U.S. Department of Energy
Office of River Protection
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

11-TF-064

JUN 15 2011

Ms. Jane A. Hedges, Program Manager
Nuclear Waste Program
State of Washington
Department of Ecology
3100 Port of Benton Blvd
Richland, Washington 99352

Dear Ms. Hedges:

ACKNOWLEDGEMENT AND FORMAL COMPLETION OF HANFORD FEDERAL FACILITY AND CONSENT ORDER (HFFACO) M-045-92K AND M-045-92M MILESTONES

Reference: Ecology letter from J. J. Lyon to S. L. Samulson, ORP, "Completion of Two Hanford Facility and Consent Order (HFFACO) M-045-92 Milestones," 11-NWP-044, dated May 19, 2011.

The U.S. Department of Energy, Office of River Protection (ORP) appreciates the collaborative effort to approve the engineering design and performance monitoring plans for the first two of four planned additional interim surface barriers. This letter serves to document Barrier 1 design/monitoring, milestone M-045-92K, due June 30, 2011 and Barrier 2 design/monitoring, milestone M-045-92M, due June 30, 2012 are completed per your approval letter (Reference) dated May 19, 2011. ORP is formally transmitting the respective approved interim surface barrier designs and monitoring plans for your records (Attached).

ORP would like to acknowledge and document the efforts of Washington State Department of Ecology, ORP, and Washington River Protection Solutions in their completion of these milestones ahead of their completion due dates.

If you have any questions, please contact me, or your staff may contact Robert W. Lober, ORP Vadose Zone Project Manager, Tank Farms Programs and Projects Division at (509) 376-7949.

Sincerely,

Thomas W. Fletcher, Assistant Manager
Tank Farms Project

TPD:RWL

Attachment (CD)
cc: See Page 2

cc w/attach:
J. J. Lyon, Ecology
J. B. Price, Ecology
M. Hendrickson, Ecology
D. A. Faulk, EPA
Administrative Record
Environmental Portal, LMSI
TPA Administrative Record (S-2-4)
WRPS Correspondence

cc w/o attach:
S. L. Leckband, HAB
J. F. Oilero, MSA
R. E. Piippo, MSA
J. G. Vance, MSA
G. Bohnee, NPT
K. Niles, ODOE
R. Lober, ORP
L. Buck, Wanapum
W. T. Dixon, WRPS
J. W. Donnelly, WRPS
S. J. Eberlein, WRPS
S. E. Killoy, WRPS
J. J. Luke, WRPS
D. L. Parker, WRPS
S. M. Sax, WRPS
F. R. Miera, WRPS
R. Jim, YN

ATTACHMENT
TO

11-TF-064

SX FARM BARRIER DESIGN DOCUMENTS
(CD)

PROJECT TITLE:

SX TANK FARM SOUTH INTERIM SURFACE BARRIER

FOR:

WASHINGTON RIVER PROTECTION SOLUTIONS, LLC.

BY:

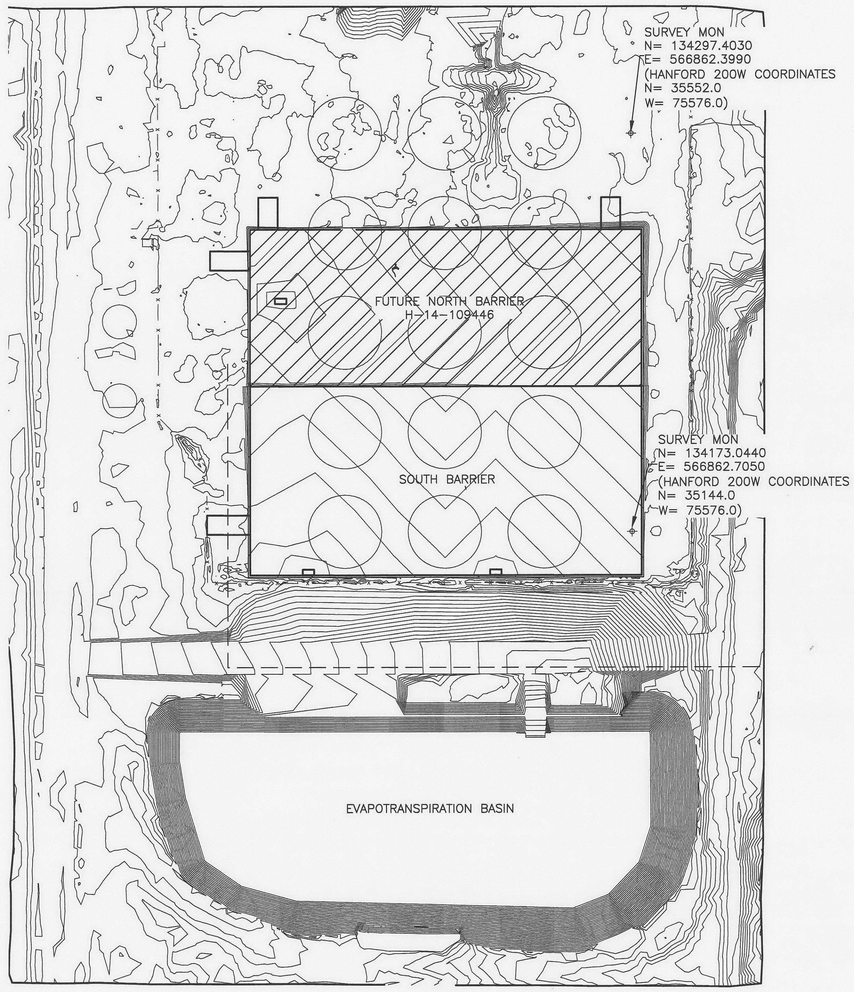
COLUMBIA ENERGY AND ENVIRONMENTAL SERVICES

GENERAL NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL DESIGN SCALES, GRIDS, DISTANCES, COORDINATES AND ELEVATIONS ARE IN METRIC UNITS UNLESS NOTED OTHERWISE. ALL PROFILES AND CONTOURS ARE IN METRIC UNITS AND ARE SHOWN FOR REFERENCE ONLY.
2. BASE MAPS TAKEN FROM PROJECT SPECIFIC TOPOGRAPHIC SURVEY DATABASE PER TOPOGRAPHIC SURVEY PERFORMED BY GLAHE & ASSOCIATES DATED AUGUST 2008, AS PROVIDED BY BUYER.

   HORIZONTAL DATUM: WASHINGTON COORDINATE SYSTEM OF 1983, SOUTH ZONE/1991 ADJUSTMENT (WCS83S/91) –METERS.

   VERTICAL DATUM: NORTH AMERICA VERTICAL DATUM OF 1988 (NAVD88) – METERS US SURVEY FEET ARE SHOWN. CONVERSION 1 M = 39.37 IN
3. EXISTING UTILITIES AND TANK FARM FEATURES ARE SHOWN FOR POTENTIAL INTERFERENCES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING WITH THE BUYER WHEN DISTURBING SOIL TO VERIFY THE LOCATION OF AND PRESERVE ALL UTILITIES AND FEATURES INCLUDING THOSE NOT SHOWN OR INCORRECTLY SHOWN ON THE PLANS, UNLESS SHOWN OR NOTED OTHERWISE.
4. EXCAVATION INSIDE THE FENCE LIMITS OF THE SX FARM IS CONSIDERED CLASSIFIED EXCAVATION, SEE SPECIFICATIONS.
5. ALL HOISTING AND RIGGING WILL BE CONDUCTED IN ACCORDANCE WITH DOE/RL–92–36 "HANFORD SITE HOISTING & RIGGING" AS APPROVED BY THE BUYER.
6. COORDINATE DATA PROVIDED IN POINT TABLES ARE FOR FINAL SUB–GRADE PRIOR TO PAVING EXCEPT AS NOTED.
7. TANKS SHOWN ARE BURIED AND ARE IDENTIFIED FOR REFERENCE.

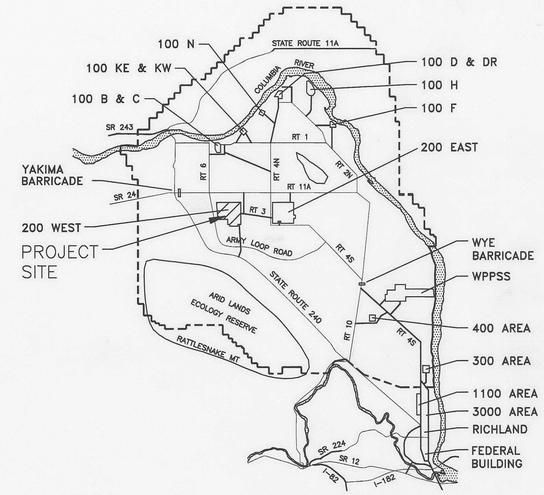


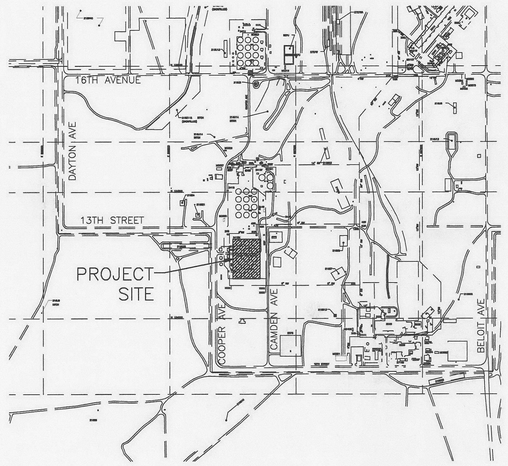
SITE PLAN

20 0 20 40
SCALE IN METERS

50 0 50 100
SCALE IN FEET

NORTH





CONSTRUCTION SPECIFICATION

SPECIFICATION NO.

RPP–SPEC–49086

CALCULATIONS

CALCULATION NO.

RPP–CALC–48447

INTERIM SURFACE BARRIER

DRAWING NO.	TITLE
H–14–109330 SH 1	COVER SHEET
H–14–109330 SH 2	SOUTH BARRIER PLAN & PROFILE
H–14–109330 SH 3	OVERALL BARRIER PLAN & PROFILES
H–14–109330 SH 4–5	EVAPOTRANSPIRATION BASIN PLAN & PROFILE
H–14–109330 SH 6–7	ACCESS ROAD PLAN & PROFILE
H–14–109330 SH 8	SOUTH WEST DRAIN PLAN & PROFILE
H–14–109330 SH 9	SOUTH EAST DRAIN PLAN & PROFILE
H–14–109330 SH 10–15	RISER LOCATION PLAN & ACCESS REQ. SX–110 – SX–115
H–14–109330 SH 16–20	DETAILS

MAY 25 2011
DATE: HANFORD RELEASE ID:
STA: 3 3

DWG NO	TITLE	REF NUMBER	TITLE
		H–14–109446	SX FARM N. INTERIM BARRIER

DRAWING TRACEABILITY LIST — REFERENCES

NEXT USED ON H–14–109447

MFD REV REL	REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY

REVISIONS

NAME	DATE	COMPANY
DRAWN BY JLGC	1/11	CEES
CHECKER DTFCIS	5/19/11	CEES
ENGINEER MTHdm	5/11	WBPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241–SX
SOUTH INTERIM
SURFACE BARRIER

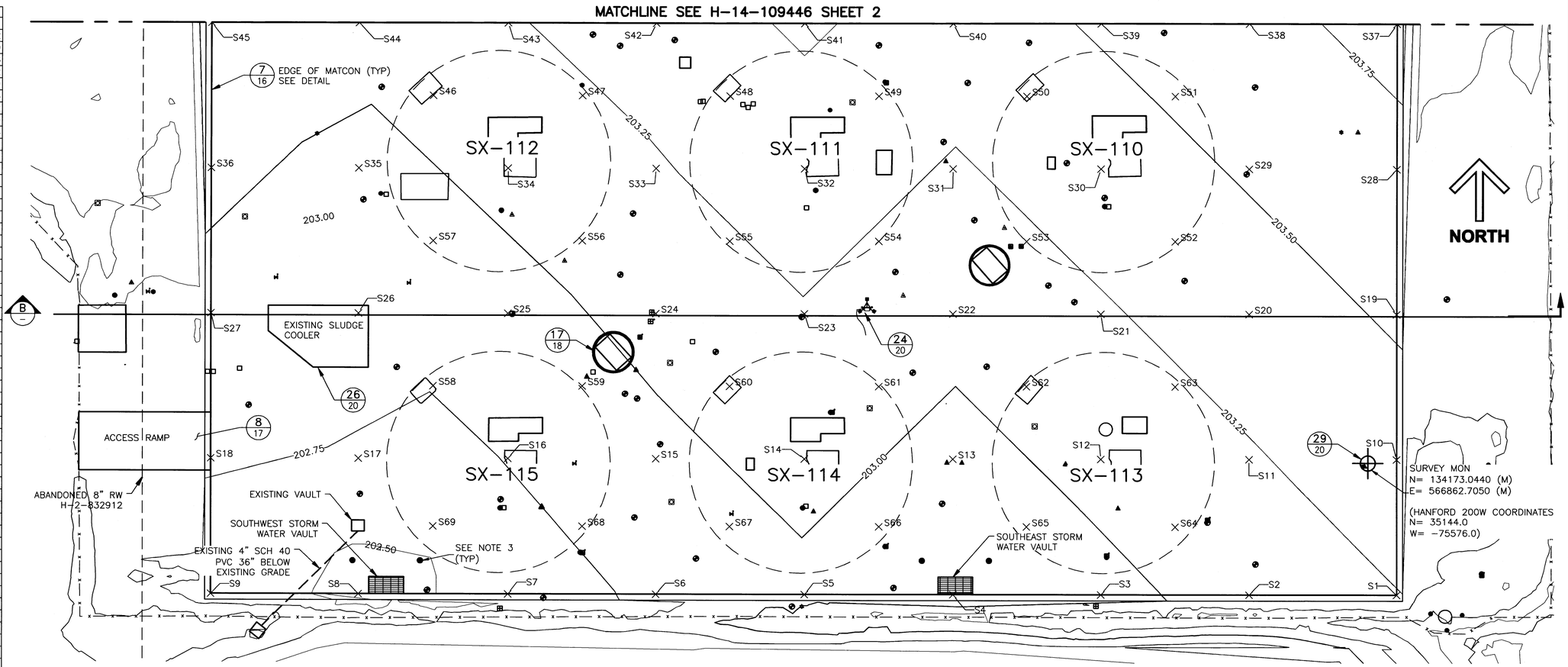
SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H–14–109330	0

SCALE AS SHOWN EDT 824512 SHEET 1 OF 20

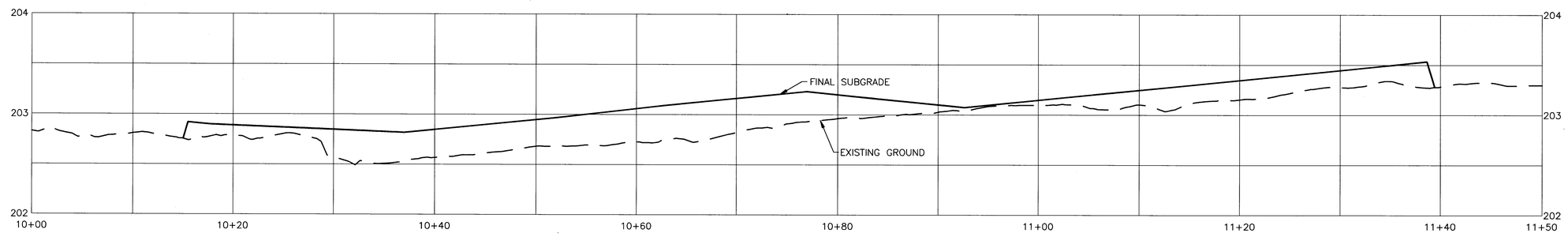
11072 DOE_TB_F.DWG (01–01)

DWG NO H–14–109330 SH 1 OF 20 REV 0

POINT TABLE						
PNT #	EL (M)	N (M)	E (M)	EL (FT)	N (FT)	E (FT)
S1	203.24	134159.42	566865.65	666.80	440154.70	1859791.72
S2	203.09	134159.42	566850.40	666.30	440154.70	1859741.69
S3	202.94	134159.42	566835.15	665.81	440154.70	1859691.66
S4	202.79	134159.42	566819.90	665.32	440154.70	1859641.62
S5	202.94	134159.42	566804.65	665.81	440154.70	1859591.59
S6	202.79	134159.42	566789.40	665.32	440154.70	1859541.56
S7	202.64	134159.42	566774.15	664.83	440154.70	1859491.52
S8	202.52	134159.42	566758.90	664.43	440154.70	1859441.49
S9	202.63	134159.42	566743.65	664.80	440154.70	1859391.46
S10	203.38	134173.42	566865.65	667.26	440200.63	1859791.72
S11	203.23	134173.42	566850.40	666.76	440200.63	1859741.69
S12	203.07	134173.42	566835.15	666.24	440200.63	1859691.66
S13	202.93	134173.42	566819.90	665.78	440200.63	1859641.62
S14	203.08	134173.42	566804.65	666.27	440200.63	1859591.59
S15	202.93	134173.42	566789.40	665.78	440200.63	1859541.56
S16	202.76	134173.42	566774.15	665.22	440200.63	1859491.52
S17	202.73	134173.42	566758.90	665.12	440200.63	1859441.49
S18	202.77	134173.42	566743.65	665.25	440200.63	1859391.46
S19	203.53	134188.42	566865.65	667.75	440249.84	1859791.72
S20	203.38	134188.42	566850.40	667.26	440249.84	1859741.69
S21	203.22	134188.42	566835.15	666.73	440249.84	1859691.66
S22	203.08	134188.42	566819.90	666.27	440249.84	1859641.62
S23	203.23	134188.42	566804.65	666.76	440249.84	1859591.59
S24	203.08	134188.42	566789.40	666.27	440249.84	1859541.56
S25	202.91	134188.42	566789.40	665.71	440249.84	1859541.56
S26	202.89	134188.42	566774.15	665.65	440249.84	1859491.52
S27	202.92	134188.42	566743.65	665.75	440249.84	1859391.46
S28	203.68	134203.42	566865.65	668.24	440299.05	1859791.72
S29	203.53	134203.42	566850.40	667.75	440299.05	1859741.69
S30	203.38	134203.42	566835.15	667.26	440299.05	1859691.66
S31	203.23	134203.42	566819.90	666.76	440299.05	1859641.62
S32	203.38	134203.42	566804.65	667.26	440299.05	1859591.59
S33	203.23	134203.42	566789.40	666.76	440299.05	1859541.56
S34	203.07	134203.42	566774.15	666.24	440299.05	1859491.52
S35	203.05	134203.42	566758.90	666.17	440299.05	1859441.49
S36	203.06	134203.42	566743.65	666.21	440299.05	1859391.46
S37	203.83	134218.42	566865.65	668.73	440348.27	1859791.72
S38	203.68	134218.42	566850.40	668.24	440348.27	1859741.69
S39	203.53	134218.42	566835.15	667.75	440348.27	1859691.66
S40	203.38	134218.42	566819.90	667.26	440348.27	1859641.62
S41	203.53	134218.42	566804.65	667.75	440348.27	1859591.59
S42	203.38	134218.42	566789.40	667.26	440348.27	1859541.56
S43	203.23	134218.42	566774.15	666.76	440348.27	1859491.52
S44	203.08	134218.42	566758.90	666.27	440348.27	1859441.49
S45	203.21	134218.42	566743.65	666.70	440348.27	1859391.46
S46	203.11	134210.92	566766.53	666.37	440323.66	1859466.52
S47	203.23	134210.92	566781.78	666.76	440323.66	1859516.56
S48	203.38	134210.92	566797.03	667.26	440323.66	1859566.59
S49	203.38	134210.92	566812.28	667.26	440323.66	1859616.62
S50	203.38	134210.92	566827.53	667.26	440323.66	1859666.66
S51	203.53	134210.92	566842.78	667.75	440323.66	1859716.69
S52	203.38	134195.92	566842.78	667.27	440274.45	1859716.69
S53	203.22	134195.92	566827.53	666.73	440274.45	1859666.66
S54	203.23	134195.92	566812.28	666.76	440274.45	1859616.62
S55	203.23	134195.92	566797.03	666.76	440274.45	1859566.59
S56	203.07	134195.92	566781.78	666.24	440274.45	1859516.56
S57	202.95	134195.92	566766.53	665.85	440274.45	1859466.52
S58	202.79	134180.92	566766.53	665.32	440225.24	1859466.52
S59	202.92	134180.92	566781.78	665.75	440225.24	1859516.56
S60	203.08	134180.92	566797.03	666.27	440225.24	1859566.59
S61	203.08	134180.92	566812.28	666.27	440225.24	1859616.62
S62	203.07	134180.92	566827.53	666.24	440225.24	1859666.66
S63	203.23	134180.92	566842.78	666.76	440225.24	1859716.69
S64	203.08	134166.42	566842.78	666.27	440177.66	1859716.69
S65	202.93	134166.42	566827.53	665.78	440177.66	1859666.66
S66	202.93	134166.42	566812.28	665.78	440177.66	1859616.62
S67	202.94	134166.42	566812.28	665.81	440177.66	1859616.62
S68	202.78	134166.42	566781.78	665.29	440177.66	1859516.56
S69	202.64	134166.42	566766.53	664.83	440177.66	1859466.52



SOUTH BARRIER SITE PLAN



B SOUTH BARRIER PROFILE

NOTES: APPLIES TO THIS SHEET ONLY

1. ELEVATIONS IN POINT TABLE ARE FOR FINISHED SUB-GRADE AT ± 1/10 FOOT (3 CM) TOLERANCE.
2. MATCON NOT SHOWN IN PROFILE FOR CLARITY
3. FOR BOLLARD SPECIFICATIONS SEE RPP-SPEC-49086
4. POINTS ARE PROVIDED TO ESTABLISH SUB-GRADE. POINTS THAT INTERFERE WITH EXISTING SURFACE FEATURES SHALL BE INTERPOLATED.

SOUTH BARRIER CUT/FILL TABLE			
MIN ELEV (FT)	MAX ELEV (FT)	AREA FT²	VOL YD³
-1.31	-0.66	1032.29	7.64
-0.66	0.00	9181.95	105.82
0.00	0.66	24958.81	1473.37
0.20	1.31	27899.95	788.37
1.31	1.97	13643.82	286.18
1.97	2.62	4801.92	17.92

* VOLUME TABLE FOR REFERENCE ONLY. SEE RPP-SPEC-49086

15 0 15 30 SCALE IN FEET

5 0 5 10 SCALE IN METERS

MAY 25 2011 DATE: STA: 3 HANFORD RELEASE ID: 3

DWG NO	TITLE	REF NUMBER	TITLE
		H-2-832912	RAW WATER DISTRIBUTION 200 W
DRAWING TRACEABILITY LIST		REFERENCES	

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
REVISIONS				

NAME	DATE	COMPANY
DRAWN BY JGC	1/11	CEES
CHECKER JT Fair	5/25/11	CEES
ENGINEER MT Hulse	5/11	HPRS

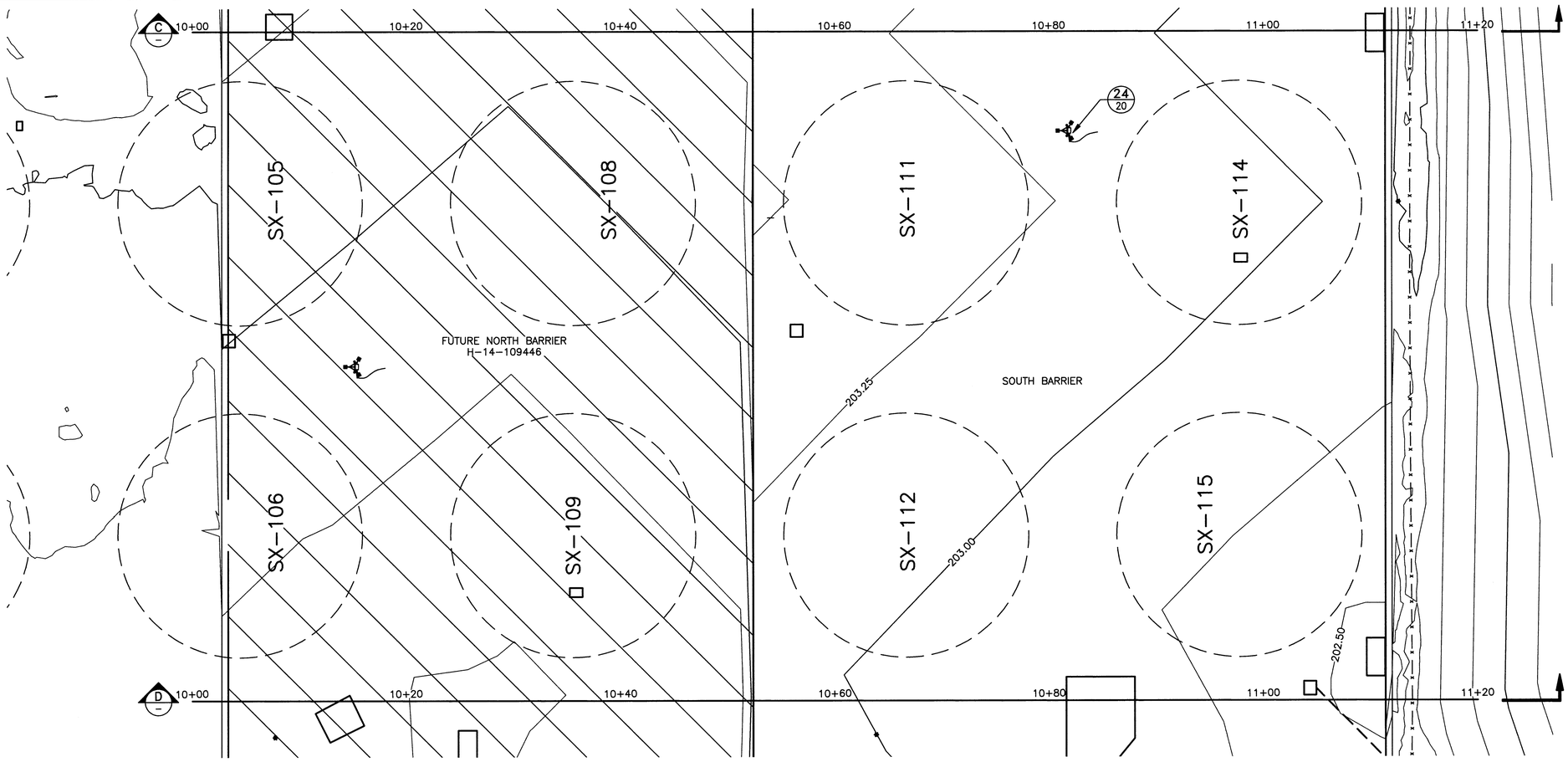
U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
SOUTH INTERIM
SURFACE BARRIER

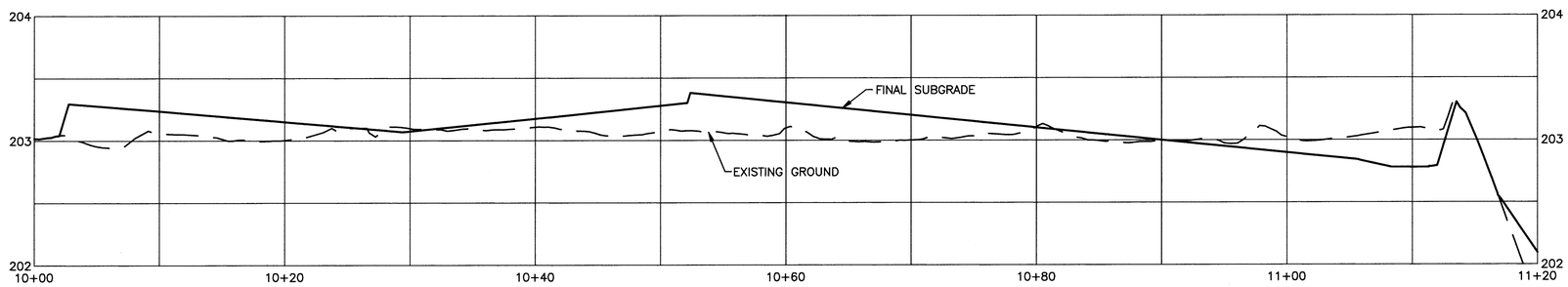
SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0
SCALE AS SHOWN	EDT	824512	SHEET 2 OF	

3009 DOE_TB_F.DWG (01-01)

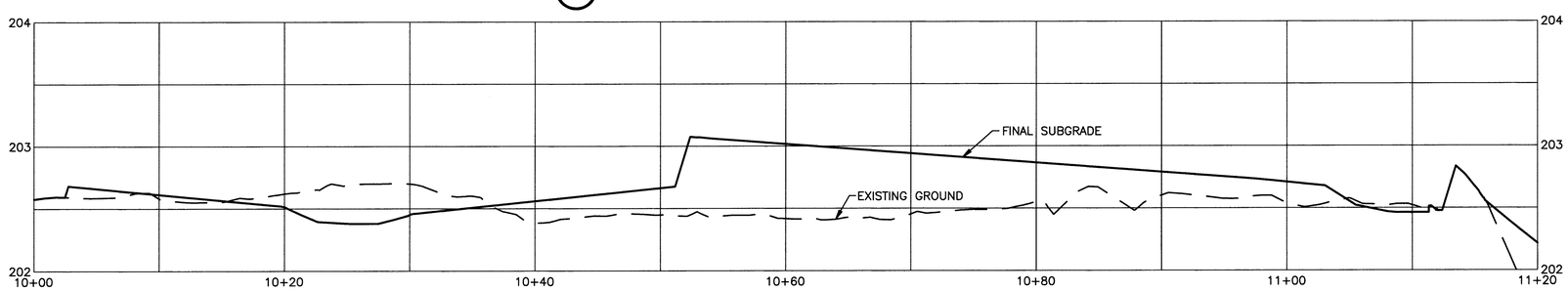
DWG NO H-14-109330 SH 2 OF REV 0



NORTH & SOUTH BARRIER SITE PLAN



C BARRIER PROFILE



D BARRIER PROFILE

15 0 15 30 SCALE IN FEET

5 0 5 10 SCALE IN METERS

MAY 25 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

MFD	REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
REV REL		REVISIONS				

NAME	DATE	COMPANY
DRAWN BY JGO	1/11	CRES
CHECKER JT Pavs	5/11/11	CRES
ENGINEER	5/11	CRES

U.S. DEPARTMENT OF ENERGY
Office of River Protection

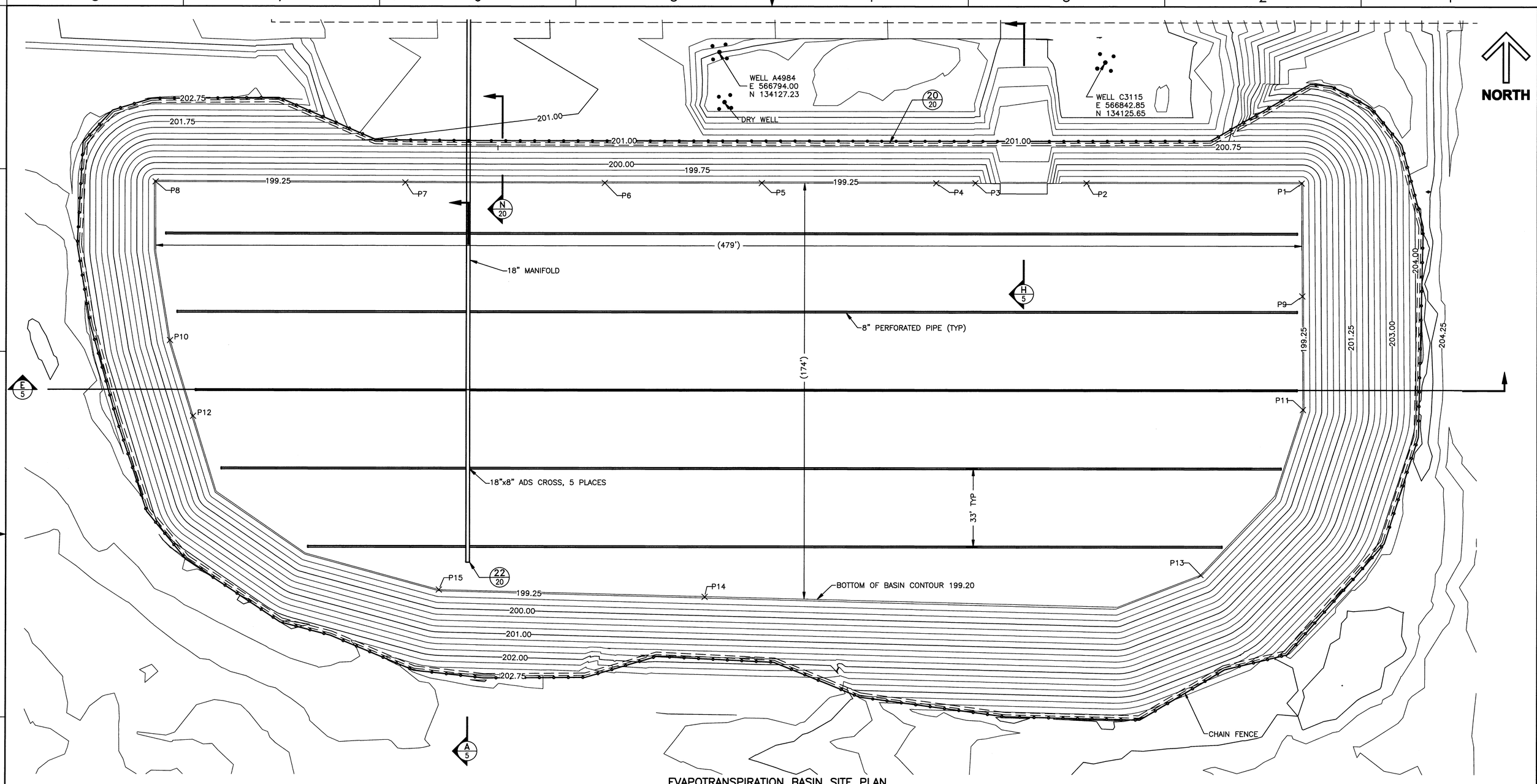
241-SX SOUTH INTERIM SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0
SCALE AS SHOWN	EDT	824512	SHEET 3 OF	

19772

DOE_TB_F.DWG (01-01)

DWG NO H-14-109330 SH 3 OF REV 0



EVAPOTRANSPIRATION BASIN SITE PLAN

POINT TABLE						
PNT #	EL (M)	N (M)	E (M)	EL (FT)	N (FT)	E (FT)
P1	199.20	134110.21	566867.88	653.54	439993.25	1859799.04
P2	199.20	134110.21	566840.49	653.54	439993.25	1859709.17
P3	199.20	134110.21	566826.35	653.54	439993.25	1859662.78
P4	199.20	134110.21	566821.35	653.54	439993.25	1859646.38
P5	199.20	134110.21	566799.15	653.54	439993.25	1859573.54
P6	199.20	134110.21	566779.15	653.54	439993.25	1859507.93
P7	199.20	134110.23	566753.76	653.54	439993.31	1859424.63
P8	199.20	134110.33	566721.95	653.54	439993.64	1859320.26
P9	199.20	134095.79	566867.98	653.54	439945.94	1859799.36
P10	199.20	134095.79	566723.81	653.54	439945.94	1859326.37
P11	199.20	134081.27	566868.08	653.54	439898.30	1859799.69
P12	199.20	134080.39	566726.77	653.54	439895.41	1859336.08
P13	199.20	134060.19	566855.08	653.54	439829.14	1859757.04
P14	199.20	134057.35	566791.94	653.54	439819.82	1859549.89
P15	199.20	134058.24	566758.11	653.54	439822.74	1859438.90

EVAPOTRANSPIRATION VOLUMES				
	NET TOTAL	CUT	FILL	3' BACKFILL OVER PIPES
METERS³	6,278 (CUT)	16,183	741	9164
YARDS³	8,211 (CUT)	21,167	969	11986

* VOLUME TABLE FOR REFERENCE ONLY. SEE RPP-CALC48447 FOR EARTHWORK VOLUME CALCULATIONS.

NOTES:
1. BACKFILL NOT SHOWN FOR CLARITY

15 0 15 30 SCALE IN FEET

5 0 5 10 SCALE IN METERS

MAY 25 2011
DATE: STA: 3 HANFORD RELEASE ID: 3

DRAWING TRACEABILITY LIST		REFERENCES	
DWG NO	TITLE	REF NUMBER	TITLE
		NEXT USED ON	

REVISIONS						
MFD	REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
REV REL						

NAME	DATE	COMPANY
DRAWN BY JJG	1/11	CEES
CHECKED JT Fess	5/10/11	CEES
ENGINEER	5/11	WRPS

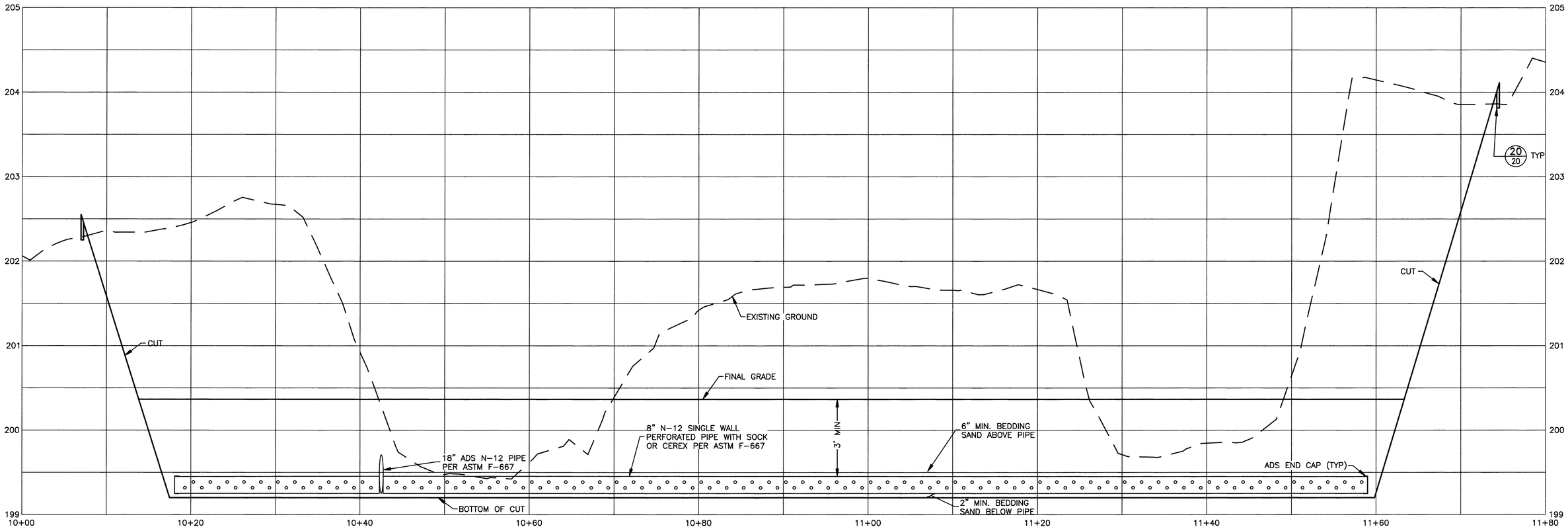
U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX SOUTH INTERIM SURFACE BARRIER

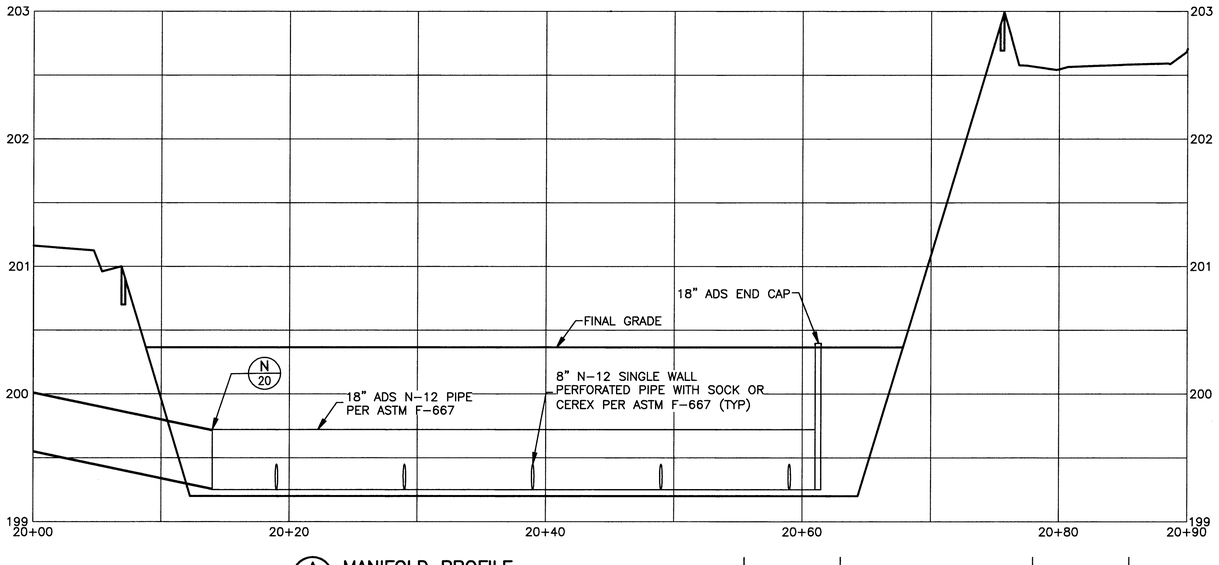
SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0
SCALE AS SHOWN	EDT	824512	SHEET 4 OF	

30710 DOE_TB_F.DWG (01-01)

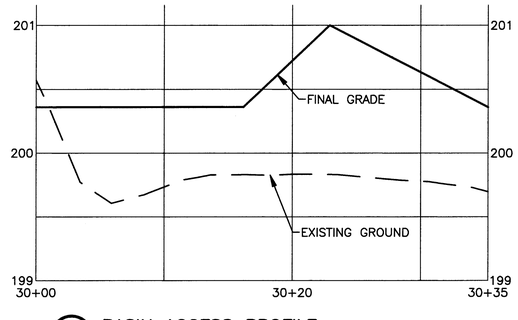
DWG NO H-14-109330 SH 4 OF REV 0



E/4 EVAPOTRANSPIRATION BASIN PROFILE



A/4 MANIFOLD PROFILE



H/4 BASIN ACCESS PROFILE

MAY 25 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

15 0 15 30
SCALE IN FEET

5 0 5 10
SCALE IN METERS

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
REVISIONS				

NAME	DATE	COMPANY
DRAWN BY JGC	1/11	CCES
CHECKER ST FOSS	5/11	CCES
ENGINEER MJS Hahn	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
SOUTH INTERIM
SURFACE BARRIER

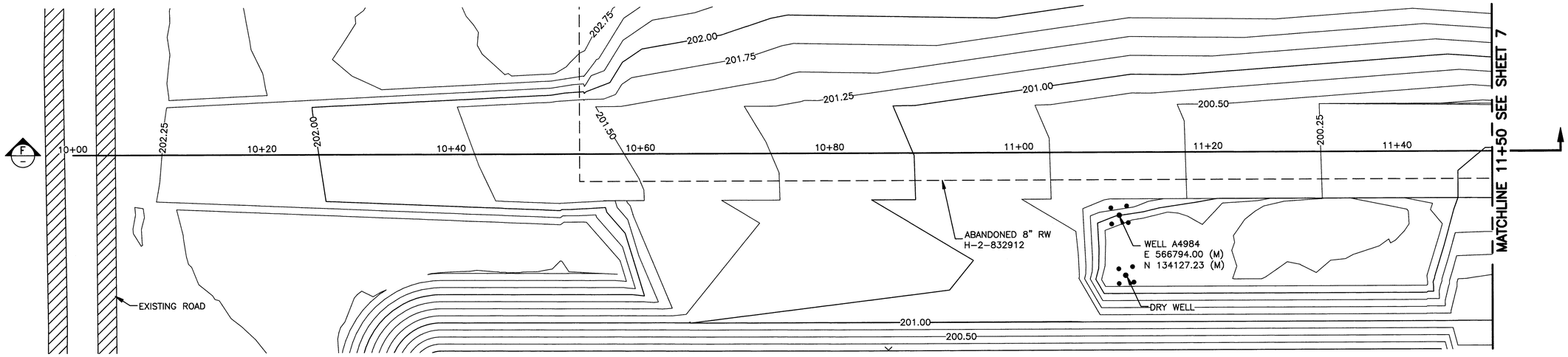
SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0

SCALE AS SHOWN | EDT 824512 | SHEET 5 OF

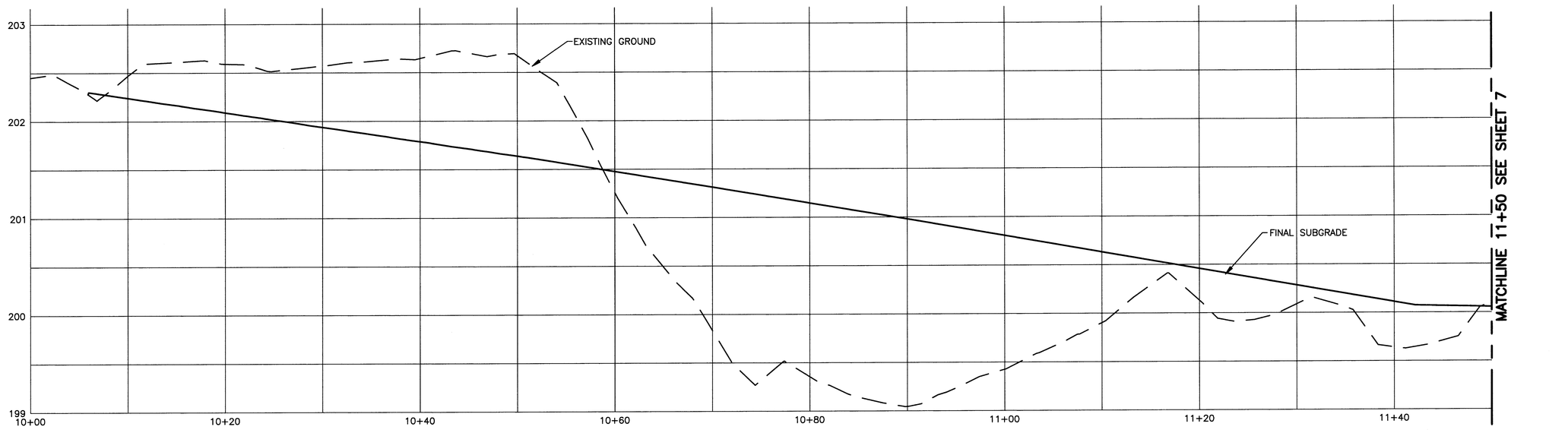
29483

DOE_TB_F.DWG (01-01)

DWG NO H-14-109330 SH 5 OF REV 0



BASIN ACCESS ROAD PLAN



F/1 BASIN ACCESS ROAD PROFILE

15 0 15 30 SCALE IN FEET

5 0 5 10 SCALE IN METERS

MAY 25 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

NAME	DATE	COMPANY
DRAWN BY MGG	1/11	
CHECKER DT FOSS	5/10/11	CCES
ENGINEER MS Dahn	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
SOUTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0

SCALE AS SHOWN | EDT 824512 | SHEET 6 OF

DWG NO	TITLE
H-2-832912	RAW WATER DISTRIBUTION 200 W

DRAWING TRACEABILITY LIST — REFERENCES — NEXT USED ON

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY

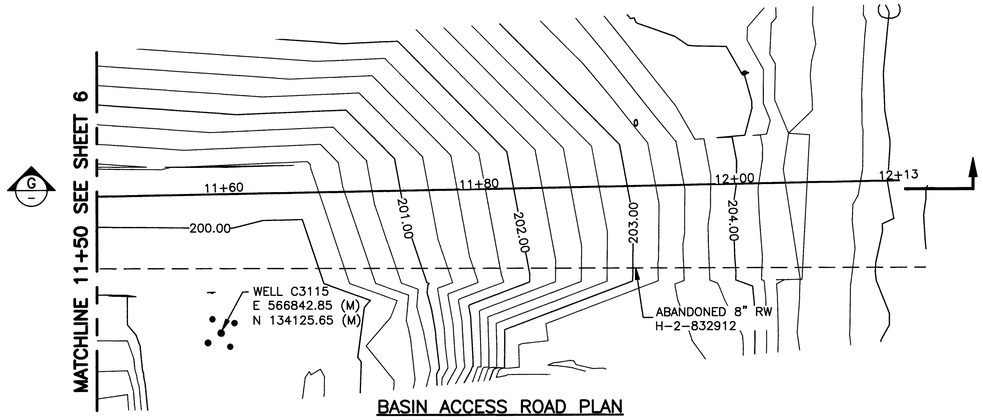
REVISIONS

29505

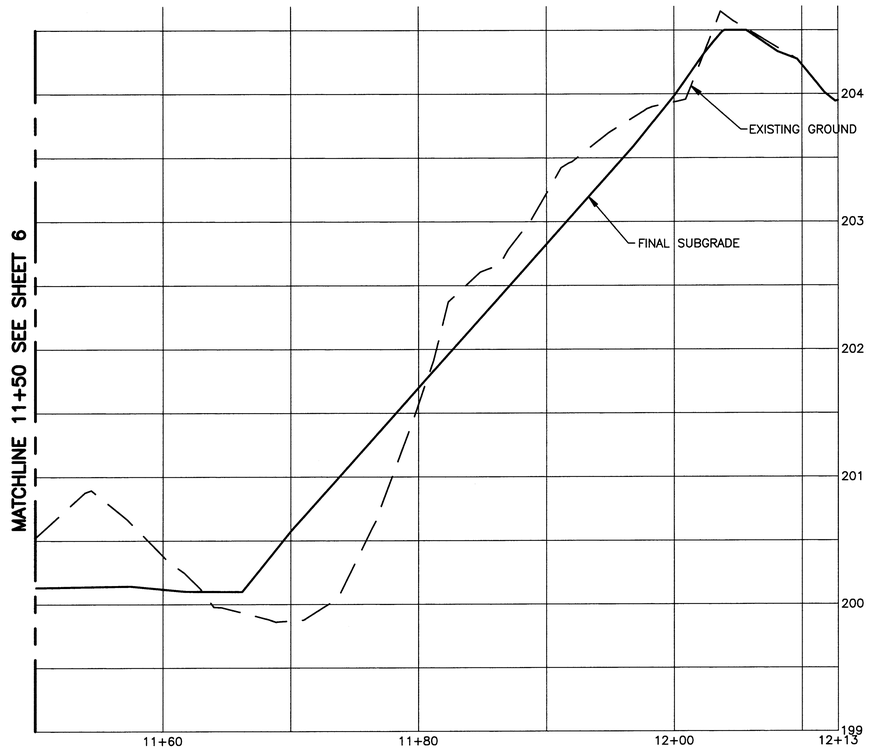
DOE_TB_F.DWG (01-01)

DWG NO H-14-109330 SH 6 OF REV 0

NORTH



BASIN ACCESS ROAD PLAN



G BASIN ACCESS ROAD PROFILE

15 0 15 30 SCALE IN FEET

5 0 5 10 SCALE IN METERS

MAY 25 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

DWG NO	TITLE
	DRAWING TRACEABILITY LIST

REF NUMBER	TITLE
H-2-832912	RAW WATER DISTRIBUTION 200 W
NEXT USED ON	REFERENCES

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
	REVISIONS			

	NAME	DATE	COMPANY
DRAWN BY	JGC	1/11	CCES
CHECKER	JT FOSS	5/11/11	CCES
ENGINEER	MS Helm	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

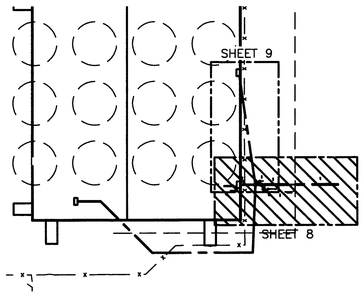
241-SX
SOUTH INTERIM
SURFACE BARRIER

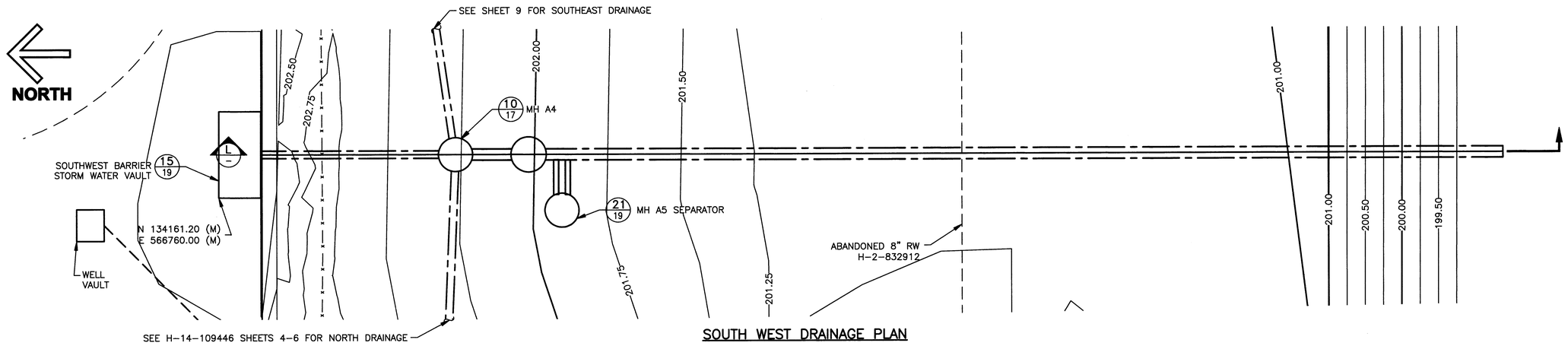
SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0

SCALE AS SHOWN EDT 824512 SHEET 7 OF

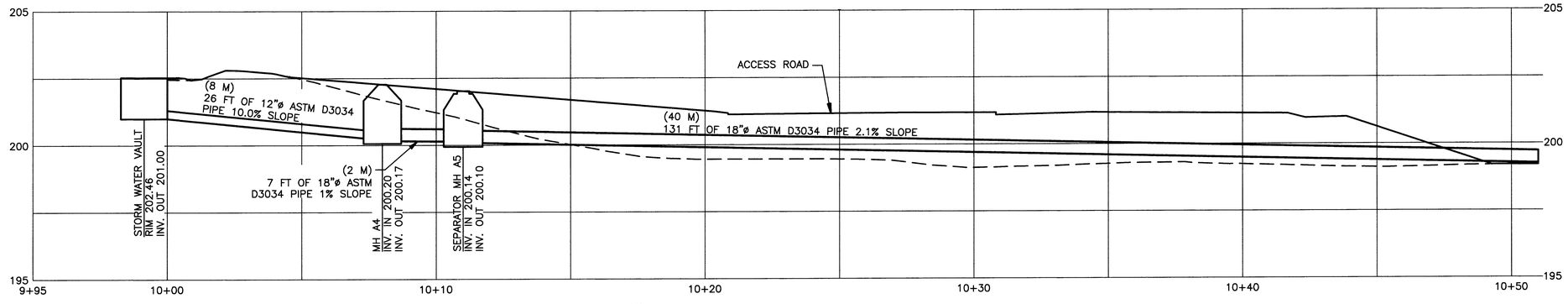
27339 DOE_TB_F.DWG (01-01)

DWG NO H-14-109330 SH 7 OF REV 0





SOUTH WEST DRAINAGE PLAN



L SOUTH WEST DRAINAGE PROFILE

5 0 5 10 SCALE IN FEET

2 0 2 4 SCALE IN METERS

MAY 25 2011
DATE: STA: 3 HANFORD RELEASE ID: 3

NAME	DATE	COMPANY
DRAWN BY JLGK	5/10/11	CGES
CHECKER DTFoss	5/10/11	CGES
ENGINEER MSHolm	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
SOUTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0

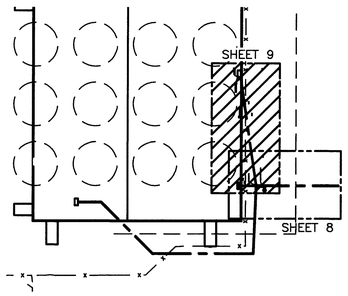
SCALE AS SHOWN EDT 824512 SHEET 8 OF

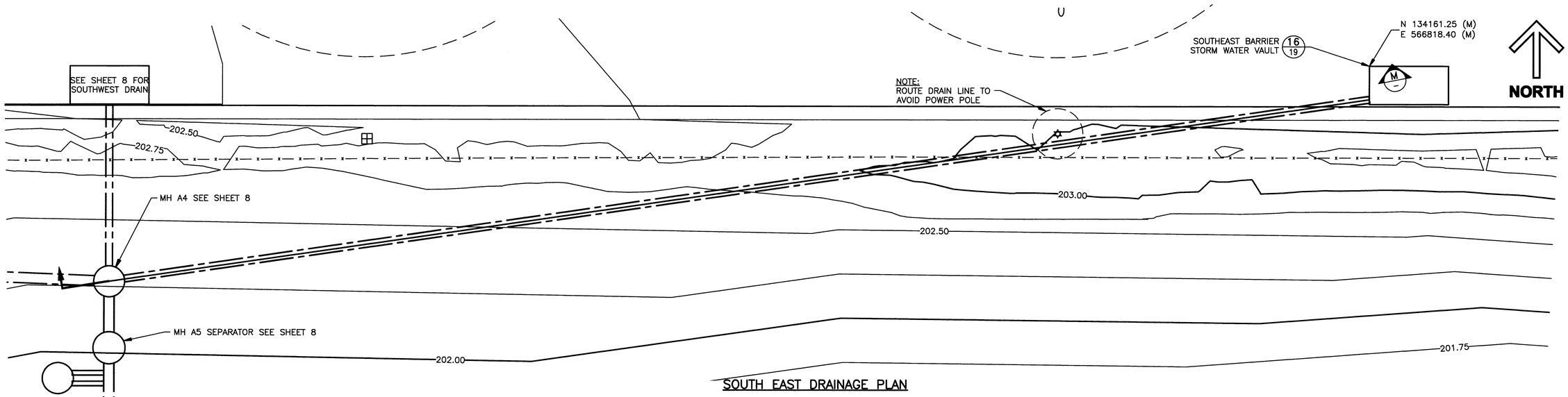
DWG NO	TITLE	REFERENCES	
		H-2-832912	RAW WATER DISTRIBUTION 200 W
		REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		NEXT USED ON	

MFD	REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
REV REL		REVISIONS				

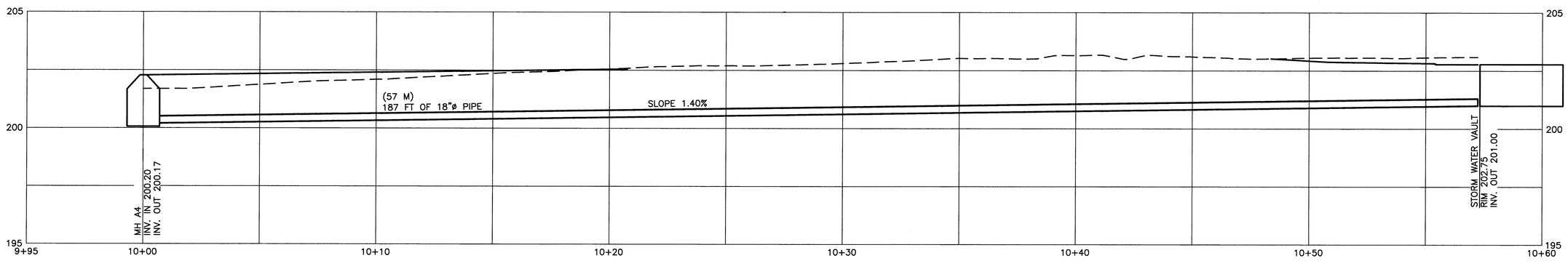
DWG NO H-14-109330 SH 8 OF REV 0

15101 DOE_TB_F.DWG (01-01)





SOUTH EAST DRAINAGE PLAN



M SOUTH EAST DRAINAGE PROFILE

MAY 25 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

SCALE IN FEET (5 0 5 10)

SCALE IN METERS (2 0 2 4)

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

MFD	REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
REV REL		REVISIONS				

	NAME	DATE	COMPANY
DRAWN BY	JGC	5/9/11	CCS
CHECKER	ST Foss	5/10/11	CCS
ENGINEER		5/11	WRPS

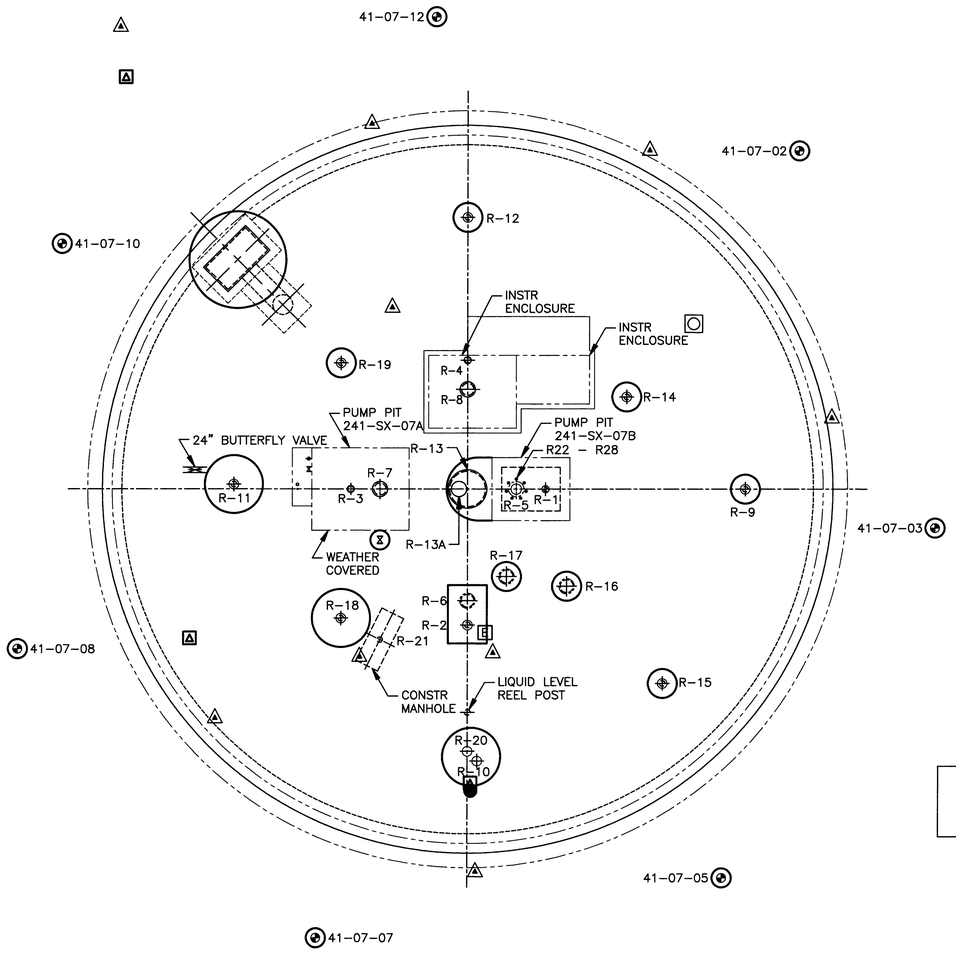
U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
SOUTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0
SCALE AS SHOWN	EDT	824512	SHEET 9 OF	

DOE_TB_F.DWG (01-01)

DWG NO H-14-109330 SH 9 OF REV 0

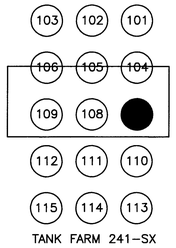


241-SX-107

NORTH

SCALE IN FEET (5 0 5 10)

SCALE IN METERS (2 0 2 4)



TANK FARM 241-SX

KEY PLAN

SCALE: NONE

LEGEND

- UTILITY POLE
- LIGHT POLE
- GUY WIRE
- JUNCTION BOX
- BOLLARD
- DRY WELLS
- SIGNS
- VALVE
- ELECTRICAL PULL BOX
- E — ELECTRICAL BOX
- P — PORTABLE SKID

RISER SUMMARY TABLE

RISER #	REF. ELEV. (FT)	SIZE (INCH)	FUNCITON/ DESCRIPTION	DETAIL	TYPE/ MODEL #	ACCESS REQ'D / LABEL	COMBINED W/RISER
R1		4	DRAIN IN PUMP PIT	12	–	NO	5
R2	663.46	4	ENRAF LIT	9	UTILITY VAULT 72"x48" (1 EA) NO. 64R-12	YES/ SX107-WST-LIT-101	6
R3		4	DRAIN IN PUMP	–	–	NO	7
R4		4	THERMOCOUPLE	1	UTILITY VAULT, SIZE AS REQD		8
R5		12	–	12	–	NO	1
R6	663.44	12	OBSV PORT	9	UTILITY VAULT 72"x48" (1 EA) NO. 64R-12	YES/ SX107-WST-LG-101	R2
R7		12	PUMP	–	–	NO	3
R8		12	AIR SUPPLY FOR LIFT CIRCULATIONS	1	UTILITY VAULT, SIZE AS REQD		4
R9	664.75	2 1/2	TEMPERATURE PROBE #5	14	3'ø CMP	NO	–
R10	664.70	2 1/2	TEMPERATURE PROBE #2	14	6'ø CMP	NO	20
R11	664.54	2 1/2	TEMPERATURE PROBE #3	14	6'ø CMP	NO	–
R12	664.63	2 1/2	TEMPERATURE PROBE #4	14	3'ø CMP	NO	–
R13		42	42" RISER ADAPTER	3	9'-8"ø CONTECH LINER	YES/ SX107-WST-RISER-013	13A
R13A		18	BREATHER FILTER	3	9'-8"ø CONTECH LINER	YES/ SX107-WST-FLT-101	13
R14	664.81	2 1/2	TEMPERATURE PROBE #8	14	3'ø CMP	NO	–
R15	664.84	2 1/2	TEMPERATURE PROBE #1	14	3'ø CMP	NO	–
R16	664.25	12	OBSERVATION PORT	14	3'ø CMP W/LID	YES/ SX107-WST-LG-102	–
R17	664.10	12	OBSERVATION PORT	14	3'ø CMP W/LID	YES/ SX107-WST-LG-103	–
R18	664.82	2 1/2	TEMPERATURE PROBE #6	14	6'ø CMP	NO	–
R19	664.68	2 1/2	TEMPERATURE PROBE #7	14	3'ø CMP	NO	–
R20		5	TEMP MON. SYSTEM	14	6'ø CMP	NO	10
21		24	EXHAUSTER PORT	4	PAVE AROUND	NO	–
22		3	PUMP PIT 241-SX-07B	12	–	NO	–
23		3	PUMP PIT 241-SX-07B	12	–	NO	–
24		3	PUMP PIT 241-SX-07B	12	–	NO	–
25		3	PUMP PIT 241-SX-07B	12	–	NO	–
26		3	PUMP PIT 241-SX-07B	12	–	NO	–
27		3	PUMP PIT 241-SX-07B	12	–	NO	–
28		3	PUMP PIT 241-SX-07B	12	–	NO	–
			24" BUTTERFLY VALVE WEST OF R11	4	PAVE AROUND	NO	–
			VALVE SOUTH OF R7	2	2ø STEEL PIPE	NO	–
			HATCHWAY	20	10'ø CMP	NO	–
			PUMP PIT 241-SX-07A	12	PAVE AROUND	NO	–
			PUMP PIT 241-SX-07B	12	PAVE AROUND	NO	–
			(3) JUNCTION BOX	4	PAVE AROUND	YES/ SX107-WST-JBX-101	–
			LIQUID LEVEL REEL POST	4	PAVE AROUND	YES/ SX107-WST-LIY-101	–
			INSTRUMENT ENCLOSURE	1	UTILITY VAULT, SIZE AS REQD		
			BOLLARD S OF R-10	4	PAVE AROUND	NO	–
41-07-02		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-07-02	–
41-07-03		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-07-03	–
41-07-05		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-07-05	–
41-07-07		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-07-07	–
41-07-08		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-07-08	–
41-07-10		6	DRY WELL	2	2ø STEEL PIPE	YES/ 41-07-10	–
41-07-12		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-07-12	–

NOTES: THIS SHEET ONLY

1. FOR DETAILS SEE SHEETS 13 THRU 16.

MAY 24 2011 DATE: STA: 3 HANFORD RELEASE ID: 3

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
REVISIONS					

	NAME	DATE	COMPANY
DRAWN BY	GA SCHELL	1/2011	CH2M
CHECKER	SY FOSS	5/10/11	CGRS
ENGINEER	MT Hall	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

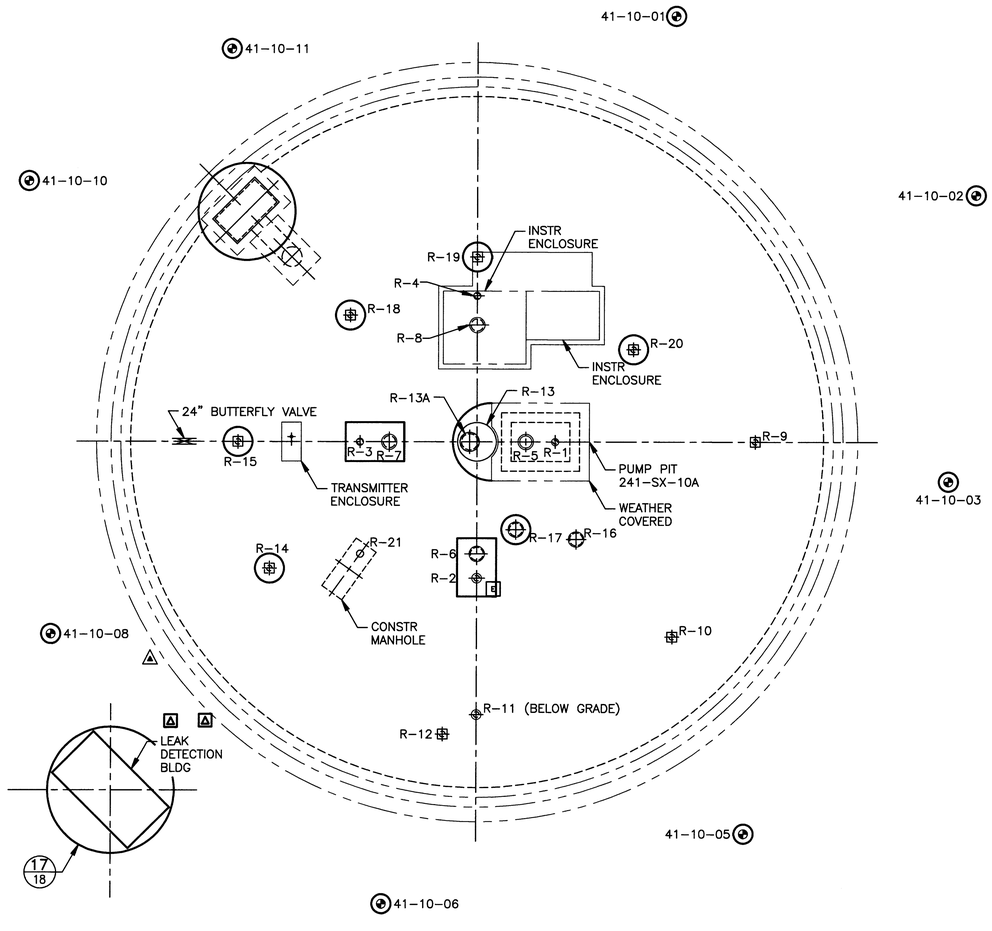
241-SX NORTH INTERIM SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109446	0

SCALE AS SHOWN | EDT 824511 | SHEET 10 OF

DWG NO H-14-109446 SH 10 OF REV 0

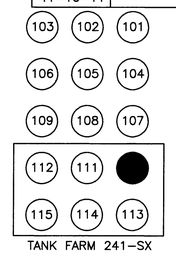
241-SX-107



241-SX-110

RISER SUMMARY TABLE

RISER #	REF. ELEV. (FT)	SIZE (INCH)	FUNCITON/ DESCRIPTION	DETAIL	TYPE/ MODEL #	ACCESS REQ'D / LABEL	COMBINED W/RISER
R1		4	DRAIN IN PUMP PIT	12	–	NO	5
R2	663.46	4	ENRAF LIT	9	UTILITY VAULT 90"x60" (1EA) No. 576R-12	YES/ SX110-WST-LIT-101	6
R3	663.45	4	THERMOMETER	9	UTILITY VAULT 72"x48" (1EA) No. 64R-18	YES/ SX110-WST-TE-101	7
R4		4	THERMOCOUPLE	1	UTILITY VAULT SIZE AS REQ'D	NO	8
R5		12	PUMP	12	–	NO	1
R6	663.44	12	TEMPERATURE PROBE	9	UTILITY VAULT 90"x60" (1EA) No. 576R-12	YES/ SX110-WST-TE-102	2
R7	663.43	12	–	9	UTILITY VAULT 72"x48" (1EA) No. 64R-18	YES/ SX110-WST-RISER-007	3
R8		12	–	1	UTILITY VAULT SIZE AS REQ'D	NO	4
R9	664.75	2 1/2	–	4	PAVE AROUND	NO	–
R10	664.84	2 1/2	–	4	PAVE AROUND	NO	–
R11		6	–	6	PAVE OVER	NO	–
R12	664.70	2 1/2	–	4	PAVE AROUND	NO	–
R13		42	–	3	9'-8"ø CONTECH LINER	YES/ SX110-WST-RISER-013	13A
R13A		20	AIR INLET FILTER	3	9'-8"ø CONTECH LINER	YES/ SX110-WST-FLT-101	13
R14	664.82	2 1/2	THERMOCOUPLE PROBE #6	14	3'ø CMP	NO	–
R15	664.54	2 1/2	THERMOCOUPLE PROBE #3	14	3'ø CMP	NO	–
R16	664.25	12	OSBV PORT	4	PAVE AROUND	NO	–
R17	664.10	12	SPARE	14	3'ø CMP W/LID	YES/ SX110-WST-RISER-017	–
R18	664.68	2 1/2	THERMOCOUPLE PROBE #1	14	3'ø CMP	YES/ SX110-WST-TE-001	–
R19	664.63	2 1/2	THERMOCOUPLE PROBE #4	14	3'ø CMP	YES/ SX110-WST-TE-004	–
R20	664.41	2 1/2	THERMOCOUPLE PROBE #8	14	3'ø CMP	YES/ SX110-WST-TE-008	–
R21		20	EXHAUSTER PORT	6	PAVE OVER	NO	–
			LEAK DETECTION BLDG	17	PAVE AROUND	YES/ SX110-WST-LDSTA-101	–
			HATCHWAY	23	10'ø CMP	NO	–
			24" BUTTERFLY VALVE WEST OF R15	4	PAVE AROUND	NO	–
			PUMP PIT 241-SX-10A	12	PAVE AROUND	NO	–
			TRANSMITTER ENCLOSURE	6	PAVE OVER	NO	–
			(2) JUNCTION BOX	4	PAVE AROUND	YES/ SX110-WST-JBX-101	–
			INSTRUMENT ENCLOSURE	1	UTILITY VAULT SIZE AS REQ'D		
41-10-01		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-10-01	–
41-10-02		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-10-02	–
41-10-03		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-10-03	–
41-10-05		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-10-05	–
41-10-06		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-10-06	–
41-10-08		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-10-08	–
41-10-10		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-10-10	–
41-10-11		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-10-11	–



TANK FARM 241-SX
KEY PLAN
SCALE: NONE

LEGEND

- UTILITY POLE
- LIGHT POLE
- GUY WIRE
- JUNCTION BOX
- BOLLARD
- DRY WELLS
- SIGNS
- VALVE
- ELECTRICAL PULL BOX
- E — ELECTRICAL BOX
- P — PORTABLE SKID

NOTES: THIS SHEET ONLY

1. FOR DETAILS SEE SHEETS 16 THRU 20.

MAY 25 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
REVISIONS				

NAME	DATE	COMPANY
DRAWN BY GA SCHELL	1/2011	CH2M
CHECKER	5/10/11	
ENGINEER	5/11	

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
SOUTH INTERIM
SURFACE BARRIER

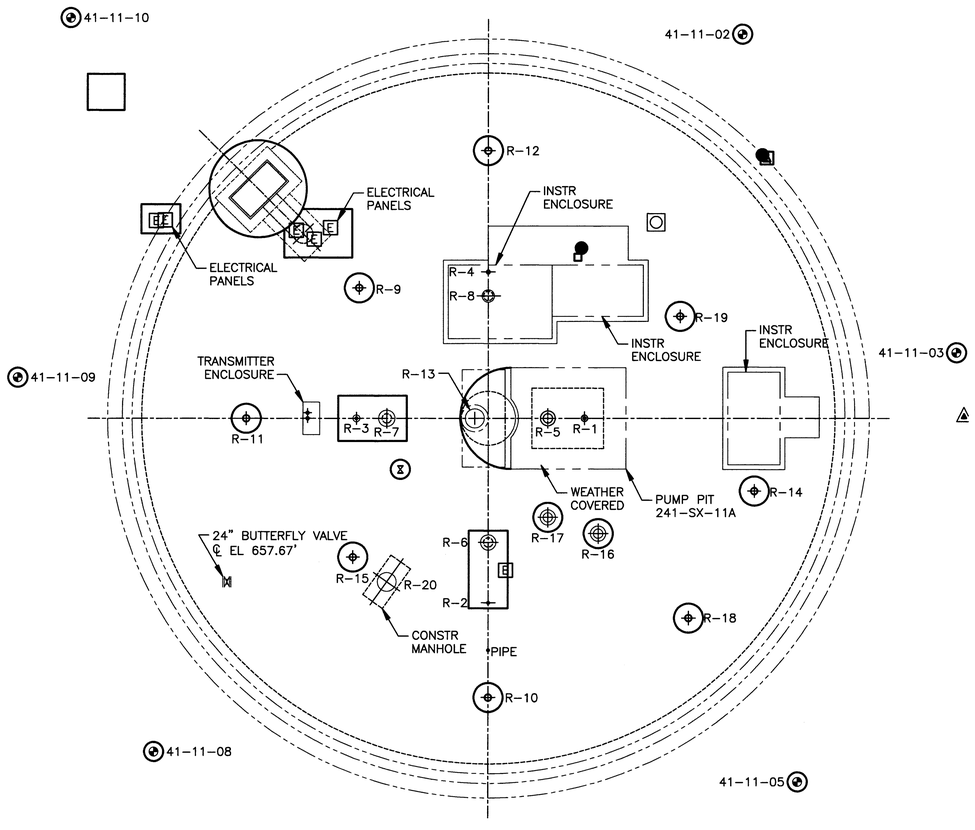
SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0

SCALE AS SHOWN | EDT 824512 | SHEET 10 OF

4830

DOE_TB_F.DWG (01-01)

DWG NO H-14-109330 SH 10 OF REV 0

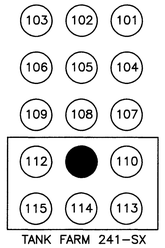


241-SX-111

NORTH

SCALE IN FEET: 5 0 5 10

SCALE IN METERS: 2 0 2 4



TANK FARM 241-SX

KEY PLAN

SCALE: NONE

LEGEND	
	UTILITY POLE
	LIGHT POLE
	GUY WIRE
	JUNCTION BOX
	BOLLARD
	DRY WELLS
	SIGNS
	VALVE
	ELECTRICAL PULL BOX
E	ELECTRICAL BOX
P	PORTABLE SKID

NOTES: THIS SHEET ONLY

1. FOR DETAILS SEE SHEETS 16 THRU 20.

RISER SUMMARY TABLE

RISER #	REF. ELEV. (FT)	SIZE (INCH)	FUNCITON/ DESCRIPTION	DETAIL	TYPE/ MODEL #	ACCESS REQ'D / LABEL	COMBINED W/RISER
R1		4	DRAIN IN PUMP PIT	12	–	NO	5
R2	662.41	4	ENRAF LIT	9	UTILITY VAULT 90"x60" (2EA) No. 576R-12	YES/ SX111-WST-LIT-101	6
R3	662.40	4	THERMOMETER	9	UTILITY VAULT 84"x56" (2EA) No. 57R-12	YES/ SX111-WST-TE-101	7
R4		4	THERMOCOUPLE	1	UTILITY VAULT SIZE AS REQ'D	NO	8
R5		12	PUMP	12	–	NO	1
R6	662.41	12	LOW 4" SPARE	9	UTILITY VAULT 90"x60" (1EA) No. 576R-12	YES/ SX111-WST-LOW-101	2
R7	662.46	12	–	9	UTILITY VAULT 84"x56" (1EA) No. 57R-12	YES/ SX111-WST-RISER-007	3
R8		12	AIR CIRCULATOR	1	UTILITY VAULT SIZE AS REQ'D	NO	4
R9	663.31	2 1/2	THERMOCOUPLE #1	14	3'ø CMP	NO	–
R10	663.98	2 1/2	THERMOCOUPLE #2	14	3'ø CMP	NO	–
R11	663.69	2 1/2	THERMOCOUPLE #3	14	3'ø CMP	NO	–
R12	663.76	2 1/2	THERMOCOUPLE #4	14	3'ø CMP	NO	–
R13		42	INLET AIR STACK	3	9'-8" CONTECH LINER	YES/ SX111-WST-FLT-101	–
R14	663.69	2 1/2	THERMOCOUPLE #5	14	3'ø CMP	NO	–
R15	663.33	2 1/2	THERMOCOUPLE #6	14	3'ø CMP	NO	–
R16	663.83	12	OSBV PORT	14	3'ø CMP	YES/ SX111-WST-LG-101	–
R17	663.77	12	SPARE	14	3'ø CMP W/LID	YES/ SX111-WST-RISER-017	–
R18	664.10	2 1/2	THERMOCOUPLE #7	14	3'ø CMP	NO	–
R19	663.64	2 1/2	THERMOCOUPLE #8	14	3'ø CMP	NO	–
R20	657.67	24	VAPOR MANIFOLD	4	PAVE AROUND	NO	–
			PIPE SOUTH OF R-2	4	PAVE AROUND	NO	–
			VALVE SOUTH OF R-7	–	2'ø STEEL PIPE	NO	–
			CONCRETE BOLLARD NE OF R19	4	PAVE AROUND	NO	–
			CONCRETE BOLLARD N OF INSTR ENCLOSURE	4	PAVE AROUND	NO	–
			HATCHWAY	23	10'ø CMP	NO	–
			ELECTRICAL PANEL SE OF HATCHWAY	11	CURBING	YES/ SX111-WST-PNL-101	–
			ELECTRICAL PANEL W OF HATCHWAY	11	CURBING	YES/ SX111-WST-PNL-102	
			24" BUTTERFLY VALVE WEST OF R20	4	PAVE AROUND	YES/ SX111-WST-V-101	–
			PUMP PIT 241-SX-11A	12	PAVE AROUND	NO	–
			TRANSMITTER ENCLOSURE	6	PAVE OVER	NO	–
			JUNCTION BOX	4	PAVE AROUND	YES/ SX111-WST-JBX-101	–
			INSTRUMENT ENCLOSURE	1	UTILITY VAULT SIZE AS REQ'D	NO	
41-11-02		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-11-02	–
41-11-03		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-11-03	–
41-11-05		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-11-05	–
41-11-06		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-11-06	–
41-11-08		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-11-08	–
41-11-09		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-11-09	–
41-11-10		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-11-10	–

MAY 25 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
REVISIONS				

NAME	DATE	COMPANY
DRAWN BY GA SCHELL	1/2011	CGS
CHECKER JT Foss	5/18	CGS
ENGINEER	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX SOUTH INTERIM SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0

SCALE AS SHOWN | EDT 824512 | SHEET 11 OF

9359

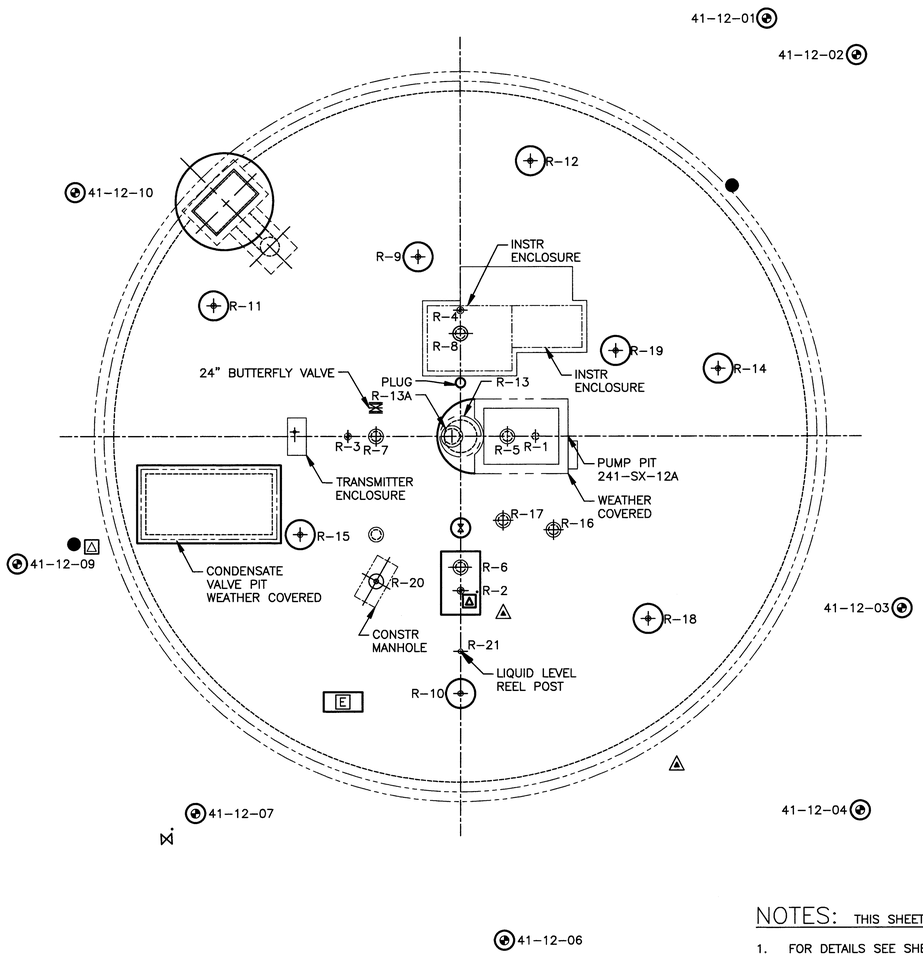
DOE_TB_F.DWG (01-01)

DWG NO H-14-109330 SH 11 OF REV 0

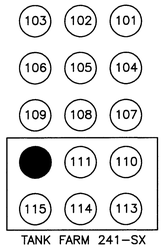
NORTH

5 0 5 10 SCALE IN FEET

2 0 2 4 SCALE IN METERS



241-SX-112



TANK FARM 241-SX

KEY PLAN

SCALE: NONE

LEGEND

	UTILITY POLE
	LIGHT POLE
	GUY WIRE
	JUNCTION BOX
	BOLLARD
	DRY WELLS
	SIGNS
	VALVE
	ELECTRICAL PULL BOX
E	ELECTRICAL BOX
P	PORTABLE SKID

NOTES: THIS SHEET ONLY

1. FOR DETAILS SEE SHEETS 16 THRU 20.

RISER SUMMARY TABLE

RISER #	REF. ELEV. (FT)	SIZE (INCH)	FUNCITON/ DESCRIPTION	DETAIL	TYPE/ MODEL #	ACCESS REQ'D / LABEL	COMBINED W/RISER
R1		4	DRAIN IN PUMP PIT	12	–	NO	5
R2	661.50	4	ENRAF LIT	9	UTILITY VAULT 90"x60" (2EA) No. 576R-12	YES/ SX112-WST-LIT-101	6
R3	661.49	4	THERMOMETER	4	PAVE AROUND	NO	–
R4		4	THERMOCOUPLE	1	UTILITY VAULT SIZE AS REQ'D	NO	8
R5		12	PUMP	12	–	NO	1
R6	661.47	12	DUAL PORT ADAPTER	9	UTILITY VAULT 90"x60" (1EA) No. 576R-12	YES/ SX112-WST-RISER-006	2
R6A		4	LIQ OBSV WELL	–	–	–	–
R6B		4	SPARE	–	–	–	–
R7		12	SPARE	6	PAVE OVER	NO	–
R8		12	AIR LIFT CIRCULATOR	1	UTILITY VAULT SIZE AS REQ'D	NO	4
R9	662.33	2 1/2	SLUDGE TEMPERATURE PROBE	14	3ø CMP	YES/ SX112-WST-TE-101	–
R10	662.50	2 1/2	SLUDGE TEMPERATURE PROBE	14	3ø CMP	YES/ SX112-WST-TE-102	–
R11	662.08	2 1/2	SLUDGE TEMPERATURE PROBE	14	3ø CMP	YES/ SX112-WST-TE-103	–
R12	662.45	2 1/2	SLUDGE TEMPERATURE PROBE	14	3ø CMP	YES/ SX112-WST-TE-104	–
R13		42	42" RISER ADAPTER	3	9'-8" CONTECH LINER	YES/ SX112-WST-RISER-013	13A
R13A		20	BREATHER ADAPTER	3	9'-8" CONTECH LINER	YES/ SX112-WST-FLT-101	13
R14	662.35	2 1/2	SLUDGE TEMPERATURE PROBE	14	3ø CMP	YES/ SX112-WST-TE-105	–
R15	662.37	2 1/2	SLUDGE TEMPERATURE PROBE	14	3ø CMP	YES/ SX112-WST-TE-106	–
R16		12	SLUDGE TEMPERATURE PROBE	6	PAVE OVER	NO	–
R17		12	TANK INSPECTION	6	PAVE OVER	NO	–
R18	662.67	2 1/2	SLUDGE TEMPERATURE PROBE	14	3ø CMP	NO	–
R19	662.35	2 1/2	SLUDGE TEMPERATURE PROBE	14	3ø CMP	NO	–
R20	656.67	24	EXHAUSTER PORT	4	PAVE AROUND	NO	–
R21		4	LIQUID LEVEL REEL PORT	4	PAVE AROUND	NO	–
			HATCHWAY	23	11'ø CMP	NO	–
			CONDENSATE VALVE PIT	13	CURB AROUND	NO	–
			ELECTRICAL SOUTH R-15	11	CURB AROUND	YES/ SX112-WST-JBX-101	–
			24" BUTTERFLY VALVE NORTH OF R-7	4	PAVE AROUND	NO	
			REBAR PLUG SOUTH OF R-8	6	PAVE OVER	NO	–
			PUMP PIT 241-SX-12A	12	PAVE AROUND	NO	–
			TRANSMITTER ENCLOSURE	6	PAVE OVER	NO	–
			VALVE NORTH OF R-6	–	2'ø STEEL PIPE	YES/ SX112-WST-V-101	–
			INSTRUMENT ENCLOSURE	1	UTILITY VAULT SIZE AS REQ'D	NO	–
			JUNCTION BOX WEST OF R15	4	PAVE AROUND	NO	–
			CONCRETE BOLLARD NORTH OF R14	4	PAVE AROUND	NO	–
			CONCRETE BOLLARD WEST OF R15	4	PAVE AROUND	NO	–
41-12-01		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-12-01	–
41-12-02		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-12-02	–
41-12-03		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-12-03	–
41-12-04		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-12-04	–
41-12-06		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-12-06	–
41-12-07		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-12-07	–
41-12-09		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-12-09	–
41-12-10		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-12-10	–

MAY 25 2011
DATE: STA: 3 HANFORD RELEASE ID: 3

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
NEXT USED ON	REFERENCES

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
	REVISIONS			

NAME	DATE	COMPANY
DRAWN BY GA SCHELL	1/2011	CGS
CHECKED ST FOSS	5/10/11	CGS
ENGINEER	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX SOUTH INTERIM SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0

SCALE AS SHOWN EDIT 824512 SHEET 12 OF

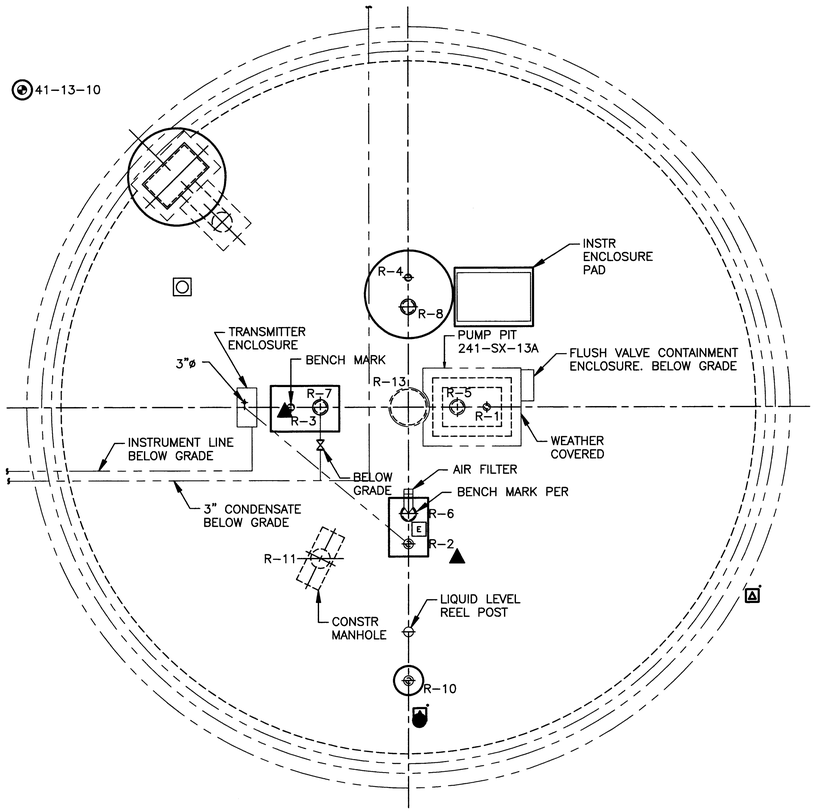
3730 DOE_TB_F.DWG (01-01)

REV 0 SH 12 OF DWG NO H-14-109330

NORTH

5 0 5 10 SCALE IN FEET

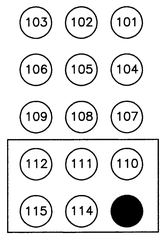
2 0 2 4 SCALE IN METERS



241-SX-113

RISER SUMMARY TABLE

RISER #	REF. ELEV. (FT)	SIZE (INCH)	FUNCITON/ DESCRIPTION	DETAIL	TYPE/ MODEL #	ACCESS REQ'D / LABEL	COMBINED W/RISER
R1		4	DRAIN IN PUMP PIT	12	–	NO	5
R2	663.51	4	ENRAF LIT	9	UTILITY VAULT 72"x48" (1EA) No. 64R-12	YES/ SX113-WST-LIT-101	6
R3	663.51	4	THERMOCOUPLE	9	UTILITY VAULT 84"x56" (1EA) No. 57R-12	YES/ SX113-WST-TE-101	7
R4	663.56	4	THERMOCOUPLE	14	9'ø CMP	NO	8
R5		12	PUMP	12	–	NO	1
R6	663.47	12	SPARE	9	UTILITY VAULT 72"x48" (1EA) No. 64R-12	YES/ SX113-WST-RISER-006	2
R7	663.51	12	OBSV PORT	9	UTILITY VAULT 84"x56" (1EA) No. 57R-12	YES/ SX113-WST-LG-101	3
R8	663.51	12	AIR LIFT CIRCULATORS	14	9ø CMP	NO	4
R10		6	TEMP RISER	14	3'ø CMP W/LID	YES/ SX113-WST-TE-102	–
R11	658.57	24	VAPOR LINE	6	PAVE OVER	NO	–
R13	663.01	42	DOME RISER	6	PAVE OVER	NO	–
			HATCHWAY	23	10'ø CMP	NO	–
			BOLLARD S. OF R10	4	PAVE AROUND	NO	–
			PUMP PIT 241-SX-13A	12	PAVE AROUND	NO	–
			TRANSMITTER ENCLOSURE	6	PAVE OVER	NO	–
			JUNCTION BOX S. OF R-10	4	PAVE AROUND	YES/ SX113-WST-JBX-101	–
			JUNCTION BOX NE OF R-10	4	PAVE AROUND	YES/ SX113-WST-JBX-102	–
			LIQUID LEVEL REEL POST	4	PAVE AROUND	YES/ SX113-WST-LIY-101	–
			INSTRUMENT ENCLOSURE PAD	9	UTILITY VAULT 104"x80" (1EA) No. 687-2	NO	
41-13-10		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-13-10	–
41-00-05		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-00-05	–



TANK FARM 241-SX

KEY PLAN

SCALE: NONE

LEGEND

- UTILITY POLE
- LIGHT POLE
- GUY WIRE
- JUNCTION BOX
- BOLLARD
- DRY WELLS
- SIGNS
- VALVE
- ELECTRICAL PULL BOX
- E — ELECTRICAL BOX
- P — PORTABLE SKID

NOTES: THIS SHEET ONLY

1. FOR DETAILS SEE SHEETS 16 THRU 20.

MAY 25 2011 DATE: STA: 3 HANFORD RELEASE ID: 3

NAME	DATE	COMPANY
DRAWN BY GA SCHELL	1/2011	CH2M
CHECKER SI Peck	5/10/11	CH2M
ENGINEER	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
SOUTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0

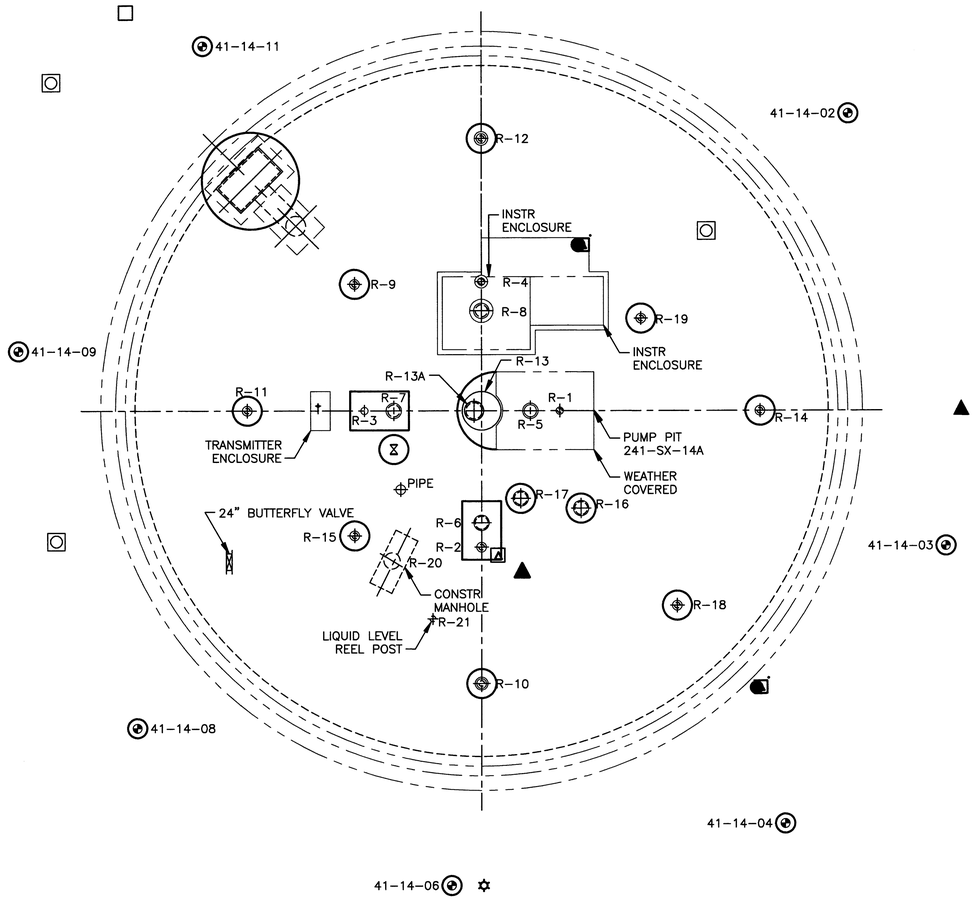
SCALE AS SHOWN | EDT 824512 | SHEET 13 OF

22939 | DOE_TB_F.DWG (01-01)

DWG NO	TITLE	REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		NEXT USED ON	REFERENCES

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
REVISIONS					

DWG NO H-14-109330 SH 13 OF REV 0



241-SX-114

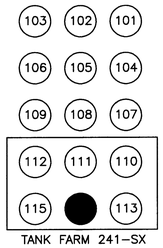
NORTH

SCALE IN FEET (5 0 5 10)

SCALE IN METERS (2 0 2 4)

RISER SUMMARY TABLE

RISER #	REF. ELEV. (FT)	SIZE (INCH)	FUNCITON/ DESCRIPTION	DETAIL	TYPE/ MODEL #	ACCESS REQ'D / LABEL	COMBINED W/RISER
R1		4	DRAIN IN PUMP PIT	12	–	NO	5
R2	662.38	4	ENRAF LIT	9	UTILITY VAULT 72"x48" (1EA) No. 64R-12	YES/ SX114-WST-LIT-101	6
R3	662.30	4	THERMOCOUPLE	9	UTILITY VAULT 72"x48" (1EA) No. 64R-18	YES/ SX114-WST-TE-101	7
R4		4	THERMOCOUPLE	1	UTILITY VAULT SIZE AS REQ'D	NO	8
R5		12	PUMP	12	–	NO	1
R6	662.41	12	EMERGENCY SPRINKLER	9	UTILITY VAULT 72"x48" (1EA) No. 64R-12	YES/ SX114-WST-RW-101	2
R7	662.26	12	SPARE	9	UTILITY VAULT 72"x48" (1EA) No. 64R-18	YES/ SX114-WST-RISER-007	3
R8		12	AIR CIRCULATOR	1	UTILITY VAULT SIZE AS REQ'D	NO	4
R9	663.68	2 1/2	THERMOCOUPLE #1	14	3'ø CMP	NO	–
R10	663.85	2 1/2	THERMOCOUPLE #2	14	3'ø CMP	NO	–
R11	663.29	2 1/2	THERMOCOUPLE #3	14	3'ø CMP	NO	–
R12	663.87	2 1/2	THERMOCOUPLE #4	14	3'ø CMP	NO	–
R13		42	RISER ADAPTER	3	9'-8" CONTECH LINER	YES/ SX114-WST-RISER-014	13A
R13A		20	BREATHER FILTER	3	9'-8" CONTECH LINER	YES/ SX114-WST-FLT-101	13
R14	664.19	2 1/2	THERMOCOUPLE #5	14	3'ø CMP	NO	–
R15	663.59	2 1/2	THERMOCOUPLE #6	14	3'ø CMP	NO	–
R16	663.63	12	SPARE W/SHIELDING PLUG	14	3'ø CMP W/LID	YES/ SX114-WST-RISER-016	–
R17	663.66	12	OBSV PORT	14	3'ø CMP W/LID	YES/ SX114-WST-LG-101	–
R18	664.29	2 1/2	THERMOCOUPLE #7	14	3'ø CMP	NO	–
R19	663.81	2 1/2	THERMOCOUPLE #8	14	3'ø CMP	NO	–
R20	657.67	24	EXHAUSTER PORT	6	PAVE OVER	NO	–
R21		4	PORT	4	PAVE AROUND	NO	–
			LIQUID LEVEL REEL POST	4	PAVE AROUND	NO	–
			24" BUTTERFLY VALVE	4	PAVE AROUND	NO	–
			HATCHWAY	23	10'ø CMP	NO	–
			JUNCTION BOX SE CORNER	4	PAVE AROUND	NO	–
			JUNCTION BOX EAST OF R-4	4	PAVE AROUND	NO	–
			VALVE SOUTH OF R-7	–	2'ø STEEL PIPE	YES/ SX114-WST-V-101	–
			TRANSMITTER ENCLOSURE	6	PAVE OVER	NO	–
			PUMP PIT 241-SX-14A	12	PAVE AROUND	NO	–
			INSTRUMENT ENCLOSURE	1	UTILITY VAULT SIZE AS REQ'D	NO	–
			CONCRETE BOLLARD SE CORNER	4	PAVE AROUND	NO	–
			CONCRETE BOLLARD E OF R4	4	PAVE AROUND	NO	–
41-14-02		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-14-02	–
41-14-03		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-14-03	–
41-14-04		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-14-04	–
41-14-06		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-14-06	–
41-14-08		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-14-08	–
41-14-09		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-14-09	–
41-14-11		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-14-11	–



TANK FARM 241-SX

KEY PLAN

SCALE: NONE

LEGEND

- UTILITY POLE
- LIGHT POLE
- GUY WIRE
- JUNCTION BOX
- BOLLARD
- DRY WELLS
- SIGNS
- VALVE
- ELECTRICAL PULL BOX
- E — ELECTRICAL BOX
- P — PORTABLE SKID

NOTES: THIS SHEET ONLY

1. FOR DETAILS SEE SHEETS 16 THRU 20.

MAY 25 2011 DATE: STA: 3 HANFORD RELEASE ID: 3

DWG NO	TITLE	REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
REVISIONS					

NAME	DATE	COMPANY
DRAWN BY CA SCHELL	1/2011	CGS
CHECKER JT Pope	5/10/11	CGS
ENGINEER	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
SOUTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0

SCALE AS SHOWN | EDT 824512 | SHEET 14 OF

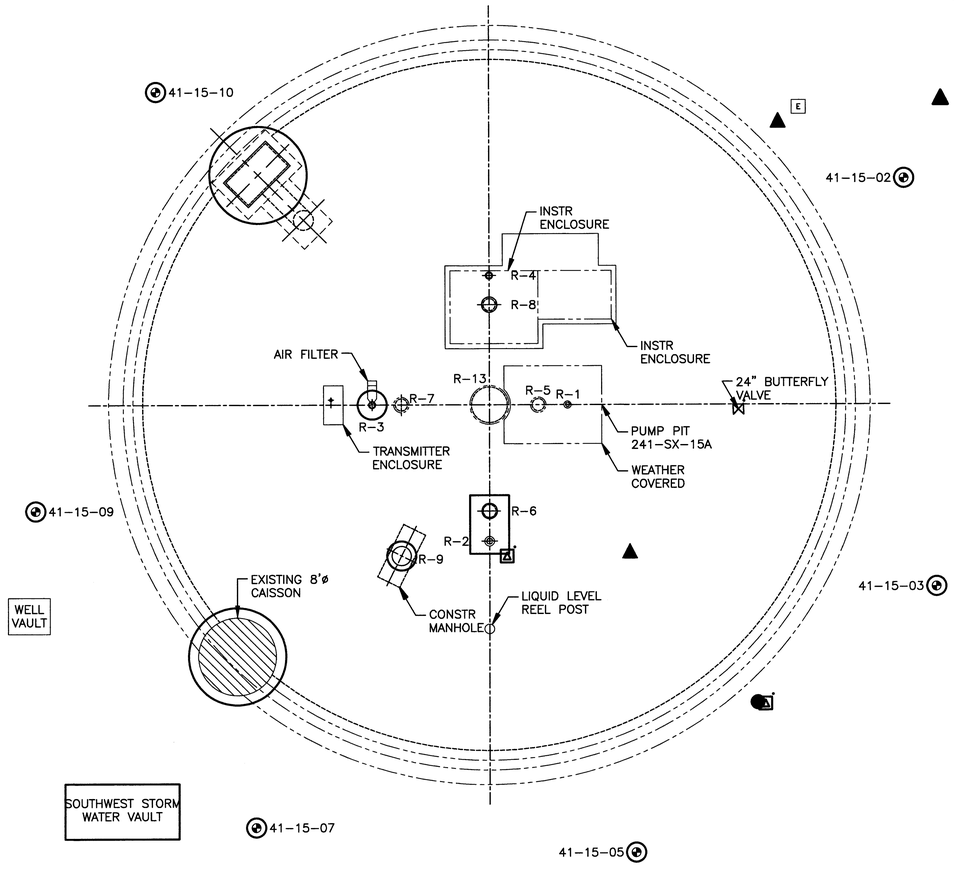
29962 | DOE_TB_F.DWG (01-01)

DWG NO H-14-109330 SH 14 OF REV 0

NORTH

5 0 5 10 SCALE IN FEET

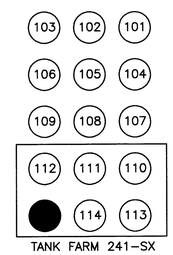
2 0 2 4 SCALE IN METERS



241-SX-115

RISER SUMMARY TABLE

RISER #	REF. ELEV. (FT)	SIZE (INCH)	FUNCITON/ DESCRIPTION	DETAIL	TYPE/ MODEL #	ACCESS REQ'D / LABEL	COMBINED W/RISER
R1		4	DRAIN IN PUMP PIT	12	–	NO	5
R2	661.39	4	ENRAF LIT	9	UTILITY VAULT 72"x48" (1EA) No. 64R-12	YES/ SX115-WST-LIT-101	6
R3	661.41	4	AIR FILTER	14	3'ø CMP	YES/ SX115-WST-TE-101	–
R4		4	THERMOCOUPLE	1	UTILITY VAULT SIZE AS REQ'D	NO	8
R5		12	PUMP	12	–	NO	1
R6	661.38	12	OBSV PORT	9	UTILITY VAULT 72"x48" (1EA) No. 64R-12	YES/ SX115-WST-LG-101	2
R7		12	–	6	PAVE OVER	NO	–
R8		12	AIR LIFT CIRCULATOR	1	UTILITY VAULT SIZE AS REQ'D		4
R9	656.67	24	VAPOR MANIFOLD	6	PAVE OVER	NO	–
R13		42	–	6	PAVE OVER	NO	–
			HATCHWAY	23	10'ø CMP	NO	–
			CONCRETE BOLLARD SE CORNER	4	PAVE AROUND	NO	–
			24" BUTTERFLY VALVE EAST OF PUMP PIT	4	PAVE AROUND	NO	–
			EXISTING CAISSON SW CORNER	27	10'ø CMP	YES/	–
			PUMP PIT 241-SX-15A	12	PAVE AROUND	NO	–
			TRANSMITTER ENCLOSURE	6	PAVE OVER	NO	–
			LIQUID LEVEL REEL POST	4	PAVE AROUND	YES/ SX115-WST-LIY-101	–
			INSTRUMENT ENCLOSURE	1	UTILITY VAULT SIZE AS REQ'D	NO	–
			JUNCTION BOX SE CORNER	4	PAVE AROUND	NO	–
			WELL VAULT	9	UTILITY VAULT 90"x60" (2EA) No. 576R-12	YES/	–
41-15-02		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-15-02	–
41-15-03		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-15-03	–
41-15-05		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-15-05	–
41-15-07		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-15-07	–
41-15-09		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-15-09	–
41-15-10		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-15-10	–



TANK FARM 241-SX

KEY PLAN

SCALE: NONE

LEGEND	
	UTILITY POLE
	LIGHT POLE
	GUY WIRE
	JUNCTION BOX
	BOLLARD
	DRY WELLS
	SIGNS
	VALVE
	ELECTRICAL PULL BOX
E	ELECTRICAL BOX
P	PORTABLE SKID

NOTES: THIS SHEET ONLY

1. FOR DETAILS SEE SHEETS 16 THRU 20.

MAY 25 2011 DATE: STA: 3 HANFORD RELEASE ID: 3

NAME	DATE	COMPANY
DRAWN BY GA SCHELL	1/2011	CCES
REVIEWED M POSK	5/10/11	CCES
ENGINEER	5/11	

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX SOUTH INTERIM SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0

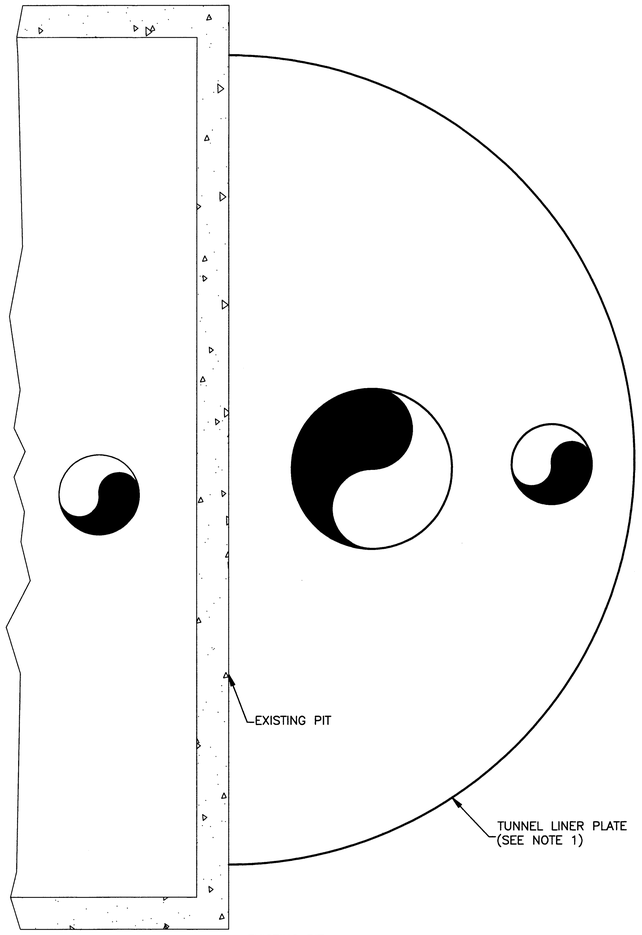
SCALE AS SHOWN | EDT 824512 | SHEET 15 OF

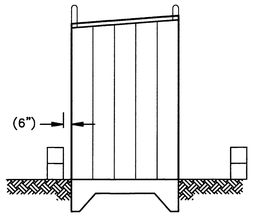
4210 DOE_TB_F.DWG (01-01)

DWG NO H-14-109330 SH 15 OF REV 0

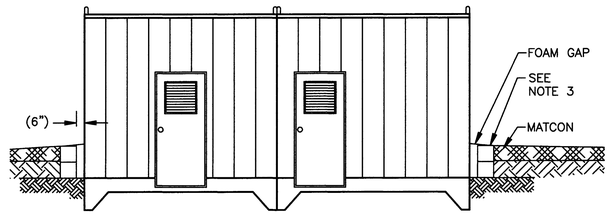
DWG NO	TITLE	REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

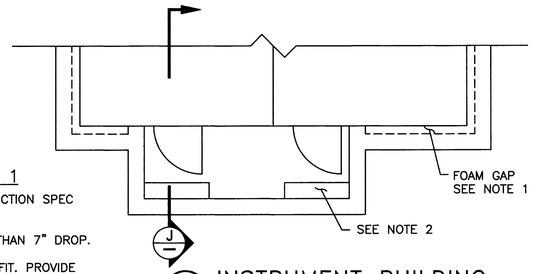
MFD REV REL	REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
REVISIONS					





J DETAIL SECTION
SCALE: N.T.S.

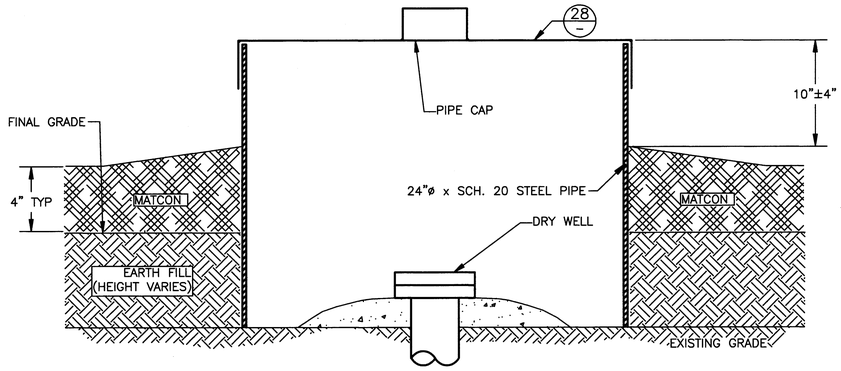




1 INSTRUMENT BUILDING
SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 1

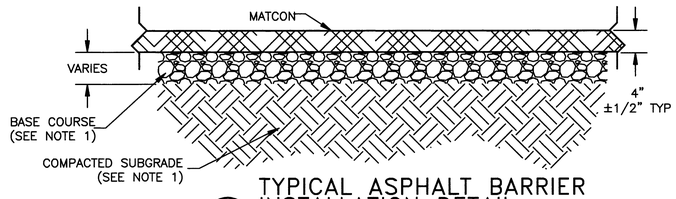
1. APPLY FOAM TO AREA PER CONSTRUCTION SPEC B-222-C1
2. PROVIDE ACCESS STEP IF GREATER THAN 7" DROP.
3. CUT AND STACK UTILITY VAULTS TO FIT. PROVIDE MINIMUM 6" CLEARANCE.
4. GRADE ASPHALT TO DRAIN AWAY FROM FACE OF VAULT, APPROXIMATE BUILD UP SHOWN. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP-SPEC-49086



2 DRYWELL PIPE PENETRATION
SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 2

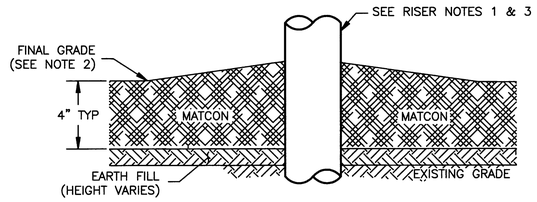
1. SEE RISER SUMMARY TABLE FOR EACH TANK FOR SPECIFIC EXISTING INFORMATION REGARDING TANK PENETRATIONS. FIELD VERIFY ELEVATIONS.
2. GRADE ASPHALT TO DRAIN AWAY FROM TANK ELEMENT, APPROXIMATE BUILD UP SHOWN. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP-SPEC-49086.
3. REMOVE EXISTING VALVE BOX CHIP AWAY OR REMOVE CONCRETE SLEEVE AS REQUIRED TO ALLOW FOR FRAME ASSEMBLY PLACEMENT.
4. MARK IDENTIFICATION OF DRY WELL NUMBER, ETC., USING 1" MINIMUM HIGH LETTERING, COLOR CONTRAST TO COVER, LOCATED SO IT IS PLAINLY VISIBLE. SEE RISER SUMMARY TABLE FOR WELL NUMBER.
5. CONTRACTOR SHALL PAINT ALL SURFACES OF NEW INSTALLATIONS (INCLUDING LIDS/COVER) ABOVE FINAL GRADE. PAINT APPLIED TO ALL SURFACES SHALL BE POLYURETHANE BASED (DURABAK 18, SMOOTH VERSION, COLOR: SAFETY YELLOW; OR APPROVED EQUAL). PREPARE SUBSTRATE SURFACES IN ACCORDANCE WITH MANUFACTURER'S REPRESENTATIVE'S RECOMMENDATIONS.



6 TYPICAL ASPHALT BARRIER INSTALLATION DETAIL
SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 6

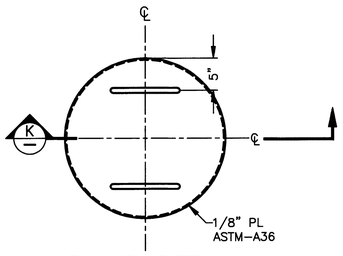
1. COMPACT IN ACCORDANCE WITH RPP-SPEC-49086.



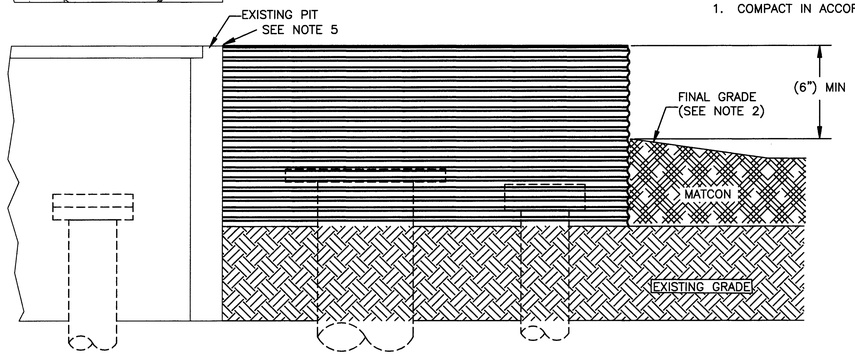
4 PAVE UP TO TANK ELEMENT DETAIL
SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 4

1. SEE RISER SUMMARY TABLE FOR EACH TANK FOR SPECIFIC EXISTING INFORMATION REGARDING TANK PENETRATIONS. FIELD VERIFY PENETRATIONS.
2. GRADE ASPHALT TO DRAIN AWAY FROM TANK ELEMENT, APPROXIMATE BUILD UP SHOWN. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP-SPEC-49086.



