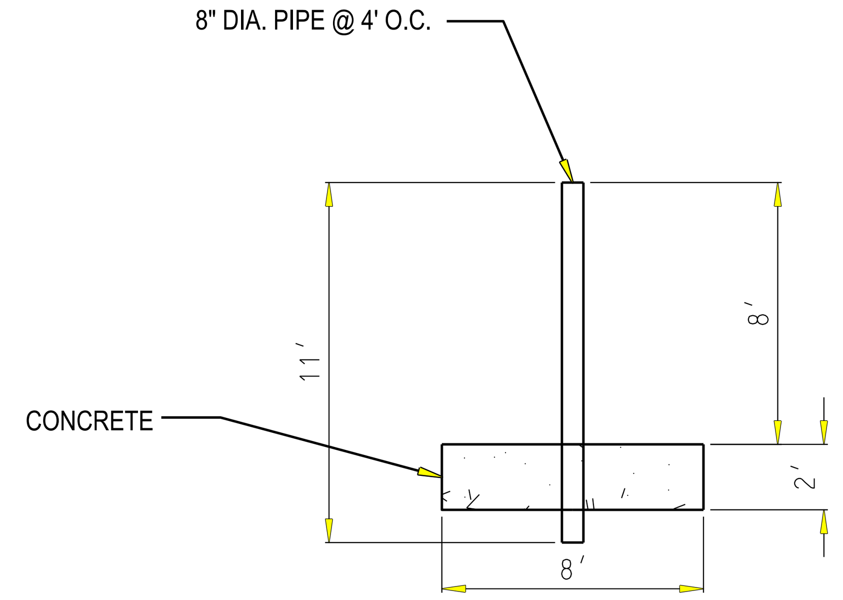
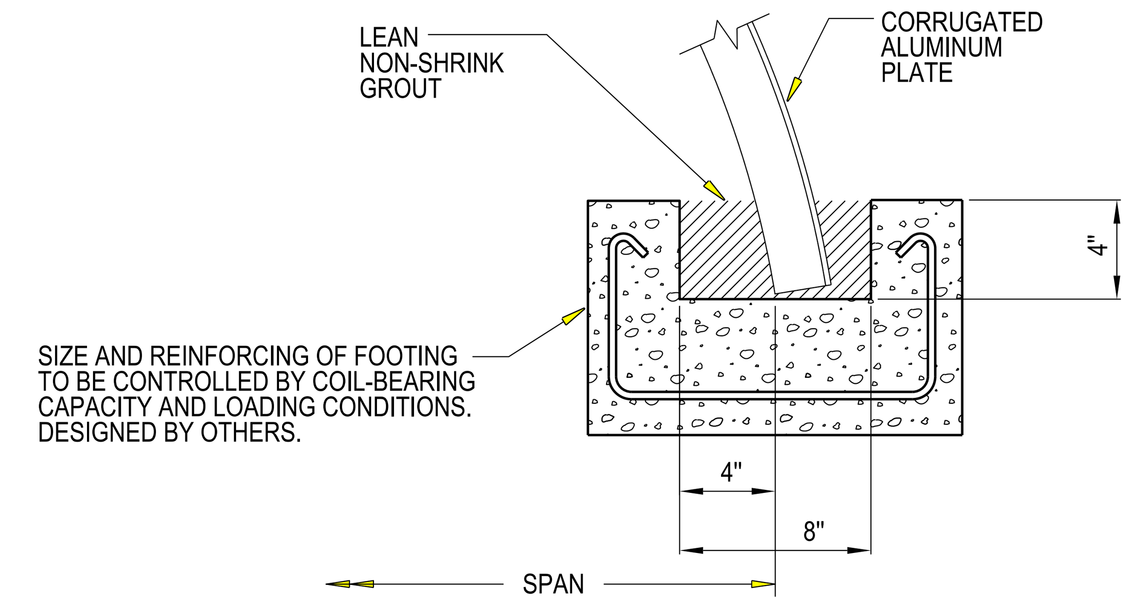


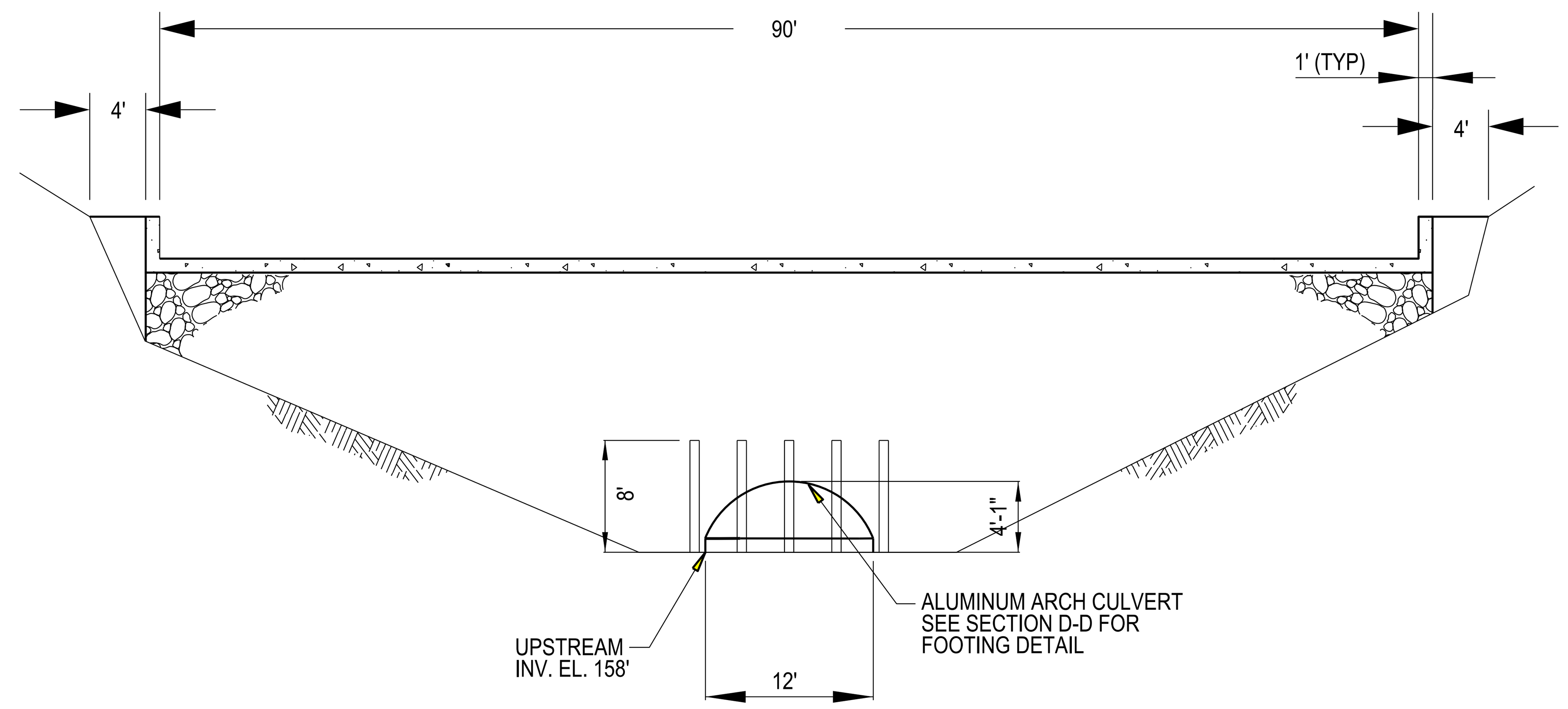
MAKIKI DEBRIS AND DETENTION BASIN SECTION A-A

SCALE: 1"=5'



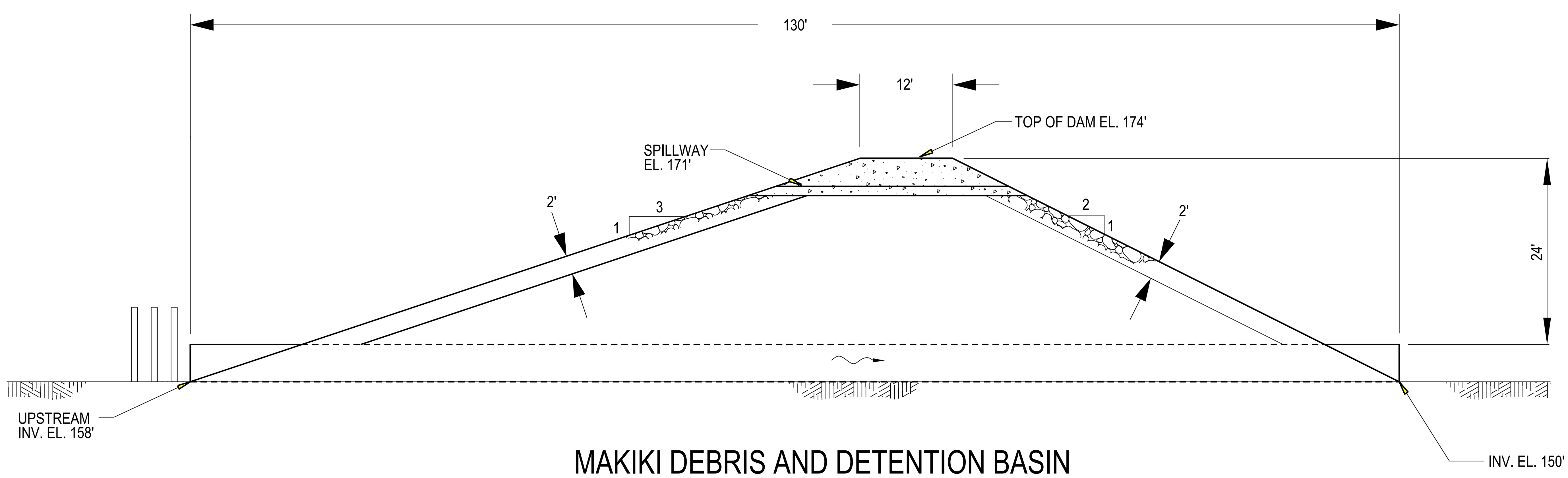
SLOTTED CONCRETE FOOTING MAKIKI DEBRIS AND DETENTION SECTION D-D

SCALE: NTS



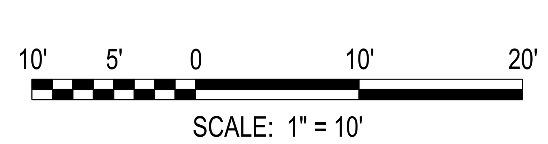
MAKIKI DEBRIS AND DETENTION BASIN SECTION B-B

SCALE: 1"=10'

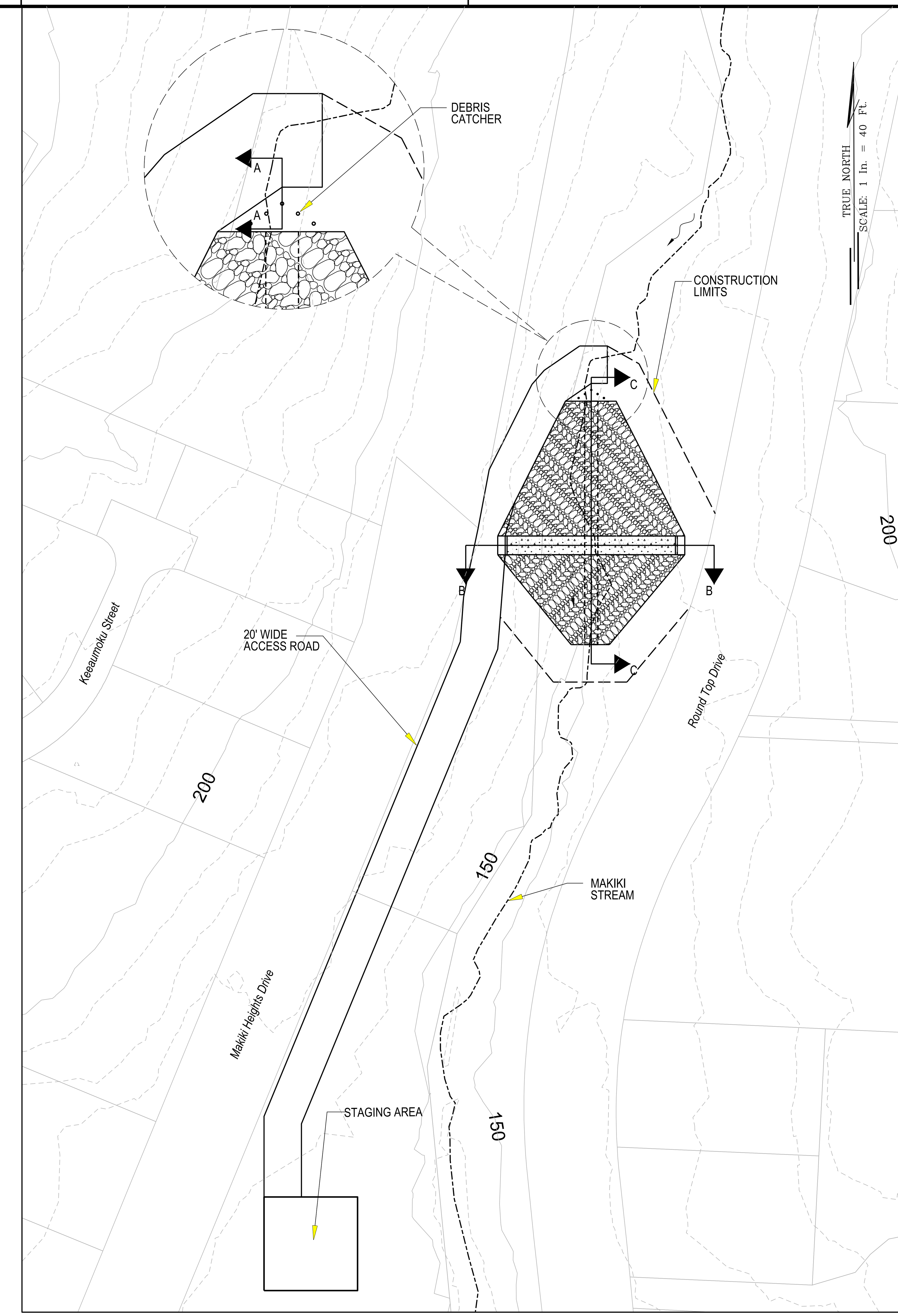


MAKIKI DEBRIS AND DETENTION BASIN SECTION C-C

SCALE: 1"=10'



Note: All elevations are feet MSL



SOLID LINE = 50' CONTOURS
DOTTED LINE = 10' CONTOURS

PLAN

SCALE: 1"=40'

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HONOLULU, HAWAII

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SUBMITTED BY:		LOCATION CODE	
PLOT SCALE: AS SHOWN	PLOT DATE: 12/15/2014	DRAWING NUMBER:	
SIZE: ANSI D	FILE NAME: MAKIKI DEBRIS & DETENTION BASIN, PLAN & SECTIONS		

ALA WAI CANAL PROJECT

MAKIKI DEBRIS AND DETENTION BASIN
PLAN AND SECTIONS
ALTERNATIVE 2A

SHEET IDENTIFICATION
C-315
SHEET 18 OF 25

FILE: c:\pw-work\poh-1\j3ec9jhh\d0139948\Ala_Wai_C-315xxx.dgn
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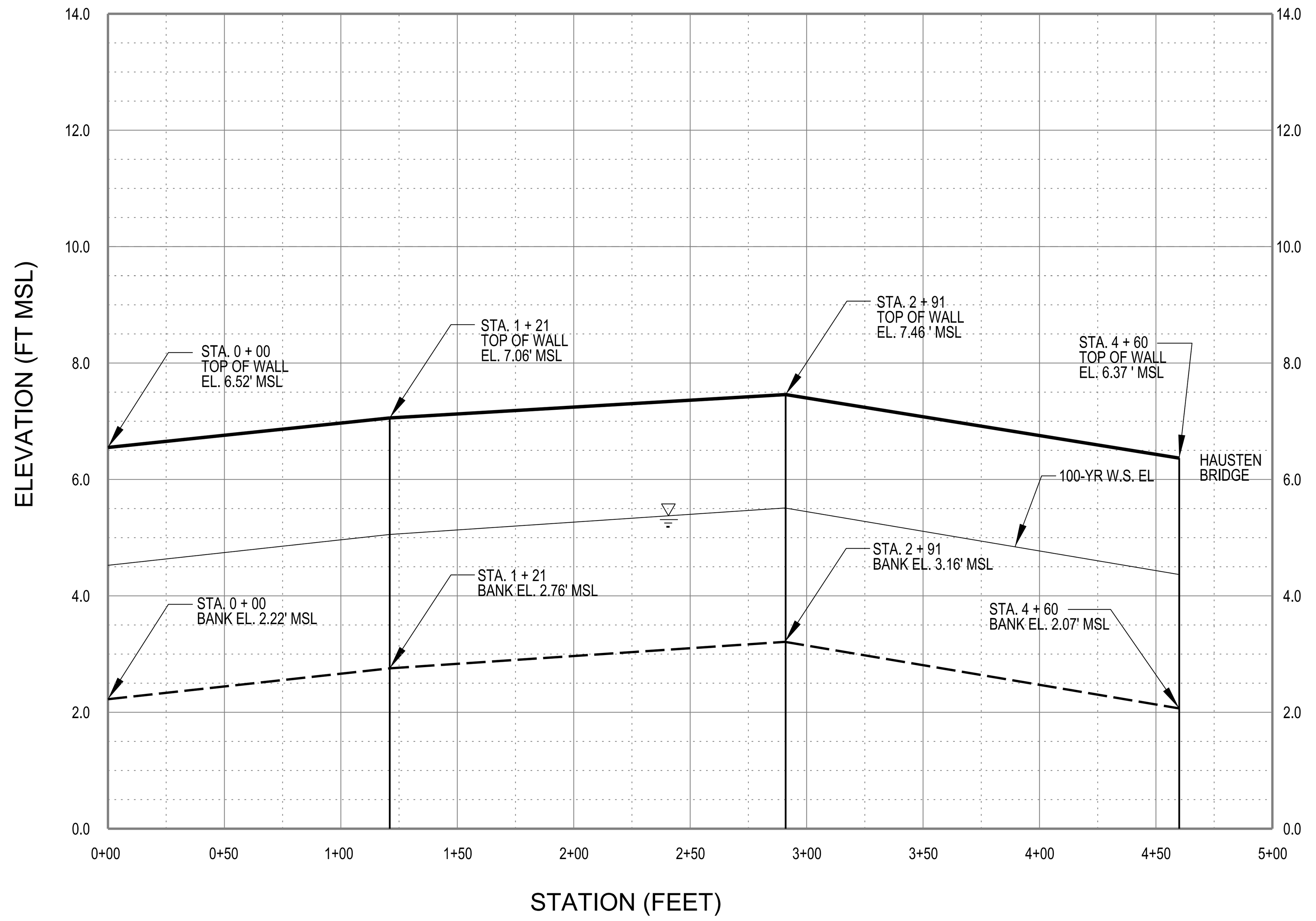
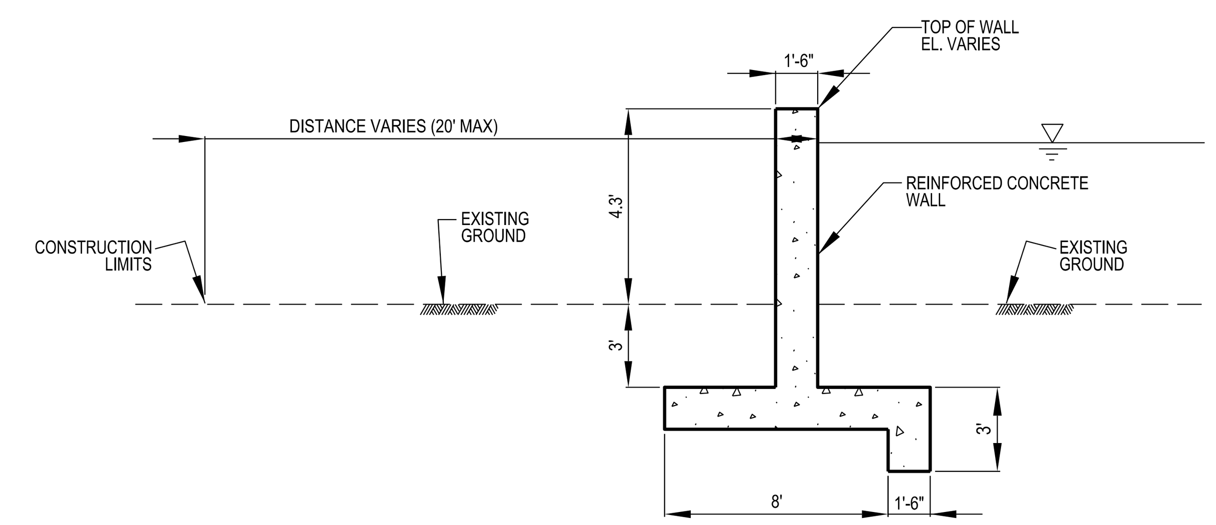
PEN TABLE: BW_and_Grayscale_Pen.tbl
PRINTED BY: J3EC9JHH



PROFILE

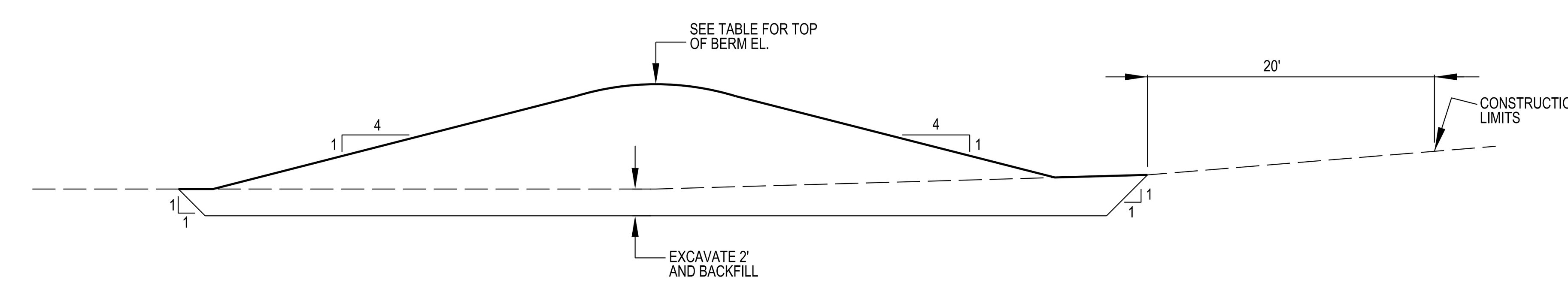
HAUSTEN DITCH RIGHT BANK FLOODWALL

SCALE:
HORIZONTAL: 1" = 50'
VERTICAL: 1" = 2'



A TYPICAL REINFORCED CONCRETE FLOODWALL SECTION

NOT TO SCALE



B HAUSTEN TYPICAL EARTHEN BERM SECTION

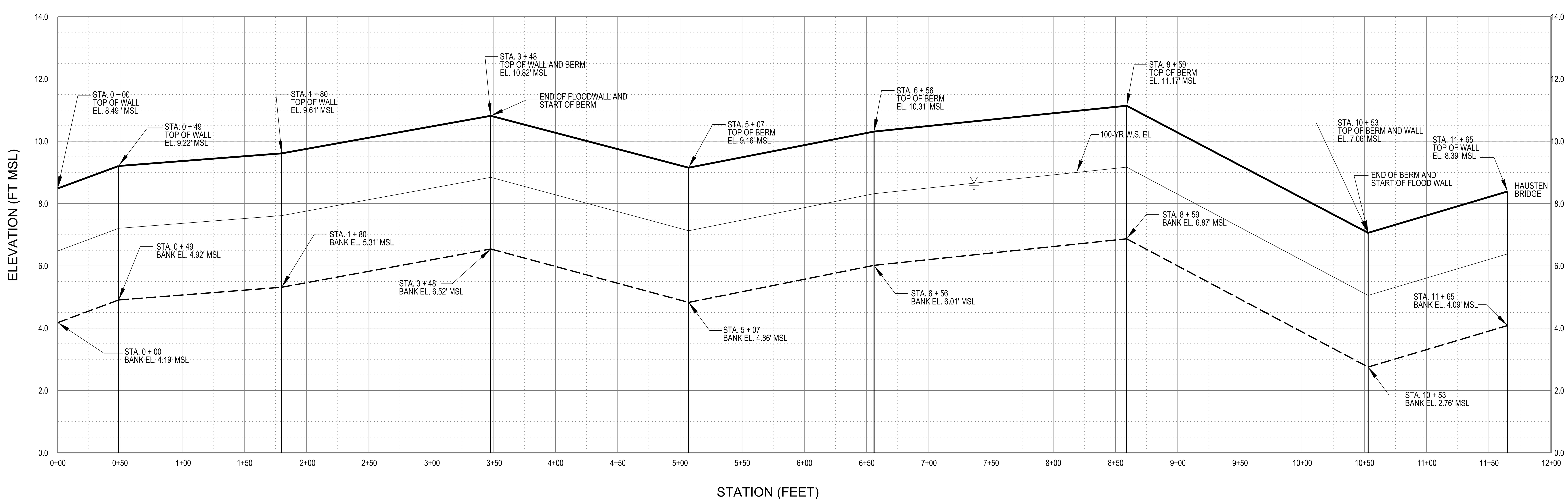
NOT TO SCALE

HAUSTEN DITCH RIGHT BANK FLOODWALL
STA TO 0 + 00 TO 4 + 60

STATION	WALL HEIGHT (FT)	FINISHED WALL ELEVATION (FT MSL)
0 + 00	4.30	6.52
1 + 21	4.30	7.06
2 + 91	4.30	7.46
4 + 60	4.30	6.37
HAUSTEN BRIDGE		

HAUSTEN DITCH LEFT BANK
FLOODWALL AND BERM
STA TO 0 + 00 TO 11 + 65

STATION	WALL HEIGHT (FT)	FINISHED WALL ELEVATION (FT MSL)
0 + 00	4.30	8.49
0 + 49	4.30	9.22
1 + 80	4.30	9.61
3 + 48	4.30	10.82
END OF FLOODWALL AND START OF BERM		
3 + 48	4.30	10.82
5 + 07	4.30	9.16
6 + 56	4.30	10.31
8 +59	4.30	11.17
10 + 53	4.30	7.06
END OF BERM AND START OF FLOODWALL		
10 + 53	4.30	7.06
11 + 65	4.30	8.39
HAUSTEN BRIDGE		



PROFILE

HAUSTEN DITCH LEFT BANK FLOODWALL AND BERM

SCALE:
HORIZONTAL: 1" = 50'
VERTICAL: 1" = 2'

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MODEL NAME: C-316
DATE & TIME: 12/15/2014 2:30:16 PM
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PLOTDRIVER: C:\ProgramData\Bentley\MicroStation V8i (SELECTseries)\WorkSpace\system\plotcfg\printer.pltcfg
PEN TABLE: BW_and_Grayscale_Pen.tbl
PRINTED BY: J3EC9JHH

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MARK	DESCRIPTION	DATE	APPR

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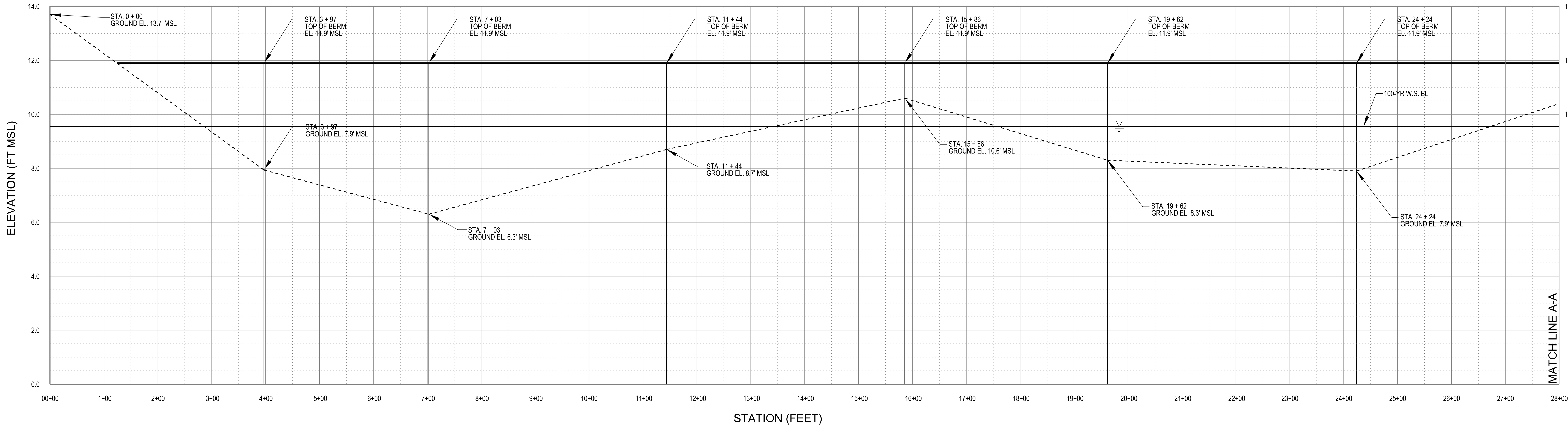
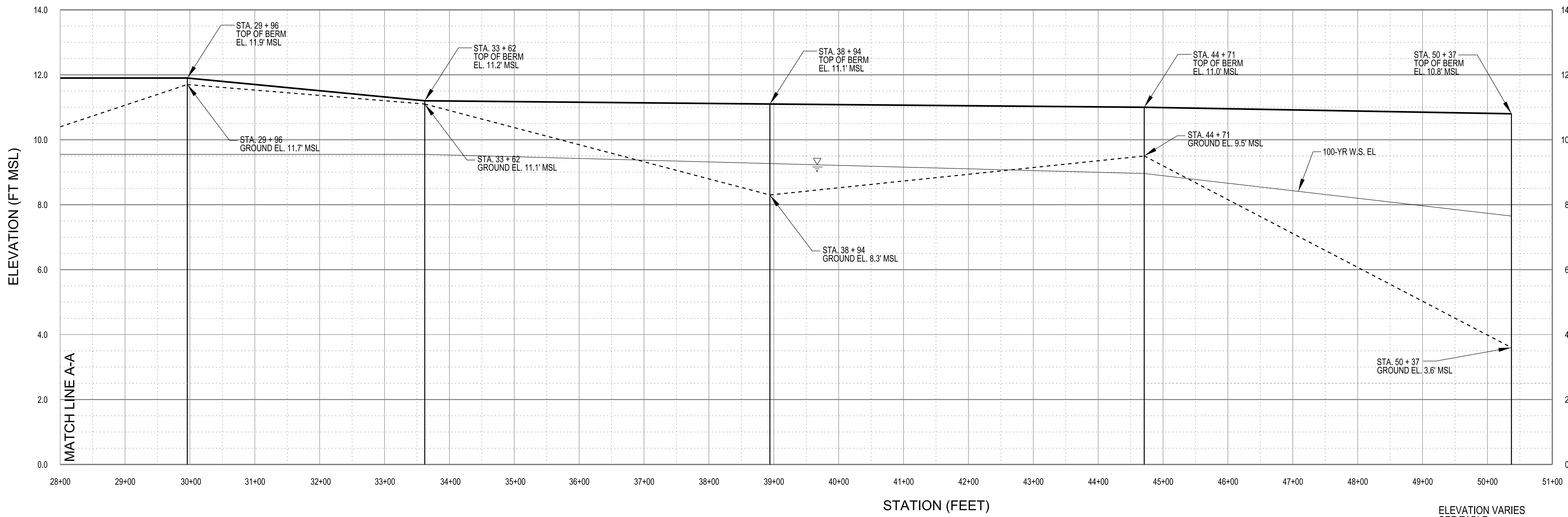
SUBMITTED BY: | SOLICIT / CONTRACT NO.: | LOCATION CODE
PLOT SCALE: AS SHOWN | PLOT DATE: 12/15/2014 | DRAWING NUMBER:
SIZE: ANSI D | FILE NAME: HAUSTEN DITCH, PROFILE & SECTIONS

ALA WAI CANAL PROJECT

HAUSTEN DITCH FLOODWALL AND BERM
PROFILE AND SECTIONS
ALTERNATIVE 2A

SHEET IDENTIFICATION
C-316
SHEET 19 OF 25





ALA WAI GOLF COURSE BERM PROFILE

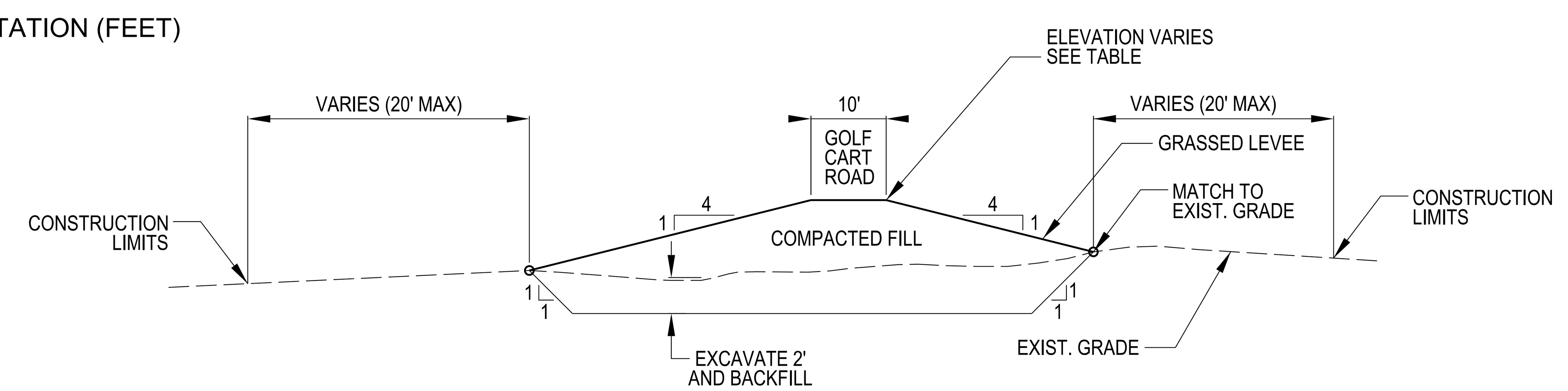
SCALE:
HORIZONTAL: 1" = 100'
VERTICAL: 1" = 2'

ALA WAI GOLF COURSE BERM
STA 0 + 00 TO 50 + 37

STATION	WALL HEIGHT (FT)	FINISHED WALL ELEVATION (FT MSL)
0 + 00	-	-
3 + 97	4.0	11.9
7 + 03	5.6	11.9
11 + 44	3.2	11.9
15 + 86	1.3	11.9
19 + 62	3.6	11.9
24 + 24	4.0	11.9
29 + 96	0.2	11.9
33 + 62	0.1	11.2
38 + 94	2.8	11.1
44 + 71	1.5	11.0
50 + 37	7.2	10.8

NOTES:

1. NEW GOLF CART ROAD IS 2' THICK AC PAVEMENT.



A TYPICAL LEVEE SECTION
NOT TO SCALE

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MARK	DESCRIPTION	DATE	APPR.

