Edition,2008
Comments:
A church is a building in which public worship service are held. A church houses an assembly hall or santuary; it may also house meeting rooms, classrooms and, occasionally, dining, catering, or party facilities.

Table 1D: Island Family Christian Church Access Analysis

Intersection	Base Year 2040						Year 2040 with Widening					
	AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
Salt Lake Boulevard/New Church Right-in/Right-out Access												
EB TH/RT	0	0.78	A	0	0.68	A	0	0.52	A	0	0.45	A
NB RT	47	0.16	E	24	0.08	C	9	0.02	A	10	0.02	B

HCM Unsignalized Intersection Capacity Analysis
16: Island Family Christian Church & Salt Lake Blvd

6/29/2012

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	1210	15	0	1070	0	15
Sign Control	Free			Free	Stop	
Grade	0%			-2%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1315	16	0	1163	0	16
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	157			1284		
pX, platoon unblocked			0.33		0.43	0.33
vC, conflicting volume			1332		2486	1323
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			986		2748	962
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	84
cM capacity (veh/h)			230		9	102

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	1332	1163	16
Volume Left	0	0	0
Volume Right	16	0	16
cSH	1700	1700	102
Volume to Capacity	0.78	0.68	0.16
Queue Length 95th (ft)	0	0	14
Control Delay (s)	0.0	0.0	46.9
Lane LOS			E
Approach Delay (s)	0.0	0.0	46.9
Approach LOS			E

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	74.6%	ICU Level of Service	D
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
12: Island Family Christian Church & Salt Lake Blvd

6/29/2012

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	1050	15	0	1450	0	15
Sign Control	Free			Free	Stop	
Grade	0%			-2%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1141	16	0	1576	0	16
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	153			1288		
pX, platoon unblocked			0.71		0.72	0.71
vC, conflicting volume			1158		2726	1149
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1019		2302	1008
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	92
cM capacity (veh/h)			485		31	208

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	1158	1576	16
Volume Left	0	0	0
Volume Right	16	0	16
cSH	1700	1700	208
Volume to Capacity	0.68	0.93	0.08
Queue Length 95th (ft)	0	0	6
Control Delay (s)	0.0	0.0	23.8
Lane LOS			C
Approach Delay (s)	0.0	0.0	23.8
Approach LOS			C

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	106.9%	ICU Level of Service	G
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
14: Salt Lake Blvd

6/29/2012

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	1210	15	0	1070	0	15
Sign Control	Free			Free	Stop	
Grade	0%			-2%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1315	16	0	1163	0	16
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	181			1261		
pX, platoon unblocked			0.77		0.79	0.77
vC, conflicting volume			1332		1905	666
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			839		1458	0
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	98
cM capacity (veh/h)			611		94	837

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	877	455	582	582	16
Volume Left	0	0	0	0	0
Volume Right	0	16	0	0	16
cSH	1700	1700	1700	1700	837
Volume to Capacity	0.52	0.27	0.34	0.34	0.02
Queue Length 95th (ft)	0	0	0	0	1
Control Delay (s)	0.0	0.0	0.0	0.0	9.4
Lane LOS					A
Approach Delay (s)	0.0		0.0		9.4
Approach LOS					A

Intersection Summary				
Average Delay		0.1		
Intersection Capacity Utilization		43.9%	ICU Level of Service	A
Analysis Period (min)		15		

HCM Unsignalized Intersection Capacity Analysis
12: island Family Christian Church & Salt Lake Blvd

6/29/2012

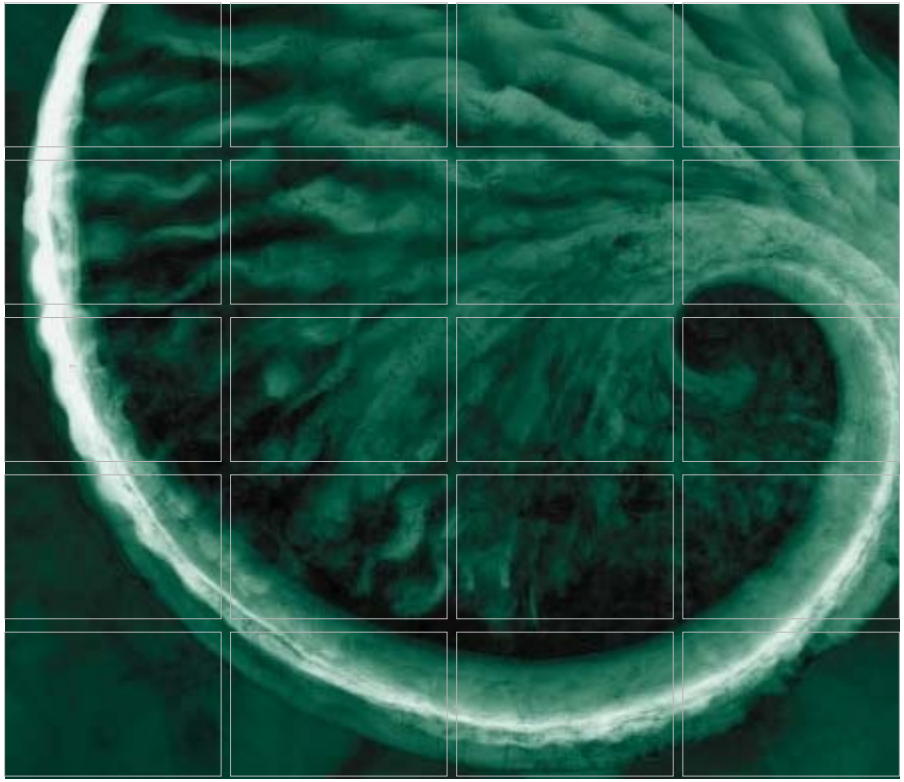
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	1050	15	0	1560	0	15
Sign Control	Free			Free	Stop	
Grade	0%			-2%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	1141	16	0	1696	0	16
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	136			1306		
pX, platoon unblocked			0.87		0.89	0.87
vC, conflicting volume			1158		1997	579
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			876		1200	209
tC, single (s)			4.1		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		100	98
cM capacity (veh/h)			665		158	692

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1
Volume Total	761	397	848	848	16
Volume Left	0	0	0	0	0
Volume Right	0	16	0	0	16
cSH	1700	1700	1700	1700	692
Volume to Capacity	0.45	0.23	0.50	0.50	0.02
Queue Length 95th (ft)	0	0	0	0	2
Control Delay (s)	0.0	0.0	0.0	0.0	10.3
Lane LOS					B
Approach Delay (s)	0.0		0.0		10.3
Approach LOS					B

Intersection Summary				
Average Delay		0.1		
Intersection Capacity Utilization		61.9%	ICU Level of Service	B
Analysis Period (min)		15		

Appendix C

Air Quality Monitoring Analysis Application



Prepared for:
Belt Collins Hawaii

Air Quality Modeling Analysis Application

Salt Lake Boulevard Widening Project

Belt Collins Hawaii
Honolulu, Hawaii

August 2012

www.erm.com

Delivering sustainable solutions in a more competitive world

Belt Collins

Air Quality Modeling Analysis Application

Salt Lake Boulevard Widening Project

August 2012

Project No. 0161242

John Koehler, Sc.D.
Program Director

Cheri Velzy
Project Manager

Environmental Resources Management
1277 Treat Blvd., Suite 500
Walnut Creek, California 94597
T: 925 946 0455
F: 925 946 9968

TABLE OF CONTENTS

LIST OF FIGURES		*ii*
LIST OF TABLES		*ii*
1.0	*INTRODUCTION*	*1*
2.0	*ANALYSIS METHODOLOGY*	*2*
2.1	*MODEL SELECTION*	*2*
2.2	*INTERSECTION SELECTION FOR MODELING ANALYSIS*	*2*
2.3	*MODEL INPUTS*	*3*
2.4	*RESULTS AND RECOMMENDATIONS*	*7*
3.0	*REFERENCES*	*10*

APPENDIX A – CAL3QHC MODEL OUTPUT FILES

LIST OF FIGURES

Figure 1 Locations of Intersections Modeled for Carbon Monoxide Analysis

LIST OF TABLES

Table 1: Model Inputs Summary	*Page 4*
Table 2: Model Output Summary	*Page 8*
Table 3: Criteria Pollutant Emissions	*Page 9*

1.0 INTRODUCTION

As part of the City and County of Honolulu Department of Design and Construction (DDC) traffic analyses of the roadway improvements along Salt Lake Boulevard on the island of Oahu, Belt Collins Hawaii has requested ERM to perform a traffic impact air quality analysis and summary in order to evaluate the impact of the proposed road widening project (Figure 1). The project site includes the roadway portion of Salt Lake Boulevard between Maluna Street and Ala Lilikoi Street. Hereinafter, "Project" shall refer to the proposed widening of Salt Lake Boulevard.

This report describes the carbon monoxide (CO) hot spot analysis that was performed on five intersections along Salt Lake Boulevard to evaluate the impacts of the proposed Project on ambient CO concentrations. Results of the air quality modeling were compared to the Hawaii and National Ambient Standards. Other criteria pollutants emissions including sulfur dioxide (SO_2), total particulate matter (PM), and volatile organic compounds (VOCs) were also calculated and presented in Section 2.4.

2.0 ANALYSIS METHODOLOGY

2.1 MODEL SELECTION

An air dispersion model is a computer model that simulates the transport and dispersion of air pollutant plumes from emission sources to estimate potential air pollutant concentrations at specified distances from the emission sources. There are many air dispersion models that have been developed for different applications. The EPA-recommended CAL3QHC dispersion model was used for this analysis. The CAL3QHC is a Gaussian line-source dispersion model developed by the EPA to estimate CO and particulate matter concentrations at locations (receptors) near roadway intersections from vehicles traveling on roadways. The CAL3QHC dispersion model can estimate emission concentrations from both free-flowing and idling vehicles and can be run for just one worst-case meteorological condition, which serves the purpose of hot-spot analysis because it is based on the highest hour of traffic in the day (peak-hour traffic). The model inputs include traffic counts for peak hour, gram-per-mile emission factors, worst-case meteorological data, roadway link and receptor coordinates, and traffic signal details such as signal cycle length, red phase length, clearance lost time, saturation flow rate, signal type and arrival type.

2.2 INTERSECTION SELECTION FOR MODELING ANALYSIS

The CO dispersion modeling was performed for the following intersections (Figure 1) that will be affected by the proposed Project based on the July 2012 traffic impact analysis report (Austin, Tsutsumi & Associate, 2012):

- Intersection 5 – Wanaka Street/Salt Lake Boulevard
- Intersection 6 – Radford Drive/Likini Place/Salt Lake Boulevard
- Intersection 7 – Kahikolu Place/Salt Lake Boulevard
- Intersection 8 – Salt Lake Shopping Center Driveway 1/Salt Lake Boulevard/Aliamanu School Parking Lot
- Intersection 9 – Salt Lake Shopping Center Driveway 2/Aliamanu Elementary/Middle School Driveway/Salt Lake Boulevard

The CO concentrations were modeled for two scenarios. The modeled scenarios include:

1. Salt Lake Boulevard widening with raised medians; and
2. Salt Lake Boulevard widening without raised medians.

The CAL3QHC dispersion model is used to estimate pollutant concentrations at signalized roadway intersections. Signalized intersections typically have longer vehicle queues, resulting in higher idling emissions. The analysis was performed following the guidelines contained in model's user manual and in the EPA *Guidelines for Modeling Carbon Monoxide from Roadway Intersections*[1]. The guidelines provide ranking and selection criteria to select signalized intersections for modeling. In general, the guidelines state that the top three intersections with highest traffic volumes or intersections experiencing congestion at level of service (LOS) D, E, or F must be analyzed to evaluate CO concentrations for comparison to ambient air quality standards.

Intersections 5, 6, and 7 are the only signalized intersections out of the five affected intersections. The proposed project would improve the overall LOS at these intersections from F (LOS for year-2040 base case) to C or better (LOS for year-2040 for project with or without raised medians). Based on the selection criteria in the EPA guidelines, none of the affected intersections need to be analyzed. Nevertheless, intersections 5, 6, and 7 were selected for evaluation in this air quality assessment.

2.3 *MODEL INPUTS*

Peak hour vehicle volumes for the year 2040 at intersections 5, 6 and 7 and other intersection-specific data for each scenario were obtained from the traffic study for the project - *Traffic Impact Analysis Report Salt Lake Boulevard Widening, Draft, July 2012*.

The Cartesian (X, Y) coordinates for roadway links and receptors at each intersection were estimated relative to a hypothetical center point at the intersection by fixing the center point and using the widths and the alignment/configuration of the roadway links provided in the traffic study and Google Earth. As recommended in the EPA guidelines, the

[1] US EPA, *Guidelines for Modeling Carbon Monoxide from Roadway Intersections*, EPA-454/R-92-005, November 1992.

free-flow links were assumed to span from the intersection of interest to the next or previous intersection.

Emission factors for input to the CAL3QHC dispersion model were obtained from the National Mobile Inventory Model (NMIM). The NMIM is an application developed by EPA to estimate current and future emission inventories for on-road motor vehicles and non-road equipment. NMIM uses current versions of MOBILE6 and NONROAD to calculate emission inventories, but contains many default values for given areas. Although MOVES has replaced MOBILE6 as EPA's emissions model, information for Hawaii was not available for MOVES, therefore NMIM was used in its place.

As recommended in the dispersion model's user manual and EPA guidelines, a conservative wind speed of 1.0 meters per second and atmospheric stability class D, along with peak hour vehicle volumes, were used to predict the maximum hourly concentrations, based on the wind angle that produces the highest result. Eight-hour concentrations are derived from the modeled 1-hour concentrations by applying a persistence factor of 0.7[2].

The 1-hour background CO concentrations were obtained from the most recent (year 2010) monitoring data at the Honolulu monitoring station and were used for the dispersion model. The highest 1-hour background monitored value included in the model is 1.8 ppm[3]. Table 1 summarizes various input parameters and their sources.

Table 1: Model Inputs Summary

Input Parameter	Value	Basis	Source
Averaging Time	60 min	1- hour ambient air quality standard for CO	-NA-
Surface Roughness	108 cm	City land use - single family residential from Google Earth image	Table 1, CAL3QHC user manual.
Settling Velocity	0 cm/s	Applicable for particulate matter only	-NA-

[2] US EPA, *Guidelines for Modeling Carbon Monoxide From Roadway Intersections*, EPA-454/R-92-005, 1992.

[3] State of Hawaii Annual Summary 2010 Air Quality Data, September 2011.

Input Parameter	Value	Basis	Source
Deposition Velocity	0 cm/s	Applicable for particulate matter only	-NA-
Receptor (X, Y) Coordinates (m)	Vary with intersection	Receptors located at 3m, 25m, 50 m from the edge of travelled roadway in both directions	EPA Guidelines (Guidelines for Modeling Carbon Monoxide From Roadway Intersections, 1992)
Receptor Height (Z Coordinate)	1.8 m/6 ft	Typical breathing height for receptor at ground level	EPA Guidelines/CAL3QHC User manual
Link Type	At-Grade	-NA-	Verbal communication with traffic consultant
Link Start (X_1, Y_1) Coordinates	Vary	-NA-	Lane width and alignment from traffic study
Link End (X_2, Y_2) Coordinates	Vary	EPA Guidelines' recommendation for link length	Lane width and alignment from traffic study and c/c distance from intersection of interest to next intersection from Google Earth
Traffic Volume on Each Link	Vary	Peak hour (PM peak)	Traffic study
Emission Factor	9.3 g/ veh-mile	Average vehicle speed of 25 mph, the defaults in NMIM, and a VMT mix from the Hawaii Department of Transportation	National Mobile Inventory Model (NMIM)
Idle Emission factor	81.6 g/ veh-hr	Average vehicle speed of 2.5 mph, the defaults in NMIM, and a VMT mix from the Hawaii Department of Transportation	NMIM
Source Height	0 m/0 ft	for at-grade roadways	EPA Guidelines/ CAL3QHC User manual
Mixing Zone Width	For queue link - Width of the travelled roadway. For free-flow link - width of the travelled roadway +	3 m (10 ft) on each side of the travelled roadway are added to account for the mixing zone created by the wake of moving vehicles.	EPA Guidelines/ CAL3QHC User manual

Input Parameter	Value	Basis	Source
	3 m (10 ft) to either side		
Average Total Signal Cycle Length for Each Intersection [s]	Varies with intersection	-NA-	Traffic study
Average Red Total Signal Cycle Length for Each Approach [s]	Varies with approach and intersection	Red time for each approach = Total cycle length - green time for approach - yellow time for approach	Total cycle length, green phase time and yellow phase time obtained from Traffic study
Clearance Interval Lost Time	2 s	Default	EPA Guidelines/ CAL3QHC User manual
Saturation Flow Rate (SFR) [veh/hr/lane of effective green time]	Varies with approach and intersection	Saturation flow rate (protected) ÷ Number of lanes in approach link	Traffic study
Signal type	2	Intersections 5, 6, and 7 are actuated	Traffic study
Arrival Type Rating	Varies with approach and intersection	Each approach was rated based on the LOS. LOS E/F = 1 LOS D = 2 LOS C = 3 LOS B = 4 LOS A = 5	Los obtained from traffic study
Wind Speed	1 m/s	Default worst-case. Model has not been validated for wind speeds below 1 m/s	EPA Guidelines/ CAL3QHC User manual
Wind Direction	Varies	All wind directions from 0 to 360° at an increment of 10° were modeled to capture the wind angle that produces the highest result.	EPA Guidelines
Stability Class	D (4)	Default for urban area	EPA Guidelines/ CAL3QHC User manual
Mixing Height	1000 m	Default	EPA Guidelines/ CAL3QHC User manual
Ambient background Concentration	1.8 ppm	Max 1-hour concentration monitored for year 2010	State of Hawaii Annual Summary 2010 Air Quality Data, September 2011

Note: -NA- = Not Applicable

2.4 RESULTS AND RECOMMENDATIONS

The predominant pollutant associated with automobile exhaust is CO. Although the ambient CO concentrations have decreased substantially over the past years due to improvements in fuel efficiency and reformulated gasoline, in spite of increase in regional traffic volume, elevated CO concentrations occur near congested intersections due mainly to a large number of vehicles moving slowly or idling. The Salt Lake Boulevard road-widening project would improve traffic progression along Salt Lake Boulevard due to the additional lanes and as a result also improve traffic operations along the minor approaches. As noted above, due to the Project, the overall LOS at the affected intersections would improve from a projected year-2040 base case LOS of F to C or better. The LOS traffic volumes and other traffic signal details used in the modeling were obtained from the traffic analysis performed by Austin, Tsutsumi & Associates, Inc. - *Traffic Impact Analysis Report Salt Lake Boulevard Widening, Draft, July 2012.*

The assumptions used in the dispersion model are conservative; that is, the modeled concentrations (including background) would likely not be reached in an actual traffic scenario along Salt Lake Boulevard. The conservative assumptions include use of lowest wind speed and most stable atmospheric condition, and use of the wind angle that produces the highest concentration regardless of the actual climatological wind patterns for the area. In addition and for the purposes of reporting total CO concentrations with ambient background added in, the highest monitored background 1- and 8-hour values of 1.8 ppm and 0.8 ppm, respectively, were used. The predicted CO concentrations at the Project area, even with the conservative assumptions, are estimated below state ambient standards thereby resulting in a less-than-significant impact (Table 2).

Emissions of all the criteria pollutants were also calculated based on the peak-hour volumes and distances traveled around the three analyzed intersections. The emissions are summarized in Table 3 below. There would be no difference in peak-hour volumes between the Project scenarios and future No Project scenario, but the Project would improve traffic flow and LOS, thus resulting in a less-than-significant impact.

Table 2: Model Output Summary

Predicted CO Concentrations Including Background from Intersections Affected by the Proposed Project (ppm)[1]				
Intersection	**Year 2040 With Road Widening and Raised Medians**		**Year 2040 With Road Widening and Without Raised Medians**	
	1-Hour	**8-Hour**	**1-Hour**	**8-Hour**
Intersection 5 – Wanaka Street/Salt Lake Boulevard - PM Peak	3.3	1.9	3.1	1.7
Intersection 6 – Radford Drive/Likini Place/Salt Lake Boulevard - PM Peak	3.6	2.1	3.6	2.1
Intersection 7 – Kahikolu Place/Salt Lake Boulevard - PM Peak	3.4	1.9	2.8	1.5
National Ambient Air Quality Standard	35	9	35	9
State Ambient Air Quality Standard	9	4.4	9	4.4

Notes:
1. Concentrations include 1-hour and 8-hour background levels of 1.8 ppm and 0.8 ppm, respectively.

Table 3: Criteria Pollutant Emissions

	Scenario 1 - Maximum Hourly Running Emissions for Project with Raised Median (lb/hr)			Scenario 2 - Maximum Hourly Running Emissions for Project without Raised Median (lb/hr)		
Pollutant	**Intersection # 5**	**Intersection # 6**	**Intersection # 7**	**Intersection # 5**	**Intersection # 6**	**Intersection # 7**
VOC	0.0318	0.0589	0.0300	0.0312	0.0580	0.0298
CO	0.5254	0.9733	0.4947	0.5160	0.9578	0.4920
NOX	0.0148	0.0275	0.0140	0.0146	0.0270	0.0139
Total PM	0.0014	0.0027	0.0014	0.0014	0.0026	0.0013
SO2	0.0005	0.0009	0.0005	0.0005	0.0009	0.0005

3.0 REFERENCES

Austin, Tsutsumi & Associates, Inc. 2012, *Traffic Impact Analysis Report Salt Lake Boulevard Widening, Draft*, July.

State of Hawaii Department of Health 2011, *State of Hawaii Annual Summary 2010 Air Quality Data*, September.

US EPA 1995, *User's Guide to CAL3QHC Version 2.0: A Modeling Methodology for Predicting Pollutant Concentrations Near Roadway Intersections*, EPA-454/R-92-006 (Revised), September.

US EPA 1992, *Guidelines for Modeling Carbon Monoxide From Roadway Intersections*, EPA-454/R-92-005, November.

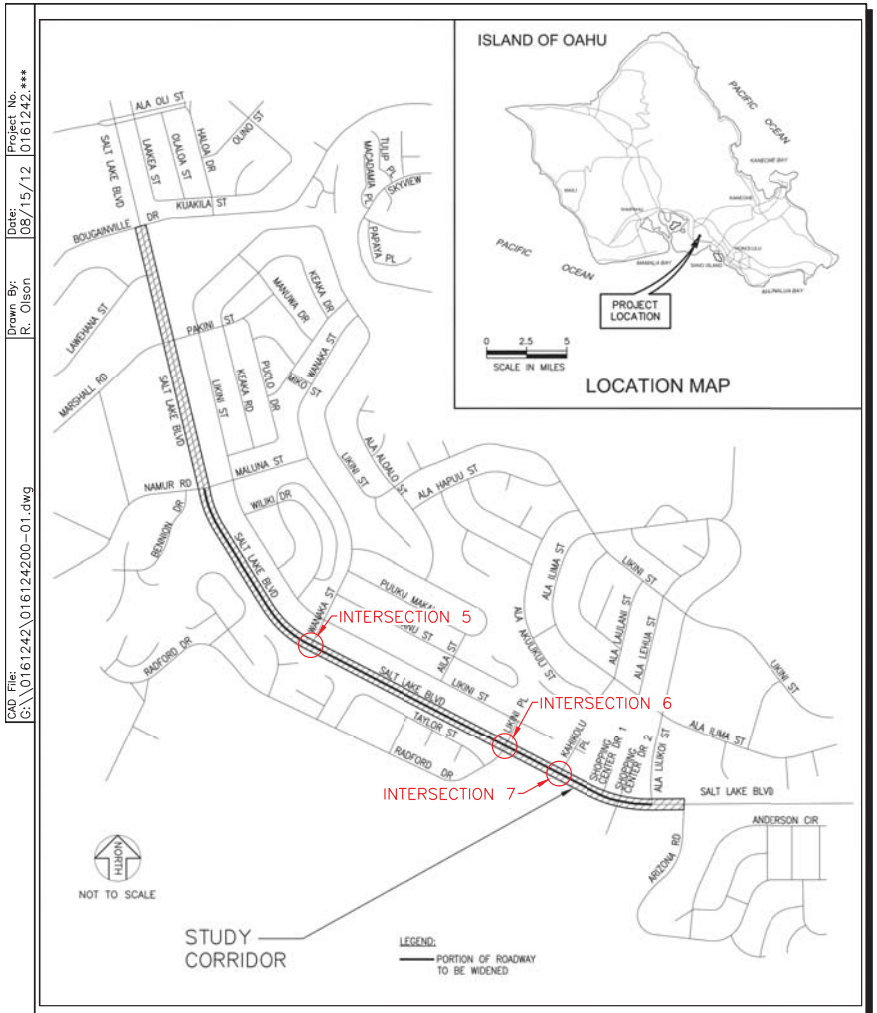


Figure 1
Locations of Intersections
Modeled for Carbon Monoxide Analysis
Salt Lake Blvd. Widening
Honolulu, Hawaii

Source: Austin, Tsutsumi & Associates

ERM 08/12

CAD File: G:\\0161242\016124200-01.dwg
Drawn By: R. Olson
Date: 08/15/12
Project No: 0161242.***

Appendix A
CAL3QHC Model Output Files

CAL3QHC: LINE SOURCE DISPERSION MODEL - VERSION 2.0 Dated 95221 PAGE 1

JOB: S L Blvd w/ Project w/o Raised Medians RUN: Intersection 5 PM Peak

DATE : 7/30/12
TIME : 12:30:26

The MODE flag has been set to C for calculating CO averages.