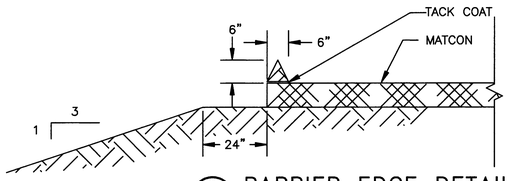
28 LID DETAIL
SCALE: N.T.S.



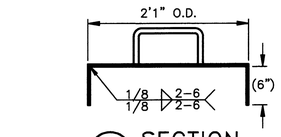
3 TANK RISER CONTECH PENETRATION
SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 3

1. THE NUMBER AND SIZE OF TANK RISERS REQUIRING A CONTECH TUNNEL LINER PLATE VARIES. SEE RISER SUMMARY TABLE, FOR EACH TANK, FOR SPECIFIC EXISTING INFORMATION REGARDING TANK PENETRATIONS REQUIRING A CONTECH LINER. FIELD VERIFY PENETRATIONS REQUIRING A CONTECH TUNNEL LINER PLATE. SUBSTITUTIONS FOR CONTECH TUNNEL LINER PLATE ARE ACCEPTABLE WITH BUYER APPROVAL.
2. GRADE ASPHALT TO DRAIN AWAY FROM TUNNEL LINER PLATE, APPROXIMATE BUILD UP SHOWN. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP-SPEC-49086.
3. CONTRACTOR SHALL PAINT ALL SURFACES OF NEW INSTALLATIONS (INCLUDING LIDS/COVER) ABOVE FINAL GRADE. PAINT APPLIED TO ALL SURFACES SHALL BE POLYURETHANE BASED (DURABAK 18, SMOOTH VERSION, COLOR: SAFETY YELLOW; OR APPROVED EQUAL). PREPARE SUBSTRATE SURFACES IN ACCORDANCE WITH MANUFACTURER'S REPRESENTATIVE'S RECOMMENDATIONS.
4. REMOVE FOAM FROM PIT WHERE LINER INTERSECTS PIT. REAPPLY WEATHER BARRIER TO PIT UPON COMPLETION PER CONSTRUCTION SPEC. B-222-C1.
5. MARK IDENTIFICATION OF RISER NUMBER, ETC., USING 1" MINIMUM HIGH LETTERING, COLOR BLACK, LOCATED SO IT IS PLAINLY VISIBLE.
6. BREAK AND DEBUR ALL SHARP EDGES. INSTALL TRIM-LOK EDGE GUARD ALONG EDGE.



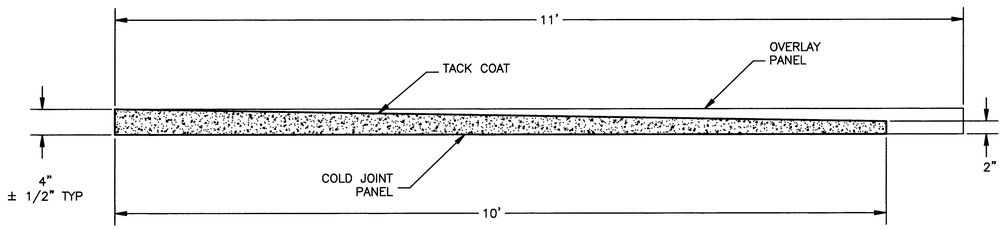
7 BARRIER EDGE DETAIL
2 SCALE: N.T.S.



K SECTION
SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 18

1. ENSURE LID DOES NOT BIND ON 24"ø PIPE.



5 TYPICAL COLD JOINT DETAIL
SCALE: N.T.S.

MAY 25 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHECKED BY DATE	ENGR	COMPANY
REVISIONS					

NAME	DATE	COMPANY
DRAWN BY JGC	1/11	CCES
JT Foss	5/11	CCES
ENGINEER MS Hahn	5/11	Waps

U.S. DEPARTMENT OF ENERGY
Office of River Protection

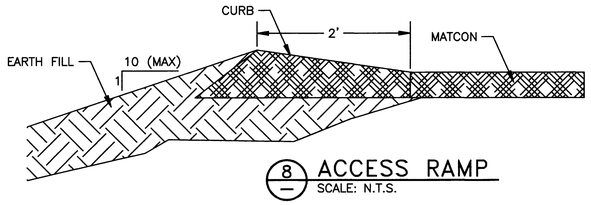
241-SX
SOUTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0

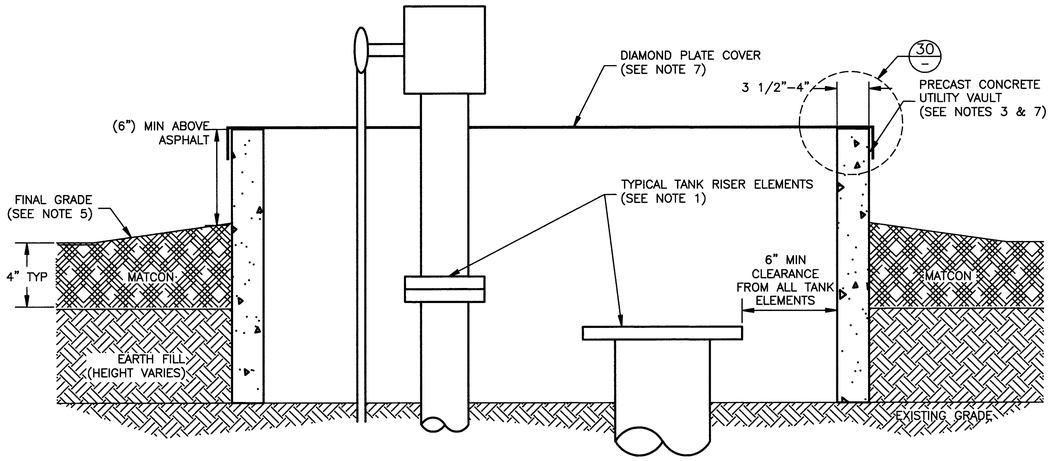
SCALE AS SHOWN | EDT 824512 | SHEET 16 OF

DWG NO H-14-109330 | SH 16 OF | REV 0

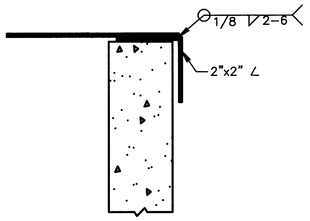
10709 DOE_TB_F.DWG (01-01)



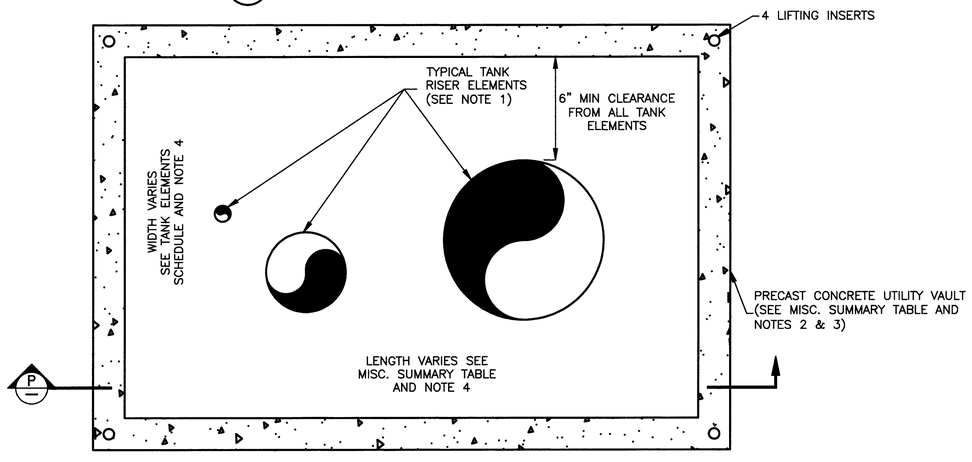
8 ACCESS RAMP
SCALE: N.T.S.



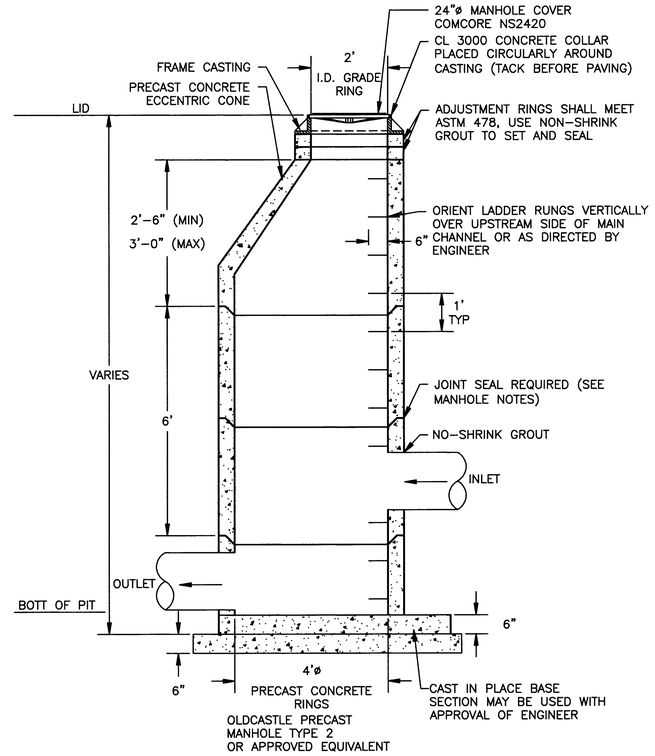
P SECTION
SCALE: N.T.S.



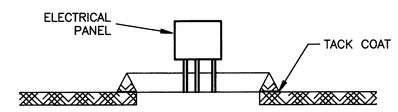
30 COVER DETAIL
SCALE: N.T.S.



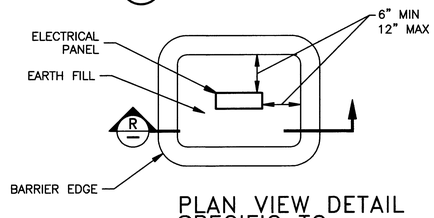
PLAN VIEW DETAIL
TANK ELEMENT UTILITY
VAULT LINER PENETRATION
9
SCALE: N.T.S.



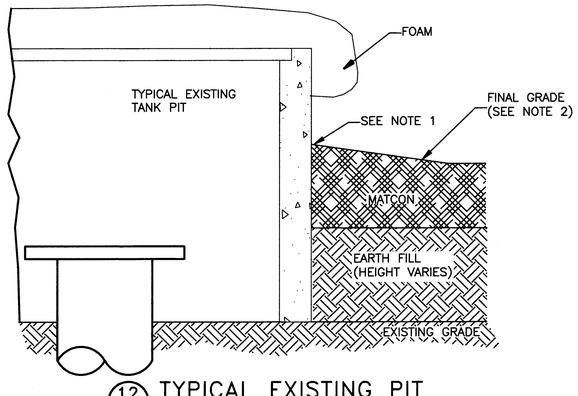
10 STANDARD MANHOLE
8
SCALE: N.T.S.



R DETAIL SECTION
SCALE: N.T.S.



PLAN VIEW DETAIL
SPECIFIC TO
ELECTRICAL PANELS
11
SCALE: N.T.S.



12 TYPICAL EXISTING PIT
SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 9

1. THE NUMBER AND SIZE OF TANK ELEMENTS (RISERS AND OTHER APPURTENANCES) WITHIN EACH VAULT VARIES. SEE RISER SUMMARY TABLE FOR EACH TANK IDENTIFYING THE NUMBER OF TANK PENETRATIONS WITHIN EACH VAULT.
2. FIELD VERIFY THAT SPECIFIED VAULT SIZE PROVIDES REQUIRED MINIMUM CLEARANCE AROUND TANK ELEMENTS. NOTIFY BUYER OF REQUIRED VAULT DIMENSION MODIFICATIONS (LARGER OR SMALLER) AS A RESULT OF FIELD MEASUREMENTS.
3. PRECAST CONCRETE UTILITY VAULT SHALL BE OF SIZE AND TYPE SHOWN ON RISER SUMMARY TABLE UNLESS AS DESCRIBED IN NOTE 2 AND APPROVED BY BUYER. DIMENSIONS SHOWN IN RISER SUMMARY TABLE ARE EXTERNAL. CONTRACTOR MAY ELECT TO PROVIDE EQUIVALENT CAST–IN–PLACE CONCRETE VAULT WITH BUYER APPROVAL.
4. PROVIDED DIMENSIONS SHOWN BY SPECIFIED MODEL TYPE IN RISER OR MISC. SUMMARY TABLE. ALL DIMENSIONS SHALL BE FIELD VERIFIED PRIOR TO ORDER AND SHIPMENT TO PROJECT SITE.
5. GRADE ASPHALT TO DRAIN AWAY FROM TANK ELEMENT, APPROXIMATE BUILD UP SHOWN. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP–SPEC–49086.
6. CONTRACTOR SHALL PAINT ALL SURFACES OF NEW INSTALLATIONS (INCLUDING LIDS/COVER) ABOVE FINAL GRADE. PAINT APPLIED TO ALL SURFACES SHALL BE POLYURETHANE BASED (DURABAK 18, SMOOTH VERSION, COLOR: SAFETY YELLOW; OR APPROVED EQUAL). PREPARE SUBSTRATE SURFACES IN ACCORDANCE WITH MANUFACTURER'S REPRESENTATIVE'S RECOMMENDATIONS.
7. PROVIDE COMPATIBLE SIZE VAULT COVER. COVER SHALL BE MINIMUM 1/4" THICK ALUMINUM DIAMOND PLATE. ATTACHED COVER TO VAULT WITH MINIMUM OF 2 BOLTS. NOTCH OR CUT COVER TO ALLOW FOR VAULT PENETRATIONS. WHERE INSERTS ARE REQUIRED, USE FASTENAL 50402 ANCHOR BOLTS OR EQUIVALENT. COVER SHALL OVERLAP UTILITY VAULT. PROVIDE CLEAR ACCESS TO BENCHMARKS.
8. MARK IDENTIFICATION OF RISER NUMBER, ETC., USING 1" MINIMUM HIGH LETTERING, COLOR BLACK, LOCATED SO IT IS PLAINLY VISIBLE.

NOTES: APPLIES TO DETAIL 12

1. REMOVE FOAM FROM PIT WALL WHERE BARRIER EDGE INTERSECTS PIT. REAPPLY FOAM TO PIT UPON COMPLETION PER CONSTRUCTION SPEC. B–222–C1.
2. GRADE MATCON TO DRAIN AWAY FROM TANK ELEMENT, APPROXIMATE BUILD UP SHOWN. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP–SPEC–49086.

DWG NO	TITLE	REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON JGC	

REV NO	DESCRIPTION	REV BY DATE	CHECKED BY DATE	ENGR COMPANY
REVISIONS				

NAME	DATE	COMPANY
DRAWN BY JGC	1/11	CRCS
STFOSS	5/16/11	CRCS
ENGINEER	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

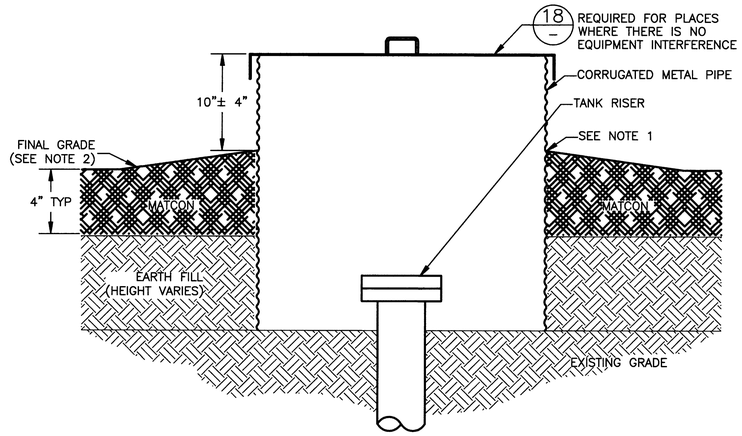
241–SX
SOUTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H–14–109330	0
SCALE AS SHOWN	EDT	824512	SHEET 17	OF

17894 DOE_TB_F.DWG (01–01)

MAY 25 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

DWG NO H–14–109330 SH 17 OF REV 0

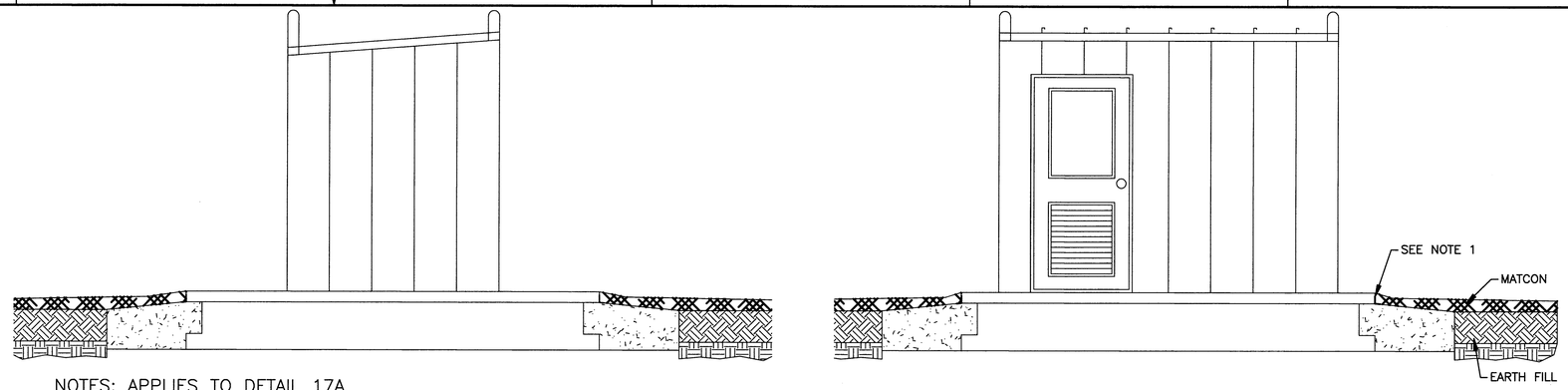


DETAIL FOR THE CMP TANK RISER PIPE SLEEVE PENETRATION

14 — SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 14

1. SEE RISER SUMMARY TABLE FOR EACH TANK FOR SPECIFIC EXISTING INFORMATION REGARDING TANK PENETRATIONS. FIELD VERIFY ELEVATIONS.
2. GRADE MATCON TO DRAIN AWAY FROM COVER. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP–SPEC–49086.
3. CONTRACTOR SHALL PAINT ALL SURFACES OF NEW INSTALLATIONS (INCLUDING LIDS/COVER) ABOVE FINAL GRADE. PAINT APPLIED TO ALL SURFACES SHALL BE POLYURETHANE BASED (DURABAK 18, SMOOTH VERSION, COLOR: SAFETY YELLOW; OR APPROVED EQUAL). PREPARE SUBSTRATE SURFACES IN ACCORDANCE WITH MANUFACTURER'S REPRESENTATIVE'S RECOMMENDATIONS.

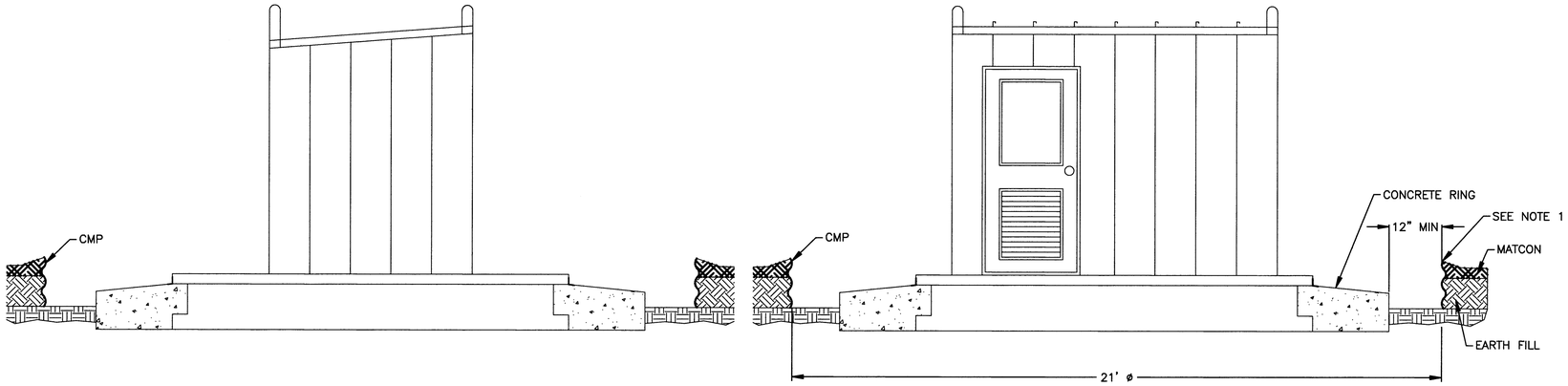


NOTES: APPLIES TO DETAIL 17A

1. SEAL INTERFACE BETWEEN MATCON AND CHANNEL APPLIED PER RPP–SPEC–49086 AND PER MANUFACTURERS RECOMMENDATIONS.
2. GRADE MATCON TO DRAIN AWAY FROM BUILDING.
3. ELEVATION OF MATCON VARIES PER LEAK DETECTION BUILDING.

17A/10 LEAK DETECTION BUILDING

SCALE: N.T.S.

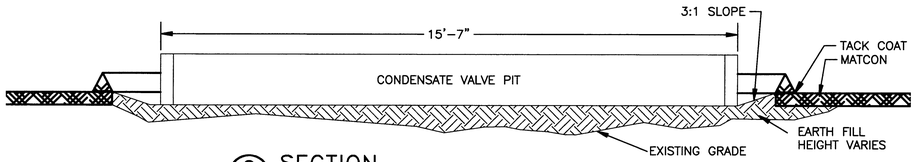


NOTES: APPLIES TO DETAIL 17B

1. USE THIS OPTION IF SUBGRADE ELEVATION IS HIGHER THAN THE OUTER CORNER OF THE EXISTING CONCRETE RING.
2. SEAL INTERFACE BETWEEN MATCON AND CMP APPLIED PER RPP–SPEC–49086 AND PER MANUFACTURERS RECOMMENDATIONS.
3. GRADE MATCON TO DRAIN AWAY FROM CMP.
4. BREAK AND DEBUR ALL SHARP EDGES. INSTALL TRIM–LOK EDGE GUARD ALONG EDGE.

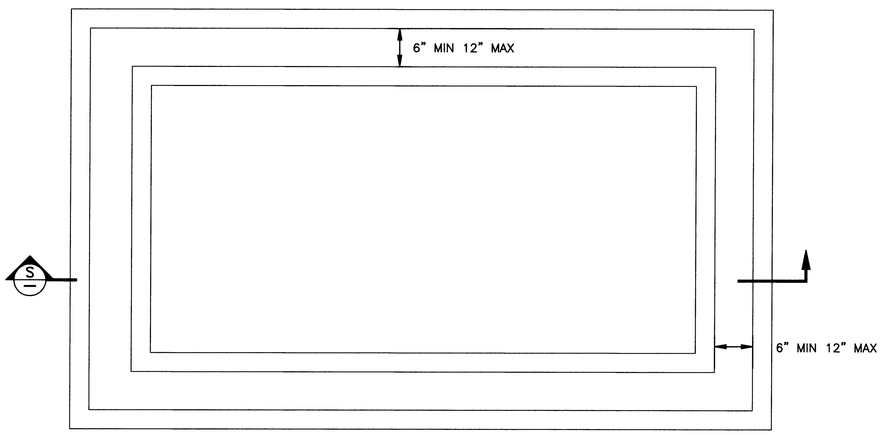
17B/10 LEAK DETECTION BUILDING OPTION

SCALE: N.T.S.



S/– SECTION

SCALE: N.T.S.

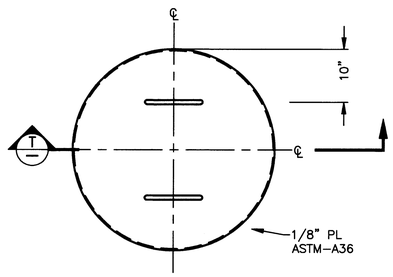


PLAN VIEW

13/– SPECIFIC TO TANK 112

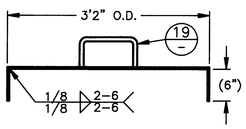
SCALE: N.T.S.

1. SIZE PER CONDENSATE VALVE BOX DIMENSIONS



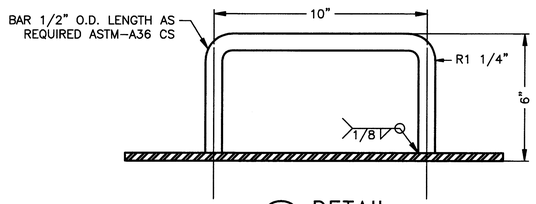
18/– LID DETAIL

SCALE: N.T.S.



T/– SECTION

SCALE: N.T.S.



19/– DETAIL

SCALE: N.T.S.

MAY 25 2011 — DATE: — STA: 3 — HANFORD RELEASE — ID: 3

DWG NO	TITLE	REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		NEXT USED ON	REFERENCES

MFD	REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
REV REL		REVISIONS				

NAME	DATE	COMPANY
DRAWN BY JGC	1/11	CGRS
CHECKED	5/6/11	CGRS
ENGINEER	5/11	

U.S. DEPARTMENT OF ENERGY
Office of River Protection

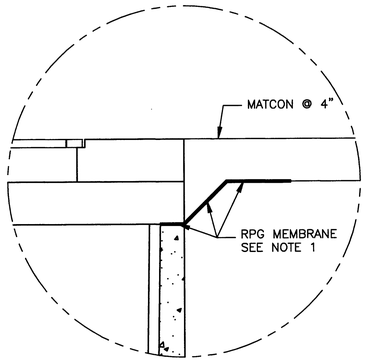
241–SX SOUTH INTERIM SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H–14–109330	0

SCALE AS SHOWN | EDT 824512 | SHEET 18 OF

21811 | DOE_TB_F.DWG (01–01)

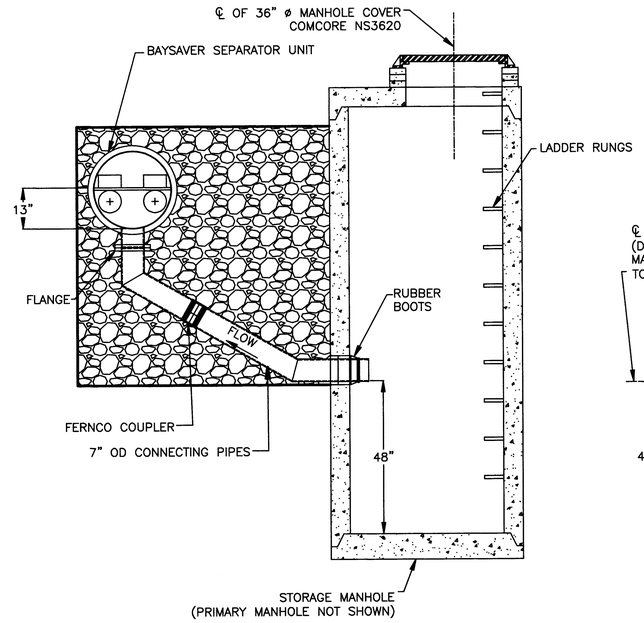
DWG NO H–14–109330 | SH 18 OF | REV 0



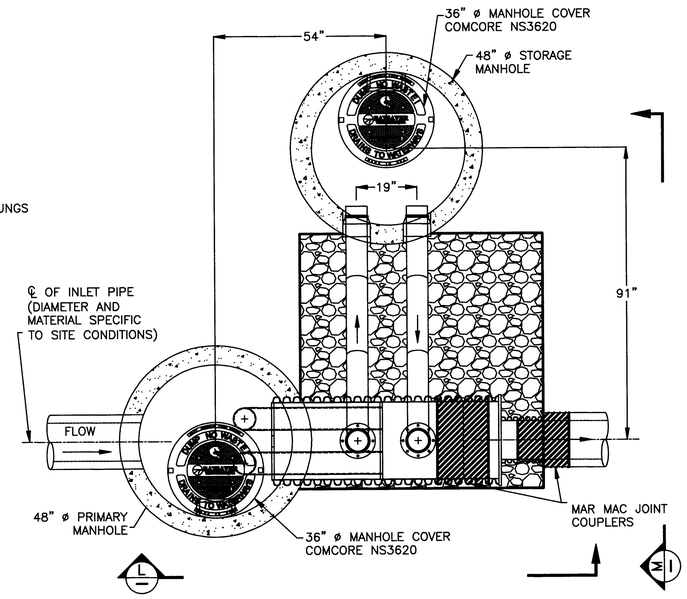
NOTES:

1. PLACE LOWER WEDGE OF MATCON PRIOR TO THE 4" FINAL LIFT AS A "LEVELING WEDGE".
2. LOWER WEDGE TO BE COMPACTED USING A SMALL ROLLER AND/OR PLATE COMPACTOR.
3. APPLY APPLICATION OF THE FFAS PRIOR TO PLACEMENT OF THE FINAL 4" MATCON LAYER ON THE LEVELING WEDGE SURFACE.
4. SEAL JOINT BETWEEN MATCON AND BOX EDGE USING FFAS.
5. TACK COAT 12" FROM EDGE OF BOX BRUSH COAT FFAS ON JOINT.

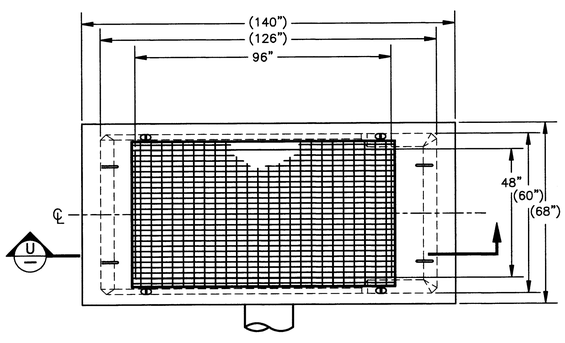
25/– MEMBRANE DETAIL
SCALE: N.T.S.



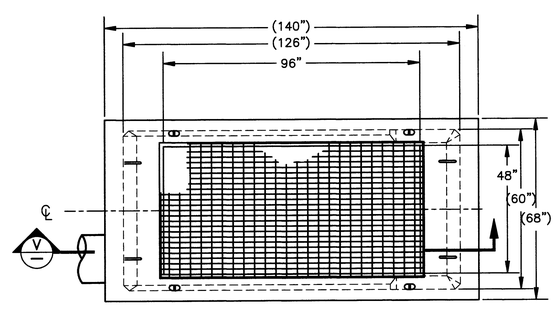
M/– PROFILE VIEW
SCALE: N.T.S.



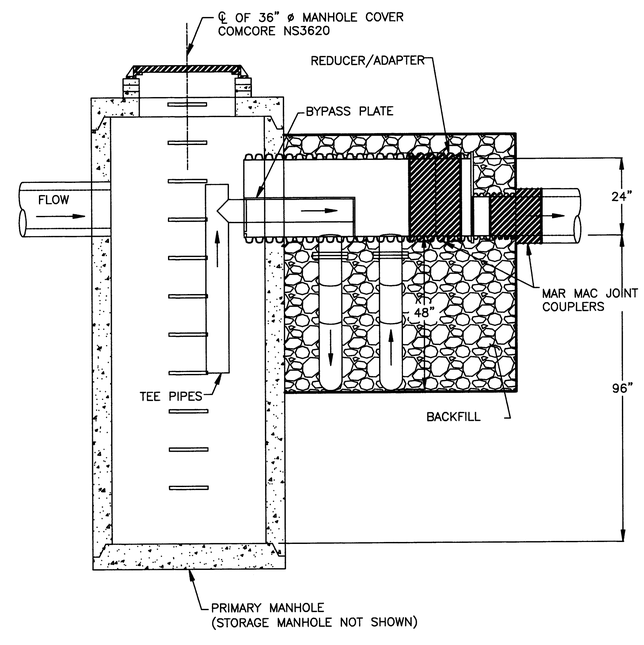
PLAN VIEW-BAYSAVER SEPARATION SYSTEM
(LEFT HAND ORIENTATION SHOWN)



15/8 STORAGE WATER INLET BOX 1 DETAIL
SCALE: 1" = 2'

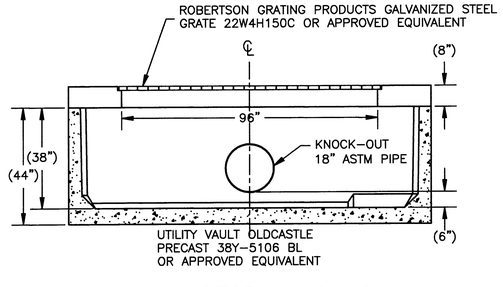


16/9 STORAGE WATER INLET BOX 2 DETAIL
SCALE: 1" = 2'

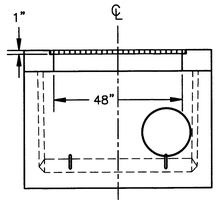


L/– PROFILE VIEW
SCALE: N.T.S.

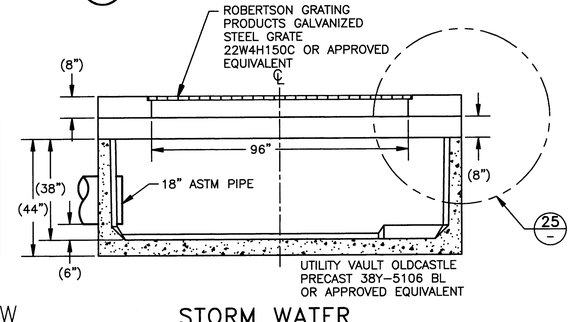
21/8 SEDIMENT CLEAN OUT
SCALE: N.T.S.



U/– STORAGE WATER INLET BOX 1
SCALE: 1" = 2'



TYPICAL END VIEW



V/– STORAGE WATER INLET BOX 2 W/ GRADE RING
SCALE: 1" = 2'

NOTE: APPLIES TO DETAIL 15 AND 16

1. LIFT IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS.

MAY 25 2011
DATE: STA: 3 HANFORD RELEASE ID: 3

DWG NO	TITLE	REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		NEXT USED ON	REFERENCES

REV NO	DESCRIPTION	REV BY DATE	CHECKED BY DATE	ENGR
REVISIONS				

NAME	DATE	COMPANY
DRAWN BY JGC	1/11	CCES
JT FOSS	5/10/11	CCES
ENGINEER	5/11	WRPS

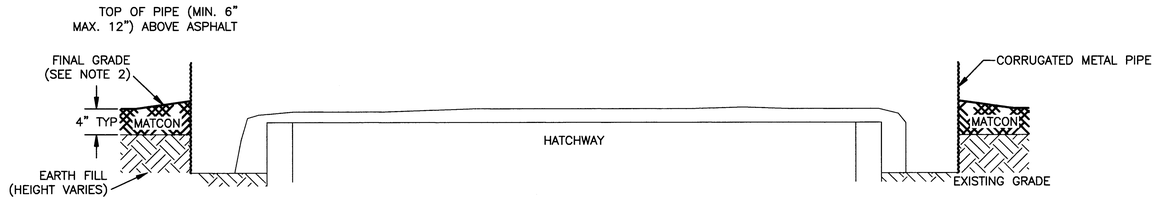
U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
SOUTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109330	0
SCALE AS SHOWN	EDT 824512		SHEET 19 OF	

30459 1 DOE_TB_F.DWG (01-01)

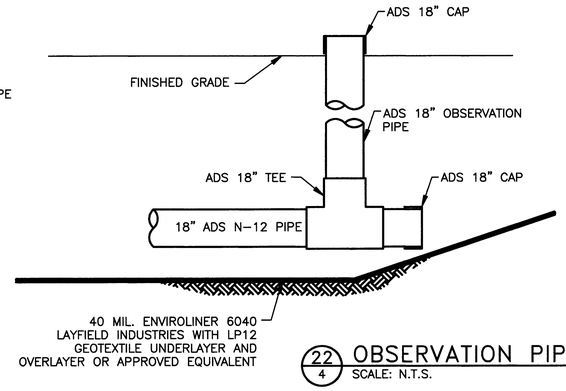
DWG NO H-14-109330 SH 19 OF REV 0



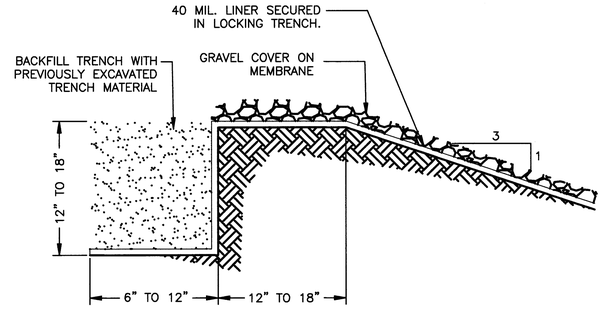
23/— DETAIL FOR THE CMP HATCHWAY
SCALE: N.T.S.

NOTES:

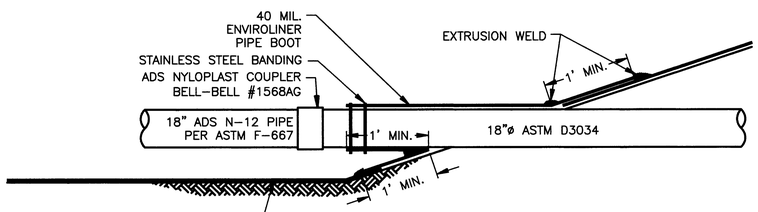
1. SEE ACCESS REQUIREMENT SHEET FOR TANKS 107–115 FOR LOCATION
2. GRADE ASPHALT TO DRAIN AWAY FROM TANK ELEMENT, APPROXIMATE BUILD UP SHOWN. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP–SPEC–49086.
3. BREAK AND DEBUR ALL SHARP EDGES. INSTALL TRIM–LOK EDGE GUARD ALONG EDGE



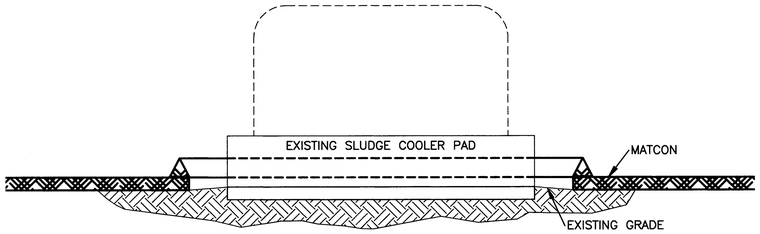
22/4 OBSERVATION PIPE
SCALE: N.T.S.



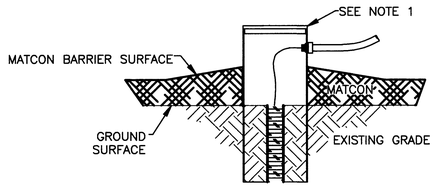
20/4,5 LOCKING TRENCH DETAIL
SCALE: 1" = 1'



N/4 PIPE PENETRATION
SCALE: N.T.S.



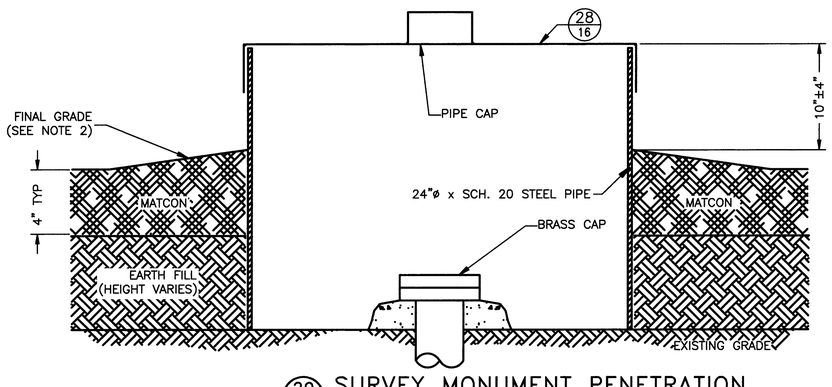
26/2 SECTION
SCALE: N.T.S.



24/2 MONITORING INSTRUMENT INSTALLATION DATA STATION #1 ONLY (2 PLACES)
SCALE: 1"=10'

NOTES:

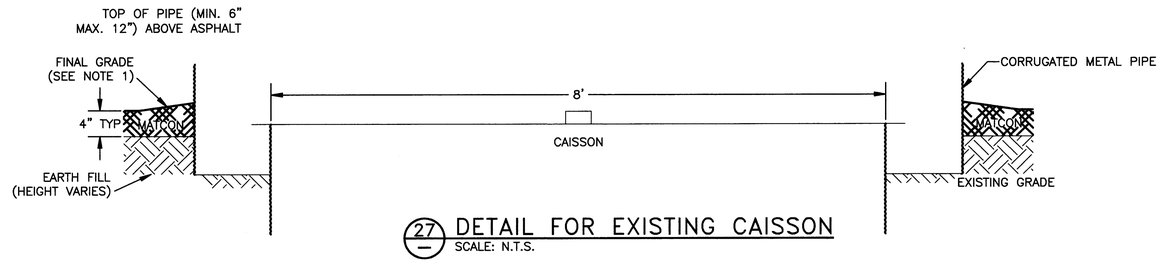
1. PROTECTIVE CASING AND CAP PROVIDED BY OTHERS
2. DETAILS PROVIDED BY OTHERS. SEE H–14–109447



29/— SURVEY MONUMENT PENETRATION
SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 29

1. FIELD VERIFY ELEVATIONS.
2. GRADE ASPHALT TO DRAIN AWAY FROM TANK ELEMENT, APPROXIMATE BUILD UP SHOWN. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP–SPEC–49086.
3. MARK IDENTIFICATION OF SURVEY MONUMENT NUMBER, ETC., USING 1" MINIMUM HIGH LETTERING, COLOR CONTRAST TO COVER, LOCATED SO IT IS PLAINLY VISIBLE. SEE RISER SUMMARY TABLE FOR WELL NUMBER.
4. CONTRACTOR SHALL PAINT ALL SURFACES OF NEW INSTALLATIONS (INCLUDING LIDS/COVER) ABOVE FINAL GRADE. PAINT APPLIED TO ALL SURFACES SHALL BE POLYURETHANE BASED (DURABAK 18, SMOOTH VERSION, COLOR: SAFETY YELLOW; OR APPROVED EQUAL). PREPARE SUBSTRATE SURFACES IN ACCORDANCE WITH MANUFACTURER'S REPRESENTATIVE'S RECOMMENDATIONS.



27/— DETAIL FOR EXISTING CAISSON
SCALE: N.T.S.

NOTES:

1. GRADE ASPHALT TO DRAIN AWAY FROM TANK ELEMENT, APPROXIMATE BUILD UP SHOWN. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP–SPEC–49086.
2. BREAK AND DEBUR ALL SHARP EDGES. INSTALL TRIM–LOK EDGE GUARD ALONG EDGE

MAY 25 2011 DATE: STA: 3 HANFORD RELEASE ID: 3

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
NEXT USED ON	REFERENCES

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
	REVISIONS				

NAME	DATE	COMPANY
DRAWN BY UGC	1/13	CCES
CHECKER	5/16/11	CCES
ENGINEER	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241–SX
SOUTH INTERIM
SURFACE BARRIER

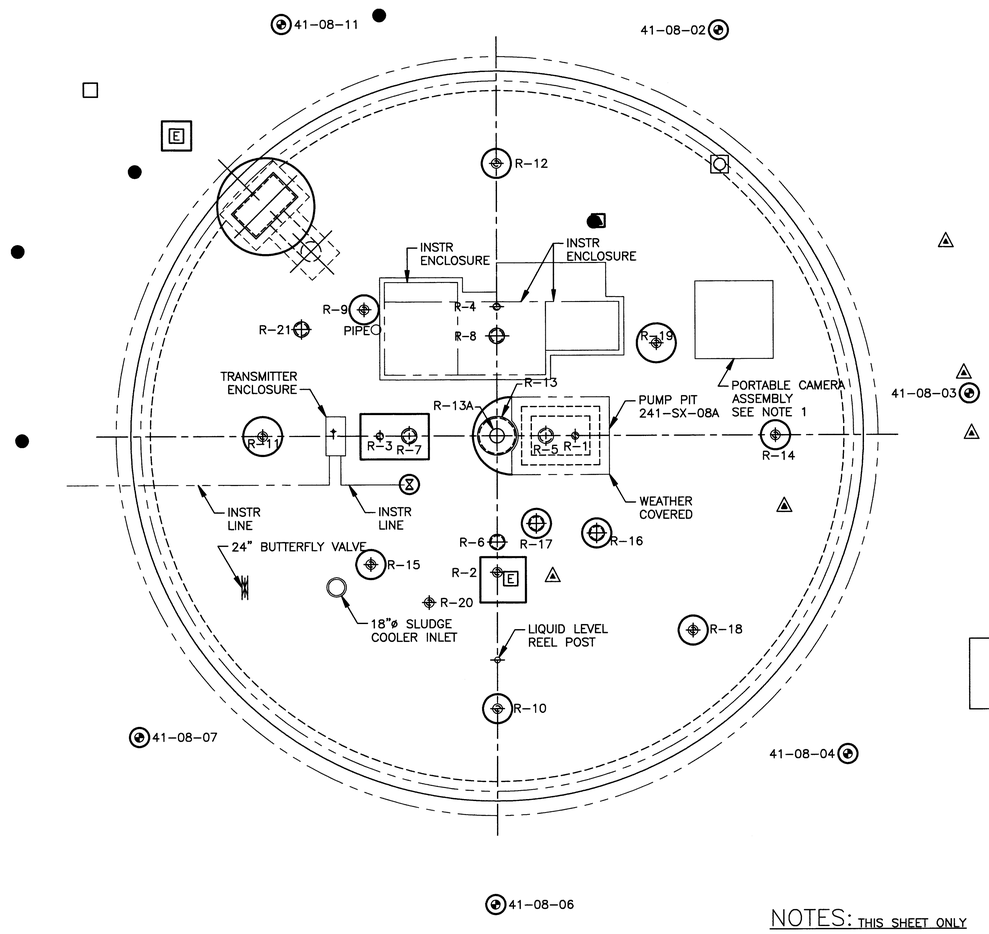
SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H–14–109330	0

SCALE AS SHOWN | EDT 824512 | SHEET 20 OF

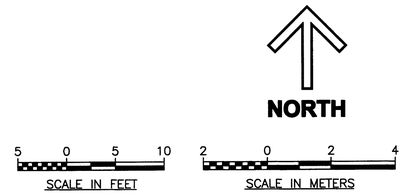
25754

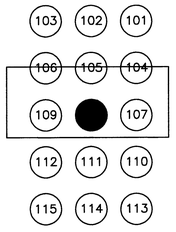
DOE_TB_F.DWG (01–01)

DWG NO H–14–109330 SH 20 OF REV 0



241-SX-108





TANK FARM 241-SX

KEY PLAN

SCALE: NONE

LEGEND

- UTILITY POLE
- LIGHT POLE
- GUY WIRE
- JUNCTION BOX
- BOLLARD
- DRY WELLS
- SIGNS
- VALVE
- ELECTRICAL PULL BOX
- E — ELECTRICAL BOX
- P — PORTABLE SKID

NOTES: THIS SHEET ONLY

1. ASSEMBLE PORTABLE CAMERA AND REMOVE FROM AREA PRIOR TO CONSTRUCTION.
2. FOR DETAILS SEE SHEETS 13 THRU 16.

RISER SUMMARY TABLE

RISER #	REF. ELEV. (FT)	SIZE (INCH)	FUNCITON/ DESCRIPTION	DETAIL	TYPE/ MODEL #	ACCESS REQ'D / LABEL	COMBINED W/RISER
R1		4	DRAIN IN PUMP PIT	12	–	NO	5
R2	662.43	4	ENRAF LEVEL GAUGE	9	UTILITY VAULT 90"x60" (2 EA) NO. 576R-12	YES/ SX108-WST-LIT-101	–
R3		4	THERMOMETER	9	UTILITY VAULT 90"x60" (1 EA) NO. 576R-12	YES/ SX108-WST-TE-101	7
R4		4	THERMOCOUPLE	1	UTILITY VAULT, SIZE AS REQD		8
R5		12	PUMP	12	–	NO	1
R6		12	TEMPERATURE PROBE	4	PAVE AROUND	NO	–
R7		12	INFRA-RED SENSOR	9	UTILITY VAULT 90"x60" (1 EA) NO. 576R-12	YES/ SX108-WST-TOI-101	3
R8		12	CIRCULATOR	1	UTILITY VAULT, SIZE AS REQD		4
R9	663.47	2 1/2	TEMPERATURE PROBE #1	14	3'ø CMP	NO	–
R10	663.46	2 1/2	TEMPERATURE PROBE #2	14	3'ø CMP	NO	–
R11	663.48	2 1/2	TEMPERATURE PROBE #3	14	4'ø CMP	NO	–
R12	663.48	2 1/2	TEMPERATURE PROBE #4	14	3'ø CMP	YES/ SX108-WST-TE-004	–
R13		42	42" RISER ADAPTER	3	9'-8"ø CONTECH LINER	YES/ SX108-WST-RISER-013	13A
R13A		18	AIR INLET FILTER	3	9'-8"ø CONTECH LINER	YES/ SX108-WST-FLT-101	13
R14	663.46	2 1/2	TEMPERATURE PROBE #5	14	3'ø CMP	NO	–
R15	663.48	2 1/2	TEMPERATURE PROBE #6	14	3'ø CMP	NO	–
R16		12	THERMAL CONDUCTIVITY PROBE	14	3'ø CMP W/LID	YES/ SX108-WST-TE-102	–
R17	664.31	12	OBSV PORT	14	3'ø CMP	YES/ SX108-WST-LG-101	–
R18	663.47	2 1/2	TEMPERATURE PROBE #7	14	3'ø CMP	NO	–
R19	663.47	2 1/2	TEMPERATURE PROBE #8	14	4'ø CMP	NO	–
R20	657.67	18	EXHAUSTER PORT	4	PAVE AROUND	NO	–
R21			THERMOCOUPLE	4	PAVE AROUND	NO	–
			TRANSMITTER ENCLOSURE	6	PAVE OVER	NO	–
			24" BUTTERFLY VALVE WEST OF R15	4	PAVE AROUND	NO	–
			VALVE SOUTH OF R7	2	2'ø STEEL PIPE	YES/ SX108-WST-V-101	
			PIPE NEAR R9	4	PAVE AROUND	NO	–
			HATCHWAY	20	10'ø CMP	NO	–
			ELECTRICAL BOX NW OF HATCHWAY	11	CURB	NO	–
			BOLLARD NEAR NW ELECTRICAL BOX	4	PAVE AROUND	NO	–
			LIQUID LEVEL REEL POST NORTH OF R10	4	PAVE AROUND	NO	–
			PUMP PIT 241-SX-08A	12	PAVE AROUND	NO	–
			JUNCTION BOX	4	PAVE AROUND	YES/ SX108-WST-JBX-101	–
			18"ø SLUDGE COOLER INLET	6	PAVE OVER	NO	–
			INSTRUMENT ENCLOSURE	1	UTILITY VAULT, SIZE AS REQD	NO	–
			(5) CONCRETE BOLLARDS	4	PAVE AROUND	NO	–
41-08-02		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-08-02	–
41-08-03		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-08-03	–
41-08-04		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-08-04	–
41-08-06		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-08-06	–
41-08-07		6	DRY WELL	2	2ø STEEL PIPE	YES/ 41-08-07	–
41-08-11		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-08-11	–

MAY 25 2011
DATE: STA: 3 HANFORD RELEASE ID: 3

DWG NO	TITLE
	DRAWING TRACEABILITY LIST

REF NUMBER	TITLE
NEXT USED ON	REFERENCES

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
	REVISIONS			

NAME	DATE	COMPANY
DRAWN BY GA SCHELL	1/2011	CGS
CHECKER JT Foss	5/10/11	CGS
ENGINEER	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
NORTH INTERIM
SURFACE BARRIER

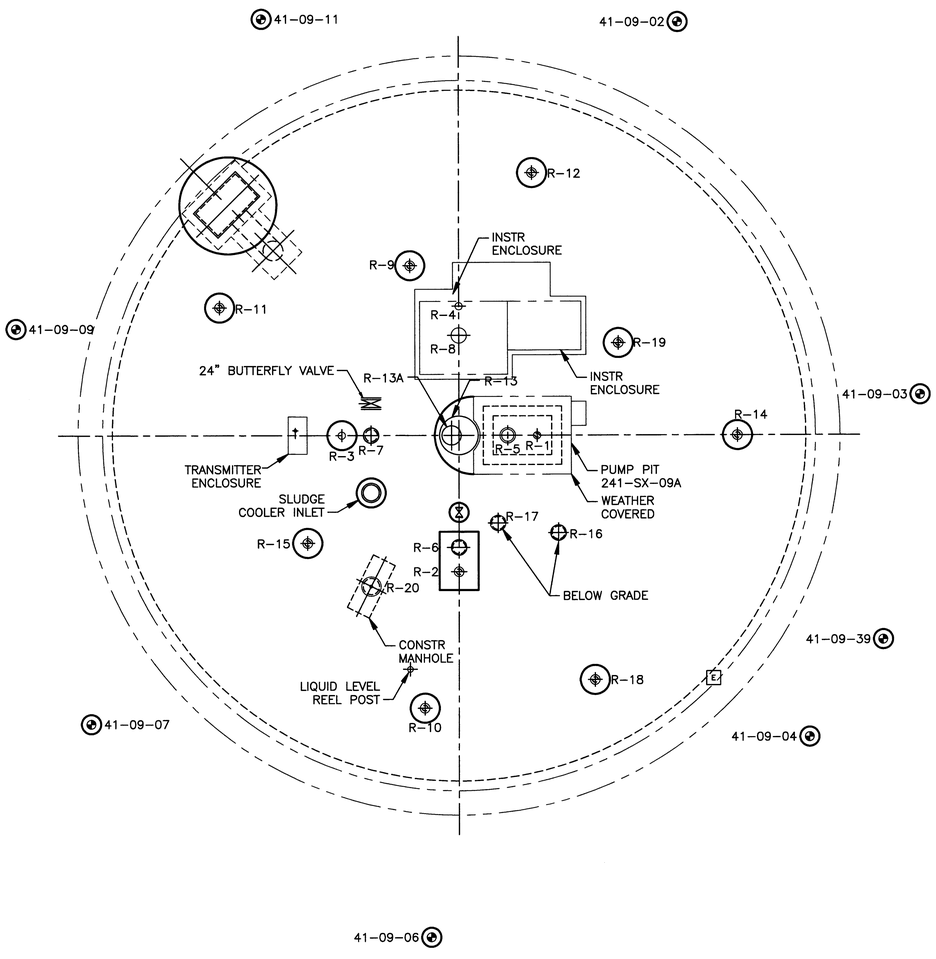
SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109446	0

SCALE AS SHOWN EDT 824511 SHEET 11 OF

22195

DOE_TB_F.DWG (01-01)

DWG NO H-14-109446 SH 11 OF REV 0



241-SX-109

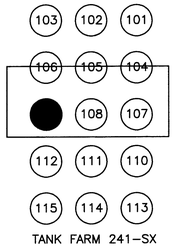
NORTH

SCALE IN FEET 5 0 5 10

SCALE IN METERS 2 0 2 4

RISER SUMMARY TABLE

RISER #	REF. ELEV. (FT)	SIZE (INCH)	FUNCITON/ DESCRIPTION	DETAIL	TYPE/ MODEL #	ACCESS REQ'D / LABEL	COMBINED W/RISER
R1		4	DRAIN IN PUMP PIT	12	–	NO	5
R2	661.42	4	ENRAF LEVEL GAUGE	9	UTILITY VAULT 90"x60" (1 EA) NO. 576R-12	YES/ SX109-WST-LIT-101	6
R3	661.40	4	THERMOMETER	14	3'ø CMP	YES/ SX109-WST-TE-101	–
R4		4	THERMOCOUPLE	1	UTILITY VAULT, SIZE AS REQD	–	8
R5		12	PUMP	12	–	NO	1
R6	661.45	12	EXHAUSTER PORT	9	UTILITY VAULT 90"x60" (1 EA) NO. 576R-12	YES/ SX109-WST-FLT-101	2
R7		12	–	6	PAVE OVER	YES/	–
R8		12	AIR LIFT CIRCULATION	1	UTILITY VAULT, SIZE AS REQD	–	4
R9	662.27	2 1/2	TEMPERATURE PROBE #1	14	3'ø CMP	NO	–
R10	662.49	2 1/2	TEMPERATURE PROBE #2	14	3'ø CMP	NO	–
R11	662.16	2 1/2	TEMPERATURE PROBE #3	14	3'ø CMP	NO	–
R12	662.29	2 1/2	TEMPERATURE PROBE #4	14	3'ø CMP	NO	–
R13		42	42" RISER ADAPTER	3	9'-8"ø CONTECH LINER	YES/ SX109-WST-RISER-013	13A
R13A		20	BREATHER FILTER	3	9'-8"ø CONTECH LINER	YES/ SX109-WST-FLT-102	13
R14	662.65	2 1/2	TEMPERATURE PROBE #5	14	3'ø CMP	NO	–
R15	662.22	2 1/2	TEMPERATURE PROBE #6	14	3'ø CMP	NO	–
R16		12	THERMAL CONDUCTIVITY PROBE	6	PAVE OVER	NO	–
R17		12	TANK INSPECTION	6	PAVE OVER	NO	–
R18	662.68	2 1/2	TEMPERATURE PROBE #7	14	3'ø CMP	NO	–
R19	624.50	2 1/2	TEMPERATURE PROBE #8	14	3'ø CMP	NO	–
R20		24	VAPOR MANIFOLD	14	PAVE TO	NO	–
			PUMP PIT 241-SX-09A	12	PAVE AROUND	NO	–
			HATCHWAY	20	10'ø CMP	NO	–
			LIQUID LEVEL REEL POST NORTH OF R10	4	PAVE AROUND	NO	–
			24" BUTTERFLY VALVE NORTH OF R7	4	PAVE AROUND	NO	–
			SLUDGE COOLER INLET	6	PAVE OVER	NO	–
			TRANSMITTER ENCLOSURE	6	PAVE OVER	NO	–
			VALVE NORTH OF R6	2	2'ø STEEL PIPE	YES/ SX109-WST-V-101	–
			INSTRUMENT ENCLOSURE	1	UTILITY VAULT, SIZE AS REQD	NO	–
41-09-02		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-09-02	–
41-09-03		6	DRY WELL	2	2ø STEEL PIPE	YES/ 41-09-03	–
41-09-04		6	DRY WELL	2	2ø STEEL PIPE	YES/ 41-09-04	–
41-09-06		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-09-06	–
41-09-07		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-09-07	–
41-09-09		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-09-09	–
41-09-11		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-09-11	–
41-09-39		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-09-39	–



TANK FARM 241-SX

KEY PLAN

SCALE: NONE

LEGEND

- UTILITY POLE
- LIGHT POLE
- GUY WIRE
- JUNCTION BOX
- BOLLARD
- DRY WELLS
- SIGNS
- VALVE
- ELECTRICAL PULL BOX
- E — ELECTRICAL BOX
- P — PORTABLE SKID

NOTES: THIS SHEET ONLY

1. FOR DETAILS SEE SHEETS 13 THRU 16.

MAY 25 2011 DATE: STA: 3 HANFORD RELEASE ID: 3

DWG NO	TITLE	REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
REVISIONS				

NAME	DATE	COMPANY
DRAWN BY GA SCHELL	1/2011	CCES
CHECKER JT Poss	5/24/11	CCES
ENGINEER	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

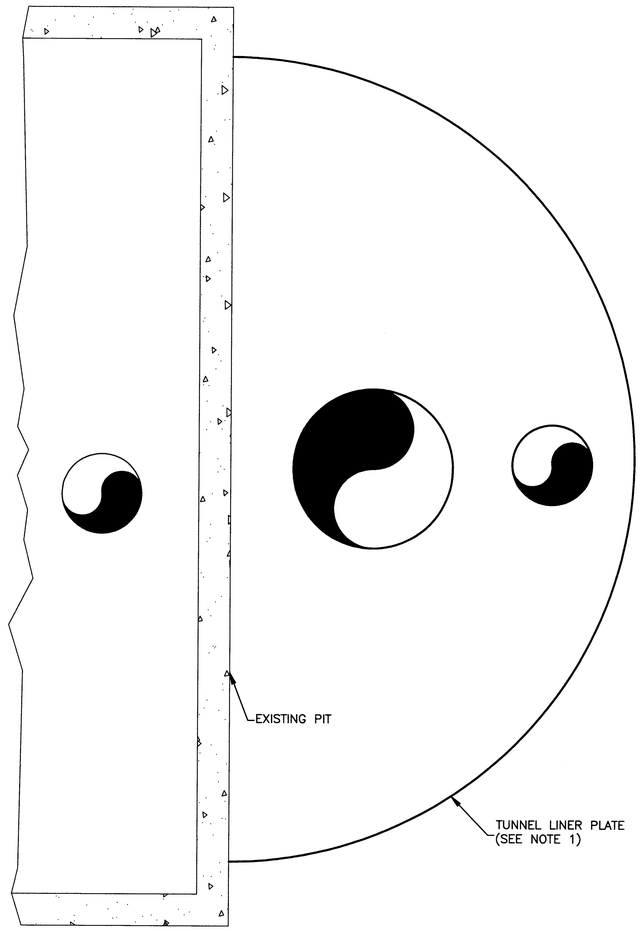
241-SX
NORTH INTERIM
SURFACE BARRIER

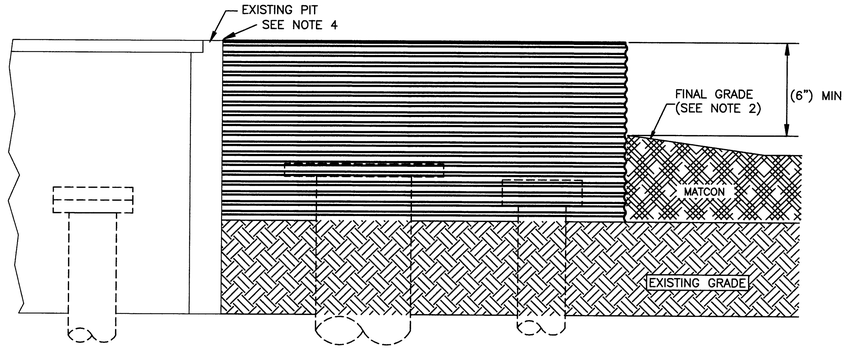
SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109446	0

SCALE AS SHOWN EDT 824511 SHEET 12 OF

28721 DOE_TB_F.DWG (01-01)

DWG NO H-14-109446 SH 12 OF REV 0

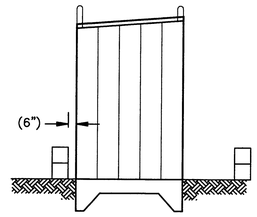




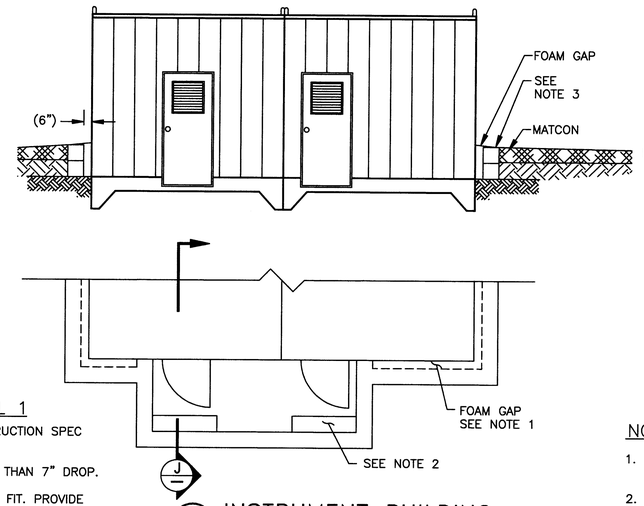
3 TANK RISER CONTECH PENETRATION
SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 3

1. THE NUMBER AND SIZE OF TANK RISERS REQUIRING A CONTECH TUNNEL LINER PLATE VARIES. SEE RISER SUMMARY TABLE, FOR EACH TANK, FOR SPECIFIC EXISTING INFORMATION REGARDING TANK PENETRATIONS REQUIRING A CONTECH LINER. FIELD VERIFY PENETRATIONS REQUIRING A CONTECH TUNNEL LINER PLATE. SUBSTITUTIONS FOR CONTECH TUNNEL LINER PLATE ARE ACCEPTABLE WITH BUYER APPROVAL.
2. GRADE ASPHALT TO DRAIN AWAY FROM TUNNEL LINER PLATE, APPROXIMATE BUILD UP SHOWN. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP-SPEC-49087.
3. CONTRACTOR SHALL PAINT ALL SURFACES OF NEW INSTALLATIONS (INCLUDING LIDS/COVER) ABOVE FINAL GRADE. PAINT APPLIED TO ALL SURFACES SHALL BE POLYURETHANE BASED (DURABAK 18, SMOOTH VERSION, COLOR: SAFETY YELLOW; OR APPROVED EQUAL). PREPARE SUBSTRATE SURFACES IN ACCORDANCE WITH MANUFACTURER'S REPRESENTATIVE'S RECOMMENDATIONS.
4. REMOVE FOAM FROM PIT WHERE LINER INTERSECTS PIT. REAPPLY WEATHER BARRIER TO PIT UPON COMPLETION PER CONSTRUCTION SPEC. B-222-C1.
5. MARK IDENTIFICATION OF RISER NUMBER, ETC., USING 1" MINIMUM HIGH LETTERING, COLOR BLACK, LOCATED SO IT IS PLAINLY VISIBLE.
6. BREAK AND DEBUR ALL SHARP EDGES. INSTALL TRIM-LOK EDGE GUARD ALONG EDGE.



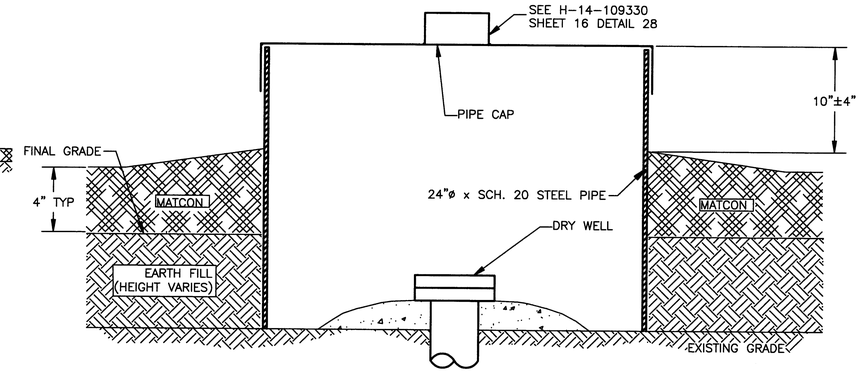
J DETAIL SECTION
SCALE: N.T.S.



1 INSTRUMENT BUILDING
SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 1

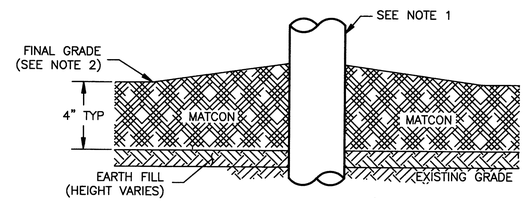
1. APPLY FOAM TO AREA PER CONSTRUCTION SPEC B-222-C1
2. PROVIDE ACCESS STEP IF GREATER THAN 7" DROP.
3. CUT AND STACK UTILITY VAULTS TO FIT. PROVIDE MINIMUM 6" CLEARANCE.
4. GRADE ASPHALT TO DRAIN AWAY FROM FACE OF VAULT, APPROXIMATE BUILD UP SHOWN. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP-SPEC-49087



2 DRYWELL PIPE PENETRATION
SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 2

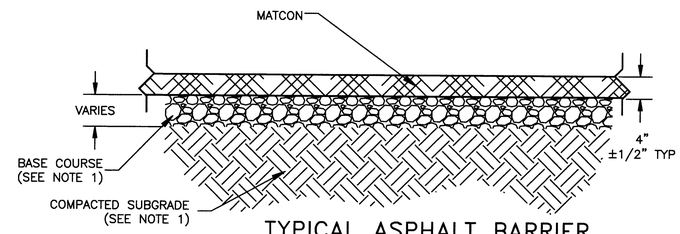
1. SEE RISER SUMMARY TABLE FOR EACH TANK FOR SPECIFIC EXISTING INFORMATION REGARDING TANK PENETRATIONS. FIELD VERIFY ELEVATIONS.
2. GRADE ASPHALT TO DRAIN AWAY FROM COVER, APPROXIMATE BUILD UP SHOWN. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP-SPEC-49087.
3. REMOVE EXISTING VALVE BOX CHIP AWAY OR REMOVE CONCRETE SLEEVE AS REQUIRED TO ALLOW FOR FRAME ASSEMBLY PLACEMENT.
4. MARK IDENTIFICATION OF DRY WELL NUMBER, ETC., USING 1" MINIMUM HIGH LETTERING, COLOR CONTRAST TO COVER, LOCATED SO IT IS PLAINLY VISIBLE. SEE RISER SUMMARY TABLE FOR WELL NUMBER.
5. CONTRACTOR SHALL PAINT ALL SURFACES OF NEW INSTALLATIONS (INCLUDING LIDS/COVER) ABOVE FINAL GRADE. PAINT APPLIED TO ALL SURFACES SHALL BE POLYURETHANE BASED (DURABAK 18, SMOOTH VERSION, COLOR: SAFETY YELLOW; OR APPROVED EQUAL). PREPARE SUBSTRATE SURFACES IN ACCORDANCE WITH MANUFACTURER'S REPRESENTATIVE'S RECOMMENDATIONS.



4 PAVE UP TO TANK ELEMENT DETAIL
SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 4

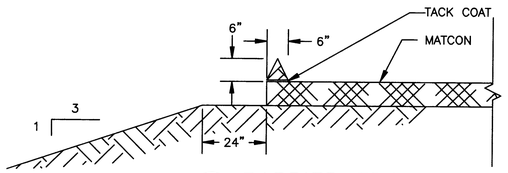
1. SEE RISER SUMMARY TABLE FOR EACH TANK FOR SPECIFIC EXISTING INFORMATION REGARDING TANK PENETRATIONS. FIELD VERIFY PENETRATIONS.
2. GRADE ASPHALT TO DRAIN AWAY FROM TANK ELEMENT, APPROXIMATE BUILD UP SHOWN. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP-SPEC-49087.



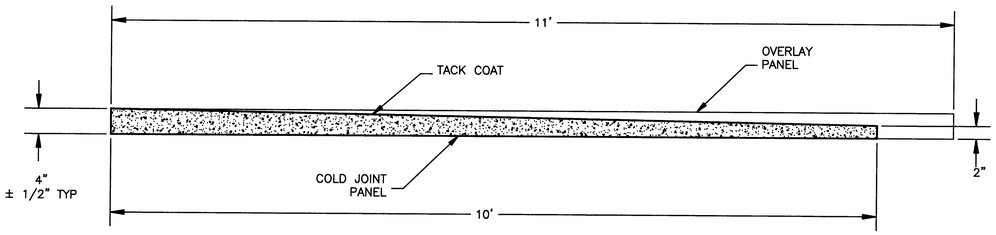
6 TYPICAL ASPHALT BARRIER INSTALLATION DETAIL
SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 6

1. COMPACT IN ACCORDANCE WITH RPP-SPEC-49087.



7 BARRIER EDGE DETAIL
SCALE: N.T.S.



5 TYPICAL COLD JOINT DETAIL
SCALE: N.T.S.

MAY 25 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHECKED BY DATE	ENGR COMPANY
REVISIONS				

NAME	DATE	COMPANY
DRAWN BY JGC	5/11	CCRS
APPROVED BY	5/11	CCRS
ENGINEER	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

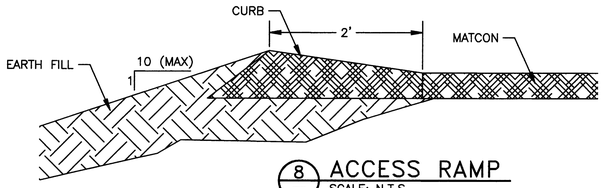
241-SX
NORTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109446	0

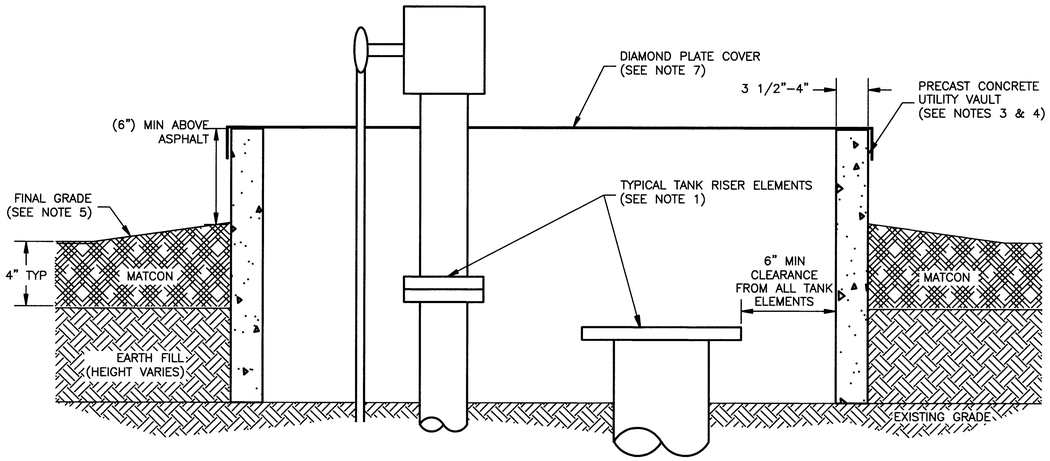
SCALE AS SHOWN | EDT 824511 | SHEET 13 OF

16707 | DOE_TB_F.DWG (01-01)

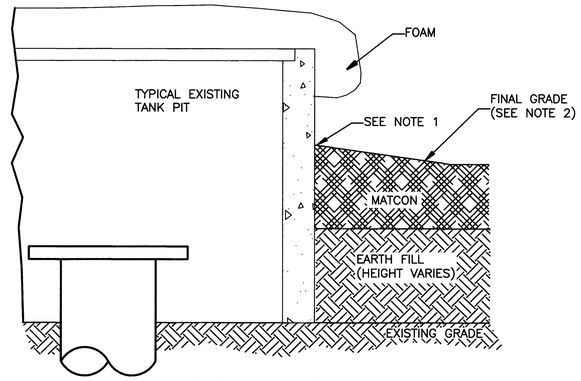
REV 0 | SH 13 OF | DWG NO H-14-109446



8 ACCESS RAMP
SCALE: N.T.S.



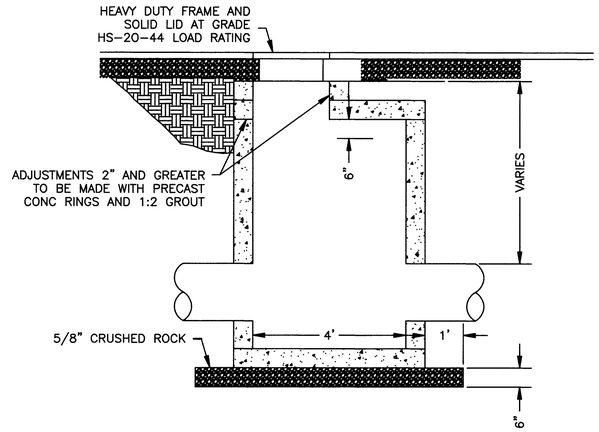
P SECTION
SCALE: N.T.S.



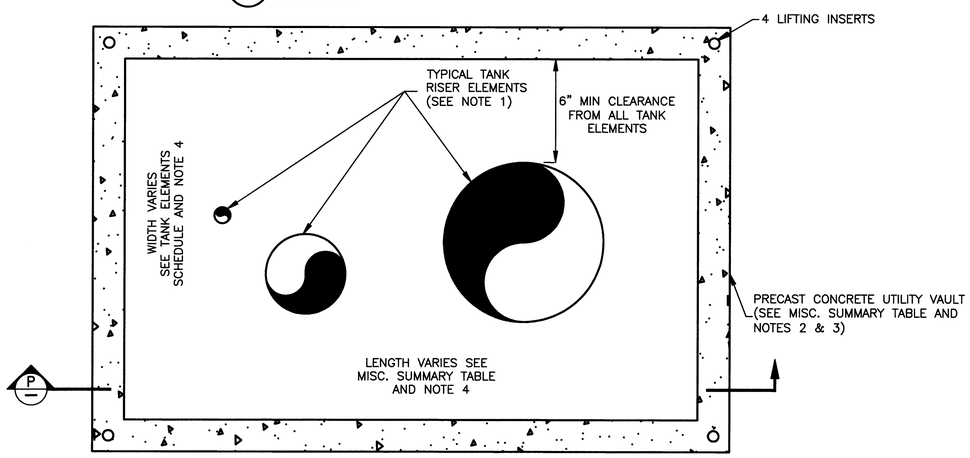
12 TYPICAL EXISTING PIT
SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 12

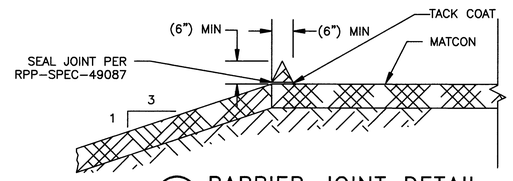
1. REMOVE FOAM FROM PIT WALL WHERE BARRIER EDGE INTERSECTS PIT. REAPPLY FOAM TO PIT UPON COMPLETION PER CONSTRUCTION SPEC. B–222–C1.
2. GRADE MATCON TO DRAIN AWAY FROM PIT, APPROXIMATE BUILD UP SHOWN. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP–SPEC–49087.



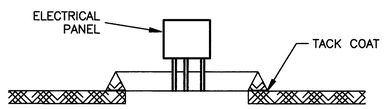
10 STANDARD CATCH BASIN
4,5
SCALE: N.T.S.



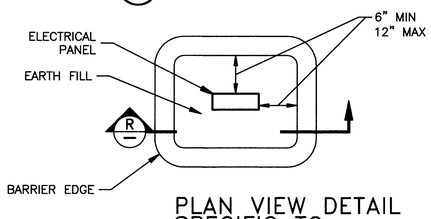
PLAN VIEW DETAIL
TANK ELEMENT UTILITY
VAULT LINER PENETRATION
9
SCALE: N.T.S.



13 BARRIER JOINT DETAIL
3
SCALE: N.T.S.



R DETAIL SECTION
SCALE: N.T.S.



PLAN VIEW DETAIL
SPECIFIC TO
ELECTRICAL PANELS
11
SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 9

1. THE NUMBER AND SIZE OF TANK ELEMENTS (RISERS AND OTHER APPURTENANCES) WITHIN EACH VAULT VARIES. SEE RISER SUMMARY TABLE FOR EACH TANK IDENTIFYING THE NUMBER OF TANK PENETRATIONS WITHIN EACH VAULT.
2. FIELD VERIFY THAT SPECIFIED VAULT SIZE PROVIDES REQUIRED MINIMUM CLEARANCE AROUND TANK ELEMENTS. NOTIFY BUYER OF REQUIRED VAULT DIMENSION MODIFICATIONS (LARGER OR SMALLER) AS A RESULT OF FIELD MEASUREMENTS.
3. PRECAST CONCRETE UTILITY VAULT SHALL BE OF SIZE AND TYPE SHOWN ON RISER SUMMARY TABLE UNLESS AS DESCRIBED IN NOTE 2 AND APPROVED BY BUYER. DIMENSIONS SHOWN IN RISER SUMMARY TABLE ARE EXTERNAL. CONTRACTOR MAY ELECT TO PROVIDE EQUIVALENT CAST–IN–PLACE CONCRETE VAULT WITH BUYER APPROVAL.
4. PROVIDE DIMENSIONS SHOWN BY SPECIFIED MODEL TYPE IN RISER OR MISC. SUMMARY TABLE. ALL DIMENSIONS SHALL BE FIELD VERIFIED PRIOR TO ORDER AND SHIPMENT TO PROJECT SITE.
5. GRADE ASPHALT TO DRAIN AWAY FROM UTILITY VAULT, APPROXIMATE BUILD UP SHOWN. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP–SPEC–49087.
6. CONTRACTOR SHALL PAINT ALL SURFACES OF NEW INSTALLATIONS (INCLUDING LIDS/COVER) ABOVE FINAL GRADE. PAINT APPLIED TO ALL SURFACES SHALL BE POLYURETHANE BASED (DURABAK 18, SMOOTH VERSION, COLOR: SAFETY YELLOW; OR APPROVED EQUAL). PREPARE SUBSTRATE SURFACES IN ACCORDANCE WITH MANUFACTURER'S REPRESENTATIVE'S RECOMMENDATIONS.
7. PROVIDE COMPATIBLE SIZE VAULT COVER. COVER SHALL BE MINIMUM 1/4" THICK ALUMINUM DIAMOND PLATE. ATTACHED COVER TO VAULT WITH MINIMUM OF 2 BOLTS. NOTCH OR CUT COVER TO ALLOW FOR VAULT PENETRATIONS. WHERE INSERTS ARE REQUIRED, USE FASTENAL 50402 ANCHOR BOLTS OR EQUIVALENT. COVER SHALL OVERLAP UTILITY VAULT. PROVIDE CLEAR ACCESS TO BENCHMARKS.
8. MARK IDENTIFICATION OF RISER NUMBER, ETC., USING 1" MINIMUM HIGH LETTERING, COLOR BLACK, LOCATED SO IT IS PLAINLY VISIBLE.

MAY 25 2011
DATE: HANFORD RELEASE ID:
STA: 3 3

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON JGC	

MFD	REV NO	DESCRIPTION	REV BY DATE	CHECKED BY DATE		ENGR COMPANY
REV. REL		REVISIONS				

NAME	DATE	COMPANY
DRAWN BY JGC	1/11	DESS
CHECKED BY JT Fish	5/11	CES
ENGINEER	5/11	WRPS

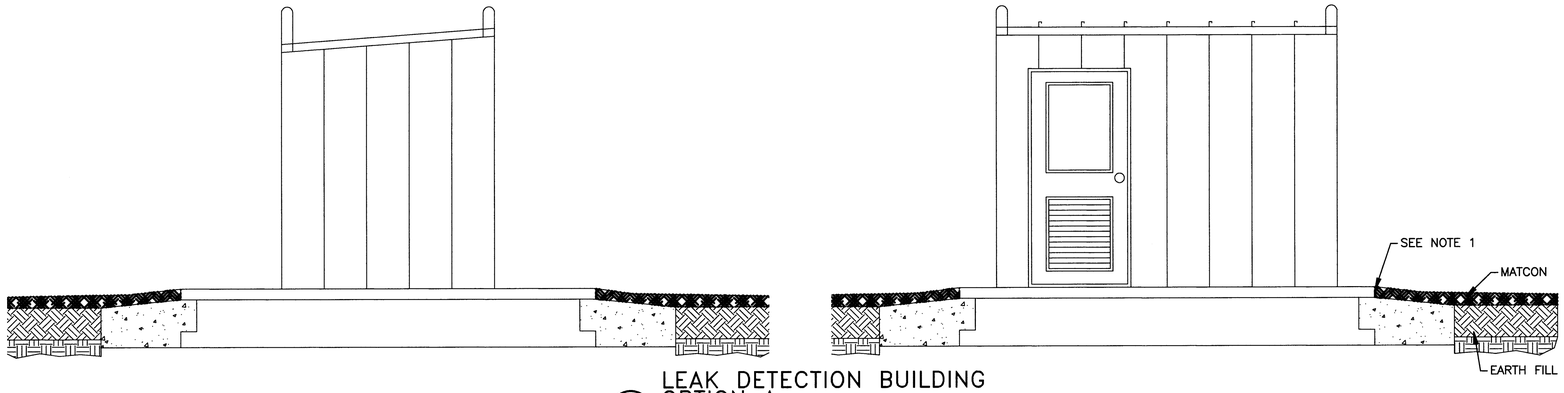
U.S. DEPARTMENT OF ENERGY
Office of River Protection

241–SX
NORTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H–14–109446	0
SCALE AS SHOWN	EDT 824511		SHEET 14 OF	

7558
DOE_TB_F.DWG (01–01)

DWG NO H–14–109446 SH 14 OF REV 0

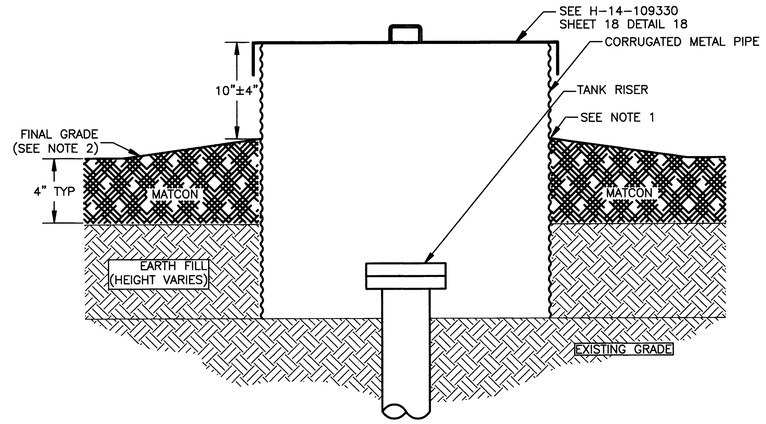


17A LEAK DETECTION BUILDING OPTION A

SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 17A

1. SEAL INTERFACE BETWEEN MATCON AND CHANNEL APPLIED PER RPP-SPEC-49087 AND PER MANUFACTURERS RECOMMENDATIONS.
2. GRADE MATCON TO DRAIN AWAY FROM BUILDING. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP-SPEC-49087.
3. ELEVATION OF MATCON VARIES PER LEAK DETECTION BUILDING.

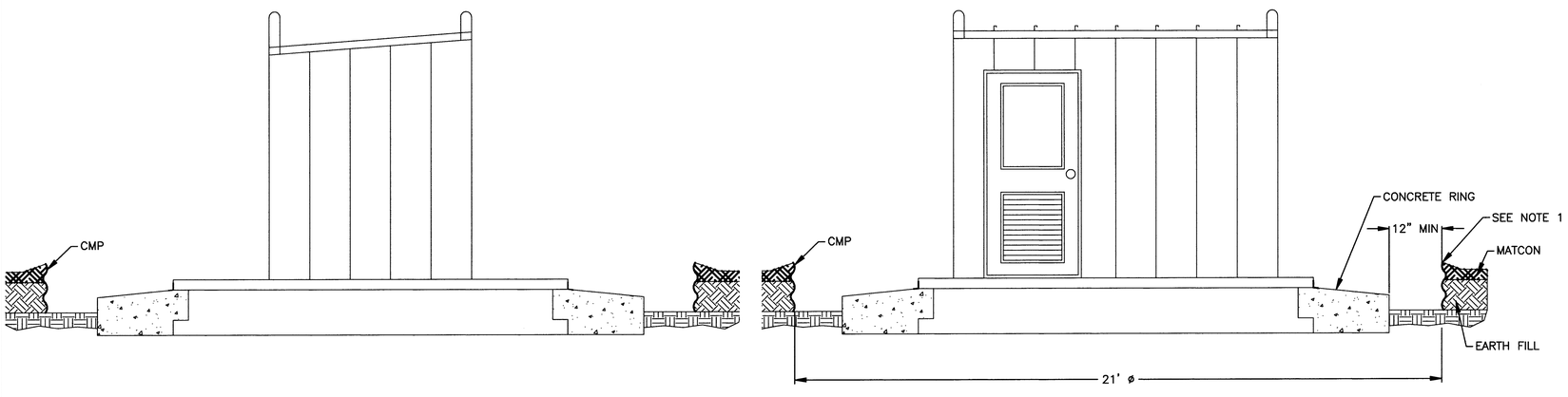


14 DETAIL FOR THE CMP TANK RISER PIPE SLEEVE PENETRATION

SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 14

1. SEAL INTERFACE BETWEEN MATCON AND CHANNEL WITH PAVEMENT MEMBRANE FLASHING APPLIED PER RPP-SPEC-49087 AND PER MANUFACTURERS RECOMMENDATIONS.
2. GRADE MATCON TO DRAIN AWAY FROM COVER. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP-SPEC-49087.
3. CONTRACTOR SHALL PAINT ALL SURFACES OF NEW INSTALLATIONS (INCLUDING LIDS/COVER) ABOVE FINAL GRADE. PAINT APPLIED TO ALL SURFACES SHALL BE POLYURETHANE BASED (DURABAK 18, SMOOTH VERSION, COLOR: SAFETY YELLOW; OR APPROVED EQUAL). PREPARE SUBSTRATE SURFACES IN ACCORDANCE WITH MANUFACTURER'S REPRESENTATIVE'S RECOMMENDATIONS.



17B LEAK DETECTION BUILDING OPTION B

SCALE: N.T.S.

NOTES: APPLIES TO DETAIL 17B

1. USE THIS OPTION IF SUBGRADE ELEVATION IS HIGHER THAN THE OUTER CORNER OF THE EXISTING CONCRETE RING
2. SEAL INTERFACE BETWEEN MATCON AND CMP APPLIED PER RPP-SPEC-49087 AND PER MANUFACTURERS RECOMMENDATIONS.
3. GRADE MATCON TO DRAIN AWAY FROM CMP. SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP-SPEC-49087.
4. BREAK AND DEBUR ALL SHARP EDGES. INSTALL TRIM-LOK EDGE GUARD ALONG EDGE.

MAY 25 2011
DATE: STA: 3 HANFORD RELEASE ID: 3

DWG NO	TITLE	REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

MFD	REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
REV REL		REVISIONS				

	NAME	DATE	COMPANY
DRAWN BY	JGC	7/11	CGS
CHECKER	ST Foss	5/04	CGS
ENGINEER	MJ Hess	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

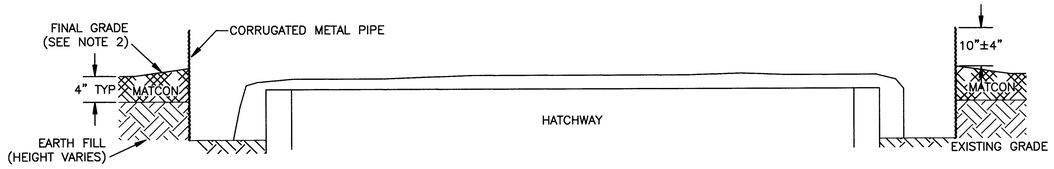
241-SX
NORTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109446	0

SCALE AS SHOWN | EDT 824511 | SHEET 15 OF

19098 | 1 | DOE_TB_F.DWG (01-01)

DWG NO H-14-109446 SH 15 OF REV 0

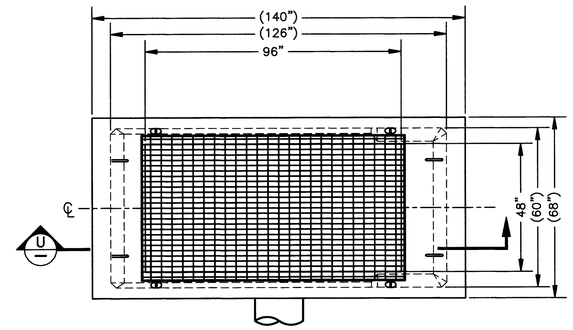


20/— DETAIL FOR THE CMP HATCHWAY

SCALE: N.T.S.

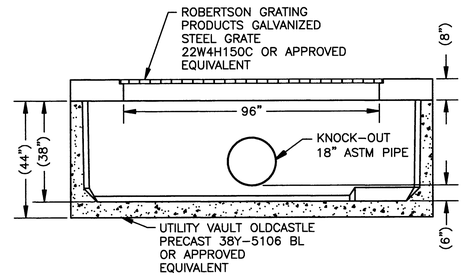
NOTES:

1. SEE ACCESS REQUIREMENT SHEET FOR TANKS 107–115 FOR LOCATION.
2. GRADE MATCON TO DRAIN AWAY FROM CMP AND SEAL INTERFACE BETWEEN MATCON AND PENETRATION PER RPP–SPEC–49087.
3. BREAK AND DEBUR ALL SHARP EDGES. APPLY TRIM–LOK RUBBER EDGE GUARD ALONG CMP EDGE.



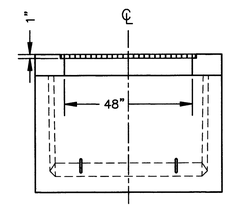
15/4 STORM WATER INLET BOX DETAIL

SCALE: 1" = 2'



U/— STORM WATER INLET BOX

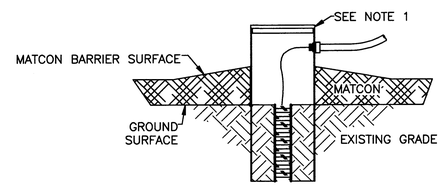
SCALE: 1" = 2'



TYPICAL END VIEW

NOTE: APPLIES TO DETAIL 15

1. INLET BOX COVER TO BE CAST TO ACCOMMODATE GRATING PER UTILITY VAULT STANDARDS.
2. LIFT IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS.



21/2,3 MONITORING INSTRUMENT INSTALLATION

SCALE: 1"=10'

NOTES:

1. PROTECTIVE CASING AND CAP PROVIDED BY OTHERS.
2. DETAILS PROVIDED BY OTHERS. SEE H–14–109447.

MAY 25 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHECKED BY DATE	ENGR COMPANY
REVISIONS				

NAME	DATE	COMPANY
DRAWN BY JGC	1/11	CRCS
ST POSS	5/10/11	CRCS
ENGINEER	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241–SX
NORTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H–14–109446	0

SCALE AS SHOWN | EDT 824511 | SHEET 16 OF

21153 | DOE_TB_F.DWG (01–01)

DWG NO H–14–109446 SH 16 OF REV 0

PROJECT TITLE:

SX TANK FARM NORTH INTERIM SURFACE BARRIER

FOR:

WASHINGTON RIVER PROTECTION SOLUTIONS, LLC.

BY:

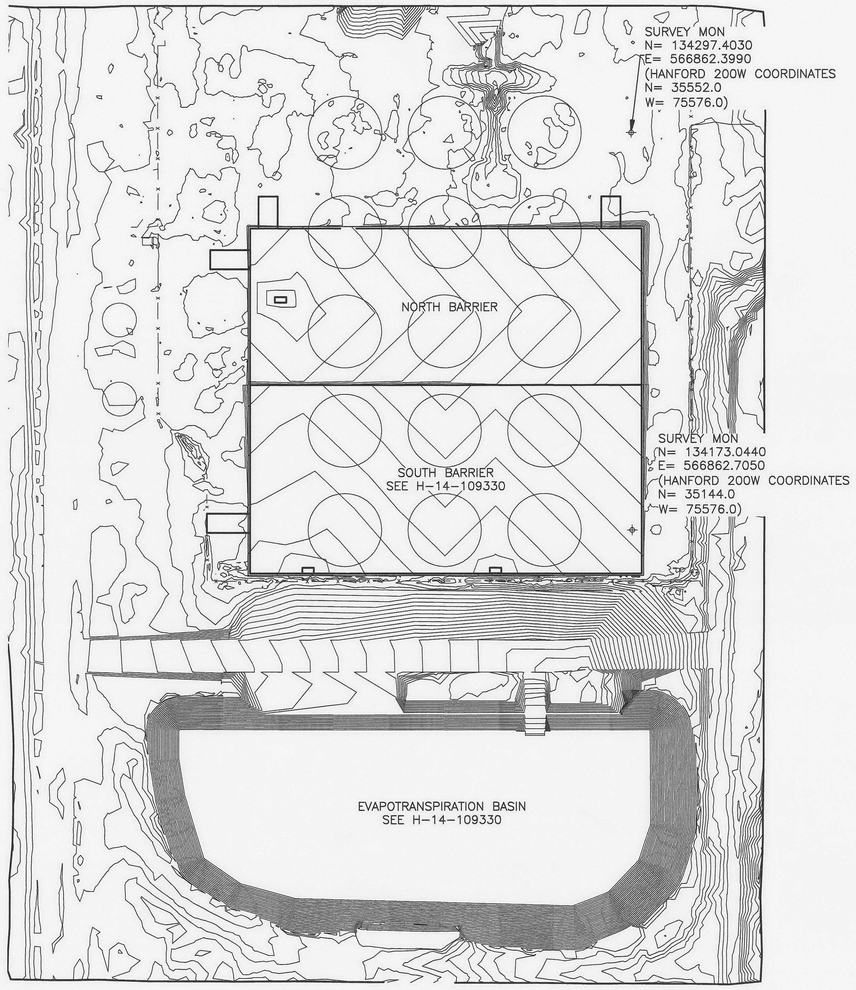
COLUMBIA ENERGY AND ENVIRONMENTAL SERVICES

GENERAL NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL DESIGN SCALES, GRIDS, DISTANCES, COORDINATES AND ELEVATIONS ARE IN METRIC UNITS UNLESS NOTED OTHERWISE. ALL PROFILES AND CONTOURS ARE IN METRIC UNITS AND ARE SHOWN FOR REFERENCE ONLY.
2. BASE MAPS TAKEN FROM PROJECT SPECIFIC TOPOGRAPHIC SURVEY DATABASE PER TOPOGRAPHIC SURVEY PERFORMED BY GLAHE & ASSOCIATES DATED AUGUST 2008, AS PROVIDED BY BUYER.

   HORIZONTAL DATUM: WASHINGTON COORDINATE SYSTEM OF 1983, SOUTH ZONE/1991 ADJUSTMENT (WCS83S/91) –METERS.

   VERTICAL DATUM: NORTH AMERICA VERTICAL DATUM OF 1988 (NAVD88) – METERS US SURVEY FEET ARE SHOWN. CONVERSION 1 M = 39.37 IN
3. EXISTING UTILITIES AND TANK FARM FEATURES ARE SHOWN FOR POTENTIAL INTERFERENCES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING WITH THE BUYER WHEN DISTURBING SOIL TO VERIFY THE LOCATION OF AND PRESERVE ALL UTILITIES AND FEATURES INCLUDING THOSE NOT SHOWN OR INCORRECTLY SHOWN ON THE PLANS, UNLESS SHOWN OR NOTED OTHERWISE.
4. EXCAVATION INSIDE THE FENCE LIMITS OF THE SX FARM IS CONSIDERED CLASSIFIED EXCAVATION, SEE SPECIFICATIONS.
5. ALL HOISTING AND RIGGING WILL BE CONDUCTED IN ACCORDANCE WITH DOE/RL–92–36 "HANFORD SITE HOISTING & RIGGING" AS APPROVED BY THE BUYER.
6. COORDINATE DATA PROVIDED IN POINT TABLES ARE FOR FINAL SUB–GRADE PRIOR TO PAVING EXCEPT AS NOTED.
7. TANKS SHOWN ARE BURIED AND ARE IDENTIFIED FOR REFERENCE.

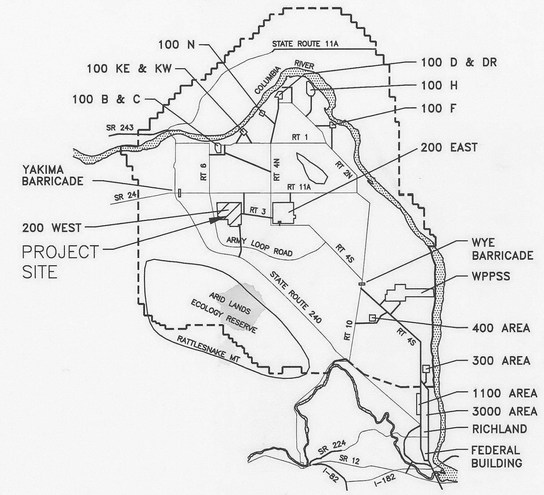


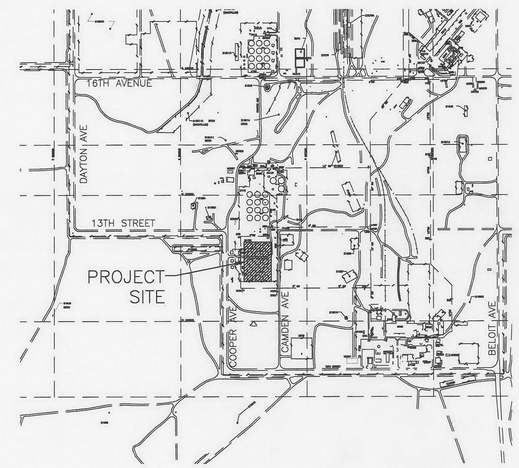
SITE PLAN

20 0 20 40
SCALE IN METERS

50 0 50 100
SCALE IN FEET

NORTH





CONSTRUCTION SPECIFICATION

SPECIFICATION NO.

RPP–SPEC–49087

CALCULATIONS

CALCULATION NO.

RPP–CALC–48447

INTERIM SURFACE BARRIER

DRAWING NO.	TITLE
H–14–109446 SH 1	COVER SHEET
H–14–109446 SH 2	NORTH BARRIER PLAN & PROFILE
H–14–109446 SH 3	OVERALL BARRIER PLAN & PROFILE
H–14–109446 SH 4–6	NORTH BARRIER DRAIN PLAN & PROFILE
H–14–109446 SH 7–12	RISER LOCATION PLAN & ACCESS REQ. SX–104 – SX–109
H–14–109446 SH 13–16	DETAILS

MAY 24 2011
DATE: STA: 3 HANFORD RELEASE ID: 3

DRAWING TRACEABILITY LIST		REFERENCES	
DWG NO	TITLE	REF NUMBER	TITLE
		H–14–109330	SX FARM S. INTERIM BARRIER
		NEXT USED ON	H–14–109447

REVISIONS						
MFD	REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
REV REL						

NAME	DATE	COMPANY
DRAWN BY JGC	1/11	CEES
CHECKER VT Pasek	5/12/11	CEES
ENGINEER MS Hoim	5/11	WCRS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241–SX
NORTH INTERIM
SURFACE BARRIER

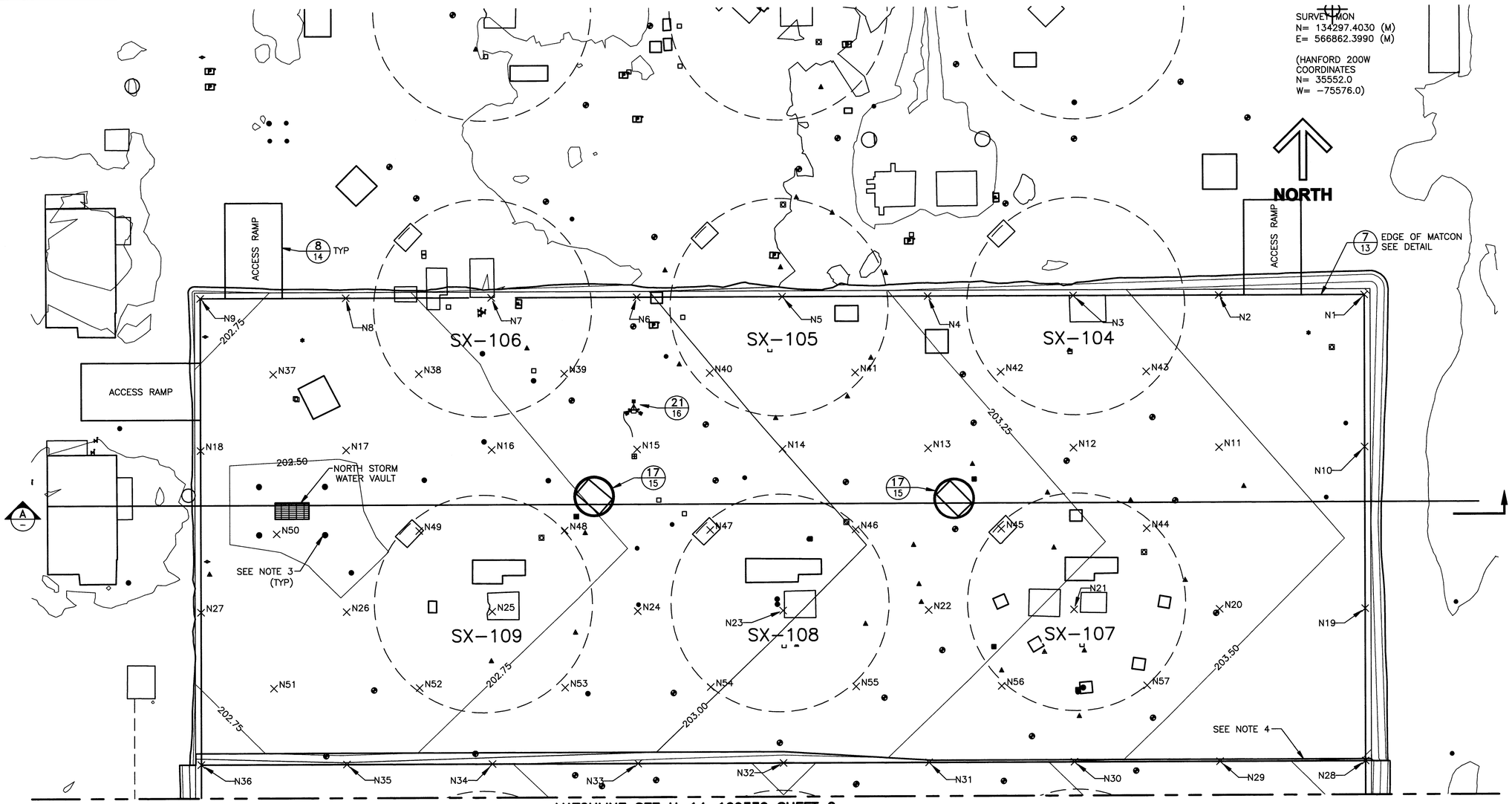
SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H–14–109446	0

SCALE AS SHOWN | EDT 824511 | SHEET 1 OF 16

29466 DOE_TB_F.DWG (01–01)

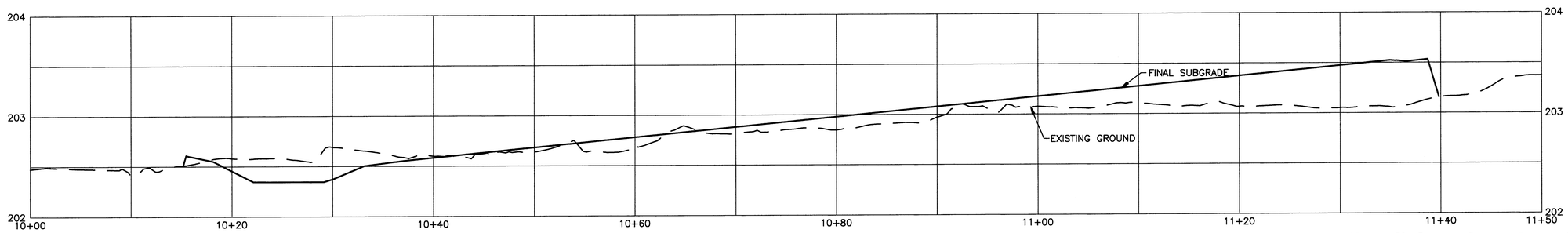
DWG NO H–14–109446 SH 1 OF 16 REV 0

POINT TABLE						
PNT#	EL (M)	N (M)	E (M)	EL(FT)	N (FT)	E (FT)
N1	203.74	134267.43	566865.65	668.44	440509.06	1859791.72
N2	203.59	134267.43	566850.40	667.94	440509.06	1859741.69
N3	203.44	134267.43	566835.15	667.45	440509.06	1859691.65
N4	203.29	134267.43	566819.90	666.96	440509.06	1859641.62
N5	203.13	134267.43	566804.65	666.44	440509.06	1859591.59
N6	202.98	134267.43	566789.40	665.94	440509.06	1859541.56
N7	202.83	134267.43	566774.15	665.45	440509.06	1859491.52
N8	202.68	134267.43	566758.90	664.96	440509.06	1859441.49
N9	202.82	134267.43	566743.65	665.42	440509.06	1859391.46
N10	203.58	134251.43	566865.65	667.91	440456.57	1859791.72
N11	203.45	134251.43	566850.40	667.49	440456.57	1859741.69
N12	203.30	134251.43	566835.15	666.99	440456.57	1859691.65
N13	203.15	134251.43	566819.90	666.50	440456.57	1859641.62
N14	203.00	134251.43	566804.65	666.01	440456.57	1859591.59
N15	202.85	134251.43	566789.40	665.52	440456.57	1859541.56
N16	202.70	134251.43	566774.15	665.02	440456.57	1859491.52
N17	202.52	134251.43	566758.90	664.43	440456.57	1859441.49
N18	202.64	134251.43	566743.65	664.83	440456.57	1859391.46
N19	203.60	134234.43	566865.65	667.98	440400.79	1859791.72
N20	203.44	134234.43	566850.40	667.45	440400.79	1859741.69
N21	203.29	134234.43	566835.15	666.96	440400.79	1859691.65
N22	203.13	134234.43	566819.90	666.44	440400.79	1859641.62
N23	202.98	134234.43	566804.65	665.94	440400.79	1859591.59
N24	202.83	134234.43	566789.40	665.45	440400.79	1859541.56
N25	202.67	134234.43	566774.15	664.93	440400.79	1859491.52
N26	202.52	134234.43	566758.90	664.43	440400.79	1859441.49
N27	202.67	134234.43	566743.65	664.93	440400.79	1859391.46
N28	203.82	134218.43	566865.65	668.70	440348.30	1859791.72
N29	203.67	134218.43	566850.40	668.21	440348.30	1859741.69
N30	203.52	134218.43	566835.15	667.72	440348.30	1859691.65
N31	203.38	134218.43	566819.90	667.26	440348.30	1859641.62
N32	203.53	134218.43	566804.65	667.75	440348.30	1859591.59
N33	203.38	134218.43	566789.40	667.26	440348.30	1859541.56
N34	203.23	134218.43	566774.15	666.76	440348.30	1859491.52
N35	203.07	134218.43	566758.90	666.24	440348.30	1859441.49
N36	203.21	134218.43	566743.65	666.70	440348.30	1859391.46
N37	202.66	134259.43	566751.28	664.89	440482.81	1859416.49
N38	202.68	134259.43	566766.53	664.96	440482.81	1859466.52
N39	202.84	134259.43	566781.78	665.48	440482.81	1859516.56
N40	202.99	134259.43	566797.03	665.98	440482.81	1859566.59
N41	203.14	134259.43	566812.28	666.47	440482.81	1859616.62
N42	203.30	134259.43	566827.53	666.99	440482.81	1859666.65
N43	203.45	134259.43	566842.78	667.49	440482.81	1859716.69
N44	203.30	134242.93	566842.78	666.99	440428.68	1859716.69
N45	203.15	134242.93	566812.28	666.50	440428.68	1859616.62
N46	203.00	134242.93	566812.28	666.01	440428.68	1859616.62
N47	202.85	134242.93	566797.03	665.52	440428.68	1859566.59
N48	202.70	134242.93	566781.78	665.02	440428.68	1859516.56
N49	202.55	134242.93	566766.53	664.53	440428.68	1859466.52
N50	202.41	134242.63	566751.60	664.07	440427.70	1859417.54
N51	202.67	134226.43	566751.28	664.93	440374.55	1859416.49
N52	202.68	134226.43	566766.53	664.96	440374.55	1859466.52
N53	202.83	134226.43	566781.78	665.45	440374.55	1859516.56
N54	202.99	134226.43	566797.03	665.98	440374.55	1859566.59
N55	203.14	134226.43	56812.28	666.47	440374.55	186391.62
N56	203.29	134226.43	566827.53	666.96	440374.55	1859666.65
N57	203.44	134226.43	566842.78	667.45	440374.55	1859716.69



MATCHLINE SEE H-14-109330 SHEET 2

NORTH BARRIER SITE PLAN



A NORTH BARRIER PROFILE

15 0 15 30 SCALE IN FEET

5 0 5 10 SCALE IN METERS

NOTES: APPLIES TO THIS SHEET ONLY

1. ELEVATIONS ARE FOR FINISHED SUB-GRADE AT ± 1/10 FOOT (3 CM) TOLERANCE.
2. MATCON NOT SHOWN FOR CLARITY
3. FOR BOLLARD SPECIFICATIONS SEE RPP-SPEC-49087
4. REMOVE 20 FEET OF EXISTING CURBING TO PROVIDE ACCESS BETWEEN NORTH AND SOUTH BARRIERS
5. POINTS ARE PROVIDED TO ESTABLISH SUB-GRADE. POINTS THAT INTERFACE WITH EXISTING SURFACE FEATURES SHALL BE INTERPOLATED.
6. MATCON NOT SHOWN IN PROFILE FOR CLARITY

NORTH BARRIER CUT/FILL TABLE			
MIN. ELEV. (FT)	MAX ELEV (FT)	AREA FT²	VOL YD³
-1.31	-0.66	974.42	5.63
-0.66	0.00	7416.26	75.34
0.00	0.66	33234.15	1063.76
0.66	1.31	17706.28	361.66
1.31	1.97	8052.77	78.82
1.97	2.13	169.17	0.39

* VOLUME TABLE FOR REFERENCE ONLY. SEE RPP-SPEC-49087

MAY 24 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

DRAWING TRACEABILITY LIST		REFERENCES		REVISIONS						
DWG NO	TITLE	REF NUMBER	TITLE	MFD REV REL	REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
		NEXT USED ON								

NAME	DATE	COMPANY
DRAWN BY JGK	1/11	
CHECKER DF Foss	5/10/11	CGS
ENGINEER MJ Helm	5/11	WRPS

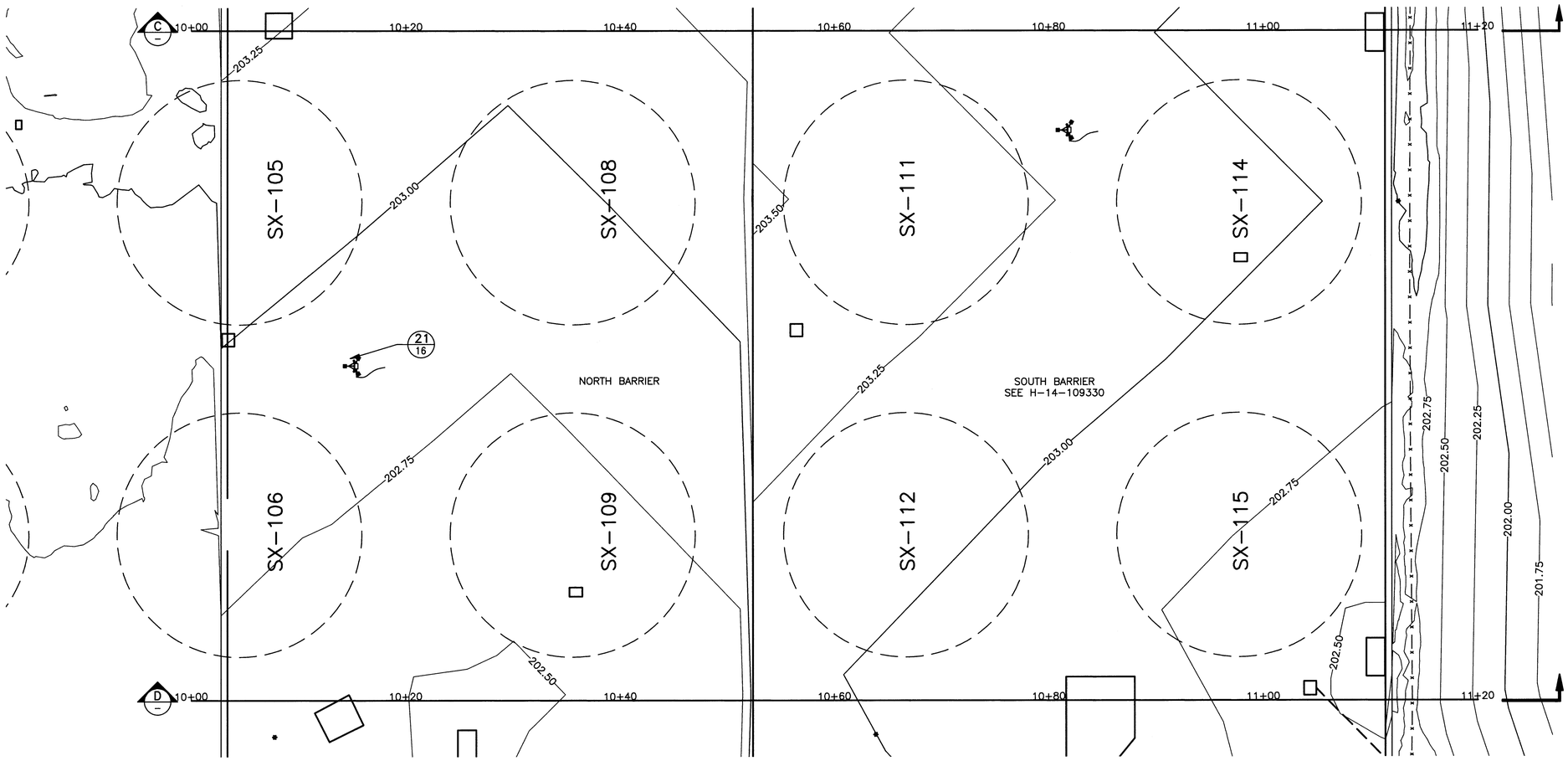
S U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
NORTH INTERIM
SURFACE BARRIER

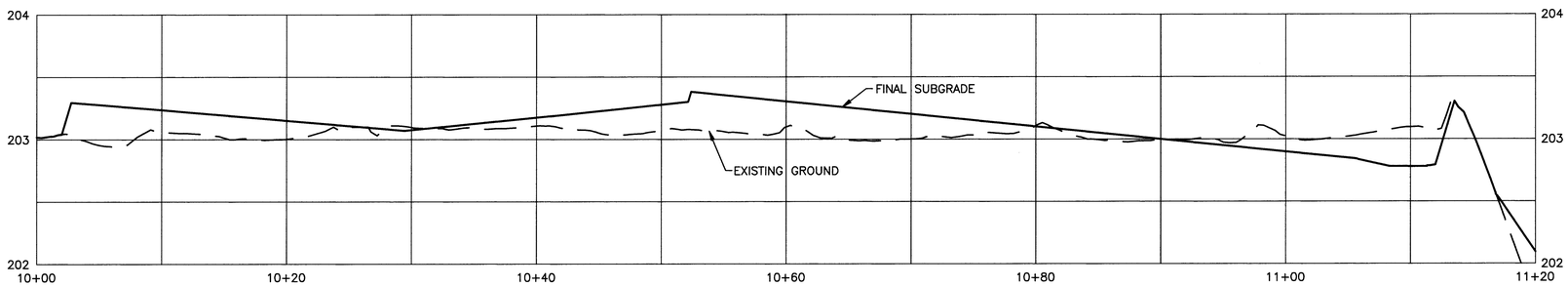
SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109446	0
SCALE AS SHOWN	EDT 824511		SHEET 2 OF	

DOE_TB_F.DWG (01-01)

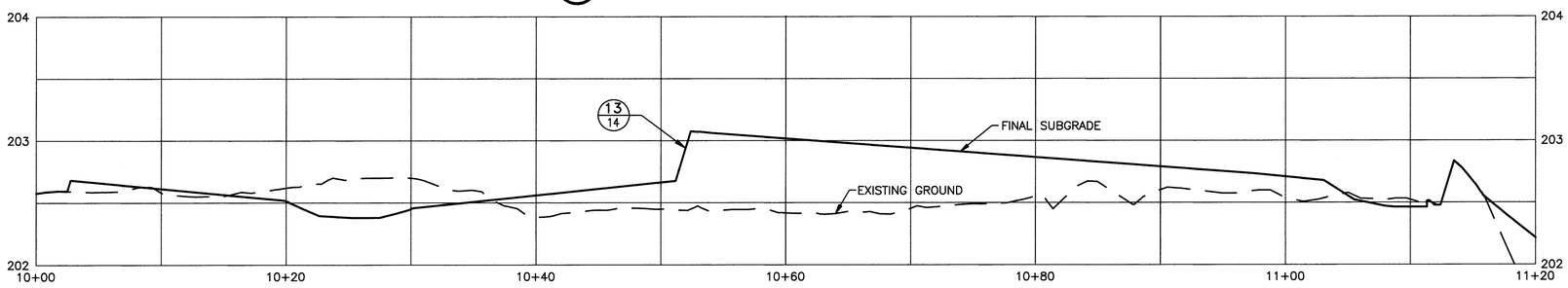
DWG NO H-14-109446 SH 2 OF REV 0



NORTH & SOUTH BARRIER SITE PLAN



C BARRIER PROFILE



D BARRIER PROFILE

15 0 15 30 SCALE IN FEET

5 0 5 10 SCALE IN METERS

MAY 24 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

NAME	DATE	COMPANY
DRAWN BY JGC	1/11	CCES
CHECKER	5/24/11	CCES
ENGINEER	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
NORTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109446	0