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SUBMITTED BY: | LOCATION CODE
PLOT SCALE: AS SHOWN | PLOT DATE: 12/15/2014 | DRAWING NUMBER:
SIZE: ANSI D | FILE NAME: ALA WAI GOLF COURSE PROFILE & SECTION

ALA WAI CANAL PROJECT

ALA WAI GOLF COURSE BERMING
PROFILE AND SECTION
ALTERNATIVE 2A

SHEET
IDENTIFICATION
C-317
SHEET 20 OF 25

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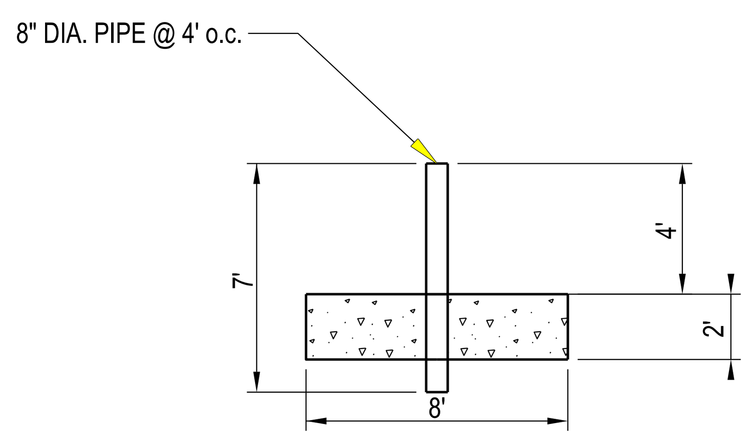
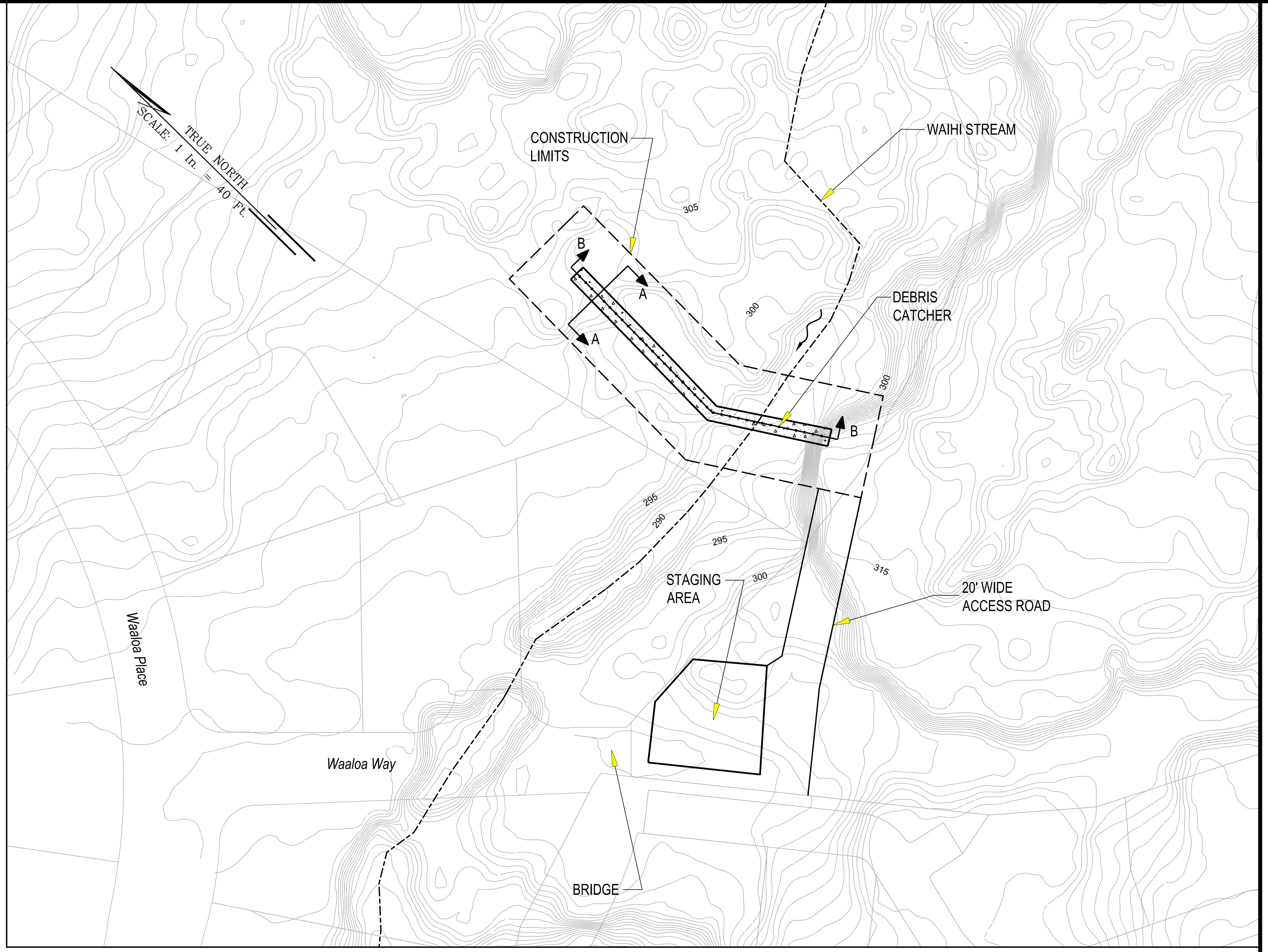
PEN TABLE: BW_and_Grayscale_Pen.tbl
PRINTED BY: J3EC9JHH

1 2 3 4 5

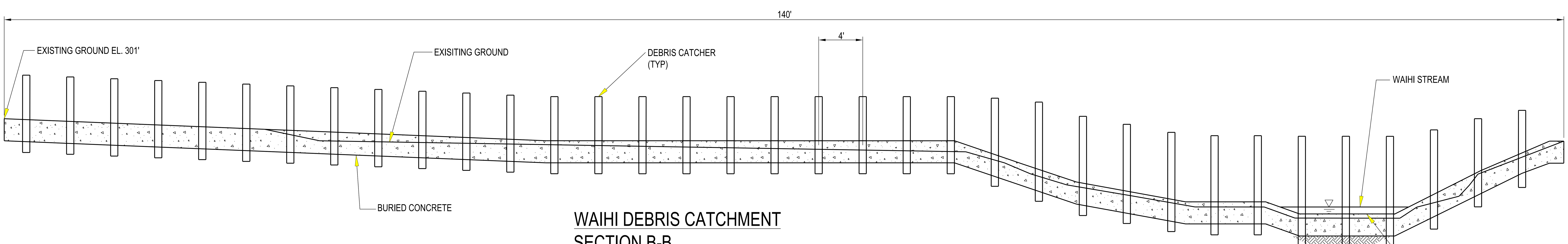


WAIHI DEBRIS CATCHMENT
SECTION A-A
SCALE: 1"=5'



PLAN
SCALE: 1"=40'

SOLID LINE = 5' CONTOURS
DOTTED LINE = 1' CONTOURS



WAIHI DEBRIS CATCHMENT
SECTION B-B
SCALE: 1"=5'

5' 2.5' 0' 5' 10'
SCALE: 1" = 5'

Note: All elevations are feet MSL

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CHECKED BY: | PLOT DATE: 12/15/2014 | FILE NAME: WAIHI DEBRIS CATCHMEN_PLAN & SECTIONS
DATE: | SOLICIT / CONTRACT NO.: | LOCATION CODE | DRAWING NUMBER:
REVISION:

ALA WAI CANAL PROJECT

WAIHI DEBRIS CATCHMENT
PLAN AND SECTIONS
ALTERNATIVE 2A

SHEET IDENTIFICATION
C-319
SHEET 21 OF 25

FILE: c:\pw-work\poh-1\j3ec9jhh\d0139948\Ala_Wai_C-319xxx.dgn
MODEL NAME: C-301A
DATE & TIME: 12/15/2014 3:00:45 PM
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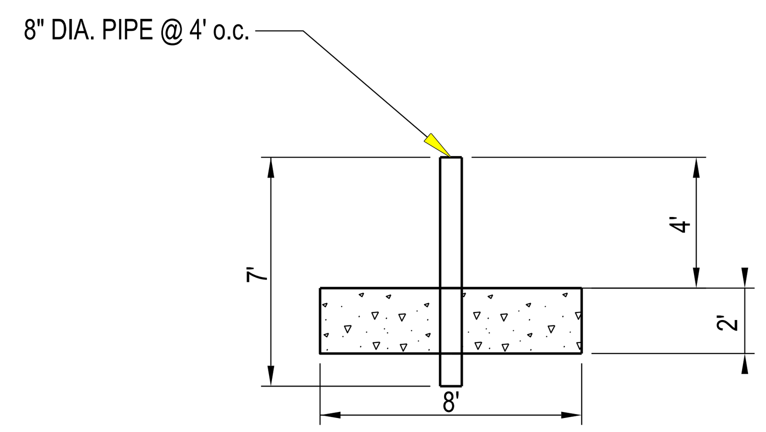
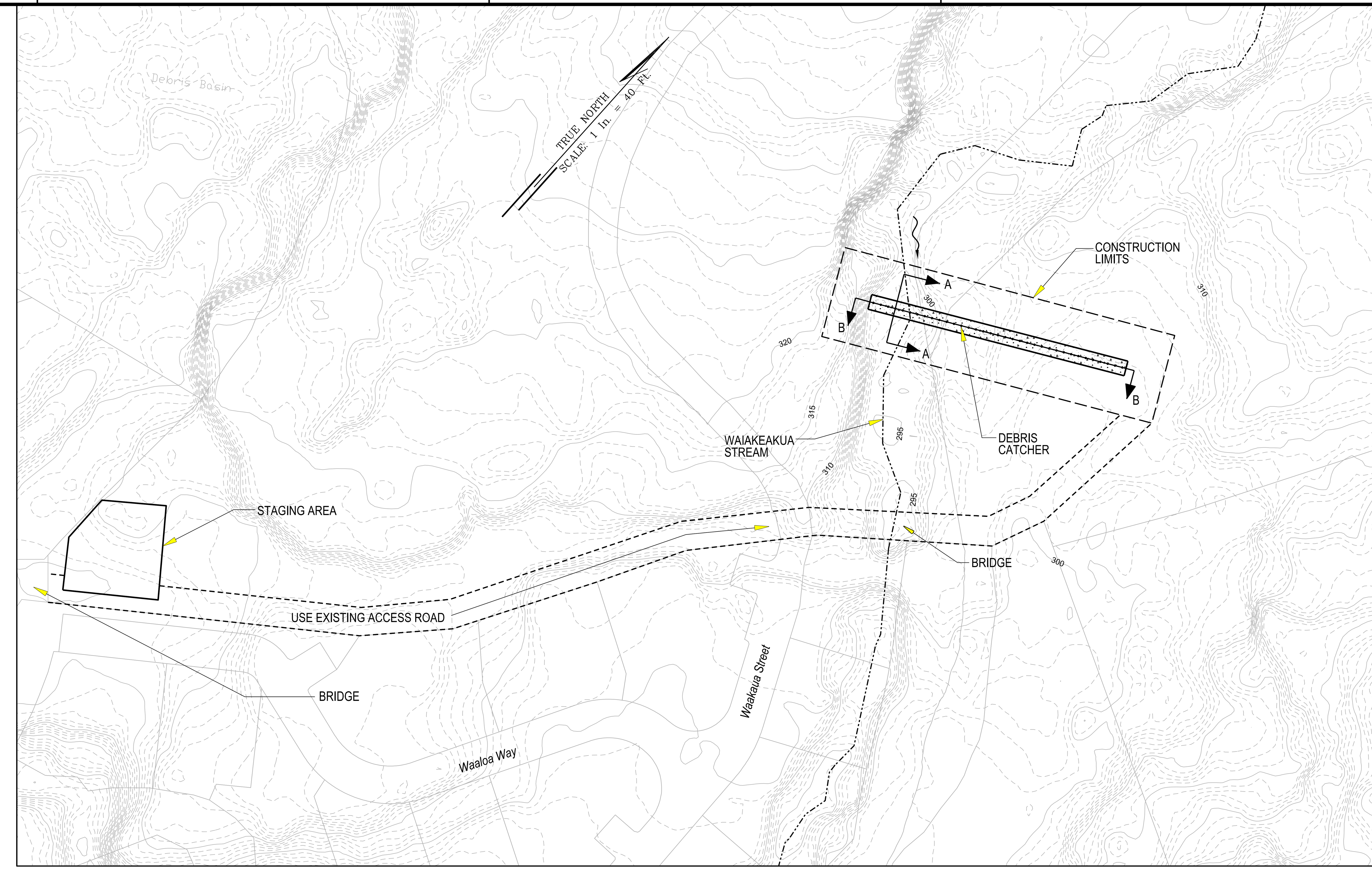
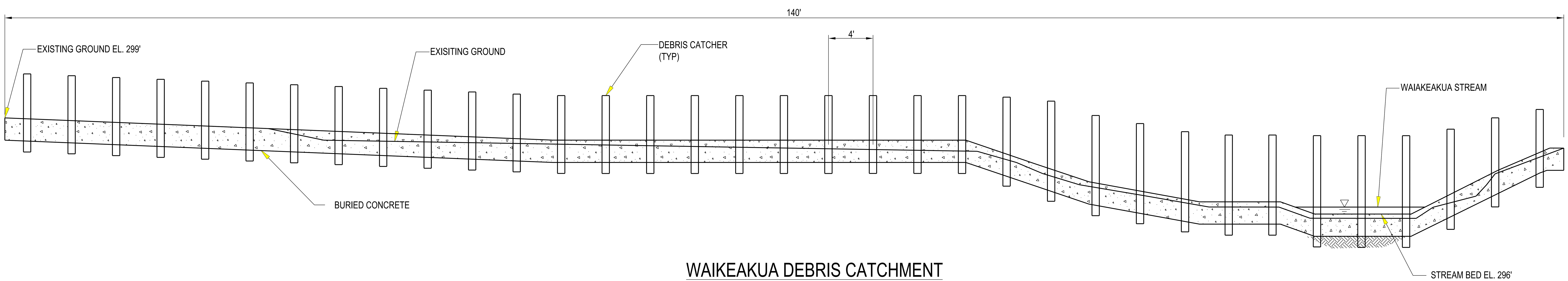


WAIAKEAKUA DEBRIS CATCHMENT
SECTION A-A
SCALE: 1"=5'



PLAN
SCALE: 1"=40'

SOLID LINE = 5' CONTOURS
DOTTED LINE = 1' CONTOURS



WAIKEAKUA DEBRIS CATCHMENT
SECTION B-B
SCALE: 1"=5'

5 2.5' 0 5 10
SCALE: 1" = 5'
Note: All elevations are feet MSL

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PEN TABLE: BW_and_Grayscale_Pen.tbl
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PLOT SCALE: AS SHOWN
PLOT DATE: 12/15/2014
SIZE: ANSI D
DATE:
REVISION:
SOLICIT / CONTRACT NO.:
LOCATION CODE
DRAWING NUMBER:
FILE NAME: WAIAKEAKUA DEBRIS CATCHMENT, PLAN & SECTIONS

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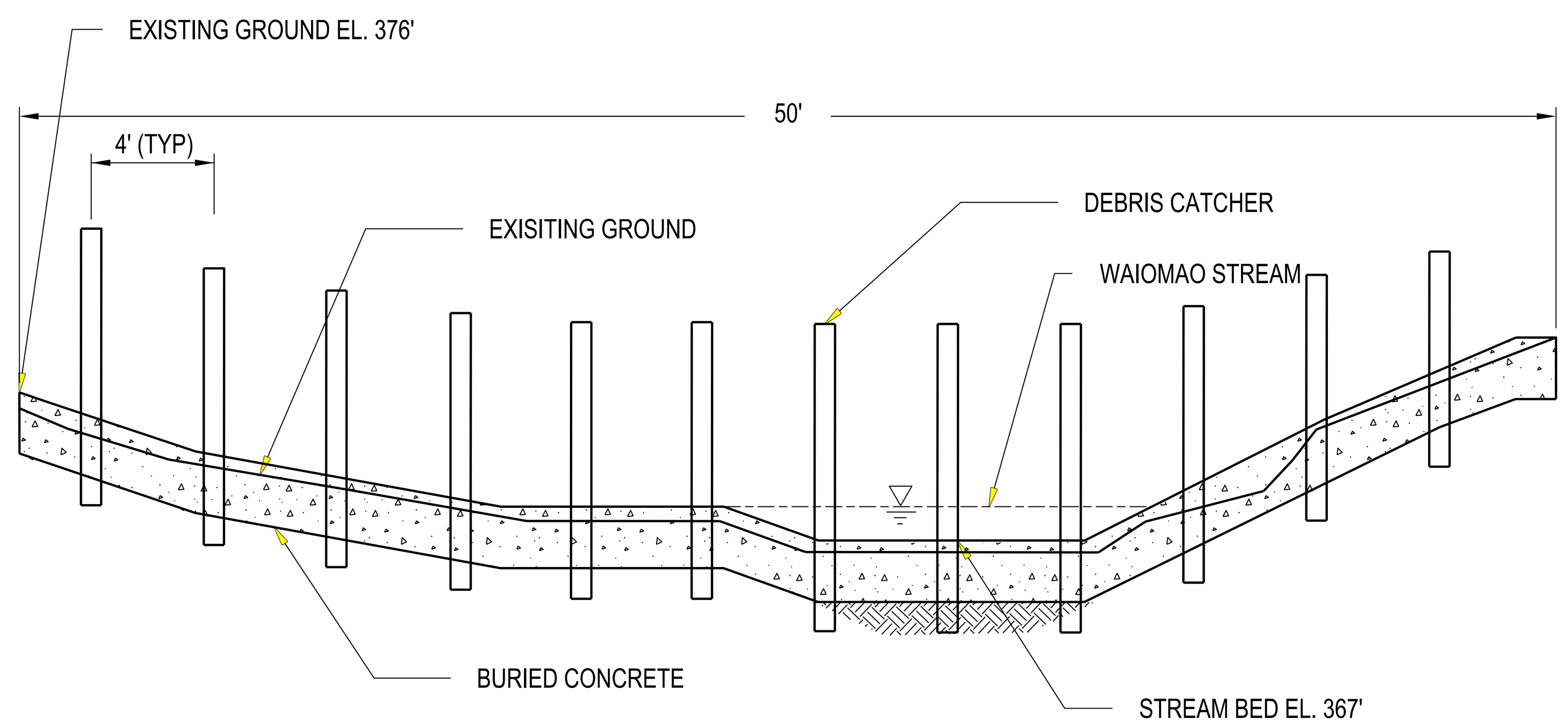
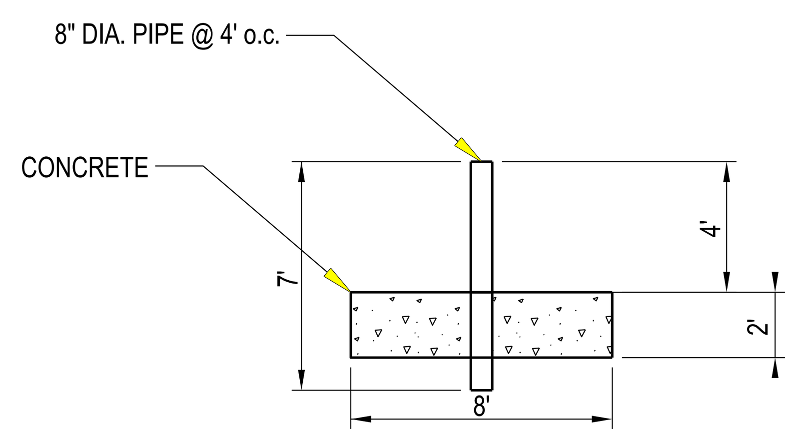
ALA WAI CANAL PROJECT

WAIAKEAKUA DEBRIS CATCHMENT
PLAN AND SECTIONS
ALTERNATIVE 2A

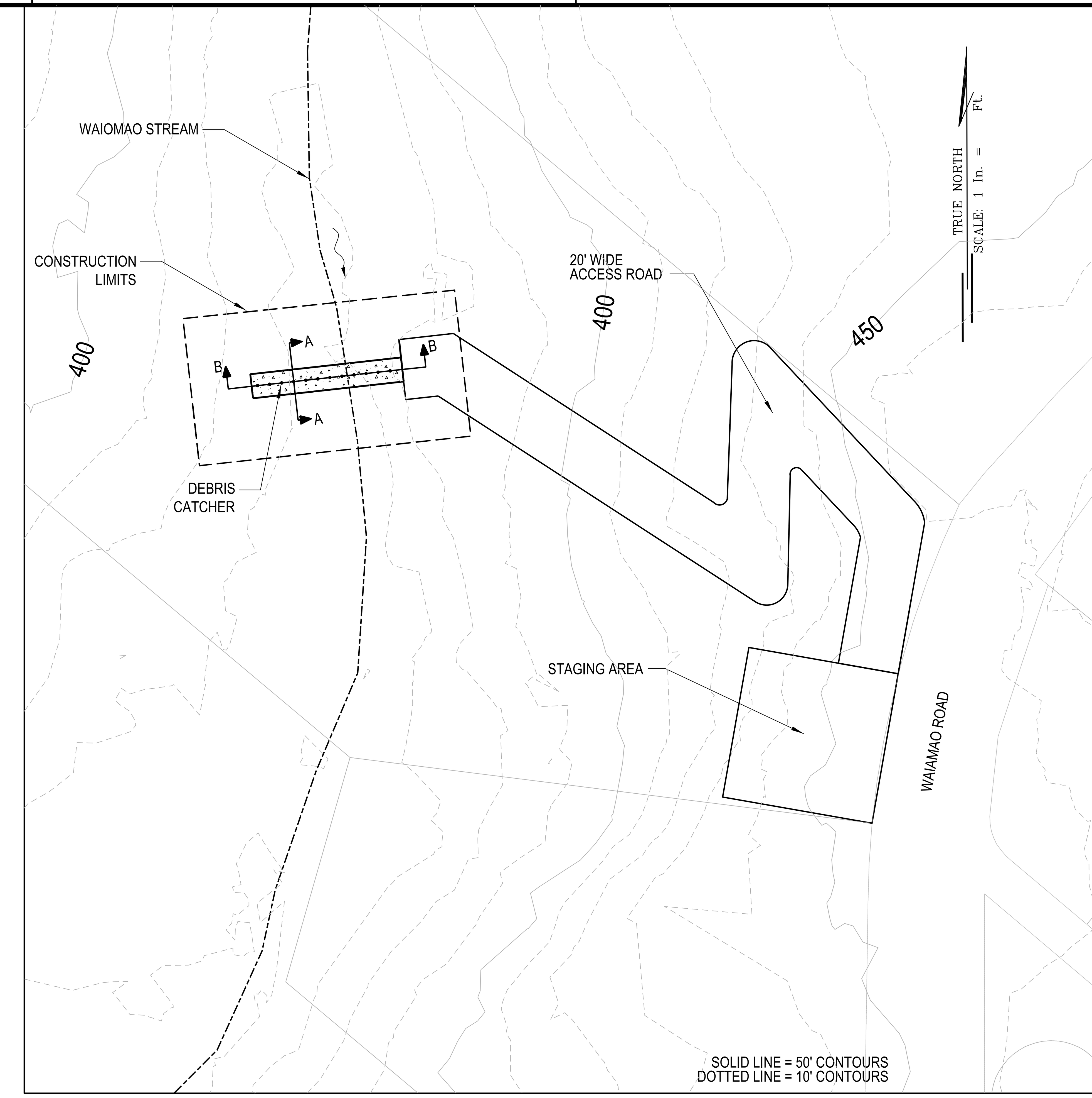
SHEET IDENTIFICATION
C-320
SHEET 22 OF 25



WAIOMAO DEBRIS CATCHMENT
SECTION B-B
SCALE: 1"=5'



WAIOMAO DEBRIS CATCHMENT
SECTION A-A
SCALE: 1"=5'



PLAN
SCALE: 1"=35'

SCALE: 1" = 10'

Note: All elevations are feet MSL

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SUBMITTED BY: | LOCATION CODE
PLOT SCALE: | PLOT DATE: 12/15/2014 | DRAWING NUMBER:
SIZE: ANSI D | FILE NAME: WAIOMAO DEBRIS CATCHMENT, PLAN & SECTIONS

JHH

ALA WAI CANAL PROJECT

WAIOMAO DEBRIS CATCHMENT
PLAN AND SECTIONS
ALTERNATIVE 2A

SHEET IDENTIFICATION
C-321
SHEET 23 OF 25

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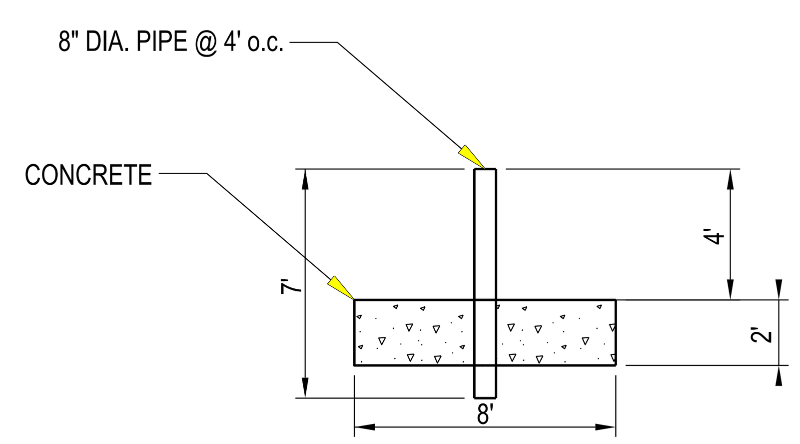
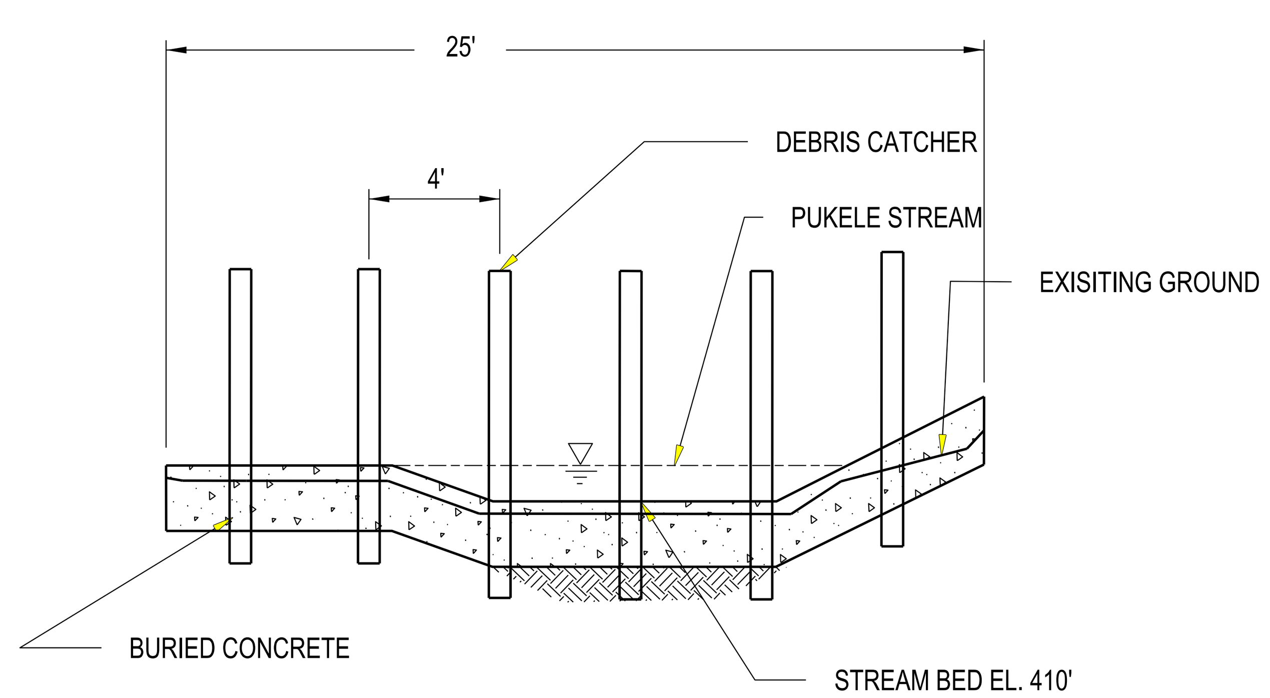


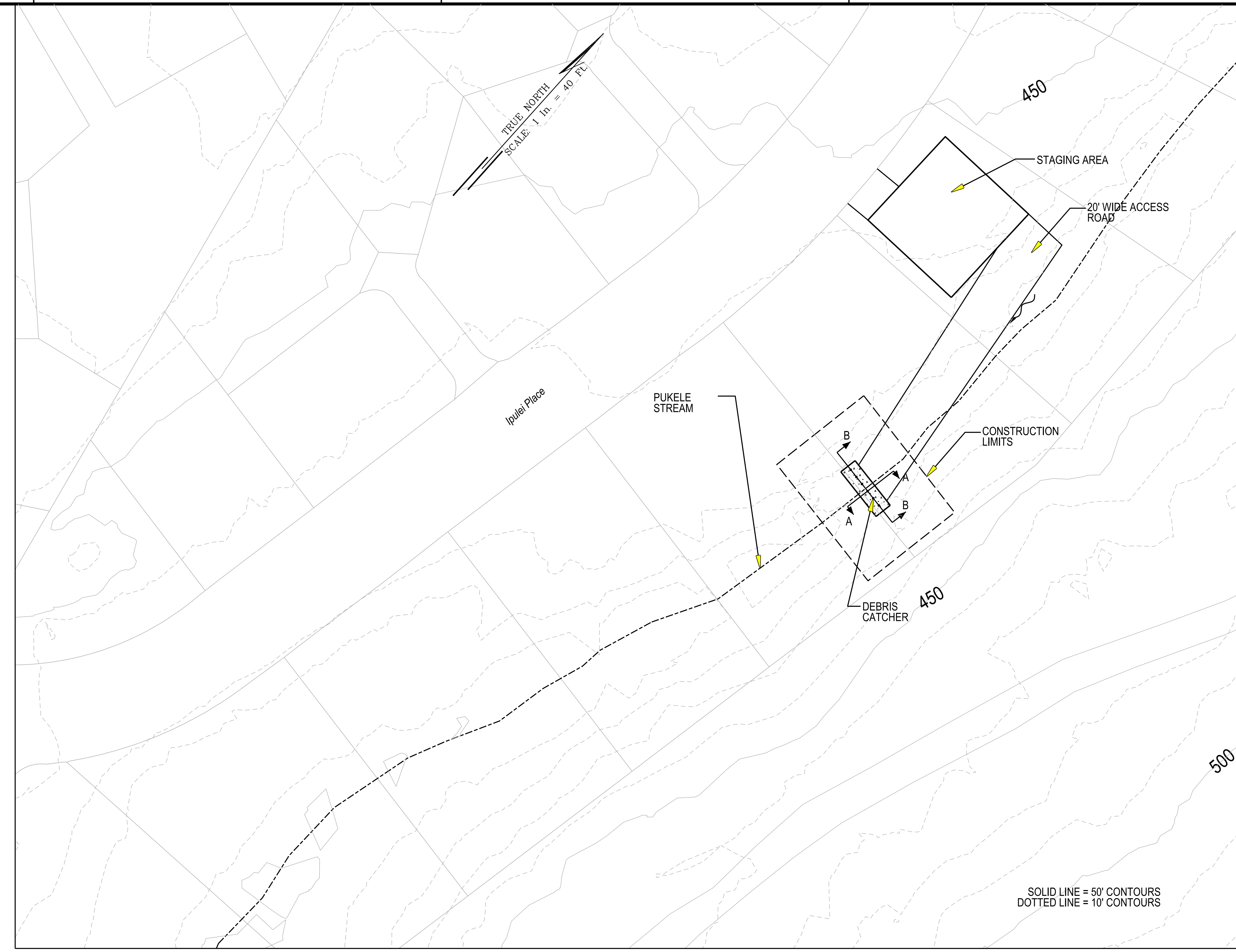
PUKELE DEBRIS CATCHMENT BASIN SECTION A-A

SCALE: 1"=5'



PUKELE DEBRIS CATCHMENT SECTION B-B

SCALE: 1"=5'



PLAN

SCALE: 1"=40'

5 2.5' 0 5 10

SCALE: 1" = 5'

Note: All elevations are feet MSL

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SUBMITTED BY:
DATE:
REVISION:
SOLICIT / CONTRACT NO.:
LOCATION CODE
PLOT SCALE: AS SHOWN
PLOT DATE: 12/15/2014
SIZE: ANSI D
FILE NAME: PUKELE DEBRIS CATCHMENT, PLAN & SECTIONS
DRAWING NUMBER:

ALA WAI CANAL PROJECT

PUKELE DEBRIS CATCHMENT
PLAN AND SECTIONS
ALTERNATIVE 2A

SHEET IDENTIFICATION
C-322
SHEET 24 OF 25

FILE: c:\pw-work\poh-1\j3ec9jhh\d0139948\Ala_Wai_C-322xxx.dgn
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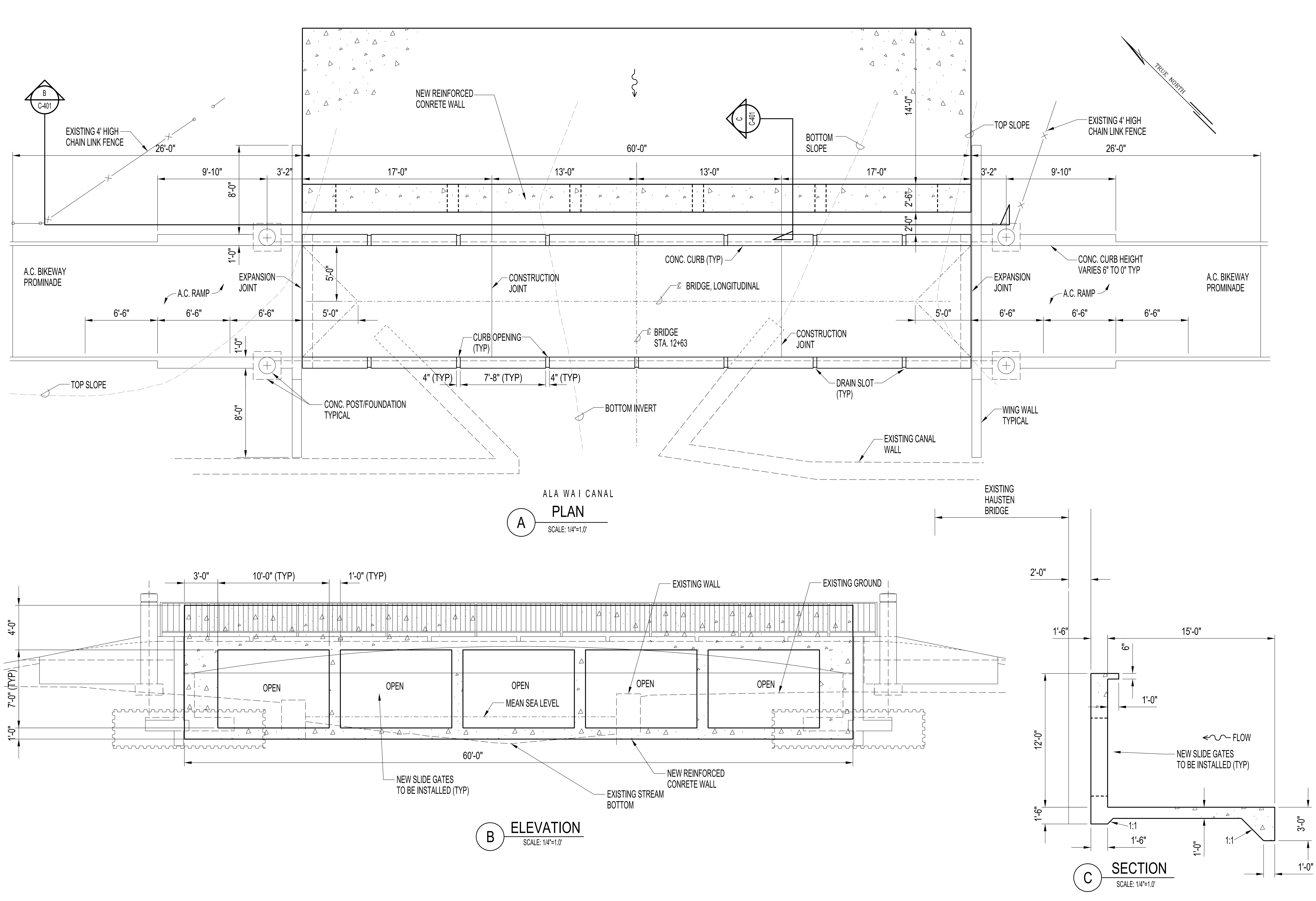

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HONOLULU, HAWAII

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DRAWN BY:	CHECKED BY:	SOLICIT / CONTRACT NO.:	
SUBMITTED BY:		LOCATION CODE	
PLOT SCALE: AS SHOWN	PLOT DATE: 12/15/2014	DRAWING NUMBER:	
SIZE: ANSI D	FILE NAME: HAUSTEN BRIDGE PLAN & SECTIONS		