SITE & METEOROLOGICAL VARIABLES

VS = 0.0 CM/S VD = 0.0 CM/S Z0 = 108. CM
U = 1.0 M/S CLAS = 4 (D) ATIM = 60. MINUTES MIXH = 1000. M AMB = 1.8 PPM

LINK VARIABLES

LINK DESCRIPTION	*	LINK COORDINATES (FT) X1	Y1	X2	Y2	*	LENGTH (FT)	BRG (DEG)	TYPE	VPH	EF (G/MI)	H (FT)	W (FT)	V/C	QUEUE (VEH)
1. Wanaka App LT Q	*	-15.0	35.0	-15.0	63.7	*	29.	360.	AG	149.	100.0	0.0	10.0	0.14	1.5
2. Wanaka App RT FF	*	-34.0	40.0	-25.0	230.0	*	190.	3.	AG	65.	9.3	0.0	30.0		
3. Wanaka App FF	*	-15.0	230.0	-15.0	0.0	*	230.	180.	AG	70.	9.3	0.0	30.0		
4. Wanaka Dep FF	*	0.0	0.0	0.0	230.0	*	230.	360.	AG	250.	9.3	0.0	40.0		
5. SLB EB App St Q	*	-30.0	-21.0	-68.0	-15.7	*	38.	278.	AG	107.	100.0	0.0	28.0	0.22	2.0
6. SLB EB App LT Q	*	-30.0	-2.0	-45.5	-2.0	*	16.	270.	AG	54.	100.0	0.0	10.0	0.09	0.8
7. SLB EB App FF	*	-540.0	50.0	0.0	-21.0	*	545.	97.	AG	625.	9.3	0.0	48.0		
8. SLB EB Dep FF	*	0.0	-21.0	1900.0	-21.0	*	1900.	90.	AG	590.	9.3	0.0	48.0		
9. SLB WB App St/RT Q	*	45.0	18.0	122.8	18.0	*	78.	90.	AG	107.	100.0	0.0	22.0	0.65	4.0
10. SLB WB App FF	*	1900.0	18.0	0.0	18.0	*	1900.	270.	AG	1055.	9.3	0.0	42.0		
11. SLB WB Dep FF	*	0.0	18.0	-540.0	115.0	*	549.	280.	AG	975.	9.3	0.0	42.0		

JOB: S L Blvd w/ Project w/o Raised Medians RUN: Intersection 5 PM Peak

DATE : 7/30/12
TIME : 12:30:26

ADDITIONAL QUEUE LINK PARAMETERS

LINK DESCRIPTION	*	CYCLE LENGTH (SEC)	RED TIME (SEC)	CLEARANCE LOST TIME (SEC)	APPROACH VOL (VPH)	SATURATION FLOW RATE (VPH)	IDLE EM FAC (gm/hr)	SIGNAL TYPE	ARRIVAL RATE
1. Wanaka App LT Q	*	110	75	2.0	70	1718	81.60	2	2
5. SLB EB App St Q	*	110	27	2.0	520	1652	81.60	2	5
6. SLB EB App LT Q	*	110	27	2.0	105	1651	81.60	2	5
9. SLB WB App St/RT Q	*	110	27	2.0	1055	1122	81.60	2	5

RECEPTOR LOCATIONS

RECEPTOR	*	COORDINATES (FT) X	Y	Z	*
1. Rec 5-1	*	0.0	-45.0	6.0	*
2. Rec 5-2	*	-80.0	-45.0	6.0	*
3. Rec 5-3	*	-165.0	-45.0	6.0	*
4. Rec 5-4	*	80.0	-45.0	6.0	*

5. Rec 5-5	*	165.0	-45.0	6.0	*
6. Rec 5-6	*	20.0	40.0	6.0	*
7. Rec 5-7	*	90.0	40.0	6.0	*
8. Rec 5-8	*	175.0	40.0	6.0	*
9. Rec 5-9	*	-40.0	40.0	6.0	*
10. Rec 5-10	*	-110.0	40.0	6.0	*
11. Rec 5-11	*	-195.0	40.0	6.0	*
12. Rec 5-12	*	-40.0	110.0	6.0	*
13. Rec 5-13	*	-40.0	195.0	6.0	*
14. Rec 5-14	*	20.0	110.0	6.0	*
15. Rec 5-15	*	20.0	195.0	6.0	*

JOB: S L Blvd w/ Project w/o Raised Medians RUN: Intersection 5 PM Peak

MODEL RESULTS

REMARKS : In search of the angle corresponding to the maximum concentration, only the first angle, of the angles with same maximum concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-360.

WIND ANGLE (DEGR) * CONCENTRATION (PPM)

	REC1	REC2	REC3	REC4	REC5	REC6	REC7	REC8	REC9	REC10	REC11	REC12	REC13	REC14	REC15
0.	2.4	2.2	2.0	2.4	2.2	1.9	1.8	1.8	1.8	2.0	2.1	1.8	1.8	1.9	1.8
10.	2.2	2.3	2.0	2.4	2.2	1.8	1.8	1.8	1.8	2.0	2.1	1.8	1.8	1.8	1.8
20.	2.1	2.2	2.0	2.3	2.2	1.8	1.8	1.8	1.9	2.0	2.1	1.8	1.8	1.8	1.8
30.	2.3	2.3	2.0	2.3	2.2	1.8	1.8	1.8	2.0	2.0	2.1	1.9	1.8	1.8	1.8
40.	2.3	2.3	2.0	2.3	2.2	1.8	1.8	1.8	2.0	2.0	2.1	1.9	1.8	1.8	1.8
50.	2.3	2.4	2.1	2.2	2.2	1.8	1.8	1.8	2.2	2.0	2.1	1.9	1.8	1.8	1.8
60.	2.3	2.7	2.2	2.3	2.3	1.8	1.8	1.8	2.2	2.0	2.2	1.9	1.8	1.8	1.8
70.	2.5	2.4	2.3	2.4	2.4	1.9	1.9	1.9	2.4	2.1	2.2	1.9	1.9	1.8	1.8
80.	2.4	2.5	2.3	2.4	2.4	2.1	2.1	2.1	2.5	2.4	2.4	1.9	1.9	1.8	1.8
90.	2.3	2.3	2.2	2.3	2.3	2.5	2.4	2.4	2.9	2.9	2.6	2.0	2.0	1.9	1.9
100.	2.1	2.0	2.0	2.1	2.1	2.8	2.6	2.6	3.1	2.8	2.7	2.2	2.0	2.1	1.9
110.	1.9	1.8	1.8	1.9	1.9	2.8	2.6	2.5	2.9	2.6	2.6	2.2	2.1	2.1	2.0
120.	1.8	1.8	1.8	1.8	1.8	2.6	2.6	2.4	2.4	2.5	2.2	2.3	2.1	2.1	2.0
130.	1.8	1.8	1.8	1.8	1.8	2.5	2.5	2.3	2.3	2.3	2.1	2.3	2.1	2.2	2.0
140.	1.8	1.8	1.8	1.8	1.8	2.4	2.6	2.3	2.4	2.3	2.1	2.2	2.0	2.2	1.9
150.	1.8	1.8	1.8	1.8	1.8	2.2	2.5	2.2	2.2	2.2	2.1	2.3	2.0	2.1	1.9
160.	1.8	1.8	1.8	1.8	1.8	2.2	2.5	2.2	2.2	2.1	2.0	2.1	2.0	2.1	2.0
170.	1.8	1.8	1.8	1.8	1.8	2.2	2.5	2.2	2.3	2.1	2.0	2.1	1.9	2.0	1.9
180.	1.8	1.8	1.8	1.8	1.8	2.2	2.5	2.2	2.3	2.1	2.0	2.1	1.9	2.0	2.0
190.	1.8	1.8	1.8	1.8	1.8	2.3	2.5	2.2	2.3	2.1	2.0	2.0	1.9	2.1	2.0
200.	1.8	1.8	1.8	1.8	1.8	2.3	2.5	2.2	2.3	2.1	2.0	2.0	1.9	2.2	2.0
210.	1.8	1.8	1.8	1.8	1.8	2.3	2.5	2.2	2.3	2.1	2.0	2.0	2.0	2.2	2.0
220.	1.8	1.8	1.8	1.8	1.8	2.4	2.6	2.3	2.2	2.1	2.0	2.0	2.0	2.2	2.1
230.	1.8	1.8	1.8	1.8	1.8	2.5	2.6	2.3	2.2	2.2	2.1	2.0	2.0	2.1	2.1
240.	1.8	1.8	1.8	1.8	1.8	2.5	2.6	2.4	2.3	2.3	2.1	2.1	2.0	2.1	2.1
250.	1.8	1.8	1.8	1.8	1.8	2.5	2.6	2.7	2.5	2.4	2.1	2.1	1.9	2.2	2.0
260.	1.9	1.8	1.8	1.9	1.9	2.6	2.5	2.7	2.5	2.5	2.2	2.1	1.9	2.2	2.0
270.	2.0	1.9	1.8	2.0	2.2	2.7	2.3	2.4	2.5	2.5	2.4	1.9	1.8	2.0	1.9

280.	*	2.3	2.1	1.9	2.4	2.3	2.4	2.1	2.1	2.5	2.6	2.5	1.9	1.8	1.9	1.9
290.	*	2.5	2.1	2.1	2.3	2.5	2.3	2.0	1.9	2.2	2.4	2.4	1.8	1.8	1.9	1.9
300.	*	2.5	2.2	2.1	2.4	2.4	2.0	1.8	1.8	2.0	2.2	2.3	1.8	1.8	1.9	1.9
310.	*	2.3	2.2	2.2	2.2	2.3	2.0	1.8	1.8	1.9	2.1	2.3	1.8	1.8	1.9	1.9
320.	*	2.3	2.2	2.2	2.3	2.3	1.9	1.8	1.8	1.9	2.0	2.2	1.8	1.8	1.9	1.9
330.	*	2.2	2.2	2.1	2.3	2.3	1.9	1.8	1.8	1.9	2.0	2.1	1.8	1.8	1.9	1.9
340.	*	2.1	2.2	2.0	2.3	2.2	1.9	1.8	1.8	1.8	2.0	2.1	1.8	1.8	1.9	1.9
350.	*	2.2	2.2	2.0	2.3	2.2	1.9	1.8	1.8	1.8	2.0	2.1	1.8	1.8	1.9	1.8
360.	*	2.4	2.2	2.0	2.4	2.2	1.9	1.8	1.8	1.8	2.0	2.1	1.8	1.8	1.9	1.8
MAX	*	2.5	2.7	2.3	2.4	2.5	2.8	2.6	2.7	3.1	2.9	2.7	2.3	2.1	2.2	2.1
DEGR.	*	70	60	70	0	290	100	100	260	100	90	100	120	110	130	220

THE HIGHEST CONCENTRATION OF 3.10 PPM OCCURRED AT RECEPTOR REC9 .

CAL3QHC: LINE SOURCE DISPERSION MODEL - VERSION 2.0 Dated 95221 PAGE 1

JOB: S L Blvd w/ Project & Raised Medians RUN: Intersection 5 PM Peak

DATE : 7/30/12
TIME : 11:39:32

The MODE flag has been set to C for calculating CO averages.

SITE & METEOROLOGICAL VARIABLES

VS = 0.0 CM/S VD = 0.0 CM/S Z0 = 108. CM
U = 1.0 M/S CLAS = 4 (D) ATIM = 60. MINUTES MIXH = 1000. M AMB = 1.8 PPM

LINK VARIABLES

LINK DESCRIPTION	*	LINK COORDINATES (FT) X1	Y1	X2	Y2	*	LENGTH (FT)	BRG (DEG)	TYPE	VPH	EF (G/MI)	H (FT)	W (FT)	V/C	QUEUE (VEH)
1. Wanaka App LT Q	*	-15.0	35.0	-15.0	59.9	*	25.	360.	AG	142.	100.0	0.0	10.0	0.13	1.3
2. Wanaka App RT FF	*	-34.0	40.0	-25.0	230.0	*	190.	3.	AG	65.	9.3	0.0	30.0		
3. Wanaka App FF	*	-15.0	230.0	-15.0	0.0	*	230.	180.	AG	70.	9.3	0.0	30.0		
4. Wanaka Dep FF	*	0.0	0.0	0.0	230.0	*	230.	360.	AG	250.	9.3	0.0	40.0		
5. SLB EB App St Q	*	-30.0	-21.0	-93.4	-12.2	*	64.	278.	AG	197.	100.0	0.0	28.0	0.31	3.3
6. SLB EB App LT/U Q	*	-30.0	-2.0	-79.0	-2.0	*	49.	270.	AG	171.	100.0	0.0	10.0	0.39	2.5
7. SLB EB App FF	*	-540.0	50.0	0.0	-21.0	*	545.	97.	AG	635.	9.3	0.0	48.0		
8. SLB EB Dep FF	*	0.0	-21.0	1900.0	-21.0	*	1900.	90.	AG	605.	9.3	0.0	48.0		
9. SLB WB App St/RT Q	*	45.0	18.0	198.4	18.0	*	153.	90.	AG	197.	100.0	0.0	22.0	0.92	7.8
10. SLB WB App LT/U Q	*	45.0	2.0	52.0	2.0	*	7.	90.	AG	171.	100.0	0.0	10.0	0.06	0.4
11. SLB WB App FF	*	1900.0	18.0	0.0	18.0	*	1900.	270.	AG	1070.	9.3	0.0	42.0		
12. SLB WB Dep FF	*	0.0	18.0	-540.0	115.0	*	549.	280.	AG	985.	9.3	0.0	42.0		

JOB: S L Blvd w/ Project & Raised Medians RUN: Intersection 5 PM Peak

DATE : 7/30/12
TIME : 11:39:32

ADDITIONAL QUEUE LINK PARAMETERS

LINK DESCRIPTION	*	CYCLE LENGTH (SEC)	RED TIME (SEC)	CLEARANCE LOST TIME (SEC)	APPROACH VOL (VPH)	SATURATION FLOW RATE (VPH)	IDLE EM FAC (gm/hr)	SIGNAL TYPE	ARRIVAL RATE
1. Wanaka App LT Q	*	100	65	2.0	70	1718	81.60	2	2
5. SLB EB App St Q	*	100	45	2.0	520	1652	81.60	2	5
6. SLB EB App LT/U Q	*	100	78	2.0	115	1652	81.60	2	2
9. SLB WB App St/RT Q	*	100	45	2.0	1055	1122	81.60	2	4
10. SLB WB App LT/U Q	*	100	78	2.0	15	1297	81.60	2	1

RECEPTOR LOCATIONS

RECEPTOR	*	COORDINATES (FT) X	Y	Z	*
1. Rec 5-1	*	0.0	-45.0	6.0	*
2. Rec 5-2	*	-80.0	-45.0	6.0	*
3. Rec 5-3	*	-165.0	-45.0	6.0	*
4. Rec 5-4	*	80.0	-45.0	6.0	*
5. Rec 5-5	*	165.0	-45.0	6.0	*
6. Rec 5-6	*	20.0	40.0	6.0	*
7. Rec 5-7	*	90.0	40.0	6.0	*

8.	Rec 5-8	*	175.0	40.0	6.0 *
9.	Rec 5-9	*	-40.0	40.0	6.0 *
10.	Rec 5-10	*	-110.0	40.0	6.0 *
11.	Rec 5-11	*	-195.0	40.0	6.0 *
12.	Rec 5-12	*	-40.0	110.0	6.0 *
13.	Rec 5-13	*	-40.0	195.0	6.0 *
14.	Rec 5-14	*	20.0	110.0	6.0 *
15.	Rec 5-15	*	20.0	195.0	6.0 *

JOB: S L Blvd w/ Project & Raised Medians RUN: Intersection 5 PM Peak

MODEL RESULTS

REMARKS : In search of the angle corresponding to the maximum concentration, only the first angle, of the angles with same maximum concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-360.

WIND ANGLE (DEGR)	* CONCENTRATION (PPM) REC1	REC2	REC3	REC4	REC5	REC6	REC7	REC8	REC9	REC10	REC11	REC12	REC13	REC14	REC15
0.	* 2.3	2.8	2.0	2.5	2.5	1.9	1.8	1.8	1.8	2.0	2.1	1.8	1.8	1.9	1.8
10.	* 2.2	2.9	2.0	2.5	2.5	1.8	1.8	1.8	1.8	2.0	2.1	1.8	1.8	1.8	1.8
20.	* 2.1	2.9	2.0	2.5	2.4	1.8	1.8	1.8	1.9	2.0	2.1	1.8	1.8	1.8	1.8
30.	* 2.3	2.8	2.0	2.5	2.3	1.8	1.8	1.8	1.9	2.0	2.1	1.9	1.8	1.8	1.8
40.	* 2.4	2.8	2.1	2.5	2.3	1.8	1.8	1.8	2.0	2.0	2.1	1.9	1.8	1.8	1.8
50.	* 2.5	2.9	2.2	2.5	2.2	1.8	1.8	1.8	2.1	2.0	2.1	1.9	1.8	1.8	1.8
60.	* 2.5	3.0	2.4	2.5	2.3	1.8	1.8	1.8	2.2	2.0	2.2	1.9	1.8	1.8	1.8
70.	* 2.6	2.8	2.7	2.5	2.4	1.9	1.9	1.9	2.3	2.1	2.3	1.9	1.9	1.8	1.8
80.	* 2.6	2.6	2.6	2.5	2.5	2.2	2.2	2.1	2.5	2.5	2.5	1.9	1.9	1.8	1.8
90.	* 2.3	2.4	2.4	2.3	2.3	2.8	2.7	2.4	3.0	2.8	2.8	2.0	2.0	1.9	1.9
100.	* 2.1	2.0	2.0	2.1	2.1	3.2	3.0	2.6	3.2	2.9	3.0	2.3	2.1	2.1	1.9
110.	* 1.9	1.8	1.8	1.9	1.9	3.1	3.1	2.6	3.0	2.9	2.8	2.3	2.1	2.2	2.0
120.	* 1.8	1.8	1.8	1.8	1.8	2.9	3.1	2.6	2.5	2.8	2.3	2.4	2.2	2.3	2.0
130.	* 1.8	1.8	1.8	1.8	1.8	2.6	3.0	2.6	2.3	2.7	2.2	2.4	2.2	2.3	2.1
140.	* 1.8	1.8	1.8	1.8	1.8	2.5	2.9	2.7	2.4	2.7	2.1	2.2	2.2	2.3	2.1
150.	* 1.8	1.8	1.8	1.8	1.8	2.3	2.8	2.7	2.2	2.6	2.1	2.3	2.1	2.2	2.0
160.	* 1.8	1.8	1.8	1.8	1.8	2.2	2.8	2.7	2.4	2.3	2.0	2.1	2.1	2.1	2.0
170.	* 1.8	1.8	1.8	1.8	1.8	2.2	2.7	2.7	2.5	2.2	2.0	2.2	1.9	2.1	2.0
180.	* 1.8	1.8	1.8	1.8	1.8	2.2	2.7	2.7	2.6	2.1	2.0	2.2	2.0	2.1	2.0
190.	* 1.8	1.8	1.8	1.8	1.8	2.3	2.7	2.7	2.7	2.1	2.0	2.2	2.0	2.1	2.0
200.	* 1.8	1.8	1.8	1.8	1.8	2.4	2.7	2.8	2.7	2.1	2.0	2.2	2.0	2.3	2.1
210.	* 1.8	1.8	1.8	1.8	1.8	2.5	2.8	2.8	2.7	2.1	2.0	2.1	2.0	2.4	2.2
220.	* 1.8	1.8	1.8	1.8	1.8	2.6	2.9	2.9	2.6	2.1	2.0	2.0	2.0	2.4	2.1
230.	* 1.8	1.8	1.8	1.8	1.8	2.7	2.8	3.0	2.4	2.2	2.1	2.1	2.0	2.2	2.1
240.	* 1.8	1.8	1.8	1.8	1.8	2.8	3.0	3.0	2.4	2.3	2.1	2.1	2.0	2.2	2.1
250.	* 1.8	1.8	1.8	1.8	1.8	2.7	2.9	3.3	2.5	2.4	2.1	2.1	1.9	2.2	2.0
260.	* 1.9	1.8	1.8	1.9	1.9	2.8	2.8	3.1	2.5	2.5	2.2	2.1	1.9	2.2	2.0
270.	* 2.1	1.9	1.8	2.1	2.3	2.7	2.4	2.6	2.5	2.5	2.4	1.9	1.8	2.0	1.9
280.	* 2.5	2.1	1.9	2.5	2.4	2.5	2.1	2.2	2.5	2.6	2.5	1.9	1.8	1.9	1.9
290.	* 2.8	2.1	2.1	2.5	2.5	2.3	2.0	1.9	2.2	2.4	2.4	1.8	1.8	1.9	1.9
300.	* 2.9	2.2	2.1	2.5	2.5	2.0	1.8	1.8	2.0	2.2	2.3	1.8	1.8	1.9	1.9
310.	* 2.7	2.3	2.2	2.2	2.5	2.0	1.8	1.8	1.9	2.1	2.3	1.8	1.8	1.9	1.9
320.	* 2.5	2.3	2.2	2.4	2.5	1.9	1.8	1.8	1.9	2.0	2.2	1.8	1.8	1.9	1.9
330.	* 2.4	2.4	2.1	2.3	2.5	1.9	1.8	1.8	1.9	2.0	2.1	1.8	1.8	1.9	1.9
340.	* 2.1	2.5	2.0	2.4	2.5	1.9	1.8	1.8	1.8	2.0	2.1	1.8	1.8	1.9	1.9
350.	* 2.3	2.7	2.0	2.5	2.5	1.9	1.8	1.8	1.8	2.0	2.1	1.8	1.8	1.9	1.8

360.	* 2.3	2.8	2.0	2.5	2.5	1.9	1.8	1.8	1.8	2.0	2.1	1.8	1.8	1.9	1.8
MAX	* 2.9	3.0	2.7	2.5	2.5	3.2	3.1	3.3	3.2	2.9	3.0	2.4	2.2	2.4	2.2
DEGR.	* 300	60	70	0	0	100	110	250	100	100	100	120	120	210	210

THE HIGHEST CONCENTRATION OF 3.30 PPM OCCURRED AT RECEPTOR REC8 .

CAL3QHC: LINE SOURCE DISPERSION MODEL - VERSION 2.0 Dated 95221 PAGE 1

JOB: S L Blvd w/ Project w/o Raised Medians RUN: Intersection 6 PM Peak

DATE : 7/30/12
TIME : 12:46: 9

The MODE flag has been set to C for calculating CO averages.

