U.S. Department of Energy
Hanford Site

July 8, 2020

20-ECD-0032

Ms. Alexandra K. Smith, Program Manager
Nuclear Waste Program
Washington State
Department of Ecology
3100 Port of Benton Blvd.
Richland, Washington 99354

Dear Ms. Smith:

SUBMITTAL OF CLASS 2 PERMIT MODIFICATION TO THE HANFORD FACILITY RESOURCE CONSERVATION AND RECOVERY ACT PERMIT, DANGEROUS WASTE PORTION FOR THE 242-A EVAPORATOR [T-2-6]

This letter transmits a Class 2 Permit Modification for Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion for the Treatment, Storage and Disposal of Dangerous Waste, for the 242-A Evaporator Operating Unit Group 4.

This proposed Class 2 Permit Modification would allow the connection of the PC-5000 transfer line to Liquid Effluent Retention Facility Basin 41.

This transmittal includes:

- Permittee Certifications, required under WAC 173-303-810(12) to support submittal of the Class 2 permit modification (Attachment 1).
- Chapter 1, Part A Form (Attachment 2).
- Permit Modification Package, which includes the Permit Change Notice C2-242-A-2020-02, Part A Form (Chapter 1), Unit Specific Conditions, Process Information (Chapter 4) and Procedures To Prevent Hazards (Chapter 6) (Attachment 3).
- Supporting Information (Attachment 4).

The public comment period for this permit modification is scheduled to begin on July 10, 2020, and continue through September 8, 2020.

If you have any questions, please contact me, or your staff may contact Chris J. Kemp, Director, Environmental Compliance Division, Office of River Protection, on (509) 373-0649.

Sincerely,

Digitally signed by Brian T. Vance
DN: cn=Brian T. Vance, o=Office of River Protection, ou=Department of Energy, email=brian.t.vance@orp.doe.gov, c=US
Date: 2020.07.07 09:49:19 -07'00'

Brian T. Vance
Manager

ECD:RLE

Attachments: (4)

cc w/attachs:
J. Cantu, Ecology
Administrative Record (AR-03743) (T-2-6)
Environmental Portal
^Operating Record (MSA)
WRPS Correspondence

cc w/o attachs:
J. Bell, NPT
R. Buck, Wanapum
A. S. Carlson, Ecology
L. Contreras, YN
S. L. Dahl, Ecology
D. Einan, EPA
J. L. Foster, WRPS
J. T. Hamilton, WRPS
S. Lowe, Ecology
J. J. Lyon, Ecology
N. Menard, Ecology
M. Murphy, CTUIR
K. Niles, Oregon Energy
A. G. Pomiak, Ecology
S. A. Thompson, WRPS
E. J. Van Mason, WRPS

Attachment 1
20-ECD-0032

U.S. Department of Energy, Office of River Protection Certification
Washington River Protection Solutions LLC Certification

(3 Pages Including Cover Sheet)

U.S. Department of Energy, Office of River Protection Certification

The following certification statement is provided for the submittal of the Hanford Facility Resource Conservation and Recovery Act Class 2 Permit Modification Notification C2-242-A-2020-02, for 242-A Evaporator.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Digitally signed by Brian T. Vance
DN: cn=Brian T. Vance, o=Office of River Protection, ou=Department of Energy, email=brian.t.vance@orp.doe.gov, c=US
Date: 2020.07.07 09:50:44-07'00'

Brian T. Vance, Manager
Office of River Protection
U.S. Department of Energy

Date

Washington River Protection Solutions LLC Certification

The following certification statement is provided for the submittal of the Hanford Facility Resource Conservation and Recovery Act Class 2 Permit Modification Notification C2-242-A-2020-02, for 242-A Evaporator.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

John R. Eschenberg
President and Project Manager
Washington River Protection Solutions LLC

June 1, 2020
Date

Attachment 2
20-ECD-0032

Certified Chapter 1 242-A Evaporator Part A Form

(21 Pages Including Cover Sheet)

CHAPTER 1
242-A EVAPORATOR
PART A FORM

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WASHINGTON STATE DEPARTMENT OF ECOLOGY

Dangerous Waste Permit Application Part A Form

Date Received	Reviewed by:	Date:	
Month Day Year	Approved by:	Date:	

I. This form is submitted to: (place an "X" in the appropriate box)

- ☒ Request modification to a final status permit (commonly called a "Part B" permit)
- ☐ Request a change under interim status
- ☐ Apply for a final status permit. This includes the application for the initial final status permit for a site or for a permit renewal (i.e., a new permit to replace an expiring permit).
- ☐ Establish interim status because of the wastes newly regulated on: (Date)

List waste codes:

II. EPA/State ID Number

W	A	7	8	9	0	0	0	8	9	6	7

III. Name of Facility

U.S. Department of Energy – Hanford Facility

IV. Facility Location (Physical address not P.O. Box or Route Number)

A. Street

Refer to Permit Attachment 2, Hanford Facility Permit Legal Description

City or Town	State	ZIP Code
Near Richland	WA	

County Code	County Name
0 0 5	Benton

B. Land Type	C. Geographic Location Latitude (degrees, mins, secs)	Longitude (degrees, mins, secs)	D. Facility Existence Date Month	Day	Year
F	Refer to TOPO Map (Section XV)		1 1	1 9	1 9 8 0

V. Facility Mailing Address

Street or P.O. Box

P.O. Box 450

City or Town	State	ZIP Code
Richland	WA	99352

VI. Facility contact (Person to be contacted regarding waste activities at facility)		
Name (last)	(first)	
Vance	Brian	
Job Title	Phone Number	
Manager	(509) 376-7395	
Contact Address		
Street or P.O. Box		
P.O. Box 450		
City or Town	State	ZIP Code
Richland	WA	99352

VII. Facility Operator Information		
A. Name	Phone Number	
U.S. Department of Energy Owner/Operator Washington River Protection Solutions, LLC Co-Operator for 242-A Evaporator	(509) 376-7395 (509) 376-2574	
Street or P.O. Box		
P.O. Box 450 P.O. Box 850		
City or Town	State	ZIP Code
Richland	WA	99352
B. Operator Type	F	
C. Does the name in VII.A reflect a proposed change in operator?	☐ Yes ☒ No	
If yes, provide the scheduled date for the change:	Month	Day	Year
D. Is the name listed in VII.A, also the owner? If yes, skip to Section VIII.C.	☐ Yes ☒ No	

VIII. Facility Owner Information		
A. Name	Phone Number	
U.S. Department of Energy Owner/Operator	(509) 376-7395	
Street or P.O. Box		
P.O. Box 450		
City or Town	State	ZIP Code
Richland	WA	99352
B. Owner Type	F	
C. Does the name in VIII.A reflect a proposed change in owner?	☐ Yes ☒ No	
If yes, provide the scheduled date for the change:	Month	Day	Year

IX. NAICS Codes (5/6 digit codes)													
A. First							B. Second						
5	6	2	2	1	1	Waste Treatment & Disposal	5	6	2	9	1	0	Remediation Services
C. Third							D. Fourth						
5	4	1	7	1	5	Research & Development in the Physical, Engineering, & Life Sciences	9	2	4	1	1	0	Administration of Air & Water Resource & Solid Waste Management Programs

X. Other Environmental Permits														
A. Permit Type			B. Permit Number											C. Description
	E		A	O	P	0	0	-	0	5	-	0	0	6	Title V Air Operating Permit. Incorporation of current non-radiological Notice of Construction permits and FF-01 radiological licenses into the AOP may be delayed up to 2 years.
	E		6	0	1	-	3	1	9	-	9	2	3		Petroleum Underground Storage Tank License

XI. Nature of Business (provide a brief description that includes both dangerous waste and non-dangerous waste areas and activities)

The 242-A Evaporator is a mixed waste treatment and storage unit that pretreats Double-Shell Tank (DST) waste supernatant. 242-A Evaporator operations began in March 1977; the evaporator is located in Hanford's 200 East Area. Tank waste is transferred from DST feed tank 241-102-AW to the 242-A Evaporator, where the evaporator removes water and most volatile organics.

<u>T04 – Other Treatment - Evaporation:</u>

The Evaporator is a conventional forced-circulation, vacuum evaporation system to reduce mixed waste from the DST System. The evaporator treats the waste by removing water and most volatile organics. This process creates two waste streams, which leave the 242-A Evaporator following the treatment process.

- Concentrated slurry (approximately 40 to 60 percent of the water is removed during evaporation along with a portion of volatile organics), is pumped back into the DST System.
- Process condensate (containing a portion of the volatile organics removed from the mixed waste during the evaporation process), is routed through condensate filters before release to the Liquid Effluent Retention Facility (LERF). Off gasses from the process are routed through a de-entrainment unit, a prefilter, and high-efficiency particulate air filters before being discharged to the environment.

<u>S02 – Tank Storage</u>

<u>Tank C-A-1 Evaporator Vessel:</u> Process slurry from the reboiler discharges to Tank C-A-1. Concentrated process slurry exits the lower section of Tank C-A-1 through a 28-inch recirculating line. Vapor flows out of Tank C-A-1 through a 42-inch vapor line at the top. The maximum design capacity of Tank C-A-1 is 35,600 gallons. Tank C-A-1 is in the Evaporator Room and consists of two sections:

- Lower (liquid) section, is a 14-foot diameter stainless steel shell.
- Upper (vapor) section is an 11.6-foot diameter stainless steel shell. The upper section contains two wire-mesh de-entrainment pads for the removal of liquids and solids that could be carried into the vapor header.

<u>Tank TK-C-100:</u> Process condensate from the primary, inter-, and after-condensers drain by gravity to tank TK-C-100. Tank TK-C-100 receives potentially contaminated drainage from the vessel vent system via a 27-gallon seal pot. Tank TK-C-100, is a 14-foot diameter x 19-foot high stainless steel tank located in the Condensate Room. The maximum design capacity of Tank TK-C-100 is 17,800 gallons.

The waste fed to the 242-A Evaporator is regulated as a mixed waste with the same waste constituents as the waste in the DST System. The concentrated slurry is a characteristic waste (D001, D002, and D003), toxic waste (D004 through D011, D018, D019, D022, D028 through D030, D033 through D036, D038 through D041, and D043), nonspecific source waste (F001 through F005 and F039), and state-only characteristic waste (WT01, WT02, WP01, WP02. Multi-source leachate (F039) is included as a waste derived from nonspecific source waste F001 through F005. The process condensate is regulated as a mixed waste due to the toxicity of ammonia (WT02) and because it is derived from the waste with a nonspecific source wastes F001 through F005. Multi-source leachate (F039) is included as a waste derived from nonspecific source waste F001 through F005. Section XIV.A includes a list of some dangerous waste constituents that may not have already been detected in the waste; however, knowledge of the processes providing the waste to the 242-A Evaporator indicates that these constituents are present in the waste or there is a potential for treating these constituents in the future.

Section XII, XIII, and XIV Capacity and Estimated Annual Quantities of Waste

T04 – Other Treatment (evaporation) process design capacity is 346,000 gallons per day based on a continuous feed operating 24 hours a day. The estimated annual quantity of waste treated for evaporation (T04) is 841,000,000 pounds per year based on 182 days of operation, processing 346,000 gallons per day, at a specific gravity (SpG) of 1.6.

S02 – Tank Storage process design capacity is 53,400 gallons based on the capacity of Tank C-A-1 (35,600 gallons), and TK-C-100 (17,800 gallons). The estimated annual quantity of waste for tank storage at any one time is 603,000 pounds per year based on the capacity of Tanks C-A-1 and TK-C-100 and each tanks SpG for the waste (1.6 and 1.0 SpG respectively).

NAICS Codes

NAICS Codes listed in Section IX.B – IX.D, apply to the Hanford Facility and not to this unit.

EXAMPLE FOR COMPLETING ITEMS XII and XIII (shown in lines numbered X-1, X-2, and X-3 below): A facility has two storage tanks that hold 1200 gallons and 400 gallons respectively. There is also treatment in tanks at 20 gallons/hr. Finally, a one-quarter acre area that is two meters deep will undergo in situ vitrification.

Section XII. Process Codes and Design Capacities								Section XIII. Other Process Codes								
Line Number		A. Process Codes (enter code)			B. Process Design Capacity		C. Process Total Number of Units	Line Number		A. Process Codes (enter code)			B. Process Design Capacity		C. Process Total Number of Units	D. Process Description
					1. Amount	2. Unit of Measure (enter code)							1. Amount	2. Unit of Measure (enter code)		
X	1	S	0	2	1,600	G	002	X	1	T	0	4	700	C	001	In situ vitrification
X	2	T	0	3	20	E	001									
X	3	T	0	4	700	C	001									
	1	T	0	4	346,000	U	001		1	T	0	4	346,000	U	001	Evaporation
	2	S	0	2	53,400	G	002		2							
	3								3							
	4								4							
	5								5							
	6								6							
	7								7							
	8								8							
	9								9							
1	0							1	0							
1	1							1	1							
1	2							1	2							
1	3							1	3							
1	4							1	4							
1	5							1	5							
1	6							1	6							
1	7							1	7							
1	8							1	8							
1	9							1	9							
2	0							2	0							
2	1							2	1							
2	2							2	2							
2	3							2	3							
2	4							2	4							
2	5							2	5							

XIV. Description of Dangerous Wastes

Example for completing this section: A facility will receive three non-listed wastes, then store and treat them on-site. Two wastes are corrosive only, with the facility receiving and storing the wastes in containers. There will be about 200 pounds per year of each of these two wastes, which will be neutralized in a tank. The other waste is corrosive and ignitable and will be neutralized then blended into hazardous waste fuel. There will be about 100 pounds per year of that waste, which will be received in bulk and put into tanks.

Line Number			A. Dangerous Waste No. (enter code)				B. Estimated Annual Quantity of Waste	C. Unit of Measure (enter code)	D. Processes									
									(1) Process Codes (enter)									(2) Process Description [If a code is not entered in D (1)]
X	1		D	0	0	2	400	P	S	0	1	T	0	1				
X	2		D	0	0	1	100	P	S	0	2	T	0	1				
X	3		D	0	0	2												Included with above
1			D	0	0	1	841,000,000	P	T	0	4							Evaporation
2			D	0	0	2												Included with above
3			D	0	0	3												Included with above
4			D	0	0	4												Included with above
5			D	0	0	5												Included with above
6			D	0	0	6												Included with above
7			D	0	0	7												Included with above
8			D	0	0	8												Included with above
9			D	0	0	9												Included with above
10			D	0	1	0												Included with above
11			D	0	1	1												Included with above
12			D	0	1	8												Included with above
13			D	0	1	9												Included with above
14			D	0	2	2												Included with above
15			D	0	2	8												Included with above
16			D	0	2	9												Included with above
17			D	0	3	0												Included with above
18			D	0	3	3												Included with above
19			D	0	3	4												Included with above
20			D	0	3	5												Included with above
21			D	0	3	6												Included with above
22			D	0	3	8												Included with above
23			D	0	3	9												Included with above
24			D	0	4	0												Included with above
25			D	0	4	1												Included with above

EPA/State ID Number	W	A	7	8	9	0	0	0	8	9	6	7

Continuation of Section XIV. Description of Dangerous Waste

Line Number	A. Dangerous Waste No. (enter code)				B. Estimated Annual Quantity of Waste	C. Unit of Measure (enter code)	D. Process									
							(1) Process Codes (enter)									(2) Process Description [If a code is not entered in D (1)]
26	D	0	4	3												Included with above
27	F	0	0	1												Included with above
28	F	0	0	2												Included with above
29	F	0	0	3												Included with above
30	F	0	0	4												Included with above
31	F	0	0	5												Included with above
32	F	0	3	9												Included with above
33	W	P	0	1												Included with above
34	W	P	0	2												Included with above
35	W	T	0	1												Included with above
36	W	T	0	2												Included with above
37	D	0	0	1	624,000	P	S	0	2							Tank Storage
38	D	0	0	2												Included with above
39	D	0	0	3												Included with above
40	D	0	0	4												Included with above
41	D	0	0	5												Included with above
42	D	0	0	6												Included with above
43	D	0	0	7												Included with above
44	D	0	0	8												Included with above
45	D	0	0	9												Included with above
46	D	0	1	0												Included with above
47	D	0	1	1												Included with above
48	D	0	1	8												Included with above
49	D	0	1	9												Included with above
50	D	0	2	2												Included with above
51	D	0	2	8												Included with above
52	D	0	2	9												Included with above
53	D	0	3	0												Included with above
54	D	0	3	3												Included with above
55	D	0	3	4												Included with above

EPA/State ID Number	W	A	7	8	9	0	0	0	8	9	6	7

Continuation of Section XIV. Description of Dangerous Waste

Line Number	A. Dangerous Waste No. (enter code)				B. Estimated Annual Quantity of Waste	C. Unit of Measure (enter code)	D. Process									
							(1) Process Codes (enter)									(2) Process Description [If a code is not entered in D (1)]
56	D	0	3	5												Included with above
57	D	0	3	6												Included with above
58	D	0	3	8												Included with above
59	D	0	3	9												Included with above
60	D	0	4	0												Included with above
61	D	0	4	1												Included with above
62	D	0	4	3												Included with above
63	F	0	0	1												Included with above
64	F	0	0	2												Included with above
65	F	0	0	3												Included with above
66	F	0	0	4												Included with above
67	F	0	0	5												Included with above
68	F	0	3	9												Included with above
69	W	P	0	1												Included with above
70	W	P	0	2												Included with above
71	W	T	0	1												Included with above
72	W	T	0	2												Included with above
73																
74																
75																
76																
77																
78																
79																
80																
81																
82																
83																
84																

XV. Map
Attach to this application a topographic map of the area extending to at least one (1) mile beyond property boundaries. The map must show the outline of the facility; the location of each of its existing and proposed intake and discharge structures; each of its dangerous waste treatment, storage, recycling, or disposal units; and each well where fluids are injected underground. Include all springs, rivers, and other surface water bodies in this map area, plus drinking water wells listed in public records or otherwise known to the applicant within ¼ mile of the facility property boundary. The instructions provide additional information on meeting these requirements.
XVI. Facility Drawing
All existing facilities must include a scale drawing of the facility (refer to Instructions for more detail).
XVII. Photographs
All existing facilities must include photographs (aerial or ground-level) that clearly delineate all existing structures; existing storage, treatment, recycling, and disposal areas; and sites of future storage, treatment, recycling, or disposal areas (refer to Instructions for more detail).

XVIII. Certifications		
I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.		
Operator Name and Official Title (type or print) Brain T. Vance, Manager U.S. Department of Energy Office of River Protection	Signature Digitally signed by Brian T. Vance DN: cn=Brian T. Vance, o=Office of River Protection, ou=Department of Energy, email=brian.t.vance@orp.doe.gov, c=US Date: 2020.07.07 09:51:58 -07'00'	Date Signed
Co-Operator* Name and Official Title (type or print) John R. Eschenberg President and Project Manager Washington River Protection Solutions, LLC	Signature John Eschenberg	Date Signed 06012020
Co-Operator – Address and Telephone Number* P.O. Box 850 Richland, WA 99352 (509) 376-2574		
Facility-Property Owner Name and Official Title (type or print) Brain T. Vance, Manager U.S. Department of Energy Office of River Protection	Signature Digitally signed by Brian T. Vance DN: cn=Brian T. Vance, o=Office of River Protection, ou=Department of Energy, email=brian.t.vance@orp.doe.gov, c=US Date: 2020.07.07 09:52:31 -07'00'	Date Signed

XIX. Comments

Photos 3/2016

Figure A.1. 242-A Evaporator

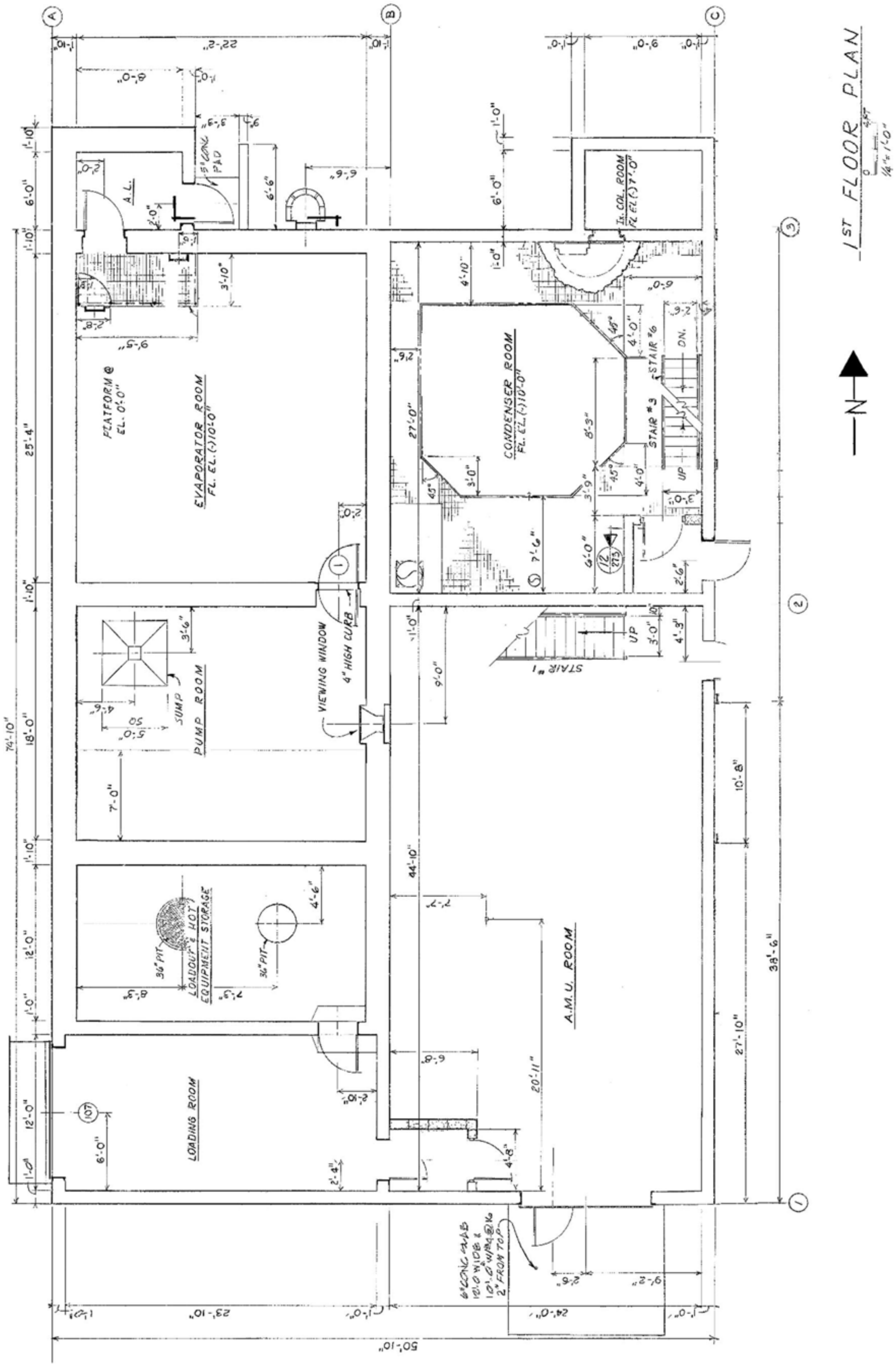


Figure A.2. 242-A Evaporator 1st Level Plan

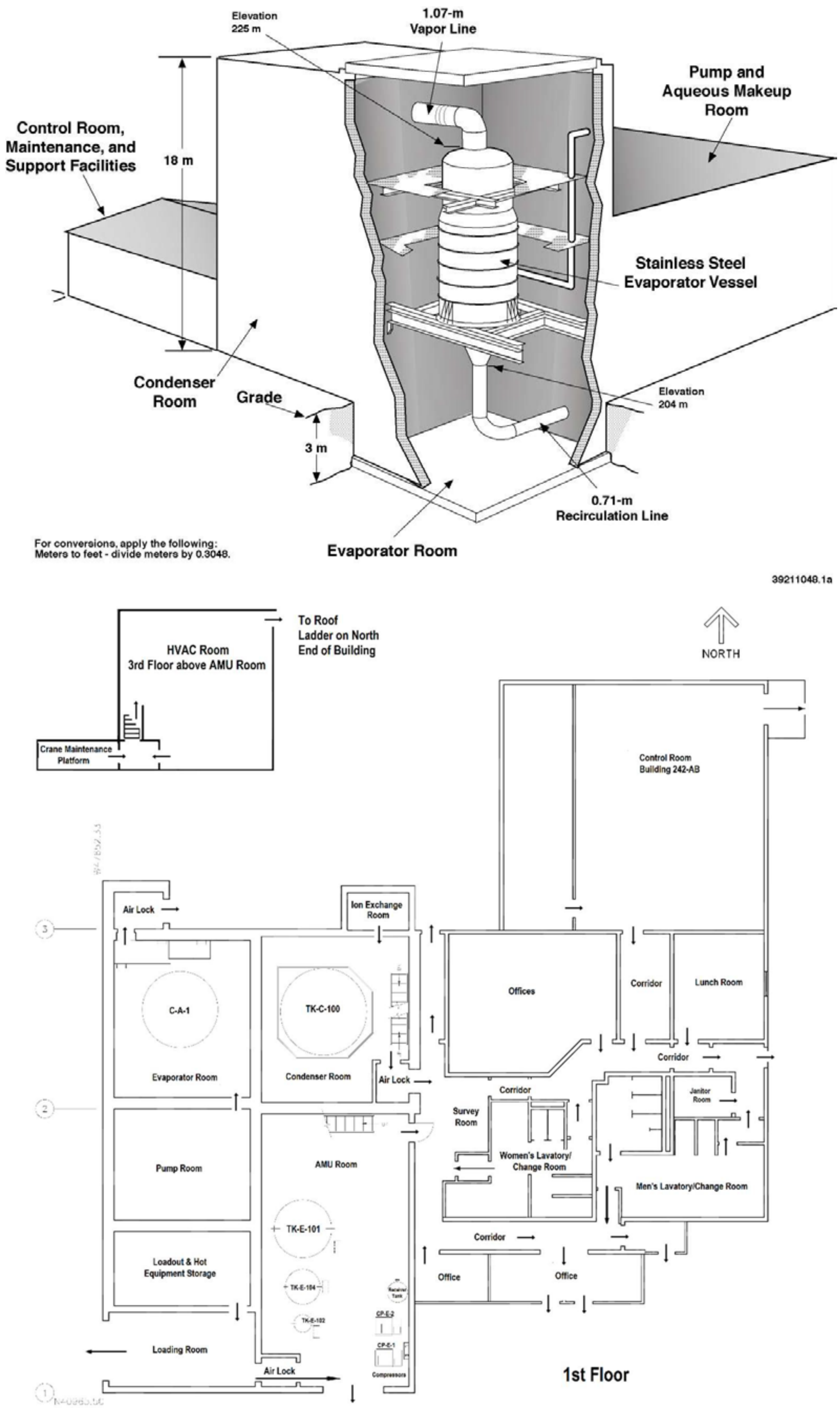
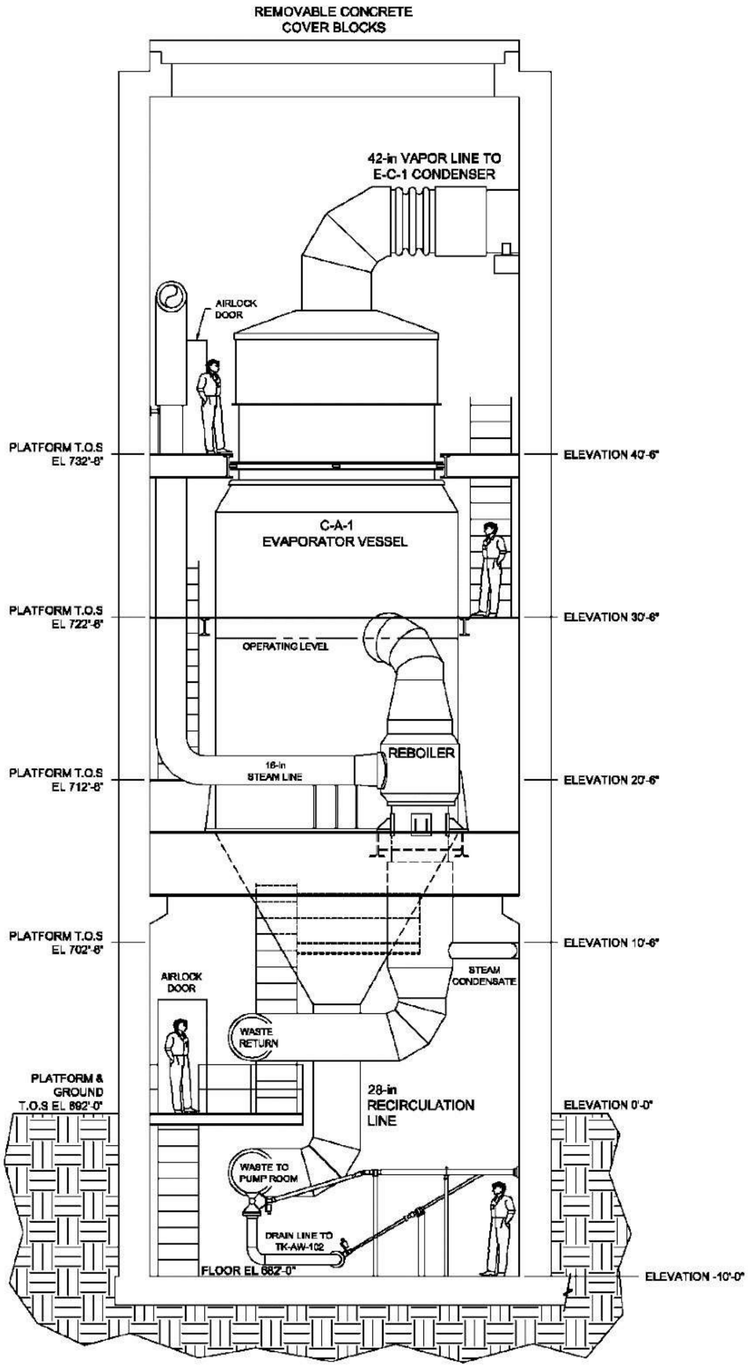


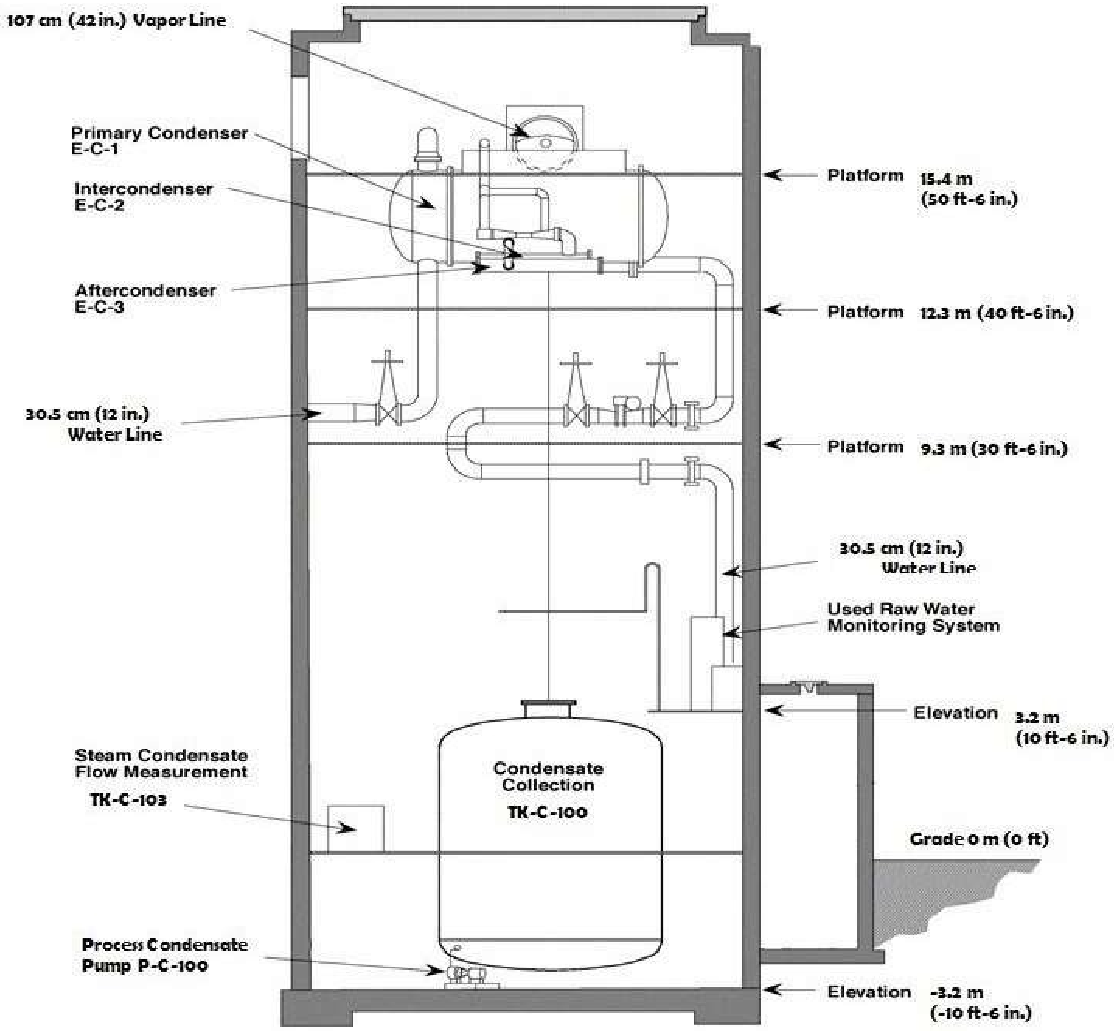
Figure A.3. 242-A Layout



Tank C-A-1 Evaporator Vessel Photo 1/2008

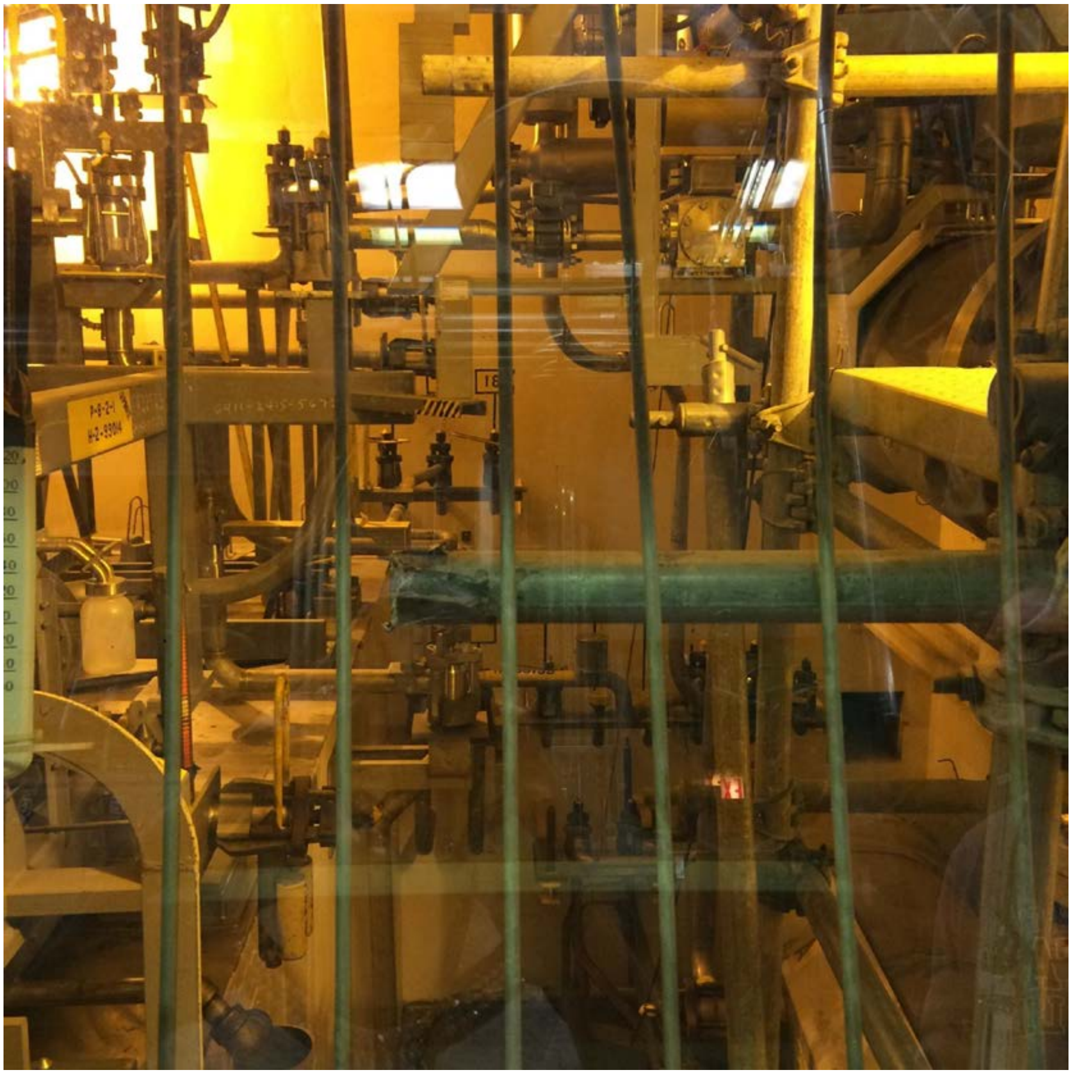
Figure A.4. Evaporator Room

Process Condensate Collection Tank TK-C-100 Photo 1/2008



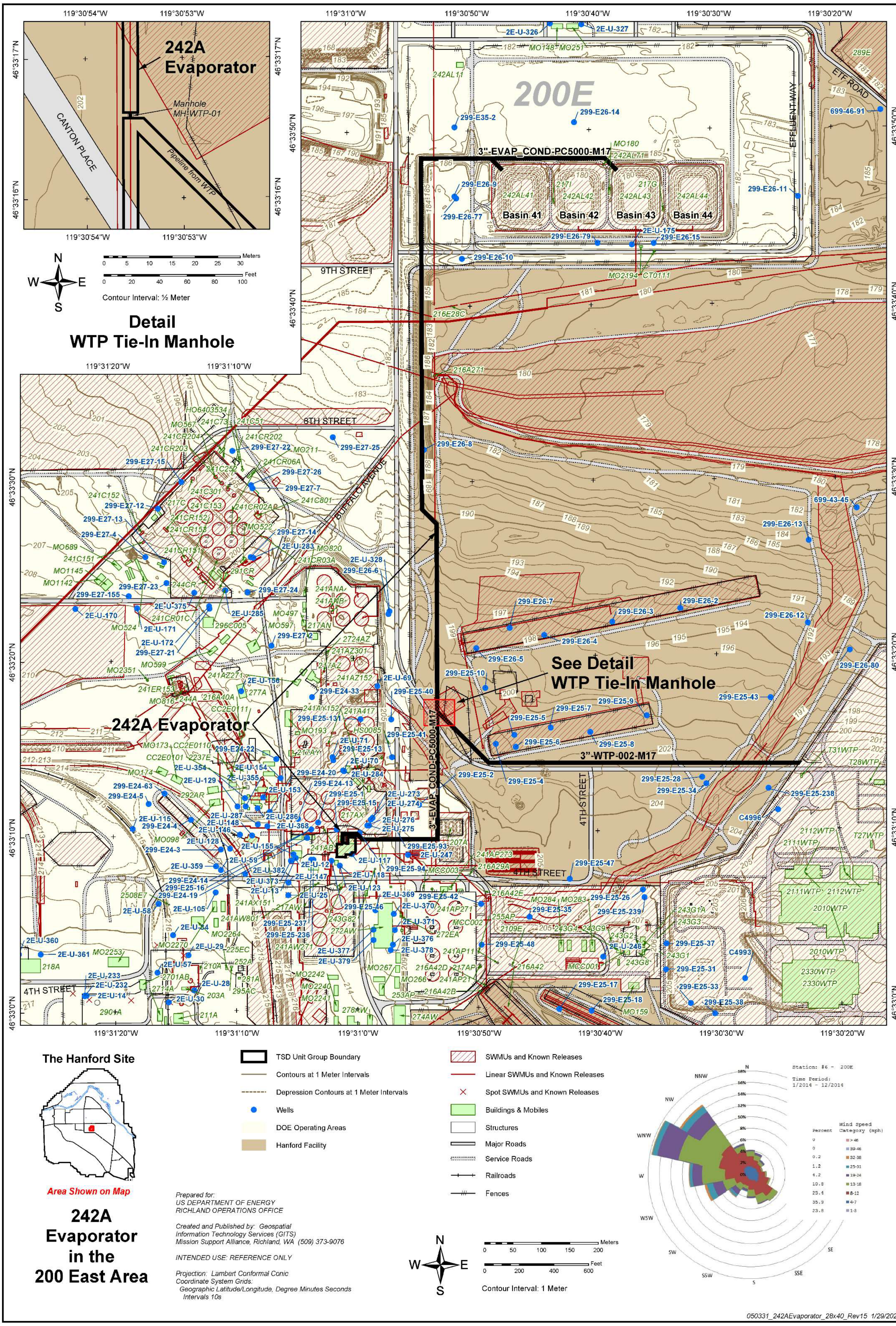
Vacuum Condenser System

Figure A.5. Condenser Room



Pump Room view from the Shield Window Photo 9/2016

Figure A.6. Pump Room


Detail
WTP Tie-In Manhole
242A
Evaporator
Manhole
MH-WTP-01
Pipeline from WTP
CANTON PLACE
Contour Interval: ½ Meter
200E
3"-EVAP_COND-PC5000-M17
3"-WTP-002-M17
Basin 41
Basin 42
Basin 43
Basin 44
See Detail
WTP Tie-In Manhole
242A Evaporator
9TH STREET
8TH STREET
4TH STREET
4TH STREET
BUFFALO AVENUE
EFFLUENT WAY
ETF ROAD
The Hanford Site
Area Shown on Map
242A
Evaporator
in the
200 East Area
TSD Unit Group Boundary
Contours at 1 Meter Intervals
Depression Contours at 1 Meter Intervals
Wells
DOE Operating Areas
Hanford Facility
SWMUs and Known Releases
Linear SWMUs and Known Releases
Spot SWMUs and Known Releases
Buildings & Mobiles
Structures
Major Roads
Service Roads
Railroads
Fences
Prepared for:
US DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
Created and Published by: Geospatial
Information Technology Services (GITS)
Mission Support Alliance, Richland, WA (509) 373-9076
INTENDED USE: REFERENCE ONLY
Projection: Lambert Conformal Conic
Coordinate System Grids:
Geographic Latitude/Longitude, Degree Minutes Seconds
Intervals 10s
Contour Interval: 1 Meter
Station: #6 - 200E
Time Period:
1/2014 - 12/2014
Wind Speed
Category (mph)
050331_242AEvaporator_28x40_Rev15 1/29/2020

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Attachment 3
20-ECD-0032

Hanford Facility RCRA Permit Modification Notification Forms
Part III, Operating Unit 4 242-A Evaporator

(18 Pages Including Cover Sheet)

Hanford Facility RCRA Permit Modification Notification Forms

Part III, Operating Unit 4

242-A Evaporator

Index

Submitted by Co-Operator:

Jeremy T. Hartley

6/1/2020

Date

Reviewed by DOE Program Office:

Brian A. Harkins

Digitally signed by Brian A. Harkins
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Robert G. Hastings

Date

<table>
<tr><td colspan="2">Hanford Facility RCRA Permit Modification Form</td></tr>
<tr><td>Unit:
242-A Evaporator</td><td>Permit Part
Part III, Operating Unit Group 4</td></tr>
<tr><td colspan="2"><u>Description of Modification:</u>

Permit Conditions

□ Updated List of Addenda Specific to Operating Unit Group 4 as follows:
Chapter 1.0 Part A Form, dated TDB ~~November 12, 2019~~
Chapter 4.0 Process Information, dated TDB ~~November 12, 2019~~
Chapter 6.0 Procedures to Prevent Hazards, dated TDB ~~November 12, 2019~~

□ Revised Permit Condition III.4.C.4.a and II.4.C.4.b, to include LERF Basin 41.

□ Added Permit Condition III.4.C.5 to submit the tightness test for the PC-5000 to LERF Basin 41 waste transfer system.

□ Added Permit Condition III.4.C.6 to submit installation integrity assessment for LERF Basin 41.</td></tr>
</table>

WAC 173-303-830 Modification Class Please mark the Modification Class:	Class 1	Class ¹1	Class 2	Class 3
			X	

Enter relevant WAC 173-303-830, Appendix I Modification citation number: -830(4)(d), Other Modifications

Enter wording of WAC 173-303-830, Appendix I Modification citation: Per WAC 173-303-830(4)(d), the Permittee requests that this modification be reviewed and approved as a Class 2

Modification Approved: ☐ Yes ☐ No (state reason for denial) <u>Reason for denial:</u>	Approved by Ecology: Stephanie Schleif Date

Hanford Facility RCRA Permit Modification Form

Unit:	Permit Part
242-A Evaporator	Part III, Operating Unit Group 4

Description of Modification:

Chapter 1, Part A Form

- Updated topographic map to show PC-5000 tie-in to LERF Basin 41.

WAC 173-303-830 Modification Class Please mark the Modification Class:	Class 1	Class '1	Class 2	Class 3
			X	

Enter relevant WAC 173-303-830, Appendix I Modification citation number: -830(4)(d), Other Modifications

Enter wording of WAC 173-303-830, Appendix I Modification citation: Per WAC 173-303-830(4)(d), the Permittee requests that this modification be reviewed and approved as a Class 2.

Modification Approved: ☐ Yes ☐ No (state reason for denial)

Reason for denial:

Approved by Ecology:

Stephanie Schleif Date

Hanford Facility RCRA Permit Modification Form	
Unit: 242-A Evaporator	Permit Part Part III, Operating Unit Group 4

<u>Description of Modification:</u>

Chapter 4, Process Information

- Section 4.1.2: revised text to address PC-5000 tie-in to LERF Catch Basin 242AL-41.
- Section 4.1.2.1: revised text to address PC-5000 tie-in to LERF Catch Basin 242AL-41, and added reference to Section 4.1.7.3.3 for information on leak detection.
- Section 4.1.2.2: revised title to include “and Immobilization”, revised text to address PC-5000 tie-in to LERF Catch Basin 242AL-41, and added reference to Section 4.1.7.3.4 for information on leak detection, and deleted duplicate text in second paragraph. Clarified that LERF and 200 Area ETF controls waste transfer to LERF Basin 41 or Basin 43.
- Sections 4.1.7.3.3 and 4.1.7.3.4: revised text to address PC-5000 tie-in to LERF Catch Basin 242AL-41, and visual inspection at the sight glass located at LERF Catch Basin 242AL-41. Also added reference to Permit Condition III.4.C.4, for instances when electronic leak detection system is not available.
- Table 4-1: added drawing H-2-88766, Sheet 6 to the table.

WAC 173-303-830 Modification Class Please mark the Modification Class:	Class 1	Class ¹1	Class 2	Class 3
			X	

Enter relevant WAC 173-303-830, Appendix I Modification citation number: -830(4)(d), Other Modifications

Enter wording of WAC 173-303-830, Appendix I Modification citation: Per WAC 173-303-830(4)(d), the Permittee requests that this modification be reviewed and approved as a Class 2.

Modification Approved: ☐ Yes ☐ No (state reason for denial) <u>Reason for denial:</u>	Approved by Ecology: Stephanie Schleif Date

Hanford Facility RCRA Permit Modification Form	
Unit: 242-A Evaporator	Permit Part Part III, Operating Unit Group 4

Description of Modification:

Chapter 6, Procedures to Prevent Hazards

- Section 6.2.2.3: revised text to address PC-5000 tie-in to LERF Catch Basin 242AL-41, and daily visual inspection at the sight glass located at LERF Catch Basins 242AL-41 and 242AL 43.
- Table 6-3: changed frequency of “Continuously” to “daily”, based on -640(6)(b)(i), which requires inspection as least once each operating day. Added Footnotes 2 and 3 for clarification.
- Table 6-3: added leak detection inspections for the PC-5000 transfer line to Basin 41 and WTP backup transfer line to Basin 41.
- Table 6-3: added Footnote 2 to address Permit Condition III.4.C.4.a.

WAC 173-303-830 Modification Class Please mark the Modification Class:	Class 1	Class [1]1	Class 2	Class 3
			X	

Enter relevant WAC 173-303-830, Appendix I Modification citation number: -830(4)(d), Other Modifications

Enter wording of WAC 173-303-830, Appendix I Modification citation: Per WAC 173-303-830(4)(d), the Permittee requests that this modification be reviewed and approved as a Class 2.

Modification Approved: ☐ Yes ☐ No (state reason for denial) Reason for denial:	Approved by Ecology: Stephanie Schleif Date

Revision Instructions:

Remove the following and replace with the revised Permit documentation:

- Permit Conditions
- Chapter 1, Part A Form
- Chapter 4, Process Information
- Chapter 6, Procedures to Prevent Hazards

OPERATING UNIT 4 UNIT-SPECIFIC CONDITIONS
242-A EVAPORATOR

UNIT DESCRIPTION

The 242-A Evaporator is a mixed waste treatment and storage unit consisting of a conventional forced-circulation, vacuum evaporation system to concentrate mixed-waste solutions located in the 200 East Area.

This document sets forth the operating conditions for the 242-A Evaporator.

III.4.A COMPLIANCE WITH UNIT SPECIFIC PERMIT CONDITIONS

The Permittees shall comply with all requirements set forth in the Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit (Permit) as specified in Permit Attachment 9, Permit Applicability Matrix, including all approved modifications. All chapters, subsections, figures, tables, and appendices included in the following unit-specific Permit Conditions are enforceable in their entirety.

In the event that the Part III-Unit-Specific Conditions for Operating Unit 4, 242-A Evaporator conflict with the Part I-Standard Conditions and/or Part II-General Facility Conditions of the Permit, the unit-specific conditions for Operating Unit 4, 242-A Evaporator prevail.

CHAPTERS SPECIFIC TO OPERATING UNIT GROUP 4:

Chapter 1.0 Part A Form, dated TDB~~November 12, 2019~~

Chapter 3.0 Waste Analysis Plan, dated November 12, 2019

Chapter 4.0 Process Information, dated TBD~~November 12, 2019~~

Chapter 5.0 Groundwater Monitoring, (not applicable)

Chapter 6.0 Procedures to Prevent Hazards, dated TBD~~November 12, 2019~~

Chapter 7.0 Contingency Plan, dated April 30, 2019

Chapter 8.0 Personnel Training, dated September 30, 2013

Chapter 11.0 Closure, dated September 30, 2013

III.4.B COMPLIANCE WITH UNIT-SPECIFIC PERMIT CONDITIONS

III.4.B.1 Portions of Permit Attachment 4 (DOE/RL-94-02) that are not made enforceable by inclusion in the applicability matrix for that document are not made enforceable by reference in this document.

III.4.C TANK SYSTEMS

III.4.C.1 Within 90 days of the effective date of the permit modification, the Permittee shall demonstrate to the department that the leak detection system for the combined PC-5000/3”-WTP-002-M17 transfer lines is designed and operated to detect the presence of liquid in the secondary containment system at the earliest practicable time if the existing detection technologies or site conditions will not allow detection of a release within 24-hours. The Permittees must consider alternative configurations for leak detection and this information will be provided to the department for concurrence. The department will provide a response within 30 days. [WAC 173-303-640(4)(c)(iii)]

III.4.C.2 Prior to receipt of any dangerous waste in the combined PC-5000/3”-WTP-002-M17 waste transfer system, the Permittees will submit the tightness test for the combined PC-5000/3”-WTP-002-M17 waste transfer system. [WAC 173-303-640(3)(e)]

III.4.C.2.a Tightness test for the combined waste transfer system piping (PC-5000/3”-WTP-002-M17) will be performed at a frequency of every 10 years upon completion of Permit Condition III.4.C.2.

III.4.C.3 Modifications to the leak detection system will be made in accordance with Permit Condition I.C.3.

III.4.C.4 The electronic leak detection system for the combined PC-5000 and 3”-WTP-002-M17 transfer lines shall be maintained and operated continuously when in use with the following exceptions:

III.4.C.4.a If the electronic leak detection system LDS-41-5 or LDE-43-2 is not operational for transfers to the Liquid Effluent Retention Facility (LERF), visual inspection shall be employed at the ~~PC-5000 catch tank 60M-TK-1 (sight glass FG-60M-001)~~ corresponding LERF Catch Basin 242AL-41 or 242AL-43 sight glass once per day ~~shift~~, during transfers. For LERF Basin 41, the sight glass is FG-60M-002; for LERF Basin 43, the sight glass is FG-60M-001.

III.4.C.4.b Ecology must be notified if either electronic leak detection system for transfers to LERF Basin 41 or Basin 43 ~~is~~are not operational ~~out of service~~ for more than 90 days. This notification must include a schedule for repairing and returning the system to service within 90 days from notification, or longer if approved by the department.

III.4.C.5 Prior to receipt of dangerous waste to Basin 41 waste transfer system, the Permittees will submit to Ecology the installation assessment report certified by an independent installation inspector or IQRPE, and the procedure for tightness testing and test results.

The 242-A Evaporator process is controlled by operators using the Monitoring Control System (MCS). The MCS computer monitors process parameters and controls the parameters where required. The MCS provides the capability to operate some components (e.g., pumps, valves) in a manual mode. Operations personnel monitor the function of the MCS and process equipment, and operate equipment in a manual mode when required to maintain safe facility operations. Once the configuration parameters and other process control inputs are set, the MCS maintains the process parameters within specified ranges by sending output signals that operate specific pieces of equipment (e.g., control valves). There are redundant MCS components in place that are not used to maintain the integrity of the mixed waste handling system and are not addressed in further detail in this permit.

4.1 Tank Systems

This section discusses information associated with design requirements, integrity assessments, and any additional requirements for tanks used to treat and store mixed waste in the 242-A Evaporator.

The 242-A Evaporator is divided into three major systems that manage mixed wastes. The systems are listed below:

- Transfer lines (PC-5000 and Waste Treatment and Immobilization Plant [WTP] backup transfer line [3”-WTP-002-M17]).
- Vapor-liquid separator (C-A-1) and ancillary equipment.
- Condensate collection tank (TK-C-100) and ancillary equipment.

4.1.1 Design Requirements

The following design requirements were addressed in the 242-A Evaporator/Crystallizer Tank System Integrity Assessment Reports (IARs), which are identified in Section 4.1.5:

- Minimum design wall thicknesses and measured wall thicknesses at various points throughout the tank systems.
- Design standards used in construction, including references.
- Waste characteristics.
- Materials of construction and compatibility of materials with the waste being processed.
- Corrosion protection.
- Seismic design basis evaluation.

The conclusion of the latest IARs are that the 242-A Evaporator system and associated PC-5000 transfer line is not leaking and is fit for use. The inspections, tests, and analyses performed provide assurance that the tank system has adequate design, sufficient structural strength, and sufficient compatibility with the waste to not collapse, rupture, or fail during operation. The report also states that a review of construction files indicates that the building structure was designed and constructed to withstand a design-basis earthquake and recommends a frequency of future integrity assessments. The codes and standards applicable to the design, construction, and testing of the 242-A Evaporator tank system are evaluated as part of the fit for use determination [WAC 173-303-640(2)(d)] reached by the latest IARs for the 242-A Evaporator and associated PC-5000 transfer line.

4.1.2 Transfer Lines

This permit includes the PC-5000 transfer line (3”-EVAP_COND-PC5000-M17) leaving the 242-A Evaporator and ending at LERF Catch Basins 242AL-41 and 242AL-43 (TSD unit group boundary between 242-A Evaporator and LERF and 200 Area ETF); and the WTP backup transfer line (3”-WTP-002-M17) leaving WTP and merging with the PC-5000 transfer line at caisson MH-WTP-01 (TSD unit group boundary between 242-A Evaporator and WTP is the WTP fence line). Addendum A, Part A Form, topographic map depicts these TSD unit group boundaries.

Caisson MH-WTP-01, is a flat bottomed fiberglass tank that contains valves for the isolation of either PC-5000 (3"-PC-5000-M17) or WTP backup transfer line (3"-WTP-002-M17) carrier pipes. All containment pipes open into caisson MH-WTP-01 allowing any leaks to transfer through the caisson to LERF Basin 43. The containment pipe lower internal surfaces are flush with the inside bottom surface of the caisson. The caisson has a 48-inch inside diameter, an overall length of 98-inches and a nominal wall thickness of ½-inch. There are four isolation valves inside the caisson that are controlled by 242-A Evaporator for transfer line use. The valves are 3-inch valves fabricated with stainless steel bodies and pipe extensions.

The PC-5000 transfer line has limited capacity, and cannot be used by both the 242-A Evaporator and WTP at the same time due to valve alignment. The use of the PC-5000 transfer line to transfer liquid effluent from WTP to LERF will be controlled by the 242-A Evaporator. The WTP process condensate transfer to LERF will satisfy the waste acceptance criteria identified in the LERF and 200 Area ETF Permit, Addendum B, Waste Analysis Plan.

4.1.2.1 PC-5000 Transfer Line (3"-EVAP_COND-PC5000-M17)

The PC-5000 primary pipeline (3"-EVAP_COND-PC5000-M17) leaves the 242-A Evaporator and ends at LERF Catch Basins 242AL-41 (valve 60M-41-2) and 242AL-43 (valve 60M-43-P). Valve 60M-41-2 and valve 60M-43-P are controlled by LERF and 200 Area ETF for transfers to LERF. The PC-5000 encasement line (6"-ENC-M17)~~"~~ includes an ~~single-point~~ end-of-line electronic leak detection element, ~~PC-5000 encasement catch tank 60M-TK-1,~~ and sight glass at LERF Catch Basins 242AL-41 and 242AL-43 (refer to Section 4.1.7.3.3) ~~FG-60M-001~~. Process condensate from the 242-A Evaporator is transferred to the LERF using a pump located in the 242-A Evaporator and approximately 5,000 feet of pipe, consisting of a 3-inch carrier pipe within a 6-inch outer containment pipeline. Flow through the pump is controlled through a valve at approximate flow rates from 40 to 80 gpm.

The encased fiberglass transfer line (PC-5000) exits the 242-A Evaporator below grade and remains below grade at a minimum 4-feet depth for freeze protection, until the pipeline emerges at the LERF Catch Basins 242AL-41 and 242AL-43. All piping at the catch basin that is above grade is wrapped with electric heat tracing tape and insulated for protection from freezing. Additional detail including information on secondary containment, leak detection and integrity assessment for this line is provided in Sections 4.1.7.3.3 and 4.1.5.1. The PC-5000 transfer line leaving the 242-A Evaporator is considered ancillary equipment to the 242-A Evaporator up to LERF Catch Basins 242AL-41 and 242AL-43.

4.1.2.2 Waste Treatment and Immobilization Plant Backup Transfer Line (3"-WTP-002-M17)

The process condensate from WTP can be transferred to LERF Basins 41 or 43, by using a pump located at WTP, and approximately 2,380 feet of pipe, consisting of a 3-inch carrier pipe within a 6-inch outer containment pipeline that merges with the PC-5000 transfer line at caisson MH-WTP-001. Valves located at LERF Catch Basin 242AL-41 (valve 60M-41-2) and Catch Basin 242AL-43 (valve 60M-43-P) are controlled by LERF and 200 Area ETF for transfers to LERF. The combined PC-5000 encasement line (6"-ENC-M17) and WTP backup transfer line (3"-WTP-002-M17) includes an ~~single-point~~ end-of-line electronic leak detection element ~~is installed at the end of the PC-5000 transfer line, PC-5000 encasement catch tank 60M-TK-1, and sight glass FG-60M-001.~~ and sight glass at LERF Catch Basins 242AL-41 and 242AL-43 (refer to Section 4.1.7.3.4).

The process condensate from WTP can be transferred to LERF by using a pump located at WTP, and approximately 2,380 feet of pipe, consisting of a 3-inch carrier pipe within a 6-inch outer containment pipeline that merges with the PC-5000 transfer line at caisson MH-WTP-001. ~~The combined PC-5000 encasement line (6"-ENC-M17) and WTP backup transfer line (3"-WTP-002-M17) includes a single-point electronic leak detection element, and sight glass FG-60M-001 is installed at the end of the PC-5000 transfer line, PC-5000 encasement catch tank 60M-TK-1, and sight glass FG-60M-001.~~

- Repair and re-certify [in accordance with WAC 173-303-810(13)(a)] the tank system before the tank system is placed back into service [WAC 173-303-640(7)(e) and (f) and WAC 173-303-806(4)(c)(vii)].
- The permittees will notify and report to Ecology any releases to the environment in accordance with WAC 173-303-640(7)(d).
- If liquids (e.g., dangerous and/or mixed waste, leaks and spills, precipitation, fire water, liquids from damaged or broken pipes) cannot be removed from the secondary containment system within 24-hours, Ecology will be verbally notified within 24-hours of determination that the liquid cannot be removed.
- If the liquids cannot be removed with 24-hours, the Permittees will provide Ecology with a written demonstration within seven (7) business days, in accordance with WAC 173-303-640(4)(c)(iv), WAC 173-303-640(7)(b)(ii), and WAC 173-303-806(4)(c)(vii). The written demonstration will identify at a minimum:
  - Reasons for delayed removal.
  - Measures implemented to ensure continued protection of human health and the environment.
  - Current actions being taken to remove liquids from secondary containment.
- The Permittees will document in the operating record the actions/procedures taken to comply with the above conditions in accordance with WAC 173-303-640(6)(d).