ALA WAI CANAL PROJECT

HAUSTEN BRIDGE CONCRETE WALL
PLAN, SECTION AND ELEVATION
ALTERNATIVE 2A

SHEET IDENTIFICATION
C-401
SHEET 25 OF 25

FILE: c:\pw-work\poh-1\j3ec9jhh\d0139948\Ala_Wai_C-401xxx.dgn
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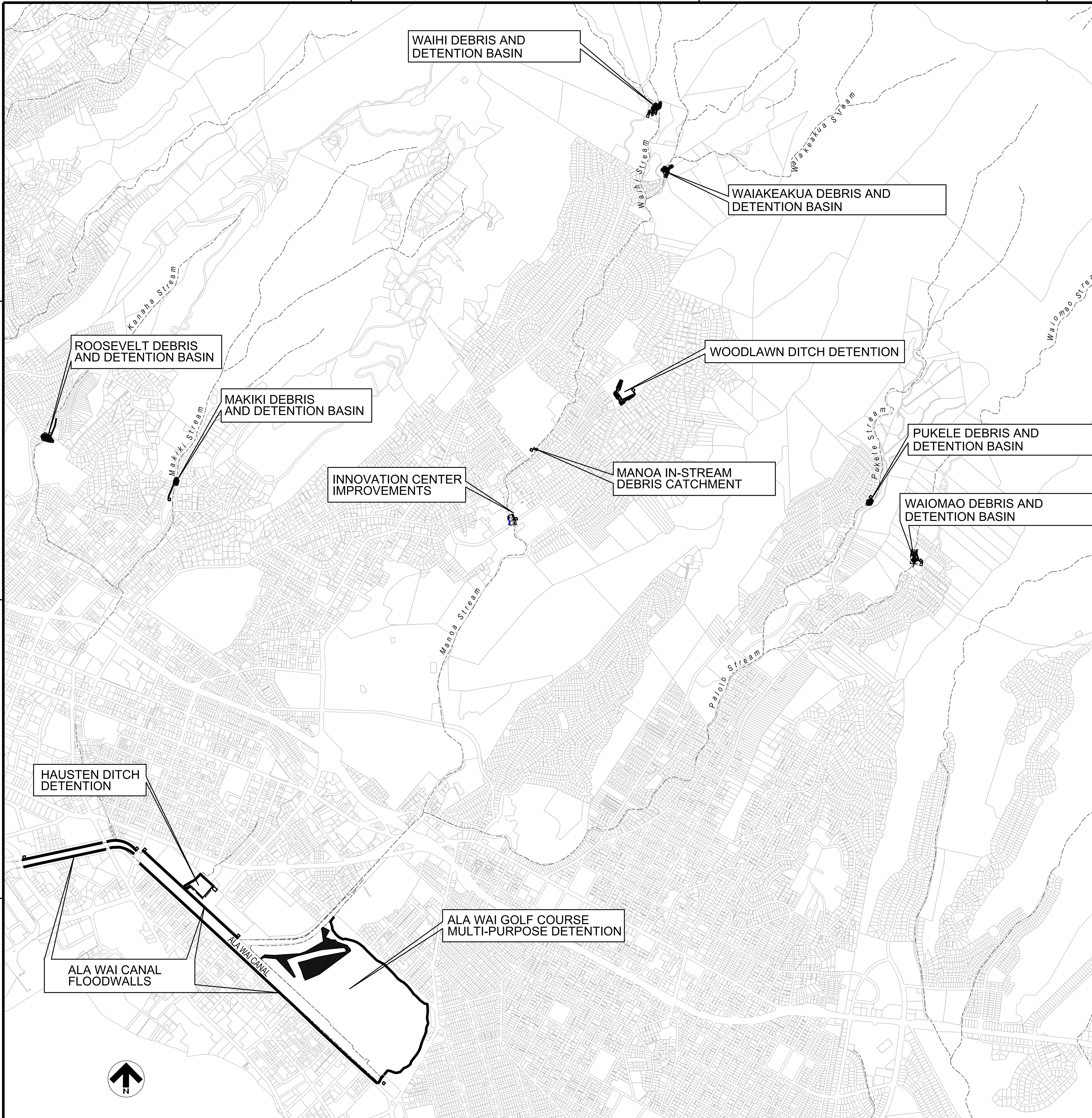
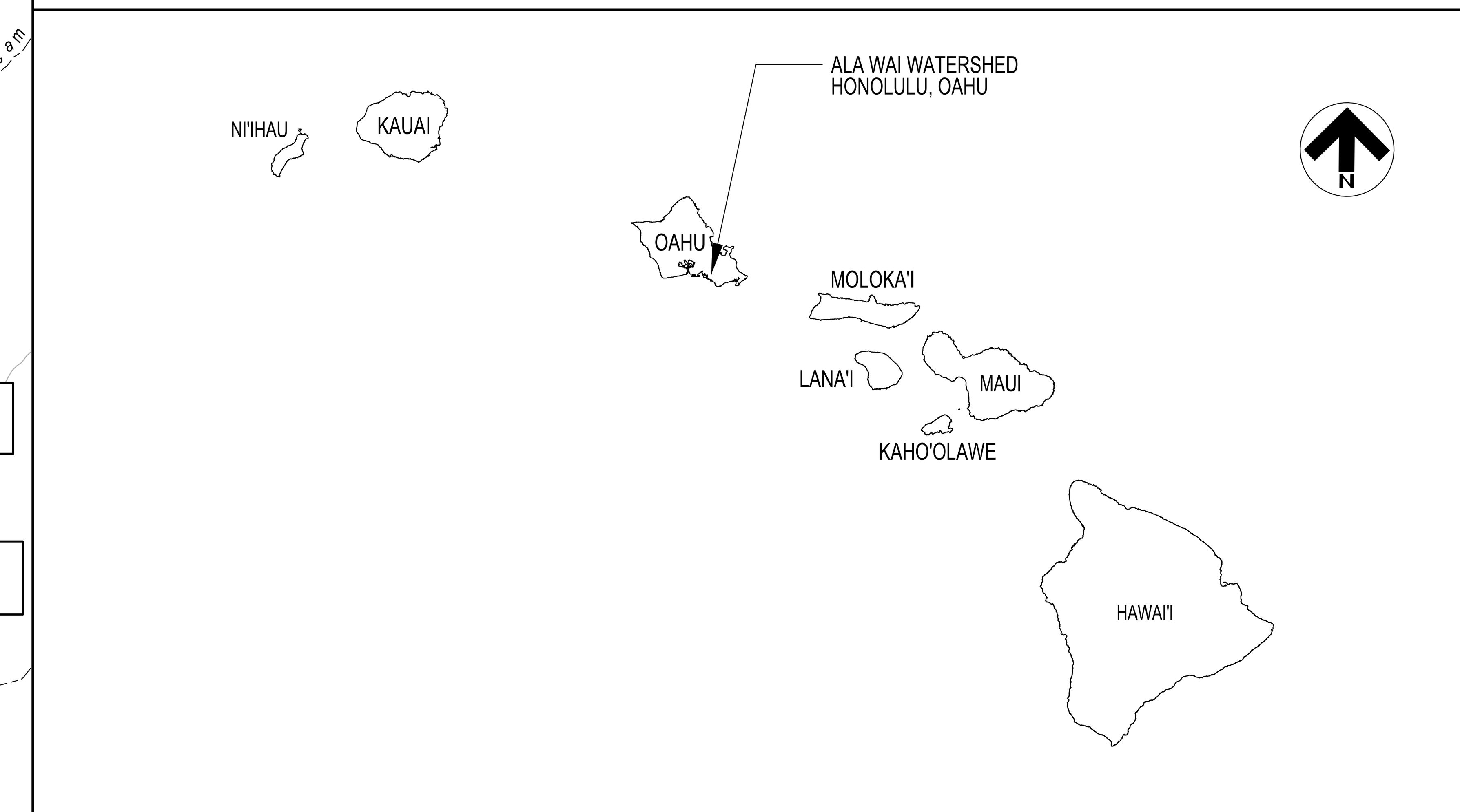


SITE LOCATIONS

NOT TO SCALE

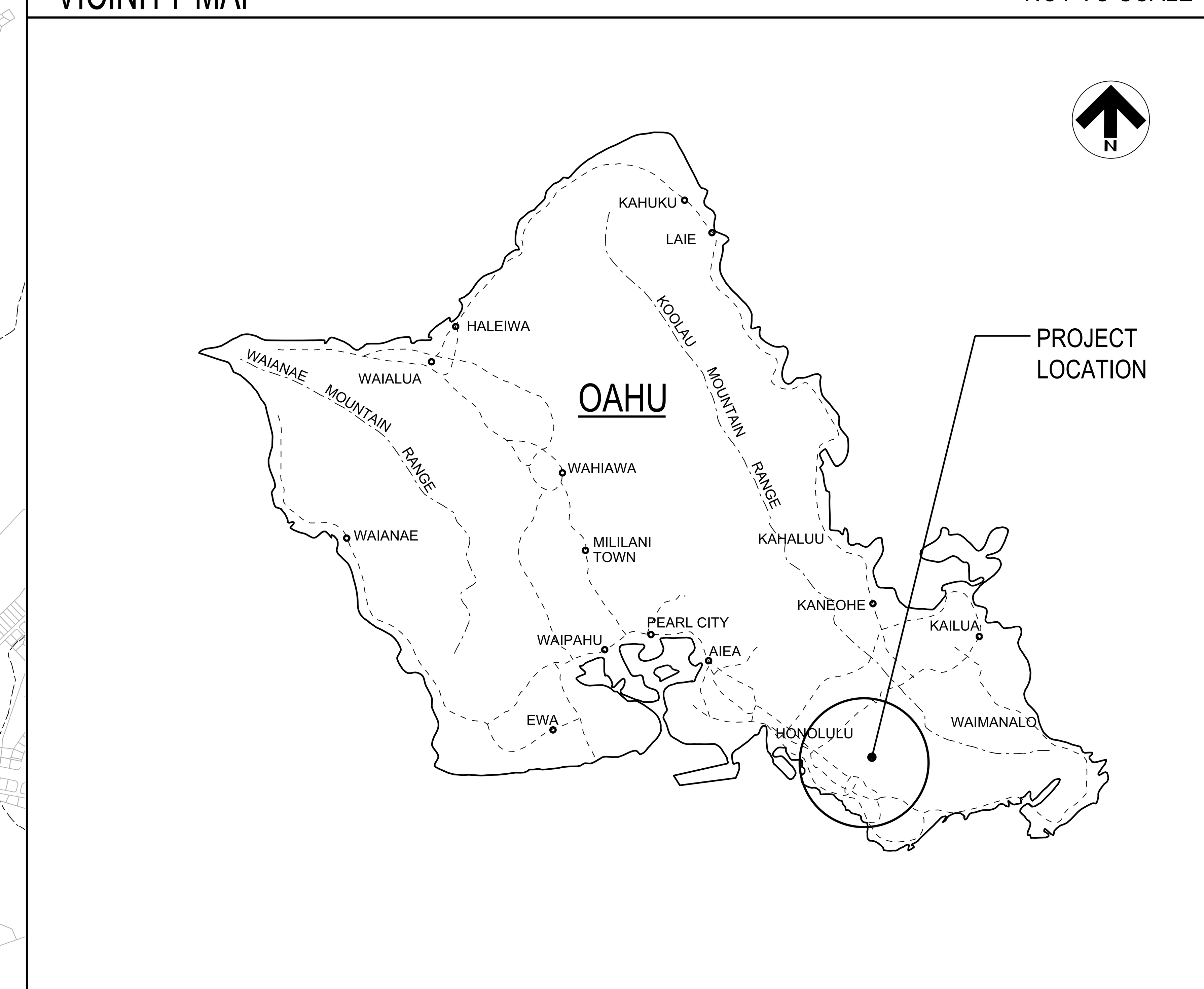
ALA WAI CANAL PROJECT
ALTERNATIVE 3A
HONOLULU, OAHU, HI

PROJECT TITLE



VICINITY MAP

NOT TO SCALE



PROJECT LOCATION

NOT TO SCALE

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MARK	DESCRIPTION	DATE	APPR

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DESIGNED BY: JHH	DATE:	REVISION:
DRAWN BY:	CHECKED BY:	SOLICIT./ CONTRACT NO.:
SUBMITTED BY:		LOCATION CODE
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SIZE: ANSI D	FILE NAME: Cover Sheet - Site Locations, Vicinity Map, Project Location - Alternative 3A	

US ARMY CORPS OF ENGINEERS
HONOLULU DISTRICT
HONOLULU, HAWAII

ALA WAI CANAL PROJECT

SITE LOCATIONS
PROJECT LOCATION & VICINITY MAP
ALTERNATIVE 3A

SHEET IDENTIFICATION
G-001A
SHEET 1 OF 20

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PEN TABLE: BW_and_Grayscale_Pen.tbl
PRINTED BY: J3EC9JHH

ALA WAI CANAL PROJECT - ALTERNATIVE 3A
INDEX TO DRAWINGS

SHT. NO	SHT. REF. NO.	DESCRIPTION
1	G-001A	SITE LOCATIONS, PROJECT LOCATION AND VICINITY MAP
2	G-002A	INDEX TO DRAWINGS
3	C-101A	ALA WAI CANAL FLOODWALLS, SITE PLAN
4	C-102A	HAUSTEN DITCH DETENTION, SITE PLAN
5	C-103A	ALA WAI GOLF COURSE MULTI-PURPOSE DETENTION, PLAN
6	C-301	WAIHI DEBRIS AND DETENTION BASIN, PLAN AND SECTIONS
7	C-302	WAIAKEAKUA DEBRIS AND DETENTION BASIN, PLAN AND SECTIONS
8	C-304A	INNOVATION CENTER IMPROVEMENTS, PLAN AND SECTIONS
9	C-305A	WOODLAWN DITCH DETENTION BASIN, PLAN AND SECTIONS
10	C-308	WAIOMAO DEBRIS AND DETENTION BASIN, PLAN AND SECTIONS
11	C-309A	ALA WAI CANAL MIDDLE AND LOWER RIGHT BANK, PROFILE AND SECTION
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13	C-311A	ALA WAI CANAL UPPER LEFT BANK, PROFILE
14	C-313	PUKELE DEBRIS AND DETENTION BASIN, PLAN AND SECTIONS
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18	C-317A	ALA WAI GOLF COURSE MULTI-PURPOSE DETENTION, PROFILE AND SECTION
19	C-318	MANOA IN-STREAM DEBRIS CATCHMENT, PLAN AND SECTIONS
20	C-401A	HAUSTEN BRIDGE CONCRETE WALL, PLAN, SECTION AND ELEVATION

GENERAL NOTES:

1. EXISTING CONDITIONS MAY VARY FROM THOSE SHOWN ON THESE PLANS. THE CONTRACTOR SHALL VERIFY EXISTING CONDITIONS AND ADJUST WORK PLAN ACCORDINGLY PRIOR TO BEGINNING CONSTRUCTION.
2. COORDINATE SYSTEM: NAD 1983 (HARN), HAWAII ZONE 3 (US FEET)
3. PROVIDE FENCING AS NECESSARY TO MAINTAIN SECURITY AT ALL TIMES.
4. UNLESS SHOWN OTHERWISE, ALL DISTURBED AREAS NOT RECEIVING A HARD SURFACE SHALL BE COVERED WITH GRASS.
5. CONTRACTOR SHALL SUBMIT A COMPLETE SOIL EROSION CONTROL PLAN FOR REGULATORY APPROVAL. CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING AND MAINTAINING EROSION CONTROL DEVICES DURING CONSTRUCTION. CONTRACTOR SHALL TAKE ALL OTHER MEASURES TO POSITIVELY PRECLUDE EROSION MATERIALS FROM LEAVING THE SITE.
6. EXISTING UNDERGROUND UTILITIES OBTAINED FROM AS-BUILTS AND FROM FIELD SURVEYS. CONTRACTOR SHALL POTHOLE AND FIELD VERIFY DEPTH AND LOCATION PRIOR TO EXCAVATION AND PROTECT ALL EXISTING UTILITIES DURING CONSTRUCTION.
7. THERE WILL BE A FLOODWARNING SYSTEM INSTALLED FOR THIS PROJECT.

GENERAL ABBREVIATIONS

A.C.	ASHPALT CONCRETE
AVE	AVENUE
BLVD	BOULEVARD
CONC	CONCRETE
DIA	DIAMETER
EL	ELEVATION
EXIST	EXISTING
FT	FOOT, FEET
IN	INCH, INCHES
INV	INVERT
LB	LEFT BANK
MAX	MAXIMUM
MSL	MEAN SEA LEVEL
NTS	NOT TO SCALE
o.c.	ON CENTER
O&M	OPERATIONS AND MAINTENANCE
PL	PLACE
RB	RIGHT BANK
RCP	REINFORCED CONCRETE PIPE
RD	ROAD
ST	STREET
STA	STATION
THK	THICK
TMK	TAX MAP KEY
TYP	TYPICAL
W.S.	WATER SURFACE
YR	YEAR

SYMBOLS

&	AND
@	AT
℄	CENTER LINE
'	FOOT, FEET
"	INCH, INCHES

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ALA WAI CANAL PROJECT

INDEX OF DRAWINGS, GENERAL NOTES
ABBREVIATIONS & SYMBOLS
ALTERNATIVE 3A

SHEET IDENTIFICATION
G-002A
SHEET 2 OF 20

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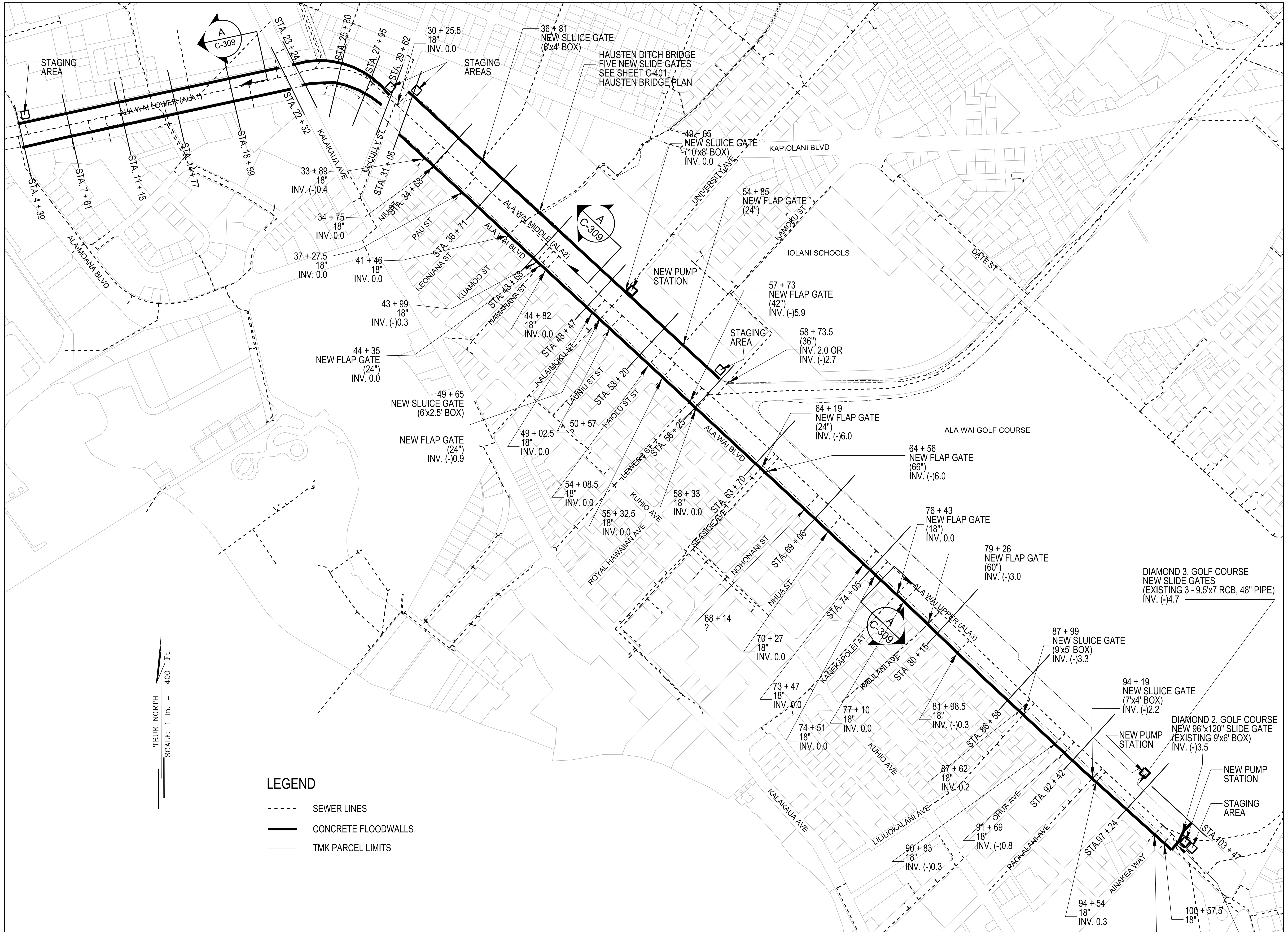

99 + 72.5
18"

DIAMOND 1, ALA WAI BLVD
2 - NEW 60"x120" SLIDE GATES
(EXISTING 12'x7' BOX)
INV. (-)4.1

PLAN
ALA WAI CANAL FLOODWALLS

SCALE 1"=400'

ALA WAI CANAL INTERIOR DRAINAGE TABLE

CULVERT NAME	STATION	SIZE & TYPE	NOTES
DIAMOND 2, GOLF COURSE	102+45.5	96"x120" SLIDE GATE	PUMP STATION
DIAMOND 1, ALA WAI BLVD	101+75	2 - 60"x120" SLIDE GATES	
DIAMOND 3, GOLF COURSE	96+67	SLIDE GATES	PUMP STATION
100+57.5	100+57.5	18" FLAP GATE	
99+72.5	99+72.5	18" FLAP GATE	
94+54	94+54	18" FLAP GATE	INV. 0.3
94+19	94+19	SLUICE GATE	INV. (-)2.2
91+69	91+69	18" FLAP GATE	INV. (-)0.8
90+83	90+83	18" FLAP GATE	INV. (-)0.3
87+99	87+99	SLUICE GATE	INV. (-)3.3
87+62	87+62	18" FLAP GATE	INV. 0.2
81+98.5	81+98.5	18" FLAP GATE	INV. (-)0.3
79+26	79+26	60" FLAP GATE	INV. (-)3.0
77+10	77+10	18" FLAP GATE	
76+43	76+43	18" FLAP GATE	INV. 0.0
74+51	74+51	18" FLAP GATE	
73+47	73+47	18" FLAP GATE	
70+27	70+27	18" FLAP GATE	
68+14	68+14	?	
64+56	64+56	66" FLAP GATE	INV. (-)6.0
64+19	64+19	24" FLAP GATE	INV. (-)6.0
58+73.5	58+73.5	36" FLAP GATE	INV. 2.0 OR (-)2.7
58+33	58+33	18" FLAP GATE	
57+73	57+73	42" FLAP GATE	INV. (-)5.9
55+32.5	55+32.5	18" FLAP GATE	
54+08.5	54+08.5	18" FLAP GATE	
54+85	54+85	24" FLAP GATE	
50+57	50+57	?	
49+65, RB	49+65	SLUICE GATE	INV. 0.0, PUMP STATION
49+65	49+65	SLUICE GATE & 24" FLAP GATE	INV. ? & (-)0.9
49+02.5	49+02.5	18" FLAP GATE	
44+82	44+82	18" FLAP GATE	
44+35	44+35	24" FLAP GATE	
43+99	43+99	18" FLAP GATE	INV. (-)0.3
HAUSTEN DITCH BRIDGE	42+10	5 - SLIDE GATES	SEE SHEET C-401
41+46	41+46	18" FLAP GATE	
37+27.5	37+27.5	18" FLAP GATE	
36+81	36+81	SLUICE GATE	
34+75	34+75	18" FLAP GATE	
33+89	33+89	18" FLAP GATE	INV. (-)0.4
30+25.5	30+25.5	18" FLAP GATE	

NOTES:

1. SEE SHEET C-309A FOR THE RIGHT BANK (MOUNTAIN SIDE) PROFILE OF ALA WAI MIDDLE (ALA2) AND ALA WAI LOWER (ALA1).
2. SEE SHEET C-310A FOR THE LEFT BANK (OCEAN SIDE) PROFILE OF ALA WAI MIDDLE (ALA2) AND ALA WAI LOWER (ALA1).
3. SEE SHEET C-311A FOR THE LEFT BANK (OCEAN SIDE) PROFILE OF ALA WAI UPPER (ALA3).
4. PUMP STATIONS WILL BE 50'x50'.

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SIZE: ANSI D	FILE NAME: ALA WAI CANAL FLOODWALLS_PLAN			

ALA WAI CANAL PROJECT

ALA WAI LOWER, MIDDLE & UPPER FLOODWALLS
SITE PLAN
ALTERNATIVE 3A

SHEET IDENTIFICATION
C-101A
SHEET 3 OF 20

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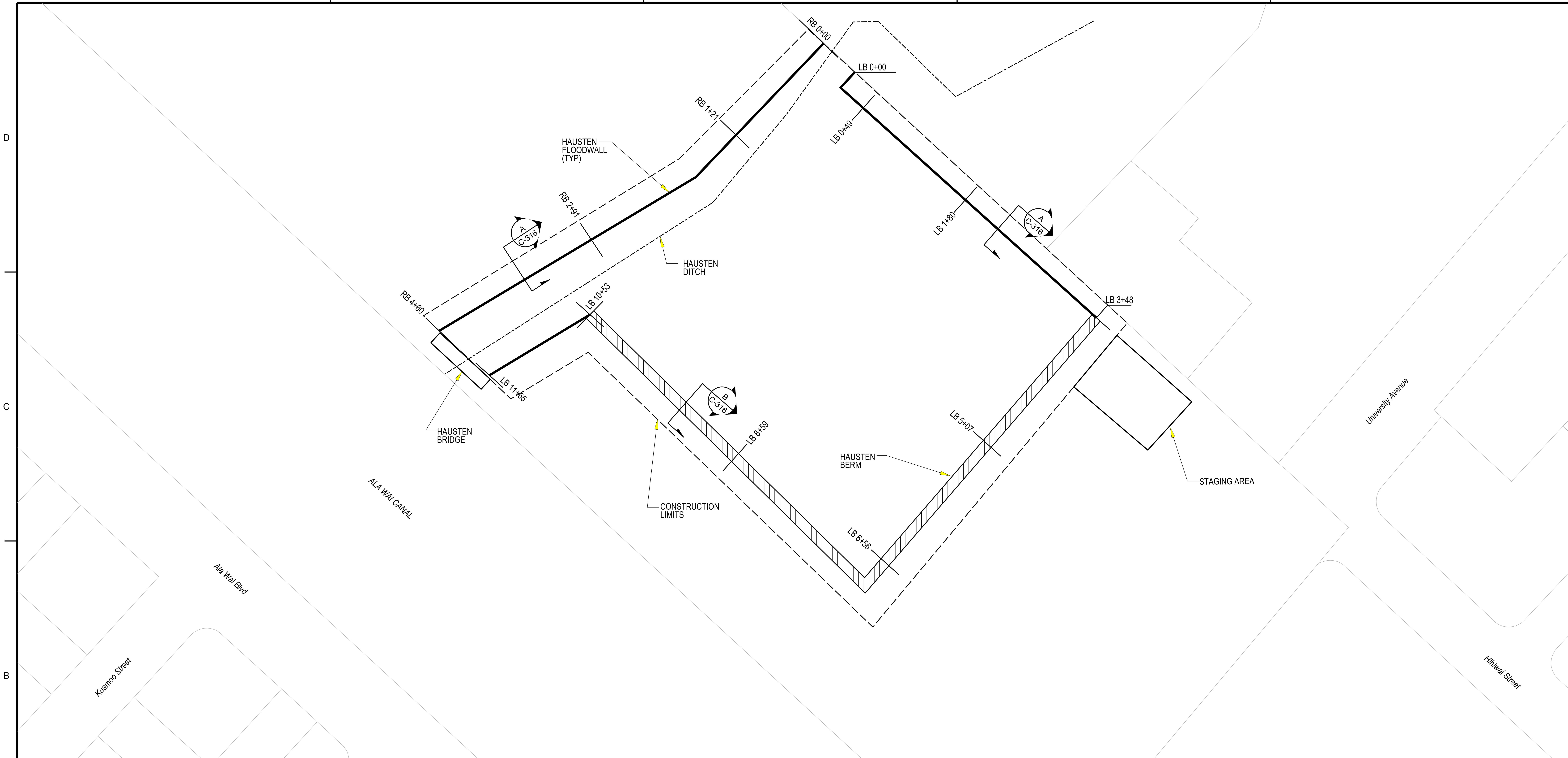
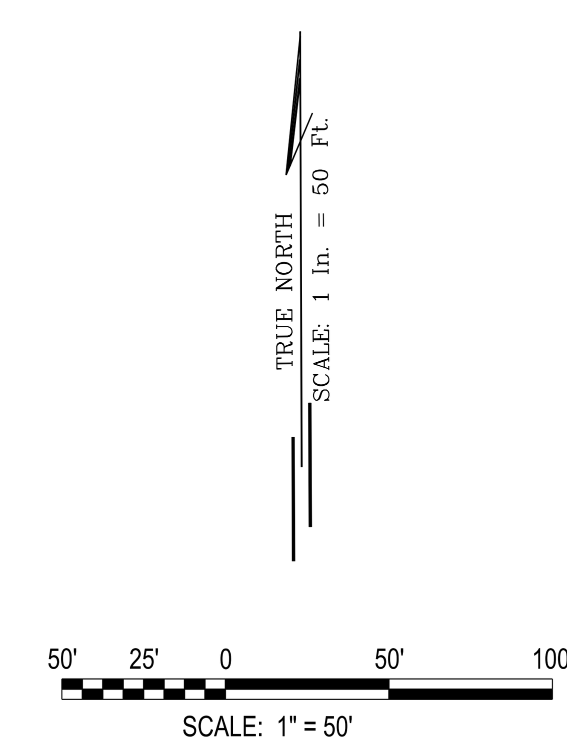


NOTES:

1. STAGING AREA WILL HAVE GEOTEXTILE AND 3" OF SURGE MATERIAL.
2. SEE SHEET C-401A FOR THE HAUSTEN DITCH BRIDGE NEW CONRETE WALL PLAN.

HAUSTEN DITCH DETENTION PLAN

SCALE: 1"=50'



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SIZE: ANSI D
PLOT DATE: 12/15/2014
FILE NAME: HAUSTEN DITCH DETENTION, PLAN
DRAWING NUMBER:

ALA WAI CANAL PROJECT

HAUSTEN DITCH DETENTION
SITE PLAN
ALTERNATIVE 3A

SHEET IDENTIFICATION
C-102A
SHEET 4 OF 20

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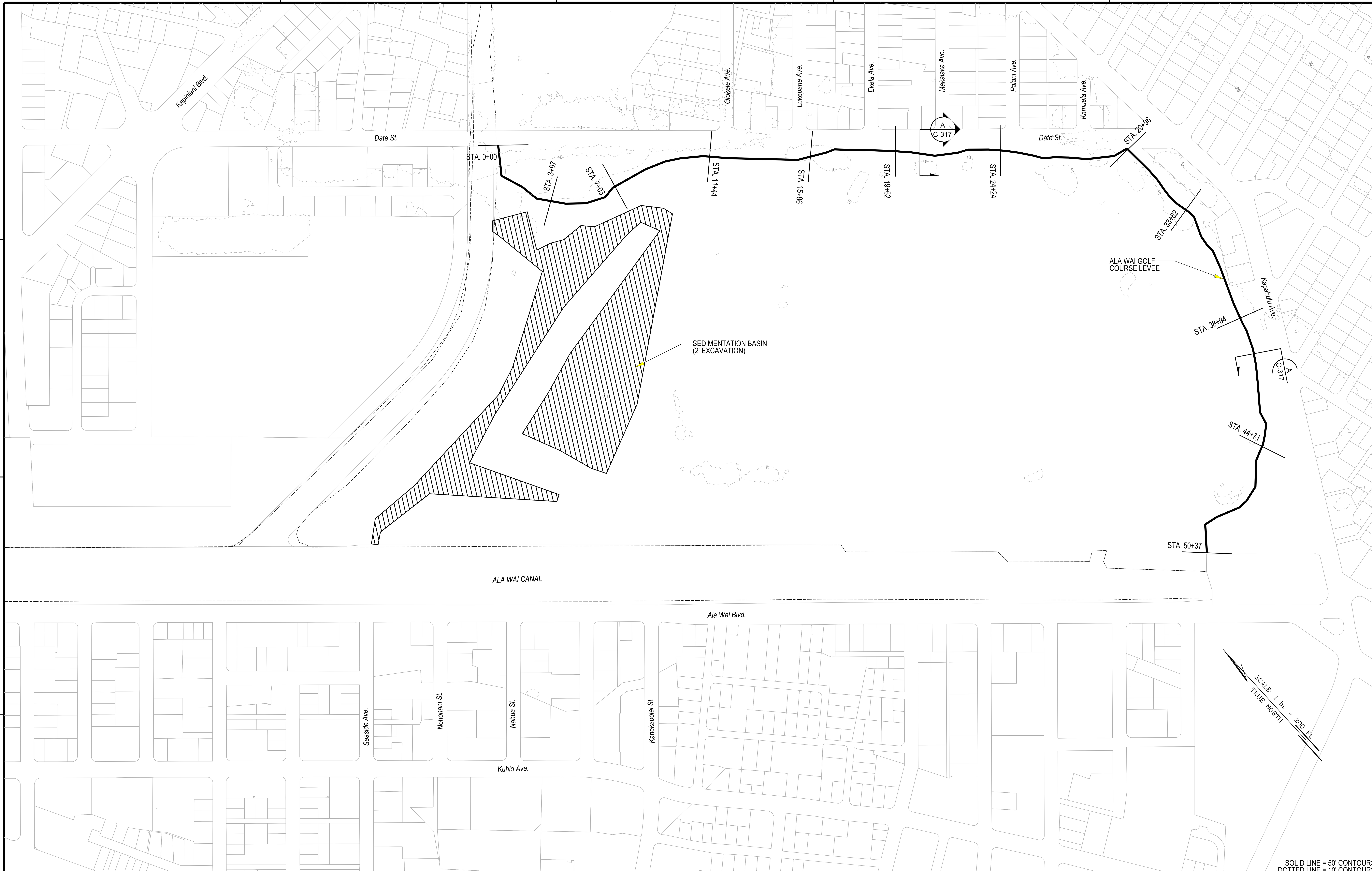

SOLID LINE = 50' CONTOURS
DOTTED LINE = 10' CONTOURS

ALA WAI GOLF COURSE MULTI-PURPOSE DETENTION

PLAN

SCALE: 1"=200'

200' 100' 0 200' 300'

SCALE: 1" = 200'

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PLOT SCALE: AS SHOWN
PLOT DATE: 12/15/2014
FILE NAME: ALA WAI GOLF COURSE MULTI-PURPOSE DETENTION
SIZE: ANSI D