SITE & METEOROLOGICAL VARIABLES

VS = 0.0 CM/S VD = 0.0 CM/S Z0 = 108. CM
U = 1.0 M/S CLAS = 4 (D) ATIM = 60. MINUTES MIXH = 1000. M AMB = 1.8 PPM

LINK VARIABLES

LINK DESCRIPTION	* LINK COORDINATES (FT) X1	Y1	X2	Y2	* LENGTH (FT)	BRG (DEG)	TYPE	VPH	EF (G/MI)	H (FT)	W (FT)	V/C	QUEUE (VEH)
1. Likini App Q	-15.0	50.0	-15.0	89.4	39.	360.	AG	143.	100.0	0.0	10.0	0.18	2.0
2. Likini App FF	-15.0	265.0	-15.0	0.0	265.	180.	AG	100.	9.3	0.0	30.0		
3. Likini Dep FF	-5.0	0.0	-5.0	265.0	265.	360.	AG	130.	9.3	0.0	30.0		
4. SLB EB App St/RT Q	-55.0	-21.0	-142.5	-21.0	88.	270.	AG	211.	100.0	0.0	28.0	0.36	4.4
5. SLB EB App LT Q	-55.0	-2.0	-58.0	-2.0	3.	270.	AG	189.	100.0	0.0	10.0	0.03	0.2
6. SLB EB App FF	-2000.0	-21.0	0.0	-21.0	2000.	90.	AG	610.	9.3	0.0	48.0		
7. SLB EB Dep FF	0.0	-14.0	570.0	-14.0	570.	90.	AG	1050.	9.3	0.0	48.0		
8. SLB WB App St/RT Q	45.0	25.0	172.5	25.0	127.	90.	AG	167.	100.0	0.0	22.0	0.54	6.5
9. SLB WB App LT Q	45.0	9.0	174.3	9.0	129.	90.	AG	167.	100.0	0.0	10.0	0.76	6.6
10. SLB WB App FF	570.0	25.0	0.0	25.0	570.	270.	AG	1380.	9.3	0.0	42.0		
11. SLB WB Dep FF	0.0	18.0	-2000.0	18.0	2000.	270.	AG	1095.	9.3	0.0	42.0		
12. Radford App St/LT Q	5.0	-50.0	5.0	-89.4	39.	180.	AG	143.	100.0	0.0	10.0	0.18	2.0
13. Radford App RT FF	5.0	-200.0	45.0	-35.0	170.	14.	AG	420.	9.3	0.0	30.0		
14. Radford App FF	5.0	-200.0	5.0	0.0	200.	360.	AG	100.	9.3	0.0	30.0		
15. Radford Dep FF	-5.0	0.0	-5.0	-200.0	200.	180.	AG	335.	9.3	0.0	30.0		

PAGE 2

JOB: S L Blvd w/ Project w/o Raised Medians RUN: Intersection 6 PM Peak

DATE : 7/30/12
TIME : 12:46: 9

ADDITIONAL QUEUE LINK PARAMETERS

LINK DESCRIPTION	* CYCLE LENGTH (SEC)	RED TIME (SEC)	CLEARANCE LOST TIME (SEC)	APPROACH VOL (VPH)	SATURATION FLOW RATE (VPH)	IDLE EM FAC (gm/hr)	SIGNAL TYPE	ARRIVAL RATE
1. Likini App Q	110	72	2.0	100	1820	81.60	2	2
4. SLB EB App St/RT Q	110	53	2.0	605	1729	81.60	2	3
5. SLB EB App LT Q	110	95	2.0	5	1761	81.60	2	1
8. SLB WB App St/RT Q	110	42	2.0	1110	1758	81.60	2	5
9. SLB WB App LT Q	110	84	2.0	270	1787	81.60	2	2
12. Radford App St/LT Q	110	72	2.0	100	1777	81.60	2	2

RECEPTOR LOCATIONS

RECEPTOR	* COORDINATES (FT) X	Y	Z
1. Rec 6-1	-20.0	-45.0	6.0
2. Rec 6-2	-90.0	-45.0	6.0
3. Rec 6-3	-175.0	-45.0	6.0
4. Rec 6-4	65.0	-40.0	6.0
5. Rec 6-5	125.0	-40.0	6.0
6. Rec 6-6	210.0	-40.0	6.0
7. Rec 6-7	10.0	46.0	6.0
8. Rec 6-8	80.0	46.0	6.0
9. Rec 6-9	165.0	46.0	6.0
10. Rec 6-10	-30.0	40.0	6.0
11. Rec 6-11	-100.0	40.0	6.0
12. Rec 6-12	-185.0	40.0	6.0
13. Rec 6-13	-30.0	110.0	6.0
14. Rec 6-14	-30.0	195.0	6.0
15. Rec 6-15	10.0	116.0	6.0
16. Rec 6-16	10.0	201.0	6.0
17. Rec 6-17	20.0	-110.0	6.0
18. Rec 6-18	20.0	-195.0	6.0
19. Rec 6-19	-20.0	-115.0	6.0
20. Rec 6-20	-20.0	-200.0	6.0

PAGE 3

JOB: S L Blvd w/ Project w/o Raised Medians RUN: Intersection 6 PM Peak

MODEL RESULTS

REMARKS : In search of the angle corresponding to the maximum concentration, only the first angle, of the angles with same maximum concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-360.

WIND ANGLE (DEGR)	* CONCENTRATION (PPM) REC1	REC2	REC3	REC4	REC5	REC6	REC7	REC8	REC9	REC10	REC11	REC12	REC13	REC14	REC15	REC16	REC17	REC18	REC19	REC20
0.	2.4	2.8	2.2	2.7	2.7	2.3	1.9	1.8	1.8	1.9	1.8	1.8	1.8	1.8	1.9	1.8	2.3	2.4	2.1	2.0
10.	2.4	2.8	2.2	2.7	2.7	2.3	1.8	1.8	1.8	2.1	1.8	1.8	1.9	1.8	1.8	1.8	2.4	2.4	2.4	2.4
20.	2.4	2.8	2.2	2.7	2.7	2.3	1.8	1.8	1.8	2.2	1.8	1.8	1.9	1.8	1.8	1.8	2.4	2.3	2.5	2.5
30.	2.3	2.8	2.3	2.8	2.7	2.3	1.8	1.8	1.8	2.1	1.8	1.8	1.8	1.8	1.8	1.8	2.5	2.3	2.6	2.5
40.	2.6	2.9	2.3	2.7	2.6	2.3	1.8	1.8	1.8	2.1	1.8	1.8	1.8	1.8	1.8	1.8	2.6	2.0	2.7	2.4
50.	2.8	2.7	2.5	2.9	2.6	2.5	1.8	1.8	1.8	2.0	1.8	1.8	1.8	1.8	1.8	1.8	2.6	2.0	2.7	2.2
60.	3.0	3.0	2.7	2.8	2.5	2.5	1.9	1.9	1.9	2.0	1.9	1.8	1.8	1.8	1.8	1.8	2.3	2.0	2.7	2.2
70.	3.1	2.8	3.2	2.8	2.6	2.6	1.9	1.9	1.9	2.0	2.1	1.9	1.8	1.8	1.8	1.8	2.2	2.0	2.3	2.2
80.	2.8	2.8	3.2	2.5	2.5	2.5	2.2	2.2	2.1	2.3	2.3	2.1	1.8	1.8	1.8	1.8	2.1	1.8	2.2	2.0
90.	2.4	2.3	2.5	2.3	2.3	2.3	2.9	2.7	2.5	2.9	2.7	2.7	1.9	1.8	1.9	1.8	1.9	1.8	2.0	2.0
100.	2.2	2.1	2.1	2.0	2.0	2.0	3.4	3.3	2.7	3.3	2.9	2.9	2.1	1.9	2.1	1.8	1.9	1.8	2.0	1.8
110.	2.2	1.9	1.8	1.9	1.9	1.9	3.5	3.4	2.7	3.1	2.8	2.8	2.3	2.0	2.2	2.0	1.9	1.8	2.0	1.8
120.	2.2	1.8	1.8	1.8	1.8	1.8	3.2	3.4	2.6	2.7	2.5	2.7	2.4	2.0	2.3	2.0	1.9	1.8	2.0	1.8
130.	2.3	1.8	1.8	1.8	1.8	1.8	2.9	3.4	2.5	2.5	2.5	2.6	2.5	2.1	2.4	2.0	1.9	1.8	2.0	1.8
140.	2.2	1.8	1.8	1.8	1.8	1.8	2.7	3.3	2.6	2.4	2.5	2.5	2.5	2.2	2.4	2.2	1.9	1.8	2.0	1.8
150.	2.3	1.8	1.8	1.8	1.8	1.8	2.5	3.2	2.5	2.3	2.4	2.3	2.2	2.2	2.3	2.2	1.9	1.8	2.0	1.8
160.	2.2	1.8	1.8	1.8	1.8	1.8	2.4	3.1	2.7	2.5	2.5	2.3	2.4	2.2	2.3	2.2	2.0	1.8	2.0	1.8

170.	*	2.0	1.8	1.8	1.8	1.8	1.8	2.5	3.2	2.9	2.4	2.5	2.2	2.2	2.1	2.1	2.1	2.0	1.8	1.9	1.8
180.	*	1.9	1.8	1.8	1.8	1.8	1.8	2.6	3.2	3.0	2.3	2.5	2.2	2.1	2.0	2.0	2.0	2.0	1.8	1.9	1.8
190.	*	1.9	1.8	1.8	1.9	1.8	1.8	2.6	3.3	3.0	2.3	2.5	2.2	2.1	2.0	2.2	2.1	2.1	1.8	1.9	1.8
200.	*	1.8	1.8	1.8	1.9	1.8	1.8	2.5	3.2	3.2	2.4	2.5	2.2	2.2	2.0	2.4	2.1	2.1	1.8	1.8	1.8
210.	*	1.8	1.8	1.8	2.0	1.8	1.8	2.4	3.2	3.2	2.4	2.4	2.2	2.3	2.0	2.4	2.1	2.0	1.8	1.8	1.8
220.	*	1.8	1.8	1.8	2.1	1.8	1.8	2.5	3.2	3.3	2.6	2.4	2.3	2.2	2.0	2.5	2.1	2.0	1.8	1.8	1.8
230.	*	1.8	1.8	1.8	2.2	1.9	1.8	2.5	3.0	3.4	2.6	2.4	2.3	2.2	2.0	2.3	2.0	2.0	1.9	1.8	1.8
240.	*	1.8	1.8	1.8	2.0	1.9	1.8	2.6	3.0	3.5	2.6	2.4	2.4	2.1	2.0	2.1	2.0	1.9	1.9	1.8	1.8
250.	*	1.9	1.9	1.9	2.0	2.0	1.9	2.7	2.9	3.6	2.7	2.6	2.6	2.1	2.0	2.1	2.0	1.9	1.9	1.8	1.8
260.	*	2.2	2.1	2.1	2.4	2.3	2.2	2.6	2.8	3.4	2.7	2.7	2.7	2.1	2.0	2.1	2.0	1.9	1.9	1.8	1.8
270.	*	2.6	2.4	2.3	2.7	2.5	2.5	2.4	2.6	2.8	2.5	2.5	2.5	1.9	1.9	1.9	1.9	2.1	2.0	2.0	1.8
280.	*	2.9	2.7	2.5	2.8	2.5	2.9	2.1	2.3	2.2	2.1	2.1	2.1	1.8	1.8	1.8	1.8	2.2	2.2	2.0	2.0
290.	*	2.9	2.8	2.4	2.6	2.8	2.9	2.0	2.0	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8	2.3	2.2	2.1	2.0
300.	*	2.7	2.9	2.3	2.4	2.7	2.8	2.0	1.9	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	2.3	2.2	2.1	2.0
310.	*	2.5	2.8	2.2	2.3	2.8	2.9	2.1	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	2.4	2.3	2.2	2.0
320.	*	2.3	2.9	2.2	2.4	2.7	2.6	2.1	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.9	2.4	2.4	2.2	2.1
330.	*	2.2	2.8	2.2	2.4	2.7	2.5	2.1	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.9	2.4	2.4	2.2	2.1
340.	*	2.2	2.8	2.2	2.5	2.7	2.4	2.0	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.9	2.5	2.4	2.1	2.1
350.	*	2.2	2.8	2.2	2.7	2.7	2.3	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.8	2.5	2.4	2.2	2.1
360.	*	2.4	2.8	2.2	2.7	2.7	2.3	1.9	1.8	1.8	1.9	1.8	1.8	1.8	1.8	1.9	1.8	2.3	2.4	2.1	2.0
MAX	*	3.1	3.0	3.2	2.9	2.8	2.9	3.5	3.4	3.6	3.3	2.9	2.9	2.5	2.2	2.5	2.2	2.6	2.4	2.7	2.5
DEGR.	*	70	60	70	50	290	280	110	120	250	100	100	100	130	140	220	140	40	0	40	20

THE HIGHEST CONCENTRATION OF 3.60 PPM OCCURRED AT RECEPTOR REC9 .

CAL3QHC: LINE SOURCE DISPERSION MODEL - VERSION 2.0 Dated 95221 PAGE 1

JOB: S L Blvd w/ Project & Raised Medians RUN: Intersection 6 PM Peak

DATE : 7/30/12
TIME : 12:10:25

The MODE flag has been set to C for calculating CO averages.

SITE & METEOROLOGICAL VARIABLES

VS = 0.0 CM/S VD = 0.0 CM/S Z0 = 108. CM
U = 1.0 M/S CLAS = 4 (D) ATIM = 60. MINUTES MIXH = 1000. M AMB = 1.8 PPM

LINK VARIABLES

LINK DESCRIPTION	*	LINK COORDINATES (FT) X1	Y1	X2	Y2	*	LENGTH (FT)	BRG (DEG)	TYPE	VPH	EF (G/MI)	H (FT)	W (FT)	V/C	QUEUE (VEH)
1. Likini App Q	*	-15.0	50.0	-15.0	89.4	*	39.	360.	AG	143.	100.0	0.0	10.0	0.18	2.0
2. Likini App FF	*	-15.0	265.0	-15.0	9.0	*	265.	180.	AG	100.	9.3	0.0	30.0		
3. Likini Dep FF	*	-5.0	0.0	-5.0	265.0	*	265.	360.	AG	130.	9.3	0.0	30.0		
4. SLB EB App St/RT Q	*	-55.0	-21.0	-154.1	-21.0	*	99.	270.	AG	239.	100.0	0.0	28.0	0.42	5.0
5. SLB EB App LT/U Q	*	-55.0	-2.0	-68.0	-2.0	*	13.	270.	AG	189.	100.0	0.0	10.0	0.14	0.7
6. SLB EB App FF	*	-2000.0	-21.0	0.0	-21.0	*	2000.	90.	AG	630.	9.3	0.0	48.0		
7. SLB EB Dep FF	*	0.0	-14.0	570.0	-14.0	*	570.	90.	AG	1060.	9.3	0.0	48.0		
8. SLB WB App St/RT Q	*	45.0	25.0	172.5	25.0	*	127.	90.	AG	167.	100.0	0.0	22.0	0.54	6.5
9. SLB WB App LT/U Q	*	45.0	9.0	162.9	9.0	*	118.	90.	AG	153.	100.0	0.0	10.0	0.59	6.0
10. SLB WB App FF	*	570.0	25.0	0.0	25.0	*	570.	270.	AG	1390.	9.3	0.0	42.0		
11. SLB WB Dep FF	*	0.0	18.0	-2000.0	18.0	*	2000.	270.	AG	1115.	9.3	0.0	42.0		
12. Radford App St/LT Q	*	5.0	-50.0	5.0	-89.4	*	39.	180.	AG	143.	100.0	0.0	10.0	0.18	2.0
13. Radford App RT FF	*	5.0	-200.0	45.0	-35.0	*	170.	14.	AG	420.	9.3	0.0	30.0		
14. Radford App FF	*	5.0	-200.0	5.0	0.0	*	200.	360.	AG	100.	9.3	0.0	30.0		
15. Radford Dep FF	*	-5.0	0.0	-5.0	-200.0	*	200.	180.	AG	335.	9.3	0.0	30.0		

PAGE 2

JOB: S L Blvd w/ Project & Raised Medians RUN: Intersection 6 PM Peak

DATE : 7/30/12
TIME : 12:10:25

ADDITIONAL QUEUE LINK PARAMETERS

LINK DESCRIPTION	*	CYCLE LENGTH (SEC)	RED TIME (SEC)	CLEARANCE LOST TIME (SEC)	APPROACH VOL (VPH)	SATURATION FLOW RATE (VPH)	IDLE EM FAC (gm/hr)	SIGNAL TYPE	ARRIVAL RATE
1. Likini App Q	*	110	72	2.0	100	1820	81.60	2	2
4. SLB EB App St/RT Q	*	110	60	2.0	605	1729	81.60	2	3
5. SLB EB App LT/U Q	*	110	95	2.0	25	1761	81.60	2	2
8. SLB WB App St/RT Q	*	110	42	2.0	1110	1758	81.60	2	4
9. SLB WB App LT/U Q	*	110	77	2.0	280	1787	81.60	2	2
12. Radford App St/LT Q	*	110	72	2.0	100	1777	81.60	2	2

RECEPTOR LOCATIONS

RECEPTOR	*	COORDINATES (FT) X	Y	Z	*
1. Rec 6-1	*	-20.0	-45.0	6.0	*
2. Rec 6-2	*	-90.0	-45.0	6.0	*
3. Rec 6-3	*	-175.0	-45.0	6.0	*

4.	Rec 6-4	*	65.0	-40.0	6.0 *
5.	Rec 6-5	*	125.0	-40.0	6.0 *
6.	Rec 6-6	*	210.0	-40.0	6.0 *
7.	Rec 6-7	*	10.0	46.0	6.0 *
8.	Rec 6-8	*	80.0	46.0	6.0 *
9.	Rec 6-9	*	165.0	46.0	6.0 *
10.	Rec 6-10	*	-30.0	40.0	6.0 *
11.	Rec 6-11	*	-100.0	40.0	6.0 *
12.	Rec 6-12	*	-185.0	40.0	6.0 *
13.	Rec 6-13	*	-30.0	110.0	6.0 *
14.	Rec 6-14	*	-30.0	195.0	6.0 *
15.	Rec 6-15	*	10.0	116.0	6.0 *
16.	Rec 6-16	*	10.0	201.0	6.0 *
17.	Rec 6-17	*	20.0	-110.0	6.0 *
18.	Rec 6-18	*	20.0	-195.0	6.0 *
19.	Rec 6-19	*	-20.0	-115.0	6.0 *
20.	Rec 6-20	*	-20.0	-200.0	6.0 *

JOB: S L Blvd w/ Project & Raised Medians RUN: Intersection 6 PM Peak

MODEL RESULTS

REMARKS : In search of the angle corresponding to the maximum concentration, only the first angle, of the angles with same maximum concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-360.

WIND * CONCENTRATION
ANGLE * (PPM)

(DEGR)	*	REC1	REC2	REC3	REC4	REC5	REC6	REC7	REC8	REC9	REC10	REC11	REC12	REC13	REC14	REC15	REC16	REC17	REC18	REC19	REC20
0.	*	2.4	2.9	2.2	2.7	2.7	2.3	1.9	1.8	1.8	1.9	1.8	1.8	1.8	1.8	1.9	1.8	2.3	2.4	2.1	2.0
10.	*	2.4	2.9	2.2	2.7	2.7	2.3	1.8	1.8	1.8	2.1	1.8	1.8	1.9	1.8	1.8	1.8	2.4	2.3	2.4	2.4
20.	*	2.4	3.0	2.3	2.7	2.7	2.3	1.8	1.8	1.8	2.2	1.8	1.8	1.9	1.8	1.8	1.8	2.4	2.3	2.5	2.4
30.	*	2.3	3.0	2.4	2.8	2.6	2.3	1.8	1.8	1.8	2.1	1.8	1.8	1.8	1.8	1.8	1.8	2.5	2.3	2.6	2.5
40.	*	2.6	3.0	2.5	2.7	2.5	2.3	1.8	1.8	1.8	2.1	1.8	1.8	1.8	1.8	1.8	1.8	2.6	2.0	2.7	2.3
50.	*	2.8	2.9	2.7	2.9	2.5	2.5	1.8	1.8	1.8	2.0	1.8	1.8	1.8	1.8	1.8	1.8	2.6	2.0	2.7	2.2
60.	*	3.0	3.0	3.0	2.8	2.5	2.5	1.9	1.9	1.9	2.0	1.9	1.8	1.8	1.8	1.8	1.8	2.3	2.0	2.7	2.2
70.	*	3.0	3.0	3.3	2.8	2.6	2.6	1.9	1.9	1.9	2.0	2.1	1.9	1.8	1.8	1.8	1.8	2.2	2.0	2.3	2.2
80.	*	2.8	2.8	3.4	2.5	2.5	2.5	2.3	2.2	2.1	2.3	2.3	2.1	1.8	1.8	1.8	1.8	2.1	1.8	2.2	2.0
90.	*	2.4	2.2	2.5	2.3	2.3	2.3	3.0	2.7	2.5	2.9	2.7	2.6	1.9	1.8	1.9	1.8	1.9	1.8	2.0	2.0
100.	*	2.2	2.1	2.1	2.0	2.0	2.0	3.3	3.3	2.8	3.3	2.9	3.0	2.1	1.9	2.1	1.8	1.9	1.8	2.0	1.8
110.	*	2.2	1.9	1.8	1.9	1.9	1.9	3.4	3.3	2.7	3.1	2.8	2.8	2.2	2.0	2.2	2.0	1.9	1.8	2.0	1.8
120.	*	2.2	1.8	1.8	1.8	1.8	1.8	3.1	3.4	2.6	2.7	2.5	2.7	2.4	2.0	2.3	2.0	1.9	1.8	2.0	1.8
130.	*	2.3	1.8	1.8	1.8	1.8	1.8	2.9	3.3	2.5	2.5	2.6	2.7	2.5	2.1	2.4	2.0	1.9	1.8	2.0	1.8
140.	*	2.2	1.8	1.8	1.8	1.8	1.8	2.7	3.2	2.6	2.4	2.6	2.6	2.5	2.2	2.4	2.1	1.9	1.8	2.0	1.8
150.	*	2.3	1.8	1.8	1.8	1.8	1.8	2.5	3.1	2.5	2.4	2.6	2.4	2.2	2.2	2.3	2.2	1.9	1.8	2.0	1.8
160.	*	2.2	1.8	1.8	1.8	1.8	1.8	2.4	3.1	2.6	2.5	2.6	2.3	2.4	2.2	2.3	2.2	2.0	1.8	2.0	1.8
170.	*	2.0	1.8	1.8	1.8	1.8	1.8	2.5	3.1	2.7	2.4	2.6	2.3	2.2	2.1	2.1	2.1	2.0	1.8	1.9	1.8
180.	*	1.9	1.8	1.8	1.8	1.8	1.8	2.6	3.1	2.9	2.3	2.6	2.2	2.2	2.1	2.0	2.0	2.0	1.8	1.9	1.8
190.	*	1.9	1.8	1.8	1.9	1.8	1.8	2.6	3.2	3.0	2.3	2.6	2.2	2.2	2.0	2.2	2.2	2.1	1.8	1.9	1.8
200.	*	1.8	1.8	1.8	1.9	1.8	1.8	2.5	3.2	3.1	2.4	2.6	2.2	2.2	2.0	2.4	2.1	2.1	1.8	1.8	1.8
210.	*	1.8	1.8	1.8	2.0	1.8	1.8	2.4	3.2	3.1	2.6	2.5	2.2	2.3	2.1	2.4	2.2	2.0	1.8	1.8	1.8
220.	*	1.8	1.8	1.8	2.1	1.8	1.8	2.6	3.2	3.3	2.8	2.5	2.3	2.3	2.0	2.6	2.2	2.0	1.8	1.8	1.8
230.	*	1.8	1.8	1.8	2.2	1.9	1.8	2.5	3.1	3.4	2.8	2.4	2.3	2.2	2.0	2.3	2.0	2.0	1.9	1.8	1.8
240.	*	1.8	1.8	1.8	2.0	1.9	1.8	2.7	3.0	3.5	2.7	2.5	2.4	2.1	2.0	2.2	2.0	1.9	1.9	1.8	1.8
250.	*	1.9	1.9	1.9	2.0	2.0	1.9	2.8	3.0	3.6	2.8	2.6	2.6	2.1	2.0	2.1	2.0	1.9	1.9	1.8	1.8
260.	*	2.2	2.1	2.1	2.4	2.3	2.2	2.7	2.9	3.4	2.8	2.7	2.7	2.1	2.0	2.1	2.0	1.9	1.9	1.8	1.8

270.	*	2.6	2.4	2.3	2.7	2.5	2.5	2.4	2.6	2.9	2.5	2.5	2.5	1.9	1.9	1.9	1.9	2.1	2.0	2.0	1.8
280.	*	3.0	2.8	2.5	2.8	2.6	2.9	2.1	2.3	2.3	2.1	2.1	2.1	1.8	1.8	1.8	1.8	2.2	2.2	2.0	2.0
290.	*	3.0	3.0	2.4	2.6	2.8	3.0	2.0	2.0	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8	2.3	2.2	2.2	2.0
300.	*	2.8	3.0	2.3	2.4	2.7	2.9	2.0	1.9	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	2.4	2.2	2.1	2.0
310.	*	2.6	3.0	2.2	2.3	2.8	2.9	2.1	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	2.4	2.3	2.2	2.0
320.	*	2.4	3.0	2.2	2.4	2.7	2.6	2.1	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.9	2.4	2.4	2.3	2.1
330.	*	2.3	2.9	2.2	2.4	2.7	2.4	2.1	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.9	2.4	2.4	2.2	2.1
340.	*	2.2	2.9	2.2	2.5	2.7	2.4	2.0	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.9	2.5	2.4	2.1	2.1
350.	*	2.2	2.9	2.2	2.7	2.7	2.3	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.8	2.5	2.4	2.2	2.2
360.	*	2.4	2.9	2.2	2.7	2.7	2.3	1.9	1.8	1.8	1.9	1.8	1.8	1.8	1.8	1.9	1.8	2.3	2.4	2.1	2.0
MAX	*	3.0	3.0	3.4	2.9	2.8	3.0	3.4	3.4	3.6	3.3	2.9	3.0	2.5	2.2	2.6	2.2	2.6	2.4	2.7	2.5
DEGR.	*	60	20	80	50	290	290	110	120	250	100	100	100	130	140	220	150	40	0	40	30

THE HIGHEST CONCENTRATION OF 3.60 PPM OCCURRED AT RECEPTOR REC9 .

