CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2015
Comment: 2015 TOTAL AM ON-RAMP

Site Information

Jurisdiction/Date: 4/19/2008
Freeway/Direction of Travel: QKH SB NELHA
Junction: NELHA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ No ☐ On ☑ Off
L_{up} = 450 ft
V_u = 23 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge
☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☑ No ☐ On ☐ Off
L_{down} = ______ ft
V_D = ______ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	15200	.09	1	1368	.9	5	.976	1	1558
v_R	220	.09		20	.9	5	.976	1	23
v_U		.09		23	.9	5	.976	1	26
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ______ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ______ (Exhibit 25-5)
v_{12} = 1558 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1581	See Exhibit 25-7	
v_{R12}	1581	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$

D_R = 16.9 pc/mi/ln
LOS = B (Exhibit 25-4)

Speed Estimation

M_s = .33 (Exhibit 25-19)
S_R = 60.8 mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = 60.8 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ______ (Equation 25-8 or 25-9)
P_{FD} = ______ using Equation ______ (Exhibit 25-12)
v_{12} = ______ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$

D_R = ______ pc/mi/ln
LOS = ______ (Exhibit 25-4)

Speed Estimation

D_s = ______ (Exhibit 25-19)
S_R = ______ mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = ______ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2020
Comment: 2020 TOAL AM ON-RAMP

Site Information

Jurisdiction/Date: 4/19/2008
Freeway/Direction of Travel: QKH SB NELHA
Junction: NELHA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ No ☐ On ☑ Off
L_{up} = 450 ft
V_u = 117 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge
☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☑ No ☐ On ☐ Off
L_{down} = ______ ft
V_D = ______ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	15700	.09	1	1413	.9	5	.976	1	1609
v_R	220	.09		20	.9	5	.976	1	23
v_U		.09		117	.9	5	.976	1	133
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ______ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ______ (Exhibit 25-5)
v_{12} = 1609 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1632	See Exhibit 25-7	
v_{R12}	1632	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$

D_R = 17.3 pc/mi/ln
LOS = B (Exhibit 25-4)

Speed Estimation

M_s = .331 (Exhibit 25-19)
S_R = 60.7 mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = 60.7 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ______ (Equation 25-8 or 25-9)
P_{FD} = ______ using Equation ______ (Exhibit 25-12)
v_{12} = ______ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$

D_R = ______ pc/mi/ln
LOS = ______ (Exhibit 25-4)

Speed Estimation

D_s = ______ (Exhibit 25-19)
S_R = ______ mi/h (Exhibit 25-19)
S_0 = ______ mi/h (Exhibit 25-19)
S = ______ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2029
Comment:

Site Information

Jurisdiction/Date: 4/19/2008
Freeway/Direction of Travel: QKH SB NELHA
Junction: NELHA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp
☑ Yes ☐ On
☐ No ☑ Off
L_{up} = 450 ft
V_u = 270 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge
☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h S_{FR} = 35 mi/h

Downstream Adjacent Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ____ ft
V_D = ____ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	17950	.09	1	1616	.9	5	.976	1	1840
v_R	275	.09		25	.9	5	.976	1	28
v_U		.09		270	.9	5	.976	1	307
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ____ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ____ (Exhibit 25-5)
v_{12} = 1840 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1868	See Exhibit 25-7	
v_{R12}	1868	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$
D_R = 19.2 pc/mi/ln
LOS = B (Exhibit 25-4)

Speed Estimation

M_s = .336 (Exhibit 25-19)
S_R = 60.6 mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = 60.6 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ____ (Equation 25-8 or 25-9)
P_{FD} = ____ using Equation ____ (Exhibit 25-12)
v_{12} = ____ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$
D_R = ____ pc/mi/ln
LOS = ____ (Exhibit 25-4)

Speed Estimation

D_s = ____ (Exhibit 25-19)
S_R = ____ mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = ____ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 2015
Comment: 2015 TOTAL PM ON-RAMP

Site Information

Jurisdiction/Date: 4/19/2008
Freeway/Direction of Travel: QKH SB NELHA
Junction: NELHA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp
☑ Yes ☐ On
☐ No ☑ Off
L_{up} = 450 ft
V_u = 77 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge
☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h S_{FR} = 35 mi/h

Downstream Adjacent Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ____ ft
V_D = ____ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	22700	.09	1	2043	.9	5	.976	1	2327
v_R	770	.09		69	.9	5	.976	1	79
v_U		.09		77	.9	5	.976	1	87
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ____ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ____ (Exhibit 25-5)
v_{12} = 2327 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2406	See Exhibit 25-7	
v_{R12}	2406	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$
D_R = 23.3 pc/mi/ln
LOS = C (Exhibit 25-4)

Speed Estimation

M_s = .354 (Exhibit 25-19)
S_R = 60.1 mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = 60.1 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ____ (Equation 25-8 or 25-9)
P_{FD} = ____ using Equation ____ (Exhibit 25-12)
v_{12} = ____ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$
D_R = ____ pc/mi/ln
LOS = ____ (Exhibit 25-4)

Speed Estimation

D_s = ____ (Exhibit 25-19)
S_R = ____ mi/h (Exhibit 25-19)
S_0 = ____ mi/h (Exhibit 25-19)
S = ____ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 2020
Comment: 2020 TOTAL PM ON-RAMP

Site Information

Jurisdiction/Date: 4/19/2008
Freeway/Direction of Travel: QKH SB NELHA
Junction: NELHA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ No; ☐ On ☑ Off
L_{up} = 450 ft
V_u = 153 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge; ☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☑ No; ☐ On ☐ Off
L_{down} = ___ ft
V_D = ___ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	23800	.09	1	2142	.9	5	.976	1	2439
v_R	770	.09		69	.9	5	.976	1	79
v_U		.09		153	.9	5	.976	1	174
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ___ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ___ (Exhibit 25-5)
v_{12} = 2439 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2518	See Exhibit 25-7	
v_{R12}	2518	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$

D_R = 24.2 pc/mi/ln
LOS = C (Exhibit 25-4)

Speed Estimation

M_s = .36 (Exhibit 25-19)
S_R = 59.9 mi/h (Exhibit 25-19)
S_0 = ___ mi/h (Exhibit 25-19)
S = 59.9 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ___ (Equation 25-8 or 25-9)
P_{FD} = ___ using Equation ___ (Exhibit 25-12)
v_{12} = ___ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$

D_R = ___ pc/mi/ln
LOS = ___ (Exhibit 25-4)

Speed Estimation

D_s = ___ (Exhibit 25-19)
S_R = ___ mi/h (Exhibit 25-19)
S_0 = ___ mi/h (Exhibit 25-19)
S = ___ mi/h (Equation 25-15)

CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 2029
Comment: 2029 TOTAL PM ON-RAMP

Site Information

Jurisdiction/Date: 4/19/2008
Freeway/Direction of Travel: QKH SB NELHA
Junction: NELHA ACCESS

☐ Operational (LOS) ☐ Design (L_A, L_D, or N) ☑ Planning (LOS) ☐ Planning (L_A, L_D, or N)

Inputs

Upstream Adjacent Ramp: ☑ Yes ☐ No; ☐ On ☑ Off
L_{up} = 450 ft
V_u = 288 veh/h

Freeway terrain: Level
Ramp terrain: Level
Ramp Type: ☑ Merge ☐ Diverge; ☑ Right side ☐ Left side
Number of freeway lanes: 2
Number of ramp lanes: 1
Length of ramp roadway: 140 ft
S_{FF} = 70 mi/h
S_{FR} = 35 mi/h

Downstream Adjacent Ramp: ☐ Yes ☑ No; ☐ On ☐ Off
L_{down} = ___ ft
V_D = ___ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	AADT (veh/day)	K	D	V (veh/h)	PHF	% HV	f_{HV}	f_p	$v = \frac{V}{PHF\ f_{HV}\ f_p}$
v_F	26300	.09	1	2367	.9	5	.976	1	2696
v_R	840	.09		76	.9	5	.976	1	86
v_U		.09		288	.9	5	.976	1	328
v_D								1	

Merge Areas

Estimation of v_{12}

$v_{12} = v_F * P_{FM}$

L_{EQ} = ___ (Equation 25-2 or 25-3)
P_{FM} = 1 using Equation ___ (Exhibit 25-5)
v_{12} = 2696 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2782	See Exhibit 25-7	
v_{R12}	2782	4600: All	

Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$

D_R = 26.3 pc/mi/ln
LOS = C (Exhibit 25-4)

Speed Estimation

M_s = .374 (Exhibit 25-19)
S_R = 59.5 mi/h (Exhibit 25-19)
S_0 = ___ mi/h (Exhibit 25-19)
S = 59.5 mi/h (Equation 25-14)

Diverge Areas

Estimation of v_{12}

$v_{12} = v_R + (v_F - v_R)P_{FD}$

L_{EQ} = ___ (Equation 25-8 or 25-9)
P_{FD} = ___ using Equation ___ (Exhibit 25-12)
v_{12} = ___ pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{FI} = v_F$		See Exhibit 25-14	
v_{12}		4400: All	
$v_{FO} = v_F - v_R$		See Exhibit 25-14	
v_R		See Exhibit 25-3	

Level-of-Service Determination (if not F)

$D_R = 4.252 + 0.0086\ v_{12} - 0.009\ L_D$

D_R = ___ pc/mi/ln
LOS = ___ (Exhibit 25-4)

Speed Estimation

D_s = ___ (Exhibit 25-19)
S_R = ___ mi/h (Exhibit 25-19)
S_0 = ___ mi/h (Exhibit 25-19)
S = ___ mi/h (Equation 25-15)

Appendix E

Highway
Level of Service (LOS) Calculations

CHAPTER 20 - DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: EX AM 2006
Comment: 2006 EXISTING AM SB

Site Information

Jurisdiction/Date: 4/19/2008
Highway: Q. KAAHUMANU HWY SB
From/To: KAIMINANI TO KOHANAIKI

☐ Operational (LOS) ☐ Design (v_p) ☑ Planning (LOS) ☐ Planning (v_p)

Input Data

Opposing direction / Analysis direction
Shoulder width 6 ft
Lane width 12 ft
Lane width 12 ft
Shoulder width 6 ft
Segment length, L_t 2 mi

Show North Arrow

☑ Class I highway ☐ Class II highway
Terrain ☐ Level ☐ Rolling
Grade Length ____ mi Up/down ____ %
Peak-hour factor, PHF .95
% Trucks and buses, P_T 3 %
% Recreational vehicles, P_R 0 %
% No-passing zone 50 %
Access points/mi 2 /mi

Analysis direction volume, V_d 865 veh/h
Opposing direction volume, V_o 915 veh/h

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalent for trucks, E_T (Exhibit 20-9 or 20-15)	1.1	1.1
Passenger-car equivalent for RVs, E_R (Exhibit 20-9 or 20-17)	1	1
Heavy-vehicle adjustment factor,[5] f_{HV} $f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$	.997	.997
Grade adjustment factor,[1] f_G (Exhibit 20-6 or 20-12)	1	1
Directional flow rate,[2] v_i (pc/h) $v_i = \frac{V_i}{PHF * f_{HV} * f_G}$	913	966

Free-Flow Speed from Field Measurement	Estimated Free-Flow Speed
Field measured speed,[3] S_{FM} 55 mi/h	Base free-flow speed,[3] BFFS ____ mi/h
Observed volume,[3] V_f 865 veh/h	Adj. for lane width and shoulder width,[3] f_{LS} (Exh. 20-5) 0 mi/h
Free-flow speed, FFS_d 61.7 mi/h	Adj. for access points,[3] f_A (Exhibit 20-6) .5 mi/h
$FFS_d = S_{FM} + 0.00776\left(\frac{V_f}{f_{HV}}\right)$	Free-flow speed, FFS_d 61.7 mi/h
	$FFS_d = BFFS - f_{LS} - f_A$

Adjustment for no-passing zones, f_{np} (mi/h) (Exhibit 20-19)	.9
Average travel speed, ATS_d (mi/h) $ATS_d = FFS_d - 0.00776(v_d + v_o) - f_{np}$	46.3

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalent for trucks, E_T (Exhibit 20-10 or 20-16)	1	1
Passenger-car equivalent for RVs, E_R (Exhibit 20-10 or 20-16)	1	1
Heavy-vehicle adjustment factor, f_{HV} $f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$	1	1
Grade adjustment factor,[1] f_G (Exhibit 20-8 or 20-14)	1	1
Directional flow rate,[2] v_i (pc/h) $v_i = \frac{V_i}{PHF * f_{HV} * f_G}$	911	963

Base percent time-spent-following,[4] $BPTSF_d$ (%) $BPTSF_d = 100(1 - e^{av_d^b})$	87.8
Adjustment for no-passing zone, f_{np} (Exhibit 20-20)	3.6
Percent time-spent-following, $PTSF_d$ (%) $PTSF_d = BPTSF_d + f_{np}$	91.4

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 or 20-4)	E
Volume to capacity ratio, v/c $v/c = \frac{v_d}{1700}$	.54
Peak 15-min vehicle-miles of travel, VMT_{15} (veh-mi) $VMT_{15} = 0.25L_t\left(\frac{V_d}{PHF}\right)$	455
Peak-hour vehicle-miles of travel, VMT_{60} (veh-mi) $VMT_{60} = V_d * L_t$	1730
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{VMT_{15}}{ATS_d}$	9.8

Notes

1. If the highway is extended segment (level) or rolling terrain, $f_G = 1.0$
2. If v_i (v_d or v_o) ≥ 1,700 pc/h, terminate analysis—the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

CHAPTER 20 - DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WITH PASSING LANE WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: EX AM 2006
Comment: 2006 EXISTING AM SB

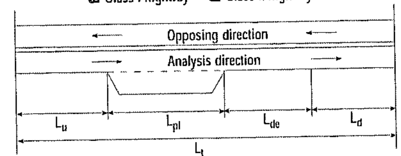
Site Information

Jurisdiction/Date: 4/19/2008
Highway: Q. KAAHUMANU HWY SB
From/To: KAIMINANI TO KOHANAIKI

☐ Operational (LOS) ☐ Design (v_p) ☑ Planning (LOS) ☐ Planning (v_p)

Input Data

☑ Class I highway ☐ Class II highway



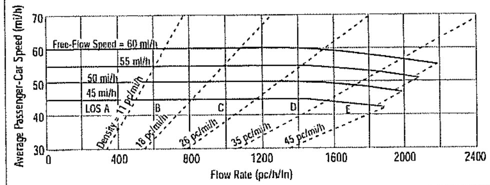
Show North Arrow

Total length of analysis segment, L_t (mi)	2
Length of two-lane highway upstream of the passing lane, L_u (mi)	0
Length of passing lane including tapers, L_{pl} (mi)	
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	46.3
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	91.4
Level of service,[1] LOS_d (from Directional Two-Lane Highway Segment Worksheet)	E
Average Travel Speed	
Downstream length of two-lane highway within effective length of passing lane for average travel speed, L_{de} (mi) (Exhibit 20-23)	1.7
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, L_d (mi) $L_d = L_t - (L_u + L_{pl} + L_{de})$	
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 20-24)	1.11
Average travel speed including passing lane,[2] ATS_{pl} $ATS_{pl} = \frac{ATS_d * L_t}{L_u + L_d + \frac{L_{pl}}{f_{pl}} + \frac{2L_{de}}{1+f_{pl}}}$	
Percent Time-Spent-Following	
Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, L_{de} (mi) (Exhibit 20-23)	5.7
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, L_d (mi) $L_d = L_t - (L_u + L_{pl} + L_{de})$	
Adj. factor for the effect of passing lane on percent time-spent-following, f_{pl} (Exhibit 20-24)	.62
Percent time-spent-following including passing lane,[3] $PTSF_{pl}$ (%) $PTSF_{pl} = \frac{PTSF_d\left[L_u + L_d + f_{pl}L_{pl} + \left(\frac{1+f_{pl}}{2}\right)L_{de}\right]}{L_t}$	
Level of Service and Other Performance Measures[4]	
Level of service including passing lane, LOS_{pl} (Exhibits 20-3 or 20-4)	
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15} = \frac{VMT_{15}}{ATS_{pl}}$	

Notes

1. If LOS_d = F, passing lane analysis cannot be performed.
2. If L_d < 0, use alternative Equation 20-22.
3. If L_d < 0, use alternative Equation 20-20.
4. v/c, VMT_{15}, and VMT_{60} are calculated on Directional Two-Lane Highway Segment Worksheet.

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB AM 2015
Comment: 2015 AM AMBIENT

Site Information

Jurisdiction/Date: 4/14/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 1370 veh/h
Annual avg. daily traffic, AADT: ____ veh/day
Peak-hour proportion of AADT, K: ____
Peak-hour direction proportion, D: ____
DDHV = AADT * K * D: ____ veh/h
Driver type: ☐ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ____ mi Up/Down ____ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ____ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ____ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ____ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 783 pc/h/ln
S: B mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 14.24

Design (v_p) or Planning (v_p)
LOS: ____
v_p: ____ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ____ veh/h
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____

Design (N) or Planning (N) 2nd Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

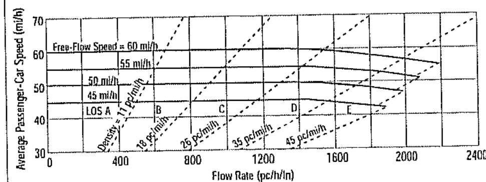
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2015
Comment: 2015 AM TOTAL

Site Information

Jurisdiction/Date: 4/14/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 1395 veh/h
Annual avg. daily traffic, AADT: ____ veh/day
Peak-hour proportion of AADT, K: ____
Peak-hour direction proportion, D: ____
DDHV = AADT * K * D: ____ veh/h
Driver type: ☐ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ____ mi Up/Down ____ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ____ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ____ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ____ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 797 pc/h/ln
S: B mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 14.5

Design (v_p) or Planning (v_p)
LOS: ____
v_p: ____ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ____ veh/h
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____

Design (N) or Planning (N) 2nd Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

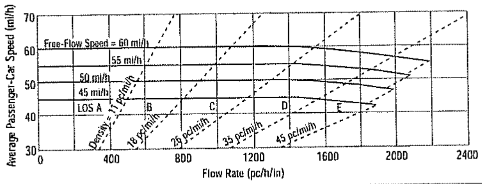
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB AM 2020
Comment: 2020 AM AMBIENT

Site Information

Jurisdiction/Date: 4/14/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 1370 veh/h
Annual avg. daily traffic, AADT: ____ veh/day
Peak-hour proportion of AADT, K: ____
Peak-hour direction proportion, D: ____
DDHV = AADT * K * D: ____ veh/h
Driver type: ☐ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ____ mi Up/Down ____ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ____ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ____ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ____ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 783 pc/h/ln
S: B mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 14.24

Design (v_p) or Planning (v_p)
LOS: ____
v_p: ____ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ____ veh/h
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____

Design (N) or Planning (N) 2nd Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

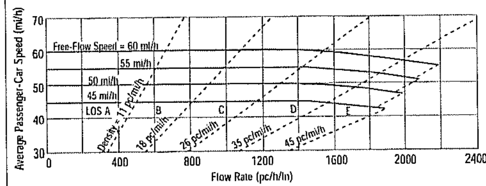
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2020
Comment: 2020 AM TOTAL

Site Information

Jurisdiction/Date: 4/14/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 1435 veh/h
Annual avg. daily traffic, AADT: ____ veh/day
Peak-hour proportion of AADT, K: ____
Peak-hour direction proportion, D: ____
DDHV = AADT * K * D: ____ veh/h
Driver type: ☑ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ____ mi Up/Down ____ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ____ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ____ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ____ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 820 pc/h/ln
S: B mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 14.92

Design (v_p) or Planning (v_p)
LOS: ____
v_p: ____ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ____ veh/h
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____

Design (N) or Planning (N) 2nd Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

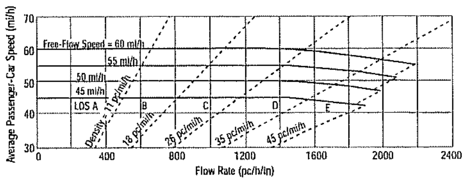
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB AM 2029
Comment: 2029 AM AMBIENT

Site Information

Jurisdiction/Date: 4/9/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIKI

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 1445 veh/h
Annual avg. daily traffic, AADT: ____ veh/day
Peak-hour proportion of AADT, K: ____
Peak-hour direction proportion, D: ____
DDHV = AADT * K * D: ____ veh/h
Driver type: ☑ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ____ mi Up/Down ____ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ____ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ____ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ____ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 826 pc/h/ln
S: B mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 15.02

Design (v_p) or Planning (v_p)
LOS: ____
v_p: ____ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ____ veh/h
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____

Design (N) or Planning (N) 2nd Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Glossary

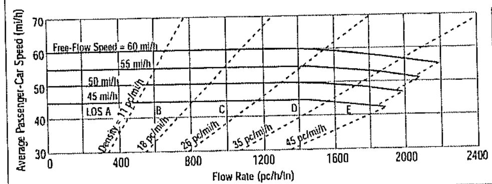
N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

HiCAP 2000 ™

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT AM 2029
Comment: 2029 AM TOTAL

Site Information

Jurisdiction/Date: 4/14/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 1640 veh/h
Annual avg. daily traffic, AADT: ____ veh/day
Peak-hour proportion of AADT, K: ____
Peak-hour direction proportion, D: ____
DDHV = AADT * K * D: ____ veh/h
Driver type: ☑ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ____ mi Up/Down ____ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ____ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ____ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ____ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 938 pc/h/ln
S: B mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 17.05

Design (v_p) or Planning (v_p)
LOS: ____
v_p: ____ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ____ veh/h
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____

Design (N) or Planning (N) 2nd Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

HiCAP 2000 ™

CHAPTER 20 - DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: EX PM 2006
Comment: 2006 EXISTING PM SB

Site Information

Jurisdiction/Date: 4/19/2008
Highway: Q. KAAHUMANU HWY SB
From/To: KAIMINANI TO KOHANAIKI

☐ Operational (LOS) ☐ Design (v_p) ☑ Planning (LOS) ☐ Planning (v_p)

Input Data

Shoulder width 6 ft
Opposing direction — Lane width 12 ft
Analysis direction — Lane width 12 ft
Shoulder width 6 ft
Segment length, L_t 2 mi

Show North Arrow

☑ Class I highway ☐ Class II highway
Terrain ☐ Level ☐ Rolling
Grade Length ____ mi Up/down ____ %
Peak-hour factor, PHF .95
% Trucks and buses, P_T 3 %
% Recreational vehicles, P_R 0 %
% No-passing zone 50 %
Access points/mi 2 /mi

Analysis direction volume, V_d 825 veh/h
Opposing direction volume, V_o 830 veh/h

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalent for trucks, E_T (Exhibit 20-9 or 20-15)	1.1	1.1
Passenger-car equivalent for RVs, E_R (Exhibit 20-9 or 20-17)	1	1
Heavy-vehicle adjustment factor,[5] f_{HV} $f_{HV}=\frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$	.997	.997
Grade adjustment factor,[1] f_G (Exhibit 20-6 or 20-12)	1	1
Directional flow rate,[2] v_i (pc/h) $v_i=\frac{V_i}{PHF*f_{HV}*f_G}$	871	876

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Field measured speed,[3] S_{FM}	55 mi/h	Base free-flow speed,[3] BFFS	____ mi/h
Observed volume,[3] V_f	865 veh/h	Adj. for lane width and shoulder width,[3] f_{LS} (Exh. 20-5)	0 mi/h
Free-flow speed, FFS_d $FFS_d=S_{FM}+0.00776\left(\frac{V_f}{f_{HV}}\right)$	61.7 mi/h	Adj. for access points,[3] f_A (Exhibit 20-6)	.5 mi/h
		Free-flow speed, FFS_d $FFS_d=BFFS-f_{LS}-f_A$	61.7 mi/h

Adjustment for no-passing zones, f_{np} (mi/h) (Exhibit 20-19)	1
Average travel speed, ATS_d (mi/h) $ATS_d=FFS_d-0.00776(v_d+v_o)-f_{np}$	47.2

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalent for trucks, E_T (Exhibit 20-10 or 20-16)	1	1
Passenger-car equivalent for RVs, E_R (Exhibit 20-10 or 20-16)	1	1
Heavy-vehicle adjustment factor, f_{HV} $f_{HV}=\frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$	1	1
Grade adjustment factor,[1] f_G (Exhibit 20-8 or 20-14)	1	1
Directional flow rate,[2] v_i (pc/h) $v_i=\frac{V_i}{PHF*f_{HV}*f_G}$	868	874
Base percent time-spent-following,[4] $BPTSF_d$ (%) $BPTSF_d=100(1-e^{av_d^b})$	86.6	
Adjustment for no-passing zone, f_{np} (Exhibit 20-20)	4.5	
Percent time-spent-following, $PTSF_d$ (%) $PTSF_d=BPTSF_d+f_{np}$	91.1	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 20-3 or 20-4)	E
Volume to capacity ratio, v/c $v/c=\frac{V_d}{1700}$	.51
Peak 15-min vehicle-miles of travel, VMT_{15} (veh-mi) $VMT_{15}=0.25L_t\left(\frac{V_d}{PHF}\right)$	434
Peak-hour vehicle-miles of travel, VMT_{60} (veh-mi) $VMT_{60}=V_d*L_t$	1650
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15}=\frac{VMT_{15}}{ATS_d}$	9.2

Notes

1. If the highway is extended segment (level) or rolling terrain, f_G = 1.0
2. If v_i (v_d or v_o) ≥ 1,700 pc/h, terminate analysis—the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

CHAPTER 20 - DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WITH PASSING LANE WORKSHEET

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: EX PM 2006
Comment: 2006 EXISTING PM SB

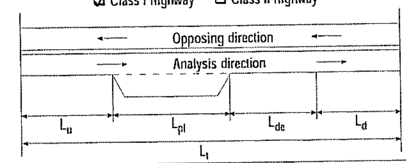
Site Information

Jurisdiction/Date: 4/19/2008
Highway: Q. KAAHUMANU HWY SB
From/To: KAIMINANI TO KOHANAIKI

☐ Operational (LOS) ☐ Design (v_p) ☑ Planning (LOS) ☐ Planning (v_p)

Input Data

☑ Class I highway ☐ Class II highway



Show North Arrow

Total length of analysis segment, L_t (mi)	2
Length of two-lane highway upstream of the passing lane, L_u (mi)	
Length of passing lane including tapers, L_{pl} (mi)	
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	47.2
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	91.1
Level of service,[1] LOS_d (from Directional Two-Lane Highway Segment Worksheet)	E

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, L_{de} (mi) (Exhibit 20-23)	1.7
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, L_d (mi) $L_d=L_t-(L_u+L_{pl}+L_{de})$	
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 20-24)	1.11
Average travel speed including passing lane,[2] ATS_{pl} $ATS_{pl}=\frac{ATS_d*L_t}{L_u+L_d+\frac{L_{pl}}{f_{pl}}+\frac{2L_{de}}{1+f_{pl}}}$	

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, L_{de} (mi) (Exhibit 20-23)	5.7
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, L_d (mi) $L_d=L_t-(L_u+L_{pl}+L_{de})$	
Adj. factor for the effect of passing lane on percent time-spent-following, f_{pl} (Exhibit 20-24)	.62
Percent time-spent-following including passing lane,[3] $PTSF_{pl}$ (%) $PTSF_{pl}=\frac{PTSF_d\left[L_u+L_d+f_{pl}L_{pl}+\left(\frac{1+f_{pl}}{2}\right)L_{de}\right]}{L_t}$	

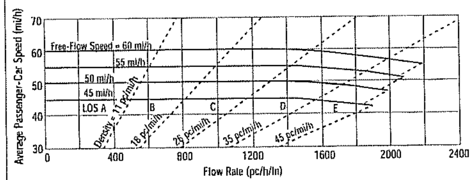
Level of Service and Other Performance Measures [4]

Level of service including passing lane, LOS_{pl} (Exhibits 20-3 or 20-4)	
Peak 15-min total travel time, TT_{15} (veh-h) $TT_{15}=\frac{VMT_{15}}{ATS_{pl}}$	

Notes

1. If LOS_d = F, passing lane analysis cannot be performed.
2. If L_d < 0, use alternative Equation 20-22.
3. If L_d < 0, use alternative Equation 20-20.
4. v/c, VMT_{15}, and VMT_{60} are calculated on Directional Two-Lane Highway Segment Worksheet.

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB PM 2015
Comment: 2015 PM AMBIENT

Site Information

Jurisdiction/Date: 4/9/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 2045 veh/h
Annual avg. daily traffic, AADT: ___ veh/day
Peak-hour proportion of AADT, K: ___
Peak-hour direction proportion, D: ___
DDHV = AADT * K * D: ___ veh/h
Driver type: ☐ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ___ mi Up/Down ___ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ___ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ___ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ___ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 1169 pc/h/ln
S: C mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 21.26

Design (v_p) or Planning (v_p)
LOS: ___
v_p: ___ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ___ veh/h
S: ___ mi/h
$D = v_p/S$: ___ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ___ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ___ pc/h/ln
LOS: ___

Design (N) or Planning (N) 2nd Iteration
N: ___ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ___ pc/h/ln
LOS: ___
S: ___ mi/h
$D = v_p/S$: ___ pc/mi/ln

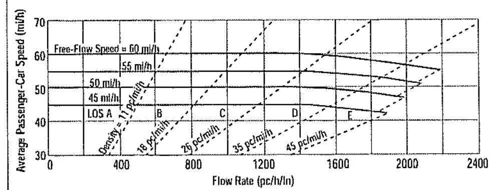
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 2015
Comment: 2015 PM TOTAL

Site Information

Jurisdiction/Date: 4/14/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 2120 veh/h
Annual avg. daily traffic, AADT: ___ veh/day
Peak-hour proportion of AADT, K: ___
Peak-hour direction proportion, D: ___
DDHV = AADT * K * D: ___ veh/h
Driver type: ☑ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ___ mi Up/Down ___ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ___ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ___ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ___ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 1212 pc/h/ln
S: C mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 22.04

Design (v_p) or Planning (v_p)
LOS: ___
v_p: ___ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ___ veh/h
S: ___ mi/h
$D = v_p/S$: ___ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ___ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ___ pc/h/ln
LOS: ___

Design (N) or Planning (N) 2nd Iteration
N: ___ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ___ pc/h/ln
LOS: ___
S: ___ mi/h
$D = v_p/S$: ___ pc/mi/ln

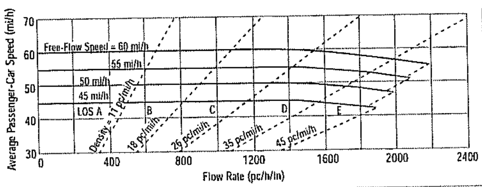
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB PM 2020
Comment: 2020 PM AMBIENT

Site Information

Jurisdiction/Date: 4/9/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 2065 veh/h
Annual avg. daily traffic, AADT: ____ veh/day
Peak-hour proportion of AADT, K: ____
Peak-hour direction proportion, D: ____
DDHV = AADT * K * D: ____ veh/h
Driver type: ☐ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ____ mi Up/Down ____ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ____ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ____ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ____ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 1180 pc/h/ln
S: C mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 21.46

Design (v_p) or Planning (v_p)
LOS: ____
v_p: ____ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ____ veh/h
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____

Design (N) or Planning (N) 2nd Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

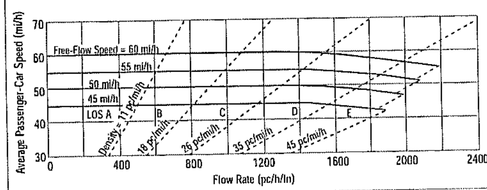
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 2020
Comment: 2020 PM TOTAL

Site Information

Jurisdiction/Date: 4/14/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 2200 veh/h
Annual avg. daily traffic, AADT: ____ veh/day
Peak-hour proportion of AADT, K: ____
Peak-hour direction proportion, D: ____
DDHV = AADT * K * D: ____ veh/h
Driver type: ☑ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ____ mi Up/Down ____ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ____ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ____ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ____ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 1258 pc/h/ln
S: C mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 22.87

Design (v_p) or Planning (v_p)
LOS: ____
v_p: ____ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ____ veh/h
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____

Design (N) or Planning (N) 2nd Iteration
N: ____ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ____ pc/h/ln
LOS: ____
S: ____ mi/h
$D = v_p/S$: ____ pc/mi/ln

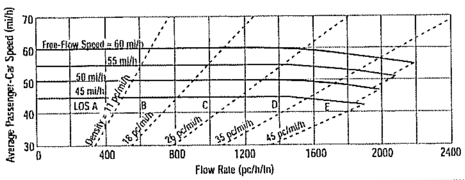
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: AMB PM 2029
Comment: 2029 PM AMBIENT

Site Information

Jurisdiction/Date: 4/9/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 2175 veh/h
Annual avg. daily traffic, AADT: ______ veh/day
Peak-hour proportion of AADT, K: ______
Peak-hour direction proportion, D: ______
DDHV = AADT * K * D: ______ veh/h
Driver type: ☑ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ______ mi Up/Down ______ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ______ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ______ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ______ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 1243 pc/h/ln
S: C mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 22.61

Design (v_p) or Planning (v_p)
LOS: ______
v_p: ______ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ______ veh/h
S: ______ mi/h
$D = v_p/S$: ______ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ______ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ______ pc/h/ln
LOS: ______

Design (N) or Planning (N) 2nd Iteration
N: ______ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ______ pc/h/ln
LOS: ______
S: ______ mi/h
$D = v_p/S$: ______ pc/mi/ln

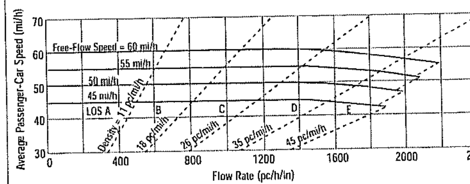
Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_T - Exhibit 21-8, 21-9, 21-11
E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

CHAPTER 21 - MULTILANE HIGHWAYS WORKSHEET



Application	Input	Output
Operational (LOS)	FFS, N, v_p	LOS, S, D
Design (N)	FFS, LOS, v_p	N, S, D
Design (v_p)	FFS, LOS, N	v_p, S, D
Planning (LOS)	FFS, N, AADT	LOS, S, D
Planning (N)	FFS, LOS, AADT	N, S, D
Planning (v_p)	FFS, LOS, N	v_p, S, D

General Information

Analyst: WY
Agency or Company: M&E PACIFIC
Analysis Period/Year: TOT PM 2029
Comment: 2029 PM TOTAL

Site Information

Jurisdiction/Date: 4/14/2008
Highway/Direction of Travel: QUEEN KAAHUMANU HWY
From/To: KAIMINANI TO KOHANAIK

☑ Oper. (LOS) ☐ Des. (N) ☐ Des. (v_p) ☐ Plan. (LOS) ☐ Plan. (N) ☐ Plan. (v_p)

Flow Inputs

Volume, V: 2450 veh/h
Annual avg. daily traffic, AADT: ______ veh/day
Peak-hour proportion of AADT, K: ______
Peak-hour direction proportion, D: ______
DDHV = AADT * K * D: ______ veh/h
Driver type: ☑ Commuter/Weekday ☐ Recreational/Weekend

Peak-hour factor, PHF: .9
% Trucks and buses, P_T: 5
% RVs, P_R: 2
General terrain: ☑ Level ☐ Rolling ☐ Mountainous
Grade: Length ______ mi Up/Down ______ %
Number of lanes: 2

Calculate Flow Adjustments

f_p: 1
E_T: 1.5
E_R: 1.2
$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$: .972

Speed Inputs

Lane width, LW: 10 ft
Total lateral clearance, TLC: 12 ft
Access points, A: ______ A/mi
Median type, M: ☐ Undivided ☑ Divided
FFS (measured): ______ mi/h
Base free-flow Speed, BFFS: 60 mi/h

Calculate Speed Adjustments and FFS

f_{LW}: 6.6 mi/h
f_{LC}: 0 mi/h
f_A: ______ mi/h
f_M: 0 mi/h
$FFS = BFFS - f_{LW} - f_{LC} - f_A - f_M$: 55 mi/h

Operational, Planning (LOS); Design, Planning (v_p)

Operational (LOS) or Planning (LOS)
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: 1401 pc/h/ln
S: C mi/h
$D = v_p/S$: 55 pc/mi/ln
LOS: 25.47

Design (v_p) or Planning (v_p)
LOS: ______
v_p: ______ pc/h/ln
$V = v_p * PHF * N * f_{HV} * f_p$: ______ veh/h
S: ______ mi/h
$D = v_p/S$: ______ pc/mi/ln

Design, Planning (N)

Design (N) or Planning (N) 1st Iteration
N: ______ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ______ pc/h/ln
LOS: ______

Design (N) or Planning (N) 2nd Iteration
N: ______ assumed
$v_p = \frac{V \text{ or } DDHV}{PHF * N * f_{HV} * f_p}$: ______ pc/h/ln
LOS: ______
S: ______ mi/h
$D = v_p/S$: ______ pc/mi/ln

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design-hour volume
S - Speed
D - Density
FFS - Free-flow speed
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Factor Location

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E_R - Exhibit 21-8, 21-10
f_p - Page 21-11
LOS, S, FFS, v_p - Exhibit 21-2, 21-3
f_{LW} - Exhibit 21-4
f_{LC} - Exhibit 21-5
f_M - Exhibit 21-6
f_A - Exhibit 21-7

Acoustic Study

ACOUSTIC STUDY FOR THE PROPOSED `O`OMA BEACHSIDE VILLAGE PROJECT

NORTH KONA, HAWAII

Prepared for:

`O`OMA BEACHSIDE VILLAGE, LLC

Prepared by:

Y. EBISU & ASSOCIATES
1126 12th Avenue, Room 305
Honolulu, Hawaii 96816

APRIL 2008

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CHAPTER I. SUMMARY

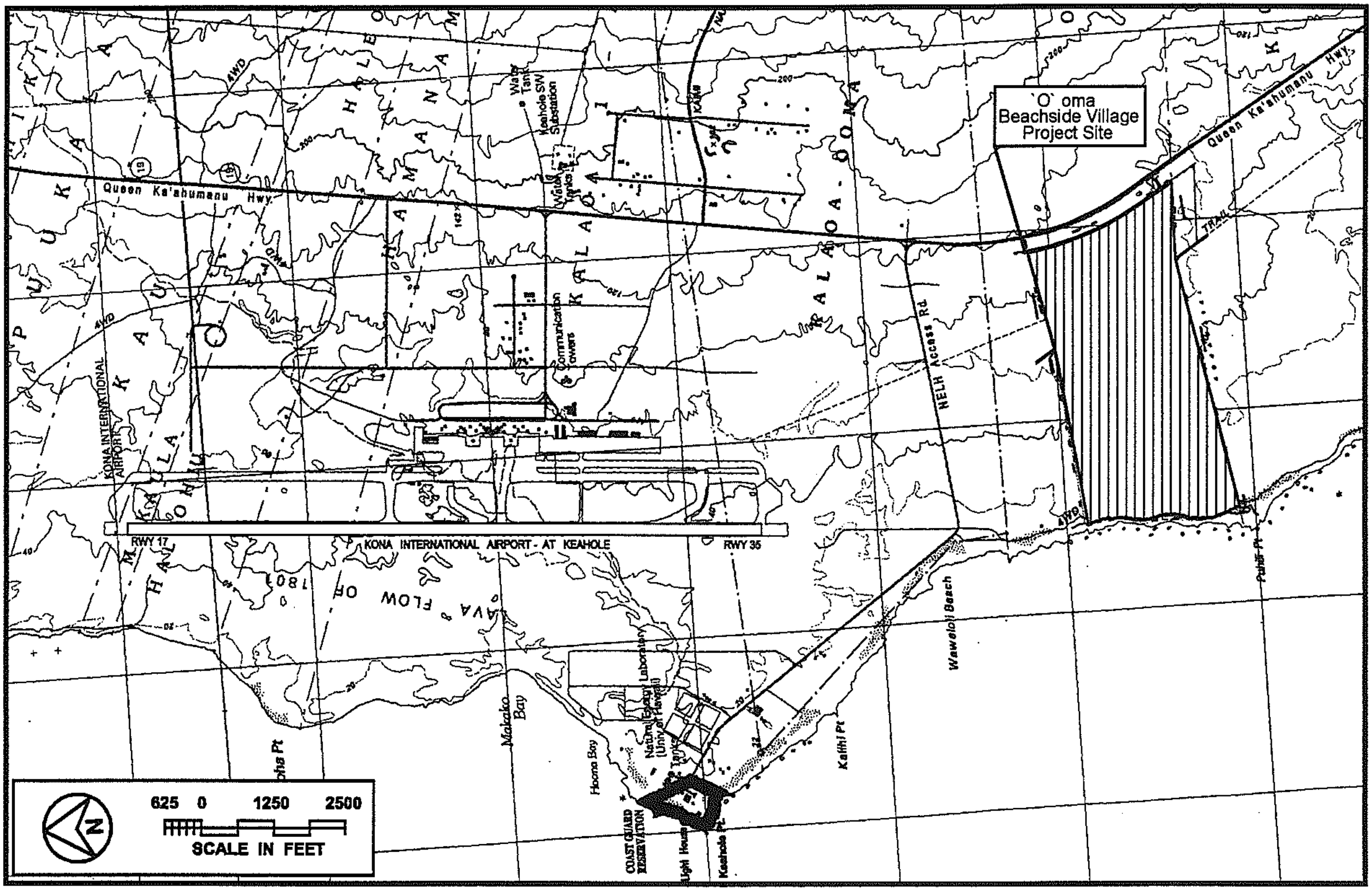
The existing and future traffic noise levels in the vicinity of the proposed `O`oma Beachside Village in North Kona, Hawaii were evaluated for their potential impact on present and future noise sensitive areas. Figure 1 depicts the location of the project site. The future traffic noise levels along the primary access roadways to the project were calculated for the year 2029.