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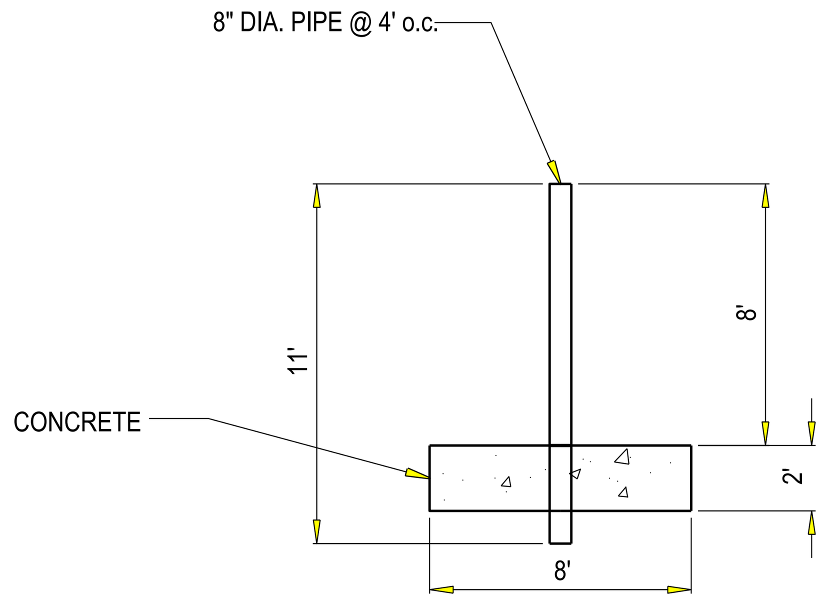
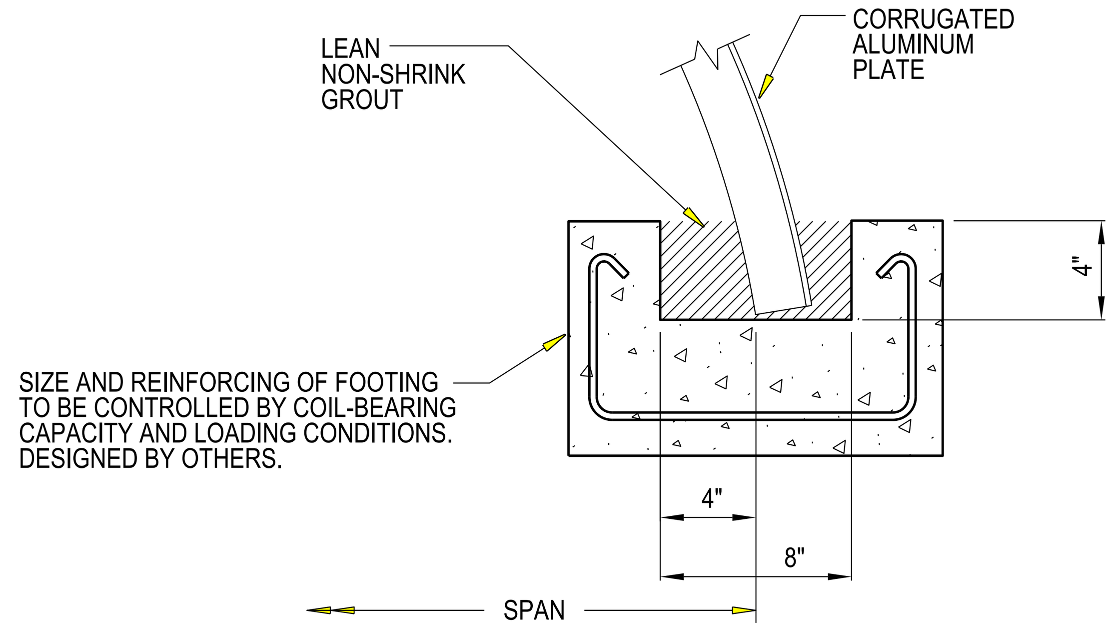
ALA WAI CANAL PROJECT

ALA WAI GOLF COURSE MULTI-PURPOSE DETENTION
PLAN
ALTERNATIVE 3A

SHEET IDENTIFICATION
C-103A
SHEET 5 OF 20

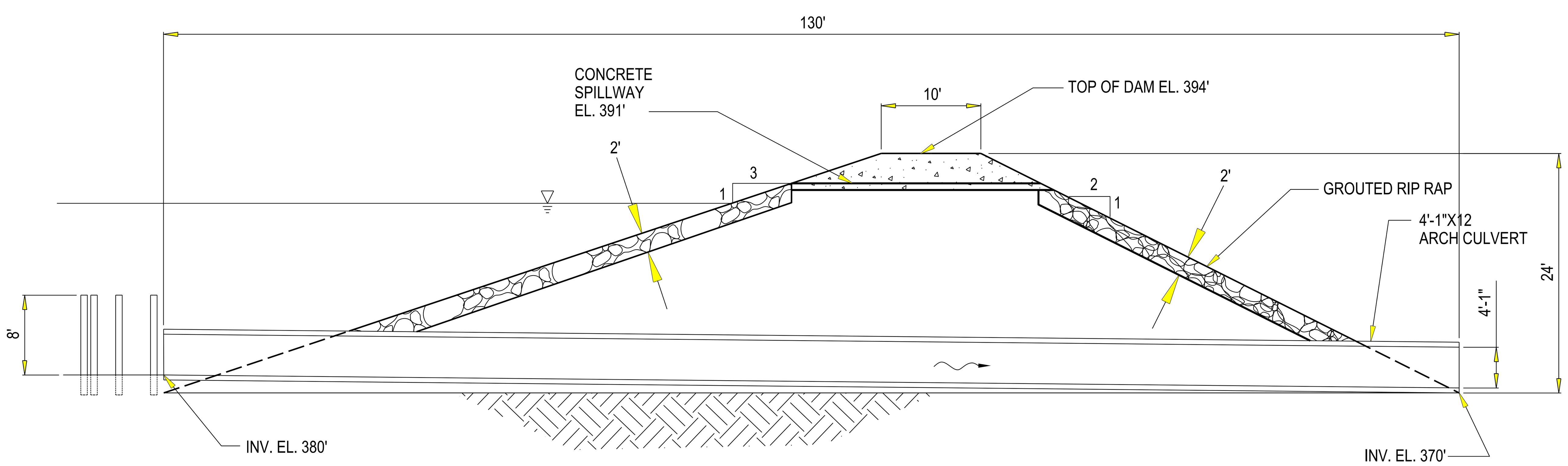


WAIHI DEBRIS AND DETENTION BASIN
SECTION C-C
SCALE: 1"=5'

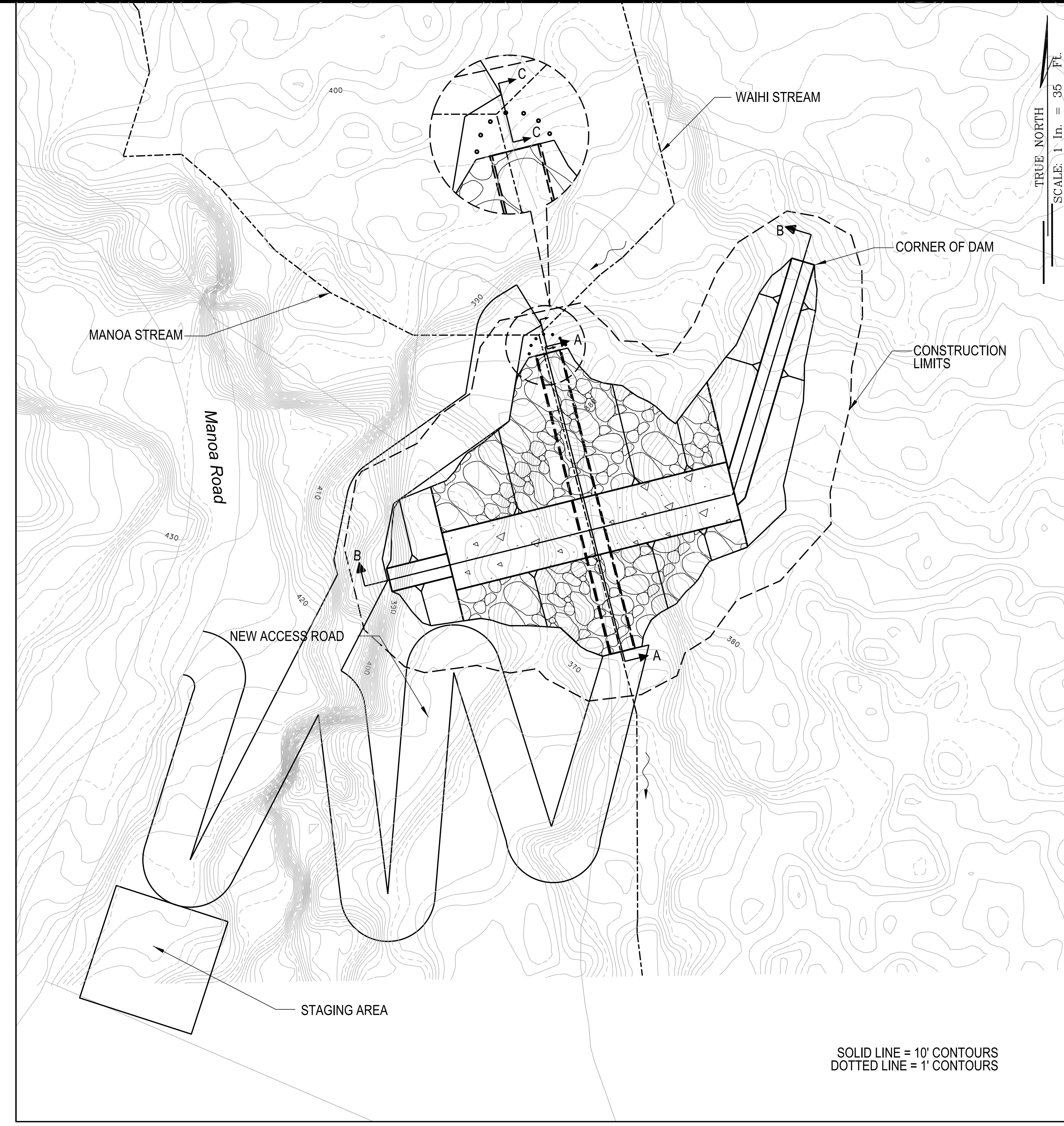


SLOTTED CONCRETE FOOTING

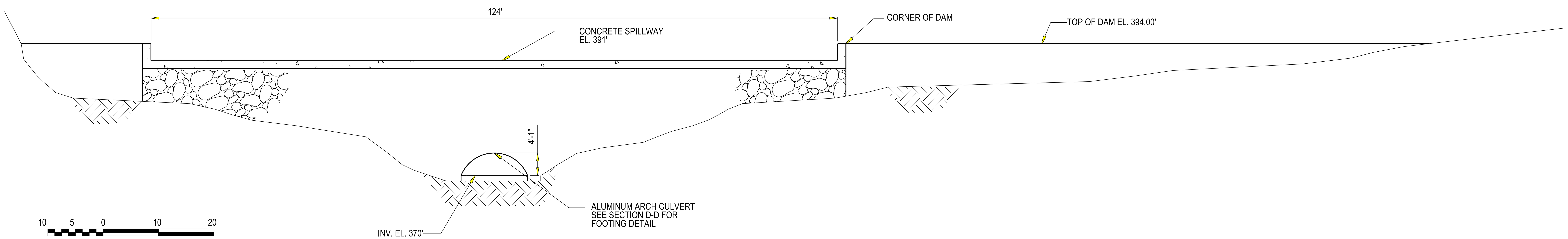
WAIHI DEBRIS AND DETENTION BASIN
SECTION D-D
SCALE: NTS



WAIHI DEBRIS AND DETENTION BASIN
SECTION A-A
SCALE: 1"=10'



PLAN
SCALE: 1"=35'



10 5 0 10 20
SCALE: 1" = 10'

Note: All elevations are feet MSL

WAIHI DEBRIS AND DETENTION BASIN
SECTION B-B
SCALE: 1"=10'

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PLOT DATE: 12/15/2014
SIZE: ANSI D
FILE NAME: WAIHI DEBRIS & DETENTION BASIN, PLAN & SECTIONS
DATE:
REVISION:
SOLICIT / CONTRACT NO.:
LOCATION CODE
DRAWING NUMBER:

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ALA WAI CANAL PROJECT

WAIHI DEBRIS AND DETENTION BASIN
PLAN AND SECTIONS
ALTERNATIVE 3A

SHEET IDENTIFICATION
C-301
SHEET 6 OF 20

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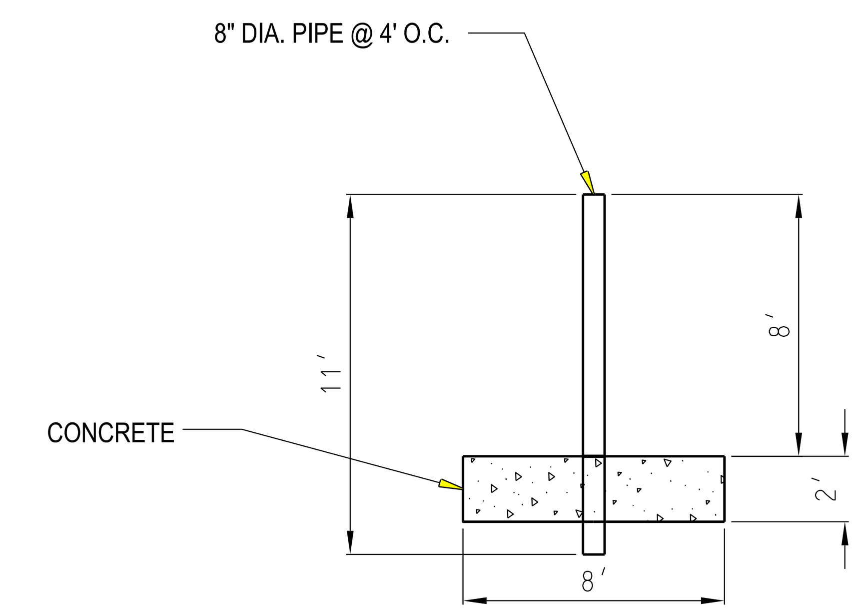
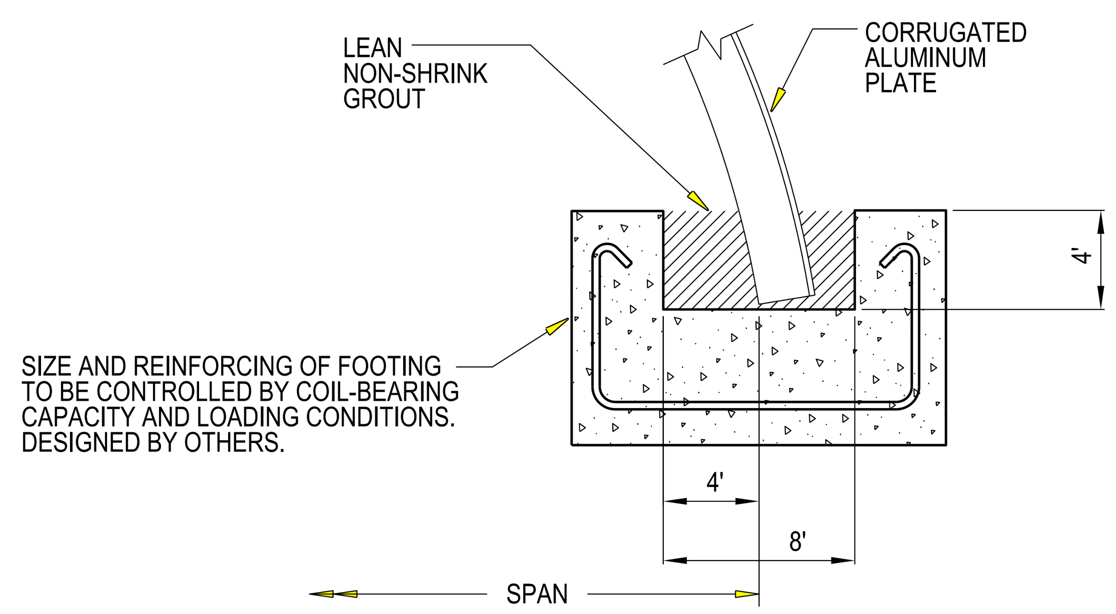
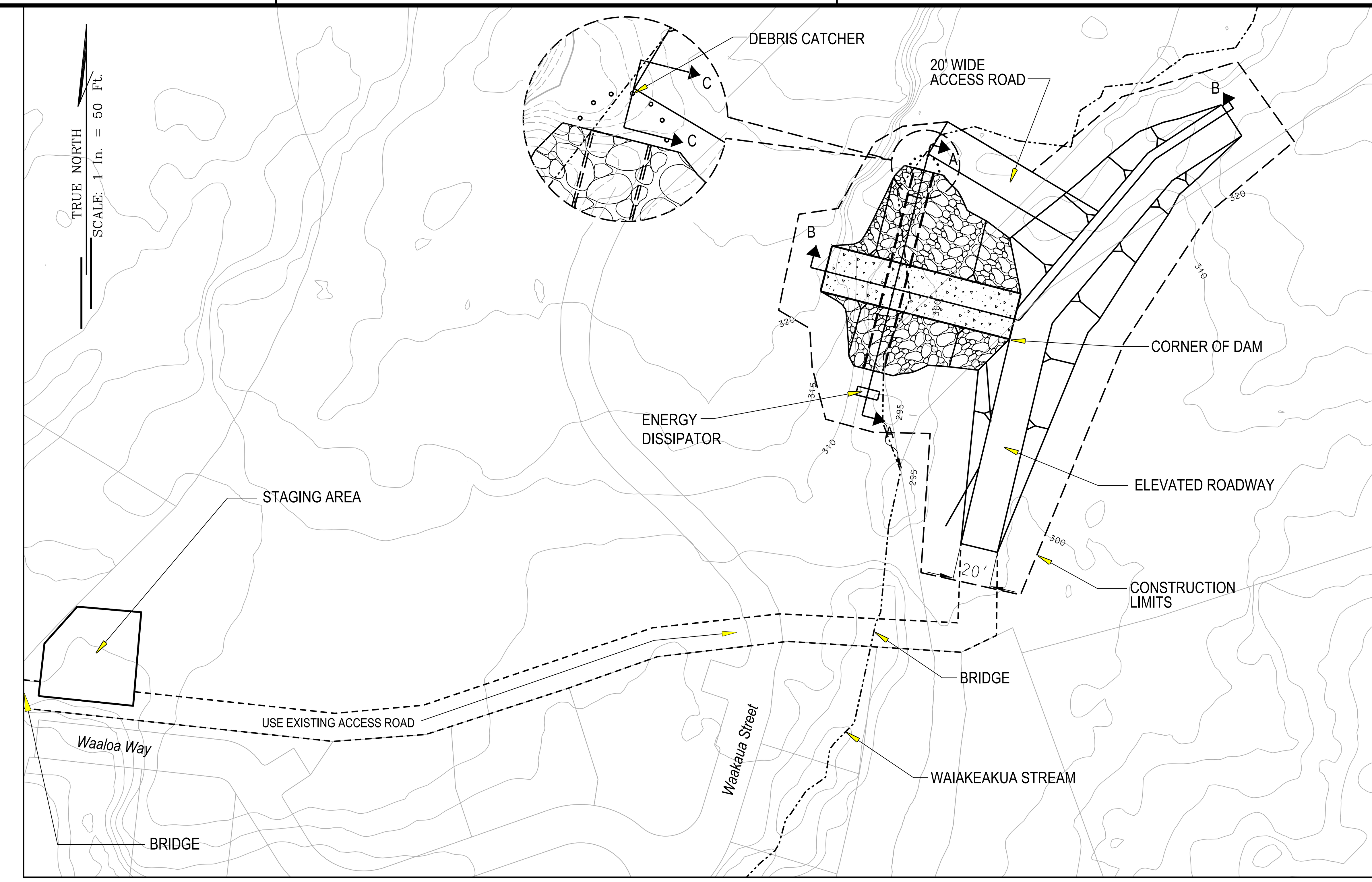


WAIAKEAKUA DEBRIS AND DETENTION BASIN
SECTION C-C
SCALE: 1"=5'

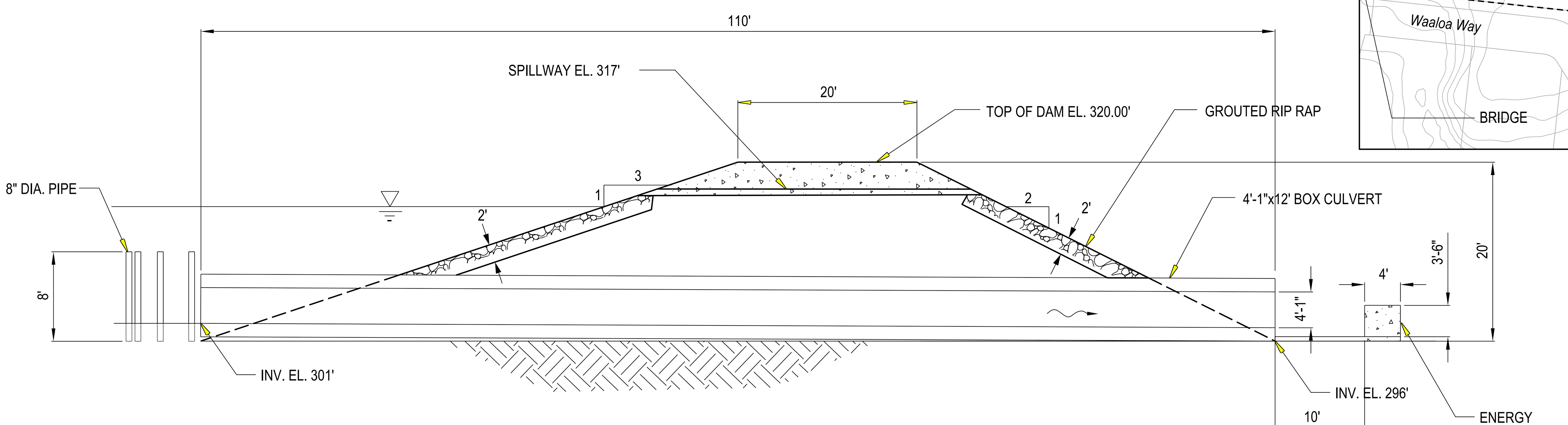


SLOTTED CONCRETE FOOTING
WAIAKEAKUA DEBRIS AND DETENTION BASIN
SECTION D-D
SCALE: NTS

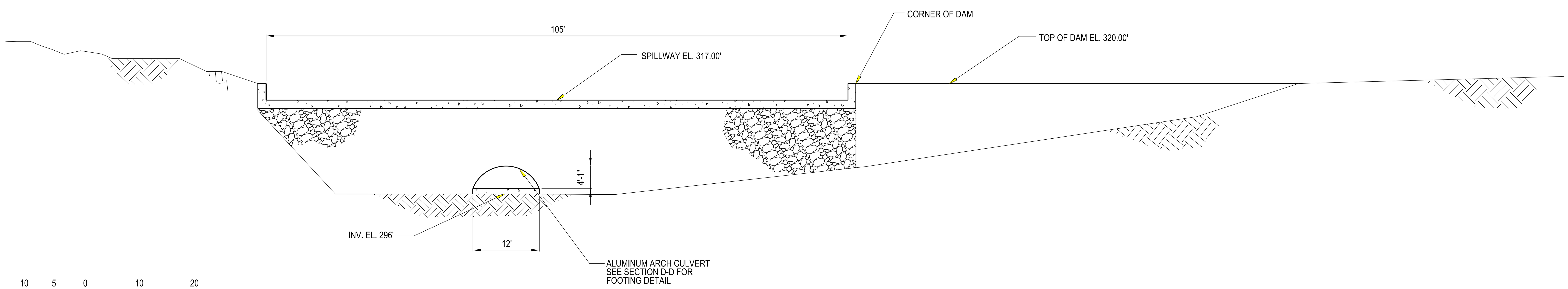


SOLID LINE = 5' CONTOURS

PLAN
SCALE: 1"=50'



WAIAKEAKUA DEBRIS AND DETENTION BASIN
SECTION A-A
SCALE: 1"=10'



10 5 0 10 20
SCALE: 1" = 10'

Note: All elevations are feet MSL

WAIAKEAKUA DEBRIS AND DETENTION BASIN
SECTION B-B
SCALE: 1"=10'

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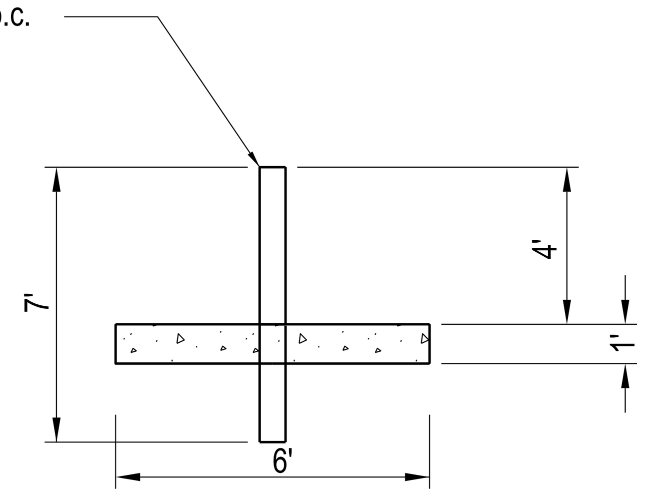
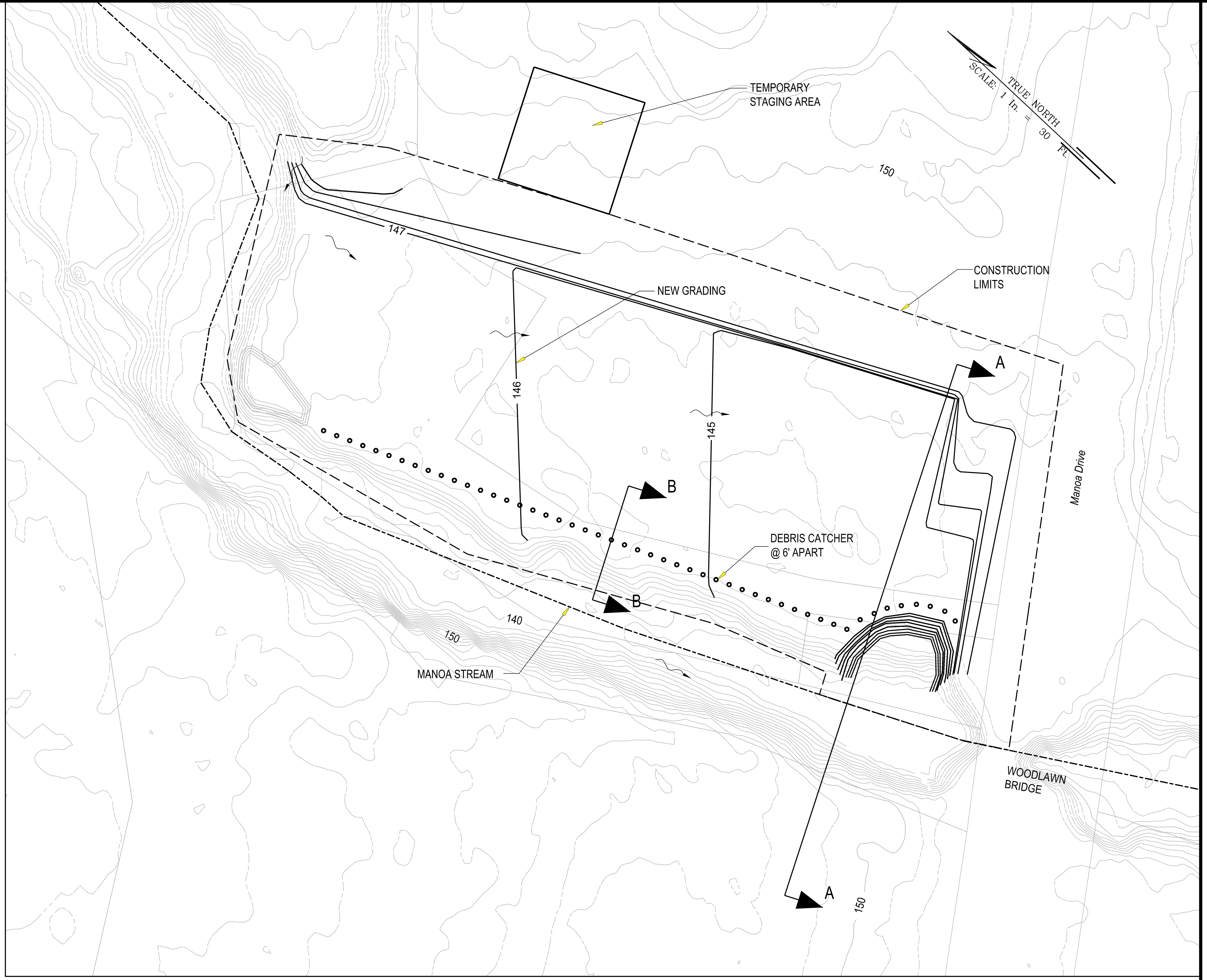
WAIAKEAKUA DEBRIS AND DETENTION
PLAN AND SECTIONS
ALTERNATIVE 3A

SHEET IDENTIFICATION
C-302
SHEET 77 OF 200



INNOVATION CENTER IMPROVEMENTS
SECTION B-B

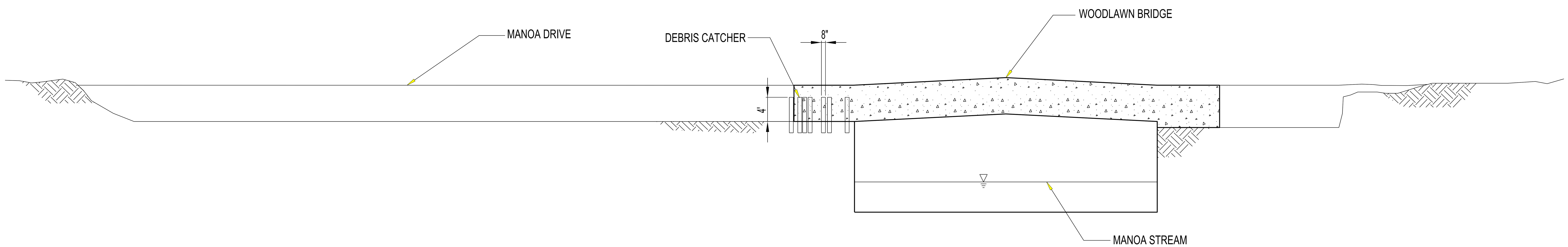
SCALE: NTS



SOLID LINE = 10' CONTOURS
DOTTED LINE = 1' CONTOURS

PLAN

SCALE: 1"=30'



10' 5' 0 10' 20'

SCALE: 1" = 10'

Note: All elevations are feet MSL

INNOVATION CENTER IMPROVEMENTS
SECTION A-A

SCALE: 1"=10'

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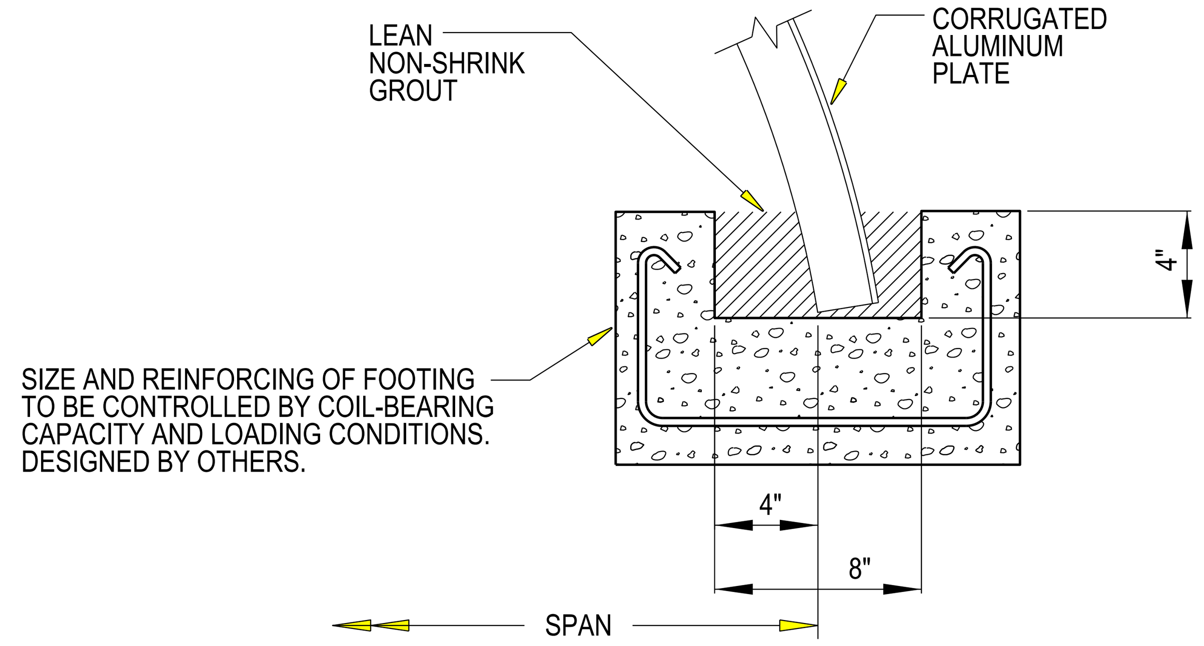
PLOT SCALE:	PLOT DATE: 12/15/2014	DRAWING NUMBER:	
SIZE: ANSI D	FILE NAME: INNOVATION CENTER IMPROVEMENTS, PLAN & SECTIONS		

ALA WAI CANAL PROJECT

INNOVATION CENTER IMPROVEMENTS
PLAN AND SECTIONS
ALTERNATIVE 3A

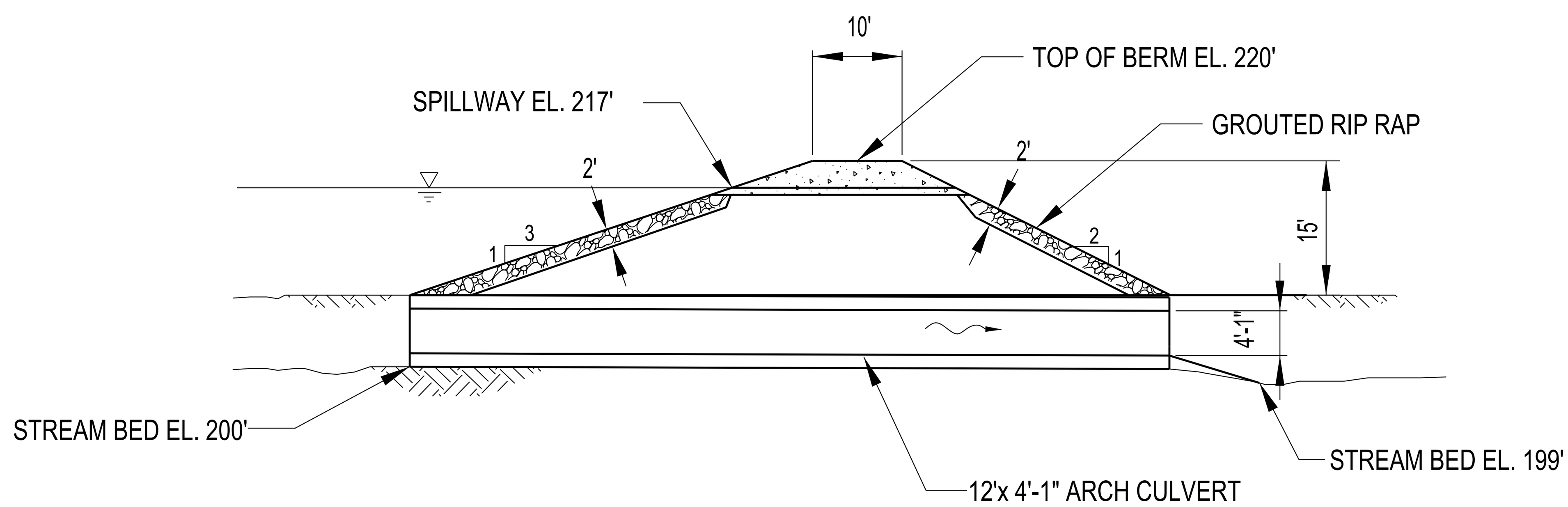
SHEET IDENTIFICATION
C-304A
SHEET 8 OF 20



SLOTTED CONCRETE FOOTING

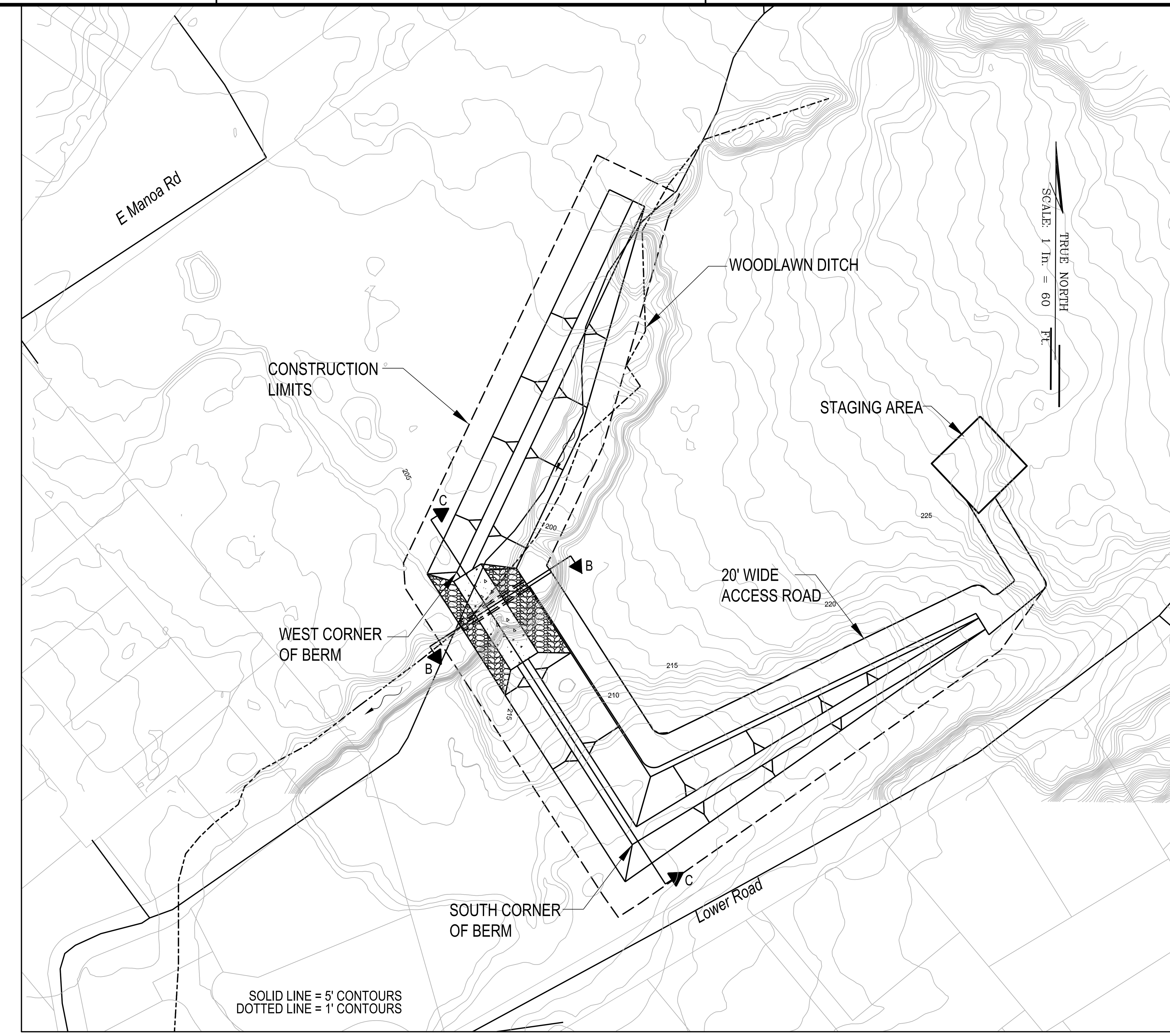
WOODLAWN DITCH DETENTION BASIN SECTION D-D

SCALE: NTS



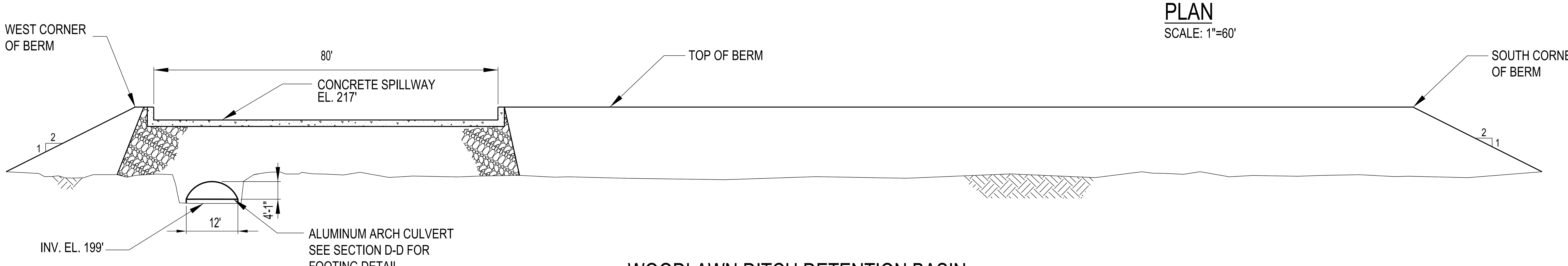
WOODLAWN DITCH DETENTION BASIN SECTION B-B

SCALE: 1"=15'



PLAN

SCALE: 1"=60'



WOODLAWN DITCH DETENTION BASIN SECTION C-C

SCALE: 1"=15'

15' 7.5' 0 15' 30'

SCALE: 1" = 15'

Note: All elevations are feet MSL

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MARK	DESCRIPTION	DATE	APPR.