CAL3QHC: LINE SOURCE DISPERSION MODEL - VERSION 2.0 Dated 95221 PAGE 1

JOB: S L Blvd w/ Project w/o Raised Medians RUN: Intersection 7 PM Peak

DATE : 7/30/12
TIME : 13: 1:42

The MODE flag has been set to C for calculating CO averages.

SITE & METEOROLOGICAL VARIABLES

VS = 0.0 CM/S VD = 0.0 CM/S Z0 = 108. CM
U = 1.0 M/S CLAS = 4 (D) ATIM = 60. MINUTES MIXH = 1000. M AMB = 1.8 PPM

LINK VARIABLES

LINK DESCRIPTION	*	LINK COORDINATES (FT) X1	Y1	X2	Y2	*	LENGTH (FT)	BRG (DEG)	TYPE	VPH	EF (G/MI)	H (FT)	W (FT)	V/C QUEUE (VEH)
1. Kahikolu Pl App FF	*	-5.0	310.0	-5.0	0.0	*	310.	180.	AG	25.	9.3	0.0	30.0	
2. Kahikolu Pl Dep FF	*	5.0	0.0	5.0	310.0	*	310.	360.	AG	30.	9.3	0.0	30.0	
3. SLB EB App FF	*	-570.0	-21.0	0.0	-21.0	*	570.	90.	AG	1020.	9.3	0.0	48.0	
4. SLB EB Dep FF	*	0.0	-21.0	440.0	-21.0	*	440.	90.	AG	1030.	9.3	0.0	48.0	
5. SLB WB App FF	*	440.0	18.0	0.0	18.0	*	440.	270.	AG	1475.	9.3	0.0	42.0	
6. SLB WB Dep FF	*	0.0	18.0	-570.0	18.0	*	570.	270.	AG	1460.	9.3	0.0	42.0	

PAGE 2

JOB: S L Blvd w/ Project w/o Raised Medians RUN: Intersection 7 PM Peak

DATE : 7/30/12
TIME : 13: 1:42

ADDITIONAL QUEUE LINK PARAMETERS

LINK DESCRIPTION	*	CYCLE LENGTH (SEC)	RED TIME (SEC)	CLEARANCE LOST TIME (SEC)	APPROACH VOL (VPH)	SATURATION FLOW RATE (VPH)	IDLE EM FAC (gm/hr)	SIGNAL TYPE	ARRIVAL RATE

RECEPTOR LOCATIONS

RECEPTOR	*	COORDINATES (FT) X	Y	Z	*
1. Rec 7-1	*	0.0	-45.0	6.0	*
2. Rec 7-2	*	-80.0	-45.0	6.0	*
3. Rec 7-3	*	-165.0	-45.0	6.0	*
4. Rec 7-4	*	80.0	-45.0	6.0	*
5. Rec 7-5	*	165.0	-45.0	6.0	*
6. Rec 7-6	*	20.0	40.0	6.0	*
7. Rec 7-7	*	90.0	40.0	6.0	*
8. Rec 7-8	*	175.0	40.0	6.0	*
9. Rec 7-9	*	-20.0	40.0	6.0	*
10. Rec 7-10	*	-90.0	40.0	6.0	*
11. Rec 7-11	*	-175.0	40.0	6.0	*
12. Rec 7-12	*	-20.0	110.0	6.0	*
13. Rec 7-13	*	-20.0	195.0	6.0	*

14. Rec 7-14	*	20.0	110.0	6.0	*
15. Rec 7-15	*	20.0	195.0	6.0	*

PAGE 3

JOB: S L Blvd w/ Project w/o Raised Medians RUN: Intersection 7 PM Peak

MODEL RESULTS

REMARKS : In search of the angle corresponding to the maximum concentration, only the first angle, of the angles with same maximum concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-360.

WIND ANGLE (DEGR) * CONCENTRATION (PPM)

(DEGR)	*	REC1	REC2	REC3	REC4	REC5	REC6	REC7	REC8	REC9	REC10	REC11	REC12	REC13	REC14	REC15
0.	*	2.4	2.4	2.4	2.4	2.4	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
10.	*	2.4	2.4	2.4	2.4	2.4	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
20.	*	2.2	2.4	2.4	2.4	2.4	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
30.	*	2.4	2.4	2.4	2.4	2.4	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
40.	*	2.4	2.4	2.4	2.4	2.4	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
50.	*	2.5	2.5	2.5	2.5	2.5	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
60.	*	2.5	2.6	2.5	2.5	2.5	1.9	1.9	1.9	1.8	1.8	1.9	1.8	1.8	1.8	1.8
70.	*	2.6	2.6	2.7	2.6	2.6	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8
80.	*	2.5	2.7	2.6	2.5	2.5	2.1	2.1	2.1	2.1	2.2	2.1	1.8	1.8	1.8	1.8
90.	*	2.3	2.3	2.3	2.3	2.3	2.5	2.5	2.4	2.5	2.5	2.6	1.9	1.8	1.8	1.8
100.	*	2.0	2.0	2.1	2.0	2.0	2.8	2.8	2.6	2.7	2.8	2.8	2.0	1.8	1.9	1.8
110.	*	1.9	1.9	1.9	1.9	1.9	2.7	2.7	2.7	2.8	2.7	2.8	2.1	1.9	2.1	1.9
120.	*	1.8	1.8	1.8	1.8	1.8	2.6	2.6	2.6	2.6	2.7	2.6	2.1	2.0	2.1	2.0
130.	*	1.8	1.8	1.8	1.8	1.8	2.6	2.6	2.6	2.5	2.6	2.5	2.1	2.0	2.1	2.0
140.	*	1.8	1.8	1.8	1.8	1.8	2.5	2.5	2.5	2.5	2.5	2.5	2.1	2.0	2.1	2.0
150.	*	1.8	1.8	1.8	1.8	1.8	2.5	2.4	2.4	2.3	2.4	2.4	2.1	2.0	2.1	2.0
160.	*	1.8	1.8	1.8	1.8	1.8	2.4	2.4	2.4	2.5	2.4	2.4	2.1	2.0	2.1	2.0
170.	*	1.8	1.8	1.8	1.8	1.8	2.4	2.4	2.4	2.4	2.4	2.4	2.2	2.0	2.1	2.0
180.	*	1.8	1.8	1.8	1.8	1.8	2.5	2.5	2.5	2.5	2.5	2.5	2.1	2.0	2.1	2.0
190.	*	1.8	1.8	1.8	1.8	1.8	2.4	2.4	2.4	2.4	2.4	2.4	2.1	2.0	2.2	2.1
200.	*	1.8	1.8	1.8	1.8	1.8	2.5	2.4	2.4	2.4	2.4	2.4	2.1	2.0	2.1	2.0
210.	*	1.8	1.8	1.8	1.8	1.8	2.3	2.4	2.4	2.5	2.4	2.4	2.1	2.0	2.1	2.0
220.	*	1.8	1.8	1.8	1.8	1.8	2.5	2.5	2.5	2.5	2.5	2.5	2.1	2.0	2.1	2.0
230.	*	1.8	1.8	1.8	1.8	1.8	2.6	2.6	2.6	2.5	2.6	2.6	2.1	2.0	2.1	2.0
240.	*	1.8	1.8	1.8	1.8	1.8	2.6	2.7	2.6	2.6	2.6	2.6	2.1	2.0	2.1	2.0
250.	*	1.9	1.9	1.9	1.9	1.9	2.8	2.7	2.8	2.7	2.7	2.7	2.1	1.9	2.1	2.0
260.	*	2.0	2.0	2.0	2.0	2.1	2.8	2.8	2.8	2.8	2.8	2.8	2.1	1.8	2.1	1.9
270.	*	2.4	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.5	2.5	2.5	1.9	1.8	1.9	1.8
280.	*	2.6	2.6	2.5	2.7	2.7	2.1	2.2	2.1	2.1	2.1	2.1	1.8	1.8	1.8	1.8
290.	*	2.6	2.6	2.6	2.6	2.7	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8
300.	*	2.5	2.5	2.5	2.6	2.5	1.8	1.8	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8
310.	*	2.5	2.5	2.5	2.5	2.5	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
320.	*	2.4	2.4	2.4	2.4	2.4	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
330.	*	2.4	2.4	2.4	2.4	2.4	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
340.	*	2.2	2.4	2.4	2.4	2.4	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
350.	*	2.4	2.4	2.4	2.4	2.4	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
360.	*	2.4	2.4	2.4	2.4	2.4	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8

```
-------*-------------------------------------------------------------------------------------------
MAX.   *   2.6   2.7   2.7   2.7   2.7   2.8   2.8   2.8   2.8   2.8   2.8   2.2   2.0   2.2   2.1
DEGR. *   70    80    70   280   280   100   100   250   110   100   100   170   120   190   190

THE HIGHEST CONCENTRATION OF    2.80 PPM OCCURRED AT RECEPTOR REC6 .
```



```
                    CAL3QHC: LINE SOURCE DISPERSION MODEL - VERSION 2.0 Dated 95221                    PAGE  1

 JOB: S L Blvd w/ Project & Raised Medians                  RUN: Intersection  7 PM Peak

 DATE :  7/30/12
 TIME : 12:15:30

    The MODE flag has been set to C for calculating CO averages.

  SITE & METEOROLOGICAL VARIABLES
  -------------------------------
  VS =   0.0 CM/S        VD =   0.0 CM/S       Z0 = 108. CM
   U =  1.0 M/S         CLAS =   4  (D)     ATIM =  60. MINUTES     MIXH =  1000. M   AMB =  1.8 PPM

  LINK VARIABLES
  --------------
    LINK DESCRIPTION     *         LINK COORDINATES (FT)          *    LENGTH  BRG TYPE   VPH     EF      H    W    V/C QUEUE
                         *   X1        Y1        X2        Y2      *     (FT)  (DEG)            (G/MI)  (FT) (FT)       (VEH)
 -------------------------*-------------------------------------*----------------------------------------------------------
  1. Kahikolu Pl App LT/R*     -5.0      50.0      -5.0      60.1 *     10.   360. AG    147. 100.0   0.0 10.0 0.05    0.5
  2. Kahikolu Pl App FF  *     -5.0     310.0      -5.0       0.0 *    310.   180. AG     25.   9.3   0.0 30.0
  3. Kahikolu Pl Dep FF  *      5.0       0.0       5.0     310.0 *    310.   360. AG     30.   9.3   0.0 30.0
  4. SLB EB App St Q     *    -25.0     -21.0    -102.6     -21.0 *     78.   270. AG    111. 100.0   0.0 28.0 0.40    3.9
  5. SLB EB App LT/U Q   *    -25.0      -2.0     -32.8      -2.0 *      8.   270. AG    189. 100.0   0.0 10.0 0.08    0.4
  6. SLB EB App FF       *   -570.0     -21.0       0.0     -21.0 *    570.    90. AG   1030.   9.3   0.0 48.0
  7. SLB EB Dep FF       *      0.0     -21.0     440.0     -21.0 *    440.    90. AG   1030.   9.3   0.0 48.0
  8. SLB WB App St/RT Q  *     25.0      18.0     182.2      18.0 *    157.    90. AG    155. 100.0   0.0 22.0 0.69    8.0
  9. SLB WB App FF       *    440.0      18.0       0.0      18.0 *    440.   270. AG   1475.   9.3   0.0 42.0
 10. SLB WB Dep FF       *      0.0      18.0    -570.0      18.0 *    570.   270. AG   1470.   9.3   0.0 42.0
                                                                                                          PAGE  2
 JOB: S L Blvd w/ Project & Raised Medians                  RUN: Intersection  7 PM Peak

 DATE :  7/30/12
 TIME : 12:15:30

  ADDITIONAL QUEUE LINK PARAMETERS
  --------------------------------
    LINK DESCRIPTION     *    CYCLE    RED     CLEARANCE  APPROACH  SATURATION   IDLE   SIGNAL   ARRIVAL
                         *   LENGTH   TIME    LOST TIME    VOL     FLOW RATE   EM FAC   TYPE     RATE
                         *    (SEC)   (SEC)    (SEC)      (VPH)      (VPH)    (gm/hr)                 RATE
 -------------------------*-------------------------------------------------------------------------------------
  1. Kahikolu Pl App LT/R*     110       74       2.0        25       1699      81.60      2        3
  4. SLB EB App St Q     *     110       28       2.0      1015       1770      81.60      2        5
  5. SLB EB App LT/U Q   *     110       95       2.0        15       1770      81.60      2        2
  8. SLB WB App St/RT Q  *     110       39       2.0      1475       1742      81.60      2        5

  RECEPTOR LOCATIONS
  ------------------
                         *          COORDINATES (FT)          *
    RECEPTOR             *      X          Y          Z       *
 -------------------------*-------------------------------------*
  1. Rec 7-1             *      0.0      -45.0        6.0     *
  2. Rec 7-2             *    -80.0      -45.0        6.0     *
  3. Rec 7-3             *   -165.0      -45.0        6.0     *
  4. Rec 7-4             *     80.0      -45.0        6.0     *
  5. Rec 7-5             *    165.0      -45.0        6.0     *
  6. Rec 7-6             *     20.0       40.0        6.0     *
  7. Rec 7-7             *     90.0       40.0        6.0     *
  8. Rec 7-8             *    175.0       40.0        6.0     *
  9. Rec 7-9             *    -20.0       40.0        6.0     *
 10. Rec 7-10            *    -90.0       40.0        6.0     *
```

11. Rec 7-11	*	-175.0	40.0	6.0	*
12. Rec 7-12	*	-20.0	110.0	6.0	*
13. Rec 7-13	*	-20.0	195.0	6.0	*
14. Rec 7-14	*	20.0	110.0	6.0	*
15. Rec 7-15	*	20.0	195.0	6.0	*

JOB: S L Blvd w/ Project & Raised Medians RUN: Intersection 7 PM Peak

MODEL RESULTS

REMARKS : In search of the angle corresponding to the maximum concentration, only the first angle, of the angles with same maximum concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-360.

WIND ANGLE (DEGR)	* CONCENTRATION (PPM) REC1	REC2	REC3	REC4	REC5	REC6	REC7	REC8	REC9	REC10	REC11	REC12	REC13	REC14	REC15
0.	2.4	2.7	2.4	2.6	2.6	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
10.	2.5	2.7	2.4	2.6	2.5	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
20.	2.3	2.7	2.4	2.6	2.5	1.8	1.8	1.8	1.9	1.8	1.8	1.8	1.8	1.8	1.8
30.	2.6	2.7	2.4	2.6	2.4	1.8	1.8	1.8	1.9	1.8	1.8	1.8	1.8	1.8	1.8
40.	2.6	2.7	2.4	2.6	2.4	1.8	1.8	1.8	2.0	1.8	1.8	1.8	1.8	1.8	1.8
50.	2.7	2.9	2.5	2.7	2.5	1.8	1.8	1.8	2.0	1.8	1.8	1.8	1.8	1.8	1.8
60.	2.7	3.0	2.6	2.6	2.5	1.9	1.9	1.9	1.9	1.8	1.9	1.8	1.8	1.8	1.8
70.	2.8	3.0	3.0	2.7	2.6	1.9	1.9	1.9	2.0	1.9	1.9	1.8	1.8	1.8	1.8
80.	2.6	2.9	2.9	2.5	2.5	2.2	2.2	2.1	2.2	2.3	2.1	1.8	1.8	1.8	1.8
90.	2.3	2.4	2.5	2.3	2.3	2.8	2.7	2.4	2.8	2.7	2.7	1.9	1.8	1.8	1.8
100.	2.0	2.0	2.1	2.0	2.0	3.3	3.1	2.6	3.1	3.0	2.9	2.0	1.8	1.9	1.8
110.	1.9	1.9	1.9	1.9	1.9	3.2	3.2	2.7	3.1	2.8	2.9	2.2	1.9	2.2	1.9
120.	1.8	1.8	1.8	1.8	1.8	3.1	3.1	2.6	2.8	2.7	2.7	2.3	2.0	2.2	2.0
130.	1.8	1.8	1.8	1.8	1.8	3.1	3.1	2.6	2.7	2.7	2.7	2.3	2.1	2.3	2.0
140.	1.8	1.8	1.8	1.8	1.8	2.9	3.0	2.6	2.5	2.6	2.5	2.3	2.1	2.3	2.1
150.	1.8	1.8	1.8	1.8	1.8	2.9	2.9	2.5	2.3	2.6	2.4	2.2	2.1	2.3	2.1
160.	1.8	1.8	1.8	1.8	1.8	2.7	2.8	2.6	2.5	2.6	2.4	2.2	2.1	2.3	2.1
170.	1.8	1.8	1.8	1.8	1.8	2.6	2.8	2.7	2.4	2.6	2.4	2.2	2.0	2.2	2.1
180.	1.8	1.8	1.8	1.8	1.8	2.6	2.9	2.9	2.7	2.6	2.5	2.1	2.0	2.2	2.1
190.	1.8	1.8	1.8	1.8	1.8	2.4	2.8	2.8	2.6	2.5	2.4	2.2	2.0	2.2	2.1
200.	1.8	1.8	1.8	1.8	1.8	2.5	2.8	2.8	2.7	2.5	2.4	2.2	2.0	2.2	2.0
210.	1.8	1.8	1.8	1.8	1.8	2.4	2.9	2.9	2.7	2.4	2.4	2.2	2.0	2.2	2.0
220.	1.8	1.8	1.8	1.8	1.8	2.6	3.0	3.0	2.7	2.5	2.5	2.1	2.0	2.2	2.0
230.	1.8	1.8	1.8	1.8	1.8	2.7	3.1	3.1	2.7	2.6	2.6	2.1	2.0	2.1	2.0
240.	1.8	1.8	1.8	1.8	1.8	2.7	3.3	3.2	2.7	2.6	2.6	2.1	2.0	2.1	2.0
250.	1.9	1.9	1.9	1.9	1.9	2.9	3.2	3.4	2.7	2.7	2.7	2.1	1.9	2.1	2.0
260.	2.0	2.0	2.0	2.0	2.1	2.8	3.1	3.2	2.8	2.8	2.8	2.1	1.8	2.1	1.9
270.	2.5	2.3	2.3	2.5	2.4	2.5	2.6	2.8	2.5	2.5	2.5	1.9	1.8	1.9	1.8
280.	2.9	2.6	2.5	2.8	2.7	2.2	2.2	2.2	2.1	2.1	2.1	1.8	1.8	1.8	1.8
290.	2.9	2.7	2.6	2.7	2.8	2.0	2.0	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8
300.	2.8	2.6	2.5	2.6	2.7	1.9	1.8	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8
310.	2.7	2.7	2.5	2.6	2.7	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
320.	2.5	2.6	2.4	2.5	2.6	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
330.	2.6	2.7	2.4	2.6	2.6	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
340.	2.2	2.7	2.4	2.6	2.6	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
350.	2.4	2.7	2.4	2.6	2.6	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
360.	2.4	2.7	2.4	2.6	2.6	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
MAX	2.9	3.0	3.0	2.8	2.8	3.3	3.3	3.4	3.1	3.0	2.9	2.3	2.1	2.3	2.1

DEGR.	280	60	70	280	290	100	240	250	100	100	100	120	130	130	140

THE HIGHEST CONCENTRATION OF 3.40 PPM OCCURRED AT RECEPTOR REC8 .

Appendix D

Noise Analysis Report

Noise Analysis Report

Salt Lake Boulevard Widening

Salt Lake, Oahu, Hawaii

Censeo AV & Acoustics

September, 2012

Table of Contents

1 Executive Summary 1

2 Introduction 1

3 Methods 3

4 Noise Abatement Criteria 6

5 Noise Analysis Results 7

6 Mitigation Measures 13

7 Construction Noise 15

Appendix A References

Appendix B Acoustic Terminology

Appendix C Model Input/Output Files Existing AM

Appendix D Model Input/Output Files Existing PM

Appendix E Model Input/Output Files Future No Build AM

Appendix F Model Input/Output Files Future No Build PM

Appendix G Model Input/Output Files Future Build AM

Appendix H Model Input/Output Files Future Build PM

LIST OF FIGURES

1 Project Location 2

2 Existing Aerial with Prediction Locations - West Half 9

3 Existing Aerial with Prediction Locations - East Half....10

4 Future Map with Potential Barrier Locations - East Half 12

LIST OF TABLES

1 Peak AM and PM Hour Traffic Volumes 5

2 Sensitive Receiver Locations 8

3 Field Verification Model Results....12

4 Noise Prediction Results 13

5 Noise Prediction Results - East End 15

6 Typical Construction Equipment Noise Levels 17

1 Executive Summary

Noise mitigation for the Salt Lake Boulevard between Maluna Street and Ala Lilikoi Street, project has been evaluated in this report. Future noise levels were predicted using TNM 2.5. The predicted Future Build noise levels exceeded the HDOT noise limits at three residential receivers along the project. Noise barriers were evaluated but deemed unfeasible. Mitigation to the residences can be obtained through installation of air conditioning.

Properties in the vicinity of the project area will be exposed to short-term noise impacts from construction activities. In cases where the construction noise exceeds, or is expected to exceed, the State's "maximum permissible" property line noise level (HDOH 9/23/1996), a permit must be obtained from the State DOH.

2 Introduction

The purpose of this document is to evaluate the traffic noise effects associated with widening a section of Salt Lake Boulevard between Maluna Street and Ala Lilikoi Street. The traffic noise analysis for the Salt Lake Boulevard project involved a series of steps. Each of these steps is discussed in detail in the following sections.