Along Queen Kaahumanu Highway, traffic noise levels are expected to increase by 3.0 to 4.4 DNL (Day-Night Average Sound Level) between CY 2006 and CY 2029 as a result of both project and non-project traffic. Traffic noise increases due to project traffic are predicted to range from 0.2 to 0.7 DNL which is much less than the range of the noise increases caused by non-project traffic on Queen Kaahumanu Highway. These increases in traffic noise levels associated with project traffic are considered to be insignificant. Larger and more significant increases in traffic noise levels of 8.0 to 11.0 DNL are expected to occur along the planned makai Frontage Road as a result of project traffic, but the traffic noise levels from Queen Kaahumanu Highway are expected to control the overall future traffic noise levels along the highway Right-of-Way.

The possible future widening of Queen Kaahumanu Highway toward the project in the makai (west) direction by 2029 was incorporated in this noise study. Predicted future traffic noise levels in CY 2029 for conditions with 4 lanes of Queen Kaahumanu Highway were determined along the `O`oma Beachside Village property Right-of-Way and at the closest buildings of the project. Future traffic noise levels from Queen Kaahumanu Highway should not exceed the FHA/HUD noise standard of 65 DNL or the Hawaii State Department of Transportation, Highways Division (HDOTH) noise abatement criteria level of 66 Leq(h). Project residents should not be impacted by future traffic noise from Queen Kaahumanu Highway since an adequate buffer distance of 150 feet has been provided from the highway Right-of-Way.

The planned makai Frontage Road was assumed to be located within `O`oma Beachside Village, and could cause traffic noise levels to exceed the FHA/HUD noise standard of 65 DNL. At an assumed posted speed limit of 25 miles per hour, with actual speed of 35 miles per hour, the minimum required buffer distance to the 65 DNL noise contour is 22 feet. Future traffic noise mitigation measures may be required along the makai Frontage Road.

Based on previously published CY 2001 14 CFR Part 150 aircraft noise contours for Kona International Airport at Keahole (KOA), the project site is partially affected by the 55 DNL and 60 DNL noise contours, which are located at the western end of the project site. Noise contours for CY 2010 and CY 2020, which were developed during the last Master Plan and 14 CFR Part 150 Study updates for KOA, also indicate that the project site would be partially affected by the airport noise contours, but these contours



PROJECT SITE LOCATION MAP

FIGURE 1

are probably overstating the potential noise impacts due to the prior and future introduction of quieter jet aircraft operations at the airport. The implementation of the airport noise disclosure provisions of Act 208 (see Reference 5) will be necessary over the western portion of project area where the CY 2001 14 CFR Part 150 noise contours cross over the project. The project's proposed land uses have been planned to avoid encroachment into the 60 DNL contour of the 14 CFR Part 150 5-Year (or 2001) Noise Exposure Map for KOA. Based on currently available information, the noise sensitive portions of `O`oma Beachside Village should be outside the 60 DNL contour for 2013 and 2030.

The planned construction of a new runway for C-17 training operations, and the subsequent increase in C-17 operations at KOA were evaluated using information available. As long as the future C-17 training operations remain within the limits described in the current environmental documentation for the new runway, and as long as a large number of those training operations do not extend into the nighttime hours of 2200 to 0700 hours, their effect on the future locations of the 55 DNL and 60 DNL noise contours should be minimal.

During the course of this acoustical impact study for `O`oma Beachside Village, the Hawaii State Department of Transportation, Airports Division (HDOTA) produced two pairs of draft 14 CFR Part 150 noise contours for KOA for years 2007/2008 and 2012/2013. These draft contours were compared to this acoustical impact study's noise contours, and were critiqued via correspondences to the HDOTA. Attempts were made to obtain copies of the noise modeling computer input files used for the HDOTA's draft noise contours, but these attempts were unsuccessful up until the time this noise study report was completed. Attempts will continue to obtain the noise modeling input files in order to verify the reasonableness of the HDOTA's noise modeling assumptions.

Unavoidable, but temporary, noise impacts may occur during the construction of `O`oma Beachside Village. Because construction activities are predicted to be audible at adjoining properties, the quality of the acoustic environment may be degraded during periods of construction. Mitigation measures to reduce construction noise to inaudible levels will not be practical in all cases. For this reason, the use of quiet equipment and construction curfew periods as required under the State Department of Health noise regulations will be implemented to minimize construction noise impacts.

CHAPTER II. PURPOSE

The objectives of this study were to describe the existing and future noise environment in the environs of `O`oma Beachside Village in North Kona on the island of Hawaii. Traffic noise level increases and impacts associated with the proposed community were to be determined within the project site as well as along the public roadways expected to service the project traffic. A specific objective was to determine the future traffic noise level increases associated with both project and non-project traffic, and the potential noise impacts associated with these increases. Assessments of possible impacts from noise resulting from fixed and rotary wing aircraft operations at nearby Kona International Airport at Keahole (KOA), and from short term construction noise at the project site were also included in the noise study objectives. Recommendations for minimizing these noise impacts were also to be provided as required.

CHAPTER III. NOISE DESCRIPTORS AND THEIR RELATIONSHIP TO LAND USE COMPATIBILITY

The noise descriptor currently used by federal agencies to assess environmental noise is the Day-Night Average Sound Level (DNL or Ldn). This descriptor incorporates a 24-hour average of instantaneous A-Weighted sound levels as read on a standard Sound Level Meter. The maximum A-Weighted sound level occurring while a noise source such as a heavy truck or aircraft is moving past a listener (i.e., the maximum sound level from a "single event") is referred to as the "Lmax value". The mathematical product (or integral) of the instantaneous sound level times the duration of the event is known as the "Sound Exposure Level", or Lse, which is analogous to the energy of the time-varying sound levels associated with a single event.

The DNL values represent the average noise during a typical day of the year. DNL exposure levels of 55 or less are typical of quiet rural or suburban areas. DNL exposure levels of 55 to 65 are typical of urbanized areas with medium to high levels of activity and street traffic. DNL exposure levels above 65 are representative of densely developed urban areas and areas fronting high volume roadways.

By definition, the minimum averaging period for the DNL descriptor is 24 hours. Additionally, sound levels which occur during the nighttime hours of 10:00 PM to 7:00 AM are increased by 10 decibels (dB) prior to computing the 24-hour average by the DNL descriptor. Because of the averaging used, DNL values in urbanized areas typically range between 50 and 75 DNL. In comparison, the typical range of intermittent noise events may have maximum Sound Level Meter readings between 75 and 105 dBA. A more complete list of noise descriptors is provided in Appendix B to this report. In Appendix B, the Ldn descriptor symbol is used in place of the DNL descriptor symbol.

Table 1, extracted from Reference 1, categorizes the various DNL levels of outdoor noise exposure with severity classifications. Table 2, also extracted from Reference 1, presents the general effects of noise on people in residential use situations. Figure 2, extracted from Reference 2, presents suggested land use compatibility guidelines for residential and nonresidential land uses. A general consensus among federal agencies has developed whereby residential housing development is considered acceptable in areas where exterior noise does not exceed 65 DNL. This value of 65 DNL is used as a federal regulatory threshold for determining the necessity for special noise abatement measures when applications for federal funding assistance are made.

As a general rule, noise levels of 55 DNL or less occur in rural areas, or in areas which are removed from high volume roadways. In urbanized areas which are shielded from high volume streets, DNL levels generally range from 55 to 65 DNL, and are usually controlled by motor vehicle traffic noise. Residences which front major roadways are generally exposed to levels of 65 DNL, and as high as 75 DNL when the

TABLE 1

EXTERIOR NOISE EXPOSURE CLASSIFICATION (RESIDENTIAL LAND USE)

NOISE EXPOSURE CLASS	DAY-NIGHT SOUND LEVEL	EQUIVALENT SOUND LEVEL	FEDERAL (1) STANDARD
Minimal Exposure	Not Exceeding 55 DNL	Not Exceeding 55 Leq	Unconditionally Acceptable
Moderate Exposure	Above 55 DNL But Not Above 65 DNL	Above 55 Leq But Not Above 65 Leq	Acceptable(2)
Significant Exposure	Above 65 DNL But Not Above 75 DNL	Above 65 Leq But Not Above 75 Leq	Normally Unacceptable
Severe Exposure	Above 75 DNL	Above 75 Leq	Unacceptable

Notes: (1) Federal Housing Administration, Veterans Administration, Department of Defense, and Department of Transportation.

(2) FHWA uses the Leq instead of the Ldn descriptor. For planning purposes, both are equivalent if: (a) heavy trucks do not exceed 10 percent of total traffic flow in vehicles per 24 hours, and (b) traffic between 10:00 PM and 7:00 AM does not exceed 15 percent of average daily traffic flow in vehicles per 24 hours. The noise mitigation threshold used by FHWA for residences is 67 Leq.

TABLE 2

EFFECTS OF NOISE ON PEOPLE
(Residential Land Uses Only)

EFFECTS[1] / DAY-NIGHT AVERAGE SOUND LEVEL IN DECIBELS	Hearing Loss	Speech Interference		Annoyance[2]	Average Community Reaction[4]	General Community Attitude Towards Area
		Indoor	Outdoor			
	Qualitative Description	%Sentence Intelligibility	Distance in Meters for 95% Sentence Intelligibility	% of Population Highly Annoyed[3]		
75 and above	May Begin to Occur	98%	0.5	37%	Very Severe	Noise is likely to be the most important of all adverse aspects of the community environment.
70	Will Not Likely Occur	99%	0.9	25%	Severe	Noise is one of the most important adverse aspects of the community environment.
65	Will Not Occur	100%	1.5	15%	Significant	Noise is one of the important adverse aspects of the community environment.
60	Will Not Occur	100%	2.0	9%	Moderate to Slight	Noise may be considered an adverse aspect of the community environment.
55 and below	Will Not Occur	100%	3.5	4%		Noise considered no more important than various other environmental factors.

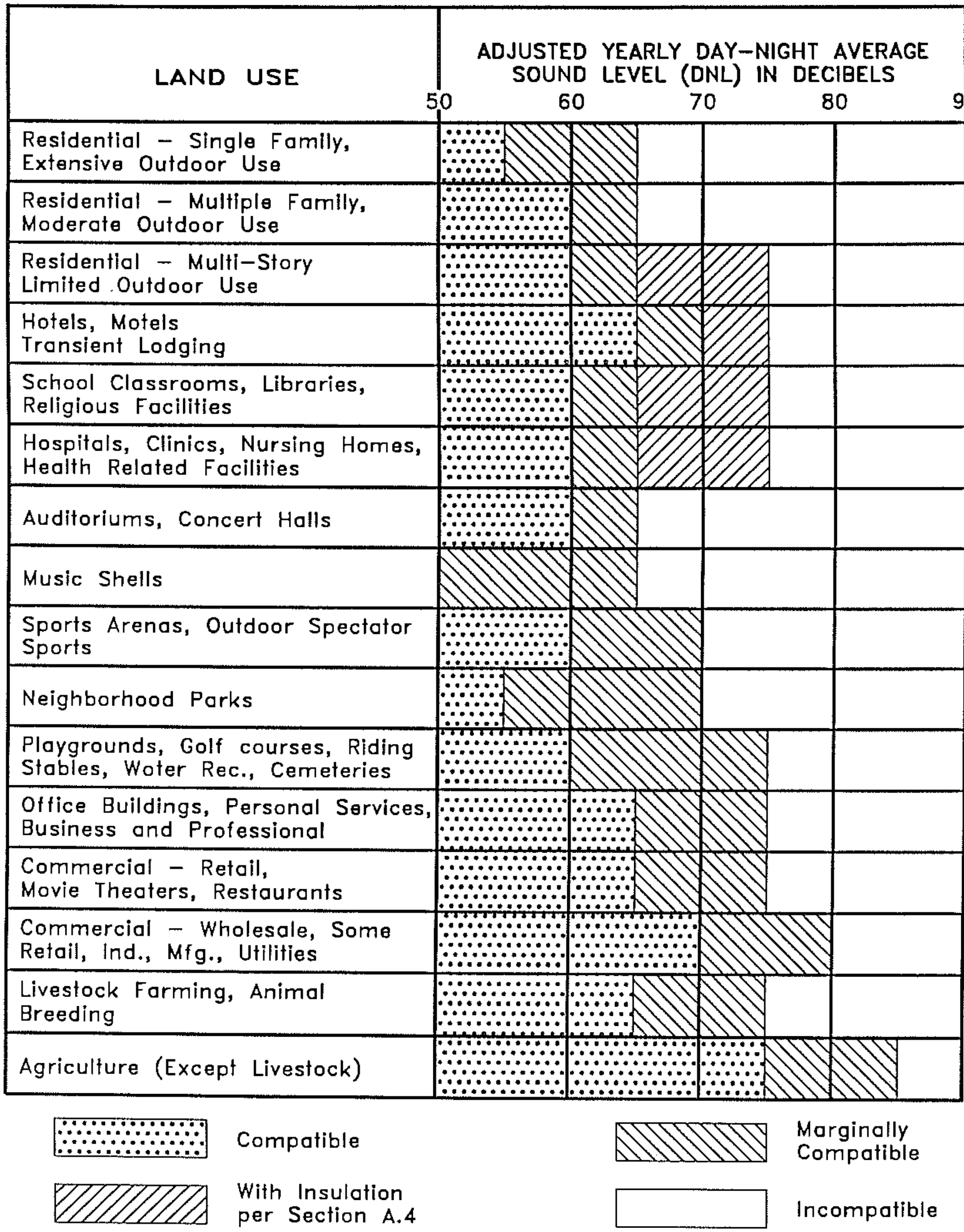
1. "Speech Interference" data are drawn from the following tables in EPA's "Levels Document": Table 3, Fig. D-1, Fig. D-2, Fig. D-3. All other data from National Academy of Science 1977 report "Guidelines for Preparing Environmental Impact Statements on Noise, Report of Working Group 69 on Evaluation of Environmental Impact of Noise."

2. Depends on attitudes and other factors.

3. The percentages of people reporting annoyance to lesser extents are higher in each case. An unknown small percentage of people will report being "highly annoyed" even in the quietest surroundings. One reason is the difficulty all people have in integrating annoyance over a very long time.

4. Attitudes or other non-acoustic factors can modify this. Noise at low levels can still be an important problem, particularly when it intrudes into a quiet environment.

NOTE: Research implicates noise as a factor producing stress-related health effects such as heart disease, high-blood pressure and stroke, ulcers and other digestive disorders. The relationships between noise and these effects, however, have not as yet been quantified.



LAND USE COMPATIBILITY WITH YEARLY AVERAGE DAY-NIGHT AVERAGE SOUND LEVEL (DNL) AT A SITE FOR BUILDINGS AS COMMONLY CONSTRUCTED.
(Source: American National Standards Institute S12.9-1998/Part 5)

FIGURE 2

roadway is a high speed freeway. Due to noise shielding effects from intervening structures, interior lots are usually exposed to 3 to 10 DNL lower noise levels than the front lots which are not shielded from the traffic noise.

For the purposes of determining noise acceptability for funding assistance from federal agencies, an exterior noise level of 65 DNL or lower is considered acceptable. These federal agencies include the Federal Aviation Administration (FAA), Department of Defense (DOD); Federal Housing Administration, Housing and Urban Development (FHA/HUD), and Veterans Administration (VA). This standard is applied nationally (see Reference 3), including Hawaii.

Because of Hawaii's open-living conditions, the predominant use of naturally ventilated dwellings, and the relatively low exterior-to-interior sound attenuation afforded by these naturally ventilated dwellings, an exterior noise level of 65 DNL does not eliminate all risks of noise impacts. Because of these factors, a lower level of 55 DNL is considered as the "Unconditionally Acceptable" (or "Near-Zero Risk") level of exterior noise (see Reference 4). For typical, naturally ventilated structures in Hawaii, an exterior noise level of 55 DNL results in an interior level of approximately 45 DNL, which is considered to be the "Unconditionally Acceptable" (or "Near-Zero Risk") level of interior noise. However, after considering the cost and feasibility of applying the lower level of 55 DNL, government agencies such as FHA/HUD and VA have selected 65 DNL as a more appropriate regulatory standard.

For aircraft noise, the Hawaii State Department of Transportation, Airports Division (HDOTA), has recommended that 60 DNL be used as the common level for determining land use compatibility in respect to noise sensitive uses near its airports. Table 3 summarizes the recommendations for compatible land uses at various levels of aircraft noise. For those noise sensitive land uses which are exposed to aircraft noise greater than 55 DNL, the division has recommended that disclosure of the aircraft noise levels be provided prior to any real property transactions. Reference 5 requires that such disclosure be provided prior to real property transactions concerning properties located within Air Installation Compatibility Use Zones (AICUZ) or located within airport noise maps developed under Federal Aviation Regulation (FAR) Part 150 - Airport Noise Compatibility Planning (14 CFR Part 150). The most recent 14 CFR Part 150 noise contours for KOA were completed in 1996 and reflect conditions through 2001. Additional airport noise contours for 2010 and 2020 were developed by the HDOTA for information purposes only during the 1996 to 1997 time frame. The HDOTA is currently updating the airport noise contours for 2008 and 2013, in conjunction with the 14 CFR Part 150 update for KOA (Reference 13). The HDOTA's draft noise contours for 2008, 2013, and 2030 are included in this report for comparison with the estimated noise contours developed for this acoustical impact study for `O`oma Beachside Village.

For commercial, industrial, and other non-noise sensitive land uses, exterior noise levels as high as 75 DNL are generally considered acceptable. Exceptions to this occur when naturally ventilated office and other commercial establishments are exposed to exterior levels which exceed 65 DNL.

TABLE 3

HAWAII STATE DEPARTMENT OF TRANSPORTATION RECOMMENDATIONS FOR LOCAL LAND USE COMPATIBILITY WITH YEARLY DAY-NIGHT AVERAGE SOUND LEVELS (DNL)

TYPE OF LAND USE	**** Yearly Day-Night Average Sound Level ****					
	< 60	60-65	65-70	70-75	75-80	80-85
RESIDENTIAL						
Low density residential, resorts, and hotels (outdoor facil.)	Y(a)	N(b)	N	N	N	N
Low density apartment with moderate outdoor use	Y	N(b)	N	N	N	N
High density apartment with limited outdoor use	Y	N(b)	N(b)	N	N	N
Transient lodgings with limited outdoor use	Y	N(b)	N(b)	N	N	N
PUBLIC USE						
Schools, day-care centers, libraries, and churches	Y	N(c)	N(c)	N(c)	N	N
Hospitals, nursing homes, clinics, and health facilities	Y	Y(d)	Y(d)	Y(d)	N	N
Indoor auditoriums and concert halls	Y(c)	Y(c)	N	N	N	N
Government services and office buildings serving the general public	Y	Y	Y(d)	Y(d)	N	N
Transportation and Parking	Y	Y	Y(d)	Y(d)	Y(d)	Y(d)
COMMERCIAL AND GOVERNMENT USE						
Offices - government, business, and professional	Y	Y	Y(d)	Y(d)	N	N
Wholesale and retail - building materials, hardware and heavy equipment	Y	Y	Y(d)	Y(d)	Y(d)	Y(d)
Airport businesses - car rental, tours, lei stands, ticket offices, etc.	Y	Y	Y(d)	Y(d)	N	N
Retail, restaurants, shopping centers, financial institutions, etc.	Y	Y	Y(d)	Y(d)	N	N
Power plants, sewage treatment plants, and base yards	Y	Y	Y(d)	Y(d)	Y(d)	N
Studios without outdoor sets, broadcasting, production facilities, etc.	Y(c)	Y(c)	N	N	N	N
MANUFACTURING, PRODUCTION, AND STORAGE						
Manufacturing, general	Y	Y	Y(d)	Y(d)	Y(d)	N
Photographic and optical	Y	Y	Y(d)	Y(d)	N	N
Agriculture (except livestock) and forestry	Y	Y(e)	Y(e)	Y(e)	Y(e)	Y(e)
Livestock farming and breeding	Y	Y(e)	Y(e)	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
RECREATIONAL						
Outdoor sports arenas and spectator sports	Y	Y(f)	Y(f)	N	N	N
Outdoor music shells, amphitheaters	Y(f)	N	N	N	N	N
Nature exhibits and zoos, neighborhood parks	Y	Y	Y	N	N	N
Amusements, beach parks, active playgrounds, etc.	Y	Y	Y	Y	N	N
Public golf courses, riding stables, cemeteries, gardens, etc.	Y	Y	N	N	N	N
Professional/resort sport facilities, locations of media events, etc.	Y(f)	N	N	N	N	N
Extensive natural wildlife and recreation areas	Y(f)	N	N	N	N	N

Numbers in parentheses refer to notes.

KEY TO TABLE 3:

Y(Yes) = Land Use and related structures compatible without restrictions.
N(No) = Land Use and related structures are not compatible and should be prohibited.

TABLE 3 (CONTINUED)

HAWAII STATE DEPARTMENT OF TRANSPORTATION RECOMMENDATIONS FOR LOCAL LAND USE COMPATIBILITY WITH YEARLY DAY-NIGHT AVERAGE SOUND LEVELS (DNL)

NOTES FOR TABLE 3:

(a) A noise level of 60 DNL does not eliminate all risks of adverse noise impacts from aircraft noise. However, the 60 DNL planning level has been selected by the State Airports Division as an appropriate compromise between the minimal risk level of 55 DNL and the significant risk level of 65 DNL.

(b) Where the community determines that these uses must be allowed, Noise Level Reduction (NLR) measures to achieve interior levels of 45 DNL or less should be incorporated into building codes and be considered in individual approvals. Normal local construction employing natural ventilation can be expected to provide an average NLR of approximately 9 dB. Total closure plus air conditioning may be required to provide additional outdoor to indoor NLR, and will not eliminate outdoor noise problems.

(c) Because the DNL noise descriptor system represents a 24-hour average of individual aircraft noise events, each of which can be unique in respect to amplitude, duration, and tonal content, the NLR requirements should be evaluated for the specific land use, interior acoustical requirements, and properties of the aircraft noise events. NLR requirements should not be based solely upon the exterior DNL exposure level.

(d) Measures to achieve required NLR must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

(e) Residential buildings require NLR. Residential buildings should not be located where noise is greater than 65 DNL.

(f) Impact of amplitude, duration, frequency, and tonal content of aircraft noise events should be evaluated.

In the State of Hawaii, the State Department of Health (DOH) regulates noise from on-site activities. State DOH noise regulations are expressed in maximum allowable property line noise limits rather than DNL (see Reference 6). The noise limits apply on all islands of the State, including the island of Hawaii. Although they are not directly comparable to noise criteria expressed in DNL, State DOH noise limits for preservation/residential, apartment/commercial, and agricultural/industrial lands equate to approximately 55, 60, and 76 DNL, respectively.

Because the `O`oma Beachside Village site is located on lands proposed for single family and multifamily residential, and commercial uses, various DOH noise limits would be applicable along the lot boundary lines or at receptor locations for the noise originating from any stationary machinery, or equipment related to commercial or construction activities. These property line limits are 60 dBA and 50 dBA during the daytime and nighttime periods, respectively, for commercial lots or receptors. For multifamily or apartment use, the State DOH limits are also 60 dBA and 50 dBA during the daytime and nighttime periods, respectively. For single family residential and public facility uses, the State DOH limits are 55 dBA and 45 dBA during the daytime and nighttime periods, respectively. These noise limits cannot be exceeded for more than 2 minutes in any 20-minute time period under the State DOH noise regulations. The State DOH noise regulations do not apply to aircraft or motor vehicles.

CHAPTER IV. GENERAL STUDY METHODOLOGY

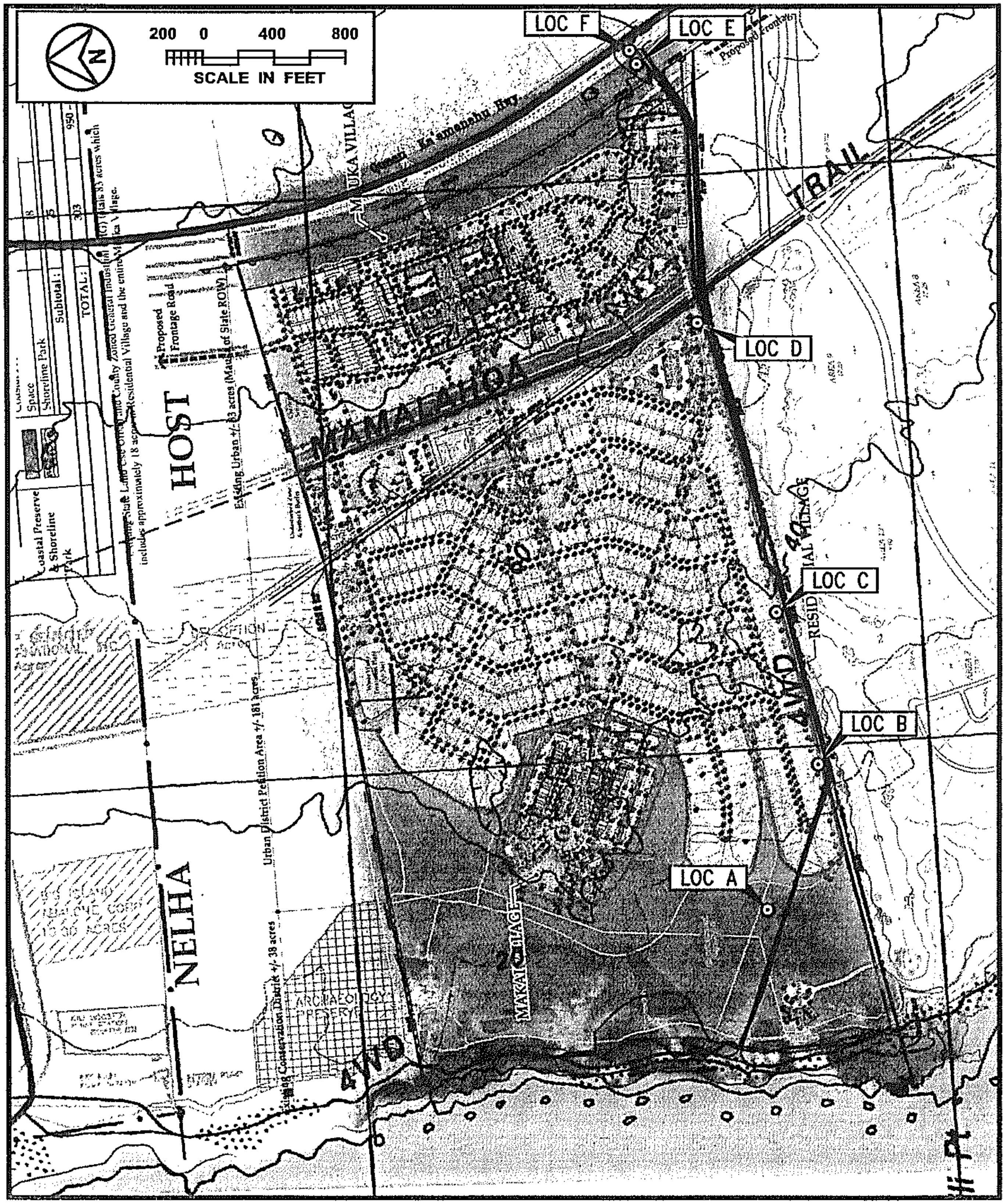
Noise Measurements. Existing traffic, aircraft, and background ambient noise levels were measured at six locations in the project environs to provide a basis for developing the traffic noise contours along Queen Kaahumanu Highway, which will service `O`oma Beachside Village, and for determining the existing background ambient noise levels in the project area. In addition, aircraft noise measurements were also obtained at the southern and western ends of the project site to validate the aircraft noise model used to develop the aircraft noise contours over the project site.

The locations of the measurement sites (Locations A through F) are shown in Figure 3. Noise measurements were performed during a six day period from March 19 to 24, 2007. The traffic noise measurement results, and their comparisons with computer model predictions of existing traffic noise levels are summarized in Table 4. The results of the traffic noise measurements were compared with calculations of existing traffic noise levels to validate the highway traffic noise computer model used. The single event aircraft noise measurement results are summarized in Tables 5 through 8, and were used to validate the aircraft noise computer model used. Comparisons of the measured DNL values at the four aircraft noise measurement sites with the various computer modeled scenarios and their aircraft noise contour values are shown in Tables 9A and 9B.

Road Traffic Noise Analysis. Traffic noise calculations for the existing conditions as well as noise predictions for the future conditions with and without the project were performed using the Federal Highway Administration (FHWA) Noise Prediction Model (Reference 8). Traffic data entered into the noise prediction model were: hourly traffic volumes, average vehicle speeds, estimates of traffic mix, and loose soil propagation loss factor. The traffic assignments for the project (Reference 9) and Hawaii State Department of Transportation counts on Queen Kaahumanu Highway (Reference 10) were the primary sources of data inputs to the model. For existing and future traffic, it was assumed that the 24-hour DNL along the highway was one unit greater than the larger of the AM or PM peak hour Leq(h). This assumption was based on computations of both the hourly Leq and the 24-hour DNL of traffic noise on Queen Kaahumanu Highway (see Figure 4).

Traffic noise calculations for both the existing and future conditions in the project environs were developed for ground level receptors without the benefit of shielding effects. Traffic assignments with and without the project were obtained from the project's traffic turning movements (Reference 9). The forecasted increases in traffic noise levels over existing levels were calculated for both scenarios, and noise impact risks evaluated. The relative contributions of non-project and project related traffic to the total noise levels were also calculated, and an evaluation was made of possible traffic noise impacts resulting from the project.

The widening of Queen Kaahumanu Highway by CY 2029 was also assumed.



NOISE MEASUREMENT LOCATIONS ON PROJECT SITE

FIGURE 3

TABLE 4
TRAFFIC NOISE MEASUREMENT RESULTS

	LOCATION	Time of Day (HRS)	Ave. Speed (MPH)	Hourly Traffic Volume AUTO	Hourly Traffic Volume M.TRUCK	Hourly Traffic Volume H.TRUCK	Measured Leq (dB)	Predicted Leq (dB)
E	150 FT from centerline of Q. Kaahumanu Hwy. (3/20/07)	0645 TO 0745	65	1,650	36	45	66.6	65.9
F	50 FT from centerline of Q. Kaahumanu Hwy. (3/20/07)	0645 TO 0745	65	1,650	36	45	74.8	74.9
E	150 FT from centerline of Q. Kaahumanu Hwy. (3/20/07)	1645 TO 1745	55	1,633	18	12	58.4	62.8
F	50 FT from centerline of Q. Kaahumanu Hwy. (3/20/07)	1645 TO 1745	55	1,633	18	12	72.0	71.9

TABLE 5

SUMMARY OF INDIVIDUAL AIRCRAFT NOISE MEASUREMENTS AT LOCATION "A"

AIRCRAFT TYPE	MAXIMUM SOUND LEVELS Lmax (in dB)	SOUND EXPOSURE LEVELS Lse (in dB)
B-737(700) (RWY 17) (TAKE OFF)	72.7; 70.7; 70.8; 76.5; 66.2; 69.3; 65.8; (AVE.=70.3)	80.1; 81.8; 81.6; 87.0; 77.5; 80.9; 77.5; (ENERGY AVE.=82.1; PRED.=83.9)
B-737(200) (RWY 17) (TAKE OFF)	85.5; 76.7; 76.8; 79.2; 77.3; 79.2; 78.1; 77.9; 85.0; 85.2; 81.2; 78.5; 82.2; 81.4; 78.0; 87.8; 81.7; 79.3; 78.5; 80.4; 92.5; 85.6; 81.4; 89.0; 83.5; 75.6; 93.1; 90.5; 81.4; 87.7; 76.7; 72.9; 79.5; 80.7; 73.1; 72.1; 84.5; 82.4; 81.5; 87.9; 76.6; 72.9; 82.6; 84.7; 88.9; 80.4; 80.0; 62.6; 76.9; 66.5; 77.2; 82.3; 77.1; 80.2; 82.5; 84.5; 75.9; 82.0; 77.8; 82.8; 86.9; 84.5; 79.9; 68.7; 81.0; 83.2; 78.3; 83.0; 78.0; 78.1; 79.6; 77.8; 79.5; 78.8; 80.8; 92.1; 80.2; 75.3; 81.2; 80.0; 76.2 (AVE.=81.0)	90.9; 87.5; 87.4; 88.4; 87.2; 89.0; 88.9; 86.0; 93.5; 95.3; 90.9; 88.1; 90.4; 89.5; 89.4; 97.0; 91.1; 89.6; 88.9; 91.4; 99.2; 94.3; 92.3; 98.4; 93.7; 85.3; 100.6; 96.9; 91.2; 96.2; 85.5; 92.6; 88.2; 90.3; 80.9; 84.1; 93.9; 91.9; 92.2; 96.5; 86.5; 85.0; 92.7; 94.6; 97.4; 89.3; 90.0; 75.5; 87.2; 73.0; 85.9; 92.0; 88.5; 89.5; 88.5; 94.5; 85.8; 91.8; 88.5; 92.5; 95.7; 93.3; 88.3; 78.4; 88.9; 92.4; 90.1; 92.6; 87.8; 88.6; 86.1; 87.5; 89.2; 88.2; 91.2; 101.9; 90.0; 86.7; 91.5; 89.5; 86.5; (ENERGY AVE.=92.1; PRED.=91.2)
B-717(200) (RWY 17) (TAKE OFF)	67.8; 75.9; 65.1; 66.2; 69.0; 67.9; 68.1; 74.0; 68.3; 66.2; 65.1; 69.9; 66.6; 69.4; 64.1; 69.6; 59.8; 65.5; 68.6; 68.0; 66.0; 65.7; 67.5; 66.4; 59.0; 72.0; 64.1; 62.2; 70.8; 64.5; 70.2; 68.6; 76.9; 66.5; 70.7; 64.1; 64.0; 66.7; 63.8; 69.4; 63.2; 63.4; 65.9; 65.9; 68.5; 66.2; 67.7; 66.5; 64.4; 63.5; 67.0; 67.7; 67.6; 68.1; 71.5; 67.4; 65.5; 65.3; 69.5; 71.3; 68.0; 67.6; 67.7; 67.7; (AVE.=67.2)	77.3; 85.2; 75.1; 77.7; 80.3; 77.2; 79.8; 83.8; 77.4; 76.5; 75.5; 78.1; 77.0; 80.4; 75.0; 78.7; 70.0; 77.0; 79.4; 77.9; 75.9; 75.9; 76.4; 76.3; 70.7; 81.1; 75.0; 73.8; 81.4; 74.9; 78.2; 77.5; 87.2; 73.0; 78.9; 74.0; 74.5; 76.6; 74.4; 80.4; 74.6; 74.5; 76.5; 76.2; 79.4; 76.5; 79.0; 76.5; 75.2; 71.3; 77.6; 77.7; 77.9; 78.7; 80.6; 77.4; 77.6; 75.3; 76.8; 80.2; 75.6; 77.3; 77.4; 77.2; (ENERGY AVE.=78.4; PRED.=80.3)
CRJ 200 (RWY 17) (TAKE OFF)	63.2; 62.7; 63.4; 66.5; 57.5; 64.9; 67.2; 65.7; 63.0; 66.7; 60.9; 55.2; 60.5; 66.2; 66.9; 61.5; 63.7; 62.1; 68.5; 61.1; 77.8; 69.2; 61.4; 62.7; 63.2; 64.4; 66.9; 64.1; 60.0; 60.5; (AVE.=63.9)	73.4; 69.9; 73.7; 76.0; 68.0; 72.8; 78.3; 76.9; 73.7; 78.4; 70.1; 68.3; 71.1; 76.8; 75.6; 73.1; 73.0; 73.4; 78.8; 70.6; 88.5; 79.2; 71.8; 74.0; 72.5; 73.0; 75.2; 73.9; 73.0; 68.3; (ENERGY AVE.=77.1; PRED.=76.1)

TABLE 5 (CONTINUED)

SUMMARY OF INDIVIDUAL AIRCRAFT NOISE MEASUREMENTS AT LOCATION "A"