4.1.7.3.1 Feed Line Piping

Waste feed is supplied to the 242-A Evaporator by two DST System feed lines (SN-269 and SN-270) (one in service and one spare), each consist of 3-inch transfer piping within a 6-inch secondary containment encasement piping. If the DST System MCS annunciates a leak alarm associated with the DST System transfer, the transfer operator notifies the 242-A Evaporator control room operator of the appropriate action regarding processing operations.

4.1.7.3.2 Slurry Line Piping

The slurry pump (P-B-2) transfers mixed waste through one of two DST System transfer lines: SL-167, for transfer to valve pit 241-AW-B (standard configuration), or SL-168 for transfer to valve pit 241-AW-A (alternate configuration). Slurry solution can be routed via double-encased piping from these valve pits to any designated DST System slurry receiver tank. If the DST System MCS annunciates a leak alarm associated with the DST System transfer, the transfer operator notifies the 242-A Evaporator control room operator of the appropriate action regarding processing operations.

4.1.7.3.3 PC-5000 Transfer Line (3”-EVAP_COND-PC5000-M17)

The process condensate transfer line (PC-5000) from the 242-A Evaporator is centrifugally cast, fiberglass-reinforced epoxy thermoset resin pressure pipe fabricated to meet the requirements of American Society of Mechanical Engineers (ASME) D2997 (ASME 1984). The 3-inch carrier piping is centered and supported within 6-inch containment piping. Pipe supports are fabricated of the same material as the pipe, and meet the strength requirements of American National Standards Institute (ANSI) B31.3 (ANSI 1987) for dead weight, thermal, and seismic loads. PC-5000 transfer line leaves the 242-A Evaporator and merges with the WTP backup transfer line (3”-WTP-002-M17) at caisson WTP-MH-01. At the intersection of the transfer lines (3”-EVAP COND-PC5000-M17 and 3”-WTP-002-M17), caisson MH-WTP-01 provides secondary containment.

The PC-5000 primary pipe leaves the 242-A Evaporator and ends at valve 60M-43-P. The encasement line (6”-ENC-M17) and caisson MH-WTP-01 provide secondary containment. If a leak develops in the primary pipe, fluid will travel down the interior of the encasement line to a leak detection system that sounds an alarm in the 242-A Evaporator Control Room. In accordance with Permit Condition III.4.C.4,

~~I~~if the electronic leak detection system for LDS-41-5 or LDE-43-2 is not available, visual inspection can be employed at the corresponding LERF Catch Basins 242AL-41 or 242AL-43 sight glass. For LERF Basin 41, the sight glass is FG-60M-002; for LERF Basin 43, the sight glass is FG-60M-001. ~~PC-5000 encasement catch tank 60M-TK-1 (sight glass FG-60M-001).~~ Upon verification of a leak, the 242-A Evaporator shift manager will direct the shutdown of the aqueous waste through the transfer line(s) to immediately prevent addition of waste. To stop 242-A Evaporator waste through the PC-5000 transfer line, the condensate pump (P-C-100), located at the 242-A Evaporator is shutdown. Any leaked waste in the encasement line is gravity drained to the corresponding LERF ~~B~~basin ~~43~~.

Drawing H-2-88766, Sheets 1 and 3, provide details of the piping from the 242-A Evaporator to LERF.

4.1.7.3.4 Waste Treatment Plant Backup Transfer Line (3”-WTP-002-M17)

The process condensate transfer line (3”-WTP-02-M17) from WTP is constructed of fiberglass-reinforced plastic. The piping material specification is American Society for Testing and Materials (ASTM) D2996, “Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe”. The 3-inch carrier piping is centered and supported within 6-inch containment piping. Pipe supports are fabricated of the same material as the pipe, and meet the strength requirements of ANSI B31.3 (ANSI 1987) for dead weight, thermal, and seismic loads. The backup transfer line leaves WTP and merges with PC-5000 transfer line at caisson WTP-MH-01. At the intersection of the transfer lines, the caisson (WTP-MH-01) provides secondary containment.

In accordance with Permit Condition III.4.C.4, ~~I~~if a leak develops in the primary pipe, fluid will travel down the interior of the secondary containment pipe to a leak detection system located at LERF Catch Basins 242AL-41 and 242AL-43, which sounds an alarm in the 242-A Evaporator control room or 200 Area ETF control room. If the electronic leak detection system for LDS-41-5 or LDE-43-2 is not available, visual inspection can be employed at the corresponding LERF Catch Basins 242AL-41 or 242AL-43 sight glass. For LERF Basin 41, the sight glass is FG-60M-002; for LERF Basin 43, the sight glass is FG-60M-001. ~~PC-5000 encasement catch tank 60M-TK-1 (sight glass FG-60M-001).~~ Upon verification of a leak, the shift manager notifies WTP to shutdown the aqueous waste through the backup transfer line from WTP (3”-WTP-002-M17). Any leaked waste in the encasement line is gravity drained to the corresponding LERF ~~B~~basin ~~43~~.

Drawing H-2-88766, Sheet 5 provides details of the transfer line from WTP to 242-A Evaporator.

4.1.7.4 Additional Requirements for Specific Types of Systems

Addressed in this section are additional requirements in WAC 173-303-640 for vault systems like the 242-A Building to ensure neither buildup of ignitable vapors nor does infiltration of precipitation occur. This section also addresses secondary containment for ancillary equipment and piping associated with the tank systems.

4.1.7.4.1 Vault Systems

The 242-A Building is a vault constructed partially below ground, providing secondary containment for the tank systems. The 242-A Evaporator Part A Form (Chapter 1) contains the ignitable waste number because of the presence of nitrite and nitrate salts, which in sufficient concentrations are considered oxidizers per WAC 173-303-090(5)(a)(iv). Because of their low volatility, these compounds are unlikely to be present in the vapor phase of the tank systems at the 242-A Evaporator. However, to prevent the spread of contamination, the vapor-liquid separator (C-A-1) is ventilated and maintained at lower air pressure than the building air space during operation. This ensures air leakage is from uncontaminated building air space into the tank vapor space. Vapors from the vapor-liquid separator (C-A-1) flow to the vacuum condenser system described in Section 4.0.

The condensate collection tank (TK-C-100), collects process condensate that is not designated ignitable or reactive. The tank systems and ancillary equipment are located within the 242-A Building, which is

4.3 Engineering Drawings

The drawings in Table 4-1 are Process and Instrumentation Diagrams (P&IDs) for the systems at the 242-A Evaporator that contact mixed waste. These drawings are provided for general information, and demonstrate adequacy of the tank systems design.

Table 4-1 Process and Instrumentation Diagrams

System	Drawing Number	Drawing Title
Vapor-Liquid Separator (C-A-1)	H-2-98988 Sheet 1	P&ID Evaporator Recirc System
Reboiler (E-A-1)/Recirculation Line	H-2-98988 Sheet 2	P&ID Evaporator Recirc System
Slurry System	H-2-98989 Sheet 1	P&ID Slurry System
Condensate Collection Tank (TK-C-100)	H-2-98990 Sheet 1	P&ID Process Condensate System
Secondary Containment Drain System	H-2-98995 Sheet 1	P&ID Drain System
Secondary Containment Drain System	H-2-98995 Sheet 2	P&ID Drain System
Condensers	H-2-98999 Sheet 1	P&ID Vacuum Condenser System
Pump Room Sump	H-2-99002 Sheet 1	P&ID Jet Gang Valve System
Condensate Recycle System	H-2-99003 Sheet 1	P&ID Filtered Raw Water System
PC-5000 Transfer Line (3"-EVAP COND-PC5000-M17)	H-2-88766, Sheets 1, ~~and~~ 3, and 6	P&ID LERF Basin & ETF Influent Evaporator
WTP backup transfer line (3"-WTP-002-M17)	H-2-88766, Sheet 5	P&ID LERF WTP Interface

The drawings in Table 4-2 are for secondary containment systems for the 242-A Evaporator. Because secondary containment systems are the final barrier for preventing the release of dangerous waste into the environment, modifications that affect the secondary containment systems will be submitted to Ecology as a Class 1, 2, or 3 Permit modifications, as required by WAC 173-303-830.

Table 4-2 242-A Evaporator Secondary Containment Systems Drawings

System	Drawing Number	Drawing Title
242-A Building	H-2-69277 Sheet 1	Structural Foundation Plan Sections & General Notes - Areas 1 & 2
	H-2-69278 Sheet 1	Structural Foundation Elevations & Details - Areas 1 & 2
	H-2-69279 Sheet 1	Structural First Floor Plan & AMU - Areas 1 & 2
Pump Room Sump Drainage	H-2-69352 Sheet 1	Sections Process Waste Drainage
242-A Building Drainage	H-2-69354 Sheet 1	Plan Process Waste Drainage
Pump Room Sump	H-2-69369 Sheet 1	Pump Room Sump Assembly & Details

The vapor liquid separator (C-A-1) is located in the evaporator room, with a portion of the recirculation loop located in the pump room. Because of the high radiation dose in the evaporator room, visual inspections cannot be performed. Leaks in the evaporator room drain to the pump room sump; monitoring of the pump room sump instrumentation is performed to determine if leaks have occurred. Visual inspection of the pump room and the loadout and hot equipment storage room is performed through the shielding windows in the AMU to constrain personnel radiological exposure to levels that are As Low as Reasonably Achievable (ALARA).

6.2.2.3 Leak Detection

The sample enclosures in the loadout and hot equipment storage room have leak detectors for both the feed and slurry samplers. For information on these systems and their secondary containment, refer to Chapter 4.0, Process Information. The DST System slurry transfer lines have a leak detection system, which is monitored and functionally tested by the DST System.

During sampling or maintenance activities associated with the evaporator room, pump room, or loadout and hot equipment storage room, a radiological contamination control curtain may be extended over the loadout room to reduce the likelihood of contaminants reaching the environment through the loadout door. When extended, the contamination control curtain will limit visibility to the loadout and hot equipment storage room from the shielding window on the AMU mezzanine while completing inspections. When this is the case, inspection forms will denote that the containment curtain was extended. Leaks in the evaporator room, pump room, and the loadout and hot equipment storage room drain to the pump room sump. The sump high-level alarm serves as a leak detector for these rooms. For information on the rooms and their drain systems, refer to Chapter 4.0, Process Information.

During 242-A Evaporator waste transfers to Liquid Effluent Retention Facility (LERF), the PC-5000 transfer line is continuously monitored by an ~~single-point~~ end-of-line electronic leak detection element, or by visual inspection ~~at the PC-5000 encasement catch tank 60M-TK-1 (sight glass FG-60M-001).~~ employed at the corresponding sight glass at LERF Catch Basins 242AL-41 (FG-60M-002) and/or 242AL-43 (FG-60M-001), in accordance with Permit Condition III.4.C.4.a. The leak detection system alarms are monitored remotely in the 242-A Evaporator control room. If any liquid is observed the 242-A Evaporator Shift Manager is notified to take corrective actions. Section 4.1.7.3 addresses secondary containment and leak detection.

During WTP waste transfers to PC-5000, the WTP backup transfer line (3”-WTP-002-M17) is continuously monitored by an ~~single-point~~ end-of-line electronic leak detection element, or by visual inspection ~~at the PC-5000 encasement catch tank 60M-TK-1 (sight glass FG-60M-001)~~ employed at the corresponding sight glass at LERF Catch Basins 242AL-41 (FG-60M-002) and/or 242AL-43 (FG-60M-001), in accordance with Permit Condition III.4.C.4.a. The leak detection system alarms are monitored remotely in the 242-A Evaporator control room or the 200 Area Effluent Treatment Facility (ETF) control room. If any liquid is observed the Shift Manager is notified to take corrective actions. Section 4.1.7.3 addresses transfer line secondary containment and leak detection.

6.2.2.4 Alternative Leak Detection during Electrical/Ventilation Outages

As part of maintenance or system upgrades, the need to secure electrical power or ventilation to the 242-A Evaporator sometimes becomes necessary. This includes activities such as, but not limited to: cleaning and inspection of the Motor Control Centers (MCCs) for distributing electrical power to the systems at the 242-A Evaporator, ventilation system maintenance and upgrades. Planned electrical or ventilation outages are performed during periods when DST System waste is not being processed.

Table 6-3 Inspection Schedule for Alarm Monitoring

Item	Inspection	Frequency[1]
Overfill Protection		
Vapor liquid separator (C-A-1): WFSH-CA11 WFSH-CA12	Monitor for vapor liquid separator (C-A-1) high level. Surveillance required only when solution is in the vapor liquid separator.	Continuously
Leak Detection		
Sampler line: LDS-SMPL2	Monitor slurry sampler lines for leaks. Surveillance required only during slurry sampling.	Continuously
Pump room sump: WFI-SUMP1	Monitor for leaks in the evaporator room, pump room, loadout and hot equipment storage room and loading room by monitoring the pump room sump (leaks from these rooms drain to the pump room sump). Surveillance required only when waste solution is present in the rooms listed. Surveillance is not required during maintenance activities or power outages.	Continuously
Transfer pipeline 242-A Evaporator to LERF Basin 41 Leak Alarm LDA-41-5	Verify no leak alarm for transfer pipeline in 242-A Evaporator Control Room; or perform daily visual inspection to check for liquid in the sight glass at LERF Catch Basin 242AL-41 (FG-60M-002). Note: Monitoring required only during 242-A Evaporator waste transfers.	Continuously [2,3]
Transfer pipeline 242-A Evaporator to LERF Basin 43 Leak Alarm LDA-43-2	Verify no leak alarm for transfer pipeline; or perform daily visual inspection to check for liquid in the sight glass (FG-60M-001) at the encasement catch tank 60M-TK-1, located in LERF Catch Basin 242AL-43. Note: Monitoring required only during 242-A Evaporator waste transfers.	Continuously [2,3]
WTP backup transfer pipeline (3”-WTP-002-M17) to PC-5000 to LERF Basin 242AL-41 Leak Alarm LDA-41-5	Verify no leak alarm for transfer pipeline in 242-A Evaporator Control Room or 200 Area ETF control room; or perform daily visual inspection to check for liquid in the sight glass at LERF Catch Basin 242AL-41 (FG-60M-002). Note: Monitoring required only during WTP waste transfers. Either the 242-A Evaporator or LERF and 200 Area ETF personnel can perform the monitoring, and either can perform the visual inspection.	Continuously [2,3]

Table 6-3 Inspection Schedule for Alarm Monitoring

WTP backup transfer pipeline (3"-WTP-002-M17) to PC-5000 to LERF Basin 242AL-43 Leak Alarm LDA-43-2	Verify no leak alarm for transfer pipeline in 242-A Evaporator Control Room or 200 Area ETF control room; or perform daily visual inspection to check for liquid in the sight glass (FG-60M-001) at ~~the PC-5000 encasement catch tank 60M-TK-1, located in~~ LERF Catch Basin 242AL-43. Note: Monitoring required only during WTP waste transfers. Either the 242-A Evaporator or LERF and 200 Area ETF personnel can perform the monitoring, and either can perform the visual inspection.	Continuously [2,3]

[1] Unless otherwise noted, inspection frequencies are defined in Section 6.2.1.2.

[2] Refer to Section 6.2.2.3, for continuous instrument monitoring during waste transfers.

[3] In accordance with Permit Condition III.4.C.4.a, if either electronic leak detection system LDS-41-5 or LDE-43-2 is not operational for transfers to LERF, visual inspection shall be employed at the corresponding LERF Catch Basins 242AL-41 sight glass FG 60M 002, or 242AL-43 sight glass FG-60M-001 once per day, during transfers.

1

Table 6-4 Inspection Schedule for Maintenance and Other Inspections

Item	Inspection	Frequency[1]
Instrumentation Functional Checks and Calibrations		
~~Slurry and~~ PC-5000 leak detectors LDS-41-5 LDE-43-2	Perform leak detector functional checks.	Annually[2]
Vapor liquid separator (C-A-1) high level alarms: WFSH-CA11 WFSH-CA12	Perform calibrations of loop instruments.	Annually
Pump room sump level: WFI-SUMP1	Perform calibrations of loop instruments.	Annually
Backup Electrical Equipment		
Uninterruptible power supply	Verify output voltage and inspect battery for signs of damage or tampering.	Annually
Fire Systems		
Fire suppressant and notification systems (i.e., sprinkler system and fire alarm pull boxes)	Water flow alarm tests of the sprinkler system to ensure the operation of a single sprinkler head will transmit an alarm, and that any of the manual fire alarm boxes will properly transmit an alarm signal.	Annually
Visual inspection of the physical condition of the sprinkler system, testing, and calibration of smoke detectors, and testing of heat detectors	A visual inspection of the sprinkler system to ensure system integrity as well as the required testing and calibration of detectors to ensure functionality. A flow test at the sprinkler system is performed to ensure proper flow to the system riser.	Biennial
Annual ignitable and reactive waste inspection	Inspect areas where ignitable or reactive wastes are permitted to be stored per WAC 173-303-395(1)(d).	Annually

[1]Unless otherwise noted, inspection frequencies are defined in Section 6.2.1.2.

1

Attachment 4
20-ECD-0032

Supporting Information

(437 Pages Including Cover Sheet)

Supporting Information:

<table>
<tr><td>H-2-79604-1, Rev 3, Piping Plot & Key Plans; 242 A Evap Cond Stream</td><td>ECN-715508, Rev. 0, LERF Basin 41 Existing Piping Connections – Mechanical</td></tr>
<tr><td>H-2-79610-1, Rev. 3, Piping Plan Retention Basins</td><td rowspan="3">ECN-715508, Rev. 0, LERF Basin 41 Existing Piping Connections – Mechanical
ECN-715509, Rev. 0, LERF Basin 41 New Piping Connections - Mechanical</td></tr>
<tr><td>H-2-88766-1, Rev 14, P&ID LERF & ETF Influent Evaporator</td></tr>
<tr><td>H-2-88766-3, Rev, 20, P&ID LERF & ETF Influent Evaporator</td></tr>
<tr><td colspan="2">H-2-88766-6, Rev. 20, P&ID LERF Basin Influent Evaporator</td></tr>
<tr><td>H-2-830097-1, Rev. 1, W-519 Site Utility Systems Plan and Profile STA 2+000 to STA 2+333.0</td><td rowspan="2">ECN-715508, Rev. 0, LERF Basin 41 Existing Piping Connections – Mechanical
ECN-715509, Rev. 0, LERF Basin 41 New Piping Connections - Mechanical</td></tr>
<tr><td>H-2-830098-1, Rev. 1, W-519 Site Utility Systems Plan & Profile LERF Basins</td></tr>
<tr><td colspan="2">H-2-838765-1, LERF Basin 41 Mechanical General Arrangement</td></tr>
<tr><td colspan="2">RPP-RPT-62215, LERF Basin 41 Material Compatibility with Wastewater</td></tr>
<tr><td colspan="2">RPP-SPEC-63632, LERF Basin 41 Construction Specification</td></tr>
</table>

ENGINEERING CHANGE NOTICE

Prepared For the U.S. Department of Energy, Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

Release Stamp

DATE: May 27,2020

HANFORD RELEASE

1a. **ECN No:** ECN-715508 **Rev.** 00	1b. **Project Number:** T1P226 ☐N/A
2. **Title:** LERF Basin 41 Existing Piping Connections - Mechanical	
3. **WA or Redline ECN:** ☐ WA ☐ REDLINE ☒ N/A	4. **Temporary Modification:** ☐ Yes ☒ No
5. **Design Type:** II	6. **Design Verification Required:** ☐Yes ☒No
7. **Safety Classification:** ☐SC ☐SS ☒GS ☐N/A	
8. **USQ Number:** ☒ N/A RPP-27195	9. **PrHA Number** **Rev.** ☒ N/A

Workflow Approval Status: For Approval
Clearance Review Restriction Type: undefined

10. **Trend Codes**

Cause	Commodity	Discipline Driver
Initial Design Release	Piping, Tubing	Mechanical

11. **Design Authority Designator**

PRJ - LERF BASIN 41

12. **Approvals**

Title	Name	Signature	Date
Design Authority	Wilson, Nathaniel W	*Wilson, Nathaniel W*	04/21/2020
Checker	Dorsh, Paul M	*Dorsh, Paul M*	03/18/2020
Document Control Approval	Alvarez, Efren	*Alvarez, Efren*	05/27/2020
Environmental Protection	Wall, Jeremy M	*Wall, Jeremy M*	04/30/2020
Originator	Hall, Richard B	*Hall, Richard B*	03/18/2020
Other Approver	Joslyn, Cameron C	*Joslyn, Cameron C*	05/07/2020
Responsible Engineering Manager	Huntington, Matthew R	*Huntington, Matthew R*	05/07/2020

13. **Problem**

The new LERF Basin 41, associated catch basin, and ancillary equipment was installed by ECN-715507. The 242-A Process Condensate and the EMF Effluent lines do not route to the new basin. Without a direct route for these two process lines to drain into Basin 41 the future liquid volume sent to LERF will overwhelm the other LERF basins.

14. **Solution**

Install a tie-in point within the existing 242-A Process Condensate (3"-EVAP COND-PC5000-M17) and EMF Effluent (4"-WTP-001-M17) lines and route new pipe to Basin 41. Install the new tie-in point in each transfer line utilizing an FRP carrier pipe and encasement pipe as identified on the design media, reference H-2-838765. Excavate into the south LERF transfer line berm to access the transfer line tie-in points as shown on the project design media. Cut and install the transfer line tie-in connections as described in the construction specification RPP-SPEC-63632 and the manufacturer's recommendations. Install the new transfer lines 4"-60M-008-M18 and 3"-60M-009-M18 up to the appropriate connection in Basin 41 with the proper piping insulation, heat trace, and pipe supports. Coordinate backfill of the transfer line berm with the installation of new transfer lines in ECN-715509.

15. **Analysis**

Perform the tie-in point into the 3"-EVAP COND-PC5000-M17 and the 4"-WTP-001-M17 at the coordinate location identified on drawing H-2-838765. Route the new pipe lines to Catch Basin 41 for connection with the catch basin piping as detailed within the design media and installed via ECN-715507. Perform all field work in accordance with the project construction specification RPP-SPEC-63632.

Design checks were performed in accordance with ARES ESD (Sargent & Lundy) Quality Assurance Procedure (QAP) 3.2 and 3.6.

16. **Description of Change**

H-2-79604 Sheet 1:
-Update drawing to depict the installation of new line 3"-60M-009-M18.

H-2-79610 Sheet 1:
-Update drawing to depict the installation of new line 3"-60M-009-M18. The installation includes the FRP tie-in into the existing transfer lines as depicted on H-2-838765.

H-2-88766 Sheet 1:
-Update the sheet and zone reference for the 3"-EVAP COND-PC5000-M17 transfer line.

H-2-88766 Sheet 2:
-Update the sheet and zone reference for the 4"-WTP-001-M17 transfer line.

H-2-88766 Sheet 3:
-Update the sheet and zone reference for the 3"-EVAP COND-PC5000-M17 transfer line

H-2-88766 Sheet 5:
-Update the sheet and zone reference for the 4"-WTP-001-M17 transfer line.

RICHARD B. HALL STATE OF WASHINGTON 53333 REGISTERED PROFESSIONAL ENGINEER

5/27/2020

ENGINEERING CHANGE NOTICE

ECN No: ECN-715508 **Rev.** 00

16. **Description of Change**

H-2-830097 Sheet 1:
-Update drawing to depict the installation of new line 3"-60M-009-M18 and the new line 4"-60M-008-M18. The installation includes the FRP tie-in into the existing transfer lines as depicted on H-2-838765.

H-2-830098 Sheet 1:
-Update drawing to depict the installation of new line 3"-60M-009-M18 and the new line 4"-60M-008-M18. The installation includes the FRP tie-in into the existing transfer lines as depicted on H-2-838765.

17. **Work Package Number(s)**

TBD

18. **TBDs or Holds** ☒N/A

19. **Related Structures, Systems, and Components**

a. **Related Building/Facilities** ☐N/A	b. **Related Systems** ☐N/A	c. **Related Equipment ID Nos. (EIN)** ☐N/A
LERF FACILITIES	LERF	3"-EVAP COND-PC5000-M17 4"-WTP-001-M17

20. **Engineering Drawings to be Changed** Does change affect the Electronic Routing Board? ☐

Drawing Number	Rev.	Title
H-2-79604 SH 001	03	PIPING PLOT & KEY PLANS 242-A EVAP COND STREAM
H-2-79610 SH 001	03	PIPING PLAN RETENTION BASINS
H-2-830097 SH 001	01	W-519 SITE/UTILITY SYSTEMS PLAN AND PROFILE STA 2+000 TO STA 2+333.0
H-2-830098 SH 001	01	W-519 SITE/UTILITY SYSTEMS PLAN & PROFILE LERF BASINS
H-2-88766 SH 001	14	P & ID LERF BASIN & ETF INFLUENT EVAPORATOR
H-2-88766 SH 002	16	P&ID LERF BASIN & ETF INFLUENT EVAPORATOR
H-2-88766 SH 003	20	P&ID LERF BASIN & ETF INFLUENT EVAPORATOR
H-2-88766 SH 005	02	P & ID LERF-WTP INTERFACE

21. **Related Modification Traveler** ☐N/A

MT-50497

22. **Related Documents** ☐N/A

Document Number	Rev.	Title
ECN-715507	00	LERF Basin 41 Installation - Mechanical
ECN-715509	00	LERF Basin 41 New Piping Connections - Mechanical
H-2-838765 SH 001	00	LERF BASIN 41 MECHANICAL GENERAL ARRANGEMENT
H-2-88766 SH 006	00	P&ID LERF BASIN & ETF INFLUENT EVAPORATOR
RPP-SPEC-63632	00	LERF Basin 41 Construction Specification

23. **Distribution**

Name	Organization
Angevine, Brennan T	MISSION ANALYSIS ENGINEERING
Blaak, Whitney S	COGNIZANT SYSTEM ENGINEERING
Demiter, Scott M	ETF OPERATIONS
Foster, Jim	242-A/AW/ETF OPERATIONS
Goessmann, Glen E	ENGINEERING PROGRAMS
Greenhalgh, Aaron M	TANK FARM PROJECTS ENGINEERING
Halgren, Dale L	ETF ENGINEERING
Harris, John W	SAFETY PROGRAM SERVICES RC/P
Joslyn, Cameron C	ETF ENGINEERING
McFerran, Brandon E	242-A/AW/ETF OPERATIONS
McShane, Michael P	ENGINEERING PROGRAMS
Omberg Carro, Susan K	NUCLEAR SAFETY
Powers, Daniel J	ETF ENGINEERING
Roosendaal, Gene D	TFP PROJECT MANAGEMENT
Rutherford, Wally	ETF ENGINEERING
Sackett, Tom E	TANK FARM PROJECTS
Samoska, Jerry A	INSTRUMENT & CNTRL ENGINEERING
Shultz, Milton V	NUCLEAR SAFETY
Smith, Gregory E	TANK FARM PROJECTS ENGINEERING
Smoot, Bill R	TFP RADCON
Swanson, Brad L	242-A/AW/ETF OPERATIONS
Wall, Jeremy M	RETRVL & CLOSURE/PROJ ENV CMPL
Wilson, Nathaniel W	ETF PROJECTS ENGINEERING

ENGINEERING CHANGE NOTICE
CONTINUATION SHEET

ECN NO.: 715508

Document/Drawing No. H-2-79604 Sheet 1 Revision 3

CONSTRUCTION NOTE: (DO NOT INCORPORATE)
THIS "WAS" CONDITION REFLECTS THE "IS" CONDITION OF ECN-715507 WHEN WORK COMPLETE.

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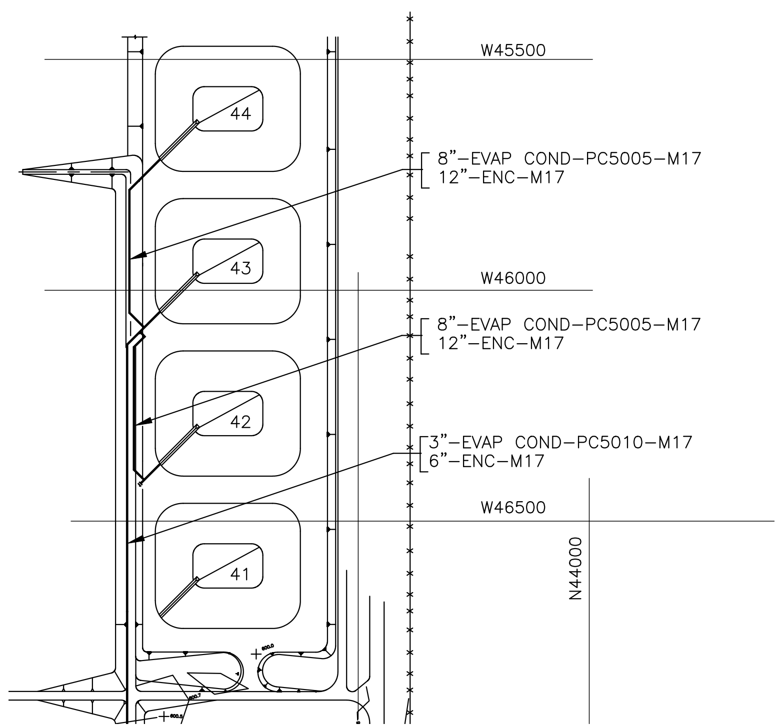

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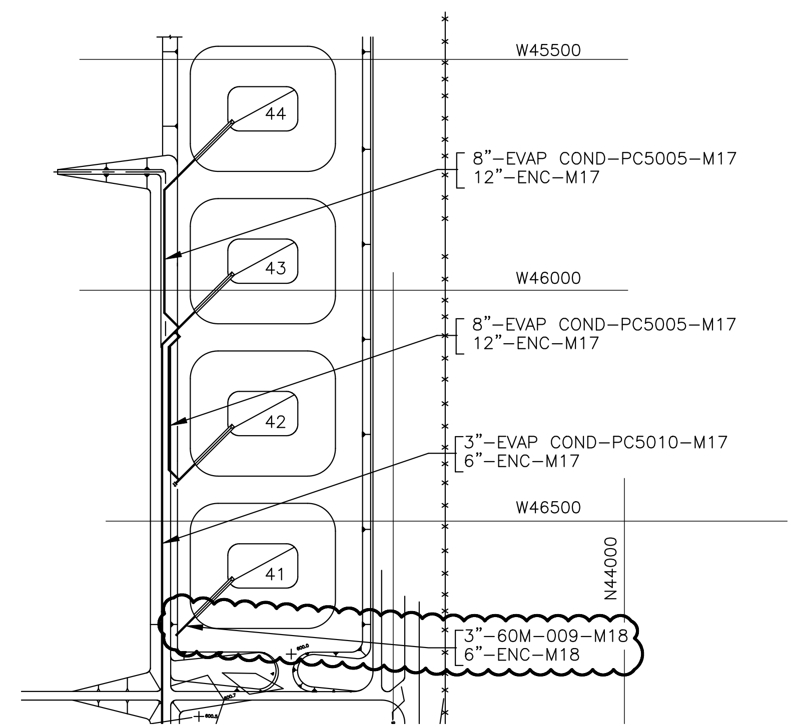


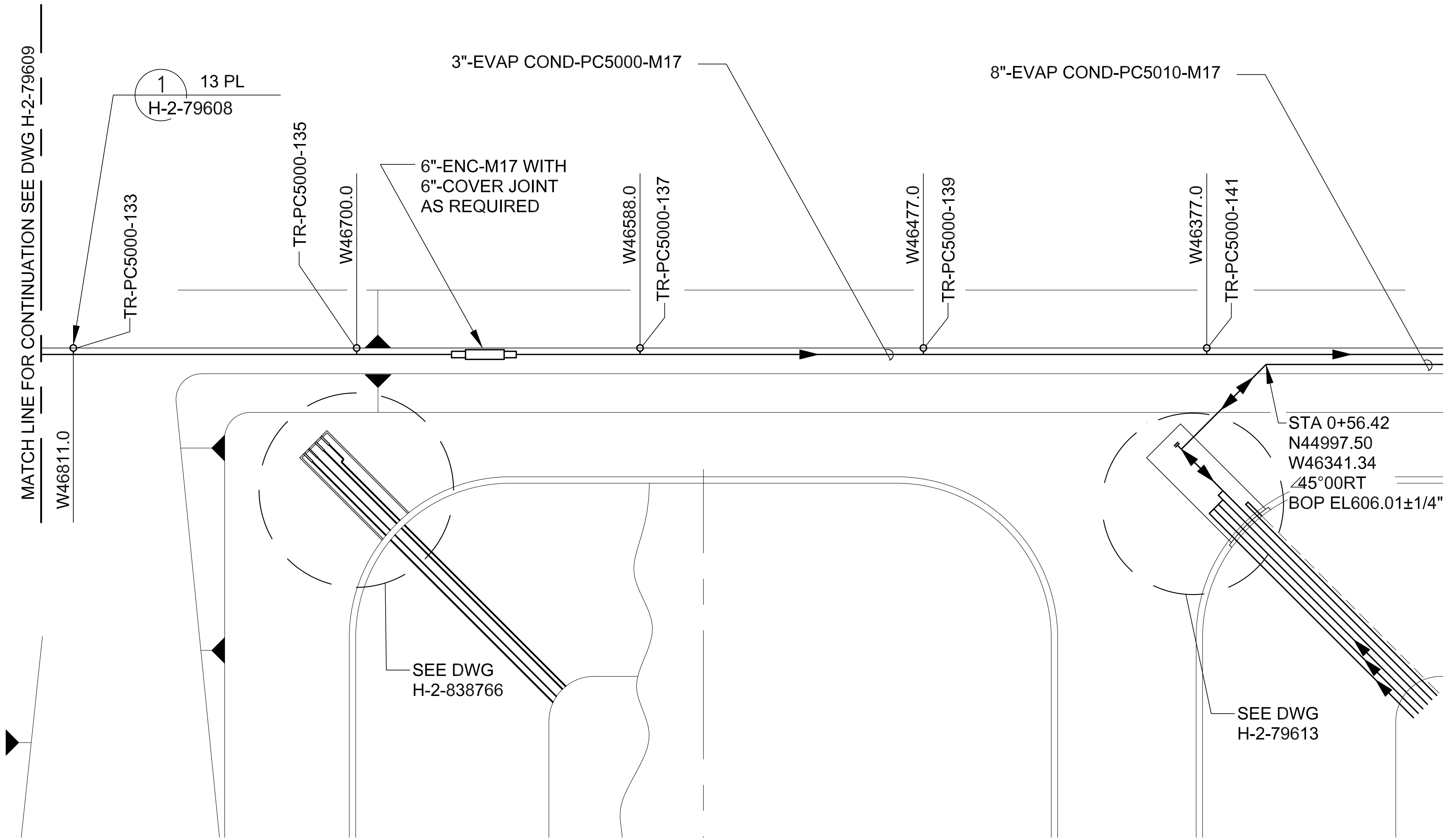
ENGINEERING CHANGE NOTICE
CONTINUATION SHEET

ECN NO.: 715508

Document/Drawing No. H-2-79610 Sheet 1 Revision 3

CONSTRUCTION NOTE: (DO NOT INCORPORATE)
THIS "WAS" CONDITION REFLECTS THE "IS" CONDITION OF ECN-715507 WHEN WORK COMPLETE.

WAS: (ZONE E/8)



ENGINEERING CHANGE NOTICE CONTINUATION SHEET

ECN NO.: 715508

Document/Drawing No. H-2-79610 Sheet 1 Revision 3

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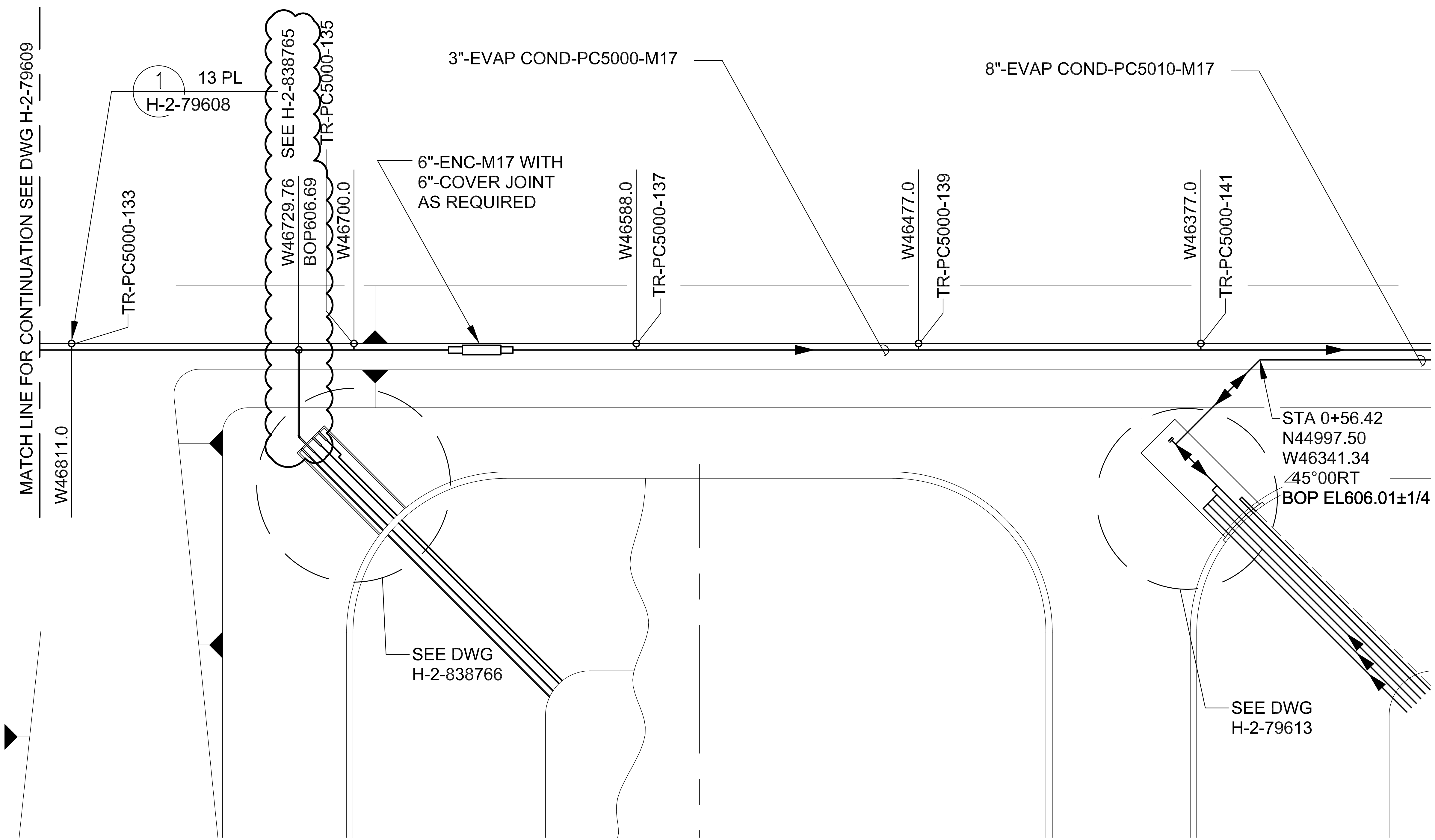

ENGINEERING CHANGE NOTICE
CONTINUATION SHEET

ECN NO.: 715508

Document/Drawing No. H-2-88766 Sheet 1 Revision 14

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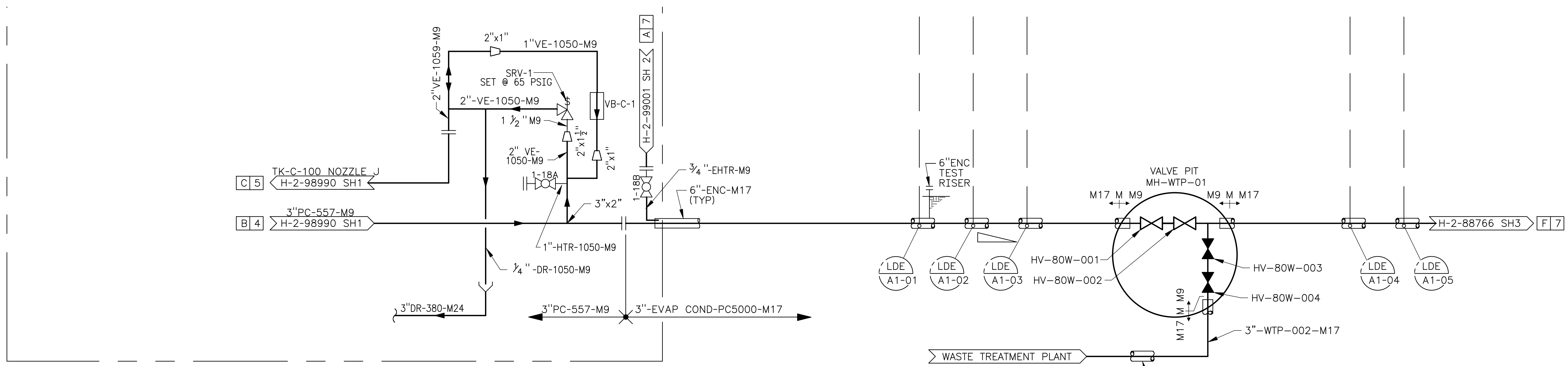
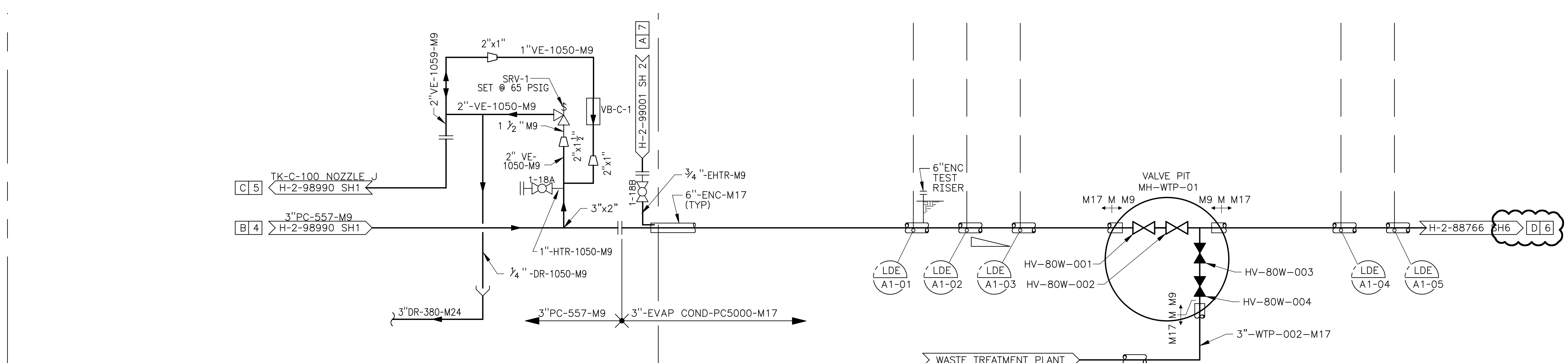


242-A EVAPORATOR BLDG
SEE NOTE 1

IS: (ZONE B/2)



242-A EVAPORATOR BLDG
SEE NOTE 1

ENGINEERING CHANGE NOTICE
CONTINUATION SHEET

ECN NO.: 715508

Document/Drawing No. H-2-88766 Sheet 2 Revision 16

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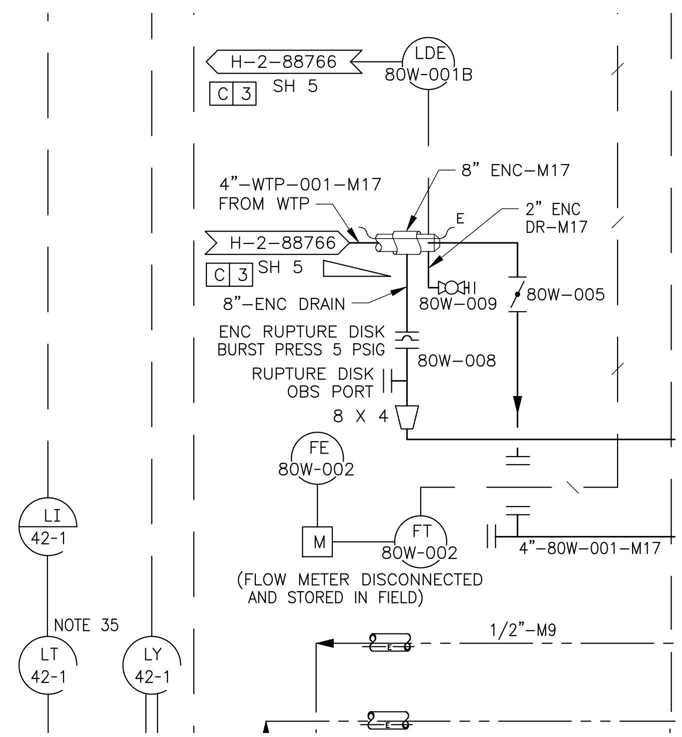

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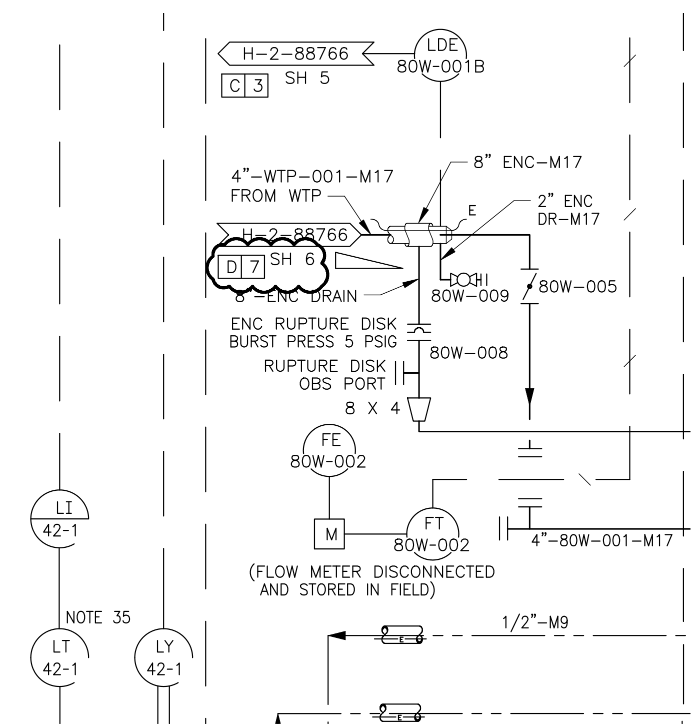

ENGINEERING CHANGE NOTICE
CONTINUATION SHEET

ECN NO.: 715508

Document/Drawing No. H-2-88766 Sheet 3 Revision 20

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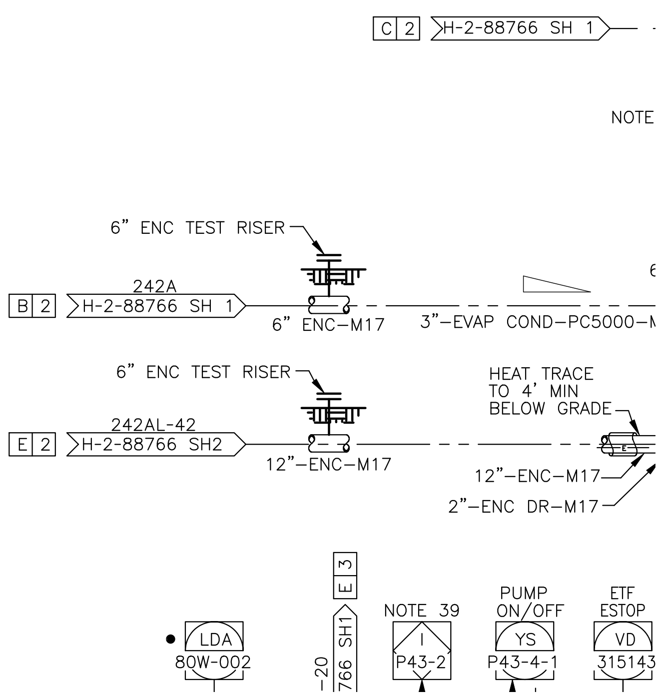

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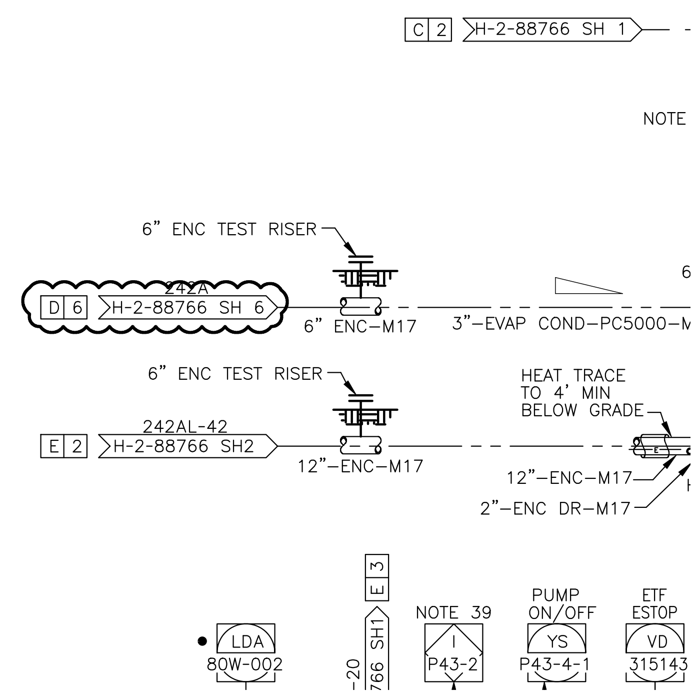

ENGINEERING CHANGE NOTICE
CONTINUATION SHEET

ECN NO.: 715508

Document/Drawing No. H-2-88766 Sheet 5 Revision 2

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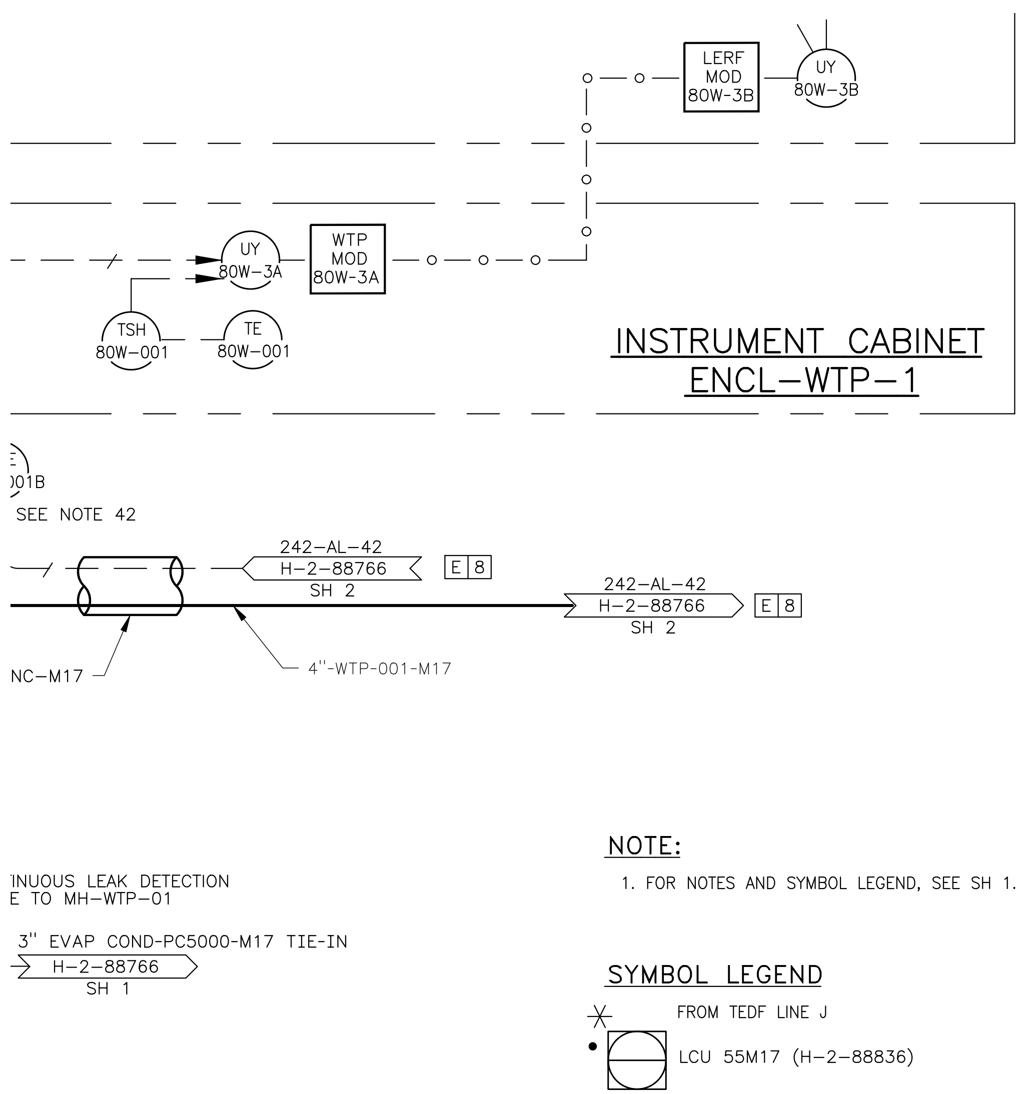

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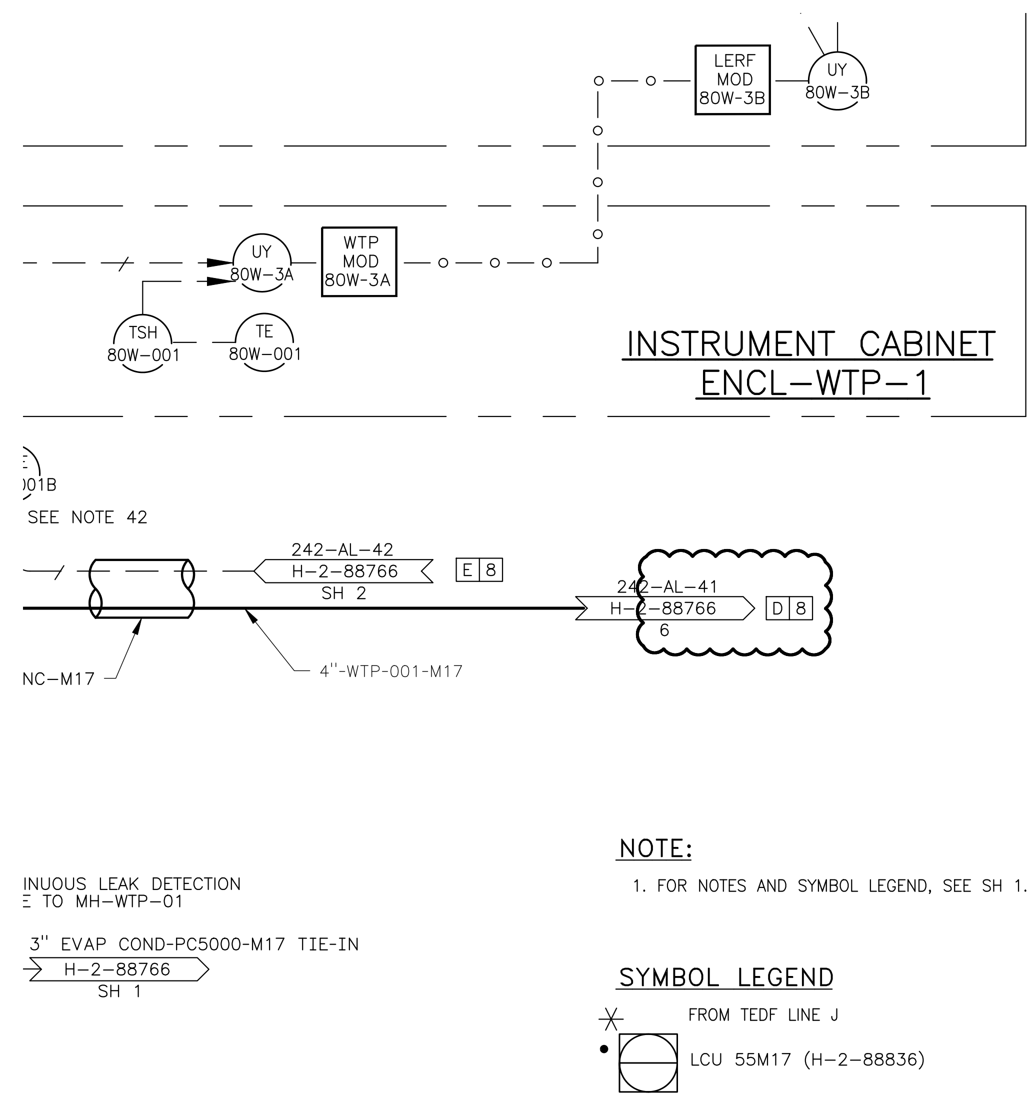


ENGINEERING CHANGE NOTICE
CONTINUATION SHEET

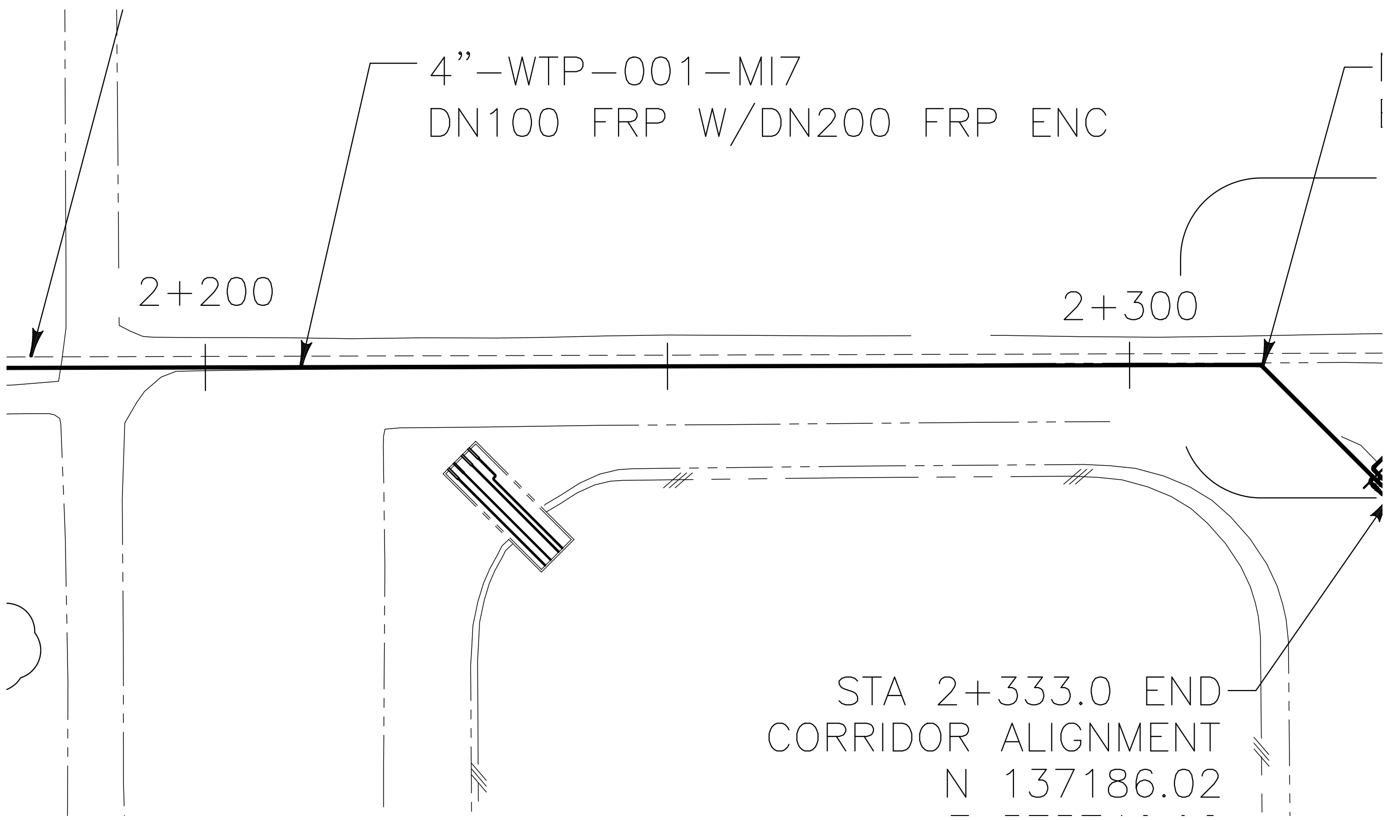
ECN NO.: 715508

Document/Drawing No. H-2-830097 Sheet 1 Revision 1

CONSTRUCTION NOTE: (DO NOT INCORPORATE)

THIS "WAS" CONDITION REFLECTS THE "IS" CONDITION OF ECN-715507 WHEN WORK COMPLETE.