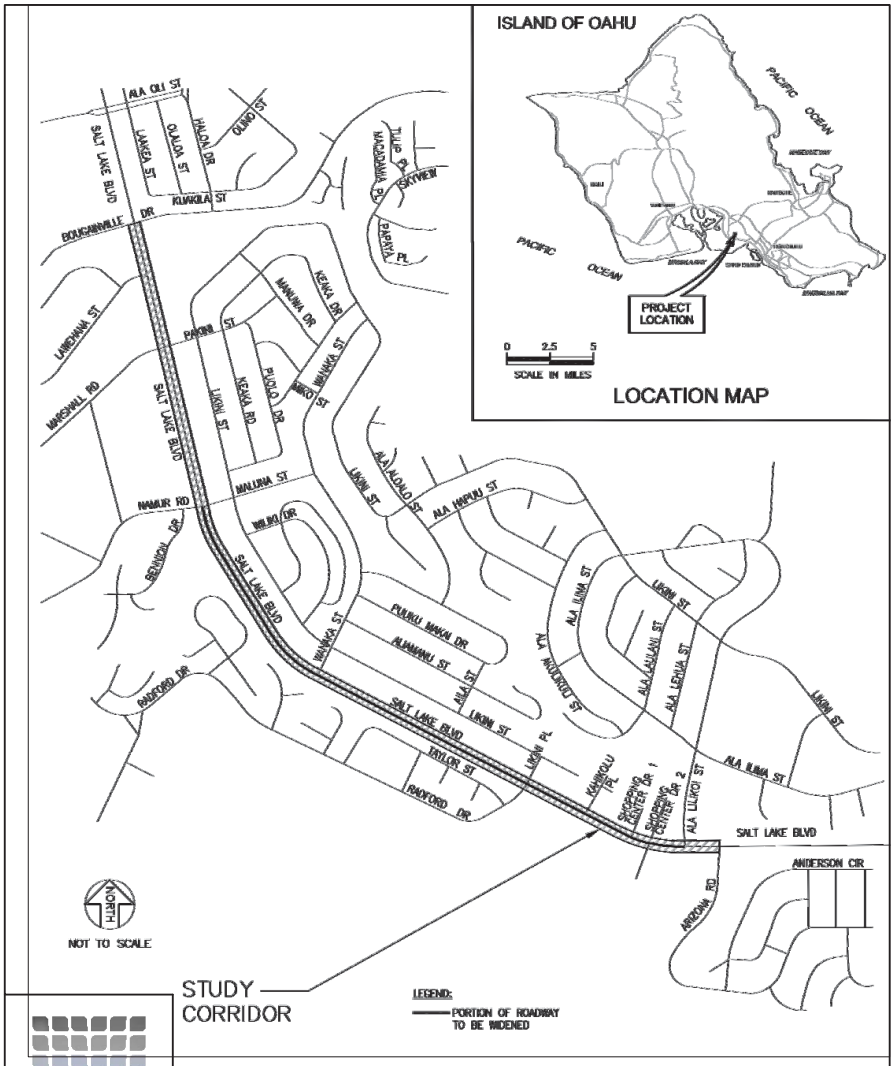
Background

The City and County of Honolulu Department of Design and Construction (DDC) has proposed continued widening of Salt Lake Boulevard. The roadway portion between Maluna Street and Ala Lilikoi Street along Salt Lake Boulevard will be widened and is the continuation of roadway improvements along Salt Lake Boulevard. The project will receive federal funding.

Project Location

The project is located approximately two miles northwest of downtown Honolulu (Figure 1). The project is located on the south central part of the island of Oahu. The Salt Lake Shopping Center is located at the east end of the project, on the northwest corner of Salt Lake Boulevard and Ala Lilikoi Street. Island Family Christian Church and Aliamanu Elementary/Intermediate School are located on the south side of Salt Lake Boulevard at the east end of the project.

Current land use in the project area is primarily residential, with a church, shopping center, and school located at the east end of the project.



CENSEO
AV+Acoustics

Project Vicinity Map			FIGURE 1
Salt Lake Blvd. Phase 3 EA		PROJECT NO: 12035	
SCALE: Not To Scale	DRAWN BY:	DATE: Sept 2012	

3 Methods

For this study, the methods for determining the future noise levels and identifying possible mitigation measures to address future noise levels involved the following series of steps:

- Assess the existing and planned land uses (residential, commercial, industrial, etc.) and determination of sensitive noise receivers within the project corridor.
- Assess the existing conditions (including: traffic volumes; vehicle types; vehicle speeds; roadway layout; area topography; existing walls, and; locations of residences relative to the roadway).
- Predict the existing and future build and future no-build scenarios for a reasonable worse case hour noise condition using the Federal Highway Administration (FHWA) Traffic Noise Model version 2.5 (TNM 2.5).
- Verify the noise model by measuring the existing noise levels at representative noise sensitive receivers.
- Compare the modeled results with the noise abatement criteria established by the Hawaii Department of Transportation (HDOT). Based on the results of the noise monitoring and modeling, potential noise mitigation are examined. This task included noise barrier modeling for noise mitigation as warranted by the results of the noise analysis. Reasonable and feasible mitigation, based on current HDOT Procedures, is then recommended.

Overview

An assessment of existing and planned land uses (residential, commercial, industrial, etc.) and determination of sensitive noise receivers was undertaken within the project corridor. Aerial photographs and field reconnaissance were used to determine the approximate locations and land use activities of potential sensitive receivers near the roadway. Field measurements were used to determine the existing noise levels throughout the Study Area, as described in Section 4.0, *Noise Analysis Results*. Noise levels were measured at five sensitive receiver locations within the project area. The noise measurement locations are representative locations selected to determine the noise impacts along the project.

The TNM 2.5 model was used to predict the noise levels that would occur with the proposed widening of Salt Lake Boulevard at receiver locations. Roadway geometry and topography, traffic volumes, existing barriers, land features, and the representative sites were entered into TNM 2.5 to replicate the conditions under which the noise level measurements were taken. Modeled noise levels were calculated and compared with the noise levels measured at sensitive receiver locations. This process examines the accuracy of the traffic noise model in performing noise level calculations for this project. Discrepancies in the model's calculations were addressed prior to using it for predicting future noise levels. Traffic volumes and speeds used in the modeling for this project represent "worst case" peak-hour traffic conditions.

Three conditions were modeled using TNM 2.5. Traffic Volumes used in the model were provided by the Austin, Tsutsumi & Associates, Inc. traffic report (Austin, Tsutsumi 2012). The model estimated the peak-hour traffic noise levels for:

- Existing traffic conditions – the model included the current street configuration and 2012 traffic volumes.
- Future no-build condition – the model included the current street configuration and 2040 traffic volumes.
- Future build condition – the model included proposed road widening and future projected 2040 traffic volumes.

Noise levels for the 2040 traffic and improved roadway conditions were compared with the appropriate noise abatement criterion to determine whether traffic noise mitigation should be considered. Generally, the mitigation considerations consist of noise barriers in the right-of-way (R/W). Although other mitigation considerations are possible, noise barriers are considered the most cost-effective and accepted technique when they are warranted.

TNM 2.5 Modeling

The TNM 2.5 model translated the roads in the Study Area into a series of endpoints on a three-dimensional X, Y, and Z coordinate system. This computer model was developed to comply with FHWA noise regulations and is considered the current standard for roadway noise analyses.

The TNM model requires input data regarding the geometry of roadways in the Study Area, vehicle mix, traffic volumes, and vehicle speeds. The following data were used in the models:

- Vehicle Speeds – the posed speed limit in the vicinity of the project is 25 mph. However, based on our observations, 30 mph speeds were assumed for all roads in the vicinity of the project.
- Traffic Volumes were provided by Austin, Tsutsumi & Associates, Inc. (Austin, Tsutsumi 2012), shown in Table 1.
- Vehicle Mix was observed during our traffic counts and noise measurements.
    - 96% of the vehicles were automobiles, 1% were medium trucks and 1% were motorcycles.
- Elevations – topographic information was used for the roads and receivers. Topographic information was provided by Austin, Tsutsumi & Associates, Inc.
- Ground – "Hard soil"
- Receiver heights – 5 feet above the ground

The proposed roadway and the surrounding arterial streets were defined by a series of roadway segment endpoints. Existing barriers, including residential privacy walls, were included in the model. Receivers were identified as single points and assigned an elevation of 5 feet above the ground to simulate the average height of human hearing. The sound levels were modeled using the A-weighted decibel (dBA), which is the measurement of sound that most closely approximates the sensitivity of the human ear. The noise level results are discussed in Section 4. *Existing Noise Environment*—is presented in LAeq1h, the equivalent average sound level measured for 1 hour, approximating the sensitivity of the human ear.

Table 1. Peak AM and PM Hour Traffic Volumes

Road	Existing Volumes (2012)		Future No-Build Volumes (2040)		Future Build Volumes (2040)	
	AM	PM	AM	PM	AM	PM
Salt Lake Boulevard (north of Maluna Street)	582	505	660	710	660	710
Salt Lake Boulevard (between Maluna St & WakanaSt)	1036	1178	1330	1645	1330	1645
Salt Lake Boulevard (between Wanaka St & Likini Pl)	1091	945	1470	1685	1470	1685
Salt Lake Boulevard (between Likini Pl & Shopping Center)	1698	1870	2280	2510	2280	2510
Salt Lake Blvd (between Shopping Center & Ala Likoi St)	1524	1700	2085	2285	2125	2285
Salt Lake Boulevard (east of Ala Likoi St)	715	998	955	1340	955	1340
Namur Road (west of Salt Lake Boulevard)	199	69	170	60	170	60
Maluna Street (east of Salt Lake Boulevard)	86	129	95	145	95	145
WakanaSt (north of Salt Lake Boulevard)	75	183	100	250	100	250
Likini Pl (north of Salt Lake Boulevard)	74	95	105	130	105	130
Radford Dr (south of Salt Lake Boulevard)	263	243	360	335	360	335
Kahikolu Pl (north of Salt Lake Boulevard)	12	18	21	30	21	30
Shopping Center (south of Salt Lake Boulevard)	307	48	415	90	490	70
Ala Likoi St (north of Salt Lake Boulevard)	439	623	590	835	590	835

The vehicles were classified as automobiles (four wheels), medium trucks (2-axle long, buses, 2-axle 6 tire), and heavy trucks (3 to 6-axle vehicles). Each of these vehicle types generates noise from a different height above the roadway, called the source height.

TNM 2.5 uses the above-described information to calculate the noise contribution from each roadway segment to each receiver and then determine the cumulative effect of all roadway noise sources for each receiver. Validation studies conducted at the Volpe National Transportation Systems Center, a facility of the United States Department of Transportation Research and Innovative Technology Administration, show that the TNM 2.5 model typically predicts noise levels within an acceptable range of accuracy.

Analysis Limitations

This noise analysis is based on design and traffic information available at the time of the analysis. The following assumptions were made to reach conclusions during the analysis phase:

- The project designs as evaluated in this report will not change.
- Future traffic volumes, vehicle mix and speed will remain consistent with those predicted in the traffic study for this project.
- The nature of the land use will remain consistent with current use and planned development (i.e., industrial businesses will not be constructed where retail and professional offices are currently planned)
- The area where people are most likely to spend time outside of their homes is in their yards, near their homes.

While the TNM 2.5 model has been calibrated and tested against actual noise measurements for several years, it should be noted that it is still a noise prediction model. The results of this analysis assume the predicting capabilities of TNM are sufficient. Assumptions have been made to simplify the calculations for TNM.

- The receiver (representing human hearing) is 5 feet above ground.
- The angle of view from the receiver to the road is 180 degrees.
- The ground type is consistent throughout the project area.

The noise levels used in the predictions are measured as peak hour A-weighted Leq (LAeq1h). As stated in Section 2, this is the A-weighted average that represents the steady level over 1 hour that would produce the same energy as the actual signal. The actual instantaneous noise levels fluctuate above and below the measured Leq during the measurement period (e.g., a police siren, a particularly noisy truck, or unusually high traffic volumes). Therefore, the use of LAeq1h for predicting noise levels and conducting the noise evaluation does not consider the noise levels as they may occur in their full range. The fluctuation of instantaneous noise levels will result in sounds that temporarily exceed (and be below) the Leq noise levels as they have been presented in the noise evaluation.

4 Noise Abatement Criteria

Potential negative impact from traffic noise is assessed on the basis of predicted noise levels approaching or exceeding Noise Abatement Criteria (NAC). Hawaii Department of Transportation (HDOT) NAC is described below.

The HDOT Highway Noise Policy and Abatement Guidelines (HDOT 4/25/2011), noise abatement should be considered if noise levels reach 66 dBA or higher at noise-sensitive properties. Additionally, mitigation measures will be considered for noise-sensitive properties if predicted traffic noise levels substantially exceed existing levels. "Substantially exceed" is defined as a 15-dBA increase between the existing noise levels and the future noise levels. The area at noise-sensitive properties from which the noise level is used to determine abatement consideration, is at an out-of-doors location assumed to be most frequented by the residents. For example, the noise levels used in consideration for abatement at a residence would be from a location outside of the house, but near the house. Noise abatement is only considered for the first floor of multi-floor units.

Noise-sensitive properties include single family or multi-family housing units. Each first floor apartment in an apartment complex or duplex is counted as a separate housing unit. Noise-sensitive properties may also include facilities such as picnic areas, recreation areas, playgrounds, active sports areas, parks, schools, churches, libraries, hospitals, places of worship, and cemeteries.

The HDOT Guidelines provide criteria for use of noise walls for noise abatement mitigation. Where a sound wall is considered all of the following criteria must be met in order to recommend the barrier:

- A reduction of at least 5 dBA must be achieved at noise sensitive receivers for there to be a benefit.
- The barrier must provide 7 dBA noise reduction for at least 75% of front row receivers
- The cost of the barrier will not exceed $60,000 per benefited receiver

- Two-thirds of the impacted property owners must approve the mitigation

5 Noise Analysis Results

Existing Noise Levels

Sensitive Noise Receivers
Sensitive noise receivers in the study area consist of single family housing units, apartment buildings, churches, a school and a shopping center. Single family housing is located on the north and south side of Salt Lake Boulevard throughout the project. Apartments are located at the east end of the project on the north side of Salt Lake Boulevard. There is a church on the north side of Salt Lake Boulevard at the east end of the project, at Location 3. A second church is located on the south side of Salt Lake Boulevard, at the west end of the project, at Location 14a. A school is located on the south side of Salt Lake Boulevard at the west end of the project. Fifteen representative sensitive receivers were identified (see Table 2). The representative noise sensitive receiver locations are shown in Figures 2 and 3.

Table 2. Sensitive Receiver Locations

Location Number	Location Description
1	1009 Maluna St – 80' east of the centerline of Salt Lake Blvd. Residence approximately 17' higher than road, retaining wall
2	1205 Namur Road – 75' west of the centerline of Salt Lake Blvd. Residence approximately 8' lower than road, 5' high plastic fence open at bottom
3	3846 Salt Lake Blvd - 65' east of the centerline of Salt Lake Blvd. First Samoan Full Gospel Pentecostal Church level with road, no wall
4	3819 Salt Lake Blvd - 75' east of the centerline of Salt Lake Blvd. Residence approximately 12' lower than road, 45 high chain linked fence with slats
5	3751 Salt Lake Blvd - 85' east of the centerline of Salt Lake Blvd. Residence approximately 6' higher than road, 6' berm and 5' high chain linked fence with slats
6	3817 Salt Lake Blvd - 65' north of the centerline of Salt Lake Blvd. Residence approximately 19' above road, 4' high fence
7	3711 Salt Lake Blvd - 80' south of the centerline of Salt Lake Blvd. Residence level with road, 6' berm and 5' high chain linked fence with slats
8	3669 Salt Lake Blvd - 90' south of the centerline of Salt Lake Blvd. Residence approximately 10' lower than road, 5' high chain linked fence with slats
9	3637 Salt Lake Blvd - 60' north of the centerline of Salt Lake Blvd. Residence level with road, no wall
10	3583 Salt Lake Blvd - 90' south of the centerline of Salt Lake Blvd. Residence approximately 10' lower than road, 5' high chain linked fence with slats
11	3545 Salt Lake Blvd - 60' north of the centerline of Salt Lake Blvd. Residence level with road, no wall
12	3515 Salt Lake Blvd - 85' south of the centerline of Salt Lake Blvd. Residence approximately 8' lower than road, 5' high chain linked fence with slats
13	3469 Salt Lake Blvd - 65' north of the centerline of Salt Lake Blvd. Residence level with road, no wall
14	3409 Salt Lake Blvd - 110' south of the centerline of Salt Lake Blvd. Residence approximately 11' lower than road, 5' high chain linked fence with slats
15	3313 Salt Lake Blvd - 50' north of the centerline of Salt Lake Blvd. Residence approximately 6' higher than road, no wall

September, 2012

Figure No. 2

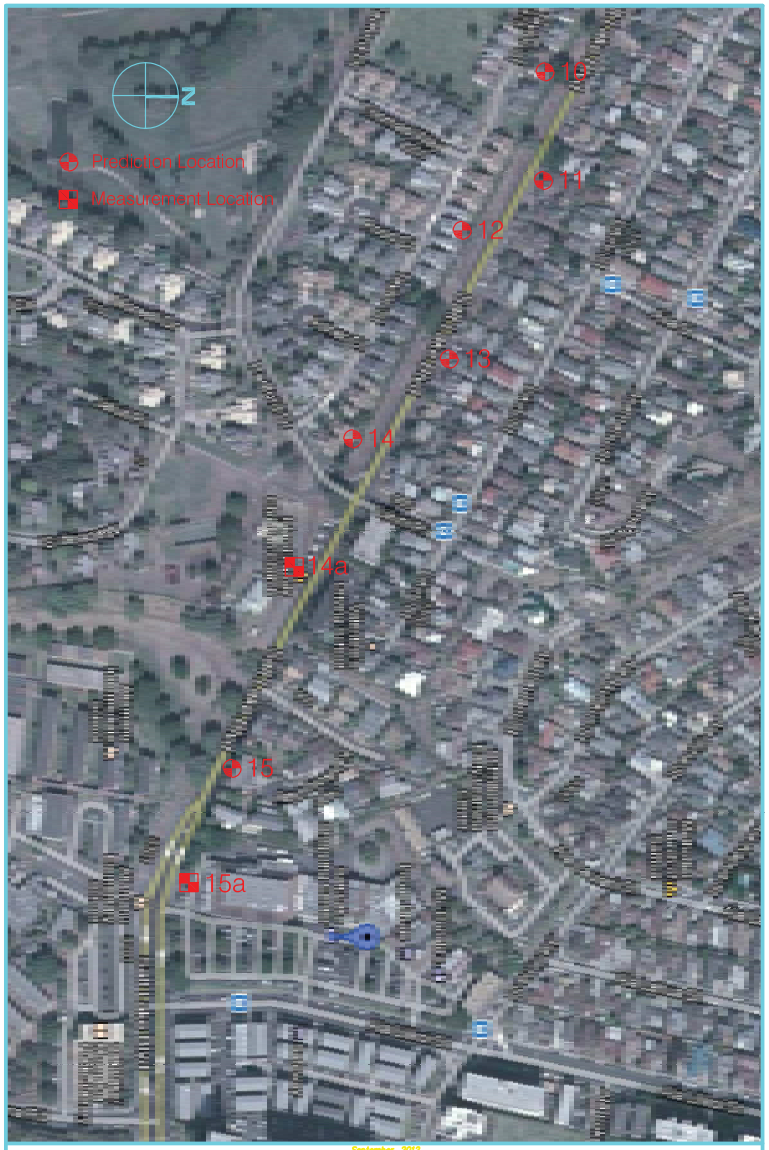
Censeo
AV + Acoustics
P.O. Box 1694
Kailua, HI 96734
808.352.5888
www.censeoav.com

INFO ONLY
Preliminary– Not for construction

Salt Lake Blvd – Maluna St to Ala Lilikoi St
Salt Lake, Oahu, Hawaii

Existing Road - Prediction Locations - Western Half

SCALE: 1" = 200'



September, 2012

Figure No. 3

Censeo
AV + Acoustics

P.O. Box 1694
Kailua, HI 96734
808.352.5888
www.censeoav.com

INFO ONLY
Preliminary– Not for construction

Salt Lake Blvd – Maluna St to Ala Lilikoi St
Salt Lake, Oahu, Hawaii

Existing Road - Prediction Locations - Eastern Half

SCALE: 1" = 200'

Traffic Noise Monitoring

An assessment of existing traffic noise conditions was made. The monitoring program focused on residential and other sensitive land uses within the project area. A series of noise measurements were performed at five monitoring locations in the study area to document existing conditions and to calibrate the Traffic Noise Model. Noise levels were measured using one Larson Davis 820 sound level meter, which meets the American National Standard Institute (ANSI) requirements for Type 1 sound level meter. The detector of the meter was set for "slow" response (1 second samples). The microphones were located approximately five feet above the ground. The sound level meter was calibrated prior to and immediately after each noise measurement. Noise levels were measured for three 5 minute periods at each of the five measurement locations.

Noise was measured during peak PM traffic hours (5 PM to 7 PM) on Thursday September 6, 2012. These times were selected to represent peak traffic hours. Actual traffic counts were used in the verification model.

The primary noise source at all of the sensitive receivers was traffic on Salt Lake Boulevard. Other noise sources included: traffic on other streets, aircraft, and birds. Measurements were made to minimize the impact of extraneous noise sources. At Location 6, noise from traffic on Wanaka Street was a major contributor. At Location 15a, noise from traffic in the Salt Lake Shopping Center influenced the measured noise level.

The atmospheric conditions during the measurement periods were in compliance with HDOT noise measurement guidelines. Since atmospheric conditions affect sound propagation, the conditions are entered into the noise model. During the measurement period, the temperature was approximately 80°F, the relative humidity was 54%, it was clear with a slight breeze from the east (2-5 mph).

Noise Model Verification

The monitoring site conditions were modeled in TNM 2.5 to evaluate the accuracy of TNM 2.5. Reported noise levels are the average of the three noise level readings taken at each monitoring site during the evening peak traffic hours. These levels were compared with predicted sound levels from the modeled conditions. This comparison was used to make any necessary adjustments to the model input to most accurately reflect site conditions. The noise model verification results are summarized in Table 3.

Table 3. Field Verification Model Results

Measurement Location	Measurement Period	Average Measured Noise Level (dBA)	Modeled Noise Level (dBA)
2a - 1205 Namur Road, on road side of fence	9/6/12 3:45-4:00 PM	65	65
4a - 3817 Salt Lake Blvd, on road side of fence	9/6/12 4:17-4:32 PM	65	65
6a - 3817 Salt Lake Blvd, along Wanaka St	9/6/12 5:45-6:00 PM	65	65
14a – Island Family Christian Church	9/6/12 4:45-5:00 PM	63	64
15a – Salt Lake Shopping Center	9/6/12 5:15-5:30 PM	68[1]	66
Source: Calculations and measurements performed by Censeo using TNM 2.5 1 Noise from traffic in the Salt Lake Shopping Center influenced the measured noise level.			

As shown in Table 3, the modeled noise levels are equal to or higher than the measured noise levels, showing that the predictions are conservative. These results reflect good agreement between measured and modeled values (within 1 dBA). Variations between measured and modeled are due to many factors including: slight wind (not accounted for in the model), specific vehicles that may be louder or quieter then the modeled level, and other noise sources (aircraft, trains, and birds) not included in the noise model.

Future Noise Levels

Noise levels were modeled for 15 sensitive receiver locations. Modeled sensitive receiver locations are shown in Figures 2 and 3. Potential traffic noise impacts were evaluated relative to the HDOT noise limit of 66 dBA for noise sensitive land use. The future build scenario was computed using projected future traffic data provided by the Austin, Tsutsumi & Associates, Inc. traffic report (Austin, Tsutsumi & Associates, Inc, 2012).

Results

As shown in Table 4, the predicted Future Build noise levels are equal to the Future No-Build noise levels at all locations because the future traffic levels in both conditions are similar. Only the noise level at Location 15 exceeds the HDOT noise limits of 66 dBA. Hence, noise mitigation needs to be evaluated in the vicinity of Location 15.

Table 4 Noise Prediction Results

Sensitive Receiver Location	Existing Noise Level (dBA)	Future No-Build Noise Level (dBA)	Future Build Noise Level (dBA)	Noise Criteria (dBA)
1 - 1009 Maluna St	56	57	57	66
2 - 1205 Namur Road	58	59	59	66
3 - 3846 Salt Lake Blvd	62	64	64	66
4 - 3819 Salt Lake Blvd	56	57	57	66
5 - 3751 Salt Lake Blvd	52	53	53	66
6 - 3817 Salt Lake Blvd	63	65	65	66
7 - 3711 Salt Lake Blvd	58	59	59	66
8 - 3669 Salt Lake Blvd	57	59	59	66
9 - 3637 Salt Lake Blvd	63	65	65	66
10 - 3583 Salt Lake Blvd	60	61	61	66
11 - 3545 Salt Lake Blvd	63	64	64	66
12 - 3515 Salt Lake Blvd	61	62	62	66
13 - 3469 Salt Lake Blvd	65	65	65	66
14 - 3409 Salt Lake Blvd	62	59	59	66
15 - 3313 Salt Lake Blvd	**66**	**67**	**67**	66
Source: Calculations performed by Censeo using TNM 2.5 Numbers in **bold** exceed noise limits				

6 Mitigation Measures

A number of mitigation strategies are available that may be applied independently or in combination to achieve the desired results. These involve elements of the road design, road surface, and restrictions on the use of road, as well as construction of noise barriers. These mitigation strategies are introduced below and analyzed for reasonability, feasibility, and desirable qualities as they relate to this project. The discussion of these measures in this report does not obligate HDOT to implement them. HDOT may choose to modify, delete, or add measures to mitigate impacts.