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PLOT SCALE: AS SHOWN | PLOT DATE: 12/15/2014 | DRAWING NUMBER:
SIZE: ANSI D | FILE NAME: WOODLAWN DITCH DETENTION BASIN, PLAN & SECTIONS

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WOODLAWN DITCH DETENTION
PLAN AND SECTIONS
ALTERNATIVE 3A

SHEET IDENTIFICATION
C-305A
SHEET 9 OF 20

FILE: c:\pw-work\poh-1\j3ec9jhh\d0133359\Ala_Wai_C-305Axx.dgn
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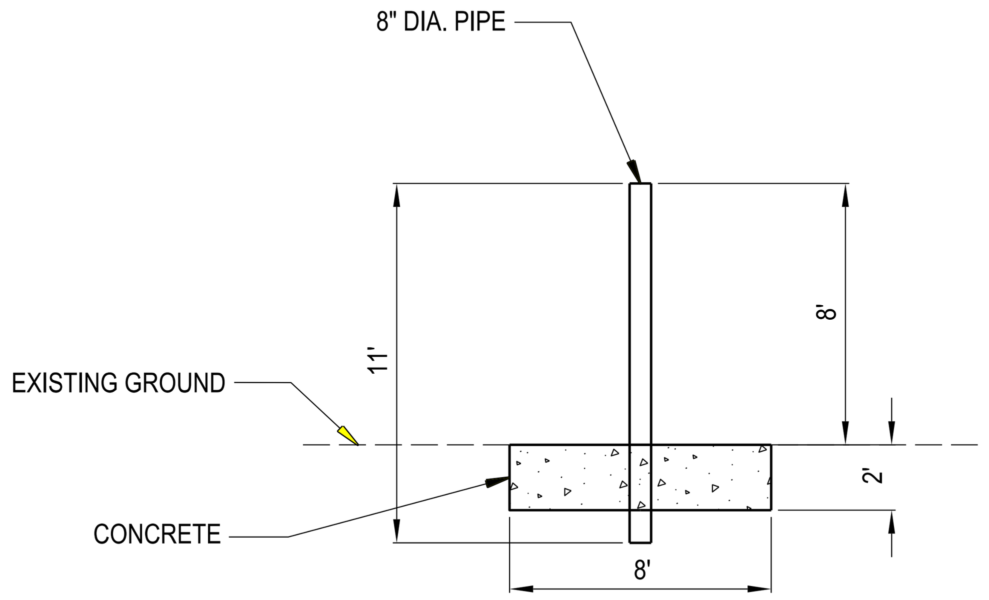
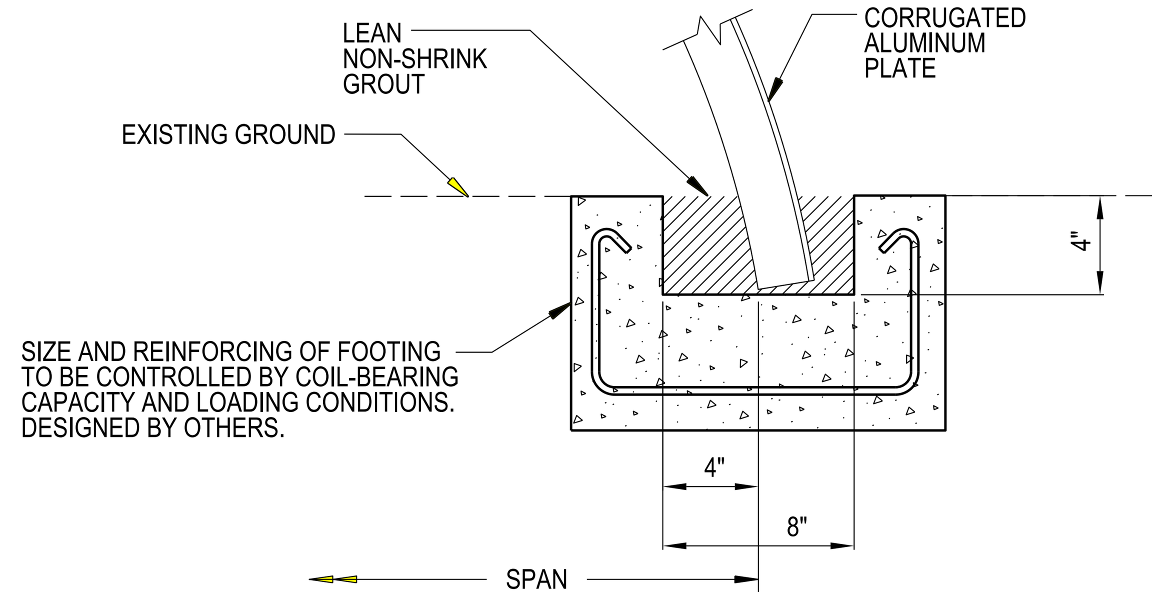
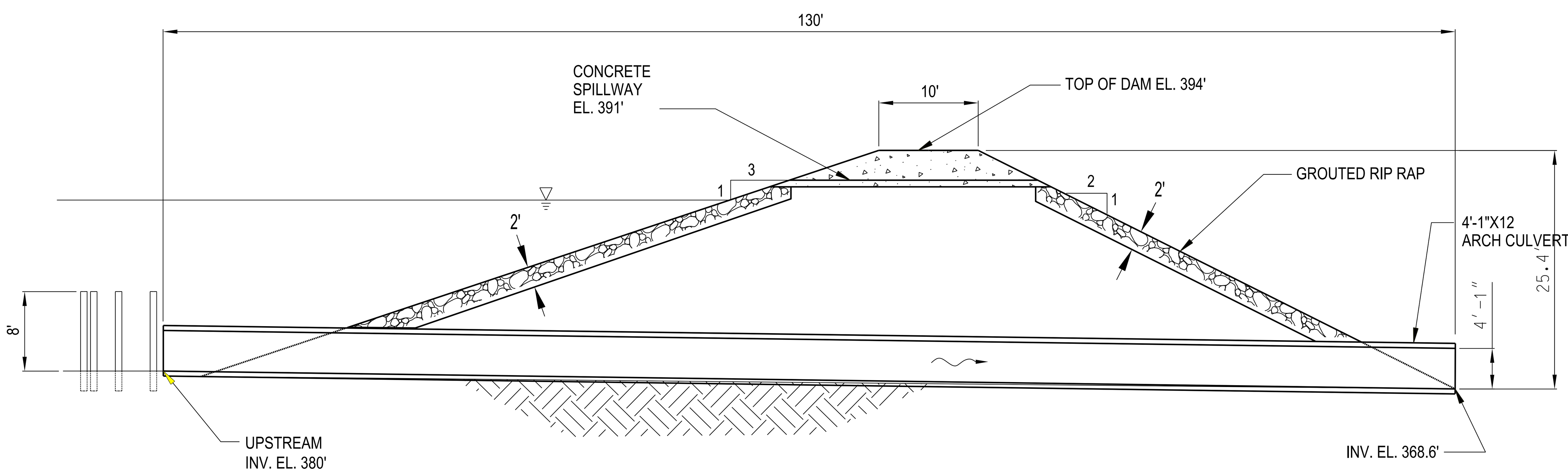
PLOTDRIVER: C:\ProgramData\Bentley\MicroStation V8i (SELECTseries)\WorkSpace\system\plotcfg\printer.pltcfg
PEN TABLE: BW_and_Grayscale_Pen.tbl
PRINTED BY: J3EC9JHH



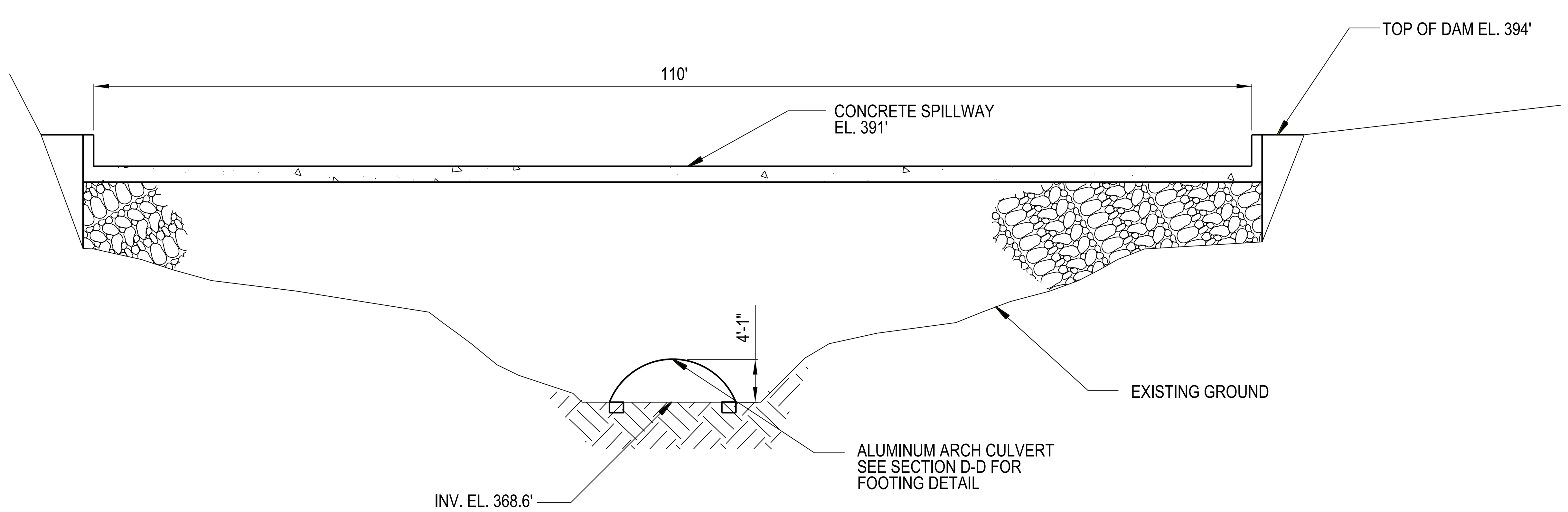
WAIOMAO DEBRIS AND DETENTION BASIN
SECTION C-C
SCALE: 1"=5'



SLOTTED CONCRETE FOOTING
WAIOMAO DEBRIS AND DETENTION BASIN
SECTION D-D
SCALE: NTS



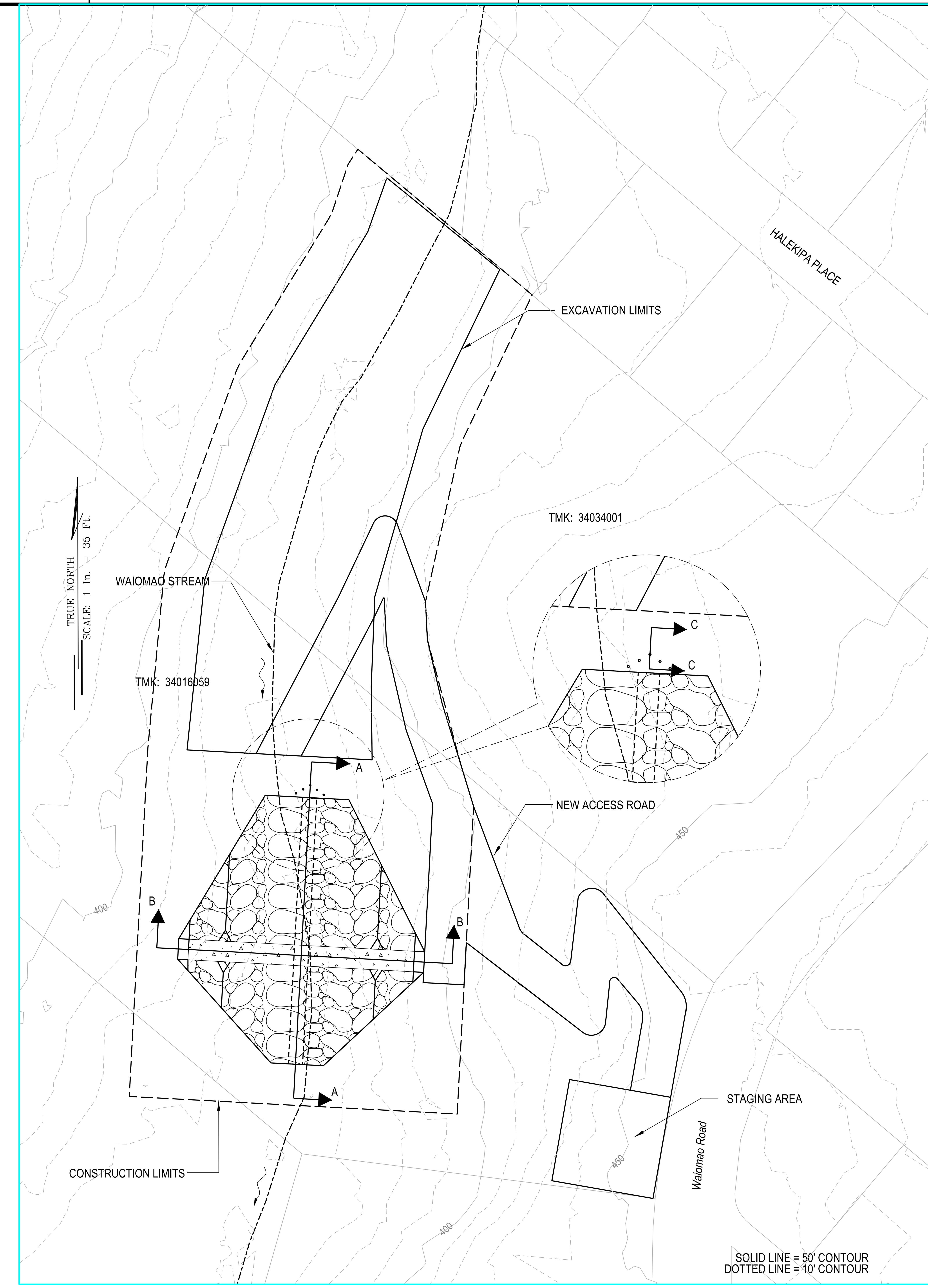
WAIOMAO DEBRIS AND DETENTION BASIN
SECTION A-A
SCALE: 1"=10'



WAIOMAO DEBRIS AND DETENTION BASIN
SECTION B-B
SCALE: 1"=10'

10 5 0 10 20
SCALE: 1" = 10'

Note: All elevations are feet MSL



PLAN
SCALE: 1"=35'

35 17.5 0 35 70
SCALE: 1" = 35'

NOTES:

1. ALUMINUM ARCH CULVERT METAL THICHNESS IS 1.50". WITH A NATURAL BOTTOM.
2. THE APPROXIMATE AREA UNDER THE ARCH CULVERT IS 35.3 SQ FT.

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DESIGNED BY: JHH	DATE:	REVISION:	
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SUBMITTED BY:		LOCATION CODE	
PLOT SCALE:	PLOT DATE: 12/15/2014	DRAWING NUMBER:	
SIZE: ANSI D	FILE NAME: WAIOMAO DEBRIS & DETENTION BASIN, PLAN & SECTIONS		

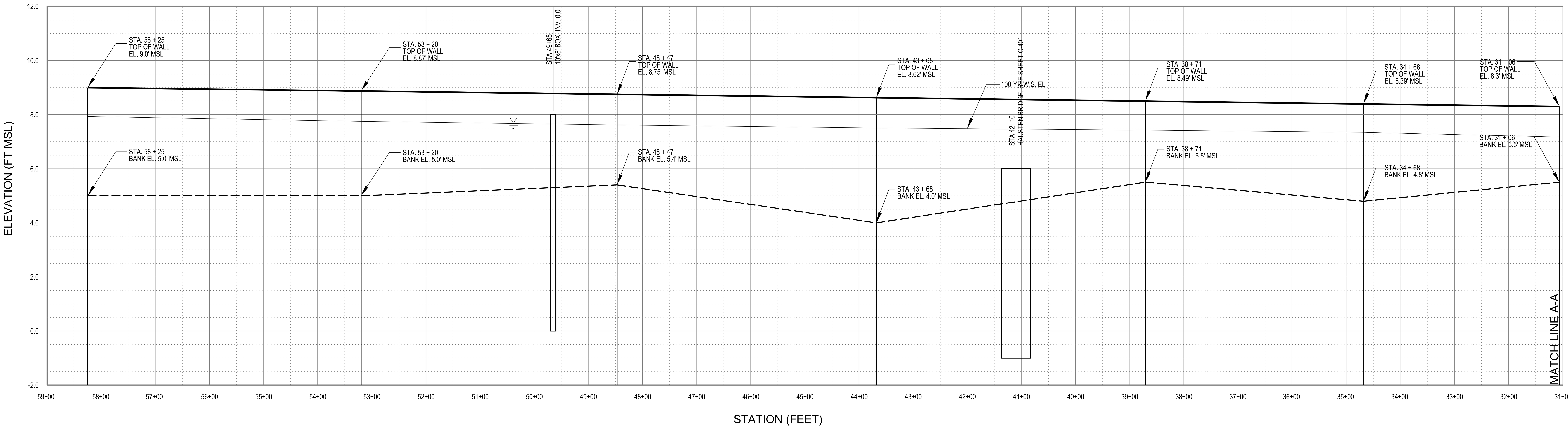
US ARMY CORPS OF ENGINEERS
HONOLULU DISTRICT
HONOLULU, HAWAII

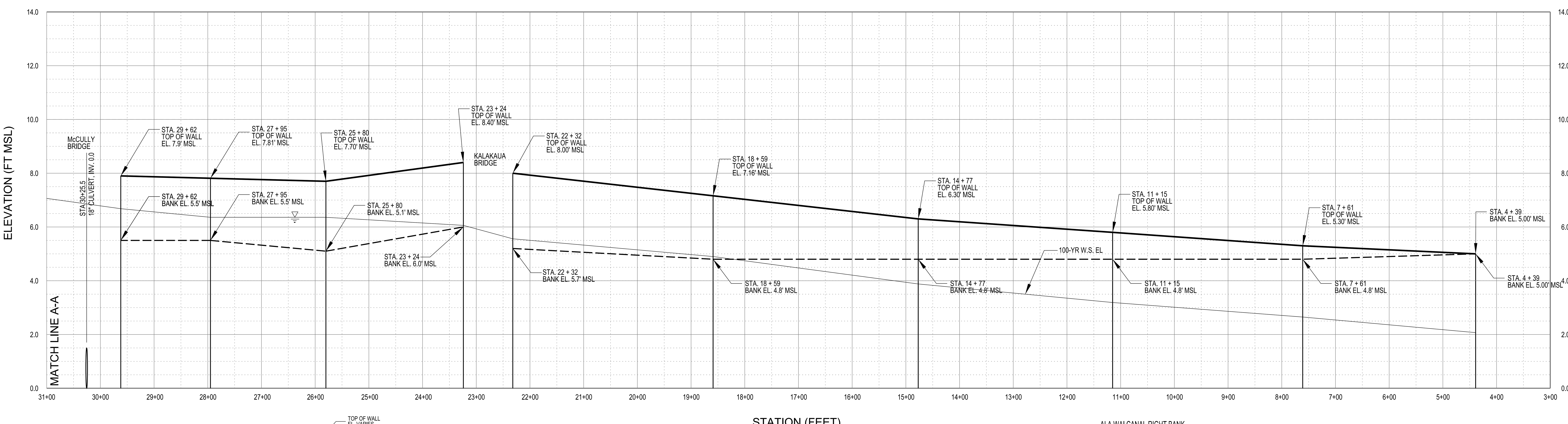
ALA WAI CANAL PROJECT

WAIOMAO DEBRIS AND DETENTION BASIN
PLAN AND SECTIONS
ALTERNATIVE 3A

SHEET IDENTIFICATION
C-308
SHEET 10 OF

FILE: c:\pw-work\poh-1\j3ec9jhh\d0133359\Ala_Wai_C-308xxx.dgn
MODEL NAME: C-308
DATE & TIME: 12/15/2014 4:33:49 PM
LAST SAVED BY: J3EC9JHH
PLOTDRIVER: C:\ProgramData\Bentley\MicroStation V8i (SELECTseries)\WorkSpace\system\pltcfg\printer.pltcfg
PEN TABLE: BW_and_Grayscale_Pen.tbl
PRINTED BY: J3EC9JHH

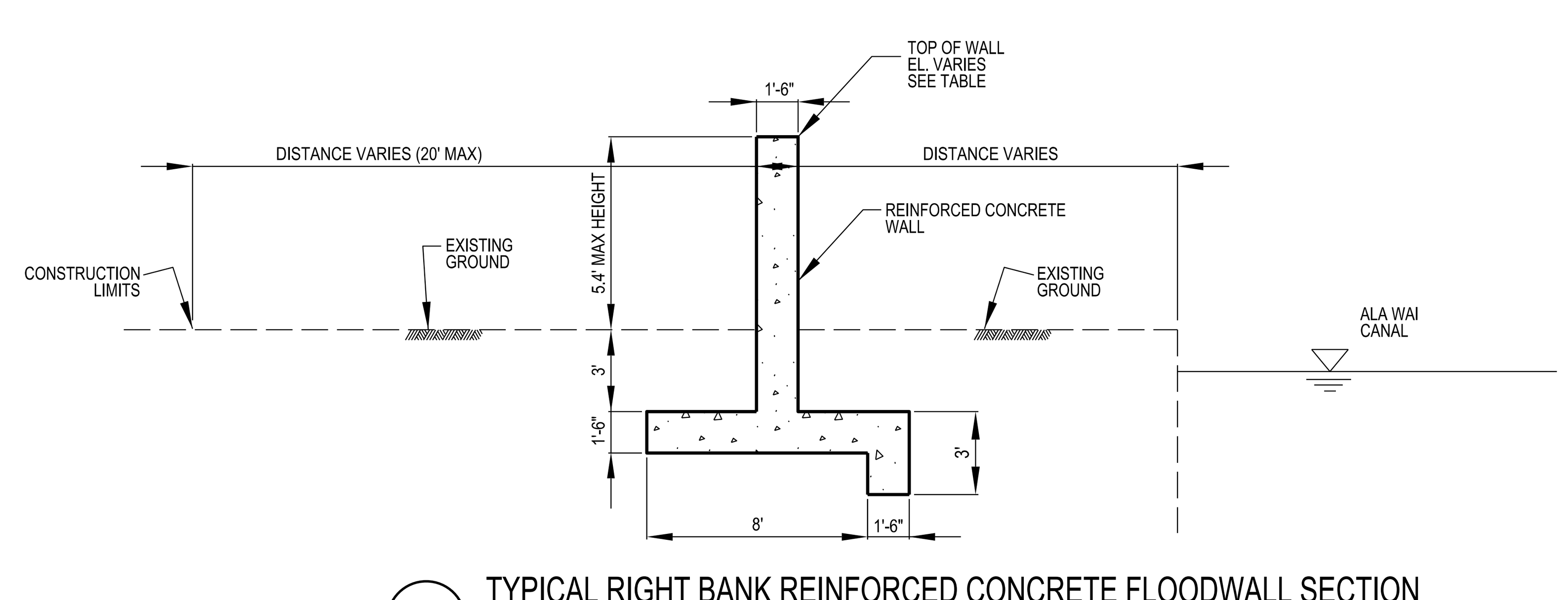




PROFILE

ALA WAI MIDDLE (ALA2) AND LOWER (ALA1) RIGHT BANK FLOODWALLS

SCALE:
HORIZONTAL: 1" = 100'
VERTICAL: 1" = 2'



A TYPICAL RIGHT BANK REINFORCED CONCRETE FLOODWALL SECTION

NOT TO SCALE

ALA WAI CANAL RIGHT BANK
STA 58 + 25 TO 25+80

STATION	WALL HEIGHT (FT)	FINISHED WALL ELEVATION (FT MSL)
58 + 25	4.00	9.00
53 + 20	3.87	8.87
48 + 47	3.35	8.75
43 + 68	4.62	8.62
38 + 71	2.99	8.49
34 + 68	3.59	8.39
31 + 06	2.80	8.30
MCCLULLY BRIDGE		
29 + 62	2.40	7.90
27 + 95	2.31	7.81
25 + 80	2.60	7.70

ALA WAI CANAL RIGHT BANK
STA 23 + 24 TO 4 + 39

STATION	WALL HEIGHT (FT)	FINISHED WALL ELEVATION (FT MSL)
23 + 24	2.40	8.40
22 + 32	2.80	8.00
18 + 59	2.36	7.16
14 + 77	1.50	6.30
11 + 15	1.00	5.80
7 + 61	0.50	5.30
4 + 39	0	5.00

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DESIGNED BY: JHH
DATE:
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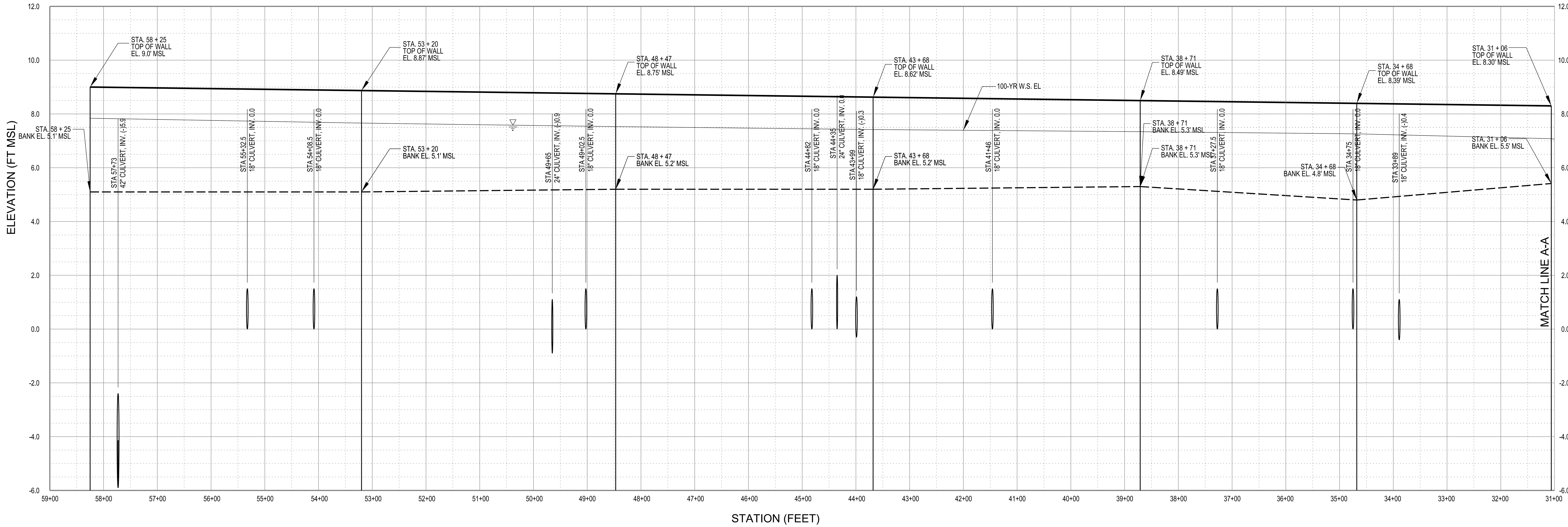
SOLICIT / CONTRACT NO.:
SUBMITTED BY:
LOCATION CODE
PLOT SCALE: AS SHOWN
PLOT DATE: 12/15/2014
DRAWING NUMBER:
SIZE: ANSI D
FILE NAME: ALA WAI CANAL MIDDLE & LOWER RIGHT BANK, PROFILE

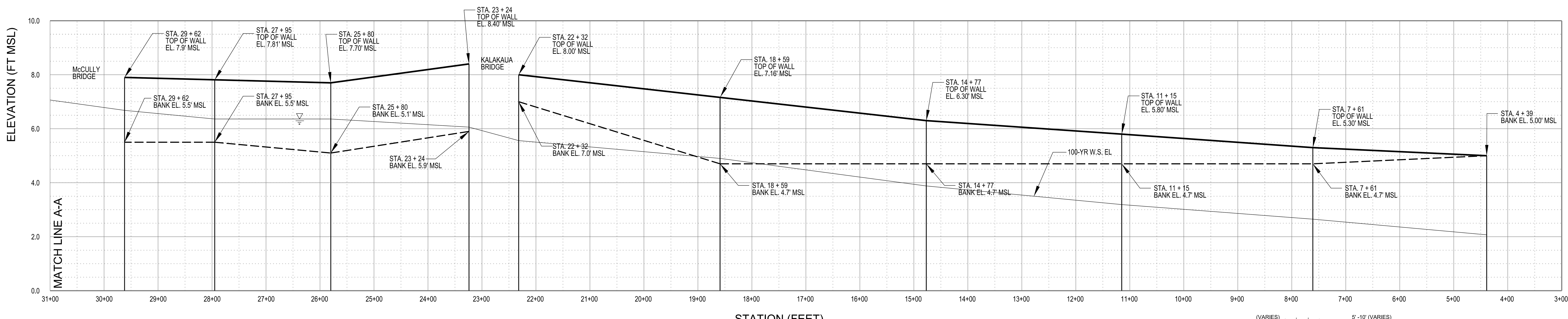
ALA WAI CANAL PROJECT

ALA WAI MIDDLE & LOWER RIGHT BANK FLOODWALLS
PROFILE AND SECTION
ALTERNATIVE 3A

SHEET IDENTIFICATION
C-309A
SHEET 11 OF 20

FILE: c:\pw-work\poh-1\j3ec9jhh\d0133359\Ala_Wai_C-309Axx.dgn
MODEL NAME: C-309A
DATE & TIME: 12/15/2014 4:35:51 PM
LAST SAVED BY: J3EC9JHH
PLOTDRIVER: C:\ProgramData\Bentley\MicroStation V8i (SELECTseries)\WorkSpace\system\pltcfg\printer.pltcfg
PEN TABLE: BW_and_Grayscale_Pen.tbl
PRINTED BY: J3EC9JHH





ALA WAI CANAL LEFT BANK
STA TO 58 + 25 TO 25+80

STATION	WALL HEIGHT (FT)	FINISHED WALL ELEVATION (FT MSL)
58 + 25	3.90	9.00
53 + 20	3.77	8.87
48 + 47	3.55	8.75
43 + 68	3.42	8.62
38 + 71	3.19	8.49
34 + 68	3.59	8.39
31 + 06	2.80	8.30
MCCLULLY BRIDGE		
29 + 62	2.40	7.90
27 + 95	2.31	7.81
25 + 80	2.60	7.70

ALA WAI CANAL LEFT BANK
STA TO 23 + 24 TO 4 + 39

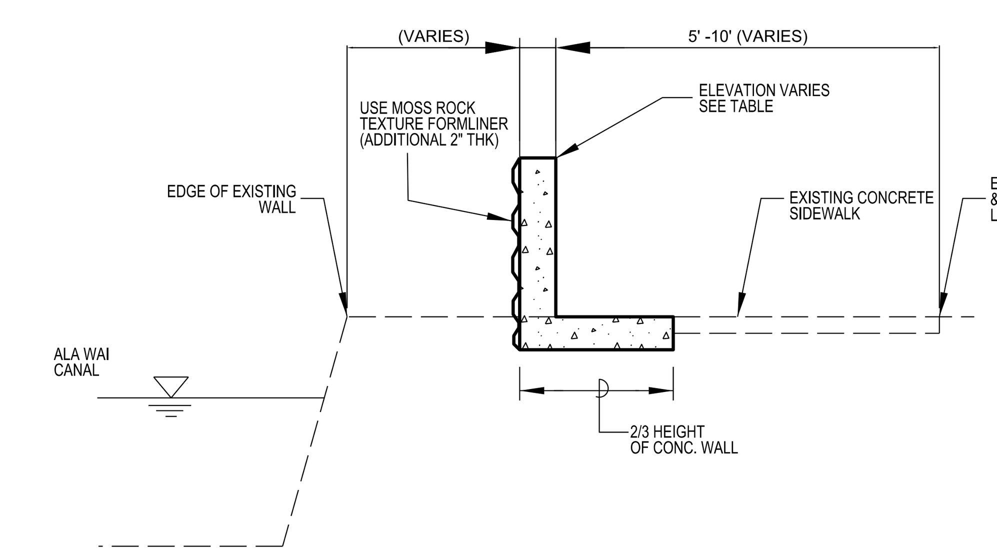
STATION	WALL HEIGHT (FT)	FINISHED WALL ELEVATION (FT MSL)
23 + 24	2.50	8.40
KALAKAUA BRIDGE		
22 + 32	1.00	8.00
18 + 59	2.46	7.16
14 + 77	1.60	6.30
11 + 15	1.10	5.80
7 + 61	0.60	5.30
4 + 39	0	5.00

PROFILE
ALA WAI CANAL MIDDLE (ALA2) AND LOWER (ALA1) LEFT BANK FLOODWALLS

SCALE:
HORIZONTAL: 1" = 100'
VERTICAL: 1" = 2'

NOTES:

1. SEE DETAIL "C" ON SHEET C-311A FOR ALA WAI CANAL MIDDLE (ALA2) TYPICAL LEFT BANK CONCRETE FLOODWALL SECTION.
2. ALA WAI CANAL LOWER (ALA1) IS FROM STATION 23+24 TO STATION 4+39.