AIRCRAFT TYPE	MAXIMUM SOUND LEVELS Lmax (in dB)	SOUND EXPOSURE LEVELS Lse (in dB)
C-17 (RWY 17) (TAKE OFF)	75.2; 67.5; 72.8; 78.2; 73.5; 79.8; 77.6; 79.2; (AVE.=75.5)	86.7; 78.9; 83.7; 88.9; 84.2; 89.6; 86.7; 85.2; (ENERGY AVE.=86.4; PRED.=88.3)
P-3C (RWY 17) (TOUCH &GO)	64.4; 67.8; 67.6; 68.9; 70.4; 67.6; 66.6; 69.0; 72.3; 78.4; 68.6; 70.7; 66.2; 69.4; 65.9; 68.7; 73.5; 67.9; 68.1; 71.1; 65.8; 65.3; 61.4; 60.5; 63.8; (AVE.=68.0)	76.2; 76.9; 76.3; 78.5; 78.7; 77.2; 76.2; 77.4; 82.8; 83.6; 76.0; 79.3; 76.0; 76.1; 75.7; 77.5; 82.5; 78.4; 77.7; 78.8; 74.2; 74.0; 71.2; 68.8; 73.3; (ENERGY AVE.=78.1; PRED.=80.5)
B-757/767 (RWY 17) (TAKE OFF)	66.2; 75.8; 67.8; 78.7; 73.6; 72.8; 74.2; 68.2; 64.6; 68.6; 72.4; 66.4; 72.5; 73.5; 66.9; 66.0; 71.4; 73.6; 77.8; 69.3; 74.6; 73.8; 71.7; 70.9; 75.1; 77.3; 80.4; 76.1; 67.8; 73.6; (AVE.=72.1)	76.3; 84.3; 76.0; 87.4; 83.6; 80.0; 83.8; 77.0; 76.1; 77.3; 81.6; 78.3; 83.7; 84.6; 78.3; 76.2; 81.7; 84.0; 87.5; 80.0; 85.7; 82.3; 79.1; 80.2; 84.8; 87.5; 85.8; 84.6; 75.6; 83.3; (ENERGY AVE.=83.0; PRED.=86.5)
KC-135R (RWY 17) (TOUCH &GO)	71.8; 81.1; 78.8; 77.7; 73.0; 79.9; 75.7; 73.5; 74.9; 72.9; 70.4; 73.3; 75.9; 74.2; 67.0; 70.2; 73.6; 63.5; 79.1; 72.2; 77.7; (AVE.=74.1)	81.9; 89.2; 87.7; 86.2; 82.1; 88.8; 84.8; 82.5; 82.5; 79.5; 79.3; 81.2; 84.5; 83.5; 77.4; 80.0; 81.6; 74.0; 86.8; 81.5; 85.8; (ENERGY AVE.=84.3; PRED.=86.6)

TABLE 6

SUMMARY OF INDIVIDUAL AIRCRAFT NOISE MEASUREMENTS AT LOCATION "B"

AIRCRAFT TYPE	MAXIMUM SOUND LEVELS Lmax (in dB)	SOUND EXPOSURE LEVELS Lse (in dB)
B-737(700) (RWY 17) (TAKE OFF)	68.1; 69.2; 68.4; (AVE.=68.6)	76.9; 78.2; 74.0; (ENERGY AVE.=76.7; PRED.=79.9)
B-737(200) (RWY 17) (TAKE OFF)	79.5; 77.6; 78.7; 79.4; 73.8; 80.6; 77.0; 81.6; 80.2; 82.0; 84.6; 76.8; 80.9; 78.1; 87.8; 84.4; 81.4; 85.0; 76.9; 71.9; 77.3; 79.6; 75.2; 76.0; 83.6; 80.8; 79.6; 84.1; 75.8; 72.4; 77.4; 78.4; 78.4; 79.4; 79.8; 80.2; 90.0; 80.3; 77.7; 82.2; 78.4; 76.6; 78.6; (AVE.=79.8)	88.6; 85.8; 85.0; 86.7; 83.5; 86.5; 84.9; 84.3; 89.3; 90.3; 88.2; 85.2; 89.4; 84.0; 94.6; 92.7; 83.6; 91.7; 84.9; 79.9; 84.8; 87.9; 84.0; 84.3; 90.8; 89.3; 88.3; 92.4; 84.3; 82.9; 85.5; 85.7; 86.4; 85.6; 86.0; 88.4; 98.2; 86.9; 84.9; 86.1; 87.9; 86.2; 85.6; (ENERGY AVE.=88.7; PRED.=88.8)
B-717(200) (RWY 17) (TAKE OFF)	66.0; 73.2; 63.4; 66.9; 77.4; 65.0; 68.5; 66.1; 74.1; 66.8; 66.2; 67.9; 68.3; 65.5; 64.0; 64.5; 69.0; 59.5; 68.5; 64.0; 67.4; 68.2; 67.5; 71.0; 66.2; 67.8; 64.6; 67.8; 67.0; 63.2; 68.2; 65.4; 65.6; (AVE.=67.1)	73.8; 81.7; 73.3; 76.3; 78.4; 74.8; 75.9; 76.1; 79.7; 74.0; 73.8; 75.8; 75.3; 74.0; 73.6; 74.0; 73.7; 69.3; 75.9; 73.1; 75.1; 74.2; 75.1; 75.8; 76.0; 76.8; 74.9; 76.1; 74.0; 72.6 73.6; 74.0; 74.2; (ENERGY AVE.=75.6; PRED.=70.9)
CRJ 200 (RWY 17) (TAKE OFF)	63.4; 59.6; 62.1; 65.4; 71.6; 58.1; 59.4; 64.1; 61.3; 62.5; 62.8; 58.2; 63.7 (AVE.=62.5)	70.7; 69.8; 71.1; 73.5; 74.9; 66.0; 68.5; 68.9; 67.0; 71.8; 70.2; 68.5; 66.1 (ENERGY AVE.=70.6; PRED.=70.9)
C-17 (RWY 17) (TAKE OFF)	73.0; 68.8; 75.0; 70.7; (AVE.=71.9)	83.4; 77.9; 85.6; 81.0; (ENERGY AVE.=82.8; PRED.=84.5)
P-3C (RWY 17) (TOUCH &GO)	63.8; 65.8; 64.6; 67.1; (AVE.=65.3)	73.9; 72.9; 73.5; 73.8; (ENERGY AVE.=73.5; PRED.=76.7)
B-757/767 (RWY 17) (TAKE OFF)	65.1; 75.1; 64.2; 75.4; 67.6; 70.2; 69.2; 75.6; 71.0; 66.9; 64.1; 72.6; 74.7; 76.2; 74.4; 68.5; 72.7; (AVE.=70.8)	75.1; 82.2; 73.4; 84.0; 78.1; 78.3; 77.5; 84.1; 81.4; 77.3; 74.5; 81.4; 83.4; 83.2; 81.2; 72.8; 81.2; (ENERGY AVE.=80.7; PRED.=82.8)

TABLE 7

SUMMARY OF INDIVIDUAL AIRCRAFT NOISE MEASUREMENTS AT LOCATION "C"

AIRCRAFT TYPE	MAXIMUM SOUND LEVELS Lmax (in dB)	SOUND EXPOSURE LEVELS Lse (in dB)
B-737(700) (RWY 17) (TAKE OFF)	70.7; 69.6; (AVE.=70.2)	78.1; 76.9; (ENERGY AVE.=77.5; PRED.=77.4)
B-737(200) (RWY 17) (TAKE OFF)	78.6; 80.9; 79.4; 80.5; 79.3; 77.7; 75.8; 78.0; 85.0; 83.0; 77.5; 81.9; 76.8; 82.6; 82.5; 79.3; 79.9; 70.8; 79.5; 76.3; 67.2; 76.4; 61.4; 74.0; 80.2; 80.4; 77.9; 76.4; 82.4; (AVE.=78.0)	85.0; 87.1; 85.5; 89.5; 86.8; 85.4; 84.3; 86.9; 91.3; 90.4; 87.2; 90.6; 87.5; 89.3; 89.2; 85.0; 85.3; 80.1; 85.8; 84.4; 75.0; 82.9; 67.3; 81.1; 86.9; 84.7; 85.9; 83.0; 88.8; (ENERGY AVE.=86.8; PRED.=88.3)
B-717(200) (RWY 17) (TAKE OFF)	66.4; 68.6; 67.8; 69.2; 61.8; 68.1; 66.6; 65.5; 65.4; 71.1; 69.5; 64.6; 68.0; 70.0; 66.2; 66.8; 64.9; 64.5; 65.1; 61.8; 64.5; (AVE.=66.5)	75.9; 75.8; 73.4; 75.0; 70.8; 75.8; 68.4; 73.2; 73.9; 77.5; 76.6; 72.7; 74.3; 77.5; 75.8; 75.2; 71.6; 71.5; 71.4; 68.5; 74.7; (ENERGY AVE.=74.5; PRED.=76.2)
CRJ 200 (RWY 17) (TAKE OFF)	66.0; 65.6; 62.8; 59.7; 66.0; 59.0; 63.2; 62.5; 64.3; 59.7; 61.4; 60.7; (AVE.=62.6)	73.0; 77.2; 72.8; 66.9; 68.6; 69.4; 74.0; 73.2; 72.5; 69.1; 69.4; 69.0; (ENERGY AVE.=72.2; PRED.=70.6)
C-17 (RWY 17) (TAKE OFF)	71.8; 74.9; 75.4; (AVE.=74.0)	81.2; 83.9; 81.8; (ENERGY AVE.=82.5; PRED.=84.4)
P-3C (RWY 17) (TOUCH &GO)	66.3; 66.1; 63.4; 62.8; 66.3; 68.7; 70.4; 70.9; 65.6; 66.6; 65.2; (AVE.=66.6)	74.3; 74.7; 74.5; 70.5; 72.6; 76.9; 74.0; 78.9; 70.7; 73.8; 72.1; (ENERGY AVE.=73.9; PRED.=75.0)
B-757/767 (RWY 17) (TAKE OFF)	71.1; 72.8; 67.8; 70.7; 67.7; 71.8; 67.8; 69.3; 72.0; 75.2; 67.8; 71.3; 74.0; 68.5; (AVE.=70.6)	79.2; 76.8; 77.6; 79.4; 76.5; 79.0; 73.2; 74.0; 78.8; 78.5; 76.2; 79.2; 81.6; 75.7; (ENERGY AVE.=78.1; PRED.=80.4)
KC-135R (RWY 17) (TOUCH &GO)	70.8; 74.6; 73.0; 74.5; 68.7; 74.1; 71.1; 70.3; 70.6; 69.0; 70.9; 68.1; 71.1; 73.8; (AVE.=71.5)	79.5; 82.6; 82.1; 80.9; 76.9; 82.4; 76.7; 77.5; 75.0; 75.5; 76.3; 77.9 78.8; (ENERGY AVE.=79.3; PRED.=79.2)

TABLE 8

SUMMARY OF INDIVIDUAL AIRCRAFT NOISE MEASUREMENTS AT LOCATION "D"

AIRCRAFT TYPE	MAXIMUM SOUND LEVELS Lmax (in dB)	SOUND EXPOSURE LEVELS Lse (in dB)
B-737(700) (RWY 17) (TAKE OFF)	70.7; 63.2; (AVE.=67.0)	78.4; 71.9; (ENERGY AVE.=76.3; PRED.=73.5)
B-737(200) (RWY 17) (TAKE OFF)	72.1; 76.3; 76.3; 79.3; 81.1; 81.7; 77.8; 74.3; 69.4; 75.8; 76.0; 77.0; 80.0; (AVE.=76.7)	81.7; 84.5; 85.1; 85.3; 87.1; 87.9; 85.9; 81.7; 75.1; 82.7; 83.7; 83.1; 85.6; (ENERGY AVE.=84.6; PRED.=83.5)
B-717(200) (RWY 17) (TAKE OFF)	60.3; 64.8; 63.1; 64.6; 66.2; 62.2; 65.2; 61.3; 59.9; 64.1; 61.2; (AVE.=63.0)	69.7; 70.6; 72.2; 73.7; 73.5; 70.3; 75.8; 67.7; 68.1; 68.8; 69.2; (ENERGY AVE.=71.6; PRED.=67.5)
CRJ 200 (RWY 17) (TAKE OFF)	60.2; 60.6; 64.4; 61.2; 61.4; (AVE.=61.6)	71.0; 68.4; 74.5; 68.4; 69.4; (ENERGY AVE.=71.0; PRED.=66.9)
P-3C (RWY 17) (TOUCH &GO)	62.4; 63.5; 63.0; 61.3; 66.4; 64.6; 64.5; 66.8; 64.5;; 59.2; 63.7; 61.2; 67.1; (AVE.=63.7)	70.3; 73.3; 71.0; 71.0; 74.4; 73.4; 72.5; 71.5; 70.2; 69.7; 73.9; 68.8; 72.1; (ENERGY AVE.=71.7; PRED.=73.5)
B-757/767 (RWY 17) (TAKE OFF)	70.4; 73.5; 67.3; 69.0; (AVE.=70.1)	79.2; 78.0; 74.4; 75.8; (ENERGY AVE.=77.2; PRED.=77.1)
KC-135R (RWY 17) (TOUCH &GO)	66.3; 68.2; 66.8; 62.0; 68.5; 68.4; 66.7; 73.7; (AVE.=67.6)	74.6; 77.0; 73.9; 71.4; 74.1; 77.0; 74.5; 78.2; (ENERGY AVE.=75.6; PRED.=75.0)

TABLE 9A
COMPARISONS OF MEASURED AND PREDICTED EXISTING AIRCRAFT NOISE LEVELS

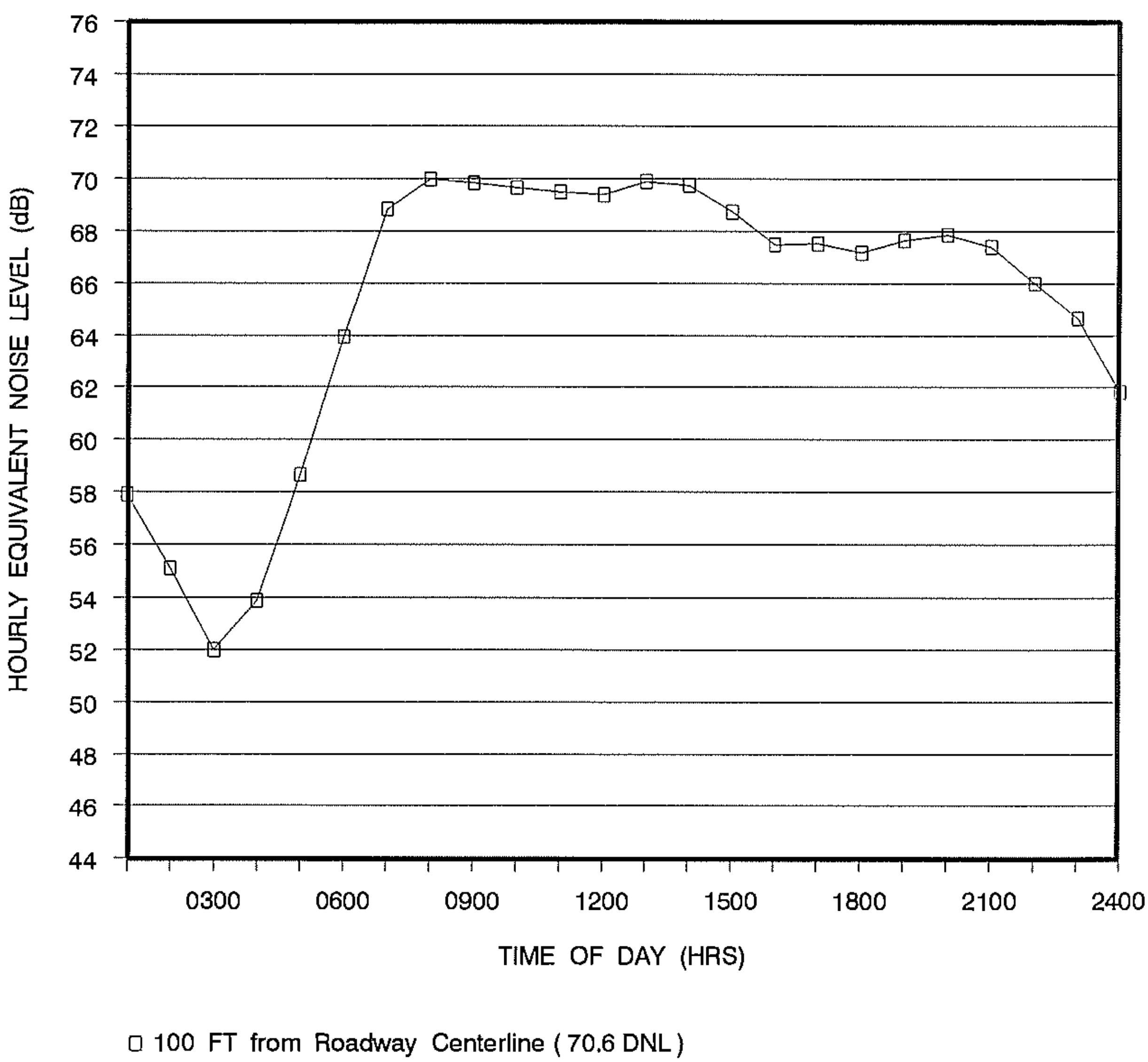
NOISE MODELING CONDITIONS	-- DNL @ MEASUREMENT LOCATION ---- A	B	C	D
1. March 2007 On-Site A/C Noise Measurements	55.8	52.0	50.8	49.4
2. FAR Part 150 5-Year (2001) Noise Contours	57.2	53.6	51.9	50.2
3a. INM 6.1 Estimated 2007/2008 Noise Contours	58.2	53.6	51.1	48.8
3b. INM 7.0 Estimated 2007/2008 Noise Contours	59.0	55.0	52.7	50.1
4. Draft 14 CFR Part 150 2008 Noise Contours	61.0	--- (Not possible to determine) ---		

TABLE 9B
COMPARISONS OF MEASURED EXISTING AND PREDICTED FUTURE AIRCRAFT NOISE LEVELS

NOISE MODELING CONDITIONS	-- DNL @ MEASUREMENT LOCATION ---- A	B	C	D
1. March 2007 On-Site A/C Noise Measurements	55.8	52.0	50.8	49.4
5a. INM 6.1 Estimated 2013 Noise Contours	60.0	55.6	53.1	51.9
5b. INM 7.0 Estimated 2013 Noise Contours	60.4	56.1	53.5	50.6
6. Draft 14 CFR Part 150 2013 Noise Contours	62.0	--- (Not possible to determine) ---		
7. HDOTA 2020 Noise Contours (1997 Study)	56.8	53.3	51.4	49.8
8. Draft 14 CFR Part 150 2030 Noise Contours	61.0	--- (Not possible to determine) ---		
9. INM 6.1 Estimated 2030 Noise Contours	60.5	56.3	53.9	52.9

FIGURE 4

HOURLY VARIATIONS OF TRAFFIC NOISE AT 100 FT SETBACK DISTANCE FROM THE CENTERLINE OF QUEEN KAAHUMANU HWY. BETWEEN OTEC ACCESS RD. AND HULIKOA ST. AT 95 MILEPOST
(Sta. B71001909280, 5/31/06)

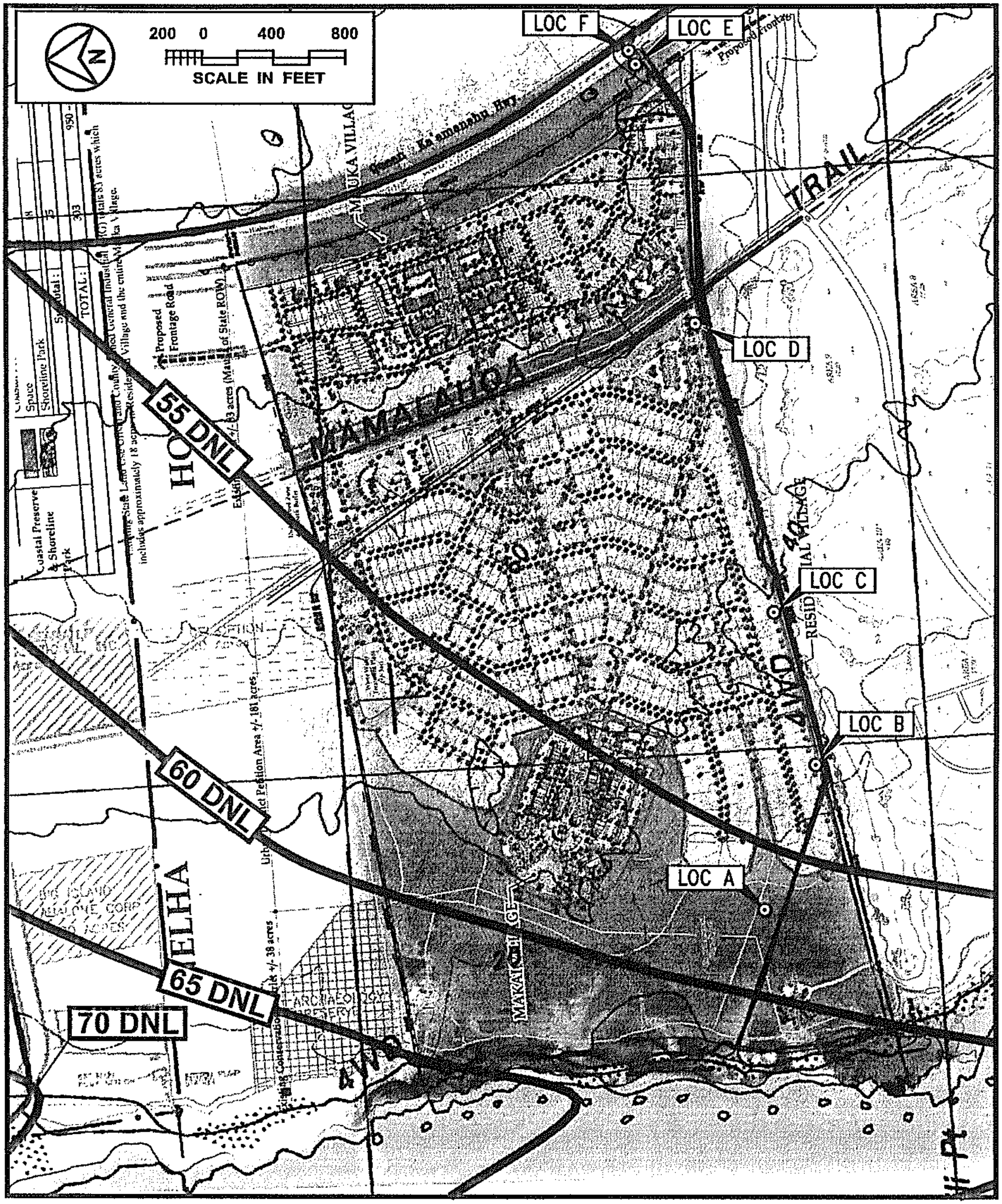


Future traffic noise levels with and without the project were calculated for conditions with 2 northbound and 2 southbound lanes, with the 2 southbound lanes located west of the existing highway pavement, and with a 72 foot wide median separating the northbound and southbound lanes.

Aircraft Noise Analysis. The potential aircraft noise impacts at the O'oma Beachside Village project site from existing and forecasted operations at KOA were evaluated. In addition, aircraft noise measurements on the project site were obtained in March 2007 to validate the reasonableness of the aircraft noise model used to develop the noise contours, and to quantify the expected noise levels from various aircraft flybys at noise sensitive locations on the project site. The potential noise impacts from additional C-17 training operations with the proposed Austere Runway at KOA were also investigated. Future 2013 noise contours with C-17, F-22A, and P-8A training operations included were developed. For the 2030 period, it was assumed that military training operations would remain the same as 2013 operations, and that the noisier B-737(200) aircraft (passenger only) would be replaced with quieter Stage 3 aircraft. The data sources for these evaluations were the current official 14 CFR Part 150 Noise Compatibility Study for KOA (Reference 7), which was completed in 1997; the Environmental Assessment for the site selection of the C-17 Short Austere Airfield (Reference 11), which was completed in 2004; the Environmental Assessment for the replacement of the F-15 aircraft with F-22A aircraft (Reference 12), which was completed in 2007; and the information provided by HDOTA from the ongoing 14 CFR Part 150 study (Reference 13).

The current and official noise contours for KOA were developed during the 14 CFR Part 150 Airport Noise Compatibility Study and Master Plan Update in the late 1900's and do not include C-17, F-22A, or P-8A operations. Figure 5 depicts the 2001 14 CFR Part 150 aircraft noise contours for the airport, which are the contours used for noise disclosure purposes during land ownership transactions near the airport. The aircraft noise contours fall over the western (makai) portions of the \`O\`oma Beachside Village project site. For noise sensitive land uses such as residential development, areas outside the 60 DNL contour are considered to be acceptable by the State of Hawaii Department of Transportation, Airports Division (HDOTA) land use compatibility recommendations. Any land ownership transactions which occur within the 55 DNL contour typically required disclosure of the aircraft noise levels prior to the transactions. Whenever State Land Use district boundary amendments or rezoning of noise sensitive lands is proposed within the 60 DNL contour, the HDOTA has recommended that sound attenuation measures be included with the noise sensitive structures and that a noise and avigation easement be provided to the HDOTA in exchange for the higher State Land Use or zoning reclassification. As indicated in Figure 5, the proposed noise sensitive residential land uses of the \`O\`oma Beachside Village project are located outside the 60 DNL contour, and were located to comply with the HDOTA land use compatibility recommendations shown in Table 3.

Estimates of current aircraft noise levels over the project site were made using



LOCATIONS OF CY 2001 AIRCRAFT NOISE CONTOURS (FROM FAR PART 150 REPORT FOR KOA)

FIGURE 5

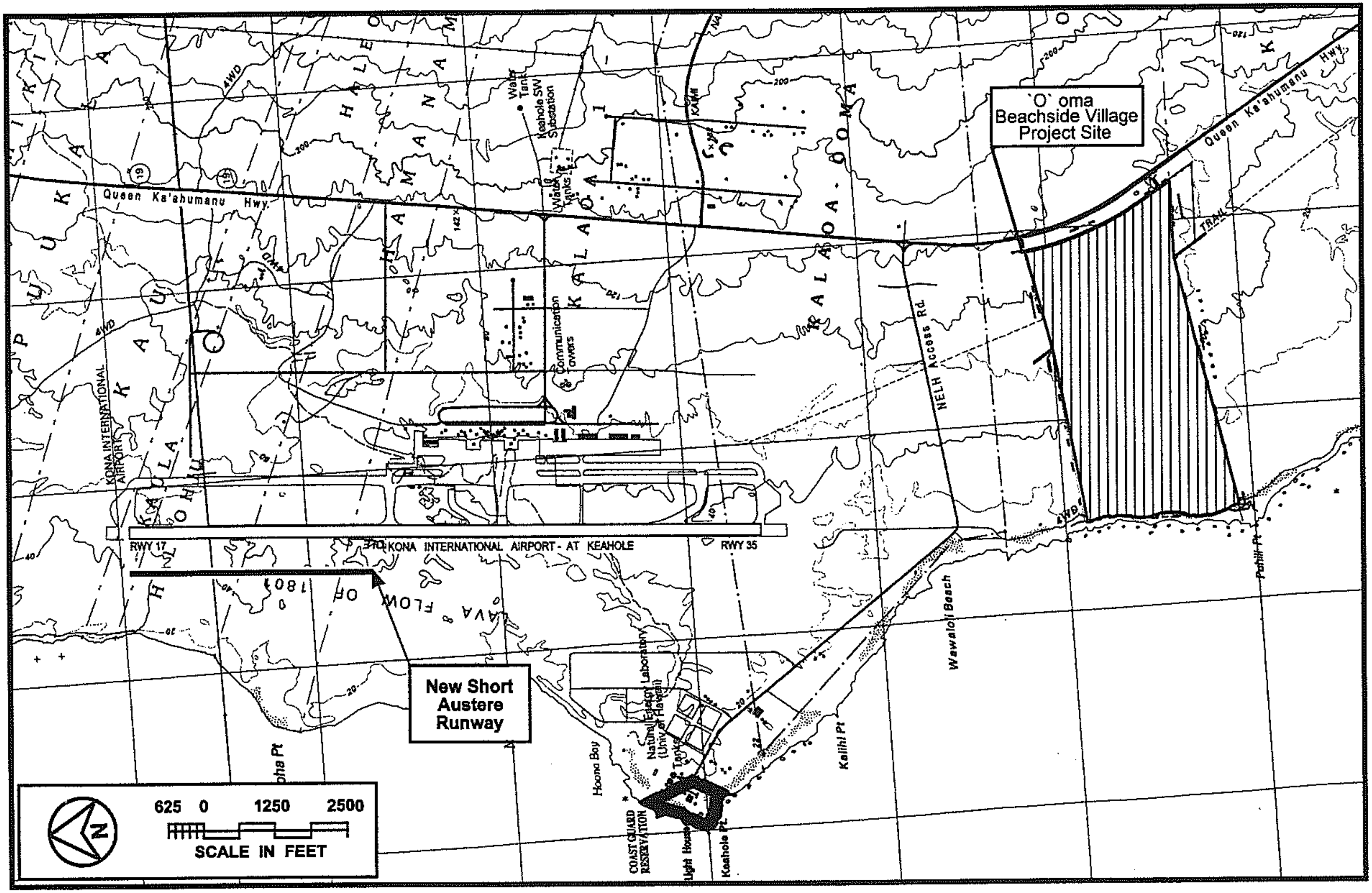
aircraft operation information contained in Reference 13 for the 2007/2008 period, and are described in Chapter V - Existing Noise Environment. Chapter V also includes the results of the aircraft noise measurements on the project site. Since this study's existing aircraft noise contours are not the "official" 14 CFR Part 150 noise contours for KOA, they should not be used for determining the aircraft noise disclosure boundaries by Reference 5.

The FAA Integrated Noise Model, Version 6.1 (FAA INM) was used to develop the aircraft noise contours for this study. In addition, the more recent Version 7.0 of the FAA INM was also used to identify any significant differences in the modeling results between Versions 6.1 and 7.0. After comparing the results from the two versions with the noise measurement data, it was concluded that the differences in results from the two FAA INM versions were insignificant when compared to the differences between measured noise levels and the predicted noise levels from both INM versions.

For the purposes of this study, estimates of the 2013 noise contours at KOA were developed in Chapter VI - Future Noise Environment. By 2013, it was assumed that the proposed Austere Runway for the C-17 would be completed, the F-15 would be replaced with the F-22A, and the P-3C would be replaced by the P-8A. These assumptions are consistent with the forecast contained in Reference 13, except for the replacement of the P-3C with the P-8A.

The proposed C-17 operations at KOA were estimated from information provided in the 2004 Environmental Assessment for the site selection of the C-17 Short Austere Airfield, which recommended KOA as the preferred airport (Reference 11), and information contained in Reference 13. The required funding for the new runway has not been secured, and the Hawaii State environmental documentation for the proposed runway has not been completed. Nevertheless, it was assumed that an additional parallel and shorter (4,250 feet long x 90 feet wide) runway will be constructed makai of and at the north end of the existing airfield where shown in Figure 6. The assumed C-17 operations at KOA with the new runway completed by 2013 were modeled using the following assumptions:

- 92 landings and 92 takeoffs per month on the new 4,250' runway;
- 92 landings and 92 takeoffs per month on the existing runway;
- 480 landings and 480 takeoffs (touch and go operations) per month on the existing runway; and
- 41 nighttime operations per month during the DNL noise penalty hours from 10:00 PM to 7:00 AM.



LOCATION OF PROPOSED NEW SHORT AUSTERE RUNWAY FOR C-17 TRAINING OPERATIONS

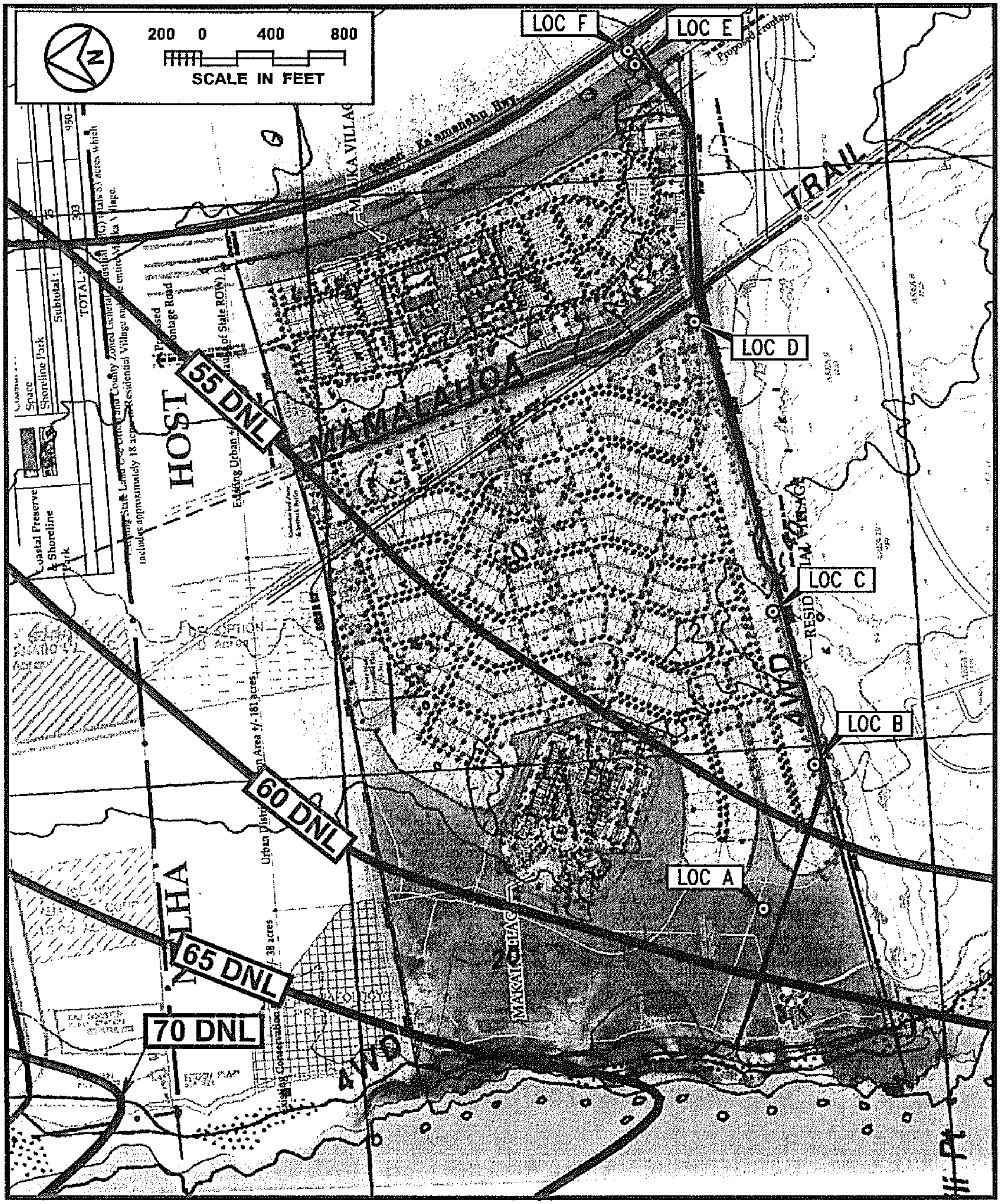
FIGURE 6

Forecasted airport noise contours for 2020 at KOA were developed during the 1997 14 CFR Part 150 Airport Noise Compatibility Study and Master Plan Update in the late 1900's and are shown in Figure 7. It should be noted that the forecasted noise contours were very similar to the 2001 contours shown in Figure 5. Both the 2001 and 2020 noise contours are in the process of being updated by the HDOTA, with the updated contours scheduled for completion within 1 year. Estimated noise contours for 2030 were developed in conjunction with this study using the available aircraft operations forecast from Reference 13.

The locations of the aircraft flight tracks and estimated airport noise contours for 2008, 2013, and 2030 were compared with the locations of the proposed noise sensitive land uses on the project site, and risks of noise impacts were evaluated. The need for special aircraft noise attenuation measures or disclosures of aircraft noise level at the project site was determined by comparing the relationship of the official 2001 14 CFR Part 150 airport noise contours with the locations of proposed land uses on the project site. In addition, noise monitoring data and the study's estimated 2008, 2013, and 2030 noise contours were also used to validate the conclusions regarding existing and future aircraft noise impacts over the project site.

Comparisons of Draft 14 CFR Part 150 Update Noise Contours with `O`oma Beachside Village Development Plans. During the course of this acoustical impact study for the `O`oma Beachside Village, the Hawaii State Department of Transportation, Airports Division (HDOTA) published its draft 14 CFR Part 150 Noise Study and contours for KOA (see Reference 13). The draft noise contours were compared with the aircraft noise contours developed for this acoustical impact study for `O`oma Beachside Village. Because of original modeling assumptions which were considered to be questionable or arbitrary, a request for a copy of the HDOTA's consultant's modeling input file was made via Reference 14. Because the request for the FAA INM modeling input file was denied, a second letter describing the concerns regarding the modeling input assumptions (see Reference 15) was also sent as comments regarding the draft 14 CFR Part 150 study results. These concerns involved the:

- incorrect assumption that daytime and nighttime winds and runway use at KOA are identical;
- lack of correlation between the departure tracks of the B-737(200) aircraft and the seaward extension of the noise contours south of the airport;
- use of a 3% increase in airport operations to account for nighttime flights;
- use of identical itinerant operations for the C-130, P-3, KC-135, and C-17 aircraft;
- apparent lack of authoritative input from the military when forecasting future military operations at KOA;



LOCATIONS OF CY 2020 AIRCRAFT NOISE CONTOURS (FROM 1997 MASTER PLAN UPDATE FOR KOA)

FIGURE 7

- lack of the new seaward runway planned for the C-17;

- continuing use of B-737(200) aircraft through 2030, when their replacement was assumed elsewhere;

- and inclusion of questionable noise monitoring data, which if deleted, would contradict the study conclusion that the south side of the airport is noisier than the north side of the airport.

Because the initial draft 14 CFR Part 150 contours for 2007 and 2012 did not cross into the planned noise sensitive developments of the `O`oma Beachside Village project site, and because the noise measurement data obtained in March 2007 also confirmed that the 60 DNL contour is probably west of the planned noise sensitive developments, the original `O`oma Beachside Village project noise analysis was considered to be adequate. A new set of draft noise contours were developed by HDOTA in 2008 which were larger than the original draft contours. Both the existing and forecast 14 CFR Part 150 contours increased in size, and these latest draft contours have been included with this study report. Continued monitoring and review of the HDOTA's 14 CFR Part 150 Update noise modeling assumptions will be performed to determine the causes of the differences between the study noise contours and the draft 14 CFR Part 150 contours.

<u>Other Noise Analysis</u>. Risks of adverse noise impacts from short term construction noise over the project site were also evaluated. Recommendations for mitigation of construction noise impacts were provided.

CHAPTER V. EXISTING NOISE ENVIRONMENT

Traffic Noise. The existing traffic noise levels in the project environs vary from levels of approximately 64 DNL along the mauka (east) property boundary, to less than 45 DNL at the makai (west) property boundary and interior locations of the project site. Traffic noise levels along Queen Kaahumanu Highway are less than 65 DNL at 180 FT or greater setback distances from the highway centerline. At the west boundary of the project which adjoins the shoreline, existing traffic noise levels are very low and less than 45 DNL.