Road Design

Road design measures include altering the road alignment or depressing road sections. Altering the road alignment could involve realigning the road along a new centerline to move the road away from a sensitive receiver. Depressing the road lowers the road below grade, also moving traffic farther away from affected receivers.

Feasibility – Design plans can be developed to shift road away from the sensitive receivers on one side.

Reasonability – Road alignment changes may be reasonable where changing the road alignment can move traffic far enough away from sensitive receivers to achieve adequate noise reduction. However, a substantial amount of space would be necessary to move the road far enough away from the receivers to achieve the desired noise level reduction. Furthermore, changing road alignment for a sensitive receive could result in the undesired affect of increase noise levels for other sensitive receivers. Acquisition of properties to create the necessary space, realignment of

connecting roads, and the relocation of utilities would make the cost unreasonable.

Traffic Management

Traffic management measures include restricting truck traffic entirely or during certain hours of the day and enforcing the posted speed limit. Both strategies would reduce the noise levels at adjacent properties because trucks produce more noise than automobiles and because higher vehicle speeds generate more noise than lower vehicle speeds (FHWA 1995).

Feasibility – Restrictions on truck traffic is not feasible because displacing the truck traffic may conflict with the planned function of the road. It was assumed that traffic speeds exceed the posted speed limit by 5 mph. It may require speed enforcement measures such as photo radar or police monitoring.

Reasonability – Implementing restrictions on truck use may be reasonable if an adequate noise reduction can be achieved. It may not be reasonable to insure vehicles maintain the 25 mph speed limit.

Noise Barriers

Construction of noise barriers between the roads and the affected receivers reduces noise levels by physically blocking the transmission of traffic-generated noise. Barriers can be constructed as walls or earthen berms. Noise barriers should be high enough to break the line-of-sight between the noise source and the receiver. They must also be long enough to prevent noise from transmitting around the ends of the barrier. Openings in a barrier, for driveways or sidewalks, can significantly reduce the barrier's effectiveness. Earthen berms require more right-of-way than do walls. They are usually constructed at a 3-to-1 slope in each direction. Thus, a berm 8 feet high would slope 24 feet in each direction, for a total width of 48 feet.

Feasibility – Construction of noise barriers are not feasible where the walls would limit sight distances for motorists and where safety barriers would limit the length of the walls.

Reasonability – Construction of noise barriers are reasonable where noise reduction is adequate and cost effective.

The HDOT regulation states that mitigation measures must be considered when either: 1) the projected noise levels at noise sensitive receivers are 66 dBA or more; or, 2) the projected noise levels are 15 dBA or more above the existing noise levels. Substantial increases in noise levels over existing levels were not found in this analysis.

The FHWA guideline states that when noise abatement measures are being considered, every reasonable effort shall be made to obtain substantial noise reduction. HDOT sets a maximum cost of noise abatement per benefited developed property at $60,000 (the construction cost is not specified). Benefited receivers are those that receive a 5 dBA noise reduction from the proposed mitigation. HDOT states that receivers are defined as first floor receivers.

Potential Mitigation Locations

Additional receivers were identified near Location 15 and are shown in Table 5 and in Figure 4. Table 5 shows the predicted noise levels.

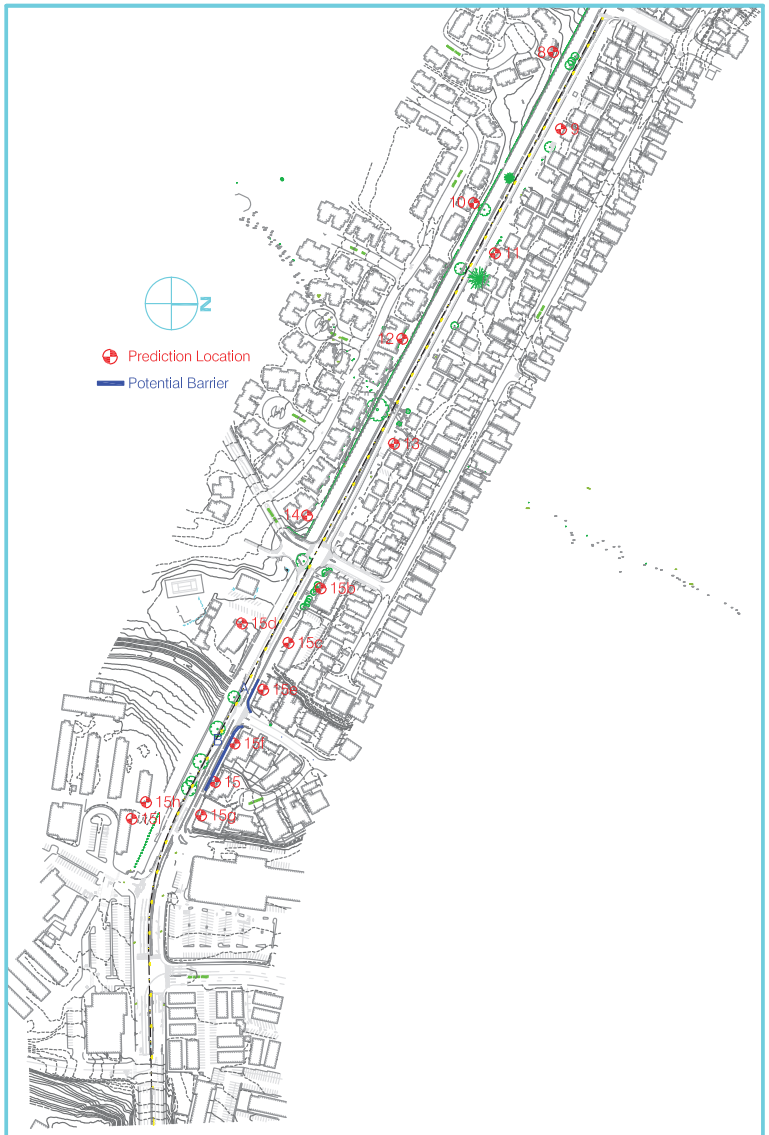


Table 5 Noise Prediction Results - East End

Sensitive Receiver Location	Existing Noise Level (dBA)	Future No-Build Noise Level (dBA)	Future Build Noise Level (dBA)	Noise Criteria (dBA)
15b - 3394 Salt Lake Blvd	64	65	65	66
15c - 3370 Salt Lake Blvd	65	66	66	66
15d - 3362 Salt Lake Blvd - Island Faith Christian Church	60	61	61	66
15e - 3328 Salt Lake Blvd	65	**67**	**67**	66
15f - 3317 Salt Lake Blvd	**67**	**68**	**68**	66
15 - 3313 Salt Lake Blvd	**66**	**67**	**67**	66
15g - 3303 Salt Lake Blvd	63	64	64	66
15h - 3313 Salt Lake Blvd - Aliamanu School	58	59	59	66
15i - 3313 Salt Lake Blvd- Aliamanu School	58	59	59	66
Source: Calculations performed by Censeo using TNM 2.5 Numbers in **bold** exceed noise limits				

As shown in Table 5, the predicted noise levels at Locations 15e, 15f, and 15 exceed the HDOT limits. Two barriers were proposed to mitigate the noise at these locations and are shown in Figure 4 and described below.

Barrier A
Because of the driveway on the west side of the residence, the barrier is limited and does not provide the required noise reduction at the single residence.

Barrier B
Because of the sloping ground along the proposed Barrier B, a barrier would need to be more then 15-feet high at the east end to provide the required noise reduction. This makes constructing a barrier not a feasible option.

The HDOT Noise Policy states the an indoor analysis will be conducted after determination that exterior abatement measures will not be feasible and reasonable. Installing air-conditioning or forced ventilation for the three impacted residences, allowing the windows to be closed, would reduce the interior noise levels by approximately 10 dBA (FHWA 6/2010). If the homes already have air conditioning, and windows can be left closed, improving the interior noise levels by at least 7 dBA could require improving the windows and walls of the homes.

7 Construction Noise

Properties in the vicinity of the project area will be exposed to short-term noise impacts from construction activities. In cases where the construction noise exceeds, or is expected to exceed, the State's "maximum permissible" property line noise level (HDOH 9/23/1996), a permit must be obtained from the State DOH to allow the operation of vehicles, power tools, heavy equipment, etc.

Specific permit restriction for construction activities (HDOH 9/23/1996) are:

- "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels ... before 7 AM and after 6 PM of the same day, Monday through Friday."

- "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels... before 9 AM and after 6 PM on Saturday."

- "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels on Sundays and on holidays."

The State DOH restricts the use of some equipment (including jack hammers and high pressure sprayers) to 9 AM to 5:30 PM, Monday through Friday. The State DOH noise permit does not limit the noise level generated by construction operations, but rather the times at which noisy construction activities can take place.

Construction noise differs from traffic noise in several ways:

- Construction noise lasts only for the duration of the construction contract, with most construction activities in noise-sensitive areas being conducted during hours that are least disturbing to adjacent and nearby residents.
- Construction activities generally are of a short-term nature, and depend on the nature of construction operations.
- Construction noise also is intermittent and depends on the type of operation, location, and function of the equipment, and the equipment usage cycle. Traffic noise, on the other hand, is present in a more continuous fashion after construction activities are completed.

Adjacent properties in the project area would be exposed to noise from construction activity.

Table 5 shows the noise levels produced by various types of construction equipment. The types of construction equipment used for this project will typically generate noise levels of 80 to 90 dBA at a distance of 15 meters (50 feet) while the equipment is operating. Construction equipment operations can vary from intermittent to fairly continuous, with multiple pieces of equipment operating concurrently.

Table 6 Typical Construction Equipment Noise Levels

Type of Equipment	Noise Level in dBA at 50 Feet
Bulldozer	80
Front Loader	72 - 84
Jack Hammer or Rock Drill	81 - 98
Crane with Headache Ball	75 - 87
Backhoe	72 - 93
Scraper and Grader	80 - 93
Electrical Generator	71 - 82
Concrete Pump	81 - 83
Concrete Vibrator	76
Concrete and Dump Trucks	83 - 90
Air Compressor	74 - 87
Pile Drivers (Peaks)	95 - 106
Pneumatic Tools	81 - 98
Roller (Compactor)	73 - 75
Saws	73 - 82
Source: U.S. EPA Noise from Construction Equipment and Operations	

Locations within about 500 meters (1,650 feet) of a construction site are expected to experience occasional episodes of noise levels greater than 60 dBA. Areas within about 150 meters (500 feet) of a construction site will experience episodes with noise levels greater than 70 dBA. Such episodes of high noise levels will not be continuous throughout the day and will generally be restricted to daytime hours.

The following noise mitigation measures are recommended to reduce impacts from construction noise; however, not all measures may be feasible for the Salt Lake Boulevard project:

- Re-route truck traffic away from residential streets, if possible. Select streets with fewest homes, if no alternatives are available.
- Locate equipment on the construction lot as far away from noise sensitive receivers as possible.
- Combine noisy operations to occur in the same time period. The total noise will not increase significantly and the duration of the noise impact will be less.
- Avoid nighttime activities. Sensitivity to noise increases during the nighttime hours at residential receivers.
- Use specially quieted equipment when possible, such as quieted and enclosed air compressors, residential or critical grade mufflers on all engines.
- Stationary equipment will be located as far away from sensitive receptors as possible. Loud, disrupting construction activities in noise sensitive areas will be conducted during hours that are least disturbing to adjacent and nearby residents.

APPENDIX A

References

Traffic Engineering Study for of Salt Lake Boulevard between Maluna Street and Ala Lilikoi Street – Austin, Tsutsumi & Associates, Inc, 2012

Hawaii Department of Transportation and USA Department of Transportation, Highway Noise Policy and Abatement Guidelines - HDOT 4/25/2011

Hawaii Department of Transportation, Corrections to Highway Noise Policy and Abatement Guidelines dated April 25, 2011- HDOT 11/29/2011

State of Hawaii, Department of Health, Chapter 46, *Community Noise Control*, Administrative Rules, Title 11, September 23, 1996 - HDOH 9/23/1996

Federal Highway Administration, DOT 23 CFR, Chapter 1, Part 772 7/13/2010

Traffic Noise Model Version 2.5 User's Guide (Addendum) 4/2004

Handbook of Acoustical Measurements and Noise Control, Third Edition, Cyril Harris 1998

Transit Noise and Vibration Impact Assessment, Federal Transit Administration 4/1995

Environmental Protections Authority – Noise Policy 1/2000

Federal Highway Administration, Measurement of Highway-Related Noise 1995

Federal Highway Administration, Highway Traffic Noise Analysis and Abatement Guidance 6/2010 - FHWA 6/2010

APPENDIX B

Acoustic Terminology

Sound Pressure Level

Sound, or noise, is the term given to variations in air pressure that are capable of being detected by the human ear. Small fluctuations in atmospheric pressure (sound pressure) constitute the physical property measured with a sound pressure level meter. Because the human ear can detect variations in atmospheric pressure over such a large range of magnitudes, sound pressure is expressed on a logarithmic scale in units called decibels (dB). Noise is defined as "unwanted" sound.

Technically, sound pressure level (SPL) is defined as:

$$SPL = 20 \log (P/P_{ref}) \text{ dB}$$

where P is the sound pressure fluctuation (above or below atmospheric pressure) and P_{ref} is the reference pressure, 20 μPa, which is approximately the lowest sound pressure that can be detected by the human ear.

The sound pressure level that results from a combination of noise sources is not the arithmetic sum of the individual sound sources, but rather the logarithmic sum. For example, two sound levels of 50 dB produce a combined sound level of 53 dB, not 100 dB. Two sound levels of 40 and 50 dB produce a combined level of 50.4 dB.

Human sensitivity to changes in sound pressure level is highly individualized. Sensitivity to sound depends on frequency content, background noise, time of occurrence, duration, and psychological factors such as emotions and expectations. However, in general, a change of 1 or 2 dB in the level of sound is difficult for most people to detect. A 3 dB change is commonly taken as the smallest perceptible change and a 6 dB change corresponds to a noticeable change in loudness. A 10 dB increase or decrease in sound level corresponds to an approximate doubling or halving of loudness, respectively.

A-Weighted Sound Level

Studies have shown conclusively that at equal sound pressure levels, people are generally more sensitive to certain higher frequency sounds (such as made by speech, horns, and whistles) than most lower frequency sounds (such as made by motors and engines)[2] at the same level. To address this preferential response to frequency, the A-weighted scale was developed. The A-weighted scale adjusts the sound level in each frequency band in much the same manner that the human auditory system does. Thus the A-weighted sound

1 D.W. Robinson and R.S. Dadson, "A Re-Determination of the Equal-Loudness Relations for Pure Tones," *British Journal of Applied Physics*, vol. 7, pp. 166 - 181, 1956. (Adopted by the International Standards Organization as Recommendation R-226).

level (read as "dBA") becomes a single number that defines the level of a sound and has some correlation with the sensitivity of the human ear to that sound. Different sounds with the same A-weighted sound level are perceived as being equally loud. The A-weighted noise level is commonly used today in environmental noise analysis and in noise regulations. Typical values of the A-weighted sound level of various noise sources are shown below.

Equivalent Sound Level

The Equivalent Sound Level (L_{eq}) is a type of average which represents the steady level that, integrated over a time period, would produce the same energy as the actual signal. The actual *instantaneous* noise levels typically fluctuate above and below the measured L_{eq} during the measurement period. The A-weighted L_{eq} is a common index for measuring environmental noise.

Common Sound Levels in dBA

Common Outdoor Sounds	Sound Pressure Level (dBA)	Common Indoor Sounds	Subjective Evaluation
Auto horn at 10' Jackhammer at 50'	**100**	Printing plant	Deafening
Gas lawn mower at 4' Pneumatic drill at 50'	**90**	Auditorium during applause Food blender at 3'	Very Loud
Concrete mixer at 50' Jet flyover at 5000'	**80**	Telephone ringing at 8' Vacuum cleaner at 5'	
Large dog barking at 50' Large transformer at 50'	**70**	Electric shaver at 1'	Loud
Automobile at 55 mph at 150' Urban residential	**60**	Normal conversation at 3'	
Small town residence	**50**	Office noise Dishwasher in adjacent room	Moderate
	40	Soft stereo music in residence Library	
Rustling leaves	**30**	Average bedroom at night Soft whisper at 3'	Faint
Quiet rural nighttime	**20**	Broadcast and recording studio	
	10	Human breathing	Very Faint
	0	Threshold of hearing (audibility)	
Source: Sound Solution measurements and reference library			

APPENDIX C

Model Input/Output Files
FHWA Traffic Noise Model
Existing AM

RESULTS: SOUND LEVELS **12032**

Censeo **15 September 2012**
wmh **TNM 2.5**
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: **12032**
RUN: **Existing AM**
BARRIER DESIGN: **INPUT HEIGHTS** **Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.**
ATMOSPHERICS: **68 deg F, 50% RH**

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
Receiver1	1	1	0.0	54.9	66	54.9	10	----	54.9	0.0	8	-8.0
Receiver2	2	1	0.0	57.6	66	57.6	10	----	57.6	0.0	8	-8.0
Receiver3	3	1	0.0	61.3	66	61.3	10	----	61.3	0.0	8	-8.0
Receiver4	4	1	0.0	55.8	66	55.8	10	----	55.8	0.0	8	-8.0
Receiver5	5	1	0.0	51.3	66	51.3	10	----	51.3	0.0	8	-8.0
Receiver6	6	1	0.0	62.3	66	62.3	10	----	62.3	0.0	8	-8.0
Receiver7	7	1	0.0	57.5	66	57.5	10	----	57.5	0.0	8	-8.0
Receiver8	8	1	0.0	57.3	66	57.3	10	----	57.3	0.0	8	-8.0
Receiver9	9	1	0.0	62.3	66	62.3	10	----	62.3	0.0	8	-8.0
Receiver10	10	1	0.0	59.7	66	59.7	10	----	59.7	0.0	8	-8.0
Receiver11	11	1	0.0	61.7	66	61.7	10	----	61.7	0.0	8	-8.0
Receiver12	12	1	0.0	60.4	66	60.4	10	----	60.4	0.0	8	-8.0
Receiver13	13	1	0.0	62.6	66	62.6	10	----	62.6	0.0	8	-8.0
Receiver14	14	1	0.0	58.0	66	58.0	10	----	58.0	0.0	8	-8.0
Receiver15	15	1	0.0	65.1	66	65.1	10	----	65.1	0.0	8	-8.0
14a	17	1	0.0	61.8	66	61.8	10	----	61.8	0.0	8	-8.0
15a	18	1	0.0	65.5	66	65.5	10	----	65.5	0.0	8	-8.0
15b	20	1	0.0	62.5	66	62.5	10	----	62.5	0.0	8	-8.0
15c	21	1	0.0	63.7	66	63.7	10	----	63.7	0.0	8	-8.0
15d	22	1	0.0	59.7	66	59.7	10	----	59.7	0.0	8	-8.0

C:\TNM25\HISaltAMexist **1** **15 September 2012**

15e	23	1	0.0	64.3	66	64.3	10	----	64.3	0.0	8	-8.0
15f	24	1	0.0	65.7	66	65.7	10	----	65.7	0.0	8	-8.0
15g	25	1	0.0	62.1	66	62.1	10	----	62.1	0.0	8	-8.0
15h	26	1	0.0	57.7	66	57.7	10	----	57.7	0.0	8	-8.0
15i	27	1	0.0	57.8	66	57.8	10	----	57.8	0.0	8	-8.0

Dwelling Units	# DUs	Noise Reduction		
		Min	Avg	Max
		dB	dB	dB
All Selected	25	0.0	0.0	0.0
All Impacted	0	0.0	0.0	0.0
All that meet NR Goal	0	0.0	0.0	0.0

Censeo 15 September 2012
wmh TNM 2.5

INPUT: RECEIVERS
PROJECT/CONTRACT: 12032
RUN: Existing AM

Receiver Name	No.	#DUs	Coordinates (ground) X	Y	Z	Height above Ground	Input Sound Levels and Criteria Existing LAeq1h	Impact Criteria LAeq1h	Sub'l	NR Goal	Active in Calc.
			ft	ft	ft	ft	dBA	dBA	dB	dB	
Receiver1	1	1	-5,690.5	-4,293.8	127.47	4.92	0.00	66	10.0	8.0	Y
Receiver2	2	1	-5,831.3	-4,374.9	121.00	4.92	0.00	66	10.0	8.0	Y
Receiver3	3	1	-5,400.7	-4,907.6	100.00	4.92	0.00	66	10.0	8.0	Y
Receiver4	4	1	-5,374.7	-5,181.2	82.91	4.92	0.00	66	10.0	8.0	Y
Receiver5	5	1	-5,137.6	-5,525.3	111.70	4.92	0.00	66	10.0	8.0	Y
Receiver6	6	1	-4,840.0	-5,588.4	131.00	4.92	0.00	66	10.0	8.0	Y
Receiver7	7	1	-4,881.8	-5,720.5	115.00	4.92	0.00	66	10.0	8.0	Y
Receiver8	8	1	-4,632.2	-5,847.9	101.00	4.92	0.00	66	10.0	8.0	Y
Receiver9	9	1	-4,411.1	-5,816.7	108.81	4.92	0.00	66	10.0	8.0	Y
Receiver10	10	1	-4,169.2	-6,098.9	99.23	4.92	0.00	66	10.0	8.0	Y
Receiver11	11	1	-3,999.5	-6,032.1	102.00	4.92	0.00	66	10.0	8.0	Y
Receiver12	12	1	-3,721.0	-6,324.0	94.56	4.92	0.00	66	10.0	8.0	Y
Receiver13	13	1	-3,391.7	-6,362.6	95.00	4.92	0.00	66	10.0	8.0	Y
Receiver14	14	1	-3,163.4	-6,637.4	84.12	4.92	0.00	66	10.0	8.0	Y
Receiver15	15	1	-2,311.9	-6,929.1	55.54	4.92	0.00	66	10.0	8.0	Y
14a	17	1	-2,851.2	-6,787.5	98.00	4.92	0.00	66	10.0	8.0	Y
15a	18	1	-2,006.4	-7,058.2	31.00	4.92	0.00	66	10.0	8.0	Y
15b	20	1	-2,935.5	-6,588.4	97.00	4.92	0.00	66	10.0	8.0	Y
15c	21	1	-2,759.9	-6,690.6	105.00	4.92	0.00	66	10.0	8.0	Y
15d	22	1	-2,815.8	-6,845.6	98.00	4.92	0.00	66	10.0	8.0	Y
15e	23	1	-2,602.5	-6,777.4	88.00	4.92	0.00	66	10.0	8.0	Y

INPUT: RECEIVERS **12032**

15f	24	1	-2,424.2	-6,872.1	77.00	4.92	0.00	66	10.0	8.0	Y
15g	25	1	-2,208.7	-6,976.8	54.00	4.92	0.00	66	10.0	8.0	Y
15h	26	1	-2,239.2	-7,167.8	33.00	4.92	0.00	66	10.0	8.0	Y
15i	27	1	-2,192.6	-7,199.9	33.00	4.92	0.00	66	10.0	8.0	Y