WAS: (ZONE E/5)



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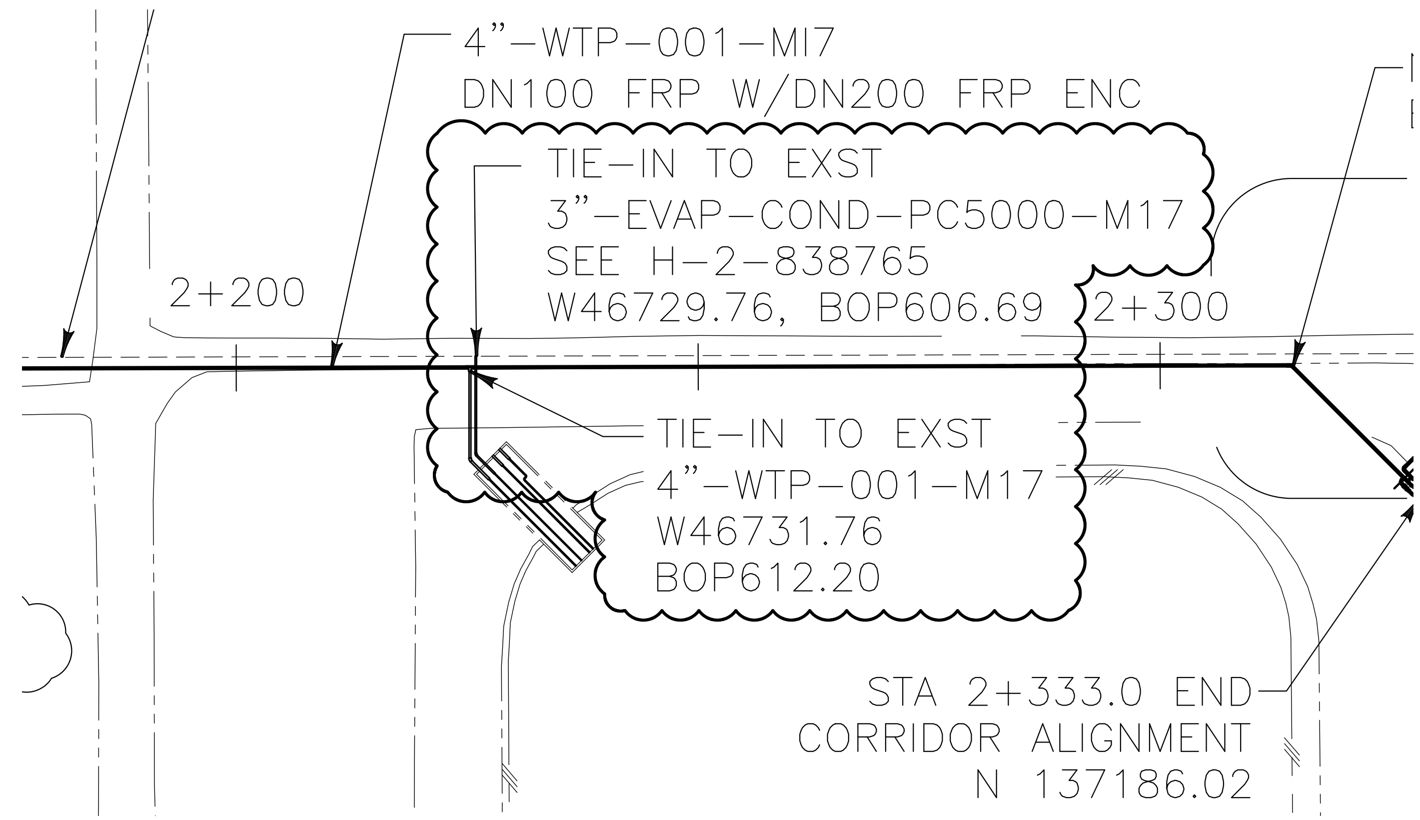

ENGINEERING CHANGE NOTICE
CONTINUATION SHEET

ECN NO.: 715508

Document/Drawing No. H-2-830098 Sheet 1 Revision 1

CONSTRUCTION NOTE: (DO NOT INCORPORATE)

THIS "WAS" CONDITION REFLECTS THE "IS" CONDITION OF ECN-715507 WHEN WORK COMPLETE.

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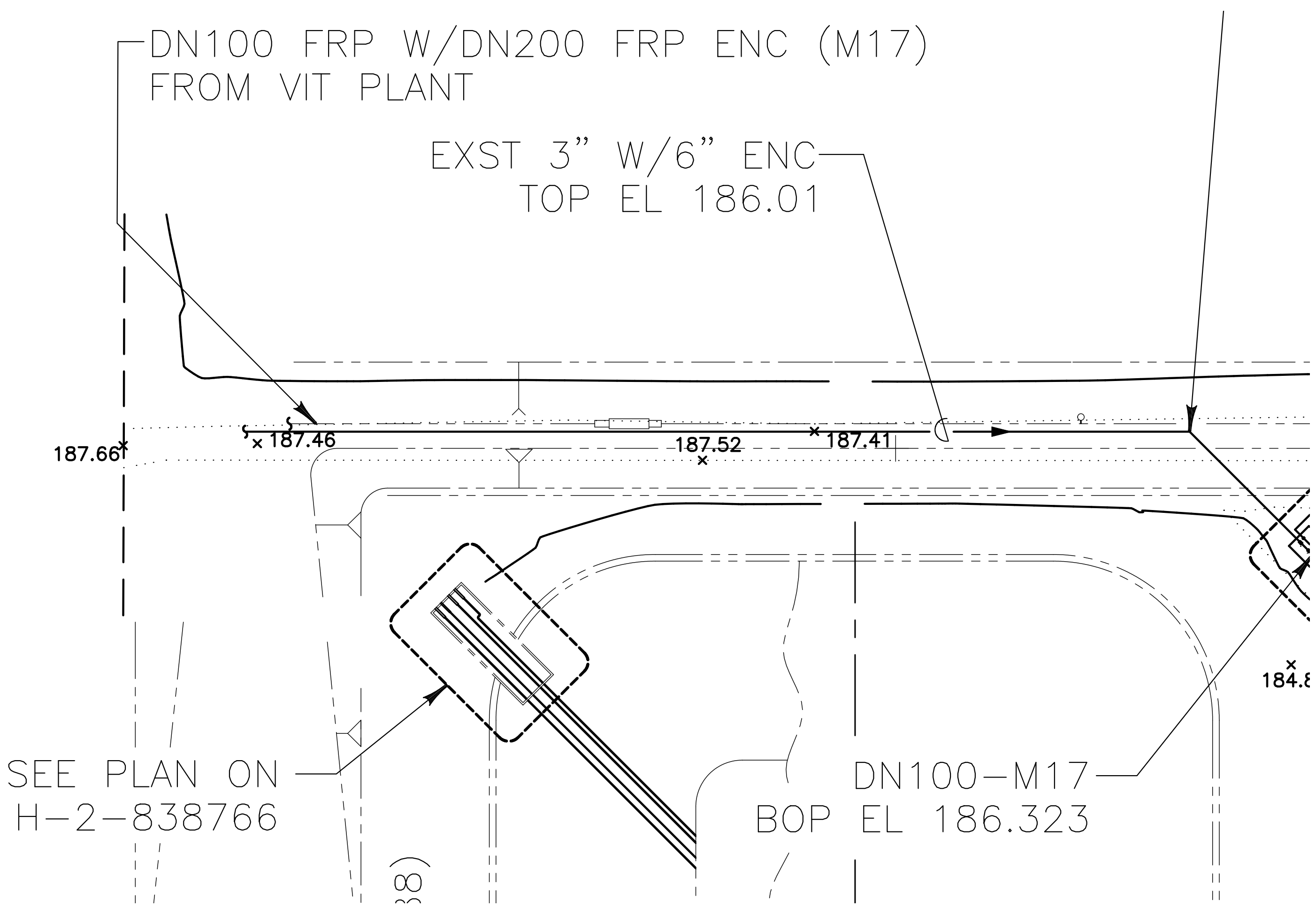

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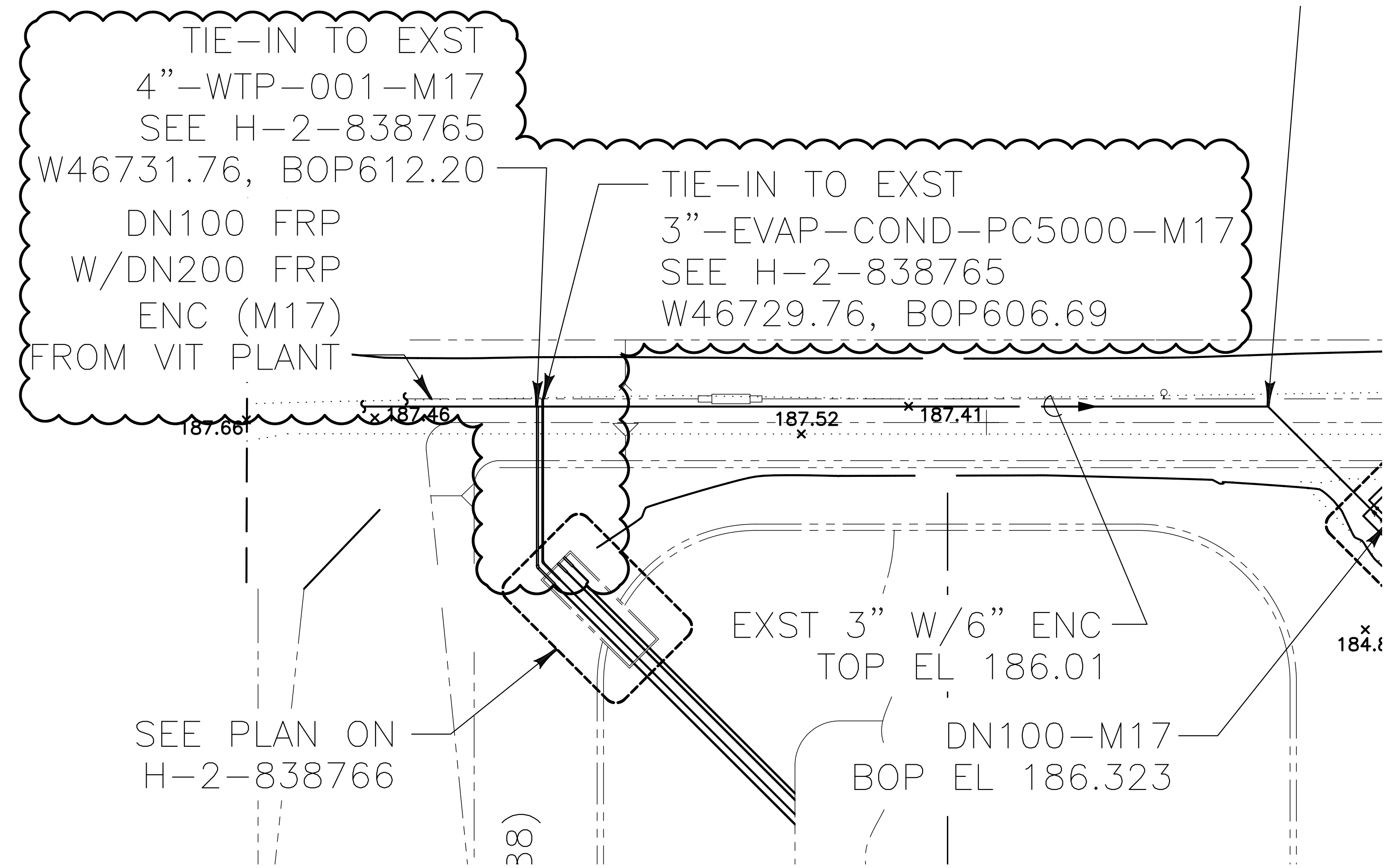


ENGINEERING CHANGE NOTICE

Prepared For the U.S. Department of Energy, Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

Release Stamp

DATE: May 27,2020 HANFORD RELEASE

1a. ECN No: ECN-715509 **Rev.** 00

1b. Project Number: T1P226 ☐N/A

2. Title: LERF Basin 41 New Piping Connections - Mechanical

3. WA or Redline ECN: ☐ WA ☐ REDLINE ☒ N/A

4. Temporary Modification: ☐ Yes ☒ No

5. Design Type: II

6. Design Verification Required: ☐Yes ☒No

7. Safety Classification: ☐SC ☐SS ☒GS ☐N/A

Workflow Approval Status: For Approval

Clearance Review Restriction Type: undefined

8. USQ Number: ☒ N/A RPP-27195

9. PrHA Number **Rev.** ☒ N/A

10. Trend Codes

Cause	Commodity	Discipline Driver
Initial Design Release	Piping, Tubing	Mechanical

11. Design Authority Designator

PRJ - LERF BASIN 41

12. Approvals

Title	Name	Signature	Date
Design Authority	Wilson, Nathaniel W	*Wilson, Nathaniel W*	04/21/2020
Checker	Dorsh, Paul M	*Dorsh, Paul M*	04/07/2020
Document Control Approval	Meinecke, Kathryn R	*Meinecke, Kathryn R*	05/27/2020
Environmental Protection	Wall, Jeremy M	*Wall, Jeremy M*	04/30/2020
Originator	Hall, Richard B	*Hall, Richard B*	03/18/2020
Other Approver	Greenhalgh, Aaron M	*Greenhalgh, Aaron M*	04/15/2020
Other Approver	Joslyn, Cameron C	*Joslyn, Cameron C*	05/07/2020
Responsible Engineering Manager	Huntington, Matthew R	*Huntington, Matthew R*	05/11/2020

13. Problem

The new LERF Basin 41, associated catch basin, and ancillary equipment was installed by ECN-715507. However, this installation did not mechanically connect Basin 41 with the other LERF piping network. As such, no liquid can be transferred from Basin 41 to the other LERF basins and/or ETF, or subsequently the other LERF basins and/or ETF can not transfer feed to Basin 41.

14. Solution

Install two new transfer lines (4"-60M-010-M18 and 4"-60M-011-M18) from Catch Basin 41 to a tie-in point within Catch Basin 42. The installation of these two new transfer lines will allow Basin 41 to be connected with the existing LERF piping network. The installed transfer lines will utilize an FRP carrier pipe and encasement pipe as identified on the new design media, reference H-2-838765. Perform the tie-in connection to Catch Basin 42 piping as shown in H-2-838765. Excavate into the south LERF transfer line berm as necessary for installation of the new transfer lines as shown on the project design media. Install the transfer line as described in the construction specification RPP-SPEC-63632 and the manufacturer's recommendations. Ensure proper piping insulation, heat trace, and pipe supports are utilized per the project design media. Coordinate backfill of the transfer line berm with the installation of other the new transfer lines in ECN-715508. Remove the existing bling flange and install valve 60M-42-8 (see H-2-838765) as shown on this ECN.

15. Analysis

Perform the installation of new transfer line 4"-60M-010-M18 and new transfer line 4"-60M-011-M18 at the coordinate location identified on drawing H-2-838765. Route the new pipe lines from Catch Basin 41 to Catch Basin 42 for connection with the existing LERF piping. The Catch Basin 41 piping installation is detailed within ECN-715507. Perform all field work in accordance with the project construction specification RPP-SPEC-63632.

Design checks were performed in accordance with S&L Quality Assurance Procedure (QAP) 3.2 and 3.6.

16. Description of Change

H-2-79610 Sheet 1:
-Update drawing to depict the installation of transfer lines 4"-60M-010-M18 and 4"-60M-011-M18.

H-2-79613 Sheet 1:
-Update drawing sheet to show the installation of transfer lines 4"-60M-010-M18 and 4"-60M-011-M18 as they interface with the existing Catch Basin 42 piping. Install new valves within the existing Catch Basin 42 piping to facilitate necessary operations functionality.

H-2-88766 Sheet 2:
-Update the Catch Basin 42 P&ID drawing sheet to depict the interface connection of transfer lines 4"-60M-010-M18 and 4"-60M-011-M18.

H-2-830097 Sheet 1:
-Update this sheet to for installation of transfer lines 4"-60M-010-M18 and 4"-60M-011-M18.

H-2-830098 Sheet 1:
-Update this sheet to for installation of transfer lines 4"-60M-010-M18 and 4"-60M-011-M18.

RICHARD B. HALL STATE OF WASHINGTON 63383 REGISTERED PROFESSIONAL ENGINEER

5/27/2020

ENGINEERING CHANGE NOTICE

ECN No: ECN-715509 **Rev.** 00

16. **Description of Change**

H-2-830099 Sheet 1:
-Update plan view indicating the installation of transfer line 4"-60M-011-M18 and it's interface with the existing Catch Basin 42 piping.

H-2-830099 Sheet 2:
-Update plan view and section views as appropriate to identify the interface of transfer line 4"-60M-011-M18 following installation.

17. **Work Package Number(s)**

TBD

18. **TBDs or Holds** ☒N/A

19. **Related Structures, Systems, and Components**

a. **Related Building/Facilities** ☐N/A	b. **Related Systems** ☐N/A	c. **Related Equipment ID Nos. (EIN)** ☐N/A
LERF FACILITIES	LERF	242AL-42

20. **Engineering Drawings to be Changed** Does change affect the Electronic Routing Board? ☐

Drawing Number	Rev.	Title
H-2-79610 SH 001	03	PIPING PLAN RETENTION BASINS
H-2-79613 SH 001	05	PIPING PLAN CATCH BASIN 242AL-42
H-2-830097 SH 001	01	W-519 SITE/UTILITY SYSTEMS PLAN AND PROFILE STA 2+000 TO STA 2+333.0
H-2-830098 SH 001	01	W-519 SITE/UTILITY SYSTEMS PLAN & PROFILE LERF BASINS
H-2-830099 SH 001	02	W-519 SITE/UTILITY SYSTEMS BASIN 242AL-42 PIPE LAYOUT
H-2-830099 SH 002	01	W-519 SITE/UTILITY SYSTEMS BASIN 243AL-42 PIPE LAYOUT
H-2-88766 SH 002	16	P&ID LERF BASIN & ETF INFLUENT EVAPORATOR

21. **Related Modification Traveler** ☐N/A

MT-50497

22. **Related Documents** ☐N/A

Document Number	Rev.	Title
ECN-715507	00	LERF Basin 41 Installation - Mechanical
ECN-715508	00	LERF Basin 41 Existing Piping Connections - Mechanical
H-2-838765 SH 001	00	LERF BASIN 41 MECHANICAL GENERAL ARRANGEMENT
H-2-88766 SH 006	00	P&ID LERF BASIN & ETF INFLUENT EVAPORATOR
RPP-SPEC-63632	00	LERF Basin 41 Construction Specification

23. **Distribution**

Name	Organization
Angevine, Brennan T	MISSION ANALYSIS ENGINEERING
Blaak, Whitney S	COGNIZANT SYSTEM ENGINEERING
Demiter, Scott M	ETF OPERATIONS
Foster, Jim	242-A/AW/ETF OPERATIONS
Goessmann, Glen E	ENGINEERING PROGRAMS
Greenhalgh, Aaron M	TANK FARM PROJECTS ENGINEERING
Harris, John W	SAFETY PROGRAM SERVICES RC/P
Joslyn, Cameron C	ETF ENGINEERING
McFerran, Brandon E	242-A/AW/ETF OPERATIONS
McShane, Michael P	ENGINEERING PROGRAMS
Omberg Carro, Susan K	NUCLEAR SAFETY
Powers, Daniel J	ETF ENGINEERING
Roosendaal, Gene D	TFP PROJECT MANAGEMENT
Rutherford, Wally	ETF ENGINEERING
Sackett, Tom E	TANK FARM PROJECTS
Samoska, Jerry A	INSTRUMENT & CNTRL ENGINEERING
Shultz, Milton V	NUCLEAR SAFETY
Smith, Gregory E	TANK FARM PROJECTS ENGINEERING
Smoot, Bill R	TFP RADCON
Stamper, Lavonne J	ETF ENGINEERING
Swanson, Brad L	242-A/AW/ETF OPERATIONS
Wall, Jeremy M	RETRVL & CLOSURE/PROJ ENV CMPL
Wilson, Nathaniel W	ETF PROJECTS ENGINEERING

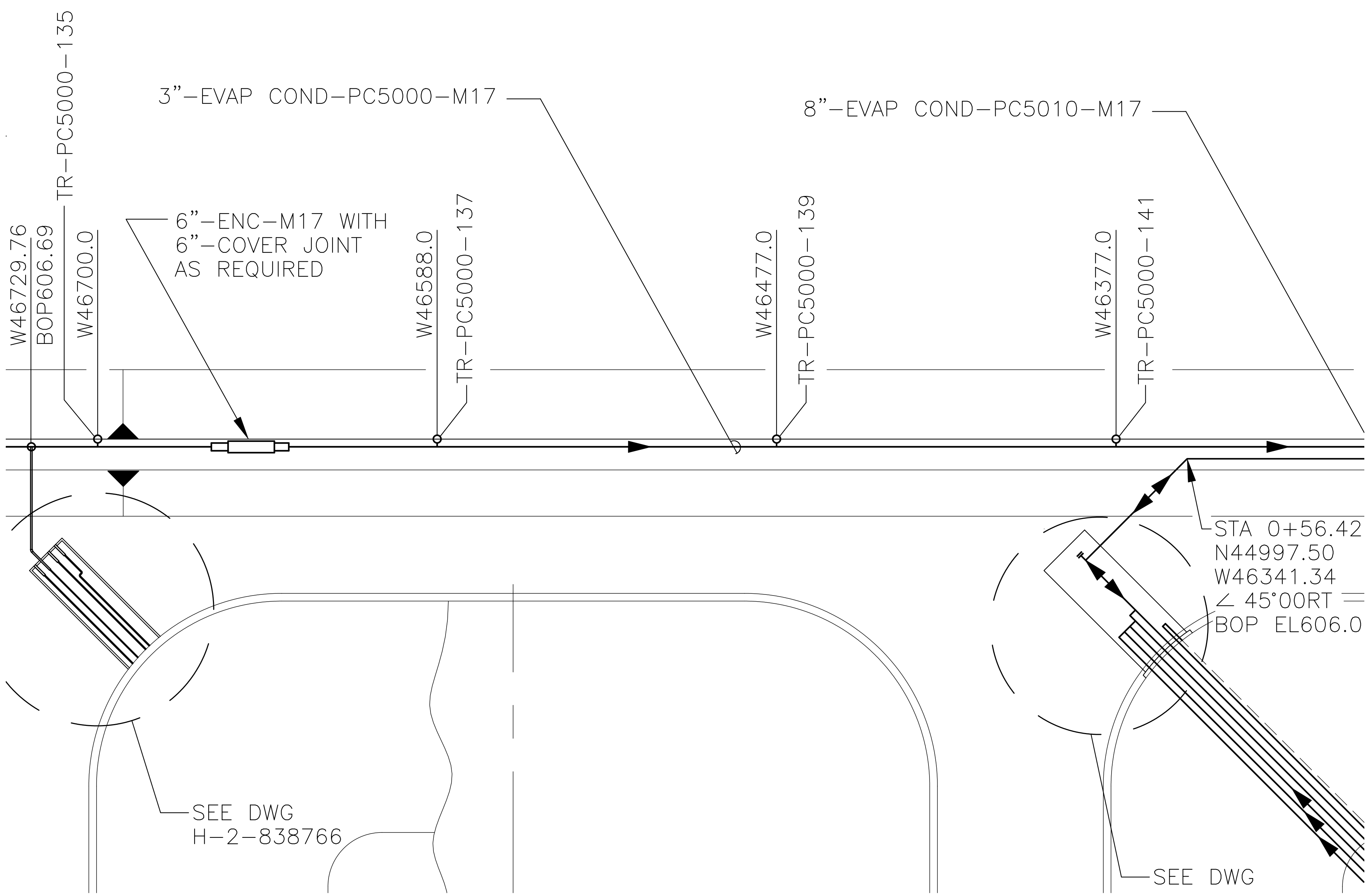
ENGINEERING CHANGE NOTICE
CONTINUATION SHEET

ECN NO.: 715509

Document/Drawing No. H-2-79610 Sheet 1 Revision 3

CONSTRUCTION NOTE: (DO NOT INCORPORATE)
THIS "WAS" CONDITION REFLECTS THE "IS" CONDITION OF ECN-715507 AND ECN-715508 WHEN WORK COMPLETE.

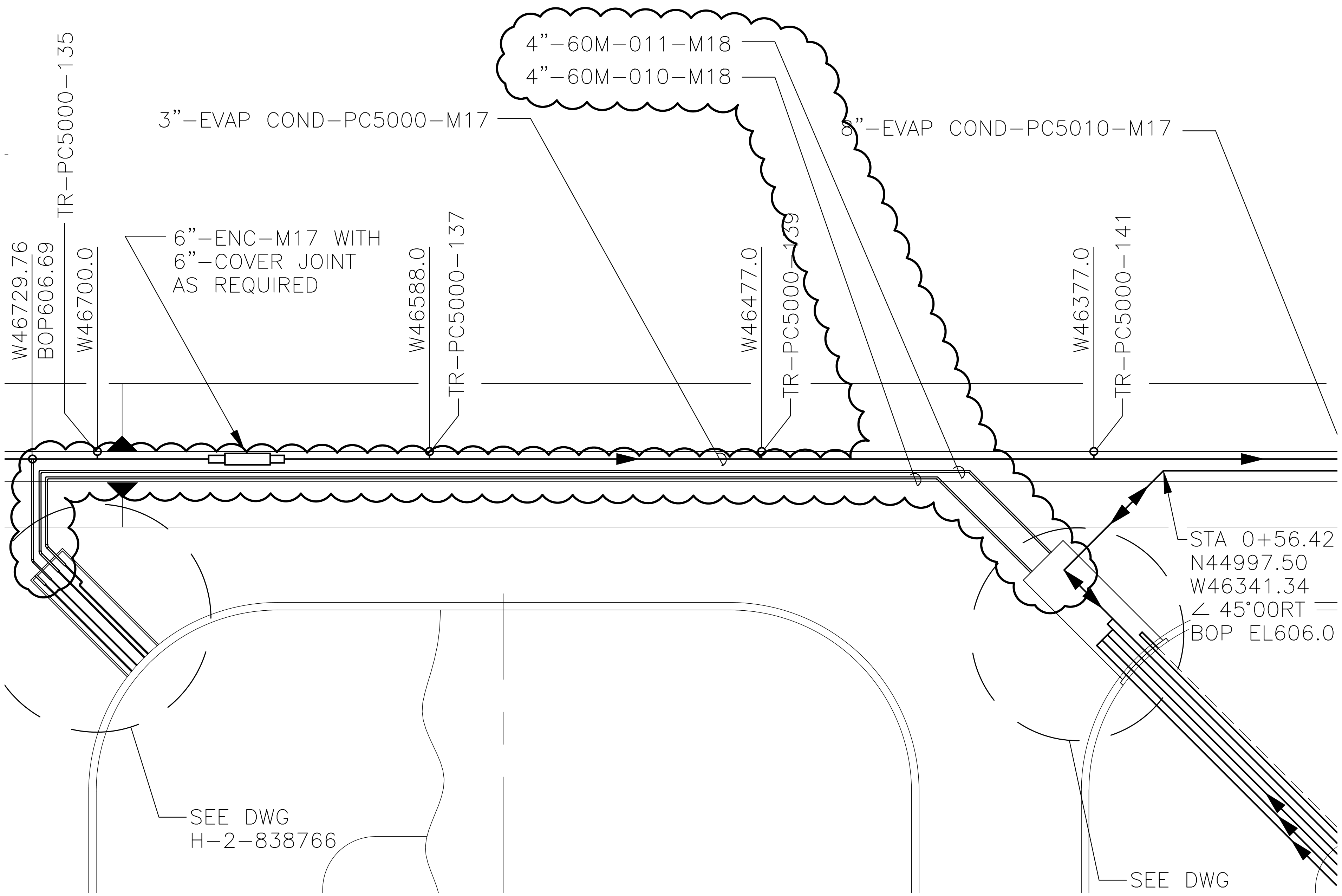
WAS: (ZONE E/6-8)



ENGINEERING CHANGE NOTICE CONTINUATION SHEET	ECN NO.: 715509

Document/Drawing No. H-2-79610 Sheet 1 Revision 3

IS: (ZONE E/6-8)

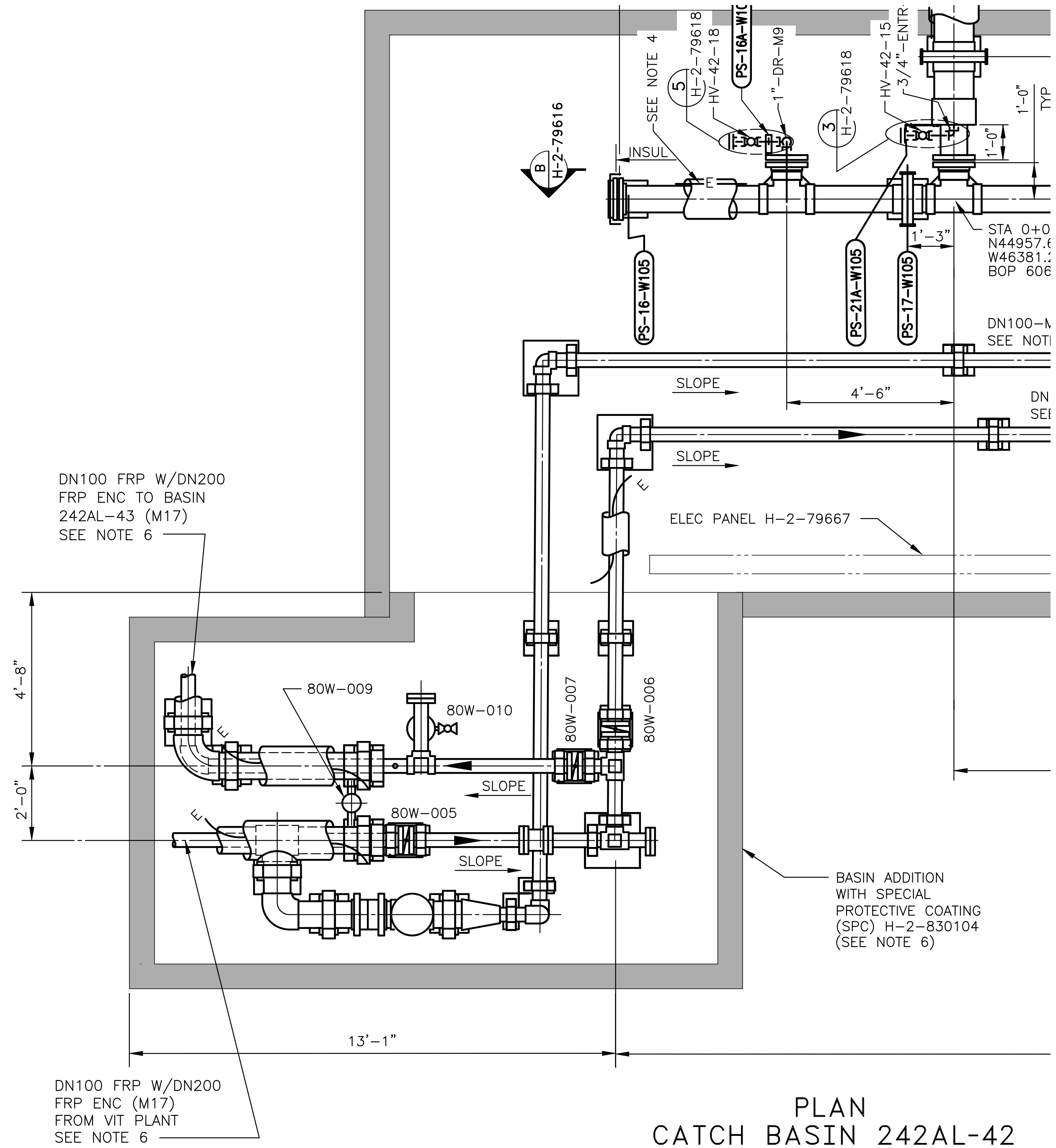


ENGINEERING CHANGE NOTICE
CONTINUATION SHEET

ECN NO.: 715509

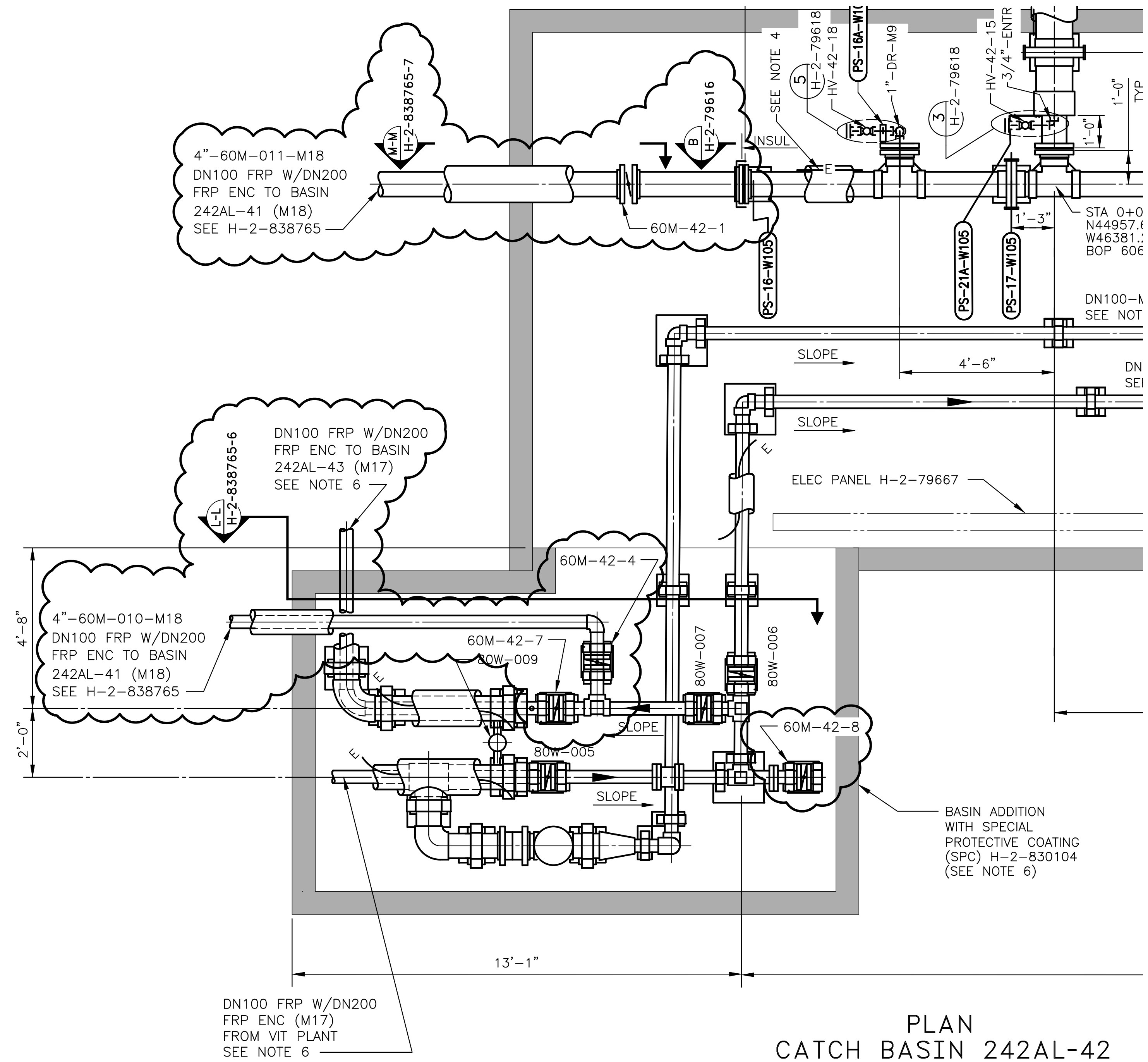
Document/Drawing No. H-2-79613 Sheet 1 Revision 5

WAS: (ZONE B-D/6-8)



PLAN
CATCH BASIN 242AL-42
SCALE: 1/2" = 1'-0"

IS: (ZONE B-D/6-8)



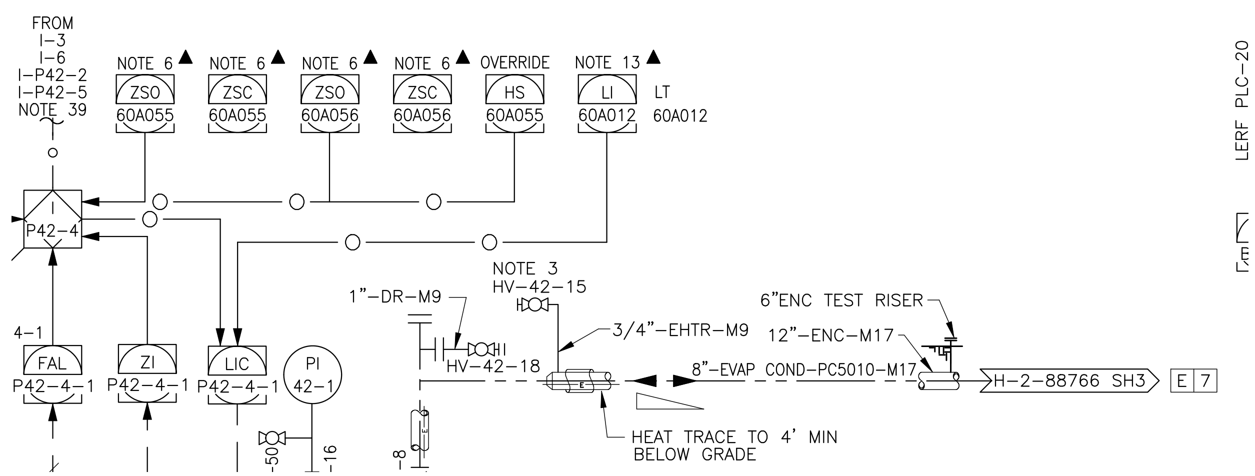
PLAN
CATCH BASIN 242AL-42
SCALE: 1/2" = 1'-0"

ENGINEERING CHANGE NOTICE CONTINUATION SHEET

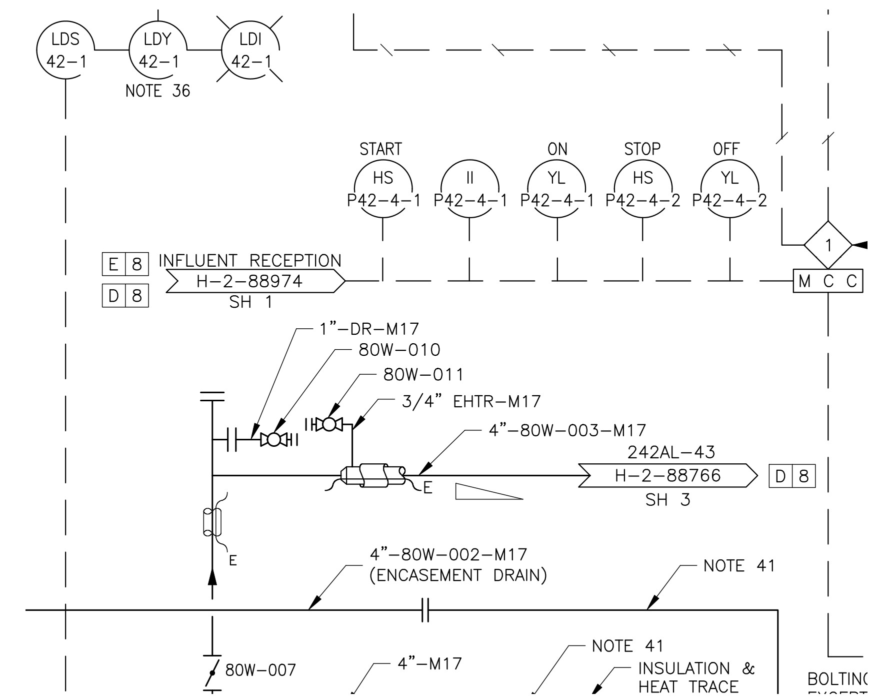
ECN NO.: 715509

Document/Drawing No. H-2-88766 Sheet 2 Revision 16

WAS: (ZONE E/3-4)



WAS: (ZONE E/6)



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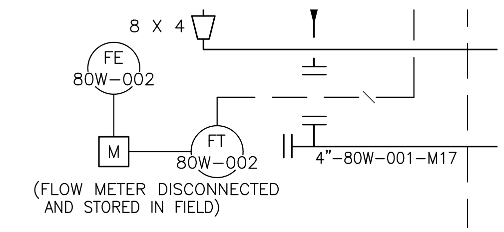

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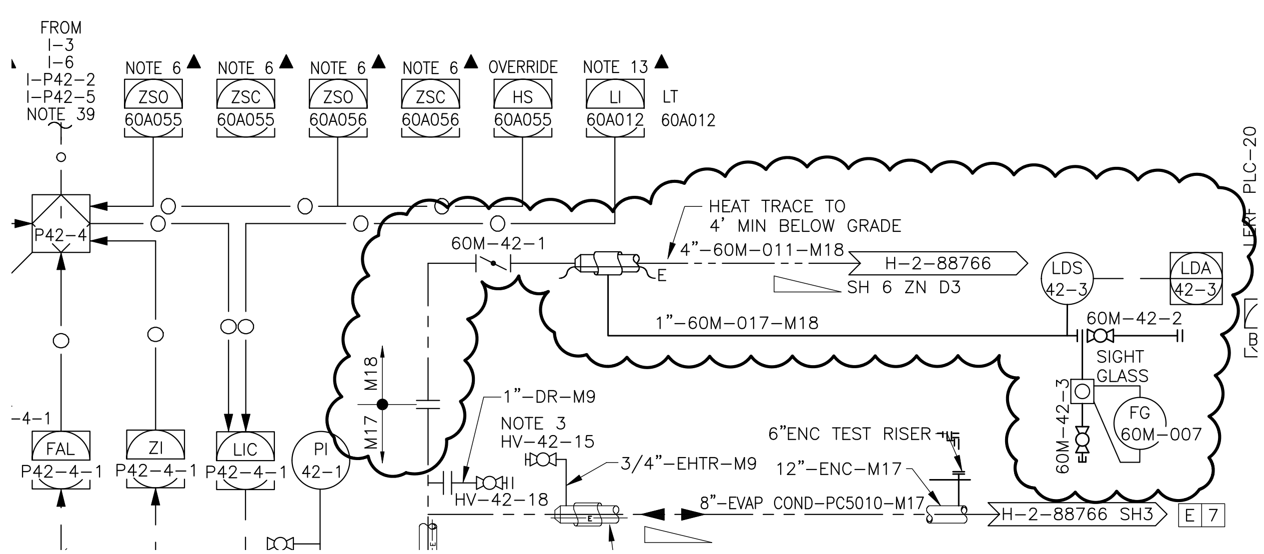

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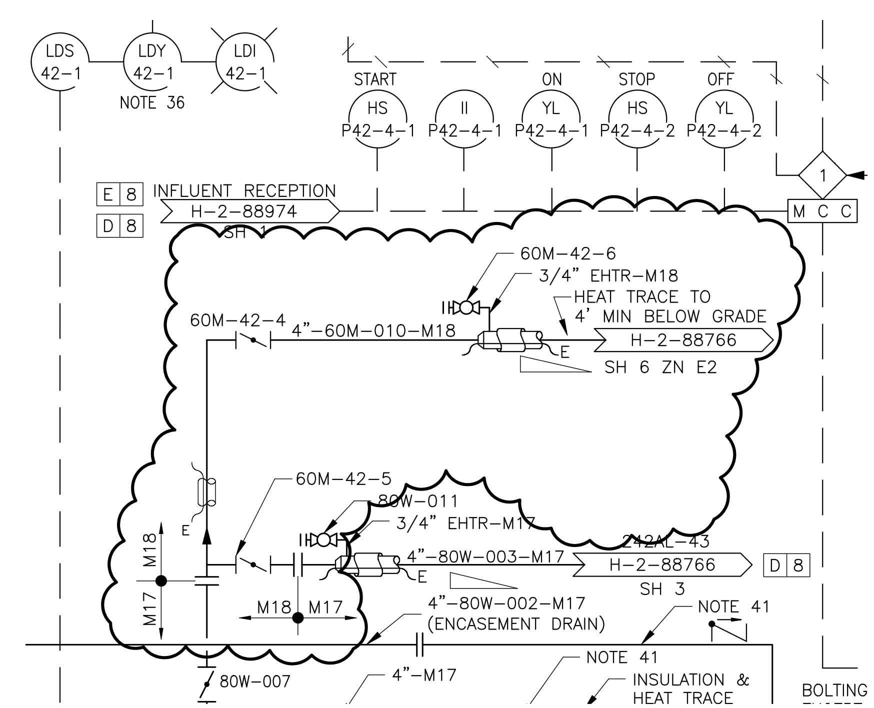

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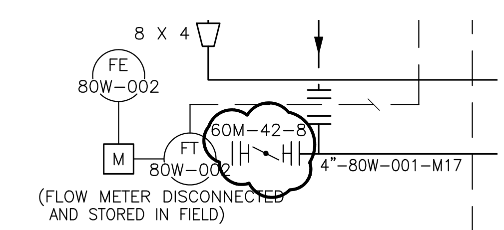


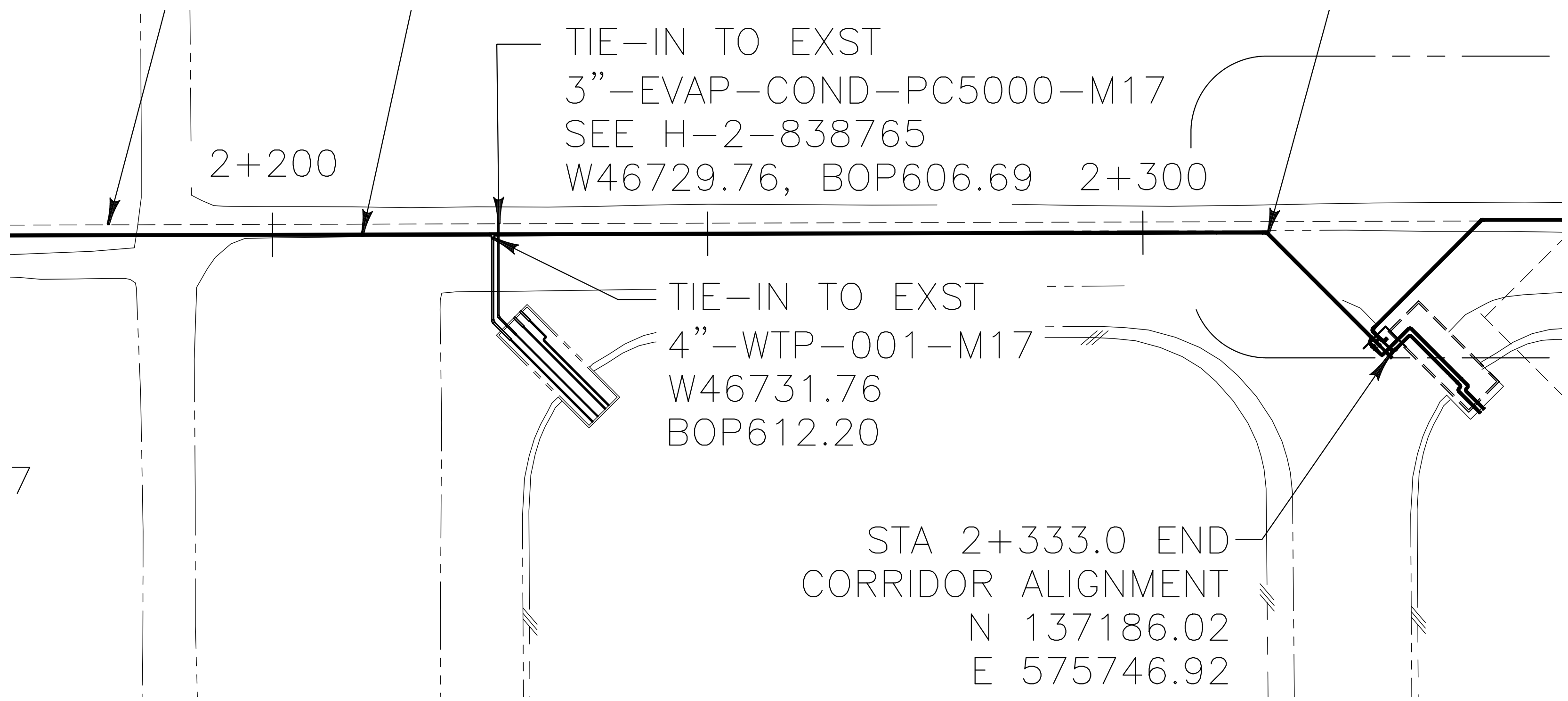
CONSTRUCTION NOTE: (DO NOT INCORPORATE)
THIS "WAS" CONDITION REFLECTS THE "IS" CONDITION OF ECN-715507 AND ECN-715508 WHEN WORK COMPLETE.

ENGINEERING CHANGE NOTICE
CONTINUATION SHEET

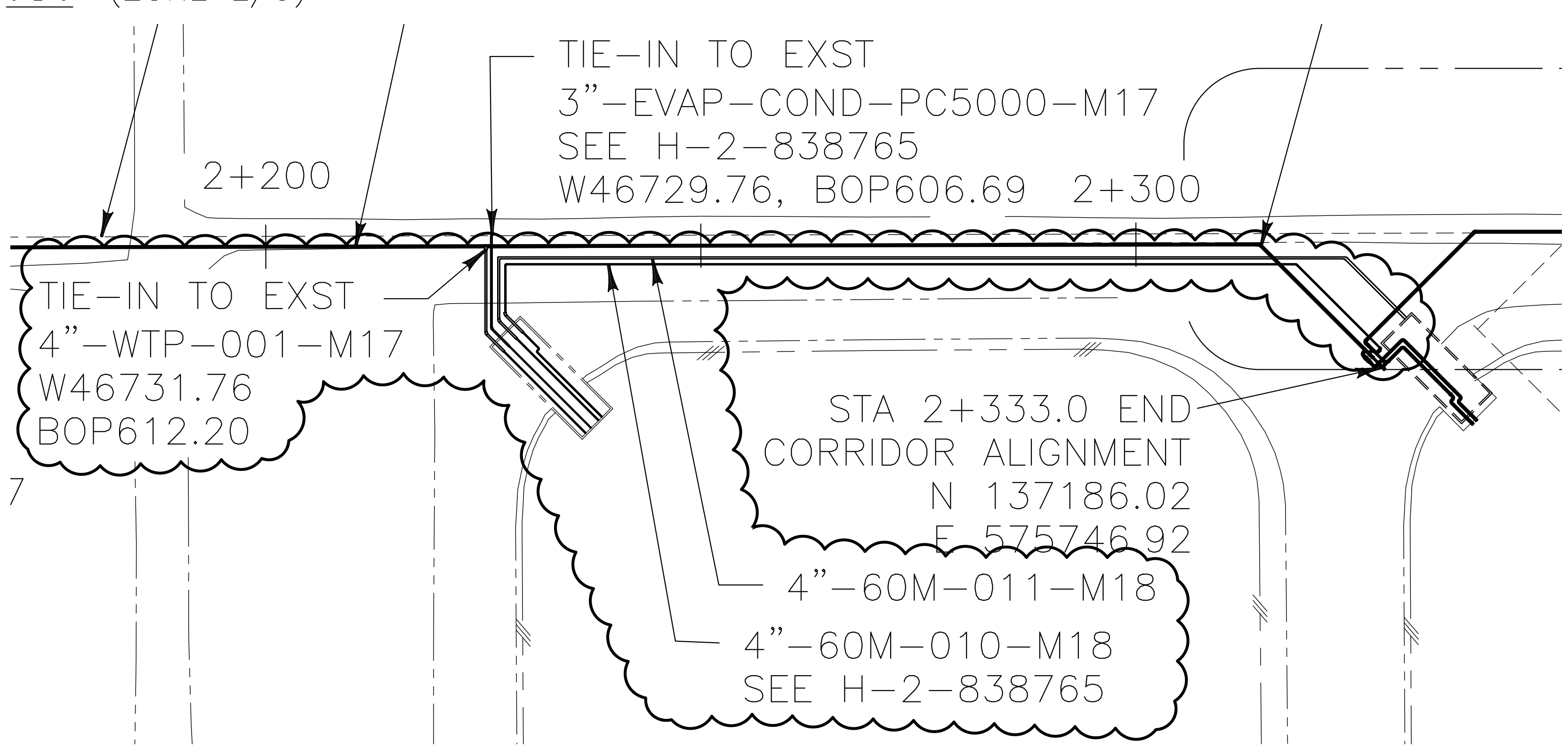
ECN NO.: 715509

Document/Drawing No. H-2-830097 Sheet 1 Revision 1

WAS: (ZONE E/5)



IS: (ZONE E/5)



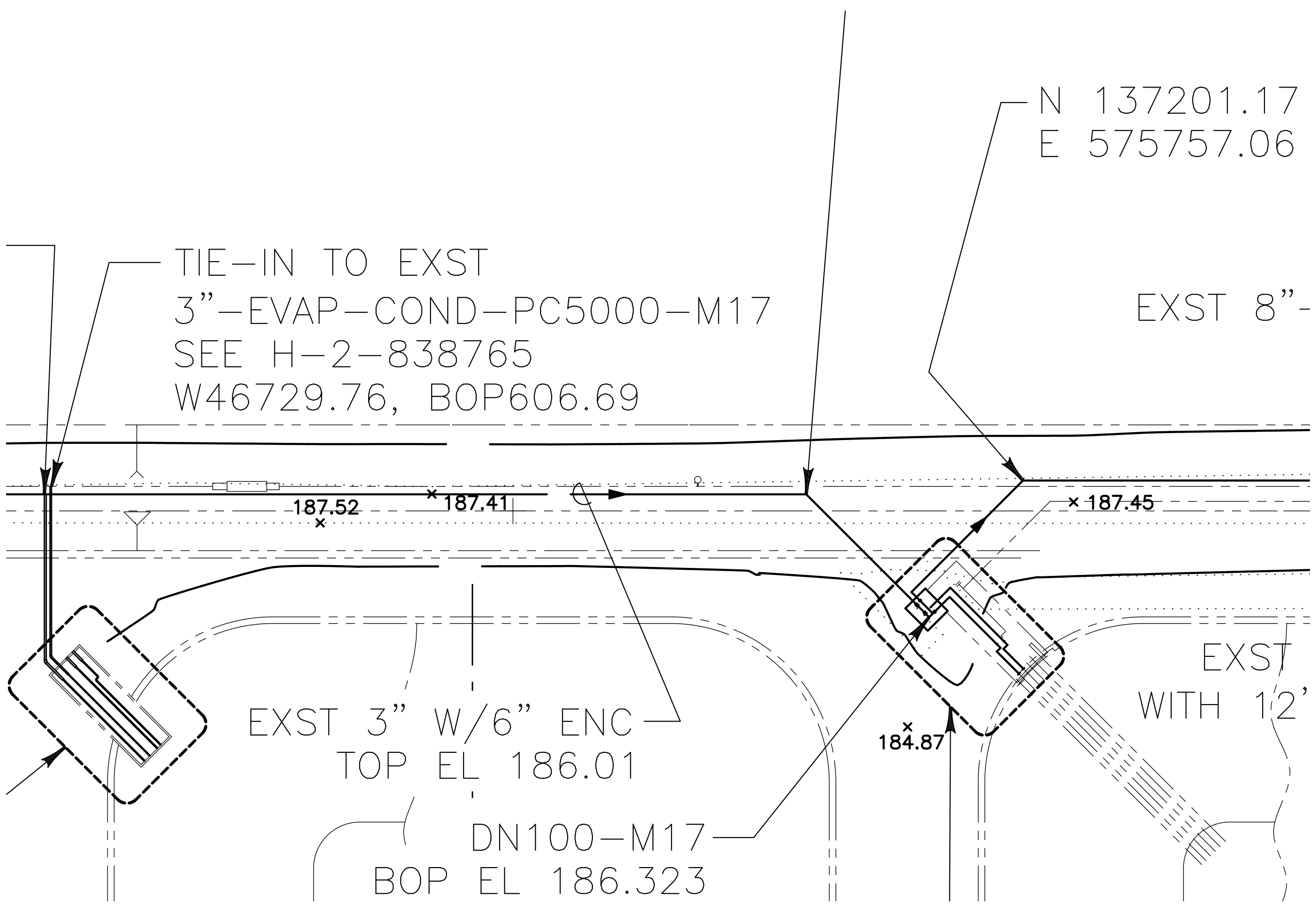
ENGINEERING CHANGE NOTICE
CONTINUATION SHEET

ECN NO.: 715509

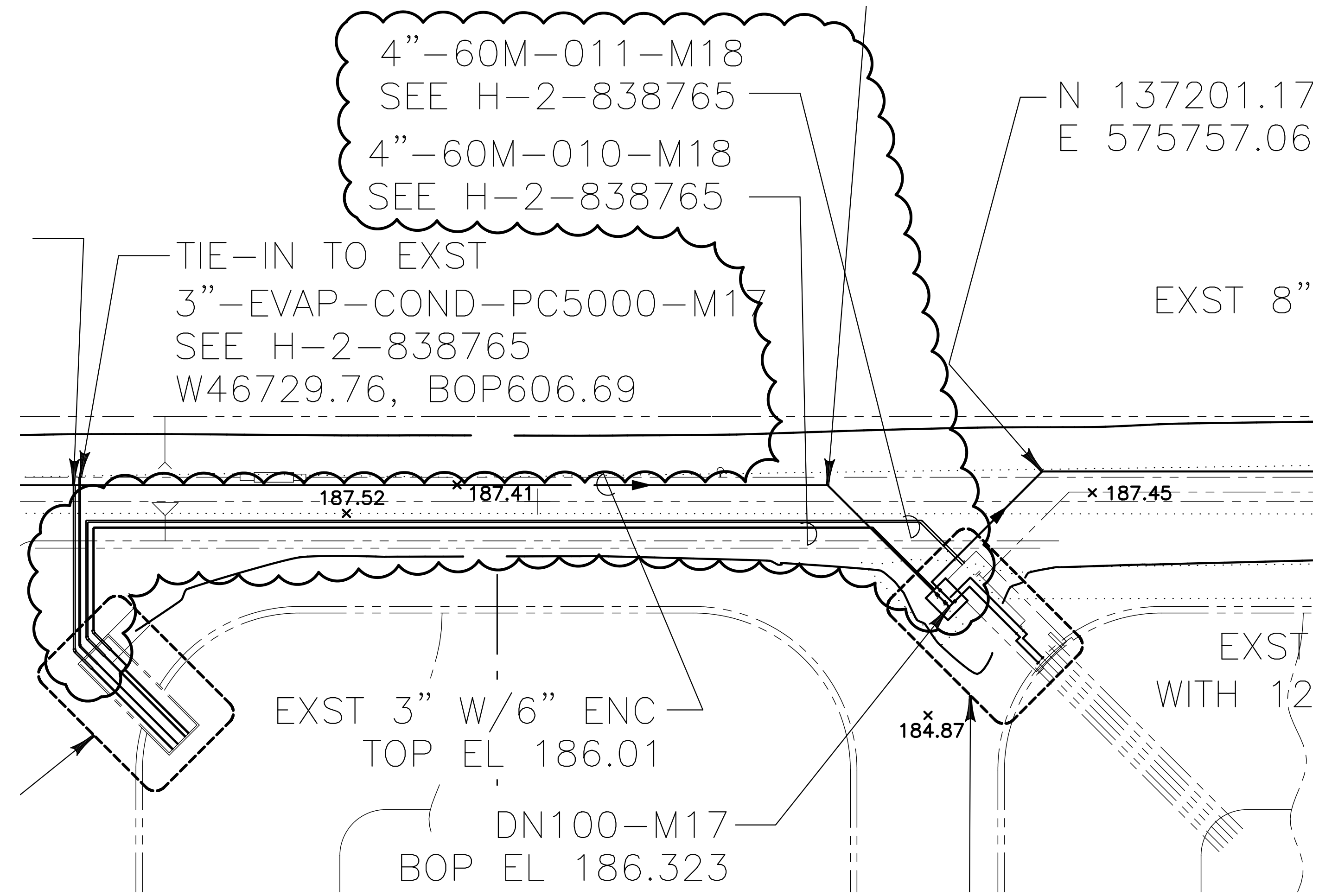
Document/Drawing No. H-2-830098 Sheet 1 Revision 1

CONSTRUCTION NOTE: (DO NOT INCORPORATE)
THIS "WAS" CONDITION REFLECTS THE "IS" CONDITION OF ECN-715507 AND ECN-715508 WHEN WORK COMPLETE.