B TYPICAL ALA WAI LOWER (ALA1) LEFT BANK CONCRETE FLOODWALL SECTION

NOT TO SCALE

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HONOLULU, HAWAII

DESIGNED BY: JHH
DRAWN BY:
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SUBMITTED BY:
PLOT SCALE: AS SHOWN
PLOT DATE: 12/15/2014
SIZE: ANSI D
FILE NAME: ALA WAI CANAL MIDDLE & LOWER LEFT BANK PROFILE
DATE:
SOLICIT./CONTRACT NO.:
LOCATION CODE
DRAWING NUMBER:
REVISION:

ALA WAI CANAL PROJECT

ALA WAI MIDDLE & LOWER LEFT BANK FLOODWALLS
PROFILE
ALTERNATIVE 3A

SHEET IDENTIFICATION
C-310A
SHEET 12 OF 20

FILE: c:\pw-work\poh-1\j3ec9jhh\d0133359\Ala_Wai_C-310Axx.dgn
MODEL NAME: C-310A
DATE & TIME: 12/15/2014 4:37:32 PM
LAST SAVED BY: J3EC9JHH
PLOTDRIVER: C:\ProgramData\Bentley\MicroStation V8i (SELECTseries)\WorkSpace\system\plotcfg\printer.pltcfg
PEN TABLE: BW_and_Grayscale_Pen.tbl
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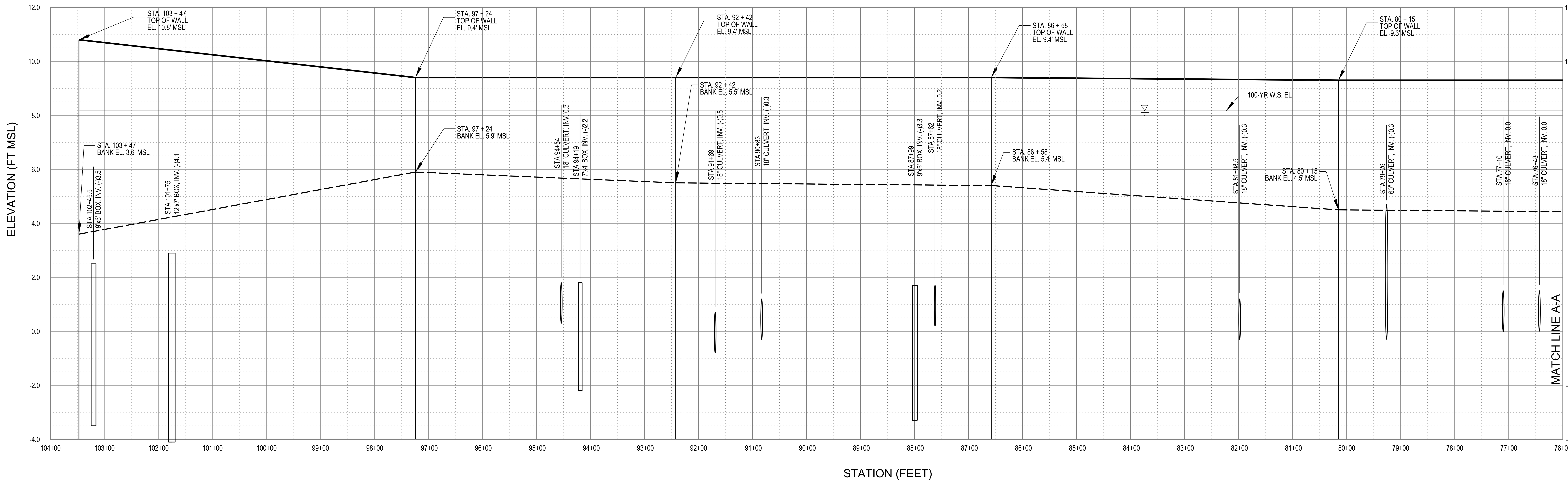

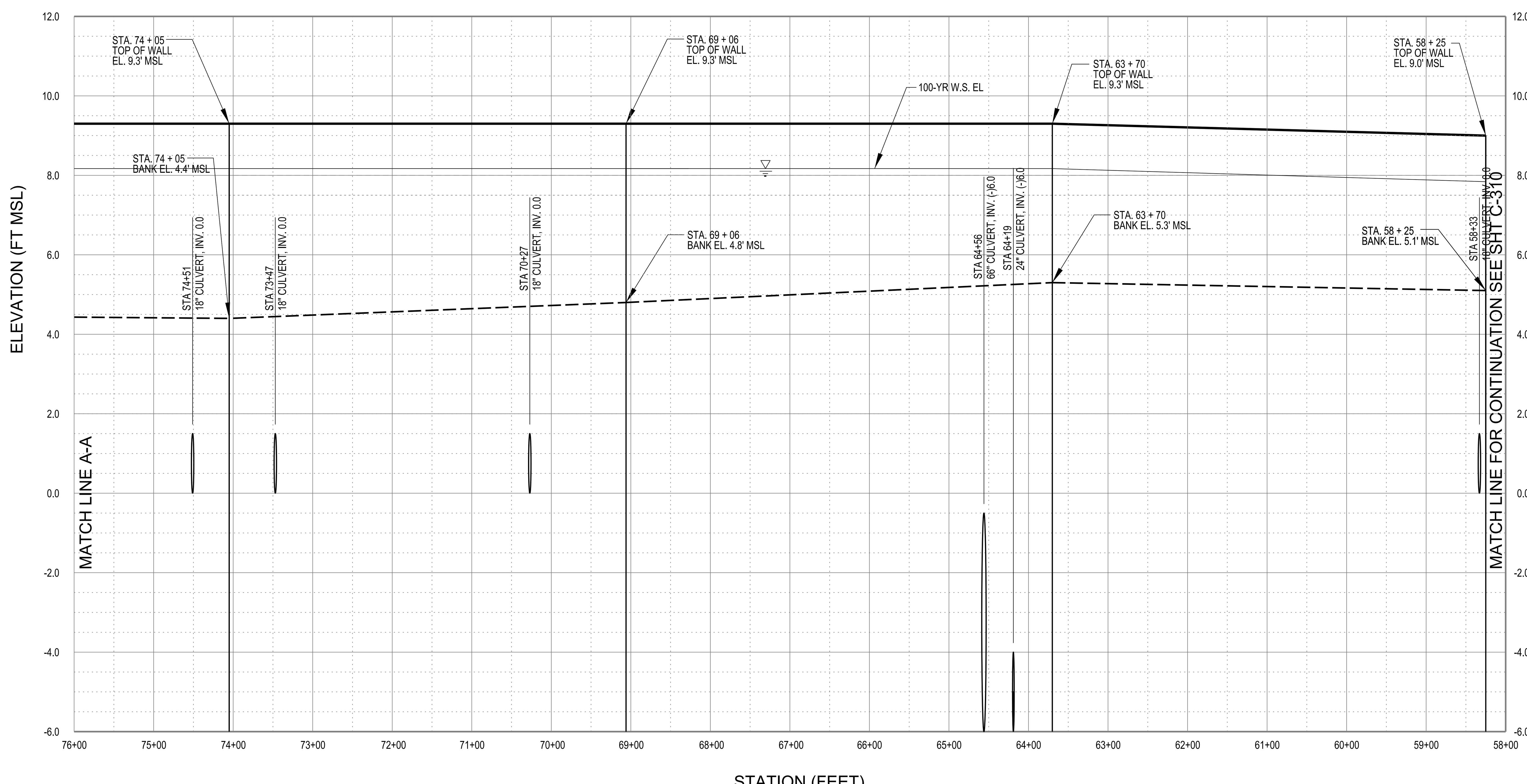

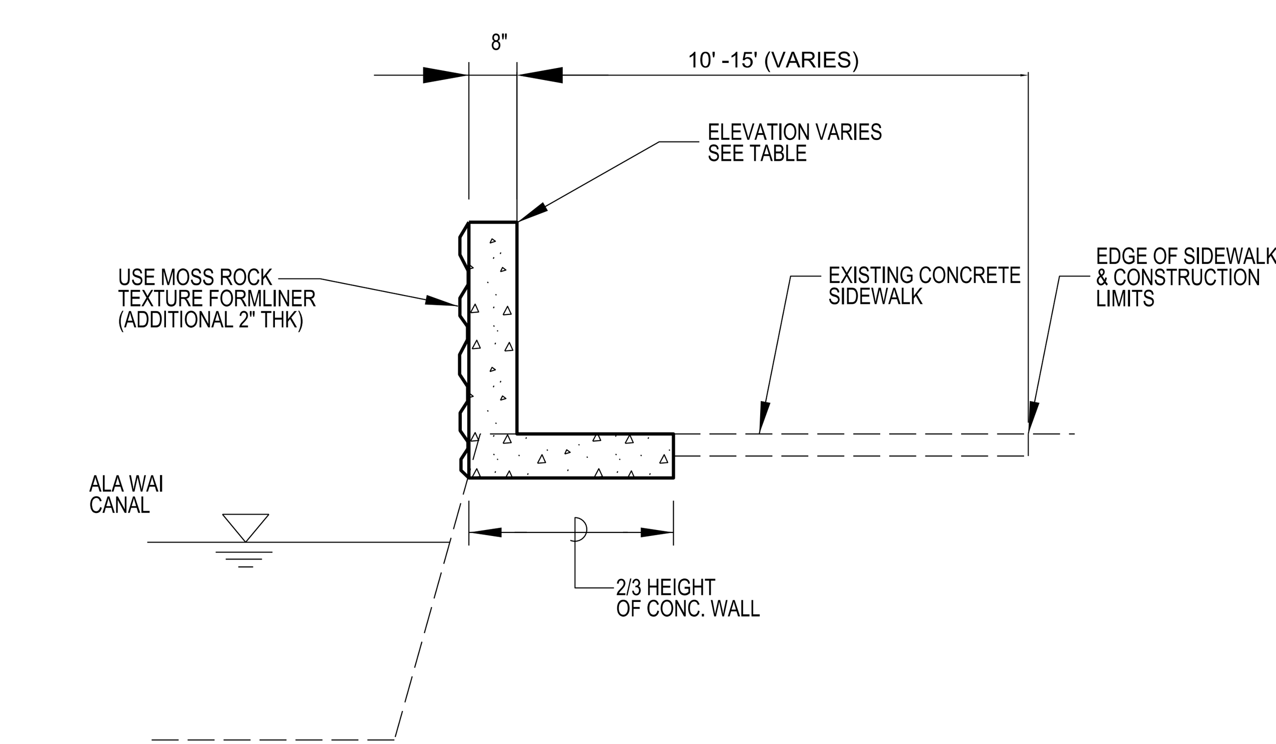

C TYPICAL LEFT BANK CONCRETE FLOODWALL SECTION

NOT TO SCALE

ALA WAI CANAL LEFT BANK
STA 101 + 24 TO 58 + 25

STATION	WALL HEIGHT (FT)	FINISHED WALL ELEVATION (FT MSL)
101 + 24	7.20	10.80
97 +24	3.50	9.40
92 + 42	3.90	9.40
86 + 58	4.00	9.40
80 + 15	4.70	9.30
74 + 05	4.80	9.30
69 + 06	4.50	9.30
63 + 70	4.00	9.30
58 + 25	3.90	9.00

PROFILE
ALA WAI CANAL UPPER (ALA3) LEFT BANK FLOODWALLS

SCALE:
HORIZONTAL: 1" = 100'
VERTICAL: 1" = 2'

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CHECKED BY:
SUBMITTED BY:
PLOT SCALE: AS SHOWN
PLOT DATE: 12/15/2014
SIZE: ANSI D
FILE NAME: ALA WAI CANAL UPPER LEFT BANK, PROFILE & SECTIO
DATE:
REVISION:
SOLICIT./ CONTRACT NO.:
LOCATION CODE
DRAWING NUMBER:

ALA WAI CANAL PROJECT

ALA WAI UPPER LEFT BANK FLOODWALLS
PROFILE AND SECTION
ALTERNATIVE 3A

SHEET IDENTIFICATION
C-311A
SHEET 13 OF 20

FILE: c:\pw-work\poh-1\j3ec9jhh\d0133359\Ala_Wai_C-311Axx.dgn
MODEL NAME: C-311A
DATE & TIME: 12/15/2014 4:49:46 PM
LAST SAVED BY: J3EC9JHH
PLOTDRIVER: C:\ProgramData\Bentley\MicroStation V8i (SELECTseries)\WorkSpace\system\plot\cfg\printer.pltcfg
PEN TABLE: BW_and_Grayscale_Pen.tbl
PRINTED BY: J3EC9JHH

8" DIA. PIPE @ 4' O.C.
CONCRETE
11'
8'
2'
8'
PUKELE DEBRIS AND DETENTION BASIN
SECTION A-A
SCALE: 1"=5'
LEAN NON-SHRINK GROUT
CORRUGATED ALUMINUM PLATE
SIZE AND REINFORCING OF FOOTING TO BE CONTROLLED BY COIL-BEARING CAPACITY AND LOADING CONDITIONS. DESIGNED BY OTHERS.
4"
4"
8"
SPAN
SLOTTED CONCRETE FOOTING
SECTION D-D
SCALE: NTS
TRUE NORTH
SCALE: 1 In. = 40 Ft.
450
STAGING AREA
DEBRIS CATCHER
Ipulei Place
A
B
C
450
CONSTRUCTION LIMITS
PUKELE STREAM
500
SOLID LINE = 50' CONTOURS
DOTTED LINE = 10' CONTOURS
PLAN
SCALE: 1"=40'
110'
TOP OF DAM EL. 431'
CONCRETE SPILLWAY EL. 428'
4'-1"
UPSTREAM INV. EL. 414'
ALUMINUM ARCH CULVERT SEE SECTION D-D FOR FOOTING DETAIL
PUKELE DEBRIS AND DETENTION BASIN
SECTION C-C
SCALE: 1"=5'
130'
CONCRETE SPILLWAY EL. 428'
10'
TOP OF DAM EL. 431'
GROUTED RIP RAP
4'-1"X12 ARCH CULVERT
1
3
2
1
2'
2'
8'
4'-1"
24'
UPSTREAM INV. EL. 414'
INV. EL. 407'
PUKELE DEBRIS AND DETENTION BASIN
SECTION B-B
SCALE: 1"=5'
5 2.5' 0 5 10
SCALE: 1" = 5'
Note: All elevations are feet MSL
FILE: c:\pw-work\poh-1\j3ec9jhh\d0133359\Ala_Wai_C-313xxx.dgn
MODEL NAME: C-313
DATE & TIME: 12/15/2014 5:05:33 PM
LAST SAVED BY: J3EC9JHH
PLOTDRIVER: C:\ProgramData\Bentley\MicroStation V8i (SELECTseries)\WorkSpace\system\pltcfg\printer.pltcfg
PEN TABLE: BW_and_Grayscale_Pen.tbl
PRINTED BY: J3EC9JHH
US Army Corps of Engineers
Honolulu District
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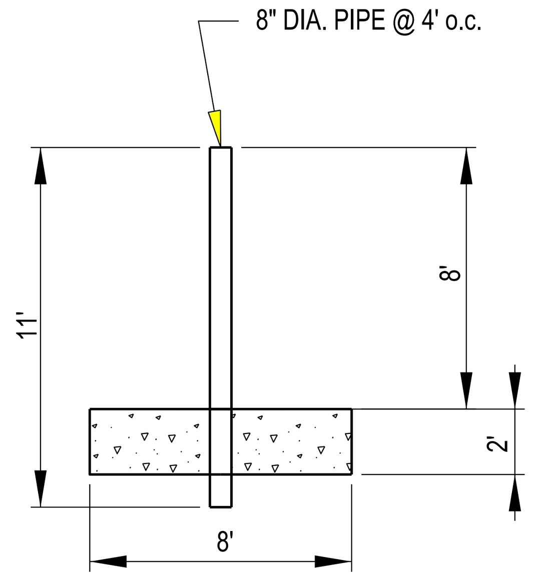
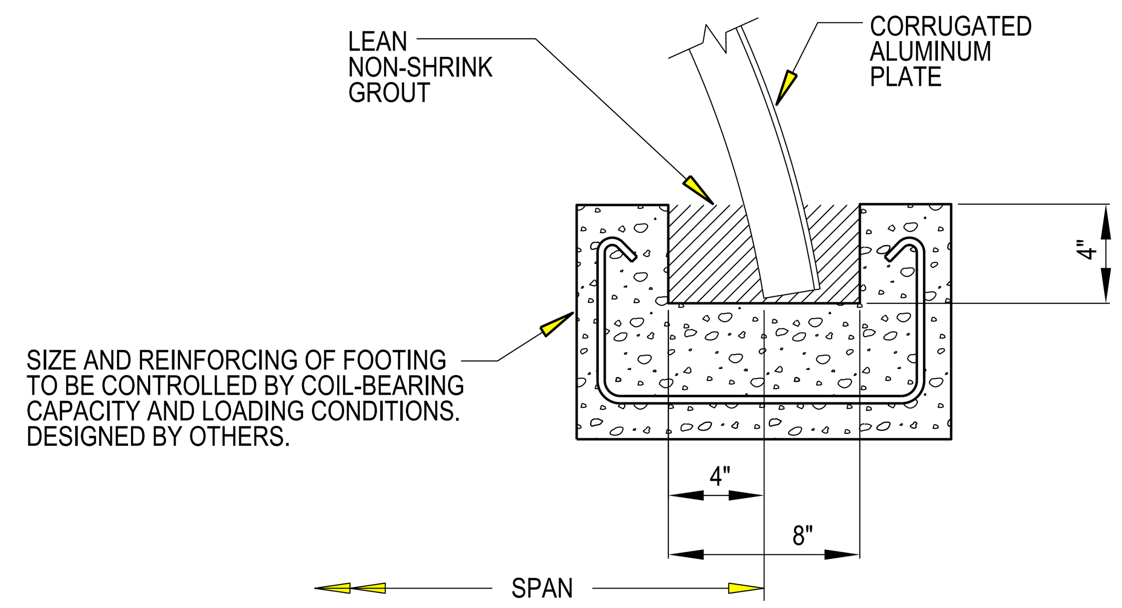
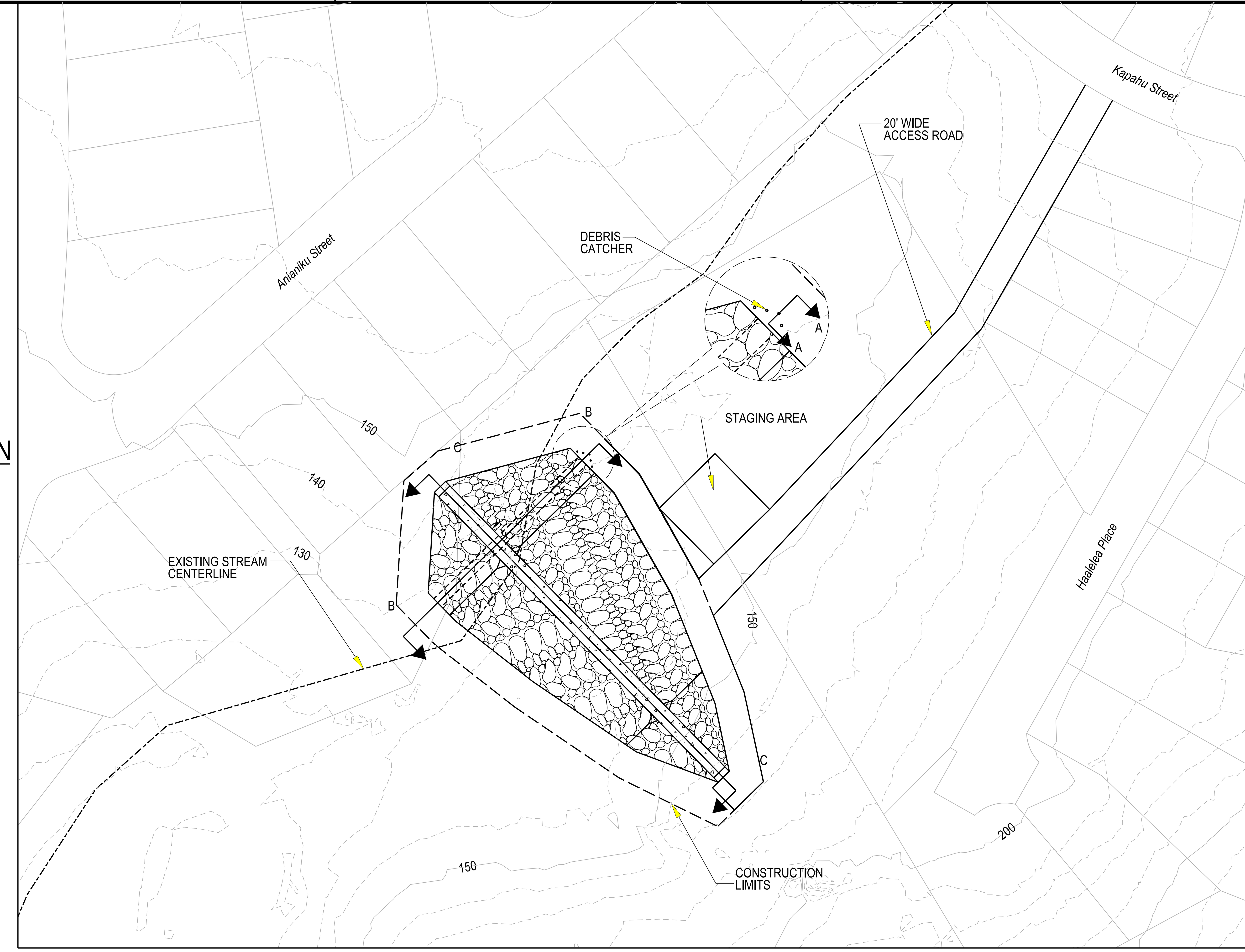
MARK DESCRIPTION DATE APPR
US ARMY CORPS OF ENGINEERS
HONOLULU DISTRICT
HONOLULU, HAWAII
DESIGNED BY: JHH
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
PLOT SCALE: AS SHOWN
SIZE: ANSI D
PLOT DATE: 12/15/2014
FILE NAME: PUKELE DEBRIS & DETENTION BASIN, PLAN & SECTION
DATE:
SOLICIT / CONTRACT NO.:
LOCATION CODE
DRAWING NUMBER:
REVISION:
ALA WAI CANAL PROJECT
PUKELE DEBRIS AND DETENTION BASIN
PLAN AND SECTIONS
ALTERNATIVE 3A
SHEET IDENTIFICATION
C-313
SHEET 14 OF 20



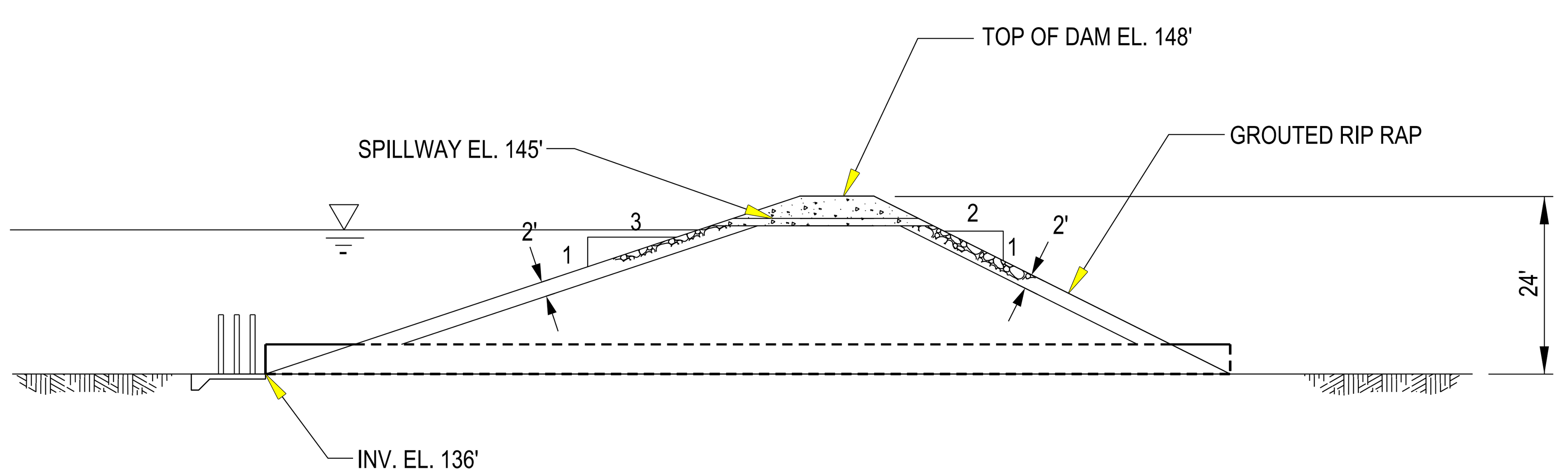
ROOSEVELT DEBRIS AND DETENTION BASIN
SECTION A-A
SCALE: 1"=5'



SLOTTED CONCRETE FOOTING
ROOSEVELT DEBRIS AND DETENTION BASIN
SECTION D-D
SCALE: NTS

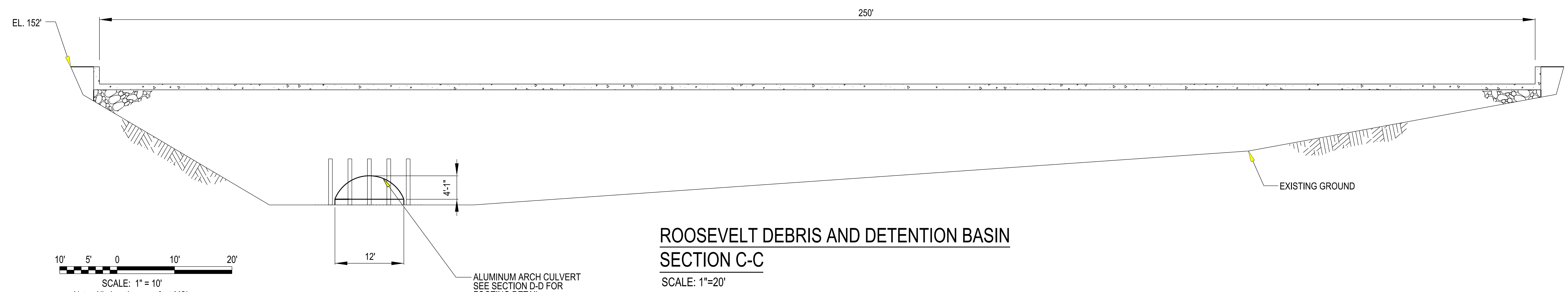


SOLID LINE = 50' CONTOURS
DOTTED LINE = 10' CONTOURS



20' 10' 0 20' 40'
SCALE: 1" = 20'
Note: All elevations are feet MSL

ROOSEVELT DEBRIS AND DETENTION BASIN
SECTION B-B
SCALE: 1"=20'



10' 5' 0 10' 20'
SCALE: 1" = 10'
Note: All elevations are feet MSL

ROOSEVELT DEBRIS AND DETENTION BASIN
SECTION C-C
SCALE: 1"=20'

FILE: c:\pw-work\poh-1\j3ec9jhh\d0133359\Ala_Wai_C-314Axx.dgn
MODEL NAME: C-314
DATE & TIME: 12/15/2014 5:08:13 PM
LAST SAVED BY: j3ec9cp9
PLOTDRIVER: C:\ProgramData\Bentley\MicroStation V8i (SELECTseries)\WorkSpace\system\plotcfg\printer.pltcfg
PEN TABLE: BW_and_Grayscale_Pen.tbl
PRINTED BY: J3EC9JHH

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MARK	DESCRIPTION	DATE	APPR.

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SUBMITTED BY:		LOCATION CODE		
PLOT SCALE: AS SHOWN	PLOT DATE: 12/15/2014	DRAWING NUMBER:		
SIZE: ANSI D	FILE NAME: ROOSEVELT DEBRIS & DETENTION BASIN, PLAN & SECTIONS			

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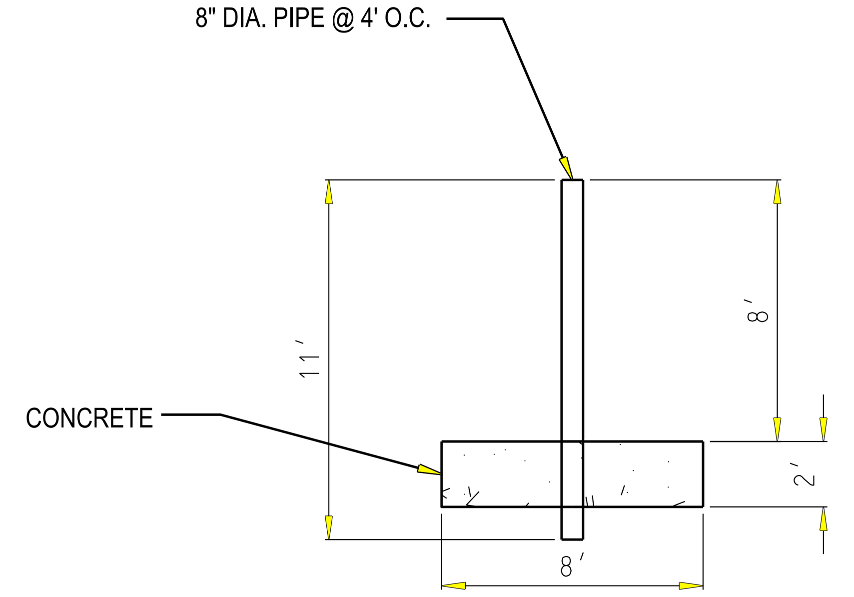
ALA WAI CANAL PROJECT

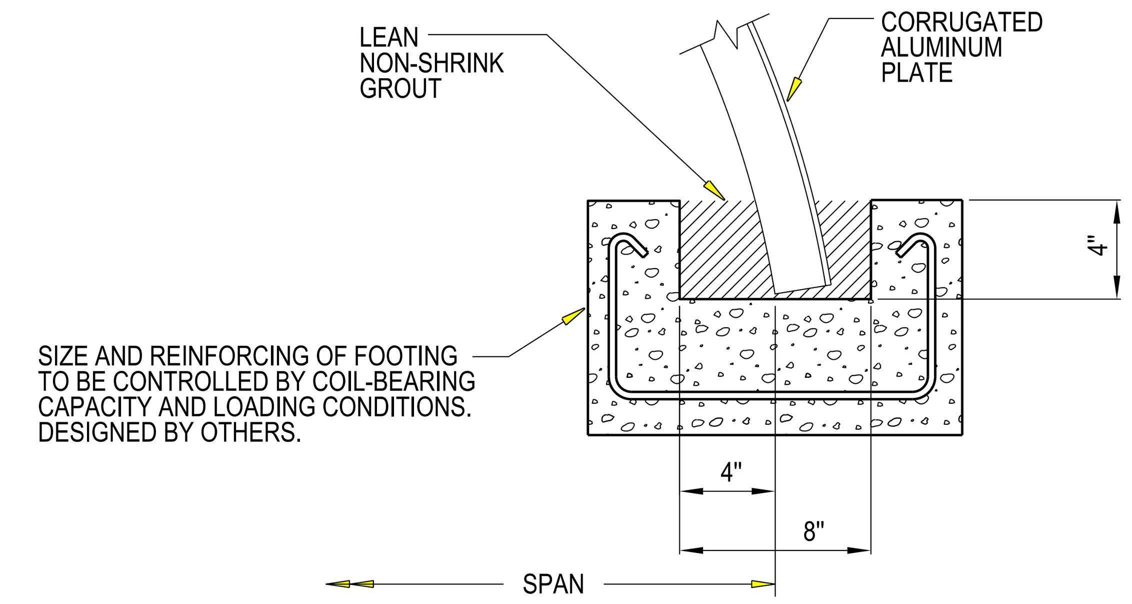
ROOSEVELT DEBRIS AND DETENTION BASIN
PLAN AND SECTIONS
ALTERNATIVE 3A

SHEET IDENTIFICATION
C-314A
SHEET 15 OF 20



MAKIKI DEBRIS AND DETENTION BASIN SECTION A-A

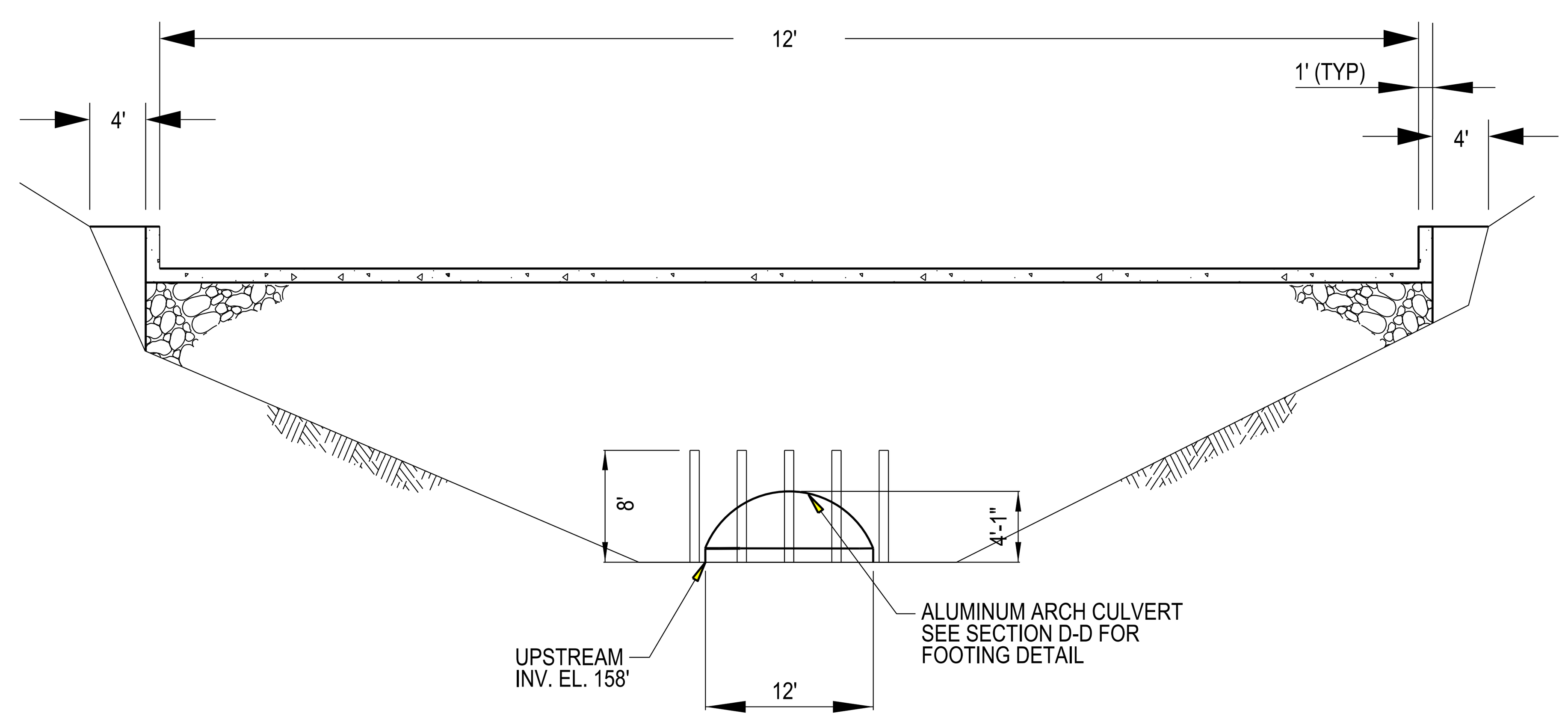
SCALE: 1"=5'