SCALE AS SHOWN | EDT 824511 | SHEET 3 OF

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

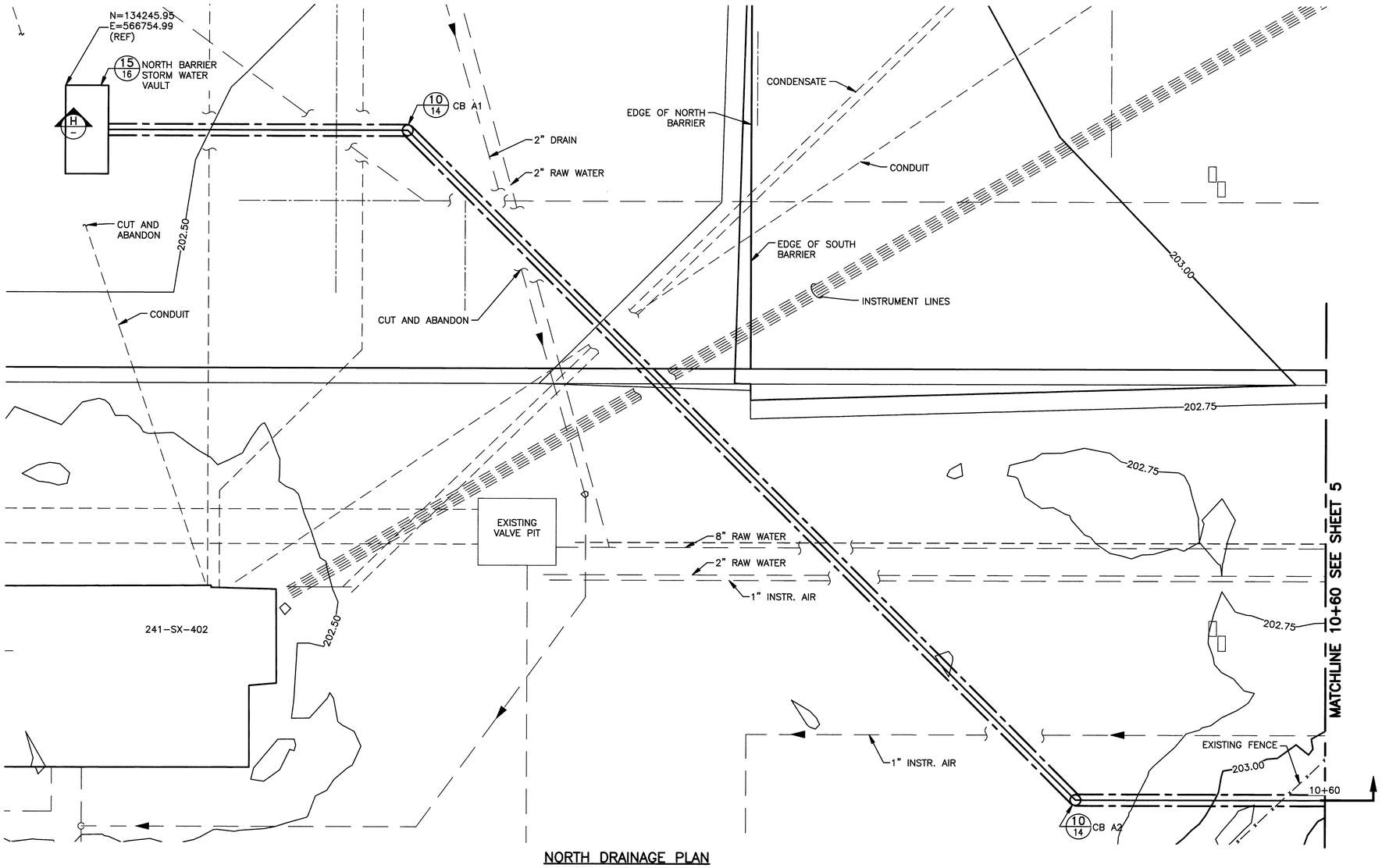
REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

MFD REV REL	REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
REVISIONS					

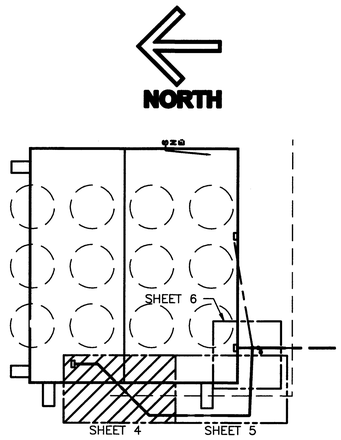
5057

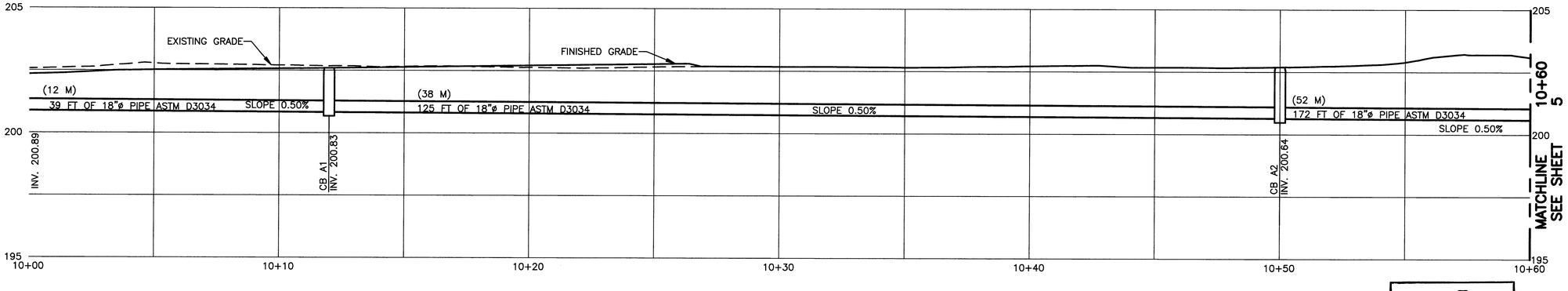
DOE_TB_F.DWG (01-01)

DWG NO H-14-109446 SH 3 OF REV 0



NORTH DRAINAGE PLAN





H NORTH DRAINAGE PROFILE

SCALE IN FEET (5 0 5 10)

SCALE IN METERS (2 0 2 4)

MAY 24 2011
DATE: STA: 3 HANFORD RELEASE ID: 3

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
REVISIONS				

NAME	DATE	COMPANY
DRAWN BY JGC		
CHECKER JT Fox	5/24/11	CHS
ENGINEER	5/11	WRPS

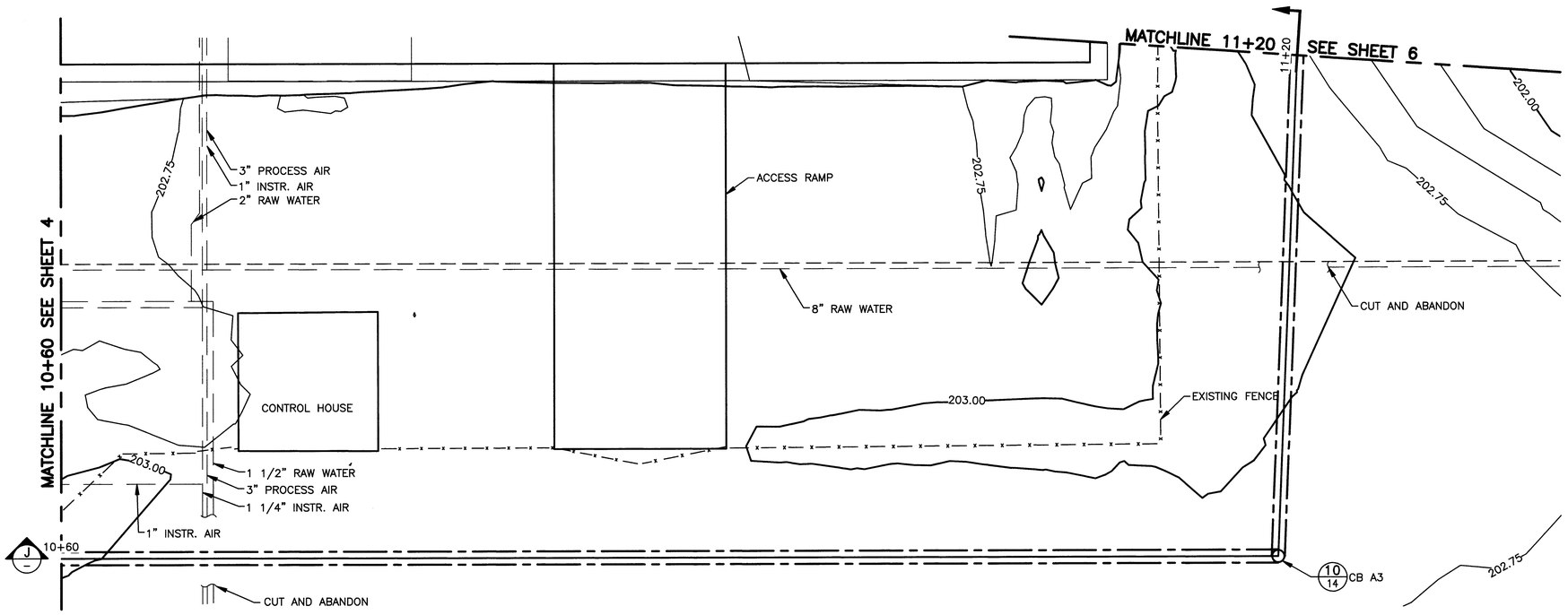
U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
NORTH INTERIM
SURFACE BARRIER

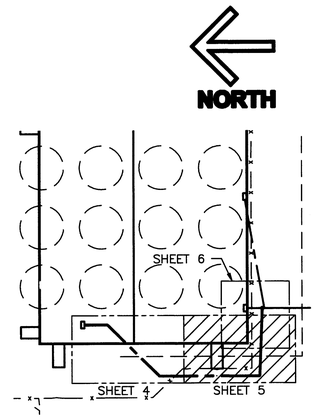
SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109446	0
SCALE AS SHOWN	EDT	824511	SHEET 4 OF	

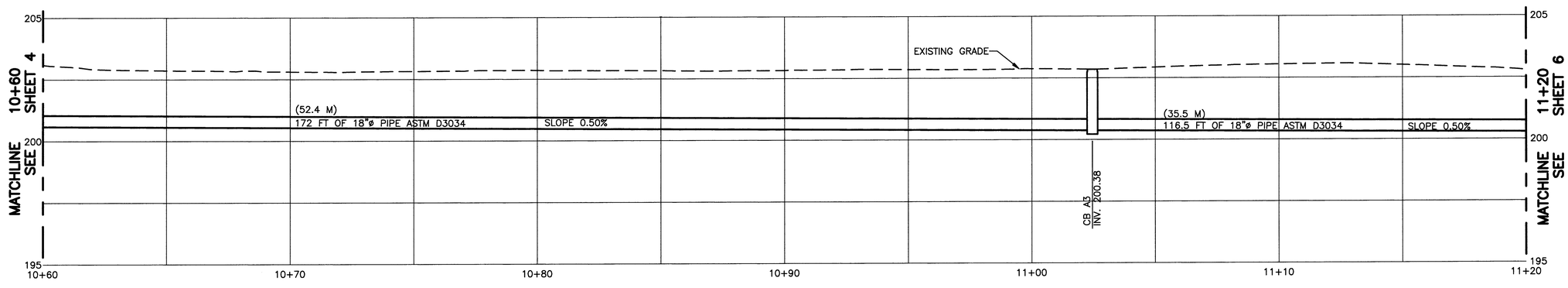
21208 DOE_TB_F.DWG (01-01)

REV 0 SH 4 OF DWG NO H-14-109446



NORTH DRAINAGE PLAN





J NORTH DRAINAGE PROFILE

5 0 5 10 SCALE IN FEET

2 0 2 4 SCALE IN METERS

MAY 24 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

NAME	DATE	COMPANY
DRAWN BY JGC	1/11	CCES
CHECKER STFOSS	5/11/11	CCES
ENGINEER MSHaim	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
NORTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109446	0

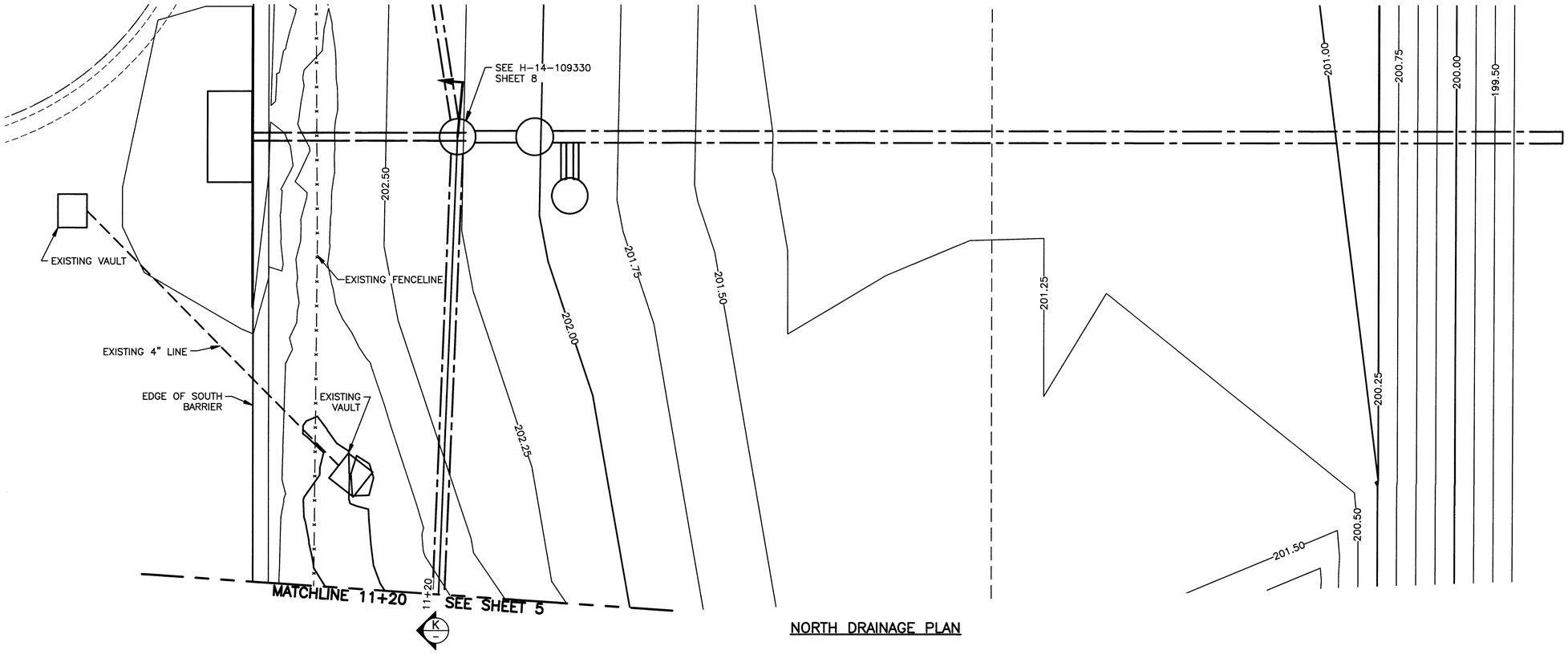
SCALE AS SHOWN | EDT 824511 | SHEET 5 OF

DOE_TB_F.DWG (01-01)

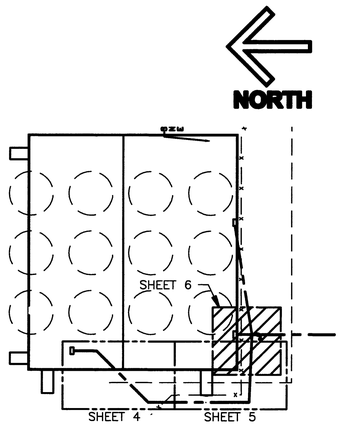
DWG NO	TITLE	REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		NEXT USED ON	REFERENCES

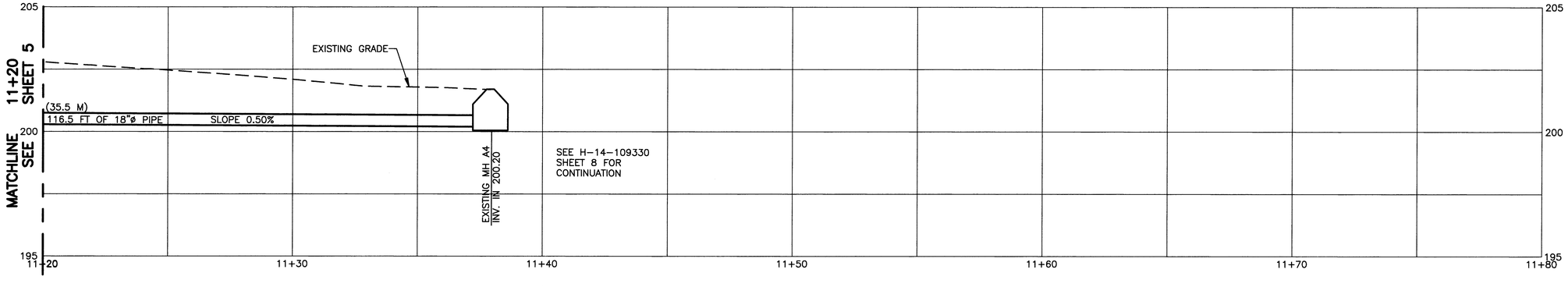
MFD	REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
REV REL		REVISIONS				

REV 0 | SH 5 OF | DWG NO H-14-109446



NORTH DRAINAGE PLAN





K NORTH DRAINAGE PROFILE

MAY 24 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

SCALE IN FEET (5 0 5 10)

SCALE IN METERS (2 0 2 4)

DWG NO	TITLE	REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
REVISIONS				

NAME	DATE	COMPANY
DRAWN BY JGC	1/11	CCES
CHECKED DT POU	5/9/11	CCES
ENGINEER	5/11	WRPS

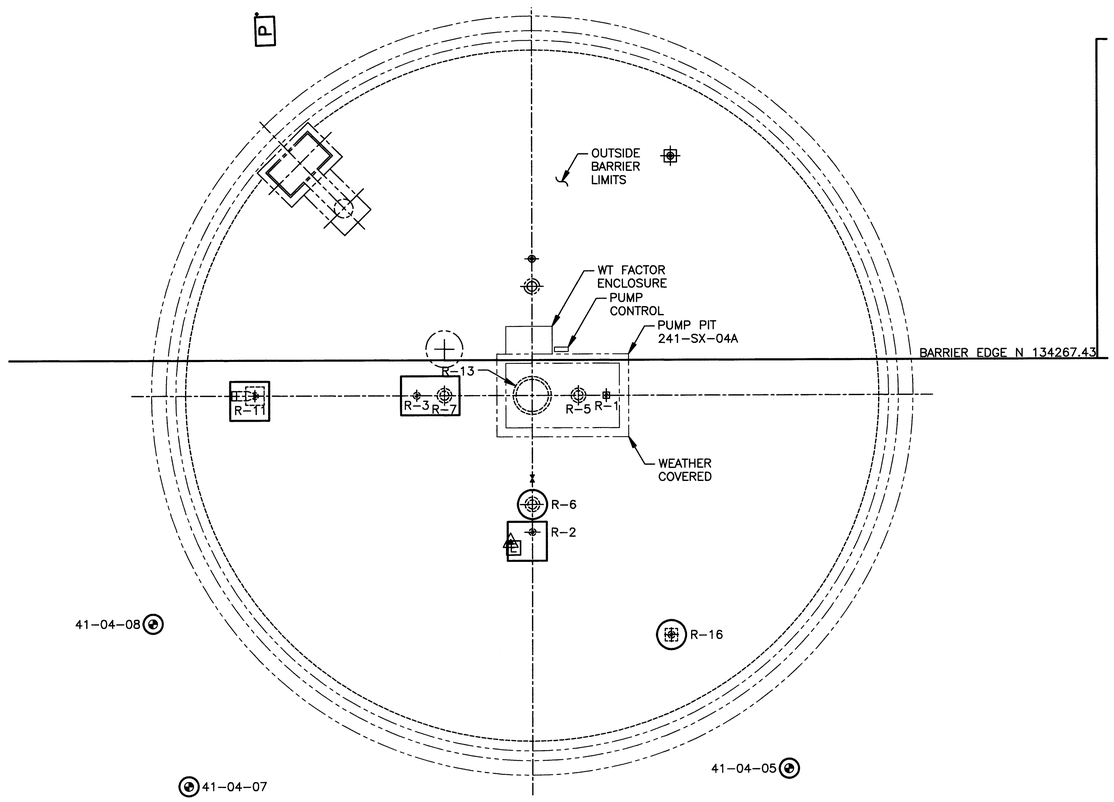
U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
NORTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109446	0
SCALE AS SHOWN	EDIT	824511	SHEET 6 OF	

24911 DOE_TB_F.DWG (01-01)

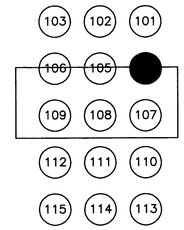
DWG NO H-14-109446 SH 6 OF REV 0



241-SX-104

RISER SUMMARY TABLE

RISER #	REF. ELEV. (FT)	SIZE (INCH)	FUNCITON/ DESCRIPTION	DETAIL	TYPE/ MODEL #	ACCESS REQ'D / LABEL	COMBINED W/RISER
R1		4	RECIRCULATING NOZZLE	12	–	NO	5, 13
R2	663.46	4	THERMOCOUPLE	11	CURBING	YES/ SX104-WST-TE-101	–
R3	663.38	4	SPARE	9	UTILITY VAULT 72"x48" (1 EA) NO. 64R-18	YES/ SX104-WST-RISER-003	7
R5		12	PUMP/RISER-005	12	–	NO	1, 13
R6	663.57	12	CRUST BREAKER	14	EXISTING 3'ø CMP	NO	–
R7		12	SPARE	9	UTILITY VAULT 72"x48" (1 EA) NO. 64R-18	NO	3
R11	663.43	4	VAPOR SAMPLE PROBE, OFFSET ADAPTER & AIR FILTER	9	UTILITY VAULT 72"x48" (3 EA) NO. 64R-18	YES/ SX104-WST-FLT-101	–
R13		42	SALTWELL JET PUMP	12	–	NO	1, 5
R16	663.65	4	L.O.W.	14	3'ø CMP W/LID	YES/ SX104-WST-LOW-101	–
			PUMP PIT 241-SX-04A	12	PAVE AROUND	NO	–
41-04-05		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-04-05	–
41-04-07		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-04-07	–
41-04-08		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-04-08	–



TANK FARM 241-SX

KEY PLAN

SCALE: NONE

LEGEND

- UTILITY POLE
- LIGHT POLE
- GUY WIRE
- JUNCTION BOX
- BOLLARD
- DRY WELLS
- SIGNS
- VALVE
- ELECTRICAL PULL BOX
- E — ELECTRICAL BOX
- P — PORTABLE SKID

NOTES: THIS SHEET ONLY

1. FOR DETAILS SEE SHEETS 13 THRU 16.

MAY 24 2011 DATE: STA: 3 HANFORD RELEASE ID: 3

NAME	DATE	COMPANY
DRAWN BY GA SCHELL	1/2011	CGS
CHECKED JT FOSC	5/24/11	CGS
ENGINEER MJ HAIG	5/11	WRGS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
NORTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109446	0

SCALE AS SHOWN | EDT 824511 | SHEET 7 OF

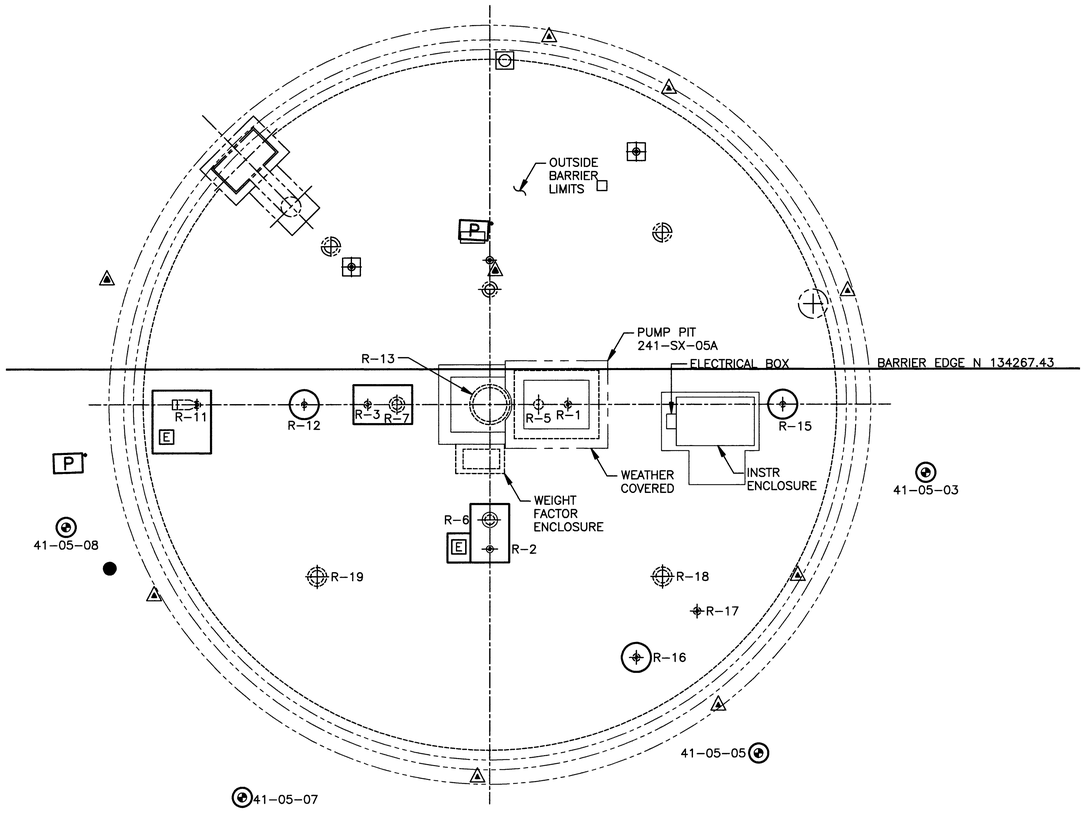
DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
NEXT USED ON	REFERENCES

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
REVISIONS					

13517 DOE_TB_F.DWG (01-01)

DWG NO H-14-109446 SH 7 OF REV 0



241-SX-105

NORTH

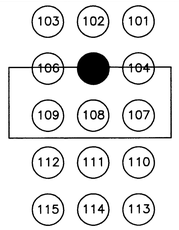
SCALE IN FEET: 5 0 5 10

SCALE IN METERS: 2 0 2 4

RISER SUMMARY TABLE

RISER #	REF. ELEV. (FT)	SIZE (INCH)	FUNCITON/ DESCRIPTION	DETAIL	TYPE/ MODEL #	ACCESS REQ'D / LABEL	COMBINED W/RISER
R1		4	RECIRCULATING NOZZLE	12	–	NO	5
R2	662.50	4	THERMOCOUPLE	9	UTILITY VAULT 72"x48" (1 EA) NO. 64R-12	YES/ SX105-WST-TE-101	6
R3	662.47	4	ENRAF 854 LEVEL GAUGE	9	UTILITY VAULT 72"x48" (1 EA) NO. 64R-12	YES/ SX105-WST-LIT-101	7
R5		12	TURBINE PUMP	12	–	NO	1
R6	662.48	12	OBSERVATION PORT	9	UTILITY VAULT 72"x48" (1 EA) NO. 64R-12	YES/ SX105-WST-LG-101	2
R7	662.47	12	(2) 1" DIP TUBES	9	UTILITY VAULT 72"x48" (1 EA) NO. 64R-12	NO	3
R11	662.62	4	STANDARD HYDROGEN MONITOR SYSTEM/AIR FILTER	11	CURBING	YES/ SX105-WST-FLT-101	ELECTRICAL BOX
R12	663.28	2 1/2	TEMPERATURE PROBE	14	3'ø CMP	NO	–
R13		42	SALTWELL	12	–	NO	–
R15	664.45	2 1/2	TEMPERATURE PROBE	14	3'ø CMP	NO	–
R16	663.10	4	L.O.W.	14	3'ø CMP W/LID	YES/ SX105-WST-LOW-101	–
R17		4	THERMOCOUPLE	6	PAVE OVER	NO	–
R18		16	AIR CIRCULATOR	6	PAVE OVER	NO	–
R19		16	SPARE	6	PAVE OVER	NO	–
			PUMP PIT 241-SX-05A	12	PAVE AROUND	NO	–
			WEIGHT FACTOR ENCLOSURE	12	PAVE AROUND	YES/ SX105-WST-WFT-101	–
			ELEC. BOX W OF R2	11	CURBING	NO	–
			INSTRUMENT ENCLOSURE	1	UTILITY VAULT SIZE AS REQD	NO	
			CONCRETE BOLLARD W. OF R19	4	PAVE AROUND	NO	–
41-05-03		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-05-03	–
41-05-05		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-05-05	–
41-05-07		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-05-07	–
41-05-08		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-05-08	–

NOTES: THIS SHEET ONLY
1. FOR DETAILS SEE SHEETS 13 THRU 16.



TANK FARM 241-SX
KEY PLAN
SCALE: NONE

LEGEND

- UTILITY POLE
- LIGHT POLE
- GUY WIRE
- JUNCTION BOX
- BOLLARD
- DRY WELLS
- SIGNS
- VALVE
- ELECTRICAL PULL BOX
- ELECTRICAL BOX
- PORTABLE SKID

MAY 24 2011 DATE: STA: 3 HANFORD RELEASE ID: B

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
REVISIONS				

NAME	DATE	COMPANY
DRAWN BY GA SCHELL	1/2011	CH2M
CHECKER JT FOU	5/10/11	CH2M
ENGINEER MT Hoag	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
NORTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109446	0

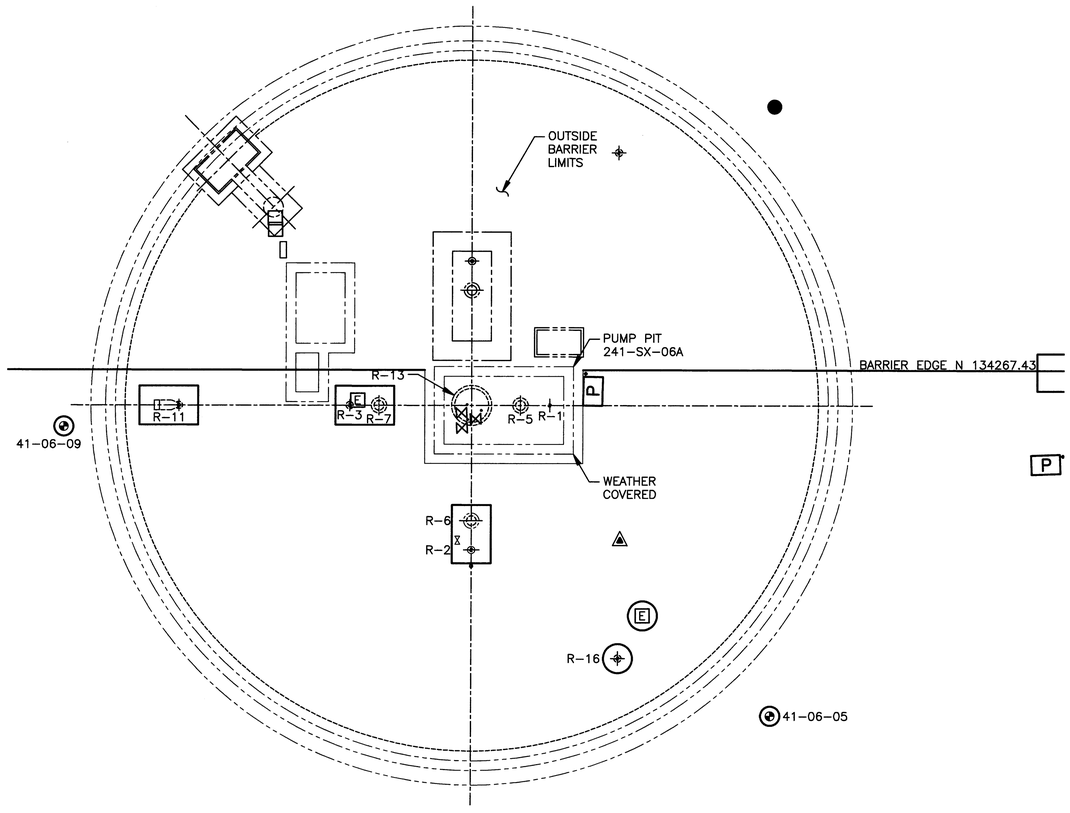
SCALE AS SHOWN EDT 824511 SHEET 8 OF

DWG NO H-14-109446 SH 8 OF REV 0

NORTH

5 0 5 10
SCALE IN FEET

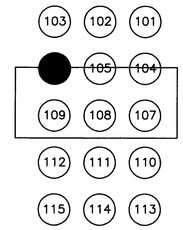
2 0 2 4
SCALE IN METERS



241-SX-106

RISER SUMMARY TABLE

RISER #	REF. ELEV. (FT)	SIZE (INCH)	FUNCITON/ DESCRIPTION	DETAIL	TYPE/ MODEL #	ACCESS REQ'D / LABEL	COMBINED W/RISER
R1		4	CONN NOZZLE	12	–	NO	5, 13
R2	661.46	4	TEMPERATURE PROBE	9	UTILITY VAULT 72"x48" (1 EA) NO. 64R-18	YES/ SX106-WST-TE-101	6
R3	661.47	4	ENRAF 854 LEVEL GAUGE	9	UTILITY VAULT 90"x60" (2 EA) NO. 576R-12	YES/ SX106-WST-LIT-101	7
R5		12	SALTWELL PUMP	12	–	NO	1, 13
R6	661.48	12	SPARE	9	UTILITY VAULT 72"x48" (1 EA) NO. 64R-18	YES/ SX106-WST-RISER-006	2
R7	661.43	12	DRY WELL	9	UTILITY VAULT 90"x60" (1 EA) NO. 576R-12	NO	3
R11	661.73	4	VAPOR SAMPLE PROBE OFFSET ADAPTER & AIR FILTER	9	UTILITY VAULT 72"x48" (2 EA) NO. 64R-18	NO	–
R13		42	SALTWELL	12	–	NO	1, 5
R16	661.86	12	SLUDGE PORT	14	3'ø CMP	YES/ SX106-WST-SLI-101	–
			PUMP PIT 241-SX-06A		CURBING	NO	–
			ELECTRICAL BOX N OF R16	14	3'ø CMP	NO	
41-06-05		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-06-05	–
41-06-09		6	DRY WELL	2	2'ø STEEL PIPE	YES/ 41-06-09	–



TANK FARM 241-SX
KEY PLAN
SCALE: NONE

LEGEND

- UTILITY POLE
- LIGHT POLE
- GUY WIRE
- JUNCTION BOX
- BOLLARD
- DRY WELLS
- SIGNS
- VALVE
- ELECTRICAL PULL BOX
- E — ELECTRICAL BOX
- P — PORTABLE SKID

NOTES: THIS SHEET ONLY

1. FOR DETAILS SEE SHEETS 13 THRU 16.

MAY 24 2011
DATE: HANFORD RELEASE ID:
STA: 3 3

NAME	DATE	COMPANY
DRAWN BY GA SCHELL	1/2011	CH2M
CHECKER JT POST	5/10/11	CH2M
ENGINEER	5/11	WRGS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241-SX
NORTH INTERIM
SURFACE BARRIER

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109446	0

SCALE AS SHOWN | EDT 824511 | SHEET 9 OF

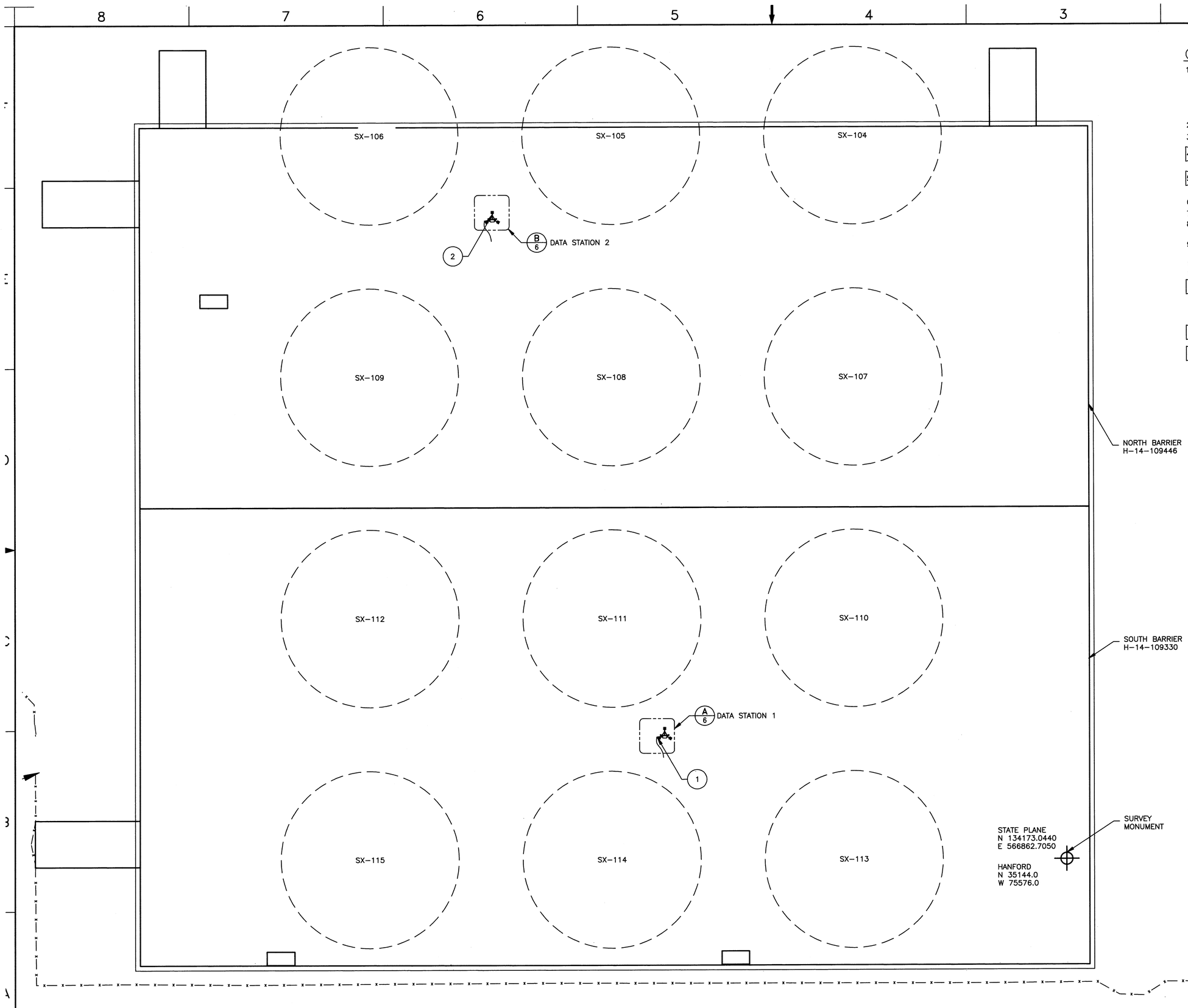
DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
REVISIONS				

2821 DOE_TB_F.DWG (01-01)

DWG NO H-14-109446 SH 9 OF REV 0



GENERAL NOTES: (UNLESS OTHERWISE SPECIFIED)

1. TOLERANCES SHALL BE AS FOLLOWS:
   FRACTIONS = ±1"
   ANGLES =±1°
   DIMENSIONS ARE IN INCHES.
2. REMOVE ALL BURRS AND BREAK SHARP EDGES.
3. TIGHTEN ALL FASTNERS SNUG TIGHT.
4. TRIPOD, JUNCTION BOXES, GUY WIRES, LIGHTNING ROD, SOLAR PANEL AND EARTH GROUNDING WILL BE FIELD ASSEMBLED.
5. INSTALL PER NEC GROUNDING REQUIREMENTS.
6. FOR INSTRUMENT NEST WELL INSTALLATION SEE SHEET 5.
7. BILL OF MATERIALS LOCATED ON SHEET 2.
8. 1" CONDUIT RUNS ARE SHOWN DIAGRAMMATICALLY, FIELD ROUTE AND SUPPORT AS REQUIRED FOR ALL WIRING EXITING PANELS INCLUDING BELOW GRADE.
9. ELECTRICAL INSTALLATIONS SHALL MEET THE REQUIREMENTS OF THE NATIONAL ELECTRICAL CODE (NEC) 2008.
10. ALL WIRES SHALL BE 22 AWG UNLESS OTHERWISE NOTED.
11. ALL COMPONENTS ARE MANUFACTURED BY CAMBELL SCIENTIFIC, INC.
12. FOR LABEL FABRICATION:
    REFERENCE NAMEPLATE LEGEND FOR CONTENT
    TEXT TYPE: BLOCK
    TEXT MATERIAL: PHENOLIC
    TEXT COLORS: BLACK ON WHITE BACKGROUND
13. SEAL PENETRATIONS WITH FLEX-FLOW EXPANSION JOINT COMPOUND IN ACCORDANCE WITH RPP-SPEC-49087 OR RPP-SPEC-49086 SECTION 32.
14. REFERENCE DRAWING H-14-109330 SHEET 20 DETAIL 24 AND H-14-109446 SHEET 16 DETAIL 21 FOR BARRIER PENETRATION DETAIL.

NORTH

5 0 5 10
SCALE IN METERS

15 0 15 30
SCALE IN FEET

MAY 24 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

DWG NO	TITLE
H-14-109330	SX FARM S. INTERIM BARRIER
H-14-109446	SX FARM N. INTERIM BARRIER

DRAWING TRACEABILITY LIST — REF NUMBER / TITLE — REFERENCES — NEXT USED ON

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY

REVISIONS

NAME	DATE	COMPANY
DRAWN BY JGC	2/11	CCES
CHECKER JT Fois	5/6/11	CCES
ENGINEER	5/11	WRPS

S U.S. DEPARTMENT OF ENERGY
Office of River Protection

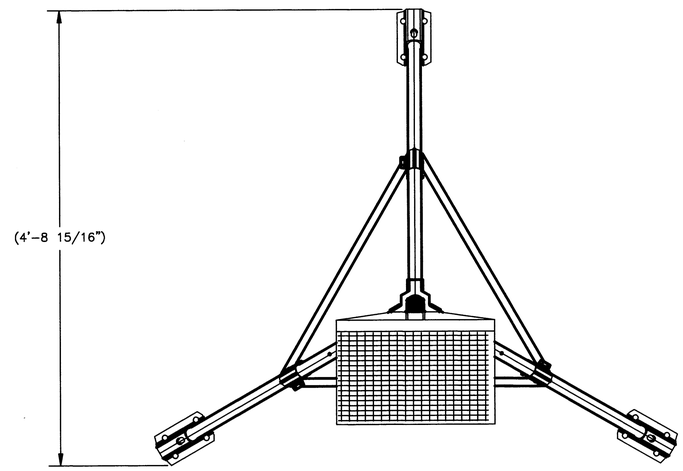
241 SX TANK FARM INTERIM SURFACE BARRIER MONITORING SYSTEM

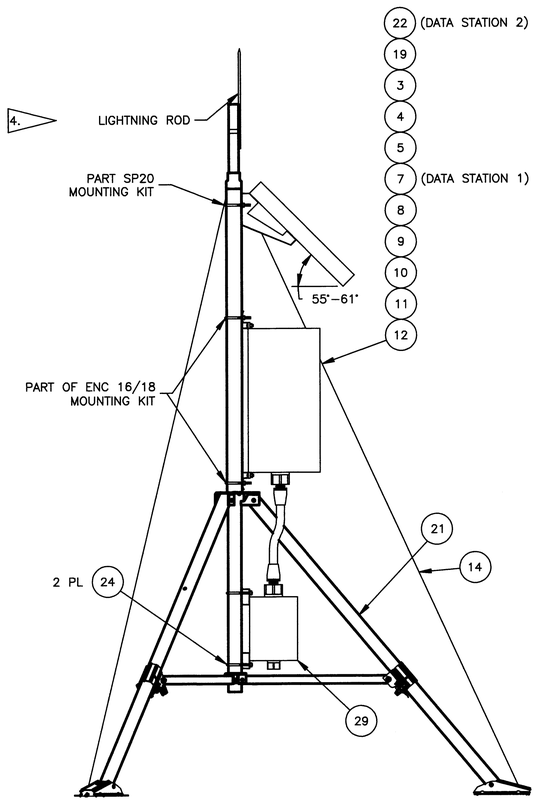
SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109447	0

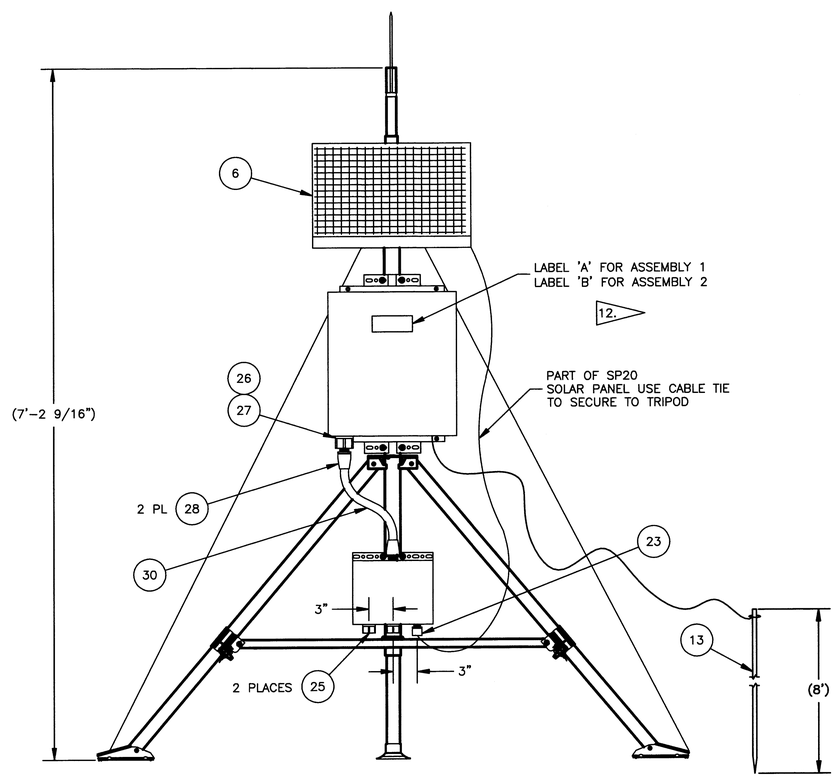
SCALE AS SHOWN — EDIT 824510 — SHEET 1 OF 7

19319 — DOE_TB_F.DWG (01-01)

DWG NO H-14-109447 SH 1 OF 7 REV 0







1 DATA STATION #1 ASSEMBLY
SCALE: 1 1/2"=1'

2 DATA STATION #2 ASSEMBLY
SCALE: 1 1/2"=1'

PARTS LIST/MATERIAL LIST

	QTY REQD -020	QTY REQD -010	PARTS / DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO
		X	-010	DATA STATION #1 ASSEMBLY		1	1
	X		-020	DATA STATION #2 ASSEMBLY		1	2
	1	1	CR1000-ST-SE-CC	MEASUREMENT & CONTROL DATALOGGER, CR1000	CAMPBELL SCIENTIFIC	2	3
	1	1	BP12	12V SEALED RECHARGEABLE BATTERY W/MOUNTS, 12AHR	CAMPBELL SCIENTIFIC	2	4
	1	1	CH100-SW	12V CHARGER/REGULATOR, CH100	CAMPBELL SCIENTIFIC	2	5
4.	1	1	SP20	20W SOLAR PANEL, 15' CABLE	CAMPBELL SCIENTIFIC	2	6
	0	1	CE8-SW	8-CHANNEL CURRENT EXCITATION MODULE	CAMPBELL SCIENTIFIC	2	7
	1	1	RF401-ST	900MHZ SPREAD SPECTRUM RADIO	CAMPBELL SCIENTIFIC	2	8
	1	1	14291	FIELD POWER CABLE 12VDC PLUG TO PIGTAIL, 2'	CAMPBELL SCIENTIFIC	2	9
	1	1	14162	RF401, RF411, OR RF416 MOUNTING KIT	CAMPBELL SCIENTIFIC	2	10
	1	1	14204	9000MHZ ODBD OMNI 1/2 WAVE WHIP ANTENNA W/RIGHT ANGLE & RPSMA FEMALE	CAMPBELL SCIENTIFIC	2	11
	1	1	15873-52	WEATHER RESISTANT 16"X18" ENCLOSURE -SC 1 CONDUIT FOR CABLES -MM TRIPOD MAST MOUNTING	CAMPBELL SCIENTIFIC	2	12
5. 4.	2	2		HRD GROUNDING ROD BONDED COPPER ø1/2" X 8' LONG	COMMERCIAL	2	13
4.	1	1	10844	TRIPOD GUY KIT, 12' CABLES, CM10	CAMPBELL SCIENTIFIC	2	14
	3	3		THREADED ROD, 1/2-13UNC-2A, 4" L	COMMERCIAL	6	15
	3	3		NUT, 1/2-13UNC-2B	COMMERCIAL	6	16
	3	3		WASHER, 1/2"	COMMERCIAL	6	17
	3	3		CONCRETE PIER BLOCK, 12" X 12" 8"	COMMERCIAL	6	18
	1	1	16505-8	DATA LOGGER TO SDI-12 INTERFACE CABLE 15' PER SENSOR CABLE	CAMPBELL SCIENTIFIC	2	19
	AR	AR		ANCHOR CEMENT	HIGH STRENGTH EPOXY TIE	4	20
	1	1	CM6	6FT TRIPOD WITH GROUNDING KIT, CM6	CAMBELL SCIENTIFIC	2	21
	2			4-CHANNEL CURRENT EXCITATION MODULE, CE4	CAMBELL SCIENTIFIC	4	22
4.	1	1	50350	TIGHT RELIEF CORD CONNECTOR	ARLINGTON INDUSTRIES	2	23
4.	2	2	AMPOLEMNT10	POLE MOUNT BRACKET	ALLIED MOULDED PRODUCTS	2	24
4.	2	2	82046	1" EMT RAIN TIGHT COMPRESSION CONNECTOR	ARLINGTON INDUSTRIES	2	25
	1	1	CHM-125DT	1 1/4" WATER TIGHT HUB	O-Z GEDNEY	2	26
	1	1	RB-325S	1 1/4" TO 3/4" REDUCING BUSHING	O-Z GEDNEY	2	27
4.	2	2	LT43E-NEW	LIQUID TIGHT 3/4" STARIGHT FITTING	CARLON	2	28
4.	1	1	AM1086	SPARE CABLE JUNCTION BOX	ALLIED MOULDED PRODUCTS	2	29
4.	1	1	15007-100	3/4" LIQUID TIGHT FLEXIBLE CONDUIT	CARLON	2	30
		1	257	SOIL WATER POTENTIAL SENSOR 257	CAMPBELL SCIENTIFIC	7	31
	AR	AR	229-L	WATER MATRIC POTENTIAL SENSOR	CAMPBELL SCIENTIFIC	7	32
							33

EQUIPMENT LABELING SCHEDULE

	SIZE(in) H x W	TEXT SIZE	TEXT
A	2 x 5	1/4	DATA STATION #1 H-14-109477-010
B	2 X 5	1/4	DATA STATION #2 H-14-109477-020

MAY 24 2011
DATE: STA: 3 HANFORD RELEASE ID: 3

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
REVISIONS				

NAME	DATE	COMPANY
DRAWN BY JGC	1/11	
CHECKER ST Foss	5/10/11	CH2M HILL
ENGINEER MJ Elder	5/11	WRPS

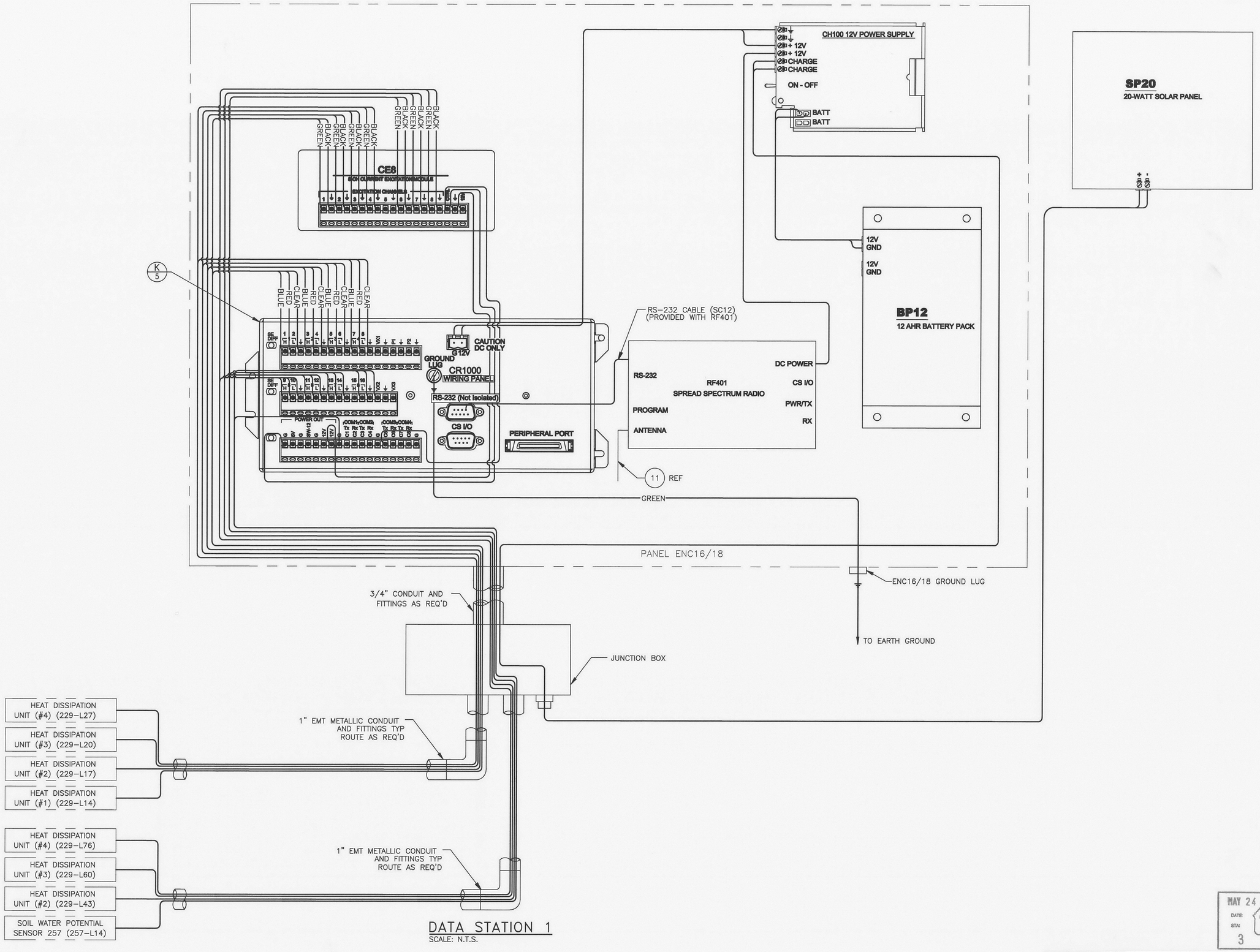
U.S. DEPARTMENT OF ENERGY
Office of River Protection

241 SX TANK FARM
INTERIM SURFACE BARRIER
MONITORING SYSTEM

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109447	0

SCALE AS SHOWN | EDT 824510 | SHEET 2 OF
31864
DOE_TB_F.DWG (01-01)

DWG NO H-14-109447 SH 2 OF REV 0



DATA STATION 1

SCALE: N.T.S.

MAY 24 2011
DATE: HANFORD RELEASE ID:
STA: 3 3

NAME	DATE	COMPANY
DRAWN BY JCC	1/11	CCES
CHECKER ST FOSS	5/10/2011	CCES
ENGINEER	5/11/2005	

U.S. DEPARTMENT OF ENERGY
Office of River Protection

241 SX TANK FARM INTERIM SURFACE BARRIER MONITORING SYSTEM

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109447	0

SCALE AS SHOWN | EDT 824510 | SHEET 3 OF

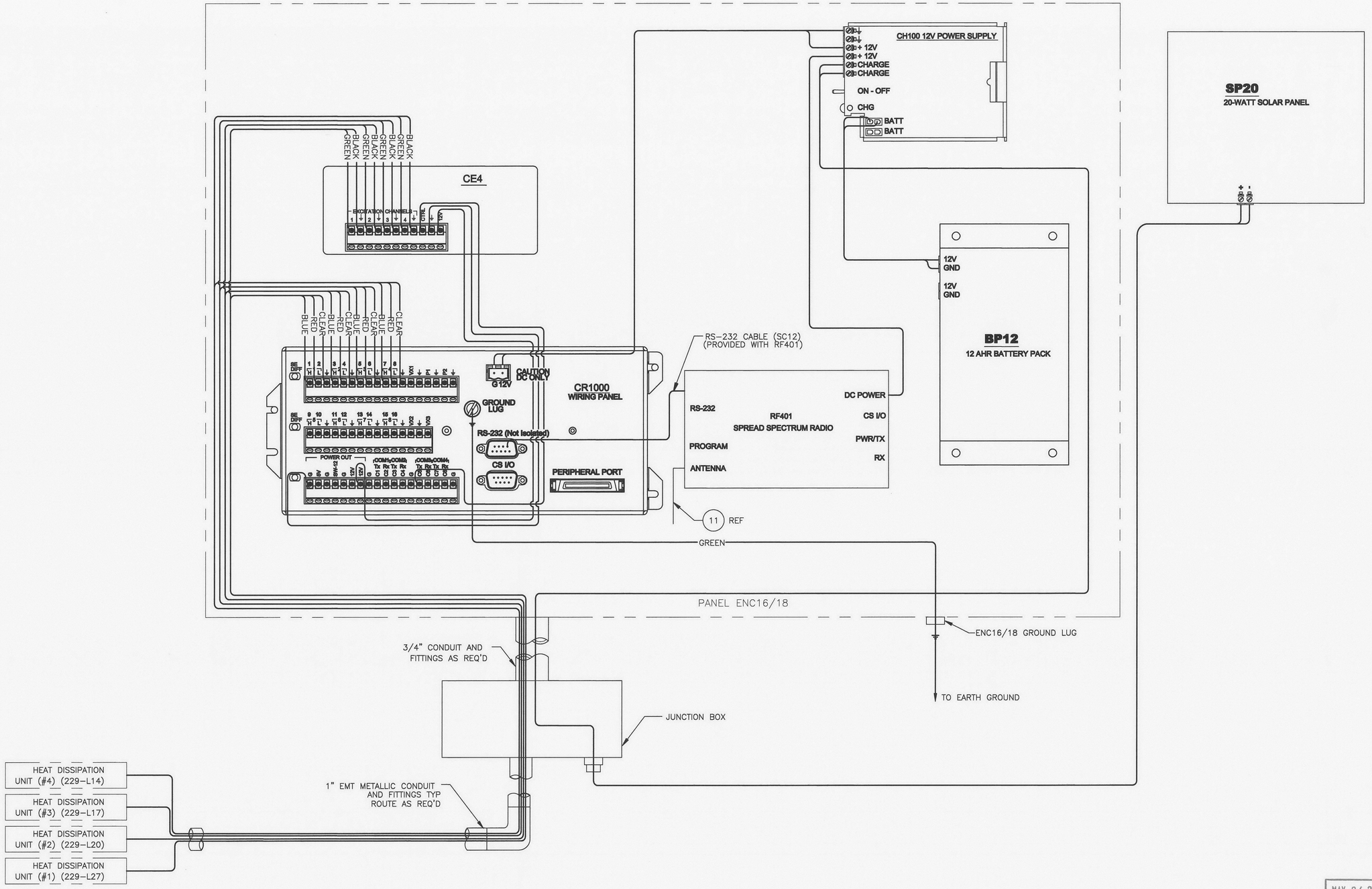
DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
NEXT USED ON	REFERENCES

MFD	REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
REV REL		REVISIONS				

10396 DOE_TB_F.DWG (01-01)

DWG NO H-14-109447 SH 3 OF REV 0



DATA STATION 2

SCALE: N.T.S.

MAY 24 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

DWG NO	TITLE
	DRAWING TRACEABILITY LIST

REF NUMBER	TITLE
	REFERENCES
NEXT USED ON	

MFD REV REL	REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
		REVISIONS			

	NAME	DATE	COMPANY
DRAWN BY	JGC	3/11	CEES
CHECKER	JT Foss	5/10/11	CEES
ENGINEER	MJ Hdm	5/11	WRPS

S U.S. DEPARTMENT OF ENERGY
Office of River Protection

241 SX TANK FARM INTERIM SURFACE BARRIER MONITORING SYSTEM

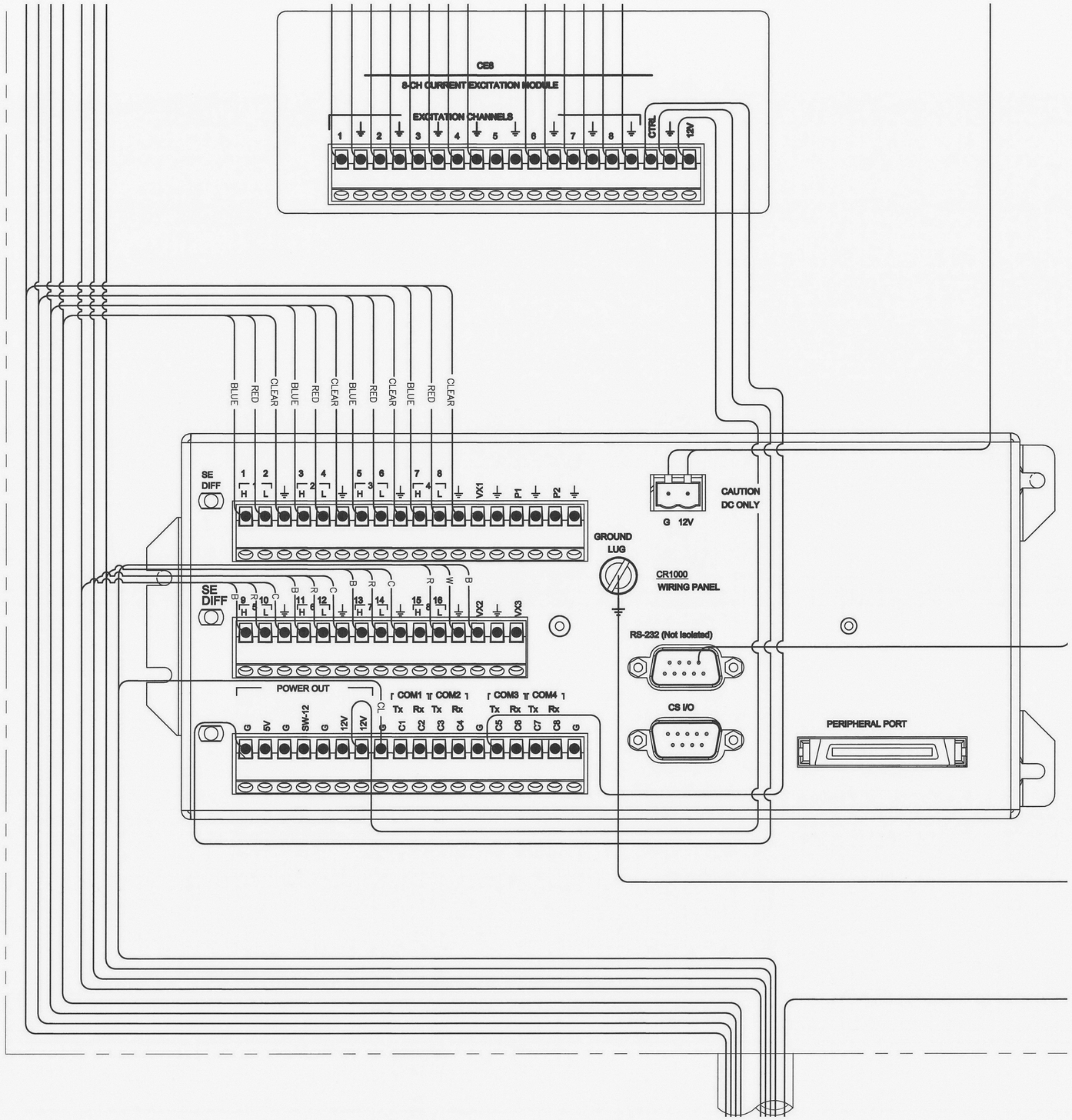
SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109447	0

SCALE AS SHOWN | EDT 824510 | SHEET 4 OF

16436

DOE_TB_F.DWG (01-01)

DWG NO H-14-109447 SH 4 OF REV 0



K 3 DETAIL
SCALE: N.T.S.

MAY 24 2011
DATE: STA: 3 HANFORD RELEASE ID: 3

DRAWING TRACEABILITY LIST			
DWG NO	TITLE	REF NUMBER	TITLE
		NEXT USED ON	REFERENCES

REVISIONS						
MFD	REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
REV REL						

NAME	DATE	COMPANY
DRAWN BY LGC	1/11	CEES
CHECKER JT Foss	5/10/11	CEES
ENGINEER MJ Hahn	5/11	WRPS

S U.S. DEPARTMENT OF ENERGY
Office of River Protection

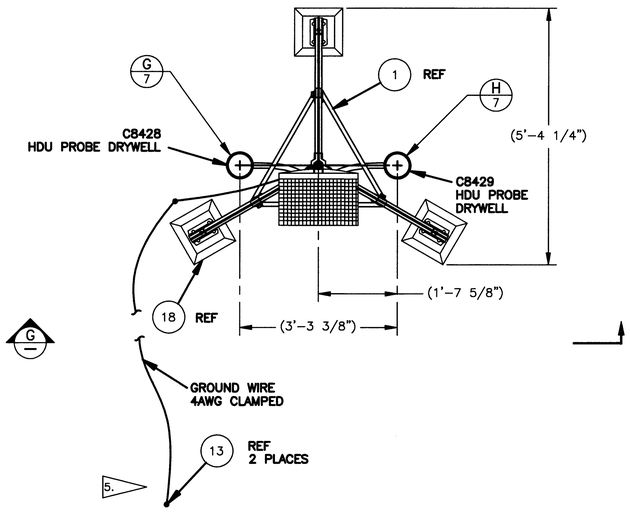
241 SX TANK FARM
INTERIM SURFACE BARRIER
MONITORING SYSTEM

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109447	0
SCALE AS SHOWN	EDT	824510	SHEET 5 OF	

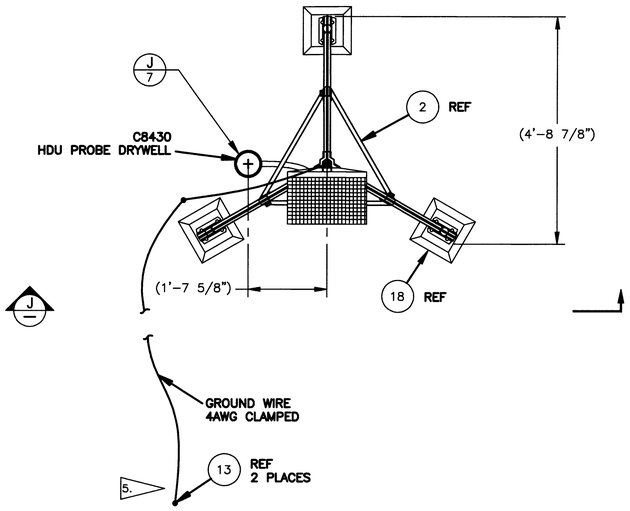
15099 DOE_TB_F.DWG (01-01)

DWG NO H-14-109447 SH 5 OF REV 0

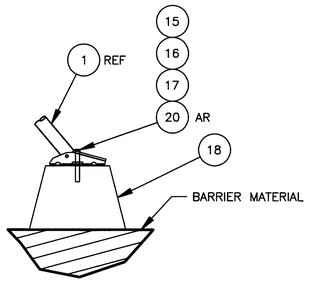
DRYWELL NUMBER	HANFORD COORDINATES	WASHINGTON STATE PLANE COORDINATES (FT)
C8428	N 35197.164 W 75747.009	N 440252.203 E 1859611.241
C8429	N 35197.164 W 75743.728	N 440252.236 E 1859614.522
C8430	N 35415.492 W 75818.428	N 440470.346 E 1859539.293



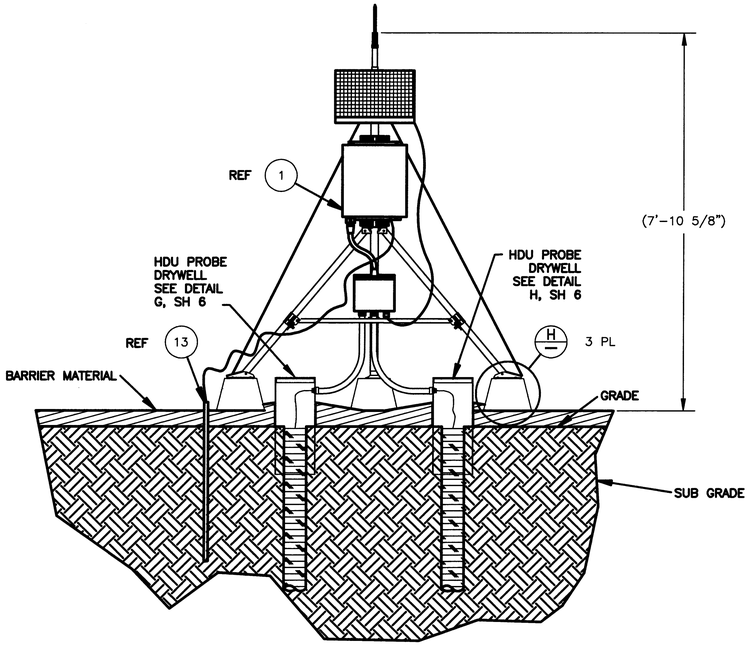
A/1 DATA STATION #1
SCALE: 3/4"=1'



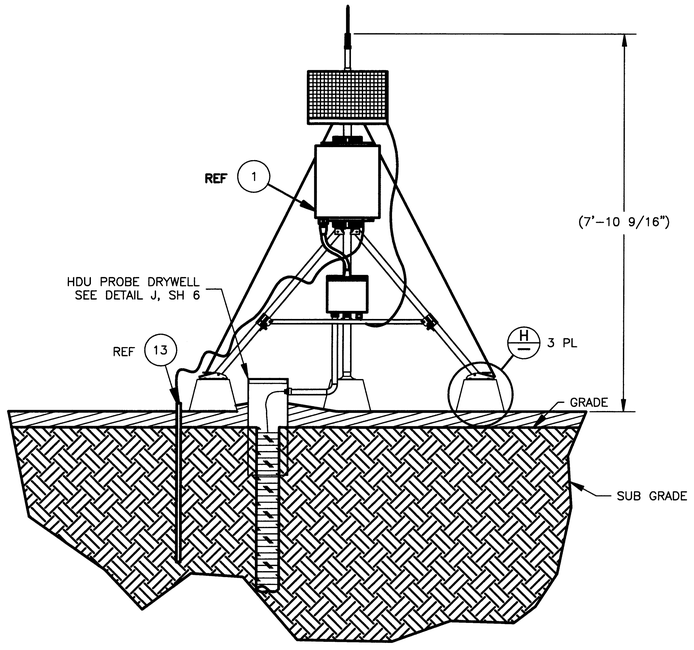
B/1 DATA STATION #2
SCALE: 3/4"=1'



H/— DETAIL
SCALE: 1 1/2"=1'



G/— SOUTH BARRIER
SCALE: 3/4"=1'



J/— NORTH BARRIER
SCALE: 3/4"=1'

MAY 24 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
NEXT USED ON	REFERENCES

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR	COMPANY
REVISIONS					

NAME	DATE	COMPANY
DRAWN BY JGC	1/11	CEES
CHECKER ST Fox	5/10/11	
ENGINEER	5/11	WRPS

U.S. DEPARTMENT OF ENERGY
Office of River Protection

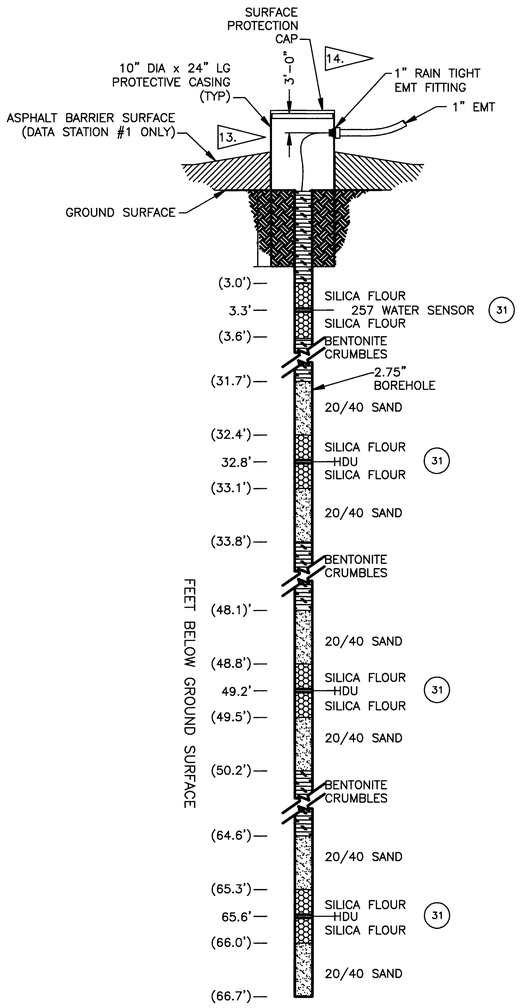
241 SX TANK FARM
INTERIM SURFACE BARRIER
MONITORING SYSTEM

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109447	0

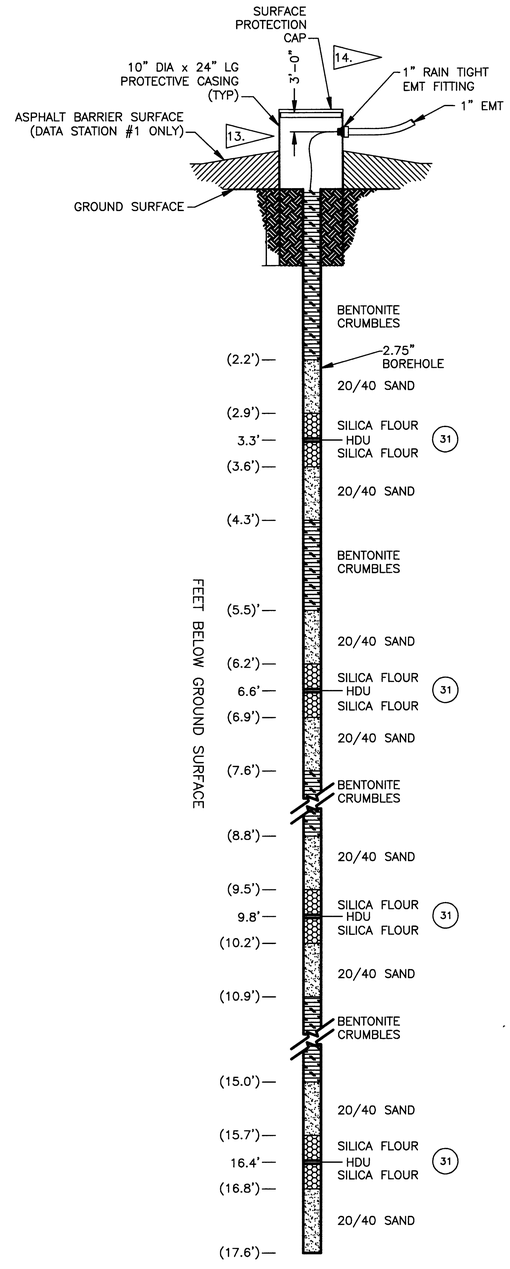
SCALE AS SHOWN | EDT 824510 | SHEET 6 OF

DOE_TB_F.DWG (01-01)

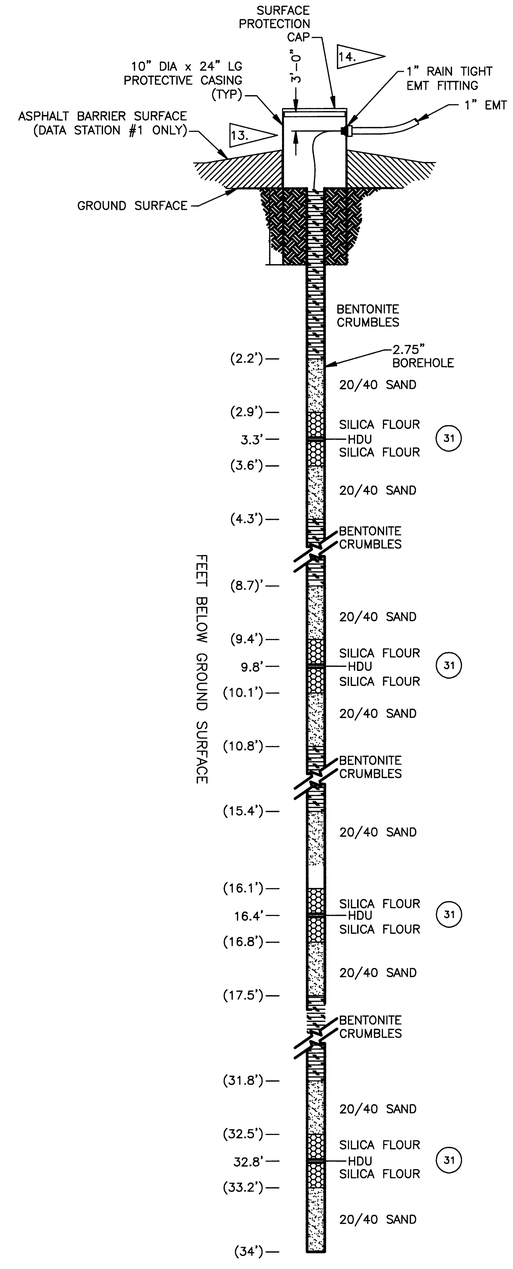
DWG NO H-14-109447 SH 6 OF REV 0



G 6 HDU PROBE DRYWELL
SCALE: N.T.S.
NOTE: BACKFILL DIMENSIONS ARE APPROXIMATE



H 6 HDU PROBE DRYWELL
SCALE: N.T.S.
NOTE: BACKFILL DIMENSIONS ARE APPROXIMATE



J 6 HDU PROBE DRYWELL
SCALE: N.T.S.
NOTE: BACKFILL DIMENSIONS ARE APPROXIMATE

MAY 24 2011
DATE:
STA: 3
HANFORD RELEASE
ID: 3

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
REFERENCES	
NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHECKER DATE	ENGR COMPANY
REVISIONS				

NAME	DATE	COMPANY
DRAWN BY JGC	1/11	GEES
CHECKED JT Ross		
ENGINEER	5/11	WRPS

S U.S. DEPARTMENT OF ENERGY
Office of River Protection

241 SX TANK FARM
INTERIM SURFACE BARRIER
MONITORING SYSTEM

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	241SX	0110	H-14-109447	0

SCALE AS SHOWN | EDT 824510 | SHEET 7 OF

DWG NO H-14-109447 SH 7 OF REV 0

S

RPP-CALC-48447, Rev. 0

Calculation Package for the SX Tank Farm Interim Surface Barrier

C. Henderson, Columbia Energy and Environmental Services, Inc. for
Washington River Protection Services, LLC
Richland, WA 99352
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Abstract: This document consists of a compilation of calculations supporting the design, and installation of the 241-SX Tank Farm Interim Surface Barrier.

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Calculation Package for the SX Tank Farm Interim Surface Barrier

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1.0 INTRODUCTION

This document is a compilation of the calculations prepared for the 241-SX tank farm North and South interim surface barriers. The design drawings for the 241-SX tank farm North interim surface barrier includes, H-14-109446, *241-SX Tank Farm North Interim Surface Barrier* and the 241-SX tank farm South interim surface barrier includes, H-14-109330, *241 SX Tank Farm South Interim Surface Barrier*. Each calculation is summarized individually in Section 3.0, with the complete calculations included as appendices to this document.

2.0 REQUIREMENTS

All calculations contained herein have been prepared in accordance with the requirements specified in RPP-SPEC-47469, *SX Tank Farm Interim Surface Barrier Subsystem Specification.*

3.0 SUMMARY OF RESULTS

This section summarizes the calculations performed in support of the 241-SX tank farm interim surface barriers.

3.1 STORM WATER RUNOFF ANALYSIS AND CONVEYANCE SYSTEM SIZING

Appendix A contains the storm water runoff analysis and sizing for two 241-SX tank farm interim surface barriers at the 200 West Area of the Hanford Site. The runoff analysis, volumes and flow rates provide a basis for sizing the collection and conveyance system for both barriers.

The calculation shows that the peak runoff flow rate for the South barrier is estimated to be 5.36 cubic feet per second and the 25-year, 24-hour storm water volume is estimated to be 9,560 cubic feet. The North barrier is estimated to be 4.15 cubic feet per second and the 25-year, 24-hour storm water volume is estimated to be 7,394 cubic feet. Calculations are provided that show the storm water collection and conveyance system is adequately sized to accommodate the flow and volume for both barriers.

3.2 EARTHWORK VOLUME

Appendix B contains an estimate of the earth work volumes associated with construction of the 241-SX Tank Farm South Interim Surface Barrier and SX Interim North Interim Surface Barrier.

Based on a comparison of the existing tank farm surface and the barrier surface, the estimated earthwork volumes for in-farm construction are 2,014 cubic yards (1,841 cubic meters) added for the South Barrier and 1,196 cubic yards (1,093 cubic meters) added for the North Barrier. The total earthwork volumes are estimated at a net 616 cubic yards (563 cubic meters) removed.

3.3 TANK LOADING

Appendix C contains the analysis of the increase in soil cover height associated with construction of the North barrier and South barrier. This calculation was performed to confirm that the additional cover heights were within the allowable soil heights above the tank domes. Also the concentrated loads associated with the clearance features added around risers and structures were calculated and compared to the allowable loads for each tank.

The calculation shows that the additional fill material plus the adjusted asphalt depth results in soil heights ranging from 6.55 feet to 8.61 feet. This is compared to an allowable height of 9.64 feet at a soil density of 115 lbf/ft^3.

3.4 EVAPOTRANSPIRATION BASIN SIZING

Appendix D contains an analysis of the basin for the disposition of stormwater runoff collected from the barriers. The basin is sized to accommodate the runoff from the North and South barriers as well as the precipitation that falls on the basin area.

Initial sizing of the basin was performed based on the TY interim surface barrier design to maintain the ratio of evaporative area to interim surface area. The basin area at the top of the backfill is shown to be 92,200 square feet.

The basin design provides for storage of approximately 1.5 ft of ponded water on top of the backfill. The total holding capacity of the basin within the soil pore space and in the available freeboard above the backfill surface is 278,000 cubic feet. The available freeboard above the top of the backfill provides for storage of 138,300 cubic feet. The total holding capacity of the basin provides for storage of 12.7 inches of precipitation which exceeds the maximum annual precipitation recorded of 12.31 inches.

The basin was analyzed using the Hydrologic Evaluation of Landfill Performance Version 3 model (HELP3). After adjusting the annual precipitation rate to 13.76 inches to account for precipitation that falls on the basin plus runoff from the barriers, results indicate an average evapotranspiration rate of 13.7 inches and an average head on top of the liner of approximately 5 inches.

3.5 BARRIER COVERAGE

Appendix E contains the evaluation of the open areas on the interim surface barrier to confirm that the open area does not exceed 5 percent of the barrier footprint in accordance with RPP-SPEC-47469.

The calculation shows that the open area associated with the various penetration details for the risers and miscellaneous equipment is 1,043 square feet for the North Barrier and 1,734 square feet for the South Barrier. This is in relation to the footprint of the interim surface barrier of 64,347 square feet for the North Barrier and 77,479 square feet for the South Barrier. The total open area is 1.62 percent of the footprint area for the North Barrier and 2.24 percent for the South Barrier.

4.0 REFERENCES

See attached calculations.

APPENDIX A

STORM WATER RUNOFF ANALYSIS AND CONVEYANCE SYSTEM SIZING

LIST OF TRADEMARKS

Excel	Registered trademark of the Microsoft Corporation.
FlowMaster	Registered trademark of Bentley Systems.
MatCon	Trademark of Matcon, Inc.
MathCAD	Registered trademark of Parametric Technology Corporation.

SUBCONTRACTOR CALCULATION REVIEW CHECKLIST

Subject: STORM WATER RUNOFF ANALYSIS AND CONVEYANCE SYSTEM SIZING

The subject document has been reviewed by the undersigned.
The reviewer reviewed and verified the following items as applicable.

Documents Reviewed: RPP-CALC-48447, Rev. 0, Appendix A

Analysis Performed By: Columbia Energy

- Design Input
- Basic Assumptions
- Approach/Design Methodology
- Consistency with item or document supported by the calculation
- Conclusion/Results Interpretation
- Impact on existing requirements

MJ Holm — 5-23-2011
Reviewer (Print/Sign) — Date

CJ ALDERMAN — 05/23/2011
Organizational Manager (Print/Sign) — Date

CALCULATION REVIEW CHECKLIST

Calculation Reviewed: Storm Water Runoff Analysis and Conveyance System Sizing

Scope of Review: Entire Calculation

(e.g., document section or portion of calculation)

Engineer/Analyst: Michael Black Michael Black Date: 5/9/11

(printed name and signature)

Organizational Manager: Colin Henderson Col Hend Date: 5/9/11

(printed name and signature)

This document consists of 3 pages and the following attachments (if applicable): ATTACHMENT A1: FLOWMASTER A2: PIPE SIZING A3: STORM VOLUME / FLOW A4: INLET CAPACITY A5: ADS CAPACITY A6: HYDROLOGY MODEL

Yes	No	N/A*		
[X]	[ ]	[ ]	1.	Analytical and technical approaches and results are reasonable and appropriate.
[ ]	[ ]	[X]	2.	Necessary assumptions are reasonable, explicitly stated, and supported.
[X]	[ ]	[ ]	3.	Ensure calculations that use software include a paper printout, microfiche, CD-ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
[X]	[ ]	[ ]	4.	Input data were checked for consistency with original source information.
[X]	[ ]	[ ]	5.	Key input data (e.g., dimensions, performance characteristics) that may affect equipment design is identified.
[ ]	[ ]	[X]	6.	For both qualitative and quantitative data, uncertainties are recognized and discussed and the data is presented in a manner to minimize design interpretations.
[X]	[ ]	[ ]	7.	Mathematical derivations were checked, including dimensional consistency of results.
[X]	[ ]	[ ]	8.	Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information.
[X]	[ ]	[ ]	9.	Software verification and validation are addressed adequately.
[X]	[ ]	[ ]	10.	Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
[X]	[ ]	[ ]	11.	Conclusions are consistent with analytical results and applicable limits.
[X]	[ ]	[ ]	12.	Results and conclusions address all points in the purpose.
[X]	[ ]	[ ]	13.	Referenced documents are retrievable or otherwise available.
[X]	[ ]	[ ]	14.	The version or revision of each reference is cited.
[X]	[ ]	[ ]	15.	The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions."
[ ]	[ ]	[X]	16.	Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents, as appropriate.
[X]	[ ]	[ ]	17.	All checker comments have been dispositioned and the design media matches the calculations.

Ryan Lang Ryan Lang 5/9/11

Checker (Print/Sign) Date

* If less than the entire calculation was checked, the scope of the check should be discussed. If any blocks are checked "No", an explanation must be provided here or attached

Originated by:	Michael Black	MB	5/9/11
	Name	Initials	Date
Checked by:	Ryan Lang	RL	5/9/11
	Name	Initials	Date

1. Objective/Purpose

These calculations provide the analysis for drainage from the 241-SX tank farm. A portion of the 241-SX tank farm facility is to receive an impermeable cover and these calculations consider the storm water runoff volume, flow, and silt recovery. The storage and management of the storm water volume is analyzed in Appendix D.

2. Introduction/Background

This project installs two impermeable barriers in the tank farm. The conveyance system (i.e., vaults, piping, and silt treatment) is designed to meet the demands of both the North and South barriers.

3. Input Data

The drawing sets, H-14-109330, *241 SX Tank Farm South Interim Surface Barrier* and H-14-109446, *241-SX Tank Farm North Interim Surface Barrier,* provided the basis for applying commonly accepted engineering methods to determine the storm water management system once the barrier is complete. The MatCon® barrier is a modified asphalt product, and the calculations assumed the same properties as asphalt. The drainage from the barrier travels to two vaults for the south drainage and one vault for the north drainage. Based on the area and slope of the drainage from the drawings the following methods are used to calculate the flow and volume of storm water:

- Flow- Washington Department of Ecology, Water Quality Program, Storm water management manual for Eastern Washington, Subsection 4.7 Rational method, Publication 04-10-076.WSDOE
- Volume- *Benton County Hydrology Manual, July, 1979,* Advanced Engineering Consultants (Attachment 7)

In both cases, we used the 25-year, 24-hour storm event as the basis for our calculations per RPP-SPEC-47469, *SX Farm Interim Surface Barrier Subsystem Specification.*

4. Assumptions

No assumptions were required other than published data such as the runoff coefficient for asphalt, the Manning's "n" for PVC pipe, etc. that are referenced in the calculations.

5. Method of Analysis

The calculation methods used MathCAD® for streamlining and presenting normal hand calculations, Bentley FlowMaster® (V08.01.071.00) for conveyance calculations, and Excel® for verification of the FlowMaster program.

6. Use of Computer Software

Bentley FlowMaster (V08.01.071.00) provided the only design "software" for our calculations that required confirmation with other methods. The FlowMaster was helpful in narrowing the range of analysis as determining the fluid depth at different flows, pipe sizes, and slopes is an iterative and time consuming process. The depth/flow relationship for each pipe size and slope arrangement was confirmed using Excel with excellent agreement in the results.

Originated by:	Michael Black	MB	5/9/11
	Name	Initials	Date
Checked by:	Ryan Lang	RL	5/9/11
	Name	Initials	Date

7. Results

Table 1 provides a summary of the storm water peak flow and volume calculations.

Table 1. SX Tank Farm Storm Water Summary.

Result	North	Southwest	Southeast
Acres	**1.478**	**0.889**	**0.889**
Square Feet	**64,360**	**38,743**	**38,743**
Peak Flow (cfs)	**4.308**	**2.591**	**2.591**
1st hr. volume (cu. ft.)	**4,104**	**2,469**	**2,469**
24 hr. volume (cu. ft.)	**3,575**	**2,150**	**2,150**
Total volume (cu. ft.)	**7,679**	**4,619**	**4,619**

Table 2 presents the results of the hydraulic analysis of the piping.

Table 2. Piping Hydraulic Analysis.

Area or Location	Pipe Diameter (in.)	Slope	Pipe Flow (ft^3/sec)	Flow Depth (ft)
North	18	0.005	4.31	0.70
Southwest	12	0.100	9.84	0.60
Southeast	18	0.014	12.76	1.00
Combined	18	0.021	9.49	0.73

The flow is laminar in all pipes except for the Southwest pipe where the flow is transitional due to the slope. Regardless, the conveyances are adequate to meet the flow requirements.

The factor of safety for the vault grates ranges from 1.4 to 1.6 for weir flow and provides a much higher factor of safety for ponded flow.

8. Conclusions

The system described herein is adequate, with some conservatism, to meet the demand of a 25-year storm.

9. Recommendations

Inspection and Maintenance should be included in the periodic inspection of the barrier. Sediment cleanout from the vaults and separator should be on an as needed basis. Construct the system to the drawings and specifications.

10. References

1. RPP-SPEC-47469, Rev. 0, *SX Farm Interim Surface Barrier Subsystem Specification,* Washington River Protection Solutions, LLC.

Originated by:	Michael Black	MB	5/9/11
	Name	Initials	Date
Checked by:	Ryan Lang	RL	5/9/11
	Name	Initials	Date

2. Flow- Washington Department of Ecology, Water Quality Program, Storm water management manual for Eastern Washington, Subsection 4.7 Rational method, Publication 04-10-076.WSDOE

3. Volume- *Benton County Hydrology Manual, July, 1979,* Advanced Engineering Consultants

4. *Standard Mathematical Tables*, 18th Ed., The Chemical Rubber Co. 1970

11. Attachments

1. *FlowMaster*™ calculations for pipe arrangements and *Excel*® spreadsheet for flow depth, 03/11/11
2. *SX Tank Farm Preliminary Calculations for Pipeline Sizes,* 3/11/11
3. *SX Tank Farms, Hanford Site, WA* (storm volume and flow), 1/31/11
4. *SX Tank Farm-Storm water inlet capacity*, 11/28/10
5. ADS Bayseparator™ Capacity sheet
6. Benton County Hydrology Manual Figures.

ATTACHMENT A1 – FLOWMASTER CALCULATIONS FOR PIPE ARRANGEMENTS AND EXCEL SPREADSHEET FOR FLOW DEPTH – 03/11/11

SX barrier, No. Drain, 18-in.

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.010	
Channel Slope	0.00500	ft/ft
Diameter	1.50	ft
Discharge	4.31	ft^3/s

Results

Normal Depth	0.70	ft
Flow Area	0.81	ft^2
Wetted Perimeter	2.26	ft
Top Width	1.50	ft
Critical Depth	0.80	ft
Percent Full	46.8	%
Critical Slope	0.00326	ft/ft
Velocity	5.31	ft/s
Velocity Head	0.44	ft
Specific Energy	1.14	ft
Froude Number	1.27	
Maximum Discharge	10.39	ft^3/s
Discharge Full	9.66	ft^3/s
Slope Full	0.00099	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	46.78	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

SX barrier, No. Drain, 18-in.

GVF Output Data

Normal Depth	0.70	ft
Critical Depth	0.80	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00326	ft/ft

SX Tank Farm
No; 0.005 slope and 18-in.

Calculation of discharge, Q, and average velocity, V (U.S. units)

Using the Manning Equation for Uniform Open Channel Flow

III. Partially full circular pipe (less than half full):

Inputs

Pipe Diameter, **D** =	18	in
Depth of flow, **y** = (must have y ≤ D/2)	0.7	ft
Manning roughness, **n** =	0.01	
Channel bottom slope, **S** =	0.005	ft/ft

Calculations

Pipe Diameter, **D** =	1.5	ft
Pipe Radius, **r** =	0.75	ft
Circ. Segment Height, **h** =	0.7	ft
Central Angle, **θ** =	3.01	radians
Cross-Sect. Area, **A** =	0.81	ft^2
Wetted Perimeter, **P** =	2.3	ft
Hydraulic Radius, **R** =	0.36	ft
Discharge, **Q** =	4.30	cfs
Ave. Velocity, **V** =	5.32	ft/sec

Columbia Engineers Michael Black, P.E, 2/16/11

SX Tank Farm
No; 0.005 slope and 18-in.

Equations used for calculations:

$r = D/2$

$h = y$

$$\theta = 2 \arccos\left(\frac{r - h}{r}\right)$$

$$A = \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = r * \theta$$

$R = A/P$

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

$V = Q/A$

SX Barrier; combined flow; 18-in.

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.010	
Channel Slope	0.02100	ft/ft
Diameter	1.50	ft
Discharge	9.49	ft^3/s

Results

Normal Depth	0.73	ft
Flow Area	0.86	ft^2
Wetted Perimeter	2.32	ft
Top Width	1.50	ft
Critical Depth	1.19	ft
Percent Full	48.8	%
Critical Slope	0.00514	ft/ft
Velocity	11.09	ft/s
Velocity Head	1.91	ft
Specific Energy	2.64	ft
Froude Number	2.59	
Maximum Discharge	21.29	ft^3/s
Discharge Full	19.79	ft^3/s
Slope Full	0.00483	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	48.78	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

SX Barrier; combined flow; 18-in.

GVF Output Data

Normal Depth	0.73	ft
Critical Depth	1.19	ft
Channel Slope	0.02100	ft/ft
Critical Slope	0.00514	ft/ft

SX Tank Farm
Combined; 0.021 slope and 18-in.

Calculation of discharge, Q, and average velocity, V (U.S. units)

Using the Manning Equation for Uniform Open Channel Flow

III. Partially full circular pipe (less than half full):

Inputs

Pipe Diameter, **D** =	18	in
Depth of flow, **y** = (must have y ≤ D/2)	0.73	ft
Manning roughness, **n** =	0.01	
Channel bottom slope, **S** =	0.021	ft/ft

Calculations

Pipe Diameter, **D** =	1.5	ft
Pipe Radius, **r** =	0.75	ft
Circ. Segment Height, **h** =	0.73	ft
Central Angle, θ =	3.09	radians
Cross-Sect. Area, **A** =	0.85	ft^2
Wetted Perimeter, **P** =	2.3	ft
Hydraulic Radius, **R** =	0.37	ft
Discharge, **Q** =	9.47	cfs
Ave. Velocity, **V** =	11.10	ft/sec

The FlowMaster shows 9.49 cfs with the same input for a difference of 17%.
The other values are quite close. After trying to program the same in MathCad, the calculations become difficult at or near 1/2 full. Therefore, I tend to believe the above result, but will use the FlowMaster result for conservatism.

Columbia Engineers Michael Black, P.E, 2/16/11

SX Tank Farm
Combined; 0.021 slope and 18-in.

Equations used for calculations:

$r = D/2$

$h = y$

$$\theta = 2 \arccos\left(\frac{r - h}{r}\right)$$

$$A = \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = r * \theta$$

$R = A/P$

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

$V = Q/A$

SOUTHEAST

SX-18-in. revised slope

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.010	
Channel Slope	0.01420	ft/ft
Normal Depth	1.00	ft
Diameter	1.50	ft

Results

Discharge	12.76	ft^3/s
Flow Area	1.25	ft^2
Wetted Perimeter	2.87	ft
Top Width	1.41	ft
Critical Depth	1.34	ft
Percent Full	66.7	%
Critical Slope	0.00772	ft/ft
Velocity	10.19	ft/s
Velocity Head	1.61	ft
Specific Energy	2.61	ft
Froude Number	1.91	
Maximum Discharge	17.50	ft^3/s
Discharge Full	16.27	ft^3/s
Slope Full	0.00873	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	66.67	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

SX-18-in. revised slope

GVF Output Data

Normal Depth	1.00	ft
Critical Depth	1.34	ft
Channel Slope	0.01420	ft/ft
Critical Slope	0.00772	ft/ft

SOUTHWEST

SX-revised slope

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.010	
Channel Slope	0.10000	ft/ft
Normal Depth	0.60	ft
Diameter	1.00	ft

Results

Discharge	9.84	ft^3/s
Flow Area	0.49	ft^2
Wetted Perimeter	1.77	ft
Top Width	0.98	ft
Critical Depth	0.99	ft
Percent Full	60.0	%
Critical Slope	0.04219	ft/ft
Velocity	20.00	ft/s
Velocity Head	6.21	ft
Specific Energy	6.81	ft
Froude Number	4.98	
Maximum Discharge	15.75	ft^3/s
Discharge Full	14.65	ft^3/s
Slope Full	0.04514	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	60.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

SX-revised slope

GVF Output Data

Normal Depth	0.60	ft
Critical Depth	0.99	ft
Channel Slope	0.10000	ft/ft
Critical Slope	0.04219	ft/ft

Reynold's No.= (645.8*velocity*hydraulic radius)/kinematic viscosity

Diam. (inches)	Slope	Kinematic viscosity (ft^2/sec)	Hydraulic Radius (ft.)	Velocity (ft/sec)	Reynold's Number	Type of flow	Manning's Equation applicable (?)
18	0.014	1.407	0.23	8.01	845.18	laminar	yes
12	0.1	1.407	0.30	15.86	2182.80	laminar	yes
18	0.021	1.407	0.36	11.09	1831.57	laminar	yes
18	0.005	1.407	0.36	5.32	878.62	laminar	yes

laminar when Re< 2,300
transitional when 2,300<Re<4,000
turbulent when 4,000<Re

ATTACHMENT A2 – SX TANK FARM PRELIMINARY CALCULATIONS FOR PIPELINE SIZES – 03/11/11

Columbia Engineers
& Constructors, LLC

SX Tank Farm Preliminary Calculations for Pipeline Sizes

Michael Black, P.E. March 11, 2011

The attached calculation sheets show the method and determination of preliminary pipeline sizes for stormwater transport at the SX Tank Farm cover project. The table below is from the calculation report summary that I performed for the North, Southwest, and Southeast runoff.

SX TANK FARM STORMWATER SUMMARY

RESULT	NORTH	SOUTHWEST	SOUTHEAST
Acres	1.478	0.889	0.889
Square ft.	64,360	38,743	38,743
Peak Flow (ft^3/sec)	4.306	2.593	2.593

The South and north covers will be discharging to the same storage basin. Beyond the individual results above, the following combinations are required:

- Combined peak flow from south cover= 5.19 ft^3/sec
- Combined peak flow from both covers= 9.49 ft^3/sec

The attached calculation sheets are summarized below:

Slope (%)	12-in (ft^3/sec)	15-in (ft^3/sec)	18-in (ft^3/sec)	24-in (ft^3/sec)
0.5	---	2.5	4.2	11.0
2.1	4.5	6.0	11.0	---

The above flows represent a 60% full design basis. As explained in the calculation sheets the 60% full design value maximizes velocity or efficiency while providing some additional capacity for contingencies. Furthermore, the combined flows in the upper table assume the peak flows are combined at the same time. While this may overestimate the pipe flows, slightly, the time of concentration's are short and the overestimation is slight.

1806 Terminal Drive
Richland, Washington 99354

A Certified SDVOSB

Phone: 509.946.7111
Fax: 509.946.9365

Project: SX Tank Farms
Engineer: Michael Black, P.E
Description:
This calculation sheet examines various pipe sizes to best fit the flow requirements for the project demand.
Parameters:

A_f= area of flow
P_w= wetted perimeter
Q= flow rate
h= distance from spring line
S= slope
R= pipe radius
R_h= hydraulic radius
Depth= depth of flow
V_f= velocity of flow
n=Manning's coefficient
α= angle in radians
D= pipe diameter

$$A_f(\alpha, D) := \frac{\left(\frac{D}{2}\right)^2}{2} \cdot (\alpha - \sin(\alpha)) \qquad P_w(\alpha, D) := \left(\frac{D}{2} \cdot \alpha\right)$$

$$R_h(\alpha, D) := \frac{A_f(\alpha, D)}{P_w(\alpha, D)} \qquad h\left(\alpha, D := \frac{D}{2} \cdot \cos\left(\frac{\alpha}{2}\right)\right.$$

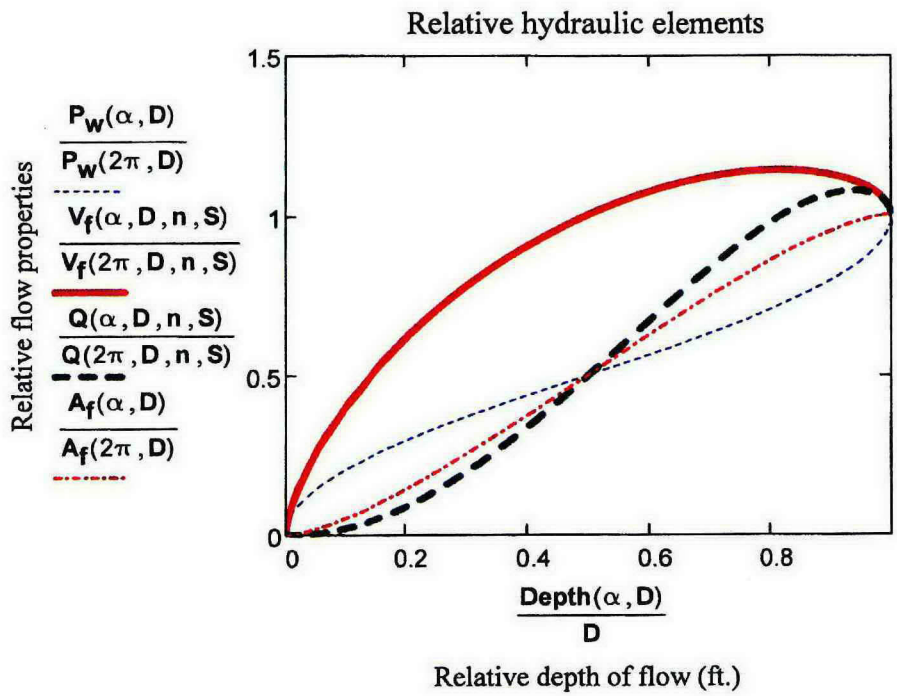
$$Depth(\alpha, D) := \frac{D}{2} - \left(\frac{D}{2} \cdot \cos\left(\frac{\alpha}{2}\right)\right)$$

$$Q(\alpha, D, n, S) := \frac{1.49}{n} \cdot A_f(\alpha, D) \cdot R_h(\alpha, D)^{\frac{2}{3}} \cdot S^{\frac{1}{2}}$$

$$V_f(\alpha, D, n, S) := \frac{1.49}{n} \cdot R_h(\alpha, D)^{\frac{2}{3}} \cdot S^{\frac{1}{2}}$$

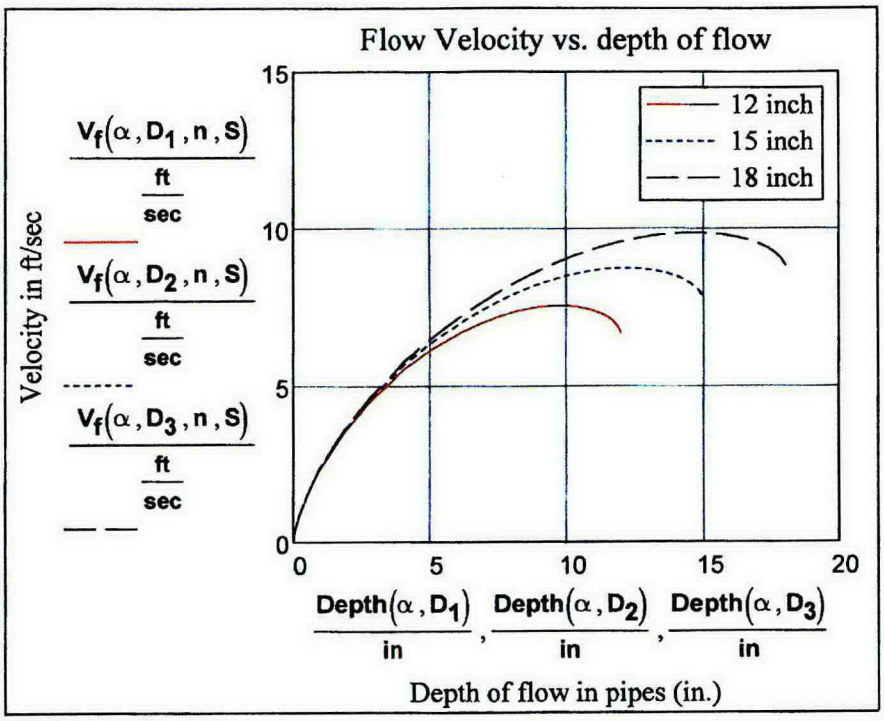
$$n := 0.013 \qquad S := 0.021 \frac{ft}{ft} \qquad D := 1ft$$

$$\alpha := 0rad, 0.1rad .. 2\pi rad$$



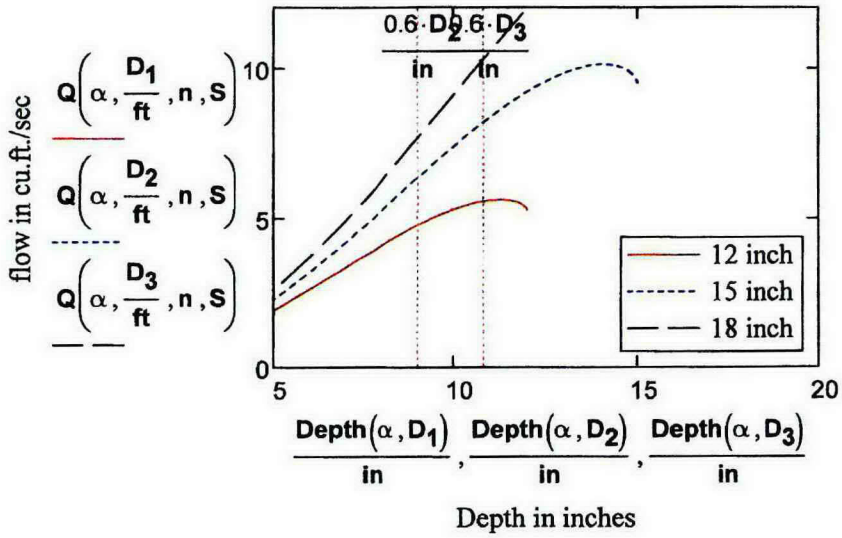
The graph on the following page evaluates depth vs. velocity for the 3 pipe diameters shown below. Note that the maximum velocity does not occur when the pipe is full.

$D_1 := 12in$ $D_2 := 15in$ $D_3 := 18in$



Note how each pipe diameter provides maximum velocity at 60-80% of the diameter. As velocity is directly proportional to the energy gradient, the maximum efficiency also occurs at 60-80% of full flow.

The graph on the following page sets markers at 0.6 full for the 15- and 18-inch pipe diameters. By observation, the 12-in pipe lacks sufficient capacity to meet around a 6 ft^3/sec flow at 60% of depth.



Flow rate vs. flow depth in pipe

From the graph above and by observation, the 12-,15, and 18-in. lines will flow aobut 4.5, 6.0, and 11.0 ft^3/sec.

Project: SX Tank Farms
Engineer: Michael Black, P.E
Description:
This calculation sheet examines various pipe sizes to best fit the flow requirements for the project demand.
Parameters:

A_f= area of flow
P_w= wetted perimeter
Q= flow rate
h= distance from spring line
S= slope
R= pipe radius
R_h= hydraulic radius
Depth= depth of flow
V_f= velocity of flow
n=Manning's coefficient
α= angle in radians
D= pipe diameter

$$A_f(\alpha, D) := \frac{\left(\frac{D}{2}\right)^2}{2} \cdot (\alpha - \sin(\alpha)) \qquad P_w(\alpha, D) := \left(\frac{D}{2} \cdot \alpha\right)$$

$$R_h(\alpha, D) := \frac{A_f(\alpha, D)}{P_w(\alpha, D)} \qquad h\left(\alpha, D := \frac{D}{2} \cdot \cos\left(\frac{\alpha}{2}\right)\right.$$

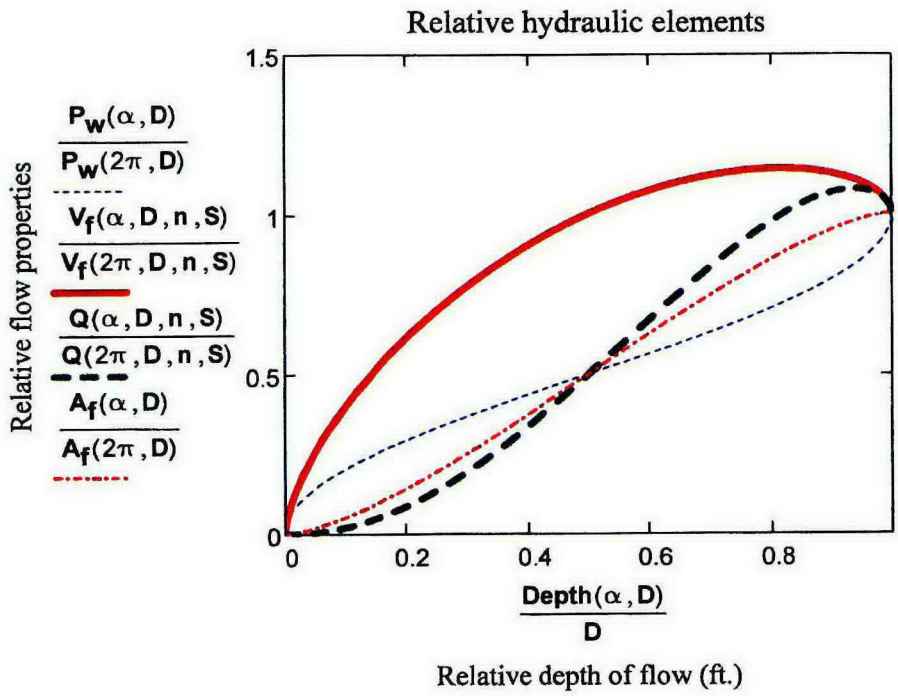
$$Depth(\alpha, D) := \frac{D}{2} - \left(\frac{D}{2} \cdot \cos\left(\frac{\alpha}{2}\right)\right)$$

$$Q(\alpha, D, n, S) := \frac{1.49}{n} \cdot A_f(\alpha, D) \cdot R_h(\alpha, D)^{\frac{2}{3}} \cdot S^{\frac{1}{2}}$$

$$V_f(\alpha, D, n, S) := \frac{1.49}{n} \cdot R_h(\alpha, D)^{\frac{2}{3}} \cdot S^{\frac{1}{2}}$$

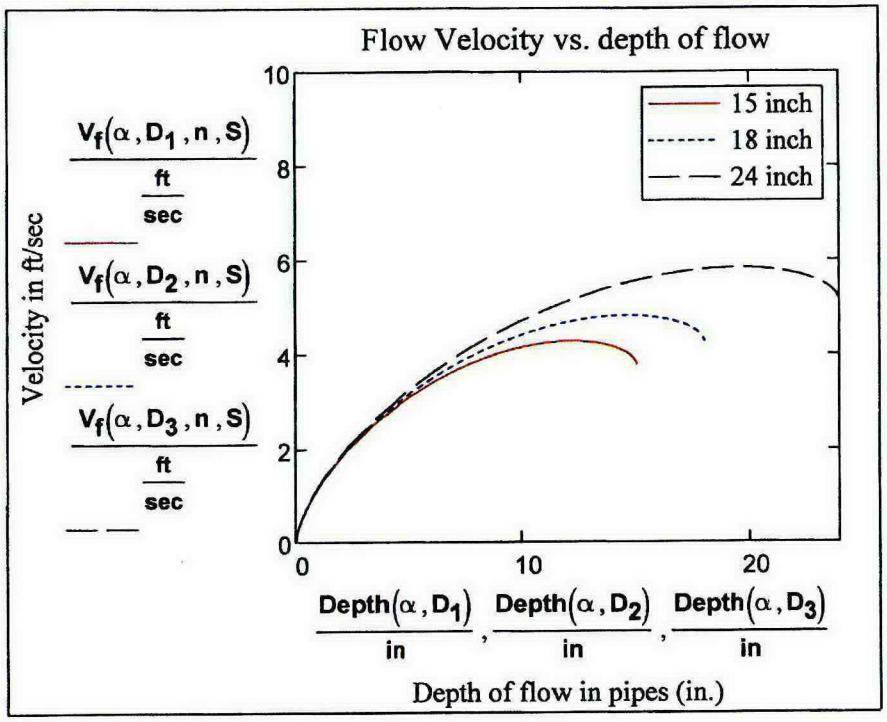
$$n := 0.013 \qquad S := 0.005 \frac{ft}{ft} \qquad D := 1ft$$

$$\alpha := 0rad, 0.1rad .. 2\pi\, rad$$



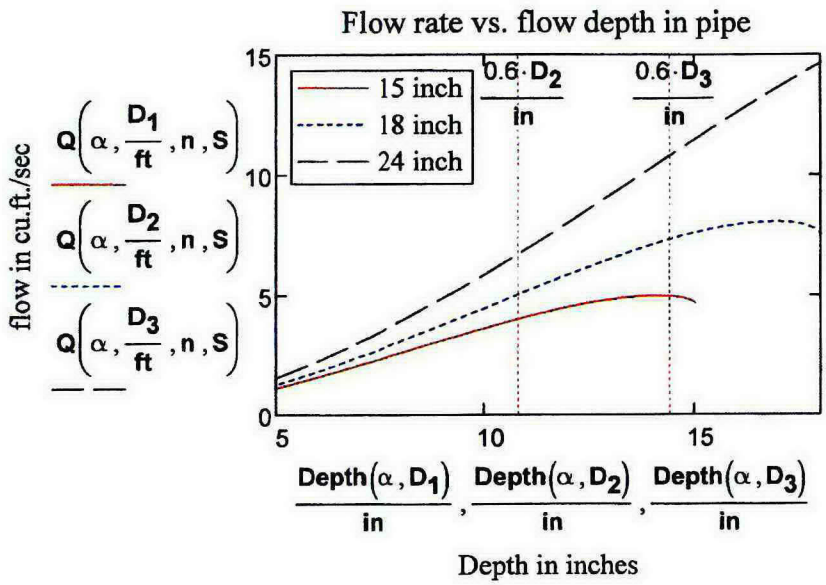
The graph on the following page evaluates depth vs. velocity for the 3 pipe diameters shown below. Note that the maximum velocity does not occur when the pipe is full.

$D_1 := 15in$ $D_2 := 18in$ $D_3 := 24in$



Note how each pipe diameter provides maximum velocity at 60-80% of the diameter. As velocity is directly proportional to the energy gradient, the maximum efficiency also occurs at 60-80% of full flow.

The graph on the following page sets markers at 0.6 full for the 15- and 18-inch pipe diameters.



By inspection of the graph above, the 15-, 18-, and 24-in lines flow approximately 2.5, 4.2, and 11 ft^3/sec respectively

ATTACHMENT A3 – SX TANK FARMS, HANFORD, WA
(STORM VOLUME AND FLOW) - 01/31/11

Originated By: Michael Black, P.E.
Columbia Engineers and Constructors, LLC
Checked By: Ryan Lang

SX Tank Farms
Hanford Site, WA

The calculation method for this project uses a combination of methods for calculating both peak storm flow and volume. The following sources were used:

- Washington Department of Ecology, Water Quality Program, *Stormwater Management Manual for Eastern Washington, Subsection 4.7 Rational method*, *Publication 04-10-076*, WSDOE, September, 2004 for peak storm flow
- *Benton County Hydrology Manual,* July, 1979, Advanced Engineering Consultants for stormwater volume

Drainage From Area

AREA NO.	(FT^2)	ACRE
North	64359.9	1.478
SW-1/2	38743.1	0.889
SE-1/2	38743.1	0.889
TOTAL	141846	3.256

WSDOE stormwater peak runoff rate

The WSDOE uses the following input to determine the peak runoff rate:

- Q= runoff in cubic feet per second.
- C= runoff coefficient from Table 4.7.1. Adjustments are required for return intervals exceeding 10-yr.
- I= rainfall intensity in inches per hour
- A_1= contributing area in acres
- m_1 and n= rainfall intensity coefficients from Table 4.7.2
- T_c= time of concentration based on slope, ground cover, and distance
- S= slope of the runoff
- L= length of runoff
- k= ground cover coefficient from Table 4.7.3

Use of these tables and formulas require determination of a "return period. Time of concentration is always taken a greater than or equal to 5 minutes. Both Q and I are empirical formulas that do not contain units.