WAS: (ZONE E-F/7)



IS: (ZONE E-F/7)

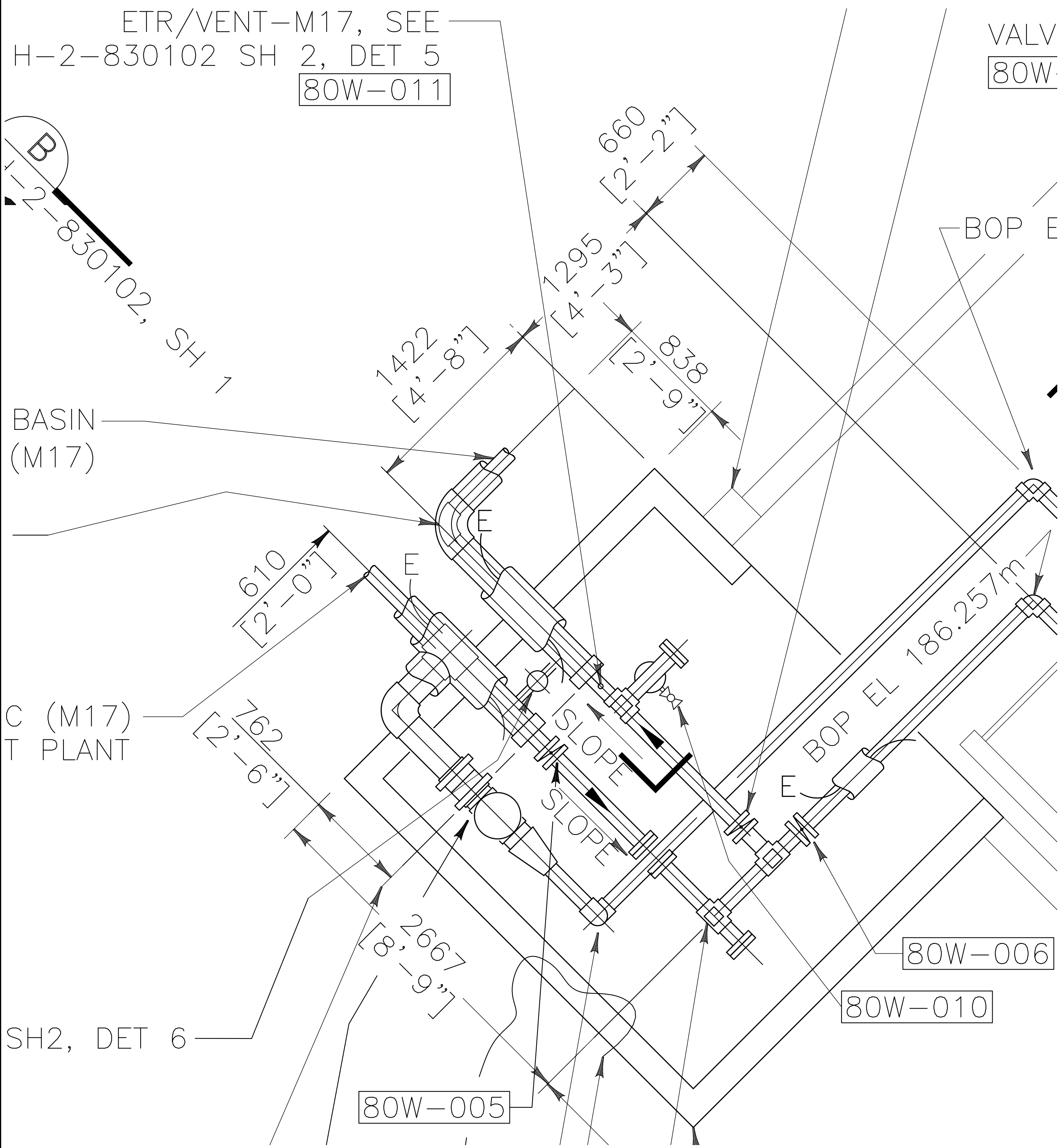


ENGINEERING CHANGE NOTICE
CONTINUATION SHEET

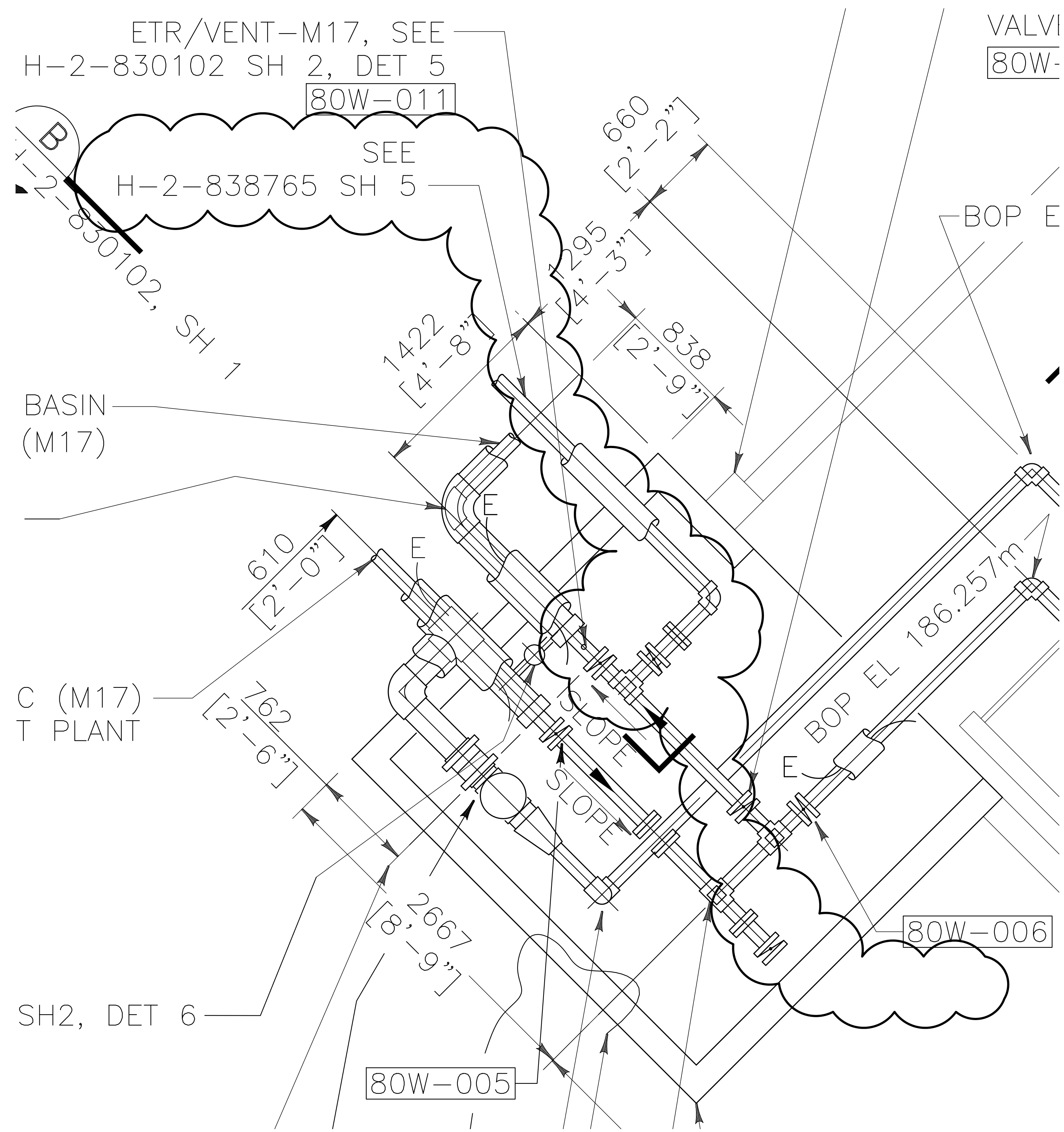
ECN NO.: 715509

Document/Drawing No. H-2-830099 Sheet 1 Revision 2

WAS: (ZONE D-E/7)



IS: (ZONE D-E/7)

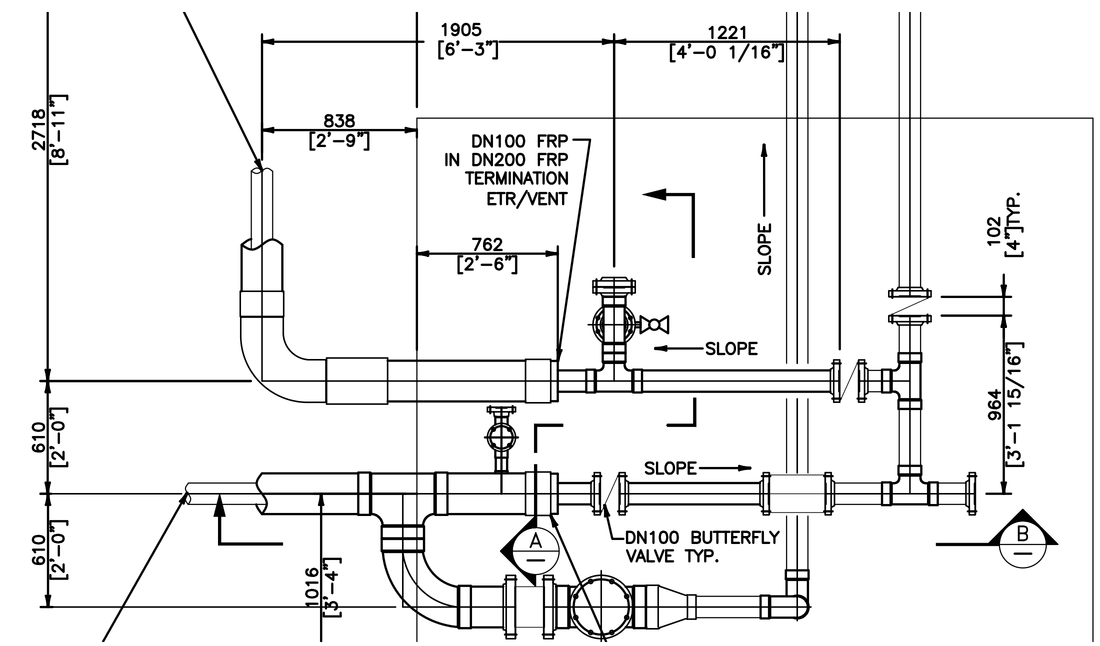


ENGINEERING CHANGE NOTICE
CONTINUATION SHEET

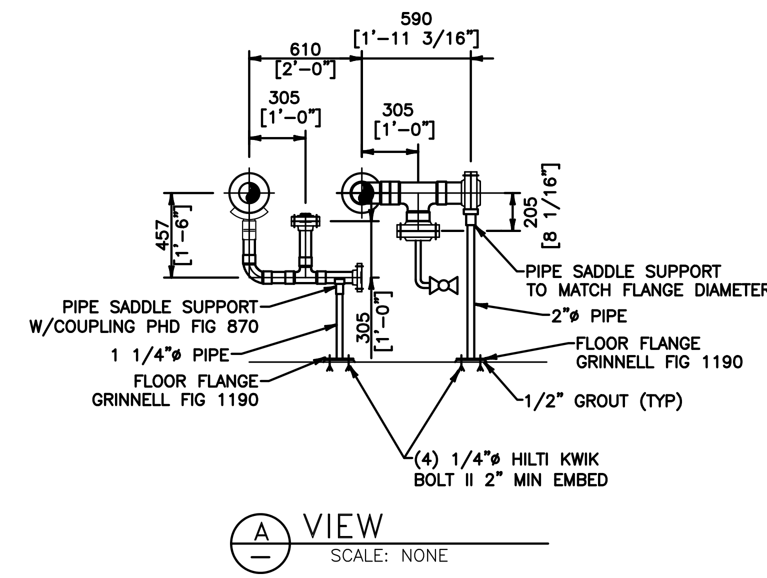
ECN NO.: 715509

Document/Drawing No. H-2-830099 Sheet 2 Revision 1

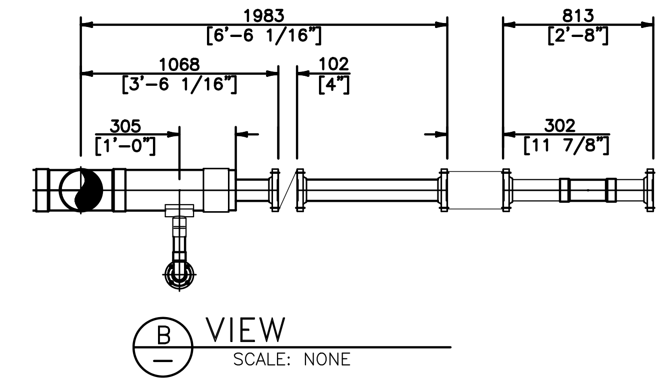
WAS: (ZONE E/7)



WAS: (ZONE B/6)



WAS: (ZONE D/1)



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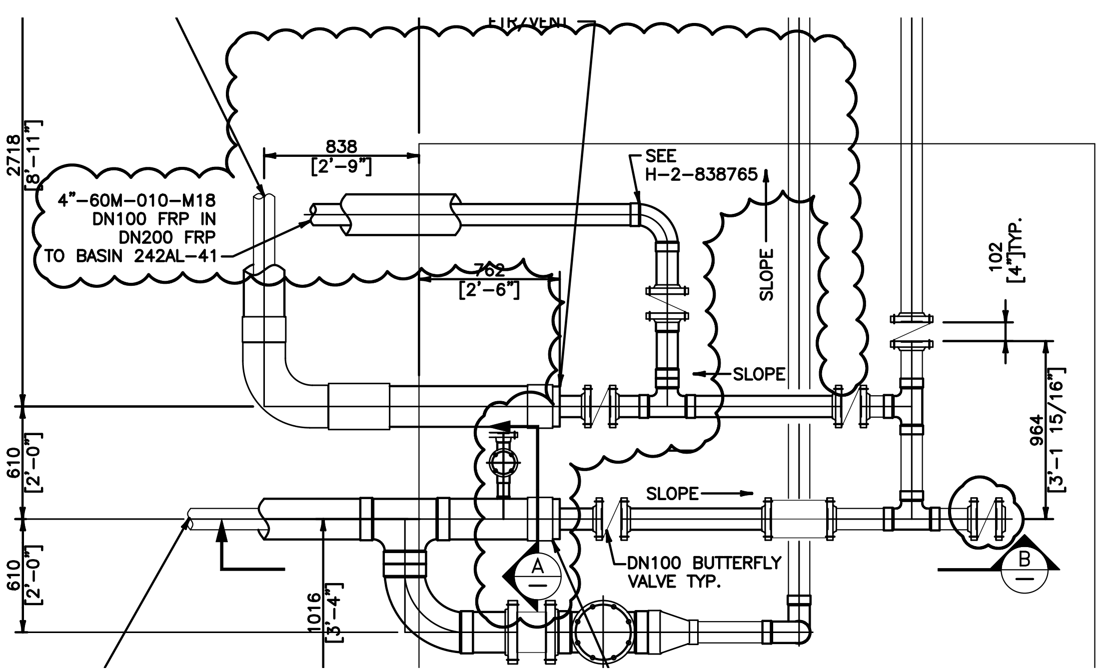

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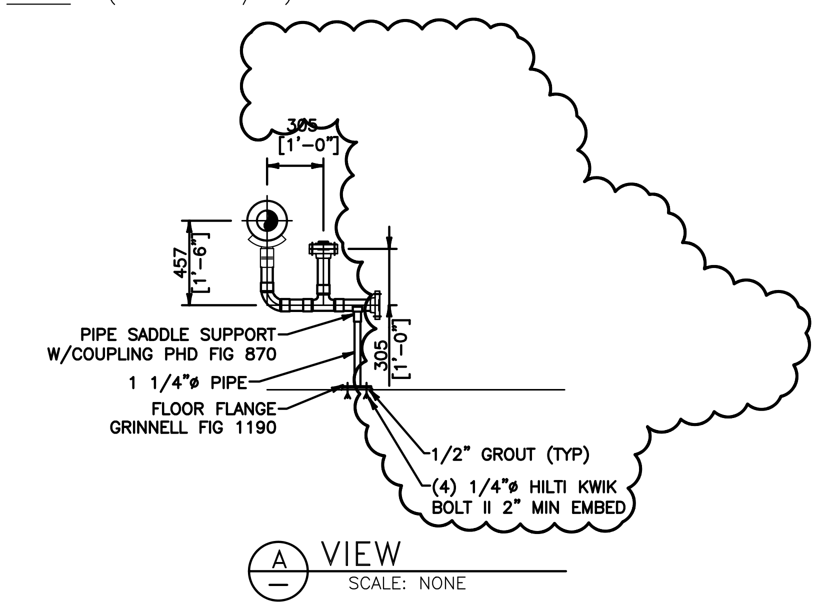
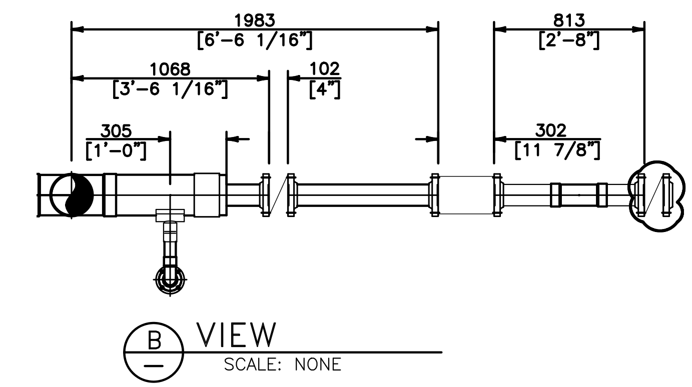
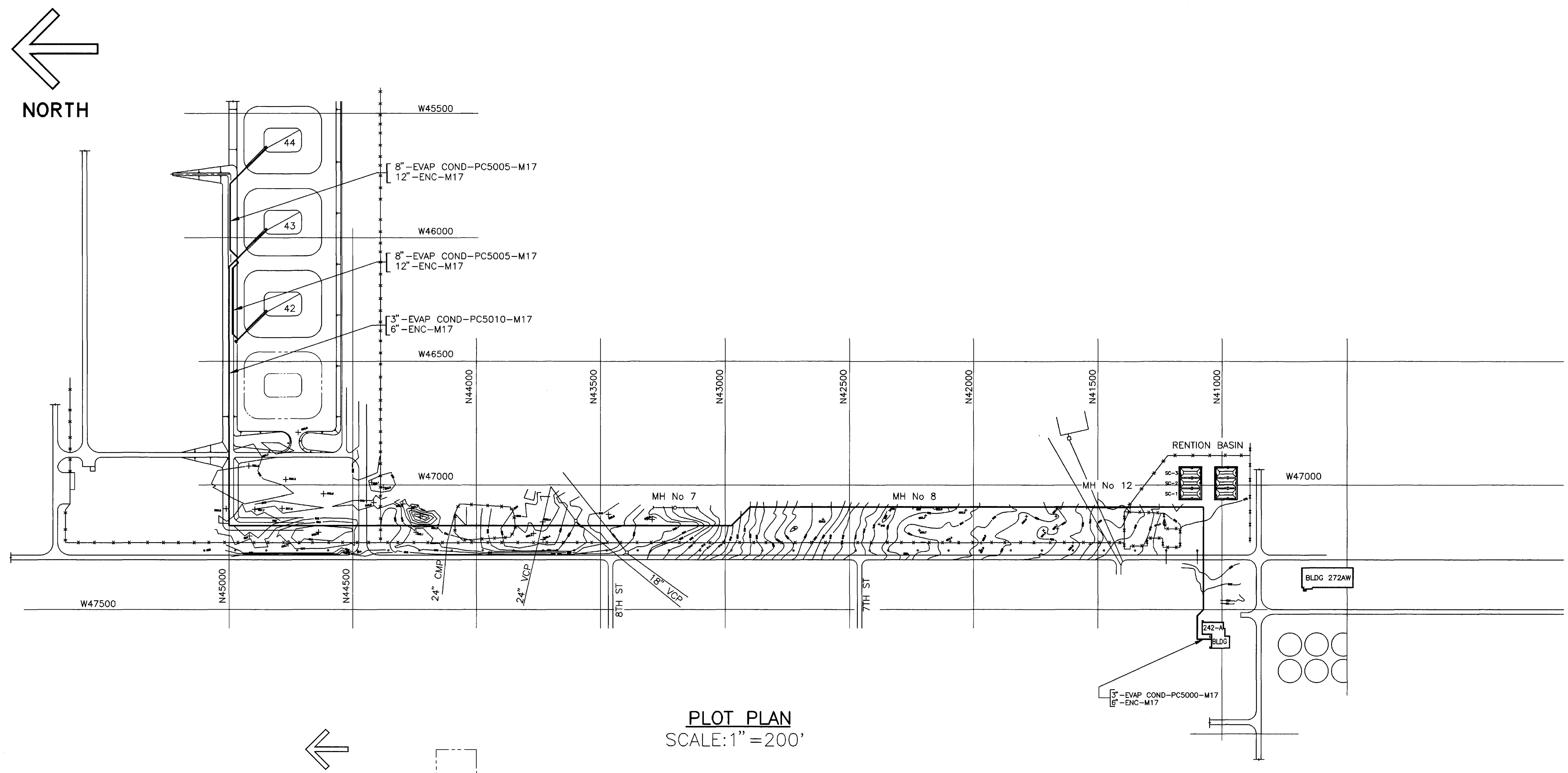
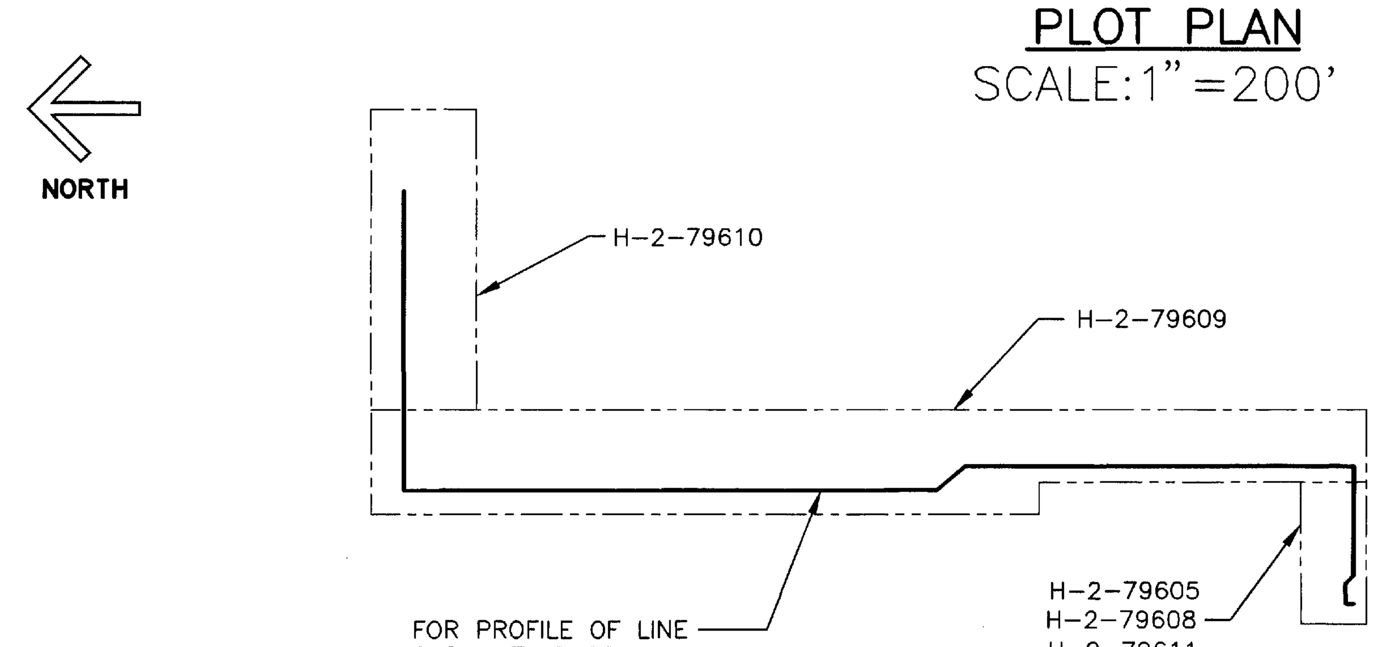


IS: (ZONE D/1)





PLOT PLAN
SCALE:1"=200'



DRAWING KEY PLAN
SCALE: NONE

DWG NO	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
H-2-79581	DWG LIST
REFERENCES	
NEXT USED ON	

MFD	REV NO	DESCRIPTION	REV BY DATE	CHK BY DATE	DFTG APVD DATE	COG ENGR COMPANY
S M	3	REV ECN 646829 REDRAWN TO AUTOCAD PER DIR	PRW 7/22/98	9/98	9/17/98	9-17-98

REVISIONS

CADFILE B079604A CADCODE WIN95:ACD2:14.0:SS

DRAWN BY / CHECKED / DFTG APVD / COG ENGR / APVD / APVD / APVD / APVD / APVD

SEE PREVIOUS REVISION

U.S. DEPARTMENT OF ENERGY
Richland Operations Office
WASTE MANAGEMENT FEDERAL SERVICES OF HANFORD

PIPING PLOT & KEY PLANS 242-A EVAP COND STREAM

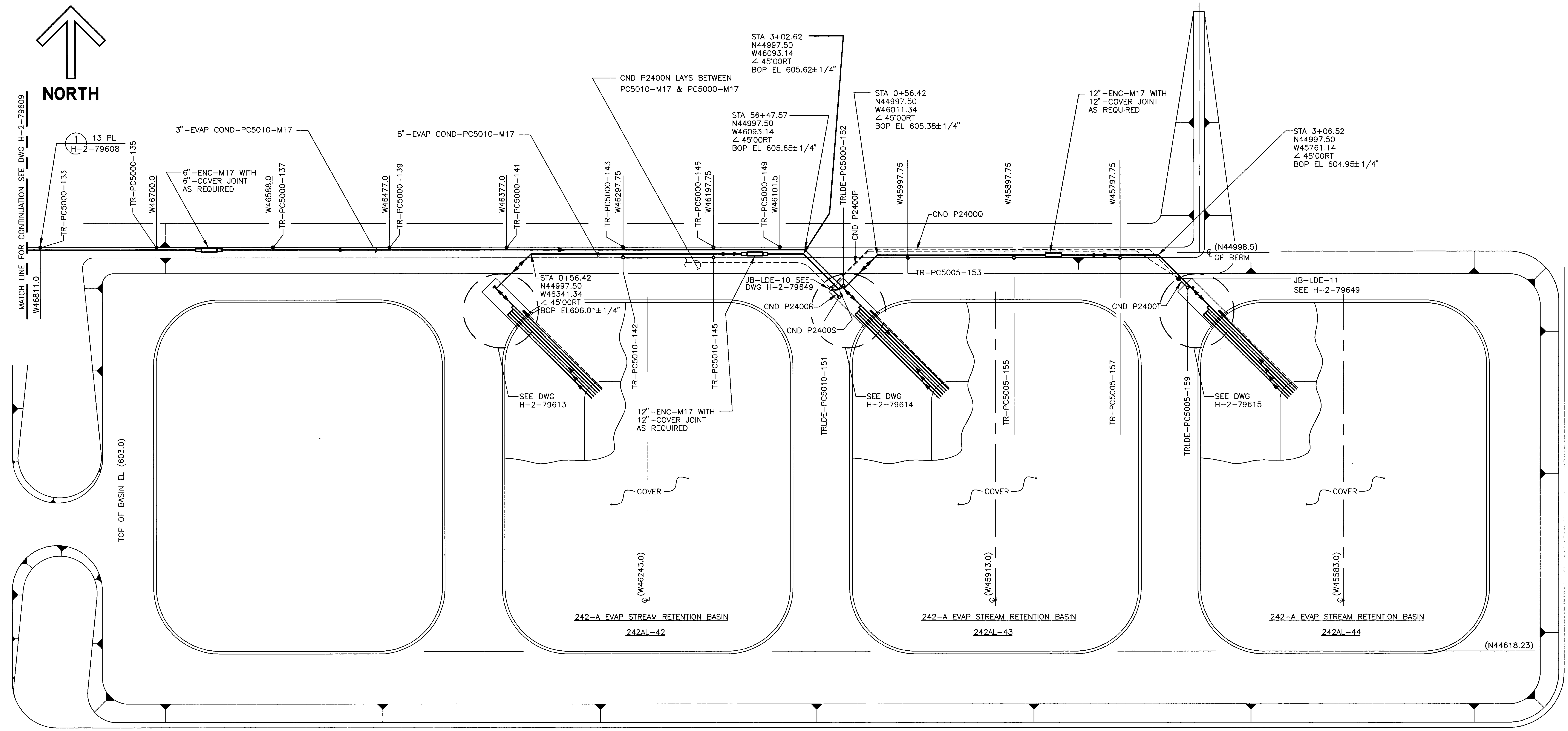
SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	0110/ 0304	200E/ 242AL	H-2-79604	3

SCALE SHOWN EDT 123424 SHEET 1 OF 1

CHK PRINT DATE COMMENT PRINT DATE PLOT SCALE: 1=1

GTITLE.DWG (10-96)

DWG NO H-2-79604 SH 1 OF 1 REV 3



PLAN
SCALE: 1"=40'-0"

NOTE:

1. FOR GENERAL NOTES SEE DWG H-2-79605

DWG NO	TITLE	REF NUMBER	TITLE
		H-2-79581	DRAWING LIST
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON	

REV NO	DESCRIPTION	REV BY DATE	CHK BY DATE	DFTG APVD DATE	COG ENGR
3	REV ECN 646829 REDRAWN TO AUTOCAD PER DIR	PRW 6/17/98			

SEE PREVIOUS REVISIONS

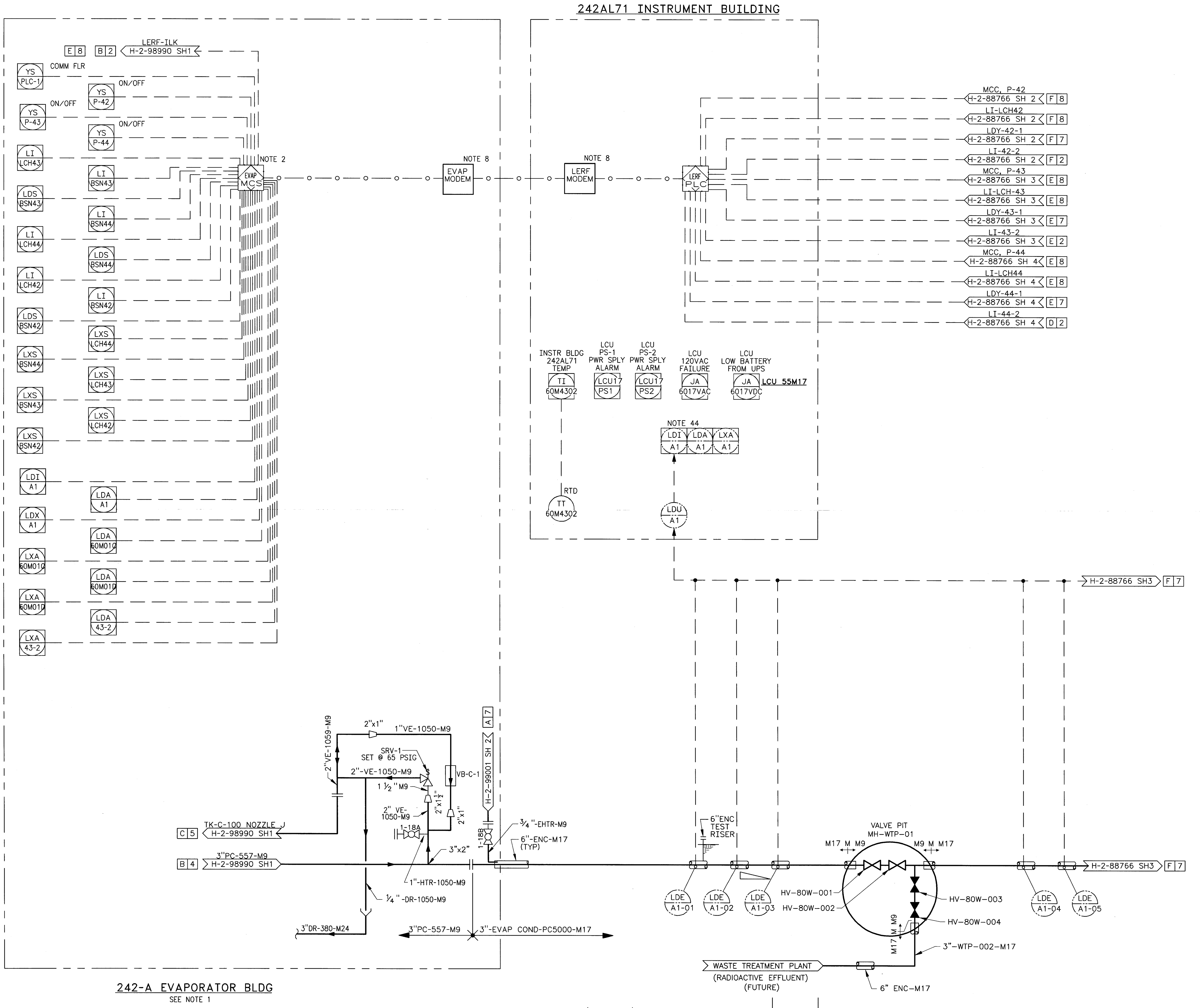
CADFILE B079610A CADCODE WIN95:ACD2:14.0:SS

U.S. DEPARTMENT OF ENERGY
Richland Operations Office
WASTE MANAGEMENT FEDERAL SERVICES OF HANFORD

PIPING PLAN
RETENTION BASINS

SIZE F | BLDG NO 200E/ 242A | INDEX NO 0110/ 0304 | DWG NO H-2-79610 | REV 3
SCALE SHOWN | EDT 123424 | SHEET 1 OF 1

PLOT SCALE: 1=1



NOTES:

1. FOR ADDITIONAL NOTES AND SYMBOL LEGEND SEE DWG H-2-79601, SH 1.
2. OPERATING CONTRACTOR TO REPROGRAM EXISTING EVAP-MCS-10 AS REQUIRED. (EXISTING SIGNALS TO 242A MCS NOT SHOWN, SEE DWG H-2-79601, SH 2).
3. DELETED
4. AIR PRESSURE SHALL NOT EXCEED 15 PSIG PER M-17 PIPING MANUFACTURER RECOMMENDATION.
5. MODIFY ETF SURGE TANK 2925E-60A-TK-1 "HIGH" LEVEL FROM ETF MCS TO NEW MCS (REFERENCE DWG H-2-89337, SH 1).
6. MODIFY ETF SURGE TANK INLET VALVES AOV-60A055 AND AOV-60A056 POSITION FROM ETF MCS TO NEW MCS (REFERENCE DWG H-2-88974).
7. MODIFY EXISTING 242A MCS INTERLOCK PER DWG H-2-88816, SH 1.
8. RADIRECT ASMI-52 DSL MODEM.
9. RUPTURE DISKS TO BE OSECO 1.5" TYPE PLR NICKEL NONFRAGMENTING RUPTURE DISK IN 1.5" TYPE PRDI 316SS RUPTURE DISK HOLDER, 150 LB. ANSI OR ENGINEERING APPROVED EQUAL. RUPTURE DISK TO BE RATED FOR A BURST PRESSURE OF 7 PSIG @ 72 DEGREES F, 0% MANUFACTURING RANGE.
10. H-2-88815 CONTAINS SOFTWARE THAT PROVIDES SHUTDOWN TO LERF TRANSFER PUMPS IN THE EVENT OF LOW FLOW. THE FLOW SWITCH ON THE PUMP IS CAPABLE OF PROVIDING THE SAME PROTECTION TO THE PUMP. HOWEVER THE SWITCH IS NOT ADJUSTABLE AND MAY TRIP AT A FLOW HIGHER THAN NECESSARY. IN THE EVENT THAT A LOWER FLOW IS REQUIRED OR IF THE SWITCH BECOMES UNRELIABLE, THE SWITCH MAY BE JUMPERED OUT VIA THE CORRECTIVE MAINTENANCE PROGRAM.
11. DELETED
12. DELETED
13. MODIFY ETF SURGE TANK 2025E-60A-TK-1 CONTINUOUS LEVEL FROM ETF MCS TO NEW MCS (REFERENCE DWG H-2-89337, SH 1)
14. DELETED
15. DELETED
16. DELETED
17. DELETED
18. DELETED
19. DELETED
20. DELETED
21. PROVIDE ENCASEMENT TEST RISERS APPROXIMATELY EVERY 100 FEET.
22. INSTALL LDE 60M01D IN EXISTING RISER.
23. DELETED
24. DELETED
25. DELETED
26. DELETED
27. DELETED
28. DELETED
29. DELETED
30. PROVIDE LEAK DETECTION APPROXIMATELY EVERY 1000 FEET OF ENCASED PIPE.
31. DELETED
32. INSTALL LDE 60M01C IN EXISTING RISER.
33. DELETED
34. DELETED
35. MODIFY EXISTING BASIN AND LEACHATE LEVEL SIGNALS, SHARED WITH THE NEW MCS, FROM EXISTING LERF-PLC-20 TO EXISTING EVAP-PLC-10 TO EXISTING 242A MCS.
36. MODIFY EXISTING LEACHATE PUMP STATUS AND CATCH BASIN LEAK DETECTION SIGNALS, RETRANSMITTED FROM THE NEW MCS, FROM EXISTING LERF-PLC-20 TO EXISTING EVAP-PLC-10 TO EXISTING 242A MCS.
37. OPERATING CONTRACTOR TO REPROGRAM EXISTING 242A MCS AS REQUIRED.
38. OPERATING CONTRACTOR TO REPROGRAM ETF MCS AS REQUIRED.
39. FOR NEW MCS LOGIC SEE DRAWINGS H-2-88815, SH 1-6.
40. BLIND FLANGE CAN BE REMOVED AND LEFT OFF FOR INSPECTION OF CONTAINMENT PIPE.
41. REMOVEABLE SPOOL PIECE TO FACILITATE INSTALLATION OF PORTABLE PUMP AND PIPE MANIFOLD.
42. CONTINUOUS LEAK DETECTION CABLE.
43. SEND LERF PLC INPUTS LDA–60M01D, LXA–60M01D, LDA–60M01C, LXA–60M01C, LDA–43–2, & LXA–43–2 SIGNALS TO EVAPORATOR BLDG PLC VIA EXST MODEM.
44. SEND LERF PLC INPUT, LDU–A1, TO EVAPORATOR BLDG VIA EXST MODEM.
THE 4–20 ANALOG SIGNAL SHOULD BE INTERPRETED AS FOLLOWS:
0mA=Loss of Power;
2.0mA=Cable Break;
3.0mA=Cable Loop Impalance/Service Needed;
3.5mA=Service Required Alarm;
5.05mA=System Normal;
~6.45–8.75mA=LDE–A1–06 Leak;
~9.26–11.56mA=LDE–A1–05 Leak;
~11.85–14.15mA=LDE–A1–04 Leak;
~14.74–17.04mA=LDE–A1–03 Leak;
~17.45–19.75mA=LDE–A1–02 Leak;
~20.16–22.46mA=LDE–A1–01 Leak.

BLDG. NO. 2025E 242A 242AL71

INDEX NO.

THIS SPACE RESERVED FOR BUILDING AND INDEX NUMBERS

APR 2 0 2010
DATE: STA: 30 HANFORD RELEASE ID: 254

NUMBER	TITLE
H-2-79601,SH2	P & ID 242-A EVAP BLDG & XCY PIPING

DRAWING TRACEABILITY LIST

NUMBER	TITLE
H-2-88737	SITE PLAN AND DRAWING LIST

REFERENCES

NEXT USED ON

MFD	REV NO	DESCRIPTION	REV BY DATE	CHK BY DATE	DFTG APVD DATE
S R9	14	INCORPORATED ECN-726604-R2 AND ECN-726604-R3	KDJ 4/10		

REVISIONS

ENGR: Zdit 4/10 — CHPRC (COMPANY)

DESIGNED	CM NICKOLAUS (DATE)
DSGN ENGR	CM NICKOLAUS 10-1 1993
CHECKED	JA SHIPMAN 9-29 1993
SAFETY	J ARCHIBALD 10-14 1993
ENVIR	JD AXFORD 10-18 1993
QUAL ENGR	TD HAYS 10-14 1993
LEAD ENGR	RT HALLUM 10-12 1993
	GR MEZGER 10-14-93
APPROVED FOR IMPLEMENTATION BY	JJ NOBLE
FOR	WHC DATE 10-14-93

SAFETY CLASS 3 | EDT

U.S. DEPARTMENT OF ENERGY
RICHLAND FIELD OFFICE
KAISER ENGINEERS HANFORD COMPANY

P & ID
LERF BASIN & ETF INFLUENT
EVAPORATOR

PROJECT C-018H 242-A EVAP PUREX PLANT CNDS TRTMT FACIL

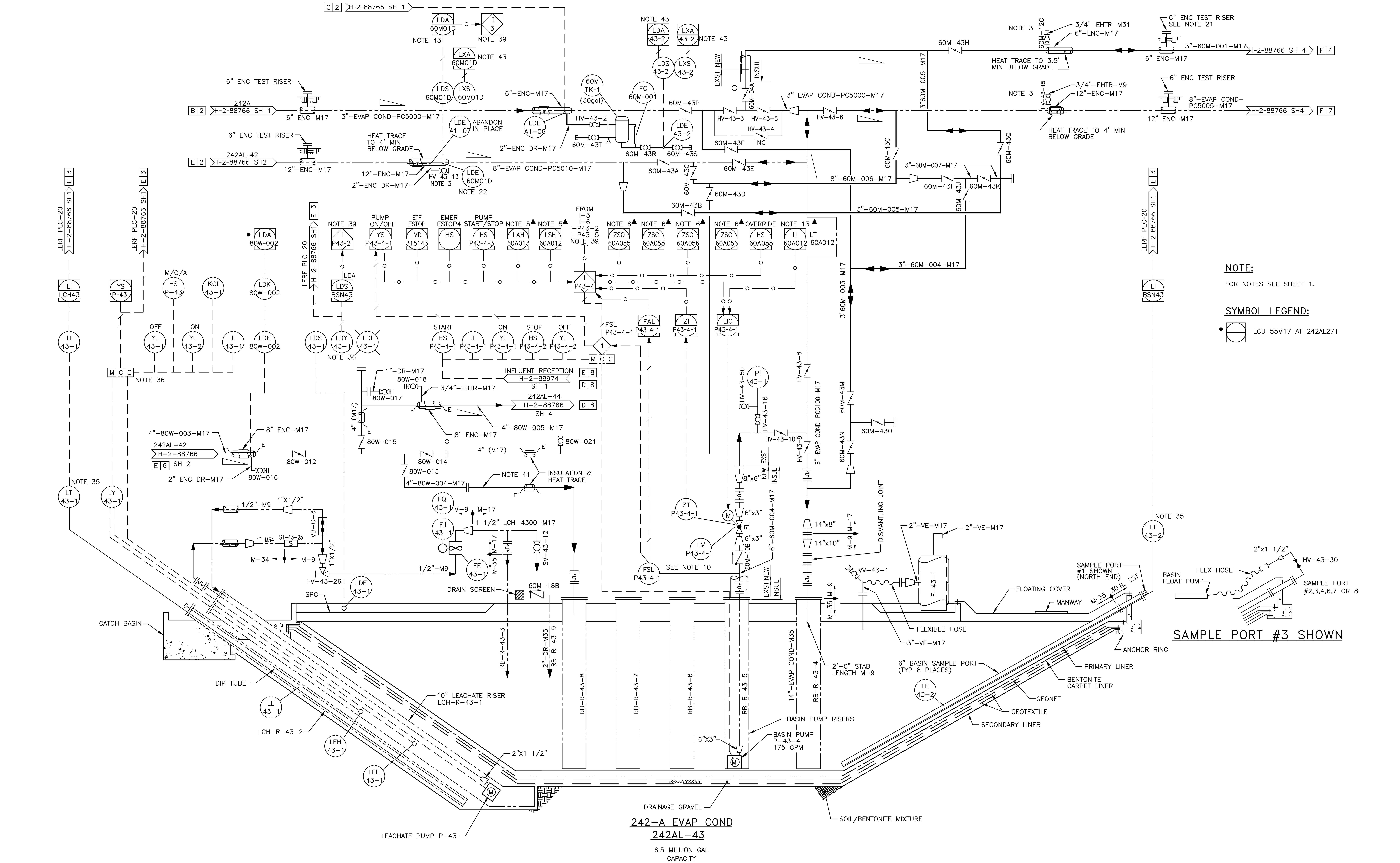
SIZE	BLDG NO.	INDEX NO.	DWG NO.	REV NO.
F	SEE ABOVE	7004	H-2-88766	14

SCALE NONE | JOB NO. CR9583 | SHEET 1 OF 5

PLOT SCALE: 1=1

18466

KEH 0350.00 (04/92)



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REV NO	DESCRIPTION
21	INC DCN-715849

REVISIONS

BLDG NO 242AL-43
INDEX NO 7004

CAUTION: NOT COMPLETE WITHOUT CURRENT CHANGE DOCUMENTS FROM DATABASE

U.S. DEPARTMENT OF ENERGY
Office of River Protection

P&ID
LERF BASIN & ETF INFLUENT
EVAPORATOR

SIZE F | DRAWING NUMBER H-2-88766 | SHEET 3 | REV 21
SCALE NONE

28722

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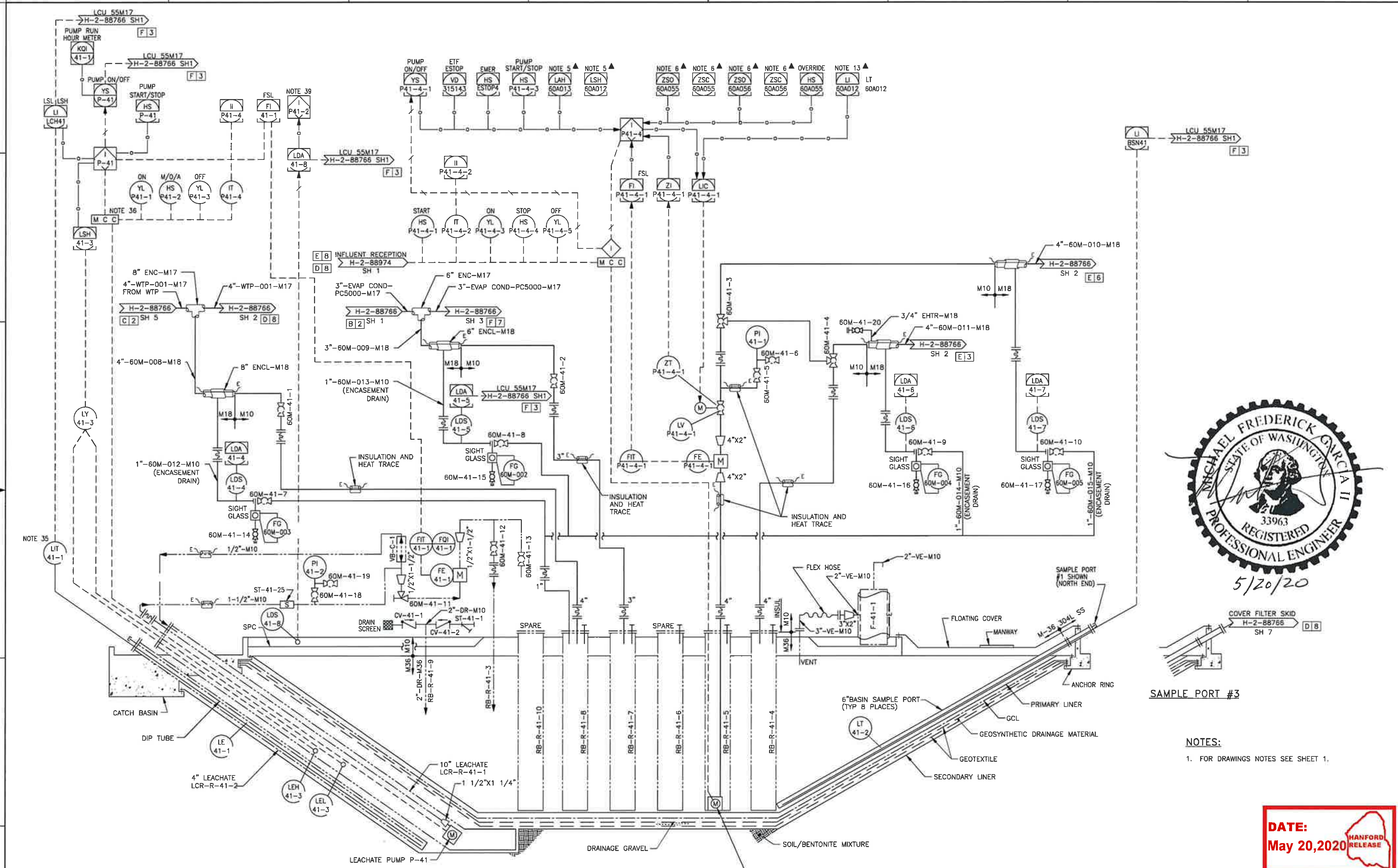

242-A EVAP COND
242AL-41

7.8 MILLION GAL CAPACITY

NOTES:

1. FOR DRAWINGS NOTES SEE SHEET 1.

5/20/20

DATE: May 20,2020 HANFORD RELEASE

DWG NUMBER	TITLE	REF NUMBER	TITLE
		H-2-838745	DRAWING LIST/TITLE SHEET
DRAWING TRACEABILITY LIST		NEXT USED ON	REFERENCES

REV	DESCRIPTION
0	RELEASED PER EDT-882459
	REVISIONS

CAUTION: NOT COMPLETE WITHOUT CURRENT CHANGE DOCUMENTS FROM DATABASE

BLDG NO 242AL-41

INDEX NO 7004

NAME	
DRAFTER	D R CHAPMAN
DRAFTING CHECKER	J R BYERS
ENGINEERING PEER REVIEWER	C C JOSLYN
DESIGN CHECKER	P M GORSH
DESIGN AUTHORITY	N W WILSON

U.S. DEPARTMENT OF ENERGY
Office of River Protection

P&ID
LERF BASIN & ETF INFLUENT EVAPORATOR

SIZE F DRAWING NUMBER H-2-88766 SHEET 6 REV 00

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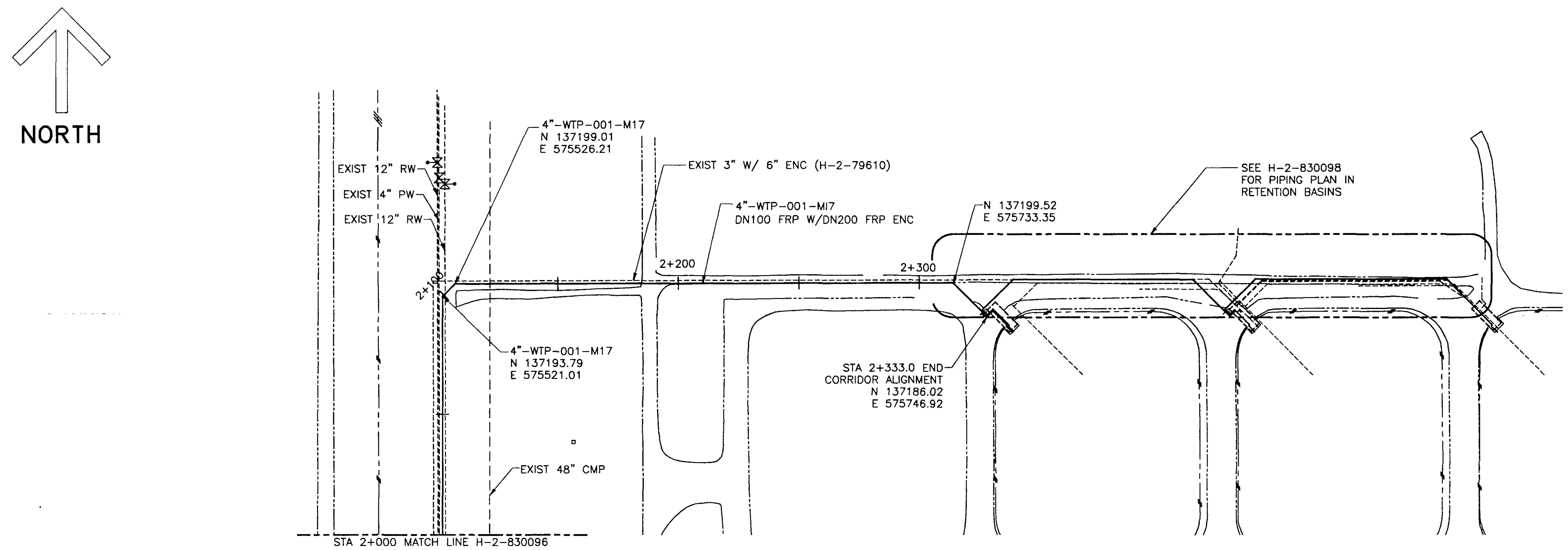
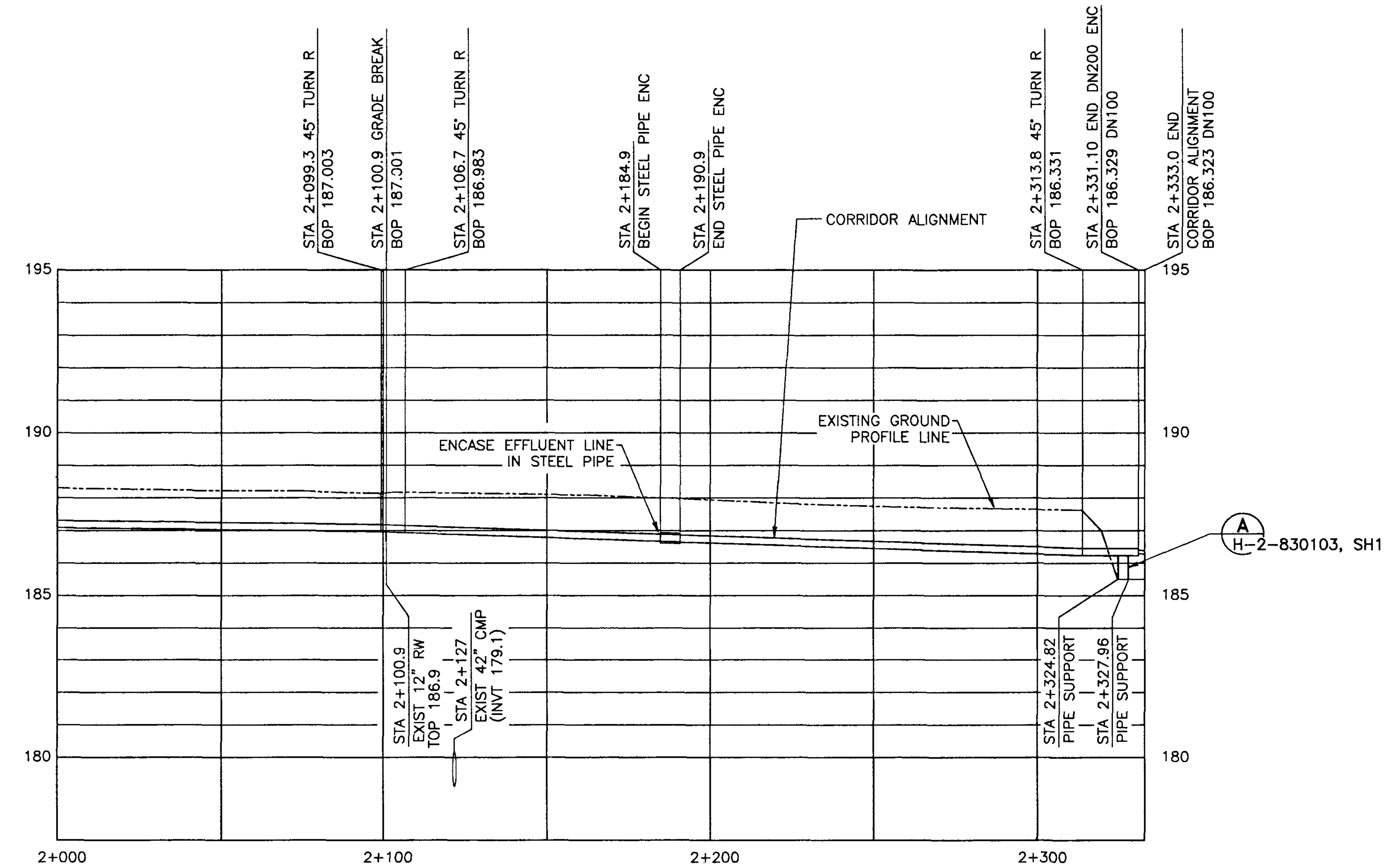


PLAN STA 2+000 TO END

1:1000
SCALE IN METERS



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1:1000
HORIZONTAL SCALE IN METERS

VERTICAL SCALE IN METERS

NOTES:

1. FOR GENERAL NOTES AND LEGEND SEE H-1-830093
2. DATE SURVEYED: 3-9-, 4-11-01.

COORDINATE TABLE

4"-WTP-001-M17

STA	NORTHING	EASTING	ELEVATION	DESCRIPTION
2+011.80	137106.246	575521.229	187.257	TOPP 66---
2+005.26	137062.971	575757.499	186.442	TOP FLANGE
2+011.44	137105.919	575521.226	187.294	TOPP 66---
2+042.27	137136.749	575521.125	187.260	TOPP 67---
2+059.47	137153.951	575521.091	187.923	TOP FLANGE
2+073.42	137167.903	575521.024	187.244	TOPP 68---
2+099.38	137193.861	575520.882	187.214	TOPP 68+87 AP
2+102.22	137195.918	575522.846	187.853	TOP FLANGE
2+106.52	137198.909	575525.940	187.171	TOPP 69+11 AP
2+133.82	137199.130	575553.233	187.112	TOPP 70---
2+164.30	137199.248	575583.814	187.004	TOPP 71---
2+184.32	137199.281	575603.837	187.190	TOP CASE
2+190.36	137199.212	575609.880	187.144	TOP CASE
2+194.52	137199.258	575614.038	186.903	TOPP 72---
2+224.95	137199.290	575644.688	186.814	TOPP 73---
2+224.84	137199.333	575644.358	187.483	TOP FLANGE
2+255.68	137199.379	575675.194	186.699	TOPP 74---
2+285.87	137199.436	575705.386	186.624	TOPP 75--
2+313.66	137199.475	575733.190	186.514	TOPP 75+91 AP
2+314.34	137198.797	575733.870	187.084	TOP FLANGE

COORDINATE TABLE

EXISTING GROUND

STA	NORTHING	EASTING	ELEVATION	DESCRIPTION
2+011.69	137106.175	575521.275	188.289	GS 66---
2+042.13	137136.602	575521.124	188.234	GS 67---
2+073.34	137167.820	575521.117	188.216	GS 68---
2+099.47	137193.951	575520.967	188.136	GS 68+87 AP
2+106.41	137198.811	575525.924	188.179	GS 69+11
2+133.58	137199.107	575553.090	188.137	GS 70---
2+164.27	137199.237	575583.778	188.081	GS 71---
2+194.58	137199.120	575614.091	187.966	GS 72---
2+224.87	137199.304	575644.385	187.829	GS 73---
2+255.83	137199.507	575675.349	187.728	GS 74---
2+286.10	137199.487	575705.619	187.675	GS 75---
2+314.11	137199.624	575733.089	187.633	GS 75+91 AP

ALL DIMENSIONS IN METERS UNO.