SLOTTED CONCRETE FOOTING

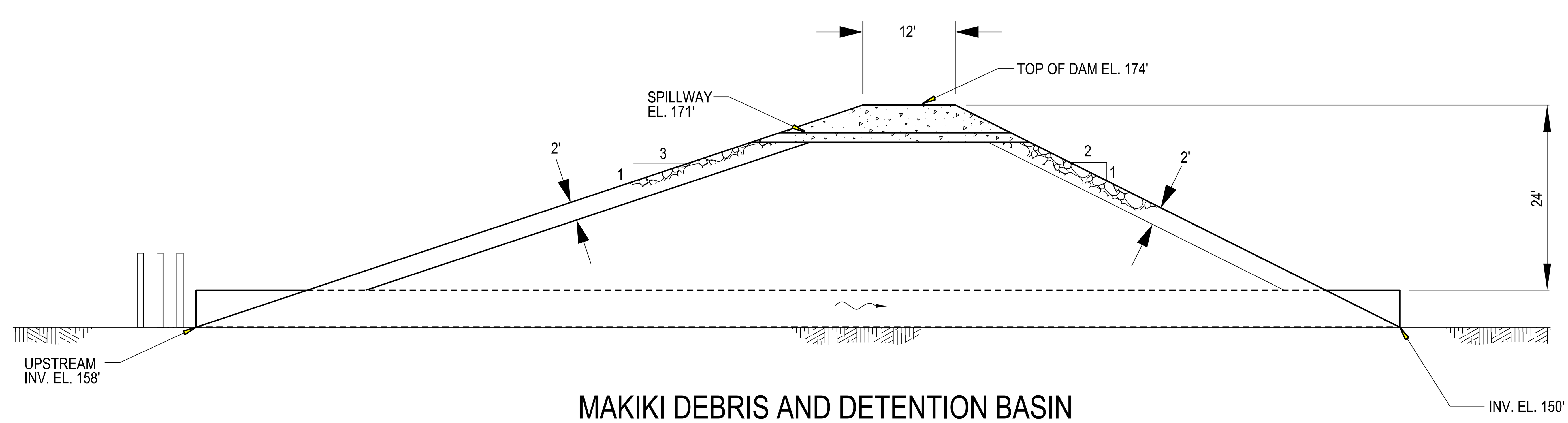
MAKIKI DEBRIS AND DETENTION SECTION D-D

SCALE: NTS



MAKIKI DEBRIS AND DETENTION BASIN SECTION B-B

SCALE: 1"=10'



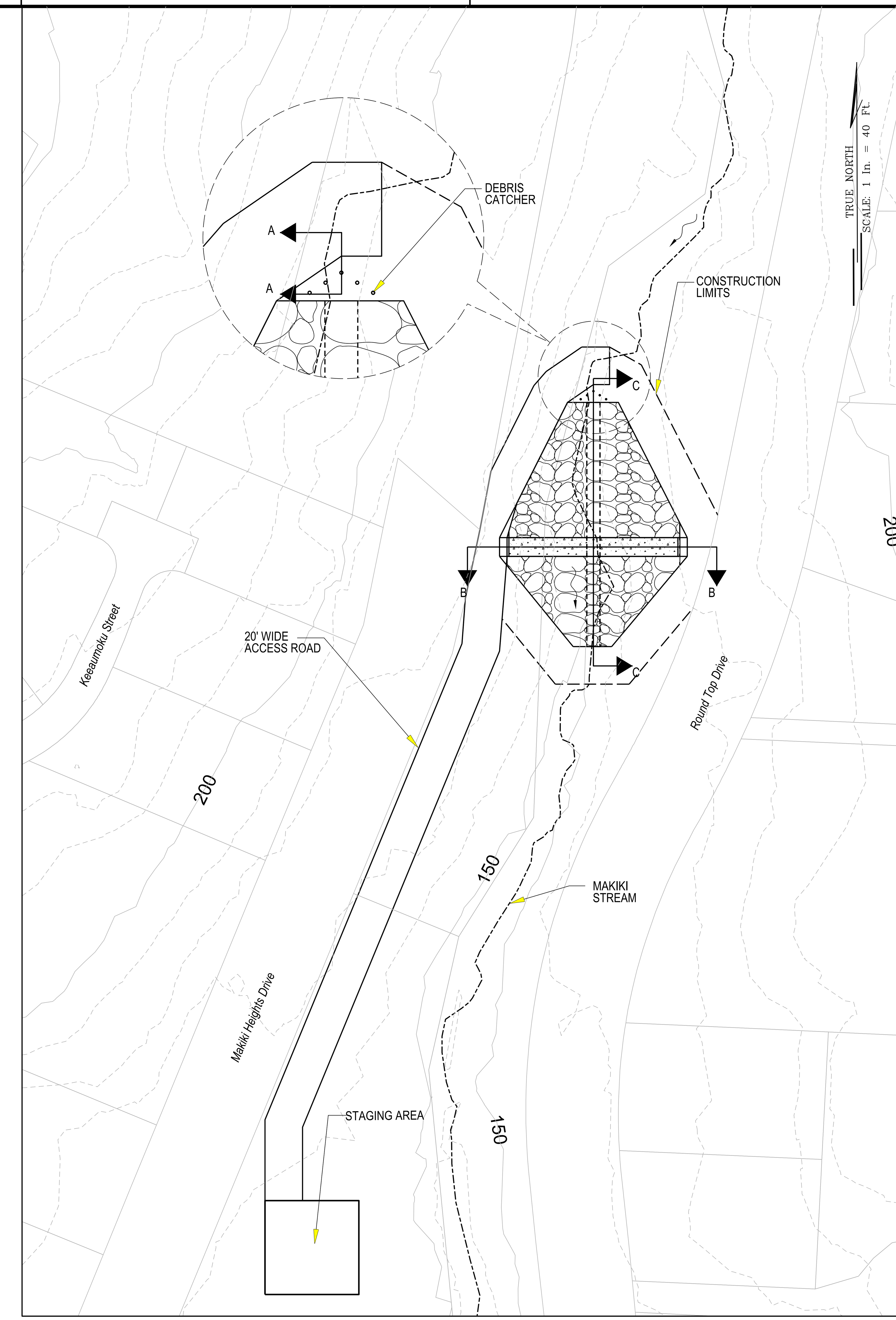
MAKIKI DEBRIS AND DETENTION BASIN SECTION C-C

SCALE: 1"=10'

10' 5' 0 10' 20'

SCALE: 1" = 10'

Note: All elevations are feet MSL



SOLID LINE = 50' CONTOURS
DOTTED LINE = 10' CONTOURS

PLAN

SCALE: 1"=40'

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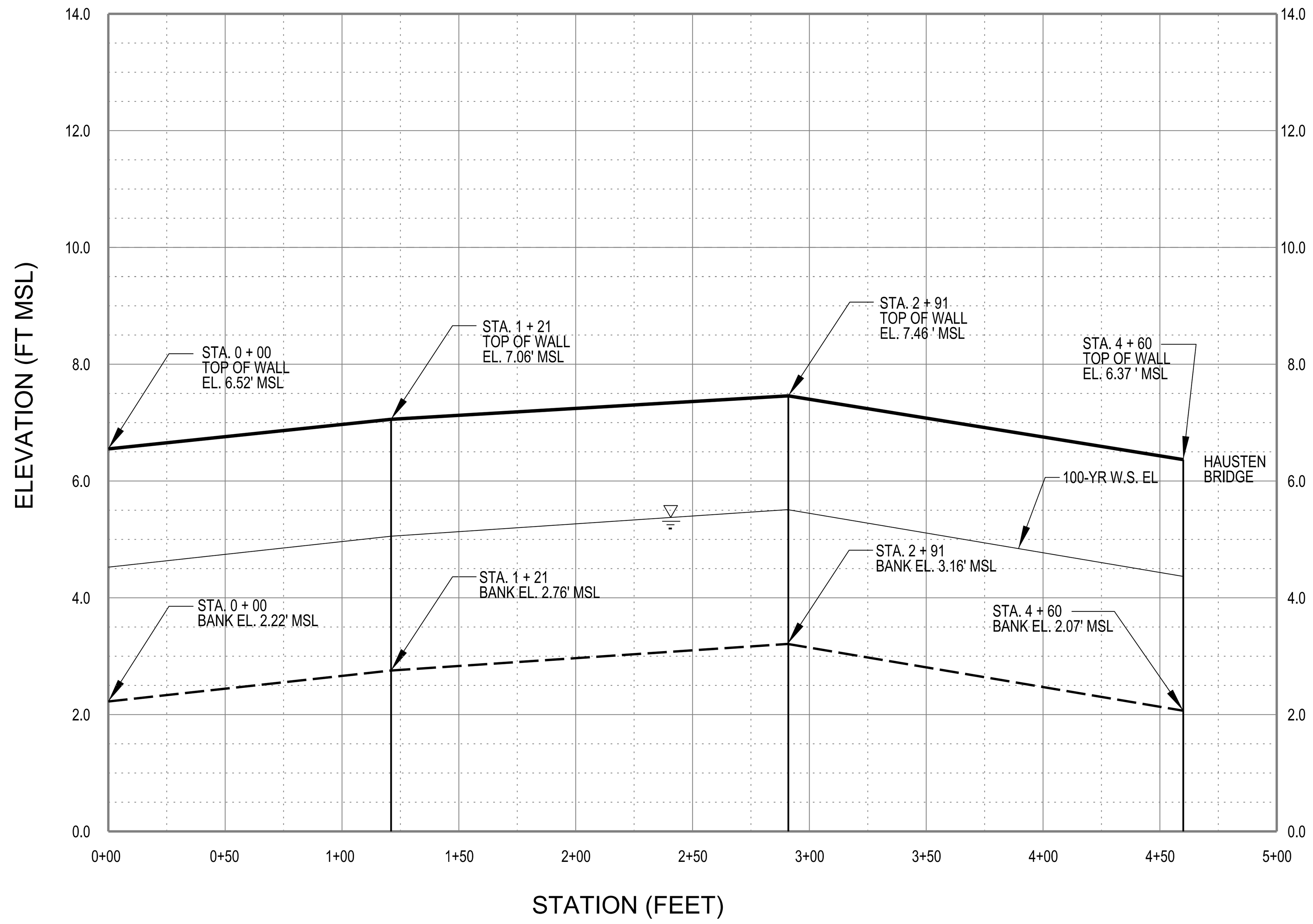
SUBMITTED BY: | LOCATION CODE
PLOT SCALE: AS SHOWN | PLOT DATE: 12/15/2014 | DRAWING NUMBER:
SIZE: ANSI D | FILE NAME: MAKIKI DEBRIS & DETENTION BASIN, PLAN & SECTIONS

ALA WAI CANAL PROJECT

MAKIKI DEBRIS AND DETENTION BASIN PLAN AND SECTIONS ALTERNATIVE 3A

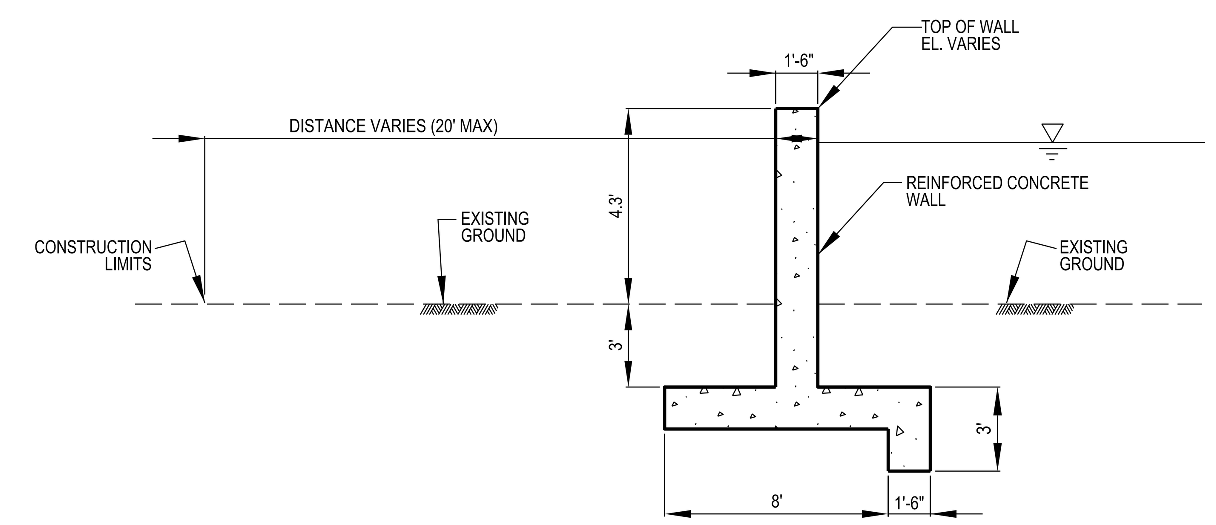
SHEET IDENTIFICATION
C-315A
SHEET 16 OF 20

FILE: c:\pw-work\poh-1\j3ec9jhh\d0133359\Ala_Wai_C-315Ax.dgn
MODEL NAME: C-315
DATE & TIME: 12/15/2014 5:10:53 PM
LAST SAVED BY: j3ec9cp9
PLOTDRIVER: C:\ProgramData\Bentley\MicroStation V8i (SELECTseries)\WorkSpace\system\pltcfg\printer.pltcfg
PEN TABLE: BW_and_Grayscale_Pen.tbl
PRINTED BY: J3EC9JHH



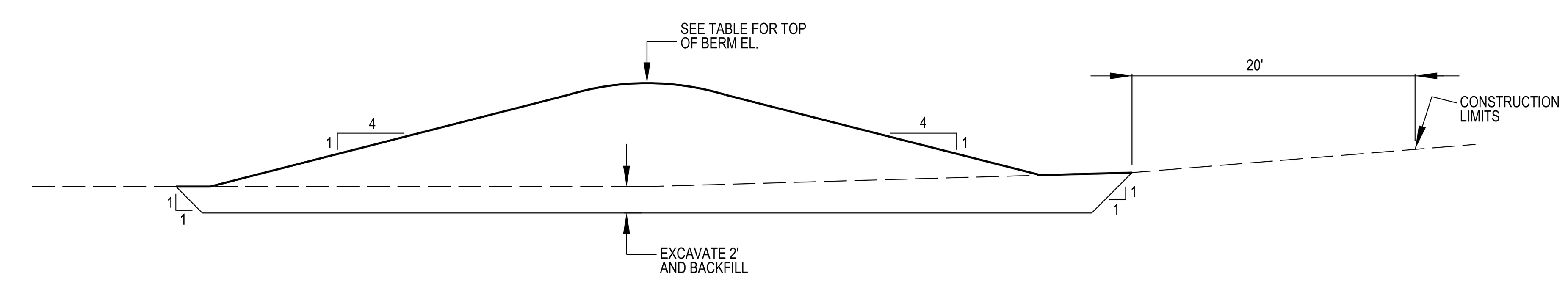
PROFILE
HAUSTEN DITCH RIGHT BANK FLOODWALL

SCALE:
HORIZONTAL: 1" = 50'
VERTICAL: 1" = 2'



A HAUSTEN DITCH TYPICAL REINFORCED CONCRETE FLOODWALL SECTION

NOT TO SCALE



B HAUSTEN DITCH TYPICAL BERM

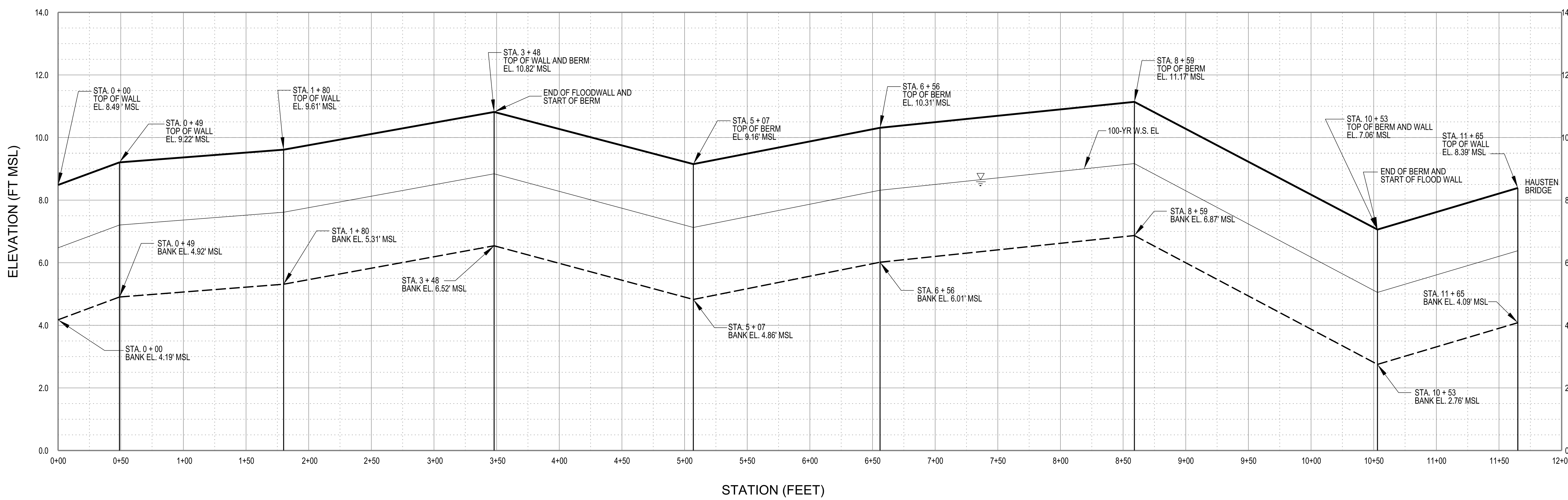
NOT TO SCALE

HAUSTEN DITCH RIGHT BANK FLOODWALL
STA TO 0 + 00 TO 4 + 60

STATION	WALL HEIGHT (FT)	FINISHED WALL ELEVATION (FT MSL)
0 + 00	4.30	6.52
1 + 21	4.30	7.06
2 + 91	4.30	7.46
4 + 60	4.30	6.37
HAUSTEN BRIDGE		

HAUSTEN DITCH LEFT BANK
FLOODWALL AND BERM
STA TO 0 + 00 TO 11 + 65

STATION	WALL HEIGHT (FT)	FINISHED WALL ELEVATION (FT MSL)
0 + 00	4.30	8.49
0 + 49	4.30	9.22
1 + 80	4.30	9.61
3 + 48	4.30	10.82
END OF FLOODWALL AND START OF BERM		
3 + 48	4.30	10.82
5 + 07	4.30	9.16
6 + 56	4.30	10.31
8 +59	4.30	11.17
10 + 53	4.30	7.06
END OF BERM AND START OF FLOODWALL		
10 + 53	4.30	7.06
11 + 65	4.30	8.39
HAUSTEN BRIDGE		



PROFILE
HAUSTEN DITCH LEFT BANK FLOODWALL AND BERM

SCALE:
HORIZONTAL: 1" = 50'
VERTICAL: 1" = 2'

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HONOLULU, HAWAII

DESIGNED BY: JHH | DRAWN BY: | CHECKED BY: | SUBMITTED BY: | PLOT SCALE: AS SHOWN | PLOT DATE: 12/15/2014 | SIZE: ANSI D | FILE NAME: HAUSTEN DITCH DETENTION, PROFILE & SECTIONS | DATE: | SOLICIT / CONTRACT NO.: | LOCATION CODE | DRAWING NUMBER: | REVISION:

ALA WAI CANAL PROJECT

HAUSTEN DITCH DETENTION FLOODWALLS AND BERM
PROFILE AND SECTIONS
ALTERNATIVE 3A

SHEET IDENTIFICATION
C-316A
SHEET 17 OF 20

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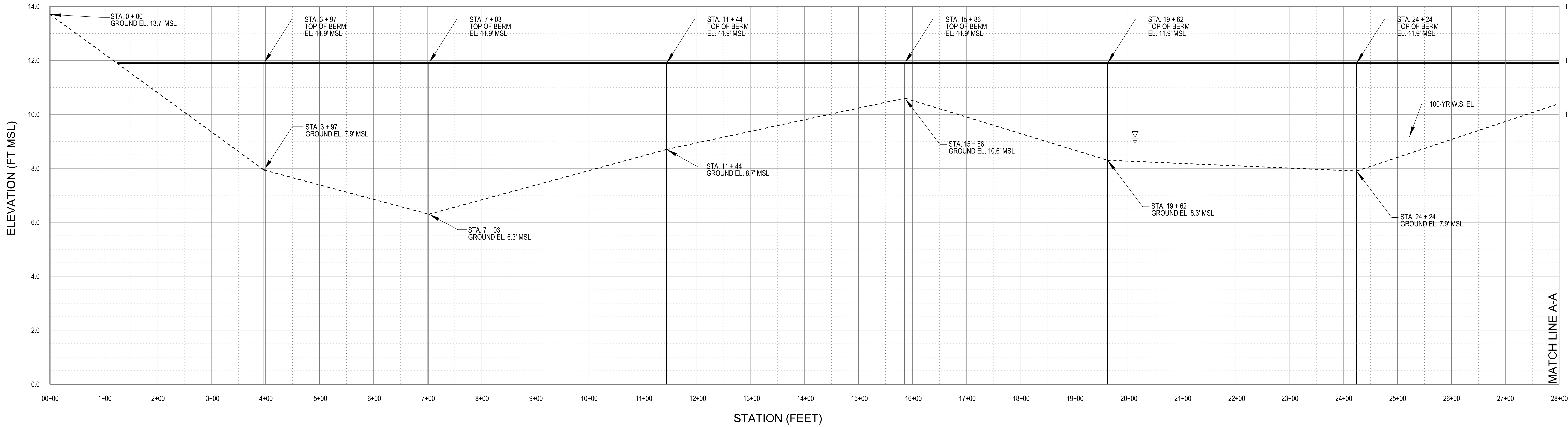

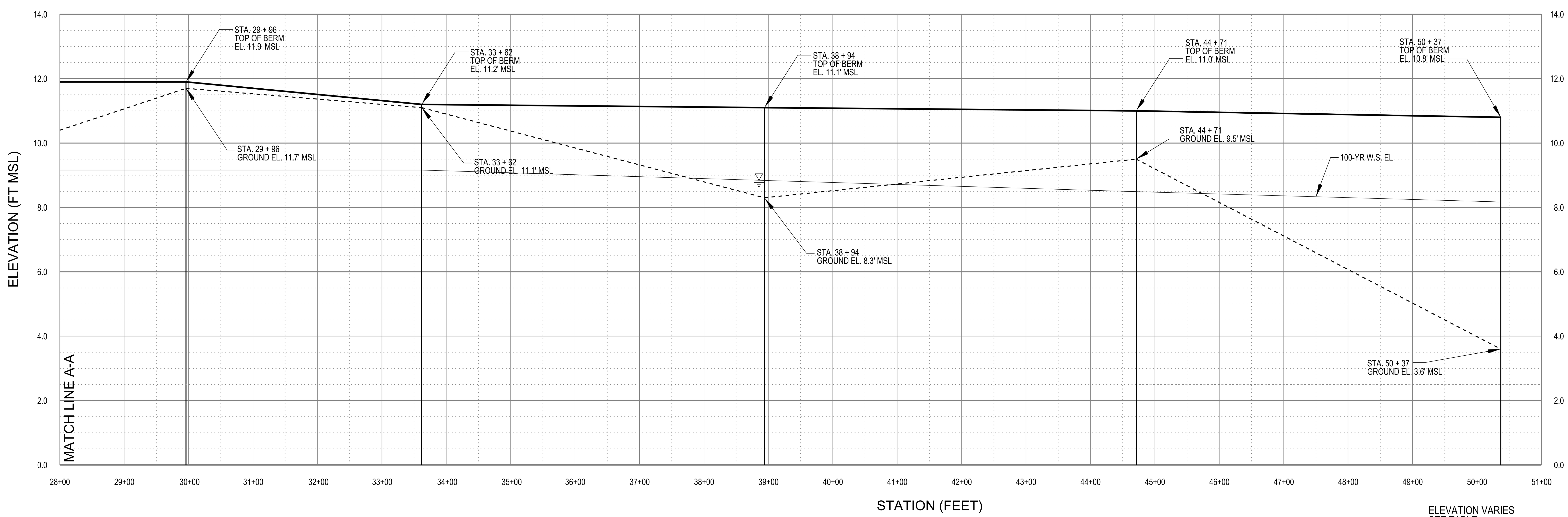

ALA WAI GOLF COURSE LEVEE
STA 0 + 00 TO 50 + 37

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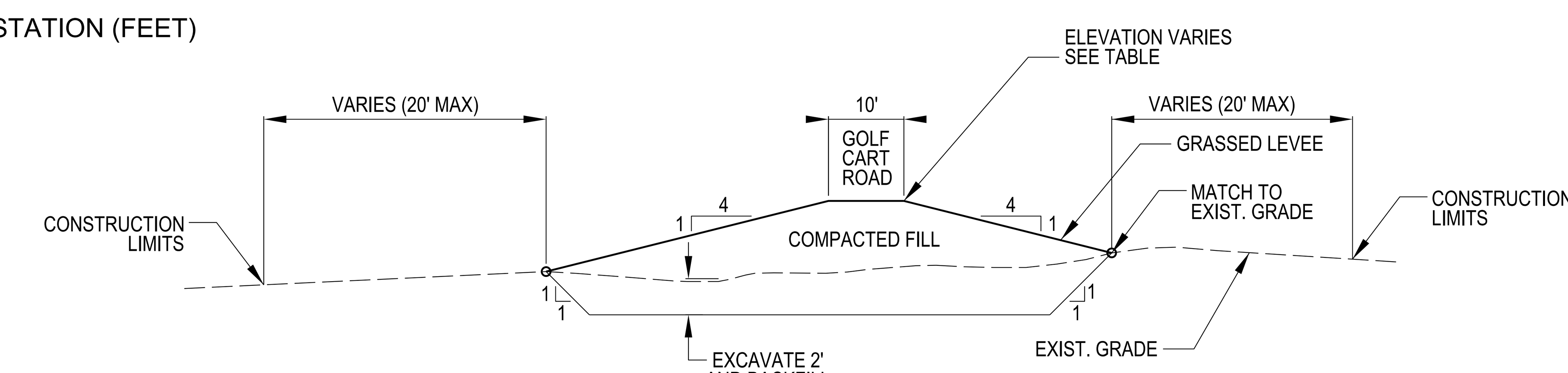
3 + 97	4.0	11.9
7 + 03	5.6	11.9
11 + 44	3.2	11.9
15 + 86	1.3	11.9
19 + 62	3.6	11.9
24 + 24	4.0	11.9
29 + 96	0.2	11.9
33 + 62	0.1	11.2
38 + 94	2.8	11.1
44 + 71	1.5	11.0
50 + 37	7.2	10.8

ALA WAI GOLF COURSE MULTI-PURPOSE DETENTION LEVEE PROFILE

SCALE:
HORIZONTAL: 1" = 100'
VERTICAL: 1" = 2'



A TYPICAL LEVEE SECTION
NOT TO SCALE

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PRINTED BY: J3EC9JHH

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LOCATION CODE
PLOT SCALE: AS SHOWN
PLOT DATE: 12/15/2014
DRAWING NUMBER:
SIZE: ANSI D
FILE NAME: ALA WAI GOLF COURSE MULTI-PURPOSE DETENTION LEVEE & SECTION

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HONOLULU DISTRICT
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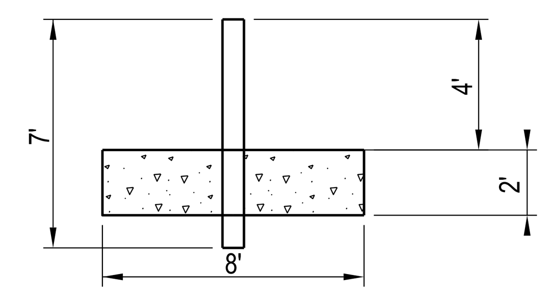
ALA WAI CANAL PROJECT

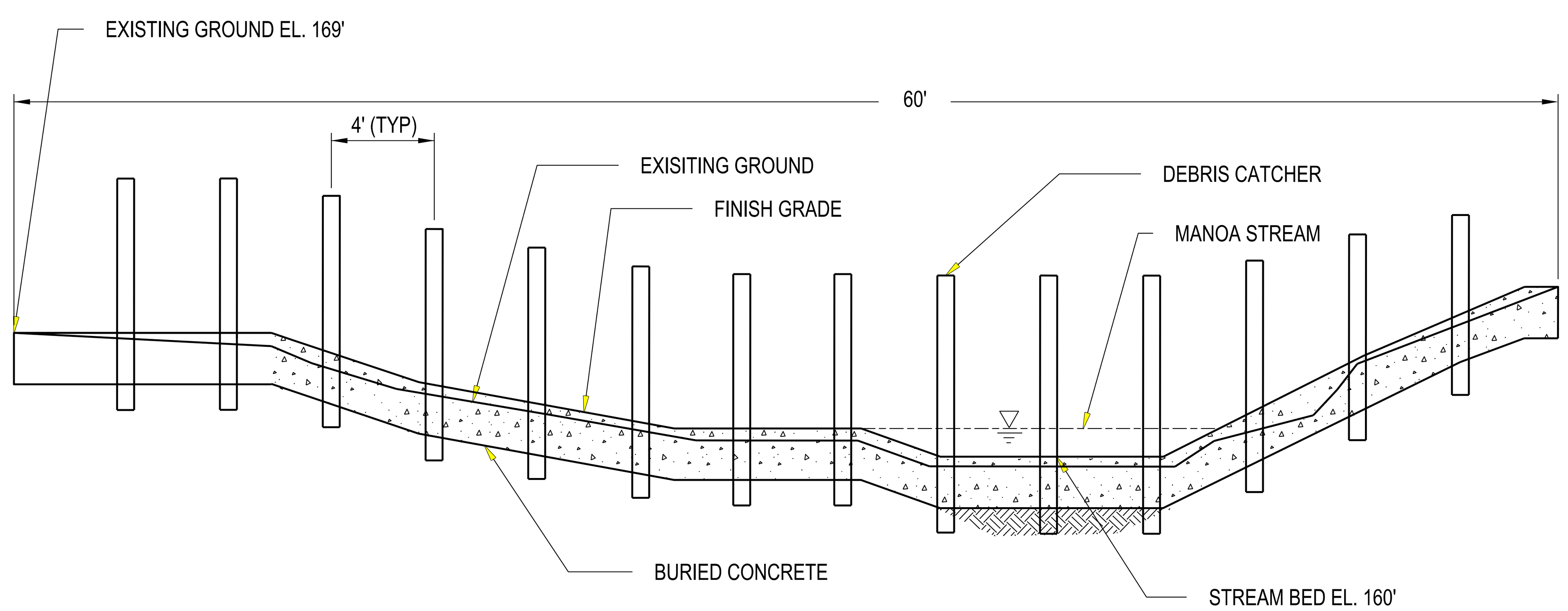
ALA WAI GOLF COURSE LEVEE
PROFILE AND SECTION
ALTERNATIVE 3A

SHEET IDENTIFICATION
C-317A
SHEET 18 OF 20



MANOA IN-STREAM DEBRIS CATHMENT
SECTION A-A

SCALE: 1"=5'



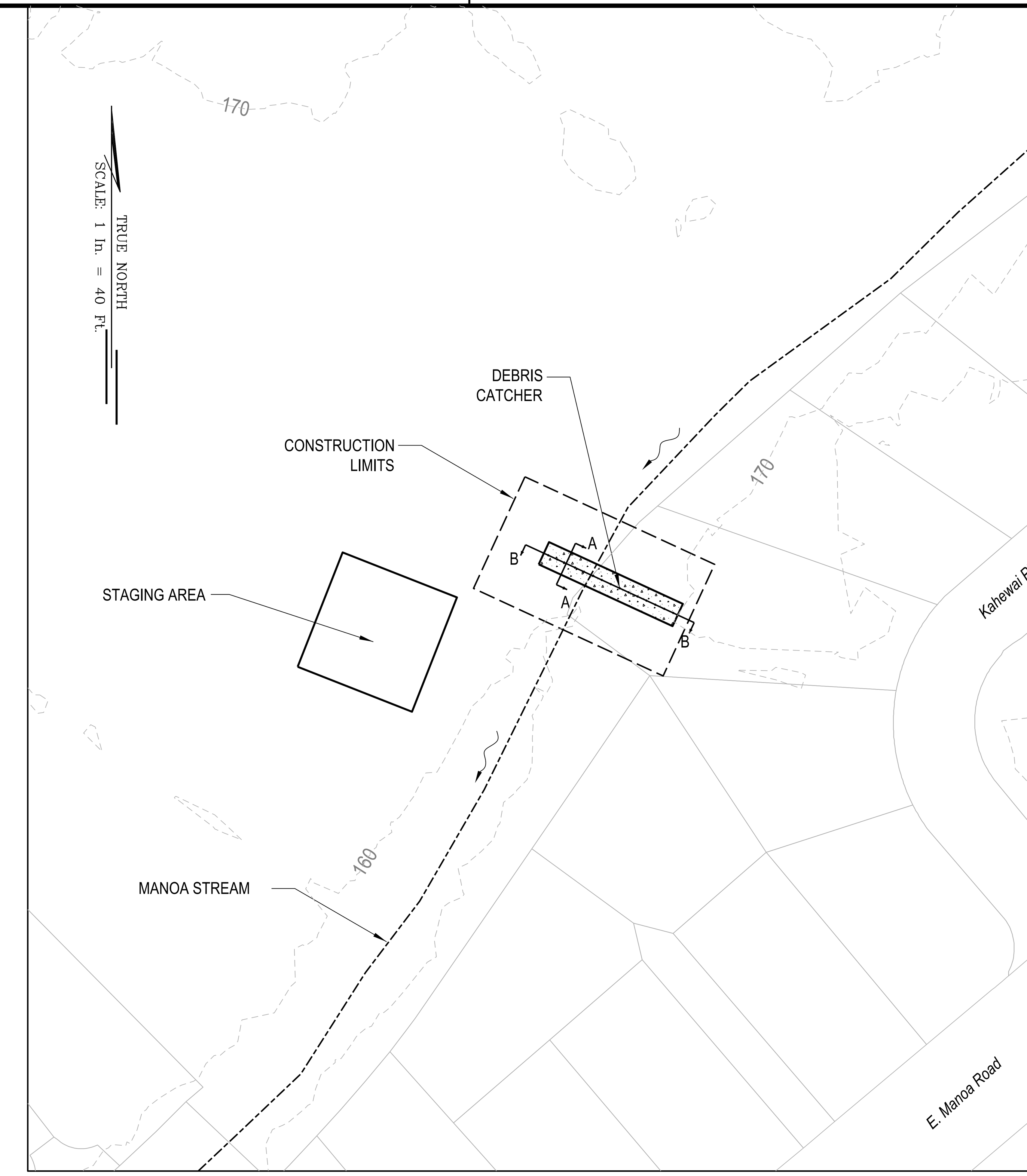
MANOA IN-STREAM DEBRIS CATCHMENT
SECTION B-B

SCALE: 1"=5'

5' 2.5' 0 5' 10'

SCALE: 1" = 5'

Note: All elevations are feet MSL



SOLID LINE = 50' CONTOURS
DOTTED LINE = 10' CONTOURS

PLAN

SCALE: 1"=40'

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MARK	DESCRIPTION	DATE	APPR.
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SUBMITTED BY: | LOCATION CODE
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SIZE: ANSI D | FILE NAME: MANOA IN-STREAM DEBRIS CATCHMENT, PLAN & SECTIONS