Calculations of existing traffic noise levels during the AM and PM peak traffic hours are presented in Table 10. Existing traffic noise levels at the project site are typically higher during the AM peak traffic hour rather than the PM peak traffic hour. This is due to the traffic congestion on Queen Kaahumanu Highway in the southbound direction and the lower number of heavy vehicles during the PM peak hour. The hourly Leq (or Equivalent Sound Level) contribution from each roadway section in the project environs were calculated for comparison with forecasted traffic noise levels with and without the project. The existing setback distances from the roadways' centerlines to their associated 65 and 75 DNL contours were also calculated as shown in Table 11. The contour line setback distances do not take into account noise shielding effects or the additive contributions of traffic noise from intersecting street sections. Based on the results of Table 11, it was concluded that the existing 65 DNL traffic noise contour is located approximately 179 FT from the centerline of Queen Kaahumanu Highway in the immediate vicinity of the project site.

Existing traffic noise levels at the interior portions of the project site are low (less than 45 DNL) due to their large setback distances from Queen Kaahumanu Highway. At these interior locations on the project site, aircraft noise and the natural sounds of surf, birds, and winds in foliage are the dominant noise sources. A discussion of existing aircraft noise levels on the project site is provided in the following section. Between aircraft noise events, background ambient noise levels drop to a range of 35 to 49 dB. During calm wind periods, background ambient noise levels decrease to levels less than 35 dB. The minimum background ambient noise levels at these interior locations are controlled by distant traffic, surf, and wind noise.

Aircraft Noise. Aircraft noise sources in the project environs are associated with fixed and rotary wing aircraft operations at KOA. Figures 8 through 10, obtained from Reference 7, depict aircraft flight tracks in the project environs. Occasionally, depending on weather, visibility, or air traffic conditions, helicopter and light, fixed wing aircraft may cross over the project site as indicated by the departure and arrival tracks shown in Figures 8 and 9, respectively. In Figures 8 through 10, flight tracks G7, HT2, H3D, H3A, T16, T17, T19, and T21 represent overflights over the project site by light fixed wing propellor and rotary wing aircraft. The flight tracks of the noisier jet aircraft typically remain west of the project site and are aligned with KOA's single runway.

TABLE 10

EXISTING (CY 2006) TRAFFIC VOLUMES AND NOISE LEVELS ALONG VARIOUS ROAD SECTIONS (AM AND PM PEAK HOURS)

LOCATION	SPEED (MPH)	TOTAL VPH	********* VOLUMES (VPH) ********** AUTOS	M TRUCKS	H TRUCKS	** Leq(h) @ Dist. from B.L. ** 50' Leq	100' Leq	200' Leq
AM Peak Hour:								
Q. Kaahumanu Hwy. - N. of Entrance Rd.	65	1,780	1,697	37	46	75.1	69.4	63.0
Q. Kaahumanu Hwy. - S. of Entrance Rd.	65	1,780	1,697	37	46	75.1	69.4	63.0
PM Peak Hour:								
Q. Kaahumanu Hwy. - N. of Entrance Rd.	55	1,655	1,625	18	12	74.2	68.4	61.8
Q. Kaahumanu Hwy. - S. of Entrance Rd.	55	1,655	1,625	18	12	74.2	68.4	61.8

Notes:

1. Traffic mix during AM Peak Hour: 95.3% Autos; 2.1% Medium Trucks; and 2.6% Heavy Trucks and Buses.
2. Traffic mix during PM Peak Hour: 98.2% Autos; 1.1% Medium Trucks; and 0.7% Heavy Trucks and Buses.
3. Loose Soil propagation loss factor used.
4. Receptor elevation of 4.92 feet above ground level was assumed.

TABLE 11

YEAR 2006 AND 2029 DISTANCES TO 65 AND 75 DNL CONTOURS

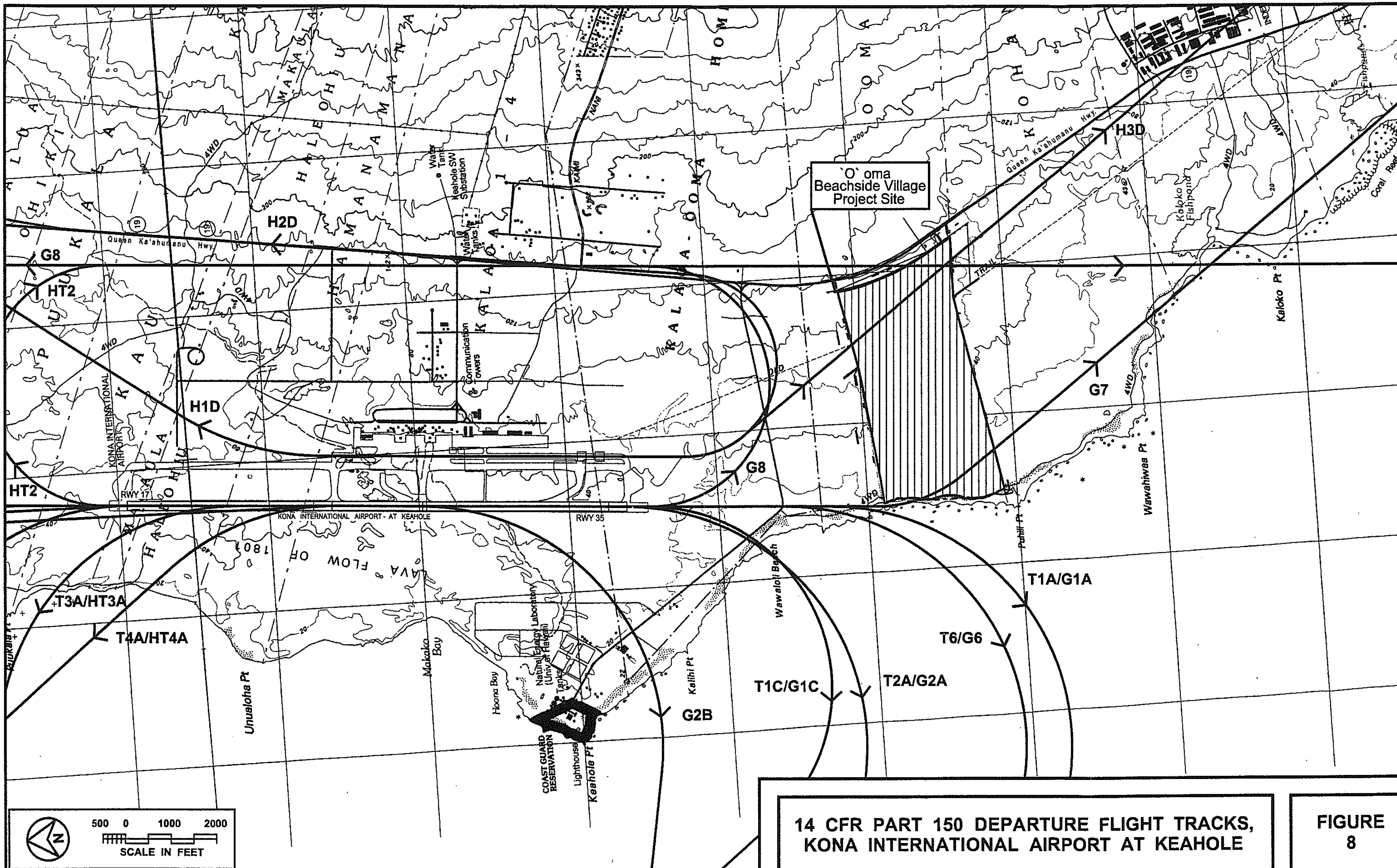
STREET SECTION	65 DNL SETBACK (FT) CY 2006	65 DNL SETBACK (FT) CY 2029	75 DNL SETBACK (FT) CY 2006	75 DNL SETBACK (FT) CY 2029
Q. Kaahumanu Hwy. - N. of Entrance Rd.	179	218	57	97
Q. Kaahumanu Hwy. - S. of Entrance Rd.	179	218	57	97
Project Entrance Rd. At Q. Kaahumanu	N/A	29	N/A	< 12
Frontage Rd. North of Proj. Entrance Rd.	N/A	22	N/A	< 12
Frontage Rd. South of Proj. Entrance Rd.	N/A	24	N/A	< 12
Project Entrance Rd. W. of Frontage Rd.	N/A	50	N/A	< 12

Notes:

(1) Setback distances are from the roadways' centerlines or baselines. For existing Q. Kaahumanu Hwy., Frontage Road, and Project Entrance Road, setback distances are from roadways' centerlines. For widened Q. Kaahumanu Hwy., setback distances are from new highway baseline, midway between northbound and new southbound lanes.

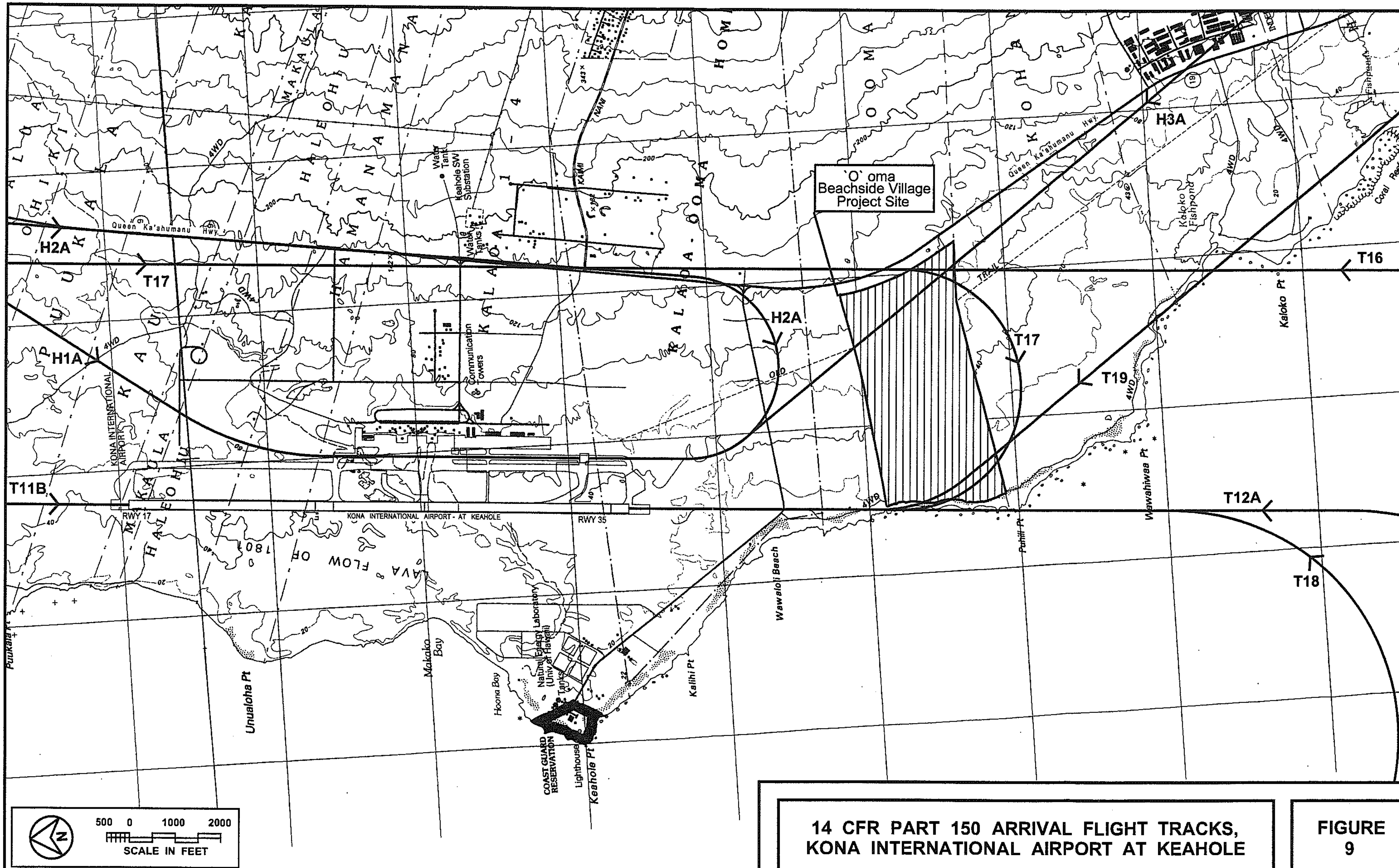
(2) See Tables 10 and 12 for traffic volume, speed, and mix assumptions.

(3) Setback distances are for unobstructed line-of-sight conditions.



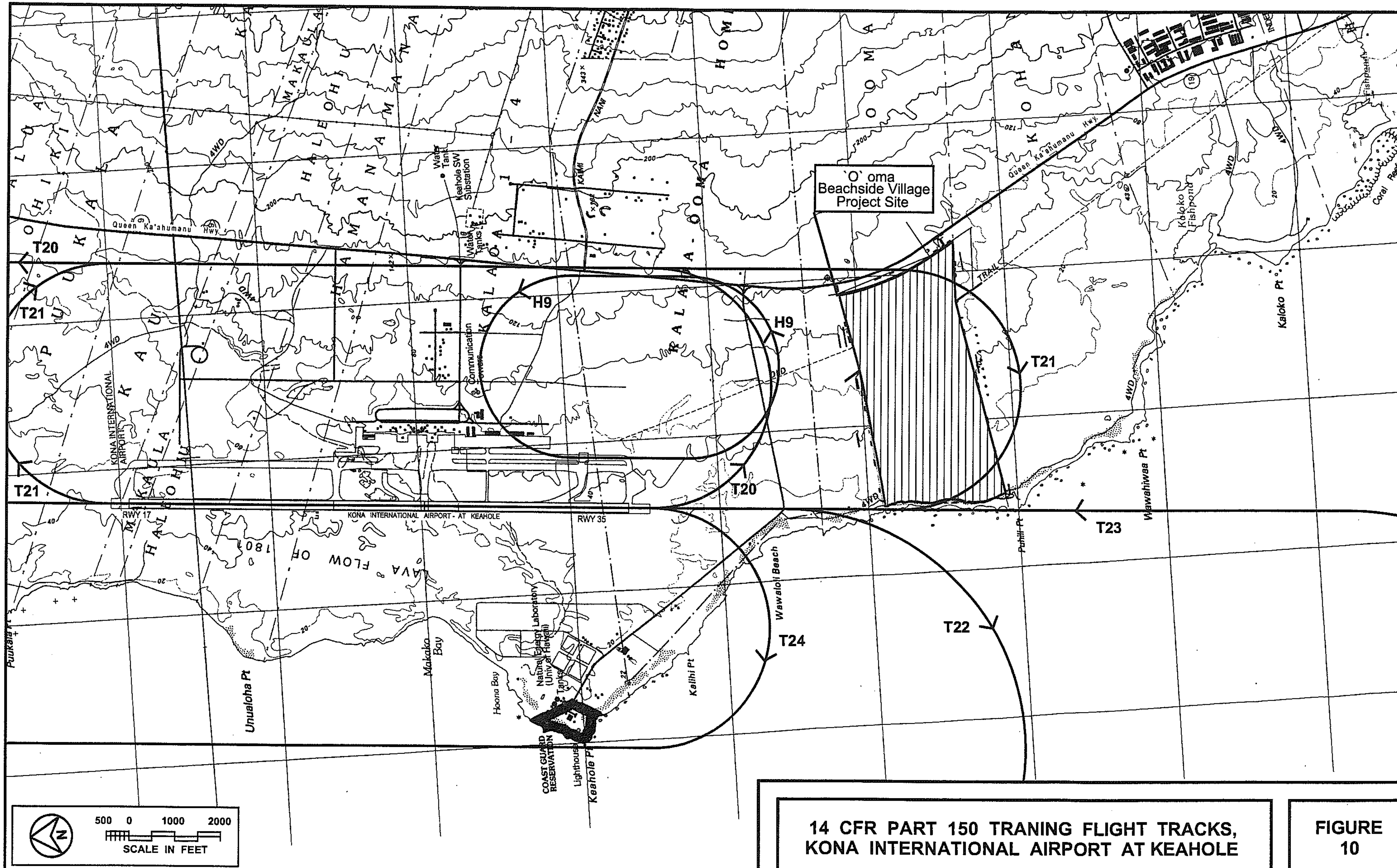
14 CFR PART 150 DEPARTURE FLIGHT TRACKS, KONA INTERNATIONAL AIRPORT AT KEAHOLE

FIGURE 8



14 CFR PART 150 ARRIVAL FLIGHT TRACKS, KONA INTERNATIONAL AIRPORT AT KEAHOLE

FIGURE 9



14 CFR PART 150 TRANING FLIGHT TRACKS, KONA INTERNATIONAL AIRPORT AT KEAHOLE

FIGURE 10

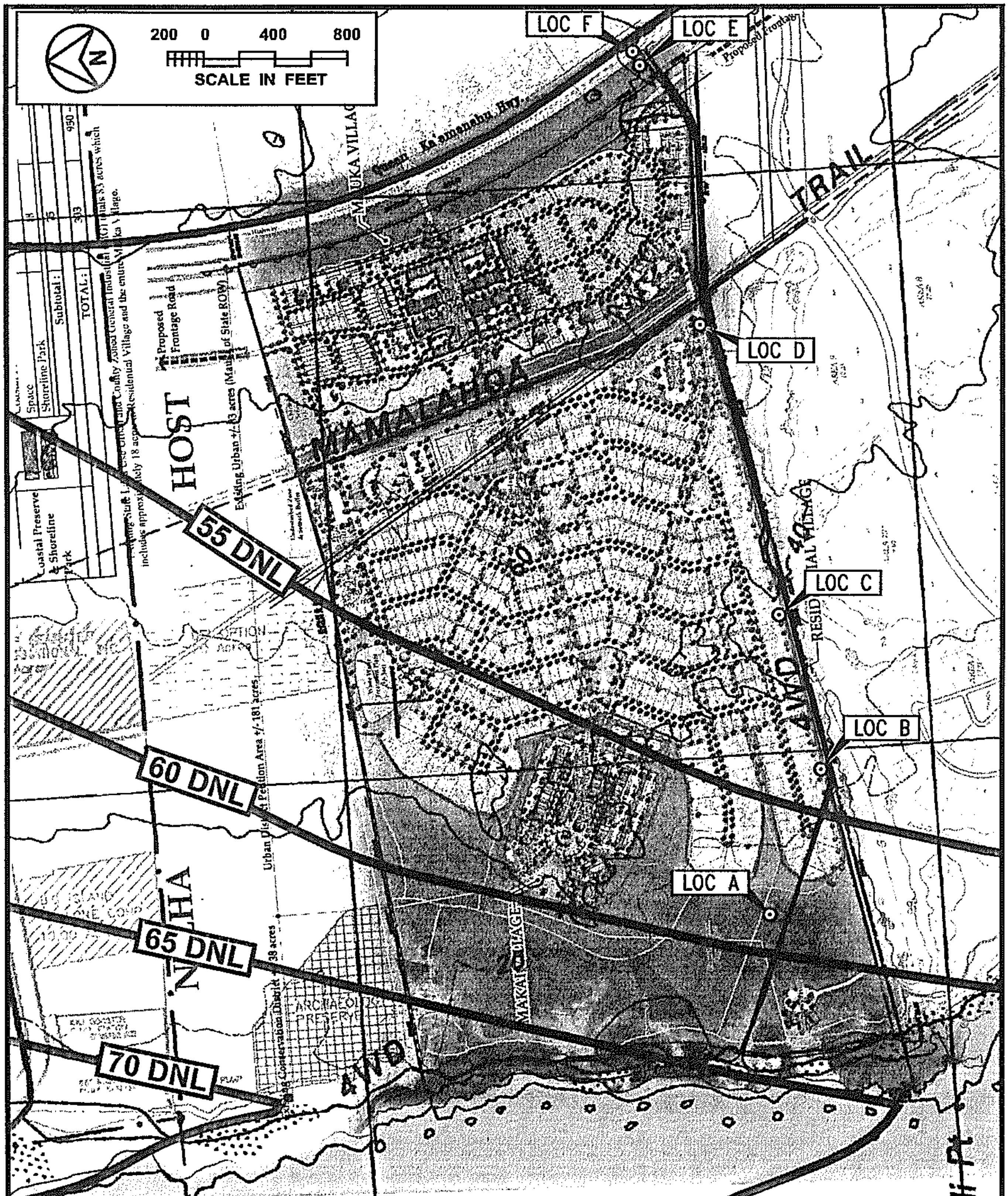
Because of their relatively low altitudes when crossing over the project site, the light fixed and rotary wing aircraft noise levels can be higher than those of the noisier jet aircraft which fly offshore. At measurement Location D, for instance, measured maximum A-Weighted (Lmax) noise levels of helicopter and single engine propeller aircraft overflights ranged from 60 to 83 dB, while the noise levels of offshore aircraft ranged from 60 to 82 dB.

Figure 11 depicts the estimated locations of the 55 through 65 DNL aircraft noise contours over the project site during the CY 2007 period. These noise contours were developed from the 2007/2008 airport operations contained in draft Table 3B of Reference 13. Only the noise from the noisier interisland, overseas, and military aircraft were included in the 2007 study noise contours, since the noise contributions from the general aviation and helicopter aircraft were not significant contributors to the noise contours. From Figure 11, aircraft noise levels over portions of the project site are above 60 DNL, and as such, place some constraints on any noise sensitive land uses on the western portions of the project site. The locations of the 2001 14 CFR Part 150 55 DNL and 60 DNL contours are shown in Figure 5, and their locations are similar to those of the 2007/2008 contours shown in Figure 11.

Figure 12 depicts the HDOTA's latest draft 14 CFR Part 150 Update noise contours for 2007/2008, which were reproduced from Reference 13. It should be noted that it is larger than the estimated study contours shown in Figure 11, and do not cross into the noise sensitive development areas of the `O`oma Beachside Village project site. The differences in the existing noise contour values at noise monitoring Location A between the study contours and the latest draft 14 CFR Part 150 contours are shown in Table 9A, and range from 2 to 3 DNL.

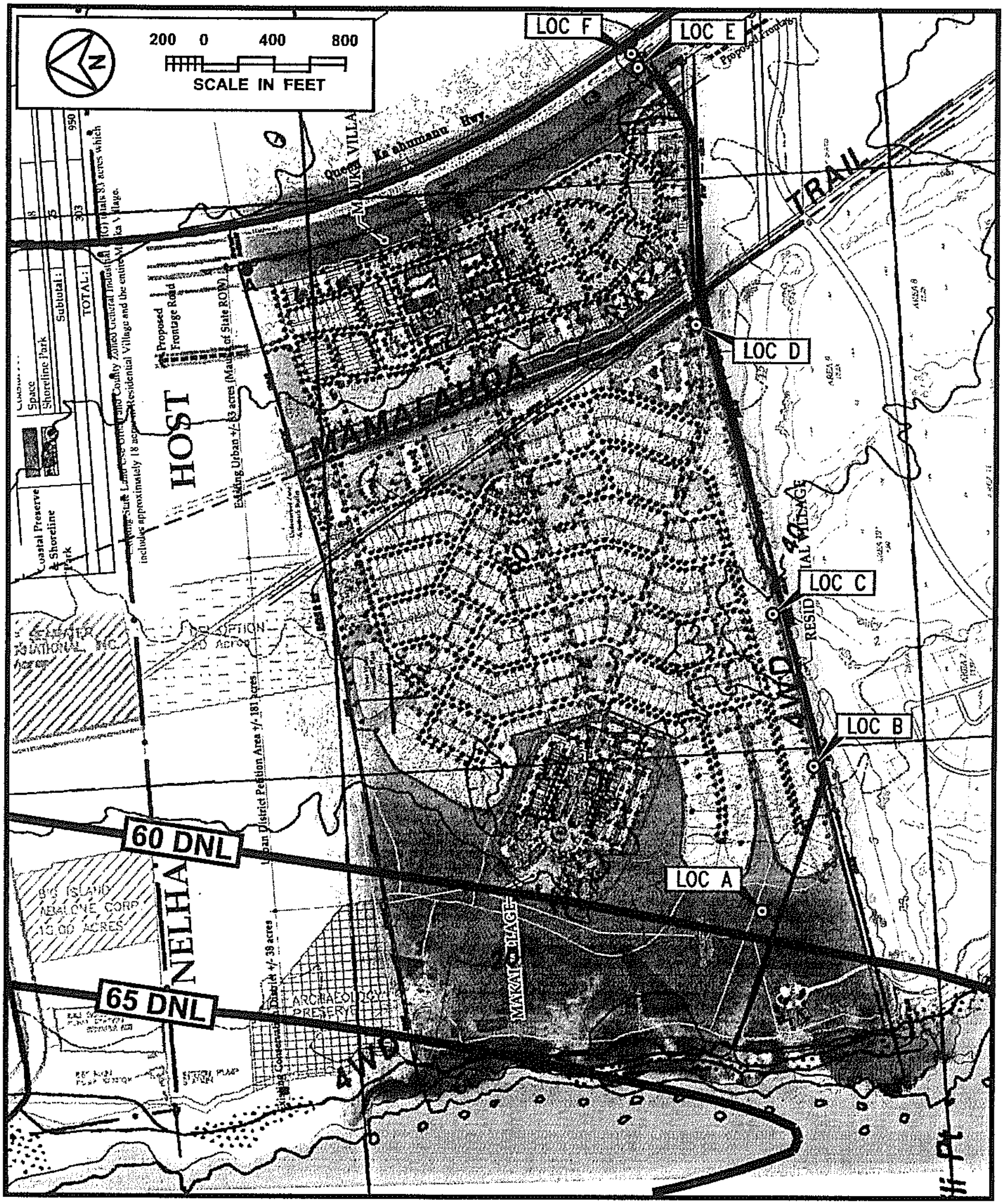
In order to validate the modeled aircraft noise levels over the western portions of the project site, measurements of aircraft noise levels were obtained during the period from March 19 to March 25, 2007. Tables 5 through 8 summarize the results of recent aircraft single event noise measurements on the project site. The locations of the aircraft noise measurement sites are shown in Figure 3. Maximum A-Weighted jet aircraft noise levels (Lmax) were typically between 60 to 88 dB at the aircraft noise measurement sites shown in Figure 3. For the purposes of comparison, typical maximum noise levels of heavy trucks are in the order of 80 to 85 dB at 50 FT distance.

Table 9A compares the measured DNL values (Line #1) at Locations "A" through "D" with those developed by the noise contour models in Figure 5 (Line #2), Figure 11 (Line #3a), and Figure 12 (Line #4). Agreement between the measured and computer model generated DNL values was considered to be good, and reinforced the conclusion that the planned noise sensitive areas of `O`oma Beachside Village are not located within the 60 DNL airport noise contour. The measured 55.8 DNL value shown for Location A represented the 6 day average of all aircraft flyby events which occurred during the monitoring period. Table 5 lists the louder aircraft noise events which occurred during the monitoring period. Based on the comparisons of the measured data with the computer modeled noise levels at Location A, it was concluded that both



ESTIMATED 2007/2008 AIRCRAFT NOISE CONTOURS OVER PROJECT SITE

FIGURE 11



HDOTA'S DRAFT 14 CFR PART 150 UPDATE NOISE CONTOURS FOR 2007/2008 OVER PROJECT SITE

FIGURE 12

this study's modeling results and the HDOTA's modeling results are probably overestimating the actual aircraft noise levels in the vicinity of Location A. These differences are approximately 2.4 DNL for this study's contour modeling, and 5.3 DNL for the HDOTA's modeling. These differences in noise modeling will probably carry forward in the noise modeling of the future noise levels by the FAA INM.

Unusually louder (by as much as 14 dB) aircraft noise events can occur during the nighttime and early morning hours due to thermal ducting effects. Examples of these aircraft noise events are engine thrust reversals during landings on Runways 17 or 35, and start-to-roll takeoff noise during departures on Runway 35. These noise events are typically inaudible during the daytime hours, but can be audible during the nighttime and early morning hours due to thermal ducting effects. An unusually loud noise event (at 70 to 71 dB), which was probably amplified by thermal ducting effects, was measured at Locations "A" and "B" during an early morning north flow departure of the noisier B-737(200) aircraft at 6:34 AM on March 24, 2007.

High, single event, aircraft noise levels over the coastal areas of the project site will occur during north wind conditions when aircraft land from the south onto the airport's Runway 35. Typical maximum noise levels from the noisier B-737(200) jet aircraft are expected to range from 75 to 80 dB. The newer, and quieter B-717(200) jet aircraft are typically quieter, and less than 75 dB. Noise levels from helicopters, fixed wing air taxi, and general aviation aircraft are generally less than 70 dB. Higher noise levels of helicopter and light fixed wing aircraft which exceed 70 dB are also possible during flyovers over the project site.

In the 1997 14 CFR Part 150 program for KOA, those noise sensitive land uses within the 60 DNL contour were considered to be exposed to incompatible levels of aircraft noise. The degree of adverse health and welfare impacts resulting from aircraft noise depends upon the sound attenuation properties of the structures containing the noise sensitive uses. For the purposes of this acoustical impact study, it was assumed that all noise sensitive properties can be considered to be adversely impacted by aircraft noise if they are located within the 60 DNL aircraft noise contour and if they are not specially treated to reduce interior noise levels to 45 DNL or less. Total closure and air conditioning is generally required for structures located within the 60 DNL contour in order to achieve the 45 DNL interior noise criteria.

As shown in Figures 5 and 11, the existing aircraft noise levels over the project site are generally compatible with the proposed land uses. Noise sensitive residential land uses are located outside the 60 DNL contour. By current HDOTA and 14 CFR Part 150 planning guidelines, sound attenuation treatment need not be incorporated into the planned residences of the project because of aircraft noise.

CHAPTER VI. FUTURE NOISE ENVIRONMENT

Traffic Noise. Predictions of future traffic noise levels were made using the traffic volume assignments of Reference 9 for CY 2029 with and without the proposed project. The future assignments of project plus non-project traffic along Queen Kaahumanu Highway, the planned makai Frontage Road, and the project's Entrance Road are shown in Table 12 for the AM and PM peak hours of traffic.

Table 11 summarizes the predicted increases in the future setback distances to the 65 and 75 DNL traffic noise contour lines along Queen Kaahumanu Highway in the project environs and attributable to both project plus non-project traffic in CY 2029. The setback distances in Table 11 do not include the beneficial effects of noise shielding from terrain features and highway cuts, or the detrimental effects of additive contributions of noise from intersecting streets. The setback distances in Table 11 for CY 2029 include the additive effects of the planned highway widening from 2 to 4 lanes. As shown in Table 11, the setback distance to the 65 DNL contour is predicted to be 218 FT from the new baseline of Queen Kaahumanu Highway following project build-out in CY 2029. Along the planned Frontage Road and project Entrance Road, future traffic noise levels are predicted to not exceed 65 DNL at distances of 22 to 50 FT from the roadways' centerlines. Posted and average vehicle speeds of 25 and 35 miles per hour, respectively, were assumed for the Frontage Road and project Entrance Road.

Table 13 presents the predicted increases in traffic noise levels associated with non-project and project traffic along Queen Kaahumanu Highway by CY 2029, and as measured by the Leq descriptor system. As indicated in Table 13, by CY 2029 and following complete project build-out, traffic noise levels on Queen Kaahumanu Highway in the areas fronting the project are predicted to increase by 3.0 to 3.8 Leq(h). This range of increases in traffic noise levels is considered to be moderate, and reflects the growth in forecasted project and non-project traffic in the project environs by CY 2029. As indicated in Table 13, the increases in traffic noise along Queen Kaahumanu Highway due to project traffic are relatively small when compared to those resulting from non-project traffic. Overall, the increases in noise levels associated with project traffic are considered to be insignificant along Queen Kaahumanu Highway. These conclusions apply to sections of Queen Kaahumanu Highway fronting the project as well as to those sections of the highway north and south of the project.

Aircraft Noise. The future aircraft noise contours for the CY 2013 period were developed using the aircraft operational forecasts of Reference 13, existing aircraft flight tracks for the existing runway, and assumed C-17 flight tracks for the new Austere Runway. Because information on the C-17 flight tracks for the new runway were not available from References 11 or 13, and because of the special spiral approach flight tracks mentioned in Reference 11, the C-17 flight tracks assumed for the new runway may not be accurate. However, for noise modeling purposes, the special spiral flight tracks should not result in significant contributions to the aircraft noise contours since

TABLE 12

FUTURE (CY 2029) TRAFFIC VOLUMES AND NOISE LEVELS ALONG VARIOUS ROADWAY SECTIONS (AM AND PM PEAK HOURS, WITH PROJECT)

LOCATION	SPEED (MPH)	TOTAL VPH	********* VOLUMES (VPH) ********** AUTOS	M TRUCKS	H TRUCKS	** Leq(h) @ Dist. from B.L. ** 85' Leq	150' Leq	300' Leq
AM Peak Hour:								
Q. Kaahumanu Hwy. - N. of Entrance Rd.	55	3,530	3,364	74	92	75.7	68.1	60.5
Q. Kaahumanu Hwy. - S. of Entrance Rd.	55	3,575	3,407	75	93	75.8	68.1	60.5
PM Peak Hour:								
Q. Kaahumanu Hwy. - N. of Entrance Rd.	55	3,950	3,879	43	28	75.5	67.7	59.7
Q. Kaahumanu Hwy. - S. of Entrance Rd.	55	3,900	3,830	43	27	75.5	67.7	59.7
						** Leq(h) @ Dist. from B.L. ** 25' Leq	50' Leq	100' Leq
AM Peak Hour:								
Project Entrance Rd. At Q. Kaahumanu	35	435	427	5	3	63.8	60.3	54.8
Frontage Rd. North of Proj. Entrance Rd.	35	380	373	4	3	63.3	59.7	54.2
Frontage Rd. South of Proj. Entrance Rd.	35	335	329	4	2	62.6	59.0	53.6
Project Entrance Rd. W. of Frontage Rd.	35	1,040	1,022	11	7	67.6	64.0	58.5
PM Peak Hour:								
Project Entrance Rd. At Q. Kaahumanu	35	530	520	6	4	64.7	61.1	55.7
Frontage Rd. North of Proj. Entrance Rd.	35	385	378	4	3	63.3	59.7	54.3
Frontage Rd. South of Proj. Entrance Rd.	35	430	422	5	3	63.8	60.2	54.7
Project Entrance Rd. W. of Frontage Rd.	35	965	947	11	7	67.3	63.7	58.2

Notes:

1. Traffic mix during AM Peak Hour on Queen Kaahumanu Hwy.: 95.3% Autos; 2.1% Medium Trucks; and 2.6% Heavy Trucks and Buses.
2. Traffic mix during PM Peak Hour on Queen Kaahumanu Hwy.: 98.2% Autos; 1.1% Medium Trucks; and 0.7% Heavy Trucks and Buses.
3. Traffic mix on Project Entrance and Frontage Road: 98.2% Autos; 1.1% Medium Trucks; and 0.7% Heavy Trucks and Buses.
4. Loose Soil propagation loss factor used.
5. Receptor elevation of 4.92 feet above ground level was assumed.
6. Queen Kaahumanu Highway widened from two to four lanes by 2029.

TABLE 13

CALCULATIONS OF PROJECT AND NON-PROJECT TRAFFIC NOISE CONTRIBUTIONS (CY 2029) (AM AND PM PEAK HOURS)

STREET SECTION	NOISE LEVEL (DB) INCREASE DUE TO: NON-PROJECT TRAFFIC	PROJECT TRAFFIC
AM Peak Hour:		
Q. Kaahumanu Hwy. - N. of Entrance Rd.	2.6	0.4
Q. Kaahumanu Hwy. - S. of Entrance Rd.	2.6	0.4
Q. Kaahumanu Hwy. - N. of Kaiminani Dr.	3.3	0.6
Q. Kaahumanu Hwy. - S. of Kohanaiki	2.8	0.7
PM Peak Hour:		
Q. Kaahumanu Hwy. - N. of Entrance Rd.	3.5	0.3
Q. Kaahumanu Hwy. - S. of Entrance Rd.	3.5	0.2
Q. Kaahumanu Hwy. - N. of Kaiminani Dr.	3.9	0.5
Q. Kaahumanu Hwy. - S. of Kohanaiki	3.0	0.6

they are expected to occur at much larger distances from the ground than the final approach tracks prior to landing.

The future aircraft flight tracks near and over the project site for operations using the existing runway are expected to be similar to the existing flight tracks shown in Figures 8 through 10. Figures 13 and 14 depict the departure and arrival flight tracks, respectively, assumed for the C-17 operations on the proposed new runway. Touch and Go flight tracks T22 and T23 on the existing Runway 17/35 and shown in Figure 10 were assumed for the C-17 military aircraft.

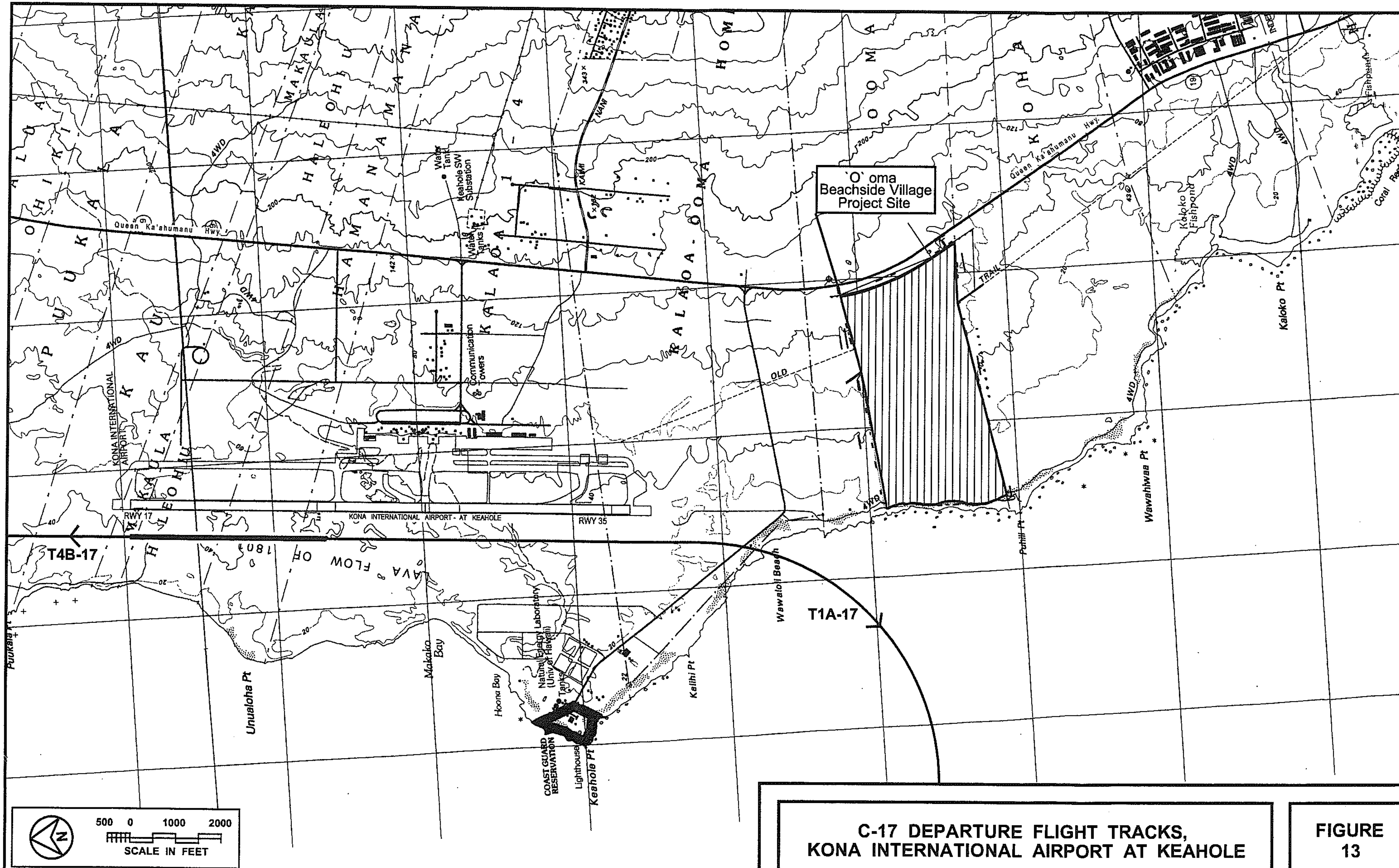
The proposed C-17 operations at KOA were estimated from information provided in the 2004 Environmental Assessment for the site selection of the C-17 Short Austere Airfield, which recommended KOA as the preferred airport (Reference 11). An additional parallel and shorter (4,250 feet long x 90 feet wide) runway is proposed for construction makai of and at the north end of the existing airfield where shown in Figure 6. In addition, forecasts of C-17 operations at KOA with and without the new runway were obtained from Reference 13.