INPUT: BARRIERS **12032**

Censeo **15 September 2012**
wmh **TNM 2.5**

INPUT: BARRIERS
PROJECT/CONTRACT: **12032**
RUN: **Existing AM**

Barrier Name	Type	Height Min	Max	If Wall $ per Unit Area	If Berm $ per Unit Vol.	Top Width	Run:Rise	Add'tnl $ per Unit Length	Points Name	No.	Coordinates (bottom) X	Y	Z	Height at Point	Segment Seg Ht Incre-ment	Perturbs #Up	#Dn	On Struct?	Important Reflec-tions?
		ft	ft	$/sq ft	$/cu yd	ft	ft:ft	$/ft			ft	ft	ft	ft	ft				
Barrier 1	W	0.00	99.99	0.00				0.00	point1	1	-5,713.6	-4,274.8	144.00	1.00	0.00	0	0		
									point2	2	-5,697.3	-4,349.3	144.00	1.00	0.00	0	0		
									point3	3	-5,652.8	-4,469.8	157.00	1.00	0.00	0	0		
									point4	4	-5,595.5	-4,577.9	145.00	1.00					
South side	W	0.00	99.99	0.00				0.00	point5	5	-5,593.5	-4,802.6	105.00	1.00	0.00	0	0		
									point6	6	-5,497.2	-4,954.4	94.00	1.00	0.00	0	0		
									point7	7	-5,425.3	-5,072.5	81.00	1.00	0.00	0	0		
									point8	8	-5,293.9	-5,280.7	92.00	1.00	0.00	0	0		
									point9	9	-5,269.7	-5,316.3	99.00	1.00	0.00	0	0		
									point10	10	-5,130.2	-5,488.1	121.00	1.00	0.00	0	0		
									point11	11	-4,979.8	-5,619.3	125.00	1.00	0.00	0	0		
									point12	12	-4,747.7	-5,756.4	109.00	1.00	0.00	0	0		
									point13	13	-4,304.6	-5,993.2	96.00	1.00	0.00	0	0		
									point14	14	-4,021.0	-6,145.3	95.00	1.00	0.00	0	0		
									point15	15	-3,759.4	-6,284.9	87.00	1.00	0.00	0	0		
									point16	16	-3,550.2	-6,396.9	91.00	1.00	0.00	0	0		
									point17	17	-3,329.9	-6,518.9	85.00	1.00	0.00	0	0		
									point18	18	-3,109.1	-6,653.1	88.00	1.00					
Barrier3	W	0.00	99.99	0.00				0.00	point19	19	-2,360.7	-6,911.1	55.00	1.00	0.00	0	0		
									point20	20	-2,311.4	-6,940.9	55.00	1.00	0.00	0	0		
									point21	21	-2,254.2	-6,970.5	55.00	1.00	0.00	0	0		
									point22	22	-2,162.3	-7,007.1	55.00	1.00					

Censeo **15 September 2012**
wmh **TNM 2.5**

INPUT: ROADWAYS
PROJECT/CONTRACT: **12032**
RUN: **Existing AM**

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with the approval of FHWA

Roadway Name	Width	Points Name	No.	Coordinates (pavement) X	Y	Z	Flow Control Control Device	Speed Constraint	Percent Vehicles Affected	Segment Pvmt Type	On Struct?
	ft			ft	ft	ft		mph	%		
Salt Lake West	12.0	W	1	-5,874.0	-3,926.0	105.00				Average	
		W2	2	-5,799.3	-4,252.3	124.00				Average	
		W3	3	-5,698.9	-4,541.1	131.24				Average	
		W4	4	-5,554.6	-4,790.5	113.30				Average	
		W5	5	-5,389.8	-5,076.2	93.75				Average	
		W6	6	-5,214.9	-5,334.9	103.45				Average	
		W7	7	-5,019.9	-5,542.1	117.27				Average	
		W8	8	-4,816.7	-5,679.7	115.39				Average	
		W9	9	-4,505.2	-5,838.4	109.00				Average	
		W10	10	-4,272.3	-5,965.9	105.00				Average	
		W11	11	-3,974.4	-6,130.6	98.50				Average	
		W12	12	-3,737.8	-6,253.4	94.96				Average	
		W13	13	-3,508.1	-6,376.0	91.36				Average	
		W14	14	-3,281.2	-6,488.3	91.70				Average	
		W15	15	-3,046.6	-6,620.7	95.00				Average	
		W16	16	-2,532.5	-6,879.9	73.00				Average	
		W17	17	-2,346.2	-6,974.4	53.00				Average	
		W18	18	-1,947.8	-7,147.6	25.63				Average	
		W19	19	-1,658.1	-7,162.5	24.93				Average	
		W20	20	-1,180.7	-7,152.7	57.00					
Salt Lake East	12.0	E	21	-5,843.2	-3,919.5	105.00				Average	
		E2	22	-5,758.2	-4,245.0	125.20				Average	

		E3	23	-5,673.6	-4,536.5	131.60				Average	
		E4	24	-5,532.3	-4,783.4	110.70				Average	
		E5	25	-5,357.4	-5,065.2	94.50				Average	
		E6	26	-5,186.0	-5,318.3	101.90				Average	
		E7	27	-4,997.3	-5,520.1	115.20				Average	
		E8	28	-4,796.3	-5,653.3	115.00				Average	
		E9	29	-4,493.1	-5,818.8	108.60				Average	
		E10	30	-4,257.9	-5,947.1	105.00				Average	
		E11	31	-3,955.4	-6,106.3	99.10				Average	
		E12	32	-3,725.7	-6,232.2	95.10				Average	
		E13	33	-3,495.7	-6,352.3	91.60				Average	
		E14	34	-3,269.9	-6,464.9	91.60				Average	
		E15	35	-3,030.8	-6,586.4	95.90				Average	
		E16	36	-2,517.3	-6,854.1	74.00				Average	
		E17	37	-2,332.4	-6,950.4	54.30				Average	
		E18	38	-1,937.9	-7,114.0	25.00				Average	
		E19	39	-1,672.7	-7,113.5	24.00				Average	
		E20	40	-1,178.8	-7,113.3	51.00					
Maluna Street N	12.0	S	41	-5,716.7	-4,233.7	126.10				Average	
		point42	42	-5,506.0	-4,181.5	143.30				Average	
		N	43	-5,321.6	-4,135.2	162.00					
Namur Rd (Maluna S)	12.0	N	44	-5,845.4	-4,250.5	122.00				Average	
		point45	45	-5,961.9	-4,269.9	114.90				Average	
		S	46	-6,222.2	-4,290.7	106.00					
Wanaka Street	12.0	point47	47	-4,787.8	-5,618.6	117.80				Average	
		point48	48	-4,692.8	-5,445.8	137.00				Average	
		point49	49	-4,612.9	-5,289.5	153.00					
Likini Pl	12.0	point50	50	-3,020.8	-6,558.7	96.70				Average	
		point51	51	-2,921.4	-6,371.9	112.90					
Radford Dr	12.0	point52	52	-3,056.7	-6,643.0	94.40				Average	
		point53	53	-3,132.7	-6,728.6	88.30				Average	
		point54	54	-3,426.8	-6,897.6	70.00					
Khaikolu Pl	12.0	point55	55	-2,507.2	-6,828.9	75.40				Average	
		point56	56	-2,382.9	-6,631.9	79.00					
Ala Lilikoi Street	12.0	point57	57	-1,680.7	-7,075.2	23.90				Average	

		point58	58	-1,684.1	-6,853.6	21.00				Average	
		point59	59	-1,657.9	-6,727.3	21.90					

APPENDIX D

Model Input/Output Files
FHWA Traffic Noise Model
Existing PM

Censeo **15 September 2012**
wmh **TNM 2.5**
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: Salt Lake Blvd
RUN: Existing PM
BARRIER DESIGN: INPUT HEIGHTS
ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
Receiver1	1	1	0.0	56.0	66	56.0	10	----	56.0	0.0	8	-8.0
Receiver2	2	1	0.0	57.6	66	57.6	10	----	57.6	0.0	8	-8.0
Receiver3	3	1	0.0	62.1	66	62.1	10	----	62.1	0.0	8	-8.0
Receiver4	4	1	0.0	55.8	66	55.8	10	----	55.8	0.0	8	-8.0
Receiver5	5	1	0.0	51.6	66	51.6	10	----	51.6	0.0	8	-8.0
Receiver6	6	1	0.0	63.4	66	63.4	10	----	63.4	0.0	8	-8.0
Receiver7	7	1	0.0	57.8	66	57.8	10	----	57.8	0.0	8	-8.0
Receiver8	8	1	0.0	57.3	66	57.3	10	----	57.3	0.0	8	-8.0
Receiver9	9	1	0.0	63.2	66	63.2	10	----	63.2	0.0	8	-8.0
Receiver10	10	1	0.0	59.6	66	59.6	10	----	59.6	0.0	8	-8.0
Receiver11	11	1	0.0	62.8	66	62.8	10	----	62.8	0.0	8	-8.0
Receiver12	12	1	0.0	60.6	66	60.6	10	----	60.6	0.0	8	-8.0
Receiver13	13	1	0.0	63.7	66	63.7	10	----	63.7	0.0	8	-8.0
Receiver14	14	1	0.0	58.1	66	58.1	10	----	58.1	0.0	8	-8.0
Receiver15	15	1	0.0	65.9	66	65.9	10	----	65.9	0.0	8	-8.0
15b	17	1	0.0	63.6	66	63.6	10	----	63.6	0.0	8	-8.0
15c	18	1	0.0	64.7	66	64.7	10	----	64.7	0.0	8	-8.0
15d	19	1	0.0	60.0	66	60.0	10	----	60.0	0.0	8	-8.0
15e	20	1	0.0	65.4	66	65.4	10	----	65.4	0.0	8	-8.0
15f	21	1	0.0	66.5	66	66.5	10	Snd Lvl	66.5	0.0	8	-8.0

15g	22	1	0.0	62.5	66	62.5	10	----	62.5	0.0	8	-8.0
15h	23	1	0.0	57.8	66	57.8	10	----	57.8	0.0	8	-8.0
15i	24	1	0.0	58.0	66	58.0	10	----	58.0	0.0	8	-8.0

Dwelling Units	# DUs	Noise Reduction Min dB	Avg dB	Max dB
All Selected	23	0.0	0.0	0.0
All Impacted	1	0.0	0.0	0.0
All that meet NR Goal	0	0.0	0.0	0.0

Censeo **15 September 2012**
wmh **TNM 2.5**

INPUT: ROADWAYS
PROJECT/CONTRACT: **Salt Lake Blvd**
RUN: **Existing PM**

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with the approval of FHWA

Roadway Name	Width	Points Name	No.	Coordinates (pavement) X	Y	Z	Flow Control Control Device	Speed Constraint	Percent Vehicles Affected	Segment Pvmt Type	On Struct?
	ft			ft	ft	ft		mph	%		
Salt Lake West	12.0	W	1	-5,874.0	-3,926.0	105.00				Average	
		W2	2	-5,799.3	-4,252.3	124.00				Average	
		W3	3	-5,698.9	-4,541.1	131.24				Average	
		W4	4	-5,554.6	-4,790.5	113.30				Average	
		W5	5	-5,389.8	-5,076.2	93.75				Average	
		W6	6	-5,214.9	-5,334.9	103.45				Average	
		W7	7	-5,019.9	-5,542.1	117.27				Average	
		W8	8	-4,816.7	-5,679.7	115.39				Average	
		W9	9	-4,505.2	-5,838.4	109.00				Average	
		W10	10	-4,272.3	-5,965.9	105.00				Average	
		W11	11	-3,974.4	-6,130.6	98.50				Average	
		W12	12	-3,737.8	-6,253.4	94.96				Average	
		W13	13	-3,508.1	-6,376.0	91.36				Average	
		W14	14	-3,281.2	-6,488.3	91.70				Average	
		W15	15	-3,046.6	-6,620.7	95.00				Average	
		W16	16	-2,532.5	-6,879.9	73.00				Average	
		W17	17	-2,346.2	-6,974.4	53.00				Average	
		W18	18	-1,947.8	-7,147.6	25.63				Average	
		W19	19	-1,658.1	-7,162.5	24.93				Average	
		W20	20	-1,180.7	-7,152.7	57.00					
Salt Lake East	12.0	E	21	-5,843.2	-3,919.5	105.00				Average	
		E2	22	-5,758.2	-4,245.0	125.20				Average	

		E3	23	-5,673.6	-4,536.5	131.60				Average	
		E4	24	-5,532.3	-4,783.4	110.70				Average	
		E5	25	-5,357.4	-5,065.2	94.50				Average	
		E6	26	-5,186.0	-5,318.3	101.90				Average	
		E7	27	-4,997.3	-5,520.1	115.20				Average	
		E8	28	-4,796.3	-5,653.3	115.00				Average	
		E9	29	-4,493.1	-5,818.8	108.60				Average	
		E10	30	-4,257.9	-5,947.1	105.00				Average	
		E11	31	-3,955.4	-6,106.3	99.10				Average	
		E12	32	-3,725.7	-6,232.2	95.10				Average	
		E13	33	-3,495.7	-6,352.3	91.60				Average	
		E14	34	-3,269.9	-6,464.9	91.60				Average	
		E15	35	-3,030.8	-6,586.4	95.90				Average	
		E16	36	-2,517.3	-6,854.1	74.00				Average	
		E17	37	-2,332.4	-6,950.4	54.30				Average	
		E18	38	-1,937.9	-7,114.0	25.00				Average	
		E19	39	-1,672.7	-7,113.5	24.00				Average	
		E20	40	-1,178.8	-7,113.3	51.00					
Maluna Street N	12.0	S	41	-5,716.7	-4,233.7	126.10				Average	
		point42	42	-5,506.0	-4,181.5	143.30				Average	
		N	43	-5,321.6	-4,135.2	162.00					
Namur Rd (Maluna S)	12.0	N	44	-5,845.4	-4,250.5	122.00				Average	
		point45	45	-5,961.9	-4,269.9	114.90				Average	
		S	46	-6,222.2	-4,290.7	106.00					
Wanaka Street	12.0	point47	47	-4,787.8	-5,618.6	117.80				Average	
		point48	48	-4,692.8	-5,445.8	137.00				Average	
		point49	49	-4,612.9	-5,289.5	153.00					
Likini Pl	12.0	point50	50	-3,020.8	-6,558.7	96.70				Average	
		point51	51	-2,921.4	-6,371.9	112.90					
Radford Dr	12.0	point52	52	-3,056.7	-6,643.0	94.40				Average	
		point53	53	-3,132.7	-6,728.6	88.30				Average	
		point54	54	-3,426.8	-6,897.6	70.00					
Khaikolu Pl	12.0	point55	55	-2,507.2	-6,828.9	75.40				Average	
		point56	56	-2,382.9	-6,631.9	79.00					
Ala Lilikoi Street	12.0	point57	57	-1,680.7	-7,075.2	23.90				Average	

		point58	58	-1,684.1	-6,853.6	21.00				Average	
		point59	59	-1,657.9	-6,727.3	21.90					

APPENDIX E

Model Input/Output Files
FHWA Traffic Noise Model
Future No-Build AM

Censeo **15 September 2012**
wmh **TNM 2.5**
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: Salt Lake Blvd
RUN: Future AM No Build
BARRIER DESIGN: INPUT HEIGHTS
ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
Receiver1	1	1	0.0	55.8	66	55.8	10	----	55.8	0.0	8	-8.0
Receiver2	2	1	0.0	58.6	66	58.6	10	----	58.6	0.0	8	-8.0
Receiver3	3	1	0.0	62.4	66	62.4	10	----	62.4	0.0	8	-8.0
Receiver4	4	1	0.0	56.8	66	56.8	10	----	56.8	0.0	8	-8.0
Receiver5	5	1	0.0	52.4	66	52.4	10	----	52.4	0.0	8	-8.0
Receiver6	6	1	0.0	63.6	66	63.6	10	----	63.6	0.0	8	-8.0
Receiver7	7	1	0.0	58.7	66	58.7	10	----	58.7	0.0	8	-8.0
Receiver8	8	1	0.0	58.6	66	58.6	10	----	58.6	0.0	8	-8.0
Receiver9	9	1	0.0	63.6	66	63.6	10	----	63.6	0.0	8	-8.0
Receiver10	10	1	0.0	60.6	66	60.6	10	----	60.6	0.0	8	-8.0
Receiver11	11	1	0.0	63.0	66	63.0	10	----	63.0	0.0	8	-8.0
Receiver12	12	1	0.0	61.7	66	61.7	10	----	61.7	0.0	8	-8.0
Receiver13	13	1	0.0	63.9	66	63.9	10	----	63.9	0.0	8	-8.0
Receiver14	14	1	0.0	59.3	66	59.3	10	----	59.3	0.0	8	-8.0
Receiver15	15	1	0.0	66.4	66	66.4	10	Snd Lvl	66.4	0.0	8	-8.0
15b	17	1	0.0	63.9	66	63.9	10	----	63.9	0.0	8	-8.0
15c	18	1	0.0	65.0	66	65.0	10	----	65.0	0.0	8	-8.0
15d	19	1	0.0	61.0	66	61.0	10	----	61.0	0.0	8	-8.0
15e	20	1	0.0	65.6	66	65.6	10	----	65.6	0.0	8	-8.0
15f	21	1	0.0	67.0	66	67.0	10	Snd Lvl	67.0	0.0	8	-8.0

15g	22	1	0.0	63.4	66	63.4	10	----	63.4	0.0	8	-8.0
15h	23	1	0.0	59.0	66	59.0	10	----	59.0	0.0	8	-8.0
15i	24	1	0.0	59.1	66	59.1	10	----	59.1	0.0	8	-8.0

Dwelling Units	# DUs	Noise Reduction Min	Avg	Max
		dB	dB	dB
All Selected	23	0.0	0.0	0.0
All Impacted	2	0.0	0.0	0.0
All that meet NR Goal	0	0.0	0.0	0.0

Censeo **15 September 2012**
wmh **TNM 2.5**

INPUT: ROADWAYS
PROJECT/CONTRACT: **Salt Lake Blvd**
RUN: **Future AM No Build**

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with the approval of FHWA

Roadway Name	Width	Points Name	No.	Coordinates (pavement) X	Y	Z	Flow Control Control Device	Speed Constraint	Percent Vehicles Affected	Segment Pvmt Type	On Struct?
	ft			ft	ft	ft		mph	%		
Salt Lake West	12.0	W	1	-5,874.0	-3,926.0	105.00				Average	
		W2	2	-5,799.3	-4,252.3	124.00				Average	
		W3	3	-5,698.9	-4,541.1	131.24				Average	
		W4	4	-5,554.6	-4,790.5	113.30				Average	
		W5	5	-5,389.8	-5,076.2	93.75				Average	
		W6	6	-5,214.9	-5,334.9	103.45				Average	
		W7	7	-5,019.9	-5,542.1	117.27				Average	
		W8	8	-4,816.7	-5,679.7	115.39				Average	
		W9	9	-4,505.2	-5,838.4	109.00				Average	
		W10	10	-4,272.3	-5,965.9	105.00				Average	
		W11	11	-3,974.4	-6,130.6	98.50				Average	
		W12	12	-3,737.8	-6,253.4	94.96				Average	
		W13	13	-3,508.1	-6,376.0	91.36				Average	
		W14	14	-3,281.2	-6,488.3	91.70				Average	
		W15	15	-3,046.6	-6,620.7	95.00				Average	
		W16	16	-2,532.5	-6,879.9	73.00				Average	
		W17	17	-2,346.2	-6,974.4	53.00				Average	
		W18	18	-1,947.8	-7,147.6	25.63				Average	
		W19	19	-1,658.1	-7,162.5	24.93				Average	
		W20	20	-1,180.7	-7,152.7	57.00					
Salt Lake East	12.0	E	21	-5,843.2	-3,919.5	105.00				Average	
		E2	22	-5,758.2	-4,245.0	125.20				Average	

		E3	23	-5,673.6	-4,536.5	131.60				Average	
		E4	24	-5,532.3	-4,783.4	110.70				Average	
		E5	25	-5,357.4	-5,065.2	94.50				Average	
		E6	26	-5,186.0	-5,318.3	101.90				Average	
		E7	27	-4,997.3	-5,520.1	115.20				Average	
		E8	28	-4,796.3	-5,653.3	115.00				Average	
		E9	29	-4,493.1	-5,818.8	108.60				Average	
		E10	30	-4,257.9	-5,947.1	105.00				Average	
		E11	31	-3,955.4	-6,106.3	99.10				Average	
		E12	32	-3,725.7	-6,232.2	95.10				Average	
		E13	33	-3,495.7	-6,352.3	91.60				Average	
		E14	34	-3,269.9	-6,464.9	91.60				Average	
		E15	35	-3,030.8	-6,586.4	95.90				Average	
		E16	36	-2,517.3	-6,854.1	74.00				Average	
		E17	37	-2,332.4	-6,950.4	54.30				Average	
		E18	38	-1,937.9	-7,114.0	25.00				Average	
		E19	39	-1,672.7	-7,113.5	24.00				Average	
		E20	40	-1,178.8	-7,113.3	51.00					
Maluna Street N	12.0	S	41	-5,716.7	-4,233.7	126.10				Average	
		point42	42	-5,506.0	-4,181.5	143.30				Average	
		N	43	-5,321.6	-4,135.2	162.00					
Namur Rd (Maluna S)	12.0	N	44	-5,845.4	-4,250.5	122.00				Average	
		point45	45	-5,961.9	-4,269.9	114.90				Average	
		S	46	-6,222.2	-4,290.7	106.00					
Wanaka Street	12.0	point47	47	-4,787.8	-5,618.6	117.80				Average	
		point48	48	-4,692.8	-5,445.8	137.00				Average	
		point49	49	-4,612.9	-5,289.5	153.00					
Likini Pl	12.0	point50	50	-3,020.8	-6,558.7	96.70				Average	
		point51	51	-2,921.4	-6,371.9	112.90					
Radford Dr	12.0	point52	52	-3,056.7	-6,643.0	94.40				Average	
		point53	53	-3,132.7	-6,728.6	88.30				Average	
		point54	54	-3,426.8	-6,897.6	70.00					
Khaikolu Pl	12.0	point55	55	-2,507.2	-6,828.9	75.40				Average	
		point56	56	-2,382.9	-6,631.9	79.00					
Ala Lilikoi Street	12.0	point57	57	-1,680.7	-7,075.2	23.90				Average	

		point58	58	-1,684.1	-6,853.6	21.00				Average	
		point59	59	-1,657.9	-6,727.3	21.90					

Censeo **15 September 2012**
wmh **TNM 2.5**

INPUT: RECEIVERS
PROJECT/CONTRACT: **Salt Lake Blvd**
RUN: **Future AM Build**

Receiver Name	No.	#DUs	Coordinates (ground) X	Y	Z	Height above Ground	Input Sound Levels and Criteria Existing LAeq1h	Impact Criteria LAeq1h	Sub'l	NR Goal	Active in Calc.
			ft	ft	ft	ft	dBA	dBA	dB	dB	
Receiver1	1	1	-5,690.5	-4,293.8	127.47	4.92	0.00	66	10.0	8.0	Y
Receiver2	2	1	-5,831.3	-4,374.9	121.00	4.92	0.00	66	10.0	8.0	Y
Receiver3	3	1	-5,400.7	-4,907.6	100.00	4.92	0.00	66	10.0	8.0	Y
Receiver4	4	1	-5,374.7	-5,181.2	82.91	4.92	0.00	66	10.0	8.0	Y
Receiver5	5	1	-5,137.6	-5,525.3	111.70	4.92	0.00	66	10.0	8.0	Y
Receiver6	6	1	-4,840.0	-5,588.4	131.00	4.92	0.00	66	10.0	8.0	Y
Receiver7	7	1	-4,881.8	-5,720.5	115.00	4.92	0.00	66	10.0	8.0	Y
Receiver8	8	1	-4,632.2	-5,847.9	101.00	4.92	0.00	66	10.0	8.0	Y
Receiver9	9	1	-4,411.1	-5,816.7	108.81	4.92	0.00	66	10.0	8.0	Y
Receiver10	10	1	-4,169.2	-6,098.9	99.23	4.92	0.00	66	10.0	8.0	Y
Receiver11	11	1	-3,999.5	-6,032.1	102.00	4.92	0.00	66	10.0	8.0	Y
Receiver12	12	1	-3,721.0	-6,324.0	94.56	4.92	0.00	66	10.0	8.0	Y
Receiver13	13	1	-3,391.7	-6,362.6	95.00	4.92	0.00	66	10.0	8.0	Y
Receiver14	14	1	-3,163.4	-6,637.4	84.12	4.92	0.00	66	10.0	8.0	Y
Receiver15	15	1	-2,311.9	-6,929.1	55.54	4.92	0.00	66	10.0	8.0	Y
15b	17	1	-2,935.5	-6,588.4	97.00	4.92	0.00	66	10.0	8.0	Y
15c	18	1	-2,759.9	-6,690.6	105.00	4.92	0.00	66	10.0	8.0	Y
15d	19	1	-2,815.8	-6,845.6	98.00	4.92	0.00	66	10.0	8.0	Y
15e	20	1	-2,602.5	-6,777.4	88.00	4.92	0.00	66	10.0	8.0	Y
15f	21	1	-2,424.2	-6,872.1	77.00	4.92	0.00	66	10.0	8.0	Y
15g	22	1	-2,208.7	-6,976.8	54.00	4.92	0.00	66	10.0	8.0	Y