ALA WAI CANAL PROJECT

MANOA IN-STREAM DEBRIS CATCHMENT
PLAN AND SECTIONS
ALTERNATIVE 3A

SHEET IDENTIFICATION
C-318
SHEET 19 OF 20

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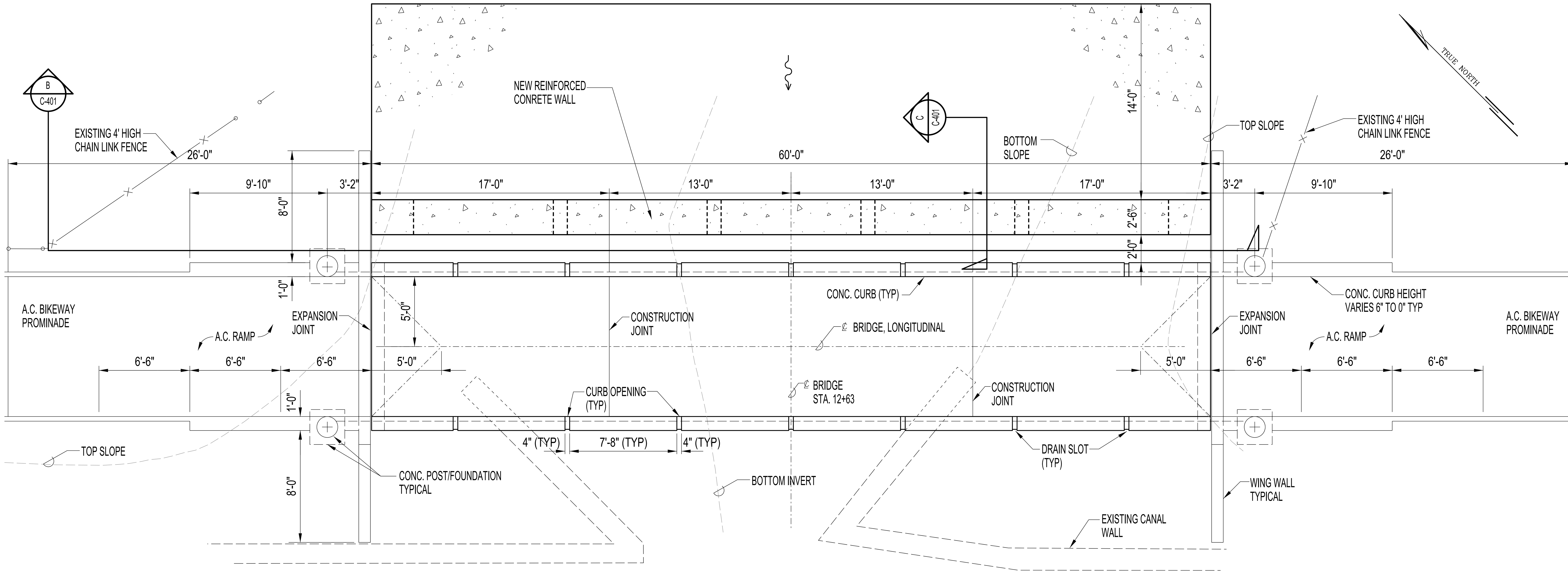
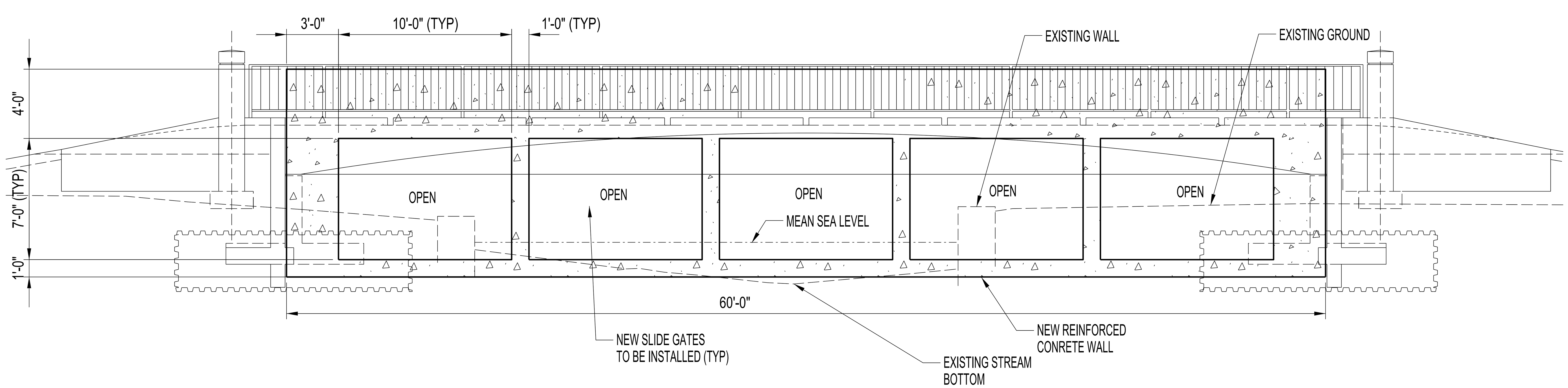
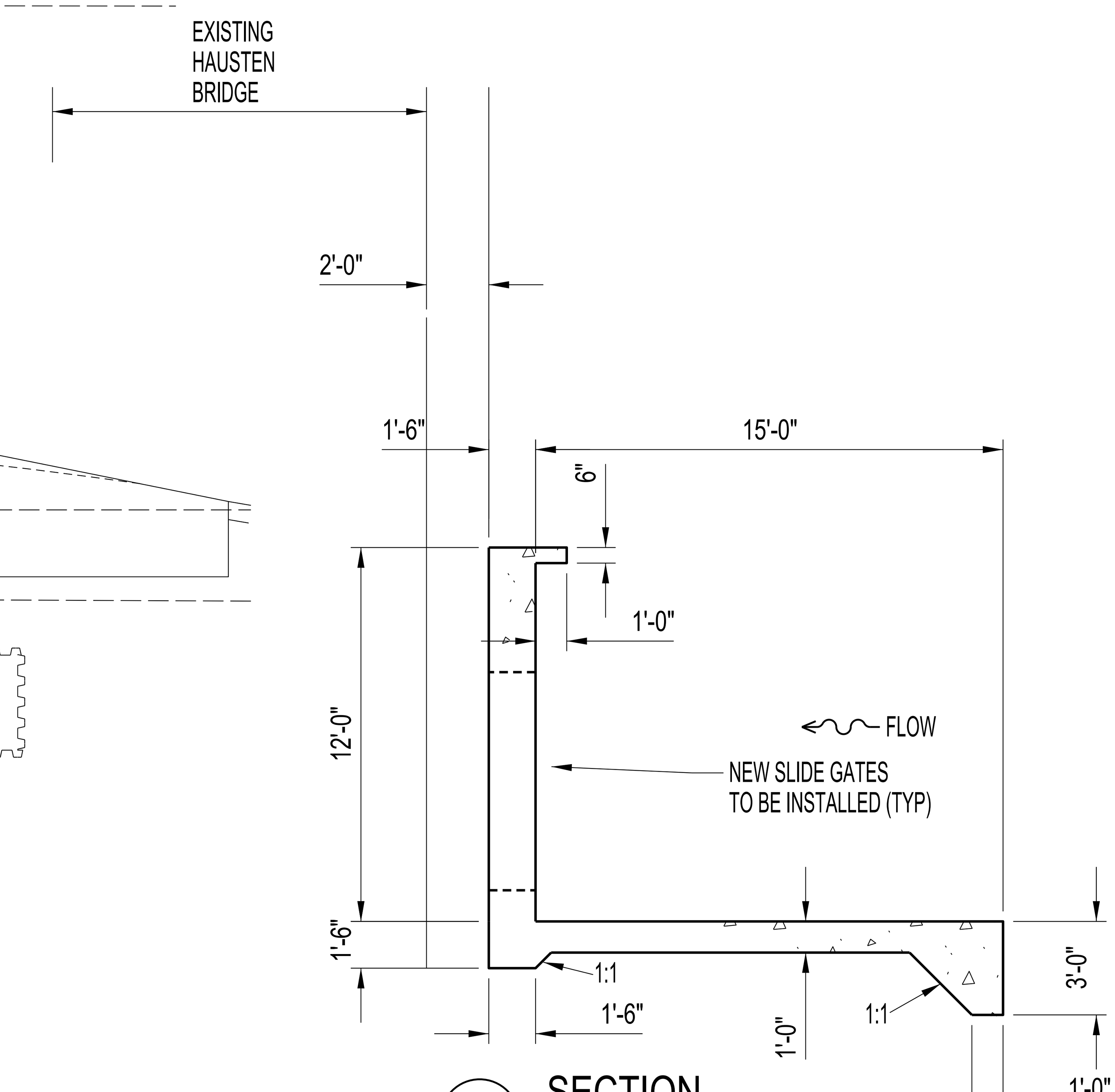


A PLAN
SCALE: 1/4"=1.0'



B ELEVATION
SCALE: 1/4"=1.0'



C SECTION
SCALE: 1/4"=1.0'

MARK	DESCRIPTION	DATE	APPR

MARK	DESCRIPTION	DATE	APPR

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SUBMITTED BY:		LOCATION CODE	
PLOT SCALE: AS SHOWN	PLOT DATE: 12/15/2014	DRAWING NUMBER:	
SIZE: ANSI D	FILE NAME: HAUSTEN BRIDGE PLAN & SECTIONS		

ALA WAI CANAL PROJECT

HAUSTEN BRIDGE CONCRETE WALL
PLAN, SECTION AND ELEVATION
ALTERNATIVE 3A

SHEET IDENTIFICATION
C-401A
SHEET 20 OF 20

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Ala Wai Canal Project
Feasibility Study
Honolulu, Hawaii

Hydrologic and Hydraulic Climate Change Scenarios Appendix

Appendix A3

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February 2017

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Hydrologic and Hydraulic
Climate Change Scenarios for the 50-year (2075)
Future without Project Conditions
Ala Wai Canal Project, Oahu, Hawaii
Fully Revised, February 2017

1.0 Introduction

The US Army Corps of Engineers' (USACE) planning guidance for civil works projects requires that the planning process incorporate a future without project scenario. The guidance also states that the planning process accounts for such future conditions such as climate variability, sea-level rise, subsidence, seismic influences, geomorphological changes, and changes from development which can place demands on the project systems during their life-cycle. Therefore, this document provides three future without-project scenarios for sea level rise for the year 2075 future conditions for the Ala Wai Watershed which will be used in the modeling, selection, and design of project alternatives.

The future without project condition attempts to describe the Ala Wai Watershed's future if there is no federal action taken to solve the flood risk problem. The future condition is fundamentally uncertain and represents a best guess of conditions in the watershed.

2.0 Purpose and Scope

The purpose of this study is to create a future without project scenario for use in the hydrologic and hydraulic analysis for the Ala Wai Canal Project. This report addresses the components of the planning process with emphasis on sea-level rise and how these components impact the hydrologic and hydraulic model results. The resultant future without project floodplains may be incorporated in the economic analysis.

Climate change impacts for Hawaii have been summarized by Fletcher (2010) and more recently in USACE (2015). These changes are rising surface air temperature, decreasing rainfall and streamflow, increasing rainfall intensity, increasing sea level and sea surface temperature, and ocean acidification. For the purposes of hydrologic and hydraulic modeling, the future without-project scenarios will concentrate on the impacts of sea-level rise, increased rainfall frequency, debris generation and transport, and increased impervious area in the Ala Wai Watershed.

3.0 Study Area

The Ala Wai watershed on the Island of Oahu includes the Makiki, Manoa, and Palolo Stream drainage areas as well as the urban Waikiki area which surrounds the Ala Wai Canal (Figure 1). Total drainage area is about 16 square miles. Mean annual rainfall varies from 20 to 150 inches from the coast to the Koolau Crest. Much of the watershed along the canal is relatively flat and subject to flooding from high intensity rainfall storms while the flooding in the Manoa and Palolo Valleys is limited to those areas along the stream. More background information as well as a discussion of the problems and opportunities in the watershed has been documented in previous studies on the Ala Wai Watershed (Townscape and Dashiell, 2003).

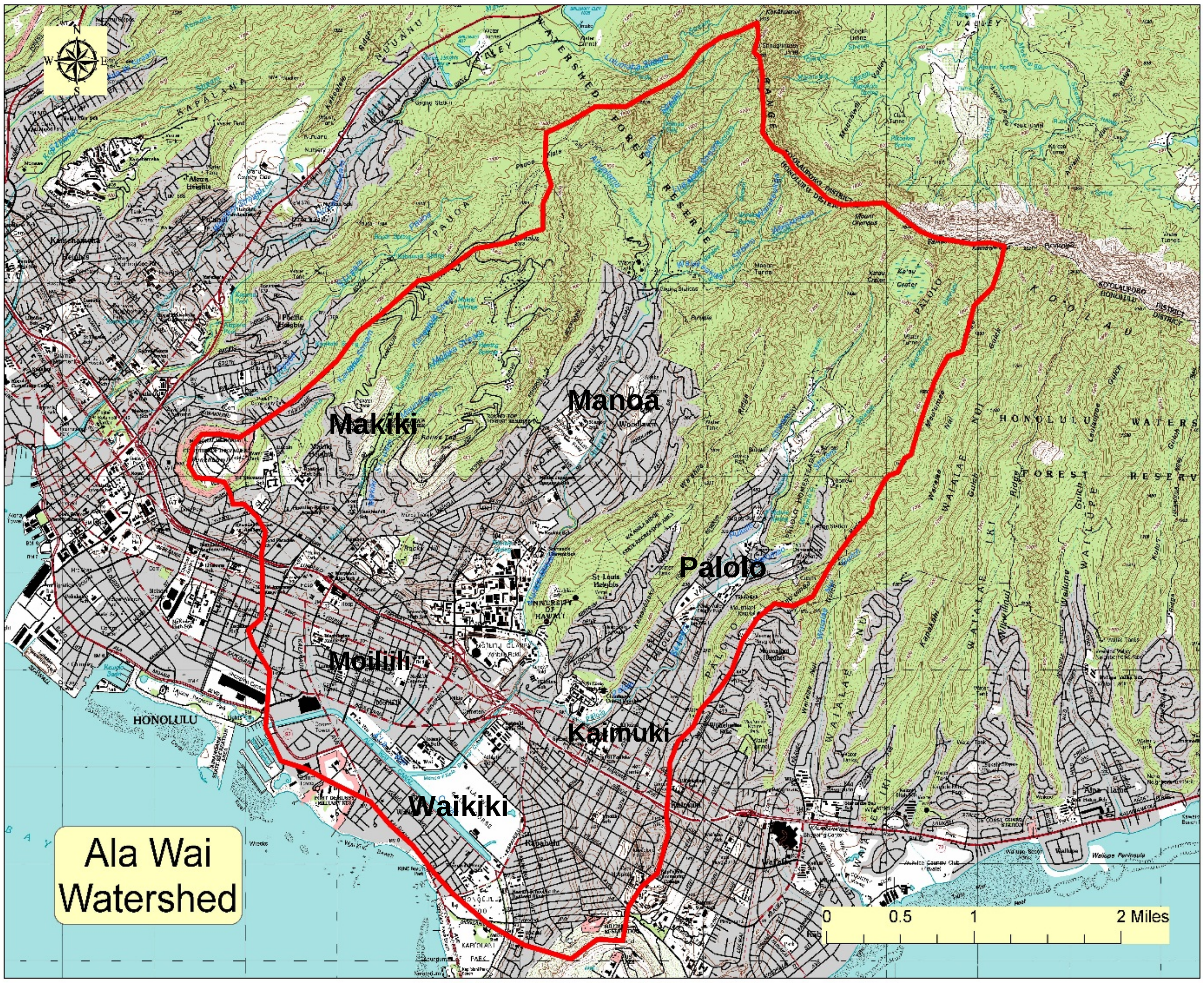

Figure 1. Ala Wai watershed Area

4.0 Methodology and Guidance

The US Army Corps of Engineers' Planning Guidance (Department of the Army, 2000; ER 1105-2-100) for Flood Damage Reduction projects requires a forecast of the future without project condition. This forecast should not exceed beyond 50 years and becomes the basis for evaluation of project alternatives. One of the forecast requirements is to account for future hydrologic changes in the project evaluations. How and what factors to use in the forecast are not discussed in the guidance but left up to the project team to determine.

Sea Level Change (SLC) guidance by USACE has been evolving starting in 2009 with the release of EC 1165-2-211, refined in 2011 as EC 1165-2-212, and finally release as a regulation ER 1100-2-8162 in 2013 (Department of the Army, 2009, 2011, and 2013). These document provide specific guidance to follow in determining sea-level rise in the planning process for projects on the coast or impacted by tidal influences. The computations required for SLC by ER 1100-2-8162 have now been automated by web-based calculator available at http://www.corpsclimate.us/ccaceslcurves.cfm.

For planning purpose, a period of economic analysis also called the period of analysis is chosen. The period of analysis is the time period chosen used to evaluate plan impacts. The period of analysis must be the same for all plans considered in a study as well as the same for all the components of the plan (Yoe and Orth, 1996). Since economic analysis uses a base year for when project benefits start accruing, the forecast period must also start at the same base year. For the Ala Wai watershed project, the base year is 2025. This date is based on a realistic construction start date of 2020 with a 5-year construction time period. Thus, the 50-year forecast period starts at 2025 and ends in 2075.

5.0 Climate Change Impacts and Scenarios:

5.1 Sea-Level Rise

Following SLC guidance, the first steps are to find and determine the applicability of tide station data for the project site. Such data has to be from tide station records longer than 40 years in length. The Honolulu Harbor tide gage, number 1612340, has a long record going back to 1905 and the harbor is located within 2 miles along the coastline to the west of the Ala Wai Canal. There is no dissimilar shoreline, bathymetry or hydrodynamic conditions between the tide station and the canal to disqualify the use of the Honolulu Harbor tide data. Previous tidal data collected in the Ala Wai Canal have shown that the tidal amplitude and phase between the harbor and the canal are nearly identical (Edward K. Noda and Associates, 1992). Thus, this data does adequately represent the local sea-level conditions at the project site.

The guidance recommends the NOAA CO-OPS values for the sea-level trend analysis if such values have been computed for that tide gage. For the Honolulu Harbor tide station, these values have been computed and are available at web site http://www.co-ops.nos.noaa.gov/sltrends. The value for Honolulu Harbor is 1.50 +/- 0.25 mm/year and is based on 100 years of data from 1905-2006. This value is the low or baseline trend rate for the low rise future without-project scenario.

The next step is to calculate a regional mean sea level trend for an identified vertically stable geologic platform in the region to determine if the regional mean sea-level trend is different from the eustatic or global mean sea-level trend of 1.7 +/- 0.5 mm/yr. For the main Hawaiian Island chain, Kauai and Oahu, have been considered relatively stable and this is shown by the very similar tide station trends (Table 1) compared to Maui and Hawaii. Geologic evidence points a slow uplift of Oahu over the last several thousand years resulting from flexural uplift from hotspot loading (Fletcher and Jones, 1996). Rates of uplift have been less than 0.1 mm/yr since the last interglacial period with an estimated mean of 0.06 mm/yr over the last 200,000 years (Fletcher and Jones, 1996; Caccamise, 2003). Given such a low rate of vertical uplift, less than the +/- 0.25 mm/yr uncertainty in the sea-level trend at Honolulu Harbor, the local sea-level trend of 1.50 mm/yr (0.00492 ft/year) was considered to also be the regional mean sea-level trend for Oahu and no vertical land movement was taken into account for determining the future sea-level change.

Table 1. Mean Sea Level Rise Trends in Hawaii

Station Number	Station Location and Island	Period of Record	Years of Record	Computed Trend (mm/yr)
1611400	Nawiliwili, Kauai	1955-2006	52	1.53 +/- 0.59
1612340	Honolulu, Oahu	1905-2006	102	1.50 +/- 0.25
1612480	Mokuoloe, Oahu	1956-2006	51	1.31 +/- 0.72
1615680	Kahului. Maui	1947-2006	60	2.32 +/- 0.53
1617760	Hilo, Hawaii	1927-2006	80	3.27 +/- 0.35

Data from NOAA Tides and Currents website at http://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml (last accessed 4 Feb 2010.

The SLC curve calculator (version 2015.46) uses the modified (National Research Council) NRC Curve I to calculate the intermediate rate of sea-level rise and modified NRC Curve III for the high rate of sea-level rise. These calculations as per guidance are done in 5-year increments starting with 1992 (mid-point of current tidal epoch) as the base year; zero SLC. The results of the low, intermediate and high sea-level rise rates for the Ala Wai Canal study are presented in Table 2. The modified NRC curves are based on NRC scenarios for global sea-level rise adjusted to include the historic sea-level change rate of 1.7 mm/yr presented by the Intergovernmental Panel on Climate Change (IPCC) in 2007 (IPCC, 2007; Solomon and others, 2007).

Table 2. Estimated Rates of Sea-Level Rise for the Ala Wai Canal Project, Oahu, Hawaii

Low Rate (1.50 mm/yr or 0.00492 ft/yr)		**Intermediate Rate** (NRC Curve I)		**High Rate** (NRC Curve III)	
Year	**Feet**	**Year**	**Feet**	**Year**	**Feet**
2025	0.16	2025	0.26	2025	0.57
2030	0.19	2030	0.32	2030	0.72
2035	0.21	2035	0.38	2035	0.90
2040	0.24	2040	0.44	2040	1.09
2045	0.26	2045	0.51	2045	1.30
2050	0.28	2050	0.59	2050	1.53
2055	0.31	2055	0.66	2055	1.78
2060	0.34	2060	0.75	2060	2.05
2065	0.36	2065	0.83	2065	2.34
2070	0.38	2070	0.93	2070	2.64
2075	0.41	2075	1.02	2075	2.96
2080	0.43	2080	1.12	2080	3.30
2085	0.46	2085	1.23	2085	3.66
2090	0.48	2090	1.34	2090	4.04
2095	0.51	2095	1.45	2095	4.44
2100	0.53	2100	1.57	2100	4.86
2105	0.56	2105	1.69	2105	5.29
2110	0.58	2110	1.82	2110	5.74
2115	0.61	2115	1.95	2115	6.21
2120	0.63	2120	2.09	2120	6.70
2125	0.66	2125	2.23	2125	7.21

Results for the three sea-level rise scenarios (Table 2 and Figure 2) show a range of 0.41 to 2.96 feet in 2075. The intermediate and high sea-level rise rates for 2100 are 0.48 and 1.48 meters (1.57 and 4.86 feet), which falls within the global sea-level rise rates of 0.5 to 1.4 meters by 2100 in the updated studies which account for accelerated glacial ice melting (Fletcher, 2009). Fletcher (2009) makes a case for a 1 meter mean global sea-level rise by 2100 which would eliminate the low rate scenario from consideration in the Ala Wai Canal planning process as being really too low and not a realistic forecast. Thus, the low rate of sea-level rise will not be further considered in project design.

The sea-level rise impacts will be incorporated into the starting backwater conditions of the Ala Wai Canal HEC-RAS model which currently assumes a high tide of 1.08 feet (Mean High High Water (MHHW) from Honolulu Harbor tide gage record, Station 1612340, current epoch) for the current or existing without-project condition for all storm frequencies. The MHHW tidal value represents a long term average at the tide gage. There is an inter-annual variability (IAV) in the data in which year to year variations can result in high tide values higher in some year and lower in others. For the Honolulu Harbor tide gage, the inter-annual variability is about 0.4 feet. Thus, to account for future annual high tide values potentially being higher than MHHW, the IAV value was added to the MHHW as part of the starting backwater conditions. The addition of the IAV makes for a slightly conservative approach, but this addition helps account for future resilience in project design. The various sea-level rise scenarios where then added to the MHHW plus IAV values. Therefore starting water surface elevations for the intermediate and high scenarios will be 1.74 and 2.05 feet in 2025 and 2.50 and 4.44 feet in 2075, respectively. These starting backwater conditions will be used in both the with-out project and with-project future scenarios.

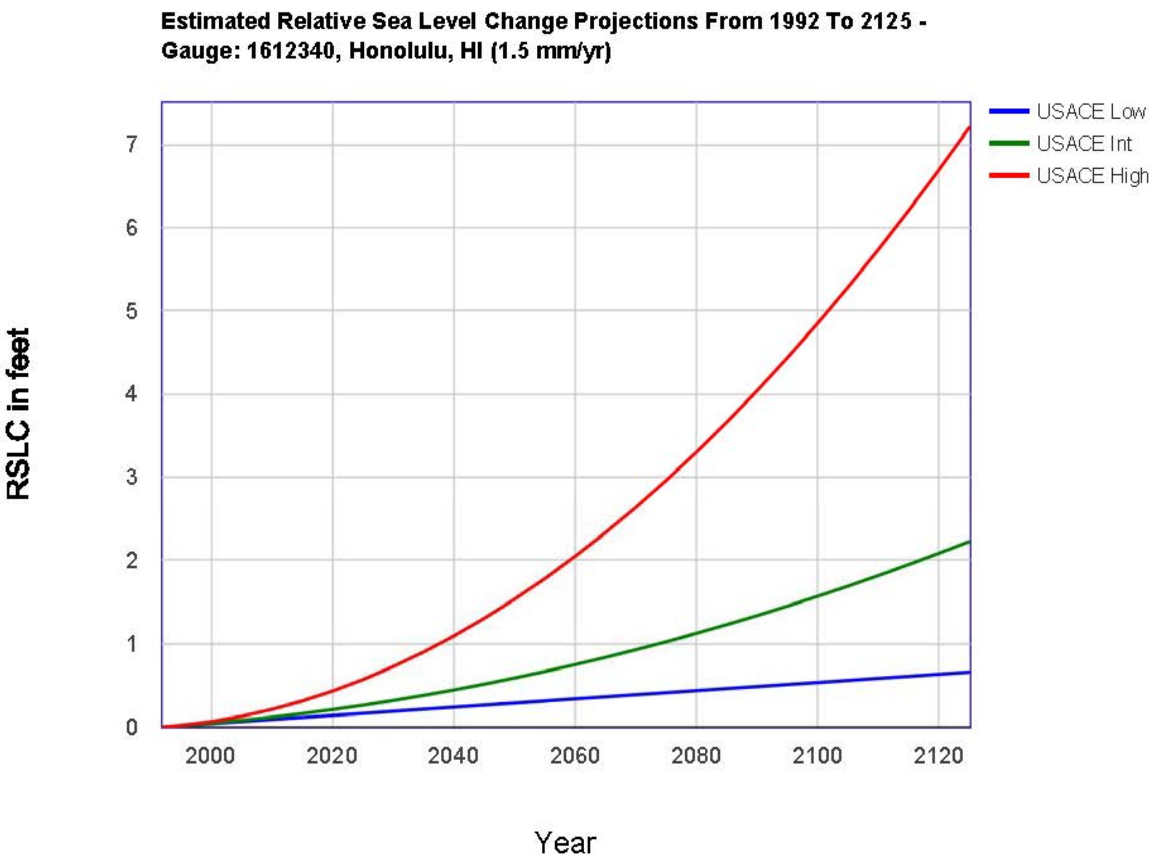

Figure 2. Plot of Relative Sea Level Rise Data in Feet for all Three Scenarios

5.2 Hurricanes

Climate change studies currently indicate that hurricanes would not increase in frequency or movement, but that the intensity of hurricanes that occur could be greater (Christensen and others, 2007; Meehl and others, 2007)). Hurricane strikes to Hawaii and especially Oahu have been rare (Haraguchi, 1984). Because hurricanes are rare in Hawaii, the current hydrological and hydraulic studies for the Ala Wai Watershed project assume no coincidence between hurricanes and the high rainfall intensity flood producing storm systems which are more common. This assumption will also be part of the future without-project condition.

Past hurricane impacts to the Ala Wai Watershed from Hurricanes Iwa in 1982 and Iniki in 1992, have been limited to oceanfront hotel garages below ground being flooded by wave action and road closures of roads fronting these hotels (US Army Corps of Engineers, 1994). Post-hurricane studies have not documented if wave action has had surge impacts to the Ala Wai Canal. Since the mouth of the canal is protected from surge by the Ala Wai Yacht Harbor breakwaters and revetments, surge impacts are assumed minimal. Hurricanes have increased the high tides recorded at tide gages so with sea-level rise, the potential exists that the canal can overtop and cause flooding from hurricanes near Oahu.

Alternatives providing protection from hurricane coastal flooding will not be addressed as part of the Ala Wai Canal project. However, other planning efforts may continue to use the worst-case hurricane condition for southern Oahu until newer studies are conducted (Bretschneider and others, 1985). The worst-case hurricane scenario has inundation limits in Moiliili up to Date Street and in Waikiki into the Ala Wai Golf Course (Bretschneider and others, 1985).

5.3 Rainfall and Runoff

5.3.1 Amount of Rainfall

Regional IPCC results for the North Pacific region (Christensen and others, 2007; page 915) show an estimated decrease of 0 to -5 percent in annual rainfall for Oahu due to estimated temperature increase in the Northern Pacific by 2080-2099. The estimated decrease is -5 to -10 percent for the winter months of December, January, and February (Christensen and others, 2007; page 915). The decadal scale regional climatic feature of El-Nino Southern Oscillation (ENSO) already create drier than normal winter months so the impact on water supply, which is dependent on the tradewind rainfall patterns, will be aggravated when ENSO events occur with the estimated decrease in rainfall. A decrease in rainfall will have an impact to water supply on Oahu, which is highly dependent on ground water wells for drinking water, as rainfall is an important component of ground-water recharge. Sea-level rise will also impact groundwater resources by decreasing the freshwater lens or available amount of freshwater which can be pumped without causing saltwater intrusion. Therefore, water supply planning may look into large and small scale rain catchment or some means to catch storm runoff and store for later non-potable use.

5.3.2 Rainfall Frequency and Intensity

According to the report: Global Climate Change Impacts in the United States (2009, p. 32), from 1958-2007, very heavy precipitation, defined as the heaviest 1 percent of all daily rain events, has increased by 12 percent for the State of Hawaii. The average number of days with heavy precipitation has increased by 8 percent for the State of Hawaii. It is expected that the frequency of heavy rainfall events will increase while the lightest precipitation is projected to decrease. The 5 percent chance (20-year) storm is expected to be between 10 to 25 percent heavier by the end of the 21st century (Global Climate Change Impacts in the United States, 2009, p. 32). It is unknown if decadal events such as ENSO variations can temper the expected increase in heavy precipitation. More recent studies show that this projected increase in heavy rainfall events is not supported by statistical trend analysis or the downscaling of the global circulation models to Hawaii.

Chu and others (2010) looked at extreme rainfall events using statistical trend analysis techniques on daily rainfall data from 2 different time periods, 1950-79 and 1980-2007 at 37 to 65 raingages in Hawaii. Trends of interest for the future without project condition concern the number of wet days, defined as any day with greater than 1 mm of precipitation and the frequency of intense precipitation, defined as the annual total of days with greater than 1 inch of rainfall. For the raingages on the Island of Oahu located in Manoa Valley that were part of their study, there were an insignificant downward trend in the frequency of intense precipitation between the two time periods. Elison Timm and others (2011) investigated trends in the frequency of heavy rainfall events in relation to statistical downscaling of global climate models. This study defined heavy rain events as the 95% quantile in the rainfall distribution during the October to April wet season. Results of the trend analysis indicates that at 9 out of 12 statewide rain gages analyzed in the study there was a downward trend in the frequency of heavy rainfall events. The Honolulu Airport rain gage, was one that did show a downward trend. Other results were that the interannual to interdecadel variability is significantly related to ENSO Southern Oscillation Index (SOI) and that the downscaled results from the global climate models are unable to account for the ENSO variations.

Norton and others (2011) use a nonlinear artificial neural networks statistical model to downscale daily extreme precipitation events on Oahu from global circulation model outputs. Their results show a tendency for increased frequency of heavy rainfall events but a decrease in rainfall intensity during the next 30 years (2011-2040) for the southern shoreline of Oahu. The most recent work on this topic is Elison Timm and others (2013) in which a statistical downscaling method is used to project future shifts in the frequency of heavy rainfall events. In this paper, heavy rain events are defined as days with rainfall amounts exceeding the 90th percentile estimated from all wet season days from 1958-2010. Their statistical downscaling model was able to reproduce the interannual variability in heavy rain events for the period 1978-2010. When applied to global circulation models scenarios, their model predicted a low likelihood of increased heavy rain events in Hawaii over the remainder of this century.

Therefore, based on the results of these studies on changes to heavy rain events in Hawaii, it is assumed for the future without project scenario that there will be no change to the rainfall frequency intensity data from that used in the without project condition.

5.4 Debris Generation

One impact of large intense rainfall storms in Hawaii has been debris generation, both from vegetation and hill slope and channel erosion sources, which can impact the ability of stream channels and stream crossing structures to function as designed. In general, narrow streams rarely transport large floating debris that can block bridges. Large floating debris usually gets trapped or lodged across the channel and rarely moves without being broken into smaller pieces. Small and intermediate size floating debris becomes an issue where bridge piers or other obstructions occur, due to the potential of significant debris pile-ups on piers. Streams in the Ala Wai Watershed have steep channel slopes and exhibit rapid responses to rainfall, "flash floods", which tend to have a large amount of energy which can move large boulders or rapidly erode sections of stream bank or channel. This type of debris also has the potential to create blockages in the stream channels or reduce the ability of bridges to pass flood flows. One method of account for debris or sediment in runoff is the use of a bulking factor. The bulking factor is just an increase in the Manning's n-value, which is used to represent channel roughness in the hydraulic model. Normally, the higher the n-value used, the higher the resulting water-surface elevation, thus, the term bulking. Normally a percentage increase, like 10- or 20-percent is used to account for debris in the flood flows.

The ability to predict the amount of debris generated by any future storm event is pure speculation. Although debris volume estimates are made to assist in debris basin sizing, such volume estimates did not account for the sediment or floating debris that passes through the basin or are generated downstream of the basin, so are not as useful as the bulking factor to account for suspended sediment and floating debris. For the future without project scenarios, it is difficult at best to make any guesses that debris amount will be larger or smaller in the future. Assuming the same land-use in 2070 as today, the amount of generated debris should not significantly change from those estimates used in the current without-project conditions models. Assuming such efforts as invasive species removal, feral pig control, stream clean-ups, and restoration of riparian vegetation are to be done in the future as smaller locally based projects, then the amount of debris generated will potentially decrease. Therefore, the future without-project scenario will look at no increase in debris generation.

5.5 Increased impervious Area

The Ala Wai Watershed is already a densely developed urban area. Residential land use dominates in the Makiki, Manoa, and Palolo areas with smaller areas of commercial activities. Waikiki is highly developed with high rise hotels and apartment buildings. Population in the watershed is not expected to increase significantly in the future. In fact a future with a decreasing quality of life may lead to population decrease in Hawaii. Future construction is assumed to continue the current trend which consists of rebuilding on existing lots, possibly with higher density residential units which may add a minimal contribution to runoff. Current observation in the Kaimuki and Palolo areas, show a slow replacement of smaller single family homes with modern double wall construction 2-story homes having larger footprints. At a specific house lot then, there would be less open space for infiltration and potentially move direct connections from roof to street. The overall impact to runoff is small but potentially cumulative over time. Such redevelopment impacts can be mitigated through low-impact development ideas to be used in new construction or as a requirement for the watershed. Therefore, the future without-project scenario may see a small increase in runoff from urban areas but this increase cannot be quantified.

6.0 Summary

The future without project condition attempts to describe the Ala Wai Watershed's future if there is no federal action taken to solve the flood risk problem. The future condition is fundamentally uncertain and represents a best guess of conditions in the watershed. Planning guidance states that the planning process accounts for such future conditions such as climate variability, sea-level rise, subsidence, seismic influences, geomorphological changes, and changes from development which can place demands on the project systems during their life-cycle. Therefore this document provides a qualitative discussion on the future hydrologic and hydraulic impacts of sea-level rise, increased rainfall frequency, debris generation and transport, and increased impervious area for the 2075 future condition.

The only quantitative analysis will be to incorporate sea level rise in the economic analysis, modeling, selection, and design of project alternatives. Using the intermediate sea level rise rate as the most probable future, the backwater conditions in the HEC-RAS model will be increased to 2.50 feet from 1.08 feet to account for future sea level rise in the future without-project scenario. Both the intermediate and high sea level rise rates will be used in the modeling to analyze project performance in the future with-project analysis for years 2075 and 2125.

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