Calculation Basis:

- Location - Richland, Washington
- Return Frequency = 25 years

Originated By: Michael Black, P.E.
Columbia Engineers and Constructors, LLC
Checked By: Ryan Lang

SX Tank Farms
Hanford Site, WA

NORTH AREA

$Area_1 := 1.478acre$ — Area of north barrier

$S_1 := 0.01$ — Slope of runoff

$C := 0.9$ — Runoff coefficient, WSDOE Manual, Table 4.7.1

$m := 9.43$ $n := 0.664$ — Rainfall intensity coefficients, WSDOE Manual, Table 4.7.2

$L_1 := 400ft$ — Estimated length of runoff/longest distance to collection, H-14-109446, sheet 2

$k := 1200$ — Ground cover coefficient, WSDOE Manual, Table 4.7.3

$$T_{c1} := \frac{\frac{L_1}{ft}}{k \cdot \sqrt{S_1}} \cdot min = 3.33 \cdot min$$

Time of concentration using velocity equation, WSDOE Manual, Pg 435

$$T_{c1} := \begin{cases} \text{return } 5min \text{ if } T_{c1} < 5min \\ T_{c1} \text{ otherwise} \end{cases}$$

$$T_{c1} = 5 \cdot min$$

$$I_1 := \frac{m}{\left(\frac{T_{c1}}{min}\right)^n} \frac{ft}{sec} = 3.239 \cdot \frac{ft}{sec}$$

Rainfall intensity, WSDOE Manual, Section 4.7.1, pg 4-56

$$Q_1 := C \cdot \frac{Area_1}{1acre} \cdot I_1 \cdot 1ft^2 = 4.308 \cdot \frac{ft^3}{sec}$$

Runoff, WSDOE Manual, Section 4.7.1, pg 4-56

***Note: the above are empirical formulas that have been modified for compatibility with MathCad. This required dividing T_c by minutes and dividing A_1 by acres.**

Originated By: Michael Black, P.E.
Columbia Engineers and Constructors, LLC
Checked By: Ryan Lang

SX Tank Farms
Hanford Site, WA

SOUTHWEST AREA

$Area_2 := 0.889acre$ — Area of southwest barrier

$S_2 := 0.01$ — Slope of runoff

$L_2 := 230ft$ — Estimated length of runoff

$$T_{c2} := \frac{\frac{L_2}{ft}}{k \cdot \sqrt{S_2}} \cdot min = 1.92 \cdot min$$

Time of concentration using velocity equation, WSDOE Manual, Pg 435

$$T_{c2} := \begin{cases} \text{return } 5min & \text{if } T_{c2} < 5min \\ T_{c2} & \text{otherwise} \end{cases}$$

$$T_{c2} = 5 \cdot min$$

$$I_2 := \frac{m}{\left(\frac{T_{c2}}{min}\right)^n} \frac{ft}{sec} = 3.239 \cdot \frac{ft}{sec}$$

Rainfall intensity, WSDOE Manual, Section 4.7.1, pg 4-56

$$Q_2 := C \cdot \frac{Area_2}{1acre} \cdot I_2 \cdot 1\left(ft^2\right) = 2.591 \cdot \frac{ft^3}{sec}$$

Runoff, WSDOE Manual, Section 4.7.1, pg 4-56

Originated By: Michael Black, P.E.
Columbia Engineers and Constructors, LLC
Checked By: Ryan Lang

SX Tank Farms
Hanford Site, WA

SOUTHEAST AREA

$Area_3 := 0.889acre$ — Area of southeast barrier

$S_3 := 0.01$ — Slope of runoff

$L_3 := 250ft$ — Estimated length of runoff

$$T_{c3} := \frac{L_3}{k \cdot \sqrt{S_3}} \cdot \frac{min}{ft}$$

Time of concentration using velocity equation, WSDOE Manual, Pg 435

$$T_{c3} := \begin{cases} \text{return } 5min \text{ if } T_{c3} < 5min \\ T_{c3} \text{ otherwise} \end{cases}$$

$T_{c3} = 5 \cdot min$

$$I_3 := \frac{m}{\left(\frac{T_{c3}}{min}\right)^n} \frac{ft}{sec} = 3.239 \cdot \frac{ft}{sec}$$

Rainfall intensity, WSDOE Manual, Section 4.7.1, pg 4-56

$$Q_3 := C \cdot \frac{Area_3}{1acre} \cdot I_3 \cdot 1ft^2 = 2.591 \cdot \frac{ft^3}{sec}$$

Runoff, WSDOE Manual, Section 4.7.1, pg 4-56

Volume of Stormwater per County of Benton Manual

The volume is broken into Phase 1 and 2. Phase 1 represents the first hour of runoff volume using the 60 minute duration rainfall from fig. 7, page 5-6, showing a 0.85 in/hr intensity (R1) based on an average annual rainfall of 8.0 inches.

For Phase 1 Flow: $R_1 := 0.85$

$$V_1 := \frac{(R_1 \cdot Area_1 \cdot C)}{12} \cdot 43560 \frac{ft^2}{acre} \cdot 1ft = 4104 \cdot ft^3$$

$$V_2 := \frac{(R_1 \cdot Area_2 \cdot C)}{12} \cdot 43560 \frac{ft^2}{acre} \cdot 1ft = 2469 \cdot ft^3$$

$$V_3 := \frac{(R_1 \cdot Area_3 \cdot C)}{12} \cdot 43560 \frac{ft^2}{acre} \cdot 1ft = 2469 \cdot ft^3$$

Originated By: Michael Black, P.E.
Columbia Engineers and
Constructors, LLC
Checked By: Ryan Lang

SX Tank Farms
Hanford Site, WA

For Phase 2 Flow:

Phase 2 flow considers the remianing 24-hours. The same formula is used *except* the "R" term (now R2) uses fig. 9, page 6-8 minus the 0.85 R1 value above. In this case, R2 is 1.12*1.42 minus 0.85.

$R2 := (1.12 \cdot 1.42) - 0.85$ $\qquad R2 = 0.74$

$$V_{12} := \frac{(R2 \cdot Area_1 \cdot C)}{12} \cdot 43560 \frac{ft^2}{acre} \cdot 1ft = 3575 \cdot ft^3$$

$$V_{22} := \frac{(R2 \cdot Area_2 \cdot C)}{12} \cdot 43560 \frac{ft^2}{acre} \cdot 1ft = 2150 \cdot ft^3$$

$$V_{32} := \frac{(R2 \cdot Area_3 \cdot C)}{12} \cdot 43560 \frac{ft^2}{acre} \cdot 1ft = 2150 \cdot ft^3$$

TOTAL STORMWATER VOLUME BY AREA

$\boxed{V_{t1} := V_1 + V_{12} = 7679 \cdot ft^3}$ North barrier total volume

$\boxed{V_{t2} := V_2 + V_{22} = 4619 \cdot ft^3}$ Southwest barrier total volume

$\boxed{V_{t3} := V_3 + V_{32} = 4619 \cdot ft^3}$ Southeast barrier total volume

ATTACHMENT A4 – SX TANK FARM-STORM WATER INLET CAPACITY – 11/28/10

PROJECT: SX Tank Farm Barrier Seal
DESCRIPTION: At least 7 by 3 ft. grate with 70% openings will receive approximately 5.364 ft^3/s of maximum stormwater flow. The grate consists of vertical bar construction.
DETERMINE: Capacity of grate to accept stormwater flow. As this design is in preliminary status, determine a range of acceptable grate sizes.
DISCUSSION: Grates are usually evaluated with an adjacent curb. In this case, the grate will be at least 3 ft. from the curb. The inlet acts as a weir for shallow depths of flow (say no more than 4-in. deep) and an orifice for deeper ponding. Therefore, analyze both the weir and orifice cases.
Reference: Mays, L.W., *Stormwater collection design,* McGraw-Hill, 2001

Weir Case

Parameters

Q_{weir}= interception capacity in ft^3/s
P= perimeter of grate in ft
C_w= weir discharge coefficient= 3
C_a= orifice discharge coefficient= 0.67
d= flow depth in ft

Estimate Flow depth for various flows

$$Q_{inflow} := \begin{pmatrix} 4.50 \\ 4.75 \\ 5.0 \\ 5.25 \\ 5.50 \\ 5.75 \\ 6.00 \end{pmatrix} \frac{ft^3}{sec}$$

$$Perimeter := 20ft$$

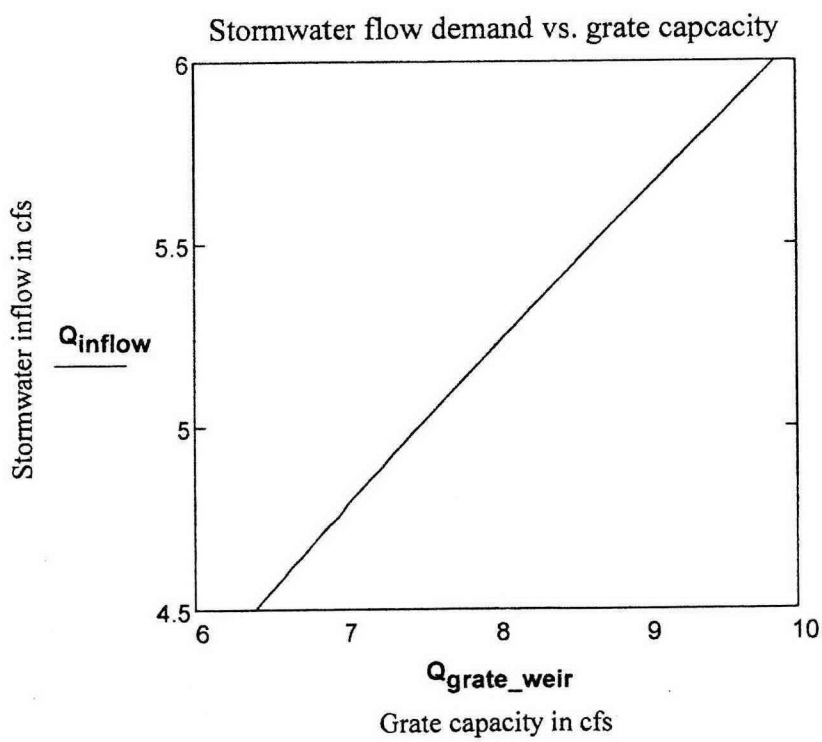
$$C_w := 3$$

$$d_{ft} := \frac{Q_{inflow}}{Perimeter \cdot 1ft} = \begin{pmatrix} 2.70 \\ 2.85 \\ 3.00 \\ 3.15 \\ 3.30 \\ 3.45 \\ 3.60 \end{pmatrix} \cdot \frac{in}{sec}$$

Note: use 1 ft. width of inflow

$$Q_{grate\_weir} := C_w \cdot Perimeter \cdot \left(d_{ft}\right)^{1.5} \cdot \frac{ft^{0.5}}{sec^{-0.5}} = \begin{pmatrix} 6.40 \\ 6.94 \\ 7.50 \\ 8.07 \\ 8.65 \\ 9.25 \\ 9.86 \end{pmatrix} \cdot \frac{ft^3}{sec}$$

Note: the $ft^{0.5}/sec^{-0.5}$ served only to provide correct units in the above empirical equation.

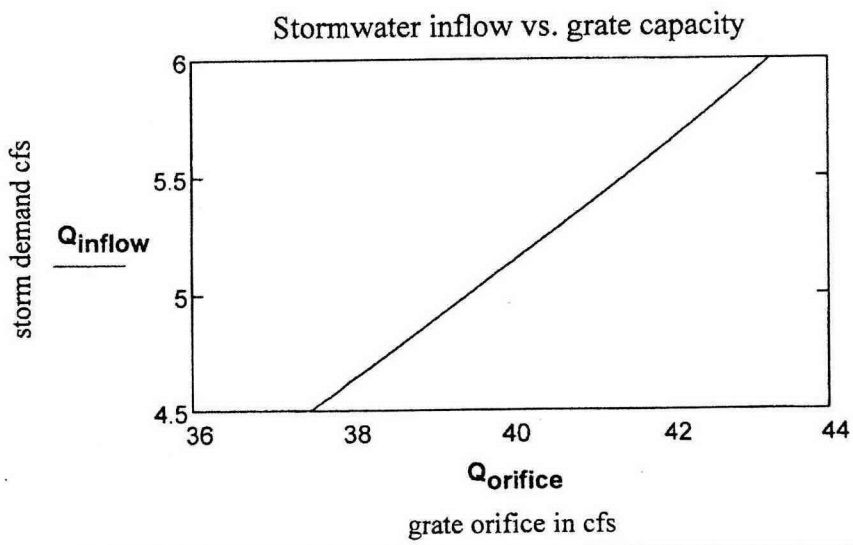


Orifice Case

Additional parameters

$g = 32.17 \frac{ft}{s^{2.00}}$ $\quad C_a := 0.67$ $\quad A_{grate} := 3ft \cdot 7ft \cdot 0.7 = 14.70 ft^{2.00}$

$$Q_{orifice} := C_a \cdot A_{grate} \cdot \sqrt{2 \cdot g \cdot d_{ft}} \cdot \frac{1}{sec^{-0.5}} = \begin{pmatrix} 37.48 \\ 38.50 \\ 39.50 \\ 40.48 \\ 41.43 \\ 42.36 \\ 43.27 \end{pmatrix} \cdot \frac{ft^3}{sec}$$



Results and Discussion

Based on the data contained herein, a 3 ft. by 7 ft. grate contains a factor of safety= 1.4 to 1.6 within the estimated flow range using weir flow. If ponding occurs to where the entire grate becomes inundated, the capacity far exceeds the demand. Therefore, the proposed 3 ft. by 7 ft. grate provides considerable conservatism in the design.

As a caution, it is important that maintenance keeps the grates clean so flow is not restricted. I recommend cleaning after each storm event.

ATTACHMENT A5 – ADS BAYSEPARATOR CAPACITY SHEET

DESIGN:

The BaySeparator is available in six (6) standard sizes as shown below:

Model Number	Diameter (inches)	Maximum Treatment Rate (cfs)	Maximum Hydraulic Rate (cfs)	Manhole Diameter (inches)	Manhole Vault Depth (feet)	Sediment Storage (cf)	Storage Oil (cf)
1/2 K	24	1.5	9.4	48	4	38–61	25–41
1 K	30	2.3	15.2	48–60	4–6	50–61	36–61
3 K	36	7.8	30	60–72	5–8	78–116	59–87
5 K	48	11.1	50	72–120	6–10	113–177	85–133
10 K	60	21.8	100	96–144	10–12	314	235
X K	Custom	Custom	Custom	Custom	Custom	Custom	Custom

The sizes of both Primary and Storage Manholes in the BaySeparator may be varied to suit specific site conditions and treatment requirements as necessary. By selecting the appropriate separator unit size and the manhole diameters, the design engineer has the freedom to adapt the BaySeparator unit to the needs of a particular site. The XK unit can be specifically designed to handle larger flows on a site by site basis.

HYDRAULIC PERFORMANCE:

The BaySeparator has two flow rates, the maximum treatment rate and the maximum hydraulic rate. The maximum treatment rate is the maximum flow that can be fully treated by the BaySeparator unit without any bypass. The maximum hydraulic rate is the maximum flow rate that can be conveyed through the BaySeparator. The ability of the BaySeparator to bypass flows allows the system to installed online without the need for a separate diversion structure.

The BaySeparator has been extensively tested in both laboratory and field conditions. The lab testing verified by field testing provides data establishing 80% annual aggregate removal efficiency for stand alone treatment applications. In addition the system can be designed for pretreatment applications in combination with other treatment technologies such as the BayFilter.

Sizing can be accomplished based on flow based, annual aggregate removal, or local design regulations. In pretreatment applications the unit is typically sized to remove 50% of the TSS on an annual aggregate removal basis. The pretreatment separator is usually part of a treatment train. The stand alone separator usually is designed to remove 80% of the TSS on an annual aggregate removal basis.

ATTACHMENT A6 – BENTON COUNTY HYDROLOGY MANUAL FIGURES

BENTON COUNTY

WASHINGTON

BENTON COUNTY
HYDROLOGY MANUAL
AND DRAINAGE DESIGN
REVIEW PROCEDURE

July, 1979

ADVANCED ENGINEERING CONSULTANTS INC.
2626 12th Court S. W.
Olympia, Washington 98502

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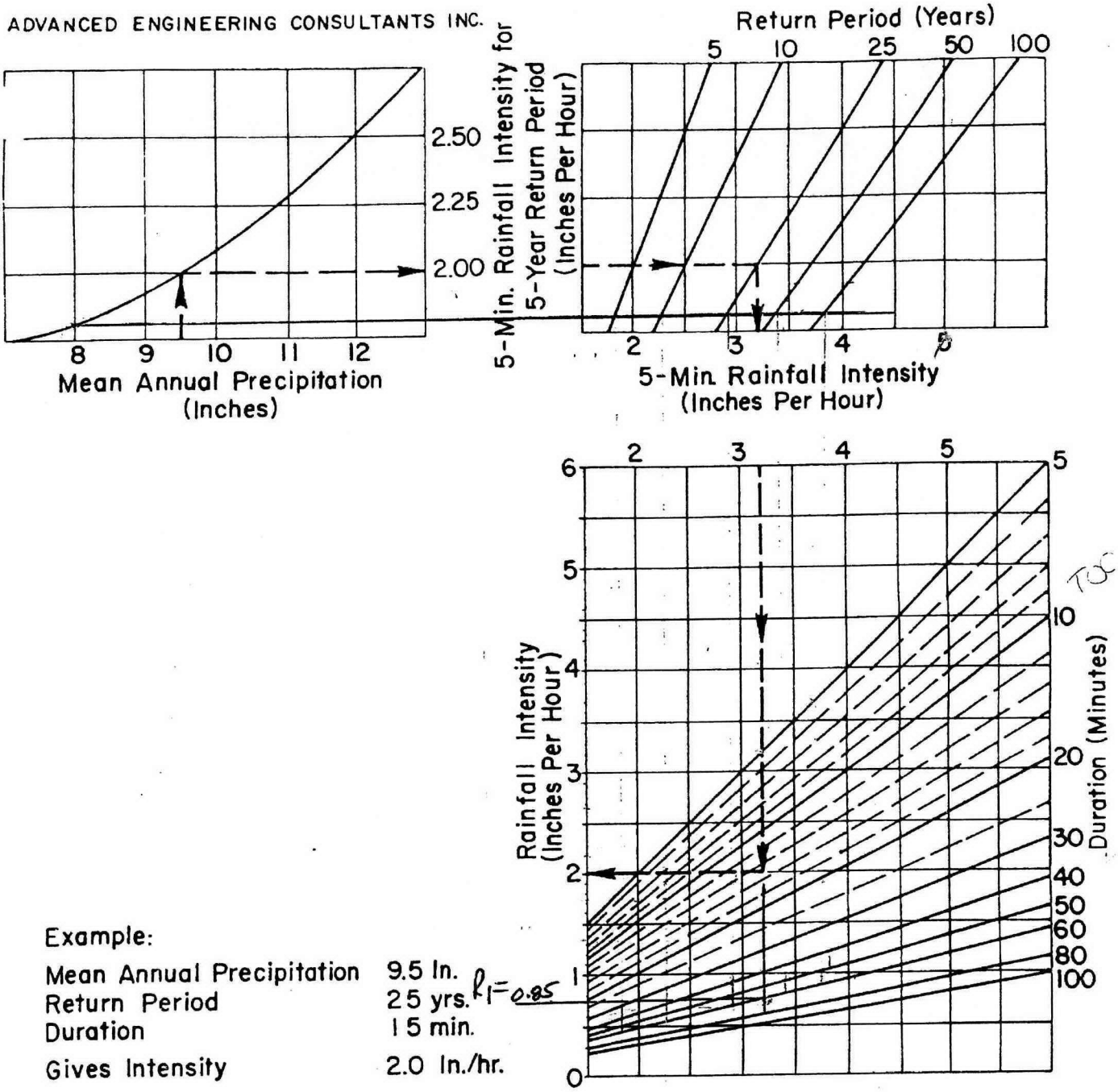


Figure 7 — Graph for Determination of Short Duration Rainfall Intensity In Benton County

(Data Derived From Several Sources by AEC)

ADVANCED ENGINEERING CONSULTANTS INC.

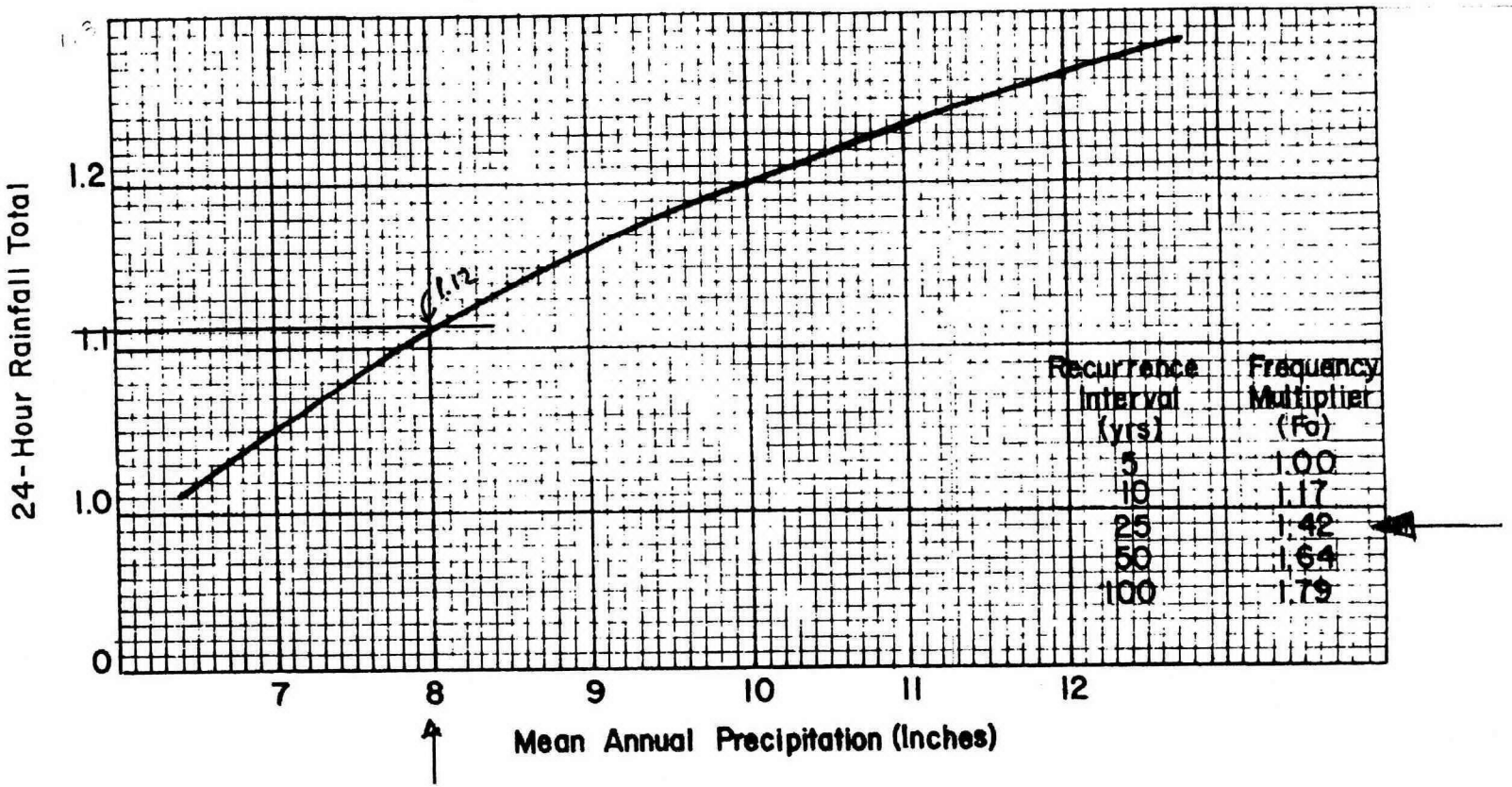


Figure 9 -24-Hour Rainfall Total at 5-year Recurrence Interval versus Mean Annual Precipitation for Benton County

(Data derived from several sources by AEC)

APPENDIX B

EARTHWORK VOLUME

LIST OF TRADEMARKS

AutoCAD	Registered trademark of Autodesk, Inc.
Civil 3D	Registered trademark of AutoDesk, Inc.
Excel	Registered trademark of Microsoft, Inc.
MatCon	Trademark of Matcon, Inc.

SUBCONTRACTOR CALCULATION REVIEW CHECKLIST

Subject: EARTHWORK VOLUME

The subject document has been reviewed by the undersigned.
The reviewer reviewed and verified the following items as applicable.

Documents Reviewed: RPP-CALC-48447, Rev. 0, Appendix B

Analysis Performed By: Columbia Energy

- Design Input
- Basic Assumptions
- Approach/Design Methodology
- Consistency with item or document supported by the calculation
- Conclusion/Results Interpretation
- Impact on existing requirements

MJ Hoin — 5-23-2011
Reviewer (Print/Sign) — Date

CJ Aldorman — 05/23/2011
Organizational Manager (Print/Sign) — Date

CALCULATION REVIEW CHECKLIST

Calculation Reviewed: Earth Work Volume

Scope of Review: Entire Calculation

(e.g., document section or portion of calculation)

Engineer/Analyst: Ryan Lang Date: 5/6/11

(printed name and signature)

Organizational Manager: Larry Ulbricht Date: 5/9/11

(printed name and signature)

This document consists of 5 pages and the following attachments (if applicable): ATTACHMENTS B1, B2, AND B3

Yes	No	N/A*		
[✓]	[ ]	[ ]	1.	Analytical and technical approaches and results are reasonable and appropriate.
[ ]	[ ]	[✓]1	2.	Necessary assumptions are reasonable, explicitly stated, and supported.
[✓]	[ ]	[ ]	3.	Ensure calculations that use software include a paper printout, microfiche, CD-ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
[✓]	[ ]	[ ]	4.	Input data were checked for consistency with original source information.
[✓]	[ ]	[ ]	5.	Key input data (e.g., dimensions, performance characteristics) that may affect equipment design is identified.
[ ]	[ ]	[✓]2	6.	For both qualitative and quantitative data, uncertainties are recognized and discussed and the data is presented in a manner to minimize design interpretations.
[✓]	[ ]	[ ]	7.	Mathematical derivations were checked, including dimensional consistency of results.
[✓]	[ ]	[ ]	8.	Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information.
[✓]	[ ]	[ ]	9.	Software verification and validation are addressed adequately.
[✓]	[ ]	[ ]	10.	Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
[✓]	[ ]	[ ]	11.	Conclusions are consistent with analytical results and applicable limits.
[✓]	[ ]	[ ]	12.	Results and conclusions address all points in the purpose.
[✓]	[ ]	[ ]	13.	Referenced documents are retrievable or otherwise available.
[✓]	[ ]	[ ]	14.	The version or revision of each reference is cited.
[✓]	[ ]	[ ]	15.	The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions."
[ ]	[ ]	[✓]3	16.	Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents, as appropriate.
[✓]	[ ]	[ ]	17.	All checker comments have been dispositioned and the design media matches the calculations.

Colin Henderson 5/6/11

Checker (Print/Sign) Date

* If less than the entire calculation was checked, the scope of the check should be discussed. If any blocks are checked "No", an explanation must be provided here or attached

1. NO ASSUMPTIONS MADE IN CALCULATION
2. NO UNCERTAINTIES ARE IDENTIFIED
3. NO REQUIREMENT IMPACTS ARE IDENTIFIED.

Originated by:	Ryan Lang	RL	5/6/11
	Name	Initials	Date
Checked by:	Colin Henderson	CH	5/9/11
	Name	Initials	Date

1. Objective/Purpose

The objective of this calculation is to estimate the earthwork volumes associated with construction of the two 241-SX Tank Farm Interim Surface Barriers. This will give the construction contractor an estimated volume of fill material to be expected. The barrier designs are specified in drawings H-14-109330, *241-SX Tank Farm North Interim Surface Barrier* and H-14-109446, *241-SX Tank Farm South Interim Surface Barrier.*

This earthwork calculation is performed in accordance with RPP-SPEC-47469, *SX Farm Interim Surface Barrier Subsystem Specification.*

2. Introduction/Background

The SX Tank Farm ground surface is to be covered with an interim barrier to reduce groundwater impacts from subsurface contamination. In order to establish a barrier surface that will drain to the collection and conveyance system, the surface of the tank farm will be modified by grading and adding fill material. A modified asphalt layer provided by MatCon™ will then be installed acting as the interim barrier.

3. Input Data

Existing SX Tank Farm surface is defined by the topographic survey performed by Glahe & Associates for Fluor Federal Services in 2008, where the electronic file for the topographic data was utilized (Attachment 2).

4. Assumptions

None.

5. Method of Analysis

The earthwork volumes are generated using AutoCAD® Civil 3D®. The electronic coordinate data associated with the topography survey completed in 2008 was imported into AutoCAD Civil 3D and used as the baseline tank farm surface. The sub-grade and interim surface barrier elevations were generated to produce the drainage slopes necessary to facilitate drainage of precipitation that falls on the barrier surfaces to an evapo-transpiration basin.

Boundaries were selected and earthwork quantities created for the following areas:

1. North Barrier
2. South Barrier
3. Evapo-transpiration basin
4. Evapo-transpiration basin (3 ft backfill)
5. Drywell Access Road
6. Pipe Cover (Alternate sides of drywell access road)
7. Basin Access (from drywell access road).

Originated by:	Ryan Lang	RL	5/6/11
	Name	Initials	Date
Checked by:	Colin Henderson	CH	5/9/11
	Name	Initials	Date

The manual calculation is performed using approximated cross sectional areas taken within the North and South Barrier areas using distances between the cross-sectional areas to calculate the volume of each grid area. The volumes of each area are calculated using the following equation:

$$V = \frac{L(A_1 + A_2)}{2}$$

Where: V = Net volume of each grid area

A_1 = Approximate cross-sectional area one

A_2 = Approximate cross-sectional area two

L = Distance between stationing

The total calculated volume of both the north and south barriers are compared to the volume output from AutoCAD Civil 3D. The comparison is based on the following equation:

$$\% = \frac{(V_A - V)}{V}$$

Where: % = Percentage comparison of barrier area

V_A = Volume by AutoCAD Civil 3D

V = Volume by manual calculation

Note to simplify the manual calculation, the cross sectional areas taken in each grid area do not take into account the volumes from the sloped areas surrounding the perimeter of the barriers.

6. Use of Computer Software

The earthwork volumes are calculated using AutoCAD Civil 3D 2010 computer software (SN: 391-15588511) on CEES-XP-129. AutoCAD Civil 3D accuracy was checked using MS Excel® with results shown in Attachment 1, providing verification and validation for the application. Volumes were found to be accurate within 9.98% for the north barrier, 0.96% for the south barrier, and 0.19% for the basin. All computations are checked with a handheld calculator.

7. Results

The AutoCAD Civil 3D calculations for total earthwork quantities are summarized in Table 1.

Originated by:	Ryan Lang	RL	5/6/14
	Name	Initials	Date
Checked by:	Colin Henderson	CH	5/9/14
	Name	Initials	Date

Table 1 – SX Tank Farm Interim Surface Barrier Earthwork Volumes*

Location	Cut (m^3)	Fill (m^3)	Net (m^3)
North Barrier	63	1,156	1,093
South Barrier	88	1,929	1,841
Sub-Total	**151**	**3,085**	**2,934**
Evapo-transpiration Basin	16,183	689	-15,494
Evap. Basin (3ft Backfill)		9,164	9,164
Sub-Total	**16,183**	**9,853**	**-6,330**
Dry-well Access Road	535	967	432
Basin Access Ramp	0	117	117
Pipe Cover	14	2,298	2,284
Sub-Total	**549**	**3,382**	**2,833**
TOTAL	**16,883**	**16,320**	**-563**

*Source: AutoCAD Civil 3D output data in Attachment 3.

Originated by:	Ryan Lang	RL	5/6/11
	Name	Initials	Date
Checked by:	Colin Henderson	CH	5/9/11
	Name	Initials	Date

Table 2 – SX Tank Farm Interim Surface Barrier Earthwork Volumes per Tank*

Tank	Cut (m^3)	Fill (m^3)	Net (m^3)
241-SX-104	0	69.69	69.69
241-SX-105	0	38.46	38.46
241-SX-106	0	44.07	44.07
241-SX-107	0.72	56.41	55.69
241-SX-108	0.96	19.85	18.89
241-SX-109	2.82	16.45	13.62
241-SX-110	0	77.47	77.47
241-SX-111	0	153.80	153.80
241-SX-112	0	170.11	170.11
241-SX-113	19.71	7.22	-12.49
241-SX-114	1.18	61.79	60.61
241-SX-115	0	89.00	89.00

*Source: AutoCAD Civil 3D output data in Attachment 3.

Comparing the volumes obtained from AutoCAD Civil 3D to the manual calculation indicate there is a negligible difference between the two values. As such, AutoCAD Civil 3D total volumes are considered accurate. Manual calculations are included in Attachment 1. Quantities are considered conservative and do not take into account volumes of existing tank elements. Topographic Northing/Easting points are used at approximate locations of SX Barrier surface points. Volumes do not include cut/fill associated with trenching for drain pipe or storm water collection box installation.

8. Conclusions

It is estimated that 2,934 cubic meters (3,210 cubic yards) of material will be added to the in-farm portion of the 241-SX Tank Farm Interim Surface Barrier. Approximately 563 cubic meters (616 cubic yards) of excess material will remain from the evapo-transpiration basin and barrier installation. Note these are bank and/or compacted values and do not account for material shrink

Originated by:	Ryan Lang	RL	5/6/11
	Name	Initials	Date
Checked by:	Colin Henderson	CH	5/9/11
	Name	Initials	Date

and/or swell. For planning purposes a value of 25% can be used for swell for the expected type of soil to be encountered.

9. Recommendations

None.

10. References

1. H-14-109330, Rev. 0, *241-SX Tank Farm North Interim Surface Barrier*
2. H-14-109446, Rev. 0, *241-SX Tank Farm South Interim Surface Barrier*
3. *Topographic Survey for Fluor Federal Services*, Glahe & Associates, Sandpoint, ID 2008

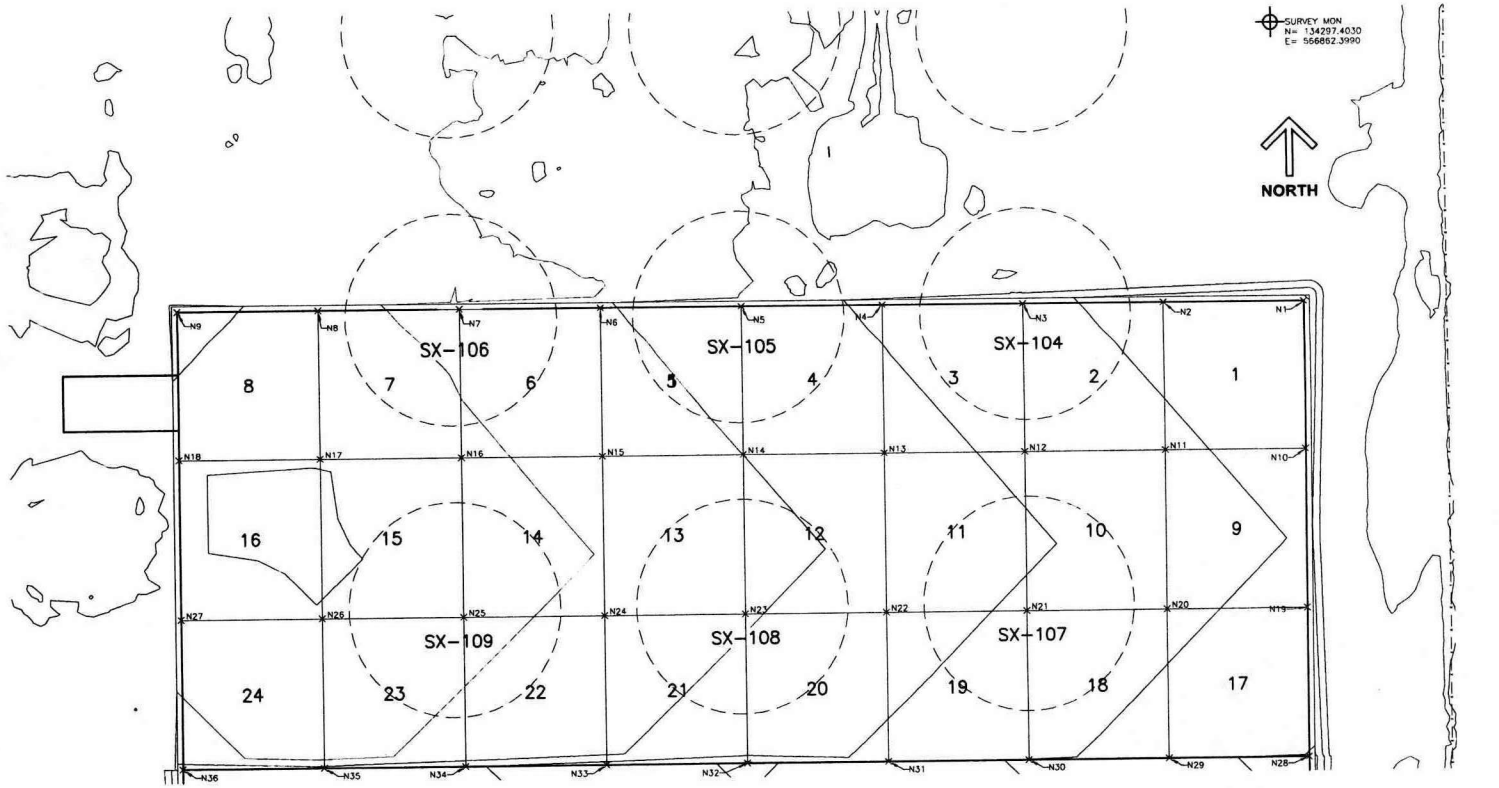
11. Attachments and Appendixes

1. Manual calculations
2. Topographic Survey
3. AutoCAD Civil 3D output data.

ATTACHMENT B1 – MANUAL CALCULATIONS

POINT TABLE			
POINT #	ELEV	NORTHING	EASTING
N1	203.11	134267.43	566865.65
N2	203.09	134267.43	566850.40
N3	203.22	134267.43	566835.15
N4	203.00	134267.43	566819.90
N5	203.03	134267.43	566804.65
N6	202.84	134267.43	566789.40
N7	202.74	134267.43	566774.15
N8	202.58	134267.43	566758.90
N9	202.61	134267.43	566743.65
N10	203.11	134251.43	566865.65
N11	203.10	134251.43	566850.40
N12	203.10	134251.43	566835.15
N13	202.99	134251.43	566819.90
N14	202.79	134251.43	566804.65
N15	202.72	134251.43	566789.40
N16	202.65	134251.43	566774.15
N17	202.64	134251.43	566758.90
N18	202.59	134251.43	566743.65
N19	203.11	134234.43	566865.65
N20	203.11	134234.43	566850.40
N21	203.17	134234.43	566835.15
N22	203.09	134234.43	566819.90
N23	203.06	134234.43	566804.65
N24	202.93	134234.43	566789.40
N25	202.68	134234.43	566774.15
N26	202.49	134234.43	566758.90
N27	202.71	134234.43	566743.65
N28	203.18	134218.43	566865.65
N29	203.14	134218.43	566850.40
N30	203.10	134218.43	566835.15
N31	203.09	134218.43	566819.90
N32	202.91	134218.43	566804.65
N33	202.72	134218.43	566789.40
N34	202.60	134218.43	566774.15
N35	202.46	134218.43	566758.90
N36	202.59	134218.43	566743.65

NOTES:
1. ELEVATIONS ARE FOR EXISTING GRADE AT ± 3 CM (1/10 FOOT) TOLERANCE.



NORTH BARRIER SITE PLAN

Originated By: Ryan Lang
Checked By: Colin Henderson

North Barrier

SX Farm Interim Surface Barrier
Earthwork Volume Analysis

Pt. (A)	Northing (B)	Easting (C)	Finished Subgrade Elev. (m) (D)	Existing Elev. (m) (E)	Elev. Δ (m) (F)	P1 (G)	P2 (H)	Avg. Δ (m) (I)	Length 1 (m) (J)	Area (m^2) (K)	Length 2 (m) (L)	Manual Volume (m^3) (M)	Quadrant # (N)
N1	134267.43	566865.65	203.74	203.11	0.63	N1	N10	0.55	16.00	8.80	15.25	118.95	1
N2	134267.43	566850.40	203.59	203.09	0.50	N2	N11	0.42	16.00	6.80	15.25	77.47	2
N3	134267.43	566835.15	203.44	203.22	0.22	N3	N12	0.21	16.00	3.36	15.25	53.07	3
N4	134267.43	566819.90	203.29	203.00	0.29	N4	N13	0.22	16.00	3.60	15.25	46.36	4
N5	134267.43	566804.65	203.13	203.03	0.10	N5	N14	0.16	16.00	2.48	15.25	35.38	5
N6	134267.43	566789.40	202.98	202.84	0.14	N6	N15	0.13	16.00	2.16	15.25	25.01	6
N7	134267.43	566774.15	202.83	202.74	0.09	N7	N16	0.07	16.00	1.12	15.25	7.32	7
N8	134267.43	566758.90	202.68	202.58	0.10	N8	N17	-0.01	16.00	-0.16	15.25	14.64	8
N9	134267.43	566743.65	202.82	202.61	0.21	N9	N18	0.13	16.00	2.08			
N10	134251.43	566865.65	203.58	203.11	0.47	N10	N19	0.48	17.00	8.16	15.25	106.29	9
N11	134251.43	566850.40	203.45	203.10	0.35	N11	N20	0.34	17.00	5.78	15.25	64.81	10
N12	134251.43	566835.15	203.30	203.10	0.20	N12	N21	0.16	17.00	2.72	15.25	33.70	11
N13	134251.43	566819.90	203.15	202.99	0.16	N13	N22	0.10	17.00	1.70	15.25	21.39	12
N14	134251.43	566804.65	203.00	202.79	0.21	N14	N23	0.06	17.00	1.10	15.25	10.37	13
N15	134251.43	566789.40	202.85	202.72	0.13	N15	N24	0.02	17.00	0.26	15.25	4.54	14
N16	134251.43	566774.15	202.70	202.65	0.05	N16	N25	0.02	17.00	0.34	15.25	-3.24	15
N17	134251.43	566758.90	202.52	202.64	-0.12	N17	N26	-0.04	17.00	-0.76	15.25	-5.19	16
N18	134251.43	566743.65	202.64	202.59	0.05	N18	N27	0.00	17.00	0.08			
N19	134234.43	566865.65	203.60	203.11	0.49	N19	N28	0.56	16.00	9.04	15.25	121.39	17
N20	134234.43	566850.40	203.44	203.11	0.33	N20	N29	0.43	16.00	6.88	15.25	85.40	18
N21	134234.43	566835.15	203.29	203.17	0.12	N21	N30	0.27	16.00	4.32	15.25	53.07	19
N22	134234.43	566819.90	203.13	203.09	0.04	N22	N31	0.16	16.00	2.64	15.25	53.07	20
N23	134234.43	566804.65	202.98	203.06	-0.08	N23	N32	0.27	16.00	4.32	15.25	67.10	21
N24	134234.43	566789.40	202.83	202.93	-0.10	N24	N33	0.28	16.00	4.48	15.25	71.98	22
N25	134234.43	566774.15	202.67	202.68	-0.01	N25	N34	0.31	16.00	4.96	15.25	76.86	23
N26	134234.43	566758.90	202.52	202.49	0.03	N26	N35	0.32	16.00	5.12	15.25	74.42	24
N27	134234.43	566743.65	202.67	202.71	-0.04	N27	N36	0.29	16.00	4.64			
N28	134218.43	566865.65	203.82	203.18	0.64								
N29	134218.43	566850.40	203.67	203.14	0.53								
N30	134218.43	566835.15	203.52	203.10	0.42								
N31	134218.43	566819.90	203.38	203.09	0.29								
N32	134218.43	566804.65	203.53	202.91	0.62								
N33	134218.43	566789.40	203.38	202.72	0.66								
N34	134218.43	566774.15	203.23	202.60	0.63								
N35	134218.43	566758.90	203.07	202.46	0.61								
N36	134218.43	566743.65	203.21	202.59	0.62								

Total Manual Volume: 1214.17
*Total AutoCAD Volume: 1093
% Error: -9.98%

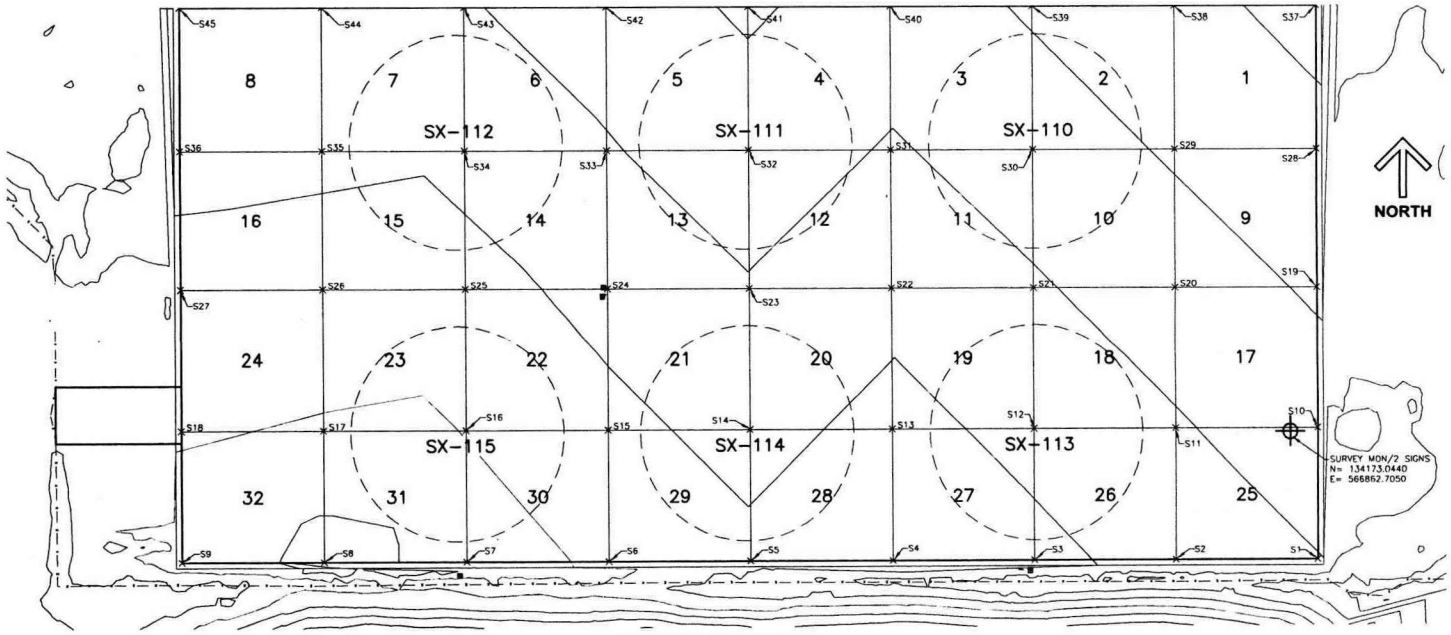
Quadrant #1 example calculations:

Elev. Δ: $F_1 = D_1 - E_1$
Avg. Δ: $I_1 = (F_1 + F_{10})/2$
Length 1: $J_1 = B_1 - B_{10}$
Area: $K_1 = I_1 * J_1$
Length 2: $L_1 = C_1 - C_2$
Manual Volume: $M_1 = L_1 * (K_1 + K_2)/2$
% Error: $\% = (V_{AutoCAD} - V_{Manual})/V_{Manual}$

*Note: Volume used here is for checking quadrants outlined in attachment only and does not take into account sloped edges around the barrier perimeter. Design drawings show volumes including sloped edges.

POINT TABLE			
POINT #	ELEV	NORTHING	EASTING
S1	203.18	134159.42	566865.65
S2	203.12	134159.42	566850.40
S3	203.12	134159.42	566835.15
S4	203.09	134159.42	566819.90
S5	202.96	134159.42	566804.65
S6	202.69	134159.42	566789.40
S7	202.47	134159.42	566774.15
S8	202.48	134159.42	566758.90
S9	202.62	134159.42	566743.65
S10	203.22	134173.42	566865.65
S11	203.06	134173.42	566850.40
S12	203.11	134173.42	566835.15
S13	203.05	134173.42	566819.90
S14	202.82	134173.42	566804.65
S15	202.69	134173.42	566789.40
S16	202.52	134173.42	566774.15
S17	202.64	134173.42	566758.90
S18	202.81	134173.42	566743.65
S19	203.28	134188.42	566865.65
S20	203.17	134188.42	566850.40
S21	203.04	134188.42	566835.15
S22	203.05	134188.42	566819.90
S23	202.93	134188.42	566804.65
S24	202.73	134188.42	566789.40
S25	202.63	134188.42	566774.15
S26	202.51	134188.42	566758.90
S27	202.76	134188.42	566743.65
S28	203.25	134203.42	566865.65
S29	203.19	134203.42	566850.40
S30	203.18	134203.42	566835.15
S31	202.98	134203.42	566819.90
S32	202.98	134203.42	566804.65
S33	202.66	134203.42	566789.40
S34	202.67	134203.42	566774.15
S35	202.47	134203.42	566758.90
S36	202.70	134203.42	566743.65
S37	203.18	134218.42	566865.65
S38	203.14	134218.42	566850.40
S39	203.10	134218.42	566835.15
S40	203.09	134218.42	566819.90
S41	202.91	134218.42	566804.65
S42	202.72	134218.42	566789.40
S43	202.60	134218.42	566774.15
S44	202.46	134218.42	566758.90
S45	202.59	134218.42	566743.65

NOTES:
1. ELEVATIONS ARE FOR EXISTING GRADE AT ± 3 CM (1/10 FOOT) TOLERANCE.



SOUTH BARRIER SITE PLAN

5 0 5 10
SCALE IN METERS

Originated By: Ryan Lang
Checked By: Colin Henderson

South Barrier

SX Farm Interim Surface Barrier
Earthwork Volume Analysis

Pt. # (A)	Northing (B)	Easting (C)	Finished Subgrade Elev. (m) (D)	Existing Elev. (m) (E)	Elev. Δ (m) (F)	P1 (G)	P2 (H)	Avg. Δ (m) (I)	Length 1 (m) (J)	Area (m^2) (K)	Length 2 (m) (L)	Manual Volume (m^3) (M)	Quadrant # (N)
S1	134159.42	566865.65	203.24	203.18	0.06	S1	S10	0.11	14.00	1.54	15.25	19.21	1
S2	134159.42	566850.40	203.09	203.12	-0.03	S2	S11	0.07	14.00	0.98	15.25	-4.27	2
S3	134159.42	566835.15	202.94	203.12	-0.18	S3	S12	-0.11	14.00	-1.54	15.25	-34.16	3
S4	134159.42	566819.90	202.79	203.09	-0.30	S4	S13	-0.21	14.00	-2.94	15.25	-9.61	4
S5	134159.42	566804.65	202.94	202.96	-0.02	S5	S14	0.12	14.00	1.68	15.25	30.96	5
S6	134159.42	566789.40	202.79	202.69	0.10	S6	S15	0.17	14.00	2.38	15.25	40.03	6
S7	134159.42	566774.15	202.64	202.47	0.17	S7	S16	0.20	14.00	2.87	15.25	28.82	7
S8	134159.42	566758.90	202.52	202.48	0.04	S8	S17	0.07	14.00	0.91	15.25	5.34	8
S9	134159.42	566743.65	202.63	202.62	0.01	S9	S18	-0.02	14.00	-0.21			
S10	134173.42	566865.65	203.38	203.22	0.16	S10	S19	0.20	15.00	3.07	15.25	45.18	9
S11	134173.42	566850.40	203.23	203.06	0.17	S11	S20	0.19	15.00	2.85	15.25	29.74	10
S12	134173.42	566835.15	203.07	203.11	-0.04	S12	S21	0.07	15.00	1.05	15.25	2.86	11
S13	134173.42	566819.90	202.93	203.05	-0.12	S13	S22	-0.05	15.00	-0.68	15.25	26.88	12
S14	134173.42	566804.65	203.08	202.82	0.26	S14	S23	0.28	15.00	4.20	15.25	65.77	13
S15	134173.42	566789.40	202.93	202.69	0.24	S15	S24	0.30	15.00	4.43	15.25	63.48	14
S16	134173.42	566774.15	202.76	202.52	0.24	S16	S25	0.26	15.00	3.90	15.25	56.62	15
S17	134173.42	566758.90	202.73	202.64	0.09	S17	S26	0.23	15.00	3.52	15.25	33.74	16
S18	134173.42	566743.65	202.77	202.81	-0.04	S18	S27	0.06	15.00	0.90			
S19	134188.42	566865.65	203.53	203.28	0.25	S19	S28	0.34	15.00	5.10	15.25	70.34	17
S20	134188.42	566850.40	203.38	203.17	0.21	S20	S29	0.28	15.00	4.13	15.25	53.18	18
S21	134188.42	566835.15	203.22	203.04	0.18	S21	S30	0.19	15.00	2.85	15.25	37.74	19
S22	134188.42	566819.90	203.08	203.05	0.03	S22	S31	0.14	15.00	2.10	15.25	56.04	20
S23	134188.42	566804.65	203.23	202.93	0.30	S23	S32	0.35	15.00	5.25	15.25	92.64	21
S24	134188.42	566789.40	203.08	202.73	0.35	S24	S33	0.46	15.00	6.90	15.25	91.50	22
S25	134188.42	566774.15	202.91	202.63	0.28	S25	S34	0.34	15.00	5.10	15.25	97.22	23
S26	134188.42	566758.90	202.89	202.51	0.38	S26	S35	0.51	15.00	7.65	15.25	88.07	24
S27	134188.42	566743.65	202.92	202.76	0.16	S27	S36	0.26	15.00	3.90			
S28	134203.42	566865.65	203.68	203.25	0.43	S28	S37	0.54	15.00	8.10	15.25	112.09	25
S29	134203.42	566850.40	203.53	203.19	0.34	S29	S38	0.44	15.00	6.60	15.25	86.35	26
S30	134203.42	566835.15	203.38	203.18	0.20	S30	S39	0.31	15.00	4.72	15.25	66.91	27
S31	134203.42	566819.90	203.23	202.98	0.25	S31	S40	0.27	15.00	4.05	15.25	89.21	28
S32	134203.42	566804.65	203.38	202.98	0.40	S32	S41	0.51	15.00	7.65	15.25	128.67	29
S33	134203.42	566789.40	203.23	202.66	0.57	S33	S42	0.61	15.00	9.22	15.25	129.24	30
S34	134203.42	566774.15	203.07	202.67	0.40	S34	S43	0.52	15.00	7.73	15.25	130.96	31
S35	134203.42	566758.90	203.05	202.41	0.64	S35	S44	0.63	15.00	9.45	15.25	128.10	32
S36	134203.42	566743.65	203.06	202.70	0.36	S36	S45	0.49	15.00	7.35			
S37	134218.42	566865.65	203.83	203.18	0.65								
S38	134218.42	566850.40	203.68	203.14	0.54								
S39	134218.42	566835.15	203.53	203.10	0.43								
S40	134218.42	566819.90	203.38	203.09	0.29								
S41	134218.42	566804.65	203.53	202.91	0.62								
S42	134218.42	566789.40	203.38	202.72	0.66								
S43	134218.42	566774.15	203.23	202.60	0.63								
S44	134218.42	566758.90	203.08	202.46	0.62								
S45	134218.42	566743.65	203.21	202.59	0.62								

Total Manual Volume: 1858.86
*Total AutoCAD Volume: 1841
% Error: -0.96%

Quadrant #1 example calculations:

Elev. Δ: $F_1 = D_1 - E_1$

Avg. Δ: $I_1 = (F_1 + F_{10})/2$

Length 1: $J_1 = B_1 - B_{10}$

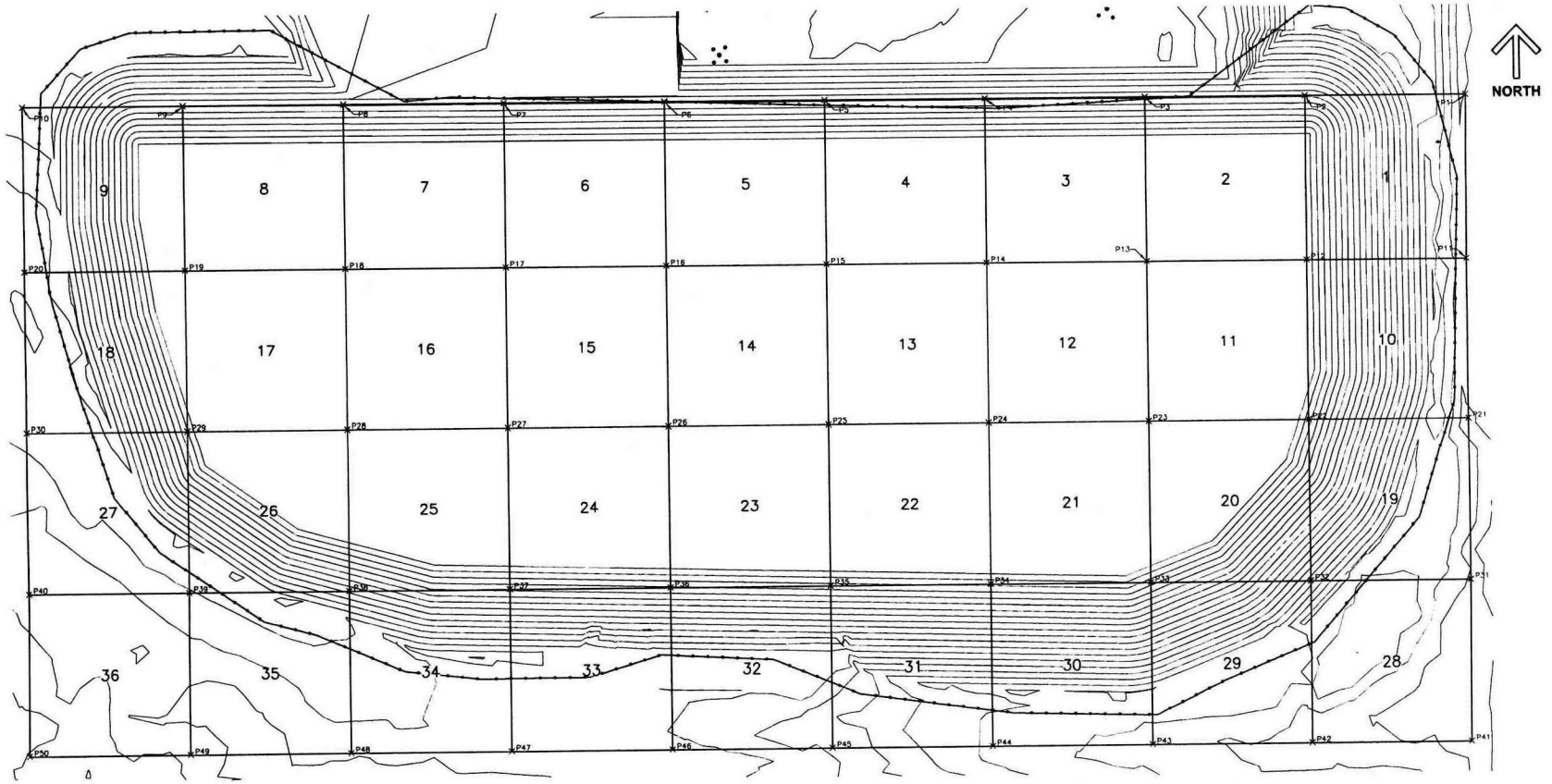
Area: $K_1 = I_1 * J_1$

Length 2: $L_1 = C_1 - C_2$

Manual Volume: $M_1 = L_1 * (K_1 + K_2)/2$

% Error: $\% = (V_{AutoCAD} - V_{Manual})/V_{Manual}$

*Note: Volume used here is for checking quadrants outlined in attachment only and does not take into account sloped edges around the barrier perimeter. Design drawings show volumes including sloped edges.



POINT TABLE FINISHED GRADE			
PNT #	ELE	N	E
P1	204.49	134114.98	566867.44
P2	200.79	134114.98	566867.44
P3	200.79	134114.98	566847.44
P4	200.79	134114.98	566827.44
P5	200.79	134114.98	566807.44
P6	200.79	134114.98	566787.44
P7	200.79	134114.98	566767.44
P8	200.78	134114.98	566747.44
P9	200.76	134114.98	566727.44
P10	202.82	134114.98	566707.44
P11	204.38	134094.98	566887.44
P12	199.20	134094.98	566867.44
P13	199.20	134094.98	566847.44
P14	199.20	134094.98	566827.44
P15	199.20	134094.98	566807.44
P16	199.20	134094.98	566787.44
P17	199.20	134094.98	566767.44

PNT #	ELE	N	E
P18	199.20	134094.98	566747.44
P19	199.20	134094.98	566727.44
P20	202.10	134094.98	566707.44
P21	204.58	134074.98	566887.44
P22	199.64	134074.98	566867.44
P23	199.20	134074.98	566847.44
P24	199.20	134074.98	566827.44
P25	199.20	134074.98	566807.44
P26	199.20	134074.98	566787.44
P27	199.20	134074.98	566767.44
P28	199.20	134074.98	566747.44
P29	199.52	134074.98	566727.44
P30	202.14	134074.98	566707.44
P31	204.54	134054.98	566887.44
P32	203.38	134054.98	566867.44
P33	199.89	134054.98	566847.44
P34	199.88	134054.98	566827.44

PNT #	ELE	N	E
P35	199.85	134054.98	566807.44
P36	200.03	134054.98	566787.44
P37	200.20	134054.98	566767.44
P38	201.18	134054.98	566747.44
P39	202.27	134054.98	566727.44
P40	202.54	134054.98	566707.44
P41	204.54	134034.98	566887.44
P42	204.44	134034.98	566867.44
P43	204.17	134034.98	566847.44
P44	203.80	134034.98	566827.44
P45	203.05	134034.98	566807.44
P46	202.66	134034.98	566787.44
P47	202.60	134034.98	566767.44
P48	202.70	134034.98	566747.44
P49	202.59	134034.98	566727.44
P50	202.48	134034.98	566707.44

POINT TABLE EXISTING GRADE			
PNT #	ELE	N	E
P1	204.49	134114.98	566887.44
P2	203.22	134114.98	566867.44
P3	199.82	134114.98	566847.44
P4	199.78	134114.98	566827.44
P5	199.61	134114.98	566807.44
P6	199.39	134114.98	566787.44
P7	199.16	134114.98	566767.44
P8	201.12	134114.98	566747.44
P9	202.48	134114.98	566727.44
P10	202.52	134114.98	566707.44
P11	204.38	134094.98	566887.44
P12	204.05	134094.98	566867.44
P13	199.88	134094.98	566847.44

PNT #	ELE	N	E
P14	200.13	134094.98	566827.44
P15	199.35	134094.98	566807.44
P16	199.34	134094.98	566787.44
P17	199.32	134094.98	566767.44
P18	202.10	134094.98	566747.44
P19	202.45	134094.98	566727.44
P20	202.10	134094.98	566707.44
P21	204.58	134074.98	566887.44
P22	204.13	134074.98	566867.44
P23	199.88	134074.98	566847.44
P24	201.69	134074.98	566827.44
P25	201.64	134074.98	566807.44
P26	201.47	134074.98	566787.44

PNT #	ELE	N	E
P27	200.40	134074.98	566767.44
P28	199.94	134074.98	566747.44
P29	202.30	134074.98	566727.44
P30	202.14	134074.98	566707.44
P31	204.54	134054.98	566887.44
P32	204.07	134054.98	566867.44
P33	201.98	134054.98	566847.44
P34	201.97	134054.98	566827.44
P35	201.47	134054.98	566807.44
P36	201.36	134054.98	566787.44
P37	201.24	134054.98	566767.44
P38	201.73	134054.98	566747.44
P39	202.27	134054.98	566727.44

PNT #	ELE	N	E
P40	202.54	134054.98	566707.44
P41	204.54	134034.98	566887.44
P42	204.44	134034.98	566867.44
P43	204.17	134034.98	566847.44
P44	203.80	134034.98	566827.44
P45	203.05	134034.98	566807.44
P46	202.66	134034.98	566787.44
P47	202.60	134034.98	566767.44
P48	202.70	134034.98	566747.44
P49	202.59	134034.98	566727.44
P50	202.48	134034.98	566707.44

5 0 5 10
SCALE IN METERS

Originated By: Ryan Lang
Checked By: Colin Henderson

Evapotranspiration Basin

SX Farm Interim Surface Barrier
Earthwork Volume Analysis

Pt. # (A)	Northing (B)	Easting (C)	Finished Subgrade Elev. (m) (D)	Existing Elev. (m) (E)	Elev. Δ (m) (F)	P1 (G)	P2 (H)	Avg. Δ (m) (I)	Length 1 (m) (J)	Area (m^2) (K)	Length 2 (m) (L)	Manual Volume (m^3) (M)	Quadrant # (N)
P1	134114.98	566887.44	204.49	204.49	0.00	P1	P11	0.00	20.00	0.00	20.00	-728.00	1
P2	134114.98	566867.44	200.79	203.22	-2.43	P2	P12	-3.64	20.00	-72.80	20.00	-677.00	2
P3	134114.98	566847.44	200.79	199.82	0.97	P3	P13	0.25	20.00	5.10	20.00	59.00	3
P4	134114.98	566827.44	200.79	199.78	1.01	P4	P14	0.04	20.00	0.80	20.00	111.00	4
P5	134114.98	566807.44	200.79	199.61	1.18	P5	P15	0.51	20.00	10.30	20.00	229.00	5
P6	134114.98	566787.44	200.79	199.39	1.40	P6	P16	0.63	20.00	12.60	20.00	277.00	6
P7	134114.98	566767.44	200.79	199.16	1.63	P7	P17	0.75	20.00	15.10	20.00	-173.00	7
P8	134114.98	566747.44	200.78	201.12	-0.34	P8	P18	-1.62	20.00	-32.40	20.00	-822.00	8
P9	134114.98	566727.44	200.76	202.48	-1.72	P9	P19	-2.49	20.00	-49.80	20.00	-498.00	9
P10	134114.98	566707.44	202.62	202.62	0.00	P10	P20	0.00	20.00	0.00			
P11	134094.98	566887.44	204.38	204.38	0.00	P11	P21	0.00	20.00	0.00	20.00	-934.00	10
P12	134094.98	566867.44	199.20	204.05	-4.85	P12	P22	-4.67	20.00	-93.40	20.00	-1048.00	11
P13	134094.98	566847.44	199.20	199.66	-0.46	P13	P23	-0.57	20.00	-11.40	20.00	-456.00	12
P14	134094.98	566827.44	199.20	200.13	-0.93	P14	P24	-1.71	20.00	-34.20	20.00	-601.00	13
P15	134094.98	566807.44	199.20	199.35	-0.15	P15	P25	-1.30	20.00	-25.90	20.00	-500.00	14
P16	134094.98	566787.44	199.20	199.34	-0.14	P16	P26	-1.21	20.00	-24.10	20.00	-373.00	15
P17	134094.98	566767.44	199.20	199.32	-0.12	P17	P27	-0.66	20.00	-13.20	20.00	-496.00	16
P18	134094.98	566747.44	199.20	202.10	-2.90	P18	P28	-1.82	20.00	-36.40	20.00	-968.00	17
P19	134094.98	566727.44	199.20	202.46	-3.26	P19	P29	-3.02	20.00	-60.40	20.00	-604.00	18
P20	134094.98	566707.44	202.10	202.10	0.00	P20	P30	0.00	20.00	0.00			
P21	134074.98	566887.44	204.56	204.56	0.00	P21	P31	0.00	20.00	0.00	20.00	-518.00	19
P22	134074.98	566867.44	199.64	204.13	-4.49	P22	P32	-2.59	20.00	-51.80	20.00	-795.00	20
P23	134074.98	566847.44	199.20	199.88	-0.68	P23	P33	-1.39	20.00	-27.70	20.00	-755.00	21
P24	134074.98	566827.44	199.20	201.69	-2.49	P24	P34	-2.39	20.00	-47.80	20.00	-884.00	22
P25	134074.98	566807.44	199.20	201.64	-2.44	P25	P35	-2.03	20.00	-40.60	20.00	-766.00	23
P26	134074.98	566787.44	199.20	201.47	-2.27	P26	P36	-1.80	20.00	-36.00	20.00	-584.00	24
P27	134074.98	566767.44	199.20	200.40	-1.20	P27	P37	-1.12	20.00	-22.40	20.00	-353.00	25
P28	134074.98	566747.44	199.20	199.94	-0.74	P28	P38	-0.64	20.00	-12.90	20.00	-407.00	26
P29	134074.98	566727.44	199.52	202.30	-2.78	P29	P39	-1.39	20.00	-27.80	20.00	-278.00	27
P30	134074.98	566707.44	202.14	202.14	0.00	P30	P40	0.00	20.00	0.00			
P31	134054.98	566887.44	204.54	204.54	0.00	P31	P41	0.00	20.00	0.00	20.00	-69.00	28
P32	134054.98	566867.44	203.38	204.07	-0.69	P32	P42	-0.34	20.00	-6.90	20.00	-278.00	29
P33	134054.98	566847.44	199.89	201.98	-2.09	P33	P43	-1.05	20.00	-20.90	20.00	-438.00	30
P34	134054.98	566827.44	199.68	201.97	-2.29	P34	P44	-1.15	20.00	-22.90	20.00	-391.00	31
P35	134054.98	566807.44	199.85	201.47	-1.62	P35	P45	-0.81	20.00	-16.20	20.00	-295.00	32
P36	134054.98	566787.44	200.03	201.36	-1.33	P36	P46	-0.67	20.00	-13.30	20.00	-237.00	33
P37	134054.98	566767.44	200.20	201.24	-1.04	P37	P47	-0.52	20.00	-10.40	20.00	-159.00	34
P38	134054.98	566747.44	201.18	201.73	-0.55	P38	P48	-0.27	20.00	-5.50	20.00	-55.00	35
P39	134054.98	566727.44	202.27	202.27	0.00	P39	P49	0.00	20.00	0.00	20.00	0.00	36
P40	134054.98	566707.44	202.54	202.54	0.00	P40	P50	0.00	20.00	0.00			
P41	134034.98	566887.44	204.54	204.54	0.00								
P42	134034.98	566867.44	204.44	204.44	0.00								
P43	134034.98	566847.44	204.17	204.17	0.00								
P44	134034.98	566827.44	203.80	203.80	0.00								
P45	134034.98	566807.44	203.05	203.05	0.00								
P46	134034.98	566787.44	202.66	202.66	0.00								
P47	134034.98	566767.44	202.60	202.60	0.00								
P48	134034.98	566747.44	202.70	202.70	0.00								
P49	134034.98	566727.44	202.59	202.59	0.00								
P50	134034.98	566707.44	202.48	202.48	0.00								

Total Manual Volume: -15464.00
*Total AutoCAD Volume: -15494
% Error: 0.19%

Quadrant #1 example calculations:

Elev. Δ: $F_1 = D_1 - E_1$

Avg. Δ: $I_1 = (F_1 + F_{11})/2$

Length 1: $J_1 = B_1 - B_{11}$

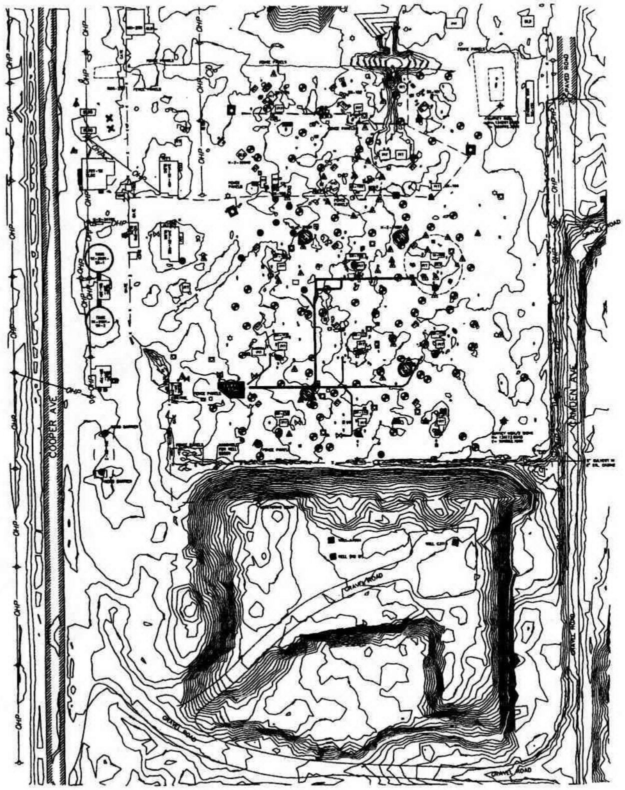
Area: $K_1 = I_1 * J_1$

Length 2: $L_1 = C_1 - C_2$

Manual Volume: $M_1 = L_1 * (K_1 + K_2)/2$

% Error: $\% = (V_{AutoCAD} - V_{Manual})/V_{Manual}$

ATTACHMENT B2 – TOPOGRAPHIC SURVEY



GRAPHIC SCALE

(IN METERS)

1 : 750

TOPOGRAPHIC SURVEY

FOR

FLUOR FEDERAL SERVICES

PROJECT: SX TANK FARM
CONTRACT NO. WIRP-9-K11939

LYING IN A PORTION OF
SECTION 12, TOWNSHIP 12 NORTH, RANGE 25 EAST, WILLAMETTE MERIDIAN
BENTON COUNTY, STATE OF WASHINGTON

P:\Projects\2009\09-060 Fluor\Images\Fluor Image.jpg

LEGEND

- SURVEY CONTROL MONUMENT, COORDINATES NOTED ON MAP.
- RISER - VARIABLE HEIGHT
- BOLLARD
- WELL
- SIGNAGE
- JUNCTION BOX
- VALVE
- CAISSON - AS NOTED
- LIGHT POLE / POWER POLE
- POWER POLE W/ GUY ANCHOR
- ROUNDED PIT
- ANODE RISER
- ELECTRICAL PEDESTAL
- TEST WELL
- ELECTRICAL HAND HOLE (CLUSTER)
- CHAIN LINK FENCE - 8 FT HIGH
- HANGING CHAIN FENCE
- OHP — OVERHEAD POWER LINE
- PIPING ABOVE GROUND
- EDGE OF GRAVEL
- EDGE OF PAVEMENT
- CONCRETE
- FENCE PANEL
- SOLAR/MONITORING EQUIPMENT

DATUM NOTE:

HORIZONTAL DATUM: WASHINGTON COORDINATE SYSTEM OF 1983, SOUTH ZONE/1991 ADJUSTMENT (WCS83S/91) - METERS

VERTICAL DATUM: NORTH AMERICA VERTICAL DATUM OF 1988 (NAVD88) - METERS

EQUIPMENT NOTE:

TOPOGRAPHIC SURVEY DATA PRESENTED ON THIS MAP WAS COLLECTED USING A LEICA 3-D IMAGING SCANSTATION.

COORDINATE NOTE:

COORDINATE VALUES FOR SURVEY CONTROL MONUMENTS PROVIDED BY FLUOR FEDERAL SERVICES VIA GPS OBSERVATION.

CONTOUR NOTE:

MAJOR CONTOUR INTERVAL = 0.6096m or 2.0ft

MINOR CONTOUR INTERVAL = 0.1524m or 0.5ft

PURPOSE OF SURVEY

TOPOGRAPHIC SURVEY ON A PORTION OF THE SX TANK FARM.

SPECIAL NOTE:

THIS SURVEY DOES NOT ATTEMPT TO SHOW ALL EASEMENTS OF RECORD OR IN VIEW, NOR PHYSICAL FEATURES AND IMPROVEMENTS OF THE PROPERTY.

SURVEYOR'S CERTIFICATE

I, LAWRENCE A. GLAHE, P.L.S. 23286, STATE OF WASHINGTON, DO HEREBY CERTIFY THAT THIS TOPOGRAPHIC MAP HAS BEEN PREPARED BY ME OR UNDER MY DIRECTION, AND THAT THE MAP SHOWN HEREON IS A TRUE REPRESENTATION OF A SURVEY MADE BY ME IN AUGUST, 2009.

Section	Township	Range	TOPOGRAPHIC SURVEY FOR FLUOR FEDERAL SERVICES		
12	12 N	25 E	GLAHE & ASSOCIATES PROFESSIONAL LAND SURVEYORS 303 Church Street Sandpoint, Idaho 83864	Scale: 1 : 750	
				Checked By: ESS	Drawn By: KV/TP
Project No. 08-093 FFS	File Name: 08-093 FFS	Plot Date: 10/9/08		Date: AUGUST 2008	Sheet: 1 of 1

B-14

RPP-CALC-48447, Rev. 0

ATTACHMENT B3 – AUTOCAD CIVIL 3D OUTPUT DATA

barrier volumes 050911

Volumes obtained using AutoCAD Civil 3D 2010 from surfaces contained in Volume Surfaces.dwg 03/08/11

North Barrier
Net volume = 1093 Cu. M.<Fill>
Cut = 63 Cu. M.
Fill = 1156 Cu. M.

South Barrier
Net volume = 1841 Cu. M.<Fill>
Cut = 88 Cu. M.
Fill = 1929 Cu. M.

Pond
Net volume = 15494 Cu. M.<Cut>
Cut = 16183 Cu. M.
Fill = 689 Cu. M.

Drywell Access Road
Net volume = 432 Cu. M.<Fill>
Cut = 535 Cu. M.
Fill = 967 Cu. M.

LOW SPOT FILL AREAS
Net volume = 2284 Cu. M.<Fill>
Cut = 14 Cu. M.
Fill = 2298 Cu. M.

Pond Access (from drywell access road)
Net volume = 117 Cu. M.<Fill>
Cut = 0 Cu. M.
Fill = 117 Cu. M.

* 1 M of fill above drain pipes in pond
(1.17 M above bottom of pond excavation)
Net volume = 9164.00 Cu. M.<Fill>
Cut = 0.00 Cu. M.
Fill = 9164.00 Cu. M.

* Volume Calculated using

(7230x1.16)+(8570x1.16)/2

bottom area 7230 sq. m
top area 8570 sq. m
depth of fill 1.16 m
This includes 3' (0.9144m) of fill over the pipes
2" (0.05m) of sand under the pipes
8" (0.20m) diameter pipe

Page 1

```
                    TANK LOAD VOLUMES 030811.txt
Volumes obtained using AutoCAD Civil 3D 2010 from surfaces contained in Volume
Surfaces.dwg 03/08/11

Select bounding polygon: SX-104
          Net volume = 69.69 Cu. M.<Fill>
                 Cut = 0.00 Cu. M.
                Fill = 69.69 Cu. M.

Select bounding polygon: SX-105
          Net volume = 38.46 Cu. M.<Fill>
                 Cut = 0.00 Cu. M.
                Fill = 38.46 Cu. M.

Select bounding polygon: SX-106
          Net volume = 44.07 Cu. M.<Fill>
                 Cut = 0.00 Cu. M.
                Fill = 44.07 Cu. M.

Select bounding polygon: SX-107
          Net volume = 55.69 Cu. M.<Fill>
                 Cut = 0.72 Cu. M.
                Fill = 56.41 Cu. M.

Select bounding polygon: SX-108
          Net volume = 18.89 Cu. M.<Fill>
                 Cut = 0.96 Cu. M.
                Fill = 19.85 Cu. M.

Select bounding polygon: SX-109
          Net volume = 13.62 Cu. M.<Fill>
                 Cut = 2.82 Cu. M.
                Fill = 16.45 Cu. M.

Select bounding polygon: SX-110
          Net volume = 77.47 Cu. M.<Fill>
                 Cut = 0.00 Cu. M.
                Fill = 77.47 Cu. M.

Select bounding polygon: SX-111
          Net volume = 153.80 Cu. M.<Fill>
                 Cut = 0.00 Cu. M.
                Fill = 153.80 Cu. M.

Select bounding polygon: SX-112
          Net volume = 170.11 Cu. M.<Fill>
                 Cut = 0.00 Cu. M.
                Fill = 170.11 Cu. M.

Select bounding polygon: SX-113
          Net volume = 12.49 Cu. M.<Cut>
                 Cut = 19.71 Cu. M.
                Fill = 7.22 Cu. M.

Select bounding polygon: SX-114
          Net volume = 60.61 Cu. M.<Fill>
                 Cut = 1.18 Cu. M.
                Fill = 61.79 Cu. M.

Select bounding polygon: SX-115\par
          Net volume = 89.00 Cu. M.<Fill>
                 Cut = 0.00 Cu. M.
                Fill = 89.00 Cu. M.
```

APPENDIX C

TANK LOADING

LIST OF TRADEMARKS

AutoCAD	Registered trademark of AutoDesk, Inc
Civil 3D	Registered trademark of AutoDesk, Inc.
MatCon	Trademark of Matcon, Inc.
MathCAD	Registered trademark of Parametric Technology Corporation.

SUBCONTRACTOR CALCULATION REVIEW CHECKLIST

Subject: TANK LOADING

The subject document has been reviewed by the undersigned.
The reviewer reviewed and verified the following items as applicable.

Documents Reviewed: RPP-CALC-48447, Rev. 0, Appendix C

Analysis Performed By: Columbia Energy

- Design Input
- Basic Assumptions
- Approach/Design Methodology
- Consistency with item or document supported by the calculation
- Conclusion/Results Interpretation
- Impact on existing requirements

EM Tress — 5-24-11
Reviewer (Print/Sign) — Date

CJ Alderman — 05/24/2011
Organizational Manager (Print/Sign) — Date

RPP-CALC-48447, Rev. 0

CALCULATION REVIEW CHECKLIST

Calculation Reviewed: Tank Loading

Scope of Review: Entire Calculation

(e.g., document section or portion of calculation)

Engineer/Analyst: Ryan Lang Date: 5/24/11

(printed name and signature)

Organizational Manager: Larry Ulbricht Date: 5/24/11

(printed name and signature)

This document consists of 7 pages and the following attachments (if applicable): C1, C2, C3, C4, C5, C6, C7

Yes	No	N/A*		
[✓]	[ ]	[ ]	1.	Analytical and technical approaches and results are reasonable and appropriate.
[ ]	[ ]	[✓] 1	2.	Necessary assumptions are reasonable, explicitly stated, and supported.
[✓]	[ ]	[ ]	3.	Ensure calculations that use software include a paper printout, microfiche, CD-ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
[✓]	[ ]	[ ]	4.	Input data were checked for consistency with original source information.
[✓]	[ ]	[ ]	5.	Key input data (e.g., dimensions, performance characteristics) that may affect equipment design is identified.
[ ]	[ ]	[✓] 2	6.	For both qualitative and quantitative data, uncertainties are recognized and discussed and the data is presented in a manner to minimize design interpretations.
[✓]	[ ]	[ ]	7.	Mathematical derivations were checked, including dimensional consistency of results.
[✓]	[ ]	[ ]	8.	Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information.
[✓]	[ ]	[ ]	9.	Software verification and validation are addressed adequately.
[✓]	[ ]	[ ]	10.	Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
[✓]	[ ]	[ ]	11.	Conclusions are consistent with analytical results and applicable limits.
[✓]	[ ]	[ ]	12.	Results and conclusions address all points in the purpose.
[✓]	[ ]	[ ]	13.	Referenced documents are retrievable or otherwise available.
[✓]	[ ]	[ ]	14.	The version or revision of each reference is cited.
[✓]	[ ]	[ ]	15.	The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions."
[ ]	[ ]	[✓] 3	16.	Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents, as appropriate.
[✓]	[ ]	[ ]	17.	All checker comments have been dispositioned and the design media matches the calculations.

Colin Henderson 5/24/11

Checker (Print/Sign) Date

* If less than the entire calculation was checked, the scope of the check should be discussed. If any blocks are checked "No", an explanation must be provided here or attached

1. NO ASSUMPTIONS MADE IN CALCULATION.
2. NO UNCERTAINTIES ARE IDENTIFIED.
3. NO REQUIREMENT IMPACTS ARE IDENTIFIED.

A-6004-162 (REV 2)

Originated by:	Ryan Lang	RL	5/24/11
	Name	Initials	Date
Checked by:	Colin Henderson	CH	5/24/11
	Name	Initials	Date

1. Objective/Purpose

The objective of this calculation is to determine that the 241-SX farm interim surface barrier will not impose loads on the tanks that exceed the dome loading limits specified in RPP-16363, *Tank Specific Allowable Dome Load for the Hanford-Site 100-Series Single Shell Tanks.* The total equivalent soil height and total concentrated load over the domes of SX tanks will be calculated. The SX tanks to be considered in this analysis include SX-104 to SX-115. Tanks SX-101 to SX-103 will not be affected by the barrier therefore they will not be included in this analysis.

The interim surface barrier design involves covering the entire tank farm so uniformly distributed loads are considered in addition to the concentrated loads being evaluated. Consideration of uniformly distributed loading involves making comparisons of the calculated soil heights against the allowable soil heights over each of the tank domes. Comparisons will also be made with the calculated loads against existing dome load data. This load summary is performed in accordance with RPP-SPEC-47469, *SX Farm Interim Surface Barrier Subsystem Specification.*

2. Introduction/Background

The 241-SX Tank Farm ground surface is to be covered with an interim barrier to reduce groundwater impacts from subsurface contamination. In order to establish a barrier surface that will drain to the collection and conveyance system, the surface of the tank farm will be modified by grading and adding fill material. A modified asphalt layer provided by MatCon™ will then be installed acting as the interim barrier.

3. Input Data

1. Density of existing backfill is 112.3 lb/ft^3 (RPP-SPEC-47469, Table 4).
2. Density of compacted earth fill expected to be used is 136.9 lb/ft^3 (RPP-CALC-36699, Appendix C. Quality Inspection Lab Report using similar material, Attachment 6).
3. Density of asphalt is 148 lb/ft^3 (MatCon, Attachment 4).
4. Density of concrete is 150 lb/ft^3 (AISC 13th, Table 17-12).
5. Density of steel is 490 lb/ft^3 (AISC 13th, Table 17-12).

4. Assumptions

None.

5. Method of Analysis

The earthwork volumes are calculated using AutoCAD® Civil 3D® and include fill directly over each tank. The electronic coordinate data associated with the topography survey completed in 2008 was imported into AutoCAD Civil 3D and used as the baseline tank farm surface. The sub-grade and interim surface barrier elevations were generated to produce the drainage slopes necessary to facilitate drainage of precipitation that falls on the barrier surface.

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	Name	Initials	Date

Volumes are also calculated for the MatCon asphalt layer that will be establishing the barrier surface. The volumes over each tank are determined by the following equation:

$$V = \frac{\pi D^2 t}{4}$$

Where: V = Volume of MatCon asphalt

π = 3.141592654...

D = Outer diameter of tank, 77.5 ft

t = thickness of MatCon asphalt, 0.33 ft (H-14-109330)

Average soil heights are calculated for each tank based on the data from AutoCAD Civil 3D. The changes in heights are determined by the following equation:

$$\Delta_s = \frac{V}{A}$$

Where: Δ_S = Change in soil depth

V = Volume of soil for the area being considered

A = Area of tank footprint

The added soil material is converted to an equivalent soil thickness using the relative densities. Equivalent soil heights are then calculated for each tank by taking a ratio of the density of added soil to that of existing soil to achieve an equivalent value of soil depth. The added soil height (as an equivalent soil depth) is determined by the following equation:

$$\Delta_{Soil\ Added} = \frac{D_{SA}\Delta_s}{D_{SE}}$$

Where: Δ_{SA} = Change in added soil depth in equivalent soil depth

D_{SE} = Density of existing soil at 112.3 lb/ft^3

Δ_S = Change in soil depth

D_{SA} = Density of soil added at 136.9 lb/ft^3

The nominal thickness of the compacted MatCon material is converted to an equivalent soil thickness using the relative densities. Asphalt heights are then calculated for each tank by taking a ratio of the density of MatCon to that of soil to achieve an equivalent value of soil depth. The MatCon height (as an equivalent soil depth) is determined by the following equation:

$$\Delta_A = \frac{D_A t}{D_S}$$

Where: Δ_A = Change in asphalt depth in equivalent soil depth, 0.44 ft

D_S = Density of compacted soil at 112.3 lb/ft^3

t = Thickness of MatCon asphalt, 0.33 ft

D_A = Density of MatCon asphalt at 148 lb/ft^3

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Checked by: Colin Henderson — Name; CH — Initials; 5/24/11 — Date

Final proposed grades are calculated and compared to the allowable soil height. Concentrated loads are calculated and compared to the allowable concentrated load for each tank.

6. Use of Computer Software

The earthwork volumes are calculated using AutoCAD Civil 3D 2010 computer software (SN: 391-15588511) on CEES-XP-129. AutoCAD Civil 3D accuracy was checked with a manual calculation in Appendix B, providing verification and validation for the application. Volumes were found to be accurate with 0.83%. MathCAD™ version 14 MO30 (14.0.3.332) computer software on CEES-XP-127 is used to document this calculation. All computations are checked with a handheld calculator.

7. Results

The AutoCAD Civil 3D calculations for total earthwork quantities at each tank location (from Attachment 3) are summarized in table 1.

Table 1 – Earth Volumes at 77.5 ft Outer Diameter

Tank	Cut (m)	Fill (m)	Net (m)
241-SX-104	0	69.69	69.69
241-SX-105	0	38.46	38.46
241-SX-106	0	44.07	44.07
241-SX-107	0.72	56.41	55.69
241-SX-108	0.96	19.85	18.89
241-SX-109	2.82	16.45	13.62
241-SX-110	0	77.47	77.47
241-SX-111	0	153.80	153.80
241-SX-112	0	170.11	170.11
241-SX-113	19.71	7.22	-12.49
241-SX-114	1.18	61.79	60.61
241-SX-115	0	89.00	89.00

The calculations for total asphalt quantities at each tank location are summarized in Table 2.

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Table 2 – Calculated MatCon Volumes at 750-Kgal SSTs in SX Farm*

Tank	Area (ft^2)	Equivalent Thickness (ft)	Volume (ft^3)
241-SX-104 to 115	4,728	0.44	2,080

*Source: MathCAD calculation in attachment 1

The change in soil height for both soil and asphalt were calculated and compared to the allowable height for each tank. This comparison is summarized in Table 3.

Table 3 – 241-SX Farm Existing Soil Depths Compared to Proposed Finished Grade. (2 sheets)

Tank	Existing Soil Depth (ft)*	Additional New Soil Height as Function of Existing Soil Δ_{SA} (ft)**	Asphalt Height as Function of Existing Soil Δ_A (ft)	Total Soil + Adjusted Asphalt Depth (ft)	Allowable Height (ft) 200 Kip Load at 115 lb/ft^3***
241-SX-104	6.22	0.63	0.44	7.29	9.64
241-SX-105	6.52	0.35	0.44	7.31	9.64
241-SX-106	6.82	0.40	0.44	7.66	9.64
241-SX-107	6.32	0.51	0.44	7.27	9.64
241-SX-108	6.52	0.17	0.44	7.13	9.64
241-SX-109	6.52	0.12	0.44	7.08	9.64
241-SX-110	6.22	0.70	0.44	7.36	9.64
241-SX-111	6.52	1.40	0.44	8.36	9.64
241-SX-112	6.62	1.55	0.44	8.61	9.64
241-SX-113	6.22	-0.11	0.44	6.55	9.64

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Checked by: Colin Henderson — Name — Initials — Date 5/24/11

Table 3 – 241-SX Farm Existing Soil Depths Compared to Proposed Finished Grade. (2 sheets)

Tank	Existing Soil Depth (ft)*	Additional New Soil Height as Function of Existing Soil Δ_{SA} (ft)**	Asphalt Height as Function of Existing Soil Δ_A (ft)	Total Soil + Adjusted Asphalt Depth (ft)	Allowable Height (ft) 200 Kip Load at 115 lb/ft^3***
241-SX-114	6.52	0.55	0.44	7.51	9.64
241-SX-115	6.62	0.81	0.44	7.87	9.64

*Source: RPP-16363, Table 2-12.

**Source: MathCAD calculation in Attachment 1.

***Source: RPP-16363, Table 5-16.

The concentrated loads were calculated for each tank and compared to the allowable loads for each tank. This comparison is summarized in Table 4.

Originated by: Ryan Lang — Name — Initials: RL — Date: 5/24/11
Checked by: Colin Henderson — Name — Initials: CH — Date: 5/24/11

Table 4 – 241-SX Farm Calculated Loads Compared to Allowable Loads

Tank	Net Increase Load (lbs)*	Existing Load (lbs)**	Combined Load (lbs)	Allowable Concentrated Load (lbs)***
241-SX-104	445	546	991	347,050
241-SX-105	927	101,070	101,997	346,250
241-SX-106	1,136	74,546	75,682	332,340
241-SX-107	2,942	69,868	72,810	347,840
241-SX-108	2,332	69,868	72,170	353,410
241-SX-109	1,964	67,991	69,955	355,400
241-SX-110	1,934	38,604	40,538	344,270
241-SX-111	4,964	42,054	47,018	299,900
241-SX-112	4,164	-34,133	-29,969	286,120
241-SX-113	886	40,159	41,045	369,520
241-SX-114	2,696	31,548	34,244	338,300
241-SX-115	1,544	24,854	26,398	323,990

*Source: MathCAD calculation in Attachment 1.

**Source: RPP-20451.

***Source: RPP-16363, Table 5-16, Interpolated in Attachment 7.

8. Conclusions

The interim surface barrier is adequate per the dome load requirements outlined in RPP-SPEC-47469.

Originated by:	Ryan Lang	RL	5/24/11
	Name	Initials	Date
Checked by:	Colin Henderson	CH	5/24/11
	Name	Initials	Date

9. Recommendations

Existing loads on tank systems will be impacted from loads generated by the installation of the interim surface barrier system. The historic dome load record data will need to be updated for SX tank farm, more specifically RPP-20451, *SX Tank Farm Historic Dome Load Record Data.*

10. References

1. RPP-11802, Rev. 0, *Analysis of Record Summary for Single Shell, Tanks*, CH2M HILL Hanford Group, Inc., Richland, WA.
2. RPP-16363, Rev. 0A, *Tank-Specific Allowable Dome Load for Hanford-Site 100-Series Single-Shell Tanks*, CH2M HILL Hanford Group, Inc., Richland, WA.
3. RPP-20451, Rev. 0, *241-SX Tank Farm Historic Dome Load Record Data,* COGEMA Engineering Corporation, Richland, WA.
4. RPP-CALC-36699, Rev. 1B, *Calculation Package for the Installation of a Large Riser on Tank 241-C-107*, Washington River Protection Solutions, LLC., Richland, WA.
5. RPP-RPT-41550, Rev. 1, *Closure Demonstration Grout Test Report*, Washington River Protection Solutions, LLC., Richland, WA.
6. RPP-SPEC-49087, Rev. 0, *241-SX Tank Farm North Interim Surface Barrier Construction Specification*, Washington River Protection Solutions, LLC., Richland, WA.
7. H-14-109330, Rev. 0, *241-SX Tank Farm North Interim Surface Barrier,* Washington River Protection Solutions, LLC., Richland, WA.
8. H-14-109446, Rev. 0, *241-SX Tank Farm South Interim Surface Barrier,* Washington River Protection Solutions, LLC., Richland, WA.
9. *Topographic Survey for Fluor Federal Services*, Glahe & Associates, Sandpoint, ID 2008.
10. *Steel Construction Manual,* AISC 13th Edition, American Institute of Steel Construction.
11. *Handbook of Steel Drainage and Highway Construction Products*, 5th Edition, American Iron and Steel Institute, 1994.

11. Attachments and Appendixes

1. MathCAD calculations.
2. Topographic Survey.
3. AutoCAD Civil 3D output data.
4. MatCon permeability study.
5. Catalog data sheets.
6. Quality Inspection Services, Inc. Lab Data.
7. Dome Load Allowable Interpolation Results.

ATTACHMENT C1 – MATHCAD CALCULATIONS

Determine Net Volume Increase Above Tanks from Barrier Installation:

Volumes generated from AutoCAD Civil 3D Results, See Attachment 3

$$Tank := \begin{pmatrix} 104 \\ 105 \\ 106 \\ 107 \\ 108 \\ 109 \\ 110 \\ 111 \\ 112 \\ 113 \\ 114 \\ 115 \end{pmatrix} \quad Net := \begin{pmatrix} 69.69 \\ 38.46 \\ 44.07 \\ 55.69 \\ 18.89 \\ 13.62 \\ 77.47 \\ 153.80 \\ 170.11 \\ -12.49 \\ 60.61 \\ 89 \end{pmatrix} m^3 \quad Net = \begin{pmatrix} 91.151 \\ 50.304 \\ 57.641 \\ 72.84 \\ 24.707 \\ 17.814 \\ 101.327 \\ 201.163 \\ 222.495 \\ -16.336 \\ 79.275 \\ 116.408 \end{pmatrix} \cdot yd^3$$

Determine Surface Area for Tanks:

$R := 38.792ft = 11.824 \cdot m$ — Radius of outer edge of 241-SX Farm 1000 Kgal SST's, RPP-11802, Table 2

$A_{tank} := \pi \cdot R^2 = 4728 \cdot ft^2$ — Area of tank

$A_{tank} = 439.202\, m^2$

Determine Soil Height at Each Tank:

$$Tank := \begin{pmatrix} 104 \\ 105 \\ 106 \\ 107 \\ 108 \\ 109 \\ 110 \\ 111 \\ 112 \\ 113 \\ 114 \\ 115 \end{pmatrix} \quad \Delta_s := \frac{Net}{A_{tank}} = \begin{pmatrix} 0.159 \\ 0.088 \\ 0.1 \\ 0.127 \\ 0.043 \\ 0.031 \\ 0.176 \\ 0.35 \\ 0.387 \\ -0.028 \\ 0.138 \\ 0.203 \end{pmatrix} m \quad \Delta_s = \begin{pmatrix} 6.247 \\ 3.448 \\ 3.950 \\ 4.992 \\ 1.693 \\ 1.221 \\ 6.944 \\ 13.787 \\ 15.249 \\ -1.120 \\ 5.433 \\ 7.978 \end{pmatrix} \cdot in \quad \Delta_s = \begin{pmatrix} 0.52 \\ 0.29 \\ 0.33 \\ 0.42 \\ 0.14 \\ 0.10 \\ 0.58 \\ 1.15 \\ 1.27 \\ -0.09 \\ 0.45 \\ 0.66 \end{pmatrix} \cdot ft$$

Determine Added Soil Height as a Ratio of Existing Soil:

$\gamma_{soil\_exist} := 112.3 \frac{lbf}{ft^3}$ — Density of existing soil, RPP-16363, Table 2-12, Page 7

$\gamma_{soil\_added} := 136.9 \frac{lbf}{ft^3}$ — Density of expected soil added, Quality Inspection Test Report

$\Delta_{soil\_added} := \frac{\gamma_{soil\_added}}{\gamma_{soil\_exist}} \cdot \Delta_s$ — Thickness of soil added as a function of soil existing

$$\Delta_{soil\_added} = \begin{pmatrix} 7.615 \\ 4.203 \\ 4.816 \\ 6.086 \\ 2.064 \\ 1.488 \\ 8.466 \\ 16.807 \\ 18.589 \\ -1.365 \\ 6.623 \\ 9.726 \end{pmatrix} \cdot in \qquad \Delta_{soil\_added} = \begin{pmatrix} 0.63 \\ 0.35 \\ 0.40 \\ 0.51 \\ 0.17 \\ 0.12 \\ 0.71 \\ 1.40 \\ 1.55 \\ -0.11 \\ 0.55 \\ 0.81 \end{pmatrix} \cdot ft$$

Determine Matcon Height as a Ratio of Existing Soil:

$\gamma_{matcon} := 148 \frac{lbf}{ft^3}$ — Density of Matcon, MatCon, Inc.

$t_{matcon} := 4in = 0.33 \cdot ft$ — Thickness of Matcon, H-14-109330, Sheet 16, Detail 6

$\Delta_{matcon} := \frac{\gamma_{matcon}}{\gamma_{soil\_exist}} \cdot t_{matcon} = 5.27 \cdot in$ — Thickness of Matcon as a function of soil existing

$\boxed{\Delta_{matcon} = 0.44 \cdot ft}$

$$Tank := \begin{pmatrix} 104 \\ 105 \\ 106 \\ 107 \\ 108 \\ 109 \\ 110 \\ 111 \\ 112 \\ 113 \\ 114 \\ 115 \end{pmatrix} \qquad Soil_{depth} := \begin{pmatrix} 6.22 \\ 6.52 \\ 6.82 \\ 6.32 \\ 6.52 \\ 6.52 \\ 6.22 \\ 6.52 \\ 6.62 \\ 6.22 \\ 6.52 \\ 6.62 \end{pmatrix} ft$$

Existing soil depth, RPP-16363, Table 2-12

Determine new equivalent soil height:

$$\Delta_{equivalent} := Soil_{depth} + \Delta_{soil\_added} + \Delta_{matcon} = \begin{pmatrix} 7.29 \\ 7.31 \\ 7.66 \\ 7.27 \\ 7.13 \\ 7.08 \\ 7.36 \\ 8.36 \\ 8.61 \\ 6.55 \\ 7.51 \\ 7.87 \end{pmatrix} \cdot ft \qquad Tank := \begin{pmatrix} 104 \\ 105 \\ 106 \\ 107 \\ 108 \\ 109 \\ 110 \\ 111 \\ 112 \\ 113 \\ 114 \\ 115 \end{pmatrix}$$

***Note: To determine new allowable dome load, interpolate using RPP-16363, Table 5-16. See Attachment 7 for results**

Load Derivations for 241-SX-104 - Loads to be Added:

RISER-002 & ELECTRICAL BOX: Curbing to capture riser and elect. box, H-14-109446 Sheet 7

$L := 48in$ — Estimated open length inside curbing

$w := 36in$ — Estimated open width inside curbing

$L_{2\_E} := 2L + 2w = 168 \cdot in$ — Total curbing length

$A_{curb} := \frac{1}{2} \cdot 6in \cdot 6in = 18 \cdot in^2$ — Area of curb, H-14-109446, Sheet 13, Detail 7

$\boxed{WT_2 := L_{2\_E} \cdot A_{curb} \cdot \gamma_{matcon} = 259 \cdot lbf}$ — Weight total

RISER-003/007: Utility Vault 72"x48", H-14-109446 Sheet 7

$Elev := 0.40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$t_{matcon} = 4 \cdot in$ — Thickness of Matcon, H-14-109446, Sheet 14, Detail 9

$t_{slope} := 2in$ — Thickness of Matcon slope, H-14-109446, Sheet 14, Detail 9

$H := Elev + t_{matcon} + t_{slope} + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 14, Detail 9

$wt_{uv72x48x18} := 2 \cdot 1770lbf = 3540 \cdot lbf$ — Use (2) No. 64R-18 Riser Extensions at 36 inches, Oldcastle Precast Utility Vault

$L := 72in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 64R-18

$w := 48in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 64R-18

$A_{3\_7} := L \cdot w = 3456 \cdot in^2$ — Area

$A_{3\_7} = 24.00 \cdot ft^2$

$wt_{soil} := A_{3\_7} \cdot Elev \cdot \gamma_{soil\_added} = 4312 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{3\_7} \cdot t_{matcon} \cdot \gamma_{matcon} = 1184 \cdot lbf$ — Weight of displaced matcon

$WT_{3\_7} := wt_{uv72x48x18} - wt_{soil} - wt_{matcon} = -1956 \cdot lbf$

$\boxed{WT_{3\_7} := 0lbf}$ — Net weight total negative, therefore 0 added weight

RISER-011: Utility Vault 72"x48", H-14-109446 Sheet 7

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 14, Detail 9

$wt_{uv72x48x18} := 2 \cdot 1770lbf = 3540 \cdot lbf$ — Use (2) No. 64R-18 Riser Extensions at 36 inches, Attachment 2

$L := 72in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 64R-18

$w := 48in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 64R-18

$A_{11} := L \cdot w = 3456 \cdot in^2$ — Open area

$A_{11} = 24.00 \cdot ft^2$

$wt_{soil} := A_{11} \cdot Elev \cdot \gamma_{soil\_added} = 4312 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{11} \cdot t_{matcon} \cdot \gamma_{matcon} = 1184 \cdot lbf$ — Weight of displaced matcon

$WT_{11} := wt_{uv72x48x18} - wt_{soil} - wt_{matcon} = -1956 \cdot lbf$

$\boxed{WT_{11} := 0lbf}$ — Net weight total negative, therefore 0 added weight

RISER-016: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 7

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{16\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 6

$\boxed{WT_{16} := L_{16\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

Table 1 - SX-104 Load Summary			
Load Type	**Item Description**	**Weight (lbs)**	**Reference Document**
Allowable Load	At existing soil depth of 6.22 ft	380,000	RPP-16363, Table 5-17
Existing Loads	Total Existing Permanent Load	546	RPP-20451, Pg SX-104-1
Loads to be Removed			
N/A		0	
	Subtotal	0	
Loads to be Added			
Riser-001	Inside pump pit 241-SX-04A	0	
Riser-002	Curbing	259	
Riser-003	Utility Vault 72"x48"	0	
Riser-005	Inside pump pit 241-SX-04A	0	
Riser-006	Existing corregated metal pipe	0	
Riser-007	Combined with Riser 3	0	
Riser-011	Utility Vault 72"x48"	0	
Riser-013	Inside pump pit 241-SX-04A	0	
Riser-016	3 ft dia. corregated metal pipe	186	AISI Handbook, Table 2.14
	Subtotal	445	
	Net Increase (Added-Removed)	445	
	New Dome Load (Existing + Net Increase)	991	
	New Allowable Dome Load with Barrier Installed at Soil Depth of 7.29 ft	347,050	RPP-16363, Table 5-16, Interpolated in Attachment 7

Load Derivations for 241-SX-105 - Loads to be Added:

RISER-002/006: Utility Vault 72"x48", H-14-109446 Sheet 8

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 14, Detail 9

$wt_{uv72x48x12} := 2 \cdot 1140lbf = 2280 \cdot lbf$ — Use (2) No. 64R-12 Riser Extensions at 24 inches, Oldcastle Precast Utility Vault

$L := 72in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 64R-12

$w := 48in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 64R-12

$A_{2\_6} := L \cdot w = 3456 \cdot in^2$ — Area

$A_{2\_6} = 24.00 \cdot ft^2$

$wt_{soil} := A_{2\_6} \cdot Elev \cdot \gamma_{soil\_added} = 2156 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{2\_6} \cdot t_{matcon} \cdot \gamma_{matcon} = 1184 \cdot lbf$ — Weight of displaced matcon

$WT_{2\_6} := wt_{uv72x48x12} - wt_{soil} - wt_{matcon} = -1060 \cdot lbf$

$\boxed{WT_{2\_6} := 0lbf}$ — Net weight total negative, therefore 0 added weight

RISER-003/007: Utility Vault 72"x48", H-14-109446 Sheet 8

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 14, Detail 9

$wt_{uv72x48x12} := 2 \cdot 1140lbf = 2280 \cdot lbf$ — Use (2) No. 64R-12 Riser Extensions at 24 inches, Oldcastle Precast Utility Vault

$L := 72in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 64R-12

$w := 48in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 64R-12

$A_{3\_7} := L \cdot w = 3456 \cdot in^2$ — Area

$A_{3\_7} = 24.00 \cdot ft^2$

$wt_{soil} := A_{3\_7} \cdot Elev \cdot \gamma_{soil\_added} = 2156 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{3\_7} \cdot t_{matcon} \cdot \gamma_{matcon} = 1184 \cdot lbf$ — Weight of displaced matcon

$WT_{3\_7} := wt_{uv72x48x12} - wt_{soil} - wt_{matcon} = -1060 \cdot lbf$

$\boxed{WT_{3\_7} := 0lbf}$ — Net weight total negative, therefore 0 added weight

RISER-011& ELECTRICAL BOX: Curbing to capture riser and elect. box, H-14-109446 Sheet 8

$L := 60in$	Estimated open length inside curbing
$w := 60in$	Estimated open width inside curbing
$L_{11\_E} := 2L + 2 \cdot w = 240 \cdot in$	Total curbing length
$A_{curb} = 18 \cdot in^2$	Area of curb calculated prior
$\boxed{WT_{11} := L_{11\_E} \cdot A_{curb} \cdot \gamma_{matcon} = 370 \cdot lbf}$	Weight total

RISER-012: 3ft diameter Corregated Metal Pipe, H-14-109446 Sheet 8

$Elev := .20m = 7.87 \cdot in$	Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A
$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$	Penetration elevation required, H-14-109446, Sheet 15, Detail 14
$L_{12\_cmp} := 2.00ft$	Use 2 ft long pipe
$wt_{cmp} := 62 \frac{lbf}{ft}$	Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60
$\boxed{WT_{12} := L_{12\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$	Weight total

RISER-015: 3ft diameter Corregated Metal Pipe, H-14-109446 Sheet 8

$Elev := .20m = 7.87 \cdot in$	Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A
$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$	Penetration elevation required, H-14-109446, Sheet 15, Detail 14
$L_{15\_cmp} := 2.00ft$	Use 2 ft long pipe
$wt_{cmp} := 62 \frac{lbf}{ft}$	Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60
$\boxed{WT_{15} := L_{15\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$	Weight total

RISER-016: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 8

$Elev := .20m = 7.87 \cdot in$	Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A
$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$	Penetration elevation required, H-14-109446, Sheet 15, Detail 14
$L_{16\_cmp} := 2.00ft$	Use 2 ft long pipe
$wt_{cmp} := 62 \frac{lbf}{ft}$	Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60
$\boxed{WT_{16} := L_{16\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$	Weight total

ELECTRICAL BOX: Curbing to capture electrical box near Riser-002, H-14-109446 Sheet 8

$L := 36in$	Estimated open length inside curbing
$w := 24in$	Estimated open width inside curbing
$L_{elect} := 2L + 2w = 120 \cdot in$	Total curbing length
$A_{curb} = 18 \cdot in^2$	Area of curb calculated prior
$\boxed{WT_E := L_{elect} \cdot A_{curb} \cdot \gamma_{matcon} = 185 \cdot lbf}$	Weight total

INSTRUMENT ENCLOSURE: Utility Vaults cut to fit, H-14-109446 Sheet 8

$Elev := .20m = 7.87 \cdot in$	Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A
$H := Elev + t_{matcon} + t_{slope} + 6in = 19.87 \cdot in$	Penetration elevation required, H-14-109446, Sheet 13, Detail 1
$L := 96in$	Estimated length of instrument building
$w := 64in$	Estimated width of instrument building
$wt_{uv128x104x24} := 4550lbf$	Use (1) No. 810-2x Riser Extension at 24 inches, Oldcastle Precast Utility Vault
$L_{out} := 128in$	Length outside vault, Oldcastle Precast Utility Vault, No. 810-2x
$w_{out} := 104in$	Width outside vault, Oldcastle Precast Utility Vault, No. 810-2x
$A_{bldg} := L_{out} \cdot w_{out} = 13312 \cdot in^2$	Area
$A_{bldg} = 92.44 \cdot ft^2$	
$wt_{soil} := A_{bldg} \cdot Elev \cdot \gamma_{soil\_added} = 8304 \cdot lbf$	Weight of displaced soil
$wt_{matcon} := A_{bldg} \cdot t_{matcon} \cdot \gamma_{matcon} = 4561 \cdot lbf$	Weight of displaced matcon
$WT_{bldg} := wt_{uv128x104x24} - wt_{soil} - wt_{matcon} = -8315 \cdot lbf$	
$\boxed{WT_{bldg} := 0lbf}$	Net weight total negative, therefore 0 added weight. Note: area in front of doors for access will be ignored due to negligible difference between displaced soil.

Table 2 - SX-105 Load Summary			
Load Type	**Item Description**	**Weight (lbs)**	**Reference Document**
Allowable Load	At existing soil depth of 6.52 ft	373,000	RPP-16363, Table 5-17
Existing Loads	Total Existing Permanent Load	101,070	RPP-20451, Pg. SX-105-1
Loads to be Removed			
N/A		0	
	Subtotal	0	
Loads to be Added			
Riser-001	Inside pump pit 241-SX-05A	0	
Riser-002	Utility Vault 72x48 (No.64R-12)	0	
Riser-003	Utility Vault 72x48 (No.64R-12)	0	
Riser-005	Inside pump pit 241-SX-05A	0	
Riser-006	Combined with Riser 2	0	
Riser-007	Combined with Riser 3	0	
Riser-011	Curbing around	370	
Riser-012	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-013	Inside pump pit 241-SX-05B	0	
Riser-015	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-016	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-017	Pave over	0	
Riser-018	Pave over	0	
Riser-019	Pave over	0	
Pump Pit	Pave around	0	
Weight factor inclosure	Pave around	0	
Electical box W. R2	Curb around	185	
Instrument Building	Utility Vault cut to fit	0	
	Subtotal	927	
	Net Increase (Added-Removed)	927	
	New Dome Load (Existing + Net Increase)	101,997	
	New Allowable Dome Load with Barrier Installed at Soil Depth of 7.31 ft	346,250	RPP-16363, Table 5-16, Interpolated in Attachment 7

Load Derivations for 241-SX-106 - Loads to be Added:

RISER-002/006: Utility Vault 72"x48", H-14-109446 Sheet 9

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 14, Detail 9

$wt_{uv72x48x18} := 2 \cdot 1770lbf = 3540 \cdot lbf$ — Use (2) No. 64R-18 Riser Extensions at 36 inches, Oldcastle Precast Utility Vault

$L := 72in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 64R-18

$w := 48in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 64R-18

$A_{2\_6} := L \cdot w = 3456 \cdot in^2$ — Area

$A_{2\_6} = 24.00 \cdot ft^2$

$wt_{soil} := A_{2\_6} \cdot Elev \cdot \gamma_{soil\_added} = 4312 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{2\_6} \cdot t_{matcon} \cdot \gamma_{matcon} = 1184 \cdot lbf$ — Weight of displaced matcon

$WT_{2\_6} := wt_{uv72x48x18} - wt_{soil} - wt_{matcon} = -1956 \cdot lbf$

$\boxed{WT_{2\_6} := 0lbf}$ — Net weight total negative, therefore 0 added weight

RISER-003/007: Utility Vault 90"x60", H-14-109446 Sheet 9

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 14, Detail 9

$wt_{uv90x60x12} := 3 \cdot 1525lbf = 4575 \cdot lbf$ — Use (3) No. 576R-12 Riser Extensions at 36 inches, Oldcastle Precast Utility Vault

$L := 90in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 576R-12

$w := 60in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 576R-12

$A_{3\_7} := L \cdot w = 5400 \cdot in^2$ — Area

$A_{3\_7} = 37.50 \cdot ft^2$

$wt_{soil} := A_{3\_7} \cdot Elev \cdot \gamma_{soil\_added} = 6737 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{3\_7} \cdot t_{matcon} \cdot \gamma_{matcon} = 1850 \cdot lbf$ — Weight of displaced matcon

$WT_{3\_7} := wt_{uv90x60x12} - wt_{soil} - wt_{matcon} = -4012 \cdot lbf$

$\boxed{WT_{3\_7} := 0lbf}$ Net weight total negative, therefore 0 added weight

RISER-011: Utility Vault 72"x48", H-14-109446 Sheet 9

$Elev := .40m = 15.75 \cdot in$ Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 27.75 \cdot in$ Penetration elevation required, H-14-109446, Sheet 14, Detail 9

$wt_{uv72x48x18} := 2 \cdot 1770lbf = 3540 \cdot lbf$ Use (2) No. 64R-18 Riser Extensions at 36 inches, Oldcastle Precast Utility Vault

$L := 72in$ Length outside vault, Oldcastle Precast Utility Vault, No. 64R-18

$w := 48in$ Width outside vault, Oldcastle Precast Utility Vault, No. 64R-18

$A_{11} := L \cdot w = 3456 \cdot in^2$ Area

$A_{11} = 24.00 \cdot ft^2$

$wt_{soil} := A_{11} \cdot Elev \cdot \gamma_{soil\_added} = 4312 \cdot lbf$ Weight of displaced soil

$wt_{matcon} := A_{11} \cdot t_{matcon} \cdot \gamma_{matcon} = 1184 \cdot lbf$ Weight of displaced matcon

$WT_{11} := wt_{uv72x48x18} - wt_{soil} - wt_{matcon} = -1956 \cdot lbf$

$\boxed{WT_{11} := 0lbf}$ Net weight total negative, therefore 0 added weight

RISER-016: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 9

$Elev := .20m = 7.87 \cdot in$ Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{16\_cmp} := 2.00ft$ Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{WT_{16} := L_{16\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ Weight total

Electrical Box North of Riser-016: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 9

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{elect\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{WT_{elect} := L_{elect\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

PUMP PIT 241-SX-06A: Curbing to capture pump pit, H-14-109446 Sheet 9

$L := 216in$ — Estimated open length inside curbing

$w := 180in$ — Estimated open width inside curbing

$L_{pit} := L + 2 \cdot w = 576 \cdot in$ — Total curbing length

$A_{curb} = 18 \cdot in^2$ — Area of curb calculated prior

$\boxed{WT_{pit} := L_{pit} \cdot A_{curb} \cdot \gamma_{matcon} = 888 \cdot lbf}$ — Weight total

Table 3 - SX-106 Load Summary

Load Type	Item Description	Weight (lbs)	Reference Document
Allowable Load	At existing soil depth of 6.82 ft	366,000	RPP-16363, Table 5-17
Existing Loads	Total Existing Permanent Load	74,546	RPP-20451, Pg. SX-106-1
Loads to be Removed			
N/A		0	
	Subtotal	0	
Loads to be Added			
Riser-001	Inside pump pit 241-SX-06A	0	
Riser-002	Utility Vault 72x48 (No.64R-18)	0	
Riser-003	Utility Vault 90x60 (No.576R-12)	0	
Riser-005	Inside pump pit 241-SX-06A	0	
Riser-006	Combined with Riser 2	0	
Riser-007	Combined with Riser 3	0	
Riser-011	Utility Vault 72x48 (No.64R-18)	0	
Riser-013	Inside pump pit 241-SX-06A	0	
Riser-016	3 ft dia. corregated metal pipe	124	AISI Handbook
Pump Pit 241-SX-06A	Curbing around	888	
Electrical box N. of R16	3 ft dia. corregated metal pipe	124	AISI Handbook
	Subtotal	1,136	
	Net Increase (Added-Removed)	1,136	
	New Dome Load (Existing + Net Increase)	75,682	
	New Allowable Dome Load with Barrier Installed at Soil Depth of 7.66 ft	332,340	RPP-16363, Table 5-16, Interpolated in attachment 7

Load Derivations for 241-SX-107 - Loads to be Added:

RISER-002/006: Utility Vault 72"x48", H-14-109446 Sheet 10

$Elev := .20m = 7.87 \cdot in$	Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A
$H := Elev + t_{matcon} + t_{slope} + 6in = 19.87 \cdot in$	Penetration elevation required, H-14-109446, Sheet 13, Detail 9
$wt_{uv72x48x12} := 2 \cdot 1140lbf = 2280 \cdot lbf$	Use (2) No. 64R-12 Riser Extensions at 24 inches
$L := 72in$	Length outside vault, Oldcastle Precast Utility Vault, No. 64R-12
$w := 48in$	Width outside vault, Oldcastle Precast Utility Vault, No. 64R-12
$A_{2\_6} := L \cdot w = 3456 \cdot in^2$	Area
$A_{2\_6} = 24.00 \cdot ft^2$	
$wt_{soil} := A_{2\_6} \cdot Elev \cdot \gamma_{soil\_added} = 2156 \cdot lbf$	Weight of displaced soil
$wt_{matcon} := A_{2\_6} \cdot t_{matcon} \cdot \gamma_{matcon} = 1184 \cdot lbf$	Weight of displaced matcon
$WT_{2\_6} := wt_{uv72x48x12} - wt_{soil} - wt_{matcon} = -1060 \cdot lbf$	
$\boxed{WT_{2\_6} := 0lbf}$	Net weight total negative, therefore 0 added weight

RISER-004/008: INSTRUMENT ENCLOSURE: Utility Vaults cut to fit, H-14-109446 Sheet 10

$Elev := .20m = 7.87 \cdot in$	Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A
$H := Elev + t_{matcon} + t_{slope} + 6in = 19.87 \cdot in$	Penetration elevation required, H-14-109446, Sheet 14, Detail 1
$L := 217in$	Estimated length of instrument building
$w := 98in$	Estimated width of instrument building
$wt_{uv128x104x24} := 2 \cdot 4550lbf$	Use (2) No. 810-2x Riser Extension at 24 inches, Oldcastle Precast Utility Vault
$L_{out} := L + 2 \cdot 6in = 229 \cdot in$	Length outside vault, Oldcastle Precast Utility Vault, No. 810-2x
$w_{out} := w + 2 \cdot 6in = 110 \cdot in$	Width outside vault, Oldcastle Precast Utility Vault, No. 810-2x
$A_{bldg} := L_{out} \cdot w_{out} = 25190 \cdot in^2$	Area
$A_{bldg} = 174.93 \cdot ft^2$	

$wt_{soil} := A_{bldg} \cdot Elev \cdot \gamma_{soil\_added} = 15714 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{bldg} \cdot t_{matcon} \cdot \gamma_{matcon} = 8630 \cdot lbf$ — Weight of displaced matcon

$WT_{bldg} := wt_{uv128x104x24} - wt_{soil} - wt_{matcon} = -15244 \cdot lbf$

$\boxed{WT_{bldg} := 0lbf}$ — Net weight total negative, therefore 0 added weight. Note: area in front of doors for access will be ignored due to negligible difference between displaced soil.