MANUAL CHANGES TO THE DRAWING HAVE BEEN INCORPORATED INTO THE CAD DATA SET
6-28-01

JUL 13 2001 (2)

MEIER Enterprises, Inc.
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RCI ENVIRONMENTAL INC.
ENVIRONMENTAL CONTRACTORS & ENGINEERS

NAME	DATE / COMPANY
DRAWN BY TT MARTIN	5/4/01
CHECKED BY JV EGGER	9/22/00
APPROVED T MEIER	9/21/00 5/21/01
D DOLD	9/29/00
MA PRZYBYLSKI	9/22/00 FFS
DESIGN AUTHORITY LILLY ~~LYN~~ Huth W BROWN	9/22/00 FH

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

W-519 SITE/UTILITY SYSTEMS
PLAN AND PROFILE
STA 2+000 TO STA 2+333.0

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	200E 242AL	0304	H-2-830097	1

SCALE SHOWN EDT 612387 SHEET 1 OF 1

MFD / REV REL	REV NO	DESCRIPTION	REV BY DATE			ENGR / COMPANY
S RS	1	FCN-W519-002, -010 GENERAL REVISION, INCORPORATED ADDED SURVEY DATA AS-BUILT	BDK 4/01	TW 5/21/01		Lilly Z Huth 7-11-01 FH

REVISIONS

DWG NO	TITLE

DRAWING TRACEABILITY LIST

REF NUMBER	TITLE

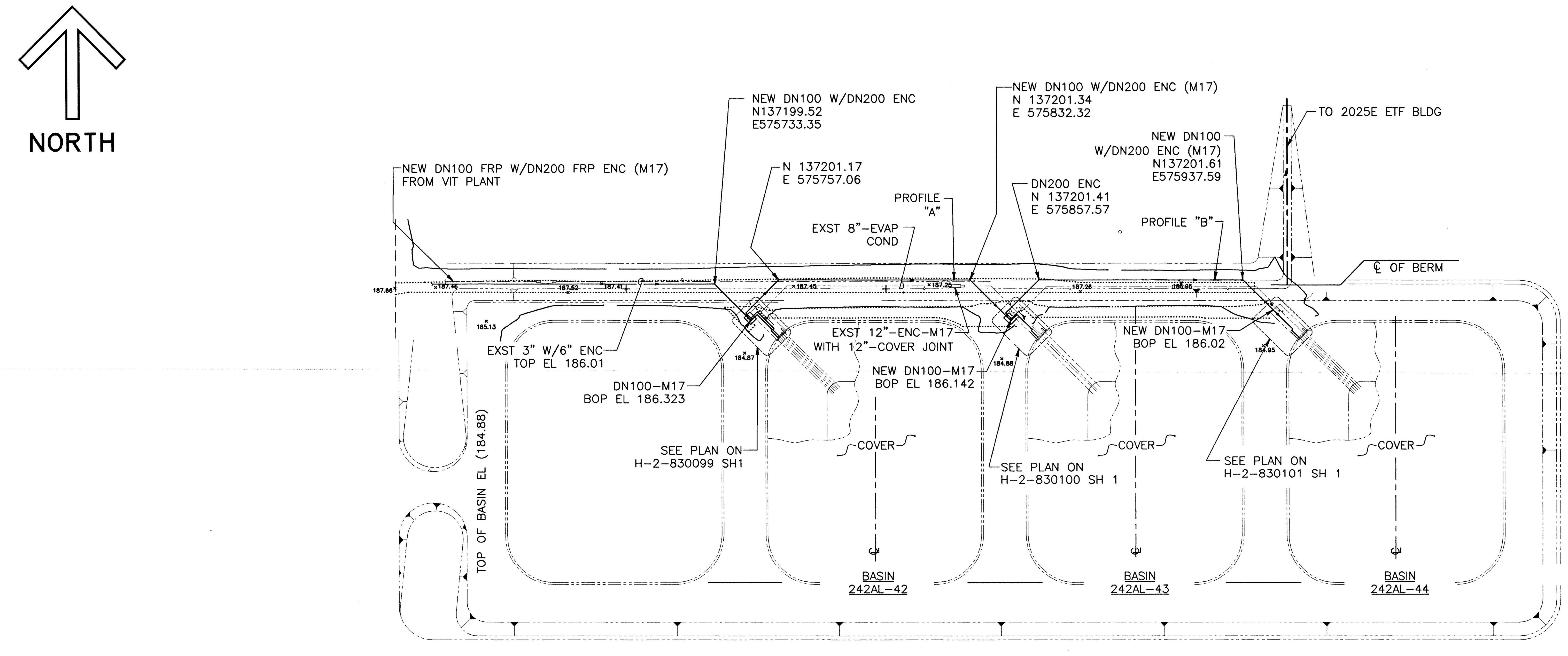
REFERENCES
NEXT USED ON

BLDG. NO.
INDEX NO.
DWG NO H-2-830097
SH 1 OF 1
REV 1
THIS SPACE RESERVED FOR BUILDING AND INDEX NUMBERS

GTITLE3.DWG (03-99)

NOTES:

1. FOR GENERAL NOTES AND LEGEND SEE H-2-830093.
2. DATE SURVEYED: FEBRUARY 5, MARCH 11, 2001.



PLAN

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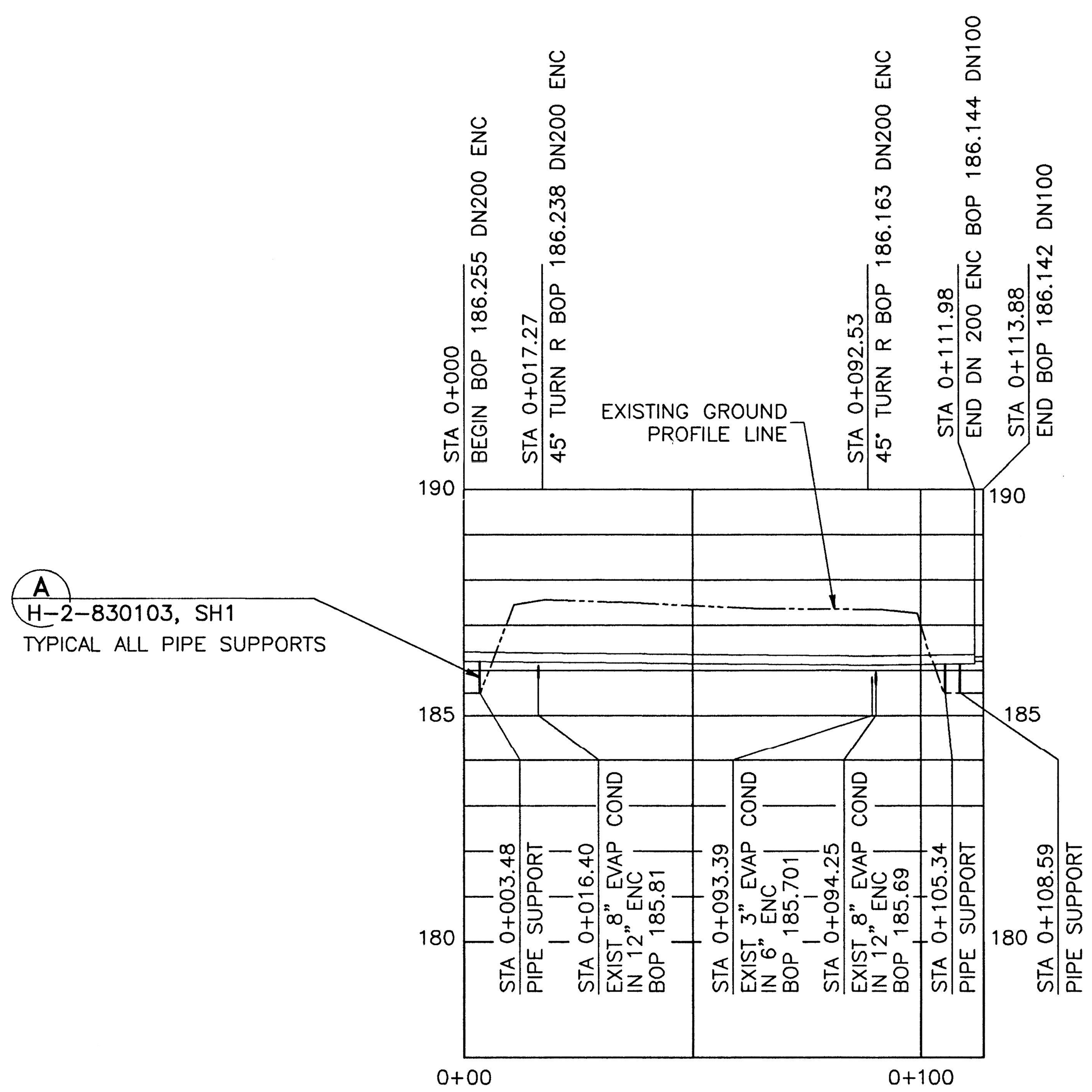

PROFILE "A"

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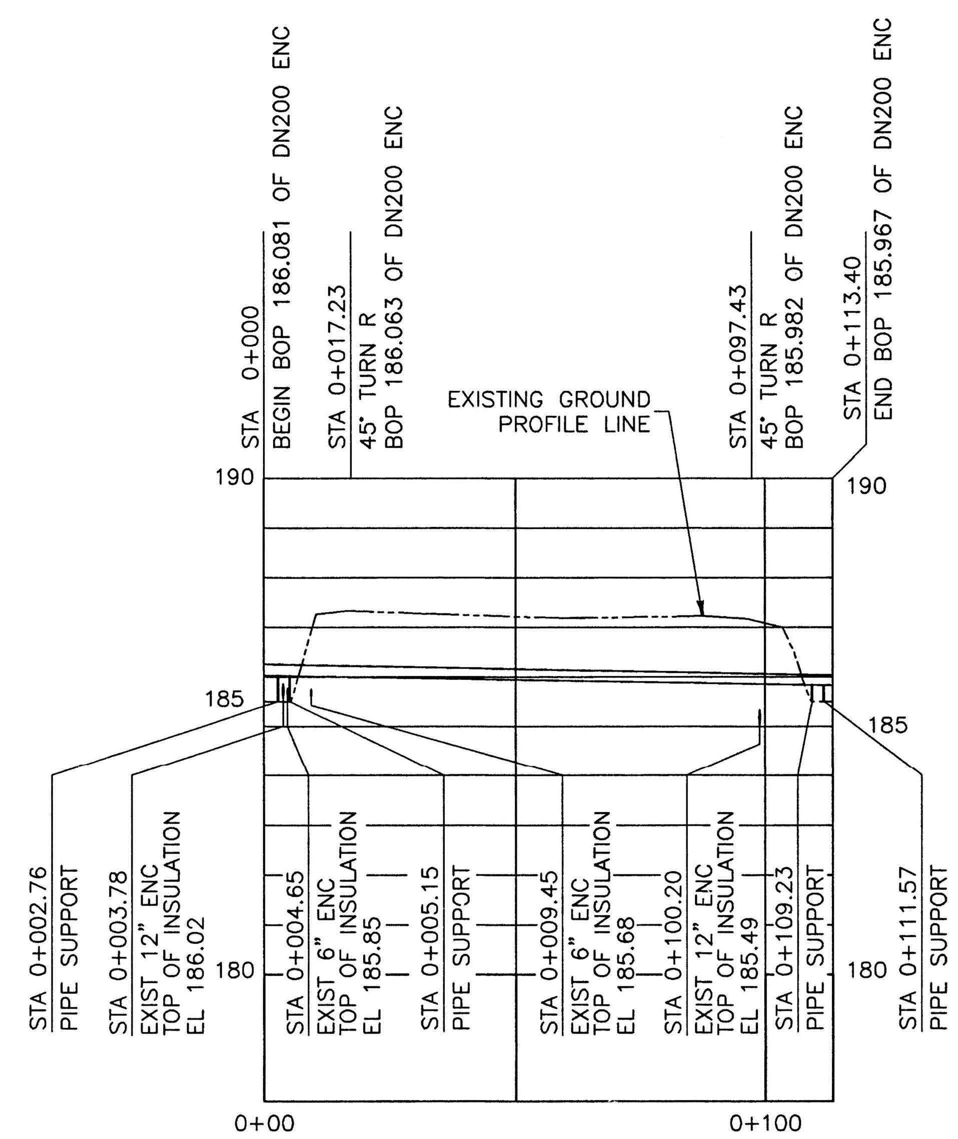
VERTICAL SCALE IN METERS



PROFILE "B"

1:1000
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VERTICAL SCALE IN METERS

COORDINATE TABLE
LERF BERM AREA
PROFILE "A"

STA	NORTHING	EASTING	NGVD 29 NAVD 88	DESC
0+017.99	137201.739	575757.4990	186.4420	TOPP 0+56
0+017.04	137201.094	575756.8140	187.1480	TOP FLANGE
0+034.13	137201.966	575776.9076	186.4330	TOPP 1+20
0+064.61	137201.967	575804.3899	186.3920	TOPP 2+10
0+092.07	137201.824	575831.8605	186.4190	TOPP 3+03
0+092.82	137201.161	575832.5508	187.1180	TOP FLANGE

COORDINATE TABLE
LERF BERM AREA
PROFILE "B"

STA	NORTHING	EASTING	NGVD 29 NAVD 88	DESC
0+015.63	137200.635	575856.0753	187.0390	TOP FLANGE
0+016.56	137201.256	575856.7676	186.2990	TOPP 0+56
0+033.44	137201.413	575873.7846	186.2700	TOPP 1+10
0+061.00	137201.575	575901.3502	186.2300	TOPP 2+00
0+088.26	137201.639	575928.6062	186.2260	TOPP 2+90
0+097.69	137201.527	575937.8446	186.2190	TOPP 3+23
0+098.43	137200.885	575938.5461	186.9160	TOP FLANGE

COORDINATE TABLE
LERF BERM AREA
EXISTING GROUND
PROFILE "A"

STA	NORTHING	EASTING	ELEV	DESC
0+017.83	137201.538	575757.490	187.562	GS 0+56
0+037.02	137201.887	575776.800	187.496	GS 1+20
0+064.57	137201.928	575804.356	187.366	GS 2+10
0+092.24	137201.694	575832.032	187.364	GS 3+03
0+092.02	137202.066	575831.808	187.346	GS 3+03

COORDINATE TABLE
LERF BERM AREA
EXISTING GROUND
PROFILE "B"

STA	NORTHING	EASTING	ELEV	DESC
0+016.67	137201.356	575856.832	187.332	GS 0+56
0+033.19	137201.423	575873.534	187.271	GS 1+10
0+061.17	137201.590	575901.511	187.182	GS 2---
0+088.34	137201.687	575928.683	187.225	GS 2+90
0+097.65	137201.586	575937.818	187.170	GS 3+23

COORDINATE TABLE
EXISTING UTILITIES

NORTHING	EASTING	ELEV	DESC
137200.115	575755.3138	187.0550	TOPP 2" CON
137200.188	575756.6675	187.0650	TOPP 2" CON
137200.450	575832.8359	186.8590	TOPP 2" CON
137200.502	575833.8828	186.8690	TOPP 2" CON

ALL DIMENSIONS IN METERS UNO.

BLDG. NO.

INDEX NO.

THIS SPACE RESERVED FOR BUILDING AND INDEX NUMBERS

DWG NO H-2-830098 SH 1 OF 1 REV 1

MANUAL CHANGES TO THE DRAWING HAVE BEEN INCORPORATED INTO THE CAD DATA SET
TLT Meier 6-28-01

DATE: STA: 4 HANFORD RELEASE ID: JUL 13 2001 (2)

MEIER Enterprises, Inc. www.meierinc.com

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TERRANCE E. MEIER STATE OF WASHINGTON 16462 REGISTERED PROFESSIONAL ENGINEER
EXPIRES 12/19/01
5/21/01

DWG NO	TITLE	REF NUMBER	TITLE
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RS	M	1	FCN-W519-002 GENERAL REVISION, INCORPORATED ADDED SURVEY DATA AS-BUILT	BDK 4/01	TM 5/21/01	MJ Brown FH

REVISIONS

NAME	DATE / COMPANY
DRAWN BY TT MARTIN	5/4/01
CHECKED BY JV EGGER	9/22/00
APPROVED T MEIER TM	9/21/00 5/21/01
D DOLD	9/29/00
MA PRZYBYLSKI	9/22/00 FFS
DESIGN AUTHORITY LILLY LYN W BROWN	9/22/00 FH

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

W-519 SITE/UTILITY SYSTEMS PLAN & PROFILE LERF BASINS

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	200E 242AL	0304	H-2-830098	1

SCALE SHOWN EDT 612387 SHEET 1 OF 1

GTITLE3.DWG (03-99)

GENERAL NOTES: (UNLESS OTHERWISE SPECIFIED)

1. DIMENSIONS ARE IN INCHES, TOLERANCES SHALL BE AS FOLLOWS:
   FRACTIONS = ±1/8" ANGLES = ±0.5° DECIMAL = .XX ±0.03 .XXX ±.010
2. REMOVE ALL BURRS AND BREAK SHARP EDGES.
3. VALVE PN: 990-0100W0A10010-I0S00S0E000KB
   FIGURE 990 SERIES VALVE, WAFER, 4", CAST IRON BODY, 316SS DISC, 316SS STEM, EPDM SEAT, ASME 150, BARE STEM VALVE.

   GEAR OPERATOR + STEM ADAPTER KIT PN'S: ISV-1103485 + ISV-1103450
   GEAR 24:1 WITH 6" HANDWEEL, BAC 1500 IN LBS + MTG KIT BAC
4. FOR BURIED PIPING ANALYSIS SEE RPP-CALC-63780.
5. USE CLASS M-18 PIPING CODE SEE CONSTRUCTION SPECIFICATION RPP-SPEC-63632 SECTION 40 40 00.
6. FOR PIPING INSULATION SEE CONSTRUCTION SPECIFICATION RPP-SPEC-63632 SECTION 40 42 13.
7. INSTALL FRP PIPING AND FITTINGS IN ACCORDANCE WITH MANUFACTURER INSTRUCTIONS AND/OR RECOMMENDATIONS.
8. WELD AND INSPECT STRUCTURAL WELDS IN ACCORDANCE WITH AWS D1.1, 2015 STATICALLY LOADED CRITERIA. ALL WELDS SHALL BE VT ON FINAL PASS UNLESS OTHERWISE SPECIFIED. WELD PROCEDURES AND QUALIFICATIONS PER ASME B&PV CODE SECTION IX, 2017 ARE ACCEPTABLE.
9. USE #251 DOUBLE CONTAINMENT INTERLOCKING UNION ON BOTH NEW M-18 LINES CENTERED ±20 FT BETWEEN BASIN 41 AND BASIN 42.
10. JOINT ADHESIVES AND BONDING MATERIAL SHALL BE OF THE SAME MANUFACTURER AS THE PIPE AND FITTINGS AND SHALL BE OF THE SAME RESIN SYSTEM. ADHESIVES SHALL BE APPLIED IN ACCORDANCE WITH MANUFACTURER RECOMMENDATIONS.

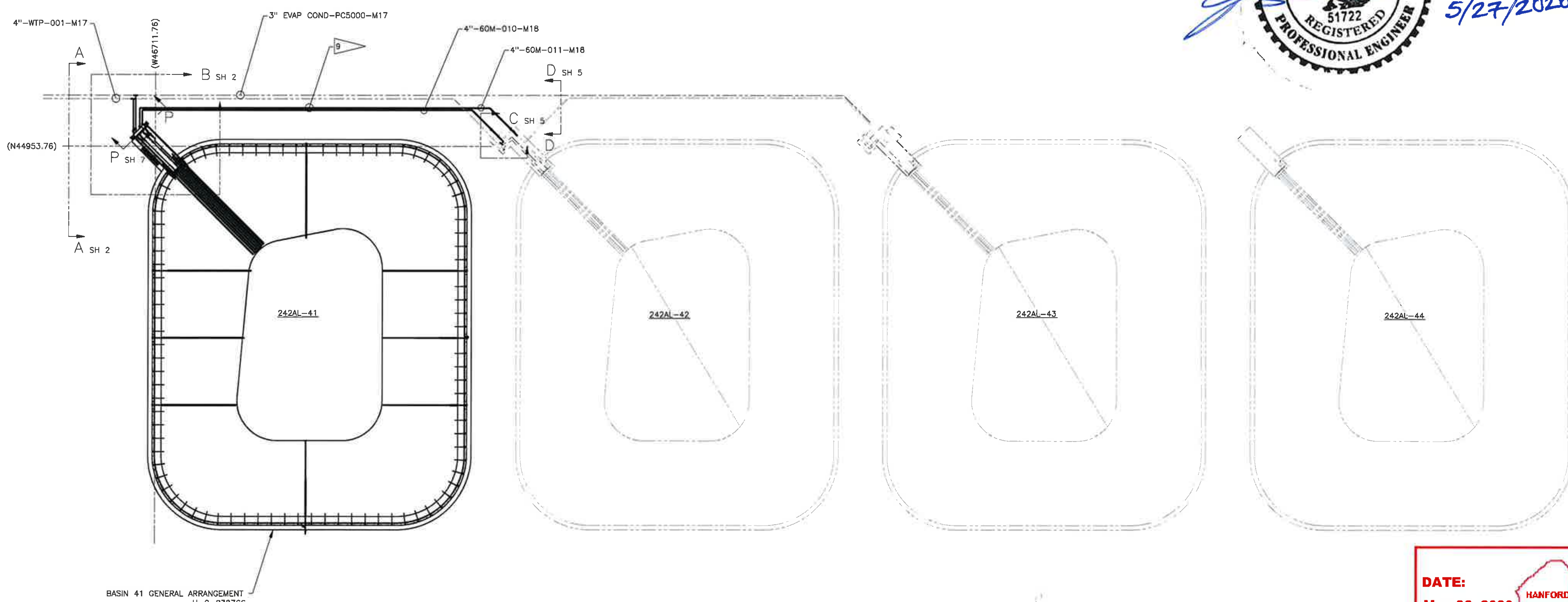
(NOTES CONTINUED)

11. PREPARE AND PAINT ALL EXPOSED CARBON STEEL SURFACES WITH PPG PSX700 OR EQUIVALENT. FINISH COLOR SHALL BE GRAY. APPLY PER MANUFACTURER'S SPECIFICATIONS. POWDER COATING IS AN ACCEPTABLE COATING SYSTEM.

NORTH

JACOB D WILLIAMS
STATE OF WASHINGTON
51722
REGISTERED
PROFESSIONAL ENGINEER

5/27/2020



DATE:
May 26, 2020
HANFORD RELEASE

LERF BASIN 41 MECHANICAL GENERAL ARRANGEMENT

SCALE: NONE

DWG NUMBER	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
H-15-38	LERF BASIN 41
H-2-838745	DRAWING LIST/TITLE SHEET

REFERENCES

NEXT USED ON END ITEM

REV NO	DESCRIPTION
0	RELEASED PER EDT-882463

REVISIONS

BLDG NO 242-AL 242AL-41

INDEX NO 8407

CAUTION: NOT COMPLETE WITHOUT CURRENT CHANGE DOCUMENTS FROM DATABASE

	NAME
DRAFTER	W T ARNDT
DRAFTING CHECKER	H A MENDEZ
ENGINEERING PEER REVIEWER	C C JOSLYN
DESIGN ENGINEER	J D WILLIAMS
DESIGN AUTHORITY	N W WILSON

U.S. DEPARTMENT OF ENERGY
Office of River Protection

LERF BASIN 41 MECHANICAL GENERAL ARRANGEMENT

SIZE F DRAWING NUMBER H-2-838765 SHEET 1 REV 00

SCALE AS SHOWN

28472

DOCUMENT RELEASE AND CHANGE FORM

Prepared For the U.S. Department of Energy, Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

Release Stamp

DATE:
May 26,2020
HANFORD RELEASE

1. **Doc No:** RPP-RPT-62215 **Rev.** 00

2. **Title:**
LERF Basin 41 Material Compatibility with Wastewater

3. **Project Number:** ☐N/A
T1P226

4. **Design Verification Required:**
☐Yes ☒No

5. **USQ Number:** ☒ N/A
RPP-27195

6. **PrHA Number** **Rev.** ☒ N/A

Clearance Review Restriction Type:
public

7. **Approvals**

Title	Name	Signature	Date
Checker	Anda, Vanessa S	*Anda, Vanessa S*	05/13/2020
Clearance Review	Aardal, Janis D	*Aardal, Janis D*	05/26/2020
Design Authority	Wilson, Nathaniel W	*Wilson, Nathaniel W*	05/14/2020
Document Control Approval	Meinecke, Kathryn R	*Meinecke, Kathryn R*	05/26/2020
Environmental Protection	Wall, Jeremy M	*Wall, Jeremy M*	05/18/2020
Originator	Dahl, Megan M	*Dahl, Megan M*	05/13/2020
Other Approver	Joslyn, Cameron C	*Joslyn, Cameron C*	05/13/2020
Other Approver	Greenhalgh, Aaron M	*Greenhalgh, Aaron M*	05/14/2020
Other Approver	Rice, Joseph P	*Rice, Joseph P*	05/18/2020
Other Approver	Roosendaal, Gene D	*Roosendaal, Gene D*	05/14/2020
Responsible Manager	Huntington, Matthew R	*Huntington, Matthew R*	05/19/2020

8. **Description of Change and Justification**

Once the Waste Treatment and Immobilization Plant (WTP) begins processing waste, it will send wastewater from the Effluent Management Facility (EMF) to the LERF, prompting the need for a fourth basin, 242AL-41, (Basin 41). This material compatibility assessment is necessary to demonstrate that the basin will be able to perform its function of retaining the wastewater.

Note, Section 5.0, Page A-7: MicroShield is a registered trademark of Grove Engineering, Inc., Lynchburg, Virginia.

9. **TBDs or Holds** ☒N/A

10. **Related Structures, Systems, and Components**

a. **Related Building/Facilities** ☐N/A	b. **Related Systems** ☐N/A	c. **Related Equipment ID Nos. (EIN)** ☒N/A
ETF FACILITIES LERF FACILITIES	ETF LERF	

11. **Impacted Documents – Engineering** ☒N/A

Document Number	Rev.	Title

12. **Impacted Documents (Outside SPF):**

N/A

13. **Related Documents** ☐N/A

Document Number	Rev.	Title
HNF-3172	09	Liquid Waste Processing Facilities Waste Acceptance Criteria
WHC-SD-W105-TD-001	00	9090 TEST RESULTS

14. **Distribution**

Name	Organization
Blaak, Whitney S	COGNIZANT SYSTEM ENGINEERING
Demiter, Scott M	ETF OPERATIONS
Dorsh, Paul M	
Greenhalgh, Aaron M	TANK FARM PROJECTS ENGINEERING
Halgren, Dale L	ETF ENGINEERING
Huntington, Matthew R	TANK FARM PROJECTS ENGINEERING
Joslyn, Cameron C	ETF ENGINEERING
Laurenz, Julian E	TANK FARM PROJECTS ENGINEERING
Rice, Joseph P	TANK & PIPELINE INTEGRITY
Roosendaal, Gene D	TFP PROJECT MANAGEMENT
Rutherford, Wally	ETF ENGINEERING
Wall, Jeremy M	RETRVL & CLOSURE/PROJ ENV CMPL
White, Michael A	

DOCUMENT RELEASE AND CHANGE FORM	Doc No: RPP-RPT-62215 Rev. 00

14. **Distribution**

Name	Organization
Wilson, Nathaniel W	ETF PROJECTS ENGINEERING

RPP-RPT-62215
Revision 0

LERF Basin 41 Material Compatibility with Wastewater

Prepared by

M.M. Dahl
Sargent & Lundy for Washington River Protection Solutions, LLC

Date Published
May 2020

washington river protection solutions

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REGISTERED
PROFESSIONAL ENGINEER
5/27/2020

Prepared for the U.S. Department of Energy
Office of River Protection

Contract No. DE-AC27-08RV14800

LERF BASIN 41 MATERIAL COMPATIBILITY WITH WASTEWATER

May 2020

prepared by

Sargent & Lundy
1100 Jadwin Avenue, Suite 400
Richland, Washington 99352-3425
(509) 946-3300

prepared for

Washington River Protection Solutions, LLC

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

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LIST OF TERMS

Acronyms

CSPE	Chlorosulfonate polyethylene
EMF	Effluent Management Facility
EPDM	Ethylene Propylene Diene Monomer Rubber
EPRI	Electric Power Research Institute
ETF	Effluent Treatment Facility
FRP	Fiberglass-Reinforced Plastic
HDPE	High Density Polyethylene
LERF	Liquid Effluent Retention Facility
RCRA	Resource Conservation and Recovery Act
WAC	Washington Administrative Code
WTP	Waste Treatment and Immobilization Plant

Units

C	°degrees Celsius
in.	inch(es)
ft	Foot/feet
mil	1/1000 inch
lb	pound

1.0 INTRODUCTION

The Liquid Effluent Retention Facility (LERF) currently operates three basins adjacent to the Effluent Treatment Facility (ETF), located just north of the 200 East tank farms. The basins store wastewater from several Hanford sources, including condensate from the 242-A Evaporator, and dilute waste streams from solid waste disposal facilities, and site cleanup activities. The wastewater is eventually processed through ETF.

Once the Waste Treatment and Immobilization Plant (WTP) begins processing waste, it will send wastewater from the Effluent Management Facility (EMF) to the LERF, prompting the need for a fourth basin, 242AL-41, (Basin 41) to ensure sufficient storage capacity from the new source. Basin 41 will be sized the same as the other three basins, and will be able to hold approximately 7.8 million gallons of wastewater. Basin 41 was roughly dug out at the same time (1990) as the other active basins (242AL-42, 242AL-43, and 242AL-44), but further work has not been performed to complete the basin.

An assessment of certain materials of construction for Basin 41 and its ancillary equipment is necessary to demonstrate that the basin will be able to perform its function of retaining the wastewater. The materials will need to be compatible with all sources of wastewater - currently 242-A Evaporator condensate, dilute waste streams, groundwater, and EMF wastewater.

2.0 BACKGROUND

The construction of Basin 41 includes the construction of the following basin and ancillary equipment per the construction specification, RPP-SPEC-63632, *LERF Basin 41 Construction Specification*:

1. Basin 41 multipart liner system (Figure 2-1).
2. Basin 41 floating cover system.
3. Concrete catch basin including:
    a. Chemical resistant coatings
    b. Metallic and non-metallic piping and manifold systems, and
    c. Anchors for in-basin equipment.
4. The double containment reinforced thermosetting resin pipe (also known as Fiberglass reinforced pipe [FRP[1]]) extending into the catch basin.
    a. Two pipelines will be tied into existing lines, EVAP COND-PC5000 and WTP-001.
    b. Two additional intra-basin lines, 60M-010 and 60M-011.

---

[1] The manufacturer of the selected pipe refers to the product as FRP (Conley Composites). As a result, the pipe will be referred to as FRP for the remainder of this report.

5. Basin 41 equipment such as piping, risers, pumps, etc.

It is expected that Basin 41 will be a recipient of wastewater from several origins, including the new EMF wastewater stream. Prior to waste acceptance, the New Waste Stream Acceptance Checklist (HNF-3172, *Liquid Waste Processing Facilities Waste Acceptance Criteria*) must be completed and approved. Among other items, the checklist ensures that the constituents of the wastewater stream do not exceed the liner compatibility limits.

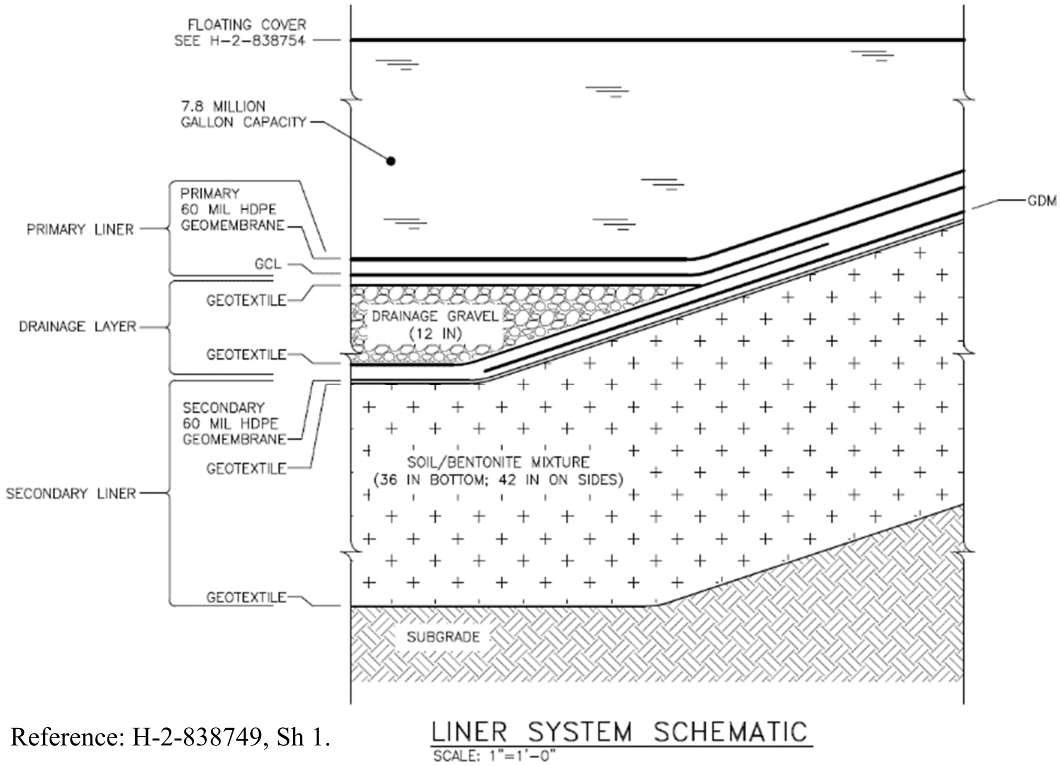
2.1 REQUIREMENT FLOWDOWN

The materials of construction are being evaluated to ensure that they are compatible with the wastewater in accordance with two Washington Administrative Codes (WACs). Waste transfer piping, up to the first valve in the catch basin, is regulated under WAC 173-303-640, *Tank Systems.* The basin liner is regulated under WAC 173-303-650, *Surface Impoundments.* The requirements from the WAC standards as they pertain to this material compatibility assessment are as described in Table 2-1. The WAC 173-303-640 regulation applicability is depicted in Figure 2-2.

Table 2-1. Wastewater Compatibility Requirement Flowdown.

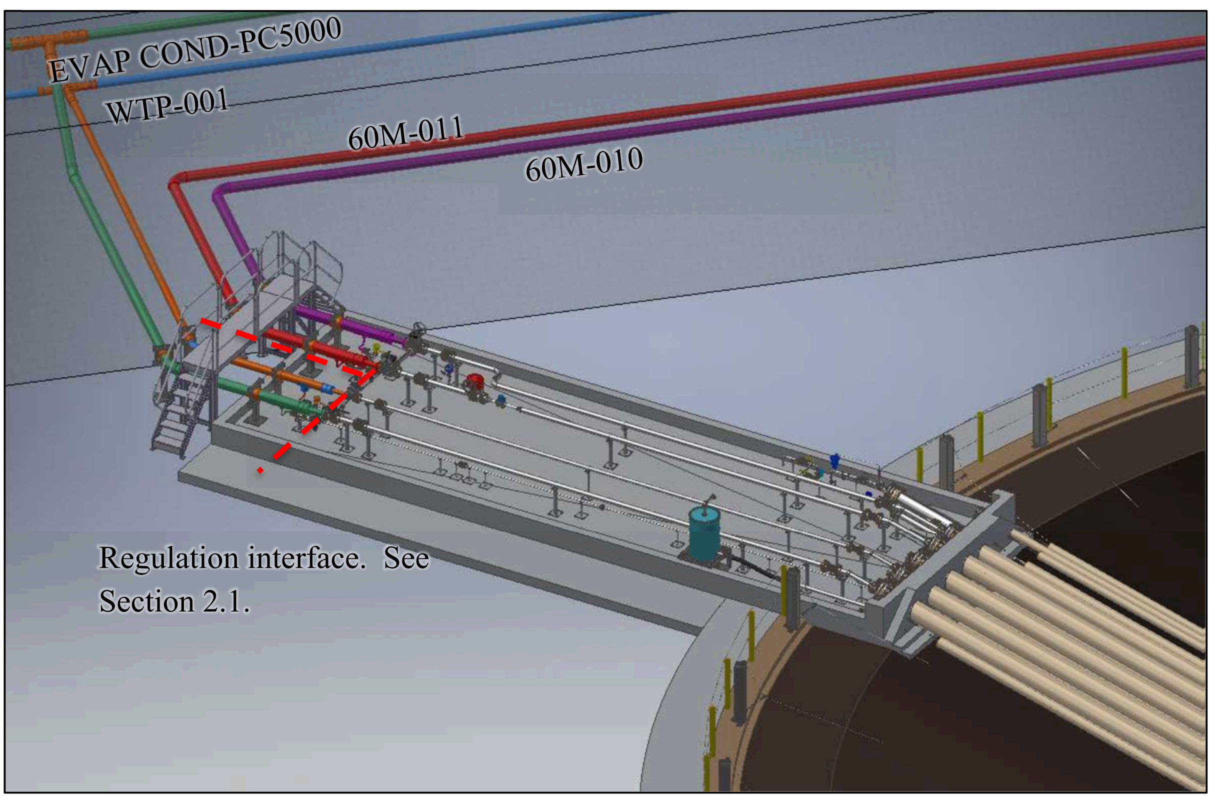
Location	WAC Requirement	Part	Requirement (paraphrased for clarity)
Basin primary liner	173-303-650	(2)(a)(i)(A)	The impoundment liner will have the appropriate chemical properties to prevent failure due to physical contact with the wastewater to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation.
Up to first valve in manifold	173-303-640	(3)(a)	Owners or operators of new tank systems or components must obtain a written assessment, reviewed and certified by an independent, qualified registered professional engineer, attesting that the tank system has sufficient structural integrity and is acceptable for the storing and treating of dangerous waste. The assessment must show the tank system has sufficient structural strength, compatibility with the waste(s) to be stored or treated, and corrosion protection to ensure that it will not collapse, rupture, or fail.
		(3)(a)(iii)(A)(VIII)(B)(I)	The type and degree of external corrosion protection that are needed to ensure the integrity of the tank system during the use of the tank system or component, consisting of: Corrosion-resistant materials of construction such as special alloys, fiberglass reinforced plastic, etc.

Figure 2-1. Basin 41 Liner System Schematic.



Reference: H-2-838749, Sh 1.

Figure 2-2. Basin 41 Piping Regulation Interface View.



3.0 SCOPE AND METHODOLOGY

3.1 ASSESSMENT METHODOLOGY

This assessment evaluates the compatibility of applicable Basin 41 and ancillary equipment materials with the anticipated wastewater. Guidance contained in standard TFC-ENG-STD-34, *Standard for the Selection of Non-Metallic Materials in Contact with Tank Waste*, has been applied for this assessment. Based on the guidance in TFC-ENG-STD-34 and the WAC requirements, only the components listed below need to be assessed in this evaluation.

- Materials under WAC 173-303-640:

  1. FRP inner liner,
  2. Full Face gaskets, and
  3. Catch basin coating (secondary containment).

- Materials under WAC 173-303-650:

  1. Geomembrane liner, and
  2. Floating cover[2].

Radiation resistance, chemical resistance, temperature constraints, and application constraints will be considered in this evaluation. Materials used to construct the three operating basins were evaluated in WHC-SD-W105-TD-001, *9090 Test Results*. A follow-up compatibility assessment was performed by ETF personnel to expand on the wastewater simulant results to include the current chemical families and constituents now identified in HNF-3172. Where the materials used to construct Basin 41 are the same or similar to the original materials, operational experience in conjunction with previously documented evaluations will be used as input for this evaluation.

The following methodology was used to determine if the components are appropriate for use in Basin 41.

1. Calculate the expected dose rate and final dose of the LERF Basin wastewater sources (Appendix A) using The LERF Safety Basis Limits identified in Appendix D of HNF-3172.

2. Develop a component list (Table 3-1) derived from applicable drawings (Table 3-2).

[2] The floating cover is only mentioned as a part of the system to be inspected for integrity during and following installation. The requirement does not mandate that it be made out of a material that must be chemically resistant; however, since it is in direct contact with wastewater, it will be included to support discussion on maintenance.

3. Provide an evaluation of each material in the expected environment (Section 4.0).

4. Provide recommendations to facilitate component life (Section 5.0).

Table 3-1. Basin 41 Component for Evaluation List.

Component	Part	Material	Assembly and Environment
Basin Primary Liner	Geomembrane	HDPE	Basin 41
Full Face Gasket	Gasket	EPDM	FRP Pipe
Double Containment Primary (Inner) Piping and Fittings	Inner Liner	FRP - Liner Nexus (polyester veil with Epoxy resin)	FRP Buried and Above Grade Pipe
Basin Floating Cover	Bottom Layer Geomembrane	CSPE	Basin 41
Catch Basin Coating	Coating	Siloxane	Catch Basin

CSPE – Chlorosulfanated Polyethylene

Table 3-2. Basin 41 Component Drawing List.

Drawing and Sheet No	Title
H-2-838765, Sh 3-7	LERF Basin 41 Mechanical Sections
H-2-838767, Sh 1-2	LERF Basin 41 Catch Basin Isometric and Parts List

3.2 INPUTS

1. A design life for Basin 41 and ancillary equipment has not been established. For the purposes of this material evaluation, a design life of 30 years has been used to provide clarification and recommendations.

2. The LERF Liner Compatibility Limit table has been generated in HNF-3172. The table has been provided in Table 3-3.

Table 3-3. LERF Liner Compatibility Limits.

Chemical family	Constituent(s) or parameter(s)	Limit[1] (mg/L)
Alcohol/glycol	1-butanol	500,000
Alkanone[2]	acetone	200,000
Alkenone[3]	none targeted	N/A
Aromatic/cyclic hydrocarbon	acetophenone, benzene, carbozole, chrysene, cresol, di-n-octyl phthalate, diphenylamine, isophorone, pyridine, tetrahydrofuran	2,000
Halogenated hydrocarbon	Aroclors, carbon tetrachloride, chloroform, hexachlorobenzene, lindane (gamma-BHC), hexachlorocyclopentadiene, methylene chloride, p-chloroaniline, tetrachloroethylene, 2,4,6-trichlorophenol	2,000
Aliphatic hydrocarbon	none targeted	N/A
Ether	dichloroisopropyl ether	2,000
Other hydrocarbons	acetontrile, carbon disulfide, nnitrosodimethylamine, tributyl phosphate	2,000
Oxidizers	none targeted	N/A
Acids, bases, salts	ammonia, cyanide, anions, cations	100,000
pH	PH	0.5 < pH < 13.0

[1] Analytical data for a chemical family (as indicated) are summed using the following sum-of-fractions technique. The individual constituent concentrations, sum concentrations (for families), and pH values for a wastewater are then evaluated against the compatibility limit.

$$\sum_{n=1}^{i}\left(\frac{conc_n}{Limit_n}\right) \leq 1$$

where ‘i’ is the number of constituents in the chemical family that were detected.

[2] Ketone containing saturated alkyl group(s).

[3] Ketone containing unsaturated alkyl group(s).

Table Reference: HNF-3172

3. Dose rates were determined for the basin cover, liner, piping, and catch basin in Appendix A. The highest estimated dose rates for each system location were used for conservatism. Note that due to the configuration, the dose rate calculated for the basin wall is less than the dose rate calculated for the bottom of the liner. The wall dose rate will be neglected, and the bottom of the liner dose rate will be used for all of the liner. The dose rate and dose at 30 years for each component is presented in Table 3-4.

Table 3-4. LERF Wastewater Estimated Bounding Dose Rates and Total Dose.

Wastewater Dose Location	Dose Rate [rad/hr]	Total Exposure at 30 Years [rad]
Basin 41 Cover	2.84E-02	7,457
Basin 41 Liner		
Transfer Piping	8.58E-03	2,254
Catch Basin	3.43E-02	9,016

Reference: Appendix A

Note: The Basin 41 wall dose rate and total dose is less than the bottom of the basin, and will not be used in this evaluation.

4. Most literature data on the degradation of non-metallic materials, exposed to ionizing radiation, come from accelerated tests using high gamma radiation dose rates on free form specimens in air. Errors can arise in applying short-term, high-dose-rate test data to predict the effects of radiation on materials exposed to lower dose rates over long periods of time in liquid. For the purposes of this evaluation, it has been assumed that short-term, high-dose-rate test data can be reasonably applied to predict the performance of the basin non-metallic materials.

3.3 ASSESSMENT LIMITATIONS

3.3.1 Radiation Resistance

Radiation effects on materials are assumed to be the result of gamma radiation in this analysis. Beta radiation has been shown to affect waste transfer components over long periods of exposure in similar ways to gamma radiation (Wright 2006, Clegg 1991); however, due to beta's decreased ability to penetrate material, it is deemed conservative to consider the total dose delivered by the media in each stream to consist entirely of gamma. Gamma radiation, while less ionizing than beta, can better penetrate most substances and is therefore considered to have a much greater effect on the properties of polymeric materials (Wright 2006, Clegg 1991). It is for this reason that the overwhelming majority of data available for the effects of radiation on non-metallic materials pertains to the effects of gamma only; data related to the effects of beta on these compounds is limited. Any damage induced by beta radiation is likely to be conservatively bounded by the anticipated effects of gamma radiation.

Under irradiation, polymers generally undergo two types of reaction: cross-linking and/or chain scission. The cross-linking process increases the rigidity and hardness. Chain scission decreases the modulus of elasticity, reduces yield stress, increases elongation, and decreases hardness. Chain scission may also cause embrittlement or affect the release of hydrogen gas. Both cross-linking and chain scission can significantly alter the properties of a polymer; however, not all polymers are affected equally.

Radiation data for polymeric materials in the literature are difficult to apply directly to LERF Basin conditions. Nearly all radiation resistance data for polymers have been generated in short-term tests using high gamma radiation dose rates where the material under test is in air and not under tensile stress. Several important factors listed below must be considered when reviewing radiation test data generated in this manner.

1. Materials exposed to high dose rates will absorb more radiation dose before exhibiting a given loss in mechanical properties than materials irradiated at lower dose rates (Wright 2006). Thus, data generated with high dose rates and short exposure times cannot be reliably used to predict the service life of similar materials exposed to much lower dose rates for a longer period of time given the same total dose exposure. Dose rates for the evaluated components are much lower than typical dose rates used in accelerated materials testing.

2. Many radiation degradation products produced in polymers require oxygen to form (Wright 2006). Thus, the rate of radiation-induced degradation is often faster for materials irradiated in oxygen-containing environments than for materials irradiated in deoxygenated environments. Results from tests on materials irradiated in oxygenated environments cannot be reliably used to predict the service life of similar materials used in deoxygenated or reduced-oxygen environments.

3. Degradation rates also increase with temperature, largely due to the increase in oxygen permeability with temperatures (Wright 2006, Clegg 1991). Depending on test temperature, test data may not accurately reflect field conditions.

4. Degradation of materials due to irradiation continues after removal from the radiation source (Wright 2006). Thus, test data may not reflect service conditions, depending on how soon mechanical testing is performed following irradiation.

5. The rate of degradation increases when stress and radiation are concurrently applied (Wright 2006). Because almost no testing is performed with the polymer under stress, test results tend to overestimate the useful life of an irradiated polymer in service.

6. Radiation testing is most often performed on thin samples of materials (Wright 2006). Thin samples degrade more rapidly than thick samples. Depending on how close test specimen thicknesses are to installed material thicknesses, data may again be skewed.

7. The performance of gaskets is strongly dependent on the compressive properties of the elastomer (Wright 2006). Under irradiation, radiation-induced cross-linking may increase the modulus of elasticity of the material only slightly, but if this occurs while the material is in compression, there will be a significant loss of “elastic memory” and an associated loss in sealing capability (Wright 2006). Tests performed on relaxed elastomers, not under compression, will not likely be representative of materials to be used in service under compression to prevent leakage.

These traits of polymer irradiation data must be considered in the material analysis (as applicable) for the LERF Basin components. Unless test conditions match service conditions, the estimated useful life analyses for polymers presented herein can only be considered a rough estimate of expected field performance.

It should be noted that these results are based only on a literature review of compatibility data and do not take into account possible synergistic effects of radiation plus chemical exposure, process upsets creating environments outside the bounds of this assessment, temperature differences, or other errors associated with applying short-term test data prediction of long-term performance.

3.3.2 Chemical Compatibility

The LERF can accept Hanford Site generated mixed, low-level, dangerous, or non-regulated wastewater, provided the wastewater meets the facilities' waste acceptance criteria as described in HNF-3172. Laboratory testing was performed on the initial wastewater simulant for compatibility with the High Density Polyethylene (HDPE) geomembrane liner and FRP prior to the construction of the original three basins (WHC-SD-W105-TD-001). As discussed in Design Input 2, the constituents in the original simulant were expanded in HNF-3172 to encompass chemical families, based on the testing and vendor compatibility data, to ensure the integrity of the basin liner and piping materials. These established threshold values are listed in HNF-3172 (and also presented in Table 3-3 in this document).

Although threshold values in HNF-3172 are already established for two of the materials in the Basin 41 system, the following information should be taken into consideration when understanding how laboratory test results apply to operational environments.

The predicted LERF Basin wastewater streams are, in effect, a dilute solution of many chemical constituents of varying concentrations. The material/chemical compatibility data generated from the original testing and the supplemental vendor data were generated from relatively short-term tests performed on material coupons subjected to solutions that do not fully represent the current wastewater composition(s). In the case of the original test data documented in WHC-SD-W105-TD-001, the recipe for the simulant no longer reflects the current wastewater water composition. The formulation for the simulant originally tested was limited to 22 constituents and as previously noted, was later expanded to encompass the chemical families in HNF-3172.

As described in TFC-ENG-STD-34, the geometry of the materials in this assessment contributes to how the material behaves in response to chemical exposure and changes in temperature. In general, “free-form” or unconstrained, unstressed specimens tend to suffer greater impacts from chemical exposure than do materials that are constrained during use (e.g., gaskets, seals, etc.). Since most chemical testing is performed on unstressed, free-form specimens of materials, test results are likely conservative as applied to constrained materials such as the gasket.

The limitations of applying laboratory test data, as described above, to predict actual operating behavior must be considered in the material analysis for the Basin 41 materials. The prediction of material behavior as presented herein can only be considered a rough estimate of expected field performance.

This evaluation may not account for all possible chemical interactions, synergistic effects (with radiation), or errors associated with applying short-term test data to long-term applications.

4.0 EVALUATION

4.1 RADIATION RESISTANCE

Radiation contribution to the degradation of Basin 41 materials is expected to be low in comparison to radiological thresholds used to evaluate materials. However, the overall impact of radiation on the integrity of the materials, including the synergistic effects of radiation with chemical attacks, cannot be ignored in this assessment. As previously stated, without test data that includes both radiation and chemical attack, the actual synergistic effects cannot be known; however, this assessment discusses the impact of both influences to help determine the expected impact on the materials.

Assuming continuous exposure to the LERF Basin wastewater bounding conditions, the maximum radiation doses over a 30 year life (Design Input 1), 7,457 rad, 2,254 rad, and 9,016 rad (0.007 Mrad, 0.002 Mrad, and 0.009 Mrad) for the basin cover and liner, transfer piping, and catch basin respectively (Design Input 3). The anticipated doses are well under the maximum material threshold values presented in Table 4-1.

Table 4-1 summarizes the results of the literature review on radiation resistance for the materials listed in Table 3-1. See below for a radiation resistance discussion of each material used in the basin.

Table 4-1. Radiation Resistance of LERF Basin Wastewater Components.

Material	Reference Name	Signs of Degradation at Radiation Exposure (Mrad) at 70°F		Notes
		Initial	Severe	
Polyester (FRP veil) [(1)]	**Polyester**	0.1	1.0	
Aromatic Amine Cured Bisphenol A Epoxy (FRP resin) [(1),(2)]	**Epoxy**	100	200	
Ethylene Propylene Diene Monomer Rubber [(1),(2)]	**EPDM**	40	200	Other sources cite initial degradation at 100 Mrad[4]
Siloxane[(3)]		0.5	N/A	Compression set highly sensitive, oxidation sensitive, peroxide cures leave residues that may oxidize radiation-cure better.
High Density Polyethlyene [(3)]	**HDPE**	0.38	10	Elongation increase at lowest reported threshold.
Chlorosulfonated Polyethelene [(1)]	**CSPE**	10	100	

(1) Wright 2006
(2) Clegg 1991
(3) Electric Power Research Institute (EPRI) NP-2129, *Radiation Effects on Organic Materials in Nuclear Plants*

<u>FRP (veil and resin)</u>

The direct buried pipes used to convey wastewater from outside of the LERF into the basins are composed of FRP. FRP is a composite material made from a polymer matrix (epoxy) reinforced with fibers (polyester veil and wound filaments). The wastewater is expected to only come into contact with and influence the inner liner. The inner liner is comprised of 60 mil composite corrosion barrier, comprised of Bisphenol A epoxy and a polyester veil. Though composite materials behave differently than their individual constituents, the resin in carbon filament epoxy composites has been shown to have the greatest effect on the outcome of mechanical properties following exposure to radiation (Clegg).

Detrimental effects posed to the polyester veil, which is more susceptible to failure, can influence the adhesion between the matrix and the fibers. However, the expected dose is low, and not expected to exceed the threshold of polyester fibers even without the barrier of an epoxy matrix.

FRP has been used to convey wastewater to the current basins since installation in the 1990s. There have been no reports of failures since installation. The ETF (including the LERF basins) was inspected in 2019 and an integrity assessment report was documented in RPP-IQRPE-50043, *FY19 Effluent Treatment Facility IQRPE Integrity Assessment*. The assessment concluded that the ETF tank system, including the FRP, is fit for use. In conjunction with the passed assessment, it was recommended that the facility and its equipment be reassessed within another ten years.

Radiation is not expected to have a great impact on the integrity of the FRP pipe used to convey wastewater to Basin 41 in a 30 year life, thus the FRP pipe is acceptable for continued use.

Ethylene Propylene Diene Monomer Rubber (EPDM)

EPDM is used as gasket material between the FRP pipe spools. EPDM is traditionally used as gasket material in other parts of Tank Farms due to its exceptional mechanical properties and radiation resistance.

Due to the high thresholds, and low expected dose, radiation is not expected to have a great impact on the integrity of the EPDM gaskets in the Basin 41 wastewater system in a 30 year life, thus the EPDM gaskets are acceptable for use.

Siloxane

Siloxane is a high performance engineered silicone-epoxy coating system intended for use as the top coat in the catch basin. The top coat is the material expected to provide secondary containment for piping in the catch basin. Additional coating details are located in RPP-SPEC-63632. The coating is expected to receive dose from wastewater in the transfer piping, and should not see any wastewater on the coating unless the piping has leaked during an upset condition. Siloxane coating systems are typically used for their broad chemical resistance, ultra-violet light resistance, flexibility, and hydrophobic nature. Traditional Siloxane resistance to ionizing radiation is not great due to crosslinking, particularly at elevated temperatures (EPRI). Little literature information could be gathered for the hybrid coating system recommended in the construction specification, so conservatively, the lower threshold will be assumed.

Due to the low expected dose, radiation is not expected to have a great impact on the integrity of the Siloxane coating on the catch basin in the Basin 41 wastewater system in a 30 year life, thus the Siloxane coating is acceptable for use.

HDPE

HDPE is used as the basin primary liner geomembrane. This material has an ionizing radiation threshold value much higher than the expected total dose for 30 years. Additionally, HDPE is used in the construction of the current basins, and has not had any reported integrity issues. As with the FRP, RPP-IQRPE-50043 concluded that the HDPE liner is fit for continued use.

Radiation is not expected to have a great impact on the integrity of the HDPE liner in the Basin 41 wastewater system in a 30 year life, thus the HDPE liner is acceptable for use.

Chlorosulfonated Polyethylene (CSPE)

A form of CSPE, Hypalon, was used in the original basin construction as the floating cover liner. Failure of a basin floating cover has been reported; however, the puncturing of the cover has been primarily attributed to mechanical means.

With respect to the radiation resistance reported for CSPE, radiation is not expected to have a great impact on the integrity of the CPSE floating cover in the Basin 41 wastewater system in a 30 year life, thus the CSPE floating cover is acceptable for use.

4.2 CHEMICAL RESISTANCE

The chemical resistance of the HDPE liner and FRP transfer piping with LERF wastewater is currently assessed using the process described in HNF-3172. Three additional materials, EPDM, CSPE, and Siloxane, require assessment per WAC regulations to ensure compatibility. These materials are compared to the chemical families listed in Table 3-3 in Table 4-2 to determine compatibility. See the evaluations for each material below.

HDPE and FRP

As previously discussed, two of the materials used in the current basin design, HDPE and FRP, were successfully tested using wastewater simulant in 1991. Both of these materials were used in the construction of the original three basins. Testing concluded that the materials did not suffer appreciable damage during waste exposure, and were fit for use. Subsequent evaluations following decades of operation have concluded the same. To ensure compliance with Resource Conservation and Recovery Act (RCRA) requirements, all wastewater streams are evaluated using the New Waste Stream Acceptance Checklist. This ensures that the components of the wastewater streams do not exceed the liner compatibility limits established to maintain integrity. As a result, these two materials are acceptable for use in the Basin 41 wastewater system for a 30 year life.

Table 4-2. EPDM, CSPE, and Siloxane Compatibility with Liner Chemical Families.

Chemical Family	Limit (mg/L)	Compatible		
		EPDM[1]	CSPE[1]	Siloxane[4,5,6]
Alcohol/glycol	500,000	Yes	Yes	Yes
Alkanone	200,000	Yes	Yes	Yes
Aromatic/cyclic hydrocarbon	2,000	No	No[2]	No
Halogenated hydrocarbon	2,000	No	No[2,3]	No
Ether	2,000	No	Yes	No
Other hydrocarbons	2,000	No	Yes	No
Acids, bases, salts	100,000	Yes	Yes	Yes
pH	$0.5 < pH < 13.0$	Yes	Yes	Yes

Note: See Table 3-3 for constituents.
Reference:
[1] Pruett, 2005
[2] Kelco
[3] Graco
[4] Ameron
[5] Warco Biltrite
[6] PPG

EPDM

EPDM is used for FRP piping gaskets. EPDM was compared to the listed chemical family and listed constituents (as available in literature) to determine if the material is acceptable for use (Table 4-2).

EPDM is considered broadly resistant to most acids at the expected ambient temperatures. EPDM is used in gaskets, seats, seals, and hoses in tank farm applications, and has excellent performance history when exposed to a broad range of chemicals in various wastes. EPDM is not considered resistant to hydrocarbons and ether. However, EPDM gaskets are currently installed between the FRP spools in existing basin infrastructure. Gasket leaking or other integrity issues have not been reported during regular inspections. As such, EPDM is acceptable for use in the Basin 41 system.

CSPE

CSPE is used for the Basin 41 floating cover. CSPE was compared to the listed chemical family and listed constituents (as available in literature) to determine if the material is acceptable for use (Table 4-2). An evaluation of the CSPE cover is not explicitly required to meet WAC 173-303-650; however, it has been included due to LERF history of cover failures, and in support of the maintenance and inspection requirements listed in the WAC.

CSPE is resistant to ultra-violet light and many chemicals, including acids and bases. CSPE is commonly used as geomembrane covers in potable water storage facilities. According to several manufacturers, CSPE is not generally considered compatible with aromatic or halogenated hydrocarbons; however, limited data could be compiled for compatibility with these chemicals. An instance of cover failure has been noted for Basin 42, however interviews with ETF personnel indicate that failure was likely due to excessive mechanical force on the liner during regular maintenance on the liner nearing the end of its design life. CSPE geomembrane manufacturer literature indicates an expected design life of 20-30 years for the cover materials (Raven). Embrittlement due to chemical exposure and long-term ultra-violet light exposure is not uncommon for polymers.

Due to regular cover inspection, wastewater stream review, limited mechanical interaction, and relatively low wastewater limits for aromatic and halogenated hydrocarbons, CSPE is acceptable for use in the Basin 41 system for a 30 year design life.

Siloxane

The selected Siloxane system is a silicone-epoxy hybrid coating system. According to the manufacturer, this system is generally considered for splash and spill resistance, and is broadly resistant to dilute and concentrated organic and inorganic acids, alkali, solvents and oxidizing chemicals (PPG). Its primary use is secondary containment applications in chemical process industries. The coating system is generally recognized to not be resistant to hydrocarbons. It is not expected to come into contact with the wastewater unless there is a leak in the FRP, limiting direct exposure. .

Based on limited exposure to the wastewater constituents, Siloxane is considered appropriate as a secondary containment coating for use for the life of the Basin 41 wastewater system.

5.0 RECOMMENDATIONS

Not all materials used to construct Basin 41 were evaluated in this report due to WAC regulations. Evaluation of radiation shows that bounding total doses are a factor of 50 to ~10^5 less than the dose at which respective materials experience initial degradation. However, a general recommendation for all non-metallic materials exposed to even low doses of radiation is to drain and flush (if possible) to reduce unnecessary exposure.

6.0 SUMMARY AND CONCLUSIONS

An assessment of the materials intended to complete the construction of Basin 41 was required to demonstrate that the basin would be able to perform its function of retaining the wastewater until further processing can be performed. The basin will need to be compatible with all sources of wastewater: 242-A Evaporator condensate, dilute waste streams, groundwater, and EMF wastewater. Prior to acceptance of each wastewater, the New Waste Stream Acceptance Checklist (HNF-3172) must be completed and approved. Among other items, the checklist ensures that the constituents of the wastewater stream do not exceed the constituents listed in the liner compatibility limits. The limits established for the liner were applied to this evaluation to determine the acceptability of materials for the new basin.

Based on the evaluation performed for each material in each environment in Section 4.0, including the assessment of historical use, all materials are fit for use for the Basin 41 wastewater system for the estimated 30 year design life assumed in this report.

The WAC requires that the liner not suffer damage a result of chemical incompatibility. The permit that the facility currently operates under accepts the initial testing and expansion of the chemical compatibility information. This assessment meets the material compatibility evaluation requirements established in WAC 173-303-640 and WAC 173-303-650.

Though the basin cover is not explicitly called out for a material evaluation prior to its use, the CSPE cover has been evaluated to support maintenance and inspection requirements listed in WAC 173-303-650. CSPE is not generally recommended for use with hydrocarbons, however, the relatively low hydrocarbon exposure and regular inspection and maintenance should ensure the life integrity of the material for 30 years.