Figure 15 and Line #5a of Table 9B depict this study's estimated 2013 DNL contours and levels associated with the assumed C-17 operations at KOA, which were modeled using the following assumptions:

- 92 landings and 92 takeoffs per month on the new 4,250' runway;
- 92 landings and 92 takeoffs per month on the existing runway;
- 480 landings and 480 takeoffs (touch and go operations) per month on the existing runway; and
- 41 nighttime operations per month during the DNL noise penalty hours from 10:00 PM to 7:00 AM.

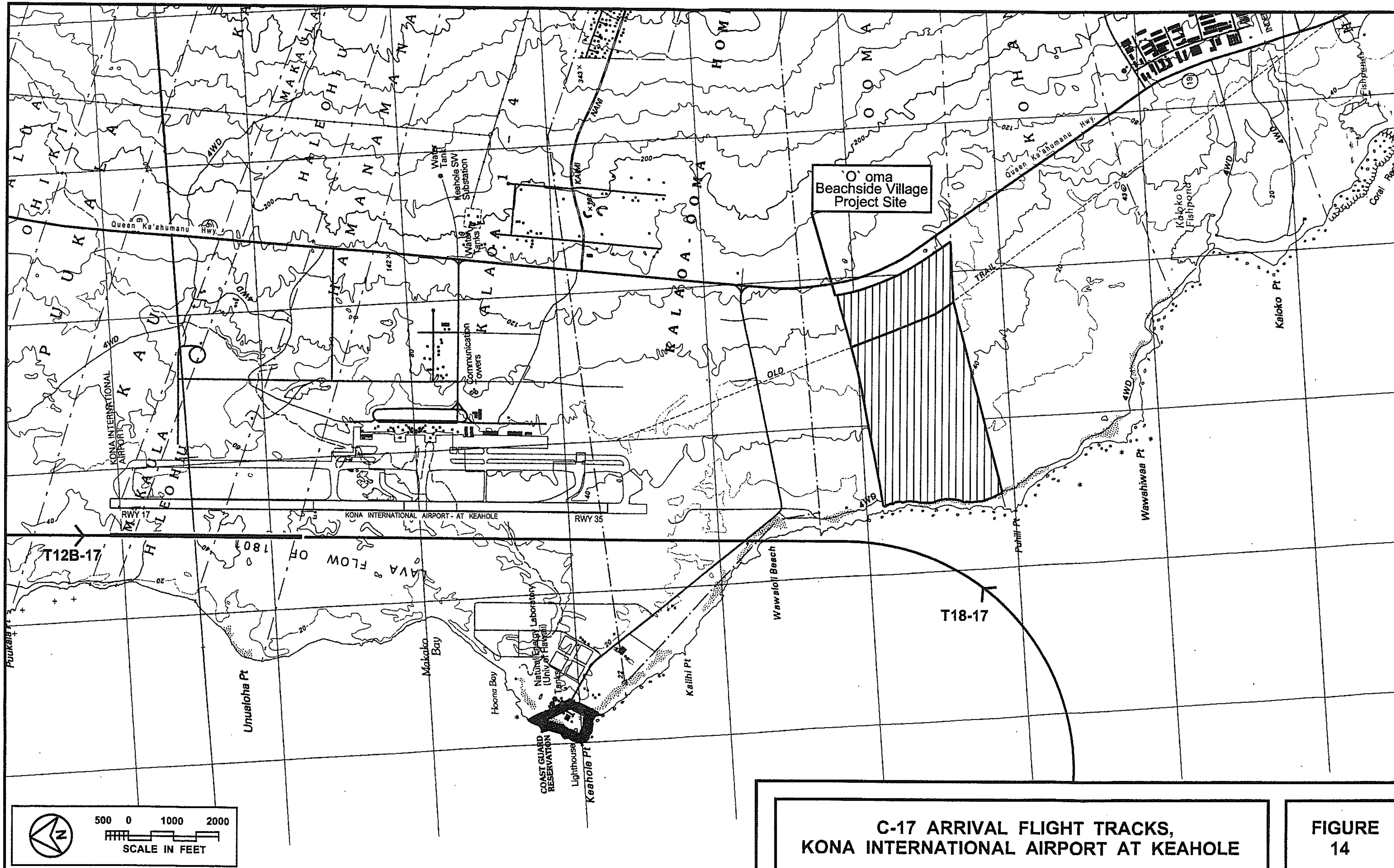
The 480 touch and go operations per month on the existing runway represent worst case assumptions for C-17 noise levels over the `O`oma Beachside Village project site. Figure 15 and Line #5a of Table 9B also include forecast operations of the new F-22A and P-8A aircraft, with the P-8A aircraft operations replacing the P-3C operations on a one-for- one basis. As shown in Figure 15, the 60 DNL contour is expected to remain outside the noise sensitive development area of `O`oma Beachside Village. It should be noted that the noise monitoring data shown in Table 9A indicates that the study's 2007/2008 noise contours of Figure 15 may be overstating actual aircraft noise levels at Location A by 2 DNL units.

Figure 16 and Line #6 of Table 9B depict the HDOTA's latest draft 14 CFR Part 150 Update noise contours for 2013, which were reproduced from Reference 13. It should be noted that it is larger than the estimated study contours shown in Figure 15



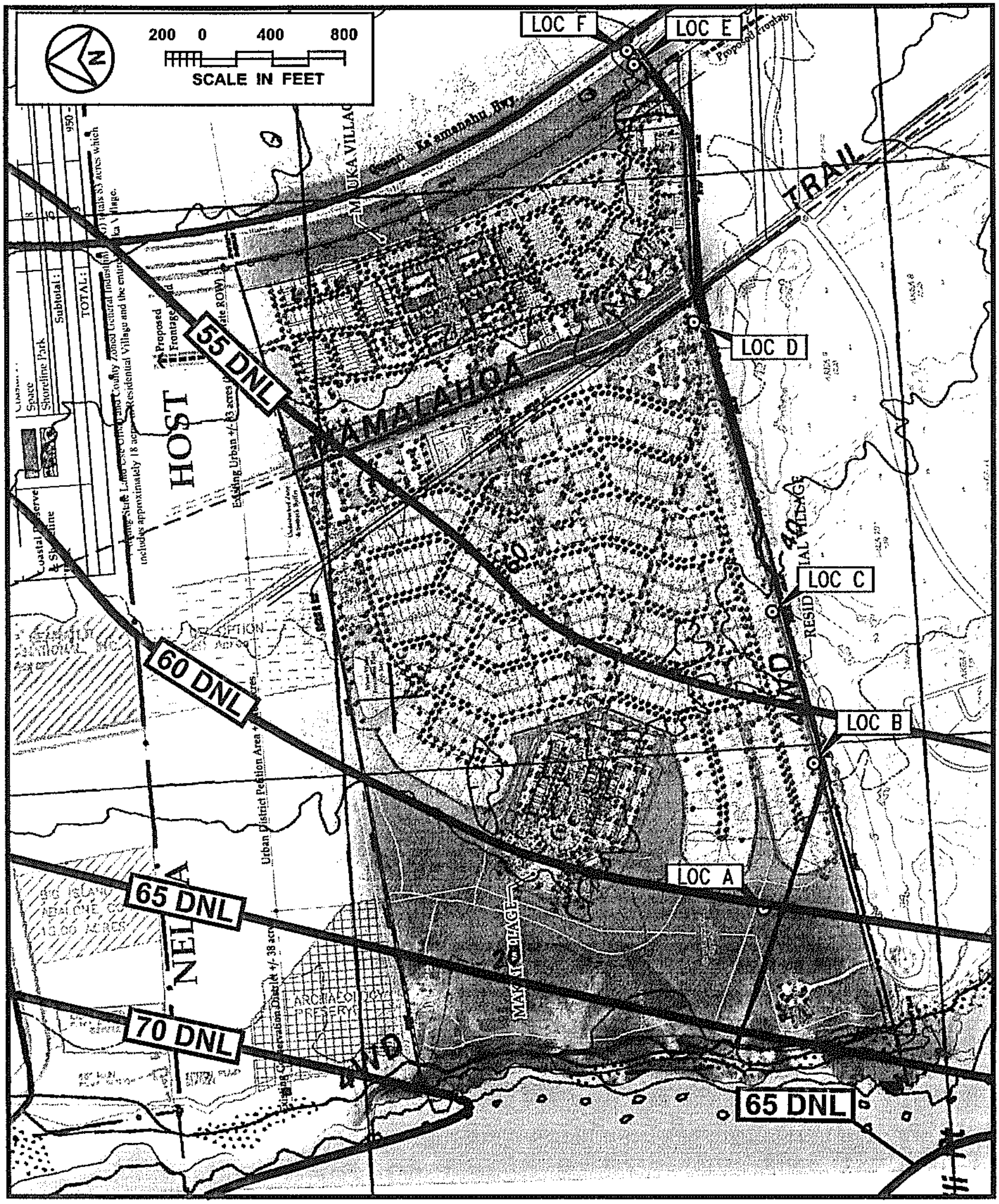
C-17 DEPARTURE FLIGHT TRACKS, KONA INTERNATIONAL AIRPORT AT KEAHOLE

FIGURE 13



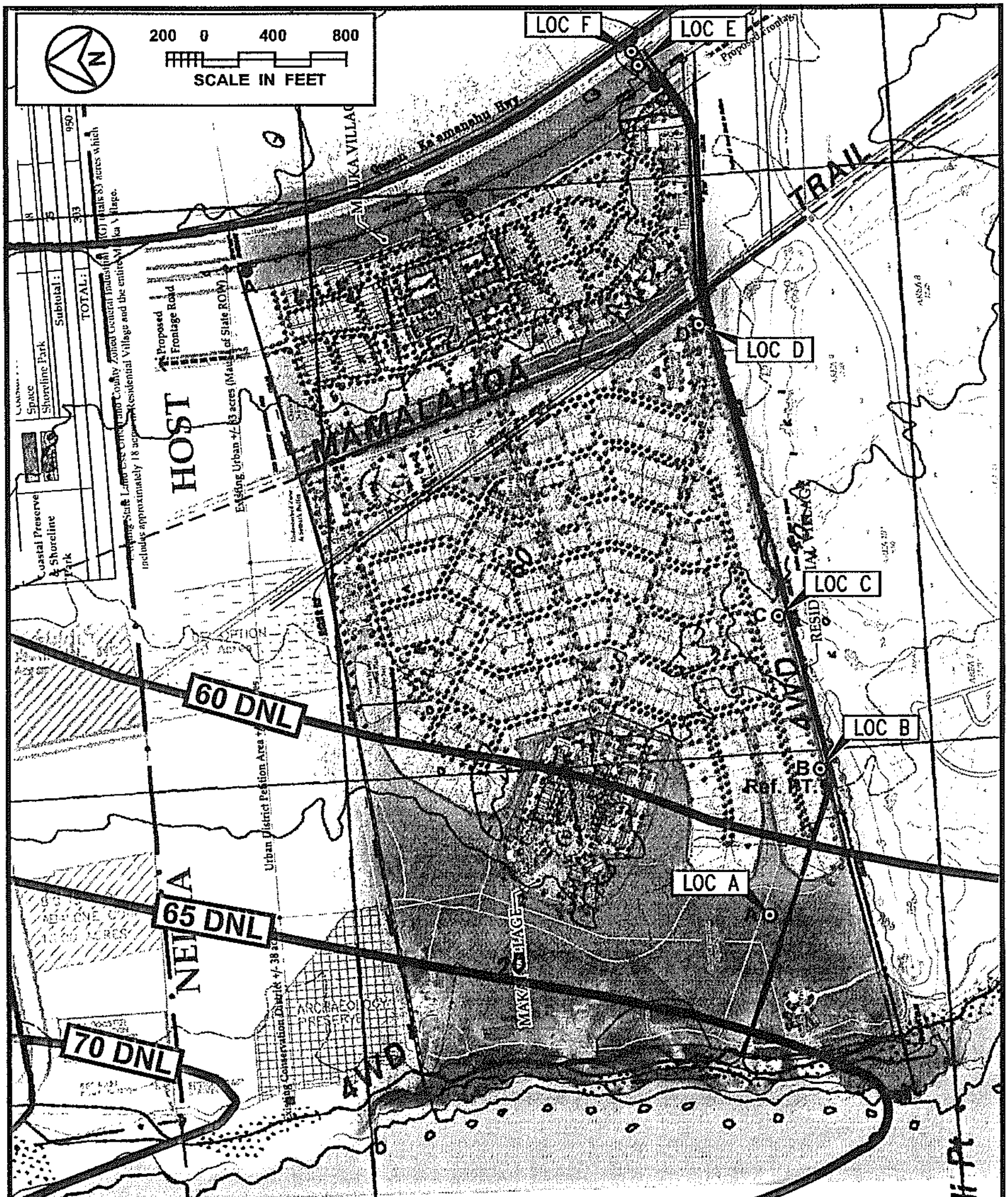
C-17 ARRIVAL FLIGHT TRACKS,
KONA INTERNATIONAL AIRPORT AT KEAHOLE

FIGURE 14



LOCATIONS OF CY 2013 ESTIMATED STUDY CONTOURS

FIGURE 15



HDOTA'S DRAFT 14 CFR PART 150 UPDATE NOISE CONTOURS FOR 2013 OVER PROJECT SITE

FIGURE 16

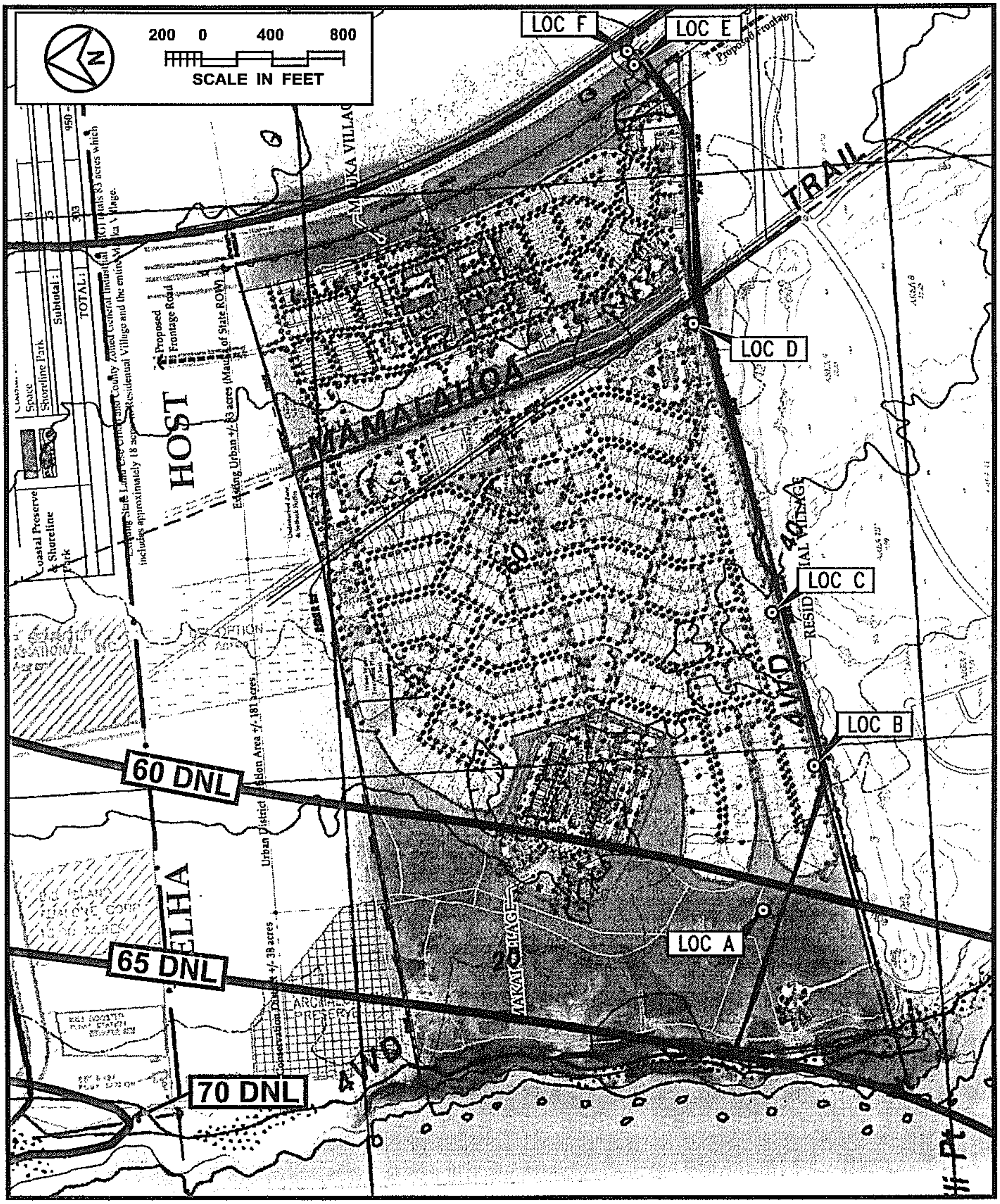
by approximately 2 DNL units, and do cross into the noise sensitive development areas of the `O`oma Beachside Village site. It should be noted, however, that the noise monitoring data shown in Table 9A indicates that the HDOTA's 2007/2008 noise contours may be overstating actual aircraft noise levels at Location A by 5 DNL units.

The future aircraft noise contours in the project environs for the CY 2020 period were developed in 1997 during the prior Master Plan and 14 CFR Part 150 Study Updates for KOA. These airport noise contours are shown in Figure 7, with DNL values at measurement Locations "A" through "D" shown on Line #7 of Table 9B. They do not include the C-17, F-22A, or P-8A operations. These noise contours may still overstate the forecasted aircraft noise levels since they do not include the 100 percent replacement of the noisier DC-9(50) aircraft with the quieter B-717(200) aircraft by Hawaiian Airlines. In addition, the anticipated replacement of all of the noisier B-737(200) aircraft with quieter aircraft by 2020 would also reduce the size of the contours shown in Figure 7. It should be noted that the forecasted 2020 noise contours of Figure 7 were very similar to the 2001 contours shown in Figure 5.

The 2020 noise contours are in the process of being updated by the HDOTA, with the updated contours scheduled for completion within 1 year. Figure 17 is a draft of the 2030 noise contours for KOA from Reference 13, with estimated DNL value shown on Line #8 of Table 9B. The planned noise sensitive developments of `O`ma Beachside Village appear to be clear of the 60 DNL contour except for a few lots in the vicinity of Location A. Figure 18 depicts this study's estimated 2030 noise contours over the project site, which was developed from aircraft operations forecast contained in Reference 13. All aircraft flight tracks were assumed to be identical to those assumed for 2013. Line #9 of Table 9B presents this study's DNL values for 2030 at measurement Locations A through D.

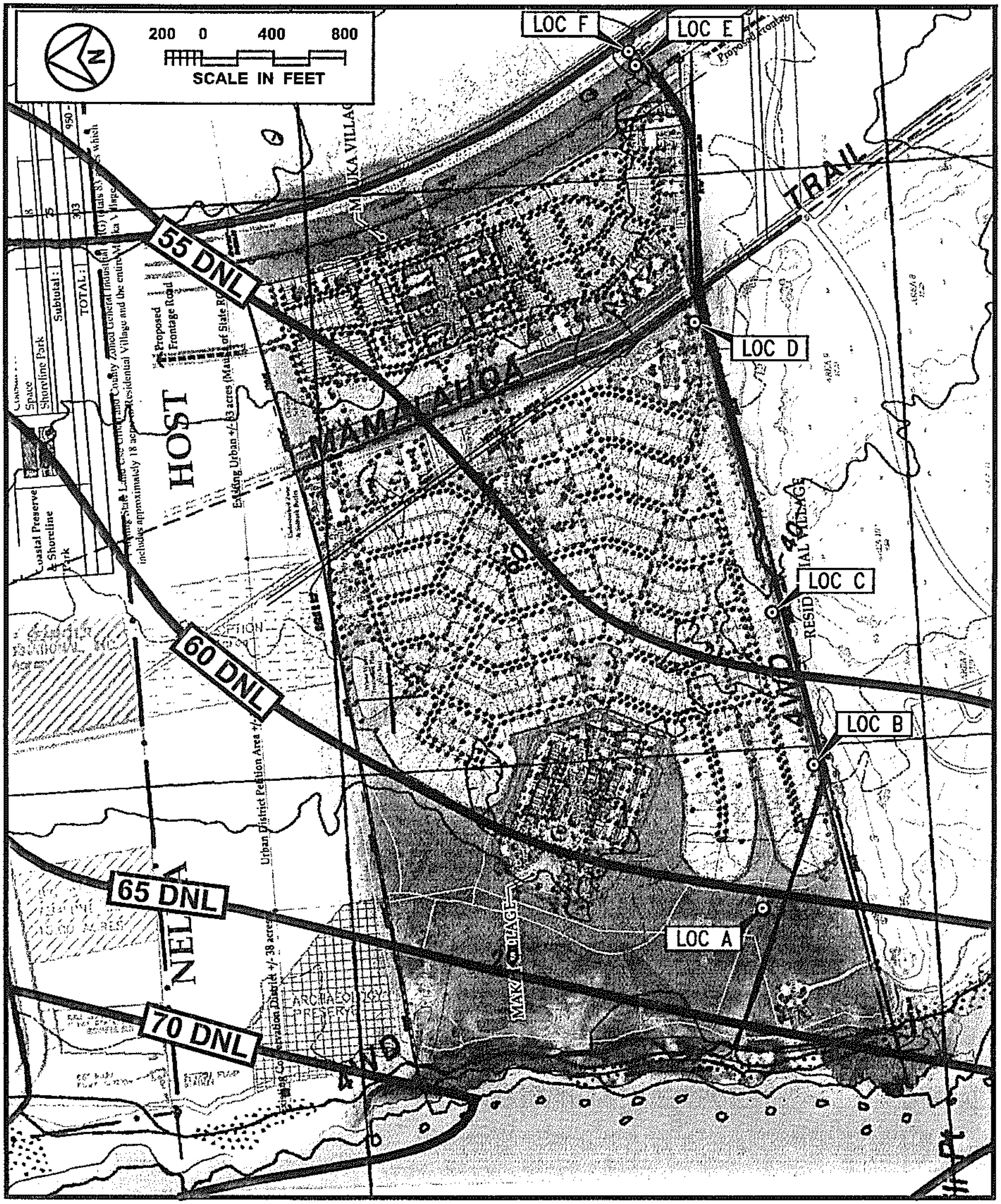
Measurements of C-17 flyby events at Location "A" (see Table 5), Location "B" (see Table 6), and Location "C" (see Table 7) indicate that it is 4 to 6 dB quieter during departures than the B-737(200), 2 to 4 dB noisier than the B-757/B-767 and KC-135R, 4 to 12 dB noisier than the B-717(200) and CRJ 200, and 8 to 9 dB noisier than the P-3C. So, in summary, the C-17 may not be noisiest aircraft operating at KOA and the DNL contours over the `O`oma Beachside Village project site did not increase significantly following inception of C-17 operations at KOA. No noise measurement data were available for the F-22A aircraft, which is similar to the F-15 during departure but approximately 20 dBA noisier during landing. The base conditions for the noise sensitive receptor on the `O`oma Beachside Village project site will worsen in the future in respect to the increased number of audible flyby events, and the greater number of these audible flyby events which occur during the hours of darkness. This will become more significant in 2030 if the noisier B-737(200) are replaced with quieter Stage 3 aircraft, and the C-17 and F-22A may then be included with the noisiest aircraft operating at KOA.

The current forecasts for aircraft noise over the project site indicate that the 60



HDOTA'S DRAFT MASTER PLAN UPDATE NOISE CONTOURS FOR 2030 OVER PROJECT SITE

FIGURE 17



LOCATIONS OF CY 2030 ESTIMATED STUDY CONTOURS

FIGURE 18

DNL contour will not extend into the proposed residential areas of the project site by CY 2030 (see Figures 6, 7, 15, and 18). The draft HDOTA contours (Figures 16 and 17) indicate that the 60 DNL contour crosses into the planned noise sensitive areas of `O`oma Beachside Village. However, the aircraft noise measurement data on the project site indicates that the HDOTA's draft noise contours are overstating the actual noise levels over the project site. Therefore, unless significant changes occur in the operational activity and HDOTA forecasts for KOA, the proposed `O`oma Beachside Village project is expected to be compatible with the aircraft noise levels associated with operations at KOA.

The HDOTA's future noise contours may change as the 14 CFR Part 150 Update Report is finalized because of issues related to the assumed aircraft flight tracks, the nighttime runway use frequencies, the proposed austere runway for the C-17, and the forecast methodology used for military operations.

CHAPTER VII. DISCUSSION OF PROJECT RELATED NOISE IMPACTS AND POSSIBLE NOISE MITIGATION MEASURES

Traffic Noise. The increases in traffic noise levels attributable to the project from the present to CY 2029 are predicted to range from 0.2 to 0.7 DNL along Queen Kaahumanu Highway, where traffic noise levels are expected to be above 65 DNL along the highway Right-of-Way. These increases in traffic noise levels along Queen Kaahumanu Highway which are attributable to the project are considered to be in the insignificant category, and are much smaller than the traffic noise increases expected as a result of non-project traffic. These increases will be difficult to measure or perceive over the duration of the 23 year forecast period. In addition, the lands along the highway Right-of-Way are generally vacant in the project environs. For these reasons, traffic noise impacts along Queen Kaahumanu Highway and resulting from project traffic are not considered to be serious. However, setback distances to the 65 DNL contour are expected to increase as a result of both project and non-project traffic.

Because of the relatively high noise levels along Queen Kaahumanu Highway and the planned widening of the highway toward the makai direction, a 150 foot wide buffer is planned for `O`oma Beachside Village. This buffer will be an effective traffic noise mitigation measure, and will keep future traffic noise levels from exceeding the 65 DNL FHA/HUD noise standard in 2029. Predicted traffic noise levels in 2029 along the first row of project structures fronting the highway are expected to range from approximately 60 DNL for ground level receptors to approximately 59 to 63 DNL for 2nd and 3rd floor receptors. Closure and air conditioning of the structures is a typical means of sound attenuation for traffic noise, and particularly at the upper floors, which are difficult to sound attenuate with berms or exterior sound walls. The first row of structures will provide 5 to 10 dB of sound attenuation for receptors along the second row and beyond, as long as they block the visual lines of sight between the highway lanes and the receptors' ears.

Traffic noise levels along the makai Frontage Road could exceed the FHA/HUD standard of 65 DNL. Setback distances to the 65 DNL traffic noise contour are predicted to be between 22 and 24 FT from the centerline of the Frontage Road in the vicinity of the `O`oma Beachside Village entrance road from Queen Kaahumanu Highway. Future traffic noise mitigation measures may be required at noise sensitive dwellings along the Frontage Road.

Because traffic noise along public roadways such as Queen Kaahumanu Highway are generated by non-project as well as project traffic, mitigation of offsite traffic noise impacts are generally performed by individual property owners along the roadways' Rights-of-Way or by public agencies during roadway improvement projects. These mitigation measures generally take the form of increased setbacks, sound attenuating walls, total closure and air conditioning, or the use of sound attenuating windows. Where adequate setbacks beyond the 65 DNL noise contour are not available, the construction of 6 FT high sound walls is generally effective for attenuating traffic noise at single story structures, or at the ground floors of multistory structures.

Whenever mitigation of traffic noise at the upper floors are required, the use of closure and air conditioning, or the use of sound attenuating windows are the more appropriate sound attenuation measures.

Aircraft Noise. Based on existing and forecasted aircraft noise contours (when adjusted for measured aircraft noise levels) over the project site, special aircraft noise attenuation measures are not considered mandatory on the project site. The implementation of the airport noise disclosure provisions of Reference 5 will be required because the existing and forecasted 14 CFR Part 150 noise contours do enter into the project area.

The siting of future noise sensitive developments within the 60 DNL airport noise contour is not recommended by HDOTA. Residences, schools, churches, health centers, day-care centers, and hotels are included within the noise sensitive land use category. The rationale for selection of the 60 DNL threshold is more fully discussed in Reference 7. By the rationale expressed in the current 14 CFR Part 150 study update (Reference 13), HDOTA has shifted its 14 CFR Part 150 aircraft noise mitigation threshold upward to 65 DNL, while retaining its prior recommendation for noise sensitive development outside the 60 DNL contour. Therefore, the HDOTA is essentially applying a double noise standard, which is 5 DNL units more stringent for the land side community (such as the `O`oma Beachside Village project) than it is for the air side community (such as the airport proprietor).

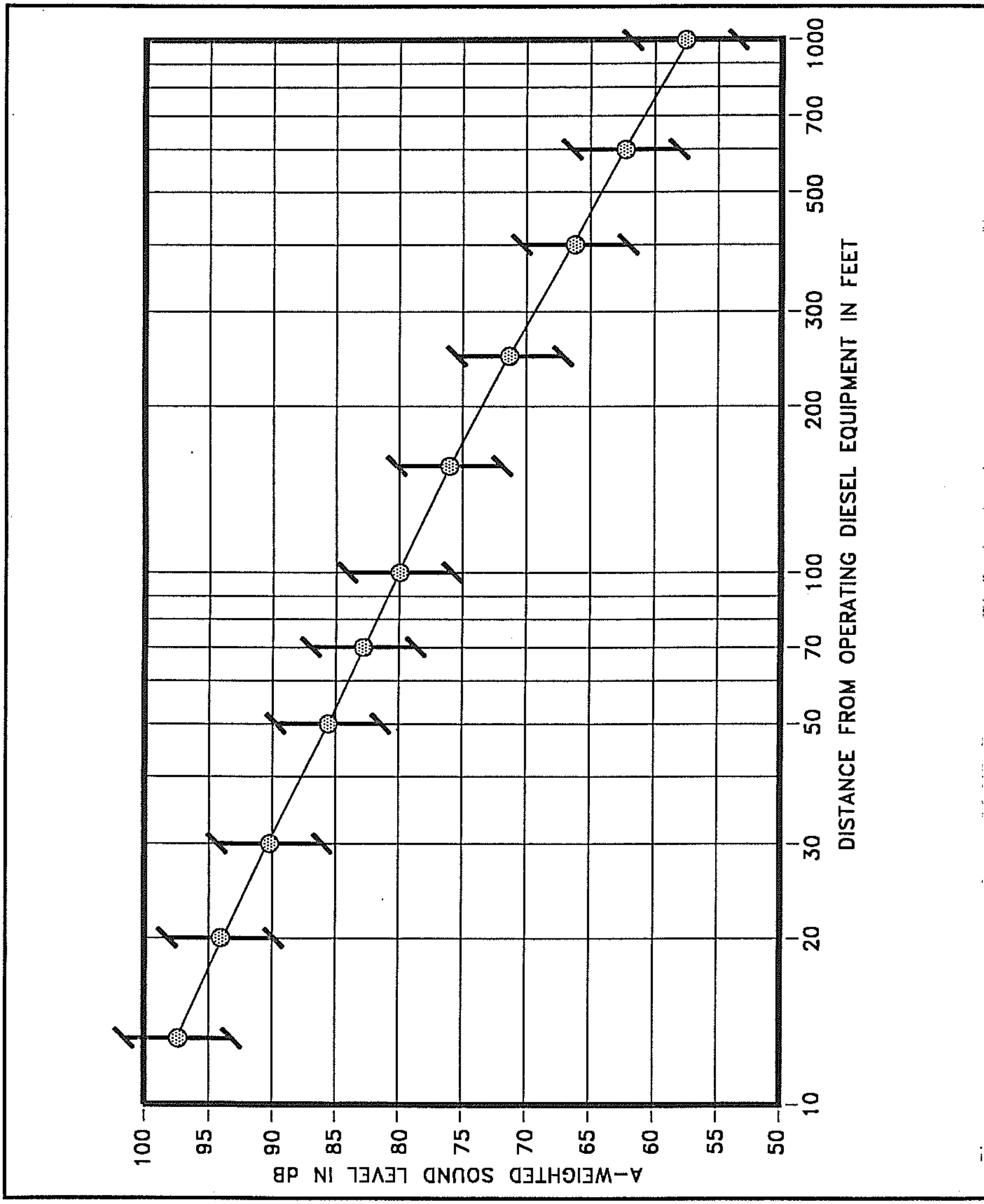
The siting of commercial uses within the 60 DNL contour is acceptable, since closure and air conditioning of commercial spaces is the rule rather than an exception. The siting of recreational uses within the 60 DNL contour is also acceptable. The siting of these types of uses within the high noise areas around an airport is usually encouraged, since it tends to preclude future development of noise sensitive uses on the same lands.

By siting planned noise sensitive uses outside the existing and forecasted 60 DNL noise contours for KOA, risks of adverse aircraft noise impacts have been reduced to acceptable levels. The noise contour disclosure provisions of Reference 5 must be applied over all project lands which are located within the aircraft noise contours developed by HDOTA during a 14 CFR Part 150 Noise Compatibility Program. Currently, and until they are officially updated, the 2001 contours (see Figure 5) are the applicable noise contours for disclosure purposes in accordance with Reference 5. Because the draft 14 CFR Part 150 noise contours (see Figure 16) do not include the outermost 55 DNL contour, the lands subject to aircraft noise disclosure will be less than those shown in the 2001 contours (see Figure 5).

Combined Traffic and Aircraft Noise. When applying for FHA/HUD financial assistance on residential developments, sound attenuation measures are normally required if total exterior noise levels exceed 65 DNL. Traffic noise levels may exceed 65 DNL along the highway corridors and major thoroughfares which service the project. If the traffic noise level equals 65 DNL and the aircraft noise level equals 60 DNL at a project dwelling, the total noise level will be 66 DNL, which exceeds the FHA/HUD standard of 65 DNL. However, existing and forecasted aircraft noise levels over the project site should not exceed 60 DNL. Under these more favorable conditions with aircraft noise levels less than 60 DNL, combined traffic and aircraft noise levels should not exceed 65 DNL when traffic noise levels are less than 63.3 DNL. With aircraft noise levels less than 55 DNL, combined traffic and aircraft noise levels should not exceed 65 DNL when traffic noise levels are less than 64.5 DNL. At the first row of structures fronting Queen Kaahumanu Highway, where predicted future traffic noise levels do not exceed 63 DNL, the combined traffic and aircraft noise levels will not exceed 65 DNL as long as the aircraft noise level at these front row structures does not exceed 60.7 DNL. As shown in Figures 11, 15, and 18, the aircraft noise level at these front row structures does not exceed 60.7 DNL, so the combined traffic plus aircraft noise levels should not exceed the 65 DNL FHA/HUD standard along the first row of homes which front Queen Kaahumanu Highway.

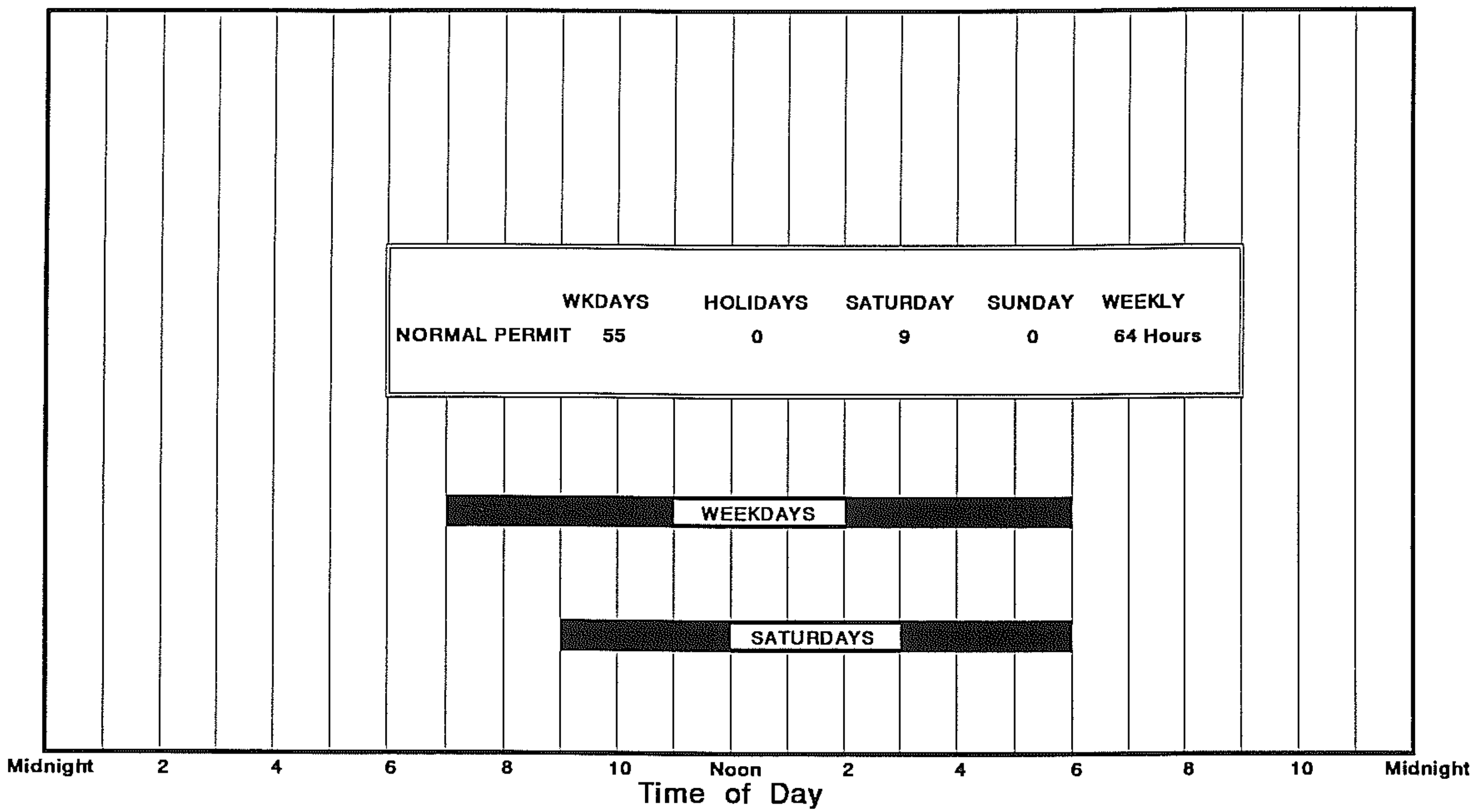
Construction Noise. Audible construction noise will probably be unavoidable during the entire project construction period. It is anticipated that the actual work will be moving from one location on the project site to another during the construction period. Actual length of exposure to construction noise at any receptor location will probably be less than the total construction period for the entire project. Typical levels of noise from construction activity (excluding pile driving activity) are shown in Figure 19. The noise sensitive properties which are predicted to experience the highest noise levels during construction activities on the project site are the future residences south of the project site. Adverse impacts from construction noise are not expected to be in the "public health and welfare" category due to the temporary nature of the work and due to the administrative controls available for its regulation. Instead, these impacts will probably be limited to the temporary degradation of the quality of the acoustic environment in the immediate vicinity of the project site.