RISER-009: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 10

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{9\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{WT_9 := L_{9\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-010/020: 6 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 10

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{10\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 171 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.15, Pg 62

$\boxed{WT_{10} := L_{10\_cmp} \cdot wt_{cmp} = 342 \cdot lbf}$ — Weight total

RISER-011: 6 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 10

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{11\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 171 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.15, Pg 62

$\boxed{WT_{11} := L_{11\_cmp} \cdot wt_{cmp} = 342 \cdot lbf}$ — Weight total

RISER-012: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 10

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{12\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{WT_{12} := L_{12\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-013/013A: Contech Liner, 9'-8" Diameter, H-14-109446 Sheet 10

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Elevation of matcon, H-14-109446, Sheet 13, Detail 3

$L_{13\_liner} := 3.00ft$ — Use 3 ft height of liner

$wt_{contech} := 152 \frac{lbf}{ft} \cdot \frac{1}{2} = 76 \cdot \frac{lbf}{ft}$ — Weight of 1/2 contech liner plate, Contech, Table 6, Pg 15

$\boxed{WT_{13\_13A} := L_{13\_liner} \cdot wt_{contech} = 228 \cdot lbf}$ — Weight total

RISER-014: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 10

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{14\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{WT_{14} := L_{14\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-015: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 10

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{15\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{WT_{15} := L_{15\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-016: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 10

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{16\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{WT_{16} := L_{16\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-017: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 10

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{17\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{WT_{17} := L_{17\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-018: 6 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 10

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{18\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 171 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.15, Pg 62

$\boxed{WT_{18} := L_{18\_cmp} \cdot wt_{cmp} = 342 \cdot lbf}$ — Weight total

RISER-019: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 10

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{19\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{WT_{19} := L_{19\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

HATCHWAY: 10 ft Diameter Corregated Metal Pipe, H-14-109446 Sheet 10

$Elev := .20m = 7.87 \cdot in$	Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A
$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$	Penetration elevation required, H-14-109446, Sheet 16, Detail 20
$L_{Hatch\_cmp} := 2.00ft$	Use 2 ft long pipe
$wt_{cmp} := 284 \frac{lbf}{ft}$	Weight of corregated metal pipe, AISI Handbook, Table 2.15, Pg 63
$\boxed{WT_{Hatchway} := L_{Hatch\_cmp} \cdot wt_{cmp} = 568 \cdot lbf}$	Weight total

Valve South of Riser-007: 2ft diameter Steel Pipe, H-14-109446 Sheet 10

$Elev := .20m = 7.87 \cdot in$	Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A
$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$	Penetration elevation required, H-14-109446, Sheet 13, Detail 2
$L_{valve\_pipe} := 2.00ft$	Use 2 ft long pipe
$w_{steel} := 95 \frac{lbf}{ft}$	Weight of steel pipe, PN Best Co.
$\boxed{W_{valve} := L_{valve\_pipe} \cdot w_{steel} = 190 \cdot lbf}$	Weight total

Table 4 - SX-107 Load Summary			
Load Type	**Item Description**	**Weight (lbs)**	**Reference Document**
Allowable Load	At existing soil depth of 6.32 ft	377,000	RPP-16363, Table 5-17
Existing Loads	Total Existing Permanent Load	69,868	RPP-20451, Pg. SX-107-1
Loads to be Removed			
N/A		0	
	Subtotal	0	
Loads to be Added			
Riser-001	Inside pump pit 241-SX-07B	0	
Riser-002	Utility Vault 72x48 (No.64R-12)	0	
Riser-003	Inside pump pit 241-SX-07A	0	
Riser-004	Utility Vaults cut to fit	0	
Riser-005	Inside pump pit 241-SX-07B	0	
Riser-006	Combined with Riser 2	0	
Riser-007	Inside pump pit 241-SX-07A	0	
Riser-008	Combined with Riser 4	0	
Riser-009	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-010	6 ft dia. corregated metal pipe	342	AISI Handbook
Riser-011	6 ft dia. corregated metal pipe	342	AISI Handbook
Riser-012	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-013	116 in dia. Contech Liner Plates	228	Contech
Riser-013A	Combined with Riser 13	0	
Riser-014	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-015	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-016	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-017	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-018	6 ft dia. corregated metal pipe	342	AISI Handbook
Riser-019	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-020	Combined with Riser 10	0	
Riser-021	Pave around	0	
Riser-022	Inside pump pit 241-SX-07B	0	
Riser-023	Inside pump pit 241-SX-07B	0	
Riser-024	Inside pump pit 241-SX-07B	0	
Riser-025	Inside pump pit 241-SX-07B	0	
Riser-026	Inside pump pit 241-SX-07B	0	
Riser-027	Inside pump pit 241-SX-07B	0	
Riser-028	Inside pump pit 241-SX-07B	0	
24" Butterfly valve	Pave around	0	
Valve S. of R7	2 ft dia. steel pipe	190	P.N. Best Co.
Condenser Hatchway	10 ft diameter corregated metal pipe	568	AISI Handbook
Junction Boxes	Pave around	0	
Liquid level reel post	Pave around	0	
	Subtotal	2,942	
	Net Increase (Added-Removed)	2,942	
	New Dome Load (Existing + Net Increase)	72,810	
	New Allowable Dome Load with Barrier Installed at Soil Depth of 7.27 ft	347,840	RPP-16363, Table 5-16, Interpolated in Attachment 7

Load Derivations for 241-SX-108 - Loads to be Added:

RISER-002 & ELECTRICAL BOX: Utility Vault 90"x60", H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ — Elevation of subgrade, H-14-109446, Sheet 2

$H := Elev + t_{matcon} + t_{slope} + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 14, Detail 9

$wt_{uv90x60x12} := 2 \cdot 1525lbf = 3050 \cdot lbf$ — Use (2) No. 576R-12 Riser Extensions at 24 inches

$L := 90in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 576R-12

$w := 60in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 576R-12

$A_2 := L \cdot w = 5400 \cdot in^2$ — Area

$A_2 = 37.50 \cdot ft^2$

$wt_{soil} := A_2 \cdot Elev \cdot \gamma_{soil\_added} = 3369 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_2 \cdot t_{matcon} \cdot \gamma_{matcon} = 1850 \cdot lbf$ — Weight of displaced matcon

$WT_2 := wt_{uv90x60x12} - wt_{soil} - wt_{matcon} = -2169 \cdot lbf$

$\boxed{WT_2 := 0lbf}$ — Net weight total negative, therefore 0 added weight

RISER-003/007: Utility Vault 90"x60", H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 14, Detail 9

$wt_{uv90x60x12} := 2 \cdot 1525lbf = 3050 \cdot lbf$ — Use (2) No. 576R-12 Riser Extensions at 24 inches

$L := 90in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 576R-12

$w := 60in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 576R-12

$A_{3\_7} := L \cdot w = 5400 \cdot in^2$ — Area

$A_{3\_7} = 37.50 \cdot ft^2$

$wt_{soil} := A_{3\_7} \cdot Elev \cdot \gamma_{soil\_added} = 3369 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{3\_7} \cdot t_{matcon} \cdot \gamma_{matcon} = 1850 \cdot lbf$ — Weight of displaced matcon

$WT_{3\_7} := wt_{uv72x48x12} - wt_{soil} - wt_{matcon} = -2939 \cdot lbf$

$\boxed{WT_{3\_7} := 0lbf}$ Net weight total negative, therefore 0 added weight

RISER-004/008: INSTRUMENT ENCLOSURE: Utility Vaults cut to fit, H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 19.87 \cdot in$ Penetration elevation required, H-14-109446, Sheet 13, Detail 1

$L := 312in$ Estimated length of instrument building

$w := 96in$ Estimated width of instrument building

$wt_{uv128x104x24} := 3 \cdot 4550lbf$ Use (3) No. 810-2x Riser Extension at 24 inches, Oldcastle Precast Utility Vault

$L_{out} := L + 2 \cdot 6in = 324 \cdot in$ Length outside vault, Oldcastle Precast Utility Vault, No. 810-2x

$w_{out} := w + 2 \cdot 6in = 108 \cdot in$ Width outside vault, Oldcastle Precast Utility Vault, No. 810-2x

$A_{bldg} := L_{out} \cdot w_{out} = 34992 \cdot in^2$ Area

$A_{bldg} = 243.00 \cdot ft^2$

$wt_{soil} := A_{bldg} \cdot Elev \cdot \gamma_{soil\_added} = 21829 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{bldg} \cdot t_{matcon} \cdot \gamma_{matcon} = 11988 \cdot lbf$ — Weight of displaced matcon

$WT_{bldg} := wt_{uv128x104x24} - wt_{soil} - wt_{matcon} = -20167 \cdot lbf$

$\boxed{WT_{bldg} := 0lbf}$ — Net weight total negative, therefore 0 added weight. Note: area in front of doors for access will be ignored due to negligible difference between displaced soil.

RISER-009: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{9\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_9 := L_{9\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-010: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{10\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{10} := L_{10\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-011: 4 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{11\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 100 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{11} := L_{11\_cmp} \cdot w_{cmp} = 200 \cdot lbf}$ — Weight total

RISER-012: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{12\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{12} := L_{12\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-013/013A: Contech Liner, 9'-8" Diameter, H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 13, Detail 3

$L_{13\_liner} := 2.00ft$ — Use 2 ft height of liner

$wt_{contech} := 152 \frac{lbf}{ft} \cdot \frac{1}{2} = 76 \cdot \frac{lbf}{ft}$ — Weight of 1/2 contech liner plate, Contech, Table 6, Pg 15

$\boxed{WT_{13\_13A} := L_{13\_liner} \cdot wt_{contech} = 152 \cdot lbf}$ — Weight total

RISER-014: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{14\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{14} := L_{14\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-015: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{15\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{15} := L_{15\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-016: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{16\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{WT_{16} := L_{16\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-017: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{17\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{17} := L_{17\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-018: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{18\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{18} := L_{18\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-019: 4 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{19\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 100 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{19} := L_{19\_cmp} \cdot w_{cmp} = 200 \cdot lbf}$ — Weight total

Valve South of Riser-007: 2 ft diameter Steel Pipe, H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ — Elevation of subgrade, H-14-109446, Sheet 2

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 13, Detail 2

$L_{valve\_pipe} := 2.00ft$ — Use 2 ft long pipe

$wt_{steel} := 95 \frac{lbf}{ft}$ — Weight of steel pipe, PN Best Co.

$\boxed{WT_{valve} := L_{valve\_pipe} \cdot wt_{steel} = 190 \cdot lbf}$ — Weight total

HATCHWAY: 10 ft Diameter Corregated Metal Pipe, H-14-109446 Sheet 11

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 16, Detail 20

$L_{Hatch\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 284 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.15, Pg 63

$\boxed{WT_{Hatchway} := L_{Hatch\_cmp} \cdot wt_{cmp} = 568 \cdot lbf}$ — Weight total

Table 5 - SX-108 Load Summary			
Load Type	**Item Description**	**Weight (lbs)**	**Reference Document**
Allowable Load	At existing soil depth of 6.52 ft	373,000	RPP-16363, Table 5-17
Existing Loads	Total Existing Permanent Load	69,868	RPP-20451, Pg. SX-108-1
Loads to be Removed			
N/A		0	
	Subtotal	0	
Loads to be Added			
Riser-001	Inside pump pit 241-SX-08A	0	
Riser-002	Utility Vault 90x60 (No.576R-12)	0	
Riser-003	Utility Vault 90x60 (No.576R-12)	0	
Riser-004	Utility Vaults cut to fit	0	
Riser-005	Inside pump pit 241-SX-08A	0	
Riser-006	Pave around	0	
Riser-007	Combined with Riser 3	0	
Riser-008	Combined with Riser 4	0	
Riser-009	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-010	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-011	4 ft dia. corregated metal pipe	200	AISI Handbook
Riser-012	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-013	116 in dia. Contech Liner Plates	152	Contech
Riser-013A	Combined with Riser 13	0	
Riser-014	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-015	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-016	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-017	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-018	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-019	4 ft dia. corregated metal pipe	200	AISI Handbook
Riser-020	Pave around	0	
Riser-021	Pave around	0	
Valve S. of R7	2 ft diameter steel pipe	190	P.N. Best Co.
Hatchway	10 ft diameter corregated metal pipe	568	AISI Handbook
Elect. Box NW of Hatchway	Curbing around		
	Subtotal	2,302	
	Net Increase (Added-Removed)	2,302	
	New Dome Load (Existing + Net Increase)	72,170	
	New Allowable Dome Load with Barrier Installed at Soil Depth of 7.13 ft	353,410	RPP-16363, Table 5-16, Interpolated in Attachment 7

Load Derivations for 241-SX-109 - Loads to be Added:

RISER-002/006: Utility Vault 90"x60", H-14-109446 Sheet 12

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 14, Detail 9

$wt_{uv90x60x12} := 2 \cdot 1525lbf = 3050 \cdot lbf$ — Use (2) No. 64R-12 Riser Extensions at 24 inches

$L := 90in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 576R-12

$w := 60in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 576R-12

$A_{2\_6} := L \cdot w = 5400 \cdot in^2$ — Area

$A_{2\_6} = 37.50 \cdot ft^2$

$wt_{soil} := A_{2\_6} \cdot Elev \cdot \gamma_{soil\_added} = 3369 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{2\_6} \cdot t_{matcon} \cdot \gamma_{matcon} = 1850 \cdot lbf$ — Weight of displaced matcon

$WT_{2\_6} := wt_{uv90x60x12} - wt_{soil} - wt_{matcon} = -2169 \cdot lbf$

$\boxed{WT_{2\_6} := 0lbf}$ — Net weight total negative, therefore 0 added weight

RISER-003: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 12

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{3\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{WT_3 := L_{3\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-004/008: INSTRUMENT ENCLOSURE: Utility Vaults cut to fit, H-14-109446 Sheet 12

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 13, Detail 1

$L := 216in$ — Estimated length of instrument building

$w := 96in$ — Estimated width of instrument building

$wt_{uv128x104x24} := 2 \cdot 4550lbf$ — Use (2) No. 810-2x Riser Extension at 24 inches, Oldcastle Precast Utility Vault

$L_{out} := L + 2 \cdot 6in = 228 \cdot in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 810-2x

$w_{out} := w + 2 \cdot 6in = 108 \cdot in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 810-2x

$A_{bldg} := L_{out} \cdot w_{out} = 24624 \cdot in^2$ — Area

$A_{bldg} = 171.00 \cdot ft^2$

$wt_{soil} := A_{bldg} \cdot Elev \cdot \gamma_{soil\_added} = 15361 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{bldg} \cdot t_{matcon} \cdot \gamma_{matcon} = 8436 \cdot lbf$ — Weight of displaced matcon

$WT_{bldg} := wt_{uv128x104x24} - wt_{soil} - wt_{matcon} = -14697 \cdot lbf$

$\boxed{WT_{bldg} := 0lbf}$ — Net weight total negative, therefore 0 added weight. Note: area in front of doors for access will be ignored due to negligible difference between displaced soil.

RISER-009: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 12

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{9\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_9 := L_{9\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-010: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 12

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{10\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{10} := L_{10\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-011: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 12

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{11\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{11} := L_{11\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-012: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 12

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{12\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{12} := L_{12\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-013/013A: Contech Liner, 9'-8" Diameter, H-14-109446 Sheet 12

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 13, Detail 3

$L_{13\_liner} := 2.00ft$ — Use 2 ft height of liner

$wt_{contech} := 152 \frac{lbf}{ft} \cdot \frac{1}{2} = 76 \cdot \frac{lbf}{ft}$ — Weight of 1/2 contech liner plate, Contech, Table 6, Pg 15

$\boxed{WT_{13\_13A} := L_{13\_liner} \cdot wt_{contech} = 152 \cdot lbf}$ — Weight total

RISER-014: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 12

$Elev := 0m = 0.00 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 12.00 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{14\_cmp} := 1.00ft$ — Use 1 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{14} := L_{14\_cmp} \cdot w_{cmp} = 62 \cdot lbf}$ — Weight total

RISER-015: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 12

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{15\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{15} := L_{15\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-018: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 12

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{18\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{18} := L_{18\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-019: 3 ft diameter Corregated Metal Pipe, H-14-109446 Sheet 12

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 15, Detail 14

$L_{19\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{19} := L_{19\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

HATCHWAY: 10 ft Diameter Corregated Metal Pipe, H-14-109446 Sheet 12

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 16, Detail 20

$L_{Hatch\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 284 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.15, Pg 63

$\boxed{WT_{Hatchway} := L_{Hatch\_cmp} \cdot wt_{cmp} = 568 \cdot lbf}$ — Weight total

Valve North of Riser-006: 2 ft diameter Steel Pipe, H-14-109446 Sheet 12

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109446, Sheet 13, Detail 2

$L_{valve\_pipe} := 2.00ft$ — Use 2 ft long pipe

$wt_{steel} := 95 \frac{lbf}{ft}$ — Weight of steel pipe, PN Best Co.

$\boxed{WT_{valve} := L_{valve\_pipe} \cdot wt_{steel} = 190 \cdot lbf}$ — Weight total

Table 6 - SX-109 Load Summary			
Load Type	**Item Description**	**Weight (lbs)**	**Reference Document**
Allowable Load	At existing soil depth of 6.52 ft	373,000	RPP-16363, Table 5-17
Existing Loads	Total Existing Permanent Load	67,991	RPP-20451, Pg. SX-109-1
Loads to be Removed			
N/A		0	
	Subtotal	0	
Loads to be Added			
Riser-001	Inside pump pit 241-SX-09A	0	
Riser-002	Utility Vault 90x60 (No.576R-12)	0	
Riser-003	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-004	Utility Vaults cut to fit	0	
Riser-005	Inside pump pit 241-SX-09A	0	
Riser-006	Combined with Riser 2	0	
Riser-007	Pave over	0	
Riser-008	Combined with Riser 4	0	
Riser-009	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-010	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-011	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-012	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-013	116 in dia. Contech Liner Plates	152	Contech
Riser-013A	Combined with Riser 13	0	
Riser-014	3 ft dia. corregated metal pipe	62	AISI Handbook
Riser-015	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-016	Pave over	0	
Riser-017	Pave over	0	
Riser-018	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-019	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-020	Pave around	0	
Hatchway	10 ft diameter corregated metal pipe	568	AISI Handbook
Valve N of Riser 6	2 ft diameter steel pipe	190	P.N. Best Co.
	Subtotal	1,964	
	Net Increase (Added-Removed)	1,964	
	New Dome Load (Existing + Net Increase)	69,955	
	New Allowable Dome Load with Barrier Installed at Soil Depth of 7.08 ft	355,400	RPP-16363, Table 5-16, Interpolated in Attachment 7

Load Derivations for 241-SX-110 - Loads to be Added:

RISER-002/006: Utility Vault 90"x60", H-14-109330 Sheet 10

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 17, Detail 9

$wt_{uv90x60x12} := 2 \cdot 1525lbf = 3050 \cdot lbf$ — Use (2) No. 576R-12 Riser Extensions at 24 inches

$L := 90in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 576R-12

$w := 60in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 576R-12

$A_{2\_6} := L \cdot w = 5400 \cdot in^2$ — Area

$A_{2\_6} = 37.50 \cdot ft^2$

$wt_{soil} := A_{2\_6} \cdot Elev \cdot \gamma_{soil\_added} = 3369 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{2\_6} \cdot t_{matcon} \cdot \gamma_{matcon} = 1850 \cdot lbf$ — Weight of displaced matcon

$WT_{2\_6} := wt_{uv90x60x12} - wt_{soil} - wt_{matcon} = -2169 \cdot lbf$

$\boxed{WT_{2\_6} := 0lbf}$ — Net weight total negative, therefore 0 added weight

RISER-003/007: Utility Vault 72"x48", H-14-109330 Sheet 10

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 17, Detail 9

$wt_{uv72x48x18} := 2 \cdot 1770lbf = 3540 \cdot lbf$ — Use (2) No. 64R-18 Riser Extensions at 36 inches

$L := 72in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 64R-18

$w := 48in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 64R-18

$A_{3\_7} := L \cdot w = 3456 \cdot in^2$ — Area

$A_{3\_7} = 24.00 \cdot ft^2$

$wt_{soil} := A_{3\_7} \cdot Elev \cdot \gamma_{soil\_added} = 4312 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{3\_7} \cdot t_{matcon} \cdot \gamma_{matcon} = 1184 \cdot lbf$ Weight of displaced matcon

$WT_{3\_7} := wt_{uv72x48x18} - wt_{soil} - wt_{matcon} = -1956 \cdot lbf$

$\boxed{WT_{3\_7} := 0lbf}$ Net weight total negative, therefore 0 added weight

RISER-004/008: INSTRUMENT ENCLOSURE: Utility Vaults cut to fit, H-14-109330 Sheet 10

$Elev := .40m = 15.75 \cdot in$ Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 27.75 \cdot in$ Penetration elevation required, H-14-109330, Sheet 16, Detail 1

$L := 216in$ Estimated length of instrument building

$w := 96in$ Estimated width of instrument building

$wt_{uv128x104x24} := 2 \cdot 4550lbf$ Use (2) No. 810-2x Riser Extension at 24 inches, Oldcastle Precast Utility Vault

$L_{out} := L + 2 \cdot 6in = 228 \cdot in$ Length outside vault, Oldcastle Precast Utility Vault, No. 810-2x

$w_{out} := w + 2 \cdot 6in = 108 \cdot in$ Width outside vault, Oldcastle Precast Utility Vault, No. 810-2x

$A_{bldg} := L_{out} \cdot w_{out} = 24624 \cdot in^2$ Area

$A_{bldg} = 171.00 \cdot ft^2$

$wt_{soil} := A_{bldg} \cdot Elev \cdot \gamma_{soil\_added} = 30722 \cdot lbf$ Weight of displaced soil

$wt_{matcon} := A_{bldg} \cdot t_{matcon} \cdot \gamma_{matcon} = 8436 \cdot lbf$ Weight of displaced matcon

$WT_{bldg} := wt_{uv128x104x24} - wt_{soil} - wt_{matcon} = -30058 \cdot lbf$

$\boxed{WT_{bldg} := 0lbf}$ Net weight total negative, therefore 0 added weight. Note: area in front of doors for access will be ignored due to negligible difference between displaced soil.

RISER-013/013A: Contech Liner, 9'-8" Diameter, H-14-109330 Sheet 10

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 16, Detail 3

$L_{13\_liner} := 2.00ft$ — Use 2 ft height of liner

$wt_{contech} := 152 \frac{lbf}{ft} \cdot \frac{1}{2} = 76 \cdot \frac{lbf}{ft}$ — Weight of 1/2 contech liner plate, Contech, Table 6, Pg 1

$\boxed{W_{13\_13A} := L_{13\_liner} \cdot wt_{contech} = 152 \cdot lbf}$ — Weight total

RISER-014: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 10

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{14\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{14} := L_{14\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-015: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 10

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{15\_cmp} := 2.00ft$ — Use 2 ft long pipe

$w_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{W_{15} := L_{15\_cmp} \cdot w_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-017: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 10

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{17\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{WT_{17} := L_{17\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-018: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 10

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{18\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{WT_{18} := L_{18\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-019: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 10

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{19\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{WT_{19} := L_{19\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-020: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 10

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{20\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.14, Pg 60

$\boxed{WT_{20} := L_{20\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

HATCHWAY: 10 ft Diameter Corregated Metal Pipe, H-14-109330 Sheet 10

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 20, Detail 23

$L_{Hatch\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 284 \frac{lbf}{ft}$ — Weight of corregated metal pipe, AISI Handbook, Table 2.15, Pg 63

$\boxed{WT_{Hatchway} := L_{Hatch\_cmp} wt_{cmp} = 852 \cdot lbf}$ — Weight total

Table 7 - SX-110 Load Summary			
Load Type	**Item Description**	**Weight (lbs)**	**Reference Document**
Allowable Load	At existing soil depth of 6.22 ft	380,000	RPP-16363, Table 5-17
Existing Loads	Total Existing Permanent Load	38,604	RPP-20451, Pg. SX-110-1
Loads to be Removed			
N/A		0	
	Subtotal	0	
Loads to be Added			
Riser-001	Inside pump pit 241-SX-10A	0	
Riser-002	Utility Vault 90x60 (No.576R-12)	0	
Riser-003	Utility Vault 72x48 (No.64R-18)	0	
Riser-004	Utility Vaults cut to fit	0	
Riser-005	Inside pump pit 241-SX-10A	0	
Riser-006	Combined with Riser 2	0	
Riser-007	Combined with Riser 3	0	
Riser-008	Combined with Riser 4	0	
Riser-009	Pave around	0	
Riser-010	Pave around	0	
Riser-011	Pave ~~around~~ over	0	
Riser-012	Pave ~~over~~ around	0	
Riser-013	116 in dia. Contech Liner Plates	152	Contech
Riser-013A	Combined with Riser 13	0	
Riser-014	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-015	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-016	Pave around	0	
Riser-017	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-018	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-019	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-020	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-021	Pave over	0	
Hatchway	10 ft diameter corregated metal pipe	852	AISI Handbook
	Subtotal	1,934	
	Net Increase (Added-Removed)	1,934	
	New Dome Load (Existing + Net Increase)	40,538	
	New Allowable Dome Load with Barrier Installed at Soil Depth of 7.36 ft	344,270	RPP-16363, Table 5-16, Interpolated in Attachment 7

Load Derivations for 241-SX-111 - Loads to be Added:

RISER-002/006: Utility Vault 90"x60", H-14-109330 Sheet 11

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 17, Detail 9

$wt_{uv90x60x18} := 3 \cdot 1525lbf = 4575 \cdot lbf$ — Use (3) No. 576R-12 Riser Extensions at 36 inches

$L := 90in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 576R-12

$w := 60in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 576R-12

$A_{2\_6} := L \cdot w = 5400 \cdot in^2$ — Area

$A_{2\_6} = 37.50 \cdot ft^2$

$wt_{soil} := A_{2\_6} \cdot Elev \cdot \gamma_{soil\_added} = 6737 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{2\_6} \cdot t_{matcon} \cdot \gamma_{matcon} = 1850 \cdot lbf$ — Weight of displaced matcon

$WT_{2\_6} := wt_{uv72x48x18} - wt_{soil} - wt_{matcon} = -5047 \cdot lbf$

$\boxed{WT_{2\_6} := 0lbf}$ — Net weight total negative, therefore 0 added weight

RISER-003/007: Utility Vault 84"x56", H-14-109330 Sheet 11

NOS 5-24-2011

$Elev := .60m = 23.62 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

H-14-109330

$H := Elev + 4in + 2in + 6in = 35.62 \cdot in$ — Penetration elevation required, Sheet 17, Detail 9

$wt_{uv84x56x12} := 3 \cdot 1550lbf = 4650 \cdot lbf$ — Use (3) No. 57R-12 Riser Extensions at 36 inches

$L := 84in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 57R-12

$w := 56in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 57R-12

$A_{3\_7} := L \cdot w = 4704 \cdot in^2$ — Area

$A_{3\_7} = 32.67 \cdot ft^2$

$wt_{soil} := A_{3\_7} \cdot Elev \cdot \gamma_{soil\_added} = 8803 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{3\_7} \cdot t_{matcon} \cdot \gamma_{matcon} = 1612 \cdot lbf$ — Weight of displaced matcon

$WT_{3\_7} := wt_{uv72x48x18} - wt_{soil} - wt_{matcon} = -6875 \cdot lbf$

$\boxed{WT_{3\_7} := 0lbf}$ Net weight total negative, therefore 0 added weight

RISER-004/008: INSTRUMENT ENCLOSURE: Utility Vaults cut to fit, H-14-109330 Sheet 11

$Elev := .60m = 23.62 \cdot in$ Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 35.62 \cdot in$ Penetration elevation required, H-14-109330, Sheet 16, Detail 1

$L := 216in$ Estimated length of instrument building

$w := 96in$ Estimated width of instrument building

$wt_{uv128x104x24} := 4 \cdot 4550lbf$ Use (4) No. 810-2x Riser Extension at 48 inches, Oldcastle Precast Utility Vault

$L_{out} := L + 2 \cdot 6in = 228 \cdot in$ Length outside vault, Oldcastle Precast Utility Vault, No. 810-2x

$w_{out} := w + 2 \cdot 6in = 108 \cdot in$ Width outside vault, Oldcastle Precast Utility Vault, No. 810-2x

$A_{bldg} := L_{out} \cdot w_{out} = 24624 \cdot in^2$ Area

$A_{bldg} = 171.00 \cdot ft^2$

$wt_{soil} := A_{bldg} \cdot Elev \cdot \gamma_{soil\_added} = 46082 \cdot lbf$ Weight of displaced soil

$wt_{matcon} := A_{bldg} \cdot t_{matcon} \cdot \gamma_{matcon} = 8436 \cdot lbf$ Weight of displaced matcon

$WT_{bldg} := wt_{uv128x104x24} - wt_{soil} - wt_{matcon} = -36318 \cdot lbf$

$\boxed{WT_{bldg} := 0lbf}$ Net weight total negative, therefore 0 added weight. Note: area in front of doors for access will be ignored due to negligible difference between displaced soil.

RISER-009: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 11

$Elev := .60m = 23.62 \cdot in$ Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 35.62 \cdot in$ Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{9\_cmp} := 3.00ft$ Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ Weight of corregated metal pipe

$\boxed{WT_9 := L_{9\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ Weight total

RISER-010: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 11

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{10\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{10} := L_{10\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-011: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 11

$Elev := .60m = 23.62 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 35.62 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{11\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{11} := L_{11\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-012: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 11

$Elev := .60m = 23.62 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 35.62 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{12\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{12} := L_{12\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-013: Contech Liner, 9'-8" Diameter, H-14-109330 Sheet 11

$Elev := .60m = 23.62 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 35.62 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 16, Detail 3

$L_{13\_liner} := 3.00ft$ — Use 3 ft height of liner

$wt_{contech} := 152 \frac{lbf}{ft} \cdot \frac{1}{2} = 76 \cdot \frac{lbf}{ft}$ — Weight of 1/2 contech liner plate

$\boxed{W_{13} := L_{13\_liner} \cdot wt_{contech} = 228 \cdot lbf}$ — Weight total

RISER-014: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 11

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{14\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{14} := L_{14\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-015: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 11

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{15\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{15} := L_{15\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-016: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 11

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{16\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{16} := L_{16\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-017: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 11

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{17\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{17} := L_{17\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-018: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 11

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{18\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{18} := L_{18\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-019: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 11

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{19\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{19} := L_{19\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

Valve South of Riser-007: 2 ft diameter Steel Pipe, H-14-109330 Sheet 11

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 16, Detail 2

$L_{valve\_pipe} := 3.00ft$ — Use 3 ft long pipe

$wt_{steel} := 95 \frac{lbf}{ft}$ — Weight of steel pipe, PN Best Co.

$\boxed{WT_{valve} := L_{valve\_pipe} \cdot wt_{steel} = 285 \cdot lbf}$ — Weight total

HATCHWAY: 10 ft Diameter Corregated Metal Pipe, H-14-109330 Sheet 11

$Elev := .60m = 23.62 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 35.62 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 20, Detail 23

$L_{Hatch\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 284 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{Hatchway} := L_{Hatch\_cmp} \cdot wt_{cmp} = 852 \cdot lbf}$ — Weight total

ELECTRICAL BOX: Curbing to capture electrical boxes SE of Hatchway, H-14-109330 Sheet 11

$L := 84in$	Estimated open length inside curbing
$w := 60in$	Estimated open width inside curbing
$L_{elect} := 2L + 2 \cdot w = 288 \cdot in$	Perimeter for electrical box curbing
$A_{curb} = 18 \cdot in^2$	Area of curb calculated prior
$\boxed{WT_E := L_{elect} \cdot A_{curb} \cdot \gamma_{matcon} = 444 \cdot lbf}$	Weight total

ELECTRICAL BOX: Curbing to capture electrical boxes W of Hatchway, H-14-109330 Sheet 11

$L := 48in$	Estimated open length inside curbing
$w := 36in$	Estimated open width inside curbing
$L_{elect2} := 2L + 2 \cdot w = 168 \cdot in$	Open area
$A_{curb} = 18 \cdot in^2$	Area of curb calculated prior
$\boxed{WT_{E2} := L_{elect2} \cdot A_{curb} \cdot \gamma_{matcon} = 259 \cdot lbf}$	Weight total

INSTRUMENT BUILDING: Utility Vault 128" x104", H-14-109330 Sheet 11

$Elev := .20m = 7.87 \cdot in$	Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A
$H := Elev + t_{matcon} + t_{slope} + 6in = 19.87 \cdot in$	Penetration elevation required, H-14-109330, Sheet 16, Detail 1
$L := 96in$	Estimated length of instrument building
$w := 64in$	Estimated width of instrument building
$wt_{uv128x104x24} := 1 \cdot 4550lbf$	Use (1) No. 810-2x Riser Extension at 24 inches, Oldcastle Precast Utility Vault
$L_{out} := 128in$	Length outside vault, Oldcastle Precast Utility Vault, No. 810-2x
$w_{out} := 104in$	Width outside vault, Oldcastle Precast Utility Vault, No. 810-2x
$A_{bldg} := L_{out} \cdot w_{out} = 13312 \cdot in^2$	Area
$A_{bldg} = 92.44 \cdot ft^2$	
$wt_{soil} := A_{bldg} \cdot Elev \cdot \gamma_{soil\_added} = 8304 \cdot lbf$	Weight of displaced soil
$wt_{matcon} := A_{bldg} \cdot t_{matcon} \cdot \gamma_{matcon} = 4561 \cdot lbf$	Weight of displaced matcon

$WT_{bldg} := wt_{uv128x104x24} - wt_{soil} - wt_{matcon} = -8315 \cdot lbf$

$\boxed{WT_{bldg} := 0lbf}$

Net weight total negative, therefore 0 added weight. Note: area in front of doors for access will be ignored due to negligible difference between displaced soil.

Table 8 - SX-111 Load Summary			
Load Type	**Item Description**	**Weight (lbs)**	**Reference Document**
Allowable Load	At existing soil depth of 6.52 ft	373,000	RPP-16363, Table 5-17
Existing Loads	Total Existing Permanent Load	42,054	RPP-20451, Pg. SX-111-1
Loads to be Removed			
N/A		0	
	Subtotal	0	
Loads to be Added			
Riser-001	Inside pump pit 241-SX-11A	0	
Riser-002	Utility Vault 90x60 (No.576R-12)	0	
Riser-003	Utility Vault 84x56 (No.57R-12)	0	
Riser-004	Utility Vaults cut to fit	0	
Riser-005	Inside pump pit 241-SX-11A	0	
Riser-006	Combined with Riser 2	0	
Riser-007	Combined with Riser 3	0	
Riser-008	Combined with Riser 4	0	
Riser-009	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-010	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-011	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-012	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-013	116 in dia. Contech Liner Plates	228	Contech
Riser-014	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-015	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-016	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-017	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-018	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-019	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-020	Pave around	0	
Valve S of R7	2 ft dia. steel pipe	285	P.N. Best Co.
Hatchway	10 ft diameter corregated metal pipe	852	AISI Handbook
Elect. Boxes SE Hatch	Curbing around	~~481~~ 444	
Elect. Boxes W Hatch	Curbing around	~~222~~ 259	
Instr. Building	Curbing around	~~1,030~~ 0	
	Subtotal	~~4,964~~ 3,928	
	Net Increase (Added-Removed)	~~4,964~~ 3,928	
	New Dome Load (Existing + Net Increase)	~~47,018~~ 45,982	
	New Allowable Dome Load with Barrier Installed at Soil Depth of 8.36 ft	299,900	RPP-16363, Table 5-16, Interpolated in Attachment 7

Load Derivations for 241-SX-112 - Loads to be Added:

RISER-002/006: Utility Vault 90"x60", H-14-109330 Sheet 12

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 17, Detail 9

$wt_{uv90x60x12} := \cancel{2}\,3 \cdot 1525lbf = \cancel{3050}\,4575 \cdot lbf$ — Use ~~(2)~~ 3 No. 576R-12 Riser Extensions at 36 inches

NCB 5-24-2011

$L := 90in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 576R-12

$w := 60in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 576R-12

$A_{2\_6} := L \cdot w = 5400 \cdot in^2$ — Area

$A_{2\_6} = 37.50 \cdot ft^2$

$wt_{soil} := A_{2\_6} \cdot Elev \cdot \gamma_{soil\_added} = 6737 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{2\_6} \cdot t_{matcon} \cdot \gamma_{matcon} = 1850 \cdot lbf$ — Weight of displaced matcon

$WT_{2\_6} := wt_{uv90x60x12} - wt_{soil} - wt_{matcon} = \cancel{-5537}\,-4012 \cdot lbf$ NCB 5-24-2011

$\boxed{WT_{2\_6} := 0lbf}$ — Net weight total negative, therefore 0 added weight

RISER-004/008: INSTRUMENT ENCLOSURE: Utility Vaults cut to fit, H-14-109330 Sheet 12

$Elev := .60m = 23.62 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 35.62 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 16, Detail 1

$L := 216in$ — Estimated length of instrument building

$w := 96in$ — Estimated width of instrument building

$wt_{uv128x104x24} := 4 \cdot 4550lbf$ — Use (4) No. 810-2x Riser Extension at 24 inches, Oldcastle Precast Utility Vault

$L_{out} := L + 2 \cdot 6in = 228 \cdot in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 810-2x

$w_{out} := w + 2 \cdot 6in = 108 \cdot in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 810-2x

$A_{bldg} := L_{out} \cdot w_{out} = 24624 \cdot in^2$ — Area

$A_{bldg} = 171.00 \cdot ft^2$

$wt_{soil} := A_{bldg} \cdot Elev \cdot \gamma_{soil\_added} = 46082 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{bldg} \cdot t_{matcon} \cdot \gamma_{matcon} = 8436 \cdot lbf$ — Weight of displaced matcon

$WT_{bldg} := wt_{uv128x104x24} - wt_{soil} - wt_{matcon} = -36318 \cdot lbf$

$\boxed{WT_{bldg} := 0lbf}$ — Net weight total negative, therefore 0 added weight. Note: area in front of doors for access will be ignored due to negligible difference between displaced soil.

RISER-009: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 12

$Elev := .60m = 23.62 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 35.62 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{9\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_9 := L_{9\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-010: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 12

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{10\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{10} := L_{10\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-011: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 12

$Elev := .60m = 23.62 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 35.62 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{11\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{11} := L_{11\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-012: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 12

$Elev := .60m = 23.62 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 35.62 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{12\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{12} := L_{12\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-013/013A: Contech Liner, 9'-8" Dia., H-14-109330 Sheet 12

$Elev := .60m = 23.62 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 35.62 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 16, Detail 3

$L_{13\_liner} := 3.00ft$ — Use 3 ft height of liner

$wt_{contech} := 152 \frac{lbf}{ft} \cdot \frac{1}{2} = 76 \cdot \frac{lbf}{ft}$ — Weight of 1/2 contech liner plate

$\boxed{W_{13} := L_{13\_liner} \cdot wt_{contech} = 228 \cdot lbf}$ — Weight total

RISER-014: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 12

$Elev := .60m = 23.62 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 35.62 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{14\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{14} := L_{14\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-015: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 12

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{15\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{15} := L_{15\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-018: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 12

$Elev := .40m = 15.75 \cdot in$	Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A
$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$	Penetration elevation required, H-14-109330, Sheet 18, Detail 14
$L_{18\_cmp} := 3.00ft$	Use 3 ft long pipe
$wt_{cmp} := 62 \frac{lbf}{ft}$	Weight of corregated metal pipe
$\boxed{WT_{18} := L_{18\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$	Weight total

RISER-019: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 12

$Elev := .60m = 23.62 \cdot in$	Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A
$H := Elev + 4in + 2in + 6in = 35.62 \cdot in$	Penetration elevation required, H-14-109330, Sheet 18, Detail 14
$L_{19\_cmp} := 3.00ft$	Use 3 ft long pipe
$wt_{cmp} := 62 \frac{lbf}{ft}$	Weight of corregated metal pipe
$\boxed{WT_{19} := L_{19\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$	Weight total

HATCHWAY: 11 ft Dia. Corregated Metal Pipe, H-14-109330 Sheet 12

$Elev := .60m = 23.62 \cdot in$	Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A
$H := Elev + 4in + 2in + 6in = 35.62 \cdot in$	Penetration elevation required, H-14-109330, Sheet 20, Detail 23
$L_{Hatch\_cmp} := 3.00ft$	Use 3 ft long pipe
$wt_{cmp} := 314 \frac{lbf}{ft}$	Weight of corregated metal pipe
$\boxed{WT_{Hatchway} := L_{Hatch\_cmp} \, wt_{cmp} = 942 \cdot lbf}$	Weight total

CONDENSATE VALVE PIT: Curbing to capture condensate valve pit, H-14-109330 Sheet 12

$L := 204in$	Estimated open length inside curbing
$w := 120in$	Estimated open width inside curbing
$L_{cvp} := 2L + 2 \cdot w = 648 \cdot in$	Perimeter for valve pit condensate curbing
$A_{curb} = 18 \cdot in^2$	Area of curbing calculated prior
$\boxed{WT_{cvp} := L_{cvp} \cdot A_{curb} \cdot \gamma_{matcon} = 999 \cdot lbf}$	Weight total

ELECTRICAL BOX: Curbing to capture electrical box South of R15, H-14-109330 Sheet 12

$L := 48in$	Estimated open length inside curbing
$w := 24in$	Estimated open width inside curbing
$L_{elect} := 2L + 2 \cdot w = 144 \cdot in$	Perimeter for electrical box curbing
$A_{curb} = 18 \cdot in^2$	Area of curb calculated prior
$\boxed{WT_{elect} := L_{elect} \cdot A_{curb} \cdot \gamma_{matcon} = 222 \cdot lbf}$	Weight total

VALVE NORTH OF RISER-006: 2 ft diameter Steel Pipe, H-14-109330 Sheet 12

$Elev := .40m = 15.75 \cdot in$	Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A
$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$	Penetration elevation required, H-14-109330, Sheet 16, Detail 2
$L_{valve\_pipe} := 3.00ft$	Use 3 ft long pipe
$wt_{steel} := 95 \frac{lbf}{ft}$	Weight of steel pipe
$\boxed{WT_{valve} := L_{valve\_pipe} \cdot wt_{steel} = 285 \cdot lbf}$	Weight total

Table 9 - SX-112 Load Summary			
Load Type	**Item Description**	**Weight (lbs)**	**Reference Document**
Allowable Load	At existing soil depth of 6.62 ft	371,000	RPP-16363, Table 5-17
Existing Loads	Total Existing Permanent Load	-34,133	RPP-20451, Pg. SX-112-1
Loads to be Removed			
N/A		0	
	Subtotal	0	
Loads to be Added			
Riser-001	Inside pump pit 241-SX-12A	0	
Riser-002	Utility Vault 90x60 (No.576R-12)	0	
Riser-003	Pave around	0	
Riser-004	Utility Vaults cut to fit	0	
Riser-005	Inside pump pit 241-SX-12A	0	
Riser-006	Combined with Riser 2	0	
Riser-007	Pave over	0	
Riser-008	Combined with Riser 4	0	
Riser-009	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-010	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-011	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-012	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-013	116 in dia. Contech Liner Plates	228	Contech
Riser-013A	Combined with Riser 13	0	
Riser-014	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-015	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-016	Pave over	0	
Riser-017	Pave over	0	
Riser-018	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-019	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-020	Pave around	0	
Riser-021	Pave around	0	
Hatchway	11 ft diameter corregated metal pipe	942	AISI Handbook
Condensate Valve Pit	Curbing around	999	
Elect. Box S. of R15	Curbing around	222	
Valve N. of R6	2 ft diameter steel pipe	285	P.N. Best & Co.
	Subtotal	4,164	
	Net Increase (Added-Removed)	4,164	
	New Dome Load (Existing + Net Increase)	-29,969	
	New Allowable Dome Load with Barrier Installed at Soil Depth of 8.60 ft	286,120	RPP-16363, Table 5-16, Interpolated in Attachment 7

Load Derivations for 241-SX-113 - Loads to be Added:

RISER-002/006: Utility Vault 72"x48", H-14-109330 Sheet 13

$Elev := 0.0m = 0.00 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 12.00 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 17, Detail 9

$wt_{uv72x48x12} := 1140lbf$ — Use (1) No. 64R-12 Riser Extensions at 12 inches

$L := 72in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 64R-12

$w := 48in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 64R-12

$A_{2\_6} := L \cdot w = 3456 \cdot in^2$ — Area

$A_{2\_6} = 24.00 \cdot ft^2$

$wt_{soil} := A_{2\_6} \cdot Elev \cdot \gamma_{soil\_added} = 0 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{2\_6} \cdot t_{matcon} \cdot \gamma_{matcon} = 1184 \cdot lbf$ — Weight of displaced matcon

$WT_{2\_6} := wt_{uv72x48x12} - wt_{soil} - wt_{matcon} = -44 \cdot lbf$

$\boxed{WT_{2\_6} := 0lbf}$ — Net weight total negative, therefore 0 added weight

RISER-003/007: Utility Vault 84"x56", H-14-109330 Sheet 13

$Elev := 0.0m = 0.00 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 12.00 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 17, Detail 9

$wt_{uv84x56x12} := \cancel{1140}lbf$ 1550 lbs MCS 5-24-2011 — Use (1) No. 57R-12 Riser Extensions at 12 inches

$L := 84in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 57R-12

$w := 56in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 57R-12

$A_{3\_7} := L \cdot w = 4704 \cdot in^2$ — Area

$A_{3\_7} = 32.67 \cdot ft^2$

$wt_{soil} := A_{3\_7} \cdot Elev \cdot \gamma_{soil\_added} = 0 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{3\_7} \cdot t_{matcon} \cdot \gamma_{matcon} = 1612 \cdot lbf$ — Weight of displaced matcon

$WT_{3\_7} := wt_{uv84x56x12} - wt_{soil} - wt_{matcon} = \cancel{-472 \cdot lbf}$ −621bf NES 5-24-2011

$\boxed{WT_{3\_7} := 0lbf}$ — Net weight total negative, therefore 0 added weight

RISER-004/008: 9 ft Dia. Corregated Metal Pipe, H-14-109330 Sheet 13

$Elev := 0.0m = 0.00 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 12.00 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 20, Detail 23

$L_{4\_8\_cmp} := 1.00ft$ — Use 1 ft long pipe

$wt_{cmp} := 256 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{4\_8} := L_{4\_8\_cmp} wt_{cmp} = 256 \cdot lbf}$ — Weight total

RISER-010: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 13

$Elev := 0.0m = 0.00 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 12.00 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{10\_cmp} := 1.00ft$ — Use 1 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{10} := L_{10\_cmp} \cdot wt_{cmp} = 62 \cdot lbf}$ — Weight total

HATCHWAY: 10 ft Diameter Corregated Metal Pipe, H-14-109330 Sheet 13

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 20, Detail 23

$L_{Hatch\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 284 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{Hatchway} := L_{Hatch\_cmp} wt_{cmp} = 568 \cdot lbf}$ — Weight total

Table 10 - SX-113 Concentrated Loads			
Load Type	**Item Description**	**Weight (lbs)**	**Reference Document**
Allowable Load	At existing soil depth of 6.22 ft	380,000	RPP-16363, Table 5-17
Existing Loads	Total Existing Permanent Load	40,159	RPP-20451, Pg. SX-113-1
Loads to be Removed			
N/A		0	
	Subtotal	0	
Loads to be Added			
Riser-001	Inside pump pit 241-SX-13A	0	
Riser-002	Utility Vault 72x48 (No.64R-12)	0	
Riser-003	Utility Vault 84x56 (No.57R-12)	0	
Riser-004	9 ft dia. corregated metal pipe	256	AISI Handbook
Riser-005	Inside pump pit 241-SX-13A	0	
Riser-006	Combined with Riser 2	0	
Riser-007	Combined with Riser 3	0	
Riser-008	Combined with riser 4	0	
Riser-010	3 ft dia. corregated metal pipe	62	AISI Handbook
Riser-011	Pave over	0	
Riser-013	Pave over	0	
Instr. Enclosure Pad	Pave around	0	
Hatchway	10 ft diameter corregated metal pipe	568	AISI Handbook
Concrete Post	Pave around	0	
Pump Pit 241-SX-13A	Pave around	0	
	Subtotal	886	
	Net Increase (Added-Removed)	886	
	New Dome Load (Existing + Net Increase)	41,045	
	New Allowable Dome Load with Barrier Installed at Soil Depth of 6.55 ft	369,520	RPP-16363, Table 5-16, Interpolated in Attachment 7

Load Derivations for 241-SX-114 - Loads to be Added:

RISER-002/006: Utility Vault 72"x48", H-14-109330 Sheet 14

$Elev := 0.20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Elevation of matcon, H-14-109330, Sheet 17, Detail 9

$wt_{uv72x48x12} := 2 \cdot 1140lbf = 2280 \cdot lbf$ — Use (2) No. 64R-12 Riser Extensions at 24 inches

$L := 72in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 64R-12

$w := 48in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 64R-12

$A_{2\_6} := L \cdot w = 3456 \cdot in^2$ — Area

$A_{2\_6} = 24.00 \cdot ft^2$

$wt_{soil} := A_{2\_6} \cdot Elev \cdot \gamma_{soil\_added} = 2156 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{2\_6} \cdot t_{matcon} \cdot \gamma_{matcon} = 1184 \cdot lbf$ — Weight of displaced matcon

$WT_{2\_6} := wt_{uv72x48x12} - wt_{soil} - wt_{matcon} = -1060 \cdot lbf$

$\boxed{WT_{2\_6} := 0lbf}$ — Net weight total

RISER-003/007: Utility Vault 72"x48", H-14-109330 Sheet 14

$Elev := 0.40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 17, Detail 9

$wt_{uv72x48x18} := 2 \cdot 1770lbf = 3540 \cdot lbf$ — Use (2) No. 64R-18 Riser Extensions at 36 inches

$L := 72in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 64R-18

$w := 48in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 64R-18

$A_{3\_7} := L \cdot w = 3456 \cdot in^2$ — Area

$A_{3\_7} = 24.00 \cdot ft^2$

$wt_{soil} := A_{3\_7} \cdot Elev \cdot \gamma_{soil\_added} = 4312 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{3\_7} \cdot t_{matcon} \cdot \gamma_{matcon} = 1184 \cdot lbf$ — Weight of displaced matcon

$WT_{3\_7} := wt_{uv72x48x18} - wt_{soil} - wt_{matcon} = -1956 \cdot lbf$

$\boxed{WT_{3\_7} := 0lbf}$ — Net weight total negative, therefore 0 added weight

RISER-004/008: INSTRUMENT ENCLOSURE: Utility Vaults cut to fit, H-14-109330 Sheet 14

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 16, Detail 1

$L := 216in$ — Estimated length of instrument building

$w := 96in$ — Estimated width of instrument building

$wt_{uv128x104x24} := 2 \cdot 4550lbf$ — Use (2) No. 810-2x Riser Extension at 24 inches, Oldcastle Precast Utility Vault

$L_{out} := L + 2 \cdot 6in = 228 \cdot in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 810-2x

$w_{out} := w + 2 \cdot 6in = 108 \cdot in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 810-2x

$A_{bldg} := L_{out} \cdot w_{out} = 24624 \cdot in^2$ — Area

$A_{bldg} = 171.00 \cdot ft^2$

$wt_{soil} := A_{bldg} \cdot Elev \cdot \gamma_{soil\_added} = 30722 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{bldg} \cdot t_{matcon} \cdot \gamma_{matcon} = 8436 \cdot lbf$ — Weight of displaced matcon

$WT_{bldg} := wt_{uv128x104x24} - wt_{soil} - wt_{matcon} = -30058 \cdot lbf$

$\boxed{WT_{bldg} := 0lbf}$ — Net weight total negative, therefore 0 added weight. Note: area in front of doors for access will be ignored due to negligible difference between displaced soil.

RISER-009: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 14

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{9\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_9 := L_{9\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-010: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 14

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{10\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{10} := L_{10\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-011: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 14

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{11\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{11} := L_{11\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-012: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 14

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{12\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{12} := L_{12\_cmp} \cdot wt_{cmp} = 186 \cdot lbf}$ — Weight total

RISER-013/013A: Contech Liner, 9'-8" Diameter, H-14-109330 Sheet 14

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 16, Detail 3

$L_{13\_liner} := 3.00ft$ — Use 3 ft height of liner

$wt_{contech} := 152 \frac{lbf}{ft} \cdot \frac{1}{2} = 76 \cdot \frac{lbf}{ft}$ — Weight of 1/2 contech liner plate

$\boxed{W_{13\_13A} := L_{13\_liner} \cdot wt_{contech} = 228 \cdot lbf}$ — Weight total

RISER-014: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 14

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{14\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{14} := L_{14\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-015: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 14

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{15\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{15} := L_{15\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-016: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 14

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{16\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{16} := L_{16\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-017: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 14

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{17\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{17} := L_{17\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-018: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 14

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{18\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{18} := L_{18\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-019: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 14

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{19\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{19} := L_{19\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

HATCHWAY: 10 ft Diameter Corregated Metal Pipe, H-14-109330 Sheet 14

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 20, Detail 23

$L_{Hatch\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 284 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{Hatchway} := L_{Hatch\_cmp} \cdot wt_{cmp} = 852 \cdot lbf}$ — Weight total

VALVE SOUTH OF RISER-007: 2 ft diameter Steel Pipe, H-14-109330 Sheet 14

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 16, Detail 2

$L_{valve\_pipe} := 2.00ft$ — Use 2 ft long pipe

$wt_{steel} := 95 \frac{lbf}{ft}$ — Weight of steel pipe

$\boxed{WT_{valve} := L_{valve\_pipe} \cdot wt_{steel} = 190 \cdot lbf}$ — Weight total

Table 11 - SX-114 Load Summary			
Load Type	**Item Description**	**Weight (lbs)**	**Reference Document**
Allowable Load	At existing soil depth of 6.52 ft	373,000	RPP-16363, Table 5-17
Existing Loads	Total Existing Permanent Load	31,548	RPP-20451, Pg. SX-114-1
Loads to be Removed			
N/A		0	
	Subtotal	0	
Loads to be Added			
Riser-001	Inside pump pit 241-SX-14A	0	
Riser-002	Utility Vault 72x48 (No.64R-12)	0	
Riser-003	Utility Vault 72x48 (No.64R-18)	0	
Riser-004	Utility Vaults cut to fit	0	
Riser-005	Inside pump pit 241-SX-14A	0	
Riser-006	Combined with Riser 2	0	
Riser-007	Combined with Riser 3	0	
Riser-008	Combined with Riser 4	0	
Riser-009	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-010	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-011	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-012	3 ft dia. corregated metal pipe	186	AISI Handbook
Riser-013	116 in dia. Contech Liner Plates	228	Contech
Riser-013A	Combined with Riser 13	0	
Riser-014	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-015	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-016	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-017	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-018	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-019	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-020	Pave over	0	
Riser-021	Pave around	0	
Hatchway	10 ft dia. corregated metal pipe	852	AISI Handbook
Valve S of R7	2 ft dia. steel pipe	190	P.N. Best Co.
	Subtotal	2,696	
	Net Increase (Added-Removed)	2,696	
	New Dome Load (Existing + Net Increase)	34,244	
	ome Load with Barrier Installed at Soil Depth of 7.51 ft	338,300	RPP-16363, Table 5-16, Interpolated in Attachment 7

Load Derivations for 241-SX-115 - Loads to be Added:

RISER-002/006: Utility Vault 72"x48", H-14-109330 Sheet 15

$Elev := 0.20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 17, Detail 9

$wt_{uv72x48x12} := 2 \cdot 1140lbf = 2280 \cdot lbf$ — Use (2) No. 64R-12 Riser Extensions at 24 inches

$L := 72in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 64R-12

$w := 48in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 64R-12

$A_{2\_6} := L \cdot w = 3456 \cdot in^2$ — Area

$A_{2\_6} = 24.00 \cdot ft^2$

$wt_{soil} := A_{2\_6} \cdot Elev \cdot \gamma_{soil\_added} = 2156 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{2\_6} \cdot t_{matcon} \cdot \gamma_{matcon} = 1184 \cdot lbf$ — Weight of displaced matcon

$WT_{2\_6} := wt_{uv72x48x12} - wt_{soil} - wt_{matcon} = -1060 \cdot lbf$

$\boxed{WT_{2\_6} := 0lbf}$ — Net weight total negative, therefore 0 added weight

RISER-003: 3 ft diameter Corregated Metal Pipe, H-14-109330 Sheet 15

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 18, Detail 14

$L_{3\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 62 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_3 := L_{3\_cmp} \cdot wt_{cmp} = 124 \cdot lbf}$ — Weight total

RISER-004/008: INSTRUMENT ENCLOSURE: Utility Vaults cut to fit, H-14-109330 Sheet 15

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + t_{matcon} + t_{slope} + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 16, Detail 1

$L := 216in$ — Estimated length of instrument building

$w := 96in$ — Estimated width of instrument building

$wt_{uv128x104x24} := 2 \cdot 4550lbf$ — Use (2) No. 810-2x Riser Extension at 24 inches, Oldcastle Precast Utility Vault

$L_{out} := L + 2 \cdot 6in = 228 \cdot in$ — Length outside vault, Oldcastle Precast Utility Vault, No. 810-2x

$w_{out} := w + 2 \cdot 6in = 108 \cdot in$ — Width outside vault, Oldcastle Precast Utility Vault, No. 810-2x

$A_{bldg} := L_{out} \cdot w_{out} = 24624 \cdot in^2$ — Area

$A_{bldg} = 171.00 \cdot ft^2$

$wt_{soil} := A_{bldg} \cdot Elev \cdot \gamma_{soil\_added} = 30722 \cdot lbf$ — Weight of displaced soil

$wt_{matcon} := A_{bldg} \cdot t_{matcon} \cdot \gamma_{matcon} = 8436 \cdot lbf$ — Weight of displaced matcon

$WT_{bldg} := wt_{uv128x104x24} - wt_{soil} - wt_{matcon} = -30058 \cdot lbf$

$\boxed{WT_{bldg} := 0lbf}$ — Net weight total negative, therefore 0 added weight. Note: area in front of doors for access will be ignored due to negligible difference between displaced soil.

HATCHWAY: 10 ft Diameter Corregated Metal Pipe, H-14-109330 Sheet 15

$Elev := .40m = 15.75 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 27.75 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 20, Detail 23

$L_{Hatch\_cmp} := 3.00ft$ — Use 3 ft long pipe

$wt_{cmp} := 284 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{Hatchway} := L_{Hatch\_cmp} \, wt_{cmp} = 852 \cdot lbf}$ — Weight total

EXISTING CAISON: 10 ft Diameter Corregated Metal Pipe, H-14-109330 Sheet 15
***Note: According to the Historic Dome Load Data for SX Farm, RPP-20451, Page SX-115-12, no credit was taken for the negative load transmitted to the dome due to the soil removed within this caison.**

$Elev := .20m = 7.87 \cdot in$ — Estimated elevation of subgrade, RPP-SPEC-49087, Appendix A

$H := Elev + 4in + 2in + 6in = 19.87 \cdot in$ — Penetration elevation required, H-14-109330, Sheet 2

$L_{Caison\_cmp} := 2.00ft$ — Use 2 ft long pipe

$wt_{cmp} := 284 \frac{lbf}{ft}$ — Weight of corregated metal pipe

$\boxed{WT_{Caison} := L_{Caison\_cmp} \, wt_{cmp} = 568 \cdot lbf}$ — Weight total

Table 12 - SX-115 Load Summary			
Load Type	**Item Description**	**Weight (lbs)**	**Reference Document**
Allowable Load	At existing soil depth of 6.62 ft	371,000	RPP-16363, Table 5-17
Existing Loads	Total Existing Permanent Load	24,854	RPP-20451, Pg. SX-115-1
Loads to be Removed			
		0	
	Subtotal	0	
Loads to be Added			
Riser-001	Inside pump pit 241-SX-15A	0	
Riser-002	Utility Vault 72x48 (No.64R-12)	0	
Riser-003	3 ft dia. corregated metal pipe	124	AISI Handbook
Riser-004	Utility Vaults cut to fit	0	
Riser-005	Inside pump pit 241-SX-15A	0	
Riser-006	Combined with Riser 2	0	
Riser-007	Pave over	0	
Riser-008	Combined with Riser 4	0	
Riser-009	Pave over	0	
Riser-013	Pave over	0	
Hatchway	10 ft dia. corregated metal pipe	852	AISI Handbook
Caison	10 ft dia. corregated metal pipe	568	AISI Handbook
	Subtotal	1,544	
	Net Increase (Added-Removed)	1,544	
	New Dome Load (Existing + Net Increase)	26,398	
	New Allowable Dome Load with Barrier Installed at Soil Depth of 7.87 ft	323,990	RPP-16363, Table 5-16, Interpolated in Attachment 7

ATTACHMENT C2 – TOPOGRAPHIC SURVEY

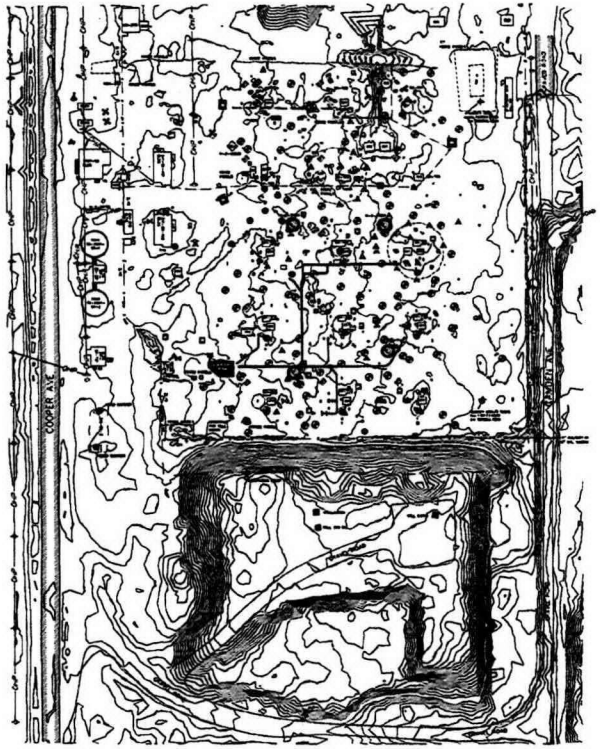
TOPOGRAPHIC SURVEY

FOR

FLUOR FEDERAL SERVICES

PROJECT: SX TANK FARM
CONTRACT NO. WIRP-9-K11939

LYING IN A PORTION OF
SECTION 12, TOWNSHIP 12 NORTH, RANGE 25 EAST, WILLAMETTE MERIDIAN
BENTON COUNTY, STATE OF WASHINGTON



GRAPHIC SCALE

(IN METERS)

1 : 750

P:\Projects\2009\09-060 Fluor\Images\Fluor Image.jpg

LEGEND

- SURVEY CONTROL MONUMENT, COORDINATES NOTED ON MAP.
- RISER - VARIABLE HEIGHT
- BOLLARD
- WELL
- SIGNAGE
- JUNCTION BOX
- VALVE
- CAISSON - AS NOTED
- LIGHT POLE / POWER POLE
- POWER POLE W/ GUY ANCHOR
- ROUNDED PIT
- ANODE RISER
- ELECTRICAL PEDESTAL
- TEST WELL
- ELECTRICAL HAND HOLE (CLUSTER)
- CHAIN LINK FENCE - 8 FT HIGH
- HANGING CHAIN FENCE
- OVERHEAD POWER LINE
- PIPING ABOVE GROUND
- EDGE OF GRAVEL
- EDGE OF PAVEMENT
- CONCRETE
- FENCE PANEL
- SOLAR/MONITORING EQUIPMENT

DATUM NOTE:

HORIZONTAL DATUM: WASHINGTON COORDINATE SYSTEM OF 1983, SOUTH ZONE/1991 ADJUSTMENT (WCS83S/91) - METERS

VERTICAL DATUM: NORTH AMERICA VERTICAL DATUM OF 1988 (NAVD88) - METERS

EQUIPMENT NOTE:

TOPOGRAPHIC SURVEY DATA PRESENTED ON THIS MAP WAS COLLECTED USING A LEICA 3-D IMAGING SCANSTATION

COORDINATE NOTE:

COORDINATE VALUES FOR SURVEY CONTROL MONUMENTS PROVIDED BY FLUOR FEDERAL SERVICES VIA GPS OBSERVATION.

CONTOUR NOTE:

MAJOR CONTOUR INTERVAL = 0.609m or 2.0ft

MINOR CONTOUR INTERVAL = 0.152m or 0.5ft

PURPOSE OF SURVEY

TOPOGRAPHIC SURVEY ON A PORTION OF THE SX TANK FARM.

SPECIAL NOTE:

THIS SURVEY DOES NOT ATTEMPT TO SHOW ALL EASEMENTS OF RECORD OR IN VIEW, NOR PHYSICAL FEATURES AND IMPROVEMENTS OF THE PROPERTY.

SURVEYOR'S CERTIFICATE

L LAWRENCE A. GLAHE, P.L.S. 23296, STATE OF WASHINGTON, DO HEREBY CERTIFY THAT THIS TOPOGRAPHIC MAP HAS BEEN PREPARED BY ME OR UNDER MY DIRECTION, AND THAT THE MAP SHOWN HEREON IS A TRUE REPRESENTATION OF A SURVEY MADE BY ME IN AUGUST, 2009.

Section	Township	Range	Bearings	TOPOGRAPHIC SURVEY FOR FLUOR FEDERAL SERVICES
12	12 N	25 E		GLAHE & ASSOCIATES PROFESSIONAL LAND SURVEYORS 303 Church Street Sandpoint, Idaho 83864
Project No. 09-093 FFS	File Name 09-093 FFS	Plot Date 10/1/09		Scale 1 : 750; Drawn By CSS; Checked By KV/RP; Date AUGUST 2009; Sheet 1 of 1

ATTACHMENT C3 – AUTOCAD CIVIL 3D OUTPUT DATA

TANK LOAD VOLUMES 030811.txt

```
Volumes obtained using AutoCAD Civil 3D 2010 from surfaces contained in Volume
Surfaces.dwg 03/08/11

Select bounding polygon: SX-104
          Net volume = 69.69 Cu. M.<Fill>
                 Cut = 0.00 Cu. M.
                Fill = 69.69 Cu. M.

Select bounding polygon: SX-105
          Net volume = 38.46 Cu. M.<Fill>
                 Cut = 0.00 Cu. M.
                Fill = 38.46 Cu. M.

Select bounding polygon: SX-106
          Net volume = 44.07 Cu. M.<Fill>
                 Cut = 0.00 Cu. M.
                Fill = 44.07 Cu. M.

Select bounding polygon: SX-107
          Net volume = 55.69 Cu. M.<Fill>
                 Cut = 0.72 Cu. M.
                Fill = 56.41 Cu. M.

Select bounding polygon: SX-108
          Net volume = 18.89 Cu. M.<Fill>
                 Cut = 0.96 Cu. M.
                Fill = 19.85 Cu. M.

Select bounding polygon: SX-109
          Net volume = 13.62 Cu. M.<Fill>
                 Cut = 2.82 Cu. M.
                Fill = 16.45 Cu. M.

Select bounding polygon: SX-110
          Net volume = 77.47 Cu. M.<Fill>
                 Cut = 0.00 Cu. M.
                Fill = 77.47 Cu. M.

Select bounding polygon: SX-111
          Net volume = 153.80 Cu. M.<Fill>
                 Cut = 0.00 Cu. M.
                Fill = 153.80 Cu. M.

Select bounding polygon: SX-112
          Net volume = 170.11 Cu. M.<Fill>
                 Cut = 0.00 Cu. M.
                Fill = 170.11 Cu. M.

Select bounding polygon: SX-113
          Net volume = 12.49 Cu. M.<Cut>
                 Cut = 19.71 Cu. M.
                Fill = 7.22 Cu. M.

Select bounding polygon: SX-114
          Net volume = 60.61 Cu. M.<Fill>
                 Cut = 1.18 Cu. M.
                Fill = 61.79 Cu. M.

Select bounding polygon: SX-115\par
          Net volume = 89.00 Cu. M.<Fill>
                 Cut = 0.00 Cu. M.
                Fill = 89.00 Cu. M.
```

Page 1

ATTACHMENT C4 – MATCON PERMEABILITY STUDY

MatCon® Permeability

Permeability testing of MatCon® dense-graded mixtures has been conducted by Soil Technology, Bainbridge Island, Washington. Testing was performed according to ASTM D-5084 on 4 inch diameter core samples and/or laboratory prepared samples.

RECOMP of Washington Ash Storage Facility
Ferndale, Washington

Flexible Wall Hydraulic Conductivity of MatCon®
Core Specimens RECOMP of Washington, Bellingham, WA

Sample Identification	Wet Density(Pcf) Before	After	Hydraulic Conductivity (1)(2) (cm/sec)
A-1 (1998)	148	149	$< 1 \times 10^{-8}$
B-1 (1998)	148	149	$< 1 \times 10^{-8}$
C-1 (1989)	147	149	$< 1 \times 10^{-8}$

(1) Average Saturated Hydraulic Conductivity Using Tap Water
(2) No discernible flow patterns were detected, at or near system detection limit (8×10^{-9} cm/sec)

Note: Sample C-1 was a core sampled from the site in 1989. Samples A-1 and B-1 were cores taken from the same location in 1998. All were then tested in the laboratory in 1998.

Dover AFB
Dover, Delaware

Flexible Wall Hydraulic Conductivity of MatCon® and
Conventional Core Specimens ASTM D-5084
Dover AFB, Dover, Delaware

Sample Identification	Wet Density (Pcf) Before	After	Hydraulic Conductivity(1) (cm/sec)
A (1999)	151	152	$< 1 \times 10^{-8}$ (3)
C (1999)	153	153	$< 1 \times 10^{-8}$ (3)
E (1999)	141	146	$< 1 \times 10^{-4}$ (2)

(1) Average Saturated Hydraulic Conductivity Using tap Water
(2) At or near system compliance $> 1 \times 10^{-4}$ cm/sec
(3) No discernable flow patterns were detected, at or near system detection limit (8×10^{-9} cm/sec)

For more information on MatCon® please contact:

W. Randall Garrett
Granite Construction Company
896 Quninnipiac Avenue, Unit 9 | New Haven, CT 06513
(203) 468-0087 | Toll Free: (866) 301-0087 | FAX: (203) 468-0079
W_R_G@sbcglobal.net

Note: Samples A & C are cores from the MatCon® cap taken at the time of construction. Sample E was from the adjacent section of conventional asphalt pavement constructed according to the Delaware DOT specifications.

For more information on MatCon® please contact:

W. Randall Garrett
Granite Construction Company
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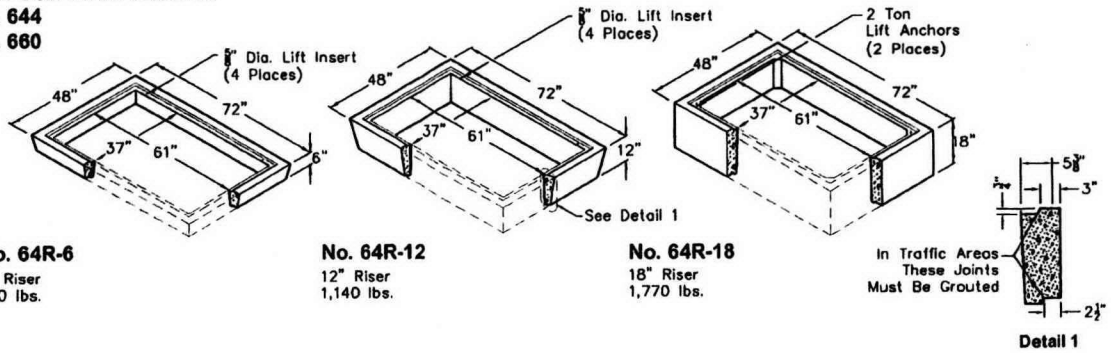
(203) 468-0087 | Toll Free: (866) 301-0087 | FAX: (203) 468-0079
W_R_G@sbcglobal.net

ATTACHMENT C5 – CATALOG DATA SHEETS

64 / 57 / 576 EXTENSIONS

RISER EXTENSIONS
FOR USE WITH VAULTS:
No. 644
No. 660

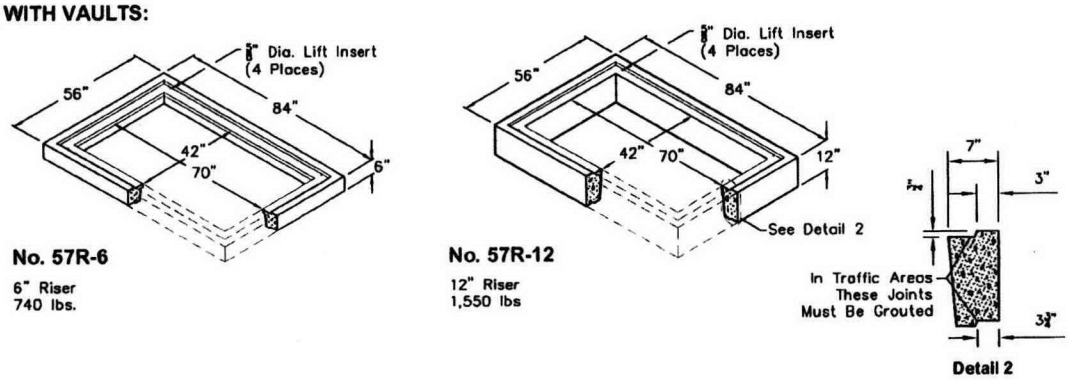


No. 64R-6
6" Riser
560 lbs.

No. 64R-12
12" Riser
1,140 lbs.

No. 64R-18
18" Riser
1,770 lbs.

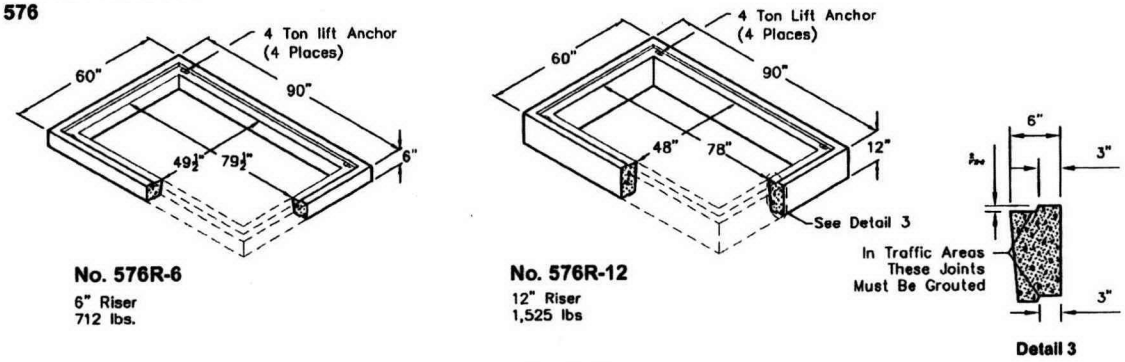
RISER EXTENSIONS
FOR USE WITH VAULTS:
No. 575
No. 577



No. 57R-6
6" Riser
740 lbs.

No. 57R-12
12" Riser
1,550 lbs

RISER EXTENSIONS
FOR USE WITH VAULT:
No. 576



No. 576R-6
6" Riser
712 lbs.

No. 576R-12
12" Riser
1,525 lbs

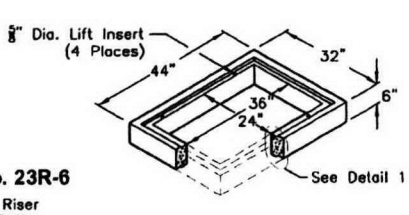
Scale: 3/16" = 1'-0"

Oldcastle Precast® Utility Vault PO Box 323, Wilsonville, Oregon 97070-0323 Tel: (503) 682-2844 Fax: (503) 682-2657	**64/57/576 EXTENSIONS** File Name: 020UCPSQRSRS2 Issue Date: 2008 www.uvwilsonville.com	**64 / 57 / 576** **RISER EXTENSIONS**

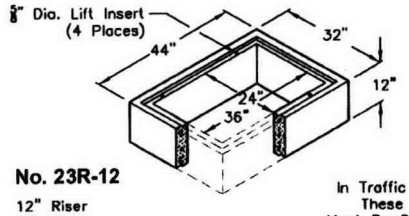
137.1

23 / 44 / 55 EXTENSIONS

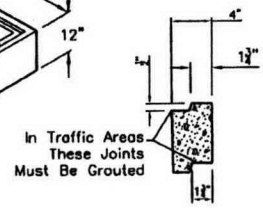
RISER EXTENSIONS
FOR USE WITH VAULT:
No. 233



No. 23R-6
6" Riser
290 lbs.

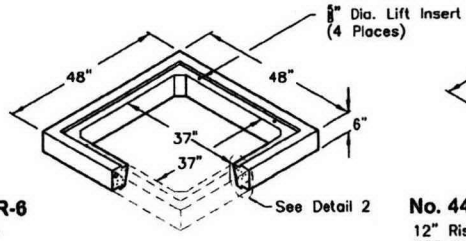


No. 23R-12
12" Riser
560 lbs.

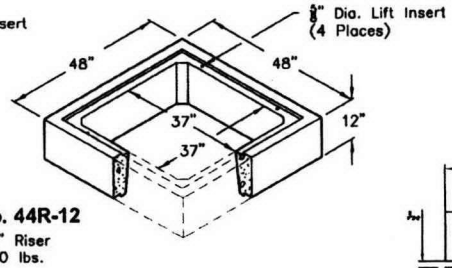


Detail 1

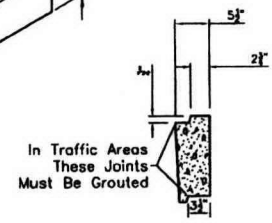
RISER EXTENSIONS
FOR USE WITH VAULTS:
No. 444
No. 446



No. 44R-6
6" Riser
440 lbs.

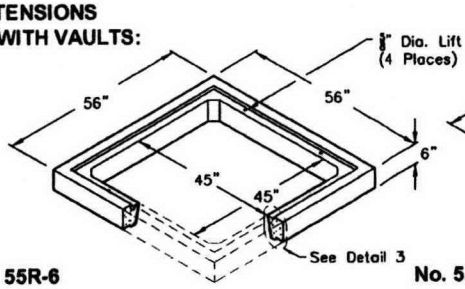


No. 44R-12
12" Riser
800 lbs.

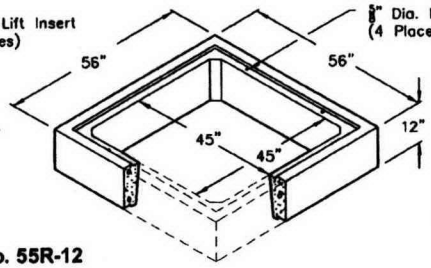


Detail 2

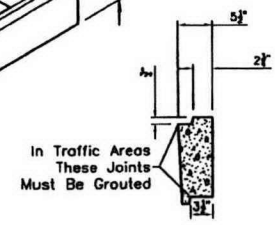
RISER EXTENSIONS
FOR USE WITH VAULTS:
No. 504
No. 506



No. 55R-6
6" Riser
540 lbs.



No. 55R-12
12" Riser
960 lbs.



Detail 3

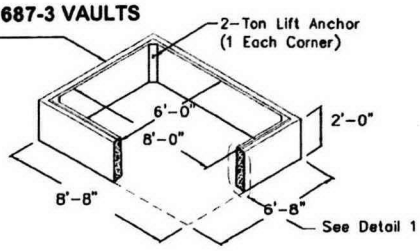
Scale: 1/4" = 1'-0"

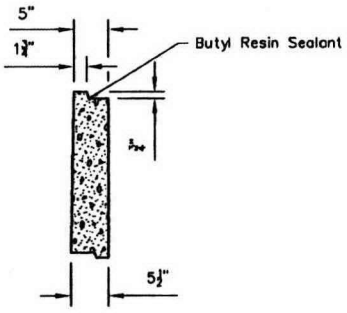
Oldcastle Precast® Utility Vault PO Box 323, Wilsonville, Oregon 97070-0323 Tel: (503) 682-2844 Fax: (503) 682-2657	**23/44/55 EXTENSIONS** File Name: 020UCPSQRSRS1 Issue Date: 2008 www.uvwilsonville.com	**23 / 44 / 55** **RISER EXTENSIONS**

137.0

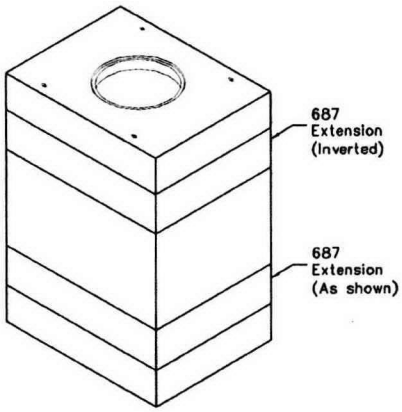
687 / 810 EXTENSIONS

24" EXTENSION
FOR 687-2 & 687-3 VAULTS
No. 687-2X
2,700 lbs.

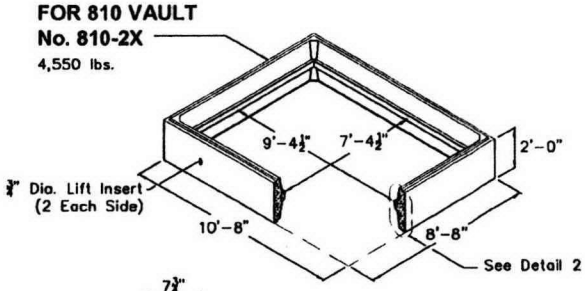


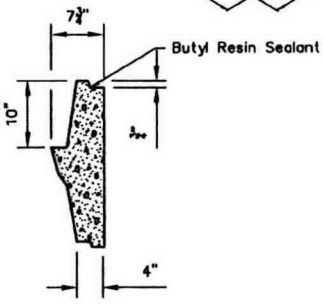


Detail 1

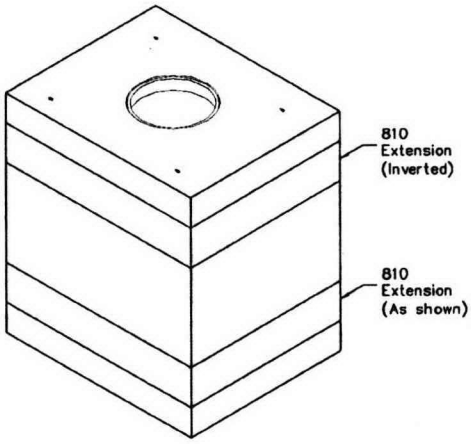


24" EXTENSION
FOR 810 VAULT
No. 810-2X
4,550 lbs.





Detail 2



Note:
- 687-2X & 810-2X may be placed between base and middle section and/or middle and top section.

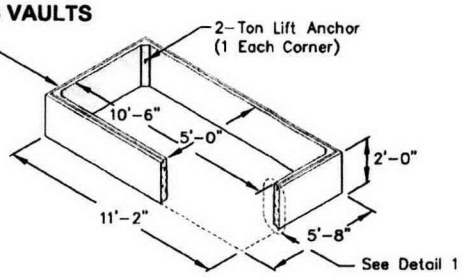
Scale: 1/4" = 1'-0"

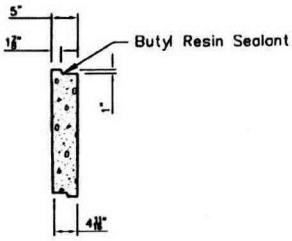
Oldcastle Precast® Utility Vault PO Box 323, Wilsonville, Oregon 97070-0323 Tel: (503) 682-2844 Fax: (503) 682-2657	**687/810 EXTENSIONS** File Name: 020UCP687810X Issue Date: 2008 www.uvwilsonville.com	**687 2X EXTENSION** **810 2X EXTENSION**

138.1

5106 / 612 EXTENSIONS

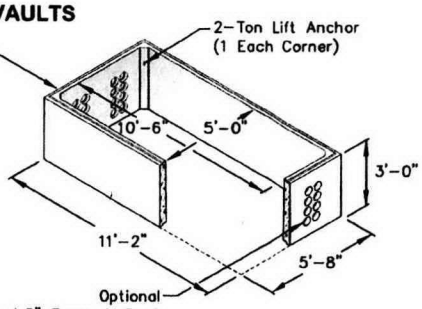
24" EXTENSION
FOR 5106-1 & 5106-3 VAULTS
No. 5106-2X
3,760 lbs.

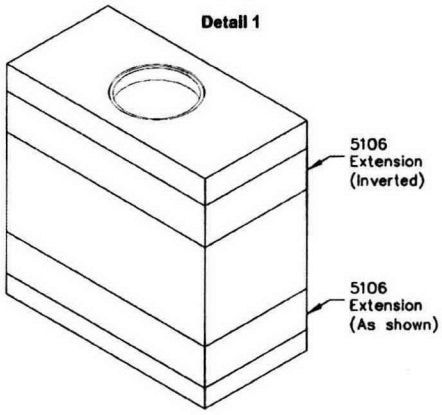




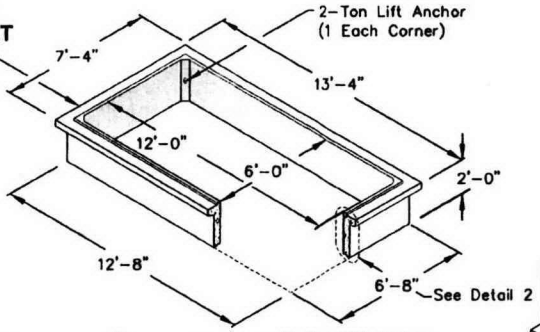
Detail 1

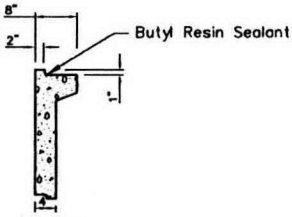
36" EXTENSION
FOR 5106-1, 5106-3 VAULTS
No. 5106-3X
5,520 lbs.





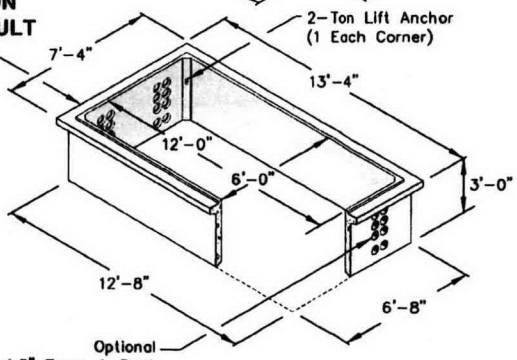
24" EXTENSION
FOR 612-3 VAULT
No. 612-3-2X
4,440 lbs.

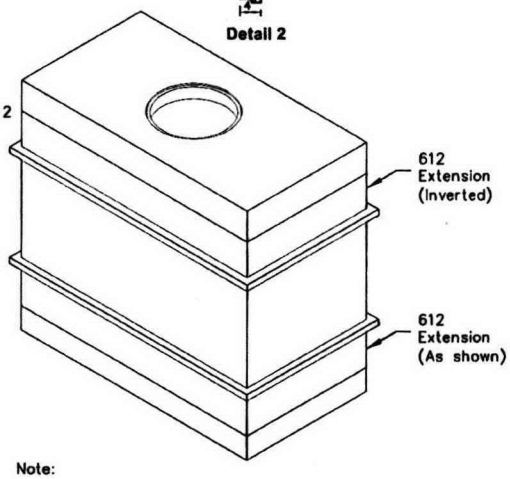




Detail 2

36" EXTENSION
FOR 612-3 VAULT
No. 612-3-3X
6,420 lbs.





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

Note:
- 5106-2X/3X & 612-2X/3X may be placed between base and middle section and/or middle and top section.

Oldcastle Precast®	**5106/612 EXTENSIONS**	**5106 2X/3X EXTENSION** **612 2X/3X EXTENSION**
PO Box 323, Wilsonville, Oregon 97070-0323 Tel: (503) 682-2844 Fax: (503) 682-2657	File Name: 020UCP5106612X Issue Date: 2011 oldcastleprecast.com/wilsonville	

143.0

TABLE V

Table of Available Diameters and Dimensions, Including Number of Specific Types of Plates Required

Neutral Axis Diameter-Inches	Appox. Inside Diameter-Inches**	Appox. Outside Diameter-Inches**	Appox. Outside Area-Sq.Ft.	Total Number Required	Plates Per Ring Plate Lengths and Offsets*								
					12 Pi. Plate			14 Pi. Plate			16 Pi. Plate		
					N	S	D	N	S	D	N	S	D
48	45.25	49.25	13.2	4	1	2	1						
50	47.25	51.25	14.3	4		2	1	1					
52	49.25	53.25	15.5	4		2		1		1			
54	51.25	55.25	16.6	4			1	1	2				
56	53.25	57.25	17.9	4				1	2	1			
58	55.25	59.25	19.1	4					2	1	1		
60	57.25	61.25	20.4	4					2		1		1
62	59.25	63.25	21.8	4						1	1	2	
64	61.25	65.25	23.2	4							1	2	1
66	63.25	67.25	24.6	5	1		1		3				
68	65.25	69.25	26.1	5			1	1	3				
70	67.25	71.25	27.7	5				1	3	1			
72	69.25	73.25	29.2	5					3	1	1		
74	71.25	75.25	30.8	5					3		1		1
76	73.25	77.25	32.5	5				1		1		3	
78	75.25	79.25	34.2	5						1	1	3	
80	77.25	81.25	36.0	5							1	3	1
82	79.25	83.25	37.8	6			1	1	4				
84	81.25	85.25	39.7	6				1	4	1			
86	83.25	87.25	41.6	6					4	1	1		
88	85.25	89.25	43.5	6					4		1		1
90	87.25	91.25	45.4	6					3		1	1	1
92	89.25	93.25	47.4	6				1		1		4	
94	91.25	95.25	49.4	6						1	1	4	
96	93.25	97.25	51.5	6							1	4	1
98	95.25	99.25	53.6	7				1	5	1			
100	97.25	101.25	55.8	7					5	1	1		
102	99.25	103.25	58.1	7					5		1		1
104	101.25	105.25	60.3	7					4		1	1	1
106	103.25	107.25	62.6	7				1	1	1		4	
108	105.25	109.25	65.0	7				1		1		5	
110	107.25	111.25	67.5	7						1	1	5	
112	109.25	113.25	70.0	7							1	5	1
114	111.25	115.25	72.5	8					6	1	1		
116	113.25	117.25	75.0	8					6		1		1
118	115.25	119.25	77.5	8					5		1	1	1
120	117.25	121.25	80.1	8					4		1	2	1
122	119.25	123.25	82.9	8				1	1	1		5	
124	121.25	125.25	85.8	8				1		1		6	
126	123.25	127.25	88.5	8						1	1	6	
128	125.25	129.25	90.5	8							1	6	1
130	127.25	131.25	93.9	9					7		1		1
132	129.25	133.25	96.8	9					6		1	1	1
134	131.25	135.25	99.8	9					5		1	2	1
136	133.25	137.25	102.8	9					4		1	3	1
138	135.25	139.25	105.8	9				1	1	1		6	
140	137.25	141.25	108.8	9				1		1		7	
142	139.25	143.25	111.9	9						1	1	7	
144	141.25	145.25	115.0	9							1	7	1
146	143.25	147.25	118.1	10					7		1	1	1
148	145.25	149.25	121.3	10					6		1	2	1
150	147.25	151.25	124.5	10					5		1	3	1
152	149.25	153.25	128.0	10					4		1	4	1
154	151.25	155.25	131.5	10				1	1	1		7	
156	153.25	157.25	135.0	10				1		1		8	
158	155.25	159.25	138.5	10						1	1	8	
160	157.25	161.25	141.9	10							1	8	1
162	159.25	163.25	145.5	11					7		1	2	1
164	161.25	165.25	149.0	11					6		1	3	1
166	163.25	167.25	152.6	11					5		1	4	1
168	165.25	169.25	156.3	11					4		1	5	1
170	167.25	171.25	160.0	11				1	1	1		8	
172	169.25	173.25	163.8	11				1		1		9	
174	171.25	175.25	167.6	11						1	1	9	
176	173.25	177.25	171.5	11							1	9	1
178	175.25	179.25	175.5	12					7		1	3	1
180	177.25	181.25	179.5	12					6		1	4	1

* Type of offset at ends of plate. N = No Offset, S = Single Offset, D = Double Offset; Diameters are available above those shown in the same pattern. Structures designed for 4 P. (12' 5") stagger in longitudinal seams in alternate rings.

** Where the tunnel clearances are important, the designer should size the structure to provide for normal deflection. Sizes shown in Table V are to the neutral axis, not the inside diameter.

*** Larger diameters are available on request.

TABLE VI (cont'd)
2-Flange Tunnel Liner Plate – Weight by Diameter

DIAMETER		14 ga.		12 ga.		10 ga.		8 ga.		7 ga.		5 ga.		3 ga.	
		0.079 in./2.00mm		0.109 in./2.77 mm		0.138 in./3.51 mm		0.168 in./4.26 mm		0.186 in./4.72 mm		0.216 in./5.46 mm		0.247 in./6.27 mm	
Inches	Meters	LB/FT.	KG/M	LB/FT.	KG/M	LB/FT.	KG/M	LB/FT.	KG/M	LB/FT.	KG/M	LB/FT.	KG/M	LB/FT.	KG/M
116	2.95	152	227	203	302	253	376	303	451	328	488	378	562	446	664
118	3.00	155	230	206	306	257	382	308	458	333	495	384	571	453	674
120	3.05	157	233	209	311	261	388	312	464	338	503	390	580	460	684
122	3.10	159	237	212	315	265	394	317	472	343	510	396	589	468	696
124	3.15	161	240	215	320	269	400	322	479	348	518	402	598	475	707
126	3.20	164	244	219	326	273	406	327	487	353	525	408	607	482	717
128	3.25	167	248	222	330	276	411	331	492	359	534	414	616	489	728
130	3.30	170	253	227	338	283	421	339	504	367	546	424	631	500	744
132	3.35	173	258	231	344	287	427	344	512	372	553	430	640	507	754
134	3.40	176	261	234	348	291	433	349	519	378	562	436	649	514	765
136	3.45	178	264	237	353	295	439	354	527	383	570	442	658	522	777
138	3.51	180	268	240	358	299	445	358	533	388	577	448	667	529	787
140	3.56	182	271	243	362	303	451	363	540	393	585	454	675	536	797
142	3.61	185	275	246	366	307	457	368	548	398	592	460	684	543	808
144	3.66	187	278	249	370	311	463	373	555	403	600	466	693	550	818
146	3.71	191	285	255	379	318	473	381	567	412	613	476	708	561	835
148	3.76	194	288	258	384	322	479	386	574	417	620	482	717	569	847
150	3.81	196	291	261	388	326	485	390	580	422	628	488	726	576	857
152	3.86	199	296	265	394	330	491	395	588	428	637	494	735	583	867
154	3.91	201	299	268	399	334	497	400	595	433	644	499	742	590	878
156	3.96	203	302	271	403	338	503	405	603	438	652	505	751	597	888
158	4.01	206	306	274	408	342	509	409	609	443	659	511	760	604	899
160	4.06	208	309	277	412	346	515	414	616	448	667	517	769	611	909
162	4.11	212	316	283	421	353	525	422	628	457	680	527	784	623	927
164	4.17	215	319	286	426	356	530	427	635	462	687	533	793	630	937
166	4.22	217	322	289	430	360	536	432	643	467	695	539	802	637	948
168	4.27	219	326	292	434	364	542	436	649	472	702	545	811	644	958
170	4.32	221	329	295	439	368	548	441	656	478	711	551	820	651	969
172	4.37	224	334	299	445	372	553	446	664	483	719	557	829	658	979
174	4.42	227	337	302	449	376	559	451	671	488	726	563	838	665	989
176	4.47	229	340	305	454	380	565	456	678	493	733	569	847	672	1000
178	4.52	233	347	311	463	387	576	464	690	502	747	579	861	684	1018
180	4.57	236	350	314	467	391	582	468	696	507	754	585	870	691	1028

* Weight based upon galvanized material. Weights may vary based upon manufacturing tolerances.
** Sizes shown in Table VI are to the neutral axis, not the inside diameter.

Table 2.14 Handling Weight of Corrugated Steel Pipe (2 ⅔ x½ in.)
Estimated Average Weights — Not for Specification Use*

Inside Diameter in Inches	Specified Thickness in Inches	Approximate Pounds per Linear Foot**					
		Metallic Coated	Full Bituminous Coated	Full Bituminous Coated and Invert Paved	Full Bituminous Coated and Full Paved	Steel Lined	Concrete Lined
12	0.052	8	10	13			
	0.064	10	12	15			
	0.079	12	14	17			
15	0.052	10	12	15	26		
	0.064	12	15	18	28		
	0.079	15	18	21	31		
18	0.052	12	14	17	31		
	0.064	15	19	22	34	17	
	0.079	18	22	25	37	20	
21	0.052	14	16	19	36		
	0.064	17	21	26	39	21	
	0.079	21	25	30	43	24	
24	0.052	15	17	20	41		
	0.064	19	24	30	45	23	65
	0.079	24	29	35	50	26	69
30	0.052	20	22	25	51		
	0.064	24	30	36	55	29	82
	0.079	30	36	42	60	34	87
36	0.052	24	26	29	50		
	0.064	29	36	44	65	35	98
	0.079	36	43	51	75	41	104
	0.109	49	56	64	90		116
	0.138	62	69	77	100		127
42	0.052	28	30	33	71		
	0.064	34	42	51	77	42	114
	0.079	42	50	59	85	48	121
	0.109	57	65	74	105		135
	0.138	72	80	89	115		149
48	0.052	31	33	36			
	0.064	38	48	57	85	46	128
	0.079	48	58	67	95	53	138
	0.109	65	75	84	120		154
	0.138	82	92	101	130		170
	0.168	100	110	119	15[illegible]		186
54	0.064	44	55	66	[illegible]5	52	
	0.079	54	65	76	.05	59	156
	0.109	73	84	95	130		173
	0.138	92	103	144	155		191
	0.168	112	123	134	175	209	
60	0.079	60	71	85		68	
	0.109	81	92	106	140	88	192
	0.138	103	114	128	180		212
	0.168	124	135	149	190		232
66	0.079	65	77	93			
	0.109	89	101	117	160	96	211
	0.138	113	125	141	180	120	233
	0.168	137	149	165	210		255

*Lock seam construction only, weights will vary with other fabrication practices.
**For other coatings or linings the weights may be interpolated.
Note: Pipe arch weights will be the same as the equivalent round pipe.
For example, for 42 x 29, 2 ⅔ x ½ in. Pipe Arch, refer to 36 in. diameter pipe weight.

Table 2.15 Handling Weight of Corrugated Steel Pipe (3 x 1 in. or 5 x 1* in.)
Estimated Average Weights — Not for Specification Use**

Inside Diameter in Inches	Specified Thickness in Inches	Approximate Pounds per Linear Foot***					
		Metallic Coated	Full Bituminous Coated	Full Bituminous Coated and Invert Paved	Full Bituminous Coated and Full Paved	Steel Lined	Concrete Lined
54	0.064	50	66	84	138	58	197
	0.079	61	77	95	149	67	207
	0.109	83	100	118	171		226
	0.138	106	123	140	194		245
	0.168	129	146	163	217		264
60	0.064	55	73	93	153	64	218
	0.079	67	86	105	165	74	229
	0.109	92	110	130	190		251
	0.138	118	136	156	216		272
	0.168	143	161	181	241		293
66	0.064	60	80	102	168	70	240
	0.079	74	94	116	181	81	252
	0.109	101	121	143	208		276
	0.138	129	149	171	236		299
	0.168	157	177	199	264		322
72	0.064	66	88	111	183	77	262
	0.079	81	102	126	197	89	275
	0.109	110	132	156	227		301
	0.138	140	162	186	257		326
	0.168	171	193	217	288		351
78	0.064	71	95	121	198	83	
	0.079	87	111	137	214	96	298
	0.109	119	143	169	246		326
	0.138	152	176	202	279		353
	0.168	185	209	235	312		380
84	0.064	77	102	130	213	89	
	0.079	94	119	147	230	104	321
	0.109	128	154	182	264		351
	0.138	164	189	217	300		379
	0.168	199	224	253	335		409
90	0.064	82	109	140	228	96	
	0.079	100	127	158	246	111	
	0.109	137	164	195	283	144	376
	0.138	175	202	233	321		406
	0.168	213	240	271	359		438
96	0.064	87	116	149	242	102	
	0.079	107	136	169	262	118	
	0.109	147	176	209	302	154	401
	0.138	188	217	250	343		433
	0.168	228	257	290	383		467

*Steel weights for 5 x 1 in. are approximately 12% less than those used in this table for metallic coated pipe.
**Lock seam construction only, Weights will vary with other fabrication practices.
***For other coatings or linings the weights may be interpolated.
Note: Pipe arch weights will be the same as the equivalent round pipe. For example: for 81 x 59, 3 x 1 in. pipe-arch, refer to 72 in. diameter pipe weight.

Table 2.15 (Continued) Handling Weight of Corrugated Steel Pipe (3 x 1 in. or 5 x 1* in.)

Estimated Average Weights — Not for Specification Use**

Inside Diameter in Inches	Specified Thickness in Inches	Approximate Pounds per Linear Foot***					
		Metallic Coated	Full Bituminous Coated	Full Bituminous Coated and Invert Paved	Full Bituminous Coated and Full Paved	Steel Lined	Concrete Lined
102	0.064	93	124	158	258	108	
	0.079	114	145	179	279	126	
	0.109	155	189	220	320	164	426
	0.138	198	229	263	363		460
	0.168	241	272	306	406		496
108	0.064	98	131	166	273	115	
	0.079	120	153	188	295	133	
	0.109	165	198	233	340	173	
	0.138	211	244	279	386		487
	0.168	256	289	324	431		525
114	0.064	104	139	176	289	121	
	0.079	127	162	199	312	141	
	0.109	174	209	246	359	183	
	0.138	222	257	294	407		514
	0.168	271	306	343	456		554
120	0.064	109	146	183	296	127	
	0.079	134	171	210	329	148	
	0.109	183	220	259	378	193	
	0.138	234	271	310	429		541
	0.168	284	321	360	479		583
126	0.079	141	179	220	346	155	
	0.109	195	233	274	400	203	
	0.138	247	285	326	452		
132	0.079	148	186	231	363	163	
	0.109	204	244	287	419	213	
	0.138	259	299	342	474		
	0.168	314	354	397	529		
138	0.079	154	196	241	379	169	
	0.109	213	255	300	438	221	
	0.138	270	312	357	495		
	0.168	328	370	415	553		
144	0.109	223	267	314	458	232	
	0.138	282	326	373	517	293	
	0.168	344	388	435	579		

*Steel weights for 5 x 1 in. are approximately 12% less than those used in this table for metallic coated pipe.

**Lock seam construction only, Weights will vary with other fabrication practices.

***For other coatings or linings the weights may be interpolated.

Note: Pipe arch weights will be the same as the equivalent round pipe. For example: for 81 x 59, 3 x 1 in. pipe-arch, refer to 72 in. diameter pipe weight.

STEEL PIPE SIZES ASTM AND API SCHEDULED

Nom. Size	O.D.	Schedule 10 Wall	Lbs/Ft	Schedule 20 Wall	Lbs/Ft	Schedule 30 Wall	Lbs/Ft	Standard (PE) Wall	Lb/Ft	Schedule 40 Wall	Lbs/Ft	Schedule 60 Wall	Lbs/Ft	Extra Strong Wall	Lbs/Ft	Schedule 80 Wall	Lbs/Ft	Schedule 100 Wall	Lbs/Ft	Schedule 120 Wall	Lbs/Ft	Schedule 140 Wall	Lbs/Ft	Schedule 160 Wall	Lb/Ft	XX Strong Wall	Lb/Ft
1/8"	.405							.068	.24	.068	.24			.095	.31	.095	.31										
1/4"	.540							.088	.42	.088	.42			.119	.54	.119	.54										
3/8"	.675							.091	.57	.091	.57			.126	.74	.126	.74							.188	1.31	.294	1.72
1/2"	.840							.109	.85	.109	.85			.147	1.09	.147	1.09							.219	1.95	.308	2.44
3/4"	1.050							.113	1.13	.113	1.13			.154	1.48	.154	1.48							.250	2.85	.358	3.66
1"	1.315							.133	1.68	.133	1.68			.179	2.17	.179	2.17							.250	3.77	.382	5.22
1-1/4"	1.660							.140	2.27	.140	2.27			.191	3.00	.191	3.00							.281	4.86	.400	6.41
1-1/2"	1.900							.145	2.72	.145	2.72			.200	3.63	.200	3.63							.344	7.47	.436	9.04
2"	2.375							.154	3.66	.154	3.65			.218	5.03	.218	5.03							.375	10.02	.552	13.71
2-1/2"	2.875							.203	5.80	.203	5.80			.276	7.67	.276	7.67							.438	14.34	.600	18.60
3"	3.500							.216	7.58	.216	7.58			.300	10.26	.300	10.26								.636	22.87	
3-1/2"	4.000							.226	9.12	.226	9.12			.318	12.52	.318	12.52							.531	22.53	.674	27.57
4"	4.500							.237	10.80	.237	10.80			.337	15.00	.337	15.00			.438	19.02			.625	32.99	.750	36.59
5"	5.563							.258	14.63	.258	14.63			.375	20.80	.375	20.80			.500	27.06			.719	45.39	.864	53.21
6"	6.625							.280	18.99	.280	18.99			.432	28.60	.432	28.60			.562	36.43						
8"	8.625			.250	22.38	.277	24.72	.322	28.58	.322	28.58	.406	35.67	.500	43.43	.500	43.43	.594	51.00	.719	60.77	.812	67.82	.906	74.76	.875	72.49
10"	10.750			.250	28.06	.307	34.27	.365	40.52	.365	40.52	.500	54.79	.500	54.79	.594	64.49	.719	77.10	.844	89.38	1.000	104.23	1.125	115.75	1.000	104.23
12"	12.750			.250	33.41	.330	43.81	.375	49.61	.406	53.57	.562	73.22	.500	65.48	.688	88.71	.844	107.42	1.000	125.61	1.125	139.81	1.312	160.42	1.000	125.61
14"	14.000	.250	36.75	.312	45.65	.375	54.62	.375	54.62	.438	63.50	.594	85.13	.500	72.16	.750	106.23	.938	130.98	1.094	150.93	1.250	170.37	1.406	189.29		
16"	16.000	.250	42.09	.312	52.32	.375	62.64	.375	62.64	.500	82.85	.656	107.60	.500	82.85	.844	136.74	1.031	164.98	1.219	192.61	1.438	223.85	1.594	245.48		
18"	18.000	.250	47.44	.312	58.99	.438	82.23	.375	70.65	.562	104.76	.750	138.30	.500	93.54	.938	171.08	1.156	208.15	1.375	244.37	1.562	274.48	1.781	308.79		
20"	20.000	.250	52.78	.375	78.67	.500	104.23	.375	78.67	.594	123.22	.812	166.56	.500	104.23	1.031	209.06	1.281	256.34	1.500	296.65	1.750	341.41	1.969	379.53		
22"	22.000	.250	58.13	.375	86.69	.500	114.92	.375	86.69	.875	197.60			.500	114.92	1.125	251.04	1.375	303.16	1.625	353.94	1.875	403.38	2.125	451.48		
24"	24.000	.250	63.47	.375	94.71	.562	140.81	.375	94.71	.688	171.45	.969	238.57	.500	125.61	1.219	296.86	1.531	367.74	1.812	429.79	2.062	483.57	2.344	542.64		
26"	26.000	.312	85.68	.500	136.30			.375	102.72					.500	136.30												
28"	28.000	.312	92.35	.500	146.99	.625	182.90	.375	110.74					.500	146.99												
30"	30.000	.312	99.02	.500	157.68	.625	196.26	.375	118.76					.500	157.68												
32"	32.000	.312	105.69	.500	168.37	.625	209.62	.375	126.78	.688	230.29			.500	168.37												
34"	34.000	.312	112.36	.500	179.06	.625	222.99	.375	134.79	.688	245.00			.500	179.06												
36"	36.000	.312	119.03	.500	189.75	.625	236.35	.375	142.81	.750	282.62			.500	189.75												

STEEL PIPE PILING COMMON SIZES DIMENSIONS & PROPERTIES

PIPE AND PILING
ANY SIZE
ANY LENGTH

SHEET PILING
NEW AND USED

H PILING
FOREIGN AND DOMESTIC

35 YEARS IN BUSINESS PERFORMANCE

Size OD In.	Wall Thickness In.	Weight Lb/Ln Ft	Moment of Inertia In.	Radius of Gyration In.	Section Modulus In.	Area External Surface SqFt/LnFt	Area of Metal Sq In	Concrete CuYd/Ln Ft Pipe
8-5/8"	.188	16.96	44.361	2.98	10.287	2.26	4.9831	.0137
	.250	22.38	57.722	2.96	13.385	2.26	6.5777	.0133
	.322	28.58	72.489	2.94	16.809	2.26	8.3993	.0129
	.500	43.43	105.72	2.88	24.514	2.26	12.763	.0117
9-5/8"	.281	28.07	90.180	3.31	18.739	2.52	8.2559	.0166
	.312	31.07	99.220	3.29	20.617	2.52	9.1425	.0163
	.352	34.89	110.38	3.28	22.936	2.52	10.254	.0160
	.395	38.97	122.20	3.27	25.391	2.52	11.454	.0157
	.435	42.73	132.88	3.25	27.612	2.52	12.559	.0155
	.545	52.90	160.80	3.22	33.412	2.52	15.546	.0147
10-3/4"	.188	21.23	86.81	3.74	16.15	2.81	6.238	.0217
	.219	24.65	100.41	3.72	18.68	2.81	7.245	.0215
	.250	28.06	113.74	3.71	21.16	2.81	8.245	.0212
	.279	31.23	126.85	3.70	23.60	2.81	9.242	.0210
	.307	34.27	137.42	3.69	25.57	2.81	10.072	.0207
	.344	38.27	152.29	3.68	28.33	2.81	11.236	.0204
	.365	40.52	160.73	3.67	29.90	2.81	11.908	.0202
	.500	54.79	211.95	3.63	39.43	2.81	16.101	.0191
12-3/4"	.188	25.25	146.05	4.44	22.91	3.34	7.419	.0309
	.219	29.34	169.13	4.43	26.53	3.34	8.621	.0306
	.250	33.41	191.82	4.42	30.09	3.34	9.818	.0303
	.281	37.45	214.26	4.41	33.61	3.34	11.008	.0300
	.312	41.48	236.26	4.40	37.06	3.34	12.191	.0297
	.344	45.62	257.96	4.39	40.47	3.34	13.398	.0293
	.375	49.61	279.34	4.37	43.81	3.34	14.579	.0290
	.438	57.65	321.09	4.36	50.37	3.34	16.923	.0285
	.500	65.48	361.54	4.33	56.71	3.34	19.242	.0279
14"	.188	27.76	194.04	4.86	27.72	3.67	8.158	.0375
	.219	32.26	224.84	4.87	32.13	3.67	9.482	.0372
	.250	36.75	255.36	4.86	36.48	3.67	10.799	.0368
	.281	41.21	283.08	4.85	40.44	3.67	12.111	.0365
	.312	45.65	314.86	4.84	44.98	3.67	13.417	.0362
	.375	54.62	372.76	4.82	53.25	3.67	16.052	.0353
	.500	72.16	483.76	4.78	69.11	3.67	21.206	.0341

Size OD In.	Wall Thickness In.	Weight Lb/Ln Ft	Moment of Inertia In.	Radius of Gyration In.	Section Modulus In.	Area External Surface SqFt/LnFt	Area of Metal Sq In	Concrete CuYd/Ln Ft Pipe
16"	.188	31.78	291.12	5.591	36.39	4.19	9.339	.0493
	.219	36.94	337.76	5.580	42.22	4.19	10.858	.0489
	.250	42.09	383.68	5.569	47.96	4.19	12.370	.0485
	.281	47.22	429.12	5.558	53.64	4.19	13.877	.0482
	.312	52.32	473.92	5.548	59.24	4.19	15.377	.0477
	.375	62.64	562.08	5.526	70.26	4.19	18.408	.0470
	.438	72.86	648.07	5.504	81.01	4.19	21.390	.0461
	.500	82.85	731.94	5.483	91.49	4.19	24.347	.0454
18"	.250	47.44	549.09	6.276	61.01	4.71	13.941	.0619
	.312	58.99	679.23	6.255	75.47	4.71	17.337	.0610
	.375	70.65	806.58	6.233	89.62	4.71	20.764	.0601
	.438	82.23	931.25	6.211	103.47	4.71	24.137	.0591
	.500	93.54	1053.2	6.188	117.02	4.71	27.469	.0583
20"	.250	52.78	756.60	6.983	75.65	5.24	15.512	.0768
	.312	65.66	936.70	6.962	93.67	5.24	19.298	.0758
	.375	78.67	1113.5	6.940	111.35	5.24	23.120	.0749
	.438	91.59	1286.9	6.918	128.69	5.24	26.888	.0738
	.500	104.23	1456.9	6.896	145.69	5.24	30.631	.0728
24"	.250	63.47	1315.44	8.397	109.62	6.28	18.653	.1115
	.281	71.25	1474.20	8.386	122.85	6.28	20.939	.1110
	.312	79.01	1631.52	8.376	135.96	6.28	23.218	.1104
	.375	94.71	1942.44	8.354	161.87	6.28	27.833	.1092
	.438	110.32	2248.3	8.332	187.36	6.28	32.385	.1079
	.500	125.61	2549.64	8.310	212.47	6.28	36.914	.1069
	.625	156.17	3136.9	8.267	261.41	6.28	45.897	.1044
30"	.375	118.76	3829.95	10.475	255.33	7.85	34.901	.1728
	.500	157.68	5043.00	10.431	336.20	7.85	46.339	.1699
36"	.375	142.81	6658.74	12.596	369.93	9.42	41.970	.2510
	.500	189.75	8785.98	12.552	488.11	9.42	55.763	.2475
42"	.375	166.86	10621.58	14.717	505.79	11.00	49.038	.3437
	.500	221.82	14035.80	14.674	668.37	11.00	65.188	.3396
48"	.375	190.92	15908.27	16.838	662.85	12.57	56.107	.4510
	.500	253.89	21045.48	16.795	876.9	12.57	74.613	.4462

STEEL PIPE SIZES NOT SCHEDULED

Nom Size	O.D.	Wall	Lbs/Ft.	Wall	Lbs/Ft.	Wall	Lbs/Ft.	Wall	Lbs/Ft.	Wall	Lbs/Ft.	Wall	Lbs/Ft.	Wall	Lbs/Ft.	Wall	Lbs/Ft.	Wall	Lbs/Ft.	Wall	Lbs/Ft.	Wall	Lbs/Ft.	Wall	Lbs/Ft.	Wall	Lbs/Ft.	Wall	Lbs/Ft.
	9.625	.312	31.00	.352	34.85	.395	39.02	.435	42.76	.472	46.18	.545	52.92																
10"	10.750	.105	11.95	.134	15.21	.188	21.23	.203	22.89	.219	24.65	.250	28.06	.279	31.23	.344	38.27	.438	48.58	.500	54.79	.594	64.49	.719	77.10	.844	89.37		
12"	12.750	.105	14.19	.134	18.07	.188	25.25	.203	27.23	.219	29.34	.250	33.41	.281	37.45	.312	41.48	.344	45.62	.438	57.65	.500	65.48	.625	81.01	.750	96.21		
13"	13.375	.330	45.02	.380	52.79	.430	59.50	.480	66.17	.514	70.67	.550	75.41	.580	79.33	.608	82.98	.719	97.28	.750	101.22								
14"	14.000	.250	36.75	.281	41.21	.344	50.22	.375	54.62	.406	59.01	.438	63.50	.469	67.84	.500	72.16	.562	80.71	.625	89.36	.688	97.91	.750	106.23	1.000	138.97		
16"	16.000	.250	42.09	.281	47.22	.344	57.57	.375	62.64	.406	67.68	.438	72.86	.469	77.87	.500	82.85	.562	92.75	.625	102.67	.688	112.57	.750	122.72	1.000	160.35		
18"	18.000	.250	47.44	.281	53.23	.344	64.93	.375	70.65	.406	76.36	.438	82.23	.469	87.89	.500	93.54	.562	104.76	.625	116.09	.688	127.33	.750	138.30	1.000	181.73		
20"	20.000	.250	52.78	.281	59.23	.344	72.28	.375	78.67	.406	85.04	.438	91.59	.469	97.92	.500	104.23	.562	116.62	.625	129.34	.688	142.03	.750	154.25	1.000	203.11		
22"	22.000	.250	58.13	.281	65.24	.344	79.64	.375	86.69	.406	93.72	.438	100.96	.469	107.95	.500	114.92	.562	128.80	.625	142.81	.688	156.74	.750	170.37	1.000	224.49		
24"	24.000	.250	63.47	.281	71.25	.344	86.99	.375	94.71	.406	102.40	.438	110.32	.469	117.97	.500	125.61	.562	140.81	.625	156.17	.688	171.45	.750	186.16	1.000	245.87		
26"	26.000	.250	68.82	.281	77.25	.344	94.35	.375	102.72	.406	111.08	.438	119.69	.469	128.00	.500	136.30	.562	152.83	.625	169.54	.688	186.16	.750	202.44	1.000	267.25		
28"	28.000	.250	74.16	.281	83.26	.344	101.70	.375	110.74	.406	119.76	.438	129.05	.469	138.03	.500	146.99	.562	164.84	.625	182.90	.688	200.87	.750	218.48	1.000	288.63		
30"	30.000	.250	79.51	.281	89.27	.344	109.06	.375	118.76	.406	128.44	.438	138.42	.469	148.06	.500	157.68	.562	176.86	.625	196.26	.688	215.58	.750	234.51	1.000	310.01		
32"	32.000	.250	84.85	.281	95.28	.344	116.41	.375	126.78	.406	137.12	.438	147.78	.469	158.08	.500	168.37	.562	188.87	.625	209.62	.688	230.29	.750	250.55	1.000	331.39		
34"	34.000	.250	90.20	.281	101.29	.344	123.77	.375	134.79	.406	145.80	.438	157.14	.469	168.11	.500	179.06	.562	200.89	.625	222.99	.688	245.00	.750	266.58	1.000	352.77		
36"	36.000	.250	95.57	.281	107.33	.344	131.17	.375	142.81	.406	154.47	.438	166.55	.469	178.10	.500	189.75	.562	212.94	.625	236.36	.688	259.66	.750	282.64	1.000	374.15		
42"	42.000	.250	111.58	.281	125.32	.344	153.18	.375	166.86	.406	108.52	.438	194.60	.469	208.22	.500	221.82	.562	248.95	.625	276.44	.688	303.84	.750	330.72	1.000	438.29		
48"	48.000	.250	127.61	.281	143.34	.344	175.25	.375	190.92	.406	206.57	.438	222.70	.469	238.30	.500	253.89	.562	285.00	.625	316.52	.688	347.97	.750	378.83	1.000	502.43		

Above data was compiled from existing industry sources and P.N. Best is not responsible for its accuracy.