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[3] *PSX* is registered trademark of PPG Industries Ohio, Inc., Pittsburgh, PA

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APPENDIX A

S&L CALCULATION S54413.024-P-001, *LERF BASIN 41 RADIOLOGICAL DOSE RATE AND EXPOSURE*

Sargent & Lundy Engineering Services, Inc.	CALCULATION COVER SHEET	Page No. 1 of 34	
		Date 5/12/2020	Rev. No. 0
		Calculation No: S54413.024-P-001	

Project No.	Project Title:	Client:
S551413.024	LERF Basin 41 Design	Washington River Protection Services, LLC

Title:
LERF Basin 41 Radiological Dose Rate and Exposure

Purpose and Objective:

The purpose of this calculation is to determine a conservative total radiological dose and expected total dose exposure at 30 years for LERF Basin 41. The results of this calculation will be used in the material compatibility evaluation, RPP-RPT-62215, *LERF Basin 41 Material Compatibility with Liquid Effluent*.

Rev. No.	Total Pages		Prepared By	Checked By	PM/TL
0	34	Print Name/ Sign:	MJ Feldmann Monika Feldmann	BD Groth Bruce D. Groth	BD Groth Bruce D. Groth
		Date:	5/12/2020	5/12/2020	5/12/2020

Revision Description (Revision Description/Affected Pages):
Initial Issue.

		Print Name/ Sign:			
		Date:			

Revision Description (Revision Description/Affected Pages):

RPP-RPT-62215, Rev. 0
Appendix A – S&L Calculation S54413.024-P-001, *LERF Basin 41 Radiological Dose Rate and Exposure* (cont.)

CALCULATION REVIEW CHECKLIST

Project No.	Calculation No.	Rev.	Page No.
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Items Checked	Accept Y	Accept N	Accept N/A	Description of Resolution for Unacceptable Items
1. Cover sheets properly completed.	√			
2. Calculation sheet headers complete with calculation number, revision number, etc.	√			
3. Calculation sheet contents are legible, accurate, and complete per format.	√			
4. Listed attachments included.	√			
5. Calculation objective clearly described.	√			
6. Criteria are suitable and properly referenced to task specific documents.	√			
7. Assumptions and input data selected, described, reasonable, and attached or referenced to task documents.	√			
8. Calculation method identified and appropriate for the design activity.	√			
9. Calculation results reasonable and correctly described in results and conclusions.	√			
10. Physical property calculations generated by CAD software verified via hand calculations.			√	
11. Computer program identified with version and revision.	√			
12. Computer input/output provided or referenced and reasonable.	√			
13. Computer run traceable to calculation (file #, etc.).	√			
14. Computer input/output data and problem type within validation/verification range of use.	√			
15. Computer program validation/verification addressed.	√			
16. Computer operating system in use for calculation preparation is the same as when the software was verified on machine.	√			

Calculation Checking Method	√	Applicable Pages
1. Direct Step-by-Step Check	√	
2. Reference Chart(s) or Book(s) Comparison (Append Documentation)		
3. Alternate Calculation (Append Documentation)		

Comments:

Preparer (Print Name and Sign): MJ Feldmann *Monika Feldmann*	**Date:** 5/12/2020
Checker (Print Name and Sign): BD Groth *Bruce D. Groth*	**Date:** 5/12/2020

Signatures obtained only after discrepancies are corrected and comments are resolved.

Quality Assurance Procedure 3.1 Calculation Review Checklist (01-19)

Sargent & Lundy

CALCULATION SHEET

Project No. S551413.024	**Calculation No.** S54413.024-P-001	**Rev.** 0	**Page No.** 3 of 34
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Prepared By: MJ Feldmann **Date:** 5/12/2020	**Checked By:** BD Groth	**Date:** 5/12/2020	

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Prepared By: MJ Feldmann	**Date:** 5/12/2020	**Checked By:** BD Groth	**Date:** 5/12/2020

Tables

Acronyms

LERF	Liquid Effluent Retention Facility
ETF	Effluent Treatment Facilty
FRP	Fiberglass reinforced pip

Sargent & Lundy Engineering Services, Inc.

CALCULATION SHEET

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Prepared By: MJ Feldmann	**Date:** 5/12/2020	**Checked By:** BD Groth	**Date:** 5/12/2020

1.0 PURPOSE

The purpose of this calculation is to determine a conservative total radiological dose and expected total dose exposure at 30 years for LERF Basin 41. The results of this calculation will be used in the material compatibility evaluation, RPP-RPT-62215, *LERF Basin 41 Material Compatibility with Liquid Effluent*.

2.0 METHODOLOGY

This analysis uses MicroShield and hand calculations to determine:

1. The dose rate for the wastewater using the LERF Safety Basis Limits, and
2. The expected radiological exposure at 30 years using the calculated dose rates.

3.0 DESIGN INPUTS

1. The LERF Safety Basis Limits from HNF-3172, *Liquid Waste Processing Facilities Waste Acceptance Criteria*, are presented in Appendix A. The LERF Safety Basis Limits were utilized in the MicroShield computer code (see Section 5.0) to determine the dose rate for the wastewater stored in LERF Basin 41 and in associated fiberglass reinforced piping (FRP).
2. LERF Basin 41 Dimensions are provided in Appendix C and are used to determine the dimensions of a representative rectangular volume for input into the MicroShield model. MicroShield uses simple geometric volumes in its analysis.
3. LERF Basin 41 is designed to be the same as the other three LERF basins and has a nominal capacity of approximately 7.8Mgal, Modification Traveler MT-50497, *Liquid Effluent Retention Facility (LERF) Basin 41* and HNF-3172, *Liquid Waste Processing Facilities Waste Acceptance Criteria*.
4. The waste specific gravity is 1.0. From a shielding perspective, the lower density is the conservative case, 67246-024-RFI-002, *Basin 41 Pump Design Criteria.*
5. FPR pipe used in the Basin 41 design is comprised of 3"/6" pipe-in-pipe and 4"/8" pipe-in-pipe (H-2-838765, *LERF Basin 41 Mechanical General Arrangement*). The 4"/8" pipe is used in this evaluation and will provide a more conservative dose rate. The nominal inside diameter of the inner 4"/8" pipe is 4". The FPR data sheet is provided in Appendix D.
6. The standard MicroShield densities were used for air and water were used.
7. The specific gravity of the FRP 1.85, Appendix D.
8. A 30ft section of FRP is evaluated.

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4.0 ASSUMPTIONS

No unverified assumptions are used in this calculation.

5.0 COMPUTER SOFTWARE

MicroShield Version 12.03 was used to model simple geometries and determine dose rate at a distance of interest. MicroShield utilizes a point kernel (discrete ordinate) algorithm, and contains built-in libraries of radionuclide decay constants, photon energies, and element- and energy-specific attenuation and build-up factors. The installation of MicroShield, Version 12.03, was verified and validated as documented in VV-19-06-006, *MicroShield Software Validation and Verification Report*. This software is installed on Sargent & Lundy Engineering Services, Inc., Computer No. RL_C0341, running on Windows 7 Version 6.1 (Build 7601: Service Pack 1).

6.0 CALCULATION

6.1 Dose Evaluation for Basin Liner and Cover

6.1.1 Average LERF Basin 41 Dimensions

At an elevation of 603.50 feet, the length of Basin 41 inside the anchor wall is 337.53 feet, the width of the basin inside the anchor wall is 277.53 feet. At an elevation of 579 feet, the length of the basin floor on the East side is 184.19 feet (34.4 feet +115.36 feet + 34.4 feet). The length of the basin floor on the south side is 124.69 feet (34.4 feet + 55.89 feet + 34.4 feet).

The average length of the basin of the basin is determined to be 260.86 feet. The average width of the basin is determined to be 201.11 feet. These dimensions are used to determine the height of the rectangle that represents the basin using a volume of 7.8Mgal. The corresponding height of the waste is determined as follows:

$$Depth = \frac{7{,}800{,}000 gal \left(\frac{1 ft^3}{7.481\ gal}\right)}{260.86\ ft\ x\ 201.11\ ft} = 19.87\ ft$$

The dimensions for the rectangular volume used in the MicroShield model used are 260.86 feet x 201.11 feet x 19.87 feet, corresponding to a basin volume of 7.8 Mgal.

6.1.2 Dose Rate for LERF Basin Liner and Cover

The dose rate for the wastewater contained in Basin 41 is determined using the LERF Safety Basis Limits. The LERF and ETF are classified as below hazard Category 3 facilities. Wastewater accepted at the LERF will be controlled so that the wastewater dose consequence does not exceed that of the maximum bounding radiological source term evaluated in the 242A Liquid Effluent Retention Facility Auditable Safety Analysis (HNF-SD-LEF-ASA-002). This maximum bounding radiological source term is provided in Appendix A. The 200 Area Effluent Treatment Facility Auditable Safety Analysis Report (HNF-SD-ETF-ASA-001) requires that the ETF radiological inventory never exceed the Hazard Category 3 sum-of-fractions threshold of 1.0 (DOE-STD-1027-

92). Thus, the LERF Safety Basis Limits in Appendix A are used in the MicroShield model using the dimensions for a rectangular volume determined Section 6.1.1. The MicroShield output files are included in appendix B.

The dose rates are evaluated at 1 cm, 30 cm and 100 cm from the side of the basin and from the center of the largest face of the rectangular volume, for evaluating the cover. The dose rate estimated in MicroShield for the Basin Cover and Liner Floor model provide the most conservative dose rate at 30-cm. The dose rate in mR/hr is converted to Rad/hr by the following equation and the results are shown in Table 6-1:

$$1\,Rad \times \frac{100\ ergs/g}{Rad} \times \frac{1\ R}{86.9\,ergs/g} = 1.15\ R$$

Table 6-1. Dose Rates Determined in MicroShield for Basin Liner.

Location	Distance from Location	Dose Rate [mR/hr]	Dose Rate [Rad/hr]
Basin Side Wall	At 1 cm from side	1.598e+00	1.39E-03
	At 30 cm from side	1.824e+00	1.59E-03
	At 100 cm from side	1.639e+00	1.43E-03
Basin Cover and Liner Floor	At 1 cm from cover	8.27E+00	7.19E-03
	At 30 cm from cover	3.26E+01	2.84E-02
	At 100 cm from cover	2.98E+01	2.59E-02

6.1.3 Estimated Exposure for LERF Basin Liner and Cover

The expected total radiological exposure for the basin liner and cover are calculated using the dose rates determined in Section 6.1.2. The total radiological exposures for 30 year period are presented in Table 6-2. The total exposure estimated for the Basin Cover and Liner Floor at 30-com provide the most conservative estimate of exposure to the liner.

For the Basin Side Wall:

$$Total\ Dose\ Exposure = 1.39E-03\frac{Rad}{hr}\ x\ 24\frac{hr}{day}\ x\ 365\frac{days}{year}\ x\ 30\,years = 365\ Rad$$

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CALCULATION SHEET

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Table 6-2. Total Dose Exposure for Basin Liner.

Location	Distance from Location	Dose Rate [Rad/hr]	Total Exposure at 30 Years [Rad]
Basin Side Wall	At 1 cm from side	1.39E-03	365
	At 30 cm from side	1.59E-03	417
	At 100 cm from side	1.43E-03	375
Basin Cover and Liner Floor	At 1 cm from cover	7.19E-03	1,889
	At 30 cm from cover	2.84E-02	**7,457**
	At 100 cm from cover	2.59E-02	6,819

6.2 Dose Evaluation for FRP Pipe

6.2.1 FRP Pipe Dimensions

The dimensions for the FRP evaluated use a nominal 4-in inner diameter, a wall thickness of 0.48-in, and a length of 30 feet. Experience with analyzing line sources shows that dose rates go up very little for line lengths longer than 10 feet, using a 30 feet length of pipe is bounding.

6.2.2 Dose Rate for FRP

The dose rate for the wastewater contained in the FRP is determined using the LERF Safety Basis Limits in Appendix A. The 200 Area Effluent Treatment Facility Auditable Safety Analysis Report (HNF-SD-ETF-ASA-001) requires that the ETF radiological inventory never exceed the Hazard Category 3 sum-of-fractions threshold of 1.0 (DOE-STD-1027-92). Thus, the LERF Safety Basis Limits in Appendix A are used in the MicroShield model using the dimensions for a rectangular volume determined Section 6.1. The MicroShield output files are included in appendix B.

The dose rate was evaluated in MicroShield at 1 cm, 30 cm and 100 cm. The results are shown in Table 6-3. The dose rate is presented in mR/hr and Rad/hr.

Table 6-3. Dose Rates Determined in MicroShield for FRP.

Location	Dose Rate [mR/hr]	Dose Rate [Rad/hr]
At 1 cm	9.86E+00	8.58E-03
At 30 cm	1.32E+00	1.14E-03
At 100 cm	4.82E-01	4.19E-04

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6.2.3 Estimated Exposure for FRP

The expected total radiological exposure is calculated using the dose rate determined in Section 6.2.2. The total radiological exposure for a 30 year period is presented in Table 6-4.

$$Total\ Dose\ Exposure = 8.58E-03\frac{Rad}{hr}\ x\ 24\frac{hr}{day}\ x\ 365\frac{days}{year}\ x\ 30\ years = 2{,}254\ Rad$$

Table 6-4. Total Dose Exposure for FRP.

Location	Dose Rate [Rad/hr]	Total Exposure at 30 Years [Rad]
At 1 cm	8.58E-03	**2,254**
At 30 cm	1.14E-03	301
At 100 cm	4.19E-04	110

6.2.4 Estimated Exposure for FRP in Catch Basin

The expected total radiological exposure for the catch basin is calculated using the dose rate and total dose determined in Section 6.2.3. There are four pipes in the catch basin. The total dose is conservatively multiplied by four to estimate the total exposure to the catch basin. The total radiological exposure for a 30 year period is presented in Table 6-5.

Table 6-5. Total Dose Exposure for Catch Basin.

Location	Dose Rate [Rad/hr]	Total Exposure at 30 Years [Rad]
At 1 cm	3.43-02	**9,016**
At 30 cm	4.56E-03	1,204
At 100 cm	1.68E-03	440

7.0 RESULTS AND CONCLUSIONS

Radiation resistance is evaluated at various exposure thresholds for the LERF within the operational environment. Radiological thresholds evaluated for non-metallic components typically include 5 Mrad, 10 Mrad, 40 Mrad, and 100 Mrad. The total expected dose determined for 30 years for LERF Basin 41 liner, cover and associated FRP are all less than 10,000 Rad (0.01 Mrad).

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Prepared By: MJ Feldmann **Date:** 5/12/2020	**Checked By:** BD Groth		**Date:** 5/12/2020

8.0 REFERENCES

67246-024-RFI-002, *Request for Information: Basin 41 Pump Design Criteria, U.S.* Rev. 0, Department of Energy, Richland, Washington

DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23*, Nuclear Safety Analysis Reports, U.S. Department of Energy, Washington, D.C.

H-2-838749 SH 1, *LERF Basin 41 Civil Bottom Liner,* U.S. Department of Energy, Richland, Washington.

H-2-838765, SH 1-11, *LERF Basin 41 Mechanical General Arrangement*, U.S. Department of Energy, Richland, Washington.

HNF-3172, *Liquid Waste Processing Facilities Waste Acceptance Criteria*, Rev. 9, Washington River Protection Solutions, LLC, Richland, Washington.

HNF-SD-ETF-ASA-001, 200 Area Effluent Treatment Facility Auditable Safety Analysis Report, Fluor Hanford Inc., Richland, Washington.

HNF-SD-LEF-ASA-002, 242AL Liquid Effluent Retention Facility Auditable Safety Analysis, Fluor Hanford Inc., Richland, Washington

MT-50497, *2019, Liquid Effluent Retention Facility (LERF) Basin 41 Modification Traveler*, Rev. 0,

RPP-RPT-62215, LERF Basin 41 Material Compatibility with Liquid Effluent.

VV-19-06-006, MicroShield Software Validation and Verification Report, Sargent & Lundy, Richland, Washington.

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APPENDIX A

LERF SAFETY BASIS LIMITS

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CALCULATION SHEET

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Table A-1. LERF Safety Basis Limits from HNF-3172, *Table D-1. Target Para LERF Maximum Bounding Radiological Source Term,*

Table D-1. Target Para LERF Maximum Bounding Radiological Source Term.

Radionuclide	Maximum Bounding Concentration (Ci/L)[1,2]
Tritium	2.4 E-04
Carbon-14	1.6 E-06
Cobalt-60	2.4 E-06
Selenium-79	1.5 E-07
Strontium-90	4.2 E-05
Niobium-94	2.6 E-07
Technetium-99	1.8 E-05
Ruthenium-106	6.5 E-07
Iodine-129	1.8 E-06
Cesium-134	4.1 E-07
Cesium-137	1.0E-05
Cerium-144	2.0E-05
Europium-154	9.8 E-06
Europium-155	6.3 E-05
Radium-226	6.4 E-08
Uranium (gross)[3]	2.1 E-10
Neptunium-237	2.1 E-09
Plutonium-238	2.8 E-09
Plutonium-239/240	1.8E-08
Plutonium-241	2.6 E-08
Americium-241	1.4 E-09
Curium-244	2.5 E-08

[1] HNF SD WM-SAD-040, *Liquid Effluent Retention Facility Final Hazard Category Determination*, Fluor Hanford Inc., Richland, Washington.

[2] Individual radionuclide concentrations in the incoming wastewater may exceed the defined maximum bounding concentration provided the dose consequence associated with the wastewater is less than or equal to the dose consequence limits defined by the LERF Hazard Category Determination.

[3] As Uranium-234

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CALCULATION SHEET

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Table A-2. LERF Liner Compatibility Limits from HNF-3172, *Table E-1. Liquid Waste Processing Facility Waste Acceptance Criteria*

Chemical family	Constituent(s) or parameter(s)	Limit[1] (mg/L)
Alcohol/glycol	1-butanol	500,000
Alkanone[2]	acetone	200,000
Alkenone[3]	none targeted	NA
Aromatic/cyclic hydrocarbon	acetophenone, benzene, carbozole, chrysene, cresol, di-n-octyl phthalate, diphenylamine, isophorone, pyridine, tetrahydrofuran	2,000
Halogenated hydrocarbon	Aroclors, carbon tetrachloride, chloroform, hexachlorobenzene, lindane (gamma-BHC), hexachlorocyclopentadiene, methylene chloride, p-chloroaniline, tetrachloroethylene, 2,4,6-trichlorophenol	2,000
Aliphatic hydrocarbon	none targeted	NA
Ether	dichloroisopropyl ether	2,000
Other hydrocarbons	acetontrile, carbon disulfide, n-nitrosodimethylamine, tributyl phosphate	2,000
Oxidizers	none targeted	NA
Acids, bases, salts	ammonia, cyanide, anions, cations	100,000
pH	PH	$0.5 < pH < 13.0$

[1] Analytical data for a chemical family (as indicated) are summed using the following sum-of-fractions technique. The individual constituent concentrations, sum concentrations (for families), and pH values for a wastewater are then evaluated against the compatibility limit.

$$\sum_{n=1}^{i}\left(\frac{conc_n}{Limit_n}\right) \le 1$$

where 'i' is the number of constituents in the chemical family that were detected.

[2] Ketone containing saturated alkyl group(s).

[3] Ketone containing unsaturated alkyl group(s).

mg/L = milligrams per liter
NA = not applicable

Quality Assurance Procedure 3.1 Calculation Sheet (01-19)

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APPENDIX B

MICROSHIELD OUTPUT FILES

Quality Assurance Procedure 3.1 Calculation Sheet (01-19)

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B1.0 LERF Basin Liner

Case Summary of LERF Basin 41 Page 1 of 4

MicroShield 12.03
Sargent & Lundy

Date	Preparer	Reviewer

File Name	Run Date	Run Time	Duration
C:\Users\mfeldmann\Desktop\LERF Dose\lerf basin.msd	May 4, 2020	6:36:15 AM	00:00:04

Project Info

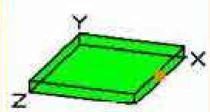
Case Title	LERF Basin 41
Description	Basin, 1 cm, 30 cm and 100 cm
Geometry	13 - Rectangular Volume

Source Dimensions

Length	6.130e+03 cm (201 ft 1.320 in)
Width	7.951e+03 cm (260 ft 10.320 in)
Height	605.638 cm (19 ft 10.440 in)

Dose Points

No.	X	Y	Z
#1	6.131e+03 cm (201 ft 1.780 in)	304.608 cm (9 ft 11.924 in)	3.976e+03 cm (130 ft 5.160 in)
#2	6.161e+03 cm (202 ft 1.591 in)	304.6 cm (9 ft 11.921 in)	3.976e+03 cm (130 ft 5.354 in)
#3	6.231e+03 cm (204 ft 5.150 in)	304.6 cm (9 ft 11.921 in)	3.976e+03 cm (130 ft 5.354 in)



Shields

Shield N	Dimension	Material	Density (g/cm^3)
Source	1.04e+06 ft^3	Water	1
Air Gap		Air	0.00122

Source Input: Grouping Method - Standard Indices
Number of Groups: 25
Lower Energy Cutoff: 0.015
Photons < 0.015: Included
Library: Grove

Nuclide	Ci	Bq	µCi/cm^3	Bq/cm^3
Am-241	4.1325e-002	1.5290e+009	1.4000e-006	5.1800e-002
Ba-137m	2.7924e+002	1.0332e+013	9.4600e-003	3.5002e+002
C-14	4.7228e+001	1.7475e+012	1.6000e-003	5.9200e+001
Ce-144	5.9036e+002	2.1843e+013	2.0000e-002	7.4000e+002
Cm-244	7.3794e-001	2.7304e+010	2.5000e-005	9.2500e-001
Co-60	7.0843e+001	2.6212e+012	2.4000e-003	8.8800e+001

file:///C:/Users/mfeldmann/Grove%20Engineering/MicroShield%2012/html/lerf%20basin-5_4_2020-6_36_19%20AM.html 5/4/2020

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Appendix A – S&L Calculation S54413.024-P-001, *LERF Basin 41 Radiological Dose Rate and Exposure* (cont.)

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Cs-134	1.2102e+001	4.4778e+011	4.1000e-004	1.5170e+001
Cs-137	2.9518e+002	1.0922e+013	1.0000e-002	3.7000e+002
Eu-154	2.8927e+002	1.0703e+013	9.8000e-003	3.6260e+002
Eu-155	1.8596e+003	6.8806e+013	6.3000e-002	2.3310e+003
H-3	7.0843e+003	2.6212e+014	2.4000e-001	8.8800e+003
I-129	5.3132e+001	1.9659e+012	1.8000e-003	6.6600e+001
Nb-94	7.6746e+000	2.8396e+011	2.6000e-004	9.6200e+000
Np-237	6.1987e-002	2.2935e+009	2.1000e-006	7.7700e-002
Pr-144	5.8191e+002	2.1531e+013	1.9714e-002	7.2942e+002
Pu-238	8.2650e-002	3.0580e+009	2.8000e-006	1.0360e-001
Pu-239	5.3132e-001	1.9659e+010	1.8000e-005	6.6600e-001
Pu-241	7.6746e-001	2.8396e+010	2.6000e-005	9.6200e-001
Ra-226	1.8891e+000	6.9898e+010	6.4000e-005	2.3680e+000
Rh-106	1.9187e+001	7.0990e+011	6.5000e-004	2.4050e+001
Ru-106	1.9187e+001	7.0990e+011	6.5000e-004	2.4050e+001
Se-79	4.4277e+000	1.6382e+011	1.5000e-004	5.5500e+000
Sr-90	1.2397e+003	4.5871e+013	4.2000e-002	1.5540e+003
Tc-99	5.3132e+002	1.9659e+013	1.8000e-002	6.6600e+002
U-234	6.1987e-003	2.2935e+008	2.1000e-007	7.7700e-003
Y-90	1.2397e+003	4.5871e+013	4.2000e-002	1.5540e+003

Buildup

Buildup: The material reference is Source.

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results With Buildup: Dose Point No. 1 - (X = 2.01e+02, Y = 9.9937, Z = 130.43) ft

Energy (MeV)	Activity (Photons/sec)	Energy Flux (MeV/cm²/sec)	Photon Flux (Photons/cm²/sec)	Exposure Rate (mR/hr)	Absorbed Dose Rate (mrad/hr)	Absorbed Dose Rate (mGy/hr)
1.500e-02	6.949e+12	3.447e-23	2.298e-21	2.956e-24	2.581e-24	2.581e-26
2.000e-02	5.651e+07	8.491e-28	4.245e-26	2.941e-29	2.568e-29	2.568e-31
3.000e-02	2.271e+12	7.371e-12	2.457e-10	7.305e-14	6.377e-14	6.377e-16
4.000e-02	1.690e+13	2.931e-06	7.327e-05	1.296e-08	1.132e-08	1.132e-10
5.000e-02	4.610e+12	9.196e-05	1.839e-03	2.450e-07	2.139e-07	2.139e-09

RPP-RPT-62215, Rev. 0
Appendix A – S&L Calculation S54413.024-P-001, *LERF Basin 41 Radiological Dose Rate and Exposure* (cont.)

CALCULATION SHEET

Project No. S551413.024	Calculation No. S54413.024-P-001	Rev. 0	Page No. 17 of 34
Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann	Date: 5/12/2020	Checked By: BD Groth	Date: 5/12/2020

6.000e-02	9.219e+11	2.363e-04	3.939e-03	4.694e-07	4.098e-07	4.098e-09
8.000e-02	2.172e+13	7.648e-02	9.561e-01	1.210e-04	1.057e-04	1.057e-06
1.000e-01	1.855e+13	2.583e-01	2.583e+00	3.952e-04	3.450e-04	3.450e-06
1.500e-01	2.359e+12	1.926e-01	1.284e+00	3.171e-04	2.769e-04	2.769e-06
2.000e-01	7.332e+11	1.614e-01	8.070e-01	2.849e-04	2.487e-04	2.487e-06
3.000e-01	1.632e+08	1.272e-04	4.239e-04	2.412e-07	2.106e-07	2.106e-09
4.000e-01	7.636e+10	1.411e-01	3.527e-01	2.749e-04	2.400e-04	2.400e-06
5.000e-01	1.760e+11	6.315e-01	1.263e+00	1.240e-03	1.082e-03	1.082e-05
6.000e-01	1.110e+13	6.811e+01	1.135e+02	1.329e-01	1.161e-01	1.161e-03
8.000e-01	5.166e+12	7.348e+01	9.186e+01	1.398e-01	1.220e-01	1.220e-03
1.000e+00	5.946e+12	1.608e+02	1.608e+02	2.963e-01	2.587e-01	2.587e-03
1.500e+00	6.881e+12	5.817e+02	3.878e+02	9.788e-01	8.545e-01	8.545e-03
2.000e+00	1.667e+11	3.053e+01	1.526e+01	4.720e-02	4.121e-02	4.121e-04
Total	**1.045e+14**	**9.161e+02**	**7.765e+02**	**1.598e+00**	**1.395e+00**	**1.395e-02**

Results With Buildup: Dose Point No. 2 - (X = 2.02e+02, Y = 9.99e+00, Z = 1.30e+02) ft

Energy (MeV)	Activity (Photons/sec)	Energy Flux (MeV/cm²/sec)	Photon Flux (Photons/cm²/sec)	Exposure Rate (mR/hr)	Absorbed Dose Rate (mrad/hr)	Absorbed Dose Rate (mGy/hr)
1.500e-02	6.949e+12	3.160e-23	2.106e-21	2.710e-24	2.366e-24	2.366e-26
2.000e-02	5.651e+07	7.784e-28	3.892e-26	2.696e-29	2.354e-29	2.354e-31
3.000e-02	2.271e+12	5.430e-11	1.810e-09	5.381e-13	4.698e-13	4.698e-15
4.000e-02	1.690e+13	1.123e-05	2.808e-04	4.968e-08	4.337e-08	4.337e-10
5.000e-02	4.610e+12	2.691e-04	5.382e-03	7.168e-07	6.258e-07	6.258e-09
6.000e-02	9.219e+11	6.006e-04	1.001e-02	1.193e-06	1.041e-06	1.041e-08
8.000e-02	2.172e+13	1.680e-01	2.100e+00	2.659e-04	2.321e-04	2.321e-06
1.000e-01	1.855e+13	5.211e-01	5.211e+00	7.972e-04	6.960e-04	6.960e-06
1.500e-01	2.359e+12	3.450e-01	2.300e+00	5.682e-04	4.960e-04	4.960e-06
2.000e-01	7.332e+11	2.685e-01	1.342e+00	4.738e-04	4.136e-04	4.136e-06
3.000e-01	1.632e+08	1.923e-04	6.411e-04	3.648e-07	3.185e-07	3.185e-09
4.000e-01	7.636e+10	2.002e-01	5.005e-01	3.901e-04	3.405e-04	3.405e-06
5.000e-01	1.760e+11	8.535e-01	1.707e+00	1.675e-03	1.463e-03	1.463e-05
6.000e-01	1.110e+13	8.867e+01	1.478e+02	1.731e-01	1.511e-01	1.511e-03
8.000e-01	5.166e+12	9.039e+01	1.130e+02	1.719e-01	1.501e-01	1.501e-03
1.000e+00	5.946e+12	1.893e+02	1.893e+02	3.490e-01	3.047e-01	3.047e-03
1.500e+00	6.881e+12	6.397e+02	4.265e+02	1.076e+00	9.396e-01	9.396e-03
2.000e+00	1.667e+11	3.218e+01	1.609e+01	4.976e-02	4.344e-02	4.344e-04
Total	**1.045e+14**	**1.043e+03**	**1.682e+03**	**1.824e+00**	**1.593e+00**	**1.593e-02**

RPP-RPT-62215, Rev. 0
Appendix A – S&L Calculation S54413.024-P-001, *LERF Basin 41 Radiological Dose Rate and Exposure* (cont.)

Sargent & Lundy Engineering Services, Inc.

CALCULATION SHEET

Project No. S551413.024	**Calculation No.** S54413.024-P-001	**Rev.** 0	**Page No.** 18 of 34
Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann	**Date:** 5/12/2020	**Checked By:** BD Groth	**Date:** 5/12/2020

Case Summary of LERF Basin 41 Page 4 of 4

Results With Buildup: Dose Point No. 3 - (X = 2.04e+02, Y = 9.99e+00, Z = 1.30e+02) ft

Energy (MeV)	Activity (Photons/sec)	Energy Flux ($MeV/cm^2/sec$)	Photon Flux ($Photons/cm^2/sec$)	Exposure Rate (mR/hr)	Absorbed Dose Rate (mrad/hr)	Absorbed Dose Rate (mGy/hr)
1.500e-02	6.949e+12	2.701e-23	1.801e-21	2.317e-24	2.023e-24	2.023e-26
2.000e-02	5.651e+07	6.655e-28	3.327e-26	2.305e-29	2.012e-29	2.012e-31
3.000e-02	2.271e+12	1.909e-10	6.364e-09	1.892e-12	1.652e-12	1.652e-14
4.000e-02	1.690e+13	2.408e-05	6.019e-04	1.065e-07	9.296e-08	9.296e-10
5.000e-02	4.610e+12	4.698e-04	9.396e-03	1.251e-06	1.093e-06	1.093e-08
6.000e-02	9.219e+11	9.428e-04	1.571e-02	1.873e-06	1.635e-06	1.635e-08
8.000e-02	2.172e+13	2.361e-01	2.951e+00	3.736e-04	3.262e-04	3.262e-06
1.000e-01	1.855e+13	6.867e-01	6.867e+00	1.051e-03	9.171e-04	9.171e-06
1.500e-01	2.359e+12	4.157e-01	2.771e+00	6.846e-04	5.976e-04	5.976e-06
2.000e-01	7.332e+11	3.061e-01	1.531e+00	5.403e-04	4.717e-04	4.717e-06
3.000e-01	1.632e+08	2.046e-04	6.821e-04	3.882e-07	3.389e-07	3.389e-09
4.000e-01	7.636e+10	2.037e-01	5.093e-01	3.969e-04	3.465e-04	3.465e-06
5.000e-01	1.760e+11	8.402e-01	1.680e+00	1.649e-03	1.440e-03	1.440e-05
6.000e-01	1.110e+13	8.510e+01	1.418e+02	1.661e-01	1.450e-01	1.450e-03
8.000e-01	5.166e+12	8.389e+01	1.049e+02	1.596e-01	1.393e-01	1.393e-03
1.000e+00	5.946e+12	1.716e+02	1.716e+02	3.164e-01	2.762e-01	2.762e-03
1.500e+00	6.881e+12	5.642e+02	3.761e+02	9.493e-01	8.287e-01	8.287e-03
2.000e+00	1.667e+11	2.812e+01	1.406e+01	4.348e-02	3.796e-02	3.796e-04
Total	**1.045e+14**	**9.356e+02**	**2.507e+03**	**1.639e+00**	**1.431e+00**	**1.431e-02**

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Sargent & Lundy Engineering Services, Inc.

CALCULATION SHEET

Project No. S551413.024	**Calculation No.** S54413.024-P-001	**Rev.** 0	**Page No.** 19 of 34
Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann	**Date:** 5/12/2020	**Checked By:** BD Groth	**Date:** 5/12/2020

B2.0 LERF Basin Cover

Case Summary of LERF Basin 41 — Page 1 of 4

MicroShield 12.03
Sargent & Lundy

Date	Preparer	Reviewer

File Name	Run Date	Run Time	Duration
C:\Users\mfeldmann\Desktop\LERF Dose\cover.msd	May 4, 2020	1:02:54 PM	00:00:04

Project Info	
Case Title	LERF Basin 41
Description	Basin Cover, 1 cm, 30 cm and 100 cm
Geometry	13 - Rectangular Volume

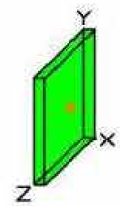
Source Dimensions	
Length	605.638 cm (19 ft 10.440 in)
Width	7.951e+03 cm (260 ft 10.320 in)
Height	6.130e+03 cm (201 ft 1.200 in)

Dose Points

No.	X	Y	Z
#1	607.0 cm (19 ft 10.976 in)	3.066e+03 cm (100 ft 7.200 in)	3.976e+03 cm (130 ft 5.160 in)
#2	636.0 cm (20 ft 10.394 in)	3.066e+03 cm (100 ft 7.200 in)	3.975e+03 cm (130 ft 4.800 in)
#3	706.0 cm (23 ft 1.953 in)	3.066e+03 cm (100 ft 7.200 in)	3.975e+03 cm (130 ft 4.800 in)

Shields

Shield N	Dimension	Material	Density (g/cm³)
Source	2.95e+10 cm³	Water	1
Air Gap		Air	0.00122



Source Input: Grouping Method - Standard Indices
Number of Groups: 25
Lower Energy Cutoff: 0.015
Photons < 0.015: Included
Library: Grove

Nuclide	Ci	Bq	μCi/cm³	Bq/cm³
Am-241	4.1323e-002	1.5289e+009	1.4000e-006	5.1800e-002
Ba-137m	2.7922e+002	1.0331e+013	9.4600e-003	3.5002e+002
C-14	4.7226e+001	1.7474e+012	1.6000e-003	5.9200e+001
Ce-144	5.9033e+002	2.1842e+013	2.0000e-002	7.4000e+002
Cm-244	7.3791e-001	2.7303e+010	2.5000e-005	9.2500e-001
Co-60	7.0839e+001	2.6210e+012	2.4000e-003	8.8800e+001

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RPP-RPT-62215, Rev. 0
Appendix A – S&L Calculation S54413.024-P-001, *LERF Basin 41 Radiological Dose Rate and Exposure* (cont.)

Sargent & Lundy Engineering Services, Inc.

CALCULATION SHEET

Project No. S551413.024	**Calculation No.** S54413.024-P-001	**Rev.** 0	**Page No.** 20 of 34
Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann	**Date:** 5/12/2020	**Checked By:** BD Groth	**Date:** 5/12/2020

Case Summary of LERF Basin 41 Page 2 of 4

Cs-134	1.2102e+001	4.4776e+011	4.1000e-004	1.5170e+001
Cs-137	2.9516e+002	1.0921e+013	1.0000e-002	3.7000e+002
Eu-154	2.8926e+002	1.0703e+013	9.8000e-003	3.6260e+002
Eu-155	1.8595e+003	6.8803e+013	6.3000e-002	2.3310e+003
H-3	7.0839e+003	2.6210e+014	2.4000e-001	8.8800e+003
I-129	5.3129e+001	1.9658e+012	1.8000e-003	6.6600e+001
Nb-94	7.6742e+000	2.8395e+011	2.6000e-004	9.6200e+000
Np-237	6.1984e-002	2.2934e+009	2.1000e-006	7.7700e-002
Pr-144	5.8188e+002	2.1530e+013	1.9714e-002	7.2942e+002
Pu-238	8.2646e-002	3.0579e+009	2.8000e-006	1.0360e-001
Pu-239	5.3129e-001	1.9658e+010	1.8000e-005	6.6600e-001
Pu-241	7.6742e-001	2.8395e+010	2.6000e-005	9.6200e-001
Ra-226	1.8890e+000	6.9895e+010	6.4000e-005	2.3680e+000
Rh-106	1.9186e+001	7.0987e+011	6.5000e-004	2.4050e+001
Ru-106	1.9186e+001	7.0987e+011	6.5000e-004	2.4050e+001
Se-79	4.4274e+000	1.6382e+011	1.5000e-004	5.5500e+000
Sr-90	1.2397e+003	4.5868e+013	4.2000e-002	1.5540e+003
Tc-99	5.3129e+002	1.9658e+013	1.8000e-002	6.6600e+002
U-234	6.1984e-003	2.2934e+008	2.1000e-007	7.7700e-003
Y-90	1.2397e+003	4.5868e+013	4.2000e-002	1.5540e+003

Buildup

Buildup: The material reference is Source.

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results With Buildup: Dose Point No. 1 - (X = 607, Y = 3066.288, Z = 3.98e+03) cm

Energy (MeV)	Activity (Photons/sec)	Energy Flux (MeV/cm²/sec)	Photon Flux (Photons/cm²/sec)	Exposure Rate (mR/hr)	Absorbed Dose Rate (mrad/hr)	Absorbed Dose Rate (mGy/hr)
1.500e-02	6.948e+12	5.158e-23	3.439e-21	4.424e-24	3.862e-24	3.862e-26
2.000e-02	5.650e+07	1.366e-21	6.830e-20	4.732e-23	4.131e-23	4.131e-25
3.000e-02	2.271e+12	2.645e-06	8.816e-05	2.621e-08	2.288e-08	2.288e-10
4.000e-02	1.690e+13	1.876e-02	4.689e-01	8.296e-05	7.242e-05	7.242e-07
5.000e-02	4.610e+12	1.113e-01	2.225e+00	2.964e-04	2.587e-04	2.587e-06

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Quality Assurance Procedure 3.1 Calculation Sheet (01-19)

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Appendix A – S&L Calculation S54413.024-P-001, *LERF Basin 41 Radiological Dose Rate and Exposure* (cont.)

Sargent & Lundy	CALCULATION SHEET		
Project No. S551413.024	**Calculation No.** S54413.024-P-001	**Rev.** 0	**Page No.** 21 of 34
Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann	**Date:** 5/12/2020	**Checked By:** BD Groth	**Date:** 5/12/2020

Case Summary of LERF Basin 41 Page 3 of 4

6.000e-02	9.218e+11	1.197e-01	1.996e+00	2.379e-04	2.076e-04	2.076e-06
8.000e-02	2.171e+13	1.562e+01	1.952e+02	2.472e-02	2.158e-02	2.158e-04
1.000e-01	1.855e+13	3.145e+01	3.145e+02	4.811e-02	4.200e-02	4.200e-04
1.500e-01	2.359e+12	1.141e+01	7.609e+01	1.879e-02	1.641e-02	1.641e-04
2.000e-01	7.332e+11	6.261e+00	3.131e+01	1.105e-02	9.647e-03	9.647e-05
3.000e-01	1.632e+08	2.882e-03	9.606e-03	5.467e-06	4.772e-06	4.772e-08
4.000e-01	7.636e+10	2.253e+00	5.633e+00	4.390e-03	3.833e-03	3.833e-05
5.000e-01	1.759e+11	7.751e+00	1.550e+01	1.521e-02	1.328e-02	1.328e-04
6.000e-01	1.110e+13	6.783e+02	1.131e+03	1.324e+00	1.156e+00	1.156e-02
8.000e-01	5.166e+12	5.374e+02	6.717e+02	1.022e+00	8.923e-01	8.923e-03
1.000e+00	5.946e+12	9.361e+02	9.361e+02	1.726e+00	1.506e+00	1.506e-02
1.500e+00	6.881e+12	2.332e+03	1.554e+03	3.923e+00	3.425e+00	3.425e-02
2.000e+00	1.666e+11	9.701e+01	4.850e+01	1.500e-01	1.310e-01	1.310e-03
Total	**1.045e+14**	**4.656e+03**	**4.984e+03**	**8.268e+00**	**7.218e+00**	**7.218e-02**

Results With Buildup: Dose Point No. 2 - (X = 636, Y = 3066.288, Z = 3974.592) cm

Energy (MeV)	Activity (Photons/sec)	Energy Flux ($MeV/cm^2/sec$)	Photon Flux ($Photons/cm^2/sec$)	Exposure Rate (mR/hr)	Absorbed Dose Rate (mrad/hr)	Absorbed Dose Rate (mGy/hr)
1.500e-02	6.948e+12	1.576e-09	1.051e-07	1.352e-10	1.180e-10	1.180e-12
2.000e-02	5.650e+07	1.219e-08	6.096e-07	4.223e-10	3.687e-10	3.687e-12
3.000e-02	2.271e+12	9.493e-01	3.164e+01	9.408e-03	8.213e-03	8.213e-05
4.000e-02	1.690e+13	8.184e+01	2.046e+03	3.620e-01	3.160e-01	3.160e-03
5.000e-02	4.610e+12	7.246e+01	1.449e+03	1.930e-01	1.685e-01	1.685e-03
6.000e-02	9.218e+11	2.763e+01	4.605e+02	5.488e-02	4.791e-02	4.791e-04
8.000e-02	2.171e+13	1.205e+03	1.506e+04	1.907e+00	1.664e+00	1.664e-02
1.000e-01	1.855e+13	1.341e+03	1.341e+04	2.051e+00	1.791e+00	1.791e-02
1.500e-01	2.359e+12	2.313e+02	1.542e+03	3.808e-01	3.325e-01	3.325e-03
2.000e-01	7.332e+11	9.092e+01	4.546e+02	1.605e-01	1.401e-01	1.401e-03
3.000e-01	1.632e+08	2.629e-02	8.762e-02	4.986e-05	4.353e-05	4.353e-07
4.000e-01	7.636e+10	1.580e+01	3.950e+01	3.078e-02	2.687e-02	2.687e-04
5.000e-01	1.759e+11	4.486e+01	8.972e+01	8.805e-02	7.687e-02	7.687e-04
6.000e-01	1.110e+13	3.404e+03	5.673e+03	6.644e+00	5.800e+00	5.800e-02
8.000e-01	5.166e+12	2.159e+03	2.698e+03	4.106e+00	3.584e+00	3.584e-02
1.000e+00	5.946e+12	3.227e+03	3.227e+03	5.949e+00	5.193e+00	5.193e-02
1.500e+00	6.881e+12	6.158e+03	4.105e+03	1.036e+01	9.045e+00	9.045e-02
2.000e+00	1.666e+11	2.175e+02	1.088e+02	3.364e-01	2.937e-01	2.937e-03
Total	**1.045e+14**	**1.828e+04**	**5.538e+04**	**3.263e+01**	**2.849e+01**	**2.849e-01**

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Sargent & Lundy Engineering Services, Inc.

CALCULATION SHEET

Project No. S551413.024	**Calculation No.** S54413.024-P-001	**Rev.** 0	**Page No.** 22 of 34
Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann	**Date:** 5/12/2020	**Checked By:** BD Groth	**Date:** 5/12/2020

Case Summary of LERF Basin 41 Page 4 of 4

Results With Buildup: Dose Point No. 3 - (X = 706, Y = 3066.288, Z = 3974.592) cm

Energy (MeV)	Activity (Photons/sec)	Energy Flux (MeV/cm^2/sec)	Photon Flux (Photons/cm^2/sec)	Exposure Rate (mR/hr)	Absorbed Dose Rate (mrad/hr)	Absorbed Dose Rate (mGy/hr)
1.500e-02	6.948e+12	1.202e-05	8.015e-04	1.031e-06	9.002e-07	9.002e-09
2.000e-02	5.650e+07	4.397e-07	2.199e-05	1.523e-08	1.330e-08	1.330e-10
3.000e-02	2.271e+12	2.327e+00	7.756e+01	2.306e-02	2.013e-02	2.013e-04
4.000e-02	1.690e+13	1.048e+02	2.620e+03	4.635e-01	4.046e-01	4.046e-03
5.000e-02	4.610e+12	7.435e+01	1.487e+03	1.981e-01	1.729e-01	1.729e-03
6.000e-02	9.218e+11	2.599e+01	4.331e+02	5.162e-02	4.506e-02	4.506e-04
8.000e-02	2.171e+13	1.075e+03	1.343e+04	1.701e+00	1.485e+00	1.485e-02
1.000e-01	1.855e+13	1.189e+03	1.189e+04	1.819e+00	1.588e+00	1.588e-02
1.500e-01	2.359e+12	2.107e+02	1.404e+03	3.469e-01	3.029e-01	3.029e-03
2.000e-01	7.332e+11	8.151e+01	4.076e+02	1.439e-01	1.256e-01	1.256e-03
3.000e-01	1.632e+08	2.400e-02	7.999e-02	4.552e-05	3.974e-05	3.974e-07
4.000e-01	7.636e+10	1.445e+01	3.612e+01	2.815e-02	2.458e-02	2.458e-04
5.000e-01	1.759e+11	4.104e+01	8.208e+01	8.056e-02	7.033e-02	7.033e-04
6.000e-01	1.110e+13	3.114e+03	5.191e+03	6.079e+00	5.307e+00	5.307e-02
8.000e-01	5.166e+12	1.972e+03	2.465e+03	3.751e+00	3.274e+00	3.274e-02
1.000e+00	5.946e+12	2.941e+03	2.941e+03	5.422e+00	4.733e+00	4.733e-02
1.500e+00	6.881e+12	5.603e+03	3.735e+03	9.427e+00	8.230e+00	8.230e-02
2.000e+00	1.666e+11	1.978e+02	9.891e+01	3.059e-01	2.671e-01	2.671e-03
Total	**1.045e+14**	**1.665e+04**	**1.017e+05**	**2.984e+01**	**2.605e+01**	**2.605e-01**

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RPP-RPT-62215, Rev. 0
Appendix A – S&L Calculation S54413.024-P-001, *LERF Basin 41 Radiological Dose Rate and Exposure* (cont.)

Sargent & Lundy Engineering Services, Inc.

CALCULATION SHEET

Project No. S551413.024	**Calculation No.** S54413.024-P-001	**Rev.** 0	**Page No.** 23 of 34
Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann **Date:** 5/12/2020	**Checked By:** BD Groth		**Date:** 5/12/2020

B3.0 FRP Section

Case Summary of Basin 41

Page 1 of 4

MicroShield 12.03
Sargent & Lundy

Date	Preparer	Reviewer

File Name	Run Date	Run Time	Duration
Case2	May 4, 2020	12:00:10 PM	00:00:02

Project Info

Case Title	Basin 41
Description	FRP Pipe - 30 ft section
Geometry	7 - Cylinder Volume - Side Shields

Source Dimensions

Height	914.4 cm (30 ft)
Radius	10.16 cm (4.000 in)

Dose Points

No.	X	Y	Z
#1	12.4 cm (4.882 in)	457.2 cm (15 ft)	0.0 cm (0 in)
#2	41.4 cm (1 ft 4.299 in)	0.0 cm (0 in)	0.0 cm (0 in)
#3	111.4 cm (3 ft 7.858 in)	0.0 cm (0 in)	0.0 cm (0 in)

Shields

Shield N	Dimension	Material	Density (g/cm^3)
Source	2.97e+05 cm^3	Water	1
Transition		Air	0.00122
Air Gap		Air	0.00122
Wall Clad	1.219 cm	Carbon	1.85

Source Input: Grouping Method - Standard Indices
Number of Groups: 25
Lower Energy Cutoff: 0.015
Photons < 0.015: Included
Library: Grove

Nuclide	Ci	Bq	µCi/cm^3	Bq/cm^3
Am-241	4.1515e-007	1.5360e+004	1.4000e-008	5.1800e-002
Ba-137m	2.8052e-003	1.0379e+008	9.4600e-003	3.5002e+002
C-14	4.7445e-004	1.7555e+007	1.6000e-003	5.9200e+001
Ce-144	5.9337e-003	2.1943e+008	2.0000e-002	7.4000e+002
Cm-244	7.4133e-006	2.7429e+005	2.5000e-005	9.2500e-001
Co-60	7.1158e-004	2.6332e+007	2.4000e-003	8.8800e+001
Cs-134	1.2158e-004	4.4984e+006	4.1000e-004	1.5170e+001

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RPP-RPT-62215, Rev. 0
Appendix A – S&L Calculation S54413.024-P-001, *LERF Basin 41 Radiological Dose Rate and Exposure* (cont.)

CALCULATION SHEET

Project No. S551413.024	**Calculation No.** S54413.024-P-001	**Rev.** 0	**Page No.** 24 of 34
Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann **Date:** 5/12/2020	**Checked By:** BD Groth		**Date:** 5/12/2020

Case Summary of Basin 41 Page 2 of 4

Cs-137	2.9653e-003	1.0972e+008	1.0000e-002	3.7000e+002
Eu-154	2.9060e-003	1.0752e+008	9.8000e-003	3.6260e+002
Eu-155	1.8682e-002	6.9122e+008	6.3000e-002	2.3310e+003
H-3	7.1168e-002	2.6332e+009	2.4000e-001	8.8800e+003
I-129	5.3376e-004	1.9749e+007	1.8000e-003	6.6600e+001
Nb-94	7.7099e-005	2.8527e+006	2.6000e-004	9.6200e+000
Np-237	6.2272e-007	2.3041e+004	2.1000e-006	7.7700e-002
Pr-144	5.8459e-003	2.1630e+008	1.9714e-002	7.2942e+002
Pu-238	8.3029e-007	3.0721e+004	2.8000e-006	1.0360e-001
Pu-239	5.3376e-006	1.9749e+005	1.8000e-005	6.6600e-001
Pu-241	7.7099e-006	2.8527e+005	2.6000e-005	9.6200e-001
Ra-226	1.8978e-005	7.0219e+005	6.4000e-005	2.3680e+000
Rh-106	1.9275e-004	7.1316e+006	6.5000e-004	2.4050e+001
Ru-106	1.9275e-004	7.1316e+006	6.5000e-004	2.4050e+001
Se-79	4.4480e-005	1.6458e+006	1.5000e-004	5.5500e+000
Sr-90	1.2454e-002	4.6081e+008	4.2000e-002	1.5540e+003
Tc-99	5.3376e-003	1.9749e+008	1.8000e-002	6.6600e+002
U-234	6.2272e-008	2.3041e+003	2.1000e-007	7.7700e-003
Y-90	1.2454e-002	4.6081e+008	4.2000e-002	1.5540e+003

Buildup

Buildup: The material reference is Source.

Integration Parameters

Radial	10
Circumferential	10
Y Direction (axial)	20

Results With Buildup: Dose Point No. 1 - (X = 12.4, Y = 457.2, Z = 0) cm

Energy (MeV)	Activity (Photons/sec)	Energy Flux ($MeV/cm^2/sec$)	Photon Flux ($Photons/cm^2/sec$)	Exposure Rate (mR/hr)	Absorbed Dose Rate (mrad/hr)	Absorbed Dose Rate (mGy/hr)
1.500e-02	6.980e+07	4.961e-03	3.308e-01	4.256e-04	3.715e-04	3.715e-06
2.000e-02	5.676e+02	2.102e-06	1.051e-04	7.280e-08	6.355e-08	6.355e-10
3.000e-02	2.282e+07	1.994e+00	6.647e+01	1.976e-02	1.725e-02	1.725e-04
4.000e-02	1.697e+08	6.391e+01	1.598e+03	2.826e-01	2.467e-01	2.467e-03
5.000e-02	4.631e+07	3.937e+01	7.875e+02	1.049e-01	9.157e-02	9.157e-04
6.000e-02	9.261e+06	1.266e+01	2.109e+02	2.514e-02	2.194e-02	2.194e-04

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RPP-RPT-62215, Rev. 0
Appendix A – S&L Calculation S54413.024-P-001, *LERF Basin 41 Radiological Dose Rate and Exposure* (cont.)

Sargent & Lundy Engineering Services, Inc.

CALCULATION SHEET

Project No. S551413.024	Calculation No. S54413.024-P-001	Rev. 0	Page No. 25 of 34
Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann	Date: 5/12/2020	Checked By: BD Groth	Date: 5/12/2020

Case Summary of Basin 41 Page 3 of 4

8.000e-02	2.181e+08	4.751e+02	5.938e+03	7.518e-01	6.563e-01	6.563e-03
1.000e-01	1.864e+08	4.966e+02	4.966e+03	7.597e-01	6.632e-01	6.632e-03
1.500e-01	2.370e+07	8.265e+01	5.510e+02	1.361e-01	1.188e-01	1.188e-03
2.000e-01	7.366e+06	3.095e+01	1.548e+02	5.463e-02	4.769e-02	4.769e-04
3.000e-01	1.639e+03	8.697e-03	2.899e-02	1.650e-05	1.440e-05	1.440e-07
4.000e-01	7.671e+05	5.083e+00	1.271e+01	9.904e-03	8.646e-03	8.646e-05
5.000e-01	1.768e+06	1.406e+01	2.811e+01	2.759e-02	2.409e-02	2.409e-04
6.000e-01	1.115e+08	1.042e+03	1.737e+03	2.034e+00	1.776e+00	1.776e-02
8.000e-01	5.190e+07	6.329e+02	7.912e+02	1.204e+00	1.051e+00	1.051e-02
1.000e+00	5.973e+07	9.111e+02	9.111e+02	1.679e+00	1.466e+00	1.466e-02
1.500e+00	6.913e+07	1.600e+03	1.066e+03	2.691e+00	2.349e+00	2.349e-02
2.000e+00	1.674e+06	5.280e+01	2.640e+01	8.165e-02	7.128e-02	7.128e-04
Total	**1.050e+09**	**5.461e+03**	**1.885e+04**	**9.863e+00**	**8.610e+00**	**8.610e-02**

Results With Buildup: Dose Point No. 2 - (X = 41.4, Y = 0, Z = 0) cm

Energy (MeV)	Activity (Photons/sec)	Energy Flux (MeV/cm²/sec)	Photon Flux (Photons/cm²/sec)	Exposure Rate (mR/hr)	Absorbed Dose Rate (mrad/hr)	Absorbed Dose Rate (mGy/hr)
1.500e-02	6.980e+07	9.035e-03	6.023e-01	7.749e-04	6.765e-04	6.765e-06
2.000e-02	5.676e+02	7.816e-07	3.908e-05	2.707e-08	2.364e-08	2.364e-10
3.000e-02	2.282e+07	3.245e-01	1.082e+01	3.216e-03	2.808e-03	2.808e-05
4.000e-02	1.697e+08	8.627e+00	2.157e+02	3.816e-02	3.331e-02	3.331e-04
5.000e-02	4.631e+07	5.083e+00	1.017e+02	1.354e-02	1.182e-02	1.182e-04
6.000e-02	9.261e+06	1.619e+00	2.698e+01	3.215e-03	2.807e-03	2.807e-05
8.000e-02	2.181e+08	6.111e+01	7.639e+02	9.670e-02	8.442e-02	8.442e-04
1.000e-01	1.864e+08	6.447e+01	6.447e+02	9.863e-02	8.610e-02	8.610e-04
1.500e-01	2.370e+07	1.080e+01	7.200e+01	1.778e-02	1.553e-02	1.553e-04
2.000e-01	7.366e+06	4.079e+00	2.040e+01	7.200e-03	6.285e-03	6.285e-05
3.000e-01	1.639e+03	1.157e-03	3.857e-03	2.195e-06	1.916e-06	1.916e-08
4.000e-01	7.671e+05	6.782e-01	1.695e+00	1.321e-03	1.154e-03	1.154e-05
5.000e-01	1.768e+06	1.880e+00	3.760e+00	3.691e-03	3.222e-03	3.222e-05
6.000e-01	1.115e+08	1.395e+02	2.326e+02	2.724e-01	2.378e-01	2.378e-03
8.000e-01	5.190e+07	8.489e+01	1.061e+02	1.615e-01	1.410e-01	1.410e-03
1.000e+00	5.973e+07	1.223e+02	1.223e+02	2.254e-01	1.968e-01	1.968e-03
1.500e+00	6.913e+07	2.149e+02	1.433e+02	3.615e-01	3.156e-01	3.156e-03
2.000e+00	1.674e+06	7.095e+00	3.547e+00	1.097e-02	9.578e-03	9.578e-05
Total	**1.050e+09**	**7.274e+02**	**2.131e+04**	**1.316e+00**	**1.149e+00**	**1.149e-02**

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Sargent & Lundy Engineering Services, Inc.