Mitigation of construction noise to inaudible levels will not be practical in all cases due to the intensity of construction noise sources (80 to 90+ dB at 50 FT distance), and due to the exterior nature of the work (grading and earth moving, trenching, concrete pouring, hammering, etc.). The use of properly muffled construction equipment should be required on the job site. The incorporation of State Department of Health construction noise limits and curfew times, which are applicable on the island of Hawaii (Reference 6), is another noise mitigation measure which will be applied to this project. Figure 20 depicts the normally permitted hours of construction for normal construction noise as well as the curfew periods for construction noise. Noisy construction activities are not allowed on Sundays and holidays under the DOH permit procedures.



ANTICIPATED RANGE OF CONSTRUCTION NOISE LEVELS VS. DISTANCE

FIGURE 19



AVAILABLE WORK HOURS UNDER DOH PERMIT PROCEDURES FOR CONSTRUCTION NOISE

FIGURE 20

APPENDIX A. REFERENCES

(1) "Guidelines for Considering Noise in Land Use Planning and Control;" Federal Interagency Committee on Urban Noise; June 1980.

(2) American National Standard, "Sound Level Descriptors for Determination of Compatible Land Use," ANSI S12.9-1998/ Part 5; Acoustical Society of America.

(3) "Environmental Criteria and Standards, Noise Abatement and Control, 24 CFR, Part 51, Subpart B;" U.S. Department of Housing and Urban Development; July 12, 1979.

(4) "Information on Levels of Environmental Noise Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety;" U.S. Environmental Protection Agency; EPA 550/9-74- 004; March 1974.

(5) "Mandatory Seller Disclosures in Real Estate Transactions;" Chapter 508D, Hawaii Revised Statutes; July 1, 1996.

(6) "Title 11, Administrative Rules, Chapter 46, Community Noise Control;" Hawaii State Department of Health; September 23, 1996.

(7) "FAR Part 150 Noise Compatibility Program Report; Kona International Airport At Keahole" State Department of Transportation, Airports Division; December 1997.

(8) "FHWA Highway Traffic Noise Model User's Guide;" FHWA-PD-96-009, Federal Highway Administration; Washington, D.C.; January 1998 and Version 2.5 Upgrade (April 14, 2004).

(9) "Draft Traffic Impact Analysis Report; O`oma Beachside Village;" M & E Pacific, Inc.; April 2008.

(10) 24-Hour Traffic Counts, Station B71001909280, Queen Kaahumanu Highway Between OTEC Access Road and Hulikoa Street at 95 Milepost; State Department of Transportation; May 30, 2006.

(11) "Final Environmental Assessment for the C-17 Short Austere Airfield, Hickam Air Force Base, Hawaii;" Department of the Air Force, USA; October 2004.

(12) "Environmental Assessment for the Replacement of F-15 Aircraft with F-22A Aircraft, Hickam AFB, Hawaii; Hawaii Air National Guard; September 2007.

(13) Drafts of 14 CFR Part 150 Noise Compatibility Study Update, KOA; Hawaii State Department of Transportation, Airports Division; July 2007 to March 2008.

APPENDIX A. REFERENCES (CONTINUED)

(14) July 19, 2007 letter to Hawaii State Department of Transportation, Airports Division from Y. Ebisu & Associates requesting copy of draft INM 7.0 modeling input file for KOA 2007.

(15) August 10, 2007 letter to Hawaii State Department of Transportation, Airports Division from Y. Ebisu & Associates with critiques of Draft 14 CFR Part 150 noise study report for KOA.

APPENDIX B

EXCERPTS FROM EPA'S ACOUSTIC TERMINOLOGY GUIDE

Descriptor Symbol Usage

The recommended symbols for the commonly used acoustic descriptors based on A-weighting are contained in Table I. As most acoustic criteria and standards used by EPA are derived from the A-weighted sound level, almost all descriptor symbol usage guidance is contained in Table I.

Since acoustic nomenclature includes weighting networks other than "A" and measurements other than pressure, an expansion of Table I was developed (Table II). The group adopted the ANSI descriptor-symbol scheme which is structured into three stages. The first stage indicates that the descriptor is a level (i.e., based upon the logarithm of a ratio), the second stage indicates the type of quantity (power, pressure, or sound exposure), and the third stage indicates the weighting network (A, B, C, D, E.....). If no weighting network is specified, "A" weighting is understood. Exceptions are the A-weighted sound level and the A-weighted peak sound level which require that the "A" be specified. For convenience in those situations in which an A-weighted descriptor is being compared to that of another weighting, the alternative column in Table II permits the inclusion of the "A". For example, a report on blast noise might wish to contrast the LCdn with the LAdn.

Although not included in the tables, it is also recommended that "Lpn" and "LepN" be used as symbols for perceived noise levels and effective perceived noise levels, respectively.

It is recommended that in their initial use within a report, such terms be written in full, rather than abbreviated. An example of preferred usage is as follows:

The A-weighted sound level (LA) was measured before and after the installation of acoustical treatment. The measured LA values were 85 and 75 dB respectively.

Descriptor Nomenclature

With regard to energy averaging over time, the term "average" should be discouraged in favor of the term "equivalent". Hence, Leq, is designated the "equivalent sound level". For Ld, Ln, and Ldn, "equivalent" need not be stated since the concept of day, night, or day-night averaging is by definition understood. Therefore, the designations are "day sound level", "night sound level", and "day-night sound level", respectively.

The peak sound level is the logarithmic ratio of peak sound pressure to a reference pressure and not the maximum root mean square pressure. While the latter is the maximum sound pressure level, it is often incorrectly labelled peak. In that sound level meters have "peak" settings, this distinction is most important.

"Background ambient" should be used in lieu of "background", "ambient", "residual", or "indigenous" to describe the level characteristics of the general background noise due to the contribution of many unidentifiable noise sources near and far.

With regard to units, it is recommended that the unit decibel (abbreviated dB) be used without modification. Hence, DBA, PNdB, and EPNdB are not to be used. Examples of this preferred usage are: the Perceived Noise Level (Lpn was found to be 75 dB. Lpn = 75 dB). This decision was based upon the recommendation of the National Bureau of Standards, and the policies of ANSI and the Acoustical Society of America, all of which disallow any modification of bel except for prefixes indicating its multiples or submultiples (e.g., deci).

Noise Impact

In discussing noise impact, it is recommended that "Level Weighted Population" (LWP) replace "Equivalent Noise Impact" (ENI). The term "Relative Change of Impact" (RCI) shall be used for comparing the relative differences in LWP between two alternatives.

Further, when appropriate, "Noise Impact Index" (NII) and "Population Weighed Loss of Hearing" (PHL) shall be used consistent with CHABA Working Group 69 Report Guidelines for Preparing Environmental Impact Statements (1977).

TABLE I

A-WEIGHTED RECOMMENDED DESCRIPTOR LIST

	TERM	SYMBOL
1.	A-Weighted Sound Level	L_A
2.	A-Weighted Sound Power Level	L_{WA}
3.	Maximum A-Weighted Sound Level	L_{max}
4.	Peak A-Weighted Sound Level	L_{Apk}
5.	Level Exceeded x% of the Time	L_x
6.	Equivalent Sound Level	L_{eq}
7.	Equivalent Sound Level over Time (T) (1)	$L_{eq(T)}$
8.	Day Sound Level	L_d
9.	Night Sound Level	L_n
10.	Day-Night Sound Level	L_{dn}
11.	Yearly Day-Night Sound Level	$L_{dn(Y)}$
12.	Sound Exposure Level	L_{SE}

(1) Unless otherwise specified, time is in hours (e.g. the hourly equivalent level is $L_{eq(1)}$). Time may be specified in non-quantitative terms (e.g., could be specified a $L_{eq(WASH)}$ to mean the washing cycle noise for a washing machine).

SOURCE: EPA ACOUSTIC TERMINOLOGY GUIDE, BNA 8-14-78,

APPENDIX B (CONTINUED)

TABLE II

RECOMMENDED DESCRIPTOR LIST

	TERM	A-WEIGHTING	ALTERNATIVE[1] A-WEIGHTING	OTHER[2] WEIGHTING	UNWEIGHTED
1.	Sound (Pressure)[3] Level	L_A	L_{pA}	L_B, L_{pB}	L_p
2.	Sound Power Level	L_{WA}		L_{WB}	L_W
3.	Max. Sound Level	L_{max}	L_{Amax}	L_{Bmax}	L_{pmax}
4.	Peak Sound (Pressure) Level	L_{Apk}		L_{Bpk}	L_{pk}
5.	Level Exceeded x% of the Time	L_x	L_{Ax}	L_{Bx}	L_{px}
6.	Equivalent Sound Level	L_{eq}	L_{Aeq}	L_{Beq}	L_{peq}
7.	Equivalent Sound Level (4) Over Time(T)	$L_{eq(T)}$	$L_{Aeq(T)}$	$L_{Beq(T)}$	$L_{peq(T)}$
8.	Day Sound Level	L_d	L_{Ad}	L_{Bd}	L_{pd}
9.	Night Sound Level	L_n	L_{An}	L_{Bn}	L_{pn}
10.	Day-Night Sound Level	L_{dn}	L_{Adn}	L_{Bdn}	L_{pdn}
11.	Yearly Day-Night Sound Level	$L_{dn(Y)}$	$L_{Adn(Y)}$	$L_{Bdn(Y)}$	$L_{pdn(Y)}$
12.	Sound Exposure Level	L_S	L_{SA}	L_{SB}	L_{Sp}
13.	Energy Average Value Over (Non-Time Domain) Set of Observations	$L_{eq(e)}$	$L_{Aeq(e)}$	$L_{Beq(e)}$	$L_{peq(e)}$
14.	Level Exceeded x% of the Total Set of (Non-Time Domain) Observations	$L_{x(e)}$	$L_{Ax(e)}$	$L_{Bx(e)}$	$L_{px(e)}$
15.	Average L_x Value	L_x	L_{Ax}	L_{Bx}	L_{px}

(1) "Alternative" symbols may be used to assure clarity or consistency.

(2) Only B-weighting shown. Applies also to C,D,E,.....weighting.

(3) The term "pressure" is used only for the unweighted level.

(4) Unless otherwise specified, time is in hours (e.g., the hourly equivalent level is Leq(1). Time may be specified in non-quantitative terms (e.g., could be specified as Leq(WASH) to mean the washing cycle noise for a washing machine.

APPENDIX C

SUMMARY OF BASE YEAR AND FUTURE YEAR TRAFFIC VOLUMES

ROADWAY LANES	**** CY 2006 ***** AM VPH	PM VPH	CY 2029 (NO BUILD) AM VPH	PM VPH	CY 2029 (BUILD) AM VPH	PM VPH
Q. Kaahumanu Hwy. - N. of Entrance Rd. (NB)	915	830	1,785	1,515	1,890	1,500
Q. Kaahumanu Hwy. - N. of Entrance Rd. (SB)	865	825	1,445	2,175	1,640	2,450
Two-Way	1,780	1,655	3,230	3,690	3,530	3,950
Q. Kaahumanu Hwy. - S. of Entrance Rd. (NB)	915	830	1,785	1,515	1,890	1,500
Q. Kaahumanu Hwy. - S. of Entrance Rd. (SB)	865	825	1,445	2,175	1,685	2,400
Two-Way	1,780	1,655	3,230	3,690	3,575	3,900
Proj. Entrance Road At Q. Kaahumanu Hwy. (EB)	N/A	N/A	N/A	N/A	240	240
Proj. Entrance Road At Q. Kaahumanu Hwy. (WB)	N/A	N/A	N/A	N/A	195	290
Two-Way	N/A	N/A	N/A	N/A	435	530
Makai Frontage Rd. - N. of Entrance Rd. (NB)	N/A	N/A	45	25	345	335
Makai Frontage Rd. - N. of Entrance Rd. (SB)	N/A	N/A	10	20	35	50
Two-Way	N/A	N/A	55	45	380	385
Makai Frontage Rd. - S. of Entrance Rd. (NB)	N/A	N/A	45	25	265	340
Makai Frontage Rd. - S. of Entrance Rd. (SB)	N/A	N/A	10	20	70	90
Two-Way	N/A	N/A	55	45	335	430
Proj. Entrance Road W. of Frontage Rd. (EB)	N/A	N/A	N/A	N/A	600	620
Proj. Entrance Road W. of Frontage Rd. (SB)	N/A	N/A	N/A	N/A	440	345
Two-Way	N/A	N/A	N/A	N/A	1,040	965
Q. Kaahumanu Hwy. - N. of Kaiminani Dr. (NB)	805	530	1,860	1,460	2,100	1,665
Q. Kaahumanu Hwy. - N. of Kaiminani Dr. (SB)	520	990	1,005	2,305	1,185	2,570
Two-Way	1,325	1,520	2,865	3,765	3,285	4,235
Q. Kaahumanu Hwy. - S. of Kohanaiki (NB)	915	830	1,795	1,600	2,100	1,870
Q. Kaahumanu Hwy. - S. of Kohanaiki (SB)	865	825	1,580	1,695	1,855	1,955
Two-Way	1,780	1,655	3,375	3,295	3,955	3,825

Air Quality Study

AIR QUALITY STUDY

FOR

O'OMA BEACHSIDE VILLAGE

NORTH KONA, HAWAII

Prepared for:

O'oma Beachside Village, LLC

May 2008

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1.0 SUMMARY

O'oma Beachside Village, LLC is proposing to develop the O'oma Beachside Village in the North Kona District on the island of Hawaii. The proposed project will include up to 1,200 residential units, commercial space, a school, a park and other associated amenities and facilities. Development of the project is expected to commence in 2011 and be completed and fully occupied by 2029. This study examines the potential short- and long-term air quality impacts that could occur as a result of construction and use of the proposed facilities and suggests mitigative measures to reduce any potential air quality impacts where possible and appropriate.

Both federal and state standards have been established to maintain ambient air quality. At the present time, seven parameters are regulated including: particulate matter, sulfur dioxide, hydrogen sulfide, nitrogen dioxide, carbon monoxide, ozone and lead. Hawaii air quality standards are comparable to the national standards except those for nitrogen dioxide and carbon monoxide which are more stringent than the national standards.

Regional and local climate together with the amount and type of human activity generally dictate the air quality of a given location. The climate of the project area is very much affected by its near coastal situation and by nearby mountains. Winds are predominantly light and variable, although kona storms generate occasional strong winds from the south or southwest during winter. Temperatures in the project area are generally very consistent and moderate with average daily temperatures ranging from about 65°F to 85°F. The extreme minimum temperature recorded at the nearby Old Kona Airport is 47°F, while the extreme maximum temperature is 93°F. Average annual rainfall in the area amounts to about 25 inches with each month typically contributing about 2 inches.

Except for periodic impacts from volcanic emissions (vog) and possibly occasional localized impacts from traffic congestion, the present air quality of the project area is believed to be relatively good. The limited air quality data that are available for the area from the Department of Health indicate that (despite the vog) concentrations are well within state and national air quality standards.

If the proposed project is given the necessary approvals to proceed, it may be inevitable that some short- and/or long-term impacts on air quality will occur either directly or indirectly as a consequence of project construction and use. Short-term impacts from fugitive dust will likely occur during the project construction phase. To a lesser extent, exhaust emissions from stationary and mobile construction equipment, from the disruption of traffic, and from workers' vehicles may also affect air quality during the period of construction. State air pollution control regulations require that there be no visible fugitive dust emissions at the property line. Hence, an effective dust control plan must be implemented to ensure compliance with state regulations. Fugitive dust emissions can be controlled to a large extent by watering of active work areas, using wind screens, keeping adjacent paved roads clean, and by covering of open-bodied trucks. Other dust control measures could include limiting the area that can be disturbed at any given time and/or mulching or chemically stabilizing inactive areas that have been worked. Paving and landscaping of project areas early in the construction schedule will also reduce dust emissions. Monitoring dust at the project boundary during the period of construction could be considered as a means to evaluate the effectiveness of the project dust control program. Exhaust emissions can be mitigated by moving construction equipment and workers to and from the project site during off-peak traffic hours.

After construction, motor vehicles coming to and from the proposed development will result in a long-term increase in air pollution emissions in the project area. To assess the impact of emissions from these vehicles, a computerized air quality modeling study was undertaken to estimate current ambient concentrations of carbon monoxide at roadway intersections in the project vicinity and to predict future levels both with and without the proposed project. During worst-case conditions, model results indicated that present 1-hour and 8-hour carbon monoxide concentrations are within both the state and the national ambient air quality standards. In the year 2029 without the project, carbon monoxide concentrations were predicted to increase in the project area, but concentrations should remain within state and federal standards. With the project in the year 2029, carbon monoxide concentrations were estimated to increase by about 10 to 20 percent compared to the without-project case, but worst-case concentrations should remain within both national and state standards. Implementing mitigation measures for traffic-related air quality impacts is probably unnecessary and unwarranted.

Depending on the demand levels, long-term impacts on air quality are also possible due to indirect emissions associated with a development's electrical power and solid waste disposal requirements. Quantitative estimates of these potential impacts were not made, but based on the estimated demand levels and emission rates involved, any significant impacts are unlikely. Nevertheless, incorporating energy conservation design features and promoting conservation and recycling programs within the proposed development could serve to further reduce any associated impacts and conserve the island's resources.

2.0 INTRODUCTION

O’oma Beachside Village, LLC is proposing to develop the O’oma Beachside Village on approximately 303 acres of undeveloped lands in the North Kona District on the island of Hawaii (see Figure 1 for project location). The project site is makai of Queen Kaahumanu Highway and south of and adjacent to the Natural Energy Lab of Hawaii Authority (NELHA). The proposed development includes 950 to 1,200 multi- and single-family residential units, commercial space for stores and services, a charter school, park and open-space areas, a canoe club, a wastewater treatment plant, and other associated facilities and infrastructure. Full development and occupancy of the development is planned by 2029.

The purpose of this study is to describe existing air quality in the project area and to assess the potential short- and long-term direct and indirect air quality impacts that could result from construction and use of the proposed facilities as planned. Measures to mitigate project impacts are suggested where possible and appropriate.

3.0 AMBIENT AIR QUALITY STANDARDS

Ambient concentrations of air pollution are regulated by both national and state ambient air quality standards (AAQS). National AAQS are specified in Section 40, Part 50 of the Code of Federal Regulations (CFR), while State of Hawaii AAQS are defined in Chapter 11-59 of the Hawaii Administrative Rules. Table 1 summarizes both the national and the state AAQS that are specified in the cited documents. As indicated in the table, national and state AAQS have been established for particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead. The state has also set a standard for hydrogen sulfide. National AAQS are stated in terms of both primary and secondary standards for most of the regulated air pollutants. National primary standards are designed to protect the public health with an "adequate margin of safety". National secondary standards, on the other hand, define levels of air quality necessary to protect the public welfare from "any known or anticipated adverse effects of a pollutant". Secondary public welfare impacts may include such effects as decreased visibility, diminished comfort levels, or other potential injury to the natural or man-made environment, e.g., soiling of materials, damage to vegetation or other economic damage. In contrast to the national AAQS, Hawaii State AAQS are given in terms of a single standard that is designed "to protect public health and welfare and to prevent the significant deterioration of air quality".

Each of the regulated air pollutants has the potential to create or exacerbate some form of adverse health effect or to produce environmental degradation when present in sufficiently high concentration for prolonged periods of time. The AAQS specify a maximum allowable concentration for a given air pollutant for one or more averaging times to prevent harmful effects. Averaging times vary from one hour to one year depending on the pollutant and type of exposure necessary to cause adverse effects. In the case of the short-term (i.e., 1- to 24-hour) AAQS, both national and state standards allow a specified number of exceedances each year.

The Hawaii AAQS are in some cases considerably more stringent than the comparable national AAQS. In particular, the Hawaii 1-hour AAQS for carbon monoxide is four times more stringent than the comparable national limit. The U.S. Environmental Protection Agency (EPA) is currently working on a plan to phase out the national 1-hour ozone standard in favor of the new (and more stringent) 8-hour standard.

The Hawaii AAQS for sulfur dioxide were relaxed in 1986 to make the state standards essentially the same as the national limits. In 1993, the state also revised its particulate standards to follow those set by the federal government. During 1997, the federal government again revised its standards for particulate, but the new standards were challenged in federal court. A Supreme Court ruling was issued during February 2001, and as a result, the new standards for particulate were implemented during 2005. To date, the Hawaii Department of Health has not updated the state particulate standards. In September 2001, the state vacated the state 1-hour standard for ozone and an 8-hour standard was adopted.

4.0 REGIONAL AND LOCAL CLIMATOLOGY

Regional and local climatology significantly affect the air quality of a given location. Wind, temperature, atmospheric turbulence, mixing height and rainfall all influence air quality. Although the climate of Hawaii is relatively moderate throughout most of the state, significant differences in these parameters may occur from one location to another. Most differences in regional and local climates within the state are caused by the mountainous topography.

The site of the proposed project is located near the midpoint of the western coast of the island of Hawaii. The topography of Hawaii Island is dominated by the great volcanic masses of Mauna Loa (13,653 feet), Mauna Kea (13,796 feet), and of Hualalai, the Kohala Mountains and Kilauea. The island consists entirely of the slopes of these mountains and of the broad saddles between them. Mauna Loa and Kilauea, located on the southern half of the island, are still active volcanoes.

Hawaii lies well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high pressure cell to the north and east. Nearly the entire western coast of the island of Hawaii, however, is sheltered from the trade winds by high mountains, except when unusually strong trade winds sweep through the saddle between the Kohala Mountains and Mauna Kea and reach some areas to the lee. Due to wind shadow effects caused by the terrain, winds in the project area are predominantly light and variable. Local winds such as land/sea breezes and/or upslope/downslope winds dominate the wind pattern for the area. During the daytime, winds typically move onshore because of seabreeze and/or upslope effects. At night, winds generally are land breezes and/or drainage winds that move downslope and out to sea. During winter, occasional strong winds from the south or southwest occur in association with the passage of winter storm systems.

Air pollution emissions from motor vehicles, the formation of photochemical smog and smoke plume rise all depend in part on air temperature. Colder temperatures tend to result in higher emissions of contaminants from automobiles but lower concentrations of photochemical smog and ground-level concentrations of air pollution from elevated plumes. In Hawaii, the annual and daily variation of temperature depends to a large degree on elevation above sea level, distance inland and exposure to the trade winds. Average temperatures at locations near sea level generally are warmer than those at higher elevations.

Areas exposed to the trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. The project site's leeward location results in a larger temperature profile compared to windward locations at the same elevation. At the Old Kona Airport, located a few miles south of the project site, average daily minimum and maximum temperatures are 67°F and 83°F, respectively [1]. The extreme minimum temperature on record at this location is 47°F, and the extreme maximum is 93°F. Temperatures at the project site are similar.

Small scale, random motions in the atmosphere (turbulence) cause air pollutants to be dispersed as a function of distance or time from the point of emission. Turbulence is caused by both mechanical and thermal forces in the atmosphere. It is often measured and described in terms of Pasquill-Gifford stability class. Stability class 1 is the most turbulent and class 6 is the least. Thus, air pollution dissipates the best during stability class 1 conditions and the worst when stability class 6 prevails. In the Kona area, stability classes 5 or 6 typically occur during the nighttime or early morning hours when temperature inversions form due to radiational cooling or to drainage flow from the mountainous interior of the island. Stability classes 1 through 4 occur during the daytime, depending mainly on the amount of cloud cover and incoming solar radiation and the onset and extent of the sea breeze.

Mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Low mixing heights can result in high ground-level air pollution concentrations because contaminants emitted from or near the surface can become trapped within the mixing layer. In Hawaii, minimum mixing heights tend to be high because of mechanical mixing caused by the trade winds and because of the temperature moderating effect of the surrounding ocean. Low mixing heights may sometimes occur, however, at inland locations and even at times along coastal areas early in the morning following a clear, cool, windless night. Coastal areas also may experience low mixing levels during sea breeze conditions when cooler ocean air rushes in over warmer land. Mixing heights in Hawaii typically are above 3000 feet (1000 meters).

Rainfall can have a beneficial affect on the air quality of an area in that it helps to suppress fugitive dust emissions, and it also may "washout" gaseous contaminants that are water soluble. Rainfall in Hawaii is highly variable depending on elevation and on location with respect to the trade wind. The climate of the project area is wetter than might be expected for a leeward location. This is due to the persistent onshore and upslope movement of marine air caused by both eddie and seabreeze or mountain slope effects. Some of the rainfall occurs during summer afternoons and evenings as a result of this onshore and upslope movement of moisture-laden marine air, and some occurs in conjunction with winter storms. At the Old Kona Airport, average annual rainfall amounts to about 25 inches with each month registering about 2 inches [1]. Rainfall at the project site is probably about the same.

5.0 PRESENT AIR QUALITY

Present air quality in the project area is mostly affected by air pollutants from vehicular, industrial, natural and/or agricultural sources. Table 2 presents an air pollutant emission summary for the island of Hawaii for calendar year 1993. The emission rates shown in the table pertain to manmade emissions only, i.e., emissions from natural sources are not included. As suggested in the table, much of the manmade particulate emissions on Hawaii originate from area sources, such as the mineral products industry and agriculture. Manmade sulfur oxides are emitted almost exclusively by point sources, such as power plants and other fuel-burning industries. Nitrogen oxides emissions emanate predominantly from area sources (mostly motor vehicle traffic), although industrial point sources contribute a significant share. The majority of carbon monoxide emissions occur from area sources (motor vehicle traffic), while hydrocarbons are emitted mainly from point sources.

It should be noted that Hawaii Island is unique from the other islands in the state in terms of the natural volcanic air pollution emissions that occur. Volcanic emissions periodically plague the project area. This is especially so since the latest eruption phase of the Kilauea Volcano began in 1983. Air pollution emissions from the Hawaiian volcanoes consist primarily of sulfur dioxide. After entering the atmosphere, these sulfur dioxide emissions are carried away by the wind and either washed out as acid rain or gradually transformed into particulate sulfates or acid aerosols. Although emissions from Kilauea are vented on the other side of a mountain barrier more than 50 miles east of the project site, the prevailing wind patterns eventually carry some of the emissions into the Kona area. These emissions can be seen in the form of the volcanic haze (vog) which persistently hangs over the area.

The major industrial source of air pollution in the project vicinity is Hawaii Electric Light Company’s Keahole Power Plant, which is located about 2 miles to the north. Air pollution emissions from Keahole Power Plant consist mostly of sulfur dioxide and oxides of nitrogen.

The project site is situated adjacent to Queen Kaahumanu Highway on the makai side. Queen Kaahumanu Highway is a regional arterial roadway that often carries substantial volumes of traffic. Downslope winds during the evening and nighttime hours will tend to carry emissions from motor vehicles traversing this roadway toward the project site.

The State Department of Health operates a network of air quality monitoring stations at various locations around the state. Unfortunately, very limited data are available for Hawaii Island, and even less data are available for the Kona area specifically. During the most recent 5-year period for which data have been reported (2001-2005), the Department of Health operated an air quality monitoring site in the Kealakekua area for measuring sulfur dioxide. Particulate was also monitored at this site, but monitoring for this parameter was discontinued during 2000. As indicated in Table 3, measurements of sulfur dioxide concentrations at this location during the 2001-2005 monitoring period were consistently low with annual average concentrations of 8 to 13 $\mu g/m^3$, which represents about 10 to 15 percent of the state and national standard. The highest annual second-highest 3-hour and 24-hour concentrations (which are most relevant to the standards) for these five years were 82 and 42 $\mu g/m^3$, respectively; these are about 6 to 12 percent of the applicable standards. No exceedances of the state/national 3-hour and 24-hour AAQS for sulfur dioxide were recorded.

Although not shown in the table, the annual average particulate concentration for the year 2000 was 18 $\mu g/m^3$, which equates to about 36 percent of the state/national standard. The second-highest 24-hour concentration of particulate matter, 23 $\mu g/m^3$, was about 15 percent of the state/national standard, and there were no violations of the state/national AAQS during the 2000 monitoring period. Monitoring of particulate matter was discontinued at this site during June 2000.

At this time, there are no reported measurements of lead, ozone, nitrogen dioxide or carbon monoxide in the project vicinity. These are primarily motor vehicle related air pollutants. Lead, ozone and nitrogen dioxide typically are regional scale problems. Concentrations of lead and nitrogen dioxide generally have not been found to exceed AAQS elsewhere in the state. Ozone concentrations, on the other hand, have been found to exceed the state standard at times at Sand Island on Oahu. Carbon monoxide air pollution typically is a microscale problem caused by congested motor vehicular traffic. In traffic congested areas such as urban Honolulu, carbon monoxide concentrations have been found to occasionally exceed the state AAQS. Present concentrations of carbon monoxide in the project area are estimated later in this study based on computer modeling of motor vehicle emissions.

6.0 SHORT-TERM IMPACTS OF PROJECT

Short-term direct and indirect impacts on air quality could potentially occur due to project construction. For a project of this nature, there are two potential types of air pollution emissions that could directly result in short-term air quality impacts during project construction: (1) fugitive dust from vehicle movement and soil excavation; and (2) exhaust emissions from on-site construction equipment. Indirectly, there also could be short-term impacts from slow-moving construction equipment traveling to and from the project site, from a temporary increase in local traffic caused by commuting construction workers, and from the disruption of normal traffic flow caused by lane closures of adjacent roadways.

Fugitive dust emissions may arise from the grading and dirt-moving activities associated with site clearing and preparation work. The emission rate for fugitive dust emissions from construction activities is difficult to estimate accurately. This is because of its elusive nature of emission and because the potential for its generation varies greatly depending upon the type of soil at the construction site, the amount and type of dirt-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The EPA [2] has provided a rough estimate for uncontrolled fugitive dust emissions from construction activity of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and precipitation/evaporation (P/E) index of 50. Uncontrolled fugitive dust emissions at the project site would likely be somewhere near that level, depending on the amount of rainfall that occurs. In any case, State of Hawaii Air Pollution Control Regulations [3] prohibit visible emissions of fugitive dust from construction activities at the property line. Thus, an effective dust control plan for the project construction phase is essential.

Adequate fugitive dust control can usually be accomplished by the establishment of a frequent watering program to keep bare-dirt surfaces in construction areas from becoming significant sources of dust. In dust-prone or dust-sensitive areas, other control measures such as limiting the area that can be disturbed at any given time, applying chemical soil stabilizers, mulching and/or using wind screens may be necessary. Control regulations further stipulate that open-bodied trucks be covered at all times when in motion if they are transporting materials that could be blown away. Haul trucks tracking dirt onto paved streets from unpaved areas is often a significant source of dust in construction areas. Some means to alleviate this problem, such as road cleaning or tire washing, may be appropriate. Paving of parking areas and/or establishment of landscaping as early in the construction schedule as possible can also lower the potential for fugitive dust emissions. Monitoring dust at the project property line could be considered to quantify and document the effectiveness of dust control measures.

On-site mobile and stationary construction equipment also will emit air pollutants from engine exhausts. The largest of this equipment is usually diesel-powered. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment, but the standard for nitrogen dioxide is set on an annual basis and is not likely to be violated by short-term construction equipment emissions. Carbon monoxide emissions from diesel engines, on the other hand, are low and should be relatively insignificant compared to vehicular emissions on nearby roadways.

Project construction activities will also likely obstruct the normal flow of traffic at times to such an extent that overall vehicular emissions in the project area will temporarily increase. The only means to alleviate this problem will be to attempt to keep roadways open during peak traffic hours and to move heavy construction equipment and workers to and from construction areas during periods of low traffic volume. Thus, most potential short-term air quality impacts from project construction can be mitigated.

7.0 LONG-TERM IMPACTS OF PROJECT

7.1 Roadway Traffic

After construction is completed, use of the proposed facilities will result in increased motor vehicle traffic in the project area, potentially causing long-term impacts on ambient air quality. Motor vehicles with gasoline-powered engines are significant sources of carbon monoxide. They also emit nitrogen oxides and other contaminates.

Federal air pollution control regulations require that new motor vehicles be equipped with emission control devices that reduce emissions significantly compared to a few years ago. In 1990, the President signed into law the Clean Air Act Amendments. This legislation requires further emission reductions, which have been phased in since 1994. More recently, additional restrictions were signed into law during the Clinton administration, which will begin to take effect during the next decade. The added restrictions on emissions from new motor vehicles will lower average emissions each year as more and more older vehicles leave the state's roadways. It is estimated that carbon monoxide emissions, for example, will go down by an average of about 30 to 40 percent per vehicle during the next 10 years due to the replacement of older vehicles with newer models.

To evaluate the potential long-term indirect ambient air quality impact of increased roadway traffic associated with a project such as this, computerized emission and atmospheric dispersion models can be used to estimate ambient carbon monoxide concentrations along roadways leading to and from the project. Carbon monoxide is selected for modeling because it is both the most stable and the most abundant of the pollutants generated by motor vehicles. Furthermore, carbon monoxide air pollution is generally considered to be a microscale problem that can be addressed locally to some extent, whereas nitrogen oxides air pollution most often is a regional issue that cannot be addressed by a single new development.

For this project, three scenarios were selected for the carbon monoxide modeling study: (1) year 2006 with present conditions, (2) year 2029 without the project, and (3) year 2029 with the project. To begin the modeling study of the three scenarios, critical receptor areas in the vicinity of the project were identified for analysis. Generally speaking, roadway intersections are the primary concern because of traffic congestion and because of the increase in vehicular emissions associated with traffic queuing. For this study, the same key intersections identified in the traffic study were also selected for air quality analysis. These included the following intersections:

- Queen Kaahumanu Highway at Kaiminani Drive
- Queen Kaahumanu Highway at Hulikoa Drive
- Queen Kaahumanu Highway at Hina Lani Street

The traffic impact report for the project [4] describes the projected future traffic conditions and laneage configurations of these intersections in detail. In performing the air quality impact analysis, it was assumed that all recommended traffic mitigation measures would be implemented.

The main objective of the modeling study was to estimate maximum 1-hour average carbon monoxide concentrations for each of the three scenarios studied. To evaluate the significance of the estimated concentrations, a comparison of the predicted values for each scenario can be made. Comparison of the estimated values to the national and state AAQS was also used to provide another measure of significance.

Maximum carbon monoxide concentrations typically coincide with peak traffic periods. The traffic impact assessment report evaluated morning and afternoon peak traffic periods. These same periods were evaluated in the air quality impact assessment.

The EPA computer model MOBILE6 [5] was used to calculate vehicular carbon monoxide emissions for each year studied. One of the key inputs to MOBILE6 is vehicle mix. Unless very detailed information is available, national average values are typically assumed, which is what was used for the present study. Based on national average vehicle mix figures, the present vehicle mix in the project area was estimated to be 40.9% light-duty gasoline-powered automobiles, 46.2% light-duty gasoline-powered trucks and vans, 3.6% heavy-duty gasoline-powered vehicles, 0.2% light-duty diesel-powered vehicles, 8.5% heavy-duty diesel-powered trucks and buses, and 0.6% motorcycles. For the future scenarios studied, the vehicle mix was estimated to change slightly with fewer light-duty gasoline-powered automobiles and more light-duty gasoline-powered trucks and vans.

Ambient temperatures of 59 and 68 degrees F were used for morning and afternoon peak-hour emission computations, respectively. These are conservative assumptions since morning/afternoon ambient temperatures will generally be warmer than this, and emission estimates given by MOBILE6 generally have an inverse relationship to the ambient temperature.

After computing vehicular carbon monoxide emissions through the use of MOBILE6, these data were then input to an atmospheric dispersion model. EPA air quality modeling guidelines [6] currently recommend that the computer model CAL3QHC [7] be used to assess carbon monoxide concentrations at roadway intersections, or in areas where its use has previously been established, CALINE4 [8] may be used. Until a few years ago, CALINE4 was used extensively in Hawaii to assess air quality impacts at roadway intersections. In December 1997, the California Department of Transportation recommended that the intersection mode of CALINE4 no longer be used because it was thought the model has become outdated. Studies have shown that CALINE4 may tend to over-predict maximum concentrations in some situations. Therefore, CAL3QHC was used for the subject analysis.

CAL3QHC was developed for the U.S. EPA to simulate vehicular movement, vehicle queuing and atmospheric dispersion of vehicular emissions near roadway intersections. It is designed to predict 1-hour average pollutant concentrations near roadway intersections based on input traffic and emission data, roadway/receptor geometry and meteorological conditions.

Although CAL3QHC is intended primarily for use in assessing atmospheric dispersion near signalized roadway intersections, it can also be used to evaluate unsignalized intersections. This is accomplished by manually estimating queue lengths and then applying the same techniques used by the model for signalized intersections. Currently, one of the study intersections, Queen Kaahumanu Highway at Hulikoa Drive, is unsignalized. In the future, in accordance with the traffic report, this intersection was assumed to be signalized.

Input peak-hour traffic data were obtained from the traffic study cited previously. This included vehicle approach volumes, saturation capacity estimates, intersection laneage and signal timings (where applicable). All emission factors that were input to CAL3QHC for free-flow traffic on roadways were obtained from MOBILE6 based on assumed free-flow vehicle speeds corresponding to the posted speed limits (25 to 45 mph depending on location).

Model roadways were set up to reflect roadway geometry, physical dimensions and operating characteristics. Concentrations predicted by air quality models generally are not considered valid within the roadway-mixing zone. The roadway-mixing zone is usually taken to include 3 meters on either side of the traveled portion of the roadway and the turbulent area within 10 meters of a cross street. Model receptor sites were thus located at the edges of the mixing zones near all intersections that were studied for all three scenarios. This implies that pedestrian sidewalks either already exist or are assumed to exist in the future. All receptor heights were placed at 1.8 meters above ground to simulate levels within the normal human breathing zone.