For weights not listed above, use the following formulas: OD – wall thickness x wall thickness x 10.69 = weight per foot

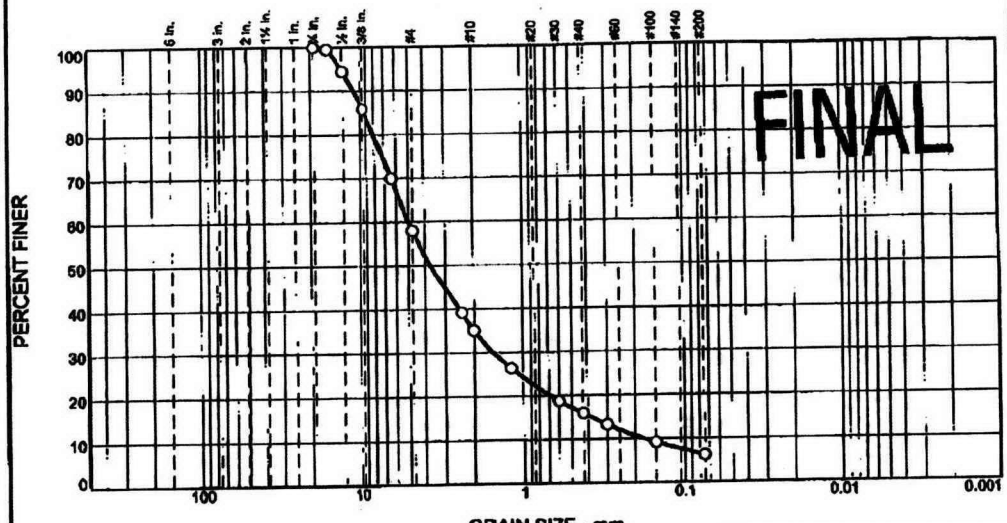
MAKE THE BEST CALL
Phone: 425-882-1000
Fax: 425-881-2003

P.N. BEST AND CO. INC.
16541 Redmond Way, #262C • Redmond, WA 98052-4463

Pnbestco@aol.com

ATTACHMENT C6 – QUALITY INSPECTION SERVICES, INC. LAB DATA

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	42.1	22.8	19.1	9.8	6.2	

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/4"	100.0		
5/8"	99.5		
1/2"	94.4		
3/8"	85.8		
1/4"	70.0		
#4	57.9		
#8	39.2		
#10	35.1		
#16	26.4		
#30	18.8		
#40	16.0		
#50	13.3		
#100	9.1		
#200	6.2		

* (no specification provided)

Material Description

5/8"-Minus, Crushed

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-a

Coefficients

D_{90}= 10.8750 D_{85}= 9.2907 D_{60}= 5.0133
D_{50}= 3.6927 D_{30}= 1.5269 D_{15}= 0.3756
D_{10}= 0.1776 C_u= 28.23 C_c= 2.62

Remarks

N/A

Date Received: 08/14/10 Date Tested: 08/19/10
Tested By: Carl Lindstrom
Checked By: Michael A. Fortier
Title: Civil Manager 09/13/10

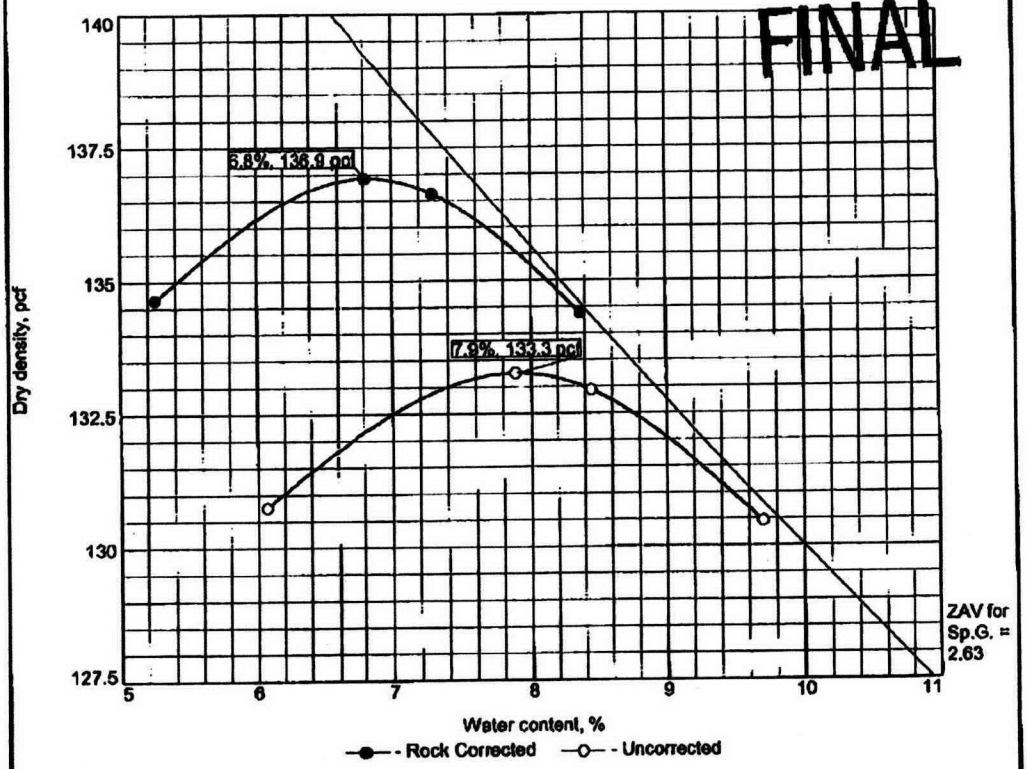
Source of Sample: SP1 ONSITE Depth: N/A Date Sampled: 08/14/10
Sample Number: RLS-10-0100

QUALITY INSPECTION SERVICES, INC.
Richland, WA

Client: Columbia Energy
Project: 2704-HV
Project No: 0300-10-civ-0035 Figure 10-0100

COMPACTION TEST REPORT

FINAL



Test specification: ASTM D 1557-07 Method B Modified
ASTM D 4718-87 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
N/A	SW-SM	A-1-a	N/A	2.63	NV	NP	14.2	6.2

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 136.9 pcf	133.3 pcf	5/8"-Minus, Crushed
Optimum moisture = 6.8 %	7.9 %	

Project No. 0300-10-civ- Client: Columbia Energy
Project: 2704-HV

o Sample Source: SP1 ONSITE Depth: N/A

Remarks:
N/A

QUALITY INSPECTION SERVICES, INC.

Richland, WA

Figure 10-0100A

Tested By: Carl Lindstrom Checked By: Michael A. Fortier 09/13/10

ATTACHMENT C7 – DOME LOAD ALLOWABLE INTERPOLATION RESULTS

Originated By: Ryan Lang
Checked By: Colin Henderson

Soil Depth above Dome, ft*	Soil Density, lb/ft³		
	110 (A)	112.3 (B)	115 (C)
6	393	382.88	371
6.55	380.90	369.52	356.15
7	371	358.58	344
7.08	368.04	355.40	340.56
7.13	366.19	353.41	338.41
7.27	361.01	347.84	332.39
7.29	360.27	347.05	331.53
7.31	359.53	346.25	330.67
7.36	357.68	344.27	328.52
7.51	352.13	338.30	322.07
7.66	346.58	332.34	315.62
7.87	338.81	323.99	306.59
8	334	318.82	301
8.35	316	299.9	281
8.36	316	299.9	281
8.52	307	290.44	271
8.6	303	286.12	266.29
8.86	290	272.06	251

*Bold indicates soil depth results from attachment 1

Interpolation Equation used: $y = y_1+(y_2-y_1)*((x-x_1)/(x_2-x_1))$

Example for 6.55 ft soil depth:

$y = A+(C-A)*(112.3-110)/(115-110)$
$y = 380.90+(356.15-380.90)*(112.3-110)/(115-110)$
$y = 369.52$

Tank Interpolation Summary Table				
Tank #	Soil Depth above Dome, ft	Soil Density, lb/ft³		
		110	112.3	115
SX-104	7.29	360.27	347.05	331.53
SX-105	7.31	359.53	346.25	330.67
SX-106	7.66	346.58	332.34	315.62
SX-107	7.27	361.01	347.84	332.39
SX-108	7.13	366.19	353.41	338.41
SX-109	7.08	368.04	355.40	340.56
SX-110	7.36	357.68	344.27	328.52
SX-111	8.36	316.00	299.90	281.00
SX-112	8.60	303.00	286.12	266.29
SX-113	6.55	380.90	369.52	356.15
SX-114	7.51	352.13	338.30	322.07
SX-115	7.87	338.81	323.99	306.59

APPENDIX D

EVAPOTRANSPIRATION BASIN SIZING

LIST OF TRADEMARKS

MatCon	Registered trademark of MatCon-Inc.

SUBCONTRACTOR CALCULATION REVIEW CHECKLIST

Subject: Evapotranspiration Basin Sizing

The subject document has been reviewed by the undersigned.
The reviewer reviewed and verified the following items as applicable.

Documents Reviewed: RPP-CALC-48447, Rev. 0, Appendix D

Analysis Performed By: Columbia Energy

- Design Input
- Basic Assumptions
- Approach/Design Methodology
- Consistency with item or document supported by the calculation
- Conclusion/Results Interpretation
- Impact on existing requirements

MJ Wohn — 5-24-2011
Reviewer (Print/Sign) — Date

C J ALDERMAN — 05/24/2011
Organizational Manager (Print/Sign) — Date

Calculation Reviewed: Evapotranspiration Basin Sizing

Scope of Review: Entire Calculation
(e.g., document section or portion of calculation)

Engineer/Analyst: Colin Henderson Colin Henderson Date: 5/6/11
(printed name and signature)

Organizational Manager: Brian Brendel D Mitchell for Date: 5/09/11
(printed name and signature)

This document consists of 7 pages and the following attachments (if applicable): ATTACHMENT 1 - SIMPLE METHOD/RUNOFF ATTACHMENT 2 - HELP MODEL

Yes	No	N/A*		
X	[ ]	[ ]	1.	Analytical and technical approaches and results are reasonable and appropriate.
[ ]	[ ]	X	2.	Necessary assumptions are reasonable, explicitly stated, and supported.
X	[ ]	[ ]	3.	Ensure calculations that use software include a paper printout, microfiche, CD-ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
X	[ ]	[ ]	4.	Input data were checked for consistency with original source information.
X	[ ]	[ ]	5.	Key input data (e.g., dimensions, performance characteristics) that may affect equipment design is identified.
X	[ ]	[ ]	6.	For both qualitative and quantitative data, uncertainties are recognized and discussed and the data is presented in a manner to minimize design interpretations.
X	[ ]	[ ]	7.	Mathematical derivations were checked, including dimensional consistency of results.
X	[ ]	[ ]	8.	Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information.
X	[ ]	[ ]	9.	Software verification and validation are addressed adequately.
X	[ ]	[ ]	10.	Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
X	[ ]	[ ]	11.	Conclusions are consistent with analytical results and applicable limits.
X	[ ]	[ ]	12.	Results and conclusions address all points in the purpose.
X	[ ]	[ ]	13.	Referenced documents are retrievable or otherwise available.
X	[ ]	[ ]	14.	The version or revision of each reference is cited.
X	[ ]	[ ]	15.	The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions."
[ ]	[ ]	X	16.	Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents, as appropriate.
X	[ ]	[ ]	17.	All checker comments have been dispositioned and the design media matches the calculations.

RYAN LAUGH Ryan Laugh 5/9/11
Checker (Print/Sign) Date

* If less than the entire calculation was checked, the scope of the check should be discussed. If any blocks are checked "No", an explanation must be provided here or attached

Originated by:	Colin Henderson	CH	5/6
	Name	Initials	Date
Checked by:	Ryan Lang	RL	5/9/11
	Name	Initials	Date

1. Objective/Purpose

The objective of this calculation is to evaluate the 241-SX Tank Farm Interim Surface Barrier basin for the disposition of storm water runoff collected from the barriers. This calculation is intended to verify that the basin is sized to handle the water from the barriers and the basin area.

The 241-SX Tank Farm Interim Surface Barriers will collect and route precipitation to a lined basin for subsequent evaporation. The basin must be sized to handle the water from the barriers for both short term single storm events and long term annual precipitation volumes.

The goal of the basin is to contain runoff water from the barriers inside the basin. The size of the basin must be able to contain the barrier runoff and the precipitation falling on the basin area during a 25 year runoff event.

The basin design is different than the typical evapotranspiration cap designs that have been evaluated for use as a part of closure. This basin will contain a geomembrane liner to prevent precipitation and runoff from draining into soil beneath the basin.

2. Introduction/Background

A portion of the 241-SX Tank Farm ground surface is to be covered with two barriers, a north and south barrier, to reduce groundwater impacts from subsurface contamination. The North barrier will cover tanks 241-SX-104 through 241-SX-109 and the South barrier will cover tanks 241-SX-110 through 241-SX-115. In order to establish a barrier surface that will drain to the collection and conveyance system, the surface of the tank farm will be modified by grading and adding fill material. A modified asphalt layer provided by MatCon® will then be installed acting as the barrier. Storm water runoff from the barriers will be collected and routed through drain lines to a basin located to the south of the tank farm.

The basin will be constructed as a lined basin with a network of perforated drain pipe installed to distribute the storm water runoff from the barriers. The drain pipe will be backfilled with approximately 3 feet of soil excavated from the site. Following placement of the backfill, the exposed surface of the basin will be planted in an effort to establish a stand of plants to help transpire water from the basin.

Water balance calculations were performed using the Hydrologic Evaluation of Landfill Performance, version 3 (HELP3) model. The HELP3 model evaluates the long-term water balance for a cover system using simulated variations in weather data and precipitation. The model allows for user input to simulate the basin concept.

The water balance for the basin will include the runoff from the two barriers as well as the precipitation that falls on the lined portion of the basin. The barrier runoff will be introduced to the basin at approximately 3 feet below ground surface within the basin. Precipitation falling on the basin will consist of that falling on the exposed surface of the basin plus that falling on the side slopes of the basin.

The basin design differs in from evapotranspiration barriers designed for closure barriers (alternative landfill covers) in that there is an impervious liner installed rather than a capillary break. The impervious liner will serve as a boundary to water flow. As water is added to the system it will saturate the lower portion of the basin and begin to rise toward the surface.

Originated by:	Colin Henderson	CH	5/6/11
	Name	Initials	Date
Checked by:	Ryan Lang	RL	5/9/11
	Name	Initials	Date

Evaporation rates will increase as the water level in the basin rises. The relationship of the evaporation rate from saturated soil has been evaluated and shown to be dependent on the availability of water at the soil surface. The maximum potential rate of evaporation occurs only when the soil surface is fully saturated and water is present on the ground surface. The evaporation rate declines once the soil surface becomes unsaturated and continues to desiccate (Wilson et. al., 1991). The actual evaporation rate will increase as the water level rises in the basin to the point that it will equal the potential evaporation rate (or approximately equal the pan evaporation rate) when there is standing water in the basin. The annual average pan evaporation for the area is approximately 47 inches of water for the Yakima area (http://www.wrcc.dri.edu). The Stormwater Management Manual for Eastern Washington, Section 6.4, recommends using an adjustment coefficient ranging from 70% to 80% to account for measured evaporation values obtained from using a shallow metal pan. Using an adjustment coefficient of 70% the potential annual evaporation from an open pond is estimated at 33 inches of water.

3. Input Data

- Surface barrier area per design drawings H-14-109330, *241 SX Tank Farm South Interim Surface Barrier* and H-14-109446, *241-SX Tank Farm North Interim Surface Barrier*.
- The following areas are taken from the design drawings. The area of the South barrier is 77,500 sq-ft. The area of the North barrier 64,400 sq-ft. Area of the evaporative basin at the bottom of the basin 77,780 sq-ft; top of backfill 92,200 sq-ft; top of basin side slopes 120,500 sq-ft.
- The annual average pan evaporation for the area is approximately 47 inches of water for the Yakima area (http://www.wrcc.dri.edu).
- 30 year average annual precipitation for the Hanford Site is 7.14 inches and maximum observed annual precipitation was 12.31 inches (PNNL-15160)
- Backfill material placed into the basin is a Quincy Sand with a soil classification as a loamy sand(DOE/RL-92-24)
- Default soil properties for a USDA soil classification for a loamy sand (Soil Type 6) from the HELP model were used. Default properties include a total porosity of 0.437 vol/vol; field capacity of 0.105 vol/vol; wilting point of 0.047 vol/vol; and a saturated hydraulic conductivity of 1.7×10^{-3} cm/sec (HELP model default parameters for loamy sand). The default saturated hydraulic conductivity is in the range of those reported for Hanford sands in PNL-10285.
- Annual average temperatures and wind speeds taken from PNNL-15160

4. Assumptions

None.

5. Method of Analysis

Basin Sizing

Originated by:	Colin Henderson	C.H.	5/6/11
	Name	Initials	Date
Checked by:	Ryan Lang	R	5/9/11
	Name	Initials	Date

Initial sizing of the basin was performed based on the 241-TY Interim Surface Barrier design (RPP-CALC-41539, Appendix D). The following 241-TY barrier areas are taken from RPP-CALC-41539:

- Barrier area = 80,570 sq-ft
- Basin area at top of backfill = 52,000 sq-ft

Based on these areas the 241-SX basin was sized to maintain the ratio of evaporative area to barrier area as follows:

(241-TY Barrier Area/241-TY Basin Area Top of Backfill) = (241-SX Barrier Area/241-SX Basin Area Top of Backfill)

Then solving for the 241-SX Basin Area Top of Backfill = (241-SX Barrier Area) * (241-TY Basin Area at Top of Backfill)/(241-TY Barrier Area)

241-SX Basin Area at Top of Backfill = (77,500+64,400) * (52,000)/80,500

241-SX Basin Area at Top of Backfill = 91,700 sq-ft

The 241-SX basin area at the top of the backfill is 92,200 > 91,700 sq-ft ➔OK.

Basin Holding Capacity

Volume of backfill in basin is 12,000 cu-yards and minimum freeboard above top of backfill is 1.5' (H-14-109330, Sheet 4).

The water storage capacity in the basin is equal to the storage capacity in the soil plus the available storage capacity above the basin backfill. The water storage capacity within the backfill is estimated based on the soil volume x soil porosity. The storage capacity is equal to: 12,000 cu-yards * 27 cu-ft/cu-yd * 0.43 vol/vol = 139,320 cu-ft. The storage capacity above the backfill is equal to freeboard height * basin area at the top of the backfill. The storage capacity above the backfill is equal to: 92,200 sq-ft * 1.5 ft = 138,300 cu-ft. The total physical storage capacity within the basin is then equal to 139,320 + 138,300 = 278,000 cu-ft.

The total combined area of the barriers and the basin combined is equal to 77,500 sq-ft + 64,400 sq-ft + 120,500 sq-ft = 262,400 sq-ft. The basin storage capacity is then equal to 278,000 cu-ft/262,400 sq-ft = 1.06 ft or 12.7 inches of precipitation. This exceeds the maximum annual precipitation of 12.31 inches reported in PNNL-15160. Note this comparison is conservative in that an entire years precipitation accumulates in the evapotranspiration basin.

Check Elevations

Check elevations of drain lines to make sure elevation at the top of the freeboard is lower than the rim of the storm water collection box.

Invert elevation of outlet of the separator manhole is 656.5 ft (200.10 meters) per H-14-109330, Sheet 8.

Bottom elevation of the basin is 653.7 ft (199.25 m)

Elevation at top of basin backfill is 657.5 ft (200.42m)

Elevation at top of freeboard above the basin backfill is 659 ft (200.9 m)

Originated by:	Colin Henderson	CH.	5/6/11
	Name	Initials	Date
Checked by:	Ryan Lang	RL	5/9/11
	Name	Initials	Date

Invert elevation at South barrier storm water collection boxes is 659.28 ft (201m)

Rim elevation of the South barrier storm water collection boxes is 664 ft (202.46m)

The elevation at the top of the freeboard is lower than the invert elevation of the storm water collection boxes.

Basin Evapotranspiration

The evapotranspiration basin was analyzed using the Hydrologic Evaluation of Landfill Performance Version 3 model (HELP3). The HELP3 model was developed by the U.S. Army Engineers Waterways Experiment Station under a cooperative agreement with the U.S. Environmental Protection Agency (EPA) to support RCRA and Super Fund programs. The EPA reports that the HELP model is the most widely used water balance model for landfill cover design. (Evapotranspiration Landfill Cover Systems Fact Sheet, EPA)

The model creates day-by-day precipitation information based off of average monthly values obtained from PNNL-15160. The water collection basin is fed by the barriers, therefore the annual precipitation values were adjusted in the model to account for the storm water runoff volume from the barriers. This accounts for the precipitation that falls in the basin. Geographic constants for the model are set to Yakima, WA, as it is the closest geographic area to the Hanford Site with preset values for the model. These values are packaged with the HELP3 model.

Annual storm water runoff volumes were estimated based on the following:

Barrier annual runoff

The annual runoff is a function of the annual rainfall, fraction of annual rainfall events that produce runoff, and the runoff coefficient for the imperviousness of the runoff surface.

The estimated annual runoff is then estimated using the method described in Attachment 1:

$R=P*P_j*R_v$

P=annual rainfall (inches)

Pj= Fraction of annual rainfall events that produce runoff

Rv=Runoff coefficient (for an impervious surface Rv is equal to 0.95)

The Soil Conservation Service Curve Number (CN) for impervious asphalt surfaces is 98 (Table 4.5.2, Eastern Washington Stormwater Management Manual). The runoff curve number for the gravel side slopes of the barrier is taken at 98.

S=1000/CN-10 where S is defined as the potential abstraction or maximum potential detention over the area.

Given the CN for asphalt/gravel side slope of 98, S= 0.2 inches

The fraction of annual rainfall events that produce rainfall is estimated using PNNL-15160, Table 4.3 where out of an average of 68 days where precipitation was greater than 0.01 inches only 23 days had precipitation greater than 0.1 inches. The fraction of annual rainfall events that produce runoff is then estimated at 23/68 = 0.34 rounded up to 0.5.

Originated by:	Colin Henderson	CH	5/6/11
	Name	Initials	Date
Checked by:	Ryan Lang	RL	5/9/11
	Name	Initials	Date

The annual barrier runoff is then = P * 0.5 * 0.95 = 0.48 P

Based on areas the ratio of area contributing runoff to the basin to the basin itself is:

Area Ratio = (Barrier Area * 0.48 +Basin Area at Top of Backfill + Basin Sideslope Area *(1-S))/Basin Area at Top of Backfill

Area Ratio = (141,900*0.48 + 92,200 + (120,500-92,200) *0.8)/92,200 = 2

Therefore, the average monthly precipitation values are increased by a factor of 2 in the model input to reflect the storm water runoff from the barriers and the side slopes of the basin.

6. Use of Computer Software

The HELP3 model, version 3.07, released August, 1994 was used in analyzing the evapotranspiration from the 241-TY Interim Surface Barrier evapotranspiration basin. The user's guide for version 3 describes the model, user inputs, default values, and solution method (Schroeder et. al., 1994). Capabilities and limitations associated with HELP3 are documented in the user's manual.

For the purpose of this calculation, design verification of the HELP3 software was performed by a literature review of tests performed to compare the HELP3 model to other water balance software packages used for landfill cap design. The HELP3 model has been tested against BOWAHALD-2D, and found both models produce similar results (Zeh et. al., 2001, *Water Balance Models and Programmes - Comparisons and Calculation Results*). A comparison was also conducted by the Desert Research Institute that included the HELP3 model (Albright et. al., *Alternative Cover Assessment Project Phase 1 Report*). This comparison noted that there are limitations associated with simple water balance methods like HELP3 and that the HELP model (regardless of the version tested) provided some of the highest estimates of drainage. It is further noted that "*the estimation error in the HELP code generally favors an underestimation of the ET, resulting in an overestimation of the drainage*". These comparisons verify and validate the HELP3 software for this calculation and indicate that the software would tend to provide conservative results.

7. Results

This section summarizes the calculations performed in support of the SX-Interim Barriers basin design.

Attachment 2 contains the results acquired by using the HELP3 model for the 241-SX Tank Farm Interim Surface Barrier water collection system design. The basin design consists of a top layer 36" deep layer of soil backfill with a geomembrane to prevent infiltration. This analysis case assumes that the surface of the basin is planted with native vegetation and is allowed to grow in the runoff area, resulting in a "poor stand of grass." The evaporative zone for this simulation is set at 36" deep.

The bedding sand layer in the bottom of the basin is used to distribute the water from the drain lines and is not included in the evaporative calculations. The average annual values for the 30 year period of analysis are provided in Table 1.

Originated by: Colin Henderson CH. 5/6/11
Name Initials Date
Checked by: Ryan Lang RR 5/9/11
Name Initials Date

Table 1. HELP Model Average Annual Results Summary	
Equivalent precipitation on basin (includes precipitation that falls on the basin plus the barrier runoff)	13.76 inches (standard deviation of 2.3 inches)
Evapotranspiration	13.72 inches (standard deviation of 1.7 inches)
Average water depth on top of the impervious liner	5.1 inches (standard deviation of 3.7 inches)

There are uncertainties associated with the inputs and outputs of this calculation. The software simulates natural processes and environmental conditions which include naturally occurring variability. There are limitations with the model in evaluating specific storm events (i.e., rapid snow melt) however for the purposes of this calculation these limitations are considered to be acceptable. Specific storm events are addressed in Appendix A. Wet years resulting from higher than average rainfalls during the winter/early spring could result in standing water in the basin. However, the evaporative potential in the area is high with the annual average pan evaporation rate for the area equal to 47 inches of water, any standing water in the basin would not be expected to remain over the summer months.

8. Conclusions

The basin is adequately sized to handle the storm water runoff from the 241-SX Tank Farm Interim Surface Barriers and the natural precipitation that falls on the basin itself.

9. Recommendations

Construct the basin system as designed for use in collection and disposal of the storm water runoff from the 241-SX Tank Farm Interim Surface Barriers.

10. References

1. H-14-109330, Rev. 0, *241-SX Tank Farm South Interim Surface Barrier*
2. H-14-109446, Rev. 0, *241-SX Tank Farm North Interim Surface Barrier*
3. Wilson et., al., 1991, *The Evaluation of Evaporative Fluxes from Soil Surfaces for Problems in Geotechnical Engineering*, Proceedings of the 44th Annual Canadian Geotechnical Conference, pp. 68-61 to 68-69. September 29 – October 2, Calgary, Alberta
4. PNNL-15160, 2005, *Hanford Site Climatological Summary 2004 with Historical Data*, Pacific Northwest National Laboratory, Richland, WA
5. DOE/RL-92-24, Rev 1, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, US Department of Energy, Richland, Wa
6. Ecology 2004, Stormwater Management Manual for Eastern Washington, Washington State Department of Ecology, Olympia Washington.

Originated by:	Colin Henderson	CH	5/6/11
	Name	Initials	Date
Checked by:	Ryan Lang	RL	5/9/11
	Name	Initials	Date

7. PNL-10285, 1995, Estimated Recharge Rates at the Hanford Site, Pacific Northwest National Laboratory, Richland, Washington.

11. Attachments and Appendixes

Attachment 1. Simple Method For Calculating Annual Runoff

Attachment 2 HELP model output

ATTACHMENT D1 – SIMPLE METHOD TO CALCULATE RUNOFF

The Simple Method to Calculate Urban Stormwater Loads

Introduction
Annual Runoff
Impervious Cover Data
Limitations of the Simple Method
References

Introduction

The Simple Method estimates stormwater runoff pollutant loads for urban areas. The technique requires a modest amount of information, including the subwatershed drainage area and impervious cover, stormwater runoff pollutant concentrations, and annual precipitation. With the Simple Method, the investigator can either break up land use into specific areas, such as residential, commercial, industrial, and roadway and calculate annual pollutant loads for each type of land, or utilize more generalized pollutant values for land uses such as new suburban areas, older urban areas, central business districts, and highways.

Stormwater pollutant concentrations can be estimated from local or regional data, or from national data sources. Tables 1 through 3 summarize pollutant concentration data for Total Suspended Solids (Table 1), Total Phosphorous (Table 2), and Total Nitrogen (Table 3) for residential, commercial, industrial, and roadway land uses, and identify default values. Table 4 identifies pollutant concentration values for Phosphorus, Nitrogen, COD, BOD, and some metals for more generalized land use categories. In general, the selected data sources are nationwide in scope, or are summaries of several regional studies. Some studies included in these data did not characterize stormwater concentrations for specific land uses, and instead reported a concentration for "urban runoff." In these instances, the data are reported as the same concentration for each land use in Tables 1 through 3.

Fecal coliform is more difficult to characterize than other pollutants. Data are extremely variable, even during repeated sampling at a single location. Because of this variability, it is difficult to establish different concentrations for each land use. Although some source monitoring data exists (Steuer *et al.*, 1997; Bannerman *et al.*, 1993), the simple method assumes a median urban runoff default value, derived from NURP data (Pitt, 1998), of 20,000 MPN/100ml. For more information on sources and pathways of bacteria in urban runoff, consult Schueler (1999).

The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration, as:

$$L = 0.226 * R * C * A$$

Where: L = Annual load (lbs)
R = Annual runoff (inches)
C = Pollutant concentration (mg/l)
A = Area (acres)
0.226 = Unit conversion factor

For bacteria, the equation is slightly different, to account for the differences in units. The modified equation for bacteria is:

$$L = 1.03 * 10^{-3} * R * C * A$$

Where: L = Annual load (Billion Colonies)
R = Annual runoff (inches)
C = Bacteria concentration (#/100 ml)
A = Area (acres)

$1.03 * 10^{-3}$ = Unit conversion factor

Annual Runoff

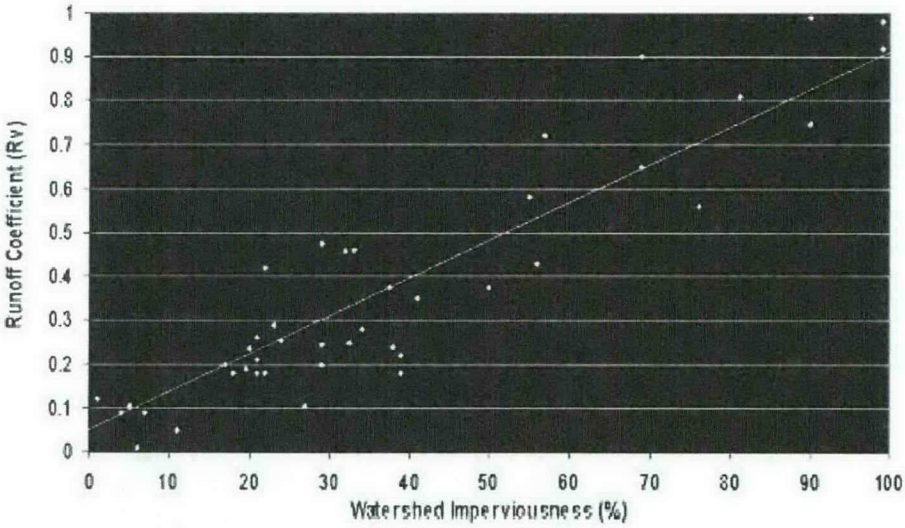
The Simple Method calculates annual runoff as a product of annual runoff volume, and a runoff coefficient (Rv). Runoff volume is calculated as:

$$R = P * P_j * Rv$$

Where: R = Annual runoff (inches)
P = Annual rainfall (inches)
P_j = Fraction of annual rainfall events that produce runoff (usually 0.9)
Rv = Runoff coefficient

In the Simple Method, the runoff coefficient is calculated based on impervious cover in the subwatershed. This relationship is shown in Figure 1. Although there is some scatter in the data, watershed imperviousness does appear to be a reasonable predictor of Rv.

Relationship Between Watershed Imperviousness (I) and the Storm Runoff Coefficient (Rv)
(Source: Schueler, 1987)



The following equation represents the best fit line for the dataset (N=47, R^2=0.71).

$$Rv=0.05+0.9Ia$$

Where: Ia = Impervious fraction

Impervious Cover Data

The model uses different impervious cover values for separate land uses within a subwatershed. Representative impervious cover data, along with Model default values, are presented in Table 5. A study is currently being conducted by the Center for Watershed Protection under a grant from the U.S. Environmental Protection Agency to update impervious cover estimates for these and other land uses. The results of this study will be available by 2001. In addition, some jurisdictions may have detailed impervious cover information if they maintain a detailed land use/land cover GIS database.

Limitations of the Simple Method

The Simple Method should provide reasonable estimates of changes in pollutant export resulting from urban development activities. However, several caveats should be kept in mind when applying this method.

The Simple Method is most appropriate for assessing and comparing the relative stormflow pollutant load changes of different land use and stormwater management scenarios. The Simple Method provides estimates of storm pollutant export that are probably close to the "true" but unknown value for a development site, catchment, or subwatershed. However, it is very important not to over emphasis the precision of the results obtained. For example, it would be inappropriate to use the Simple Method to evaluate relatively similar development scenarios (e.g., 34.3% versus 36.9% Impervious cover). The simple method provides a general planning estimate of likely storm pollutant export from areas at the scale of a development site, catchment or subwatershed. More sophisticated modeling may be needed to analyze larger and more complex watersheds.

In addition, the Simple Method only estimates pollutant loads generated during storm events. It does not consider pollutants associated with baseflow volume. Typically, baseflow is negligible or non-existent at the scale of a single development site, and can be safely neglected. However, catchments and subwatersheds do generate baseflow volume. Pollutant loads in baseflow are generally low and can seldom be distinguished from natural background levels (NVPDC, 1979). Consequently, baseflow pollutant loads normally constitute only a small fraction of the total pollutant load delivered from an urban area. Nevertheless, it is important to remember that the load estimates refer only to storm event derived loads and should not be confused with the total pollutant load from an area. This is particularly important when the development density of an area is low. For example, in a large low density residential subwatershed (Imp. Cover < 5%), as much as 75% of the annual runoff volume may occur as baseflow. In such a case, the annual baseflow nutrient load may be equivalent to the annual stormflow nutrient load.

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ATTACHMENT D2 – HELP MODEL OUTPUT

Att2-SX1OUT12

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******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      H:\_MODEL~1\HELP3\HELP\SX4.D4
TEMPERATURE DATA FILE:        H:\_MODEL~1\HELP3\HELP\SX7.D7
SOLAR RADIATION DATA FILE:    H:\_MODEL~1\HELP3\HELP\SX13.D13
EVAPOTRANSPIRATION DATA:      H:\_MODEL~1\HELP3\HELP\SX11.D11
SOIL AND DESIGN DATA FILE:    H:\_MODEL~1\HELP3\HELP\SX10.D10
OUTPUT DATA FILE:             H:\_MODEL~1\HELP3\HELP\SX1OUT.OUT


TIME:   9:19     DATE:   4/30/2011


******************************************************************************

     TITLE:  Evap Basin

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   4
          THICKNESS                  =     36.00   INCHES
          POROSITY                   =      0.4370 VOL/VOL
          FIELD CAPACITY             =      0.1050 VOL/VOL
          WILTING POINT              =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.1707 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.170000002000E-02 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
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Page 1

Att2-SX1OUT12

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.04	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	0.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	1 - PERFECT	

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 1.% AND A SLOPE LENGTH OF 250. FEET.

SCS RUNOFF CURVE NUMBER	=	80.60	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.200	ACRES
EVAPORATIVE ZONE DEPTH	=	36.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	6.146	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	15.732	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.692	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	6.146	INCHES
TOTAL INITIAL WATER	=	6.146	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM YAKIMA WASHINGTON

STATION LATITUDE	=	46.34	DEGREES
MAXIMUM LEAF AREA INDEX	=	1.00	
START OF GROWING SEASON (JULIAN DATE)	=	108	
END OF GROWING SEASON (JULIAN DATE)	=	292	
EVAPORATIVE ZONE DEPTH	=	36.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.00	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	70.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	49.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	73.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR YAKIMA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

Page 2

Att2-SX1OUT12

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.90	1.30	1.00	0.94	1.02	1.06
0.42	0.50	0.60	1.06	1.76	2.06

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR YAKIMA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
31.80	37.90	46.10	53.30	61.80	69.30
76.30	75.40	65.90	53.00	40.10	31.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR YAKIMA WASHINGTON
AND STATION LATITUDE = 46.29 DEGREES

****

MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.77	0.97	1.28	0.25	0.22	0.61
	0.00	0.25	2.58	0.00	3.13	2.09
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.112	1.081	1.529	0.392	0.430	1.147
	2.729	1.383	1.674	0.542	0.934	0.487
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	1.798	2.054	3.944	5.522	7.467	8.030
TOP OF LAYER 2	5.995	0.360	0.000	0.000	0.000	0.452
STD. DEVIATION OF DAILY	0.000	0.396	0.442	0.430	0.099	0.140
HEAD ON TOP OF LAYER 2	1.913	0.671	0.000	0.000	0.000	0.394

****

Att2-SX1OUT12

****

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.15	52925.402	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	12.441	54194.922	102.40
PERC./LEAKAGE THROUGH LAYER 2	0.000184	0.804	0.00
AVG. HEAD ON TOP OF LAYER 2	2.9684		
CHANGE IN WATER STORAGE	-0.292	-1270.327	-2.40
SOIL WATER AT START OF YEAR	6.776	29517.334	
SOIL WATER AT END OF YEAR	6.485	28247.006	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.002	0.00

****

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.50	0.63	0.26	2.76	0.70	1.29
	0.35	0.59	0.52	0.43	4.85	2.89
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.427	0.163	1.131	1.978	1.441	2.067
	2.560	2.726	0.987	0.049	0.746	0.494
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

Page 4

Att2-SX1OUT12

AVERAGE DAILY HEAD ON	0.872	0.872	7.865	10.422	10.955	11.094
TOP OF LAYER 2	9.295	3.902	0.212	0.000	0.091	1.781
STD. DEVIATION OF DAILY	0.000	0.000	2.577	0.273	0.069	0.023
HEAD ON TOP OF LAYER 2	1.810	1.849	0.305	0.000	0.092	0.763

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****

ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.77	77406.141	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	14.769	64332.859	83.11
PERC./LEAKAGE THROUGH LAYER 2	0.000298	1.299	0.00
AVG. HEAD ON TOP OF LAYER 2	4.7800		
CHANGE IN WATER STORAGE	3.001	13071.934	16.89
SOIL WATER AT START OF YEAR	6.485	28247.006	
SOIL WATER AT END OF YEAR	7.205	31384.725	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	2.281	9934.215	12.83
ANNUAL WATER BUDGET BALANCE	0.0000	0.052	0.00

****

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.39	1.61	0.13	0.65	2.56	0.67
	0.20	0.00	2.89	1.47	2.74	0.66
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.179	1.299	0.658	0.322	2.507	1.937
	3.004	2.606	2.441	1.231	0.763	0.416
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001