CALCULATION SHEET

Project No. S551413.024	**Calculation No.** S54413.024-P-001	**Rev.** 0	**Page No.** 26 of 34
Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann	**Date:** 5/12/2020	**Checked By:** BD Groth	**Date:** 5/12/2020

Case Summary of Basin 41 Page 4 of 4

Results With Buildup: Dose Point No. 3 - (X = 111.4, Y = 0, Z = 0) cm

Energy (MeV)	Activity (Photons/sec)	Energy Flux (MeV/cm²/sec)	Photon Flux (Photons/cm²/sec)	Exposure Rate (mR/hr)	Absorbed Dose Rate (mrad/hr)	Absorbed Dose Rate (mGy/hr)
1.500e-02	6.980e+07	2.906e-03	1.937e-01	2.493e-04	2.176e-04	2.176e-06
2.000e-02	5.676e+02	2.718e-07	1.359e-05	9.416e-09	8.220e-09	8.220e-11
3.000e-02	2.282e+07	1.167e-01	3.889e+00	1.156e-03	1.009e-03	1.009e-05
4.000e-02	1.697e+08	3.137e+00	7.843e+01	1.388e-02	1.211e-02	1.211e-04
5.000e-02	4.631e+07	1.857e+00	3.714e+01	4.947e-03	4.319e-03	4.319e-05
6.000e-02	9.261e+06	5.928e-01	9.880e+00	1.177e-03	1.028e-03	1.028e-05
8.000e-02	2.181e+08	2.242e+01	2.803e+02	3.548e-02	3.098e-02	3.098e-04
1.000e-01	1.864e+08	2.367e+01	2.367e+02	3.622e-02	3.162e-02	3.162e-04
1.500e-01	2.370e+07	3.966e+00	2.644e+01	6.532e-03	5.702e-03	5.702e-05
2.000e-01	7.366e+06	1.498e+00	7.492e+00	2.644e-03	2.309e-03	2.309e-05
3.000e-01	1.639e+03	4.248e-04	1.416e-03	8.058e-07	7.035e-07	7.035e-09
4.000e-01	7.671e+05	2.489e-01	6.222e-01	4.849e-04	4.233e-04	4.233e-06
5.000e-01	1.768e+06	6.898e-01	1.380e+00	1.354e-03	1.182e-03	1.182e-05
6.000e-01	1.115e+08	5.118e+01	8.530e+01	9.990e-02	8.721e-02	8.721e-04
8.000e-01	5.190e+07	3.112e+01	3.890e+01	5.920e-02	5.168e-02	5.168e-04
1.000e+00	5.973e+07	4.482e+01	4.482e+01	8.261e-02	7.212e-02	7.212e-04
1.500e+00	6.913e+07	7.871e+01	5.247e+01	1.324e-01	1.156e-01	1.156e-03
2.000e+00	1.674e+06	2.597e+00	1.299e+00	4.016e-03	3.506e-03	3.506e-05
Total	**1.050e+09**	**2.666e+02**	**2.222e+04**	**4.823e-01**	**4.210e-01**	**4.210e-03**

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Quality Assurance Procedure 3.1 Calculation Sheet (01-19)

CALCULATION SHEET			
Project No. S551413.024	Calculation No. S54413.024-P-001	Rev. 0	Page No. 27 of 34
Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann	Date: 5/12/2020	Checked By: BD Groth	Date: 5/12/2020

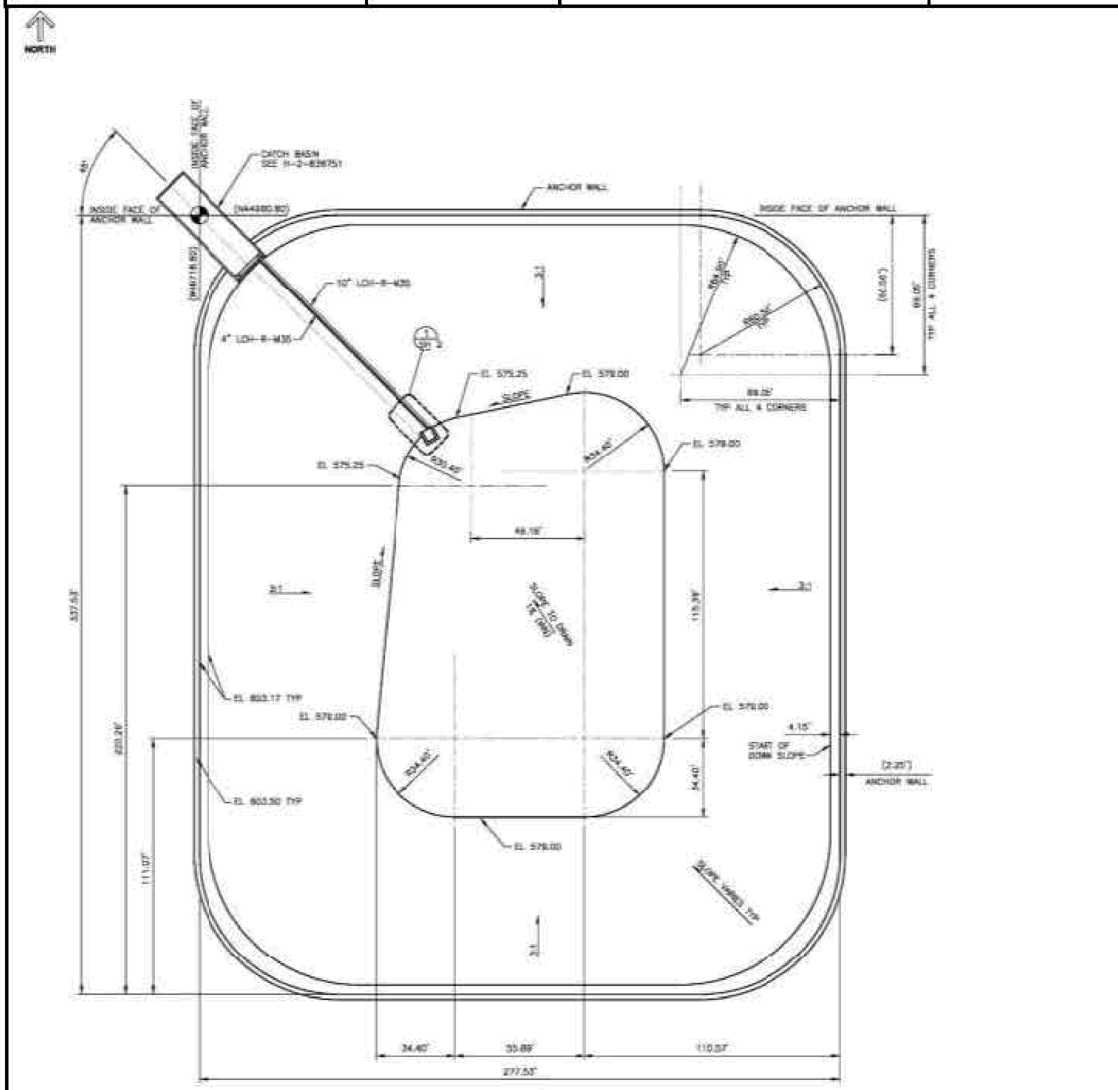
APPENDIX C

LERF BASIN 41 SKETCHES

Sargent & Lundy

CALCULATION SHEET

Project No. S551413.024	Calculation No. S54413.024-P-001	Rev. 0	Page No. 28 of 34
Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann Date: 5/12/2020	Checked By: BD Groth		Date: 5/12/2020



PLAN – TOP OF SECONDARY LINER

CALCULATION SHEET

Project No. S551413.024	**Calculation No.** S54413.024-P-001	**Rev.** 0	**Page No.** 29 of 34
Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann **Date:** 5/12/2020	**Checked By:** BD Groth	**Date:** 5/12/2020	

APPENDIX D

FRP DATA SHEET

CALCULATION SHEET

Project No. S551413.024	**Calculation No.** S54413.024-P-001	**Rev.** 0	**Page No.** 30 of 34
Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann	**Date:** 5/12/2020	**Checked By:** BD Groth	**Date:** 5/12/2020

Conley Composites
an ANDRONACO INDUSTRIES company

EPOXY SCHEDULE 40/30
DOUBLE CONTAINED PIPING

ASTM DESIGNATION CODE RTRP-11FW1-2113

Conley Product Data

RUGGED TOP OF THE LINE PERFORMANCE ~ AFFORDABLE COST

Description

- Extra heavy duty filament wound piping for service up to 150 psi
- 63 mil double Nexus® reinforced corrosion barrier (inner liner)
- Premium aromatic amine cured product for operating temperatures up to 275°F
- Sizes available from 2" through 30"
- Complete line of filament wound fittings available
- In house fabrication facilities "From your blueprints to pipe assemblies"
- Color coding available
- Patented interlocking union for thermal expansion (US Patent #5449204 & 5988338)
- See Sch 40/30 Specification
- See Sch 40 Product Data
- See Sch 30 Product Data

Typical Applications

- Waste water treatment
- Steel pickling
- Automotive
- Petrochemical
- Pharmaceutical
- Chemical processing
- Brine and brackish water
- Jet fuel
- Gasoline – Desel – Fuel Oil
- Cooling water
- Odor control
- Industrial waste
- Food and beverages
- Bridge, roof and floor drains

Performance

- Excellent chemical resistance inside and outside to a variety of caustics, acids, brines and petroleum products – See the chemical resistance chart for fluid services
- External UV/Corrosion barrier minimum 10/20 mil on all pipe and fittings
- 25 year guarantee against *'fiber blooming'* on all pipe and fittings
- Straight socket joining system (No expensive tapering tools required)

Specifications

- ASTM D2996 Filament-Wound "Fiberglass" Pipe
- ASTM D2310 Classification for Machine-Made "Fiberglass" Pipe
- ASTM D3567 Determining Dimensions of "Fiberglass" Pipe and Fittings
- ASTM D4024 Machine Made "Fiberglass" Flanges
- ASTM D5685 "Fiberglass" Pressure Pipe Fittings

Codes & Standards

- AWWA C950 Fiberglass Pressure Pipe Standards
- ASME B31.1 Power Piping Code
- ASME B31.3 Process Piping Code

Listings

- U.S. Federal Regulations FDA 21 CFR 175.300

Application Legislation

- 40 CFR 280, RCRA, Subtitle 1
- 40 CFR 264/5
- CERCLA "Superfund Act"

Sargent & Lundy Engineering Services, Inc.

CALCULATION SHEET

Project No. S551413.024	**Calculation No.** S54413.024-P-001	**Rev.** 0	**Page No.** 31 of 34
Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann	**Date:** 5/12/2020	**Checked By:** BD Groth	**Date:** 5/12/2020

Schedule 40/30
Pipe Dimensional Data* and Pressure Ratings[1] from –50° to 275°F

[1]Static pressure rating; steady (stationary) pressure is created when using a gear pump, turbine pump, centrifugal pump, etc.
[2]Vacuum Service: A full vacuum within the pipe is equivalent to 14.7 psi external pressure at sea level. Contact Conley for higher external pressure ratings.

NOM SIZE	ANNULUS CLEAR (IN)	SPIDER MIN OPENING (IN)	ANNULUS VOLUME (GAL/FT)	COMBINED WEIGHT (LB/FT)	ANNULUS PRESS (PSI)	ANNULUS VAC PRESS (PSI)[2]
2"/4"	0.81	0.6	0.51	3.14	150	24.1
2"/6"	1.81	1.6	1.32	4.32	150	13.8
3"/6"	1.27	1.0	1.10	4.89	150	13.8
3"/8"	2.27	2.0	2.24	5.85	150	6.1
4"/6"	0.78	0.5	0.82	5.54	150	13.8
4"/8"	1.76	1.5	1.98	6.50	150	6.1
6"/8"	0.72	0.5	1.14	8.45	150	6.1
6"/10"	1.72	1.5	2.61	10.86	150	10.2
8"/10"	0.70	0.5	1.47	12.63	150	10.2
8"/12"	1.83	1.6	3.51	14.02	100	5.7
10"/12"	0.79	0.5	2.04	16.61	100	5.7
10"/14"	1.79	1.5	4.20	18.60	100	3.6
12"/14"	0.63	0.4	2.16	21.67	100	3.6
12"/16"	1.63	1.4	4.65	23.01	100	2.5
14"/16"	0.63	0.4	2.49	24.91	100	2.5
14"/18"	1.63	1.4	5.30	27.91	100	4.2
16"/18"	0.63	0.4	2.82	29.80	100	4.2
16"/20"	1.63	1.4	5.96	31.32	100	3.1
18"/20"	0.63	0.4	3.14	33.21	100	3.1
18"/24"	2.63	2.0	10.40	39.70	100	3.5
20"/24"	1.65	1.4	7.25	40.54	100	3.5
20"/30"	4.77	2.0	21.22	50.49	100	3.1
24"/30"	2.70	2.0	13.96	58.82	100	3.1

*All values are nominal. Minimum wall thickness shall not be less than 87.5% of nominal wall thickness in accordance with ASTM D2996.

NOTES:
For carrier pipe dimensions, see Schedule 40 Pipe Dimensional Data Table
For containment pipe dimensions, see Schedule 30 Pipe Dimensional Data Table

Sargent & Lundy

CALCULATION SHEET

Project No. S551413.024	**Calculation No.** S54413.024-P-001	**Rev.** 0	**Page No.** 32 of 34
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Prepared By: MJ Feldmann	**Date:** 5/12/2020	**Checked By:** BD Groth	**Date:** 5/12/2020

Support Spans (FT)

NOM SIZE	CARRIER PIPE TEMPERATURE							
	75	100	125	150	175	200	225	250
2"/4"	15.3	15.3	15.3	15.3	15.2	15.2	15.1	15.1
2"/6"	19.6	19.6	19.6	19.6	19.5	19.5	19.5	19.5
3"/6"	18.3	18.3	18.3	18.3	18.3	18.2	18.2	18.1
3"/8"	21.5	21.5	21.5	21.5	21.4	21.4	21.4	21.4
4"/6"	17.9	17.9	17.9	17.9	17.8	17.7	17.5	17.5
4"/8"	20.5	20.5	20.5	20.5	20.5	20.4	20.3	20.3
6"/8"	19.9	19.9	19.9	19.9	19.8	19.6	19.3	19.3
6"/10"	23.1	23.1	23.1	23.1	23.1	22.9	22.8	22.8
8"/10"	22.5	22.5	22.5	22.5	22.4	22.1	21.9	21.8
8"/12"	24.5	24.5	24.5	24.5	24.4	24.3	24.1	24.1
10"/12"	23.8	23.8	23.8	23.8	23.7	23.4	23.2	23.1
10"/14"	25.3	25.3	25.3	25.3	25.2	25.0	24.8	24.7
12"/14"	25.4	25.4	25.4	25.4	25.2	24.9	24.6	24.5
12"/16"	26.6	26.6	26.6	26.6	26.5	26.2	25.9	25.9
14"/16"	26.4	26.4	26.4	26.4	26.3	25.9	25.6	25.5
14"/18"	28.6	28.6	28.6	28.6	28.5	28.2	28.0	27.9
16"/18"	28.3	28.3	28.3	28.3	28.1	27.8	27.5	27.4
16"/20"	29.4	29.4	29.4	29.4	29.3	29.0	28.7	28.7
18"/20"	29.1	29.1	29.1	29.1	29.0	28.6	28.3	28.2
18"/24"	32.4	32.4	32.4	32.4	32.3	32.0	31.8	31.7
20"/24"	31.9	31.9	31.9	31.9	31.7	31.5	31.2	31.1
20"/30"	36.8	36.8	36.8	36.8	36.7	36.5	36.4	36.3
24"/30"	35.7	35.7	35.7	35.7	35.6	35.3	35.0	34.9

NOTE: These spans are valid for the containment pipe operating at ambient temperatures.

Span multipliers for fluids of different specific gravities

FLUD SPECIFIC GRAVITY							
AIR	0.75	0.9	1.0	1.1	1.25	1.5	2.0
1.40	1.07	1.02	1.0	0.96	0.95	0.90	0.84
(MULTIPLIER FOR CORRECTED SPAN LENGTHS)							

Span multipliers for fluids at different temperatures

FLUID TEMPERATURE						
75°F	100°F	150°F	200°F	225°F	250°F	275°F
1.0	0.98	0.93	0.88	0.84	0.80	0.75
(MULTIPLIER FOR CORRECTED SPAN LENGTHS)						

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CALCULATION SHEET

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Title: LERF Basin 41 Radiological Dose Rate and Exposure			
Prepared By: MJ Feldmann Date: 5/12/2020	Checked By: BD Groth		Date: 5/12/2020

Anchor Loads Due to Restrained Thermal Expansion (LBS)

NOM SIZE	TEMPERATURE CHANGE IN CONTAINMENT PIPE			
	1°F	25°F	50°F	75°F
2"/4"	519	1,535	2,592	3,650
2"/6"	547	2,232	3,987	5,742
3"/6"	751	2,436	4,191	5,946
3"/8"	774	3,003	5,325	7,647
4"/6"	981	2,666	4,421	6,176
4"/8"	1,004	3,233	5,555	7,877
6"/8"	1,697	3,926	6,248	8,570
6"/10"	1,754	5,349	9,095	12,841
8"/10"	2,379	5,975	9,721	13,466
8"/12"	2,412	6,798	11,366	15,934
10"/12"	3,330	7,716	12,284	16,852
10"/14"	3,377	8,888	14,628	20,367
12"/14"	4,469	9,979	15,719	21,459
12"/16"	4,500	10,770	17,301	23,831
14"/16"	5,172	11,441	17,972	24,503
14"/18"	5,243	13,215	21,519	29,824
16"/18"	5,914	13,886	22,191	30,495
16"/20"	5,950	14,782	23,981	33,181
18"/20"	6,621	15,453	24,653	33,853
18"/24"	6,775	19,288	32,323	45,357
20"/24"	7,071	19,584	32,618	45,653
20"/30"	7,306	25,461	44,372	63,284
24"/30"	10,258	28,413	47,325	66,236

NOTE: Thermal end loads on anchors are independent of the carrier pipe temperature. The loads are based on the change in temperature of the containment pipe plus 10% or the maximum load from the carrier pipe at 150°F with uninsulated containment pipe.

† PDS 1030K (12/14)

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Typical Properties

TEMPERATURE	75°F	250°F	
PROPERTY	**VALUE**	**VALUE**	**METHOD**
AXIAL TENSILE STRENGTH	*4,200 psi	10,650 psi	ASTM D2105
AXIAL TENSILE DESIGN STRENGTH	3,550 psi	2,660 psi	ASTM D2105
AXIAL MODULUS OF ELASTICITY	1.75×10^6 psi	1.30×10^6 psi	ASTM D2105
COMPRESSIVE STRENGTH	22,750 psi	17,000 psi	ASTM D695
COMPRESSIVE DESIGN STRENGTH	5,685 psi	4,250 psi	ASTM D695
COMPRESSION MODULUS	2.80×10^6 psi	2.10×10^6 psi	ASTM D695
POISSON'S RATIO V_{ah} (V_{ha})	0.33 (0.23)		*CONLEY METHOD #20
BEAM BENDING, ULTIMATE STRESS	30,000 psi	22,500 psi	CONLEY METHOD 8
BEAM BENDING, DESIGN STRESS[1]	3,750 psi	2,810 psi	CONLEY METHOD 8
SHEAR MODULUS	1.30×10^6 psi	1.00×10^6 psi	*CONLEY METHOD #9
HYDROSTATIC DESIGN BASIS	*6,000 psi	8,000 psi	ASTM D2992 PROCEDURE B
HYDROSTATIC BURST (WALL STRESS @ 72°F)	32,000 psi	24,000 psi	ASTM D1599
CIRCUMFERENTIAL MODULUS OF ELASTICITY	2.50×10^6 psi	1.87×10^6 psi	ASTM D1599
FLEXURAL MODULUS OF ELASTICITY	1.75×10^6 psi	1.30×10^6 psi	ASTM 2790
COEFFICIENT OF LINEAR THERMAL EXPANSION	9.5×10^{-6} IN / IN-°F		CONLEY METHOD 3
COEFFICIENT OF THERMAL CONDUCTIVITY	2.9 BTU/HR-IN / FT^2-°F		CONLEY METHOD 16
SPECIFIC GRAVITY	1.85		
DENSITY	0.067 LB/CU IN		
DIELECTRIC STRENGTH	535 VOLTS / MIL		ASTM D149
DEGREE OF CURE	175°C (347°F) Tg		DMA
HEAT DEFLECTION TEMPERATURE	150°C (302°F)		ISO 75-3
FLOW FACTOR (HAZEN-WILLIAMS)	150		
SURFACE ROUGHNESS	1.7×10^{-5} FEET		
MANNING'S "n"	0.009 INCH		

[1] Beam bending design stress is 1/8 of ultimate to allow for combined stress (bending and pressure)

[illegible] 5

CALCULATION SHEET

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ISO 9001:2008
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Kentwood, MI

This product data sheet and recommendations it contains are based on data reasonably believed to be reliable. It is intended that this data be used by competent personnel having acceptable training in accordance with current industry practice and operating conditions. Variation in environment, application or installation, changes in operating procedures, or extrapolation of data may cause unsatisfactory results. Conley Composites makes no representation or warranty, express or implied, including warranties of merchantability or fitness for purpose, as to accuracy, adequacy or completeness of the recommendations or information contained herein. Conley Composites assumes no liability whatsoever in connection with this literature or the information or recommendations it contains.

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6 PDS4030E (12/14)

DOCUMENT RELEASE AND CHANGE FORM

Prepared For the U.S. Department of Energy, Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

Release Stamp

DATE: May 26,2020 HANFORD RELEASE

1. **Doc No:** RPP-SPEC-63632 **Rev.** 00

2. **Title:**
LERF Basin 41 Construction Specification

3. **Project Number:** ☐N/A
T1P226

4. **Design Verification Required:**
☐Yes ☒No

5. **USQ Number:** ☒ N/A
RPP-27195

6. **PrHA Number** **Rev.** ☒ N/A

Clearance Review Restriction Type:
public

7. **Approvals**

Title	Name	Signature	Date
Clearance Review	Ayers, Lynn M	*Ayers, Lynn M*	05/26/2020
Design Authority	Wilson, Nathaniel W	*Wilson, Nathaniel W*	05/14/2020
Checker	Dorsh, Paul M	*Dorsh, Paul M*	05/05/2020
Document Control Approval	Alvarez, Efren	*Alvarez, Efren*	05/26/2020
Environmental Protection	Wall, Jeremy M	*Wall, Jeremy M*	05/18/2020
Originator	Hillebrant, Thomas A	*Hillebrant, Thomas A*	05/05/2020
Other Approver	Joslyn, Cameron C	*Joslyn, Cameron C*	05/19/2020
Responsible Engineering Manager	Huntington, Matthew R	*Huntington, Matthew R*	05/20/2020

8. **Description of Change and Justification**

Initial Release.

Design checks were performed in accordance with Sargent & Lundy ESD Quality Assurance Procedure (QAP). Because of the General Service status of the equipment, a graded approach was applied and design verification was not performed as allowed by QAP 3.5, Design Verification.

9. **TBDs or Holds** ☒N/A

10. **Related Structures, Systems, and Components**

a. Related Building/Facilities ☐N/A	b. Related Systems ☐N/A	c. Related Equipment ID Nos. (EIN) ☒N/A
LERF FACILITIES	LERF	

11. **Impacted Documents – Engineering** ☒N/A

Document Number	Rev.	Title

12. **Impacted Documents (Outside SPF):**

N/A

13. **Related Documents** ☐N/A

Document Number	Rev.	Title
MT-50497	00	Liquid Effluent Retention Facility (LERF) Basin 41

14. **Distribution**

Name	Organization
Angevine, Brennan T	MISSION ANALYSIS ENGINEERING
Blaak, Whitney S	COGNIZANT SYSTEM ENGINEERING
Demiter, Scott M	ETF OPERATIONS
Goessmann, Glen E	ENGINEERING PROGRAMS
Greenhalgh, Aaron M	TANK FARM PROJECTS ENGINEERING
Halgren, Dale L	ETF ENGINEERING
Harris, John W	SAFETY PROGRAM SERVICES RC/P
Joslyn, Cameron C	ETF ENGINEERING
McFerran, Brandon E	242-A/AW/ETF OPERATIONS
McShane, Michael P	ENGINEERING PROGRAMS
Nixie, Dennis A	CONSTRUCTION
Omberg Carro, Susan K	NUCLEAR SAFETY
Powers, Daniel J	ETF ENGINEERING
Roosendaal, Gene D	TFP PROJECT MANAGEMENT
Rutherford, Wally	ETF ENGINEERING
Sackett, Tom E	TANK FARM PROJECTS
Samoska, Jerry A	INSTRUMENT & CNTRL ENGINEERING
Shultz, Milton V	NUCLEAR SAFETY
Smith, Gregory E	TANK FARM PROJECTS ENGINEERING

DOCUMENT RELEASE AND CHANGE FORM

Doc No: RPP-SPEC-63632 **Rev.** 00

14. **Distribution**

Name	Organization
Smoot, Bill R	TFP RADCON
Swanson, Brad L	242-A/AW/ETF OPERATIONS
Wall, Jeremy M	RETRVL & CLOSURE/PROJ ENV CMPL
Wilson, Nathaniel W	ETF PROJECTS ENGINEERING

RPP-SPEC-63632
Revision 0

LERF BASIN 41 DESIGN CONSTRUCTION SPECIFICATION

Prepared by

TA Hillebrant
Sargent & Lundy for Washington River Protection Solutions, LLC

Date Published
April 2020

DAVID E. NIELSON
STATE OF WASHINGTON
28592
REGISTERED
PROFESSIONAL ENGINEER

5-28-202

washington river protection solutions

Prepared for the U.S. Department of Energy
Office of River Protection

Contract No. DE-AC27-08RV14800

LERF BASIN 41 DESIGN
CONSTRUCTION SPECIFICATION

May 2020

prepared for

WASHINGTON RIVER PROTECTION SOLUTIONS, LLC

prepared by

SARGENT & LUNDY
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RPP-SPEC-63632, Rev. 0

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SECTION 03 30 00

CAST-IN-PLACE CONCRETE (NON-SAFETY RELATED)

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Formwork

B. Reinforcement

C. Cast-In-Place Items

D. Concrete

E. Non-Shrink Grout

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M 254	Standard Specification for Corrosion-Resistant Coated Dowel Bars

B. American Concrete Institute (ACI)

ACI 117	Tolerances for Concrete Construction and Materials
ACI 301, 2010	Specification for Structural Concrete
ACI 305.1	Standard Specification for Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 308.1	Specification for Curing Concrete
ACI 318, 2014	Building Code Requirements for Structural Concrete and Commentary
ACI CP-1	Technical Workbook for ACI Certification of Concrete Field Testing Technician-Grade 1

C. ASTM International (ASTM)

ASTM A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A706	Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
ASTM A853	Standard Specification for Steel Wire, Carbon, for General Use
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field.
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C511	Standard Specification for Mixing Rooms, Moist Cabinets, Moist Rooms and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
ASTM C881	Standard Specification for Epoxy Resin Based Bonding Systems for Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
ASTM D1752	Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

D. National Ready Mixed Concrete Association (NRMCA)

Quality Control Manual	Certification of Ready Mixed Concrete Production – Section 3 Facilities

E. Washington Administrative Code (WAC)

WAC 173-303-640	Dangerous Waste Regulations Washington State
WAC 173-303-650	Surface Impoundments

1.3 SUBMITTALS

A. See Contract Statement of Work for submittal procedures.

B. Approval Required.

1. Concrete Data: Before mixing, submit concrete materials, mix design, and mix proportions, in accordance with ACI 301, Section 4.1.2. Identify each material to be used in concrete, including amount, by weight, to be utilized in each cubic yard of plastic mix.

2. Product Data: Admixtures, bonding agent, bond breaker, expansion joint material, grout, and patching materials.

3. Reinforcement Shop Drawings: Prior to fabrication of reinforcement, submit placement Drawings that detail fabrication, bending, and placement. Include bars sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

4. Setting Drawings, diagrams, templates, and instructions: Prior to fabrication, submit information for installation of anchorages, such as concrete inserts, anchor bolts, and miscellaneous items having integral anchors, to be embedded in concrete.

5. Detailed plan for cold weather placements including curing and protection of concrete placed and cured in ambient temperature below 40°F.

6. Detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 80°F.

7. Concrete Placement Drawings: Prior to setting of forms, submit placement Drawings indicating planned pouring sequence and locations of any planned joints, including those not shown on the Contract Drawings.

8. Concrete repair methods and materials.

9. Submittals shall include the documentation listed in Paragraph 1.4.

1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work.

A. The concrete supplier shall be currently certified by the NRMCA "Certification of Ready Mixed Concrete Production Facilities" with compliance to ASTM C94 requirements for production facilities and equipment.

B. Qualification of Concrete Inspection/Testing Laboratory: The laboratory including equipment, personnel, and procedures shall meet the requirements of ASTM C1077 and shall be currently accredited by an independently recognized authority.

C. Deliverable Documentation: The following documents and records, required by this Section, shall be delivered to the WRPS Construction Representative in accordance with Contract Documents.

Document	Paragraph
Supplier Certification	1.4.A
Laboratory Qualifications	1.4.B
Inspection Personnel Qualification Records	1.6.A & 1.6.B
Pre-Pour Inspection Checklist and Trip Tickets	3.2.C.1.b, 3.2.C.1.c, and 3.4.B
Concrete Test Results	3.4.C

D. Perform work in accordance with the applicable sections of ACI 117, ACI 301, and ACI 318.

E. Suspect and Misrepresented Products: See Contract Statement of Work for required measures to prevent use of misrepresented products.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See the Contract Statement of Work for general requirements.

1.6 QUALIFICATION OF CONCRETE INSPECTORS

A. Personnel performing field-testing of concrete shall be ACI Concrete Field Testing Technicians, Grade I, who have received formal certification in accordance with ACI CP-1 or equivalent. Equivalent certification programs shall include requirements for written and performance examination as stipulated in ACI 301, Section 1.6.2.

B. Personnel performing laboratory testing shall be certified as an ACI Concrete Laboratory Technician—Grade 1.

PART 2 PRODUCTS

2.1 SUBSTITUTION

A. See the Contract Statement of Work for substitution approvals.

2.2 MATERIALS

A. Concrete

1. Cement: ASTM C150, Type II (low alkali).

2. Aggregates: ASTM C33, 3/4 in. maximum size. Fine aggregate: free of materials with deleterious reactivity to alkali in cement.

3. Air entraining admixture: ASTM C260, Sika Chemical Company "SIKA AER," Chem Masters Corporation "Adz Air," or Protex Industries "AES."

4. Properties (if not specified on Drawings):

a. Minimum allowable compressive strength: 4,500 lb/in2 at 28 days, or as required by design documents.

b. Slump: 4 in. in accordance with ACI 301, Section 4.2.2.2.

c. Air content: In accordance with ACI 301, Table 4.2.2.4.

d. Proportions: In accordance with ACI 301, Section 4.2.3, and ASTM C94.

e. Time of discharge: In accordance with ASTM C94, Section 12 and ACI 301, Section 4.3.2.2.

B. Measuring, Mixing, and Delivery: In accordance with ASTM C94.

C. Controlled Density Fill: Portland cement based, minimum compressive strength of 100 psi at 28 days, maximum compressive strength of 300 psi at 28 days.

D. Reinforcing Steel

1. Steel bars: ASTM A615 or ASTM A706, deformed, Grade 60.

2. Tie wire: ASTM A853 carbon steel, 16-gage minimum, annealed.

E. Post-Installed Anchors: See Section 05 05 38, "Concrete Anchors."

F. Expansion joint filler: ASTM D1752, Type II, flexible foam, Ceramar®[1] by W.R. Meadows, 1/2 in. thick.

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[1] Ceramar is a registered trademark of W. R. Meadows, Inc., Hampshire, Illinois.

G. Expansion joint filler (between asphalt and concrete): ASTM D1752, asphalt impregnated fiberboard or felt, 1/2 in. thick.

H. Joint sealants: See Section 07 92 00, “Joint Sealants.”

I. Forms: Wood, steel, plywood, or Masonite Corporation “Concrete Form Presswood,” as required for various specified finishes.

J. Bonding Agent: Epoxy resin emulsion appropriate for bonding fresh concrete to existing set concrete, ASTM C881, Type IV.

K. Non-Shrink Grout:

1. In accordance with ASTM C1107

2. Minimum strength of fluid grout, 2,000 psi at 1 day, 4,000 psi at 3 days, and 7,500 psi at 28 days.

L. Joint Dowel Bars: ASTM A615, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs. Install with grease/epoxy or a sleeve.

1. Paint with one coat of paint conforming to AASHTO M 254 and coat one-half of the bar with grease.

2. Plastic or gage metal (26 gage minimum) sleeves with an inside diameter of 1/16-in. greater than the dowel bar that it encases, that have the strength, durability, and design to provide free movement of the dowel relative to the concrete slab and that are specifically manufactured for this purpose.

PART 3 EXECUTION

3.1 PREPARATION

A. Form Construction

1. Install formwork in accordance with ACI 301, Section 2.3. Interior shape and rigidity shall be such that finished concrete will meet requirements of Drawings and approved shop Drawings within tolerances specified in ACI 117, Section 4.

2. Prepare form surfaces in accordance with ACI 301, Section 2, using specified form coating materials, or as described below.

3. Forms for surfaces, which will be permanently concealed from view, may be saturated with water, before placing concrete, instead of other treatment. In freezing weather, forms shall be treated with oil or stearate.

4. Clean forms of foreign material before placing concrete.

B. Prepare setting Drawings, diagrams, templates, and instructions for installation of anchorages, such as concrete inserts, anchor bolts, embedded plates, and miscellaneous items having integral anchors, to be embedded in concrete.

3.2 INSTALLATION

A. Reinforcing Steel

1. Fabricate and place bars to dimensions shown on Contract Drawings, within tolerances shown in ACI 117, Sections 2.1 and 2.2.

2. Tie to prevent displacement during placement of concrete.

3. Do not force into concrete after initial set has started.

4. Provide concrete cover for reinforcement protection per dimensions given in ACI 301, Section 3.3, except where shown otherwise on Contract Drawings or approved shop Drawings.

5. Reinforcement shall be supported and fastened together to prevent displacement by construction loads, or placement of concrete beyond specified tolerances. Reinforcement supported from ground shall rest on precast, square concrete blocks, with a minimum surface area of 4-in^2 and having a compressive strength equal to specified compressive strength of concrete being placed. Other means of support require prior approval.

B. Verify that reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete. Document inspection on the Pre-Pour Inspection Checklist.

C. Concrete

1. Before placing:

a. Notify WRPS Construction Representative prior to placement of concrete components for witnessing of activities by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.

b. Approve “Pre-Pour Inspection Checklist,” including identification of sections of structure to be placed, maximum size of coarse aggregate, and design strength.

c. For each truckload, collect “Trip Ticket.” Trip Tickets shall contain information listed in ASTM C94, paragraphs 14.1.1 through 14.1.10, and water to cementitious material ratio. Before test sampling and placing concrete, Trip Ticket shall be reviewed by the field inspector of the Testing Agency. After depositing concrete, Trip Ticket shall be completed and submitted.

d. Discharge concrete rinsate at Company-approved location.

e. Place in accordance with ACI 301, Section 5.3. Do not drop more than 5 ft.

f. Slump field adjustment only as permitted in ACI 301, Section 4.3.

2. Placing concrete against subgrade/base material: Place on or against firm, damp surfaces free of frost, ice, and free water. Dampen earth surfaces to receive fresh concrete.

3. Consolidation: Consolidate concrete in accordance with ACI 301, Section 5.3.2.5. Avoid contact between vibrator head and forms, reinforcement, or embedded items.

4. Construction joints: Make in accordance with ACI 301, Section 5.3.2.6. Coat joints with epoxy resin, in accordance with manufacturer recommendations.

5. Expansion and Contraction Joints:

   a. Make in accordance with ACI 301, Section 2.2.2.5.

   b. Saw cuts are used to create control joints in concrete. The cuts should be made at a predetermined spacing and only after the concrete has obtained sufficient strength to prevent raveling, but before internal cracking begins. Typically, these cuts are made the morning following the pour.

   c. Install control joint filler in accordance with manufacturer instructions.

   d. Install joint filler 1/2 in. (6 mm) below concrete finish level.

   e. Prior to sealing, slide expansion joint cap over the expansion joint.

   f. After concrete is placed and cured, install screwdriver through the top of expansion joint cap, pull free, and discard.

   g. Seal with suitable joint sealant as specified in Section 07 92 00, “Joint Sealants.”

6. Form Removal and Concrete Repair:

   a. Form removal: Remove in accordance with ACI 301, Section 2.3.2.

   b. Cut back form ties and examine concrete surfaces for defects. Repair only after permission for patching is given by the WRPS Construction Representative.

   c. Place concrete repair mortar within one hour after mixing. Do not re-temper mortar.

   d. Repair surface defects in accordance with ACI 301, Section 5.3.7. Cure concrete repairs same as new concrete. Repair and patch defective areas when approved by the WRPS Construction Representative. Remove and replace concrete that cannot be repaired and patched to the approval of the WRPS Construction Representative. Complete all concrete repairs prior to final acceptance.

7. Concrete Finishes and Tolerances:

   a. Measuring for tolerances shall be performed in accordance with ACI 301, Section 5.3.4.2.

   b. Formed surfaces: Start finishing following concrete repair and complete within 96 hours after forms have been removed. Finish in accordance with ACI 301 Section 5.3.3.

      i. Surfaces exposed to earth backfill: Rough form finish.

      ii. Exterior surfaces exposed to view and/or weather: Smooth form finish.

   c. Unformed surfaces: Finish in accordance with ACI 301, Section 5.3.4.

      i. Exterior slabs: Broom finish. Surface shall be flat per ACI 117, Section 4.8.

D. Place non-shrink grout where shown on Contract Drawings, in accordance with manufacturer recommendations.

3.3 CONCRETE PROTECTION AND CURING

A. Weather conditions: Protect concrete in accordance with ACI 301, ACI 308.1, and ACI 305.1 or ACI 306.1, if weather conditions so dictate.

B. Cure concrete in accordance with ACI 301, Section 5.3.6. Clear curing compounds shall be tinted or applied to surfaces marked to show extent of spraying.

C. Protect concrete during adverse weather conditions in accordance with ACI 301.

D. Protect concrete from mechanical damage in accordance with ACI 301, Section 1.8.

3.4 FIELD INSPECTIONS AND TESTS

A. Engage a qualified special inspector and qualified testing and inspecting agency to perform field tests and inspections, and prepare test reports.

B. Personnel performing field testing of concrete shall be ACI Concrete Field Testing Technicians, Grade I, and personnel performing laboratory testing shall be certified as an ACI Concrete Laboratory Technician, Grade 1 (or higher).

C. Pre-Pour Inspection: A concrete Pre-Pour Inspection Checklist shall be prepared and signed off prior to any concrete pouring. The inspection checklist shall include inspection of the following items prior to pouring concrete: forms, reinforcement, design mix, chamfer of exposed concrete edges, subgrade, embedments, and other items that may need inspection.

   Ensure rebar is correctly located, supported, and tied. Document on Pre-Pour Inspection Checklist along with other required attributes.

D. Concrete samples shall be obtained in accordance with ASTM C172 for each 50 cubic yards or fraction thereof of concrete placed in any given day. Each concrete test sample shall be tested as follows.

1. Air content per ASTM C231.

2. Slump per ASTM C143.

3. Concrete temperature and surrounding air temperature shall also be measured at point of discharge each time a set of compressive strength test specimens is made and hourly when ambient temperature is below 40°F or when above 80°F.

4. Mold, transport, cure, and test concrete strength test specimen per ASTM C31, ASTM C511, and ASTM C39. The required number and frequency of test specimens shall be in accordance with the following table.

PART 4 SCHEDULE OF CONCRETE TEST CYLINDERS

Table 4-1. Cylinders to be Tested.

	Number of Cylinders to be Tested at Various Ages for Each 50 Cubic Yards of Concrete or Faction Thereof		
Cylinder Size	7 Days	28 Days	Spare
6” x 12”	2 cylinders	2 cylinders	2 cylinders
4” x 8”	3 cylinders	3 cylinders	3 cylinders

Notes:

1. One set of two 6” x 12” (150 mm x 300 mm) cylinders or one set of three 4” x 8” (100 mm x 200 mm) cylinders comprises a strength test.

2. If any cylinder in the 28-day strength test shows evidence of improper sampling, molding, or testing, discard the specimen and use one of the spare cylinders to determine the strength. Other spare cylinders may be used only when authorized by the purchaser. The Contractor shall not use these cylinders for any other purpose and shall make additional cylinders if additional strength tests are desired such as 3-day test.

END OF SECTION 03 30 00

SECTION 05 05 38

CONCRETE ANCHORS

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Material and installation for post-installed concrete anchors shall conform to the requirements of this Section.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. ASTM International (ASTM)

ASTM C881/C881M	Epoxy-Resin-Based Bonding Systems for Concrete
ASTM E488/E488M	Strength of Anchors in Concrete and Masonry Elements
ASTM E1512	Testing Bond Performance of Adhesive-Bonded Anchors
ASTM F593	Stainless Steel Bolts, Hex Cap Screws and Studs

B. American Concrete Institute (ACI)

ACI 318	Building Code Requirements for Structural Concrete
ACI 349-06	Code Requirements for Nuclear Safety-Related Concrete Structures
ACI 355.2	Standard for Evaluating the Performance of Post-Installed Mechanical Anchors in Concrete
ACI 355.4	Qualification of Post-Installed Adhesive Anchors in Concrete

C. International Code Council (ICC)

ICC-ES AC01	Acceptance Criteria for Expansion Anchors in Masonry Elements
ICC-ES AC58	Acceptance Criteria for Adhesive Anchors in Masonry Elements

ICC-ES AC308	Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements

D. U.S. Federal Government Specifications

A-A-1922A, A-A01923A and A-A-55614 for Expansion and Shield-Type Anchors

1.3 SUBMITTALS

A. Submit product data and manufacturer installation instructions to Owner for record. All documents shall be submitted in accordance with the requirements.

B. Test Reports: ICC-ES Code approvals and performance data that includes recommended loading for each application.

C. Only manufacturers with an ICC-ES Report will be considered for substitution requests. Contractor shall submit, for Engineer review, calculations that are prepared and sealed by a registered Professional Engineer showing substituted product can achieve an equivalent holding capacity using the appropriate design procedure as required by the Building Code. The calculations should indicate diameter and embedment—with consideration of all applicable reduction and modification factors—for substituted product to achieve equivalent performance of that illustrated on the Design Drawings. Any increase in material costs for such submittal shall be the responsibility of the Contractor.

1.4 QUALITY ASSURANCE

A. Post-installed anchors and related materials shall be listed by one or more of the following agencies, as applicable:

1. ICC-ES
2. UL and/or FM

B. Post-installed anchors shall be qualified as Anchor Category I anchors (low sensitivity to installation and high reliability) in accordance with ACI 355.2 Chapter 10 and ACI 349-06 Commentary Section RD.3.3.

C. Post-installed anchors shall also be qualified for use in cracked concrete and shall have passed the Simulated Seismic Tests in accordance with ACI 355.2. Pullout strength, Np, and steel strength of the anchor in shear, V_{sa}, shall be based on the results of ACI 355.2 Simulated Seismic Tests.

D. Anchors qualified for use only in uncracked concrete are not permitted.

E. Anchors qualified for use only in redundant applications are not permitted.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to job site in manufacturer or distributor packaging undamaged, complete with installation instructions.

B. Protect and handle materials in accordance with manufacturer recommendations to prevent damage or deterioration.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Drillco National Group, Astoria, NY 11103

B. Hilti Corp., Plano, TX 75024

C. ITW Ramset/Red Head, Glendale Heights, IL 60137

D. Powers Fasteners, Inc., Brewster, NY 10509

E. Simpson Strong-Tie Co., Pleasanton, CA 94588

2.2 EXPANSION ANCHORS

A. Concrete expansion anchors shall be used where specifically stated on the Drawings.

B. Expansion anchors are used for the installation of comparatively light metal accessories that are not required to be installed before the concrete is placed. Expansion anchors will not be permitted in applications that will be subjected to vibrations or impact loads.

C. Expansion anchor body, nut, washer, and expansion sleeve shall be Type 316 stainless steel. All threaded portions of stainless steel anchors shall be coated with an approved thread lubricant (anti-seize).

D. Acceptable Products:

1. Hilti, Inc., Kwik Bolt®[2] TZ SS 316,

2. ITW Ramset/Red Head, Trubolt®[3] Wedge,

3. Simpson Strong-Tie Company, Inc., Strong-Bolt®[4] 2 Wedge Anchor,

4. Or approved equal.

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[2] Kwik Bolt is a registered trademark of Hilti Aktiengesellschaft Corporation, Liechtenstein.
[3] Trubolt is a registered trademark of Illinois Tool Works, Inc., Glenview, Illinois.
[4] Strong-Bolt is a registered trademark of Simpson Strong-Tie Company, Inc., Pleasanton, California.

2.3 ADHESIVE ANCHORS

A. Concrete Adhesive Anchors: Anchors shall be Type 316 stainless steel studs, bolts, nuts, and washers. After anchor stud installation, and prior to assembly, all threaded portions of stainless steel bolts, studs, and cap screws shall be coated with an approved thread lubricant (anti-sieze).

B. Two-Part Chemical Adhesives: Adhesives shall be a cartridge-type, two-component, solid epoxy-based system dispensed and mixed through a static mixing nozzle supplied by the manufacturer. It shall be insensitive to moisture, and be designed for installation in adverse environments. The cure temperature, pot life, and workability of adhesive shall be compatible for intended use and anticipated environmental conditions.

C. Manufacturers and Products for Two-Part Adhesives for use with solid base concrete:

1. Hilti Corp., Plano, TX:
   a. HIT-HY 200
   b. HIT-RE 500 v3
2. ITW Ramset/Red Head, Glendale Heights, IL:
   a. C6 Epoxy
   b. G5 Epoxy
   c. A7 Acrylic
3. Powers Fasteners, Brewster, NY:
   a. Pure110+
   b. AC100+Gold®[5]
4. Simpson Strong-Tie Co., Pleasanton, CA:
   a. AT
   b. SET-XP
   c. SET

D. Adhesive Limitations:

1. Installation Temperature: When the base material temperature drops below 40°F (5°C), only Acrylic Adhesives shall be used for adhesive installations. See manufacturer instructions for additional minimum temperature requirements.

[5] AC100+Gold is a registered trademark of Powers Fasteners, Inc., Brewster, New York.

2. Moisture: Refer to manufacturer information when moisture is present in or around hole.

3. Oversized Holes: Refer to manufacturer information if drilled hole size is larger than what is recommended.

4. Core-drilled Holes: Refer to manufacturer information if holes are drilled with a core-drill bit.

2.4 ANCHOR SIZES

A. Anchor size (nominal diameter and embedment as appropriate) shall be as indicated on the Design Drawings. If not indicated on these Drawings, sizes shall be provided as required to maintain not less than the appropriate Code safety factors over manufacturer performance load tables. If the actual concrete compressive strength is not known, the compressive strength shall be determined through testing.

PART 3 EXECUTION

3.1 GENERAL

A. Drilled-in concrete anchors shall be installed in accordance with the manufacturer printed instruction/specifications and to the requirements specified herein. In case of conflict, the requirements specified herein shall govern. The locations where anchors will be installed, and the sizes and types of anchors, shall be as indicated on the Design Drawings.

B. Where manufacturer recommends use of special tools for installation of anchors, such tools shall be used unless otherwise permitted specifically by the Owner.

C. The minimum projection of the threaded part of a bolt, beyond the nut. Shall be 1/4 in. (6 mm), after anchor installation is completed. The projection over 1/4 in. (6 mm) shall not be removed without Owner approval.

D. The overall anchor length and hole depth that is required shall be determined by the Contractor, such that the specified minimum effective embedded length and bolt projection can be obtained.

E. Holes for the anchors may be drilled through hardened grout, finished concrete, or surface repaired concrete, but the effective embedded length shall be determined from the surface of the rough concrete. Holes shall not be drilled through grout or concrete that has not completely hardened, nor shall grout or concrete be placed around untightened anchors.

F. Reuse of anchors **WILL NOT BE PERMITTED**.

G. Anchors that are 1/4 in. (6mm) diameter are allowed in all locations as indicated on the Design Drawings, provided the required hole depth is less than the depth of the concrete covering the main reinforcement.

H. Welding of/to anchors **WILL NOT BE PERMITTED**.

I. Expansion anchors shall not be used for equipment subjected to vibration (i.e., rotating machinery) or to support piping subjected to flow induced vibrations.

J. Minimum effective embedded lengths (Le), spacings (S), edge distance (ED), and distance to embedded steel (ES) shall be adjusted as follows under certain conditions:

1. When two anchors of different diameters are installed adjacent to each other, the dimension "S" shall be the average of the two "S" dimensions for these diameters, respectively.

2. If dimensions ED, ES, and S cannot be maintained between two anchor assemblies, the allowable erection tolerance indicated on the Design Drawings shall be used to resolve the problem. If the problem involves anchors installed by two different Contractors, their erection tolerances shall be used, or Owner shall be notified for a resolution.

3. Distance from the centerline of an anchor to the edge of an embedded steel plate shall be equal to or less than S.

K. Anchor relocation tolerances may be provided by the Engineer of Record to avoid cutting of reinforcing steel.

3.2 DRILLING OF HOLES

A. For all anchors, holes in concrete shall be drilled with quality carbide tipped solid bits, using a rotary, or percussion-type power drill.

B. Embedded Items: Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing reinforcing or embedded items. Notify the Engineer if reinforcing steel or other embedded items are encountered during drilling. Take precautions, as necessary, to avoid damaging electrical and telecommunications conduit.

C. Each hole shall be drilled precisely in order to maintain the anchor pullout value. The tolerances on the bit shall be as specified by the anchor manufacturer for each anchor size. The anchor shall be no more than 6° out of plumb after installation of undercut anchors or 10° out of plumb after installation of other anchors. Holes shall be cleaned in accordance with the manufacturer recommendations. Square or rectangular beveled washers shall be used to maintain full bearing of the nut.

D. The maximum depth of the hole shall not be greater than the thickness of the concrete, minus 2 1/2 in. (65 mm).

E. Holes for the anchors shall not be drilled until the concrete has been cured for a minimum of 28 days.

F. If drilled holes are not used, they shall be filled with dry-pack grout.

3.3 TIGHTENING OF ANCHORS

A. After the anchors are driven into the holes, they shall be brought to a "hand-tight" condition so that all parts of the connection are in good contact with one another.

B. Anchors shall be tightened to the torque values recommended by the manufacturer. Contractor shall exercise caution not to over-torque the anchor, causing damage to the concrete or anchor. Tightening shall proceed systematically from the most rigid or inner part of the connection to its free edges. During this operation, there shall be no rotating of the parts, except the nuts and washers.

C. A calibrated torque wrench shall be used for tightening anchors. Calibration and recalibration shall be performed on the following frequency:

1. For a direct reading torque wrench, on a monthly basis.

2. For a snap-type torque wrench, on a monthly basis.

3. For an air-driven impact wrench, on a daily basis.

3.4 REPAIR OF FAILURES

A. Failures shall be rectified as follows:

1. Concrete Failure (this includes all cracking or spalling of the concrete in the vicinity of an installed anchor):

   a. Concrete shall be repaired in accordance with the project concrete repairing procedure.

   b. After the concrete has been repaired, the anchor hole may be redrilled, in accordance with Article 301.2 of this Section.

2. Anchor Failure (this includes anchor breakage, slippage or loosening to the extent that the anchor cannot be tightened to the installation torque):

   a. If the unacceptable anchor can be removed without damaging the surrounding concrete, the hole may be redrilled and the anchor replaced with the next larger size anchor. The effective embedded length shall conform to the requirements of the manufacturer.

   b. If the unacceptable anchor cannot be removed without damaging the surrounding concrete, the anchor location shall be moved within the tolerance given for the connection by the Engineer of Record. The minimum center-to-center distance from the unacceptable anchor to the replacement hole shall be two times the nominal bolt diameter. If this distance exceeds the given tolerance on the placement of the anchors, Owner shall be notified before proceeding.

3.5 INSPECTION AND TESTING

A. Special inspection, periodic or continuous, of post-installed anchors shall be provided as required by ICC Reports and/or as specified by the Engineer of Record. This service shall be performed by an independent testing/inspection agency hired by the Contractor.

B. The Engineer of Record may require pullout or shear tests, in addition to Special Inspection to determine the adequacy of the anchors. A field-testing program shall be established by the independent test laboratory and/or the Engineer of Record and performed in accordance with appropriate ASTM test standards. Field tests shall be non-destructive when at all possible.

C. During the course of the work, Owner may inspect the various phases of the work at the Project Site, for full compliance with the requirements specified herein and to the requirements indicated on the Design Drawings. Any work failing to meet the specified requirements shall be rectified or replaced by Contractor at its expense.

END OF SECTION 05 05 38

SECTION 05 50 00

METAL FABRICATION

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Fabrication of steel or other metal structures and equipment shown on Design Drawings.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American Society of Mechanical Engineers (ASME)

ASME B&PVC, 2017	Boiler and Pressure Vessel Code
Section IX	Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operations

B. American Society for Nondestructive Testing (ASNT)

ASNT SNT-TC-1A, 2016	Personnel Qualifications and Certification in Nondestructive Testing

C. ASTM International (ASTM)

ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A240/A240M	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A992	Standard Specification for Structural Steel Shapes

D. American Welding Society (AWS)

AWS D1.1/D1.1M, 2015	Structural Welding Code – Steel
AWS D1.6/D1.6M, 2017	Structural Welding Code – Stainless Steel

AWS QC1 Certification of Welding Inspectors

1.3 SUBMITTALS

A. See the Contract Statement of Work for submittal procedures.

B. Approval Required:

1. Welding personnel qualifications: Five days minimum before start of fabrication, submit Welder Performance Qualification Records and Welder Continuity Logs, as required by Paragraph 1.4.B.1.

2. Welding procedure qualifications: Five days minimum before first use, submit Weld Procedure Specifications and Procedure Qualification Records, as required by Paragraph 1.4.B.1.

3. Examination personnel certifications and qualifications: Five days minimum before first use, submit examination personnel qualification, as required by Paragraph 1.4.B.2.

4. Examination procedures: Five days minimum before start of fabrication, submit examination procedures, as required by Paragraph 1.4.B.3.a.

5. Carbon Steel Weld Examination, as required by Paragraph 3.5.A.1.

6. Shop Drawings and production travelers.

C. Approval Not Required: None.

1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

A. Misrepresented Products: See the Contract Statement of Work for required measures to prevent use of misrepresented products.

B. Qualifications of Welding Personnel and Procedures:

1. Personnel and procedures for welding structural carbon steel shall be qualified in accordance with AWS D1.1/D1.1M for steel structure before welding. Qualification of welding personnel and procedures in accordance with ASME B&PVC, Section IX, may be substituted for components welded in accordance with AWS D1.1/D1.1M. Maintain copy of welding procedure Specifications, procedure qualification records, and welder performance qualification test results and renewal of qualification documentation. Where stainless steel materials are welded to carbon steel, (or stainless to stainless), AWS D1.6/D1.6M procedures shall govern, unless ASME B&PVC, Section IX, was substituted.

2. Qualification of examination personnel: Maintain copies of examination personnel certifications and written examination performance procedures.

a. Personnel performing visual examinations shall be Certified Welding Inspectors who have received certification in accordance with AWS QC1.

b. Personnel performing other nondestructive examinations (NDEs) shall be certified in accordance with approved procedure, which shall meet the requirements of ASNT SNT-TC-1A. Use Level II or III personnel to interpret results.

3. Qualification and certification of NDE personnel shall be in accordance with the written practice of the vendor, based on the Recommended Practice ASNT SNT-TC-1A.

a. Examination procedures: Examination procedures shall be in accordance with AWS D1.1/D1.1M or AWS D1.6/D1.6M as applicable, and this Specification. Examination shall use statically loaded criteria for both codes. Maintain copies of examination procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See the Contract Statement of Work for general requirements.

1.6 PROJECT CONDITIONS

A. General: Every item shipped is to arrive at the job site in the same condition as when it passed all quality control inspections and tests.

B. Preservation and Packaging: All items shall be dried and cleaned to protect against rust and corrosion. Do not wrap the assemblies in shrink-wrap or other substances that can cause condensation to collect inside the wrapper. All items shall be protected from dirt, soil, and moisture and packaged for long-term storage in an unprotected exterior environment. All items shall be boxed, crated, or otherwise packaged to eliminate damage during shipping, handling, and storage.

C. Marking: Packages shall be suitably marked on the outside to facilitate identification of the purchase order, the procurement Specification, the package contents, and any special handling instructions.

1.7 PERMITS

A. Obtain and conspicuously post the following permits before starting work under this Section.

1. Hot Work Permit: See the Contract Statement of Work.

PART 2 PRODUCTS

2.1 SUBSTITUTES

A. See the Contract Statement of Work for substitution approvals.

2.2 MATERIALS

Use the following materials, unless otherwise shown on Contract Drawings:

A. Rolled Steel Shapes, Plates, and Bars: ASTM A36, ASTM A992 Grade 50, or ASTM A240/A240M Grade 304L.

B. Hollow Structural Sections (i.e., Steel Tubing): ASTM A500, Grade B

C. Fasteners

1. Weld studs: Nelson Stud Welding Co., Type H4L or approved substitute.

D. Welding Electrodes/Filler Metal:

1. Carbon steel – Matching filler metal with F_u = 70,000 psi (minimum).

E. Coating: See Section 09 91 00, “Painting.”

2.3 FABRICATION

A. General

1. Verify measurements, including field measurements, before fabrication. Provide miscellaneous bolts and anchors, supports, braces, and connections necessary for completion of metal fabrications. Cut, reinforce, drill, and tap metal fabrications shown to receive finish hardware and similar items. Weld or bolt connections as shown on the Drawings.

2. Perform welding of steel connections in accordance with AWS D1.1/D1.1M or AWS D1.6/D1.6M, as applicable.

B. Miscellaneous Steel Items: Supply required clips, frames, equipment supports, and other fabrications not shown on the Drawings. Fabricate parts from standard structural sections or shapes, to sizes required. Wherever miscellaneous parts are exposed, grind edges, corners, and rough cuts smooth and free of snags. Shop paint parts except those to be embedded in concrete or those that require other specific finishes.

C. Finishes

1. Prime and paint ferrous metal in accordance with Section 09 91 00, “Painting.” Do not coat members to be embedded in concrete, surfaces and edges to be field welded, or items to be galvanized. Shop paint may extend into embedded areas where impractical to remove.

2. Touch up damaged zinc surfaces with zinc-rich coating. Apply in accordance with manufacturer instructions.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas where metal fabrications are to be installed and notify the WRPS Construction Representative, in writing, of conditions detrimental to proper and timely completion of work. Do not proceed with work until detrimental conditions have been corrected.

3.2 PREPARATION

A. Prepare setting Drawings, diagrams, templates, and instructions for installation of anchorages, such as concrete inserts and miscellaneous items having integral anchors to be embedded in concrete. Coordinate with WRPS Construction Representative for delivery of items to Site.

3.3 INSTALLATION

A. Install metal fabrications plumb, level, or as shown on the Drawings.

B. Make field connections as neatly as possible, with joints flush and smooth. Grind smooth exposed field welds before field painting. Repair welds in galvanized work with two coats of zinc-rich coating.

C. Weld Studs: Installation, testing and welder qualification shall be in accordance with the manufacturer written instructions and AWS D1.1/D1.1M, Section 7 for carbon steel, or AWS D1.6/D1.6M, Section 9, for stainless steel.

3.4 APPLICATION

A. After installation has been completed, clean and paint connections with primer. Touch-up shop prime coat, wherever damaged. Repair breaks in galvanized coating with zinc-rich coating.

3.5 FIELD INSPECTIONS AND TESTS

A. Weld Examination

1. Perform visual examination of steel welds in accordance with AWS D1.1/D1.1M and AWS D1.6/D1.6M, Sections 6.5 and 6.9 (statically loaded structures). Record examination results.

END OF SECTION 05 50 00

SECTION 07 92 00

JOINT SEALANTS

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Clean and prepare joint surfaces.

B. Apply sealant and backing materials.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. Code of Federal Regulations (CFR)

40 CFR 59	National Volatile Organic Compound Emission Standards for Consumer and Commercial Products

B. ASTM International (ASTM)

ASTM C920	Elastomeric Joint Sealants

1.3 SUBMITTALS

A. Submit the following in accordance with the Contract Statement of Work.

1. Catalog Data: Manufacturer data sheets on each product to be used, including preparation instructions and recommendations, storage and handling requirements and recommendations, and installation methods. Additional information to include Material Safety Data Sheet, shelf life, and temperature range of storage and application.

1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

A. Installer qualifications: Trained and/or experienced in the application of sealants to be used.

B. Source limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Contract Statement of Work.

B. Store products in manufacturer unopened packaging, with labels intact, until ready for installation.

C. Store products off ground.

D. Store materials at minimum of 68°F for at least 24 hours prior to installation, regardless of temperature at location.

E. Do not allow materials to freeze prior to application.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. See the Contract Statement of Work for substitution approvals.

2.2 MATERIALS

A. General: Provide exterior sealants that comply with the following limits for volatile organic compound content when calculated according to 40 CFR 59, Subpart D (EPA Method 24) or approved equal:

1. Sealants for Nonporous Substrates: 250 g/L.

2. Sealants for Porous Substrates: 775 g/L.

B. Sealant: Single component, traffic-grade, neutral-curing silicone joint sealant - ASTM C920, Type S, Grade NS or P, Class 100/50 or approved equal.

2.3 ACCESSORIES

A. Joint Cleaner: Noncorrosive and nonstaining type, recommended by sealant manufacturer, compatible with joint-forming materials.

B. Joint Sealant Backing: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

C. Bond Breaker: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

2.4 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 EXECUTION

3.1 EXAMINATION

A. Prior to installation, ensure that joint dimensions and physical and environmental conditions are suitable for application of joint sealers.

B. By beginning work of this Section, subcontractor warrants it has examined and verified that existing conditions are in accordance with provisions of Paragraph 3.1.A.

3.2 PREPARATION

A. Clean, prepare, and size joints in accordance with manufacturer instructions. Remove any loose materials and other foreign matter that might impair adhesion of sealant.

B. Verify that joint-shaping materials and release tapes are compatible with sealant.

C. Examine joint dimensions and size materials to achieve required width/depth ratios.

D. To allow sealants to perform properly, use joint filler to achieve required joint depths.

E. Use bond breaker where required.

3.3 INSTALLATION

A. Install sealant per manufacturer instructions.

B. Apply sealant within recommended temperature ranges. Consult manufacturer when sealant cannot be applied within recommended temperature ranges.

C. Tool joints as indicated on Drawings.

D. Joints: Free of air pockets, foreign embedded matter, ridges, and sags.

E. Coverage: Replace sealants that fail because of loss of cohesion or adhesion onto surfaces applied, or that does not cure. If the sealant can be detached from a surface by rubbing the surface contact point with a finger, then the surface adhesion is inadequate.

F. Follow manufacturer recommended cure time before painting or over coating.

END OF SECTION 07 92 00

SECTION 09 85 50

CHEMICAL RESISTANT DECONTAMINABLE COATINGS

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. This applies to the special protective coatings applied to the finished concrete catch basin.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American National Standards Institute (ANSI)

ASNI N512	Protective Coatings (Paints) for the Nuclear Industry

B. ASTM International (ASTM)

ASTM D412	Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers – Tension
ASTM D570	Test Method for Water Absorption of Plastics
ASTM D638	Test Method for Tensile Properties of Plastics
ASTM D714	Test Method for Evaluating Degree of Blistering of Paints
ASTM D772	Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints
ASTM D1653	Test Methods for Water Vapor Transmission of Organic Coating Films
ASTM D3912	Test Method for Chemical Resistance of Coatings Used in Light – Water Nuclear Power Plants
ASTM D4060	Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4082	Test Method for Effects of Gamma Radiation on Coatings for Use in Light – Water Nuclear Power Plants

ASTM D4256	Test Method for Determination of the Decontaminability of Coatings Used in Light – Water Nuclear Power Plants
ASTM D4529	Standard Practice for Abrading Concrete
ASTM D4263	Test Method for Indicating Moisture Content in Concrete by the Plastic Sheet Method
ASTM D4541	Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D5139	Sample Preparation for Qualification Testing of Coatings to be Used in Nuclear Power Plants
ASTM D5144	Guide for Use of Protective Coating Standards in Nuclear Power Plants
ASTM E84	Test Method for Surface Burning Characteristics of Building Materials

D. National Fire Protection Association®[6] (NFPA®)[6]

NFPA 255	Method of Test of Surface Burning Characteristics of Building Materials

C. Steel Structures Painting Council (SSPC)

SSPC SP 3	Power Tool Cleaning
SSPC SP 6	Commercial Blast Cleaning

D. U.S. Department of Energy

	Waste Isolation Pilot Plant Industrial Safety and Health (IS&H) Manual

1.3 SUBMITTALS

A. See the Contract Statement of Work for submittal procedures.

B. Approval Required

1. List of materials: Unless specified on the design media, before delivery, submit colors and location to be used, and manufacturer catalog data sheets and charts showing adequate information to substantiate compliance to the requirements of this Section. Submittal shall also enumerate percentage of volatile and nonvolatile materials, percentage of component parts of each type of material,

[6] National Fire Protection Association, NFPA, NFPA 70, and NEC are registered trademark of National Fire Protection Association, Quincy, Massachusetts.

and the conversion factors to determine dry-film thickness from applied wet-film thickness. Also, submit Material Safety Data Sheets for materials proposed to be used.