Input meteorological conditions for this study were defined to provide "worst-case" results. One of the key meteorological inputs is atmospheric stability category. For these analyses, atmospheric stability category 6 was assumed for the morning cases, while atmospheric stability category 4 was assumed for the afternoon cases. These are the most conservative stability categories that are generally used for estimating worst-case pollutant dispersion within suburban areas for these periods. A surface roughness length of 100 cm and a mixing height of 1000 meters were used in all cases. Worst-case wind conditions were defined as a wind speed of 1 meter per second with a wind direction resulting in the highest predicted concentration. Concentration estimates were calculated at wind directions of every 5 degrees.

Existing background concentrations of carbon monoxide in the project vicinity are believed to be at low levels. Thus, background contributions of carbon monoxide from sources or roadways not directly considered in the analysis were accounted for by adding a background concentration of 0.5 ppm to all predicted concentrations for 2006. Although increased traffic is expected to occur within the project area during the next several years with or without the project, background carbon monoxide concentrations may not change significantly since individual emissions from motor vehicles are forecast to decrease with time. Hence, a background value of 0.5 ppm was assumed to persist for the future scenarios studied.

Predicted Worst-Case 1-Hour Concentrations

Table 4 summarizes the final results of the modeling study in the form of the estimated worst-case 1-hour morning and afternoon ambient carbon monoxide concentrations. These results can be compared directly to the state and the national AAQS. Estimated worst-case carbon monoxide concentrations are presented in the table for three scenarios: year 2006 with existing traffic, year 2029 without the project and year 2029 with the project. The locations of these estimated worst-case 1-hour concentrations all occurred at or very near the indicated intersections.

As indicated in the table, the highest estimated 1-hour concentration within the project vicinity for the present (2006) case was 5.5 mg/m^3. This was projected to occur during the morning peak traffic hour near the intersection of Queen Kaahumanu Highway and Kaiminani Drive. Concentrations at other locations and times studied were 5.2 mg/m^3 or lower. All predicted worst-case 1-hour concentrations for the 2006 scenario were within both the national AAQS of 40 mg/m^3 and the state standard of 10 mg/m^3.

In the year 2029 without the proposed project, the highest worst-case 1-hour concentration was predicted to continue to occur during the morning at the intersection of Queen Kaahumanu Highway and Kaiminani Drive. A value of 6.2 mg/m^3 was predicted to occur at this location and time. Peak-hour worst-case values at the other locations and times studied for the 2029 without project scenario ranged between 3.2 and 5.8 mg/m^3. Compared to the existing case, concentrations increased, but all projected worst-case concentrations for this scenario remained within the state and national standards.

In the year 2029 with the proposed project and with the recommended traffic mitigation measures, the predicted highest worst-case 1-hour concentration continued to occur during the morning at the intersection of Queen Kaahumanu Highway and Kaiminani Drive with a value of 7.7 mg/m^3, which is about 24 percent higher compared to the without project case. Other concentrations for this scenario ranged between 3.8 and 6.4 mg/m^3. With the project and with the recommended traffic mitigation measures, concentrations would increase about 10 to 20 percent compared to the without project scenario. All concentrations would remain within the state and federal standards.

Predicted Worst-Case 8-Hour Concentrations

Worst-case 8-hour carbon monoxide concentrations were estimated by multiplying the worst-case 1-hour values by a persistence factor of 0.5. This accounts for two factors: (1) traffic volumes averaged over eight hours are lower than peak 1-hour values, and (2) meteorological conditions are more variable (and hence more favorable for dispersion) over an 8-hour period than they are for a single hour. Based on monitoring data, 1-hour to 8-hour persistence factors for most locations generally vary from 0.4 to 0.8 with 0.6 being the most typical. One study based on modeling [9] concluded that 1-hour to 8-hour persistence factors could typically be expected to range from 0.4 to 0.5. EPA guidelines [10] recommend using a value of 0.7 unless a locally derived persistence factor is available. Recent monitoring data for locations on Oahu reported by the Department of Health [11] suggest that this factor may range between about 0.2 and 0.6 depending on location and traffic variability. Considering the location of the project and the traffic pattern for the area, a 1-hour to 8-hour persistence factor of 0.5 will likely yield reasonable estimates of worst-case 8-hour concentrations.

The resulting estimated worst-case 8-hour concentrations are indicated in Table 5. For the 2006 scenario, the estimated worst-case 8-hour carbon monoxide concentrations for the five locations studied ranged from 2.2 mg/m^3 at Queen Kaahumanu Highway and Hulikoa Drive to 2.8 mg/m^3 at Queen Kaahumanu Highway and Kaiminani Drive. The estimated worst-case concentrations were within both the state standard of 5 mg/m^3 and the national limit of 10 mg/m^3.

For the year 2029 without project scenario, worst-case concentrations ranged between 2.6 and 3.1 mg/m^3, with the highest concentration at the Queen Kaahumanu Highway and Kaiminani Drive intersection. Concentrations at all locations studied increased slightly compared to the existing case, but all predicted concentrations were within the standards.

For the 2029 with project scenario (assuming traffic mitigation measures), concentrations ranged from 3.0 mg/m^3 at Queen Kaahumanu Highway and Hina Lani Street to 3.8 mg/m^3 at Queen Kaahumanu Highway and Kaiminani Drive. Worst-case concentrations increased compared to the without project case, but all predicted 8-hour concentrations for this scenario were well within both the national and the state AAQS.

<u>Conservativeness of Estimates</u>

The results of this study reflect several assumptions that were made concerning both traffic movement and worst-case meteorological conditions. One such assumption concerning worst-case meteorological conditions is that a wind speed of 1 meter per second with a steady direction for 1 hour will occur. A steady wind of 1 meter per second blowing from a single direction for an hour is extremely unlikely and may occur only once a year or less. With wind speeds of 2 meters per second, for example, computed carbon monoxide concentrations would be only about half the values given above. The 8-hour estimates are also conservative in that it is unlikely that anyone would occupy the assumed receptor sites (within 3 m of the roadways) for a period of 8 hours.

7.2 Electrical Demand

The proposed project also will cause indirect air pollution emissions from power generating facilities as a consequence of electrical power usage. The annual electrical demand of the project when fully developed is expected to reach a maximum of approximately 71 million kilowatt-hours [12]. Electrical power for the project will most probably be provided mainly by oil-fired generating facilities, but some of the project power may also be derived from geothermal energy, photovoltaic systems, wind power or other sources. In order to meet the electrical power needs of the proposed project, power generating facilities will likely be required to burn more fuel and hence more air pollution will be emitted at these facilities. Given in Table 6 are estimates of the indirect air pollution emissions that would result from the project electrical demand assuming all power is provided by burning more fuel oil at local power plants. These values can be compared to the island-wide emission estimates for 1993 given in Table 2. The estimated indirect emissions from project electrical demand amount to 2 percent or less of the present (manmade) air pollution emissions occurring on Hawaii Island even if all power is assumed to be derived from oil.

7.3 Solid Waste Disposal

Solid waste generated by the proposed development when fully completed and occupied is not expected to exceed about 2,568 tons per year [12]. Currently, all solid waste on the island is buried at solid waste landfills. Thus, assuming this continues to be the method for solid waste disposal, the only associated air pollution emissions that will occur will be from trucking the waste to the landfill and burying it. These emissions should be relatively minor.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The major potential short-term air quality impact of the project will occur from the emission of fugitive dust during construction. Uncontrolled fugitive dust emissions from construction activities are estimated to amount to about 1.2 tons per acre per month, depending on rainfall. To control dust, active work areas and any temporary unpaved work roads should be watered at least twice daily on days without rainfall. Use of wind screens and/or limiting the area that is disturbed at any given time will also help to contain fugitive dust emissions. Wind erosion of inactive areas of the site that have been disturbed could be controlled by mulching or by the use of chemical soil stabilizers. Dirt-hauling trucks should be covered when traveling on roadways to prevent windage. A routine road cleaning and/or tire washing program will also help to reduce fugitive dust emissions that may occur as a result of trucks tracking dirt onto paved roadways in the project area. Paving of parking areas and establishment of landscaping early in the construction schedule will also help to control dust. Monitoring dust at the project boundary during the period of construction could be considered as a means to evaluate the effectiveness of the project dust control program and to adjust the program if necessary.

During construction phases, emissions from engine exhausts (primarily consisting of carbon monoxide and nitrogen oxides) will also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

After construction of the proposed project is completed and it is fully occupied, carbon monoxide concentrations in the project area due to motor vehicle emissions will likely increase, but worst-case concentrations should remain within both the state and the national ambient air quality standards. Implementing any air quality mitigation measures for long-term traffic-related impacts is probably unnecessary and unwarranted.

Any long-term impacts on air quality due to indirect emissions from supplying the project with electricity and from the disposal of solid waste materials generated by the project will likely be small based on the relatively small magnitudes of these emissions. Nevertheless, indirect emissions from project electrical demand could likely be reduced somewhat by incorporating energy-saving features into project design requirements. This might include the use of solar water heaters; designing building space so that window positions maximize indoor light without unduly increasing indoor heat; using landscaping where feasible to provide afternoon shade to cut down on the use of air conditioning; installation of insulation and double-glazed doors to reduce the effects of the sun and heat; providing movable, controlled openings for ventilation at opportune times; and possibly installing automated room occupancy sensors.

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Figure 1 - Project Location

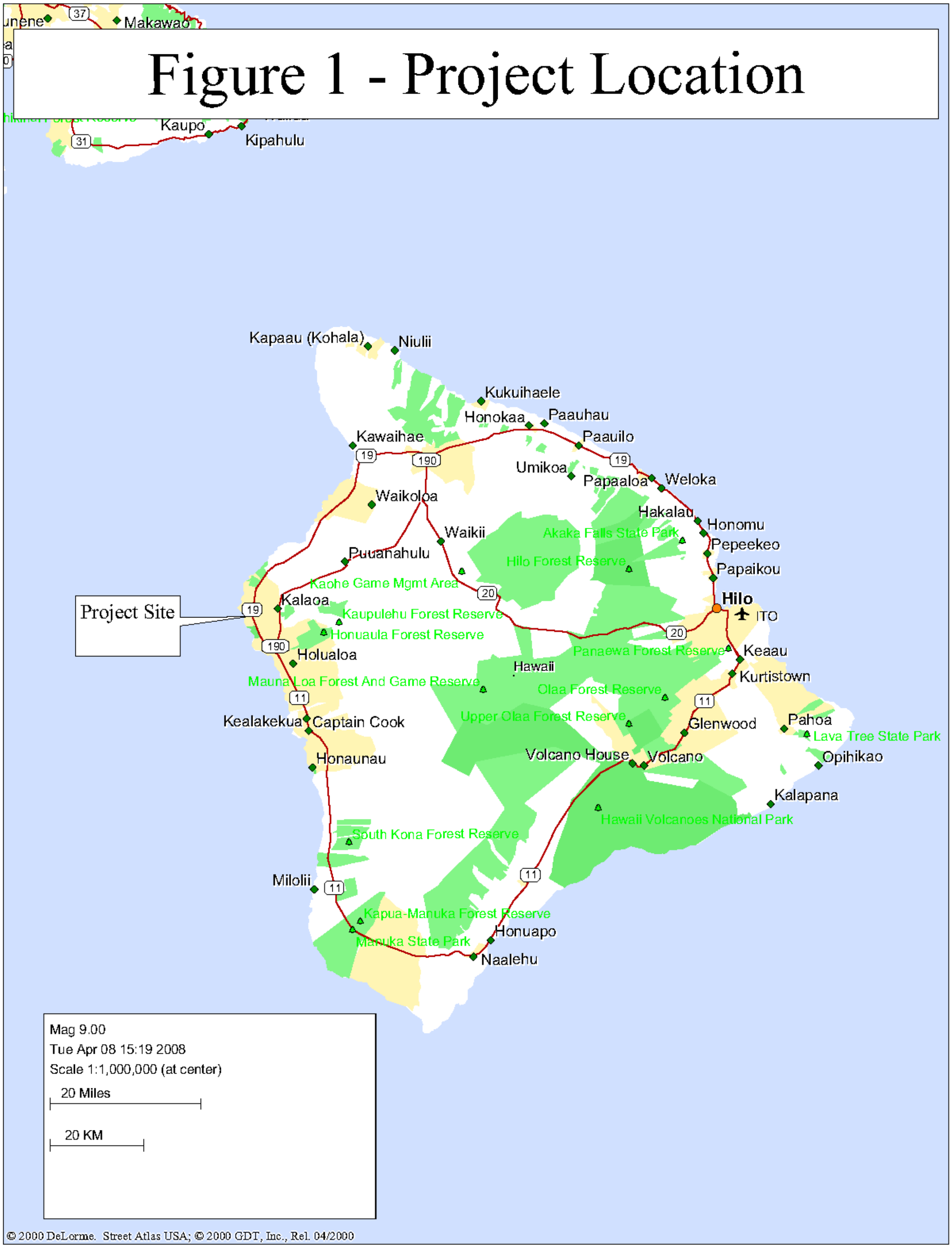

Table 1

SUMMARY OF STATE OF HAWAII AND NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Units	Averaging Time	Maximum Allowable Concentration		
			National Primary	**National Secondary**	**State of Hawaii**
Particulate Matter (<10 microns)	μg/m³	Annual 24 Hours	50[a] 150[b]	50[a] 150[b]	50 150[c]
Particulate Matter (<2.5 microns)	μg/m³	Annual 24 Hours	15[a] 65[d]	15[a] 65[d]	- -
Sulfur Dioxide	μg/m³	Annual 24 Hours 3 Hours	80 365[c] -	- - 1300[c]	80 365[c] 1300[c]
Nitrogen Dioxide	μg/m³	Annual	100	100	70
Carbon Monoxide	mg/m³	8 Hours 1 Hour	10[c] 40[c]	- -	5[c] 10[c]
Ozone	μg/m³	8 Hours 1 Hour	157[e] 235[f]	157[e] 235[f]	157[e] -
Lead	μg/m³	Calendar Quarter	1.5	1.5	1.5
Hydrogen Sulfide	μg/m³	1 Hour	-	-	35[c]

[a] Three-year average of annual arithmetic mean.

[b] 99th percentile value averaged over three years.

[c] Not to be exceeded more than once per year.

[d] 98th percentile value averaged over three years.

[e] Three-year average of fourth-highest daily 8-hour maximum.

[f] Standard is attained when the expected number of exceedances is less than or equal to 1.

Table 2

AIR POLLUTION EMISSIONS INVENTORY FOR ISLAND OF HAWAII, 1993

Air Pollutant	Point Sources (tons/year)	Area Sources (tons/year)	Total (tons/year)
Particulate	30,311	9,157	39,468
Sulfur Oxides	9,345	nil	9,345
Nitrogen Oxides	4,054	8,858	12,912
Carbon Monoxide	3,357	23,934	27,291
Hydrocarbons	1,477	203	1,680

Source: Final Report, "Review, Revise and Update of the Hawaii Emissions Inventory Systems for the State of Hawaii", prepared for Hawaii Department of Health by J.L. Shoemaker & Associates, Inc., 1996

Table 3

ANNUAL SUMMARIES OF AIR QUALITY MEASUREMENTS FOR MONITORING STATIONS NEAREST O'OMA BEACHSIDE VILLAGE

Parameter / Location	2001	2002	2003	2004	2005
Sulfur Dioxide / Kealakekua, Kona					
3-Hour Averaging Period:					
No. of Samples	2869	2877	2886	2513	2341
Highest Concentration (μg/m^3)	38	50	91	55	83
2nd Highest Concentration (μg/m^3)	37	37	58	54	82
No. of State AAQS Exceedances	0	0	0	0	0
24-Hour Averaging Period:					
No. of Samples	360	362	364	317	296
Highest Concentration (μg/m^3)	22	19	39	21	47
2nd Highest Concentration (μg/m^3)	20	18	22	19	42
No. of State AAQS Exceedances	0	0	0	0	0
Annual Average Concentration (μg/m^3)	8	8	10	8	13

Source: State of Hawaii Department of Health, "Annual Summaries, Hawaii Air Quality Data, 2001 - 2005"

Table 4

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR O'OMA BEACHSIDE VILLAGE (milligrams per cubic meter)

Roadway Intersection	Year/Scenario					
	2006/Present		2029/Without Project		2029/With Project[a]	
	AM	PM	AM	PM	AM	PM
Queen Kaahumanu Hwy at Kaimiani Drive	5.5	2.6	6.2	3.9	7.7	4.4
Queen Kaahumanu Hwy at Hulikoa Drive	4.4	2.6	5.3	3.2	6.4	3.8
Queen Kaahumanu Hwy at Hina Lani Street	5.2	4.0	5.8	4.0	6.1	4.3

Hawaii State AAQS: 10
National AAQS: 40

[a]Includes mitigation measures given in project traffic report.

Table 5

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR O'OMA BEACHSIDE VILLAGE (milligrams per cubic meter)

Roadway Intersection	Year/Scenario		
	2006/Present	2029/Without Project	2029/With Project[a]
Queen Kaahumanu Hwy at Kaimiani Drive	2.8	3.1	3.8
Queen Kaahumanu Hwy at Hulikoa Drive	2.2	2.6	3.2
Queen Kaahumanu Hwy at Hina Lani Street	2.6	2.9	3.0

Hawaii State AAQS: 5
National AAQS: 10

[a]Includes mitigation measures given in project traffic report.

Table 6

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM O’OMA BEACHSIDE VILLAGE ELECTRICAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	18
Sulfur Dioxide	184
Carbon Monoxide	18
Volatile Organics	<1
Nitrogen Oxides	79

[a]Based on U.S. EPA emission factors for utility boilers [2]. Assumes demand of 71 million kw-hrs per year of electrical power use. Estimated emission rates assume low-sulfur oil used to generate power.

Civil & Electrical Infrastructure Assessment

Civil & Electrical Infrastructure Assessment Report 'O'oma Beachside Village

'O'oma, North Kona, Island of Hawai'i, Hawai'i

Tax Map Key Number (3)7-3-009: 004 & 022

DECEMBER 2008

Prepared for:
'O'oma Beachside Village, LLC

Prepared by:

AECOM

Davies Pacific Center, 841 Bishop Street
Suite 1900, Honolulu, Hawai'i 96813

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APPENDICES

1.0 INTRODUCTION

‘O‘oma Beachside Village, a 302.38 acre residential and commercial mixed-use community, is being planned at ‘O‘oma, North Kona, Hawai‘i. This report assesses existing conditions, future demands, and future infrastructure requirements for the community.

1.0.1 Project Description

‘O‘oma Beachside Village, LLC intends to develop a 302.383 acre property (hereinafter referred to as the Property) at ‘O‘oma, North Kona, Hawai‘i. The Property is comprised of a:

- 217.566-acre parcel identified by TMK (3)7-3-009: 004 (Parcel 4);
- 83-acre parcel identified by TMK (3)7-3-009: 022 (Parcel 22); and
- 1.814-acre portion of the State-owned Right-of-Way (ROW) located on by TMK (3)7-3-009: (State ROW).

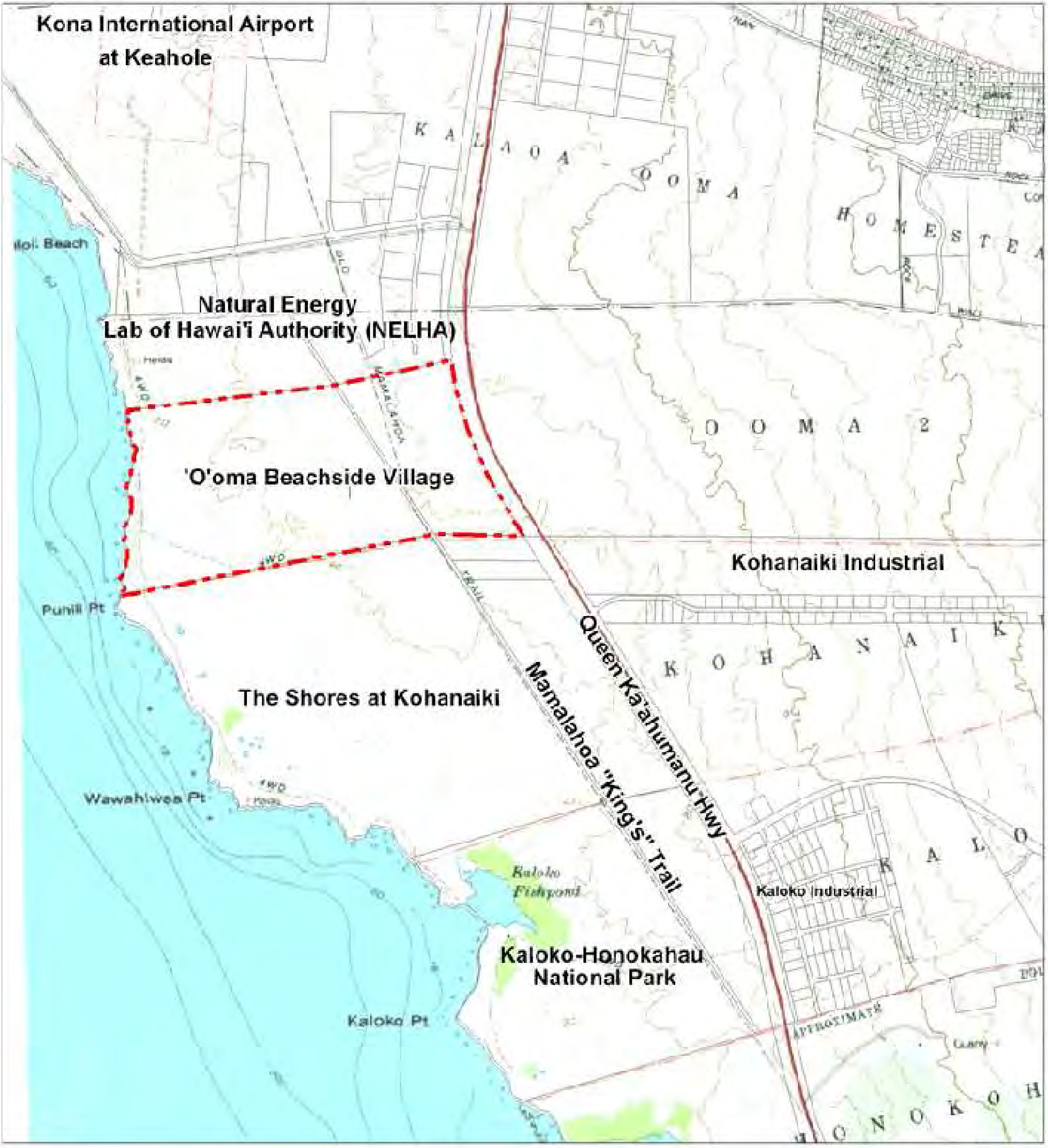
The Property is bordered by Queen Ka‘ahumanu Highway to the east, Kohanaiki Shores to the south and the Natural Energy Laboratory of Hawai‘i Authority (NELHA) to the north. The Property is located *makai* of Queen Ka‘ahumanu Highway and runs toward the shoreline (Ref **Figure 1**).

The Conceptual Plan provides for single family homes, multi-family homes, mixed-use villages combining commercial and residential uses, parks public coastal open space, and a coastal preserve area (Ref **Figure 2**).

‘O‘oma Beachside Village is planned to include:

- Approximately 950 to 1,200 homes, including:
  - Single family units,
  - Multi-family units, and
  - “Live-work” units with commercial uses on the ground floor and residential uses above.
- 200,000 square feet of commercial space, including:
  - Space for a small grocery store,
  - Restaurants, and
  - Retail and office space.
- A private or charter school site.
- A public beach park, including a community pavilion.

Construction of ‘O‘oma Beachside Village is expected to begin in 2011 and will continue through approximately 2029. For the purpose of infrastructure development and demand projection, ‘O‘oma Beachside Village is roughly divided into three (3) areas: Area A, Area B, and Area C as shown on **Figure 3**.



Legend

'O'oma Beachside Village

FIGURE 1
Regional Location Map

'O'oma Beachside Village

North Kona Village, LLC — ISLAND OF HAWAII

NORTH — LINEAR SCALE (FEET) 0 500 1,000 2,000 4,000

PBR HAWAII & ASSOCIATES, INC.
4/03/2008

Source: U.S. Geological Survey

Disclaimer: This graphic has been prepared for general planning purposes only.

PATH/FILENAME: P:\Projects\Hawaii\60012984 NKV Ooma\500 Deliverables\Draft Civil Assessment\Figure 1 Location.dwg LAST UPDATE: May 05, 2008 @ 05:46:34 pm PLOT DATE: May 05, 2008 @ 05:46:44 pm

FIGURE 2
Conceptual Plan
`O`OMA BEACHSIDE VILLAGE

FIGURE 3
PROJECT AREAS
`O`OMA BEACHSIDE VILLAGE

1.1 ROADWAY

1.1.1 Existing Conditions

Presently, an unpaved jeep road intersects with Queen Ka‘ahumanu Highway at an unsignalized junction on the southern Property boundary. This connection is a State of Hawai‘i Department of Transportation (SDOT) recognized access point for the Property. There are no other existing roadways into the Property.

The State ROW, erroneously referred to on survey maps as “King’s Highway,” is located between Parcels 4 and 22 and extends north-south, paralleling Queen Ka‘ahumanu Highway. At the southern boundary of the Property, the State ROW and the Mamalahoa Trail share the same alignment; however, approximately one-third of the way into the Property, the two separate, with the historic Mamalahoa Trail veering slightly *mauka* and the State ROW coming to a dead end north of ‘O‘oma Beachside Village. It is understood that the portion of the State ROW not aligned with the Mamalahoa Trail is the result of a mapping error.

The Queen Ka‘ahumanu Highway is the primary arterial highway on the west side of Hawai‘i. The highway passes through the North Kona and South Kohala districts and connects Kailua Village with the Kona International Airport at Keahole, the Kohala resort areas, and Kawaihae. It is a two-lane Class I State Highway with limited access and a design speed of 70 miles per hour.

1.1.2 Development Demand

The SDOT and County of Hawai‘i have many roadway improvements planned to meet the expected growth of the West Hawai‘i area. The “Keahole to Honaunau Regional Circulation Plan County Action Plan” (August 2006) prepared by the County of Hawai‘i Planning Department (hereinafter referred to as the RCP) identifies nine (9) specific improvements pertinent to this study. Those improvements include the widening of Queen Ka‘ahumanu Highway to the airport and the development of an extensive roadway network *mauka* of the highway.

The SDOT is presently constructing a widening project on Queen Ka‘ahumanu Highway to four lanes between Henry Street and Kealakehe Parkway (Phase I). Phase I began in 2005 and is expected to continue through 2008. Continued widening to the Kona International Airport at Keahole (Phase II) is scheduled to begin in 2008. Existing and new intersections within the corridor will be signalized when warranted.

A separate Traffic Impact Assessment Report (TIAR) has been prepared for ‘O‘oma Beachside Village that assesses access to Queen Ka‘ahumanu Highway and traffic conditions along Queen Ka‘ahumanu Highway.

While this section focuses on the interior roads within ‘O‘oma Beachside Village, the RCP does impact the circulation of the private lands as well. As part of the RCP, a new network of roadways *mauka* of Queen Ka‘ahumanu Highway is planned to alleviate some of the north/south congestion. This new roadway network will be County-managed and will serve the local traffic in the Kona region. A timetable for the development of the new roadways has not been established. This *mauka* road will involve many individual land owners/developers and is not anticipated to be fully completed for another ten years.

In concert with a *mauka* road, the Draft Kona Community Development Plan (CDP) dated June 21, 2007 describes a frontage road *makai* of Queen Ka‘ahumanu Highway between the airport and Huliko‘a Drive. This frontage street will consolidate vehicular access points to Queen Ka‘ahumanu for the developments *makai* of the highway is intended to serve as a secondary transit route.

1.1.3 Proposed Infrastructure

The internal roadways of ‘O‘oma Beachside Village are being planned for private ownership and maintenance. However, for future consideration of County dedication, the roads will be built to County of Hawai‘i standards with curb, gutter, and sidewalks. The roadway will act as an access and maintenance easement for the County of Hawaii and utility companies. Landscaping at the entrance and along the main drive will enhance the ambience of ‘O‘oma Beachside Village. Reference **Figure 2** for the Conceptual Master Plan.

As noted above the internal roadways will follow the County of Hawai‘i Department of Public Works and Subdivision standards. The surface, base course, and subbase requirements will be determined during the preliminary design phase with the recommendations of a geotechnical engineer. The following schemes are made for the roadway pavement widths (not including sidewalks and landscaping):

Main Driveway:	50 feet	(including planting median)
Roadway Loop:	50 feet	
Alleyways (Minor Streets)	25 feet	

1.2 WATER

1.2.1 Existing Conditions

The Kona area receives minimal trade wind rainfall due to the high elevation land masses of Mauna Loa, Mauna Kea, and Hualalai.

Total annual rainfall estimated for the Kona area is approximately 1,200 mgd, with most of the activity occurring at the higher elevations of 1,200 to 3,500 feet msl. Most of this rainfall, over two thirds, is lost through evapotranspiration.

Water resources in the Kona area are groundwater based. The County of Hawai‘i Department of Water Supply (DWS) is the major purveyor for potable water. Four (4) major wells serve the North Kona System, running from Keahole International Airport south to Kealakekua.

Presently there are no public or private water transmission lines within the Property. An existing 12” waterline runs along Queen Ka‘ahumanu Highway from the Keahole Tank mauka of the Kona International Airport at Keahole, and presently terminates along the frontage of National Energy Laboratory of Hawai‘i Authority (NELHA) before reaching the ‘O’oma property. This waterline provides service to the Airport and NELHA.

There are currently 92 DWS water commitments available for Parcel 22. Each commitment is based on a 400 gallon per day per unit residence. The Water Standards categorize a standard Single Family unit with a consumption rate of 400 gallons per day.

There are considerations for a higher per residence usage on the West side of the island as the area is arid and the residence lots tend to be larger than a typical 5,000 square foot plot, thereby requiring more water usage for irrigation of landscaping. In addition, homes on the West side tend to be more than three bedrooms and thus the potential domestic use of potable water is increased.

DWS has informed us that since there are no similar type developments existing in the area, they would use an adjacent area’s water usage as a gauge on what gallon per day per unit amount that they would accept. The nearest developments with similar water usage are Keauhou to the South and Waikoloa to the North. DWS recognizes that these are two separate regions, as well as development types, and neither matches the ‘O‘oma Beachside Village.

Section 1.2.2 provides the estimated demand for ‘O‘oma Beachside Village and presents the assumed consumption rates for single family, multi-family, and non-residential uses.

Discussion with the DWS also confirms that while the credits are due to a customer, the use of the credits depends on the availability of source water. At this time, the Kona district water systems are reaching their current limits and DWS is looking at other source wells.

1.2.2 Development Demand

Due to the availability of R-1 effluent from the private wastewater treatment plant to be installed with ‘O‘oma Beachside Village as described in **Section 1.3** of this report, non-potable recycled water will be used for general irrigation of common landscaping features within the community. Potable water demand will be limited to that used for consumption, general household/commercial use, and irrigation of landscaping within individual residential lots.

The DWS determines water use demand based on land use converted to a capita per unit or capita per acre basis. For ‘O‘oma Beachside Village, the potable water demands have been calculated for the varying uses, as summarized in **Table 1** – Potable Water Consumption.

The irrigation (non-potable) water use demand is based on the acreages of general landscaped areas within ‘O‘oma Beachside Village, with an applied DWS demand rate for parks in the County of Hawai‘i. The estimated non-potable water demands are summarized in **Table 2** – Non-Potable Water Consumption.

Table 1 - Potable Water Consumption Estimate

Land Use Description	Area A (mgd)	Area B (mgd)	Area C (mgd)	Total (mgd)
Single Family Residential – Large Lots	0.077	---	---	**0.077**
Single Family Residential – Regular Lots	0.055	---	0.165	**0.220**
Multi-Family Residential	0.024	0.100	0.030	**0.154**
Mixed Use Residential	0.024	0.080	---	**0.104**
Multi-Family & Mixed Use Common Landscaping	0.014	0.027	0.006	**0.047**
Live-Work Residential	---	0.028	---	**0.028**
Commercial/Public Use	0.019	0.045	---	**0.064**
Total (mgd)	**0.213**	**0.280**	**0.201**	**0.694**

Table 2 - Non-Potable Water Consumption Estimate

Land Use Description	Area A (mgd)	Area B (mgd)	Area C (mgd)	Total (mgd)
Commercial/Public Use	0.006	0.009	---	**0.015**
Roads & Parking	0.078	0.030	0.048	**0.156**
Parks & Trails	0.036	0.018	0.084	**0.144**
Mamalahoa Trail Buffer	0.003	0.021	0.036	**0.060**
Other	---	---	---	**0.036**
Total (mgd)	**0.123**	**0.078**	**0.168**	**0.405**

The support calculations for these potable and irrigation water demand estimates can be found in **Appendix A**.

1.2.3 Proposed Infrastructure

There are several systems that can be considered for potable water infrastructure. The conventional potable water system within the area is comprised of a groundwater well *mauka* of Mamalahoa Highway with the DWS Kona Water System. Consideration for a private well, a joint-venture, or County well has been investigated; however, due to various reasons potable well water is not a feasible alternative for ‘O‘oma Beachside Village at this time.

To ensure a potable water source and a reliable system for ‘O‘oma Beachside Village, a desalination facility feeding a transmission, storage, and distribution system is proposed.

Several desalination processes are available and include Reverse Osmosis (RO), Multi-Stage Flash (MSF) Distillation, Ion Exchange, and Electrodialysis Reversal, among others. These processes were evaluated on the basis of feed and product water requirements, energy consumption, performance, operation and maintenance (O&M) requirements, and cost.

For operations and conditions in Hawai‘i, RO is a preferred process as it requires less energy compared to distillation techniques and it removes a wider range of minerals than electrodialysis reversal. RO has a higher water product recovery rate than distillation, reducing the volume of brine disposal.

The RO process uses a membrane filter that is highly permeable to water and only slightly permeable to dissolved solids. The membranes are subjected to high-pressure seawater, allowing only pure (potable) water through the membrane and leaving a brine solution as a filter reject solution. The major steps are:

- Intake Screening
- Pretreatment (removal of silts & solids)
- Desalination (removal of salts and dissolved constituents)
- Post-treatment (conditioning of water for potable use)
- Disposal of Byproducts (solids & brine by-products)

INTAKE SCREENING

Two possible sources of feedwater supply considered for desalinization are: 1) the NELHA deep (cold) or shallow (warm) systems, or 2) onsite deep wells that would tap saline groundwater at a depth beneath the brackish lens. A study conducted by Tom Nance Water Resource Engineering (under separate cover), concludes that feedwater received from NELHA or drawn from wells at depths below the basal lens will not impact the existing basal groundwater source. The desalination alternative is self-sufficient and environmentally sound, as it will not impact the basal lens or draw from the high groundwater within the Kona water system.

PRE-TREATMENT

Prior to RO, the feedwater will undergo pre-treatment. The pre-treatment process improves the RO process by removing particles and compounds that can negatively impact RO membranes. During pretreatment, the feedwater is conditioned and filtered. This process adjusts the acidity of the feedwater, and prevents formation of scales on RO membranes thereby maximizing the RO performance and life span.

DESALINATION

After pre-treatment, the feedwater is sent through the RO membranes at a pressure of up to 1,200 psi. During the RO process, total dissolved solids (TDS) in the filtrate will be reduced from approximately 37,700 mg/l to 300 mg/l. The salinity of the resulting reject brine (filtrates) solution is at a concentration of about twice that of the intake seawater.

POST TREATMENT

The RO product water will be conditioned by: 1) a small amount of sodium hydroxide for pH adjustment that will have no impact on the safety of the water for human consumption, and 2) sodium hypochlorite in small quantities for disinfection. This water is then the final product water and available for storage and distribution as “potable” (or “drinkable”) water.

DISPOSAL OF BYPRODUCTS

The proposed desalination facility will produce four (4) waste streams as listed below:

- Reject water from the ultrafiltration process (UF)
- Backwash water from the UF membrane cleaning process
- Reject water from the RO process (brine solution)
- Wasted membrane cleaning solution (WMCS)

Reject water from the pre-treatment process will contain compounds used for water conditioning. This waste stream will also include material rejected by the filter. Backwash water from the UF membrane cleaning process will be similar to the UF reject water. Disposal options include pretreatment and diffusing it into the nearby proposed wastewater treatment facility for processing. Another option would be through pretreatment and disposal into injection wells into the underground injection control area. A permit for injection wells will have to be filed with the State of Hawai‘i Department of Health (DOH) for this disposal option.

Reject water from the RO process will be a brine solution as mentioned above. The brine solution will be disposed of in on-site wells that will deliver the solution into the saltwater zone below the basal lens. The brine solution would have a salinity of approximately 60 percent, which is substantially denser than either open coastal seawater (salinity of 35 percent) or saline groundwater (salinity of 33-35 percent). Owing to the greater density, as well as the horizontal-to-vertical anisotropy of the subsurface lava flows, the concentrate will flow seaward without rising into and impacting basal groundwater. Discharge into the marine environment would be offshore at a substantial distance and depth.

For maintenance purposes, the process membranes will need more cleaning than can be provided by backwashing. Continuous monitoring of water quality and adjusting dosage of conditioning compounds can avoid this. Membrane cleaning solution (MCS), which will contain citric acid, can be used to help remove biological and precipitated inorganic buildup on the membranes. Most of the MCS will be recirculated; however, a part of the solution will be discarded after its cleaning ability is diminished. The MCS will be neutralized through basic additive prior to disposal. Disposal options for the MCS are same as the filter reject and backwash waters, i.e. pre-treatment prior to proposed wastewater treatment facility or underground injection.

ON-SITE DESALINATION ALTERNATIVE

Under the on-site alternative a 1.0 mgd desalination plant is proposed on the NELHA border of ‘O‘oma Beachside Village, *makai* of the proposed wastewater treatment plant. This location will allow efficient use of NELHA drawn waters (if provided) by minimizing the length of salt water transmission. Should deep saltwater wells be required, the lower ground elevation will also help in minimizing the well depth. A pressurized transmission system will be installed to pump the ‘potable’ water into a storage facility and be gravity-fed into an on-site distribution system.

The storage facility is proposed to be a new 0.5 million gallon tank located:

1. At the existing DWS Keahole Tank site (TMK (3) 7-3-010: 043);
2. On land on or in the vicinity of the future 1.0 million gallon Pālamanui reservoir site (TMK (3) 7-3-010: portion of 044);
3. On land directly mauka of ‘O‘oma Beachside Village (TMK (3) 7-3-009: portion of 005); OR
4. On other mauka lands mutually agreed upon by the Department of Water Supply, and ‘O‘oma Beachside Village, LLC.

For locations 1 and 2 a pressurized 8-inch forcemain will run along the NELHA/‘O‘oma boundary (on the Property), enter a utility corridor on Queen Ka‘ahumanu Highway and proceed up to the storage facility. Potable desalinated water from the proposed storage facility would be piped through a new 12” transmission main down to the Highway and South to ‘O‘oma and enter the Property at the Northern-most point. Reference **Figures 4 and 5** for water treatment, transmission, storage, and distribution. For locations 3 and 4, transmission line locations would need to be determined based on the location.