Page 5

```
                                   Att2-SX1OUT12
  LAYER  2                       0.0001  0.0001  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                    MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------

AVERAGE DAILY HEAD ON            2.459  18.945  22.753  22.902  22.688  22.115
  TOP OF LAYER  2               17.129  10.060   5.985   5.922   5.921   5.921

STD. DEVIATION OF DAILY          0.000   5.692   0.160   0.018   0.107   0.513
  HEAD ON TOP OF LAYER  2        2.179   2.012   0.114   0.000   0.001   0.000
*******************************************************************************


*******************************************************************************
                          ANNUAL TOTALS FOR YEAR    3
-------------------------------------------------------------------------------
                                        INCHES         CU. FEET     PERCENT
                                       --------       ----------    -------
  PRECIPITATION                         15.97         69565.336    100.00

  RUNOFF                                 0.000            0.000      0.00

  EVAPOTRANSPIRATION                    17.361         75626.141    108.71

  PERC./LEAKAGE THROUGH LAYER  2         0.000839         3.655      0.01

  AVG. HEAD ON TOP OF LAYER  2          13.5667

  CHANGE IN WATER STORAGE               -1.392         -6064.491     -8.72

  SOIL WATER AT START OF YEAR            7.205         31384.725

  SOIL WATER AT END OF YEAR              8.093         35254.449

  SNOW WATER AT START OF YEAR            2.281          9934.215     14.28

  SNOW WATER AT END OF YEAR              0.000            0.000      0.00

  ANNUAL WATER BUDGET BALANCE            0.0000           0.029      0.00
*******************************************************************************


*******************************************************************************
                    MONTHLY TOTALS (IN INCHES) FOR YEAR    4
-------------------------------------------------------------------------------

                                 JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                 ------- ------- ------- ------- ------- -------

PRECIPITATION                     0.75    0.13    1.04    1.96    0.72    0.35
                                  0.00    0.73    0.34    1.85    1.52    1.01
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Att2-SX1OUT12

RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.295	0.519	0.974	2.036	1.143	1.348
	2.862	2.274	0.257	1.055	0.563	0.397
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	5.921	5.921	8.307	9.388	9.913	10.050
	7.314	1.019	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.003	0.000	0.882	0.216	0.080	0.031
	2.077	1.277	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.40	45302.398	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	13.723	59777.238	131.95
PERC./LEAKAGE THROUGH LAYER 2	0.000300	1.305	0.00
AVG. HEAD ON TOP OF LAYER 2	4.8193		
CHANGE IN WATER STORAGE	-3.323	-14476.131	-31.95
SOIL WATER AT START OF YEAR	8.093	35254.449	
SOIL WATER AT END OF YEAR	4.735	20626.105	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.035	152.212	0.34
ANNUAL WATER BUDGET BALANCE	0.0000	-0.009	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.26	0.83	1.12	0.97	0.04	1.54
	0.13	0.66	1.71	1.78	1.75	2.53
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.232	0.184	1.639	0.955	0.536	1.561
	2.666	1.219	0.273	1.420	1.023	0.666
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	0.000	0.000	0.261	1.892	2.770	3.184
	3.075	0.026	0.000	0.000	0.000	0.394
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.000	0.000	0.411	0.294	0.199	0.060
	0.835	0.105	0.000	0.000	0.000	0.324

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.32	62377.930	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	12.373	53898.863	86.41
PERC./LEAKAGE THROUGH LAYER 2	0.000060	0.263	0.00
AVG. HEAD ON TOP OF LAYER 2	0.9669		
CHANGE IN WATER STORAGE	1.946	8478.809	13.59
SOIL WATER AT START OF YEAR	4.735	20626.105	
SOIL WATER AT END OF YEAR	6.717	29257.127	
SNOW WATER AT START OF YEAR	0.035	152.212	0.24
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.001	0.00

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                    MONTHLY TOTALS (IN INCHES) FOR YEAR    6
-------------------------------------------------------------------------------
                                JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                ------- ------- ------- ------- ------- -------

PRECIPITATION                    2.77    0.93    1.47    0.48    0.49    0.79
                                 0.40    0.59    1.54    1.18    3.93    0.73

RUNOFF                           0.000   0.000   0.000   0.000   0.000   0.000
                                 0.000   0.000   0.000   0.000   0.000   0.000

EVAPOTRANSPIRATION               0.478   0.349   1.662   0.404   0.443   1.611
                                 2.794   2.721   1.343   1.041   0.860   0.713

PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0001  0.0001  0.0001  0.0001
  LAYER  2                       0.0001  0.0000  0.0000  0.0000  0.0000  0.0000

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                  MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
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AVERAGE DAILY HEAD ON            2.512   3.678  13.060  15.223  15.501  15.480
  TOP OF LAYER  2               12.920   6.491   3.411   3.321   3.665   4.226

STD. DEVIATION OF DAILY          0.437   2.392   1.516   0.168   0.038   0.114
  HEAD ON TOP OF LAYER  2        1.568   1.539   0.431   0.141   0.098   0.128
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                         ANNUAL TOTALS FOR YEAR    6
-------------------------------------------------------------------------------
                                        INCHES        CU. FEET      PERCENT
                                       --------      ----------     -------

  PRECIPITATION                         15.30        66646.805     100.00

  RUNOFF                                 0.000           0.000       0.00

  EVAPOTRANSPIRATION                    14.421       62817.465      94.25

  PERC./LEAKAGE THROUGH LAYER  2         0.000516        2.249       0.00

  AVG. HEAD ON TOP OF LAYER  2           8.2907

  CHANGE IN WATER STORAGE                0.879        3827.099       5.74

  SOIL WATER AT START OF YEAR            6.717       29257.127

  SOIL WATER AT END OF YEAR              7.595       33084.227
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SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.001	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 7

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.40	1.58	0.41	1.26	0.70	0.45
	0.00	1.57	2.01	0.88	0.42	1.08
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.385	0.200	1.091	0.988	1.279	1.225
	2.589	3.316	1.662	0.347	0.538	0.534
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001
	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	4.279	4.279	9.073	14.068	14.523	14.409
	11.526	5.480	3.754	4.241	4.808	5.461
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.000	0.000	3.825	0.114	0.054	0.084
	1.851	1.203	0.213	0.092	0.209	0.175

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.76	51226.570	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	14.154	61656.113	120.36
PERC./LEAKAGE THROUGH LAYER 2	0.000497	2.166	0.00

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AVG. HEAD ON TOP OF LAYER 2	7.9916		
CHANGE IN WATER STORAGE	-2.395	-10431.726	-20.36
SOIL WATER AT START OF YEAR	7.595	33084.227	
SOIL WATER AT END OF YEAR	5.200	22652.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.020	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 8

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.10	1.95	0.75	1.60	1.75	2.14
	0.02	0.46	0.20	0.00	1.56	1.40
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.642	1.203	0.555	1.485	1.804	2.840
	2.674	1.445	0.189	0.011	0.470	0.464
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	5.997	6.219	6.932	7.409	7.588	7.752
	5.262	0.316	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.013	0.119	0.226	0.079	0.111	0.330
	1.474	0.516	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT

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PRECIPITATION	12.93	56323.094	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	13.782	60033.344	106.59
PERC./LEAKAGE THROUGH LAYER 2	0.000246	1.070	0.00
AVG. HEAD ON TOP OF LAYER 2	3.9563		
CHANGE IN WATER STORAGE	-0.852	-3711.344	-6.59
SOIL WATER AT START OF YEAR	5.200	22652.500	
SOIL WATER AT END OF YEAR	4.348	18941.156	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.025	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 9

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.84	0.47	2.06	1.57	0.63	0.36
	0.67	0.16	0.00	0.26	1.91	1.69
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.283	0.477	1.553	2.066	0.542	1.398
	2.763	1.703	0.000	0.134	0.400	0.551
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	0.000	0.003	1.872	3.446	4.780	5.389
	5.543	0.763	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.000	0.018	0.694	0.378	0.243	0.120
	0.624	1.124	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.62	54972.719	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	11.871	51710.871	94.07
PERC./LEAKAGE THROUGH LAYER 2	0.000113	0.494	0.00
AVG. HEAD ON TOP OF LAYER 2	1.8163		
CHANGE IN WATER STORAGE	0.749	3261.365	5.93
SOIL WATER AT START OF YEAR	4.348	18941.156	
SOIL WATER AT END OF YEAR	4.406	19193.217	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.691	3009.304	5.47
ANNUAL WATER BUDGET BALANCE	0.0000	-0.010	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.04	0.46	1.06	1.55	0.65	1.04
	0.53	0.41	2.86	0.78	2.48	1.49
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.357	0.596	1.311	1.594	0.884	1.608
	3.075	1.018	1.718	0.735	0.562	0.615
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

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AVERAGE DAILY HEAD ON	0.000	0.130	2.596	3.841	4.490	4.780
TOP OF LAYER 2	4.096	0.055	0.000	0.000	0.000	0.317
STD. DEVIATION OF DAILY	0.000	0.318	0.621	0.221	0.133	0.053
HEAD ON TOP OF LAYER 2	1.279	0.189	0.000	0.000	0.000	0.273

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.35	66864.602	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	14.073	61301.945	91.68
PERC./LEAKAGE THROUGH LAYER 2	0.000106	0.460	0.00
AVG. HEAD ON TOP OF LAYER 2	1.6921		
CHANGE IN WATER STORAGE	1.277	5562.200	8.32
SOIL WATER AT START OF YEAR	4.406	19193.217	
SOIL WATER AT END OF YEAR	6.045	26330.852	
SNOW WATER AT START OF YEAR	0.691	3009.304	4.50
SNOW WATER AT END OF YEAR	0.329	1433.869	2.14
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 11

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.12	1.09	0.15	1.33	0.76	0.35
	0.00	0.90	0.52	1.47	0.58	3.88
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.206	0.473	0.996	1.245	0.790	1.238
	2.591	2.214	0.458	0.764	0.432	0.571

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PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  2                       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

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                    MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
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AVERAGE DAILY HEAD ON            0.627   1.122   5.747   8.123   8.672   8.809
  TOP OF LAYER  2                6.391   0.496   0.000   0.000   0.316   0.679

STD. DEVIATION OF DAILY          0.000   0.984   1.209   0.212   0.080   0.024
  HEAD ON TOP OF LAYER  2        1.822   0.873   0.000   0.000   0.125   0.207
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                          ANNUAL TOTALS FOR YEAR   11
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                                         INCHES        CU. FEET      PERCENT
                                        --------      ----------     -------
  PRECIPITATION                          12.15        52925.395     100.00

  RUNOFF                                  0.000           0.000       0.00

  EVAPOTRANSPIRATION                     11.977       52169.773      98.57

  PERC./LEAKAGE THROUGH LAYER  2          0.000213        0.926       0.00

  AVG. HEAD ON TOP OF LAYER  2            3.4151

  CHANGE IN WATER STORAGE                 0.173         754.702       1.43

  SOIL WATER AT START OF YEAR             6.045       26330.852

  SOIL WATER AT END OF YEAR               4.590       19994.855

  SNOW WATER AT START OF YEAR             0.329        1433.869       2.71

  SNOW WATER AT END OF YEAR               1.957        8524.567      16.11

  ANNUAL WATER BUDGET BALANCE             0.0000          -0.003       0.00
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                    MONTHLY TOTALS (IN INCHES) FOR YEAR   12
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                                 JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                 ------- ------- ------- ------- ------- -------

PRECIPITATION                     1.18    0.71    0.31    1.26    1.73    1.27
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	1.20	0.34	0.08	1.69	0.85	2.61
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.607	0.489	1.268	0.986	0.805	3.061
	3.377	1.632	0.059	0.347	0.858	0.634
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	0.965	0.965	1.480	3.502	4.383	4.819
	4.804	0.534	0.000	0.000	0.000	0.139
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.000	0.000	0.677	0.369	0.188	0.086
	0.604	0.847	0.000	0.000	0.000	0.131

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ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.23	57629.887	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	14.123	61521.113	106.75
PERC./LEAKAGE THROUGH LAYER 2	0.000112	0.488	0.00
AVG. HEAD ON TOP OF LAYER 2	1.7992		
CHANGE IN WATER STORAGE	-0.893	-3891.719	-6.75
SOIL WATER AT START OF YEAR	4.590	19994.855	
SOIL WATER AT END OF YEAR	4.834	21055.852	
SNOW WATER AT START OF YEAR	1.957	8524.567	14.79
SNOW WATER AT END OF YEAR	0.820	3571.852	6.20
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 13

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.21	0.48	1.04	0.93	0.49	1.78
	0.00	0.33	0.08	1.40	1.43	3.22
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.495	0.020	1.449	1.163	0.523	1.936
	3.192	0.813	0.056	0.299	0.674	0.694
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	0.404	0.404	0.587	2.851	3.905	4.286
	3.578	0.011	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.000	0.000	0.376	0.483	0.192	0.053
	1.354	0.054	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.39	53970.844	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	11.314	49282.930	91.31
PERC./LEAKAGE THROUGH LAYER 2	0.000083	0.362	0.00
AVG. HEAD ON TOP OF LAYER 2	1.3355		
CHANGE IN WATER STORAGE	1.076	4687.564	8.69
SOIL WATER AT START OF YEAR	4.834	21055.852	
SOIL WATER AT END OF YEAR	5.792	25228.330	
SNOW WATER AT START OF YEAR	0.820	3571.852	6.62
SNOW WATER AT END OF YEAR	0.938	4086.939	7.57
ANNUAL WATER BUDGET BALANCE	0.0000	-0.009	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 14

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.79 0.02	2.30 0.41	0.66 1.16	1.02 1.38	1.54 1.51	0.70 3.08
RUNOFF	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
EVAPOTRANSPIRATION	0.621 2.502	0.468 2.708	1.076 1.013	1.428 1.292	1.431 0.696	1.246 0.668
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000 0.0001	0.0000 0.0000	0.0001 0.0000	0.0001 0.0000	0.0001 0.0000	0.0001 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	0.000 14.815	2.210 8.248	16.883 4.260	17.726 3.406	17.957 3.565	17.755 3.620
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.000 1.940	5.350 1.847	0.449 0.769	0.120 0.050	0.057 0.046	0.201 0.023

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ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.57	72178.930	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	15.149	65989.383	91.42
PERC./LEAKAGE THROUGH LAYER 2	0.000574	2.500	0.00
AVG. HEAD ON TOP OF LAYER 2	9.2036		
CHANGE IN WATER STORAGE	1.420	6187.028	8.57
SOIL WATER AT START OF YEAR	5.792	25228.330	

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SOIL WATER AT END OF YEAR	5.949	25914.979	
SNOW WATER AT START OF YEAR	0.938	4086.939	5.66
SNOW WATER AT END OF YEAR	2.201	9587.317	13.28
ANNUAL WATER BUDGET BALANCE	0.0000	0.019	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 15

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.95 1.23	0.01 0.27	0.47 1.20	0.63 0.77	0.06 1.56	1.64 2.04
RUNOFF	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
EVAPOTRANSPIRATION	0.481 3.462	0.060 2.252	1.346 0.988	0.569 0.372	0.416 0.627	2.387 0.682
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000 0.0001	0.0000 0.0000	0.0001 0.0000	0.0001 0.0000	0.0001 0.0000	0.0001 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	3.685 13.149	3.685 7.190	13.263 4.959	15.972 5.312	16.249 5.671	16.326 5.920
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.000 1.809	0.001 1.543	3.889 0.123	0.184 0.153	0.027 0.075	0.117 0.088

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ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.83	55887.480	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	13.640	59417.172	106.32

PERC./LEAKAGE THROUGH LAYER 2	0.000578	2.518	0.00
AVG. HEAD ON TOP OF LAYER 2	9.2817		
CHANGE IN WATER STORAGE	-0.811	-3532.222	-6.32
SOIL WATER AT START OF YEAR	5.949	25914.979	
SOIL WATER AT END OF YEAR	7.194	31338.297	
SNOW WATER AT START OF YEAR	2.201	9587.317	17.15
SNOW WATER AT END OF YEAR	0.145	631.778	1.13
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 16

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.71	0.01	1.40	0.39	0.17	1.47
	0.21	0.19	0.00	1.66	1.05	1.55
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.791	0.975	1.223	0.561	0.454	2.203
	2.710	1.650	0.000	1.048	0.703	0.626
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	7.042	8.845	10.028	10.335	10.428	10.349
	6.771	0.738	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.869	0.548	0.201	0.053	0.013	0.242
	1.760	1.031	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 16

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	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.81	42732.359	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	12.944	56382.699	131.94
PERC./LEAKAGE THROUGH LAYER 2	0.000334	1.454	0.00
AVG. HEAD ON TOP OF LAYER 2	5.3781		
CHANGE IN WATER STORAGE	-3.134	-13651.793	-31.95
SOIL WATER AT START OF YEAR	7.194	31338.297	
SOIL WATER AT END OF YEAR	3.543	15431.686	
SNOW WATER AT START OF YEAR	0.145	631.778	1.48
SNOW WATER AT END OF YEAR	0.663	2886.596	6.76
ANNUAL WATER BUDGET BALANCE	0.0000	0.002	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 17

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.24	2.52	0.26	0.05	0.25	1.16
	0.06	0.64	0.82	1.00	0.85	2.42
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.721	0.182	1.091	0.341	0.400	2.090
	2.456	1.569	0.502	0.686	0.251	0.584
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	0.000	0.000	3.477	6.426	7.741	8.275
	5.760	0.316	0.000	0.164	0.581	0.997
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.000	0.000	1.796	0.836	0.170	0.163
	1.695	0.655	0.000	0.152	0.112	0.257

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ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.27	53448.121	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	10.873	47361.750	88.61
PERC./LEAKAGE THROUGH LAYER 2	0.000175	0.764	0.00
AVG. HEAD ON TOP OF LAYER 2	2.8114		
CHANGE IN WATER STORAGE	1.397	6085.618	11.39
SOIL WATER AT START OF YEAR	3.543	15431.686	
SOIL WATER AT END OF YEAR	4.328	18854.697	
SNOW WATER AT START OF YEAR	0.663	2886.596	5.40
SNOW WATER AT END OF YEAR	1.274	5549.203	10.38
ANNUAL WATER BUDGET BALANCE	0.0000	-0.010	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 18

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.34	0.36	1.30	0.81	1.78	1.51
	1.31	0.05	0.10	1.06	1.60	2.64
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.358	0.281	1.150	1.079	1.426	2.444
	3.152	1.850	0.100	0.288	0.769	0.452
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

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AVERAGE DAILY HEAD ON	1.414	1.414	1.549	3.768	5.022	5.562
TOP OF LAYER 2	5.717	1.081	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.295	0.610	0.203	0.098
HEAD ON TOP OF LAYER 2	0.396	1.439	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.86	60374.172	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	13.350	58152.234	96.32
PERC./LEAKAGE THROUGH LAYER 2	0.000132	0.576	0.00
AVG. HEAD ON TOP OF LAYER 2	2.1273		
CHANGE IN WATER STORAGE	0.510	2221.330	3.68
SOIL WATER AT START OF YEAR	4.328	18854.697	
SOIL WATER AT END OF YEAR	6.112	26625.229	
SNOW WATER AT START OF YEAR	1.274	5549.203	9.19
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.033	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 19

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.33	0.48	0.82	1.13	0.24	3.09
	0.00	0.09	0.15	1.98	1.10	1.27
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.358	0.147	1.653	1.313	0.481	3.173
	2.449	1.396	0.105	0.265	0.747	0.537

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PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	0.000	0.000	1.744	4.078	4.804	5.146
	5.116	0.513	0.000	0.000	0.180	0.769
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.000	0.000	1.267	0.349	0.125	0.118
	0.810	0.874	0.000	0.000	0.197	0.081

ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.68	50878.078	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	12.624	54990.340	108.08
PERC./LEAKAGE THROUGH LAYER 2	0.000116	0.506	0.00
AVG. HEAD ON TOP OF LAYER 2	1.8626		
CHANGE IN WATER STORAGE	-0.944	-4112.780	-8.08
SOIL WATER AT START OF YEAR	6.112	26625.229	
SOIL WATER AT END OF YEAR	5.168	22512.449	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.013	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

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PRECIPITATION	2.83	1.63	0.40	0.52	0.67	1.75
	0.30	0.04	1.25	0.46	2.04	0.48
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.478	0.590	0.824	0.458	0.694	2.003
	3.435	2.503	0.695	0.423	0.495	0.719
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	0.799	1.606	9.107	10.220	10.610	10.847
	8.912	2.341	0.000	0.005	0.135	0.338
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.000	1.652	0.720	0.179	0.066	0.104
	1.722	2.138	0.000	0.013	0.045	0.060

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ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.37	53883.727	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	13.317	58010.652	107.66
PERC./LEAKAGE THROUGH LAYER 2	0.000285	1.243	0.00
AVG. HEAD ON TOP OF LAYER 2	4.5766		
CHANGE IN WATER STORAGE	-0.948	-4128.177	-7.66
SOIL WATER AT START OF YEAR	5.168	22512.449	
SOIL WATER AT END OF YEAR	4.220	18384.271	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.009	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 21

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.58	1.21	0.79	3.09	0.28	1.31
	0.20	0.29	1.41	0.08	0.63	1.82
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.985	1.085	1.123	2.588	1.263	1.753
	1.506	0.325	0.815	0.417	0.212	0.464
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	0.480	1.208	1.709	2.246	2.567	2.652
	0.640	0.000	0.000	0.000	0.000	0.066
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.148	0.189	0.097	0.149	0.024	0.276
	0.792	0.000	0.000	0.000	0.000	0.131

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ANNUAL TOTALS FOR YEAR 21

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.69	55277.645	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	12.536	54605.844	98.78
PERC./LEAKAGE THROUGH LAYER 2	0.000060	0.259	0.00
AVG. HEAD ON TOP OF LAYER 2	0.9639		
CHANGE IN WATER STORAGE	0.154	671.559	1.21
SOIL WATER AT START OF YEAR	4.220	18384.271	
SOIL WATER AT END OF YEAR	4.204	18313.701	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.170	742.130	1.34
ANNUAL WATER BUDGET BALANCE	0.0000	-0.016	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 22

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.42	0.24	3.38	0.00	0.92	0.58
	0.46	0.44	0.56	1.03	1.79	3.67
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.892	0.388	1.654	0.438	1.157	1.181
	2.343	0.440	0.559	0.588	0.529	0.559
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	0.488	0.717	1.040	2.154	2.679	3.226
	2.033	0.000	0.000	0.000	0.289	0.957
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.027	0.119	0.161	0.245	0.138	0.244
	1.356	0.000	0.000	0.001	0.203	0.282

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ANNUAL TOTALS FOR YEAR 22

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.49	58762.441	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	10.728	46729.262	79.52
PERC./LEAKAGE THROUGH LAYER 2	0.000070	0.306	0.00
AVG. HEAD ON TOP OF LAYER 2	1.1319		
CHANGE IN WATER STORAGE	2.762	12032.870	20.48
SOIL WATER AT START OF YEAR	4.204	18313.701	

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SOIL WATER AT END OF YEAR	5.176	22548.223	
SNOW WATER AT START OF YEAR	0.170	742.130	1.26
SNOW WATER AT END OF YEAR	1.961	8540.479	14.53
ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 23

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.22	1.62	2.41	0.84	0.22	2.68
	2.48	0.19	0.51	0.90	1.86	1.84
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.445	0.776	2.352	1.272	0.484	2.557
	4.368	2.640	0.950	0.485	0.637	0.676
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001
	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	1.192	7.668	17.812	19.171	19.166	18.537
	17.132	12.008	7.609	7.418	8.088	8.603
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.000	7.516	0.795	0.064	0.080	0.421
	0.984	1.793	0.330	0.164	0.242	0.200

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ANNUAL TOTALS FOR YEAR 23

	INCHES	CU. FEET	PERCENT
PRECIPITATION	18.77	81762.141	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	17.642	76849.281	93.99

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PERC./LEAKAGE THROUGH LAYER 2	0.000748	3.260	0.00
AVG. HEAD ON TOP OF LAYER 2	12.0337		
CHANGE IN WATER STORAGE	1.127	4909.558	6.00
SOIL WATER AT START OF YEAR	5.176	22548.223	
SOIL WATER AT END OF YEAR	8.264	35998.258	
SNOW WATER AT START OF YEAR	1.961	8540.479	10.45
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.045	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 24

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.60	0.69	1.22	0.12	1.19	1.08
	0.00	0.85	0.56	0.00	1.89	1.25
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.712	0.311	1.094	0.391	0.798	2.520
	2.729	2.708	0.502	0.124	0.360	0.473
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001
	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	8.755	6.000	14.304	19.719	19.909	19.004
	14.275	8.116	5.655	5.719	5.958	6.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	1.551	0.000	5.772	0.097	0.110	0.604
	2.138	1.466	0.127	0.066	0.057	0.002

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ANNUAL TOTALS FOR YEAR 24
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	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.45	49876.191	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	12.723	55423.051	111.12
PERC./LEAKAGE THROUGH LAYER 2	0.000693	3.018	0.01
AVG. HEAD ON TOP OF LAYER 2	11.1179		
CHANGE IN WATER STORAGE	-1.274	-5549.844	-11.13
SOIL WATER AT START OF YEAR	8.264	35998.258	
SOIL WATER AT END OF YEAR	6.990	30448.416	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.031	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 25

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.51 0.04	0.44 1.07	0.00 1.08	1.42 0.81	1.61 2.08	1.18 4.37
RUNOFF	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
EVAPOTRANSPIRATION	0.487 2.678	0.276 2.748	0.963 1.046	1.224 0.480	1.872 0.763	2.298 0.537
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0001 0.0000	0.0001 0.0000	0.0001 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	6.000 8.505	6.000 2.546	7.444 0.003	10.408 0.165	11.119 0.718	11.409 1.643
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.001 2.108	0.001 1.250	1.594 0.016	0.332 0.146	0.135 0.328	0.097 0.136

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ANNUAL TOTALS FOR YEAR 25

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.61	72353.164	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	15.372	66962.367	92.55
PERC./LEAKAGE THROUGH LAYER 2	0.000341	1.485	0.00
AVG. HEAD ON TOP OF LAYER 2	5.4966		
CHANGE IN WATER STORAGE	1.237	5389.297	7.45
SOIL WATER AT START OF YEAR	6.990	30448.416	
SOIL WATER AT END OF YEAR	5.156	22460.928	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	3.071	13376.785	18.49
ANNUAL WATER BUDGET BALANCE	0.0000	0.019	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 26

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.21 1.09	1.07 1.34	1.96 0.62	1.02 2.44	1.18 0.80	1.19 2.47
RUNOFF	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
EVAPOTRANSPIRATION	0.541 3.255	0.600 3.004	1.690 0.496	1.167 1.068	1.756 0.823	1.427 0.577
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000 0.0001	0.0000 0.0001	0.0001 0.0000	0.0001 0.0000	0.0001 0.0000	0.0001 0.0001

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
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Att2-SX10UT12

AVERAGE DAILY HEAD ON TOP OF LAYER 2	1.725 15.229	4.232 10.736	16.462 7.927	17.781 8.427	18.305 9.497	17.830 10.188
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.000 1.515	4.038 1.301	1.371 0.204	0.162 0.474	0.159 0.228	0.262 0.202

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ANNUAL TOTALS FOR YEAR 26

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.39	75750.859	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	16.404	71456.773	94.33
PERC./LEAKAGE THROUGH LAYER 2	0.000718	3.129	0.00
AVG. HEAD ON TOP OF LAYER 2	11.5283		
CHANGE IN WATER STORAGE	0.985	4290.962	5.66
SOIL WATER AT START OF YEAR	5.156	22460.928	
SOIL WATER AT END OF YEAR	9.212	40128.672	
SNOW WATER AT START OF YEAR	3.071	13376.785	17.66
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.005	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 27

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.30 0.39	0.59 0.34	0.87 0.00	1.50 0.49	1.14 2.08	1.42 2.00
RUNOFF	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
EVAPOTRANSPIRATION	1.044	1.027	0.995	1.695	1.291	2.627

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                                  Att2-SX1OUT12
                                 2.433   2.551   0.382   0.137   0.499   0.873

PERCOLATION/LEAKAGE THROUGH      0.0001  0.0001  0.0001  0.0001  0.0001  0.0001
  LAYER  2                       0.0001  0.0000  0.0000  0.0000  0.0000  0.0000

-------------------------------------------------------------------------------
                    MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------

AVERAGE DAILY HEAD ON            11.817  12.560  13.257  13.581  13.584  13.216
  TOP OF LAYER  2                10.433   3.997   0.425   0.161   0.399   0.686

STD. DEVIATION OF DAILY           0.452   0.360   0.116   0.056   0.022   0.416
  HEAD ON TOP OF LAYER  2         1.680   1.806   0.302   0.026   0.151   0.136
*******************************************************************************


*******************************************************************************
                         ANNUAL TOTALS FOR YEAR    27
-------------------------------------------------------------------------------
                                        INCHES        CU. FEET      PERCENT
                                       --------      ----------     -------
  PRECIPITATION                         12.12        52794.723     100.00

  RUNOFF                                 0.000           0.000       0.00

  EVAPOTRANSPIRATION                    15.554       67754.461     128.34

  PERC./LEAKAGE THROUGH LAYER  2         0.000485        2.113       0.00

  AVG. HEAD ON TOP OF LAYER  2           7.8431

  CHANGE IN WATER STORAGE               -3.435      -14961.864     -28.34

  SOIL WATER AT START OF YEAR            9.212       40128.672

  SOIL WATER AT END OF YEAR              5.778       25166.811

  SNOW WATER AT START OF YEAR            0.000           0.000       0.00

  SNOW WATER AT END OF YEAR              0.000           0.000       0.00

  ANNUAL WATER BUDGET BALANCE            0.0000          0.012       0.00
*******************************************************************************


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                    MONTHLY TOTALS (IN INCHES) FOR YEAR    28
-------------------------------------------------------------------------------

                                  JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
                                  ------- ------- ------- ------- ------- -------
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Att2-SX1OUT12

PRECIPITATION	2.72	1.63	1.04	0.60	0.88	2.03
	0.36	1.51	0.62	1.18	1.15	1.61
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.613	0.220	1.693	0.437	1.074	2.875
	2.418	3.189	1.378	0.473	0.673	0.607
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001
	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	1.071	1.171	9.453	11.093	11.735	12.692
	11.209	5.428	2.245	1.820	2.256	2.495
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.082	0.057	1.635	0.185	0.144	0.410
	1.294	1.170	0.594	0.085	0.027	0.089

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ANNUAL TOTALS FOR YEAR 28

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.33	66777.492	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	15.651	68177.781	102.10
PERC./LEAKAGE THROUGH LAYER 2	0.000378	1.646	0.00
AVG. HEAD ON TOP OF LAYER 2	6.0556		
CHANGE IN WATER STORAGE	-0.322	-1401.936	-2.10
SOIL WATER AT START OF YEAR	5.778	25166.811	
SOIL WATER AT END OF YEAR	5.419	23604.035	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.037	160.839	0.24
ANNUAL WATER BUDGET BALANCE	0.0000	0.006	0.00

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Att2-SX1OUT12

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MONTHLY TOTALS (IN INCHES) FOR YEAR 29

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.03	0.54	1.55	0.33	0.95	1.28
	0.10	1.11	0.25	1.59	1.43	1.02
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.408	0.144	1.861	0.615	0.672	2.319
	2.618	1.865	0.360	0.934	0.676	0.547
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	2.564	2.563	3.077	4.961	5.636	6.481
	5.831	0.532	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.001	0.001	0.620	0.299	0.152	0.499
	1.212	0.818	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 29

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.18	53056.082	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	13.020	56713.285	106.89
PERC./LEAKAGE THROUGH LAYER 2	0.000164	0.713	0.00
AVG. HEAD ON TOP OF LAYER 2	2.6370		
CHANGE IN WATER STORAGE	-0.840	-3657.942	-6.89
SOIL WATER AT START OF YEAR	5.419	23604.035	
SOIL WATER AT END OF YEAR	4.412	19220.850	
SNOW WATER AT START OF YEAR	0.037	160.839	0.30
SNOW WATER AT END OF YEAR	0.203	886.083	1.67

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ANNUAL WATER BUDGET BALANCE	0.0000	0.029	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.46	0.99	1.89	1.21	2.18	1.31
	0.12	0.78	0.06	0.37	3.70	2.82
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.194	0.241	1.277	0.577	3.235	1.660
	2.480	2.570	0.060	0.109	0.488	0.769
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	0.000	0.000	2.149	4.952	5.679	6.979
	6.574	1.588	0.000	0.000	0.000	0.304
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.000	0.000	1.610	0.291	0.157	0.444
	0.872	1.530	0.000	0.000	0.000	0.710

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ANNUAL TOTALS FOR YEAR 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.89	73572.844	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	13.659	59497.305	80.87
PERC./LEAKAGE THROUGH LAYER 2	0.000147	0.639	0.00
AVG. HEAD ON TOP OF LAYER 2	2.3521		
CHANGE IN WATER STORAGE	3.231	14074.878	19.13

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SOIL WATER AT START OF YEAR	4.412	19220.850	
SOIL WATER AT END OF YEAR	7.847	34181.809	
SNOW WATER AT START OF YEAR	0.203	886.083	1.20
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.020	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.89	0.94	1.05	1.04	0.89	1.27
	0.40	0.55	0.86	1.01	1.81	2.05
STD. DEVIATIONS	0.78	0.66	0.76	0.72	0.66	0.66
	0.56	0.43	0.85	0.65	1.02	0.99
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.494	0.494	1.296	1.059	1.068	1.991
	2.796	2.035	0.702	0.572	0.626	0.586
STD. DEVIATIONS	0.236	0.363	0.382	0.610	0.672	0.601
	0.494	0.797	0.623	0.401	0.193	0.110
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

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AVERAGES	2.4288	3.4824	7.5745	9.4394	10.0275	10.2161
	8.3008	3.1630	1.5481	1.5361	1.7378	2.0653
STD. DEVIATIONS	2.9993	4.2575	6.1117	6.1017	5.8127	5.4594
	4.5130	3.7054	2.5621	2.5949	2.7749	2.8344

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	13.76	(2.305)	59916.8	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	13.719	(1.7375)	59759.90	99.738
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.00032	(0.00023)	1.389	0.00232
AVERAGE HEAD ON TOP OF LAYER 2	5.127	(3.730)		
CHANGE IN WATER STORAGE	0.036	(1.7600)	155.48	0.259

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	1.71	7448.760
RUNOFF	0.000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.000004	0.01700
AVERAGE HEAD ON TOP OF LAYER 2	22.946	
SNOW WATER	4.36	18996.7852

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3358

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0470

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Att2-SX1OUT12

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	7.2171	0.2005
2	0.0000	0.0000
SNOW WATER	0.000	

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APPENDIX E

BARRIER COVERAGE

LIST OF TRADEMARKS

AutoCAD	Registered trademark of AutoDesk, Inc.
Civil 3D	Registered trademark of AutoDesk, Inc.
Contech	Registered trademark of Contech Construction Products.
MatCon	Trademark of MatCon, Inc.
MathCAD	Registered trademark of Mathsoft, Inc.

SUBCONTRACTOR CALCULATION REVIEW CHECKLIST

Subject: Barrier Coverage

The subject document has been reviewed by the undersigned.
The reviewer reviewed and verified the following items as applicable.

Documents Reviewed: RPP-CALC-48447, Rev. 0, Appendix E

Analysis Performed By: Columbia Energy

- Design Input
- Basic Assumptions
- Approach/Design Methodology
- Consistency with item or document supported by the calculation
- Conclusion/Results Interpretation
- Impact on existing requirements

MJ Holm — 5-24-2011
Reviewer (Print/Sign) — Date

CJ ALDERMAN — 05/24/2011
Organizational Manager (Print/Sign) — Date

CALCULATION REVIEW CHECKLIST

Calculation Reviewed: Barrier Coverage

Scope of Review: Entire calculation
(e.g., document section or portion of calculation)

Engineer/Analyst: Erica Lucas Erica D Lucas Date: 5/6/11
(printed name and signature)

Organizational Manager: Colin Henderson Colin Henderson Date: 5/9/11
(printed name and signature)

This document consists of 3 pages and the following attachments (if applicable): ATTACHMENT E-1: MATHCAD CALCULATIONS. ATTACHMENT E2: TOPO SURVEY, ATTACHMENT E3: CATALOG INFORMATION.

Yes	No	N/A*		
X	[ ]	[ ]	1.	Analytical and technical approaches and results are reasonable and appropriate.
[ ]	[ ]	X	2.	Necessary assumptions are reasonable, explicitly stated, and supported.
X	[ ]	[ ]	3.	Ensure calculations that use software include a paper printout, microfiche, CD-ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
X	[ ]	[ ]	4.	Input data were checked for consistency with original source information.
X	[ ]	[ ]	5.	Key input data (e.g., dimensions, performance characteristics) that may affect equipment design is identified.
[ ]	[ ]	X	6.	For both qualitative and quantitative data, uncertainties are recognized and discussed and the data is presented in a manner to minimize design interpretations.
X	[ ]	[ ]	7.	Mathematical derivations were checked, including dimensional consistency of results.
X	[ ]	[ ]	8.	Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information.
X	[ ]	[ ]	9.	Software verification and validation are addressed adequately.
X	[ ]	[ ]	10.	Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
X	[ ]	[ ]	11.	Conclusions are consistent with analytical results and applicable limits.
X	[ ]	[ ]	12.	Results and conclusions address all points in the purpose.
X	[ ]	[ ]	13.	Referenced documents are retrievable or otherwise available.
X	[ ]	[ ]	14.	The version or revision of each reference is cited.
X	[ ]	[ ]	15.	The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions."
[ ]	[ ]	X	16.	Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents, as appropriate.
X	[ ]	[ ]	17.	All checker comments have been dispositioned and the design media matches the calculations.

Ryan Lang Ryan Lang Date 5/9/11
Checker (Print/Sign)

* If less than the entire calculation was checked, the scope of the check should be discussed. If any blocks are checked "No", an explanation must be provided here or attached

Originated by:	Erica Lucas	EDL	5/6/11
	Name	Initials	Date
Checked by:	Ryan Lang	RL	5/9/11
	Name	Initials	Date

1. Objective/Purpose

The objective of this calculation is to verify the requirements are met in accordance with RPP-SPEC-47469, *SX Farm Interim Surface Barrier Subsystem Specification*. According to section 3.2 of the specification, the open areas should not exceed 5% of the barrier footprint. The barrier design is specified in drawings H-14-109446, *241-SX Tank Farm North Interim Surface Barrier* and H-14-109330, *241-SX Tank Farm South Interim Surface Barrier.*

2. Introduction/Background

The SX Tank Farm ground surface is to be covered with two interim barriers, a north and south barrier, to reduce groundwater impacts from subsurface contamination. The North barrier will cover tanks SX-104 through SX-109 and the South barrier will cover tanks SX-110 through SX-115. In order to establish a barrier surface that will drain to the collection and conveyance system, the surface of the tank farm will be modified by grading and adding fill material. A modified asphalt layer provided by MatCon™ will then be installed acting as the interim barrier.

3. Input Data

1. Liner diameters per Contech® catalog (Attachment 3).
2. Curb dimensions per design drawings H-14-109330 and H-14-109446.
3. Utility Vault dimensions per Oldcastle Precast catalog (Attachment 3).
4. Corrugated metal pipe diameters per AISI 1994, Table 2.14, 5th Edition (Attachment 3).
5. Corrugated metal pipe diameters per AISI 1994, Table 2.15, 5th Edition (Attachment 3).
6. Surface barrier area per design drawings H-14-109330 and H-14-109446.
7. Standard steel pipe diameters per ASTM A53 2002, Table X2.1 (Attachment 3).

4. Assumptions

None.

5. Method of Analysis

The total surface areas for the north and south barriers are generated from AutoCAD® Civil 3D® using a topographic survey performed by Glahe & Associates in 2008. The total combined uncovered areas of the tank elements are compared to the total surface area of the North and South barriers to determine the approximate open area percentage using the following equations:

$$\text{North:} \quad \% = \frac{(A_{ON})*100}{A_{TN}} \qquad \text{South:} \quad \% = \frac{(A_{OS})*100}{A_{TS}}$$

Where: % = Open area percentage

$A_{O(N\ or\ S)}$ = Open areas in either the North or South barrier

$A_{T(N\ or\ S)}$ = Total barrier area for the North or South

Originated by:	Erica Lucas	EDL	5/6/11
	Name	Initials	Date
Checked by:	Ryan Lang	RL	5/9/11
	Name	Initials	Date

6. Use of Computer Software

The north and south barrier surface area is calculated using AutoCAD Civil 3D 2010 computer software (SN: 391-15588511) on CEES-XP-129. MathCAD® version 14.0 MO30 (14.0.3.332) computer software on CE-IT-10050 is used to document this calculation. All computations are checked with a handheld calculator.

7. Results

Table 1 – North Barrier Open Area Results

Tank Number	Open Area (ft^2)
241-SX-104	43.35
241-SX-105	88.73
241-SX-106	71.48
241-SX-107	297.80
241-SX-108	290.08
241-SX-109	251.58
Total Open Area	1043.02
Total Surface Area	64,346.66
Percentage (%)	**1.62%**

Table 2 – South Barrier Open Area Results

Tank Number	Open Area (ft^2)
241-SX-110	236.03
241-SX-111	331.25
241-SX-112	439.01
241-SX-113	226.25
241-SX-114	249.86
241-SX-115	251.32
Total Open Area	1733.72
Total Surface Area	77,478.63
Percentage (%)	**2.24%**

Originated by:	Erica Lucas	EDL	5/6/11
	Name	Initials	Date
Checked by:	Ryan Lang	RL	5/9/11
	Name	Initials	Date

8. Conclusions

The north barrier open area equates to approximately 1.62% of the total north barrier surface area. The south barrier open area equates to approximately 2.24% of the total south barrier surface area. Both of these values are well below the required maximum 5% of the barrier footprint. The interim surface barriers are adequate per RPP-SPEC-47469.

9. Recommendations

Field verify dimensions for chosen liner systems will provide enough clearance prior to installation.

10. References

1. RPP-SPEC-47469, Rev. 0, *SX Farm Interim Surface Barrier Subsystem Specification*
2. H-14-109330, Rev. 0, *241-SX Tank Farm South Interim Surface Barrier*
3. H-14-109446, Rev. 0, *241-SX Tank Farm North Interim Surface Barrier*
4. *Handbook of Steel Drainage and Highway Construction Products*, 5th Edition, American Iron and Steel Institute, 1994
5. *Topographic Survey for Fluor Federal Services*, Glahe & Associates, Sandpoint, ID 2008
6. ASTM A53: *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*, ASTM International, 2002.

11. Attachments and Appendixes

1. MathCAD calculations
2. Topographic survey
3. Catalog Information

ATTACHMENT E1 – MATHCAD CALCULATIONS

Originated By: Erica Lucas EDL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

NORTH SURFACE BARRIER:

Determine open areas for Tank 241-SX-104:

RISER-002 & ELECTRICAL BOX: Curbing to capture riser and elect. box, H-14-109446 Sheet 7

$L := 48in$ — Minimum clearance needed for the length inside this curbing

$w := 36in$ — Minimum clearance needed for the width inside this curbing

$A_{2\_E} := L \cdot w = 1728 \cdot in^2$ — Open area

$\boxed{A_{2\_E} = 12.00 \cdot ft^2}$

RISER-003/007: Utility Vault 72"x48", H-14-109446 Sheet 7

$L := 61in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 64R-18

$w := 37in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 64R-18

$A_{3\_7} := L \cdot w = 2257 \cdot in^2$ — Open area

$\boxed{A_{3\_7} = 15.67 \cdot ft^2}$

RISER-011: Utility Vault 72"x48", H-14-109446 Sheet 7

$L := 61in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 64R-18

$w := 37in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 64R-18

$A_{11} := L \cdot w = 2257 \cdot in^2$ — Open area

$\boxed{A_{11} = 15.67 \cdot ft^2}$

NOT INCLUDED IN OPEN AREA CALCULATION:

RISER-001/005/013:	paved up to existing weather covered pump pit
RISER-006:	paved up to existing CMP
RISER-016:	paved up to CMP and capped
Pump Pit 241-SX-04A:	paved around
Monitoring Dry Wells:	paved up to steel pipe and capped

TOTAL OPEN AREA IN TANK 241-SX-104:

$A_{104} := A_{2\_E} + A_{3\_7} + A_{11}$

$\boxed{A_{104} = 43.35 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/10/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

Determine open areas for Tank 241-SX-105:

RISER-002/006: Utility Vault 72"x48", H-14-109446 Sheet 8

$L := 61in$ Open length inside vault, Oldcastle Precast Utility Vault, No. 64R-12

$w := 37in$ Open width inside vault, Oldcastle Precast Utility Vault, No. 64R-12

$A_{2\_6} := L \cdot w = 2257 \cdot in^2$ Open area

$\boxed{A_{2\_6} = 15.67 \cdot ft^2}$

RISER-003/007: Utility Vault 72"x48", H-14-109446 Sheet 8

$L := 61in$ Open length inside vault, Oldcastle Precast Utility Vault, No. 64R-12

$w := 37in$ Open width inside vault, Oldcastle Precast Utility Vault, No. 64R-12

$A_{3\_7} := L \cdot w = 2257 \cdot in^2$ Open area

$\boxed{A_{3\_7} = 15.67 \cdot ft^2}$

RISER-011& ELECTRICAL BOX: Curbing to capture riser and elect. box, H-14-109446 Sheet 8

$L := 60in$ Estimated open length inside curbing

$w := 60in$ Estimated open widh inside curbing

$A_{11\_E} := L \cdot w = 3600 \cdot in^2$ Open area

$\boxed{A_{11\_E} = 25.00 \cdot ft^2}$

ELECTRICAL BOX: Curbing to capture electrical box near Riser-002, H-14-109446 Sheet 8

$L := 36in$ Estimated open length inside curbing

$w := 24in$ Estimated open width inside curbing

$A_{elect} := L \cdot w = 864 \cdot in^2$ Open area

$\boxed{A_{elect} = 6.00 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/10/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

INSTRUMENT ENCLOSURE ACCESS: Utility Vaults to capture building, H-14-109446 Sheet 8

$A_1 := 3.5ft \cdot 3.5ft = 12.25 \cdot ft^2$ — Minimum required open area around one portion of the instrument enclosure with 3.5 feet offset by doors

$A_{access} := A_1$ — Open Area

$\boxed{A_{access} = 12.25 \cdot ft^2}$

RISER-012: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 8

$D_i := 3ft$ — Inside diameter of CMP

$A_{12} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{12} = 7.07 \cdot ft^2}$

RISER-015: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 8

$D_i := 3ft$ — Inside diameter of CMP

$A_{15} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{15} = 7.07 \cdot ft^2}$

NOT INCLUDED IN OPEN AREA CALCULATION:

RISER-001/005:	paved up to existing weather covered pump pit
RISER-013:	paved up to pump pit
RISER-016:	paved up to CMP and capped
RISER-017-019:	paved over
Pump Pit 241-SX-05A:	paved around
Weight Factor Enclosure:	paved around
Monitoring Dry Wells:	paved up to steel pipe and capped
Bollard:	paved around.

TOTAL OPEN AREA IN TANK 241-SX-105:

$A_{105} := A_{2\_6} + A_{3\_7} + A_{11\_E} + A_{elect} + A_{access} + A_{12} + A_{15}$

$\boxed{A_{105} = 88.73 \cdot ft^2}$

Originated By: Erica Lucas EXL 5/12/11
Checked By: Ryan Lang RL 5/12/11

SX Farm Interim Surface Barrier
Open Area Analysis

Determine open areas for Tank 241-SX-106:

RISER-002/006: Utility Vault 72"x48", H-14-109446 Sheet 9

$L := 61in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 64R-18

$w := 37in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 64R-18

$A_{2\_6} := L \cdot w = 2257 \cdot in^2$ — Open area

$\boxed{A_{2\_6} = 15.67 \cdot ft^2}$

RISER-003/007: Utility Vault 90"x60", H-14-109446 Sheet 9

$L := 78in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$w := 48in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$A_{3\_7} := L \cdot w = 3744 \cdot in^2$ — Open area

$\boxed{A_{3\_7} = 26.00 \cdot ft^2}$

RISER-011: Utility Vault 72"x48", H-14-109446 Sheet 9

$L := 61in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 64R-18

$w := 37in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 64R-18

$A_{11} := L \cdot w = 2257 \cdot in^2$ — Open area

$\boxed{A_{11} = 15.67 \cdot ft^2}$

RISER-016: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 9

$D_i := 3ft$ — Inside diameter of CMP

$A_{16} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{16} = 7.07 \cdot ft^2}$

ELECTRICAL BOX: 3' Diameter Corrugated Metal Pipe to capture Electrical Box, H-14-109446 Sheet 9

$D_i := 3ft$ — Inside diameter of CMP

$A_{elect} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{elect} = 7.07 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/9/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

NOT INCLUDED IN OPEN AREA CALCULATION:

RISER-001/005/013:	curbing around existing weather covered pump pit and gap filled with foam
Pump Pit 241-SX-06A:	curbing around and gap filled with foam
Monitoring Dry Wells:	paved up to steel pipe and capped

TOTAL OPEN AREA IN TANK 241-SX-106:

$A_{106} := A_{2\_6} + A_{3\_7} + A_{11} + A_{16} + A_{elect}$

$\boxed{A_{106} = 71.48 \cdot ft^2}$

Determine open areas for Tank 241-SX-107:

RISER-002/006: Utility Vault 72"x48", H-14-109446 Sheet 10

$L := 61in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 64R-12

$w := 37in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 64R-12

$A_{2\_6} := L \cdot w = 2257 \cdot in^2$ — Open area

$\boxed{A_{2\_6} = 15.67 \cdot ft^2}$

RISER-013/013A: Contech Liner, 9'-8" Diameter, H-14-109446 Sheet 10

$D := 116in$ — Diameter of liner

$D_i := 113.25in$ — Inside diameter of liner, Contech, Table 5

$A_{13\_13A} := \frac{\pi D_i^2}{4} \cdot \frac{1}{2}$ — Open area

$\boxed{A_{13\_13A} = 34.98 \cdot ft^2}$

INSTRUMENT ENCLOSURE ACCESS: Utility Vaults to capture building, H-14-109446 Sheet 10

$A_1 := 3.5ft \cdot 13ft = 45.5 \cdot ft^2$ — Minimum required open area around one portion of the instrument enclosure with 3.5 feet offset by doors

$A_{access} := A_1$ — Open Area

$\boxed{A_{access} = 45.50 \cdot ft^2}$

Originated By: Erica Lucas 5/10/11
Checked By: Ryan Lang 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

RISER-009: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 10

$D_i := 3ft$ Inside diameter of CMP

$A_9 := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_9 = 7.07 \cdot ft^2}$

RISER-010/020: 6' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 10

$D_i := 6ft$ Inside diameter of CMP

$A_{10\_20} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{10\_20} = 28.27 \cdot ft^2}$

RISER-011: 6' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 10

$D_i := 6ft$ Inside diameter of CMP

$A_{11} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{11} = 28.27 \cdot ft^2}$

RISER-012: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 10

$D_i := 3ft$ Inside diameter of CMP

$A_{12} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{12} = 7.07 \cdot ft^2}$

RISER-014: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 10

$D_i := 3ft$ Inside diameter of CMP

$A_{14} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{14} = 7.07 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/16/11
Checked By: Ryan Lang RL 5/19/11

SX Farm Interim Surface Barrier
Open Area Analysis

RISER-015: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 10

$D_i := 3ft$ Inside diameter of CMP

$A_{15} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{15} = 7.07 \cdot ft^2}$

RISER-018: 6' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 10

$D_i := 6ft$ Inside diameter of CMP

$A_{18} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{18} = 28.27 \cdot ft^2}$

RISER-019: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 10

$D_i := 3ft$ Inside diameter of CMP

$A_{19} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{19} = 7.07 \cdot ft^2}$

HATCHWAY: 10' Diameter Corrugated Metal Pipe to capture Hatchway, H-14-109446 Sheet 10

$D_i := 10ft$ Inside diameter of CMP

$A_{Hatch} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{Hatch} = 78.54 \cdot ft^2}$

VALVE: 2' Diameter Std. Steel Pipe to capture Valve South of Riser-007, H-14-109446 Sheet 10

$D := 2ft$ Outside diameter of steel pipe

$D_i := 2ft - 2 \cdot 0.375in = 1.938 \cdot ft$ Inside diameter of steel pipe, ASTM A53 Table X2.1

$A_{valve} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{valve} = 2.95 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

NOT INCLUDED IN AREA CALCULATION:

RISER-001/005:	paved up to existing pump pit
RISER-003/007:	paved up to existing weather covered pump pit
RISER-004/008:	inside instrument enclosure
RISER-016&017:	paved up to CMP and capped
RISER-021:	paved around
RISER-022-028:	paved up to pump pit
Pump Pit 241-SX-07A:	paved around
Pump Pit 241-SX-07B:	paved around
24" Butterfly Valve:	paved around
Junction Boxes:	paved around
Liquid Level Reel Post:	paved around
Monitoring Dry Wells:	paved up to steel pipe and capped
Bollard:	paved around

TOTAL OPEN AREA IN TANK 241-SX-107:

$$A_{107} := A_{2\_6} + A_{13\_13A} + A_{access} + A_9 + A_{10\_20} + A_{11} + A_{12} + A_{14} + A_{15} + A_{18} + A_{19} \cdots + A_{Hatch} + A_{valve}$$

$$\boxed{A_{107} = 297.80 \cdot ft^2}$$

Determine open areas for Tank 241-SX-108:

RISER-002 & ELECT. BOX: Utility Vault 90"x60", H-14-109446 Sheet 11

$L := 78in$ Open length inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$w := 48in$ Open width inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$A_{2\_E} := L \cdot w = 3744 \cdot in^2$ Open area

$$\boxed{A_{2\_E} = 26.00 \cdot ft^2}$$

RISER-003/007: Utility Vault 90"x60", H-14-109446 Sheet 11

$L := 78in$ Open length inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$w := 48in$ Open width inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$A_{3\_7} := L \cdot w = 3744 \cdot in^2$ Open area

$$\boxed{A_{3\_7} = 26.00 \cdot ft^2}$$

Originated By: Erica Lucas EDL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

RISER-013/013A: Contech Liner, 9'-8" Diameter, H-14-109446 Sheet 11

$D := 116in$ — Diameter of liner

$D_i := 113.25in$ — Inside diameter of liner, Contech, Table 5

$A_{13\_13A} := \frac{\pi \cdot D_i^2}{4} \cdot \frac{1}{2}$ — Open area

$\boxed{A_{13\_13A} = 34.98 \cdot ft^2}$

ELECTRICAL BOX: Curbing to capture electrical box near Hatchway, H-14-109446 Sheet 11

$L := 48in$ — Minimum clearance needed for the length inside this curbing

$w := 36in$ — Minimum clearance needed for the width inside this curbing

$A_{elect} := L \cdot w = 1728 \cdot in^2$ — Open area

$\boxed{A_{elect} = 12.00 \cdot ft^2}$

INSTRUMENT ENCLOSURE ACCESS: Utility Vaults to capture building, H-14-109446 Sheet 11

$A_1 := 3.5ft \cdot 10ft = 35 \cdot ft^2$ — Minimum required open area around one portion of the instrument enclosure with 3.5 feet offset by doors

$A_{access} := A_1$ — Open Area

$\boxed{A_{access} = 35.00 \cdot ft^2}$

RISER-009: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 11

$D_i := 3ft$ — Inside diameter of CMP

$A_9 := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_9 = 7.07 \cdot ft^2}$

RISER-010: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 11

$D_i := 3ft$ — Inside diameter of CMP

$A_{10} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{10} = 7.07 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

RISER-011: 4' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 11

$D_i := 4ft$ Inside diameter of CMP

$A_{11} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{11} = 12.57 \cdot ft^2}$

RISER-012: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 11

$D_i := 3ft$ Inside diameter of CMP

$A_{12} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{12} = 7.07 \cdot ft^2}$

RISER-014: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 11

$D_i := 3ft$ Inside diameter of CMP

$A_{14} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{14} = 7.07 \cdot ft^2}$

RISER-015: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 11

$D_i := 3ft$ Inside diameter of CMP

$A_{15} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{15} = 7.07 \cdot ft^2}$

RISER-017: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 11

$D_i := 3ft$ Inside diameter of CMP

$A_{17} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{17} = 7.07 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/10/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

RISER-018: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 11

$D_i := 3ft$ Inside diameter of CMP

$A_{18} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{18} = 7.07 \cdot ft^2}$

RISER-019: 4' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 11

$D_i := 4ft$ Inside diameter of CMP

$A_{19} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{19} = 12.57 \cdot ft^2}$

HATCHWAY: 10' Diameter Corrugated Metal Pipe to capture Hatchway, H-14-109446 Sheet 11

$D_i := 10ft$ Inside diameter of CMP

$A_{Hatch} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{Hatch} = 78.54 \cdot ft^2}$

VALVE: 2' Diameter Std. Steel Pipe to capture Valve South of Riser-007, H-14-109446 Sheet 11

$D := 2ft$ Outside diameter of steel pipe

$D_i := 2ft - 2 \cdot 0.375in = 1.938 \cdot ft$ Inside diameter of steel pipe, ASTM A53 Table X2.1

$A_{valve} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{valve} = 2.95 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/10/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

NOT INCLUDED IN AREA CALCULATION:

RISER-001/005:	paved up to existing weather covered pump pit
RISER-004/008:	inside instrument closure
RISER-006:	paved around
RISER-016:	paved up to CMP and capped
RISER-020&021:	paved around
Pump Pit 241-SX-08A:	paved around
24" Butterfly Valve:	paved around
Pipe near R9:	paved around
Bollard near Elect. Box:	paved around
Liquid Level Reel Post:	paved around
Junction Box:	paved around
Transmitter Enclosure:	paved over
Monitoring Dry Wells:	paved up to steel pipe and capped
Sludge Cooler Inlet:	paved over
Bollards:	paved around

TOTAL OPEN AREA IN TANK 241-SX-108:

$$A_{108} := A_{2\_E} + A_{3\_7} + A_{13\_13A} + A_{elect} + A_{access} + A_9 + A_{10} + A_{11} + A_{12} + A_{14} + A_{15} + A_{17} \cdots + A_{18} + A_{19} + A_{Hatch} + A_{valve}$$

$$\boxed{A_{108} = 290.08 \cdot ft^2}$$

Determine open areas for Tank 241-SX-109:

RISER-002/006: Utility Vault 90"x60", H-14-109446 Sheet 12

$L := 78in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$w := 48in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$A_{2\_6} := L \cdot w = 3744 \cdot in^2$ — Open area

$$\boxed{A_{2\_6} = 26.00 \cdot ft^2}$$

RISER-013/013A: Contech Liner, 9'-8" Diameter, H-14-109446 Sheet 12

$D := 116in$ — Diameter of liner

$D_i := 113.25in$ — Inside diameter of liner, Contech, Table 5

$A_{13\_13A} := \frac{\pi \cdot D_i^2}{4} \cdot \frac{1}{2}$ — Open area

$$\boxed{A_{13\_13A} = 34.98 \cdot ft^2}$$

Originated By: Erica Lucas EDL 5/9/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

INSTRUMENT ENCLOSURE ACCESS: Utility Vaults to capture building, H-14-109446 Sheet 12

$A_1 := 3.5ft \cdot 13ft = 45.5 \cdot ft^2$ — Minimum required open area around one portion of the instrument enclosure with 3.5 feet offset by doors

$A_{access} := A_1$ — Open Area

$\boxed{A_{access} = 45.50 \cdot ft^2}$

RISER-003: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 12

$D_i := 3ft$ — Inside diameter of CMP

$A_3 := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_3 = 7.07 \cdot ft^2}$

RISER-009: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 12

$D_i := 3ft$ — Inside diameter of CMP

$A_9 := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_9 = 7.07 \cdot ft^2}$

RISER-010: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 12

$D_i := 3ft$ — Inside diameter of CMP

$A_{10} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{10} = 7.07 \cdot ft^2}$

RISER-011: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 12

$D_i := 3ft$ — Inside diameter of CMP

$A_{11} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{11} = 7.07 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

RISER-012: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 12

$D_i := 3ft$ Inside diameter of CMP

$A_{12} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{12} = 7.07 \cdot ft^2}$

RISER-014: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 12

$D_i := 3ft$ Inside diameter of CMP

$A_{14} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{14} = 7.07 \cdot ft^2}$

RISER-015: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 12

$D_i := 3ft$ Inside diameter of CMP

$A_{15} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{15} = 7.07 \cdot ft^2}$

RISER-018: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 12

$D_i := 3ft$ Inside diameter of CMP

$A_{18} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{18} = 7.07 \cdot ft^2}$

RISER-019: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109446 Sheet 12

$D_i := 3ft$ Inside diameter of CMP

$A_{19} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{19} = 7.07 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

HATCHWAY: 10' Diameter Corrugated Metal Pipe to capture Hatchway, H-14-109446 Sheet 12

$D_i := 10ft$ Inside diameter of CMP

$A_{Hatch} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{Hatch} = 78.54 \cdot ft^2}$

VALVE: 2' Diameter Std. Steel Pipe to capture Valve North of Riser-006, H-14-109446 Sheet 12

$D := 2ft$ Outside diameter of steel pipe

$D_i := 2ft - 2 \cdot 0.375in = 1.938 \cdot ft$ Inside diameter of steel pipe, ASTM A53 Table X2.1

$A_{valve} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{valve} = 2.95 \cdot ft^2}$

NOT INCLUDED IN OPEN AREA CALCULATION:

RISER-001/005:	paved up to existing weather covered pump pit
RISER-004/008:	inside instrument enclosure
RISER-007:	paved over
RISER-016&017:	paved over
RISER-020:	paved up to existing CMP
Pump Pit 241-SX-09A:	paved around
24" Butterfly Valve:	paved around
Sludge Cooler Line:	paved over
Liquid Level Reel Post:	paved around
Transmitter Enclosure:	paved over
Monitoring Dry Wells:	paved up to steel pipe and capped

TOTAL OPEN AREA IN TANK 241-SX-109:

$$A_{109} := A_{2\_6} + A_{13\_13A} + A_{access} + A_3 + A_9 + A_{10} + A_{11} + A_{12} + A_{14} + A_{15} + A_{18} + A_{19} \ldots + A_{Hatch} + A_{valve}$$

$\boxed{A_{109} = 251.58 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/10/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

SOUTH SURFACE BARRIER:

Determine open areas for Tank 241-SX-110:

RISER-002/006: Utility Vault 90"x60", H-14-109330 Sheet 10

$L := 78in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$w := 48in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$A_{2\_6} := L \cdot w = 3744 \cdot in^2$ — Open area

$\boxed{A_{2\_6} = 26.00 \cdot ft^2}$

RISER-003/007: Utility Vault 72"x48", H-14-109330 Sheet 10

$L := 61in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 64R-18

$w := 37in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 64R-18

$A_{3\_7} := L \cdot w = 2257 \cdot in^2$ — Open area

$\boxed{A_{3\_7} = 15.67 \cdot ft^2}$

RISER-013/013A: Contech Liner, 9'-8" Diameter, H-14-109330 Sheet 10

$D := 116in$ — Diameter of liner

$D_i := 113.25in$ — Inside diameter of liner, Contech, Table 5

$A_{13\_13A} := \frac{\pi \cdot D_i^2}{4} \cdot \frac{1}{2}$ — Open area

$\boxed{A_{13\_13A} = 34.98 \cdot ft^2}$

INSTRUMENT ENCLOSURE ACCESS: Utility Vaults to capture building, H-14-109330 Sheet 10

$A_1 := 3.5ft \cdot 13ft = 45.5 \cdot ft^2$ — Minimum required open area around one portion of the instrument enclosure with 3.5 feet offset by doors

$A_{access} := A_1$ — Open Area

$\boxed{A_{access} = 45.50 \cdot ft^2}$

Originated By: Erica Lucas EWL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

RISER-014: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 10

$D_i := 3ft$ Inside diameter of CMP

$A_{14} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{14} = 7.07 \cdot ft^2}$

RISER-015: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 10

$D_i := 3ft$ Inside diameter of CMP

$A_{15} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{15} = 7.07 \cdot ft^2}$

RISER-018: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 10

$D_i := 3ft$ Inside diameter of CMP

$A_{18} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{18} = 7.07 \cdot ft^2}$

RISER-019: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 10

$D_i := 3ft$ Inside diameter of CMP

$A_{19} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{19} = 7.07 \cdot ft^2}$

RISER-020: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 10

$D_i := 3ft$ Inside diameter of CMP

$A_{20} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{20} = 7.07 \cdot ft^2}$

Originated By: Erica Lucas ECL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

HATCHWAY: 10' Diameter Corrugated Metal Pipe to capture Hatchway, H-14-109330 Sheet 10

$D_i := 10ft$ Inside diameter of CMP

$A_{Hatch} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{Hatch} = 78.54 \cdot ft^2}$

NOT INCLUDED IN OPEN AREA CALCULATION:

RISER-001/005:	paved up to existing weather covered pump pit
RISER-004/008:	inside instrument enclosure
RISER-009-010:	paved around
RISER-011:	paved over
RISER-012:	paved around
RISER-016:	paved around
RISER-021:	paved over
Pump Pit 241-SX-10A:	paved around
24" Butterfly Valve:	paved around
Transmitter Enclosure:	paved over
Junction Boxes:	paved around
Monitoring Dry Wells:	paved up to steel pipe and capped
Leak Detection Bldg:	paved around

TOTAL OPEN AREA IN TANK 241-SX-110:

$A_{110} := A_{2\_6} + A_{3\_7} + A_{13\_13A} + A_{access} + A_{14} + A_{15} + A_{18} + A_{19} + A_{20} + A_{Hatch}$

$\boxed{A_{110} = 236.03 \cdot ft^2}$

<u>Determine open areas for Tank 241-SX-111:</u>

RISER-002/006: Utility Vault 90"x60", H-14-109330 Sheet 11

$L := 78in$ Open length inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$w := 48in$ Open width inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$A_{2\_6} := L \cdot w = 3744 \cdot in^2$ Open area

$\boxed{A_{2\_6} = 26.00 \cdot ft^2}$

Originated By: Erica Lucas EJL 5/10/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

RISER-003/007: Utility Vault 84"x56", H-14-109330 Sheet 11

$L := 70in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 57R-12

$w := 42in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 57R-12

$A_{3\_7} := L \cdot w = 2940 \cdot in^2$ — Open area

$\boxed{A_{3\_7} = 20.42 \cdot ft^2}$

RISER-013: Contech Liner, 9'-8" Diameter, H-14-109330 Sheet 11

$D := 116in$ — Diameter of liner

$D_i := 113.25in$ — Inside diameter of liner, Contech, Table 5

$A_{13} := \frac{\pi \cdot D_i^2}{4} \cdot \frac{1}{2}$ — Open area

$\boxed{A_{13} = 34.98 \cdot ft^2}$

ELECTRICAL BOX: Curbing to capture electrical boxes SE of Hatchway, H-14-109330 Sheet 11

$L := 84in$ — Minimum clearance needed for the length inside this curbing

$w := 60in$ — Minimum clearance needed for the width inside this curbing

$A_{E\_SE} := L \cdot w = 5040 \cdot in^2$ — Open area

$\boxed{A_{E\_SE} = 35.00 \cdot ft^2}$

ELECTRICAL BOX: Curbing to capture electrical panels West of Hatchway, H-14-109330 Sheet 11

$L := 48in$ — Minimum clearance needed for the length inside this curbing

$w := 36in$ — Minimum clearance needed for the width inside this curbing

$A_{E\_W} := L \cdot w = 1728 \cdot in^2$ — Open area

$\boxed{A_{E\_W} = 12.00 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/6/11
Checked By: Ryan Lang RL 5/6/11

SX Farm Interim Surface Barrier
Open Area Analysis

INSTRUMENT ENCLOSURE ACCESS: Utility Vaults to capture building, H-14-109330 Sheet 11

$A_1 := 3.5ft \cdot 13ft = 45.5 \cdot ft^2$ — Minimum required open area around one portion of the instrument enclosure with 3.5 feet offset by doors

$A_{access} := A_1$ — Open Area

$\boxed{A_{access} = 45.50 \cdot ft^2}$

INSTRUMENT ENCLOSURE ACCESS 2: Utility Vaults to capture building 2, H-14-109330 Sheet 11

$A_1 := 3.5ft \cdot 3.5ft = 12.25 \cdot ft^2$ — Minimum required open area around one portion of the instrument enclosure with 3.5 feet offset by doors

$A_{access2} := A_1$ — Open area

$\boxed{A_{access2} = 12.25 \cdot ft^2}$

RISER-009: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 11

$D_i := 3ft$ — Inside diameter of CMP

$A_9 := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_9 = 7.07 \cdot ft^2}$

RISER-010: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 11

$D_i := 3ft$ — Inside diameter of CMP

$A_{10} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{10} = 7.07 \cdot ft^2}$

RISER-011: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 11

$D_i := 3ft$ — Inside diameter of CMP

$A_{11} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{11} = 7.07 \cdot ft^2}$

RISER-012: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 11

$D_i := 3ft$ Inside diameter of CMP

$A_{12} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{12} = 7.07 \cdot ft^2}$

RISER-014: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 11

$D_i := 3ft$ Inside diameter of CMP

$A_{14} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{14} = 7.07 \cdot ft^2}$

RISER-015: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 11

$D_i := 3ft$ Inside diameter of CMP

$A_{15} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{15} = 7.07 \cdot ft^2}$

RISER-016: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 11

$D_i := 3ft$ Inside diameter of CMP

$A_{16} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{16} = 7.07 \cdot ft^2}$

RISER-018: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 11

$D_i := 3ft$ Inside diameter of CMP

$A_{18} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{18} = 7.07 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/10/11
Checked By: Ryan Lang RL 5/10/11

SX Farm Interim Surface Barrier
Open Area Analysis

RISER-019: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 11

$D_i := 3ft$ Inside diameter of CMP

$A_{19} := \frac{\pi \cdot D_i^2}{4}$ Open area

$A_{19} = 7.07 \cdot ft^2$

HATCHWAY: 10' Diameter Corrugated Metal Pipe to capture Hatchway, H-14-109330 Sheet 11

$D_i := 10ft$ Inside diameter of CMP

$A_{Hatch} := \frac{\pi \cdot D_i^2}{4}$ Open area

$A_{Hatch} = 78.54 \cdot ft^2$

VALVE: 2' Diameter Std. Steel Pipe to capture Valve South of Riser-007, H-14-109330 Sheet 11

$D := 2ft$ Outside diameter of steel pipe

$D_i := 2ft - 2 \cdot 0.375in = 1.938 \cdot ft$ Inside diameter of steel pipe, ASTM A53 Table X2.1

$A_{valve} := \frac{\pi \cdot D_i^2}{4}$ Open area

$A_{valve} = 2.95 \cdot ft^2$

NOT INCLUDED IN OPEN AREA CALCULATION:

RISER-001/005:	paved up to existing weather covered pump pit
RISER-004/008:	inside instrument enclosure
RISER-017:	paved up to CMP and capped
RISER-020:	paved around
Pump Pit 241-SX-11A:	paved around
24" Butterfly Valve:	paved around
Pipe S of R2:	paved around
Transmitter Enclosure:	paved over
Junction Box:	paved around
Bollards:	paved around
Monitoring Dry Wells:	paved up to steel pipe and capped

TOTAL OPEN AREA IN TANK 241-SX-111:

$$A_{111} := A_{2\_6} + A_{3\_7} + A_{13} + A_{E\_SE} + A_{E\_W} + A_{access} + A_{access2} + A_9 + A_{10} + A_{11} + A_{12} \cdots + A_{14} + A_{15} + A_{16} + A_{18} + A_{19} + A_{Hatch} + A_{valve}$$

$A_{111} = 331.25 \cdot ft^2$

Originated By: Erica Lucas 5/9/11
Checked By: Ryan Lang 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

Determine open areas for Tank 241-SX-112:

RISER-002/006: Utility Vault 90"x60", H-14-109330 Sheet 12

$L := 78in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$w := 48in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$A_{2\_6} := L \cdot w = 3744 \cdot in^2$ — Open area

$\boxed{A_{2\_6} = 26.00 \cdot ft^2}$

RISER-013/013A: Contech Liner, 9'-8" Diameter, H-14-109330 Sheet 12

$D := 116in$ — Diameter of liner

$D_i := 113.25in$ — Inside diameter of liner, Contech, Table 5

$A_{13\_13A} := \frac{\pi \cdot D_i^2}{4} \cdot \frac{1}{2} = 5036.6 \cdot in^2$ — Open area

$\boxed{A_{13\_13A} = 34.98 \cdot ft^2}$

CONDENSATE VALVE PIT: Curbing to capture condensate valve pit, H-14-109330 Sheet 12

$L := 204in$ — Minimum clearance needed for the length inside this curbing

$w := 120in$ — Minimum clearance needed for the width inside this curbing

$A_{cond} := L \cdot w = 24480 \cdot in^2$ — Open area

$\boxed{A_{cond} = 170.00 \cdot ft^2}$

ELECTRICAL BOX: Curbing to capture electrical box South of R15, H-14-109330 Sheet 12

$L := 48in$ — Minimum clearance needed for the length inside this curbing

$w := 24in$ — Minimum clearance needed for the width inside this curbing

$A_{E\_S} := L \cdot w = 1152 \cdot in^2$ — Open area

$\boxed{A_{E\_S} = 8.00 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

INSTRUMENT ENCLOSURE ACCESS: Utility Vaults to capture building, H-14-109330 Sheet 12

$A_1 := 3.5ft \cdot 13ft = 45.5 \cdot ft^2$ — Minimum required open area around one portion of the instrument enclosure with 3.5 feet offset by doors

$A_{access} := A_1$ — Open Area

$\boxed{A_{access} = 45.50 \cdot ft^2}$

RISER-009: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 12

$D_i := 3ft$ — Inside diameter of CMP

$A_9 := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_9 = 7.07 \cdot ft^2}$

RISER-010: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 12

$D_i := 3ft$ — Inside diameter of CMP

$A_{10} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{10} = 7.07 \cdot ft^2}$

RISER-011: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 12

$D_i := 3ft$ — Inside diameter of CMP

$A_{11} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{11} = 7.07 \cdot ft^2}$

RISER-012: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 12

$D_i := 3ft$ — Inside diameter of CMP

$A_{12} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{12} = 7.07 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

RISER-014: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 12

$D_i := 3ft$ Inside diameter of CMP

$A_{14} := \frac{\pi \cdot D_i^2}{4}$ Open area

$A_{14} = 7.07 \cdot ft^2$

RISER-015: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 12

$D_i := 3ft$ Inside diameter of CMP

$A_{15} := \frac{\pi \cdot D_i^2}{4}$ Open area

$A_{15} = 7.07 \cdot ft^2$

RISER-018: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 12

$D_i := 3ft$ Inside diameter of CMP

$A_{18} := \frac{\pi \cdot D_i^2}{4}$ Open area

$A_{18} = 7.07 \cdot ft^2$

RISER-019: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 12

$D_i := 3ft$ Inside diameter of CMP

$A_{19} := \frac{\pi \cdot D_i^2}{4}$ Open area

$A_{19} = 7.07 \cdot ft^2$

HATCHWAY: 11' Diameter Corrugated Metal Pipe to capture Hatchway, H-14-109330 Sheet 12

$D_i := 11ft$ Inside diameter of CMP

$A_{Hatch} := \frac{\pi \cdot D_i^2}{4}$ Open area

$A_{Hatch} = 95.03 \cdot ft^2$

Originated By: Erica Lucas EDL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

VALVE: 2' Diameter Std. Steel Pipe to capture Valve North of Riser-006, H-14-109330 Sheet 12

$D := 2ft$ — Outside diameter of steel pipe

$D_i := 2ft - 2 \cdot 0.375in = 1.938 \cdot ft$ — Inside diameter of steel pipe, ASTM A53 Tabl X2.1

$A_{valve} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{valve} = 2.95 \cdot ft^2}$

NOT INCLUDED IN AREA CALCULATION:

RISER-001/005:	paved up to existing weather covered pump pit
RISER-003:	paved around
RISER-004/008:	inside instrument enclosure
RISER-007:	paved over
RISER-016&017:	paved over
RISER-020&021:	paved around
Pump Pit 241-SX-12A:	paved around
24" Butterfly Valve:	paved around
Rebar Plug:	paved over
Transmitter Enclosure:	paved over
Monitoring Dry Wells:	paved up to steel pipe and capped
Junction Box:	paved around
Bollards:	paved around

TOTAL OPEN AREA IN TANK 241-SX-112:

$$A_{112} := A_{2\_6} + A_{13\_13A} + A_{cond} + A_{E\_S} + A_{access} + A_9 + A_{10} + A_{11} + A_{12} + A_{14} + A_{15} \cdots + A_{18} + A_{19} + A_{Hatch} + A_{valve}$$

$\boxed{A_{112} = 439.01 \cdot ft^2}$

<u>Determine open areas for Tank 241-SX-113:</u>

RISER-002/006: Utility Vault 72"x48", H-14-109330 Sheet 13

$L := 61in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 64R-12

$w := 37in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 64R-12

$A_{2\_6} := L \cdot w = 2257 \cdot in^2$ — Open area

$\boxed{A_{2\_6} = 15.67 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

RISER-003/007: Utility Vault 84"x56", H-14-109330 Sheet 13

$L := 70in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 57R-12

$w := 42in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 57R-12

$A_{3\_7} := L \cdot w = 2940 \cdot in^2$ — Open area

$\boxed{A_{3\_7} = 20.42 \cdot ft^2}$

RISER-004/008: 9' Diameter Corrugated Metal Pipe to capture Risers, H-14-109330 Sheet 13

$D_i := 9ft$ — Inside diameter of CMP

$A_{4\_8} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{4\_8} = 63.62 \cdot ft^2}$

INSTRUMENT ENCLOSURE PAD: Utility Vault 104"x80", H-14-109330 Sheet 13

$L := 96in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 687-2

$w := 72in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 687-2

$A_{slab} := L \cdot w = 6912 \cdot in^2$ — Open area

$\boxed{A_{slab} = 48.00 \cdot ft^2}$

HATCHWAY: 10' Diameter Corrugated Metal Pipe to capture Hatchway, H-14-109330 Sheet 13

$D_i := 10ft$ — Inside diameter of CMP

$A_{Hatch} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{Hatch} = 78.54 \cdot ft^2}$

NOT INCLUDED IN AREA CALCULATION:

RISER-001/005:	paved up to existing weather covered pump pit
RISER-010:	paved up to CMP and capped
RISER-011:	paved over
RISER-013:	paved over
Pump Pit 241-SX-13A:	paved around
Liquid level reel post:	paved around
Transmitter Enclosure:	paved over
Junction Boxes:	paved around
Bollards:	paved around
Monitoring Dry Wells:	paved up to steel pipe and capped

TOTAL OPEN AREA IN TANK 241-SX-113:

$A_{113} := A_{2\_6} + A_{3\_7} + A_{4\_8} + A_{slab} + A_{Hatch}$

$\boxed{A_{113} = 226.25 \cdot ft^2}$

Determine open areas for Tank 241-SX-114:

RISER-002/006: Utility Vault 72"x48", H-14-109330 Sheet 14

$L := 61in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 64R-12

$w := 37in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 64R-12

$A_{2\_6} := L \cdot w = 2257 \cdot in^2$ — Open area

$\boxed{A_{2\_6} = 15.67 \cdot ft^2}$

RISER-003/007: Utility Vault 72"x48", H-14-109330 Sheet 14

$L := 61in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 64R-18

$w := 37in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 64R-18

$A_{3\_7} := L \cdot w = 2257 \cdot in^2$ — Open area

$\boxed{A_{3\_7} = 15.67 \cdot ft^2}$

RISER-013/013A: Contech Liner, 9'-8" Diameter, H-14-109330 Sheet 14

$D := 116in$ — Diameter of liner

$D_i := 113.25in$ — Inside diameter of liner, Contech, Table 5

$A_{13\_13A} := \frac{\pi \cdot D_i^2}{4} \cdot \frac{1}{2}$ — Open area

$\boxed{A_{13\_13A} = 34.98 \cdot ft^2}$

INSTRUMENT ENCLOSURE: Utility Vaults to capture existing building, H-14-109330 Sheet 14

$A_1 := 3.5ft \cdot 13ft = 45.5 \cdot ft^2$ — Minimum required open area around one portion of the instrument enclosure with 3.5 feet offset by doors

$A_{access} := A_1$ — Open Area

$\boxed{A_{access} = 45.50 \cdot ft^2}$

Originated By: Erica Lucas EDL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

RISER-009: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 14

$D_i := 3ft$ Inside diameter of CMP

$A_9 := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_9 = 7.07 \cdot ft^2}$

RISER-010: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 14

$D_i := 3ft$ Inside diameter of CMP

$A_{10} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{10} = 7.07 \cdot ft^2}$

RISER-011: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 14

$D_i := 3ft$ Inside diameter of CMP

$A_{11} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{11} = 7.07 \cdot ft^2}$

RISER-012: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 14

$D_i := 3ft$ Inside diameter of CMP

$A_{12} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{12} = 7.07 \cdot ft^2}$

RISER-014: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 14

$D_i := 3ft$ Inside diameter of CMP

$A_{14} := \frac{\pi \cdot D_i^2}{4}$ Open area

$\boxed{A_{14} = 7.07 \cdot ft^2}$

Originated By: Erica Lucas EJL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

RISER-015: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 14

$D_i := 3ft$ Inside diameter of CMP

$A_{15} := \frac{\pi \cdot D_i^2}{4}$ Open area

$A_{15} = 7.07 \cdot ft^2$

RISER-018: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 14

$D_i := 3ft$ Inside diameter of CMP

$A_{18} := \frac{\pi \cdot D_i^2}{4}$ Open area

$A_{18} = 7.07 \cdot ft^2$

RISER-019: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 14

$D_i := 3ft$ Inside diameter of CMP

$A_{19} := \frac{\pi \cdot D_i^2}{4}$ Open area

$A_{19} = 7.07 \cdot ft^2$

HATCHWAY: 10' Diameter Corrugated Metal Pipe to capture Hatchway, H-14-109330 Sheet 14

$D_i := 10ft$ Inside diameter of CMP

$A_{Hatch} := \frac{\pi \cdot D_i^2}{4}$ Open area

$A_{Hatch} = 78.54 \cdot ft^2$

VALVE: 2' Diameter Std. Steel Pipe to capture Valve South of Riser-007, H-14-109330 Sheet 14

$D := 2ft$ Outside diameter of steel pipe

$D_i := 2ft - 2 \cdot 0.375in = 1.938 \cdot ft$ Inside diameter of steel pipe, ASTM A53 Table X2.1

$A_{valve} := \frac{\pi \cdot D_i^2}{4}$ Open area

$A_{valve} = 2.95 \cdot ft^2$

Originated By: Erica Lucas ELL 5/9/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

NOT INCLUDED IN OPEN AREA CALCULATION:

RISER-001/005:	paved up to existing weather covered pump pit
RISER-004/008:	inside instrument enclosure
RISER-016&017:	paved up to CMP and capped
RISER-020:	paved over
RISER-021:	paved around
Pump Pit 241-SX-14A:	paved around
24" Butterfly Valve:	paved around
Liquid level reel post:	paved around
Transmitter Enclosure:	paved over
Junction Boxes:	paved around
Monitoring Dry Wells:	paved up to steel pipe and capped
Bollards:	paved around

TOTAL OPEN AREA IN TANK 241-SX-114:

$$A_{114} := A_{2\_6} + A_{3\_7} + A_{13\_13A} + A_{access} + A_9 + A_{10} + A_{11} + A_{12} + A_{14} + A_{15} + A_{18} + A_{19} \cdots + A_{Hatch} + A_{valve}$$

$$\boxed{A_{114} = 249.86 \cdot ft^2}$$

Determine open areas for Tank 241-SX-115:

RISER-002/006: Utility Vault 72"x48", H-14-109330 Sheet 15

$L := 61in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 64R-12

$w := 37in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 64R-12

$A_{2\_6} := L \cdot w = 2257 \cdot in^2$ — Open area

$$\boxed{A_{2\_6} = 15.67 \cdot ft^2}$$

RISER-003: 3' Diameter Corrugated Metal Pipe to capture Riser, H-14-109330 Sheet 15

$D_i := 3ft$ — Inside diameter of CMP

$A_{R3} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$$\boxed{A_3 = 7.07 \cdot ft^2}$$

Originated By: Erica Lucas EDL 5/10/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

INSTRUMENT ENCLOSURE: Utility Vaults to capture existing building, H-14-109330 Sheet 15

$A_1 := 3.5ft \cdot 13ft = 45.5 \cdot ft^2$ — Minimum required open area around one portion of the instrument enclosure with 3.5 feet offset by doors

$A_{access} := A_1$ — Open Area

$\boxed{A_{access} = 45.50 \cdot ft^2}$

HATCHWAY: 10' Diameter Corrugated Metal Pipe to capture Hatchway, H-14-109330 Sheet 15

$D_i := 10ft$ — Inside diameter of CMP

$A_{Hatch} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{Hatch} = 78.54 \cdot ft^2}$

CAISSON: 10' Diameter Corrugated Metal Pipe to capture Caission in SW Corner, H-14-109330 Sheet 15

$D_i := 10ft$ — Inside diameter of CMP

$A_{Caisson} := \frac{\pi \cdot D_i^2}{4}$ — Open area

$\boxed{A_{Caisson} = 78.54 \cdot ft^2}$

Vault: Utility Vault 90"x60" to capture Well Vault in SW Corner, H-14-109330 Sheet 15

$L := 78in$ — Open length inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$w := 48in$ — Open width inside vault, Oldcastle Precast Utility Vault, No. 576R-12

$A_{vault} := L \cdot w = 3744 \cdot in^2$ — Open area

$\boxed{A_{vault} = 26.00 \cdot ft^2}$

Originated By: Erica Lucas ELL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

NOT INCLUDED IN OPEN AREA CALCULATION:

RISER-001/005:	paved up to existing weather covered pump pit
RISER-004/008:	inside instrument enclosure
RISER-007:	paved over
RISER-009:	paved over
RISER-013:	paved over
Pump Pit 241-SX-15A:	paved around
24" Butterfly Valve:	paved around
Liquid level reel post:	paved around
Transmitter Enclosure:	paved over
Junction Boxes:	paved around
Monitoring Dry Wells:	paved up to steel pipe and capped
Bollards:	paved around

TOTAL OPEN AREA IN TANK 241-SX-115:

$$A_{115} := A_{2\_6} + A_3 + A_{access} + A_{Hatch} + A_{Caisson} + A_{vault}$$

$$\boxed{A_{115} = 251.32 \cdot ft^2}$$

Summary of Open Areas:

North Barrier:

$$\boxed{A_{104} = 43.35 \cdot ft^2}$$

$$\boxed{A_{105} = 88.73 \cdot ft^2}$$

$$\boxed{A_{106} = 71.48 \cdot ft^2}$$

$$\boxed{A_{107} = 297.80 \cdot ft^2}$$

$$\boxed{A_{108} = 290.08 \cdot ft^2}$$

$$\boxed{A_{109} = 251.58 \cdot ft^2}$$

South Barrier:

$$\boxed{A_{110} = 236.03 \cdot ft^2}$$

$$\boxed{A_{111} = 331.25 \cdot ft^2}$$

$$\boxed{A_{112} = 439.01 \cdot ft^2}$$

$$\boxed{A_{113} = 226.25 \cdot ft^2}$$

$$\boxed{A_{114} = 249.86 \cdot ft^2}$$

$$\boxed{A_{115} = 251.32 \cdot ft^2}$$

Originated By: Erica Lucas EDL 5/6/11
Checked By: Ryan Lang RL 5/9/11

SX Farm Interim Surface Barrier
Open Area Analysis

DETERMINE PERCENT OF OPEN AREAS FOR NORTH BARRIER:

Total Open Area in North:

$A_{ON} := A_{104} + A_{105} + A_{106} + A_{107} + A_{108} + A_{109}$

$\boxed{A_{ON} = 1043.03 \cdot ft^2}$

Total 241-SX Tank Farm Interim Surface Barrier - North (taken from AutoCAD 3D Model):

$\boxed{A_{TN} := 5978m^2 = 64346.66 \cdot ft^2}$

Percent Open Area of North 241-SX Tank Farm Interim Surface Barrier:

$$\% := \frac{A_{ON} \cdot 100}{A_{TN}}$$

$\boxed{\% = 1.62}$

DETERMINE PERCENT OF OPEN AREAS FOR SOUTH BARRIER:

Total Open Area in South:

$A_{OS} := A_{110} + A_{111} + A_{112} + A_{113} + A_{114} + A_{115}$

$\boxed{A_{OS} = 1733.72 \cdot ft^2}$

Total Area of South 241-SX Tank Farm Surface Barrier (taken from AutoCAD 3D Model):

$\boxed{A_{TS} := 7198m^2 = 77478.63 \cdot ft^2}$

Percent Open Area of South 241-SX Tank Farm Interim Surface Barrier:

$$\% := \frac{A_{OS} \cdot 100}{A_{TS}}$$

$\boxed{\% = 2.24}$

ATTACHMENT E2 – TOPOGRAPHIC SURVEY

TOPOGRAPHIC SURVEY

FOR

FLUOR FEDERAL SERVICES

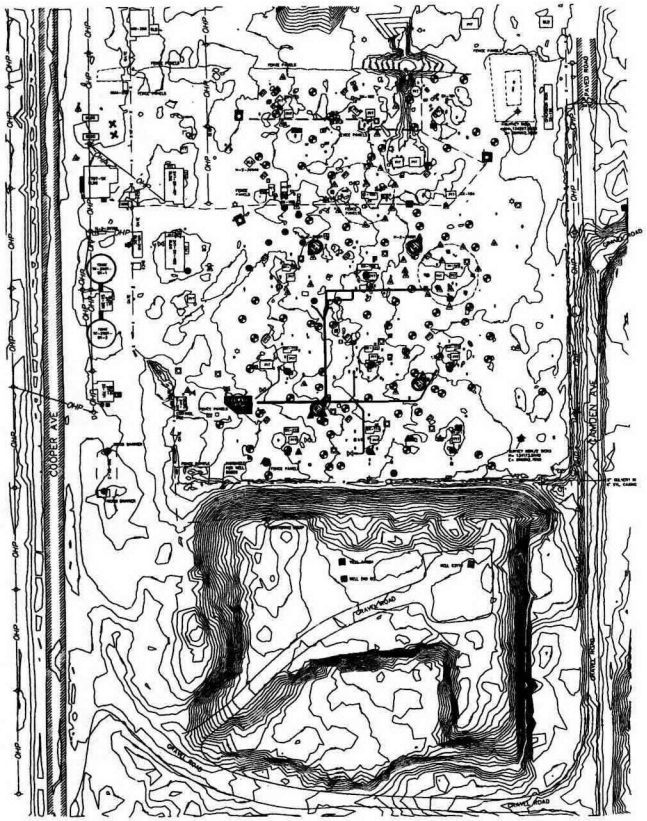
PROJECT: SX TANK FARM

CONTRACT NO. W1RP-9-K11939

LYING IN A PORTION OF

SECTION 12, TOWNSHIP 12 NORTH, RANGE 25 EAST, WILLAMETTE MERIDIAN

BENTON COUNTY, STATE OF WASHINGTON



P:\Projects\2009\09-060 Fluor\Images\Fluor Image.jpg

LEGEND

- SURVEY CONTROL MONUMENT, COORDINATES NOTED ON MAP.
- RISER - VARIABLE HEIGHT
- BOLLARD
- WELL
- SIGNAGE
- JUNCTION BOX
- VALVE
- CAISSON - AS NOTED
- LIGHT POLE / POWER POLE
- POWER POLE W/ GUY ANCHOR
- ROUNDED PIT
- ANODE RISER
- ELECTRICAL PEDESTAL
- TEST WELL
- ELECTRICAL HAND HOLE (CLUSTER)
- CHAIN LINK FENCE - 8 FT HIGH
- HANGING CHAIN FENCE
- OHP — OVERHEAD POWER LINE
- PIPING ABOVE GROUND
- EDGE OF GRAVEL
- EDGE OF PAVEMENT
- CONCRETE
- FENCE PANEL
- SOLAR/MONITORING EQUIPMENT

DATUM NOTE:

HORIZONTAL DATUM: WASHINGTON COORDINATE SYSTEM OF 1983, SOUTH ZONE/1991 ADJUSTMENT (WCS835/91) - METERS

VERTICAL DATUM: NORTH AMERICA VERTICAL DATUM OF 1988 (NAVD88) - METERS

EQUIPMENT NOTE:

TOPOGRAPHIC SURVEY DATA PRESENTED ON THIS MAP WAS COLLECTED USING A LEICA 3-D IMAGING SCANSTATION.

COORDINATE NOTE:

COORDINATE VALUES FOR SURVEY CONTROL MONUMENTS PROVIDED BY FLUOR FEDERAL SERVICES VIA GPS OBSERVATION.

CONTOUR NOTE:

MAJOR CONTOUR INTERVAL = 0.6096m or 2.0ft

MINOR CONTOUR INTERVAL = 0.1524m or 0.5ft

PURPOSE OF SURVEY

TOPOGRAPHIC SURVEY ON A PORTION OF THE SX TANK FARM

SPECIAL NOTE:

THIS SURVEY DOES NOT ATTEMPT TO SHOW ALL EASEMENTS OF RECORD OR IN VIEW, NOR PHYSICAL FEATURES AND IMPROVEMENTS OF THE PROPERTY.

SURVEYOR'S CERTIFICATE

I, LAWRENCE A. GLAHE, P.L.S. 23286, STATE OF WASHINGTON, DO HEREBY CERTIFY THAT THIS TOPOGRAPHIC MAP HAS BEEN PREPARED BY ME OR UNDER MY DIRECTION, AND THAT THE MAP SHOWN HEREON IS A TRUE REPRESENTATION OF A SURVEY MADE BY ME IN AUGUST, 2009.

LAWRENCE A. GLAHE — STATE OF WASHINGTON — 23286 — PROFESSIONAL LAND SURVEYOR — EXPIRES

GRAPHIC SCALE

(IN METERS)

15 0 7.5 15 30 45 60 75

1 : 750

SECTION	TOWNSHIP	RANGE
12	12 N	25 E

ALASKA ARIZONA IDAHO MONTANA NEVADA OREGON WASHINGTON

Project No.	File Name	Plot Date
08-093 FFS	08-093 FFS	10/9/08

TOPOGRAPHIC SURVEY FOR FLUOR FEDERAL SERVICES

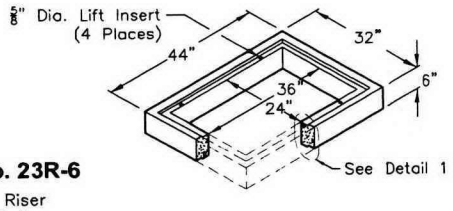
GLAHE & ASSOCIATES
PROFESSIONAL LAND SURVEYORS
303 Church Street
Sandpoint, Idaho 83864

Scale	1 : 750
Checked By ESS	Drawn By KV/TP
Date AUGUST 2008	Sheet 1 of 1

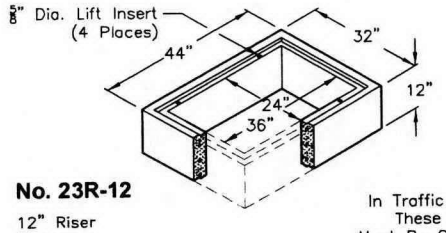
ATTACHMENT E3 – CATALOG INFORMATION

23 / 44 / 55 EXTENSIONS

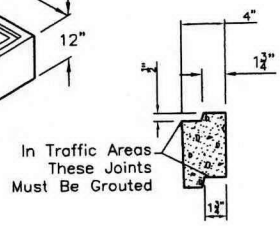
RISER EXTENSIONS FOR USE WITH VAULT:
No. 233



No. 23R-6
6" Riser
290 lbs.

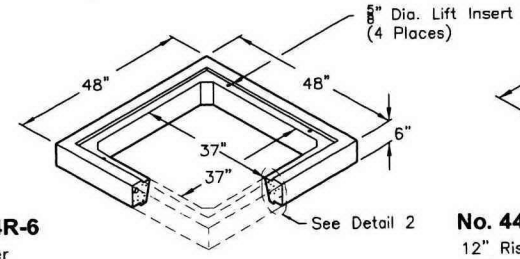


No. 23R-12
12" Riser
560 lbs.

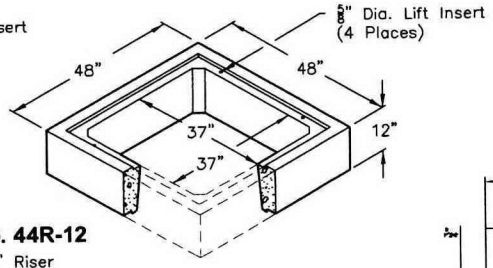


Detail 1

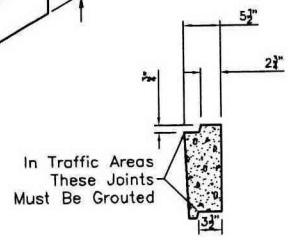
RISER EXTENSIONS FOR USE WITH VAULTS:
No. 444
No. 446



No. 44R-6
6" Riser
440 lbs.

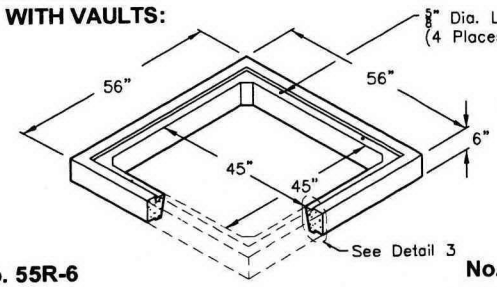


No. 44R-12
12" Riser
800 lbs.

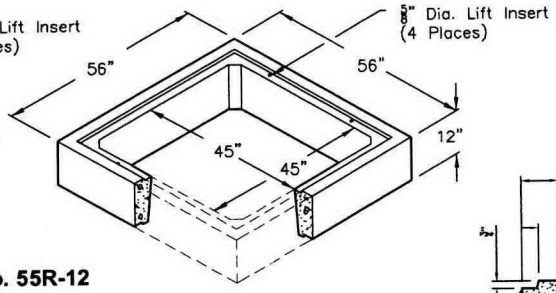


Detail 2

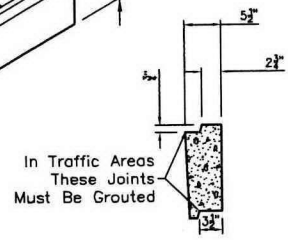
RISER EXTENSIONS FOR USE WITH VAULTS:
No. 504
No. 506



No. 55R-6
6" Riser
540 lbs.



No. 55R-12
12" Riser
960 lbs.



Detail 3

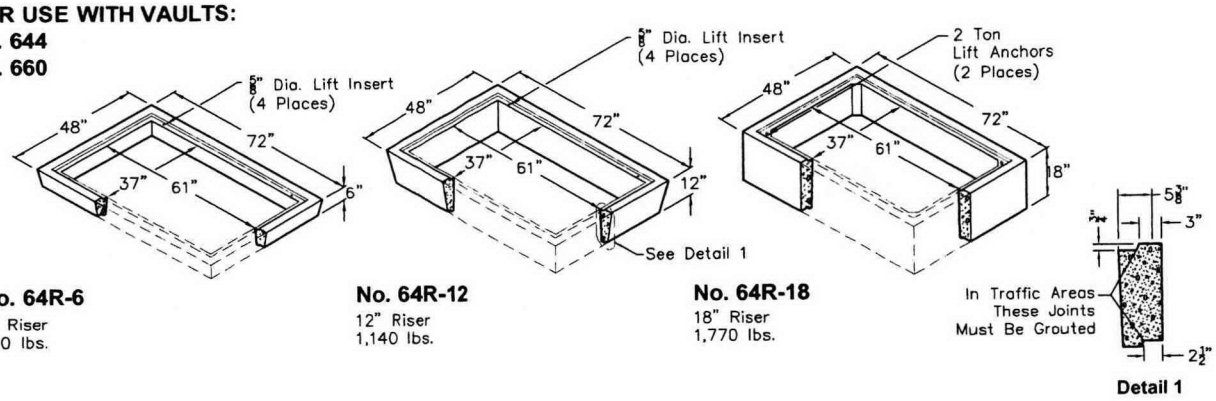
Scale: 1/4" = 1'-0"

Oldcastle Precast® Utility Vault PO Box 323, Wilsonville, Oregon 97070-0323 Tel: (503) 682-2844 Fax: (503) 682-2657	**23/44/55 EXTENSIONS** File Name: 020UCPSQRSRS1 Issue Date: 2008 www.uvwilsonville.com	**23 / 44 / 55 RISER EXTENSIONS**

137.0

64 / 57 / 576 EXTENSIONS

RISER EXTENSIONS
FOR USE WITH VAULTS:
No. 644
No. 660



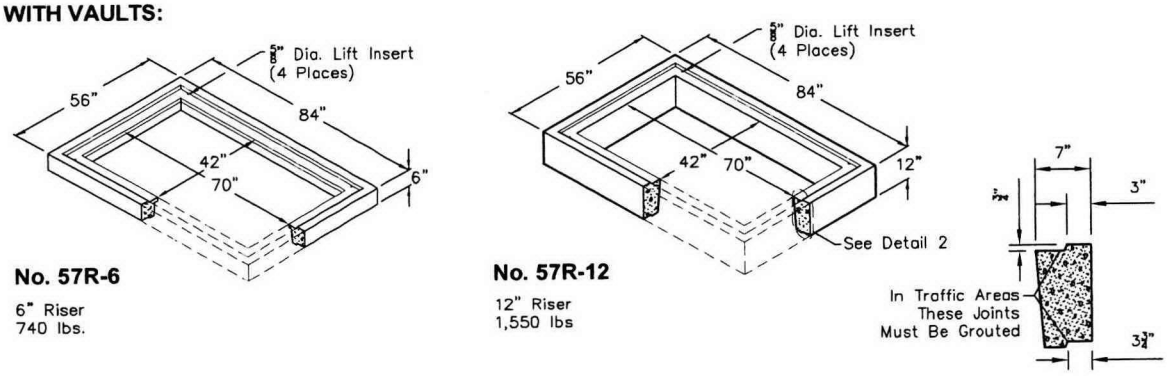
No. 64R-6
6" Riser
560 lbs.

No. 64R-12
12" Riser
1,140 lbs.

No. 64R-18
18" Riser
1,770 lbs.

Detail 1

RISER EXTENSIONS
FOR USE WITH VAULTS:
No. 575
No. 577

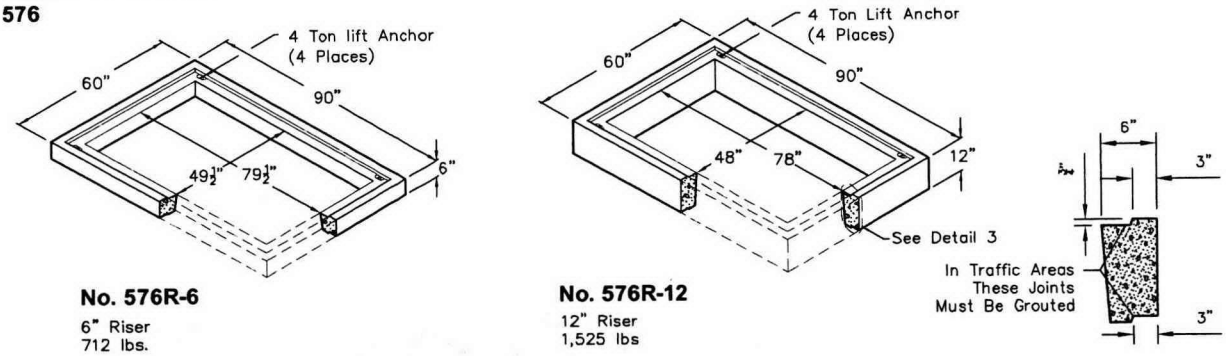


No. 57R-6
6" Riser
740 lbs.

No. 57R-12
12" Riser
1,550 lbs

Detail 2

RISER EXTENSIONS
FOR USE WITH VAULT:
No. 576



No. 576R-6
6" Riser
712 lbs.

No. 576R-12
12" Riser
1,525 lbs

Detail 3

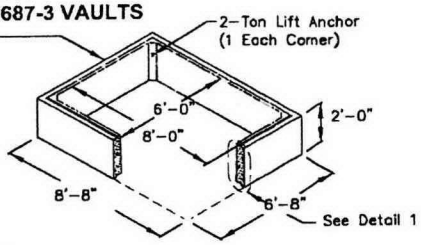
Scale: 3/16" = 1'-0"

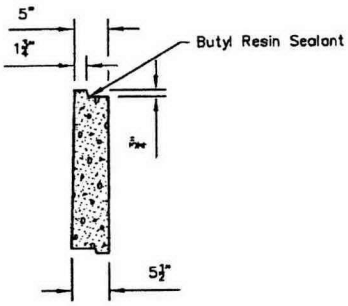
Oldcastle Precast® Utility Vault PO Box 323, Wilsonville, Oregon 97070-0323 Tel: (503) 682-2844 Fax: (503) 682-2657	**64/57/576 EXTENSIONS** File Name: 020UCPSQRSRS2 Issue Date: 2008 www.uvwilsonville.com	**64 / 57 / 576** **RISER EXTENSIONS**

137.1

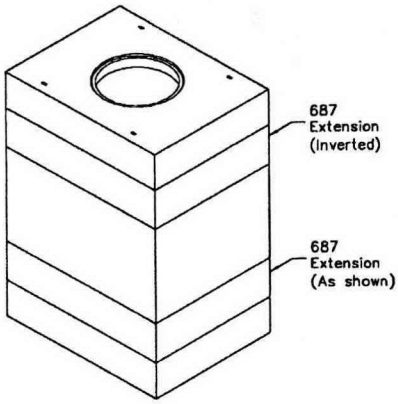
687 / 810 EXTENSIONS

24" EXTENSION
FOR 687-2 & 687-3 VAULTS
No. 687-2X
2,700 lbs.

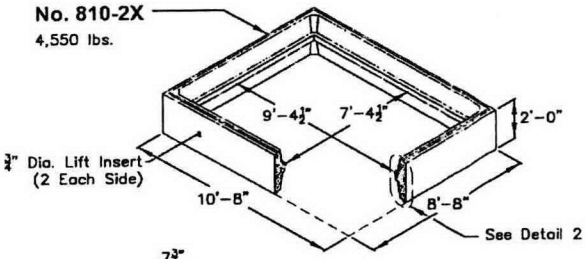


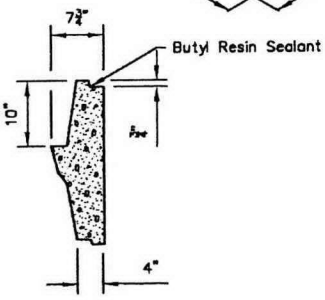


Detail 1

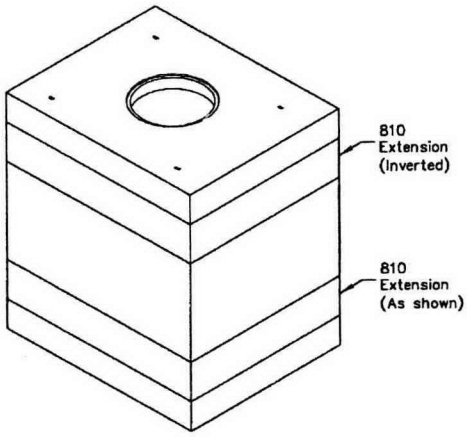


24" EXTENSION
FOR 810 VAULT
No. 810-2X
4,550 lbs.





Detail 2



Note:
– 687–2X & 810–2X may be placed between base and middle section and/or middle and top section.

Scale: 1/4" = 1'–0"

Oldcastle Precast®	**687/810 EXTENSIONS**	**687 2X EXTENSION** **810 2X EXTENSION**
PO Box 323, Wilsonville, Oregon 97070-0323 Tel: (503) 682-2844 Fax: (503) 682-2657	File Name: 020UCP687810X Issue Date: 2011 **oldcastleprecast.com/wilsonville**	

143.1

X2. TABLES FOR DIMENSIONAL AND CERTAIN MECHANICAL REQUIREMENTS

X2.1 Tables X2.1-X2.4 address dimensional and certain mechanical requirements.

TABLE X2.1 Calculated *H* Values for Seamless Pipe

NPS Designator	DN Designator	Outside Diameter, in. [mm]	Nominal Wall Thickness, in. [mm]	Distance, in. [mm], Between Plates "*H*" by Formula: $H = (1 + e)t/(e + t/D)$	
				Grade A	Grade B
2½	65	2.875 [73.0]	0.203 [5.16]	1.378 [35.0]	1.545 [39.2]
			0.276 [7.01]	1.618 [41.1]	1.779 [45.2]
3	80	3.500 [88.9]	0.216 [5.49]	1.552 [39.4]	1.755 [44.6]
			0.300 [7.62]	1.861 [47.3]	2.062 [52.4]
3½	90	4.000 [101.6]	0.226 [5.74]	1.682 [42.7]	1.912 [48.6]
			0.318 [8.08]	2.045 [51.9]	2.276 [57.8]
4	100	4.500 [114.3]	0.237 [6.02]	1.811 [46.0]	2.067 [52.5]
			0.337 [8.56]	2.228 [56.6]	2.489 [63.2]
5	125	5.563 [141.3]	0.258 [6.55]	2.062 [52.4]	2.372 [60.2]
			0.375 [9.52]	2.597 [66.0]	2.920 [74.2]
6	150	6.625 [168.3]	0.280 [7.11]	2.308 [58.6]	2.669 [67.8]
			0.432 [10.97]	3.034 [77.1]	3.419 [86.8]
8	200	8.625 [219.1]	0.277 [7.04]	2.473 [62.8]	2.902 [73.7]
			0.322 [8.18]	2.757 [70.0]	3.210 [81.5]
			0.500 [12.70]	3.683 [93.5]	4.181 [106.2]
10	250	10.750 [273.0]	0.279 [7.09][A]	2.623 [66.6]	3.111 [79.0]
			0.307 [7.80]	2.823 [71.7]	3.333 [84.7]
			0.365 [9.27]	3.210 [81.5]	3.757 [95.4]
			0.500 [12.70]	3.993 [101.4]	4.592 [116.6]
12	300	12.750 [323.8]	0.300 [7.62]	3.105 [78.9]	3.683 [93.5]
			0.375 [9.52]	3.423 [86.9]	4.037 [102.5]
			0.500 [12.70]	4.218 [107.1]	4.899 [124.4]
14	350	14.000 [355.6]	0.375 [9.52]	3.500 [88.9]	4.146 [105.3]
			0.500 [12.70]	4.336 [110.1]	5.061 [128.5]
16	400	16.000 [406.4]	0.375 [9.52]	3.603 [91.5]	4.294 [109.1]
			0.500 [12.70]	4.494 [114.1]	5.284 [134.2]
18	450	18.000 [457]	0.375 [9.52]	3.688 [93.7]	4.417 [112.2]
			0.500 [12.70]	4.628 [117.6]	5.472 [139.0]
20	500	20.000 [508]	0.375 [9.52]	3.758 [95.5]	4.521 [114.8]
			0.500 [12.70]	4.740 [120.4]	5.632 [143.1]
24	600	24.000 [610]	0.375 [9.52]	3.869 [98.3]	4.686 [119.0]
			0.500 [12.70]	4.918 [124.9]	5.890 [149.6]

[A] Special order only.

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Table 2.14 Handling Weight of Corrugated Steel Pipe (2 ⅔ x ½ in.)
Estimated Average Weights — Not for Specification Use*

Inside Diameter in Inches	Specified Thickness in Inches	Approximate Pounds per Linear Foot**					
		Metallic Coated	Full Bituminous Coated	Full Bituminous Coated and Invert Paved	Full Bituminous Coated and Full Paved	Steel Lined	Concrete Lined
12	0.052	8	10	13			
	0.064	10	12	15			
	0.079	12	14	17			
15	0.052	10	12	15	26		
	0.064	12	15	18	28		
	0.079	15	18	21	31		
18	0.052	12	14	17	31		
	0.064	15	19	22	34	17	
	0.079	18	22	25	37	20	
21	0.052	14	16	19	36		
	0.064	17	21	26	39	21	
	0.079	21	25	30	43	24	
24	0.052	15	17	20	41		
	0.064	19	24	30	45	23	65
	0.079	24	29	35	50	26	69
30	0.052	20	22	25	51		
	0.064	24	30	36	55	29	82
	0.079	30	36	42	60	34	87
36	0.052	24	26	29	50		
	0.064	29	36	44	65	35	98
	0.079	36	43	51	75	41	104
	0.109	49	56	64	90		116
	0.138	62	69	77	100		127
42	0.052	28	30	33	71		
	0.064	34	42	51	77	42	114
	0.079	42	50	59	85	48	121
	0.109	57	65	74	105		135
	0.138	72	80	89	115		149
48	0.052	31	33	36			
	0.064	38	48	57	85	46	128
	0.079	48	58	67	95	53	138
	0.109	65	75	84	120		154
	0.138	82	92	101	130		170
	0.168	100	110	119	155		186
54	0.064	44	55	66	75	52	
	0.079	54	65	76	105	59	156
	0.109	73	84	95	130		173
	0.138	92	103	144	155		191
	0.168	112	123	134	175	209	
60	0.079	60	71	85		68	
	0.109	81	92	106	140	88	192
	0.138	103	114	128	180		212
	0.168	124	135	149	190		232
66	0.079	65	77	93			
	0.109	89	101	117	160	96	211
	0.138	113	125	141	180	120	233
	0.168	137	149	165	210		255

*Lock seam construction only, weights will vary with other fabrication practices.
**For other coatings or linings the weights may be interpolated.
Note: Pipe arch weights will be the same as the equivalent round pipe.
For example, for 42 x 29, 2 ⅔ x ½ in. Pipe Arch, refer to 36 in. diameter pipe weight.

Table 2.15 (Continued) Handling Weight of Corrugated Steel Pipe (3 x 1 in. or 5 x 1* in.)

Estimated Average Weights — Not for Specification Use**

Inside Diameter in Inches	Specified Thickness in Inches	Approximate Pounds per Linear Foot***					
		Metallic Coated	Full Bituminous Coated	Full Bituminous Coated and Invert Paved	Full Bituminous Coated and Full Paved	Steel Lined	Concrete Lined
102	0.064	93	124	158	258	108	
	0.079	114	145	179	279	126	
	0.109	155	189	220	320	164	426
	0.138	198	229	263	363		460
	0.168	241	272	306	406		496
108	0.064	98	131	166	273	115	
	0.079	120	153	188	295	133	
	0.109	165	198	233	340	173	
	0.138	211	244	279	386		487
	0.168	256	289	324	431		525
114	0.064	104	139	176	289	121	
	0.079	127	162	199	312	141	
	0.109	174	209	246	359	183	
	0.138	222	257	294	407		514
	0.168	271	306	343	456		554
120	0.064	109	146	183	296	127	
	0.079	134	171	210	329	148	
	0.109	183	220	259	378	193	
	0.138	234	271	310	429		541
	0.168	284	321	360	479		583
126	0.079	141	179	220	346	155	
	0.109	195	233	274	400	203	
	0.138	247	285	326	452		
132	0.079	148	188	231	363	163	
	0.109	204	244	287	419	213	
	0.138	259	299	342	474		
	0.168	314	354	397	529		
138	0.079	154	196	241	379	169	
	0.109	213	255	300	438	221	
	0.138	270	312	357	495		
	0.168	328	370	415	553		
144	0.109	223	267	314	458	232	
	0.138	282	326	373	517	293	
	0.168	344	388	435	579		

*Steel weights for 5 x 1 in. are approximately 12% less than those used in this table for metallic coated pipe.

**Lock seam construction only, Weights will vary with other fabrication practices.

***For other coatings or linings the weights may be interpolated.

Note: Pipe arch weights will be the same as the equivalent round pipe. For example: for 81 x 59, 3 x 1 in. pipe-arch, refer to 72 in. diameter pipe weight.

TABLE V

Table of Available Diameters and Dimensions, Including Number of Specific Types of Plates Required

Neutral Axis Diameter-Inches	Appox. Inside Diameter-Inches**	Appox. Outside Diameter-Inches**	Appox. Outside Area-Sq.Ft.	Total Number Required	Plates Per Ring Plate Lengths and Offsets*								
					12 Pi. Plate			14 Pi. Plate			16 Pi. Plate		
					N	S	D	N	S	D	N	S	D
48	45.25	49.25	13.2	4	1	2	1						
50	47.25	51.25	14.3	4		2	1	1					
52	49.25	53.25	15.5	4		2		1		1			
54	51.25	55.25	16.6	4			1	1	2				
56	53.25	57.25	17.9	4				1	2	1			
58	55.25	59.25	19.1	4					2	1	1		
60	57.25	61.25	20.4	4					2		1		1
62	59.25	63.25	21.8	4						1	1	2	
64	61.25	65.25	23.2	4							1	2	1
66	63.25	67.25	24.6	5	1		1		3				
68	65.25	69.25	26.1	5			1	1	3				
70	67.25	71.25	27.7	5				1	3	1			
72	69.25	73.25	29.2	5					3	1	1		
74	71.25	75.25	30.8	5					3		1		1
76	73.25	77.25	32.5	5				1		1		3	
78	75.25	79.25	34.2	5						1	1	3	
80	77.25	81.25	36.0	5							1	3	1
82	79.25	83.25	37.8	6			1	1	4				
84	81.25	85.25	39.7	6				1	4	1			
86	83.25	87.25	41.6	6					4	1	1		
88	85.25	89.25	43.5	6					4		1		1
90	87.25	91.25	45.4	6					3		1	1	1
92	89.25	93.25	47.4	6				1		1		4	
94	91.25	95.25	49.4	6						1	1	4	
96	93.25	97.25	51.5	6							1	4	1
98	95.25	99.25	53.6	7				1	5	1			
100	97.25	101.25	55.8	7					5	1	1		
102	99.25	103.25	58.1	7					5		1		1
104	101.25	105.25	60.3	7					4		1	1	1
106	103.25	107.25	62.6	7				1	1	1		4	
108	105.25	109.25	65.0	7				1		1		5	
110	107.25	111.25	67.5	7						1	1	5	
112	109.25	113.25	70.0	7							1	5	1
114	111.25	115.25	72.5	8					6	1	1		
116	113.25	117.25	75.0	8					6		1		1
118	115.25	119.25	77.5	8					5		1	1	1
120	117.25	121.25	80.1	8					4		1	2	1
122	119.25	123.25	82.9	8				1	1	1		5	
124	121.25	125.25	85.8	8				1		1		6	
126	123.25	127.25	88.5	8						1	1	6	
128	125.25	129.25	90.5	8							1	6	1
130	127.25	131.25	93.9	9					7		1		1
132	129.25	133.25	96.8	9					6		1	1	1
134	131.25	135.25	99.8	9					5		1	2	1
136	133.25	137.25	102.8	9					4		1	3	1
138	135.25	139.25	105.8	9				1	1	1		6	
140	137.25	141.25	108.8	9				1		1		7	
142	139.25	143.25	111.9	9						1	1	7	
144	141.25	145.25	115.0	9							1	7	1
146	143.25	147.25	118.1	10					7		1	1	1
148	145.25	149.25	121.3	10					6		1	2	1
150	147.25	151.25	124.5	10					5		1	3	1
152	149.25	153.25	128.0	10					4		1	4	1
154	151.25	155.25	131.5	10				1	1	1		7	
156	153.25	157.25	135.0	10				1		1		8	
158	155.25	159.25	138.5	10						1	1	8	
160	157.25	161.25	141.9	10							1	8	1
162	159.25	163.25	145.5	11					7		1	2	1
164	161.25	165.25	149.0	11					6		1	3	1
166	163.25	167.25	152.6	11					5		1	4	1
168	165.25	169.25	156.3	11					4		1	5	1
170	167.25	171.25	160.0	11				1	1	1		8	
172	169.25	173.25	163.8	11				1		1		9	
174	171.25	175.25	167.6	11						1	1	9	
176	173.25	177.25	171.5	11							1	9	1
178	175.25	179.25	175.5	12					7		1	3	1
180	177.25	181.25	179.5	12					6		1	4	1

* Type of offset at ends of plate. N = No Offset, S = Single Offset, D = Double Offset, Diameters are available above those shown in the same pattern. Structures designed for 4 Pi (12.5") stagger in longitudinal seams in alternate rings.

** Where the tunnel clearances are important, the designer should size the structure to provide for normal deflection. Sizes shown in Table V are to the neutral axis, not the inside diameter.

*** Larger diameters are available on request.

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(c) Responsible Manager (Print/Sign): D. Parker Date: 6/7/2011

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241-SX Tank Farm South Interim Surface Barrier Monitoring Plan

Author Name: Colin Henderson
Columbia Energy and Environmental Services, Inc. for
Washington River Protection Solutions, LLC
Richland, WA 99352
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Abstract: This plan describes the planned monitoring activities for the southern interim surface barrier to be constructed at the SX tank farm.

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LIST OF TERMS

Abbreviations and Acronyms

CSI	Campbell Scientific, Inc.
HDU	heat dissipation unit
SST	single-shell tank
WMA	waste management area
WRPS	Washington River Protection Solutions, LLC

Units

ft	feet
L	liter
m	meter

1.0 INTRODUCTION

The Hanford Site in southeastern Washington State has 149 underground single-shell tanks (SST) that have been used to store hazardous radioactive waste. A number of these tanks and their associated infrastructure (e.g., pipelines, diversion boxes) have leaked. Some of the leaked waste has entered the groundwater. Corrective measures are being taken to mitigate the groundwater impacts from past leaks and spills from contaminants that still reside within the vadose zone. Washington River Protection Solutions, LLC (WRPS) plans to construct two interim surface barriers (identified as south and north interim surface barriers) over the southern portion of the 241-SX tank farm to minimize the migration of the residual contamination. This monitoring plan is prepared to guide the monitoring program for the south SX farm interim surface barrier. Following approval of this plan and installation of the monitoring system, PNNL-19772, *T-TY Tank Farm Interim Surface Barrier Demonstration – Vadose Zone Monitoring Plan* will be modified to address implementation of the monitoring program.

1.1 SX TANK FARM

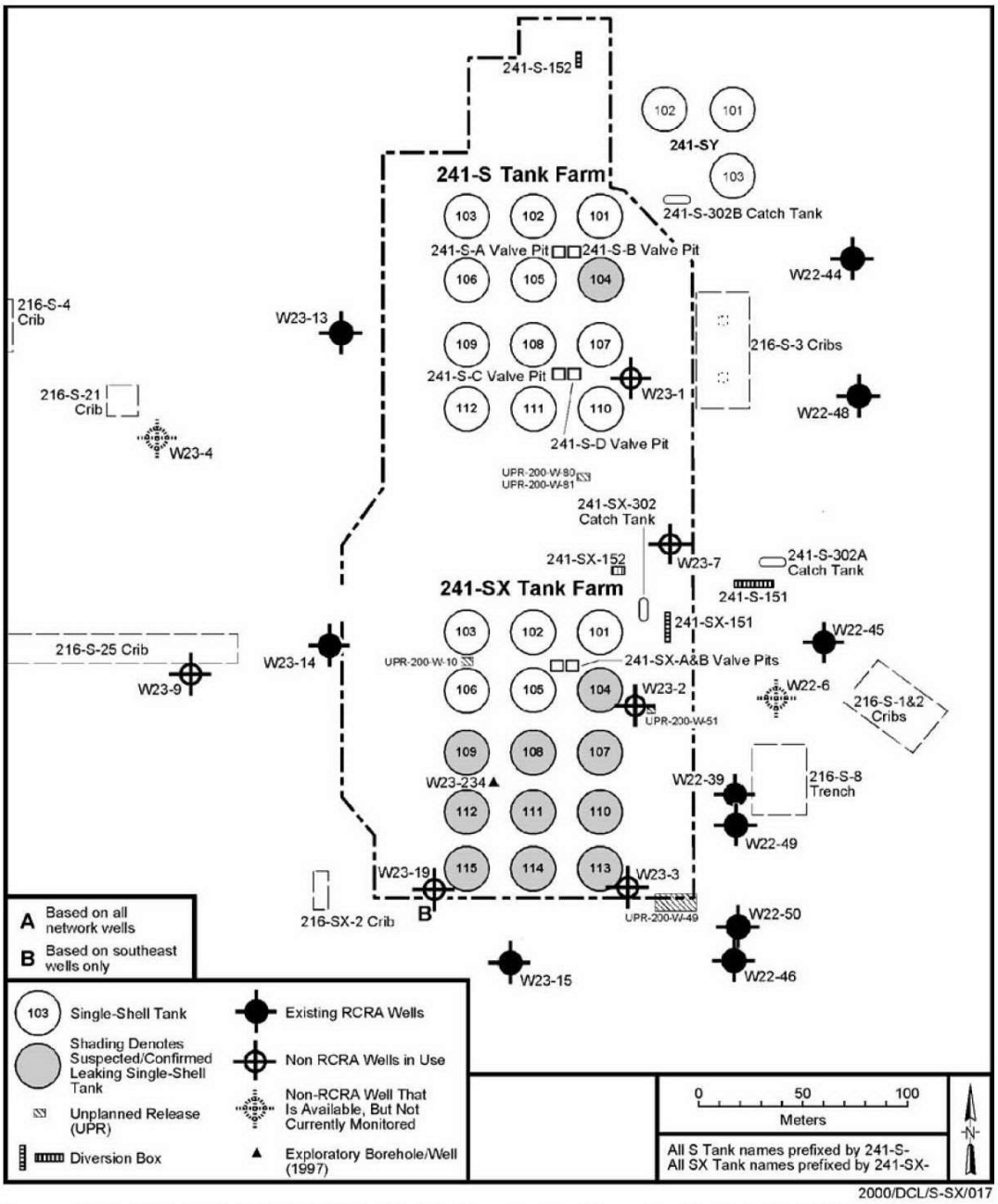
The SX tank farm was constructed between years 1953 and 1954. The 241-SX Tank farm (SX tank farm) contains fifteen 100-series SST with a diameter of 23 meters (m) (75 feet [ft]) and a capacity of 3,785,000 liters (L) (1 million gallons), waste-transfer lines, leak-detection systems, and tank ancillary equipment. The soil cover from the apex of the tank domes to ground surface is approximately 2.4 m (8 ft). Figure 1 shows the SX tank farm within the S-SX waste management area (WMA) and surrounding facilities.

The SX tank farm was constructed into the upper Hanford formation sediments underlying the 200 West Area, along the north limb of the Cold Creek syncline, which exists just west of WMA S-SX and is oriented generally north to south. The upper 12 m (40 ft) of the Hanford formation was locally excavated and backfilled with gravelly sand during installation of the SST.

Stratigraphic units in the vadose zone underlying or adjacent to these tank farms (in descending order) include backfill materials and naturally occurring Hanford formation sediments, the Plio-Pleistocene unit, and the Miocene- to Pliocene-age Ringold Formation (RPP-7884, *Field Investigation Report for Waste Management Area S-SX*).

A detailed discussion of the historical information associated with tank leaks and unplanned releases is provided in RPP-ENV-39658, *Hanford SX-Farm Leak Assessments Report*. This report identifies the numerous evaluations that have been performed using both in-tank and ex-tank data to investigate the nature and extent of subsurface contamination in the SX tank farm. The combination of historical information was taken into consideration in defining the footprint for the two interim surface barriers in the SX tank farm. The footprint of the interim surface barriers was established at a Tri-Party Agreement Project Managers Meeting on December 7, 2010 with representatives WRPS, ORP, and Ecology (Meeting Minutes M-045-92 Barrier Decision Meeting, Tri-Party Agreement Administrative Record).

Figure 1. Location of the SX Tank Farm in the 200 West Area.



Source: DOE/ORP-2008-01, 2008, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas,* Revision 0, U.S. Department of Energy, Office of River Protection, Richland, Washington.

1.2 SURFACE BARRIER AND MONITORING

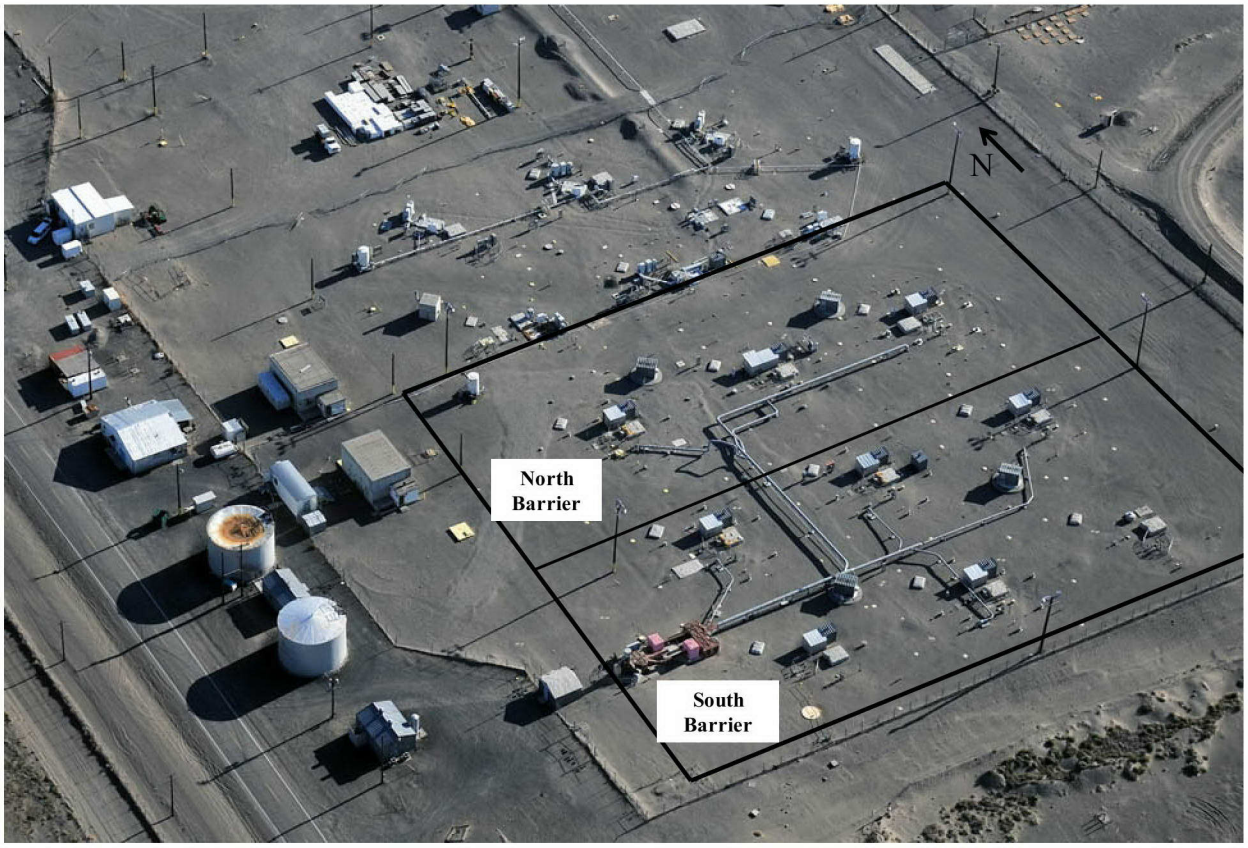
Washington River Protection Solutions, LLC has proposed two interim barriers over the southern portion of the SX tank farm. The approximate footprints of the two barriers are shown in Figure 2. The North barrier partially covers tanks SX-104 through SX-106 and entirely covers tanks SX-107 through SX-109. The South barrier entirely covers tanks SX-110 through SX-115. It is expected that the interim barriers will prevent meteoric water from entering into the soil and consequently will reduce the downward migration of moisture and contaminants beneath the barrier footprint. An evaluation of materials for use in constructing the SX farm interim barrier identified modified asphalt as the preferred material for construction of the interim barrier (RPP-RPT-47488, *241-SX Tank Farm Interim Surface Barrier Materials and Runoff Alternatives Study*).

There is an ongoing monitoring program in place for the T and TY farm interim surface barriers. The monitoring plan for the T farm interim surface barrier is documented in PNNL-16538, *T Tank Farm Interim Surface Barrier Demonstration – Vadose Zone Monitoring Plan*, and is oriented at providing data to monitor the soil-water regime and evaluate the impacts of the interim surface barrier on subsurface moisture and soil water pressure conditions. The T farm interim surface barrier monitoring plan is designed to document pre-cover conditions and changes beneath the cover as a function of distance from the edge of the cover and to depths up to 10 m (33 ft) for heat dissipating units (HDU) and up to 15 m (49 ft) for neutron logging wells below the interim barrier surface. The monitoring plan for the TY interim surface barrier is documented in RPP-PLAN-36705, *241-TY Tank Farm Interim Surface Barrier Monitoring Plan* and in PNNL-19772.

The monitoring system installed for the T farm interim surface barrier consists of four separate solar powered and remotely controlled instrument nests that allow for continuous monitoring of soil moisture conditions at four locations. One instrument nest is located outside of the barrier footprint, one is locate at the edge of the barrier, and two are located beneath the barrier.

The monitoring system installed for the TY farm interim surface barrier is similar to the T farm monitoring system and includes two separate solar powered and remotely controlled instrument nests that allow for continuous monitoring of soil moisture and pressure conditions at two locations. One instrument nest is located outside the barrier footprint and one is located within the barrier footprint.

Figure 2. Proposed Footprints for SX Farm Interim Barriers.



1.3 OBJECTIVES AND SCOPE

Two possible objectives for monitoring interim barriers include:

1. Measuring soil properties near and beneath the barrier to document changes in soil moisture over time and demonstrate that the surface barrier is effectively reducing the water flux into a contaminated region
2. Monitoring to ensure that the integrity of the barrier is intact and that there is no damage or failure of the barrier system that allows water to leak through.

The monitoring system installed at the T farm interim surface barrier was established to document pre-cover conditions and changes beneath the cover as a function of distance from the edge of the cover and to depths below the surface of up to 15 m (50 ft) for neutron logging wells and 10 m (33 ft) for HDUs (PNNL-15913, *T Tank Farm Interim Cover Test - Design Plan*). The T farm interim barrier monitoring strategy addresses objective 1 in the previous paragraph through the use of instruments at specific locations. The data collected through the T farm monitoring program can be utilized to demonstrate the effectiveness of covers in reducing the water flux under the cover footprint and quantify edge effects to help define minimum footprint requirements for future covers. The data and interpretations from the T farm barrier monitoring program can be used to infer the performance of other interim barrier applications in reducing

water flux beneath the barrier footprint at the tank farms, provided the barriers are functionally equivalent. Functionally equivalent barriers consist of materials impervious to water runoff collection and conveyance system to route the water away from the barrier for disposal.

Data collected from both the T farm and TY farm interim barrier monitoring programs can be utilized to infer the near surface effectiveness of the interim barriers at other tank farms. In order to attain consistency with WAC 173-303-64620(4)(d), performance monitoring of the interim corrective action measure to ensure its function will be provided through the collection of soil moisture data. However, in order to assess the effectiveness of interim surface barriers to reduce moisture flux at greater depths, data at depths greater than current 10 m deep HDU installations at TY and T barriers is needed. Collection of moisture data at depths greater than at TY and T barriers will help to assess the effectiveness of barriers at depth. Although monitoring systems at T and TY farms were designed to allow the monitoring nests to be extended beyond the original construction depths should monitoring results indicate that deeper monitoring is needed, it is also possible to provide deeper monitoring capabilities with the installation of monitoring systems at the SX barrier. Therefore, one objective of the SX interim barrier monitoring strategy will be to provide moisture monitoring at greater depths than at current T or TY barriers.

2.0 MONITORING REQUIREMENTS

Prescriptive monitoring requirements for an interim surface barrier are not addressed in either the state dangerous waste regulations or in RPP-SPEC-47469, *SX Farm Interim Surface Barrier Subsystem Specification*. Monitoring requirements for the SX farm interim surface barrier are, therefore, established in this monitoring plan.

The interim barriers at T and TY farms have monitoring programs underway to measure soil properties over time to verify the reduction in water flux and soil moisture beneath the barriers. These interim barriers were constructed as demonstration projects and monitoring plans were established to provide a means to evaluate the effectiveness of surface barriers and compare the performance of different surface barrier materials. The performance of interim surface barriers at reducing infiltration and soil moisture beneath the barrier footprint will be evaluated over time through the T and TY interim barrier projects. It is expected that a number of years of monitoring data will be required to document interim barrier performance. The successful installation and performance of the two demonstration projects has led to a decision to continue the installation of interim surface barriers beyond the demonstration projects.

The two interim surface barriers to be constructed at SX farm are the first two of the four additional interim surface barriers called for in the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989) Milestone M-045-92. Although the TY barrier monitoring system provides data on the performance of modified asphalt as a barrier material, the 10 m depth of the HDU array may not provide long term monitoring capabilities. As the drying front beneath the barrier progresses downward, it will eventually extend below the 10 m depth currently installed at both T and TY farms.

The requirements for monitoring the two SX interim barriers are then to monitor the two SX interim barriers to ensure that the integrity of the barrier is intact and that there is no damage or failure of the barrier system that allows water to leak through barriers.

3.0 MONITORING METHODS AND EQUIPMENT

Candidate methods for interim surface barrier monitoring are identified and described in RPP-PLAN-37605 and PNNL-16538. This section describes the potential monitoring methods and the rationale used to select the methods for the SX farm interim barriers.

3.1 POTENTIAL MONITORING METHODS

Monitoring methods for evaluating the integrity of an interim barrier are dependent on barrier type and materials used for construction. Based on the material evaluation performed in RPP-RPT-47488, modified asphalt has been selected as the preferred material/configuration for the interim barriers at the SX tank farm.

Potential monitoring methods include instrumentation to directly or indirectly measure physical properties at a specific location; and electrical and electromagnetic geophysical methods oriented at monitoring soil moisture or changes in properties that can be related to changes in soil moisture over larger areas/volumes.

Monitoring the volume of water diverted by the interim barrier was considered but not evaluated in detail. Because the barrier will evaporate a percentage of the precipitation that falls during short duration events that occur in the warm months, the measurement of the runoff volume would provide limited value. The weather station at the T farm combined with the geometry of the SX interim barriers can be used to report the volume of precipitation diverted by the interim barrier.

Potential monitoring methods that were evaluated for the demonstration barriers included:

- Measurement of soil properties; soil moisture content, soil water pressure, soil temperature, and soil water movement.
- Geophysical methods; electrical property measurement and electromagnetic.

Based on knowledge gained from monitoring at T and TY, only the HDU arrays and neutron monitoring are capable of detecting the small initial moisture changes due to barrier installation, and provide the longevity needed for barrier monitoring. The capacitance probes are also capable of detecting the small initial moisture changes, but have an operational life expectancy of only one to two years. The main limitation of the monitoring systems at T and TY farms is the maximum 10 m depth of the HDU installations. Both T and TY monitoring nests were designed to allow their monitoring nests to be extended beyond the original construction depths should monitoring results indicate that deeper monitoring is needed.

3.2 METHOD SELECTION

Monitoring for the south SX barrier will be performed through a combination of subsurface measurements coupled with visual inspection of the exposed barrier surface. Subsurface monitoring of the soil beneath the south SX barrier will be provided by measuring soil water pressure using HDUs and soil moisture content using neutron monitoring of existing drywells. Visual inspection of the exposed barrier surface will also be performed by periodic visual examination of the barrier surface and penetrations designed to collect and route storm water out of the tank farm. Operator round sheets will be developed to document inspection of specific areas and features.

The HDU array under the south SX barrier will consist of two monitoring installations, 1 to 5 m in depth and 1 to 20 m in depth. The 5 m installation will include HDUs at depths of approximately 1 m, 2 m, 3 m, and 5 m. This spacing was chosen over the HDU spacing used at T and TY barriers to provide greater monitoring of the upper portion of the vadose zone where moisture changes due to barrier placement would be expected earliest.

The 20 m installation under the south SX barrier will address deeper soil moisture changes. The 20 m installation would have HDUs at depths of approximately 10 m, 15 m, and 20 m to provide data on soil moisture changes deeper in the vadose zone. Lessons learned from the TY interim barrier monitoring installation indicated that the soil was too wet near the surface for the HDU probes to function properly. In response to this, an alternate soil moisture measurement instrument will be tested, which is expected to be more responsive early in the soil drying cycle. A soil water potential sensor 257 produced by Campbell Scientific, Inc. will be installed at a depth of approximately 1 m. The soil water potential sensor 257 will be redundant to the HDU placed at approximately 1 m depth in the 5 m installation, and will allow a side-by-side comparison of the HDU and the soil water potential sensor 257. The combination of the 5 m and 20 m installations provide duplicate measurements with different instruments at the 1 m depth, along with measurement at depths of 2 m, 3 m, 5 m, 10 m, 15 m, and 20 m.

Neutron monitoring will utilize existing vadose zone wells known locally as drywells. Three drywells near the HDU instrument nests will be logged to the full depth of the drywells. Logging will be performed using established equipment and methods. Logging frequency will be quarterly for the first year and annually thereafter or as deemed necessary by results of the drywell logging. The neutron monitoring will provide data that can be compared to the HDUs and will also provide the ability to collect moisture data in the event that the near surface soils are too wet for measurement with the HDU probes. Changes in the soil moisture content beneath the barrier are expected to change slowly; quarterly monitoring over the first year following construction will establish a baseline and the subsequent annual monitoring will serve to monitor the drying trend. Other types of geophysical logging are not included in the monitoring plan (i.e., spectral gamma logging) because the primary objective is to monitor the effectiveness of the barrier to reduce the moisture content below the barrier rather than to monitor contaminant migration.

Although not a required element of the interim barrier monitoring plan, the Tank Operations Contractor plans to perform neutron logging in the drywells and install the monitoring instruments prior to construction of the barrier in order to establish a pre-construction baseline.

Routine visual examination of the barrier surface and barrier details designed to collect and route storm water out of the tank farm will be performed. The routine visual examination will be performed through periodic walk down and visual assessment of the barrier surface for degradation (i.e., cracks, material separation at penetration locations, settling) that could lead to localized infiltration of rainwater and snowmelt.

3.3 MONITORING SYSTEM LOCATIONS

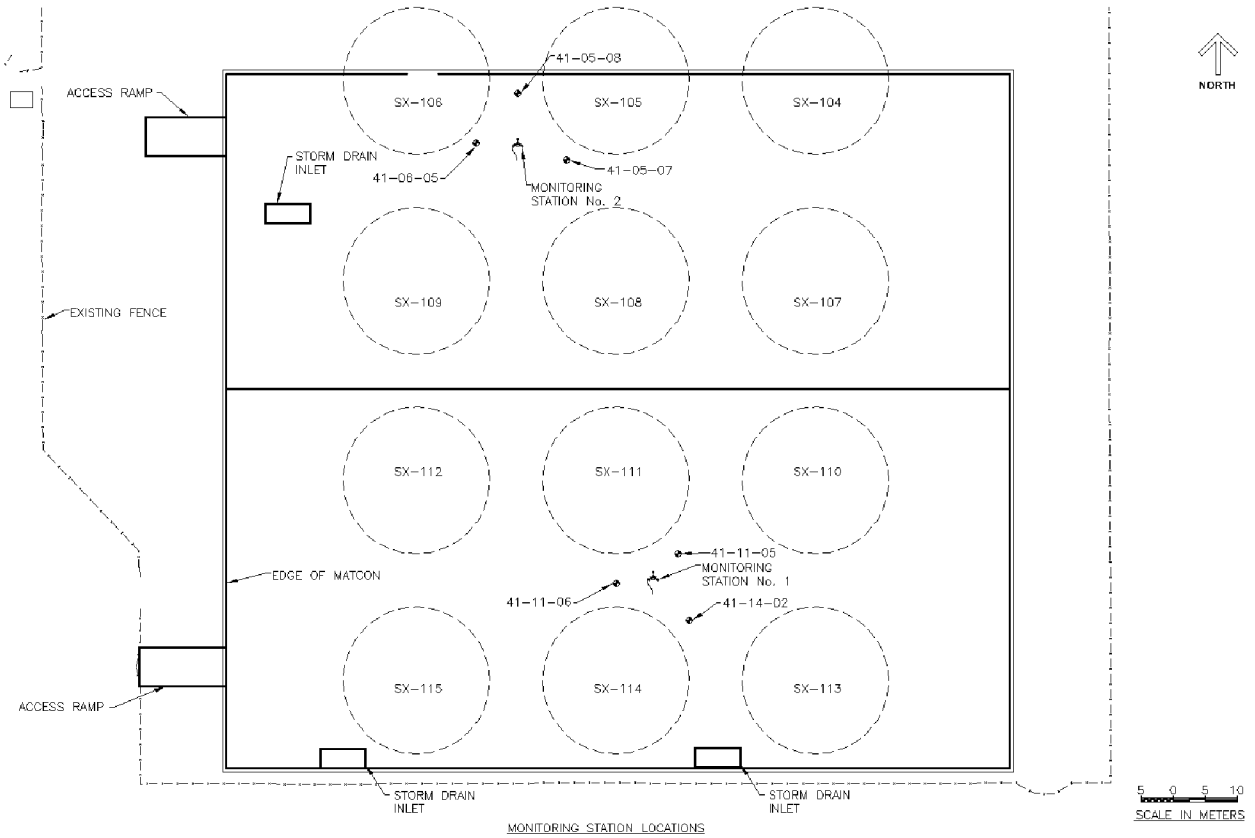
Planned monitoring locations on the south and north interim barriers are shown in Figure 3. The north interim barrier location is shown in Figure 3 to provide information on the combined monitoring plans for both south and north interim barriers. Monitoring plans for the north interim barrier are described in RPP-PLAN-49187, *241-SX Tank Farm North Interim Surface Barrier Monitoring Plan.* These locations were selected to be well beneath the barrier footprint, away from known subsurface infrastructure, and away from above grade infrastructure that would likely have some open area that would provide for some water to penetrate beneath the barrier surface. Due to the difficulty in sealing all equipment penetrations, there is an allowance for some open area within the footprint of the barrier.

The monitoring station locations are approximate and the final location will be adjusted to provide clearance from potential interferences with below grade infrastructure based on a drawing review and a ground penetrating radar survey. The drywells identified in Figure 3 around each of the monitoring nests are the drywells that are planned to be surveyed using neutron moisture logging. Both of the monitoring locations are away from areas of significant cesium-137 contamination based on a review of RPP-7884. Although there is some concern over the influence of the radiation field and/or high temperature associated on the monitoring instruments, the monitoring station locations selected are not expected to impede monitoring.

As shown in Figure 3, the drywells surrounding the planned instrument nests will be subject to neutron logging. The drywells on the south barrier selected for neutron logging include:

- 41-11-05
- 41-11-06
- 41-14-02.

Figure 3. Planned Monitoring Locations for the SX Interim Barriers.



3.4 EQUIPMENT SELECTION

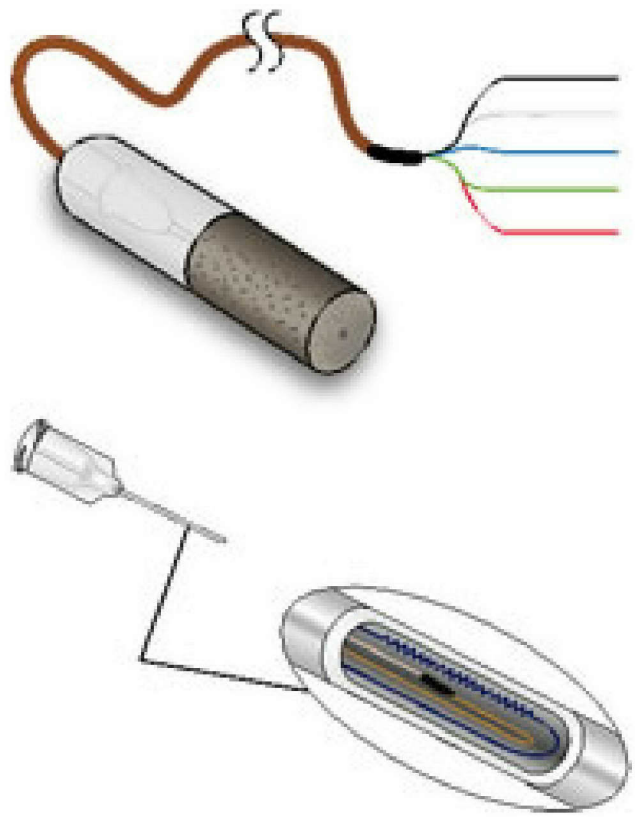
In order to provide consistency between the existing T and TY interim barrier monitoring systems, equivalent instrumentation and dataloggers will be used. The following instruments will be utilized.

- Neutron Probe – Neutron logging of the existing drywells surrounding the instrument nests will be performed. Neutron logging is expected to provide data that can be compared to the data from the HDU sensors. Additionally, the neutron probes provide the ability to collect data under high moisture conditions that may exceed the range of the HDU sensors. Of the eight HDU probes installed at the TY interim barrier the two installed at the 1 m depth provide good data while the other six provide data that are very close to the upper limit that the HDU probes can measure.
- Dataloggers – Campbell Scientific, Inc. (CSI) Model CR10X or equivalent. One dedicated datalogger will be used for each instrument array.
- HDU Sensor – The HDU to be used is made by Campbell Scientific, Inc. and is called the "229 Heat Dissipation Matric Water Potential Sensor" (Figure 4). The sensor has a cylindrically-shaped porous ceramic body. A heating element that has the same length as

the ceramic body is positioned at the center of the cylinder. A thermocouple is located at mid-length of the ceramic and heating element. The position of the heating element and the thermocouple is maintained by placing both inside a hypodermic needle, which also protects the delicate wires. The volume inside the needle, which is not occupied by wiring, is filled with epoxy. HDUs provide affordable measurements of soil matric potential and also the added benefit of measuring soil temperature. The size of a single HDU is also a benefit, with the CSI HDU (Model 299) dimensions being 1.5 centimeters in diameter and 60 millimeters in length. There is some uncertainty in using HDU sensors in areas with elevated temperatures due to the presence of contamination. The HDU sensor literature provides a methodology to correct for soil temperature.

- The soil water potential sensor to be used is made by CSI and is called a "257 Soil Water Potential Sensor" (Figure 5). The sensor consists of two concentric electrodes embedded in a reference matrix material. The matrix material is surrounded by a synthetic membrane for protection against deterioration. An internal gypsum tablet buffers against the salinity levels found in soils. The cable jacket is resistant to temperature extremes, water, and ultraviolet degradation.

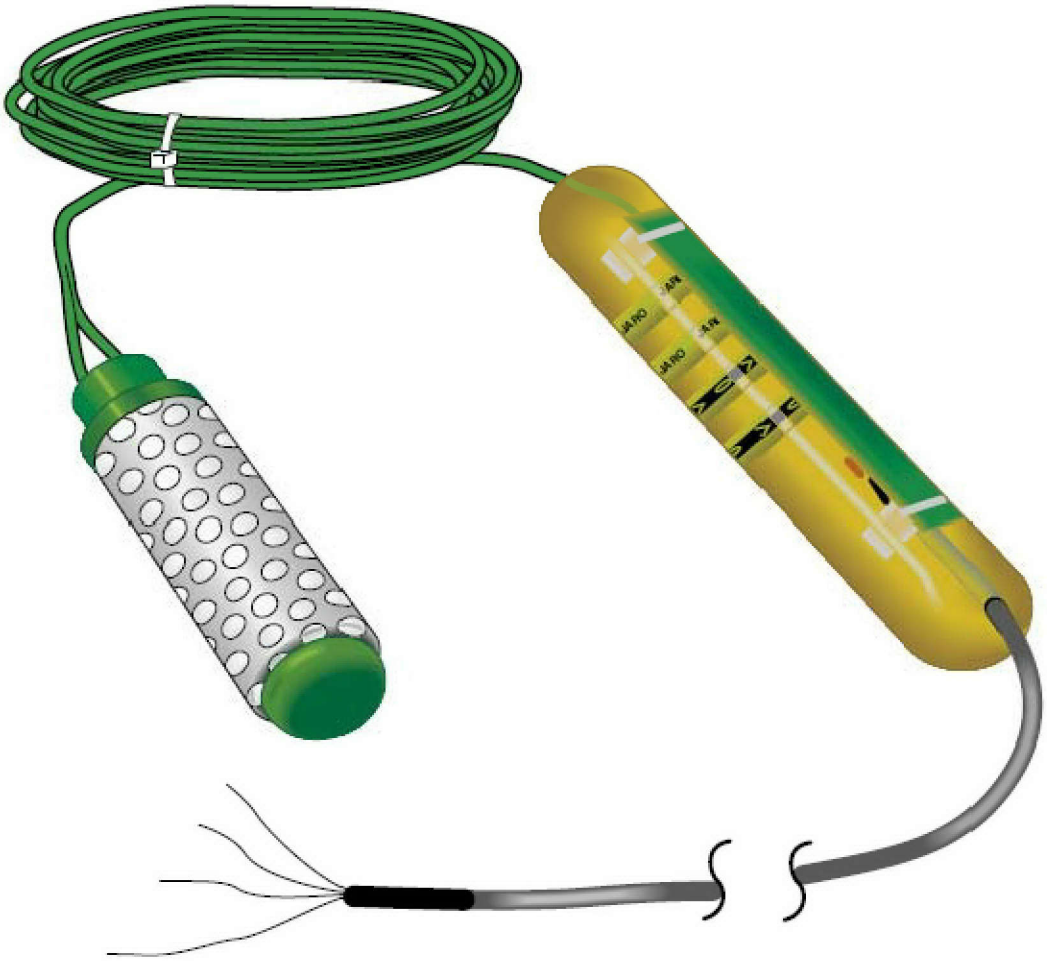
Figure 4. Heat Dissipation Unit Sensor.



Source: Campbell Scientific Instruments.
www.campbellsci.com.

Note: A 229 Heat Dissipation Matric Water Potential Sensor is shown at the top. The hypodermic assembly (without epoxy and ceramic) is shown just below. Cutaway view shows longitudinal section of the needle with heater and thermocouple junction.

Figure 5. Campbell Scientific Soil Water Potential Sensor.



Campbell Scientific's 257 includes blocking capacitors in its cable to mitigate ground loops and galvanic degradation.

Source: Campbell Scientific Instruments. www.campbellsci.com.

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241-SX Tank Farm North Interim Surface Barrier Monitoring Plan

Author Name: Colin Henderson
Columbia Energy and Environmental Services, Inc. for
Washington River Protection Solutions, LLC
Richland, WA 99352
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Abstract: This plan describes the planned monitoring activities for the northern interim surface barrier to be constructed at the SX tank farm.

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Kelly U Wheeler 6/7/2011
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LIST OF TERMS

Abbreviations and Acronyms

CSI	Campbell Scientific, Inc.
HDU	heat dissipation unit
SST	single-shell tank
WMA	waste management area
WRPS	Washington River Protection Solutions, LLC

Units

ft	feet
L	liter
m	meter

1.0 INTRODUCTION

The Hanford Site in southeastern Washington State has 149 underground single-shell tanks (SST) that have been used to store hazardous radioactive waste. A number of these tanks and their associated infrastructure (e.g., pipelines, diversion boxes) have leaked. Some of the leaked waste has entered the groundwater. Corrective measures are being taken to mitigate the groundwater impacts from past leaks and spills from contaminants that still reside within the vadose zone. Washington River Protection Solutions, LLC (WRPS) plans to construct two interim surface barriers (identified as south and north interim surface barriers) over the southern portion of the 241-SX tank farm to minimize the migration of the residual contamination. This monitoring plan is prepared to guide the monitoring program for the north SX farm interim surface barrier. Following approval of this plan and installation of the monitoring system, PNNL-19772, *T-TY Tank Farm Interim Surface Barrier Demonstration – Vadose Zone Monitoring Plan* will be modified to address implementation of the monitoring program.

1.1 SX TANK FARM

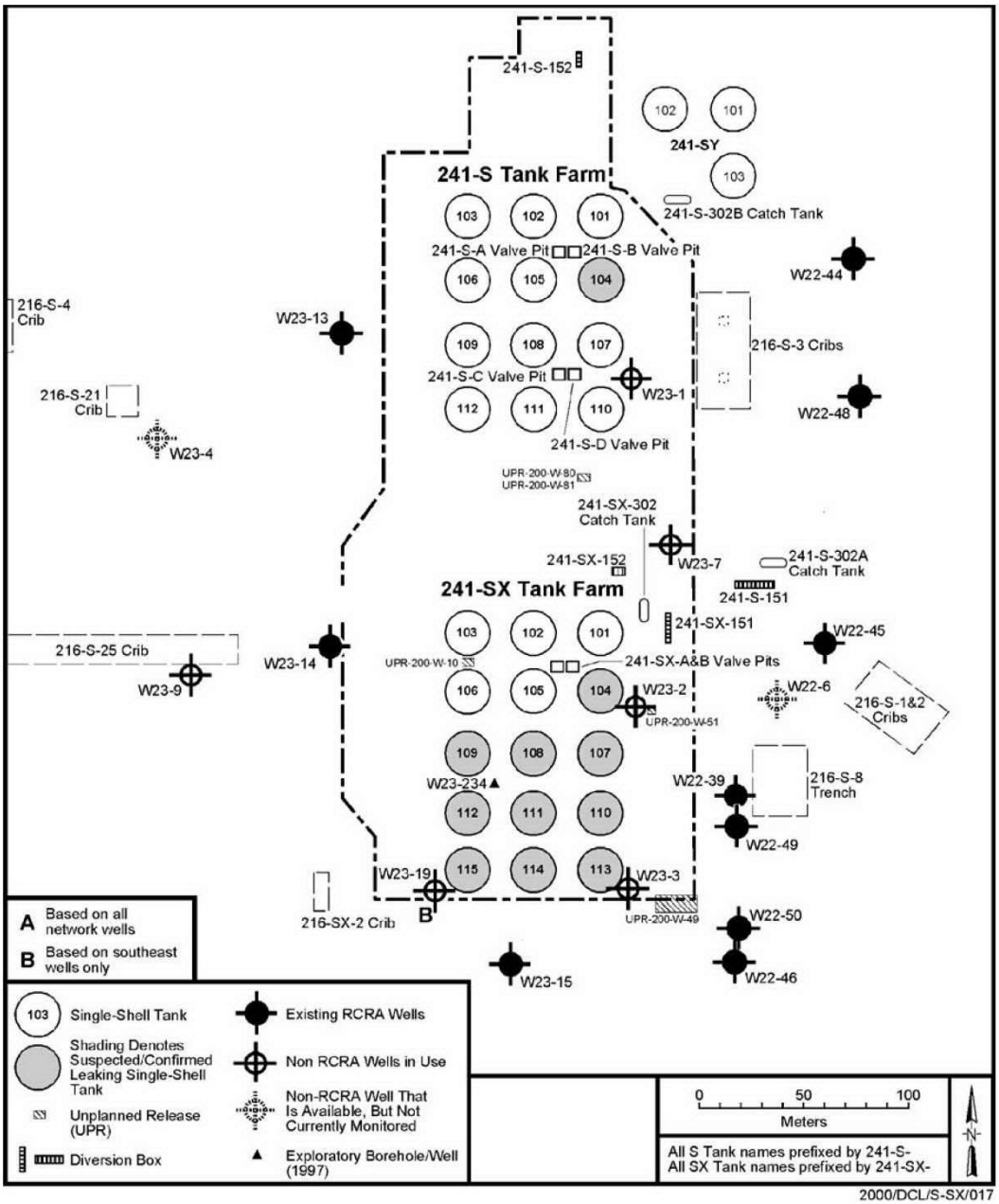
The SX tank farm was constructed between years 1953 and 1954. The 241-SX Tank Farm (SX tank farm) contains fifteen 100-series SST with a diameter of 23 meters (m) (75 feet [ft]) and a capacity of 3,785,000 liters (L) (1 million gallons), waste-transfer lines, leak-detection systems, and tank ancillary equipment. The soil cover from the apex of the tank domes to ground surface is approximately 2.4 m (8 ft). Figure 1 shows the SX tank farm within the S-SX waste management area (WMA) and surrounding facilities.

The SX tank farm was constructed into the upper Hanford formation sediments underlying the 200 West Area, along the north limb of the Cold Creek syncline, which exists just west of WMA S-SX and is oriented generally north to south. The upper 12 m (40 ft) of the Hanford formation was locally excavated and backfilled with gravelly sand during installation of the SST.

Stratigraphic units in the vadose zone underlying or adjacent to these tank farms (in descending order) include backfill materials and naturally occurring Hanford formation sediments, the Plio-Pleistocene unit, and the Miocene- to Pliocene-age Ringold Formation (RPP-7884, *Field Investigation Report for Waste Management Area S-SX*).

A detailed discussion of the historical information associated with tank leaks and unplanned releases is provided in RPP-ENV-39658, *Hanford SX-Farm Leak Assessments Report*. This report identifies the numerous evaluations that have been performed using both in-tank and ex-tank data to investigate the nature and extent of subsurface contamination in the SX tank farm. The combination of historical information was taken into consideration in defining the footprint for the two interim surface barriers in the SX tank farm. The footprint of the interim surface barriers was established at a Tri-Party Agreement Project Managers Meeting on December 7, 2010, with representatives WRPS, ORP, and Ecology (Meeting Minutes M-045-92 Barrier Decision Meeting, Tri-Party Agreement Administrative Record).

Figure 1. Location of the SX Tank Farm in the 200 West Area.



Source: DOE/ORP-2008-01, 2008, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas, Revision* 0, U.S. Department of Energy, Office of River Protection, Richland, Washington.

1.2 SURFACE BARRIER AND MONITORING

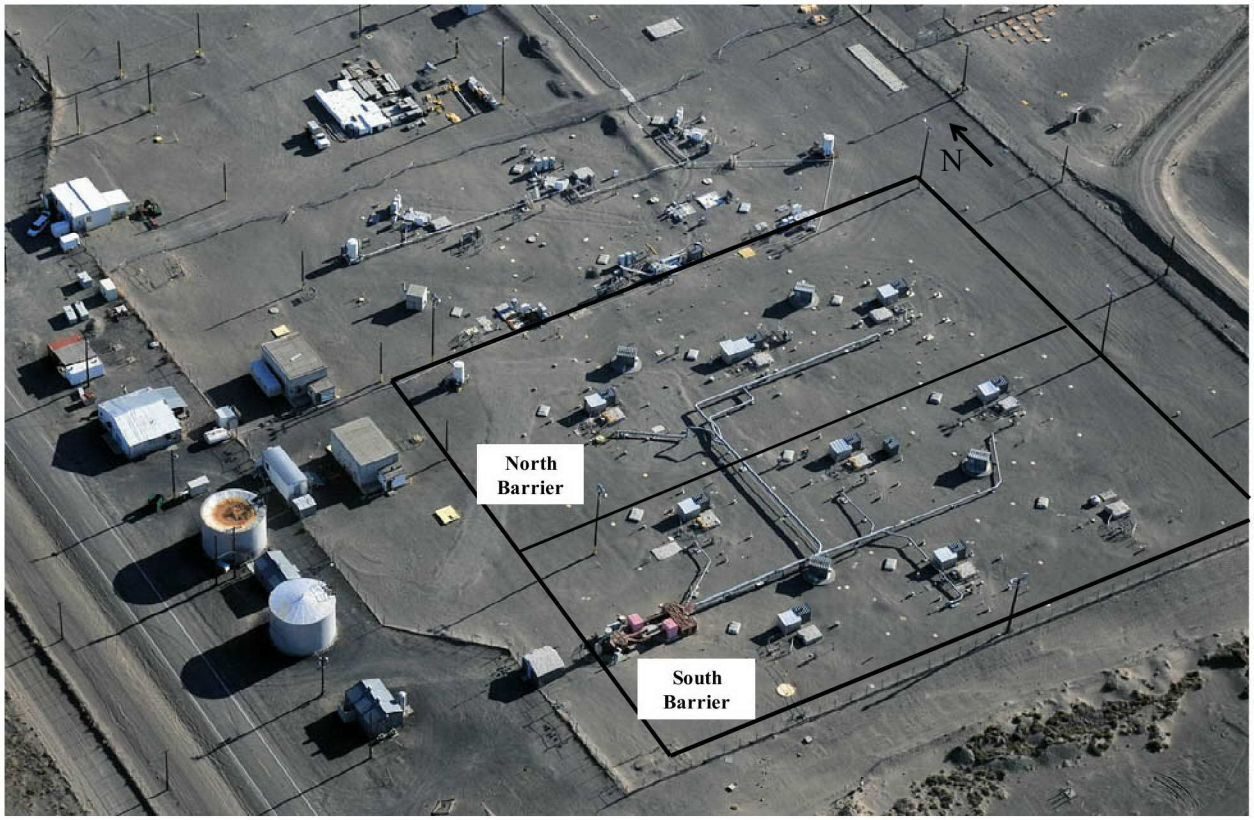
Washington River Protection Solutions, LLC has proposed two interim barriers over the southern portion of the SX tank farm. The approximate footprints of the two barriers are shown in Figure 2. The North barrier partially covers tanks SX-104 through SX-106 and entirely covers tanks SX-107 through SX-109. The South barrier entirely covers tanks SX-110 through SX-115. It is expected that the interim barriers will prevent meteoric water from entering into the soil and consequently will reduce the downward migration of moisture and contaminants beneath the barrier footprint. An evaluation of materials for use in constructing the SX farm interim barrier identified modified asphalt as the preferred material for construction of the interim barrier (RPP-RPT-47488, *241-SX Tank Farm Interim Surface Barrier Materials and Runoff Alternatives Study*).

There is an ongoing monitoring program in place for the T and TY farm interim surface barriers. The monitoring plan for the T farm interim surface barrier is documented in PNNL-16538, *T Tank Farm Interim Surface Barrier Demonstration – Vadose Zone Monitoring Plan*, and is oriented at providing data to monitor the soil-water regime and evaluate the impacts of the interim surface barrier on subsurface moisture and soil water pressure conditions. The T farm interim surface barrier monitoring plan is designed to document pre-cover conditions and changes beneath the cover as a function of distance from the edge of the cover and to depths up to 10 m (33 ft) for heat dissipating units (HDU) and up to 15 m (49 ft) for neutron logging wells below the interim barrier surface. The monitoring plan for the TY interim surface barrier is documented in RPP-PLAN-36705, *241-TY Tank Farm Interim Surface Barrier Monitoring Plan* and in PNNL-19772.

The monitoring system installed for the T farm interim surface barrier consists of four separate solar powered and remotely controlled instrument nests that allow for continuous monitoring of soil moisture conditions at four locations. One instrument nest is located outside of the barrier footprint, one is locate at the edge of the barrier, and two are located beneath the barrier.

The monitoring system installed for the TY farm interim surface barrier is similar to the T farm monitoring system and includes two separate solar powered and remotely controlled instrument nests that allow for continuous monitoring of soil moisture and pressure conditions at two locations. One instrument nest is located outside the barrier footprint and one is located within the barrier footprint.

Figure 2. Proposed Footprints for SX Farm Interim Barriers.



1.3 OBJECTIVES AND SCOPE

Two possible objectives for monitoring interim barriers include:

1. Measuring soil properties near and beneath the barrier to document changes in soil moisture over time and demonstrate that the surface barrier is effectively reducing the water flux into a contaminated region
2. Monitoring to ensure that the integrity of the barrier is intact and that there is no damage or failure of the barrier system that allows water to leak through.

The monitoring system installed at the T farm interim surface barrier was established to document pre-cover conditions and changes beneath the cover as a function of distance from the edge of the cover and to depths below the surface of up to 15 m (50 ft) for neutron logging wells and 10 m (33 ft) for HDUs (PNNL-15913, *T Tank Farm Interim Cover Test - Design Plan*). The T farm interim barrier monitoring strategy addresses objective 1 in the previous paragraph through the use of instruments at specific locations. The data collected through the T farm monitoring program can be utilized to demonstrate the effectiveness of covers in reducing the water flux under the cover footprint and quantify edge effects to help define minimum footprint requirements for future covers. The data and interpretations from the T farm barrier monitoring program can be used to infer the performance of other interim barrier applications in reducing water beneath the barrier footprint at the tank farms, provided the barriers are functionally

equivalent. Functionally equivalent barriers consist of materials impervious to water runoff collection and conveyance system to route the water away from the barrier for disposal.

Data collected from both the T farm and TY farm interim barrier monitoring programs can be utilized to infer the near surface effectiveness of the interim barriers at other tank farms. In order to attain consistency with WAC 173-303-64620(4)(d), performance monitoring of the interim corrective action measure to ensure its function will be provided through the collection of soil moisture data. However, in order to assess the effectiveness of interim surface barriers to reduce moisture flux at greater depths, data at depths greater than current 10 m deep HDU installations at T and TY barriers is needed. Collection of moisture data at depths greater than at TY and T barriers will help to assess the effectiveness of barriers at depth. Although monitoring systems at T and TY farms were designed to allow the monitoring nests to be extended beyond the original construction depths should monitoring results indicate that deeper monitoring is needed, it is also possible to provide deeper monitoring capabilities with the installation of monitoring systems at the SX barrier. Therefore, one objective of the SX interim barrier monitoring strategy will be to provide moisture monitoring at greater depths than at current T or TY barriers.

2.0 MONITORING REQUIREMENTS

Prescriptive monitoring requirements for an interim surface barrier are not addressed in either the state dangerous waste regulations or in RPP-SPEC-47469, *SX Farm Interim Surface Barrier Subsystem Specification*. Monitoring requirements for the SX farm interim surface barrier are, therefore, established in this monitoring plan.

The interim barriers at T and TY farms have monitoring programs underway to measure soil properties over time to verify the reduction in water flux and soil moisture beneath the barriers. These interim barriers were constructed as demonstration projects and monitoring plans were established to provide a means to evaluate the effectiveness of surface barriers and compare the performance of different surface barrier materials. The performance of interim surface barriers at reducing infiltration and soil moisture beneath the barrier footprint will be evaluated over time through the T and TY interim barrier projects. It is expected that a number of years of monitoring data will be required to document interim barrier performance. The successful installation and performance of the two demonstration projects has led to a decision to continue the installation of interim surface barriers beyond the demonstration projects.

The two interim surface barriers to be constructed at SX Farm are the first two of the four additional interim surface barriers called for in the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989) Milestone M-045-92. Although the TY barrier monitoring system provides data on the performance of modified asphalt as a barrier material, the 10 m depth of the HDU array may not provide long term monitoring capabilities. As the drying front beneath the barrier progresses downward, it will eventually extend below the 10 m depth currently installed at both T and TY farms.

The requirements for monitoring the two SX interim barriers are then to monitor the two SX interim barriers to ensure that the integrity of the barrier is intact and that there is no damage or failure of the barrier system that allows water to leak through barriers.

3.0 MONITORING METHODS AND EQUIPMENT

Candidate methods for interim surface barrier monitoring are identified and described in RPP-PLAN-37605 and PNNL-16538. This section describes the potential monitoring methods and the rationale used to select the methods for the SX farm interim barriers.

3.1 POTENTIAL MONITORING METHODS

Monitoring methods for evaluating the integrity of an interim barrier are dependent on barrier type and materials used for construction. Based on the material evaluation performed in RPP-RPT-47488, modified asphalt has been selected as the preferred material/configuration for the interim barriers at the SX tank farm.

Potential monitoring methods include instrumentation to directly or indirectly measure physical properties at a specific location and electrical and electromagnetic geophysical methods oriented at monitoring soil moisture or changes in properties that can be related to changes in soil moisture over larger areas/volumes.

Monitoring the volume of water diverted by the interim barrier was considered but not evaluated in detail. Because the barrier will evaporate a percentage of the precipitation that falls during short duration events that occur in the warm months, the measurement of the runoff volume would provide limited value. The weather station at the T farm combined with the geometry of the SX interim barriers can be used to report the volume of precipitation diverted by the interim barrier.

Potential monitoring methods that were evaluated for the demonstration barriers included:

- Measurement of soil properties; soil moisture content, soil water pressure, soil temperature, and soil water movement.
- Geophysical methods; electrical property measurement and electromagnetic.

Based on knowledge gained from monitoring at T and TY, only the HDU arrays and neutron monitoring are capable of detecting the small initial moisture changes due to barrier installation, and provide the longevity needed for barrier monitoring. The capacitance probes are also capable of detecting the small initial moisture changes, but have an operational life expectancy of only one to two years. The main limitation of the monitoring systems at T and TY farms is the maximum 10 m depth of the HDU installations. Both T and TY monitoring nests were designed to allow their monitoring nests to be extended beyond the original construction depths should monitoring results indicate that deeper monitoring is needed.

3.2 METHOD SELECTION

Monitoring for the north SX barrier will be performed through a combination of subsurface measurements coupled with visual inspection of the exposed barrier surface. Subsurface monitoring of the soil beneath the north SX barrier will be provided by measuring soil water pressure using HDUs and soil moisture content using neutron monitoring of existing drywells. Visual inspection of the exposed barrier surface will also be performed by periodic visual examination of the barrier surface and penetrations designed to collect and route storm water out

of the tank farm. Operator round sheets will be developed to document inspection of specific areas and features.

The HDU array under the north SX barrier will use a 10 m HDU array with HDUs located at depths of approximately 1 m, 3 m, 5 m, and 10 m. This array will allow a direct comparison to the monitoring results from T and TY barriers, and a comparison to the results from the south SX barrier.

Neutron monitoring will utilize existing vadose zone wells known locally as drywells. Three drywells near the HDU instrument nests will be logged to the full depth of the drywells. Logging will be performed using established equipment and methods. Logging frequency will be quarterly for the first year and annually thereafter or as deemed necessary by results of the drywell logging. The neutron monitoring will provide data that can be compared to the HDUs and will also provide the ability to collect moisture data in the event that the near surface soils are too wet for measurement with the HDU probes. Changes in the soil moisture content beneath the barrier are expected to change slowly; quarterly monitoring over the first year following construction will establish a baseline and the subsequent annual monitoring will serve to monitor the drying trend. Other types of geophysical logging are not included in the monitoring plan (i.e., spectral gamma logging) because the primary objective is to monitor the effectiveness of the barrier to reduce the moisture content below the barrier rather than to monitor contaminant migration.

Although not a required element of the interim barrier monitoring plan, the Tank Operations Contractor plans to perform neutron logging in the drywells and install the monitoring instruments prior to construction of the barrier in order to establish a pre-construction baseline.

Routine visual examination of the barrier surface and barrier details designed to collect and route storm water out of the tank farm will be performed. The routine visual examination will be performed through periodic walk down and visual assessment of the barrier surface for degradation (i.e., cracks, material separation at penetration locations, settling) that could lead to localized infiltration of rainwater and snowmelt.

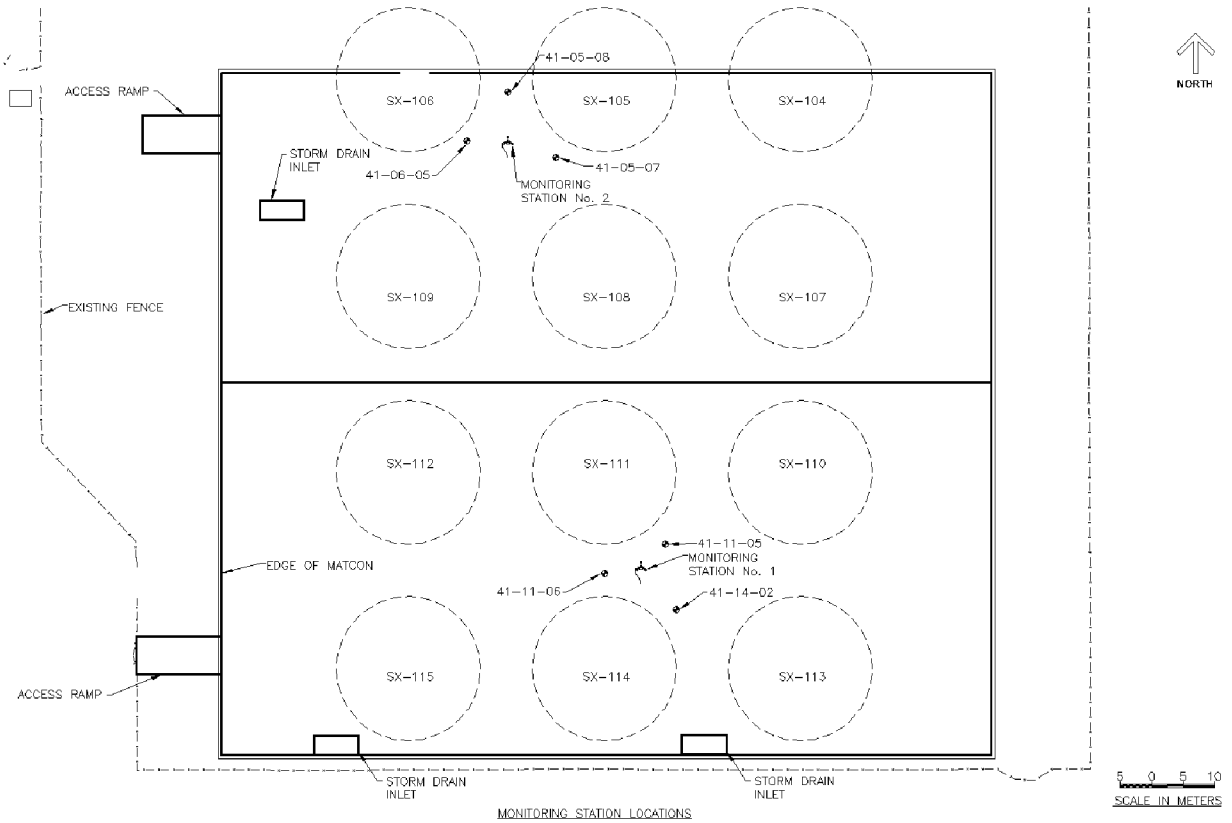
3.3 MONITORING SYSTEM LOCATIONS

Planned monitoring locations on the south and north interim barriers are shown in Figure 3. The south interim barrier location is shown in Figure 3 to provide information on the combined monitoring plans for both south and north interim barriers. Monitoring plans for the south interim barrier are described in RPP-PLAN-48439. These locations were selected to be well beneath the barrier footprint, away from known subsurface infrastructure, and away from above grade infrastructure that would likely have some open area that would provide for some water to penetrate beneath the barrier surface. Because of the difficulty in sealing all equipment penetrations, there is an allowance for some open area within the footprint of the barrier.

The monitoring station locations are approximate and the final location will be adjusted to provide clearance from potential interferences with below grade infrastructure based on a drawing review and a ground penetrating radar survey. The drywells identified in Figure 3 around each of the monitoring nests are the drywells that are planned to be surveyed using neutron moisture logging. Both of the monitoring locations are away from areas of significant cesium-137 contamination based on a review of RPP-7884. Although there is some concern

over the influence of the radiation field and/or high temperature associated on the monitoring instruments, the monitoring station locations selected are not expected to impede monitoring.

Figure 3. Planned Monitoring Locations for the SX Interim Barriers.



As shown in Figure 3 the drywells surrounding the planned instrument nests will be subject to neutron logging. Drywells on the north barrier selected for neutron logging include:

- 41-05-07
- 41-05-08
- 41-06-05.

3.4 EQUIPMENT SELECTION

In order to provide consistency between the existing T and TY interim barrier monitoring systems, equivalent instrumentation and dataloggers will be used. The following instruments will be utilized:

- Neutron Probe – Neutron logging of the existing drywells surrounding the instrument nests will be performed. Neutron logging is expected to provide data that can be compared to the data from the HDU sensors. Additionally, the neutron probes provide the ability to collect data under high moisture conditions that may exceed the range of the HDU sensors. Of the eight HDU probes installed at the TY interim barrier the two

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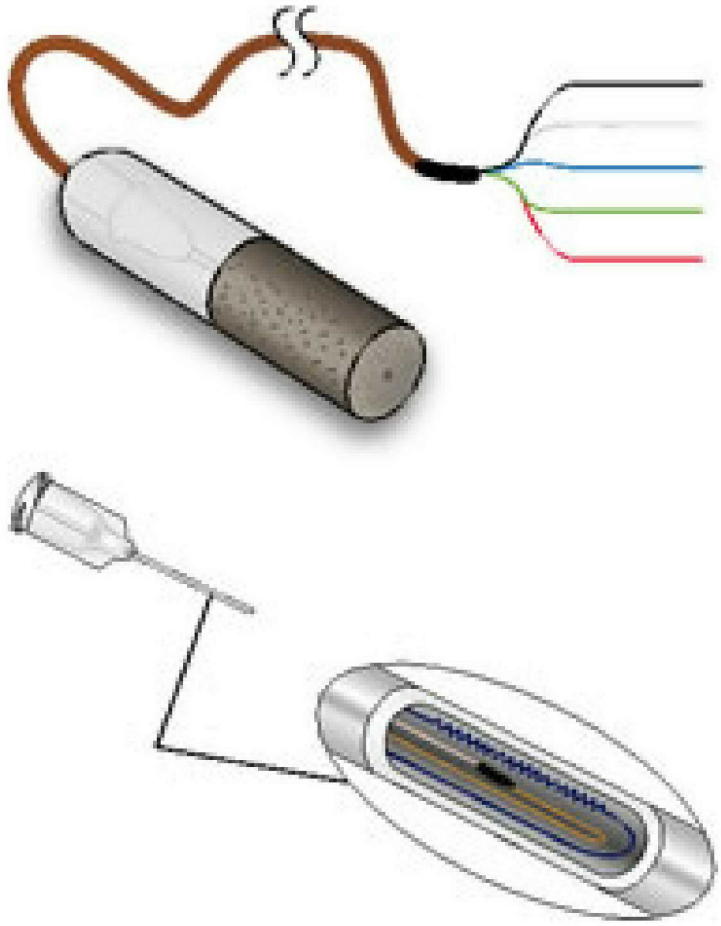

Source: Campbell Scientific Instruments. www.campbellsci.com.

Note: A 229 Heat Dissipation Matric Water Potential Sensor is shown at the top. The hypodermic assembly (without epoxy and ceramic) is shown just below. Cutaway view shows longitudinal section of the needle with heater and thermocouple junction.

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RPP-SPEC-47469, 2010, *SX Farm Interim Surface Barrier Subsystem Specification,* Revision 0, Washington River Protection Solutions, Richland, Washington.

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RPP-SPEC-49086, Rev. 0

241-SX Tank Farm South Interim Surface Barrier Construction Specification

Prepared by MJ Holm
Washington River Protection Solutions
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-08RV14800

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Key Words: SX farm, surface barrier, interim measure, SX farm south interim surface barrier construction specification.

Abstract: This document establishes the SX tank farm south interim surface barrier construction specifications. An interim infiltration barrier will be constructed over the SX tank farm to reduce vadose zone leak plume migration.

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241-SX TANK FARM SOUTH INTERIM SURFACE BARRIER CONSTRUCTION SPECIFICATION

May 5, 2011

Prepared by

Columbia Energy and Environmental Services, Inc.

Richland, Washington 99354

for

Washington River Protection Solutions, LLC

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SECTION 011000

SUMMARY

PART 1 GENERAL

1.1 PROJECT INFORMATION

A. Project: 241-SX Tank Farm South Interim Surface Barrier.

1. Project Location: Hanford Site, 200 West Area.

B. Owner: US Department of Energy Office of River Protection.

C. Contractor: Washington River Protection Solutions, LLC (WRPS)

D. The work consists of the following:

1. Introduction

The SX tank farm south interim surface barrier project will install a barrier over the southern area of the SX tank farm. The SX tank farm is located in the 200 West Area, in a controlled access area of the Hanford Site, approximately 30 road miles north of Richland, Washington.
This specification provides for construction of a modified asphalt barrier to cover the SX tank farm. The runoff water collected on the barrier will be collected and routed to an evapotranspiration basin located to the South of the SX tank farm. The majority of the Division 01 requirements will be addressed in the statement of work for construction of the SX tank farm interim surface barrier. Division 01 requirements that are specific to each sub-section will be described within that sub-section.

2. Summary of Work

Work consists of furnishing supervision, labor, equipment, materials, transportation, and services for procurement, receiving, handling, storage, protection, fabrication, installation, inspection, quality assurance and testing to provide a modified asphalt barrier over the southern area of the 241-SX tank farm in accordance with H-14-109330. The following list of work elements are associated with the SX interim surface barrier and are intended to provide a broad overview and are not all inclusive:

a. Evapotranspiration Basin

1) Excavation of evapotranspiration basin
2) Installation of geomembrane liner in evapotranspiration basin
3) Installation of drain line header and perforated drain line in the basin
4) Back fill of the evapotranspiration basin
5) Planting the evapotranspiration basin.

b. Stormwater Collection and Routing

1) Excavation and placement of stormwater catch basins and drain lines within the farm.
2) Excavation and placement of drain line between the tank farm and the evapotranspiration basin.

c. In Farm Subgrade Preparation

1) Installation of pipe sleeves and utility vault risers around tank riser penetrations and existing tank farm equipment.