INPUT: RECEIVERS Salt Lake Blvd

15h	23	1	-2,239.2	-7,167.8	33.00	4.92	0.00	66	10.0	8.0	Y
15i	24	1	-2,192.6	-7,199.9	33.00	4.92	0.00	66	10.0	8.0	Y

APPENDIX F

Model Input/Output Files
FHWA Traffic Noise Model
Future No-Build PM

Censeo **15 September 2012**
wmh **TNM 2.5**
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: Salt Lake Blvd
RUN: Future PM No Build
BARRIER DESIGN: INPUT HEIGHTS
ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
Receiver1	1	1	0.0	57.1	66	57.1	10	----	57.1	0.0	8	-8.0
Receiver2	2	1	0.0	59.1	66	59.1	10	----	59.1	0.0	8	-8.0
Receiver3	3	1	0.0	63.5	66	63.5	10	----	63.5	0.0	8	-8.0
Receiver4	4	1	0.0	57.4	66	57.4	10	----	57.4	0.0	8	-8.0
Receiver5	5	1	0.0	53.1	66	53.1	10	----	53.1	0.0	8	-8.0
Receiver6	6	1	0.0	64.8	66	64.8	10	----	64.8	0.0	8	-8.0
Receiver7	7	1	0.0	59.2	66	59.2	10	----	59.2	0.0	8	-8.0
Receiver8	8	1	0.0	58.6	66	58.6	10	----	58.6	0.0	8	-8.0
Receiver9	9	1	0.0	64.5	66	64.5	10	----	64.5	0.0	8	-8.0
Receiver10	10	1	0.0	60.9	66	60.9	10	----	60.9	0.0	8	-8.0
Receiver11	11	1	0.0	64.1	66	64.1	10	----	64.1	0.0	8	-8.0
Receiver12	12	1	0.0	61.9	66	61.9	10	----	61.9	0.0	8	-8.0
Receiver13	13	1	0.0	65.0	66	65.0	10	----	65.0	0.0	8	-8.0
Receiver14	14	1	0.0	59.4	66	59.4	10	----	59.4	0.0	8	-8.0
Receiver15	15	1	0.0	67.2	66	67.2	10	Snd Lvl	67.2	0.0	8	-8.0
15b	17	1	0.0	64.8	66	64.8	10	----	64.8	0.0	8	-8.0
15c	18	1	0.0	65.9	66	65.9	10	----	65.9	0.0	8	-8.0
15d	19	1	0.0	61.2	66	61.2	10	----	61.2	0.0	8	-8.0
15e	20	1	0.0	66.7	66	66.7	10	Snd Lvl	66.7	0.0	8	-8.0
15f	21	1	0.0	67.9	66	67.9	10	Snd Lvl	67.9	0.0	8	-8.0

15g	22	1	0.0	63.7	66	63.7	10	----	63.7	0.0	8	-8.0
15h	23	1	0.0	59.1	66	59.1	10	----	59.1	0.0	8	-8.0
15i	24	1	0.0	59.3	66	59.3	10	----	59.3	0.0	8	-8.0

Dwelling Units	# DUs	Noise Reduction Min dB	Avg dB	Max dB
All Selected	23	0.0	0.0	0.0
All Impacted	3	0.0	0.0	0.0
All that meet NR Goal	0	0.0	0.0	0.0

Censeo **15 September 2012**
wmh **TNM 2.5**

INPUT: ROADWAYS
PROJECT/CONTRACT: **Salt Lake Blvd**
RUN: **Future PM No Build**

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with the approval of FHWA

Roadway Name	Width	Points Name	No.	Coordinates (pavement) X	Y	Z	Flow Control Device	Speed Constraint	Percent Vehicles Affected	Segment Pvmt Type	On Struct?
	ft			ft	ft	ft		mph	%		
Salt Lake West	12.0	W	1	-5,874.0	-3,926.0	105.00				Average	
		W2	2	-5,799.3	-4,252.3	124.00				Average	
		W3	3	-5,698.9	-4,541.1	131.24				Average	
		W4	4	-5,554.6	-4,790.5	113.30				Average	
		W5	5	-5,389.8	-5,076.2	93.75				Average	
		W6	6	-5,214.9	-5,334.9	103.45				Average	
		W7	7	-5,019.9	-5,542.1	117.27				Average	
		W8	8	-4,816.7	-5,679.7	115.39				Average	
		W9	9	-4,505.2	-5,838.4	109.00				Average	
		W10	10	-4,272.3	-5,965.9	105.00				Average	
		W11	11	-3,974.4	-6,130.6	98.50				Average	
		W12	12	-3,737.8	-6,253.4	94.96				Average	
		W13	13	-3,508.1	-6,376.0	91.36				Average	
		W14	14	-3,281.2	-6,488.3	91.70				Average	
		W15	15	-3,046.6	-6,620.7	95.00				Average	
		W16	16	-2,532.5	-6,879.9	73.00				Average	
		W17	17	-2,346.2	-6,974.4	53.00				Average	
		W18	18	-1,947.8	-7,147.6	25.63				Average	
		W19	19	-1,658.1	-7,162.5	24.93				Average	
		W20	20	-1,180.7	-7,152.7	57.00					
Salt Lake East	12.0	E	21	-5,843.2	-3,919.5	105.00				Average	
		E2	22	-5,758.2	-4,245.0	125.20				Average	

		E3	23	-5,673.6	-4,536.5	131.60				Average	
		E4	24	-5,532.3	-4,783.4	110.70				Average	
		E5	25	-5,357.4	-5,065.2	94.50				Average	
		E6	26	-5,186.0	-5,318.3	101.90				Average	
		E7	27	-4,997.3	-5,520.1	115.20				Average	
		E8	28	-4,796.3	-5,653.3	115.00				Average	
		E9	29	-4,493.1	-5,818.8	108.60				Average	
		E10	30	-4,257.9	-5,947.1	105.00				Average	
		E11	31	-3,955.4	-6,106.3	99.10				Average	
		E12	32	-3,725.7	-6,232.2	95.10				Average	
		E13	33	-3,495.7	-6,352.3	91.60				Average	
		E14	34	-3,269.9	-6,464.9	91.60				Average	
		E15	35	-3,030.8	-6,586.4	95.90				Average	
		E16	36	-2,517.3	-6,854.1	74.00				Average	
		E17	37	-2,332.4	-6,950.4	54.30				Average	
		E18	38	-1,937.9	-7,114.0	25.00				Average	
		E19	39	-1,672.7	-7,113.5	24.00				Average	
		E20	40	-1,178.8	-7,113.3	51.00					
Maluna Street N	12.0	S	41	-5,716.7	-4,233.7	126.10				Average	
		point42	42	-5,506.0	-4,181.5	143.30				Average	
		N	43	-5,321.6	-4,135.2	162.00					
Namur Rd (Maluna S)	12.0	N	44	-5,845.4	-4,250.5	122.00				Average	
		point45	45	-5,961.9	-4,269.9	114.90				Average	
		S	46	-6,222.2	-4,290.7	106.00					
Wanaka Street	12.0	point47	47	-4,787.8	-5,618.6	117.80				Average	
		point48	48	-4,692.8	-5,445.8	137.00				Average	
		point49	49	-4,612.9	-5,289.5	153.00					
Likini Pl	12.0	point50	50	-3,020.8	-6,558.7	96.70				Average	
		point51	51	-2,921.4	-6,371.9	112.90					
Radford Dr	12.0	point52	52	-3,056.7	-6,643.0	94.40				Average	
		point53	53	-3,132.7	-6,728.6	88.30				Average	
		point54	54	-3,426.8	-6,897.6	70.00					
Khaikolu Pl	12.0	point55	55	-2,507.2	-6,828.9	75.40				Average	
		point56	56	-2,382.9	-6,631.9	79.00					
Ala Lilikoi Street	12.0	point57	57	-1,680.7	-7,075.2	23.90				Average	

		point58	58	-1,684.1	-6,853.6	21.00				Average	
		point59	59	-1,657.9	-6,727.3	21.90					

APPENDIX G

Model Input/Output Files
FHWA Traffic Noise Model
Future Build AM

Censeo **15 September 2012**
wmh **TNM 2.5**
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: **Salt Lake Blvd**
RUN: **Future AM Build**
BARRIER DESIGN: **INPUT HEIGHTS**
ATMOSPHERICS: **68 deg F, 50% RH**

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
Receiver1	1	1	0.0	55.8	66	55.8	10	----	55.8	0.0	8	-8.0
Receiver2	2	1	0.0	58.6	66	58.6	10	----	58.6	0.0	8	-8.0
Receiver3	3	1	0.0	62.4	66	62.4	10	----	62.4	0.0	8	-8.0
Receiver4	4	1	0.0	56.8	66	56.8	10	----	56.8	0.0	8	-8.0
Receiver5	5	1	0.0	52.4	66	52.4	10	----	52.4	0.0	8	-8.0
Receiver6	6	1	0.0	63.6	66	63.6	10	----	63.6	0.0	8	-8.0
Receiver7	7	1	0.0	58.7	66	58.7	10	----	58.7	0.0	8	-8.0
Receiver8	8	1	0.0	58.6	66	58.6	10	----	58.6	0.0	8	-8.0
Receiver9	9	1	0.0	63.6	66	63.6	10	----	63.6	0.0	8	-8.0
Receiver10	10	1	0.0	60.6	66	60.6	10	----	60.6	0.0	8	-8.0
Receiver11	11	1	0.0	63.0	66	63.0	10	----	63.0	0.0	8	-8.0
Receiver12	12	1	0.0	61.7	66	61.7	10	----	61.7	0.0	8	-8.0
Receiver13	13	1	0.0	63.9	66	63.9	10	----	63.9	0.0	8	-8.0
Receiver14	14	1	0.0	59.3	66	59.3	10	----	59.3	0.0	8	-8.0
Receiver15	15	1	0.0	66.4	66	66.4	10	Snd Lvl	66.4	0.0	8	-8.0
15b	17	1	0.0	63.9	66	63.9	10	----	63.9	0.0	8	-8.0
15c	18	1	0.0	65.0	66	65.0	10	----	65.0	0.0	8	-8.0
15d	19	1	0.0	61.0	66	61.0	10	----	61.0	0.0	8	-8.0
15e	20	1	0.0	65.6	66	65.6	10	----	65.6	0.0	8	-8.0
15f	21	1	0.0	67.0	66	67.0	10	Snd Lvl	67.0	0.0	8	-8.0

15g	22	1	0.0	63.4	66	63.4	10	----	63.4	0.0	8	-8.0
15h	23	1	0.0	59.0	66	59.0	10	----	59.0	0.0	8	-8.0
15i	24	1	0.0	59.1	66	59.1	10	----	59.1	0.0	8	-8.0

Dwelling Units	# DUs	Noise Reduction Min dB	Avg dB	Max dB
All Selected	23	0.0	0.0	0.0
All Impacted	2	0.0	0.0	0.0
All that meet NR Goal	0	0.0	0.0	0.0

Censeo **15 September 2012**
wmh **TNM 2.5**

INPUT: ROADWAYS
PROJECT/CONTRACT: **Salt Lake Blvd**
RUN: **Future AM Build**

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with the approval of FHWA

Roadway Name	Width	Points Name	No.	Coordinates (pavement) X	Y	Z	Flow Control Control Device	Speed Constraint	Percent Vehicles Affected	Segment Pvmt Type	On Struct?
	ft			ft	ft	ft		mph	%		
Salt Lake West	12.0	W	1	-5,874.0	-3,926.0	105.00				Average	
		W2	2	-5,799.3	-4,252.3	124.00				Average	
		W3	3	-5,698.9	-4,541.1	131.24				Average	
		W4	4	-5,554.6	-4,790.5	113.30				Average	
		W5	5	-5,389.8	-5,076.2	93.75				Average	
		W6	6	-5,214.9	-5,334.9	103.45				Average	
		W7	7	-5,019.9	-5,542.1	117.27				Average	
		W8	8	-4,816.7	-5,679.7	115.39				Average	
		W9	9	-4,505.2	-5,838.4	109.00				Average	
		W10	10	-4,272.3	-5,965.9	105.00				Average	
		W11	11	-3,974.4	-6,130.6	98.50				Average	
		W12	12	-3,737.8	-6,253.4	94.96				Average	
		W13	13	-3,508.1	-6,376.0	91.36				Average	
		W14	14	-3,281.2	-6,488.3	91.70				Average	
		W15	15	-3,046.6	-6,620.7	95.00				Average	
		W16	16	-2,532.5	-6,879.9	73.00				Average	
		W17	17	-2,346.2	-6,974.4	53.00				Average	
		W18	18	-1,947.8	-7,147.6	25.63				Average	
		W19	19	-1,658.1	-7,162.5	24.93				Average	
		W20	20	-1,180.7	-7,152.7	57.00					
Salt Lake East	12.0	E	21	-5,843.2	-3,919.5	105.00				Average	
		E2	22	-5,758.2	-4,245.0	125.20				Average	

		E3	23	-5,673.6	-4,536.5	131.60				Average	
		E4	24	-5,532.3	-4,783.4	110.70				Average	
		E5	25	-5,357.4	-5,065.2	94.50				Average	
		E6	26	-5,186.0	-5,318.3	101.90				Average	
		E7	27	-4,997.3	-5,520.1	115.20				Average	
		E8	28	-4,796.3	-5,653.3	115.00				Average	
		E9	29	-4,493.1	-5,818.8	108.60				Average	
		E10	30	-4,257.9	-5,947.1	105.00				Average	
		E11	31	-3,955.4	-6,106.3	99.10				Average	
		E12	32	-3,725.7	-6,232.2	95.10				Average	
		E13	33	-3,495.7	-6,352.3	91.60				Average	
		E14	34	-3,269.9	-6,464.9	91.60				Average	
		E15	35	-3,030.8	-6,586.4	95.90				Average	
		E16	36	-2,517.3	-6,854.1	74.00				Average	
		E17	37	-2,332.4	-6,950.4	54.30				Average	
		E18	38	-1,937.9	-7,114.0	25.00				Average	
		E19	39	-1,672.7	-7,113.5	24.00				Average	
		E20	40	-1,178.8	-7,113.3	51.00					
Maluna Street N	12.0	S	41	-5,716.7	-4,233.7	126.10				Average	
		point42	42	-5,506.0	-4,181.5	143.30				Average	
		N	43	-5,321.6	-4,135.2	162.00					
Namur Rd (Maluna S)	12.0	N	44	-5,845.4	-4,250.5	122.00				Average	
		point45	45	-5,961.9	-4,269.9	114.90				Average	
		S	46	-6,222.2	-4,290.7	106.00					
Wanaka Street	12.0	point47	47	-4,787.8	-5,618.6	117.80				Average	
		point48	48	-4,692.8	-5,445.8	137.00				Average	
		point49	49	-4,612.9	-5,289.5	153.00					
Likini Pl	12.0	point50	50	-3,020.8	-6,558.7	96.70				Average	
		point51	51	-2,921.4	-6,371.9	112.90					
Radford Dr	12.0	point52	52	-3,056.7	-6,643.0	94.40				Average	
		point53	53	-3,132.7	-6,728.6	88.30				Average	
		point54	54	-3,426.8	-6,897.6	70.00					
Khaikolu Pl	12.0	point55	55	-2,507.2	-6,828.9	75.40				Average	
		point56	56	-2,382.9	-6,631.9	79.00					
Ala Lilikoi Street	12.0	point57	57	-1,680.7	-7,075.2	23.90				Average	

INPUT: ROADWAYS Salt Lake Blvd

		point58	58	-1,684.1	-6,853.6	21.00				Average	
		point59	59	-1,657.9	-6,727.3	21.90					

APPENDIX H

Model Input/Output Files
FHWA Traffic Noise Model
Future Build PM

Censeo **15 September 2012**
wmh **TNM 2.5**
Calculated with TNM 2.5

RESULTS: SOUND LEVELS
PROJECT/CONTRACT: Salt Lake Blvd
RUN: Future PM Build
BARRIER DESIGN: INPUT HEIGHTS
ATMOSPHERICS: 68 deg F, 50% RH

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with approval of FHWA.

Receiver Name	No.	#DUs	Existing LAeq1h	No Barrier LAeq1h Calculated	Crit'n	Increase over existing Calculated	Crit'n Sub'l Inc	Type Impact	With Barrier Calculated LAeq1h	Noise Reduction Calculated	Goal	Calculated minus Goal
			dBA	dBA	dBA	dB	dB		dBA	dB	dB	dB
Receiver1	1	1	0.0	57.1	66	57.1	10	----	57.1	0.0	8	-8.0
Receiver2	2	1	0.0	59.1	66	59.1	10	----	59.1	0.0	8	-8.0
Receiver3	3	1	0.0	63.5	66	63.5	10	----	63.5	0.0	8	-8.0
Receiver4	4	1	0.0	57.4	66	57.4	10	----	57.4	0.0	8	-8.0
Receiver5	5	1	0.0	53.1	66	53.1	10	----	53.1	0.0	8	-8.0
Receiver6	6	1	0.0	64.8	66	64.8	10	----	64.8	0.0	8	-8.0
Receiver7	7	1	0.0	59.2	66	59.2	10	----	59.2	0.0	8	-8.0
Receiver8	8	1	0.0	58.6	66	58.6	10	----	58.6	0.0	8	-8.0
Receiver9	9	1	0.0	64.5	66	64.5	10	----	64.5	0.0	8	-8.0
Receiver10	10	1	0.0	60.9	66	60.9	10	----	60.9	0.0	8	-8.0
Receiver11	11	1	0.0	64.1	66	64.1	10	----	64.1	0.0	8	-8.0
Receiver12	12	1	0.0	61.9	66	61.9	10	----	61.9	0.0	8	-8.0
Receiver13	13	1	0.0	65.0	66	65.0	10	----	65.0	0.0	8	-8.0
Receiver14	14	1	0.0	59.4	66	59.4	10	----	59.4	0.0	8	-8.0
Receiver15	15	1	0.0	67.2	66	67.2	10	Snd Lvl	67.2	0.0	8	-8.0
15b	17	1	0.0	64.8	66	64.8	10	----	64.8	0.0	8	-8.0
15c	18	1	0.0	65.9	66	65.9	10	----	65.9	0.0	8	-8.0
15d	19	1	0.0	61.2	66	61.2	10	----	61.2	0.0	8	-8.0
15e	20	1	0.0	66.7	66	66.7	10	Snd Lvl	66.7	0.0	8	-8.0
15f	21	1	0.0	67.9	66	67.9	10	Snd Lvl	67.9	0.0	8	-8.0

15g	22	1	0.0	63.7	66	63.7	10	----	63.7	0.0	8	-8.0
15h	23	1	0.0	59.1	66	59.1	10	----	59.1	0.0	8	-8.0
15i	24	1	0.0	59.3	66	59.3	10	----	59.3	0.0	8	-8.0

Dwelling Units	# DUs	Noise Reduction Min dB	Avg dB	Max dB
All Selected	23	0.0	0.0	0.0
All Impacted	3	0.0	0.0	0.0
All that meet NR Goal	0	0.0	0.0	0.0

Censeo **15 September 2012**
wmh **TNM 2.5**

INPUT: ROADWAYS
PROJECT/CONTRACT: **Salt Lake Blvd**
RUN: **Future PM No Build**

Average pavement type shall be used unless a State highway agency substantiates the use of a different type with the approval of FHWA

Roadway Name	Width	Points Name	No.	Coordinates (pavement) X	Y	Z	Flow Control Device	Speed Constraint	Percent Vehicles Affected	Segment Pvmt Type	On Struct?
	ft			ft	ft	ft		mph	%		
Salt Lake West	12.0	W	1	-5,874.0	-3,926.0	105.00				Average	
		W2	2	-5,799.3	-4,252.3	124.00				Average	
		W3	3	-5,698.9	-4,541.1	131.24				Average	
		W4	4	-5,554.6	-4,790.5	113.30				Average	
		W5	5	-5,389.8	-5,076.2	93.75				Average	
		W6	6	-5,214.9	-5,334.9	103.45				Average	
		W7	7	-5,019.9	-5,542.1	117.27				Average	
		W8	8	-4,816.7	-5,679.7	115.39				Average	
		W9	9	-4,505.2	-5,838.4	109.00				Average	
		W10	10	-4,272.3	-5,965.9	105.00				Average	
		W11	11	-3,974.4	-6,130.6	98.50				Average	
		W12	12	-3,737.8	-6,253.4	94.96				Average	
		W13	13	-3,508.1	-6,376.0	91.36				Average	
		W14	14	-3,281.2	-6,488.3	91.70				Average	
		W15	15	-3,046.6	-6,620.7	95.00				Average	
		W16	16	-2,532.5	-6,879.9	73.00				Average	
		W17	17	-2,346.2	-6,974.4	53.00				Average	
		W18	18	-1,947.8	-7,147.6	25.63				Average	
		W19	19	-1,658.1	-7,162.5	24.93				Average	
		W20	20	-1,180.7	-7,152.7	57.00					
Salt Lake East	12.0	E	21	-5,843.2	-3,919.5	105.00				Average	
		E2	22	-5,758.2	-4,245.0	125.20				Average	

		E3	23	-5,673.6	-4,536.5	131.60				Average	
		E4	24	-5,532.3	-4,783.4	110.70				Average	
		E5	25	-5,357.4	-5,065.2	94.50				Average	
		E6	26	-5,186.0	-5,318.3	101.90				Average	
		E7	27	-4,997.3	-5,520.1	115.20				Average	
		E8	28	-4,796.3	-5,653.3	115.00				Average	
		E9	29	-4,493.1	-5,818.8	108.60				Average	
		E10	30	-4,257.9	-5,947.1	105.00				Average	
		E11	31	-3,955.4	-6,106.3	99.10				Average	
		E12	32	-3,725.7	-6,232.2	95.10				Average	
		E13	33	-3,495.7	-6,352.3	91.60				Average	
		E14	34	-3,269.9	-6,464.9	91.60				Average	
		E15	35	-3,030.8	-6,586.4	95.90				Average	
		E16	36	-2,517.3	-6,854.1	74.00				Average	
		E17	37	-2,332.4	-6,950.4	54.30				Average	
		E18	38	-1,937.9	-7,114.0	25.00				Average	
		E19	39	-1,672.7	-7,113.5	24.00				Average	
		E20	40	-1,178.8	-7,113.3	51.00					
Maluna Street N	12.0	S	41	-5,716.7	-4,233.7	126.10				Average	
		point42	42	-5,506.0	-4,181.5	143.30				Average	
		N	43	-5,321.6	-4,135.2	162.00					
Namur Rd (Maluna S)	12.0	N	44	-5,845.4	-4,250.5	122.00				Average	
		point45	45	-5,961.9	-4,269.9	114.90				Average	
		S	46	-6,222.2	-4,290.7	106.00					
Wanaka Street	12.0	point47	47	-4,787.8	-5,618.6	117.80				Average	
		point48	48	-4,692.8	-5,445.8	137.00				Average	
		point49	49	-4,612.9	-5,289.5	153.00					
Likini Pl	12.0	point50	50	-3,020.8	-6,558.7	96.70				Average	
		point51	51	-2,921.4	-6,371.9	112.90					
Radford Dr	12.0	point52	52	-3,056.7	-6,643.0	94.40				Average	
		point53	53	-3,132.7	-6,728.6	88.30				Average	
		point54	54	-3,426.8	-6,897.6	70.00					
Khaikolu Pl	12.0	point55	55	-2,507.2	-6,828.9	75.40				Average	
		point56	56	-2,382.9	-6,631.9	79.00					
Ala Lilikoi Street	12.0	point57	57	-1,680.7	-7,075.2	23.90				Average	

INPUT: ROADWAYS **Salt Lake Blvd**

		point58	58	-1,684.1	-6,853.6	21.00				Average	
		point59	59	-1,657.9	-6,727.3	21.90					