The existing 12” transmission main servicing Kona International Airport and NELHA presently runs along Queen Ka‘ahumanu Highway, however with the demands of new development, an additional main or upsizing of the existing main is required. This line may be extended further south as part of the Queen Ka‘ahumanu Widening Phase II project.

There is a potential to blend the potable and desalinated system and utilizing both the existing and proposed transmission main, as this will further stabilize DWS’s overall distribution system.

Presently, the DWS does not have a policy or regulations for the infusing of desalinated water into the distribution systems. However, due to decreasing potable well water availability in the region for existing and new customers, DWS has begun to consider the use of a blended well/desalination system. The present DWS Keahole storage tank does not have adequate capacity to hold and service ‘O‘oma Beachside Village and therefore an additional tank will be required, as previously stated.

This system will also provide fire protection for the development. During fire flow usage, the domestic meter is bypassed and flows are provided for fire protection. The proposed system and storage is sized accordingly and will accommodate fire flow requirements for the ‘O‘oma Beachside Village.

Should an off-site reservoir site and *mauka* transmission lines prove unfeasible, an option is an on-site pressurization system to provide a direct distribution system with ‘O‘oma Beachside Village. A storage tank and pressurized system would originate at the desalination facility and feed the distribution system for the community. A system of check valves and pressure reducing valves would regulate water pressure for domestic, commercial and fire protection use. This method of distribution, although kept within the Property, would incur higher operational costs.

PROPOSED UTILITY PLAN OVERALL LAYOUT

SCALE: NOT TO SCALE

AECOM

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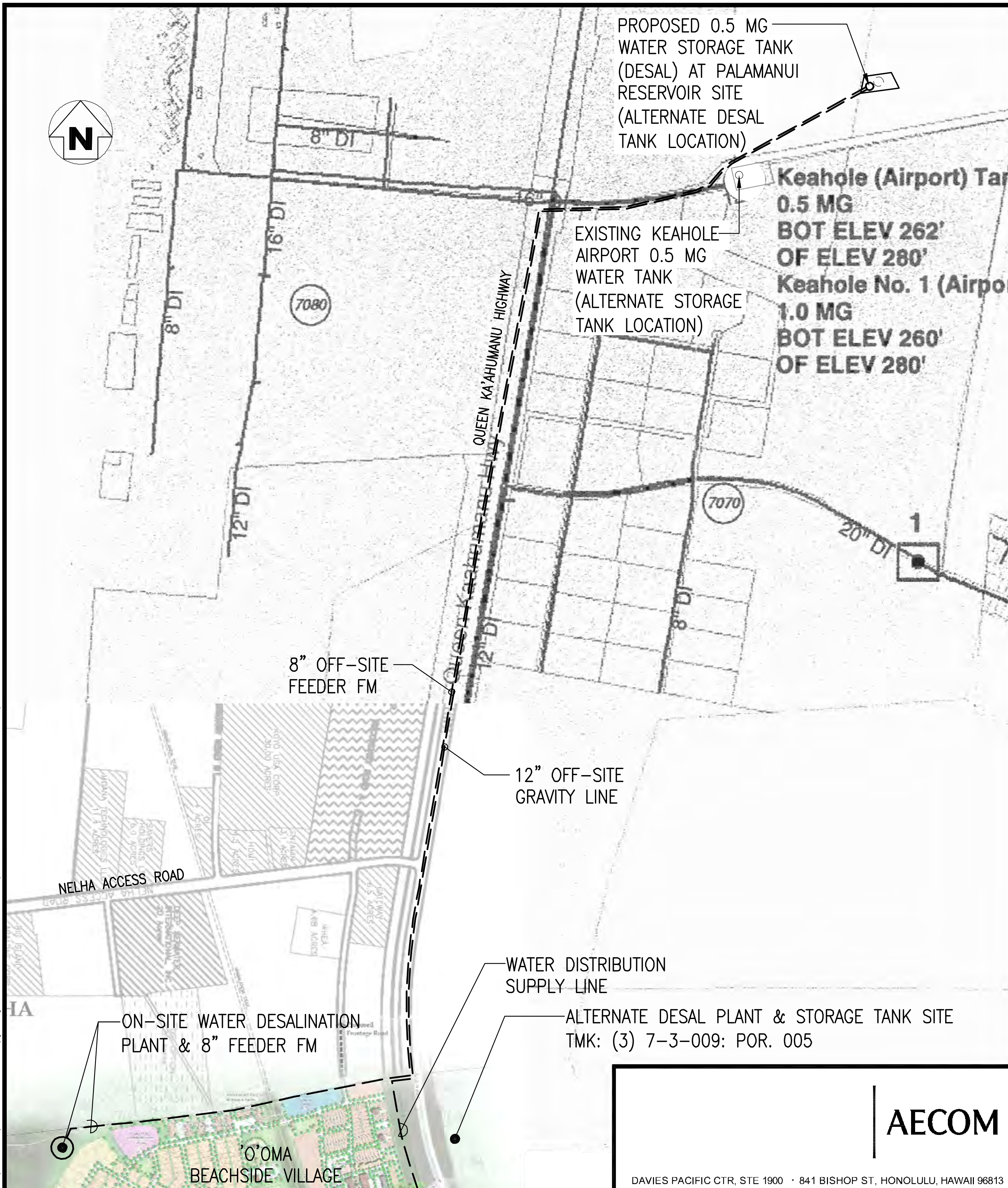
Figure 4
Proposed Utility Plan
Overall Layout

Infrastructure Report
'O'oma Beachside Villages
December 2008



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PROPOSED UTILITY PLAN
ON-SITE DESAL & OFF-SITE STORAGE

SCALE: NOT TO SCALE

Figure 5
Proposed Utility Plan
On-Site Desal & Off-Site Storage Layout
Infrastructure Report
'O'oma Beachside Village
December 2008

PATH/FILENAME: P:\Projects\Hawaii\60012984 NKV Ooma\500 Deliverables\Final Civil Assessment Revision 1\Figure 5.dwg LAST UPDATE: December 08, 2008 @ 03:41:43 pm PLOT DATE: December 08, 2008 @ 03:41:49 pm

Based on the availability of higher elevations on the *mauka* side of the highway, a gravity-fed distribution system is being pursued by the ‘O‘oma Beachside Village. However, a mechanically pressurized system is commonly operated in lower lying areas around the Country such as the mid-western plains, and level topographic municipalities found in Florida, Texas, among others.

OFF-SITE DESALINATION ALTERNATIVE

The off-site alternative follows the same principles of treatment and distribution as the on-site desalination and off-site storage alternative. (3)The proposed location of the off-site desalination facility would be the same as for the off-site storage alternative for the on-site desalination alternative:

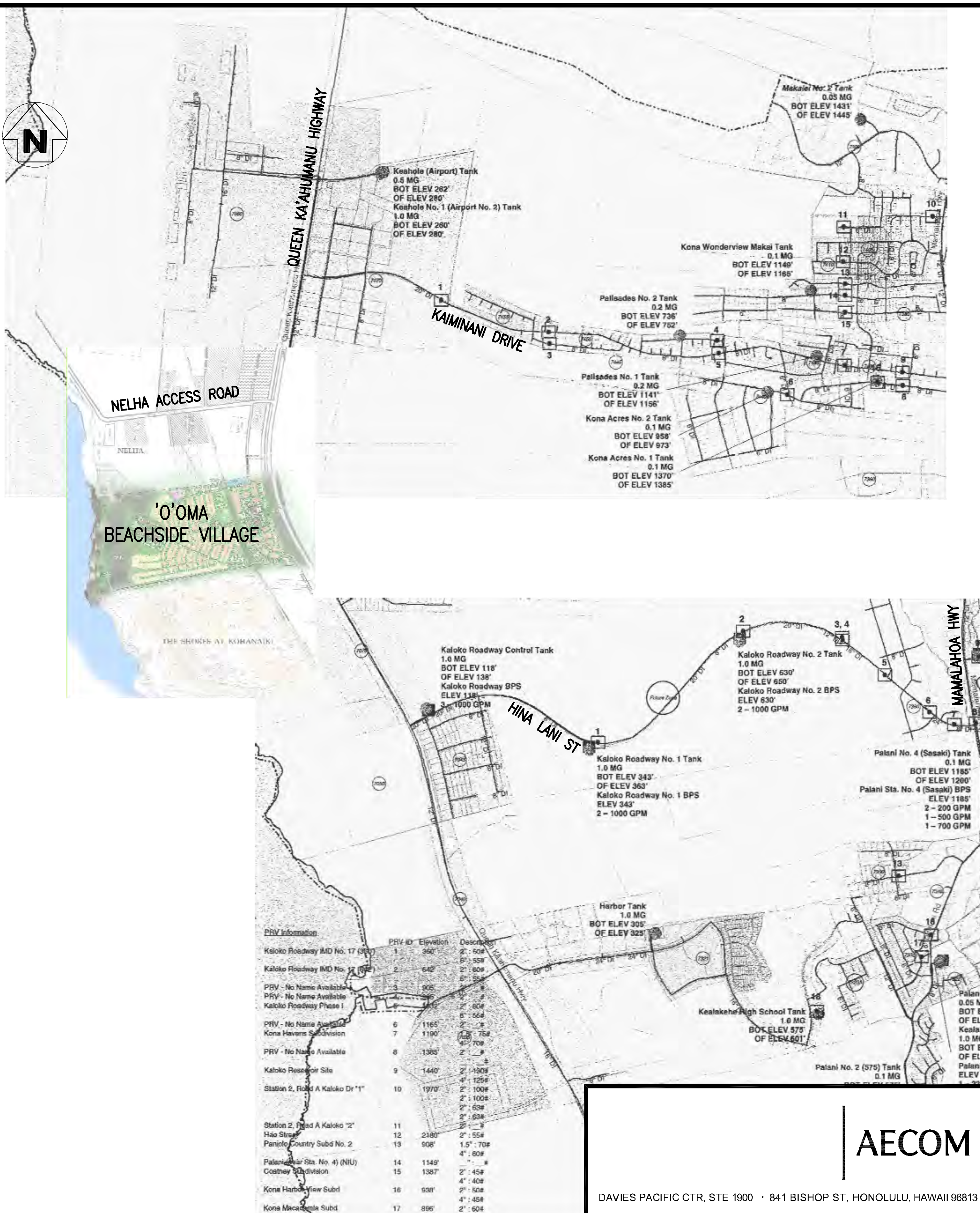
1. At the existing DWS Keahole Tank site (TMK (3) 7-3-010: 043);
2. On land on or in the vicinity of the future 1.0 million gallon Pālamanui reservoir site (TMK (3) 7-3-010: portion of 044);
3. On land directly mauka of ‘O‘oma Beachside Village (TMK (3) 7-3-009: portion of 005); OR
4. On other mauka lands mutually agreed upon by the Department of Water Supply, and ‘O‘oma Beachside Village, LLC.

Under this alternative, non-potable wells would be installed at the off-site location as a feedwater source in lieu of on-site wells or NELHA drawn waters. Similar to the previous alternative, ‘O‘oma Beachside Village would require a new 1.0 mgd desalination plant, and the potable water from the plant would be stored in a 0.5 million gallon storage tank located next to the desalination facility. Similar potable water distribution will occur downstream where a gravity-fed 12-inch pressurized main will run back along Queen Ka‘ahumanu Highway and enter the Property at the Northern-most point.

ALTERNATE SYSTEM

An alternate source of potable water could be utilizing the existing County Kona Water System as described in Section 1.2.1. The alternative requires use of the existing DWS 12” line along the Queen Ka‘ahumanu Highway that presently terminates along the frontage of NELHA. This line is planned to be extended south to the Kohanaiki Shores development (South of the Property) as part of the Queen Ka‘ahumanu Widening Phase II project.

The present DWS infrastructure is able to accommodate the increase in demand on the water system as additional source wells become available. Future well sites to be dedicated to the DWS are being negotiated with other developers and land owners. A proposed well into high level waters could be located south of Ka‘iminani Drive down to the Honokohau Tanks South of Hina Lani Street. The Kona Water System ties all the wells shown on **Figure 6** (Obtained from DWS Kona Water Mater Plan), and with the addition of source waters, this alternatives provides minimal construction of offsite infrastructure.



AECOM

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Figure 6
Department of Water Supply
Kona Water System
Infrastructure Report
'O'oma Beachside Village
December 2008

DWS KONA WATER SYSTEM

SCALE: NOT TO SCALE

PATH/FILENAME: P:\Projects\Hawaii\60012984 NKY Ooma\500 Deliverables\Final Civil Assessment Revision 1\Figure 6.dwg LAST UPDATE: December 04, 2008 @ 05:04:12 pm PLOT DATE: December 08, 2008 @ 03:20:07 pm

ON-SITE DISTRIBUTION

For either of the proposed potable water systems (desalination or potable well source), an on-site water distribution main will run along the ‘O‘oma Beachside Village access road from Queen Ka‘ahumanu Highway (however this would not be necessary if a on-site pressurization system is utilized). A 12” loop is recommended with 8” lines running into each development cluster. This system will be comprised of all new infrastructure, and will be design and constructed to meet DWS Design Standards. The total length of the on-site water infrastructure from the highway is approximately 9,300 linear feet. A preliminary layout of this on-site water system is also shown as part of **Figure 4**.

1.3 WASTEWATER

1.3.1 Existing Conditions

Wastewater treatment and disposal in the Kona area is mainly through individual wastewater systems (IWS) and private treatment facilities. Many single family residential units and public parks and facilities still utilize cesspool systems. However, the State Department of Health is presently governed by a consent decree to eliminate the use of such systems. For smaller facilities, a minimum treatment of a septic tank with disposal through leaching is required. For a community the size of ‘O‘oma Beachside Village, treatment by a private package plant or transmission to a larger treatment facility is necessary.

The three (3) closest treatment facilities to the Property are located at the Crown Lands of Keauhou and Kealakehe to the South and Kona International Airport at Keahole to the North.

The wastewater collection, treatment, and disposal system of the Keauhou Resorts area is a privately owned system that is maintained by the resort developers; mainly Kamehameha Investment Corporation (KIC). The wastewater from the resort’s lands is transported through a system of gravity lines and force mains to a 3.6 mgd sequencing batch reactors (SBR) facility. Effluent from the treatment facility is discharged into series of basins and used for irrigation at the resort golf courses.

This wastewater system is the farthest from the Property which makes this connection to this system an unfeasible alternative. Whereas there is currently some capacity available at the facility, this volume is reserved for KIC development.

A municipal wastewater treatment facility is located in the Kealakehe area south of Kealakehe Parkway. The 2.8 mgd wastewater treatment facility utilizes aerated lagoons for achieving secondary treated wastewater generated from the Kailua town area and along Ali‘i drive southward to Disappearing Sands. The excess capacity at this facility is reserved for its adjacent planned area.

The newly constructed tertiary treatment facility at the Kona International Airport at Keahole treats the wastewater generated from the airport and support facilities. This facility has expansion capabilities, however, past efforts to have the plant expanded for non-airport use by the County of Hawai‘i and others have been denied by the State of Hawai‘i, Department of Transportation, Airports Division. Effluent from this treatment facility is used for irrigation of the landscape at the airport entrance and main roadway.

Presently there are no public or private wastewater transmission lines fronting the Property. In December 2003, the County of Hawai‘i adopted Resolution 129-03 for the preparation of a North Kona Regional Sewerage Master Plan and a North Kona District Implementation Study for wastewater and recycled water system improvements for the Kealakehe, Honokohau, Kaloko, and Kohanaiki regions. The areas included in the implementation study are located adjacent to and just below the Property. As of April 2008, the sewer master plan for this implementation plan is in a draft stage.

A related resolution (Resolution 70-01) to initiate the extension of the municipal sewer system from Kealakehe Wastewater Treatment Plant to Kohanaiki was filed in December 2003, after a deferral in May 2001. The Kealakehe WWTP is currently slated for an upgrade and expansion (Hawai‘i County 2007). In addition, DEM will be installing infrastructure from Kealakehe Parkway to Kohanaiki in conjunction with Phase II of the DOT’s Queen Ka‘ahumanu widening project[1]. Plans for installing additional sewer and reuse infrastructure to service the North Kona Area and upgrades of the Kealakehe WWTP to provide R-1 reuse water are to be performed in additional phases. The DEM has indicated they may be able to supplement the irrigation supply for ‘O‘oma Beachside Village with effluent reuse from the Kealakehe WWTP.

There have been preliminary discussions between the County and DOT Highways to include a collection line and an effluent transmission line in Queen Ka‘ahumanu Highway as part of the second phase of the Highway expansion project. Along with the issues of including utility lines in the Highway expansion, the DOT, County, and other land owners are in discussion regarding the scope of the improvements.

1.3.2 Development Demand

The County of Hawai‘i Department of Public Works determines wastewater requirements on the basis of acreage, residential unit counts, and inflow/infiltration for dry and wet weather conditions. For design purposes, three (3) wastewater requirements are considered: the Design Average Flow, the Design Maximum Flow, and the Design Peak Flow. For ‘O‘oma Beachside Village, the demands have been calculated based on the County standards and are summarized in **Table 3** – Wastewater Demand Estimate. The wastewater system will be designed for the estimated Design Average Flow shown below.

Table 3 - Wastewater Demand Estimate

Flow Description	**Area A (mgd)**	**Area B (mgd)**	**Area C (mgd)**	**Total (mgd)**
Design Average Flow	0.132	0.219	0.128	**0.479**
Design Maximum Flow	0.627	1.036	0.608	**2.271**
Design Peak Flow	0.701	1.113	0.659	**2.473**

The support calculations for these demand estimates can be found in **Appendix B**.

[1] DEM letter dated May 30, 2007; letter included in Section 11.0 of this EIS.

1.3.3 Proposed Infrastructure

1.3.3.1 Wastewater Treatment

A private package wastewater treatment plant (WWTP) is recommended for ‘O‘oma Beachside Village. With the State Department of Health (DOH) and County of Hawai‘i Department of Water Supply (DWS) advocating the use of recycled water for non-potable purposes, a secondary facility that produces R-2 effluent is a minimal requirement. The production and use of R-1 effluent is preferred as it allows for the widest range of irrigation uses with the least amount of regulation and restrictions. Therefore, the WWTP for ‘O‘oma Beachside Village will be designed to produce an R-1 quality effluent for non-potable reuse throughout the community.

The proposed WWTP will utilize a membrane bioreactor (MBR) system to treat the wastewater from ‘O‘oma Beachside Village to produce R-1 recycled water. A MBR process is a biological treatment process (activated sludge process) combined with a separation process (membrane system). MBR systems are widely used throughout the world and are considered an industry standard for the production of reliable R-1 recycled water. An additional benefit of the MBR system is that is has a smaller facility footprint than other systems to allow for a minimal visual impact on the surrounding environment.

The specific components of the proposed MBR wastewater treatment system will be determined during the design phase of the project. Generally, however, an MBR system can reduce wastewater nitrogen concentrations from a typical 30-40 mg/l to <5 mg/l post-treatment, and phosphorous concentrations from a typical 7 mg/l to <2.0 mg/l post-treatment.

On-site sewer mains will run along the roadways wherever possible for the ease of maintenance. The majority of the collection system will be designed as a gravity system for discharge to the planned WWTP. However, due to the location of the WWTP a portion of the wastewater flow from Area A will be pumped to the WWTP via a package pump station and force main following primary collection by gravity flow.

The interior sewer mains will be a system of 8” gravity sewer lines with a 6” force main that discharges to the WWTP. The total length of the on-site wastewater infrastructure is approximately 32,200 linear feet. A preliminary layout of this on-site collection system is also shown as a part of **Figure 4**.

As previously mentioned, Resolution 70-01 was filed in 2001. The related Resolution 129-03, Draft 2, was adopted by the Hawai‘i County Council in December 2003. The adopted resolution proposed to initiate the preparation and submission of an Improvement District Implementation Study for the construction of wastewater system improvements for Kealakehe, Honokohau, Kaloko, and Kohanaiki. The Kona Community Development Plan (CDP) includes conceptual plans which may result in a new decentralized WWTP mauka of the Property. Thus, public wastewater treatment facilities to serve ‘O‘oma Beachside Village and the surrounding area may be available in the future. Under this scenario, a pump station and force main transmission line would replace the need for a private, on-site wastewater treatment facility. However, as the above resolution has already been adopted, it would be the responsibility of the ‘O‘oma Beachside Village, LLC to introduce a new resolution to the Council to include the Project area as a part of the study.

While a new County WWTP as noted in the CDP would be a viable alternative, without confirmation on schedule and redefining of the improvement district, ‘O‘oma Beachside Village will move forward with plans of developing its own treatment facility and R-1 reuse system.

1.3.3.2 Effluent Disposal / Reuse

There are essentially three (3) methods for effluent disposal including surface discharge (ocean outfall or stream discharge), reuse especially for crop/turf irrigation, and ground disposal (injection wells, seepage pits/trenches, percolation ponds). The alternative for effluent disposal via an ocean outfall is not feasible for various reasons including cost ($4,600 per linear foot) and environmental requirements and therefore will not be considered for this project. Effluent reuse and ground disposal will be considered in this section.

EFFLUENT REUSE

Over the last decade, the recycling of treated wastewater has gained public acceptance and is highly promoted as the preferred means of effluent disposal by the State of Hawai‘i as well as the Environmental Protection Agency (EPA).

Effluent reuse is governed by the DOH Chapter 11-62 and the Guidelines for the Treatment and Use of Recycled Water. The proposed effluent reuse areas are determined based on a water budget calculation that uses the following input variables:

- Rainfall.
- Evapotranspiration rate.
- Irrigation application.

In ‘O‘oma, and throughout the Kona coast, the climate is generally dry, with seasonal precipitation. Rainfall in this area is generally heaviest from October through March, and the average annual rainfall is approximately 25 inches. Less irrigation is needed to sustain plant growth during this “wet” period. From April to September, especially during the dry summer months, irrigation would be essential for proper plant growth.

For all reuse alternatives, DOH requires zero runoff of recycled water and zero percolation to the ground water aquifer during irrigation. During rainfall events, the DOH guidelines require that the effluent be stored or be discharged through a backup disposal system.

The DOH *Guidelines for the Treatment and Use of Recycled Water* (May 2002), state that R-1 quality water is suitable for any form of irrigation for food crops, with the stipulation that there will be no effluent irrigation within 50 feet of any drinking water supply well.

Another common use of R-1 water is for landscape irrigation. O‘oma Beachside Village is envisioned to be a sustainable and environmentally conscientious community, and recycling the effluent by means of landscape irrigation of parks and other common areas is part of this vision.

The effluent reuse system for ‘O‘oma Beachside Village would require an effluent storage facility for at least two (2) days storage, recycled water pumps, and recycled water transmission mains. As mentioned previously, little irrigation is expected during the “wet” period of October through March. Therefore, a 1.2 million gallon effluent storage reservoir is recommended for the effluent reuse system.

Injection wells, absorption trenches, and/or leachfields will be utilized as a backup means of effluent disposal to the primary method of effluent reuse. In extreme conditions, excess effluent may be produced which cannot be reused or stored. If this occurs, the overflow from the proposed irrigation reservoir would discharge into the standby ground disposal system(s).

GROUND DISPOSAL

The proposed WWTP site is below the Underground Injection Control (UIC) line and therefore injection wells within the Property are theoretically allowed. In accordance with the City and County of Honolulu *Design Standards, Volume 2* (as used by the County of Hawai‘i, per HRS §11-62-25), “the total injection capacity of the injection system shall be equal to or greater than 200 percent of the design peak flow rate.”

However, due to its proximity to the shoreline and its location within the Special Maintenance Area (SMA) the stand-by injection wells may potentially affect the ground water and shoreline water resources. The impacts of the proposed stand-by injection wells to the ground water resources or shoreline water quality are addressed in separate reports prepared by Tom Nance Water Resources Engineering and Marine Research Consultants. These reports conclude that ‘O‘oma Beachside Village will not have any significant negative effect on ground water or ocean water quality.

It is expected that the stand-by injection well capacity may deteriorate over time. Therefore, the standby injection wells will be periodically maintained and cleaned per DOH requirements. The proposed stand-by injection wells will be monitored for water depth, flow rate, and amount entering wells, as well as chemical usage during cleaning operations.

Additional methods of ground disposal include the use of absorption trenches and/or leachfields, which provide lateral effluent discharge at shallower depths and larger areas than the injection wells described above. Although the principals of these disposal methods are similar to that of the injection well, they are harder to maintain due to their extended layout and larger footprint. As an injection well is accessible from the surface, it can be flushed, pumped and cleaned as part of a maintenance program. Absorption trenches and leachfield disposal would be buried and have more limited access.

The WWTP will be run by a private operator, who will also be responsible for monitoring the stand-by ground disposal system(s) in accordance with Federal, State, and County regulations.

1.3.3.3 Sludge Handling

The County of Hawai‘i will not accept liquid waste sludge at County-run wastewater treatment facilities as they have difficulty in accepting large septage loads from private facilities. Therefore, the MBR system will provide on-site sludge handling, including a sludge holding tank with a capacity for at least five (5) days storage for waste sludge and a sludge dewatering facility. The holding tank will allow the downstream sludge dewatering facility to operate on a “batch” mode of operation (as opposed to continuously operated) and to produce a homogeneous sludge feed characteristic that will allow for optimal sludge dewatering. The dewatering process will produce “cake sludge” that can be disposed of at the Pu‘uanahulu landfill, which accepts sewage sludge.

1.4 STORM WATER DRAINAGE

1.4.1 Existing Conditions

Kona’s dry weather and very porous surface conditions support the design of a stream-lined, non-extravagant storm drain system.

During wet weather conditions, the typical drainage pattern due to the topography of the area would direct storm water runoff from the mountains flows down to Queen Ka‘ahumanu Highway. However, due to high permeability of the natural ground surface across the Property and on the upland slopes mauka of the Property, surface runoff rarely occur even during heavy rainfalls. At present, about half of the annual rainfall that occurs on the Property percolates to the underlying groundwater. The balance is evaporated or transpired into the atmosphere.

During extreme storm conditions, such as design 50- or 100-year storms, storm water sheet flow is cut off by the highway and diverted parallel-wise to a series of culverts that run under the roadway. The nearest highway culverts to the Property are located at milepost (MP) 94.43 and MP 95.25.

The existing 30” Corrugated Metal Pipe (CMP) at MP 94.43 is located closer to the airport and is over 1,000 feet north of the Property. A 14’-10” by 9’-1” culvert located at MP 95.25 is situated approximately 950 feet south of the existing access road. This runoff should continue to the south and not impact the Property.

Presently there are no other recorded storm drain culverts nearby or within the Property. The area downstream of the Property is open to the ocean. The existing drainage pattern allows for any on-site storm water runoff that has not evaporated back into the atmosphere or detained by natural topography to discharge into the ocean. As mentioned previously, these storm conditions are based on theoretical design storms as a significant majority of storm waters do not reach the ocean front.

The ocean waters along the coastline in the area of the development are classified as Class AA. The DOH requires that marine waters with this classification “remain in their natural pristine state as nearly possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions,” (Ref. HAR §11-54-3(c)). Therefore, any additional storm water runoff generated by O‘oma Beachside Village will be collected and effectively discharged or treated to maintain the integrity of the shoreline waters.

1.4.2 Development Runoff Flow

The County of Hawai‘i Department of Public Works determines stormwater discharge flows based on acreage, ground cover conditions, rainfall intensity (by locale), and a design storm condition. For drainage areas of 100 acres or less, a 10-year recurrence interval design storm is considered.

The drainage area considered for the Property is bounded on the north, south, by the Property’s boundary, to the West by the limits of the Area A (as shown on **Figure 3**), and to the east by Queen Ka‘ahumanu Highway. As discussed in Section 1.4.1, stormwater from the *mauka* side of the highway runs parallel to the highway and discharges *makai* of the highway through a series of culverts none of which are located within the Property.

Based on these drainage limits and design conditions, the following discharge flows have been calculated using County standards for the existing conditions.

Total Area:	303 acres
Total Flow (10-year storm):	228.5 cfs

As the area is developed, the amount of open, porous ground surface is replaced by impervious rooftops and roadway pavement. This increases the amount of runoff produced by the same area under the same storm conditions. The primary design criterion for storm water runoff used by County Public Works is containment of any net increase in flow within the source’s property. Thus, all increase in flow has to be retained by the developed property via retention basins or drywells.

Based upon the conceptual plan for the future development, an approximate future flow condition has been calculated for the master-planned areas.

Area A	143.5	cfs
Area B	115.5	cfs
Area C	152.5	cfs

A preliminary layout of the described on-site storm water collection system is shown as a part of **Figure 4**. The support calculations for existing and future flows can be found in **Appendix C**.

1.4.3 Proposed Infrastructure

For ‘O‘oma Beachside Village, the increase in storm runoff flow will be fully contained within the Property via a combination of on-site permanent Best Management Practices (BMPs) and a roadway storm drain system. The permanent BMPs are discussed in **Section 1.4.4** of this report. Due to the location and existing soil conditions of the Property, it is recommended that the storm drain system consist of drain inlets and/or catch basins (where there may be roadway curb) with drywells. The use of drywell discharge will require an underground injection control (UIC) permit from the DOH Safe Drinking Water Branch. All the drywells within the Property will be installed, operated, and maintained in accordance with the applicable Federal, State, and local regulations for UIC discharge.

The minimum storm drain line size is 18” diameter per County requirements. However, if the system is maintained as a private system, there may be local areas where 8” and 12” lines may be installed. The typical drywell design will be 6-foot diameter and 20 foot depth, with an average capacity of 6 cfs per well.

The design of the storm drain system shall be done to eliminate any on-site flooding and ponding conditions. For smaller confined areas where low flows make it impractical to construct a 20-foot deep drywell, a shorter 8-foot wide by 8-foot deep drywell can be utilized. These smaller wells have a lesser capacity for storm drain discharge of 2 cfs.

In September 2002, a proposed development nearby in the Kaloko district called for a pilot system where storm drain filtration devices are used in drainage structures. (Ref **Appendix C**, TSA Rezoning Ordinance No. 02-114, Section F.) However, in discussions with the County of Hawai‘i, Department of Public Works, the implementation of this program is being re-evaluated in light of maintenance issues. During design of ‘O‘oma Beachside Village, the status of the pilot system will be acknowledged and the storm drain system shall be designed in conjunction with County requirements.

Based on the runoff quantities approximated in **Section 1.4.2** and the delineation of estimated drainage areas, a minimum of 42 drywells (6 cfs capacity) for Area A, 45 for Area B, and 34 for Area C will be required. At this stage, actual grading of the Property has not been conducted; therefore, the future flow runoff may be affected by steeper/flatter slopes, less/additional pavement areas, intermediate low spots or sump conditions, etc. To minimize any impacts from non-point source discharge, ‘O‘oma Beachside Village will be designed with paved roadway swales and/or curb and gutters and other permanent BMP considerations as discussed in **Section 1.4.4** of this report. As stated earlier, under all conditions, containment of any net increase in runoff flow to the downstream parcels is required to obtain County approval.

The safeguarding of ground water and shoreline water quality is not just a temporary issue but also requires the consideration and inclusion of permanent Best Management Practices (BMPs) to assure continuous protection of the State’s water bodies. The County of Hawai‘i is planning to establish a Storm Water Management Plan (SWMP) and may potentially add water quality measures as part of the County drainage standards. The City and County of Honolulu is currently implementing such a program and is in the process of updating their drainage standards to include various water quality protection requirements. While the formulation of a County of Hawai‘i SWMP is not yet contracted as of April 2008, additional consideration should be given to the addition of more detention ponds, grassing, and other permanent BMPs.

Similar to the wastewater reuse and disposal concerns, the storm water discharge may potentially affect the ground water and shoreline water in the area. As previously mentioned, Tom Nance Water Resources Engineering and Marine Research Consultants conducted separate reports analyzing storm drain infiltration, potential effluent reuse, and other issues that may impact the quality of groundwater and shoreline waters. These reports conclude that ‘O‘oma Beachside Village will not have any significant negative effect on ground water or ocean water quality.

1.4.4 Best Management Practices (BMPs)

Best Management Practices (BMPs) are control measures used during construction activities (temporary) or incorporated into a project design (permanent) that serve to reduce pollutants from storm water and protect the downstream drainage systems or waterbodies. BMPs used for any particular project are site-specific to ensure the measures are used to their greatest effectiveness. As the grading and design of the ‘O‘oma Beachside Village has not yet been determined, the actual BMPs to be implemented for ‘O‘oma Beachside Village will be selected during the design and construction phases of the project.

The Project will utilize both temporary and permanent BMPs during its design and construction. Temporary or Construction BMPs are practices that are intended to be used only during the construction phase of the project. These measures are installed before any construction activities begin on the site, and are only removed when construction is complete and the permanent BMPs have been adequately established. Construction BMPs may typically consist of, but are not limited to: measures to control soil erosion, storm water runoff, dust pollution, and water quality protection.

The safeguarding of ground water and shoreline water quality is not just a temporary issue but also requires the consideration and inclusion of permanent BMPs to assure continuous protection of the State’s water bodies. The County of Hawai‘i is planning to establish a Storm Water Management Plan (SWMP) and may potentially add water quality measures as part of the County drainage standards. The City and County of Honolulu is currently implementing such a program and is in the process of updating their drainage standards to include various water quality protection requirements. While the formulation of a County of Hawai‘i SWMP is not yet contracted as of December 2008, additional consideration should be given to the addition of more detention ponds, grassing, and other permanent BMPs.

Unlike construction BMPs, permanent BMPs are incorporated into the design of a project and are intended to reduce runoff from the project site, control the sources of pollutants, and treat polluted runoff. These BMPs are monitored and maintained after project completion. Permanent BMPs that may be considered for implementation at the ‘O‘oma Beachside Village include, but are not limited to measures that will: decrease impervious surfaces, minimize earthwork activities, increase bioretention, localize storm water runoff for discharge and reuse, and protect downstream water quality.

While these approaches will ease the quantitative impacts of storm runoff, the BMP measures that are implemented during construction and as permanent features will also mitigate the qualitative aspects of the storm runoff throughout ‘O‘oma Beachside Village.

1.5 SOLID WASTE

1.5.1 Existing Conditions

The County of Hawai‘i currently maintains two (2) active landfills on the island of Hawai‘i. One landfill is located in Hilo, and the other is located north of the Property at Pu‘uanahulu. Island residents collect their solid waste trash and transport it to any one of the 21 solid waste transfer stations located around the island. In some areas of the island, residents may hire a private collection company to pick-up their solid waste for disposal at a landfill.

The nearest transfer station to the Property is the Kailua Transfer Station, located approximately 2.7 miles to the southeast of the Property. According to the latest County of Hawai‘i *Integrated Solid Waste Management Plan* (December 2002), this transfer station collects approximately 22% of the total solid waste that is eventually transported to the Pu‘uanahulu landfill, which is anticipated to reach full capacity in about 40 years.

1.5.2 Development Waste Generation

The County of Hawai‘i Department of Environmental Management Solid Waste Division (DEM-SWD) does not have a means of estimating the anticipated solid waste that will be generated for a new development. To obtain an estimate for master-planning purposes, the rates used for a recent preliminary solid waste management plan prepared for an existing Kauai residential and commercial development were applied to ‘O‘oma Beachside Village on the basis of residential unit counts, residential area acreages, commercial area acreages, and an estimated population.

For ‘O‘oma Beachside Village it is estimated that approximately 2,160 to 2,568 tons of solid waste will be generated each year. The solid waste generation estimate is summarized in **Table 4** - Solid Waste Generation. The support calculations for these generation estimates can be found in **Appendix D**.

Table 4 - Solid Waste Generation

Land Use Description	Area A (tons/year)	Area B (tons/year)	Area C (tons/year)	Total (tons/year)
Single Family Residential – Large Lots	123 – 149	---	---	**123 – 149**
Single Family Residential – Regular Lots	158 – 175	---	455 – 525	**613 – 700**
Multi-Family Residential	67.5 – 90	293 – 375	82.5 – 113	**443 – 455**
Mixed Use Residential	61.3 – 105	263 – 350	---	**324.3 – 455**
Live-Work Residential	---	75 – 105	---	**75 – 105**
Commercial/Public Use	135	446	---	**689**
Total (tons/year)	**545 – 654**	**1,077 – 1,276**	**538 – 638**	**2,160 – 2,568**

1.6 POWER AND COMMUNICATIONS INFRASTRUCTURE

1.6.1 Electrical System – Existing Conditions

The Property is not currently served by any existing HELCo facilities. The nearest source of existing power is the 69 KV transmission overhead line on the *mauka* (east) side of Queen Ka‘ahumanu Highway. The next available source of power is the existing substation serving the NELHA. However, HELCo has determined that the substation does not have the spare capacity to accommodate our 18.6 MVA maximum projected loads. Reference power calculations and HELCo letter dated September 12, 2006 in **Appendix E**.

1.6.2 Electrical System – Proposed Infrastructure

HELCo will require a new fenced 150’ x 150’ lot for the substation’s 69 KV tower and pad-mounted transformer, preferably adjacent to the existing 69 KV overhead line. If creating a substation *mauka* of the Queen Ka‘ahumanu Highway right-of-way is problematic, the alternate choice would be to construct the substation *makai* of the highway within the Property. HELCo would install an overhead 69 KV crossing of the highway to the new substation, with underground distribution to the Property. An underground 69 KV line extension in lieu of an overhead drop may be considered, however this would need to be coordinated with the Department of Transportation, Highways Division.

Previous discussions with the County Planning Department have suggested the 150’ highway setback area along Queen Ka‘ahumanu Highway may be used for the HELCo substation. This solution shall be pursued, as submission of this portion of the Property would not impact the overall developable land area that is planned. Whereas the substation is not housed in a building, solid fences and landscaping may be necessary to soften the visual impact of the substation.

HELCo estimates a $1.2 million basic overhead service cost and a 2-year design/ construction schedule for the substation. The $1.2 million Advance will be refunded to the payee over the next 5 years as load is added to the substation and meter revenue is generated.

The electrical consumption demand is summarized in **Tables 5 & 6** – Electrical Consumption Estimate in MVA and kW-hr/yr, respectively. The support calculations for these consumption estimates can be found in **Appendix E**.

Table 5 - Electrical Consumption Estimate (MVA)

Land Use Description	**Area A (MVA)**	**Area B (MVA)**	**Area C (MVA)**	**Total (MVA)**
Single Family Residential – Large Lots	0.85	---	---	**0.85**
Single Family Residential – Regular Lots	1.00	---	3.00	**4.00**
Multi-Family Residential	0.60	2.50	0.75	**3.85**
Mixed Use Residential	0.60	2.00	---	**2.60**
Live-Work Residential	---	0.70	---	**0.70**
Commercial/Public Use	2.17	3.55	---	**5.72**
Street Lighting & Incidentals	0.26	0.44	0.19	**0.89**
Total (MVA)	**5.48**	**9.19**	**3.94**	**18.6**