2) Excavation and earthwork necessary to establish the subgrade within the SX tank farm.

d. Installation of the MatCon® (modified asphalt) barrier in the SX tank farm.

3. Multiple Contract Summary

This specification has been divided into three discrete scopes of work to accomplish the construction of the SX tank farm interim surface barrier. These work scopes include: earthwork for the barrier and evapotranspiration basin; exterior improvements including installation of the asphalt barrier; and utilities including installation of the geomembrane liner in the evapotranspiration basin and location of drainage piping.

4. Work Sequence

The work defined in this specification has been divided into logical sub-sections due to scheduling and weather concerns. The plan is to perform construction activities in the early summer 2011. Planting of vegetation in the evapotranspiration basin will be scheduled in late fall or early spring, depending on the weather conditions following the completion of the evapotranspiration basin.

E. Work by Owner: WRPS will provide specific support defined in the Statement of Work.

F. Work Under Separate Contracts:

Not applicable.

G. Owner-furnished Items: The following products will be furnished by Owner and shall be installed by contractor as part of the work:

There is no government furnished material identified for this work.

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H. Owner-furnished Equipment: The following products will be furnished by Owner and shall be utilized by contractor as part of the work:

Government furnished equipment, if any, will be identified in the Statement of Work.

1.2 WORK RESTRICTIONS

Work restrictions are defined in the statement of work.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION 011000

SECTION 311000

SITE CLEARING

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. Utility Locator Service: Confirm with Buyer that prerequisite utility location surveys have been completed before site clearing and excavation.

B. Do not commence site clearing operations until temporary dust control measures are in place.

1.2 DEFINITIONS

A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface within the project limits and outside of the tank farm.

C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2 inch(es) (in.) calliper to a depth of 6 in. below sub-grade within the project limits and outside the tank farm.

D. Project Limits: Areas, as shown or specified, within which work is to be performed.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PREPERATION

A. Protect and maintain benchmarks and survey control points from disturbance.

B. Protect site improvements to remain from damage. Restore damaged improvements to condition existing before start of site clearing.

C. Provide temporary dust control measures in accordance with the approved dust control plan.

3.2 SITE CLEARING

A. Clear and grub areas actually needed for waste disposal, borrow, or site improvements within limits shown on or specified outside of modified asphalt

barrier limits and evaporation basin limits. Minimize disturbances outside of the tank farm to areas necessary for equipment access and laydown.

B. Do not injure or deface vegetation that is not designated for removal.

C. Dispose of waste materials, including trash, debris, and excess topsoil, at direction of the buyer. Burning waste materials on-site is not permitted.

END OF SECTION 311000

SECTION 312000

EARTH MOVING

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals

1. Certified test results from independent civil testing laboratory.
2. Excavation Plan for approval a minimum of 2 weeks prior to mobilization that addresses:
   a. Manufacturer's data sheet for compaction equipment.
   b. Methods and sequencing of excavation.
   c. Numbers, types, and sizes of equipment proposed to perform excavations.
   d. Anticipated difficulties and proposed resolutions.
   e. Reclamation of onsite spoil disposal areas.
3. Dust Control Plan: The contractor shall submit a dust control plan for approval a minimum of 2 weeks prior to mobilizing equipment. The dust control plan shall address:
   a. Continuous control of dust generation during excavation.
   b. Control of wind generated dust in disturbed areas.
   c. Plans to water haul roads/access roads.
   d. Plans to stabilize spoil pile.
   e. Identification of equipment that will be available for dust control.
4. Backfill, Compaction, and inspection procedure: As an option to the requirements in Section 3.2 and 3.3 the contractor may submit for approval a procedure for placement, compaction, and inspection requirements. Include maximum lift height, moisture content requirements, list of compaction equipment to be used, include compaction effort and inspection and surveillance requirements.

B. An area just to the south of the SX tank farm evapotranspiration basin has been identified for stockpiling excess soil. Specific limits shall be coordinated through the WRPS construction manager.

C. Locations and areas for temporary construction facilities and equipment laydown areas adjacent to the construction site shall be coordinated through the WRPS construction manager.

1.2 REFERENCES

A. ASTM International (ASTM): D1557, *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort* (56,000 ft-lb/ft^3).

B. ASTM International (ASTM): D2487, *Standard Practice for Classification of Soils for Engineering Purposes* (Unified Soil Classification System).

C. ASTM International (ASTM): D2940, *Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports.*

D. ASTM International (ASTM): D4253, *Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.*

E. ASTM International (ASTM): D4254, *Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.*

F. ASTM International (ASTM): D6938, *Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods* (Shallow Depth).

1.3 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent (%), of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.

2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Buyer.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM® Standard specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4-in. sieve.

C. Prepared Ground Surface: Ground surface outside of modified asphalt barrier system footprint after completion of clearing and grubbing, stripping of topsoil, excavation to grade, and compaction of sub-grade.

D. Completed Course: A course or layer that is ready for next layer or next phase of work.

E. Lift: Loose (un-compacted) layer of material.

F. Well-Graded:

1. A mixture of particle sizes with no specific concentration, or lack thereof of one or more sizes used to define material type that, when compacted,

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produces a strong and relatively incompressible soil mass free from detrimental voids.

G. Excavation:

1. Common (unclassified) Excavation: Removal of material not classified as contaminated soil.

2. Classified Excavation: Removal of contaminated soil material inside the boundary of the SX tank farm project limits.

H. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.

I. Subgrade:

1. For areas under the modified asphalt barrier footprint, the subgrade is the prepared surface where the asphalt will be placed.

2. All other areas (outside the modified asphalt barrier limits), subgrade is the layer of existing soil after completion of clearing and grubbing, prior to placement of the evaporation basin liner or placement of stormwater system components.

1.4 SEQUENCING AND SCHEDULING

A. Complete applicable work specified in Sections 311000, Site Clearing, prior to excavation and subgrade preparation outside of modified asphalt barrier limits.

B. Coordinate subgrade preparation with installation of modified asphalt barrier system inside of the barrier footprint.

C. Coordinate subgrade preparation with installation of the stormwater collection, routing, and discharge system for other areas.

1.5 QUALITY ASSURANCE

NOTE: The following identify hold points for inspection and/or testing activities:

A. Notify Buyer prior to initiating fill/backfill activities; following completion of the first lift of material placement; and following completion of each subsequent lift.

B. Notify Buyer when backfilling operations are resumed after a period of inactivity (more than 3 consecutive working days).

C. Notify Buyer when soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.

D. Notify Buyer whenever fill material appears to be deviating from specifications.

E. Notify Buyer when prepared subgrade in area to be covered by the modified asphalt barrier system is compacted and thought to be ready for modified asphalt

installation. Also notify Buyer for work resumed after a period of extended inactivity (more than 3 consecutive working days).

F. Notify Buyer when prepared subgrade under the evaporative basin is compacted and ready for installation of the geo-membrane liner.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Prepare subgrade when unfrozen and free of standing water, ice, and snow.

PART 2 PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM; free of rock or gravel larger than 3 inch in any dimension, debris, waste, frozen materials, vegetation, or other deleterious matter.

B. Backfill and Fill: Satisfactory soil materials.

C. Base Courses: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand in accordance with Washington State Department of Transportation Specification 9.03-4 of M 41-10, *Standard Specifications for Road, Bridges, and Municipal Construction*.
Screen size 5/8 in. minus.

NOTE: This is for new base course material. There may be areas within the footprint of the interim surface barrier where the existing gravel surface will be utilized as the base course.

D. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100% passing a 1-in. sieve and not more than 8% passing a No. 200 sieve.

E. Drain Field Bedding Course: Scalping Sand (American Rock Products) with 100% passing a 1/2 in. sieve and less than 5% passing a 200 sieve.

F. Evapotranspiration Basin Fill: Native soils removed from the evapotranspiration basin and stockpiled. Obtain WRPS Project Engineering approval of stockpile prior to placement in basin.

G. Controlled Density Fill (CDF): CDF or controlled low-strength material (CLSM) material with a design compressive strength of 50 to 100 lb/in2 and a cast density of no greater than 130 lb/ft3 may be optionally used as backfill for the following:

1. Anchor trench securing the evaporation basin liner.

2. Stabilizing in-farm features designated on the design drawings.

3. Backfilling the storm water drain line.

H. Water for Moisture Conditioning:

1. Coordinate with Buyer for suitable location to obtain raw or potable water for use in conditioning materials for compaction.

2. Use the least amount of moisture for fill material inside the SX farm fence line limits to achieve the required compaction level specified.

3. Do not allow water outside the tank farm fence line to run into the tank farm areas inside the fence line.

I. Compactor as approved by Buyer.

PART 3 EXECUTION

3.1 EARTHWORK

A. Vibratory modes on roller compactors are not permitted for use within the boundary of the tank farm. Vibratory modes on compaction equipment must be physically disconnected prior to use within the tank farm. Plate whackers for localized compaction are acceptable.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Prevent surface water from entering excavations, from ponding on prepared subgrades, and from flooding project site and surrounding area.

D. Excavate to subgrade elevations outside of the tank farm. Notify Buyer if infrastructure or unexpected materials are encountered.

E. Stockpile excavated material that is suitable for use as fill or backfill until material is needed. Material excavated inside the SX farm fence line limits (classified excavation) shall be used inside the fence line at designated areas in coordination with the Buyer. Material excavated outside the SX farm fence limits (unclassified excavation) shall be stockpiled outside of fence or directly transported inside the fence for use as fill in the construction of the SX farm interim barrier. Segregate material removed from top 6-8 inches for use as the final lift of backfill within the basin. Coordinate with Buyer.

1. Do not block roads or access routes or stockpile material adjacent to trenches and other excavations unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads

2. Do not stockpile excavated materials near or over existing facilities, buried tanks, adjacent property, or completed work, if weight of stockpiled material could induce excessive settlement or damage facilities.

F. Excavate to subgrade elevations required for pavements.

G. Utility Trenches: Excavate trenches to indicated slopes, lines, depths, and invert elevations. Maintain 12 in. of working clearance on each side of pipe or conduit.

1. Place, compact, and shape bedding course to provide continuous support for pipes over rock and other unyielding bearing surfaces and to fill over excavated soils.

2. Place and compact initial backfill of satisfactory soil material or sub-base material, free of particles larger than 1 in., to a height of 8 in. over the utility pipe. Place and compact final backfill of satisfactory soil material to final subgrade.

H. When subgrade or existing ground surface to receive fill has a density less than that required for fill, break up ground surface, pulverize, moisture-condition or aerate soil, and recompact. Excavate and replace unsuitable material with suitable material.

3.2 BACKFILL

A. Do not stockpile or otherwise pile fill material for barrier construction inside the SX farm fence limits. Limit concentrated fill loads in this area to a maximum of 3 feet (ft) in any localized area.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even. Protect all survey monuments at all times.

C. Tolerances

1. Final lines and grades: within a tolerance of 0.1 ft unless dimensions or grades are shown or specified otherwise.

2. Grade to establish and maintain slopes and drainage as shown on design drawings.

D. Damage to any structures caused by settlement of fill or backfill material shall be immediately reported to Buyer. Repair of such damage shall be accomplished using Buyer-approved method.

E. Backfill around Vertical Features

1. Carefully place fill after installation of vault extension, pipe, or clearance detail in accordance with the design drawings.

2. Within 3 ft of risers, vaults, and other existing vertical features, compact using hand-held equipment using controlled method outlined in RPP-19407, Attachment B.

3. Smaller compactor units may be used in areas where access is limited and the larger compactor cannot access.

F. Bring subgrade to proper grade and cross-section and uniformly compact surface. Place backfill and fill in layers not more than 8 in. in loose depth at optimum moisture content. Compact each layer per approved backfill, compaction, and

inspection procedure or compact each layer under pavements to 95% of maximum dry unit weight according to ASTM D 1557; anchor trench zones to 95%; evapotranspiration basin to 85%; elsewhere to 90%. Trim sub-bases to required lines and grades.

G. Grade areas to a smooth surface to cross sections, lines, and elevations indicated. Grade areas under pavements to ± 1/2 in. Leave final surface grade smooth and without ruts. Surfaces shall not have holes, depressions more than 1 in. in 12-in. width, or protrusions extending above the surface more than 1 in.

H. Under pavements place sub-base course material on prepared subgrades and compact at optimum moisture content to required grades, lines, cross sections, and thicknesses.

I. Allow testing agency to inspect and test each subgrade and each fill or backfill layer and verify compliance with requirements.

J. Obtain asphalt contractors approval of subgrade prior to deployment of modified asphalt.

K. Stabilize all exposed cut and fill slopes with a minimum of 3 in. of bedding course material, spread evenly, do not compact.

L. After backfilling the evapotranspiration basin is completed, cover all exposed portions of the evapotranspiration basin liner on the side slopes and the vehicle access ramp with a minimum of 3 in. of bedding course material (1 in. minus crushed rock).

M. Coordinate with Buyer for management and disposal of contaminated soil materials.

3.3 FIELD QUALITY CONTROL TESTING/SURVEYING

A. Gradation:

1. Test if variation in gradation is occurring, or if material appears to depart from specifications, as directed by Buyer.

2. If test results indicate material does not meet specification requirements, terminate material placement until corrective measures are taken.

3. Remove material placed in work that does not meet specification requirements.

B. In-Place Density Tests: In accordance with ASTM D6938. During placement of materials, test as follows:

1. Earthfill: Five per lift within footprint of the asphalt barrier, or more frequently as required by Buyer.

END OF SECTION 312000

SECTION 321216

ASPHALT PAVING

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product data and the job mix formula shall be submitted in writing by the contractor to the WRPS Construction Manager at least three (3) weeks prior to the start of paving operations. The certification(s) test reports shall show the appropriate AASHTO/ASTM test(s) for each material, test results, and a statement that the material meets the specification requirement. Submittals shall include as a minimum:

1. Mix designation/identification number.
2. Plant where mix will be produced.
3. MatCon® binder certification.
   a. Type of binder
   b. Certification from supplier of conformance with requirements for MatCon
   c. Temperature-viscosity relationship of the MatCon binder asphalt cement
   d. Minimum mixing temperature (°F)
   e. Minimum compaction temperature (°F).
4. Coarse Aggregate Certified Test Reports:
   a. Source, location, and type of aggregate
   b. Angularity
   c. Bulk and apparent specific gravity
   d. Flat and elongated particles
   e. Soundness
   f. Toughness.
5. Fine Aggregate Certified Test Reports:
   a. Source, location, and type of aggregate
   b. Bulk and apparent specific gravity

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c. Liquid limit

d. Plastic index

e. Percent natural sand (if used)

f. Sand equivalent

g. Soundness

h. Toughness.

6. Anti-strip agent (if required):

   a. Certification

   b. Percentage by weight.

7. Percentage of MatCon asphalt binder by weight.

8. Proportions and percentage of aggregate gradations by weight.

9. Temperature of mix when discharged from the mixer.

10. Maximum specific gravity at the target binder content.

11. Marshall Compaction data in accordance with recommendations given in The Asphalt Institute MS-2 Manual.

12. Bulk specific gravity at design binder content.

13. Air voids content at design binder content.

14. Voids in mineral aggregate at design binder content.

15. Voids filled with asphalt at design binder content.

16. Graphical plots of air voids, voids in the mineral aggregate, voids filled with asphalt, ratio of fines to effective binder content, and unit weight verses asphalt content. Plots shall indicate values at –0.5% design asphalt content, design asphalt content, and +0.5% design asphalt content.

17. Tensile strength ratio (TSR) and worksheets (AASHTO T283).

18. Certification by MatCon, Inc. that the binder and mix design meets the requirements for MatCon materials.

19. The mix design shall meet the requirements specified in RPP-SPEC-47469 for vehicle loads (the SX farm interim surface barrier should be sufficiently robust to accommodate vehicle loads based on tire pressures of 100 pounds per square in. without damage or permanent deformation of the barrier surface).

20. The mix design shall address variations in mix design and binder variance to accommodate equipment access within the footprint of the SX interim surface barrier.

NOTE: Roller access to areas between tank pits and adjacent to tank equipment will be limited.

21. Mix design submittal shall be stamped by a professional engineer registered in the State of Washington.

22. Physical site inspection following preparation of subgrade under 312000.

23. Structural assessment of tank farm areas to be paved using a falling weight deflectometer (FWD) or alternately a light weight deflectometer (LWD).

24. Mechanistic pavement design based on the results of the physical site inspection. This consists of a structural design of the MatCon paving system.

25. Paving plan to minimize cold joints, material waste, and onsite time. Paving plan submittal shall be stamped by a professional engineer licensed in the state of Washington.

26. Quality control plan (see Section 1.2).

27. Material safety data sheet (MSDS) data for all asphalt components, all sealants, and associated products used for installing the hot mix asphalt (HMA).

B. The WRPS construction manager may request samples for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

C. MatCon mix designs and job mix formula shall be submitted in writing by the contractor to the WRPS construction manager at least three (3) weeks prior to the start of paving operations.

D. The contractor shall submit samples to the WRPS construction manager, upon request, testing for job mix formula verification.

E. The job mix formula for each mixture shall be in effect until modified in writing by the WRPS construction manager. Should a change in mix or sources of materials be made, a new job mix formula must be tested and resubmitted for approval by the WRPS construction manager before the new mix is used.

F. The certified nuclear gauge operator qualifications shall be submitted to and approved by the WRPS construction manager. If during the life of the contract the gauge operator changes, the contractor shall resubmit new qualifications to the WRPS construction manager.

1.2 QUALITY ASSURANCE

A. The HMA contractor shall submit a quality control plan for approval at the commencement of the project. This plan shall be submitted at least 4-weeks before commencement of installation operations on site. The quality control plan shall define the control measures necessary to ensure the interim surface barrier

complies with the design requirements. The quality control plan shall address the following:

1. Independent laboratory testing.
2. Binder manufacturing.
3. HMA facility (aggregate properties, storage of materials, HMA manufacture, and HMA transport).
4. HMA placement (training, thickness and temperature control, compaction field density measurements, cold joint construction, and surface finishing and hand work).
5. Sampling and testing.

B. At the completion of project, the HMA contractor shall submit a final quality assurance report to the WRPS construction manager, which locates all grids, sample locations, and appurtenances / structures that were paved during the course of the project.

PART 2 PRODUCTS

2.1 DESCRIPTION OF SYSTEMS

A. MatCon HMA is a mixture produced with MatCon binder and aggregate to provide a material with a low hydraulic conductivity and longevity which will function as an environmental cap for a contaminated site. The MatCon binder and construction oversight are available from MatCon, Inc. MatCon, Inc., point of contact is Jerry Thayer (425.239.3332).

B. Reference minimum values and other typical properties of MatCon HMA provided for information only are as follows:

Reference values:

- Hydraulic Conductivity (maximum) $k < 1x10^{-7}$ cm/sec (ASTM D 5084)
- Air Voids (Maximum – average 2,000 ft^2), 3% (ASTM D 2041 ASTM D 3203)
- Tensile Strength Ratio (minimum): 80% (AASHTO T283)
- Typical values:
- Bending resistance (minimum): .79 in. deflection without cracking (MatCon, Inc. method)
- Tensile strength at -4 degrees Fahrenheit (°F) (minimum): 3.00MPa (AASHTO TP-9)
- Thermal Crack Resistance (maximum): -22 °F (AASHTO TP-10)
- Depth of Penetration to Fuel (maximum): .79 in. (ASTM 1856)
- Wheel tracking at 147.2 °F (maximum): .20 in. (Asphalt Pavement Analyzer)

- Performance history: >10 years of successful performance history with a minimum of 25 acres of installation.

NOTE: Verification testing of reference values is not required.

C. MatCon HMA is produced in accordance with a Quality Control Plan which incorporates additional guide specifications developed by MatCon, Inc. This plan shall be submitted in accordance with the requirements of paragraph 1.2 of this specification.

2.2 MATERIALS

A. General Requirements

1. MatCon Inc will provide the MatCon binder. The binder will be pumped into empty storage tanks.

2. The various mineral materials may be furnished in whole or in part by the contracting agency for the manufacture of MatCon HMA, or the contractor may be required to furnish them. If the contracting agency does not provide any of these mineral materials, it shall be understood that the contractor shall furnish such materials in the amounts required for the designated mix. Mineral materials include coarse and fine aggregates, blending sand, and mineral filler.

3. Production of aggregates, stockpiling and the removal of aggregates from stockpiles shall comply with the requirements of Paragraph 2.2.D.

B. Anti-Stripping Additive

1. When directed by the MatCon Inc Project Engineer, heat-stable liquid anti-stripping additive shall be added to the MatCon HMA. At the option of the contractor, the anti-stripping additive can be either added to the liquid binder or sprayed on the aggregate on the cold feed. Once the process and type of anti-stripping additive proposed by the contractor have been approved by MatCon Inc, the process, brand, grade, and amount of anti-stripping additive shall not be changed without approval of the MatCon Inc Project Engineer.

2. When liquid anti-stripping additive is added to the liquid asphalt, the percentage by weight will be designated by MatCon Inc.

3. The use of another process or procedure for adding anti-stripping additive to the asphalt mix will be considered based on a proposal from the contractor.

C. Mineral Filler

1. Mineral filler, when used in MatCon HMA, shall conform to the requirements of AASHTO M17.

D. Aggregates

1. General Requirements

   a. Aggregates used in MatCon HMA shall be manufactured from ledge rock, talus, or gravel. The material from which they are produced shall meet the following test requirements:

ASTM C 131 LA Wear	30% maximum loss
ASTM C 127 SPG & Absorb Coarse Agg.	2% maximum absorption
ASTM C 128 SPG & Absorb Fine Agg.	2% maximum absorption
ASTM D 2419 Sand Equivalent	40% minimum.

   b. Aggregates shall be uniform in quality, substantially free from wood, roots, bark, extraneous materials, and adherent coatings. The presence of a thin, firmly adhering film of weathered rock will not be considered as coating unless it exists on more than 50% of the surface area of any size between consecutive laboratory sieves.

   c. Aggregate removed from deposits contaminated with various types of wood waste shall be washed, processed, selected, or otherwise treated to remove sufficient wood waste, so that the oven-dried material retained on a1/4 -in. square sieve shall not contain more than 0.1% by weight of material with a specific gravity less than 1.

2. Test Requirements for Aggregates

   Aggregate for MatCon HMA shall meet the following test requirements:

   a. The fracture requirements are at least one fractured face on 75% of the material retained on each specification sieve size U.S. No. 10 and above, if that sieve retains more than 5% of the total sample.

   b. When material is being produced and stockpiled for use on a specific contract the fracture and sand equivalent requirements shall apply at the time of stockpiling. When material is used from a stockpile that has not been tested as provided above, the requirements for fracture and sand equivalents shall apply at the time of its introduction to the cold feed of the mixing plant.

   c. Contractor may submit current test results from a certified testing laboratory for materials that were tested to meet state department of transportation or other agency requirements to meet the requirements of this specification.

3. Gradation: The contractor may furnish aggregates for use on the same contract from a single stockpile or from multiple stockpiles. The gradation of the aggregates shall be such that the completed mixture complies in all respects with the pertinent requirements of Paragraph 2.2.D.5. Acceptance of the aggregate gradation shall be based on samples taken from the final mix.

4. Blending Sand

   a. In the production of aggregate for MatCon HMA there is often a deficiency of material passing the U.S. No. 40 sieve. When this occurs, blending sand in an amount specified by MatCon, Inc., may be used to make up this deficiency, provided that a satisfactory final mix is produced, including fracture requirements.

   b. Blending sand shall be clean, hard, sound material, with either naturally occurring sand or crusher fines, and must be material which will readily accept a MatCon binder coating. The exact grading requirements for the blending sand shall be such that, when it is mixed with an aggregate, the combined product shall meet the requirements of Paragraph 2.2.D.5. Blending sand shall meet the following quality requirement:

      1) Sand Equivalent 40% minimum
      2) The materials laboratory shall test blending sand before it will be approved for use.

5. Proportions of Materials

   a. The materials of which MatCon binder is composed shall be of such sizes, gradation, and quantities that, when proportioned and mixed together, they will produce a well-graded dense impermeable mixture (or an open graded very permeable drainage layer using a modified gradation and shall be covered by special provision) within the requirements listed in the table that follows. All sieve testing shall be in accordance with ASTM C 136.

Table 1. Recommended Aggregate Gradation for Dense MatCon® HMA.

Sieve Size	Percent Passing Based on Total Wt. of Aggregate
1/2 in.	100
3/8 in.	85-100
No. 4 Sieve	60-80
No. 8 Sieve	40-60
No. 16 Sieve	25-40
No. 30 Sieve	15-25
No. 50 Sieve	11-20
No. 100 Sieve	7-15
No. 200 Sieve	3-8

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6. Basis of Acceptance

a. The MatCon HMA will be accepted based on its conformance to the project job mix formula (JMF). For the determination of a project JMF, the contractor shall submit to MatCon Inc, representative samples of the various aggregate and blend sand, to be used along with the gradation data showing the various aggregate stockpile averages and the proposed combining ratios and the average gradation of the completed mix. Based on this submittal from thecontractor, MatCon Inc will determine the MatCon binder content, anti-strip requirement, and retention factor in the mix design process. Using the representative samples submitted and proposed proportion of each, trial mix tests will be run to determine the percentage of MatCon binder, by weight, to be added. The JMF thus established shall be changed only upon order of MatCon Inc.

b. The intermingling of MatCon HMA produced from more than one JMF is prohibited. Each paver path of MatCon HMA placed during a working shift shall conform to a single job mix formula established for the class of mixture specified unless there is a need to make an adjustment in the JMF.

c. No mixture shall be produced for use on the project until the amount of MatCon binder and anti-strip additive to be added has been established.

d. Job mix formula (JMF) tolerances and adjustments:

1) Tolerances: After the JMF is determined, the several component of the mixture at the time of acceptance shall conform to the following tolerances:

Table 2. Tolerances.

Component of Mixture	Tolerance Limits
Aggregate passing 1/2", and 3/8" Sieves	Table 1 Limits
Aggregate passing No. 4 Sieve	±5%
Aggregate passing No. 8 Sieve	±4%
Aggregate passing No. 16 Sieve	±4%
Aggregate passing No. 30 Sieve	±4%
Aggregate passing No. 50 Sieve	±3%
Aggregate passing No. (100) Sieve	±3%
Aggregate passing No. (200) Sieve	±2%
MatCon binder	±0.3%
Temperature of Mixing	±25°F

2) Aggregates Adjustments: Upon written request from the contractor, the project engineer, with MatCon, Inc. concurrence may approve field adjustments to the JMF including the contractor's proposed combining ratios for mineral aggregate stockpiles and blend sand. The maximum allowed gradation change shall be 2% for the aggregate retained on the No. 8 sieve and above, 1% for the aggregate passing the No. 16, No. 30, and No. 50 sieves, and 0.5% for the aggregate passing the No. 100 and No. 200 sieve. The project engineer may make these field adjustments to the JMF provided the change will produce material of equal or better quality. The above adjustments and/or any further adjustments as ordered by the engineer will be considered as a new JMF. Adjustments beyond these limits will require development of a new JMF. The adjusted JMF ± the allowed tolerances shall be within the range of the broadband specifications.

7. Gradation: The contractor may furnish aggregates for use on the same contract from a single stockpile or from multiple stockpiles. The gradation of the aggregates shall be such that the completed mixture complies in all respects with the pertinent requirements of Paragraph 2.2.D.5.a.

E. Stockpiling Aggregates

1. Description: This work shall consist of placing the specified aggregates in the stockpiles at the sites and in the amounts as shown in the plans or as approved by the engineer. This section also includes the requirements pertaining to the removal of aggregates from stockpiles.

2. Construction of Stockpiles

a. Stockpiles in excess of 200 cubic yards shall be built up in layers not more than four (4) ft in depth. Stockpile layers shall be constructed by trucks, clamshells, or other methods approved by the engineer. Pushing aggregates into piles with a bulldozer will not be permitted. Each layer shall be completed over the entire area of the pile before depositing aggregates in the succeeding layer. The aggregate shall not be dumped so that any part of it runs down and over the lower layers in the stockpile. The method of dropping from a bucket or spout in one location to form a cone shaped pile will not be permitted. Any method of placing aggregates in stockpiles, which in the opinion of the engineer, breaks, degrades, or otherwise damages the aggregate, will not be permitted. Stockpiles of less than 200 cubic yards shall be piled in a manner to prevent segregation of the various sizes of material.

b. No equipment other than pneumatic tired equipment shall be used in constructing the stockpiles of processed or manufactured aggregates.

c. Stockpiles of different types or sizes of aggregate shall be spaced far enough apart, or separated by suitable walls or partitions, to prevent the mixing of the aggregates. Aggregate shall not be deposited where traffic, vehicles, or contractor's equipment will either run over or through the piles, or in any way cause foreign matter to become mixed with the aggregates.

3. Removing Aggregates from Stockpiles

a. Aggregates shall be removed from stockpile in a manner to avoid separation of sizes or admixture of dirt or foreign material. The engineer will approve the method and equipment used for loading.

b. No equipment other than pneumatic tired equipment shall be used on stockpiles of processed or manufactured aggregates in removing the materials from the stockpiles. When removing materials from the face of the stockpile, the equipment shall be operated in a manner to face-load from the floor to the top of the stockpile to obtain maximum uniformity of material.

F. Penetration Flashings: See Section 321273.

G. Bollards: Use schedule 40 steel pipe with yellow plastic sleeve; cored style.

2.3 EQUIPMENT

A. Hauling Equipment

1. Trucks used for hauling MatCon HMA shall have tight, clean, smooth metal beds, which have been thinly coated with a minimum amount of paraffin oil, or other approved material to prevent the mixture from adhering to the beds. Each truck shall have a cover of canvas or other suitable material of sufficient size to protect the mixture from the weather.

2. When dump truck beds are sprayed with oil, or other approved release agent, the excess oil shall be drained prior to loading with the asphalt mixture. For hopper trucks, the conveyer shall be in operation during the process of oiling the bed.

B. Pavers

1. Pavers used to install MatCon HMA shall be self-contained, power-propelled units, provided with an activated heated screed or strike-off assembly, and capable of spreading and finishing courses of MatCon HMA in panel widths applicable to the specified typical section and thicknesses shown in the Plans.

NOTE: Pavers with open flame (e.g., propane fired heaters) are not acceptable for use in the tank farm without specific approval from WRPS.

2. The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, segregating, or gouging the mixture. Any bolt-on or hydraulic extensions shall produce the same results including ride, density, and surface texture as the screed or strike off assembly. Hydraulic extenders without screeds, augers, and vibration shall not be used.

3. The transverse slope controller shall be capable of maintaining the screed at the desired slope within ± 0.1%. The paver shall be equipped with automatic feeder controls, properly adjusted to maintain a uniform depth of material ahead of the screed.

C. Rollers and Compactors

1. Rollers shall be of the steel wheel or pneumatic tire type, in good condition, capable of reversing without backlash, and shall be operated at speeds slow enough to avoid displacement of the mixture. The number and weight of rollers shall be sufficient to compact the mixture as required in Paragraph 3.5. The use of equipment, which results in excessive crushing of the aggregate, will not be permitted. Rollers producing pickup, washboard, and uneven compaction of the surface or other undesirable results will be rejected. Compaction, in areas too small for the use of conventional sized rollers, shall be achieved using vibratory plate compactors or other approved equipment.

2. The following specifications shall apply to the various types of rollers:

a. Vibratory Rollers. Vibratory rollers will not be permitted to operate in the vibratory mode and the vibratory feature must be physically disconnected.

b. Pneumatic Tired Rollers

1) The maximum rate of travel shall be limited to five (5) miles per hour (mph).

2) Skirts shall be firmly affixed to the perimeter of the roller and shall uniformly extend to within 1 in. of the pavement surface.

c. Steel Wheel Rollers

3) The maximum rate of travel shall be limited to four (4) mph.

2.4 MIX DESIGN

A. The contractor shall obtain representative samples from mineral aggregate stockpiles and blend sand sources to be used for MatCon HMA production,

submitting them to MatCon, Inc., for development of a mix design and job mix formula.

B. The contractor shall allow 30 working days for approval of the mix design once the material has been received by MatCon, Inc. Additional time may be required if the proportions will not make an adequate design as determined by MatCon, Inc. The contractor is also advised that production of MatCon HMA shall not commence until the job mix design has been established. Expedited mix designs may be performed provided arrangements are made in advance with MatCon, Inc.

2.5 SOURCE QUALITY CONTROL

A. Prior to lay-down, the following shall be done at the HMA facility or Plant:

1. Each MatCon binder delivery truck shall be sampled at the HMA facility for temperature. The sample taken shall be retained by MatCon Inc.

2. Each MatCon HMA delivery truck shall be sampled at the HMA facility for temperature and visually inspected for uniformity.

3. The HMA facility storage tanks containing the MatCon binder shall be tested hourly for temperature.

B. General: The dense-graded MatCon HMA will be evaluated for quality of gradation and binder content per the approved QA plan.

C. MatCon HMA

1. Sampling

a. A sample for testing and compliance will not be obtained from either the first or last 25 tons of mix produced in each production shift.

b. Samples for compliance of gradation and binder content will be obtained on a random basis from the hauling vehicle.

2. Definition of Sampling: Sampling and testing for acceptance shall be performed on a random basis at a minimum frequency of one sample for each sub lot of 500 tons, or per 0.5 acres, or a minimum of 3 per day.

3. Testing of MatCon HMA samples collected at the HMA facility prior to hauling to the site shall include:

a. Gradation

b. Binder content

c. Rice maximum density

d. Temperature.

D. Reject Mixture

1. Rejection by Contractor: The contractor may, prior to sampling, elect to remove any defective material and replace it with new material at no expense to the contracting agency. Any such new material will be sampled, tested, and evaluated for acceptance.

2. Rejection without Testing: The WRPS construction manager may, without sampling, reject any batch, load, or section of the cap or liner that appears defective in gradation or MatCon binder content. Material rejected before placement shall not be incorporated into the work. Any rejected section of the work shall be removed.

PART 3 EXECUTION

3.1 CONTRACTOR PLANS

A. The contractor shall provide a paving plan for approval by the WRPS construction manager at least five (5) days prior to the planned paving start date.

3.2 MIXING

A. The prepared aggregates shall be combined in the mixer in the amount of each fraction of aggregates as specified or as directed by the MatCon Inc Project Engineer. The asphalt material shall be measured or gauged and introduced into the mixer in the amount determined by the MatCon Inc Project Engineer.

B. After the required amounts of aggregate and asphalt material have been introduced into the mixer, unless otherwise specified, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the binder material throughout the aggregate is ensured. Wet mixing time shall be sufficient to produce 95% coated particles. When discharged, the temperature of the mix shall not exceed the mix design temperature. A maximum water content of 1% in the mix, at discharge, will be allowed providing the water causes no problems with handling, stripping, or flushing. In this case, the moisture content shall be reduced as directed by the WRPS construction manager.

C. The MatCon binder shall be heated to a range between 310 and 360 °F as determined by the mix design. The asphalt shall be heated in a manner that will avoid local overheating and provide a continuous supply of asphalt material to the mixer at a uniform temperature ± 10 °F from the mix design temperature.

D. Storing or holding of the MatCon HMA in approved storage facilities will be permitted during the daily operation but in no event shall the materials be held for more than 2 hours, unless approved by the MatCon Inc. Project Engineer. Materials held for more than 2 hours after mixing may be rejected and disposed of by the contractor at no expense to the contracting agency. The storage facility shall have a visible device located at the top of the cone or about the third point to indicate the amount of material in storage. No material shall be accepted from the

storage facility when the material in storage is below the top of the cone of the storage facility, except at the end of the working day.

3.3 PREPARATION OF EXISTING SURFACES

A. Before construction of a MatCon liner or cap system, the existing surface will be constructed to plan sub-grade elevations with a tolerance of ± 1/2 in., and brought to a firm and unyielding condition as evidenced by proof rolling with a loaded tandem rear-axle dump truck. Further, the surface must be capable of maintaining its smooth and unyielding condition when loaded repeatedly by the MatCon HMA delivery trucks.

B. Areas of existing surface that are damaged, or disturbed for any reason prior to paving shall be repaired to meet the requirements of this specification by the contractor prior to paving.

3.4 SPREADING AND FINISHING

A. The mixture shall be laid upon an approved surface, spread, and struck off to the grade and elevation established. Asphalt pavers complying with Paragraph 2.3.B shall be used to distribute the mixture. Unless otherwise directed by the WRPS construction manager or specified in the plans or in the special provisions, the nominal compacted depth of any layer or lift of any course shall not be less than 4 in.

B. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the paving may be done with other equipment or by hand. When the MatCon HMA is being produced by more than one plant, the material produced by each plant shall be placed by separate spreading and compacting equipment.

3.5 COMPACTION

A. Immediately after MatCon HMA has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted. The completed course shall be free from ridges, ruts, humps, depressions, objectionable marks, or irregularities and in conformance with the line, grade, and cross-section shown in the plans or as established by the WRPS construction manager.

B. Compaction shall take place when the mixture is in the proper condition so that no undue displacement, cracking, or shoving occurs. All compaction units shall be operated at the speed, within specification limits, that will produce the required compaction. Areas inaccessible to large compaction equipment shall be compacted by mechanical or hand tampers. Any MatCon HMA that becomes loose, broken, contaminated, shows an excess or deficiency of MatCon binder, or is in any way defective, shall be removed and replaced at no additional cost with fresh MatCon HMA which shall be immediately compacted to conform with the surrounding area.

C. The type of rollers to be used and their relative position in the compaction sequence shall generally be the contractor's option, provided specification densities are attained. Compaction or coverage with a steel wheel roller may precede pneumatic tired rolling.

3.6 COMPLETION

A. While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

B. Install bollards per design drawings.

3.7 FIELD QUALITY CONTROL TESTING

A. The quantity represented by each density lot will be no greater than a single day's production or approximately 500 tons, whichever is less.

B. Prior to paving, the prepared grade shall be examined for suitability of pavement installations. Specifically:

1. The subgrade shall be firm and unyielding

2. The grade shall be in accordance with the approved drawings (unless otherwise approved by the WRPS construction manager)

3. The elevation shall be within ± 1/2 in. of the design grade.

C. Prior to beginning of paving, a site construction map shall be developed. It shall show the location of all grid sites and all proposed sample locations. The recommended grid system is 10 ft (paver width) by 200 ft or 2,000 ft^2 (approximately 500 tons for 4 in. nominal thickness).

D. The MatCon HMA in each haul truck shall be inspected and tested for temperature on site prior to off load. The temperature and tonnage of each truck shall be recorded on each weigh ticket by truck number and grid and on a summary quality control form.

E. A minimum of three days prior to the start of paving, a test section shall be constructed, as directed by the WRPS construction manager, to determine the compactness of the mix design and confirmation of the JMF. Compactness shall be evaluated as the ability of the mix to attain a quality level of 97% of the maximum density determined by AASHTO T 209.

F. Lay-down and Compaction Tests –Test Section Requirements

1. As pavement is placed on the test section site, the temperature and thickness of pavement shall be recorded.

2. As pavement is compacted, the following operations shall be done:

a. Record temperature for a minimum of 10 locations.

b. Test for in-place density at 10 separate locations per each grid site using a nuclear density gauge in a warm condition within one hour of completion of rolling.

3. After compaction is complete and pavement has cooled to ambient temperature (typically overnight) retest all ten locations previously evaluated with the nuclear density gauge. Then cut one 4-inch diameter core sample for each location tested in paragraph 3.7F.2b. The core samples shall be tested in accordance with specifications with at least 3 of the samples tested to measure hydraulic conductivity of the sample. The core samples selected for hydraulic conductivity shall represent the 10, 50 and 90th percentile density values.

4. Produce and report NDM calibration factors for each gauge evaluated using the readings obtained in the warm and cold conditions.

G. Following determination of compactness, the contractor is responsible for the control of the compaction effort.

H. NOTES:

1. Contractor responsible for all costs for construction quality control of their contracted work per MatCon Guide Specifications.

2. MatCon, Inc., to provide quality assurance on contractor's entire MatCon installation process.

3. All samples to be collected in duplicate, unless noted (one for testing plus one for archive by MatCon, Inc.)

4. All samples to be handled in accordance with strict chain-of-custody protocol.

5. All laboratory tests to be performed in accordance with AASHTO® or ASTM test methods and procedures.

6. Construction and installations that fail to meet MatCon Guide Specifications to be corrected by contractor.

I. Contractor is responsible to perform quality control inspections and testing in accordance with the approved quality control plan to ensure materials and workmanship meets the requirements specified herein. Observation and monitoring of quality control testing will be performed by the WRPS construction manager or manager's designated representative to verify compliance of the work to the drawings and specifications.

J. The contractor shall engage the services of a testing laboratory to perform quality control testing as specified in the approved quality control plan.

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3.8 JOINTS

A. The construction of dense-graded MatCon HMA requires the elimination of nearly all-cold joints. This is accomplished by keeping the paving panels short enough, so that when the paver is set back to start another panel, the joint being placed against is still hot and not yet compacted. Once placement of the adjacent panel has started, the hot joint between the two panels can be compacted, resulting in a seamless connection.

B. When a prolonged break is anticipated, such as the end of a work shift, the cold joint panel will have the following configuration, as defined in the construction drawings and this description. The inside edge of the panel which is adjacent to the previously laid hot panel will be approximately, three (3) in. thick when compacted; however the outer edge of this last (cold joint) panel (defined as a full width of the paving machine – or a minimum width of 10 ft) will be approximately two (2) in. thick after compaction, creating a tapered joint panel. Prior to placing the overlay hot panel a tack coat shall be applied over the entire cold joint panel and milled area at the rate of 0.1 gal/yd2, or at a rate determined by the MatCon, Inc. The overlay hot panel will be laid a minimum of one (1) ft wider than the cold joint panel.

3.9 SURFACE SMOOTHNESS

A. The completed dense MatCon HMA surface shall be of uniform texture, smooth, uniform as to crown and grade, and free from defects of all kinds. The primary purpose of a MatCon surface is to achieve the required impermeability and surface drainage. Therefore, typical highway surface smoothness requirements are not applicable.

3.10 WEATHER LIMITATIONS

A. MatCon HMA shall not be placed on any wet surface, or when the average surface temperatures are less than those specified below, or when weather conditions otherwise prevent the proper handling or finishing of the MatCon HMA.

B. Surface temperature limitations for MatCon HMA at the beginning of paving are 35 °F minimum.

3.11 SAMPLES

A. The WRPS construction manager reserves the right to have samples cut or cored from the completed project or as MatCon HMA is being placed. Additionally, the WRPS construction manager may take samples of the uncompressed MatCon HMA mixtures as well as all materials incorporated in the work. Where samples have been taken from the uncompressed mixture, new MatCon HMA material shall be placed and compacted to conform with the surrounding area at no additional expense to the contracting agency.

END OF SECTION 321216

SECTION 321273

WATERPROOFING TREATMENT & MISCELANOUS PREPERATIONS

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. The work covered by this Section includes the furnishing of all material and equipment and the performing of all labor to complete all waterproofing treatments around and inside structures within the pavement reconstruction area as shown on the contract drawings.

B. The work covered by this Section includes but is not limited to the following:

1. Sealants used at the interface of the exterior of structures penetrating the asphalt barrier and reconstructed asphalt and concrete pavements.

1.2 REFERENCES

A. References in these specifications to standards, test methods, codes etc., are implied to mean the latest edition of each such standard adopted. The following is an abbreviated list of associations, institutions, and societies that may be used as references throughout these specifications.

B. American Society for Testing and Materials (ASTM)

1. ASTM D412 *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomer.*
2. ASTM D570 *Standard Test Method for Water Absorption of Plastics.*
3. ASTM D638 *Standard Test Method for Tensile Properties of Plastics.*
4. ASTM D732 *Standard Test Method for Shear Strength of Plastics by Punch Tool.*
5. ASTM D2240 *Standard Test Method for Rubber Property—Durometer Hardness.*
6. ASTM D5147 *Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material.*
7. ASTM E154 *Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.*

PART 2 PRODUCTS

2.1 DESCRIPTION OF SYSTEMS

A. The methods make use of a number of proprietary and non-proprietary systems and materials. These materials or equivalents approved by WRPS shall be used as given below:

1. Royston® Pavement-Glas (RPG®) reinforced rubberized asphalt membrane, or equivalent
2. Royston 120-29 Edge Sealer Rubberized asphalt adhesive sealant, or equivalent
3. Flex-Flo® Adhesive Sealant (FFAS)
4. Asphalt emulsions, CMS, SS-1 or CSS.

2.2 MATERIALS

A. RPG Membrane

1. RPG, a proprietary membrane system available from: Chase Construction Products, 201 Zeta Drive, Pittsburgh, PA 15237, Phone: 412 828 1500, Fax: 412 828 4826.
2. Typical properties of RPG Membrane
   a. Thickness (average): 65 mils (ASTM D 5147)
   b. Thickness (minimum): 60 mils (ASTM D 5147)
   c. Weight (minimum per 100 square ft of coverage): 48 pounds
   d. Elongation: typical 28%, minimum 20% (ASTM D412)
   e. Puncture resistance (minimum): 210 pounds (ASTM E154).

B. Royston 120-29 Edge Sealer

1. Royston 120-29 is a proprietary material and is available from: Chase Construction Products, 201 Zeta Drive, Pittrburgh, PA 15237, Phone: 412 828 1500, Fax: 412 828 4826.
2. Typical properties of ROYSTON 120-29
   a. Color: Black
   b. Density: 8.6 lb/gal
   c. Flash point (typical): 45 °F
   d. Solid Content (by volume): 61 %.

® RPG and Flex-Flo are registered trademarks of Chase Construction Products.

C. Flex-Flo Adhesive Sealant

1. FFAS is a black two component, primerless, solventless adhesive sealant which cures over a wide temperature range to a tough, adherent rubber. It is a proprietary material and is available from: Chase Construction Products, 201 Zeta Drive, Pittsburgh, PA 15237, Phone: 412 828 1500, Fax: 412 828 4826.

2. Typical properties of the finished product

a. Initial set (at 77 °F); 8-12 hours

b. Initial cure (at 77 °F); 90% at 24 hrs

c. Full chemical cure; 7 days

d. Tensile strength (minimum); 50 pounds per square in. (ASTM D638)

e. Elongation (minimum); 300% (ASTM D638)

f. Shore A Hardness (maximum); 50 (ASTM D2240)

g. Water Absorption (average); <1% (ASTM D570).

PART 3 EXECUTION

3.1 PREPARATION

A. Sweep or vacuum all surfaces, removing all loose aggregate and foreign substances prior to commencement of treatment.

3.2 PRODUCT DELIVERIES, STORAGE AND HANDLING

A. Deliveries: Deliver materials in the manufacturer's original sealed and labelled containers and in quantities required to allow continuity of application.

B. Storage: Store materials out of direct exposure to the elements. Store materials such as solvents, adhesives and asphalt cutback products away from open flames, sparks or excessive heat. Cover all material using a breathable cover such as a canvas. Polyethylene or other non-breathable plastic coverings are not acceptable.

C. Handling: Handle all materials in such a manner as to preclude damage and contamination with moisture or foreign matter. Damage: Any materials that are found to be damaged or stored in any manner other than stated above will be automatically rejected, removed, and replaced at the contractor's expense.

3.3 REQUIREMENTS PRIOR TO JOB START

A. Safety: Familiarize every member of the application crew with all fire and safety regulations recommended by Occupational Safety and Health Administration, NRCA, and other industry or local governmental groups.

B. Precipitation: Do not apply materials during precipitation or in the event there is a probability of precipitation during application. Take adequate precautions to ensure that materials are protected from possible moisture damage or contamination.

3.4 PROTECTION REQUIREMENTS

A. Site Condition: Complete, to the owner's satisfaction, all jobsite clean-up including building interior, exterior, and landscaping where affected by the construction.

B. After the MatCon has been compacted against the feature, the surface of the MatCon shall receive an application of tack coat at the rate of 0.1 gal/yd^2, or at a rate determined by MatCon, for a distance of 12 inches from edge of the feature ensuring a good seal of the surface. The interface with the structure shall receive an application of FFAS to form a fillet with minimum base and height dimensions 1 inch to form a seal against the feature treated.

3.5 MEMBRANE INSTALLATION PAVEMENT-GLAS – INLETS

A. Bitumen Consistency: Cutting or alterations of bitumen, primer, and sealants will not be permitted.

B. Membrane Application: Apply all layers free of wrinkles, creases, or fish mouths. Exert sufficient pressure on the roll during application to ensure prevention of air pockets.

C. Compact stabilized base to required density for at least 22 in. around storm water inlet box.

D. Ensure all exposed inlet masonry shoulder surfaces are level and clean and prime with FFAS or equivalent.

E. Lay pre-cut RPG membrane or equivalent 16 in. around opening using emulsion binder to ensure membrane is fully adhered to masonry shoulder.

F. Ensure any gaps in the membrane, such as at the corners of the inlet are covered with additional membrane layers and sealed with emulsion binder.

G. Apply emulsion binder to membrane and lay asphalt layer to specified density, ensuring use of whacker plate around the ironwork does not tear, displace or damage the membrane.

3.6 FIELD QUALITY CONTROL TESTING

A. Site Condition: Leave all areas around jobsite free of debris, materials, equipment, and related items after completion of job.

END OF SECTION 321273

SECTION 329300

PLANTS

PART 1 GENERAL

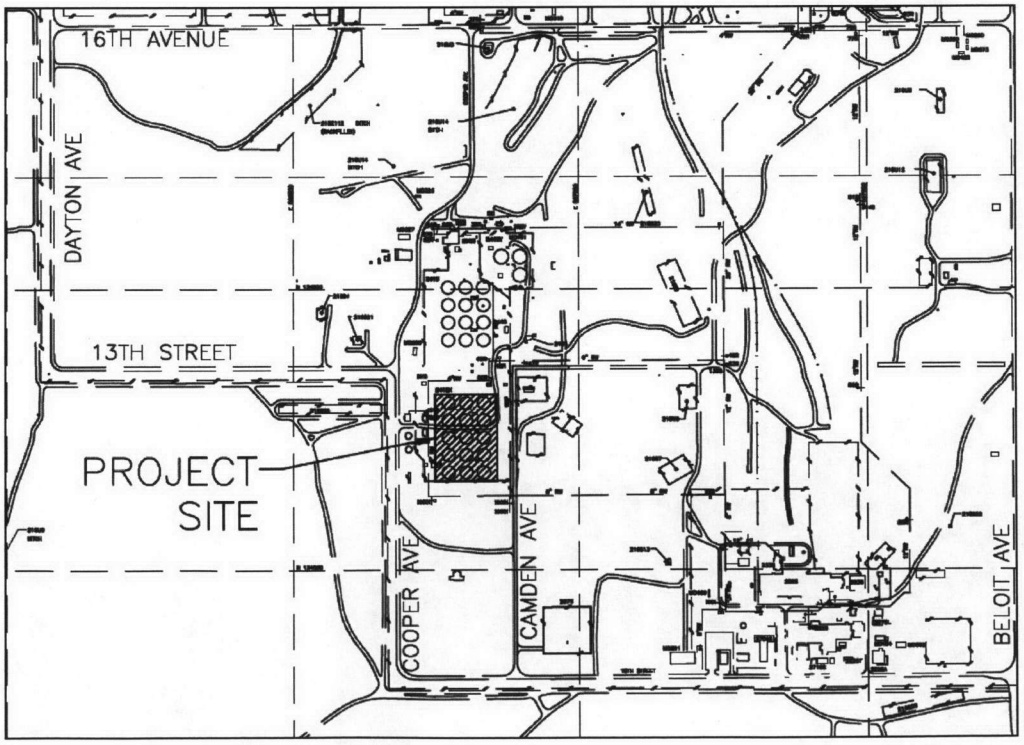
1.1 PURPOSE

A. An interim surface barrier will be constructed over SX tank farm on the Hanford site. To control precipitation runoff and prevent uncontrolled infiltration of precipitation to the soil, a storage and evaporation basin will be constructed to collect runoff from the barrier. The purpose of this plan is to establish a planting strategy for a vegetation layer within the storage and evaporation basin that will stabilize the soil within the basin and aid in removal of water through transpiration.

1.2 PROJECT LOCATION

A. The project is located on the Hanford Site next to SX tank farm in the 200 West area. Revegetation work will occur within the storage and evaporation basin constructed in the southern portion of the project site (see Figure 1).

Figure 1. Project Location.



1.3 STORAGE AND EVAPOTRANSPIRATION BASIN DESIGN

1.4 The basin will consist of an 8,600 square meter area depression. The basin size was designed to accommodate precipitation that would occur during a 25-year storm event. Walls and floor of the basin will be sloped. The basin will be lined with an impermeable membrane. A drainage grid of perforated pipe will distribute runoff collected from the tank barrier to the lower layer of the lined basin. A layer of sand approximately 8 in. thick will bury the perforated pipe. A 3 ft layer of backfill soil will be placed on the sand layer. Existing soil excavated from construction of the basin will be used as backfill and vegetation will be planted on this layer. The top of the backfill layer will be lower than the surrounding terrain (see Figure 2).

1.5 EXISTING SITE CONDITIONS

A. The basin site is located in an area that has been previously excavated directly south of the tank farm. The excavated area shows evidence of being previously disturbed including the addition of excess fill material. However; several native and non-native species are currently established in the basin and the surrounding area. The site is currently dominated by uniformly distributed Chrysothamnus nauseum (grey rabbitbrush) along with Cheatgrass and the occasional native bunchgrass and tumbleweed. The soil consists of a fine sandy loam.

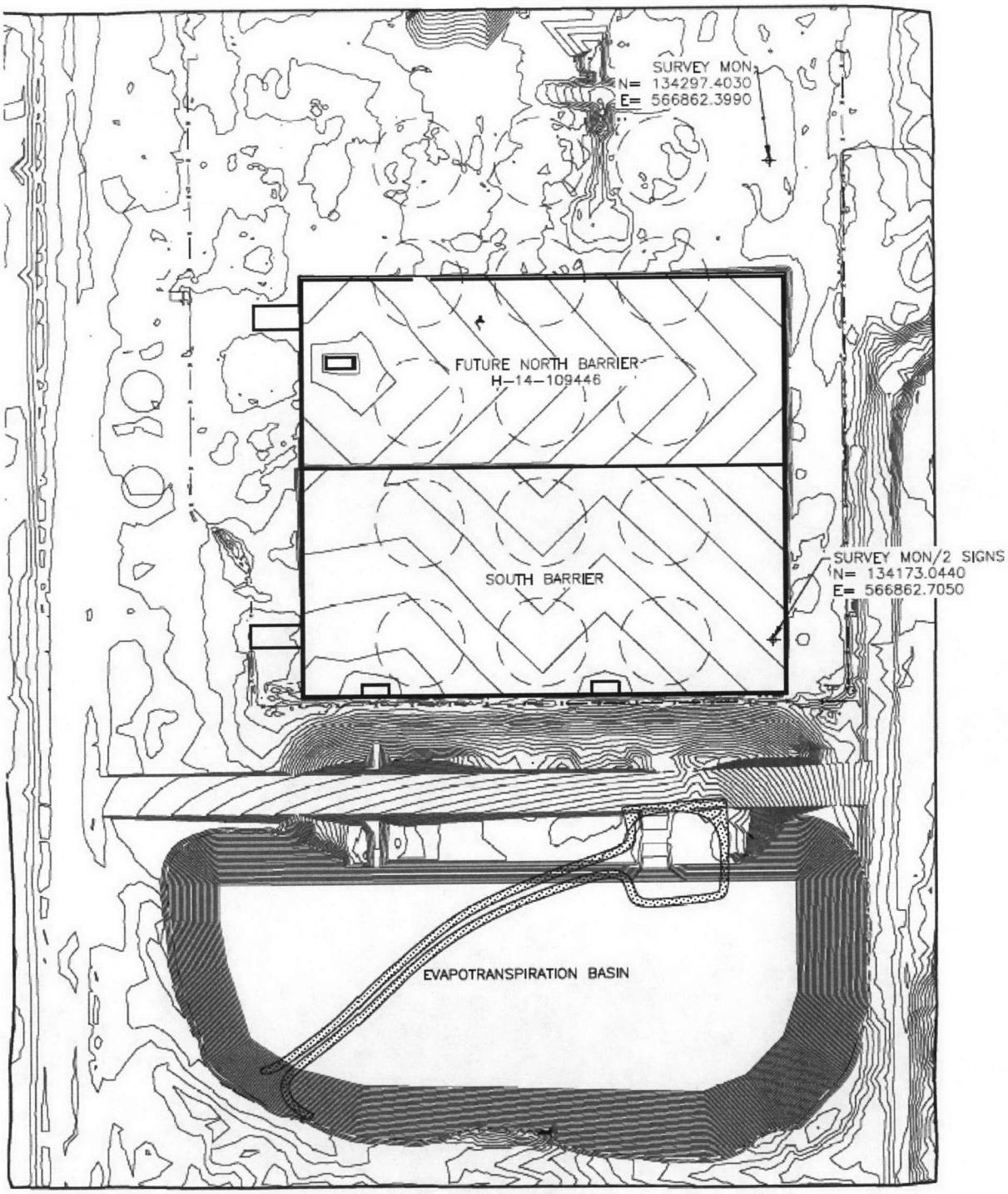
1.6 VEGETATION DESIGN CONCEPT

A. Goal and functional requirements:

1. The goal of revegetation of the basin will be long term interim stabilization of the soil consistent with the Hanford Site Biological Resources Management Plan (DOE/RL 96-32), as well as aiding in the removal of water from the basin through transpiration. Long term interim stabilization is appropriate when a site requires stabilization for an indefinite period of time, normally measured in years. Species used for long term stabilization should normally only include relatively shallow rooted species such as bunchgrasses, since it is expected that the site will eventually be re-disturbed, making the added expense of planting shrubs unjustified. However, since the vegetation will need to serve the additional function of removing water from basin through transpiration, planting of deeper rooted shrubs along with more shallow rooted bunchgrasses is appropriate.

2. The vegetation planted in the basin will consist of plants native to the Hanford Site, capable of removing accumulated moisture from the upper and lower areas of the soil column within the basin. Plants will be selected that can accommodate periodic moisture levels in the soil of up to approximately 3 times normal but also withstand drought like conditions that often occur in summer. Planting will consist of both seedling transplants of deeper rooting perennial shrubs and seed planting of more shallow rooting grass and forbs.

Figure 2. Storage and Evapotranspiration Basin Location.



1.7 MAINTENANCE

A. The installation contractor should recommend whether temporary irrigation will be necessary to help establish the shrub transplants. Supplemental watering may be needed through the first summer growing season after planting to increase the chances of plant survival. Annual weeds such as tumbleweed will likely be a problem during the first few growing seasons, especially since the planting area will have been recently disturbed. Since the planting level of the basin will be lower than the surrounding area, windblown weeds such as tumbleweed may accumulate in the basin at a rate higher than would normally occur in the surrounding area. Maintenance may be needed to remove accumulated tumbleweed if it interferes with the native species ability to access adequate light, i.e. smothers them. It is expected that, over time, the native species will effectively compete with the invasive species and maintenance requirements should be minimal. Contractor is not responsible for maintenance after contract has ended.

1.8 SECTION REQUIREMENTS

A. Submittals:

1. Vegetation Plan for establishing vegetation according to the requirements of this specification for Buyer approval. Hydroseeding with a cellulose mulch and tackifier may be proposed as an alternate means of establishing the grass and forb stand.

2. Vegetation Maintenance Plan for maintaining vegetation according to the requirements of this specification.

B. Provide plants according to quality, size, genus, and species, of plants indicated in this specification, complying with applicable requirements in ANSI Z60.1.

C. Provide labor and equipment for installation of plants according to specifications in Part 3.

PART 2 PRODUCTS

2.1 PLANTING MATERIALS

A. Shrub Material: Chrysothamnus nauseosus, 10 cubic in. container size, nursery grown from seed collected locally from the Hanford Site or Columbia Basin region, with healthy root systems and free of defects. As an option to planting shrub material chrysothamnus nauseosus may be incorporated into the grass and forb seed mix if hydroseeding and hydromulching is used to establish the stand.

B. Grass and Forb Seed mix: Clean local seed mix containing, Poa sandbergii, Agropyron dasystachyu, Oryzopsis hymenoides, Stipa comate, Pseudoroegneria spicata, Sitanion hystrix, and chrysothamnus nauseosus (if option to seed is selected). Recommended seed mix:

1. Poa sandbergii – 5 pounds/acre pure live seed
2. Agropyron dasystachyu – 5 pounds/acre pure live seed
3. Oryzopsis hymenoides – 3 pounds/acre pure live seed
4. Stipa comate – 0.5 pounds/acre pure live seed
5. Pseudoroegneria spicata – 0.5 pounds/acre pure live seed
6. Sitanion hystrix – 2 pounds/acre pure live seed
7. Chrysothamnus nauseosus – 0.25 pounds/acre pure live seed.

2.2 SOIL AND AMENDMENTS

A. Mulch: Native straw of sufficient quality and length to withstand crimping.

PART 3 EXECUTION

3.1 PREPARATION

A. Planting Bed Establishment: Remove established weeds if present.

B. Grass seed: Evenly broadcast seed mix.

C. Shrubs: Plant 1 shrub every 64 ft^2.

Dig holes approximately twice the diameter of the root ball. Fill the holes with water and allow water to soak into the soil. Place plants in hole and backfill soil around roots of the plants ensuring roots are oriented in the direction of natural growth. Make sure the stem and crown of the plant remain above the soil surface. Create a slight saucer around the plants to hold water. Water after planting.

D. Mulching: After broadcasting seed, mulch with approximately 2,000 pounds straw per acre or less to allow at least 10% of the soil surface visible after mulching.

E. Crimping: Crimp mulch to anchor it in the soil.

F. Maintenance: Maintain plantings by watering and weeding as required to establish healthy, viable plantings.

END OF SECTION 329300

SECTION 334100

STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Receipt inspection of all pipe and materials
2. MSDS for materials as appropriate.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)

1.	ASTM C478	*Standard Specification for Precast Reinforced Concrete Manhole Sections*
2.	ASTM C857	*Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures*
3.	ASTM C858	*Standard Specification for Underground Precast Concrete Utility Structures*
4.	ASTM C1433	*Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers.*

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

A. Polyvinyl Chloride Type PSM Sewer Pipe and Fittings, ASTM D 3034, SDR 35, for gasketed joints. Include ASTM F 477 elastomeric-seal gaskets.

B. Polyethylene Plastic Piping, ASTM F-667.

2.2 UTILITY STRUCTURES

A. Solids Separator – ADS, 1K BaySeparator® or Buyer approved equivalent.

B. Precast Concrete Catch Basins: Utility Vault 38Y-5106-BL, Oldcastle Precast, in accordance with design drawings, or Buyer approved equivalent.

C. Metal Grating Inlets: RGP 22W4H150C-Galvanized per design drawings H-14-109330, or Buyer approved equivalent.

D. Manhole sections: in accordance with ASTM C478.

® BaySeparator is a registered trademark of Advanced Drainage Systems, Inc.

E. Manhole Covers: Comcore® NS3620 Lightweight lid or Buyer approved quivalent.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream.

B. Install piping pitched at minimum slope of 1% and 24-in. minimum cover unless otherwise indicated.

C. Install PE pipe and fittings according to ASTM D 2321. Join pipe, tubing, and fittings with couplings for soil-tight joints according to manufacturer's written instructions. Install corrugated piping according to Corrugated Polyethylene Pipe Association's (CPPA) "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."

D. Install PVC pipe and gasketed fittings with gaskets according to ASTM D 2321.

E. Vault to finish grade shall be even with surrounding finish grade surface unless otherwise noted on plans.

F. Contractor shall grout all inlet and outlet pipes flush with vault interior wall.

G. Any grout used within the system shall meet the ASTM C 1107 "Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)," Grades A, B and DC at a pourable and plastic consistency of 70deg F.

END OF SECTION 334100

® Comcore is a registered trademark of CDR Systems Corporation.

SECTION 334713.13

POND LINERS

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. Verify dimensions by field measurements before fabrication and indicate on Shop Drawings.

B. Warranties: Provide standard manufacturer's pro-rated written warranty, signed by manufacturer agreeing to promptly repair or replace products that fail in materials or workmanship for the period of 20 years.

1.2 References

A. ASTM D638 – Test Method for Tensile Properties of Plastics.

B. ASTM D792 – Test Methods for Density and Specific Gravity of Plastics by displacement.

C. ASTM D1004 – Test Method for Initial Tear Resistance of Plastic Film and Sheeting.

D. ASTM D1505 – Test Method for Density of Plastics by the Density-Gradient Technique.

E. ASTM D1603 – Test Method for Carbon Black in Olefin Plastics.

F. ASTM D4329 – Practice for Fluorescent UV Exposure of Plastics.

G. ASTM D4437 - Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.

H. ASTM D4759 – Standard Practice for Determining the Specification Conformance of Geosynthetics.

I. ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

J. ASTM D5397 – Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembrane Using Notched Constant Tensile Load Test.

K. ASTM D5596 – Standard Test Method for Microscopic Evaluation of the Dispersion oif Carbon Black in Polyolefin Geosynthetics.

L. ASTM D5641 – Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.

M. ASTM D5885 – Standard Test Method for Qxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry.

N. ASTM D6392 – Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

O. ASTM D6497- Standard Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures.

P. ASTM D6693 – Determining Tensile Properties of Non-*reinforced Polyethylene and Non-reinforced flexible Polypropylene Geomembranes.*

1.3 Submittals

A. Submit the following product data to the Buyer, for review and approval, within a reasonable time so as to expedite shipment or installation of the Geomembrane:

1. The general contractor shall provide a quality assurance plan for receipt, handling, storage, and installation of geomembranes. The plan shall address the requirements identified in this section.
2. Provide specification sheets for geomembrane.
3. Provide mill test reports for geomembrane roll stock used to make liner.
4. Provide shop test reports for each fabricated panel produced.
5. Provide field test reports for all welds completed in the field.

1.4 Quality Control

A. Installer to follow documented quality assurance plan, installation plan, and work procedures.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Layfield Poly Films Ltd.

2.2 MATERIALS

A. Geomembrane material: Enviro Liner® 6040

B. Surface: Smooth, no striations, gels, pinholes or bubbles.

C. Minimum Thickness (ASTM D 5199): 0.040 in.

D. Maximum Membrane Density (ASTM D792 or ASTM D1505): 0.940 g/cc.

® Enviro Liner is a registered trademark of Layfield Plastics.

E. Minimum Tensile Properties (ASTM D638 or ASTM D6693): Machine direction and perpendicular to machine direction average values on the basis of five (5) test specimens each direction:

1. Break Strength: 152 pounds per in.

2. Break Elongation: 800%.

F. Minimum Tear Resistance (ASTM D1004): 22 pounds.

G. Minimum Puncture Resistance (ASTM D4833): 61 pounds.

H. Carbon Black Content: 2.0 - 3.0% to ASTM D1603.

I. Carbon Black Dispersion (ASTM D5596):

1. Carbon Black dispersion for 10 different views:

2. Minimum nine views in categories 1 or 2 and one view in Category 3.

J. High Pressure Oxidative Induction Time (ASTM D5885):

1. Minimum 2,000 minutes.

K. Stress Crack Resistance Under Constant Load (ASTM D5397):

1. Minimum 1,000 hours.

L. UV Resistance (ASTM D 4329):

1. Minimum 90% strength retained after 30,000 hours testing

a. Testing performed on 30 mil specimen

b. Irradiance of .75 W/yd^2 at a wavelength of 339 nano yd.

c. Alternating 10 hour ultra violet (UV) cycles at 140 °F followed by 2 hour condensation cycles at 122 °F.

M. Shop Seam Properties (ASTM D6693):

1. Shear Strength: 70 pounds per in.

2. Peel Strength: 60 pounds per in.

N. Field Seam Properties (ASTM D6693):

1. Shear Strength: 60 pounds per in.

2. Peel Strength: 53 pounds per in.

2.3 Fabricator

Layfield Geosynthetics and Industrial Fabrics Ltd., or;
Layfield Plastics Inc. or;
An approved fabricator of Layfield products.

2.4 Fabrication

A. Set Up

1. Carefully transfer rolls of geomembrane from storage to unwinding rack.
2. The floor or table must be clean, dry, and free of foreign objects that could damage the liner.
3. Pull panels to specified length, after double-checking dimensions on the work order.
4. Ensure seaming equipment is in good repair and functioning properly. Ensure equipment is adjusted to the material.
5. Follow documented welding procedures.

B. Qualification Seam

1. A qualification seam will be run prior to any fabrication.
2. The qualification seam must be run using the same material and equipment that will be used for fabrication.
3. Machine conditions and operator used for fabrication must be the same as those used for the qualification weld.
4. Qualification seam must be tested in shear and peel and meet the specified requirements for the material as stated in the materials section.
5. A qualification seam must be rerun whenever the operator is changed, the equipment adjusted, shift changed, or if the equipment is idle for more than 2 hours.

C. Fabrication Seams

1. Fabrication seams must meet the specified requirements in peel and shear for the material.
2. Fabrication seams will be destructively tested in shear and peel according to ASTM D6392.
3. Test one specimen each in peel and shear on the first and last welded panel, and,
4. Test one specimen each in peel and shear for every 1,000 lineal ft of welding.
5. A record of the seam test results is maintained on the Shop QC report.
6. The seaming process must be constantly supervised by the equipment operator. During seaming, 100% of the fabrication seams must be visually inspected.

D. Protection from Damage

1. Protect completed panels from damage.

2. Handle carefully to avoid damaging the liner.

E. Packaging

1. Each panel will be accordion folded in one direction, and rolled or folded in the other direction.

2. Wrap completed panels in a weather resistant, opaque cover material.

3. Hold wrapper securely in place using UV resistant tape or other secure method.

4. Label the packaged liner to clearly show:

   a. Material type
   b. Dimensions
   c. Stock code
   d. Sales order number
   e. QC number
   f. Panel number
   g. Unfolding and deployment directions.

2.5 Delivery, Storage, and Protection

A. Shipping

1. Completed panels will be placed on clean, serviceable pallets, free from exposed nails or other obstructions.

2. A layer of geomembrane, geotextile, or wood will be placed on all pallets to protect the panel from damage.

3. Secure panels to the pallet using metal or plastic bands. Use a layer of geomembrane between the packaged liner and the band to prevent damage to the liner as the band is tightened.

4. The packaged liner must not extend beyond the outer edges of the pallet. Use larger pallets or a layer of plywood to extend the pallet edges to match the liner.

5. Carefully handle and place on the truck to avoid damage to the liner.

6. Panels may be stacked not more that two high.

B. Delivery

1. All panels will be inspected for damage on delivery.

2. Use suitable unloading equipment to handle panels. Do not drag, slide, or drop panels during unloading.

3. Place panels in a prepared area away from soft ground, standing water, or other deleterious surfaces.

4. Replace any pallets that may become damaged during shipping or handling.

5. Store liner panels in a secure area protected from extremes of heat or cold.

6. Protect panels from damage prior to use.

2.6 Accessories

A. Welding rod will be manufactured from the same formulation as the geomembrane.

B. Preformed pipe boots will be vacuum formed from thicker sheet material manufactured from the same formulation as the geomembrane.

PART 3 EXECUTION

3.1 Installer

A. Layfield Environmental Systems or
An installer approved by Layfield Environmental Systems.

3.2 Preparation

A. Ensure subgrade is compacted and surface finished to not impair installed membrane.

B. Subgrade to provide firm, unyielding surface with no sharp changes or abrupt breaks in grade. A smooth drum rolled surface is preferable.

C. Ensure surfaces to be lined are smooth, free of foreign and organic material, sharp objects, or debris of any kind.

D. Excavate anchor trench to line, grade, and width indicated on drawings, prior to liner placement. Provide slightly rounded corners in the trench to avoid sharp bends in the geomembrane.

E. Prepare mechanical attachments according to ASTM D6497, Standard Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures.

F. Compaction at pipe penetrations and areas of mechanical attachment will be inspected carefully as these are areas where differential settlement can occur.

G. A certificate of subgrade acceptance will be prepared by the liner installation contractor prior to liner installation.

3.3 Installation

A. Installation of the geomembrane shall be performed in a logical sequence.

B. Place panels according to the drawings, the panel layout, and the label on each panel.

C. Sufficient thermal slack shall be incorporated during placement to ensure that harmful stresses do not occur in service.

D. Weather Conditions at Time of Installation:

1. Site welding may proceed at any temperature providing a suitable qualification weld can be prepared at site conditions using the operator, equipment, and materials intended for the project.

2. Installation of membrane in winds above 12 mph can proceed only if the installer can demonstrate that the liner will not be at risk of damage.

3. Do not install membrane during precipitation or in the presence of excessive moisture.

4. Do not install in weather conditions that may be detrimental to the function of the membrane.

E. Ensure personnel working on geomembrane do not use damaging footwear.

F. Protect completed panels from damage; handle carefully to avoid damaging the liner.

G. Equipment and methods used to unroll liner panels should not damage the prepared subgrade.

H. Ballast used to prevent uplift by wind must not damage the geomembrane. A continuous load is recommended along the edges of panels to eliminate the risk of wind uplift.

I. Qualification Seams

1. A qualification seam will be run prior to any field seams.

2. A qualification seam is made with separate pieces of geomembrane using the same material and equipment that will be used for production welding.

3. Machine conditions, and operator used for welding must be the same as those used for the qualification weld.

4. Qualification seam must be tested in shear and peel, and meet the specified requirements for the material as stated in the materials section.

5. A qualification seam must be rerun whenever the operator is changed, the equipment adjusted, or at least every 4 hours.

J. Field Seams

1. Field seams will be sampled for testing in a way that does not compromise the installed liner.

a. One sample to be tested for every 500 ft of field seam.

b. Test samples are to be removed from the ends of seams, from the anchor trench, or other location that does not introduce a defect into the liner.

c. Samples to be approximately 4 in. long to permit testing of one shear and two peel specimens (ASTM D6392).

d. Test samples immediately after seaming.

e. Record date, location and pass/fail description.

2. Field seams must meet the specified requirements in peel and shear for the material.

3. A written record will be maintained for all field seam tests.

4. All completed field seams will be 100% non-destructively tested using an air lance test (ASTM D4437 method 7.2).

3.4 Tolerances

A. Seam Tests:

1. Follow the procedure in ASTM D6392.

2. Test three specimens per sampling point, one in shear and two in peel.

a. All specimens to meet seam strength requirements.

3. Procedures for Destructive Test Failure:

a. Cut out seam and re-weld; or,

b. Retrace welding path to 10 ft from location of failed test. Take sample for additional test. If passed, cap strip or extrusion weld between failed location and original failed location.

3.5 Repair

A. Inspect seams and non-seam areas for defects, holes, blisters, undispersed raw materials.

B. Identify any signs of foreign matter contamination.

C. Repair all through-thickness defects.

D. Defective Seams: Cap strip or replace.

E. Small Holes: Repair by extrusion welding using a bead of extruded material over hole. Patch if hole is larger than 1/4 in.

F. Tears: Patch and seal round sharp ends of tears on slope or stressed area prior to patching.

G. Repair blisters, large cuts and undispersed raw materials with patch.

H. Secure Patches by extrusion welding or hot air welding:

1. Extrusion welding.

a. Clean area to be patched.

b. Tack patch in place with hot air welding or with double sided tape.

c. Prepare patch area by roughening with a wire brush.

d. Extrude all the way around patch.

e. More than one extrusion bead can be laid side-by-side on Enviro Liner 6000 materials. A maximum of three extrusion beads can be laid side-by side on Enviro Liner 6000.

2. Hot Air Welding

a. Hand hot air welding is permitted for patching Enviro Liner.

b. Clean area to be patched.

c. Hand weld the patch with a hot air gun and suitable roller.

3. Patches: Round or oval, of same geomembrane. Extend minimum 3 in. beyond the edge of the defect.

4. Verification of Repairs: All repairs to be non-destructively tested using

a. ASTM D4437 Method 7.2, *Air Lance Test*

b. ASTM D5641, *Vacuum Box Test.*

5. Redo failed repairs and re-test.

6. Keep records of all repairs and the results of repair testing.

3.6 Cleaning

A. Cleaning solvents shall not be used unless product is approved by membrane manufacturer.

B. Use water and rags for all cleaning. If soap is used for cleaning rinse with clean water and dry before welding.

3.7 Protection of Finished Work

A. Protect finished work from damage. See instructions on backfilling if applicable.

END OF SECTION 334713.13

APPENDIX A

SX TANK FARM REFERENCE INFORMATION

A1.0 GENERAL INFORMATION

The following photographs and figures provide reference information to support the construction specification. The photographs are provided for reference information only.

Figure A-1. SX Farm Aerial Photo.

Figure A-2. SX Farm Aerial Photo.

Figure A-3. SX Farm Cut/Fill Areas.

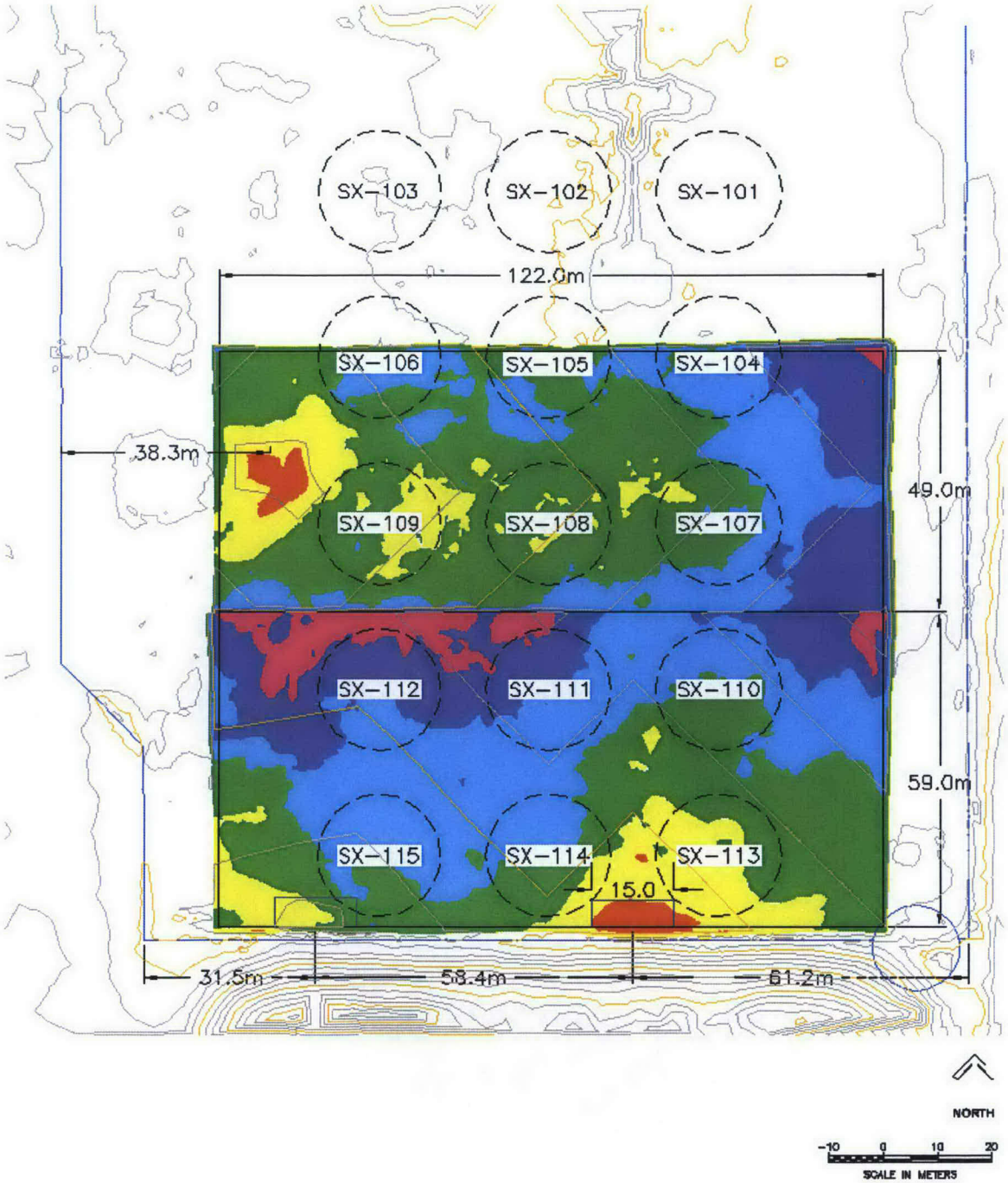


Figure A-4. SX Farm Cut/Fill Table.

NORTH

ELEVATIONS TABLE				
NUMBER	MIN ELEV	MAX ELEV	AREA M²	COLOR
1	-0.40	-0.20	90.53	
2	-0.20	0.00	666.99	
3	0.00	0.20	3087.55	
4	0.20	0.40	1844.97	
5	0.40	0.60	748.13	
6	0.60	0.85	15.72	

SOUTH

ELEVATIONS TABLE				
NUMBER	MIN ELEV	MAX ELEV	AREA M²	COLOR
1	-0.40	-0.20	95.90	
2	-0.20	0.00	853.03	
3	0.00	0.20	2316.75	
4	0.20	0.40	2591.99	
5	0.40	0.60	1267.55	
6	0.60	0.80	446.11	

S

241-SX Tank Farm North Interim Surface Barrier Construction Specification

Prepared by MJ Holm
Washington River Protection Services, LLC
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-08RV14800

EDT/ECN: EDT-824611 UC:
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Key Words: 241-SX Tank Farm Interim Surface Barrier, 241-SX Farm, interim measure, construction specification

Abstract: This document establishes the 241-SX Tank Farm North Interim Surface Barrier construction specification. An interim barrier will be constructed over the 241-SX Tank Farm to reduce vadose zone leak plume migration.

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Approved For Public Release

Tank Operations Contractor (TOC) **RECORD OF REVISION**	(1) Document Number: **RPP-SPEC-49087**	Page 1

(2) Title:

241- SX Tank Farm North Interim Surface Barrier Construction Specification

Change Control Record

(3) Revision	(4) Description of Change – Replace, Add, and Delete Pages	Authorized for Release	
		(5) Resp. Engr. (print/sign/date)	(6) Resp. Mgr. (print/sign/date)
0 [redacted]	Initial release.	MJ Holm 6-1-2011	CJ Alderman 06/01/11

241-SX TANK FARM NORTH INTERIM SURFACE BARRIER CONSTRUCTION SPECIFICATION

May 5, 2011

Prepared by

Columbia Energy and Environmental Services, Inc.

Richland, Washington 99354

for

Washington River Protection Solutions, LLC

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SECTION 011000

SUMMARY

PART 1 GENERAL

1.1 PROJECT INFORMATION

A. Project: 241-SX Tank Farm North Interim Surface Barrier.

1. Project Location: Hanford Site, 200 West Area.

B. Owner: US Department of Energy Office of River Protection.

C. Contractor: Washington River Protection Solutions, LLC (WRPS)

D. The work consists of the following:

1. Introduction

The SX tank farm north interim surface barrier project will install a barrier over the northern area of the SX tank farm. The SX tank farm is located in the 200 West Area, in a controlled access area of the Hanford Site, approximately 30 road miles north of Richland, Washington. This specification provides for construction of a modified asphalt barrier to cover the SX tank farm. The runoff water collected on the barrier will be collected and routed to an existing evapotranspiration basin located to the South of the SX tank farm. The majority of the Division 01 requirements will be addressed in the statement of work for construction of the SX tank farm interim surface barrier. Division 01 requirements that are specific to each sub-section will be described within that sub-section.

2. Summary of Work

Work consists of furnishing supervision, labor, equipment, materials, transportation, and services for procurement, receiving, handling, storage, protection, fabrication, installation, inspection, quality assurance and testing to provide a modified asphalt barrier over the northern area of the 241-SX tank farm in accordance with H-14-109446. The following list of work elements are associated with the SX interim surface barrier and are intended to provide a broad overview and are not all inclusive:

a. Stormwater Collection and Routing

1) Excavation and placement of stormwater catch basins and drain lines within the farm.
2) Excavation and placement of drain line between the tank farm and the evapotranspiration basin.

b. In Farm Subgrade Preparation

1) Installation of pipe sleeves and utility vault risers around tank riser penetrations and existing tank farm equipment.
2) Excavation and earthwork necessary to establish the subgrade within the SX tank farm.

c. Installation of the MatCon® (modified asphalt) barrier in the SX tank farm.

3. Multiple Contract Summary

This specification has been divided into two discrete scopes of work to accomplish the construction of the SX tank farm interim surface barrier. These work scopes include: earthwork for the barrier and exterior improvements including installation of the asphalt barrier.

4. Work Sequence

The work defined in this specification has been divided into logical sub-sections due to scheduling and weather concerns. The plan is to perform construction activities in the early summer 2012.

E. Work by Owner: WRPS will provide specific support defined in the statement of work.

F. Work Under Separate Contracts:

Not applicable.

G. Owner-furnished Items: The following products will be furnished by Owner and shall be installed by contractor as part of the work:

There is no government furnished material identified for this work.

H. Owner-furnished Equipment: The following products will be furnished by Owner and shall be utilized by contractor as part of the work:

Government furnished equipment, if any, will be identified in the Statement of Work.

1.2 WORK RESTRICTIONS

Work restrictions are defined in the statement of work.

PART 2 PRODUCTS

Not used.

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PART 3 EXECUTION

Not used.

END OF SECTION 011000

SECTION 311000

SITE CLEARING

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. Utility Locator Service: Confirm with Buyer that prerequisite utility location surveys have been completed before site clearing and excavation.

B. Do not commence site clearing operations until temporary dust control measures are in place.

1.2 DEFINITIONS

A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface within the project limits and outside of the tank farm.

C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2 inch(es) (in.) caliper to a depth of 6 in. below subgrade within the project limits and outside the tank farm.

D. Project Limits: Areas, as shown or specified, within which work is to be performed.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PREPERATION

A. Protect and maintain benchmarks and survey control points from disturbance.

B. Protect site improvements to remain from damage. Restore damaged improvements to condition existing before start of site clearing.

C. Provide temporary dust control measures in accordance with the approved dust control plan.

3.2 SITE CLEARING

A. Clear and grub areas actually needed for waste disposal, borrow, or site improvements within limits shown on or specified outside of modified asphalt

barrier limits and evaporation basin limits. Minimize disturbances outside of the tank farm to areas necessary for equipment access and laydown.

B. Do not injure or deface vegetation that is not designated for removal.

C. Dispose of waste materials, including trash, debris, and excess topsoil, at direction of the buyer. Burning waste materials on-site is not permitted.

END OF SECTION 311000

SECTION 312000

EARTH MOVING

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals

1. Certified test results from independent civil testing laboratory.
2. Excavation Plan for approval a minimum of 2 weeks prior to mobilization that addresses:
   a. Manufacturer's data sheet for compaction equipment.
   b. Methods and sequencing of excavation.
   c. Numbers, types, and sizes of equipment proposed to perform excavations.
   d. Anticipated difficulties and proposed resolutions.
   e. Reclamation of onsite spoil disposal areas.
3. Dust Control Plan: The contractor shall submit a dust control plan for approval a minimum of 2 weeks prior to mobilizing equipment. The dust control plan shall address:
   a. Continuous control of dust generation during excavation
   b. Control of wind generated dust in disturbed areas
   c. Plans to water haul roads/access roads
   d. Plans to stabilize spoil pile
   e. Identification of equipment that will be available for dust control.
4. Backfill, Compaction, and inspection procedure: As an option to the requirements in Section 3.2 and 3.3 the contractor may submit for approval a procedure for placement, compaction, and inspection requirements. Include maximum lift height, moisture content requirements, list of compaction equipment to be used, include compaction effort and inspection and surveillance requirements.

B. An area just to the south of the SX tank farm evapotranspiration basin has been identified for stockpiling excess soil. Specific limits shall be coordinated through the WRPS construction manager.

C. Locations and areas for temporary construction facilities and equipment laydown areas adjacent to the construction site shall be coordinated through the WRPS construction manager.

1.2 REFERENCES

A. ASTM International (ASTM): D1557, *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort* (56,000 ft-lb/ft^3).

B. ASTM International (ASTM): D2487, *Standard Practice for Classification of Soils for Engineering Purposes (*Unified Soil Classification System*)*.

C. ASTM International (ASTM): D2940, *Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports*.

D. ASTM International (ASTM): D4253, *Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table*.

E. ASTM International (ASTM): D4254, *Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density*.

F. ASTM International (ASTM): D6938, *Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods* (Shallow Depth).

1.3 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent (%), of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.

2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Buyer.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4-in. sieve.

C. Prepared Ground Surface: Ground surface outside of modified asphalt barrier system footprint after completion of clearing and grubbing, stripping of topsoil, excavation to grade, and compaction of subgrade.

D. Completed Course: A course or layer that is ready for next layer or next phase of work

E. Lift: Loose (uncompacted) layer of material.

F. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

G. Excavation:

1. Common (unclassified) Excavation: removal of material not classified as contaminated soil.

2. Classified Excavation: Removal of contaminated soil material inside the boundary of the SX tank farm project limits.

H. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.

I. Subgrade:

1. For areas under the modified asphalt barrier footprint, the subgrade is the prepared surface where the asphalt will be placed.

2. All other areas (outside the modified asphalt barrier limits), subgrade is the layer of existing soil after completion of clearing and grubbing, prior to placement of the evaporation basin liner or placement of stormwater system components.

1.4 SEQUENCING AND SCHEDULING

A. Complete applicable work specified in Sections 311000, Site Clearing, prior to excavation and subgrade preparation outside of modified asphalt barrier limits.

B. Coordinate subgrade preparation with installation of modified asphalt barrier system inside of the barrier footprint.

C. Coordinate subgrade preparation with installation of the stormwater collection, routing, and discharge system for other areas.

1.5 QUALITY ASSURANCE

Note: the following identify hold points for inspection and/or testing activities:

A. Notify Buyer prior to initiating fill/backfill activities; following completion of the first lift of material placement; and following completion of each subsequent lift.

B. Notify Buyer when backfilling operations are resumed after a period of inactivity (more than 3 consecutive working days).

C. Notify Buyer when soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.

D. Notify Buyer whenever fill material appears to be deviating from specifications.

E. Notify Buyer when prepared subgrade in area to be covered by the modified asphalt barrier system is compacted and thought to be ready for modified asphalt installation. Also notify Buyer for work resumed after a period of extended inactivity (more than 3 consecutive working days).

F. Notify Buyer when prepared subgrade under the evaporative basin is compacted and ready for installation of the geomembrane liner.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Prepare subgrade when unfrozen and free of standing water, ice, and snow.

PART 2 PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM; free of rock or gravel larger than 3 in. in any dimension, debris, waste, frozen materials, vegetation, or other deleterious matter.

B. Backfill and Fill: Satisfactory soil materials.

C. Base Courses: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand in accordance with Washington State Department of Transportation Specification 9.03-4 of M 41-10, *Standard Specifications for Road, Bridges, and Municipal Construction*. Screen size 5/8 in. minus.

Note: this is for new base course material. There may be areas within the footprint of the interim surface barrier where the existing gravel surface will be utilized as the base course.

D. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100% passing a 1-in. sieve and not more than 8% passing a No. 200 sieve.

E. Controlled Density Fill (CDF): CDF or controlled low-strength material (CLSM) material with a design compressive strength of 50 to 100 lb/in2 and a cast density of no greater than 130 lb/ft3 may be optionally used as backfill for the following:

1. Stabilizing in-farm features designated on the design drawings.

2. Backfilling the stormwater drainline.

F. Water for Moisture Conditioning:

1. Coordinate with Buyer for suitable location to obtain raw or potable water for use in conditioning materials for compaction.

2. Use the least amount of moisture for fill material inside the SX farm fenceline limits to achieve the required compaction level specified.

3. Do not allow water outside the tank farm fenceline to run into the tank farm areas inside the fenceline.

G. Compactor as approved by Buyer.

PART 3 EXECUTION

3.1 EARTHWORK

A. Vibratory modes on roller compactors are not permitted for use within the boundary of the tank farm. Vibratory modes on compaction equipment must be physically disconnected prior to use within the tank farm. Plate whackers for localized compaction are acceptable.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Prevent surface water from entering excavations, from ponding on prepared subgrades, and from flooding project site and surrounding area.

D. Excavate to subgrade elevations outside of the tank farm. Notify Buyer if infrastructure or unexpected materials are encountered.

E. Stockpile excavated material that is suitable for use as fill or backfill until material is needed. Material excavated inside the SX farm fence line limits (classified excavation) shall be used inside the fence line at designated areas in coordination with the Buyer. Material excavated outside the SX farm fence limits (unclassified excavation) shall be stockpiled outside of fence or directly transported inside the fence for use as fill in the construction of the SX farm interim barrier. Coordinate with Buyer.

1. Do not block roads or access routes or stockpile material adjacent to trenches and other excavations unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads

2. Do not stockpile excavated materials near or over existing facilities, buried tanks, adjacent property, or completed work, if weight of stockpiled material could induce excessive settlement or damage facilities.

F. Excavate to subgrade elevations required for pavements.

G. Utility Trenches: Excavate trenches to indicated slopes, lines, depths, and invert elevations. Maintain 12 in. of working clearance on each side of pipe or conduit.

1. Place, compact, and shape bedding course to provide continuous support for pipes over rock and other unyielding bearing surfaces and to fill over excavated soils.

2. Place and compact initial backfill of satisfactory soil material or sub-base material, free of particles larger than 1 in., to a height of 8 in. over the utility pipe. Place and compact final backfill of satisfactory soil material to final subgrade.

H. When subgrade or existing ground surface to receive fill has a density less than that required for fill, break up ground surface, pulverize, moisture-condition or

aerate soil, and recompact. Excavate and replace unsuitable material with suitable material.

3.2 BACKFILL

A. Do not stockpile or otherwise pile fill material for barrier construction inside the SX farm fence limits. Limit concentrated fill loads in this area to a maximum of 3 feet (ft) in any localized area.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even. Protect all survey monuments at all times.

C. Tolerances

1. Final lines and grades: within a tolerance of 0.1 ft unless dimensions or grades are shown or specified otherwise.

2. Grade to establish and maintain slopes and drainage as shown on design drawings.

D. Damage to any structures caused by settlement of fill or backfill material shall be immediately reported to Buyer. Repair of such damage shall be accomplished using Buyer-approved method.

E. Backfill Around Vertical Features

1. Carefully place fill after installation of vault extension, pipe, or clearance detail in accordance with the design drawings.

2. Within 3 ft of risers, vaults, and other existing vertical features, compact using hand-held equipment using controlled method outlined in RPP-19407, Attachment B.

3. Smaller compactor units may be used in areas where access is limited and the larger compactor cannot access.

F. Bring subgrade to proper grade and cross-section and uniformly compact surface. Place backfill and fill in layers not more than 8 in. in loose depth at optimum moisture content. Compact each layer per approved backfill, compaction, and inspection procedure or compact each layer under pavements to 95% of maximum dry unit weight according to ASTM D 1557; anchor trench zones to 95%; evapotranspiration basin to 85%; elsewhere to 90%. Trim sub-bases to required lines and grades.

G. Grade areas to a smooth surface to cross sections, lines, and elevations indicated. Grade areas under pavements to ± 1/2 in. Leave final surface grade smooth and without ruts. Surfaces shall not have holes, depressions more than 1 in. in 12-in. width, or protrusions extending above the surface more than 1 in.

H. Under pavements place sub-base course material on prepared subgrades and compact at optimum moisture content to required grades, lines, cross sections, and thicknesses.

I. Allow testing agency to inspect and test each subgrade and each fill or backfill layer and verify compliance with requirements.

J. Obtain asphalt contractors approval of subgrade prior to deployment of modified asphalt.

K. Stabilize all exposed cut and fill slopes with a minimum of 3 in. of bedding course material, spread evenly, do not compact.

L. Coordinate with Buyer for management and disposal of contaminated soil materials.

3.3 FIELD QUALITY CONTROL TESTING/SURVEYING

A. Gradation:

1. Test if variation in gradation is occurring, or if material appears to depart from specifications, as directed by Buyer.

2. If test results indicate material does not meet specification requirements, terminate material placement until corrective measures are taken.

3. Remove material placed in work that does not meet specification requirements.

B. In-Place Density Tests: In accordance with ASTM D6938. During placement of materials, test as follows:

1. Earthfill: Five per lift within footprint of the asphalt barrier, or more frequently as required by Buyer.

END OF SECTION 312000

SECTION 321216

ASPHALT PAVING

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product data and the job mix formula shall be submitted in writing by the contractor to the WRPS Construction Manager at least three (3) weeks prior to the start of paving operations. The certification(s) test reports shall show the appropriate AASHTO/ASTM test(s) for each material, test results, and a statement that the material meets the specification requirement. Submittals shall include as a minimum:

1. Mix designation/identification number.
2. Plant where mix will be produced.
3. MatCon® binder certification.
   a. Type of binder
   b. Certification from supplier of conformance with requirements for MatCon
   c. Temperature-viscosity relationship of the MatCon binder asphalt cement
   d. Minimum mixing temperature (°F)
   e. Minimum compaction temperature (°F).
4. Coarse Aggregate Certified Test Reports:
   a. Source, location, and type of aggregate
   b. Angularity
   c. Bulk and apparent specific gravity
   d. Flat and elongated particles
   e. Soundness
   f. Toughness.
5. Fine Aggregate Certified Test Reports:
   a. Source, location, and type of aggregate
   b. Bulk and apparent specific gravity

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c. Liquid limit

d. Plastic index

e. Percent natural sand (if used)

f. Sand equivalent

g. Soundness

h. Toughness.

6. Anti-strip agent (if required):

   a. Certification

   b. Percentage by weight.

7. Percentage of MatCon asphalt binder by weight.

8. Proportions and percentage of aggregate gradations by weight.

9. Temperature of mix when discharged from the mixer.

10. Maximum specific gravity at the target binder content.

11. Marshall Compaction data in accordance with recommendations given in The Asphalt Institute MS-2 Manual.

12. Bulk specific gravity at design binder content.

13. Air voids content at design binder content.

14. Voids in mineral aggregate at design binder content.

15. Voids filled with asphalt at design binder content.

16. Graphical plots of air voids, voids in the mineral aggregate, voids filled with asphalt, ratio of fines to effective binder content, and unit weight verses asphalt content. Plots shall indicate values at –0.5% design asphalt content, design asphalt content, and +0.5% design asphalt content.

17. Tensile strength ratio (TSR) and worksheets (AASHTO T283).

18. Certification by MatCon, Inc. that the binder and mix design meets the requirements for MatCon materials.

19. The mix design shall meet the requirements specified in RPP-SPEC-47469 for vehicle loads (the SX farm interim surface barrier should be sufficiently robust to accommodate vehicle loads based on tire pressures of 100 pounds per square in. without damage or permanent deformation of the barrier surface).

20. The mix design shall address variations in mix design and binder variance to accommodate equipment access within the footprint of the SX interim surface barrier.

NOTE: Roller access to areas between tank pits and adjacent to tank equipment will be limited.

21. Mix design submittal shall be stamped by a professional engineer registered in the State of Washington.

22. Physical site inspection following preparation of subgrade under 312000.

23. Structural assessment of tank farm areas to be paved using a falling weight deflectometer (FWD) or alternately a light weight deflectometer (LWD).

24. Mechanistic pavement design based on the results of the physical site inspection. This consists of a structural design of the MatCon paving system.

25. Paving plan to minimize cold joints, material waste, and onsite time. Paving plan submittal shall be stamped by a professional engineer licensed in the state of Washington.

26. Quality control plan (see Section 1.2).

27. Material safety data sheet (MSDS) data for all asphalt components, all sealants, and associated products used for installing the hot mix asphalt (HMA).

B. The WRPS construction manager may request samples for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

C. MatCon mix designs and job mix formula shall be submitted in writing by the contractor to the WRPS construction manager at least three (3) weeks prior to the start of paving operations.

D. The contractor shall submit samples to the WRPS construction manager, upon request, testing for job mix formula verification.

E. The job mix formula for each mixture shall be in effect until modified in writing by the WRPS construction manager. Should a change in mix or sources of materials be made, a new job mix formula must be tested and resubmitted for approval by the WRPS construction manager before the new mix is used.

F. The certified nuclear gauge operator qualifications shall be submitted to and approved by the WRPS construction manager. If during the life of the contract the gauge operator changes, the contractor shall resubmit new qualifications to the WRPS construction manager.

1.2 QUALITY ASSURANCE

A. The HMA contractor shall submit a quality control plan for approval at the commencement of the project. This plan shall be submitted at least 4-weeks before commencement of installation operations on site. The quality control plan shall define the control measures necessary to ensure the interim surface barrier

complies with the design requirements. The quality control plan shall address the following:

1. Independent laboratory testing
2. Binder manufacturing
3. HMA facility (aggregate properties, storage of materials, HMA manufacture, and HMA transport)
4. HMA placement (training, thickness and temperature control, compaction field density measurements, cold joint construction, and surface finishing and hand work)
5. Sampling and testing.

B. At the completion of project, the HMA contractor shall submit a final quality assurance report to the WRPS construction manager, which locates all grids, sample locations, and appurtenances / structures that were paved during the course of the project.

PART 2 PRODUCTS

2.1 DESCRIPTION OF SYSTEMS

A. MatCon HMA is a mixture produced with MatCon binder and aggregate to provide a material with a low hydraulic conductivity and longevity which will function as an environmental cap for a contaminated site. The MatCon binder and construction oversight are available from MatCon, Inc. MatCon, Inc., point of contact is Jerry Thayer (425.239.3332).

B. Reference minimum values and other typical properties of MatCon HMA provided for information only are as follows:

Reference values:
Hydraulic Conductivity (maximum) $k < 1x10^{-7}$ cm/sec (ASTM D 5084)
Air Voids (Maximum – average 2,000 ft^2), 3% (ASTM D 2041 ASTM D 3203)
Tensile Strength Ratio (minimum): 80% (AASHTO T283)
Typical values:
Bending resistance (minimum): .79 in. deflection without cracking (MatCon, Inc method)
Tensile strength at -4 degrees Fahrenheit (°F) (minimum): 3.00MPa (AASHTO TP-9)
Thermal Crack Resistance (maximum): -22 °F (AASHTO TP-10)
Depth of Penetration to Fuel (maximum): .79 in. (ASTM 1856)
Wheel tracking at 147.2 °F (maximum): .20 in. (Asphalt Pavement Analyzer)
Performance history: >10 years of successful performance history with a minimum of 25 acres of installation.

NOTE: Verification testing of reference values is not required.

C. MatCon HMA is produced in accordance with a Quality Control Plan which incorporates additional guide specifications developed by MatCon, Inc. This plan shall be submitted in accordance with the requirements of paragraph 1.2 of this specification.

2.2 MATERIALS

A. General Requirements

1. MatCon Inc will provide the MatCon binder. The binder will be pumped into empty storage tanks.

2. The various mineral materials may be furnished in whole or in part by the contracting agency for the manufacture of MatCon HMA, or the contractor may be required to furnish them. If the contracting agency does not provide any of these mineral materials, it shall be understood that the contractor shall furnish such materials in the amounts required for the designated mix. Mineral materials include coarse and fine aggregates, blending sand, and mineral filler.

3. Production of aggregates, stockpiling and the removal of aggregates from stockpiles shall comply with the requirements of Paragraph 2.2.D.

B. Anti-Stripping Additive

1. When directed by the MatCon Inc Project Engineer, heat-stable liquid anti-stripping additive shall be added to the MatCon HMA. At the option of the contractor, the anti-stripping additive can be either added to the liquid binder or sprayed on the aggregate on the cold feed. Once the process and type of anti-stripping additive proposed by the contractor have been approved by MatCon Inc, the process, brand, grade, and amount of anti-stripping additive shall not be changed without approval of the MatCon Inc Project Engineer.

2. When liquid anti-stripping additive is added to the liquid asphalt, the percentage by weight will be designated by MatCon Inc.

3. The use of another process or procedure for adding anti-stripping additive to the asphalt mix will be considered based on a proposal from the contractor.

C. Mineral Filler

1. Mineral filler, when used in MatCon HMA, shall conform to the requirements of AASHTO M17.

D. Aggregates

1. General Requirements

a. Aggregates used in MatCon HMA shall be manufactured from ledge rock, talus, or gravel. The material from which they are produced shall meet the following test requirements:

ASTM C 131 LA Wear	30% maximum loss
ASTM C 127 SPG & Absorb Coarse Agg.	2% maximum absorption
ASTM C 128 SPG & Absorb Fine Agg.	2% maximum absorption
ASTM D 2419 Sand Equivalent	40% minimum.

b. Aggregates shall be uniform in quality, substantially free from wood, roots, bark, extraneous materials, and adherent coatings. The presence of a thin, firmly adhering film of weathered rock will not be considered as coating unless it exists on more than 50% of the surface area of any size between consecutive laboratory sieves.

c. Aggregate removed from deposits contaminated with various types of wood waste shall be washed, processed, selected, or otherwise treated to remove sufficient wood waste, so that the oven-dried material retained on a1/4 -in. square sieve shall not contain more than 0.1% by weight of material with a specific gravity less than 1.

2. Test Requirements for Aggregates

Aggregate for MatCon HMA shall meet the following test requirements:

a. The fracture requirements are at least one fractured face on 75% of the material retained on each specification sieve size U.S. No. 10 and above, if that sieve retains more than 5% of the total sample.

b. When material is being produced and stockpiled for use on a specific contract the fracture and sand equivalent requirements shall apply at the time of stockpiling. When material is used from a stockpile that has not been tested as provided above, the requirements for fracture and sand equivalents shall apply at the time of its introduction to the cold feed of the mixing plant.

c. Contractor may submit current test results from a certified testing laboratory for materials that were tested to meet state department of transportation or other agency requirements to meet the requirements of this specification.

3. Gradation: The contractor may furnish aggregates for use on the same contract from a single stockpile or from multiple stockpiles. The gradation of the aggregates shall be such that the completed mixture complies in all respects with the pertinent requirements of Paragraph 2.2.D.5. Acceptance of the aggregate gradation shall be based on samples taken from the final mix.

4. Blending Sand

   a. In the production of aggregate for MatCon HMA there is often a deficiency of material passing the U.S. No. 40 sieve. When this occurs, blending sand in an amount specified by MatCon, Inc., may be used to make up this deficiency, provided that a satisfactory final mix is produced, including fracture requirements.

   b. Blending sand shall be clean, hard, sound material, with either naturally occurring sand or crusher fines, and must be material which will readily accept a MatCon binder coating. The exact grading requirements for the blending sand shall be such that, when it is mixed with an aggregate, the combined product shall meet the requirements of Paragraph 2.2.D.5. Blending sand shall meet the following quality requirement:

      1) Sand Equivalent 40% minimum
      2) The materials laboratory shall test blending sand before it will be approved for use.

5. Proportions of Materials

   a. The materials of which MatCon binder is composed shall be of such sizes, gradation, and quantities that, when proportioned and mixed together, they will produce a well-graded dense impermeable mixture (or an open graded very permeable drainage layer using a modified gradation and shall be covered by special provision) within the requirements listed in the table that follows. All sieve testing shall be in accordance with ASTM C 136.

Table 1. Recommended Aggregate Gradation for Dense MatCon® HMA. (2 Sheets)

Sieve Size	Percent Passing Based on Total Wt. of Aggregate
1/2 in.	100
3/8 in.	85-100
No. 4 Sieve	60-80
No. 8 Sieve	40-60
No. 16 Sieve	25-40
No. 30 Sieve	15-25
No. 50 Sieve	11-20
No. 100 Sieve	7-15
No. 200 Sieve	3-8

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6. Basis of Acceptance

a. The MatCon HMA will be accepted based on its conformance to the project job mix formula (JMF). For the determination of a project JMF, the contractor shall submit to MatCon Inc, representative samples of the various aggregate and blend sand, to be used along with the gradation data showing the various aggregate stockpile averages and the proposed combining ratios and the average gradation of the completed mix. Based on this submittal from the contractor, MatCon Inc will determine the MatCon binder content, anti-strip requirement, and retention factor in the mix design process. Using the representative samples submitted and proposed proportion of each, trial mix tests will be run to determine the percentage of MatCon binder, by weight, to be added. The JMF thus established shall be changed only upon order of MatCon Inc.

b. The intermingling of MatCon HMA produced from more than one JMF is prohibited. Each paver path of MatCon HMA placed during a working shift shall conform to a single job mix formula established for the class of mixture specified unless there is a need to make an adjustment in the JMF.

c. No mixture shall be produced for use on the project until the amount of MatCon binder and anti-strip additive to be added has been established.

d. Job mix formula (JMF) tolerances and adjustments:

1) Tolerances: After the JMF is determined, the several component of the mixture at the time of acceptance shall conform to the following tolerances:

Table 2. Tolerances.

Component of Mixture	Tolerance Limits
Aggregate passing 1/2", and 3/8" Sieves	Table 1 Limits
Aggregate passing No. 4 Sieve	±5%
Aggregate passing No. 8 Sieve	±4%
Aggregate passing No. 16 Sieve	±4%
Aggregate passing No. 30 Sieve	±4%
Aggregate passing No. 50 Sieve	±3%
Aggregate passing No. (100) Sieve	±3%
Aggregate passing No. (200) Sieve	±2%
MatCon binder	±0.3%
Temperature of Mixing	±25°F

2) Aggregates Adjustments: Upon written request from the contractor, the project engineer, with MatCon, Inc. concurrence may approve field adjustments to the JMF including the contractor's proposed combining ratios for mineral aggregate stockpiles and blend sand. The maximum allowed gradation change shall be 2% for the aggregate retained on the No. 8 sieve and above, 1% for the aggregate passing the No. 16, No. 30, and No. 50 sieves, and 0.5% for the aggregate passing the No. 100 and No. 200 sieve. The project engineer may make these field adjustments to the JMF provided the change will produce material of equal or better quality. The above adjustments and/or any further adjustments as ordered by the engineer will be considered as a new JMF. Adjustments beyond these limits will require development of a new JMF. The adjusted JMF ± the allowed tolerances shall be within the range of the broadband specifications.

7. Gradation: The contractor may furnish aggregates for use on the same contract from a single stockpile or from multiple stockpiles. The gradation of the aggregates shall be such that the completed mixture complies in all respects with the pertinent requirements of Paragraph 2.2.D.5.a.

E. Stockpiling Aggregates

1. Description: This work shall consist of placing the specified aggregates in the stockpiles at the sites and in the amounts as shown in the plans or as approved by the engineer. This section also includes the requirements pertaining to the removal of aggregates from stockpiles.

2. Construction of Stockpiles

a. Stockpiles in excess of 200 cubic yards shall be built up in layers not more than four (4) ft in depth. Stockpile layers shall be constructed by trucks, clamshells, or other methods approved by the engineer. Pushing aggregates into piles with a bulldozer will not be permitted. Each layer shall be completed over the entire area of the pile before depositing aggregates in the succeeding layer. The aggregate shall not be dumped so that any part of it runs down and over the lower layers in the stockpile. The method of dropping from a bucket or spout in one location to form a cone shaped pile will not be permitted. Any method of placing aggregates in stockpiles, which in the opinion of the engineer, breaks, degrades, or otherwise damages the aggregate, will not be permitted. Stockpiles of less than 200 cubic yards shall be piled in a manner to prevent segregation of the various sizes of material.

b. No equipment other than pneumatic tired equipment shall be used in constructing the stockpiles of processed or manufactured aggregates.

c. Stockpiles of different types or sizes of aggregate shall be spaced far enough apart, or separated by suitable walls or partitions, to prevent the mixing of the aggregates. Aggregate shall not be deposited where traffic, vehicles, or contractor's equipment will either run over or through the piles, or in any way cause foreign matter to become mixed with the aggregates.

3. Removing Aggregates from Stockpiles

a. Aggregates shall be removed from stockpile in a manner to avoid separation of sizes or admixture of dirt or foreign material. The engineer will approve the method and equipment used for loading.

b. No equipment other than pneumatic tired equipment shall be used on stockpiles of processed or manufactured aggregates in removing the materials from the stockpiles. When removing materials from the face of the stockpile, the equipment shall be operated in a manner to face-load from the floor to the top of the stockpile to obtain maximum uniformity of material.

F. Penetration Flashings: See Section 321273.

G. Bollards: Use schedule 40 steel pipe with yellow plastic sleeve; cored style.

2.3 EQUIPMENT

A. Hauling Equipment

1. Trucks used for hauling MatCon HMA shall have tight, clean, smooth metal beds, which have been thinly coated with a minimum amount of paraffin oil, or other approved material to prevent the mixture from adhering to the beds. Each truck shall have a cover of canvas or other suitable material of sufficient size to protect the mixture from the weather.

2. When dump truck beds are sprayed with oil, or other approved release agent, the excess oil shall be drained prior to loading with the asphalt mixture. For hopper trucks, the conveyer shall be in operation during the process of oiling the bed.

B. Pavers

1. Pavers used to install MatCon HMA shall be self-contained, power-propelled units, provided with an activated heated screed or strike-off assembly, and capable of spreading and finishing courses of MatCon HMA in panel widths applicable to the specified typical section and thicknesses shown in the Plans.

Note: Pavers with open flame (e.g., propane fired heaters) are not acceptable for use in the tank farm without specific approval from WRPS.

2. The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, segregating, or gouging the mixture. Any bolt-on or hydraulic extensions shall produce the same results including ride, density, and surface texture as the screed or strike off assembly. Hydraulic extenders without screeds, augers, and vibration shall not be used.

3. The transverse slope controller shall be capable of maintaining the screed at the desired slope within ± 0.1%. The paver shall be equipped with automatic feeder controls, properly adjusted to maintain a uniform depth of material ahead of the screed.

C. Rollers and Compactors

1. Rollers shall be of the steel wheel or pneumatic tire type, in good condition, capable of reversing without backlash, and shall be operated at speeds slow enough to avoid displacement of the mixture. The number and weight of rollers shall be sufficient to compact the mixture as required in Paragraph 3.5. The use of equipment, which results in excessive crushing of the aggregate, will not be permitted. Rollers producing pickup, washboard, and uneven compaction of the surface or other undesirable results will be rejected. Compaction, in areas too small for the use of conventional sized rollers, shall be achieved using vibratory plate compactors or other approved equipment.

2. The following specifications shall apply to the various types of rollers:

a. Vibratory Rollers. Vibratory rollers will not be permitted to operate in the vibratory mode and the vibratory feature must be physically disconnected.

b. Pneumatic Tired Rollers

1) The maximum rate of travel shall be limited to five (5) miles per hour (mph).

2) Skirts shall be firmly affixed to the perimeter of the roller and shall uniformly extend to within 1 in. of the pavement surface.

c. Steel Wheel Rollers

3) The maximum rate of travel shall be limited to four (4) mph.

2.4 MIX DESIGN

A. The contractor shall obtain representative samples from mineral aggregate stockpiles and blend sand sources to be used for MatCon HMA production,

submitting them to MatCon, Inc. for development of a mix design and job mix formula.

B. The contractor shall allow 30 working days for approval of the mix design once the material has been received by MatCon, Inc. Additional time may be required if the proportions will not make an adequate design as determined by MatCon, Inc. The contractor is also advised that production of MatCon HMA shall not commence until the job mix design has been established. Expedited mix designs may be performed provided arrangements are made in advance with MatCon, Inc.

2.5 SOURCE QUALITY CONTROL

A. Prior to lay-down, the following shall be done at the HMA facility or Plant:

1. Each MatCon binder delivery truck shall be sampled at the HMA facility for temperature. The sample taken shall be retained by MatCon Inc.
2. Each MatCon HMA delivery truck shall be sampled at the HMA facility for temperature and visually inspected for uniformity.
3. The HMA facility storage tanks containing the MatCon binder shall be tested hourly for temperature.

B. General: The dense-graded MatCon HMA will be evaluated for quality of gradation and binder content per the approved QA plan.

C. MatCon HMA

1. Sampling
   a. A sample for testing and compliance will not be obtained from either the first or last 25 tons of mix produced in each production shift.
   b. Samples for compliance of gradation and binder content will be obtained on a random basis from the hauling vehicle.
2. Definition of Sampling: Sampling and testing for acceptance shall be performed on a random basis at a minimum frequency of one sample for each sub lot of 500 tons, or per 0.5 acres, or a minimum of 3 per day.
3. Testing of MatCon HMA samples collected at the HMA facility prior to hauling to the site shall include:
   a. Gradation
   b. Binder content
   c. Rice maximum density
   d. Temperature.

D. Reject Mixture

1. Rejection by Contractor: The contractor may, prior to sampling, elect to remove any defective material and replace it with new material at no expense to the contracting agency. Any such new material will be sampled, tested, and evaluated for acceptance.

2. Rejection without Testing: The WRPS construction manager may, without sampling, reject any batch, load, or section of the cap or liner that appears defective in gradation or MatCon binder content.
Material rejected before placement shall not be incorporated into the work. Any rejected section of the work shall be removed.

PART 3 EXECUTION

3.1 CONTRACTOR PLANS

A. The contractor shall provide a paving plan for approval by the WRPS construction manager at least five (5) days prior to the planned paving start date.

3.2 MIXING

A. The prepared aggregates shall be combined in the mixer in the amount of each fraction of aggregates as specified or as directed by the MatCon Inc Project Engineer. The asphalt material shall be measured or gauged and introduced into the mixer in the amount determined by the MatCon Inc Project Engineer.

B. After the required amounts of aggregate and asphalt material have been introduced into the mixer, unless otherwise specified, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the binder material throughout the aggregate is ensured. Wet mixing time shall be sufficient to produce 95% coated particles. When discharged, the temperature of the mix shall not exceed the mix design temperature. A maximum water content of 1% in the mix, at discharge, will be allowed providing the water causes no problems with handling, stripping, or flushing. In this case, the moisture content shall be reduced as directed by the WRPS construction manager.

C. The MatCon binder shall be heated to a range between 310 and 360 °F as determined by the mix design. The asphalt shall be heated in a manner that will avoid local overheating and provide a continuous supply of asphalt material to the mixer at a uniform temperature ± 10 °F from the mix design temperature.

D. Storing or holding of the MatCon HMA in approved storage facilities will be permitted during the daily operation but in no event shall the materials be held for more than 2 hours, unless approved by the MatCon Inc Project Engineer. Materials held for more than 2 hours after mixing may be rejected and disposed of by the contractor at no expense to the contracting agency. The storage facility shall have a visible device located at the top of the cone or about the third point to indicate the amount of material in storage. No material shall be accepted from the

storage facility when the material in storage is below the top of the cone of the storage facility, except at the end of the working day.

3.3 PREPARATION OF EXISTING SURFACES

A. Before construction of a MatCon liner or cap system, the existing surface will be constructed to plan sub-grade elevations with a tolerance of ± 1/2 in., and brought to a firm and unyielding condition as evidenced by proof rolling with a loaded tandem rear-axle dump truck. Further, the surface must be capable of maintaining its smooth and unyielding condition when loaded repeatedly by the MatCon HMA delivery trucks.

B. Areas of existing surface that are damaged, or disturbed for any reason prior to paving shall be repaired to meet the requirements of this specification by the contractor prior to paving.

3.4 SPREADING AND FINISHING

A. The mixture shall be laid upon an approved surface, spread, and struck off to the grade and elevation established. Asphalt pavers complying with Paragraph 2.3.B shall be used to distribute the mixture. Unless otherwise directed by the WRPS construction manager or specified in the plans or in the special provisions, the nominal compacted depth of any layer or lift of any course shall not be less than 4 in.

B. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the paving may be done with other equipment or by hand. When the MatCon HMA is being produced by more than one plant, the material produced by each plant shall be placed by separate spreading and compacting equipment.

3.5 COMPACTION

A. Immediately after MatCon HMA has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted. The completed course shall be free from ridges, ruts, humps, depressions, objectionable marks, or irregularities and in conformance with the line, grade, and cross-section shown in the plans or as established by the WRPS construction manager.

B. Compaction shall take place when the mixture is in the proper condition so that no undue displacement, cracking, or shoving occurs. All compaction units shall be operated at the speed, within specification limits, that will produce the required compaction. Areas inaccessible to large compaction equipment shall be compacted by mechanical or hand tampers. Any MatCon HMA that becomes loose, broken, contaminated, shows an excess or deficiency of MatCon binder, or is in any way defective, shall be removed and replaced at no additional cost with fresh MatCon HMA which shall be immediately compacted to conform with the surrounding area.

C. The type of rollers to be used and their relative position in the compaction sequence shall generally be the contractor's option, provided specification densities are attained. Compaction or coverage with a steel wheel roller may precede pneumatic tired rolling.

3.6 COMPLETION

A. While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

B. Install bollards per design drawings.

3.7 FIELD QUALITY CONTROL TESTING

A. The quantity represented by each density lot will be no greater than a single day's production or approximately 500 tons, whichever is less.

B. Prior to paving, the prepared grade shall be examined for suitability of pavement installations. Specifically:

1. The subgrade shall be firm and unyielding

2. The grade shall be in accordance with the approved drawings (unless otherwise approved by the WRPS construction manager)

3. The elevation shall be within ± 1/2 in. of the design grade.

C. Prior to beginning of paving, a site construction map shall be developed. It shall show the location of all grid sites and all proposed sample locations. The recommended grid system is 10 ft (paver width) by 200 ft or 2,000 ft^2 (approximately 500 tons for 4 in. nominal thickness).

D. The MatCon HMA in each haul truck shall be inspected and tested for temperature on site prior to off load. The temperature and tonnage of each truck shall be recorded on each weigh ticket by truck number and grid and on a summary quality control form.

E. A minimum of three days prior to the start of paving, a test section shall be constructed, as directed by the WRPS construction manager, to determine the compactness of the mix design and confirmation of the JMF. Compactness shall be evaluated as the ability of the mix to attain a quality level of 97% of the maximum density determined by AASHTO T 209.

F. Lay-down and Compaction Tests –Test Section Requirements

1. As pavement is placed on the test section site, the temperature and thickness of pavement shall be recorded.

2. As pavement is compacted, the following operations shall be done:

a. Record temperature for a minimum of 10 locations.

b. Test for in-place density at 10 separate locations per each grid site using a nuclear density gauge in a warm condition within one hour of completion of rolling.

3. After compaction is complete and pavement has cooled to ambient temperature (typically overnight) retest all ten locations previously evaluated with the nuclear density gauge. Then cut one 4-inch diameter core sample for each location tested in paragraph 3.7F.2b. The core samples shall be tested in accordance with specifications with at least 3 of the samples tested to measure hydraulic conductivity of the sample. The core samples selected for hydraulic conductivity shall represent the 10, 50 and 90th percentile density values.

4. Produce and report NDM calibration factors for each gauge evaluated using the readings obtained in the warm and cold conditions.

G. Following determination of compactness, the contractor is responsible for the control of the compaction effort.

H. NOTES:

1. Contractor responsible for all costs for construction quality control of their contracted work per MatCon Guide Specifications.

2. MatCon, Inc., to provide quality assurance on contractor's entire MatCon installation process.

3. All samples to be collected in duplicate, unless noted (one for testing plus one for archive by MatCon, Inc.)

4. All samples to be handled in accordance with strict chain-of-custody protocol.

5. All laboratory tests to be performed in accordance with AASHTO or ASTM test methods and procedures.

6. Construction and installations that fail to meet MatCon Guide Specifications to be corrected by contractor.

I. Contractor is responsible to perform quality control inspections and testing in accordance with the approved quality control plan to ensure materials and workmanship meets the requirements specified herein. Observation and monitoring of quality control testing will be performed by the WRPS construction manager or manager's designated representative to verify compliance of the work to the drawings and specifications.

J. The contractor shall engage the services of a testing laboratory to perform quality control testing as specified in the approved quality control plan.

3.8 JOINTS

A. The construction of dense-graded MatCon HMA requires the elimination of nearly all-cold joints. This is accomplished by keeping the paving panels short

enough, so that when the paver is set back to start another panel, the joint being placed against is still hot and not yet compacted. Once placement of the adjacent panel has started, the hot joint between the two panels can be compacted, resulting in a seamless connection.

B. When a prolonged break is anticipated, such as the end of a work shift, the cold joint panel will have the following configuration, as defined in the construction drawings and this description. The inside edge of the panel which is adjacent to the previously laid hot panel will be approximately, three (3) in. thick when compacted; however the outer edge of this last (cold joint) panel (defined as a full width of the paving machine – or a minimum width of 10 ft) will be approximately two (2) in. thick after compaction, creating a tapered joint panel. Prior to placing the overlay hot panel a tack coat shall be applied over the entire cold joint panel and milled area at the rate of 0.1 gal/yd2, or at a rate determined by the MatCon, Inc. The overlay hot panel will be laid a minimum of one (1) ft wider than the cold joint panel.

3.9 SURFACE SMOOTHNESS

A. The completed dense MatCon HMA surface shall be of uniform texture, smooth, uniform as to crown and grade, and free from defects of all kinds. The primary purpose of a MatCon surface is to achieve the required impermeability and surface drainage. Therefore, typical highway surface smoothness requirements are not applicable.

3.10 WEATHER LIMITATIONS

A. MatCon HMA shall not be placed on any wet surface, or when the average surface temperatures are less than those specified below, or when weather conditions otherwise prevent the proper handling or finishing of the MatCon HMA.

B. Surface temperature limitations for MatCon HMA at the beginning of paving are 35 °F minimum.

3.11 SAMPLES

A. The WRPS construction manager reserves the right to have samples cut or cored from the completed project or as MatCon HMA is being placed. Additionally, the WRPS construction manager may take samples of the uncompressed MatCon HMA mixtures as well as all materials incorporated in the work. Where samples have been taken from the uncompressed mixture, new MatCon HMA material shall be placed and compacted to conform with the surrounding area at no additional expense to the contracting agency.

END OF SECTION 321216

SECTION 321273

WATERPROOFING TREATMENT & MISCELANOUS PREPERATIONS

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. The work covered by this Section includes the furnishing of all material and equipment and the performing of all labor to complete all waterproofing treatments around and inside structures within the pavement reconstruction area as shown on the contract drawings.

B. The work covered by this Section includes but is not limited to the following:

1. Sealants used at the interface of the exterior of structures penetrating the asphalt barrier and reconstructed asphalt and concrete pavements.

1.2 REFERENCES

A. References in these specifications to standards, test methods, codes etc., are implied to mean the latest edition of each such standard adopted. The following is an abbreviated list of associations, institutions, and societies that may be used as references throughout these specifications.

B. American Society for Testing and Materials (ASTM)

1. ASTM D412 *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomer.*
2. ASTM D570 *Standard Test Method for Water Absorption of Plastics.*
3. ASTM D638 *Standard Test Method for Tensile Properties of Plastics.*
4. ASTM D732 *Standard Test Method for Shear Strength of Plastics by Punch Tool.*
5. ASTM D2240 *Standard Test Method for Rubber Property—Durometer Hardness.*
6. ASTM D5147 *Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material.*
7. ASTM E154 *Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.*

PART 2 PRODUCTS

2.1 DESCRIPTION OF SYSTEMS

A. The methods make use of a number of proprietary and non-proprietary systems and materials. These materials or equivalents approved by WRPS shall be used as given below:

1. Royston® Pavement-Glas (RPG®) reinforced rubberized asphalt membrane, or equivalent
2. Royston 120-29 Edge Sealer rubberized asphalt adhesive sealant, or equivalent
3. Flex-Flo® Adhesive Sealant (FFAS)
4. Asphalt emulsions, CMS, SS-1 or CSS.

2.2 MATERIALS

A. RPG Membrane

1. RPG, a proprietary membrane system available from: Chase Construction Products, 201 Zeta Drive, Pittsburgh, PA 15237, Phone: 412 828 1500, Fax: 412 828 4826.
2. Typical properties of RPG Membrane
   a. Thickness (average): 65 mils (ASTM D 5147)
   b. Thickness (minimum): 60 mils (ASTM D 5147)
   c. Weight (minimum per 100 square ft of coverage): 48 pounds
   d. Elongation: typical 28%, minimum 20% (ASTM D412)
   e. Puncture resistance (minimum): 210 pounds (ASTM E154).

B. Royston 120-29 Edge Sealer

1. Royston 120-29 is a proprietary material and is available from: Chase Construction Products, 201 Zeta Drive, Pittsburgh, PA 15237, Phone: 412 828 1500, Fax: 412 828 4826.
2. Typical properties of Royston 120-29
   a. Color: Black
   b. Density: 8.6 lb/gal
   c. Flash point (typical): 45 °F
   d. Solid Content (by volume): 61 %.

® RPG and Flex-Flo are registered trademarks of Chase Construction Products.

C. Flex-Flo Adhesive Sealant

1. FFAS is a black two component, primerless, solventless adhesive sealant which cures over a wide temperature range to a tough, adherent rubber. It is a proprietary material and is available from: Chase Construction Products, 201 Zeta Drive, Pittsburgh, PA 15237, Phone: 412 828 1500, Fax: 412 828 4826.

2. Typical properties of the finished product

   a. Initial set (at 77 °F); 8-12 hours

   b. Initial cure (at 77 °F); 90% at 24 hrs

   c. Full chemical cure; 7 days

   d. Tensile strength (minimum); 50 pounds per square in. (ASTM D638)

   e. Elongation (minimum); 300% (ASTM D638)

   f. Shore A Hardness (maximum); 50 (ASTM D2240)

   g. Water Absorption (average); <1% (ASTM D570).

PART 3 EXECUTION

3.1 PREPARATION

A. Sweep or vacuum all surfaces, removing all loose aggregate and foreign substances prior to commencement of treatment.

3.2 PRODUCT DELIVERIES, STORAGE AND HANDLING

A. Deliveries: Deliver materials in the manufacturer's original sealed and labelled containers and in quantities required to allow continuity of application.

B. Storage: Store materials out of direct exposure to the elements. Store materials such as solvents, adhesives and asphalt cutback products away from open flames, sparks or excessive heat. Cover all material using a breathable cover such as a canvas. Polyethylene or other non-breathable plastic coverings are not acceptable.

C. Handling: Handle all materials in such a manner as to preclude damage and contamination with moisture or foreign matter. Damage: Any materials that are found to be damaged or stored in any manner other than stated above will be automatically rejected, removed, and replaced at the contractor's expense.

3.3 REQUIREMENTS PRIOR TO JOB START

A. Safety: Familiarize every member of the application crew with all fire and safety regulations recommended by Occupational Safety and Health Administration, NRCA, and other industry or local governmental groups.

B. Precipitation: Do not apply materials during precipitation or in the event there is a probability of precipitation during application. Take adequate precautions to ensure that materials are protected from possible moisture damage or contamination.

3.4 PROTECTION REQUIREMENTS

A. Site Condition: Complete, to the owner's satisfaction, all jobsite clean-up including building interior, exterior, and landscaping where affected by the construction.

B. After the MatCon has been compacted against the feature, the surface of the MatCon shall receive an application of tack coat at the rate of 0.1 gal/yd^2, or at a rate determined by MatCon, for a distance of 12 inches from edge of the feature ensuring a good seal of the surface. The interface with the structure shall receive an application of FFAS to form a fillet with minimum base and height dimensions 1 inch to form a seal against the feature treated.

3.5 MEMBRANE INSTALLATION PAVEMENT-GLAS – INLETS

A. Bitumen Consistency: Cutting or alterations of bitumen, primer, and sealants will not be permitted.

B. Membrane Application: Apply all layers free of wrinkles, creases, or fish mouths. Exert sufficient pressure on the roll during application to ensure prevention of air pockets.

C. Compact stabilized base to required density for at least 22 in. around storm water inlet box.

D. Ensure all exposed inlet masonry shoulder surfaces are level and clean and prime with FFAS or equivalent.

E. Lay pre-cut RPG membrane or equivalent 16 in. around opening using emulsion binder to ensure membrane is fully adhered to masonry shoulder.

F. Ensure any gaps in the membrane, such as at the corners of the inlet are covered with additional membrane layers and sealed with emulsion binder.

G. Apply emulsion binder to membrane and lay asphalt layer to specified density, ensuring use of whacker plate around the ironwork does not tear, displace or damage the membrane.

3.6 FIELD QUALITY CONTROL TESTING

A. Site Condition: Leave all areas around jobsite free of debris, materials, equipment, and related items after completion of job.

END OF SECTION 321273

SECTION 334100

STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Receipt inspection of all pipe and materials
2. MSDS for materials as appropriate.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)

1.	ASTM C478	*Standard Specification for Precast Reinforced Concrete Manhole Sections*
2.	ASTM C857	*Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures*
3.	ASTM C858	*Standard Specification for Underground Precast Concrete Underground Precast Concrete Utility Structures*
4.	ASTM C1433	*Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers.*

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

A. Polyvinyl Chloride Type PSM Sewer Pipe and Fittings, ASTM D 3034, SDR 35, for gasketed joints. Include ASTM F 477 elastomeric-seal gaskets.

B. Polyethylene Plastic Piping, ASTM F-667.

2.2 UTILITY STRUCTURES

A. Solids Separator: ADS, 1K Bayseparator® or Buyer approved equivalent.

B. Precast Concrete Catch Basins: Utility Vault 38Y-5106-BL, Oldcastle Precast, in accordance with design drawings, or Buyer approved equivalent.

C. Metal Grating Inlets: RGP 22W4H150C-Galvanized per design drawings H-14-109330, or Buyer approved equivalent.

® BaySeparator is a registered trademark of Advanced Drainage Systems, Inc.

D. Manhole sections shall be in accordance with ASTM C478

E. Manhole covers: Comcore® NS3620 Lightweight lid or Buyer approved equivalent.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream.

B. Install piping pitched at minimum slope of 1% and 24-in. minimum cover unless otherwise indicated.

C. Install PE pipe and fittings according to ASTM D 2321. Join pipe, tubing, and fittings with couplings for soil-tight joints according to manufacturer's written instructions. Install corrugated piping according to Corrugated Polyethylene Pipe Association's (CPPA) "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."

D. Install PVC pipe and gasketed fittings with gaskets according to ASTM D 2321.

E. Vault to finish grade shall be even with surrounding finish grade surface unless otherwise noted on plans.

F. Contractor shall grout all inlet and outlet pipes flush with vault interior wall.

G. Any grout used within the system shall meet the ASTM C 1107 "Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)," Grades A, B and DC at a pourable and plastic consistency of 70deg F.

END OF SECTION 334100

® Comcore is a registered trademark of CDR Systems Corporation.

APPENDIX A

SX TANK FARM REFERENCE INFORMATION

A1.0 GENERAL INFORMATION

The following photographs and figures provide reference information to support the construction specification. The photographs are provided for reference information only.

Figure A-1. SX Farm Aerial Photo.

Figure A-2. SX Farm Aerial Photo.

Figure A-3. SX Farm Cut/Fill Areas.

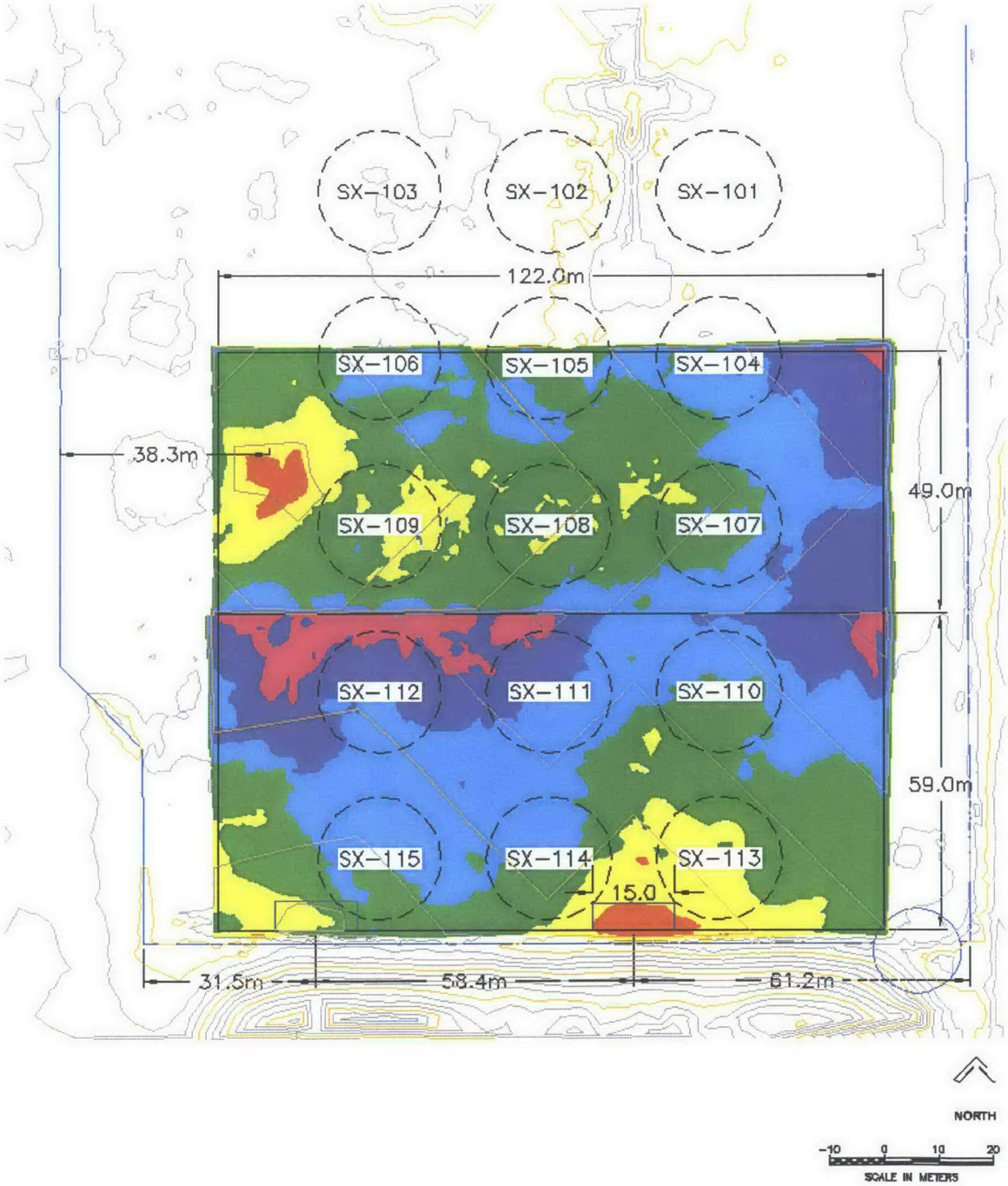

Figure A-4. SX Farm Cut/Fill Table.

NORTH

ELEVATIONS TABLE				
NUMBER	MIN ELEV	MAX ELEV	AREA M²	COLOR
1	-0.40	-0.20	90.53	
2	-0.20	0.00	666.99	
3	0.00	0.20	3087.55	
4	0.20	0.40	1844.97	
5	0.40	0.60	748.13	
6	0.60	0.65	15.72	

SOUTH

ELEVATIONS TABLE				
NUMBER	MIN ELEV	MAX ELEV	AREA M²	COLOR
1	-0.40	-0.20	95.90	
2	-0.20	0.00	653.03	
3	0.00	0.20	2318.75	
4	0.20	0.40	2591.99	
5	0.40	0.60	1267.55	
6	0.60	0.80	446.11	