2. Installers certificate (decontaminable coatings only): Before application, submit documentation that the application crew has been certified by the coating system manufacturer, as qualified to apply the selected coating system. As an alternative to crew certification, a submittal documenting onsite training by a technical representative from the coating manufacturer would be acceptable.

C. Approval Not Required: None.

1.4 QUALITY ASSURANCE

See Division 01 – General Requirements (under separate cover).

1.5 DELIVERY, STORAGE, AND HANDLING

A. See the Contract Statement of Work for general requirements. Store materials indoors.

1.6 PROJECT CONDITIONS

A. Environment for Coating: Coat exterior surfaces only when ambient and surface temperatures are within the range recommended by the coating manufacturer for the respective coating, which is within 40°F to 120°F, and ambient temperature is 5°F above the dew point.

B. General: Ensure that surfaces are dry and have attained required temperatures and conditions before starting work or continuing previously started work.

C. Weather: No exterior work shall be performed on unprotected surfaces if rain or moisture from other sources is present or expected before applied finishes can dry or attain proper cure.

D. Dust: No finishes shall be applied if dust is being generated at worksite.

PART 2 PRODUCTS

2.1 SUBSTITUTIONS

A. See the Contract Statement of Work for substitution approvals.

2.2 MATERIALS

A. Coating is limited to coat/repair/recoat of the catch basin surfaces and coating of newly installed plain carbon steel material located on the catch basin surface.

B. Primer for carbon steel assemblies: Inorganic zinc primer – "Dimetcote®[7] Steel Primer 21-5" by the Protective Coatings Division of Ameron.

C. Coating are to follow:

Manufacturer: Ameron, or Approved Substitute	
Use	**Product**
Field Primer	Amerlock®[8] 2/400
Concrete Surfacer	Nu-Klad 114A
Primer & Base Coating	Amerlock 400
Intermediate & Finish Coating	PSX 700 Siloxane

D. Filler and joint sealant as follows: "Nu-Klad 750A/760A" by Ameron Protective Coating Group, "Sikaflex – 1A" by Sika Corporation, or "COR-SEAL PS" by General Polymers.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces scheduled to receive coatings for conditions that will adversely affect execution, permanence, and quality of work, and which cannot be corrected through specified preparation.

B. Report, in writing to WRPS Construction Representative, conditions that may affect proper application of finish. Correct unsuitable conditions before beginning surface preparation or coating application.

3.2 PREPARATION

A. Ferrous Metal and Carbon Steel:

1. Prepare shop assemblies in accordance with SSPC SP 6. Remove abrasive residue and dust, and prime within four hours after preparation. Apply minimum of 0.5 mil of shop primer in accordance with manufacturer recommendations.

2. Prepare field erections in accordance with SSPC SP 3 and SSPC SP 6. Remove abrasive residue and dust, and prime within four hours after preparation.

B. Preparing a previously coated surface to be recoated:

1. Edges of tightly adherent coating remaining around the area to be recoated must be feathered so that the re-coating surface has a smooth finish.

[7] Dimetcote is a registered trademark of Amercoat Corporation, South Gate, California.
[8] Amerlock is a registered trademark of PPG Industries Ohio, Inc., Cleveland, Ohio.

C. Prepare of repair construction joints, shrinkage cracks, and other non-expanding cracks, gaps, or crevices in the surface to be coated, in accordance with coating manufacturer recommendations. Scratches, cracks, holes, entrapped air pockets, and abrasions shall be cut back to proper key and filled with surfacer, specified in Paragraph 2.2.C.

D. Post-priming:

1. Feather abrasions, chips, skips, and holidays occurring in prime coat by sanding, and recoat with material and color to minimum dry film thickness specified.

2. Previously coated surfaces shall be re-coated only after existing film is completely dry. Some coating systems require application of succeeding coats within a set time frame in order to properly adhere to the previous coat. Should the time frame recommended by the coating manufacturer be exceeded, prepare the base coat as recommended by the coating manufacturer.

3.3 APPLICATION

A. Apply coating materials and cure in accordance with manufacturer recommendations.

B. Apply with equipment recommended by coating manufacturer.

C. Coatings for new concrete shall be in accordance with coating schedule in Paragraph 3.6. Runs, drips, and other finish discontinuities shall be removed and surface repaired, to ensure smooth decontaminable surfaces.

3.4 PROTECTION

A. Provide and install drop cloths, shields, and other protective devices required to protect surfaces adjacent to areas being coated. Keep spatter, smears, droppings, and over-run of coating materials to a minimum and remove as coating work progresses.

B. Protect coating from rain until dry to the touch.

A. Upon completion of each coating application, protect coated surfaces from physical damage. Provide temporary stanchions, ropes, barricades, signs, etc., as required, to prevent foot or vehicular traffic (excepting application crew) on polyurethane-coated surfaces, for a minimum duration noted in the following chart:

Daily Mean Temperature	Minimum Duration of Protection	
	With Accelerator	Without Accelerator
Above 70°F	2 Days	5 Days
Between 55°F and 69°F	5 Days	10 Days
Between 45°F and 54°F	7 Days	14 Days

3.5 CLEANING

A. Collect and dispose of materials spotted or soaked with paint, oil, or solvents, and other flammable waste materials, daily, in accordance with the IS&H Program Manual. Minimize volume of potentially contaminated solids and liquids that must be disposed.

B. Salvageable brushes, rollers, spatulas, and spray equipment shall be thoroughly cleaned after use and shall contain no oils, thinners, or other residue.

C. Dispose of empty cans at the end of each shift, in accordance with the Statement of Work.

D. At completion of coating work, remove and dispose of materials, containers, rags, cloths, brushes, equipment, and miscellaneous other debris, in accordance with the Statement of Work. Clean up spills and report, if required, in accordance with the Statement of Work.

3.6 COAT SCHEDULE

Coat	Description	Color (*see note)	Minimum Dry Film µm (mils)
Concrete			
Base	Prime and base coats may be applied in a single 180 µm coat, if base coat is self-priming.	*	100 (4.0)
Intermediate	Intermediate and finish coats may be applied in a single 200 µm dry film coat.	*	100 (4.0)
Finish	Intermediate and finish coats may be applied in a single 200 µm dry film coat.	*	100 (4.0)
Carbon Steel			
Primer	Inorganic Zinc.	*	13 (0.5)
Field Primer	Prime and base coats may be applied in a single 180 µm coat.	*	75 (3.0)
Base	Prime and base coats may be applied in a single 180 µm coat.	*	100 (4.0)
Intermediate	Intermediate and finish coats may be applied in a single 200 µm dry film coat.	*	100 (4.0)
Finish	Intermediate and finish coats may be applied in a single 200 µm dry film coat.	*	100 (4.0)

NOTE: Contrast each coat from primer-darker to finish-lighter. Finish coat to be off-white to white.

3.7 FIELD INSPECTIONS AND TESTS

A. Measure the Wet Film Thickness (WFT) of each coat of material with a notched WFT gage (Nordson 790-015) at a minimum of five evenly spaced points for each 100 ft^2 of surface area or portion thereof to verify the application will provide the specified minimum dry film thickness. Document results in work package or fabrication documentation.

B. Verify and document that the coating material is within its specified shelf life.

C. Document results to verify coating materials are applied as specified in this Section.

END OF SECTION 09 85 50

SECTION 09 91 00

PAINTING

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. This section includes materials, surface preparation and application of coatings for steel structures where specified per the Design Drawings.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. Society for Protective Coatings (SSPC)

SSPC-SP 3	Power Tool Cleaning
SSPC-SP 7/NACE No. 4	Brush-Off Blast Off Cleaning
SSPC-SP 10/NACE No. 2	Near White Blast Cleaning

1.3 SUBMITTALS

A. See the Contract Statement of Work for submittal procedures.

B. Approval Required

1. List of materials: Unless specified on the design media, before delivery, submit complete list of materials, colors, and location to be used. List shall enumerate percentage of volatile and nonvolatile materials and percentage of component parts of each type of material and the conversion factors to determine dry film thickness from applied wet film thickness.

2. Dry film thickness test results as required by Paragraph 3.6.A.

C. Approval Not Required: None.

1.4 QUALITY ASSURANCE

See Division 01 – General Requirements (under separate cover).

1.5 DELIVERY, STORAGE, AND HANDLING

A. See the Contract Statement of Work for general requirements. Store materials indoors.

1.6 PROJECT CONDITIONS

A. General: Ensure that surfaces are dry and have attained required temperatures and conditions before starting work or continuing previously started work.

B. Weather: No exterior work shall be performed on unprotected surfaces if rain or moisture from other sources is present or expected before applied finishes can dry or attain proper cure.

C. Dust: No finishes shall be applied if dust is being generated at worksite.

D. Temperature

1. Unless recommended otherwise by paint manufacturer, apply coatings when the following temperatures exist.

    a. Coating: Epoxy.

    b. Ambient Temperature: As recommended by manufacturer.

    c. Surface Temperature: As recommended by manufacturer.

2. If necessary, provide temporary heat until specified temperatures exist for required time period. Maintain temporary heat for 24 hours after paint application.

E. Humidity: Follow manufacturer directions for extremes.

F. Ventilation: Provide ventilation recommended for extremes.

PART 2 PRODUCTS

2.1 SUBSTITUTIONS

A. See the Contract Statement of Work for substitution approvals.

2.2 MATERIALS

A. Furnish Sherwin-Williams MACROPOXY®[9] 646 Fast Cure Epoxy, Part A (B58-600) and Part B (B58V600).

B. Furnish Sherwin-Williams Zinc Clad IV Coating, Part U (B69A8) and Part V (B69V8).

C. Furnish Sherwin-Williams SEAGUARD®[9] MP Multi-Purpose Epoxy Primer, Part A (N12Y200) and Part B (N12V200).

D. Furnish PPG Amercoat/Amerlock 400, Low VOC/ High-solids epoxy coating.

E. Furnish PPG PSX 700, Engineered Siloxane Coating.

[9] MACROPOXY and SEAGUARD are registered trademarks of SWIMC LLC, Cleveland, Ohio.

F. Furnish appropriate applicators per manufacturer recommendations.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces scheduled to receive coatings for conditions that will adversely affect execution, permanence, and quality of work, and which cannot be corrected through specified preparation.

B. Report, in writing to WRPS Construction Representative, conditions that may affect proper application of finish. Correct unsuitable conditions before beginning surface preparation or coating application.

3.2 PREPARATION

A. Protection

1. Provide and install drop cloths, shields, and other protective devices to protect surfaces adjacent to areas being painted. Keep spatter, smears, droppings, and over-run of paint materials to a minimum and remove as painting work progresses.

2. Promptly remove spills, splashes, and splatter. Use removal methods that do not damage surfaces being cleaned/painted.

3. Repair or replace surfaces damaged by painting work as directed by TOC Construction Representative.

4. Remove electrical outlet and switch plates, mechanical diffusers, escutcheons, registers, surface hardware, fittings, fastening, and similar items before starting work.

B. New Surface Preparation

1. Carbon Steel:

a. Prepare surfaces for scheduled finish systems in accordance with SSPC-SP 10/NACE No. 2.

2. Obtain written approval from WRPS Construction Representative before using dry or liquid abrasive blasting.

C. Old Surface Preparation

1. Prepare touch up area for scheduled touch-up system in accordance with SSPC-SP 3.

3.3 APPLICATION

A. Perform work in accordance with manufacturer instructions and this Section.

3.4 CLEANING

A. Furnish and maintain at Site, closed metal containers for disposal of waste materials. Collect materials spotted or soaked with paint, oil, or solvents and place in containers.

B. At completion of coating work, remove materials, containers, rags, cloths, brushes, tools, and equipment from site.

3.5 SCHEDULES

A. Paint and Finish

1. Carbon Steel: Light and ordinary exposures (not galvanized).

a. Primer: Sherwin-Williams Zinc Clad. Shop apply one coat. Coat should be 3 mils in thickness. Apply per manufacturer instructions.

b. Top Coat: Sherwin-Williams MACROPOXY 646. Field apply two coats. Coats should be 5-6 mils in thickness. Apply per manufacturer instructions.

2. Touch-Up

a. Sherwin-Williams MACROPOXY 646. Field apply two coats. Coats should be 5-6 mils in thickness. Apply per manufacturer instructions.

3.6 FIELD INSPECTIONS AND TESTS

A. Measure the Wet Film Thickness (WFT) of each coat of material with a notched WFT gage (Nordson 790-015) at a minimum of five evenly spaced points for each 100 ft^2 of surface area or portion thereof to verify the application will provide the specified minimum dry film thickness. Document results in work package or fabrication documentation.

B. Inspection and testing will be performed by Quality Control Inspector.

END OF SECTION 09 91 00

SECTION 22 08 13

TESTING FOR PIPING

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Pressure testing of the following systems:

1. Process Piping (ASME B31.3)

2. Pressure testing shall be completed for the stainless steel piping (M-10) and the RTRP piping (M18). Pressure testing shall not be completed on the HDPE piping (M36).

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawing and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American Society of Mechanical Engineers (ASME)

ASME B31.3, 2016	Process Piping

B. ASTM International (ASTM)

ASTM E515-11	Standard Practice for Leaks Using Bubble Emission Techniques
ASTM E1003-13	Standard Practice for Hydrostatic Leak Testing

C. International Association of Plumbing and Mechanical Officials (IAPMO)

IAPMO UPC-2012	Uniform Plumbing Code

D. Underwriters Laboratories (UL)

UL 404	Standard for Gauges, Indicating Pressure, for Compressed Gas Service

E. Washington Administrative Code

WAC 173-303-640	Dangerous Waste Regulations Washington State
WAC 173-303-650	Surface Impoundments

1.3 SUBMITTALS

A. Action Submittals

1. Test plan for approval that includes:

    a. Material of construction.

    b. Design pressures.

    c. Test pressures and duration of tests.

    d. Test medium and method of achieving the test pressure.

    e. Certification on calibration of pressure gauges.

    f. Method to exclude personnel from the area containing the system to be tested.

    g. Over-pressurization protection/prevention: Device make/model number, certification, pressure relief set point, point of installation in system.

B. Informational Submittals

1. Test Reports: Submit within 10 working days of successful test.

1.4 QUALITY ASSURANCE

See Division 01, General Requirements (under separate cover).

1.5 DELIVERY, STORAGE, AND HANDLING

A. See the Contract Statement of Work for general requirements.

1.6 SUBCONTRACTOR REQUIREMENTS

A. Notify WRPS Subcontract Technical Representative at least 24 hours (1 working day) in advance, to arrange for onsite witnessing by WRPS inspector of the piping test (a hold/witness point).

B. Notify WRPS, immediately, in the event of any accidental discharge.

C. Notify WRPS Construction Representative at least 24 hours (1 working day) in advance, to arrange for onsite witnessing of the above described testing (a hold/witness point) by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.

1. IQRPE witnessing is limited to the work scope associated with the tie-in to the EMF and the 242-A condensate transfer lines, and ending at the new isolation valves installed within Basin 41 Catch Basin. Contract WRPS for further clarification.

PART 2 PRODUCTS

2.1 MATERIALS

A. Furnish instruments, equipment, material, and labor necessary to conduct tests.

B. Calibrate testing equipment, at reasonable intervals, with devices of accuracy traceable to National Institute of Standards and Technology (NIST). Test pressure shall be within the calibration range.

C. Test gauges used, shall be in accordance with IAPMO UPC-2012, Section 318.

1. Pressure gauges meeting Underwriters Laboratories (UL) in accordance with UL 404, Standard for Safety.

2. Gauges shall be protected by tempered safety glass, or plastic face or shield, and blowout back or plug.

PART 3 EXECUTION

3.1 GENERAL

A. After completion of NDE, perform leak/pressure testing of new piping in accordance with ASME B31.3 for normal service, this Section, and manufacturer recommendations.

B. Tie-In Joints:

1. Where leak/pressure testing of tie-in joints cannot be performed due to impracticability of leak/pressure test application, perform an initial service leak test in accordance with ASME B31.3, Paragraph 345.7. These joints may include tie-in flange connection to existing carrier pipe, bonds made to existing carrier pipe, or tee joints connecting new and existing piping.

2. Joints impracticable to leak/pressure test are where an existing expansion joint cannot be isolated from the leak test pressure, or where new piping cannot be isolated and leak tested without pressurizing long sections of existing piping. Tie-in joints that are impracticable to hydrostatically leak pressure test shall be identified by Contractor and approved by WRPS.

3.2 FIELD QUALITY CONTROL

A. Perform piping pressure test, before cleaning or flushing, to avoid possible discharge of chemicals due to pipe or joint failure during a pressure test.

B. All examination records and pressure test plans must be complete and submitted prior to testing.

C. Piping being tested shall remain exposed until WRPS has approved the test results.

D. Document testing of each piping system. Delineate, describe, and record each piping system. Within the description of each pressure test, include enough detail for correlation to weld/bond identification Drawings, shop fabrication Drawings, and/or project Design Drawing as applicable. For systems tested segmentally, provide references from various pressure tests to ensure entire systems have been tested.

E. Trenches may be backfilled between joints before testing, to prevent movement of pipe during testing. Ensure that thrust blocks are sufficiently hardened before testing.

F. Piping being tested shall not leak nor show any change in test pressure for duration specified, unless otherwise noted.

G. Where portion of piping system is to be concealed before completion, the portion shall be tested separately, as specified for the entire system.

H. Ensure piping supports are in place.

I. Isolate system gages, sensors, etc., from pressure tests, so instruments and devices are not damaged. Test pressure shall not exceed the maximum allowable test pressure for any vessel, pump, valves, or other component in the system.

J. Hydrostatic (Water) Testing:

1. Use potable water as test medium. Do not fill system until WRPS has approved the source of water supply.

2. Provide vents at high points to release trapped air while filling system.

3. Provide drains at low points for complete removal of test liquid.

4. Follow ASTM E1003 for detecting leaks, or use other enhanced detection methods, like pressure decay or vacuum decay techniques.

5. After the test duration, reduce pressure to design pressure and visually examine the system for leaks.

6. Drain system if there is a potential for freezing, e.g., no heat in building, coil in outside air stream, or other similar situations.

K. Pneumatic (Air) Testing – ASME B31.3 345.1(c), pneumatic testing is only allowed with Owner approval and is currently set at a maximum of 2 cubic feet (ft^3).

1. Use clean dry air (excluded from use with natural gas pipe testing) or inert gas as the test medium.

2. Barricade the area around the system to be tested.

3. Prior to application of full air test pressure, apply a preliminary test of not more than 10 psig to reveal possible major leaks.

4. After preliminary test, raise pressure in stages not more than 25% up to full test pressure, allowing at least 10 minutes for equalization of strain and detection of major leaks at each intermediate stage. Hold final test pressure for time specified.

   a. If test pressure is 25 psig or less, pressure can be raised in a single increment.

5. Use ASTM E515 for detecting leaks, or use other enhanced detection methods, like pressure decay or vacuum decay techniques.

6. After the test duration, reduce pressure to design pressure and visually examine the system for leaks.

L. If leaks are found, eliminate them by tightening, repair, or replacement, as appropriate, and repeat test until no leakage is found.

M. Where repairs or additions are made to piping system following the pressure test, test the affected piping. Testing is not required in cases where it does not include addition to, replacement, alteration or relocation of, any piping or in any cases where piping is set up temporarily for exhibition purposes.

3.3 RETESTING

A. If piping does not pass test, locate leak, safely vent pressure repair leaks, and repeat testing procedure until satisfactory results are obtained.

B. Make repairs to piping with new materials. Caulking on screwed joints, cracks, or holes is not acceptable.

C. Notify WRPS Construction Representative at least 24 hours (1 working day) in advance to arrange for onsite witnessing of the piping retesting (a hold/witness point) by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.

1. IQRPE witnessing is limited to the work scope associated with the tie-in to EMF and 242-A condensate transfer lines and ending at the new isolation valves installed within Basin 41 Catch Basin. Contract WRPS Construction Representative for further clarification.

END OF SECTION 22 08 13

SECTION 26 05 02

BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. This section covers the work required in conjunction with other Division 26 Specifications necessary to procure, detail, manufacture, deliver to the jobsite, and install the electrical systems.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. National Electrical Contractors Association (NECA)

	National Electrical Installation Standards

B. National Electrical Manufacturers Association (NEMA)

NEMA Z535.4	Product Safety Signs and Labels

C. National Fire Protection Association (NFPA)

D. NFPA 70, 2017 National Electrical Code (NEC

E. Underwriters Laboratories (UL)

	Electrical Appliance and Utilization Equipment Directory

1.3 SUBMITTALS

A. See Contract Statement of Work for submittal procedures.

1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

A. Provide the work in accordance with the NEC. Electrical material and equipment shall be accepted, certified, listed, labeled, or otherwise determined safe by a Nationally Recognized Testing Laboratory (NRTL) and indicated by an NRTL label applied by the manufacturer or labeled by an NRTL representative following an NRTL field evaluation to provide basis for approval under NEC.

B. Materials and equipment, manufactured within the scope of standards published by UL, shall conform to those standards and shall have an applied UL listing mark or label.

C. Provide materials and equipment acceptable to the Authority Having Jurisdiction for Class, Division, and Group of hazardous area indicated.

D. Electrical inspection shall be performed by personnel that are certified to perform NEC inspections.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Statement of Work.

B. All components, unless specified otherwise in this Section or related sections, shall be compatible with being transported by public roadway to contract specified destination. Items shall either be self-supporting or provided with packing and dunnage to ensure their stability and protection from damage.

PART 2 PRODUCTS

2.1 GENERAL

A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

B. Material and equipment installed in heated and air-conditioned areas shall be capable of continuous operation at their specified ratings within an ambient temperature range of 40°F to 104°F.

C. Materials and equipment installed outdoors shall be capable of continuous operation at their specified rating within the ambient temperature range of -25°F to 115°F, unless otherwise specified on Drawings.

D. Electrical ratings of materials and equipment that are reduced by increased elevation shall be derated as required for Site elevation.

2.2 EQUIPMENT FINISH

A. Manufacturer standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment in accordance with light gray color finish as approved by the WRPS Construction Representative.

2.3 SIGNS AND LABELS

A. Sign size, lettering, and color shall be in accordance with NEMA Z535.4.

PART 3 EXECUTION

3.1 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned. Contractor shall be responsible for actual location of equipment and devices and for proper routing and support of raceways, subject to approval of WRPS Construction Representative.

B. Check approximate locations of light fixtures, switches, electrical outlets, equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify WRPS Construction Representative in writing.

C. Install work in accordance with NECA National Electrical Installation Standards, unless otherwise specified.

D. Keep openings in boxes and equipment closed during construction.

E. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of WRPS Construction Representative. Carefully perform cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces to original condition.

3.2 COMBINING CIRCUITS INTO COMMON RACEWAY

A. Do not combine raceways where conduit numbers or wire run numbers are shown on the Drawings.

B. Homerun circuits shown on Drawings indicate functional wiring requirements for power and control circuits. Circuits may be combined into common raceways in accordance with the following requirements:

1. Analog control circuits from devices in same general area to same destination.

    a. No power circuits shall be combined in same conduit with analog circuits.

    b. No Class 2 or Class 3 circuits shall be combined with power or Class 1 circuits.

    c. Analog circuits shall be continuous from source to destination. Do not splice or combine into a multi-pair cable without authorization of WRPS Construction Representative.

    d. Raceways shall be sized per General Circuit and Raceway Schedule and shall not exceed values specified in the NEC.

e. Changes shall be documented on record Drawings.

2. Discrete control circuits from devices in the same general area to the same destination.

a. No power circuits shall be combined in same conduit with discrete circuits.

b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, and paging system circuits shall be combined with power or Class 1 circuits.

c. Raceways shall be sized per the General Circuit and Raceway Schedule and shall not exceed values specified in the NEC.

d. Changes shall be documented on record Drawings.

3. Power circuits from loads in same general area to same source location.

a. Lighting Circuits: Combine no more than three circuits to a single raceway. Provide a separate, identified neutral conductor for each 120-volt and 277-volt circuit. Contractor shall be responsible for increasing conduit and conductor size, if derating is required by NEC.

b. Receptacle Circuits, 120-Volt Only: Combine no more than three circuits to a single raceway. Provide a separate identified neutral conductor for each circuit. Contractor shall be responsible for increasing conduit and conductor size, if derating is required by NEC.

c. All Other Power Circuits: Do not combine power circuits without authorization of WRPS Construction Representative.

3.3 NAMEPLATES, SIGNS, AND LABELS

A. Arc Flash Protection Warning Signs:

1. Field mark switchboards and panelboards to warn qualified persons of potential arc-flash hazards. Locate marking so to be clearly visible to persons before working on energized equipment.

2. Use arc flash hazard boundary, energy level, shock hazard, bolted fault current, and equipment name from WRPS Construction Representative, as basis for warning signs.

B. Equipment Nameplates:

1. Provide a nameplate to label electrical equipment including tap cabinets, switchboards, panelboards, motor starters, adjustable speed drives, transformers, terminal junction boxes, disconnect switches, light switches, control stations, receptacles, and lights.

2. Switchboards, panelboards, and motor control centers shall include equipment designation, service voltage, phases, power source, and circuit number.

3. Transformer and disconnect switch shall include equipment designation, power source, and circuit number.

4. Motor starter and adjustable speed drive shall include equipment designation and power source. Include circuit number when power source is a switchboard or panelboard.

5. Lighting switch and receptacles shall include power source and circuit number.

6. Control station shall include controlled equipment designation.

7. Pad mount utility transformer shall include equipment designation, primary and secondary voltages, and power source.

8. Tap cabinet shall include equipment designation, service voltage, phases, and power source.

9. Provide a nameplate to label HVAC and plumbing equipment including electric heaters, heat pumps, air handling and makeup units, water heaters, exhaust fans, supply fans, and freeze-proof safety showers. Include equipment designation, power source, and circuit number.

3.4 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement. Obtain WRPS Construction Representative approval, prior to relocating or reconnecting loads.

3.5 CLEANING AND TOUCH-UP PAINTING

A. Cleaning: Throughout the work, clean interior and exterior of devices and equipment by removing debris and vacuuming.

B. Touch-Up Paint:

1. Touch up scratches, scrapes, and chips on exterior and interior surfaces of devices and equipment with finish matching type, color, and consistency and type of surface of original finish.

2. If extensive damage is done to equipment paint surfaces, refinish entire equipment in a manner that provides a finish equal to or better than factory

finish, that meets requirements of Specification, and is acceptable to WRPS Construction Representative.

3.6 PROTECTION FOLLOWING INSTALLATION

A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation and contact surfaces.

B. When equipment intended for indoor installation is installed at Contractor convenience in areas where subject to dampness, moisture, dirt or other adverse atmosphere until completion of construction, ensure adequate protection from these atmospheres is provided and acceptable to WRPS Construction Representative.

END OF SECTION 26 05 02

SECTION 26 05 19

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Building wire (600V)

B. TC cable (2000V and 600V)

C. Wire and cable connectors

D. Insulating tape and tubing

E. Wire pulling lubricant

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. ASTM International (ASTM)

ASTM B3	Standard Specification for Soft or Annealed Copper Wire
ASTM D3005	Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

B. National Electrical Contractors Association (NECA)

NECA 1	Standard for Good Workmanship in Electrical Contracting

C. National Fire Protection Association (NFPA)

NFPA 70, 2017	National Electrical Code (NEC)

D. Underwriters Laboratories (UL)

UL 44	Thermoset-Insulated Wires and Cables
UL 83	Thermoplastic-Insulated Wires and Cables

UL 486A-486B	Wire Connectors
UL 486C	Splicing Wire Connectors
UL 486D	Sealed Wire Connector Systems
UL 510	Standard for Polyvinyl Chloride Polyethylene and Rubber Insulating Tape
UL 1277	Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members

1.3 SUBMITTALS

A. See the Contract Statement of Work for the submittal process.

B. Approval Required

1. Project Record Documents: Submit project record documents including specified certifications and all field test reports.

C. Approval Not Required

1. Catalog Data: Conductors/cables; compression connectors; indicate compression tools and dies that will be used.

1.4 QUALITY ASSURANCE

A. Comply with the NEC for components and installation.

B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application and environment in which installed.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect, and handle products according to manufacturer instructions and NECA 1.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Refer to the Contract Statement of Work.

2.2 CONDUCTORS 600 VOLTS AND BELOW

A. General:

1. Description: Single conductor 600 V, 90°C insulated wire.

2. Conductor:

   a. 98% conductivity, annealed, uncoated copper (per ASTM B3) solid or stranded as specified in Part 3 of this Section.

   b. 120 V circuits, 10 AWG and smaller: Solid Copper.

   c. All other circuits: Stranded Copper.

3. Insulation: The following types, unless otherwise indicated on the Drawings.

   a. 1 AWG and smaller, Type THHN/THWN-2 per UL 83.

   b. 1/0 AWG and larger, Type XHHW per UL 44 or Type THHN/THWN-2 per UL 83.

B. Color-Code Conductors as Follows:

1. Use colored insulation for color-coding conductors 6 AWG and smaller.

2. Use water and oil resistant colored plastic adhesive tape, 3/4 in. minimum width, for color-coding conductor 4 AWG and larger. Manufacturer: 3M “Scotch 35.”

3. Provide black conductor insulation where colored tape is used for color-coding.

4. Use the following color codes for AC power system conductors:

Conductor Color Codes			
System Voltage: **Conductor:**	**480Y/277V**	**120/240V**	**208Y/120V**
Phase A:	Red	Black	Black
Phase B:	Yellow	Brown	Purple
Phase C:	Blue	---	Brown
Grounded (Neutral):	White/Gray	White/Gray	White/Gray
Equipment Grounding:	Green	Green	Green
Isolated Ground:	---	---	---
Switched:	Purple	Blue	Black

5. Use the following color codes for DC power system conductors:

   Positive: Red
   Negative: Black

6. Provide color code for control conductors as indicated on equipment or control system manufacturer Drawings.

2.3 TC-ER CABLE

A. Provide tray cable (Type TC-ER) that complies with UL 1277*,* the NEC, and this Section.

B. TC-ER cable shall be rated 90°C, minimum of 600V insulation rating, UL listed, sunlight and weather-resistant, rated for direct burial and rated for variable frequency drive (VFD) use where specified on the Drawings. TC cable rated for VFD use shall have a 2,000V insulation rating.

C. Provide TC-ER cables with quantities and sizes (minimum 12 AWG for power) of conductors as indicated on the Drawings.

D. TC-ER cable manufacturer: General Cable or equal.

2.4 CABLE PROTECTORS

A. Cable Protectors: Where cables require protection from vehicle or pedestrian traffic, use a cable protector such as Yellow Jacket, Bumblebee, or Cable Guard. Cable Guard or other engineering approved protection shall be used at vehicle and crane crossings.

2.5 WIRING CONNECTORS

A. For splices and taps on copper wire, sizes 8 AWG and smaller, use pressure type, or spring type rated for use with copper conductors with insulating caps or covers rated for 600V and 105°C that are NRTL-listed to UL 486C. Thomas and Betts Corporation "Sta-Kon®[10]," 3M Company "Scotchlok®[11]," or approved substitute, where required by the NEC.

B. For splices and taps on copper wire, sizes 6 AWG through 1 AWG, use the following materials:

1. Tin-plated copper split-bolt connectors that meet the requirements in UL 486A-486B; provide with matching 600V snap-on insulating cover. Manufacturer: FCI Burndy "Type KSA" with "Type SC" insulating cover.

2. Multi-tap connectors that meet the requirements of UL 486A-486B that have two or more range-taking mechanical lugs and matching 600V insulated cover. Manufacturers: Burndy "POLYTAP" or "UNITAP®[12]," Ilsco "Type PCT," Blackburn®[10] "AMT."

C. For copper wire, sizes 1/0 AWG and larger, use UL 486A-486B listed circumferential or hexagonal crimp compression terminals, splices, or adapters.

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[10] Sta-Kon and Blackburn are registered trademarks of Thomas & Betts International, Inc., Wilmington, Delaware.
[11] Scotchlock is a registered trademark of 3M Company, St. Paul, Minnesota.
[12] UNITAP is a registered trademark of ITW New Zealand Company, Auckland, New Zealand.

1. Provide compression terminals and splices made from electro-tin plated seamless copper tubing and marked with wire size, die index/color code, and number/locations of crimps. Manufacturers: FCI Burndy Types “YA,” “YA-L,” “YA-L-NT,” “YS,” and “YC-C.” Thomas & Betts “Color-Keyed.”

2. Provide straight and offset compression adapters made from electro-tin plated aluminum, NRTL-listed for use on copper conductors, and marked with wire size, die index/color code, and number/locations of crimps. Each adapter shall include a 600V, 90°C rated insulating cover. Manufacturer: FCI Burndy Types “AYP” and “AYPO.”

3. Range-taking, die-less, or indenter-applied terminals are not acceptable for control wiring. Use nylon insulated crimp-on terminals with insulation grip that meet the requirements of UL 486A-486B. Manufacturer: 3M “Scotchlok MNG,” Thomas & Betts “Sta-Kon.”

4. Use ring tongue terminals for nutted studs.

5. Use flanged fork terminals for barrier terminal blocks.

D. Insulation-piercing type connectors are not acceptable for power or control wiring.

2.6 INSULATING TAPE AND TUBING

A. For making re-enterable tape-insulated splices and connections, provide varnished cambric electrical insulating tape made of cotton cambric fabric that is oil primed and coated with electrical insulating varnish. Manufacturer: 3M “Scotch 2510” (no adhesive) and “Scotch 2520” (pressure-sensitive adhesive).

B. Insulate taped splices and connections using ethylene propylene rubber tape that meets the requirements of UL 510 and is rated for 90°C continuous operation and 130°C short-term overload service. Manufacturer: 3M “Scotch 130C.”

C. For the outer covering of tape-insulated splices and connections, use vinyl plastic tape that meets the requirements of UL 510 and has the following listed characteristics.

1. 8.5 mil minimum thickness.

2. ASTM D3005, Rated 600V and 105°C, suitable for indoor and outdoor applications.

3. Retains flexibility, adhesion, and applicable at temperature ranges from 0 through 100°F without loss of physical or electrical properties.

4. Resistant to abrasion, moisture, alkalis, acid, corrosion, and sunlight.

5. Manufacturer: 3M “Scotch Super 88.”

D. Provide heat shrinkable tubing that meets the requirements of UL 486D and has the following listed characteristics.

1. Rated 600V.

2. Factory applied adhesive/sealant.

3. Split resistant.

4. Manufacturer: 3M "ITCSN."

E. Use motor lead splicing kits to insulate and seal connections to leads for motors rated 480V and less. Manufacturer: 3M "5300 Series."

2.7 WIRE PULLING LUBRICANT

A. Provide NRTL-listed wire pulling lubricant that is compatible with the conductor insulation or jacket, has a maximum coefficient of dynamic friction of 0.25, and leaves no flammable residue. For cold weather installations, provide wire-pulling lubricant suitable for conduit temperature.

B. Manufacturer:

1. For conduit temperature above freezing: American Polywater Corporation, "Polywater" "Lubricant J."

2. For conduit temperature below freezing: American Polywater Corporation, "Polywater" "Lubricant WJ."

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that work of other trades has not damaged wires and cables.

B. Verify raceway/conduit installation is complete and supported.

C. Verify that field measurements are as shown on Drawings.

D. Wire and cable routing shown on Drawings is approximate unless dimensioned.

1. Route wire and cable, as required, meeting project conditions.

2. Where cable routing is not shown, and destination only is indicated, determine exact routing and lengths required to meet field conditions.

3.2 PREPARATION

A. Do not handle or pull cables that are colder than +15°F. Store cold cables for at least 24 hours in a heated building prior to installation.

3.3 TYPE TC CABLE INSTALLATION

A. Install TC cables according to the NEC and requirements in this Section.

B. Install and support Type TC cables as required in Article 336 of the NEC.

3.4 CONNECTOR INSTALLATION

A. Install conductors in terminals, splices, adapters, and connectors in accordance with the manufacturer instructions. Have the manufacturer installation instructions available at the construction site.

B. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise above the conductor temperature.

C. Do not nick conductors when removing insulation.

D. Do not cut conductor strands to fit into connectors, splices, adapters, or terminals.

E. Make connections using clean connection surfaces. Wire brush conductors immediately before installing lugs, terminals, splices, or adapters.

F. Connect conductors 1/0 AWG and larger using compression terminals at the locations described below. Compression terminals shall be installed where there is adequate wire bending space to accommodate compression terminals. Select compression terminals suitable for the conductor sizes, materials, and termination point configurations. Install compression terminals using the manufacturer recommended dies and minimum 12-ton force compression tools.

1. Circuit breakers with frame size greater than 100 amperes that are NRTL-listed for use with compression terminals.

2. Safety switches and fused switches rated more than 100 amperes.

3. Transformers; refer to Section 26 22 13, “Low Voltage Distribution Transformers.”

4. Switchboards, panelboards, motor control centers, and similar service and distribution equipment.

5. Utilization equipment connections that are NRTL-listed for use with compression terminals.

G. For conductors sized 1/0 AWG and larger, and where compression lugs cannot be installed, connect using mechanical lugs, in the locations or conditions described below.

1. Connection points not NRTL-listed for either compression terminals or compression adapters.

2. Where there is insufficient wire bending space to accommodate either compression terminals or compression adapters.

H. Connect outlets and components to wiring and to ground, as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer published torque-tightening values for equipment connectors.

3.5 INSULATING TAPE AND TUBING INSTALLATION

A. Install insulating tape and tubing, in accordance with the manufacturer instructions. Have the manufacturer installation instructions available at the construction site.

B. Insulate splices and taps of irregular shapes with manufactured insulating covers or insulating tape built up to not less than 150% of insulation rating of conductor.

1. Apply varnished cambric tape over connections where re-entry is likely, such as motor lead connections.

2. Use rubber-insulating tape in half-lapped layers to develop the basic insulation over splices and taps.

3. Use vinyl plastic tape in half-lapped layers to provide the outer protective covering over splices and taps.

C. Insulate cylinder-shaped splices and taps, connector barrels, and adapter barrels using heat shrinkable insulating tubing, insulating covers manufactured for the connector, or tape insulation as described above.

3.6 IDENTIFICATION

A. Identify wire and cable under provisions of Section 26 05 53, "Identification for Electrical Systems."

B. Identify each conductor with its circuit number or other designation indicated on Drawings.

C. Apply color-coding tape on conductors at each termination, splice, junction, and pull box.

3.7 FIELD QUALITY CONTROL

A. Observe conductors and cables during the installation process.

1. Reject and replace entire reels, rolls, or boxes containing conductors or cables with material or manufacturing defects.

2. Reject and replace cable or conductor segments that have been kinked, dented, or otherwise damaged during handling or installation.

B. Perform the following inspections:

1. Inspect exposed conductors and cables for:

a. Material defect and physical damage.

b. Correct conductor size, material, and insulation type.

c. Correct color-coding and identification.

d. Proper connections in accordance with the Drawings.

2. Inspect connections for:

a. Correct connector size and type according to the Specifications and Drawings.

b. The use of the correct compression dies and the correct number of crimps on compression connectors in accordance with the connector manufacturer instructions.

C. Perform the following tests:

1. Before connecting conductors to equipment, use a megohmmeter in a 1-minute test to verify the insulation integrity of each service conductor and feeder conductor, and all conductors in 480V circuits, with respect to ground and other conductors in the same raceway.

a. Use 1000VDC to test conductors rated 600V and 2000V and 500VDC for conductors rated 300V or less.

b. Insulation test values shall be in accordance with the following:

i. Conductors with 300V insulation rating and insulation resistances over 25 megohms are acceptable.

ii. Conductors with 600V insulation rating and insulation resistances over 100 megohms are acceptable.

iii. Conductors with 2000V insulation rating and insulation resistances over 500 megohms are acceptable.

c. Conductors with insulation resistances less than indicated above shall be investigated.

2. Prior to connecting conductors to equipment, test continuity to ensure proper circuit is identified to facilitate correct connection of each power circuit conductor and each control circuit conductor.

3. Test the equipment and wiring for continuity and unintentional grounds, and verify proper phase sequence and voltage at equipment served before attempt is made to operate equipment.

4. Perform insulation resistance testing on electric heat trace cable at installation, before and after insulation is installed, in accordance with manufacturer instructions.

5. Measure and record the tightness of not less than 10% of each size and type of mechanical or bolted connection using a calibrated torque wrench or torque screwdriver. Additionally, verify proper crimping method, as applicable.

   a. Compare measured torque with torque recommended by the connector manufacturer or as shown in Attachment 1, “Recommended Tightening Torque per UL 486A-486B.”

   b. If any connection is found to be less than 90% of the recommended torque, notify the Buyer Technical Representative and re-torque all bolted connections on the Project.

D. Remove and replace defective, incorrect, or improperly installed conductors and connectors. Re-inspect and re-test replacement conductors and connectors.

E. Submit test and inspection records to the Buyer Technical Representative.

F. Verify inspections and tests required by other sections are completed before conductors may be energized.

SECTION 26 05 19 – ATTACHMENT 1

RECOMMENDED TIGHTENING TORQUE PER UL 486A-486B

Table 21 - Tightening torque for screws

Conductor Size installed in Connector		Tightening Torque, N•m (lbf-in)			
		Slotted Head No. 10 and Larger*		Hexagonal Head – External Drive Socket Wrench	
		Slot Width – 1.2mm (.047 in) or Less and Slot Length – 6.4mm (1/4 in.) or less	Slot Width – Over 1.2mm (.047 in) or Slot Length – Over 6.4mm (1/4 in.) or less		
AWG or kcmil	mm^2			Split-Bolt Connectors	Other Connectors
30 - 10	.05 - 5.3	2.3 (20)	4.0 (35)	9.0 (80)	8.5 (75)
8	8.4	2.8 (25)	4.5 (40)	9.0 (80)	8.5 (75)
6 - 4	13.2 - 21.2	4.0 (35)	5.1 (45)	18.6 (165)	12.4 (110)
3	26.7	4.0 (35)	5.6 (50)	31.1 (275)	16.9 (150)
2	33.6	4.5 (40)	5.6 (50)	31.1 (275)	16.9 (150)
1	42.4	-	5.6 (50)	31.1 (275)	16.9 (150)
1/0 - 2/0	53.5 - 67.4	-	5.6 (50)	43.5 (385)	20.3 (180)
3/0 - 4/0	85.0 - 107.2	-	5.6 (50)	56.5 (500)	28.2 (250)
250 - 350	127 - 177	-	5.6 (50)	73.4 (650)	36.7 (325)
400	203	-	5.6 (50)	93.2 (825)	36.7 (325)
500	253	-	5.6 (50)	93.2 (825)	42.4 (375)
600 - 750	304 - 380	-	5.6 (50)	113.0 (1000)	42.4 (375)
800 - 1000	406 - 508	-	5.6 (50)	124.3 (1100)	56.5 (500)
1250 - 2000	635 - 1000	-	-	124.3 (1100)	67.8 (600)

* For values of slot width or length not corresponding to those specified, select the largest torque value associated with the conductor size. Slot width is the nominal design value. Slot length shall be measured at the bottom of the slot.

Table 22 - Tightening torque for slotted head screws smaller than No. 10 intended for use with 8 AWG (8.4 mm2) or smaller conductors

Slot Length of Screw*		Tightening Torque, N•m (lbf-in)	
mm	inch	Slot Width of Screw Smaller than 1.2mm (.047 in.)	Slot Width of Screw 1.2mm (.047 in.) and larger**
Less than 4	Less than 5/32	0.79 (7)	1.0 (9)
4	5/32	0.79 (7)	1.4 (12)
4.8	3/16	0.79 (7)	1.4 (12)
5.6	7/32	0.79 (7)	1.4 (12)
6.4	1/4	1.0 (9)	1.4 (12)
7.1	9/32	-	1.7 (15)
Above 7.1	Above 9/32	-	2.3 (20)

* For slot lengths of intermediate values, select torques pertaining to next shorter slot length.
Also, see Table 21 for screws with multiple tightening means.
Slot length shall be measured at the bottom of the slot.

** Slot width is the nominal design value

Table 23 - Tightening torque for screws with recessed Allen or Square drives

Socket Width Across Flats*		Tightening Torque, N•m (lbf-in)
mm	inch	
3.2	1/8	5.1 (45)
4.0	5/32	11.3 (100)
4.8	3/16	13.6 (120)
5.6	7/32	16.9 (150)
6.4	1/4	25.4 (225)
7.9	5/16	33.9 (300)
9.5	3/8	45.2 (400)
12.7	1/2	56.6 (500)
14.3	9/16	67.8 (600)

* See Table 21 for screws with multiple tightening means

END OF SECTION 26 05 19

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Connection to Grounding Electrode System.

B. Circuit and System Grounding.

C. Enclosure and Equipment Grounding System.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. ASTM International (ASTM)

ASTM B8	Standard Specification for Concentric-Lay Stranded Copper Conductors

B. Institute of Electrical and Electronics Engineers (IEEE)

IEEE 81	Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System
IEEE 837	IEEE Standard for Qualifying Permanent Connections used in Substation Grounding

C. National Fire Protection Association (NFPA)

NFPA 70, 2017	National Electrical Code (NEC)

D. Underwriters Laboratories (UL)

UL 486A-486B	Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486C	Splicing Wire Connectors

1.3 SUBMITTALS

A. See the Contract Statement of Work for the submittal process.

B. Approval Required

1. None.

C. Approval Not Required

1. Test Reports.

1.4 QUALITY ASSURANCE

A. Comply with the NEC for components and installation.

B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application and environment in which installed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, protect, and handle products according to manufacturer instructions.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work.

2.2 GROUNDING ELECTRODE CONDUCTOR

A. Provide bare stranded, soft temper copper cable that conforms to ASTM B8.

2.3 EQUIPMENT GROUNDING CONDUCTORS

A. Provide NRTL-listed THHN/THWN insulated copper wire.

B. Use solid grounding conductors 12 AWG and smaller where not subject to vibration or repeated flexing.

C. Use stranded grounding conductors for 10 AWG and larger.

D. Use stranded grounding conductors where subject to vibration or repeated flexing.

E. Color-code grounding conductors as follows:

1. Equipment ground:

a. Conductors 6 AWG and smaller: Green colored insulation.

b. Conductors 4 AWG and larger: Green colored insulation or black colored insulation with 3/4 in. wide band of water and oil-resistant green plastic adhesive tape.

2.4 GROUND PLATES

A. Provide ground plates designed for flush mounting in concrete.

B. Furnish copper alloy castings with four 1/2 in. x 13 in. threaded holes at 1.75 in. x 1.75 in. NEMA spacing and a welding stud or compression connection suitable for 2 AWG to 250 kcmil copper conductor.

C. Manufacturer: Burndy "YGF."

2.5 CONDUIT GROUNDING BUSHINGS

A. Provide NRTL-listed, galvanized malleable iron, 150°C rated insulated throat grounding bushings with lay-in type ground cable lugs.

B. Manufacturers: O-Z/Gedney Type "BLG."

2.6 COMPRESSION GROUNDING CONNECTIONS

A. Provide wrought copper connectors, terminals, taps, and splices for making irreversible compression grounding connections.

B. Furnish NRTL-listed grounding connectors that are suitable for direct burial and have been tested successfully according to the requirements of IEEE 837.

C. Provide connector manufacturer hydraulic compression tools and dies that match the connectors.

D. Match connector and die size to material shapes and conductor sizes to be joined.

E. Use two-hole heavy-duty compression lugs for bolted connections to ground bars, ground plates, and equipment ground pads.

F. Manufacturer: Burndy "Hyground®[13]."

[13] Hyground is a registered trademark of Hubbell Incorporated Corporation, Shelton, Connecticut.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that work of other trades has not damaged grounding or bonding connections.

B. Verify that field measurements are as shown on Drawings.

C. Grounding cable routing shown on Drawings is approximate, unless dimensioned.

1. Install and route cable, as required meeting project conditions.

2. Where cable routing is not shown and destination only is indicated, determine exact locations, routing, and lengths required to meet project conditions.

3.2 PREPARATION

A. Examine equipment that is to receive grounding and bonding material for compliance with installation tolerances and other conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 GENERAL

A. Comply with the requirements of the NEC, this Section, and the Drawings.

B. Install grounding and bonding material according to manufacturer instructions. Have the manufacturer installation instructions available at the construction site.

C. Use the following connection methods, unless otherwise specified or indicated on the Drawings. Use compression or bolted grounding connection methods.

1. Make bolted connections using bolts, nuts, flat washers, and toothed lock washers suitable for the connector and the installation environment; acceptable materials include high strength silicon bronze and 18-8 alloy stainless steel.

2. Make irreversible bolted connections using 18-8 alloy stainless steel tamper-resistant bolts and tamper-resistant nuts, along with flat washers and toothed lock washers. Tamper-resistant nuts and bolts must resist loosening with common tools; acceptable tamper-resistant fasteners include penta-head, breakaway, and oval designs.

D. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer published torque-tightening values for connectors and bolts. Where manufacturer torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in Section 26 05 19, “Low Voltage Electrical Power Conductors and Cables, “Attachment 1, “Recommended Tightening Torque per UL 486A-486B.” Use a calibrated torque wrench.

E. Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Follow connector manufacturer installation instructions and use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed.

F. Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.

2. Make connections with clean bare metal at points of contact.

3. Make aluminum to steel connections with stainless steel separators and mechanical clamps.

4. Make aluminum to galvanized steel connections with tin-plated copper jumpers and mechanical clamps.

5. Coat and seal connections involving dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.4 GROUNDING ELECTRODE SYSTEM

A. Install in accordance with the NEC and the Drawing.

B. Concrete-Encased Grounding Electrodes.

1. Install a concrete-encased grounding electrode in lower part of perimeter footing or grade beam to form a complete and continuous loop around the structure. Encase electrode with at least 2 in. of concrete from the bottom of foundation or footing. Use one of the following materials for the electrode:

   a. Bare or zinc galvanized or other electrically conductive-coated steel reinforcing bars, minimum 1/2-in. diameter. Bond reinforcing rods together using steel wire ties or other effective means.

   b. Bare 4/0 copper conductor, unless otherwise shown on the Drawings. Space cable from the bottom and sides of the grade beam so it has at least 2 in. of concrete coverage. Bond to rebar in one place.

   c. Perform NEC inspection of grounding electrode prior to concrete placement.

C. Install ground plates flush with top of concrete. Locate ground plates adjacent to electrical equipment as shown on the Drawings. Bond grounding electrode to ground plates with UL-listed compression fittings.

3.5 CIRCUIT AND SYSTEM GROUNDING

A. Bond service entrance equipment ground bus to grounding electrode system; use ground cable as indicated on the Drawings, or not smaller than the grounding electrode conductor required by the NEC and not smaller than 4 AWG.

B. In the service entrance equipment, connect the neutral bus to the ground bus using a bonding jumper not smaller than the grounding electrode conductor required by the NEC; do not use a bonding screw for this purpose. Make no other neutral-to-ground connections on the load side of the service entrance disconnect.

C. Separately Derived Systems:

1. Connect ground bus of first disconnecting means for separately derived systems (e.g., dry type transformers) to the nearest ground plate (preferred) or building structural steel column; use grounding conductor sized as shown on the Drawings or as required by the NEC.

2. At the first system overcurrent device or disconnecting means, connect the neutral bus to the ground bus using a bonding jumper sized as required by the NEC. Size grounding electrode conductor in accordance with the NEC and use UL-Listed pipe grounding clamp or to an existing ground tap on riser with the approval of the WRPS Construction Representative.

3.6 ENCLOSURE AND EQUIPMENT GROUNDING

A. Provide permanent and effective equipment, enclosure, and raceway grounding in accordance with NEC requirements, and as further specified or shown on the Drawings.

B. Provide an equipment ground bar, separate from any neutral bar, in all switchgear, switchboards, panelboards, transformers, motor control centers, starters, disconnect switches, cabinets, etc., for grounding the enclosure and for connecting other equipment and raceway ground conductors. Make connections to the ground bar using mechanical lugs or compression lugs.

C. Make connections and couplings on metallic conduit systems wrench tight.

D. Grounding Bushings:

1. Install grounding bushings on metallic conduit containing circuits rated 480 VAC or 100 amperes and higher.

2. Install grounding bushings on metallic conduits entering enclosures through concentric, eccentric, or oversize knockouts.

3. Install grounding bushings on metallic conduits that terminate to a metallic enclosure without effective electrical connection such as locknuts or threaded bushings.

4. Bond conduit grounding bushing lug to the equipment ground bar or ground lug in switchboard, panelboards, transformers, starters, disconnect switches, cabinets, etc. Size bonding jumpers in accordance with the NEC.

E. Provide an insulated equipment grounding conductor for each feeder and branch circuit.

1. Install the grounding conductor within the common conduit or raceway with the related phase and neutral conductors, and connect to the grounding terminal or grounding bus in each box or cabinet.

2. Size equipment ground conductor in accordance with the NEC or as shown on the Drawings.

F. In each 15 or 20 ampere branch circuit outlet box and junction box, install a green colored washer head grounding screw with a 12 AWG equipment grounding conductor pigtail.

G. Connect receptacle grounding terminals to the equipment ground system using minimum 12 AWG equipment grounding conductor. Do not use a “self-grounding” receptacle strap as the only equipment grounding path.

3.7 FIELD QUALITY CONTROL

A. General: Perform on-site verification and acceptance testing of the grounding installation during construction.

B. Notify the WRPS Construction Representative ten working days in advance of the expected completion of a concrete-encased grounding electrode system installation. Verification and testing can be scheduled in parts or by area, depending on the system and construction schedule.

C. Before work is concealed, verify and certify that the following grounding installations have been made correctly:

1. Grounding electrode system;

2. Ground plates and grounding bars; and

3. All other underground grounding installations.

D. Acceptance Testing: Perform acceptance testing for grounding electrode system and submit written reports to the WRPS Construction Representative.

1. Measure resistance between grounding electrode and each ground plate, prior to concrete placement. Use the “Two-Point Direct Method” of IEEE 81. Investigate and correct equipment ground resistances that exceed 0.5 ohm.

2. Prepare test reports of the ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe any measures taken to improve test results.

E. Perform the following inspections and tests of grounding systems.

1. Visual and Mechanical Inspection:

   a. Equipment and circuit grounds in panelboard for proper connection and tightness.

   b. Ground bus connections in panelboard for proper termination and tightness.

   c. Effective dry-type transformer equipment grounding.

   d. Accessible connections to grounding electrodes for proper fit and tightness.

   e. Accessible compression connections grounding connections to verify that proper bonding was obtained.

2. Electrical Tests:

   a. Measure resistance between equipment ground system, equipment frames, and system neutral and derived neutral points. Use the "Two-Point Direct Method of IEEE 81.

   b. Equipment ground resistance shall not exceed main ground system resistance by 0.5 ohm.

3. Neutral Bus Isolation:

   a. Test each neutral bus, individually, with neutral bonding jumper removed at separately derived system.

   b. Evaluate ohmic values by measuring resistance between ground bus and neutral bus.

   c. Investigate values less than 50 megohms.

END OF SECTION 26 05 26

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Furnish and install, hangers, supports, anchors, concrete bases, and other positive fastenings for non-structural electrical components such that gravity loads are safely transferred to the structure.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. Code of Federal Regulations (CFR)

29 CFR 1910	Occupational Safety and Health Standards (OSHA)

B. International Code Council (ICC)

IBC, 2015	International Building Code

C. Metal Framing Manufacturers Association (MFMA)

MFMA-4	Metal Framing Standards Publication
MFMA-103	Guidelines for the Use of Metal Framing

D. National Fire Protection Association (NFPA)

NFPA 70, 2017	National Electrical Code (NEC)

1.3 SUBMITTALS

A. See the Contract Statement of Work for the submittal process.

B. Approval Required: None.

1.4 QUALITY ASSURANCE

A. Furnish and install hangers and supports that conform to the Drawings and requirements of the following codes and standards:

1. NEC,

2. IBC, 2015,

3. MFMA-4, and

4. MFMA-103.

B. Where a Nationally Recognized Testing Laboratory (NRTL) has requirements for such products, provide products that are NRTL-listed and labeled for the application, installation condition, and the environment in which installed.

C. Suspect and Misrepresented Products: See Contract Statement of Work for required measures to prevent use of misrepresented products.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, protect, and handle products according to manufacturer instructions.

PART 2 PRODUCTS

2.1 SUBSTITUTIONS

A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work. Any substitution must be submitted to the WRPS Construction Representative for approval before procurement of alternate products.

2.2 COATINGS AND MATERIALS

A. Furnish products for use indoors protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic.

B. Furnish products for use outdoors or in damp or corrosive indoor locations with hot-dip-galvanized coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or material such as stainless steel with inherent corrosion resistant characteristics.

2.3 RACEWAY SUPPORTING DEVICES

A. Furnish supports, as described below, for the installation of raceway systems.

B. Use pressed steel, hot-dipped galvanized, single bolt hangers to support individual conduits from threaded rods or beam clamps. Manufacturer: Steel City "6H Series."

2.4 FASTENERS

A. Concrete Anchors:

1. Furnish concrete anchors per Section 05 05 38, “Concrete Anchors,” and as shown on the Drawings.

2. Each anchor shall have an ICC-ES evaluation report stating that the product is compliant with the current edition of the IBC, and the intended conditions of use.

3. For applications in outdoor, damp, or corrosive locations, furnish stainless steel post-installed anchors.

4. Furnish expansion, adhesive, and undercut anchors specified on the Drawings.

2.5 FRAMING CHANNEL SYSTEMS

A. Furnish U-channel framing systems that conform to MFMA-4 and are fabricated using minimum 12-gage steel.

B. Furnish fittings and accessories that mate and match with U-channel and are of the same manufacturer.

C. Manufacturers: B-Line or Unistrut.

2.6 FABRICATED SUPPORTING DEVICES

A. Furnish shop or field-fabricated supports, or manufactured supports assembled from U-channel components.

B. Furnish steel brackets fabricated from angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 EXECUTION

3.1 GENERAL

A. Install hangers and supports according to the NEC, the requirements in this Section, and specific supporting requirements in other sections and Drawings.

B. Conform to manufacturer instructions and recommendations for selection and installation of hangers and supports.

C. Do not use wire or perforated strap for permanent supports.

D. Use appropriate, calibrated, special tools when installing devices for which special installation tools are recommended by the manufacturer.

3.2 EXAMINATION

A. Examine surfaces to receive supports for compliance with installation tolerances and other conditions affecting performance of the system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 FASTENERS

A. Concrete expansion anchors: Install in accordance with Section 05 05 38, “Concrete Anchors,” and the product ICC-ES report conditions of use.

B. Use machine bolts, nuts, and washers for fastening to metal.

C. Fasten equipment to concrete or masonry with expansion anchors.

D. The use of lead-cinch drop-in anchors is not allowed.

E. Torque threaded fasteners as recommended by the manufacturer instructions.

3.4 RACEWAY SUPPORTS

A. Support individual horizontal raceways by separate pipe hangers.

3.5 BOXES AND CABINETS

A. Support sheet metal boxes by approved brackets or bar hangers, as shown on the Drawings or as required. Where bar hangers are used, attach the bar to structure on opposite sides of the box.

B. In open overhead spaces, cast boxes threaded to raceways need not be supported separately, except where used for fixture support.

C. Install surface-mounted cabinets and panelboards, as shown on the Drawings or as required.

3.6 FRAMING CHANNEL SYSTEMS

A. Select and install framing channel systems in accordance with MFMA-103.

B. Use framing channel to support electrical equipment that is mounted free of walls.

END OF SECTION 26 05 29

SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Conduits and fittings.

B. Outlet boxes and handholes.

C. Pull and junction boxes.

D. Wireway.

E. Handholes.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. National Electrical Contractors Association (NECA)

NECA 1	Standard for Good Workmanship in Electrical Construction

B. National Electrical Manufacturers Association (NEMA)

NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA C80.1	Electrical Rigid Steel Conduit (ERSC)
NEMA FB1	Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing (EMT) and Cable
NEMA ICS 6, R2011	Industrial Control and Systems: Enclosures
NEMA RN 1	Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA OS 1	Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports

NEMA OS 3	Selection and Installation Guidelines for Electrical Outlet Boxes
NEMA TC 2	Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
NEMA TC 3	Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
NEMA TC 6 and 8	Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations
NEMA TC 7	Smooth Wall Coilable Electrical Polyethylene Conduit
NEMA TC 9	Fitting for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation

C. National Fire Protection Association (NFPA)

NFPA 70, 2017	National Electrical Code (NEC)

D. Society of Cable Telecommunications Engineers (SCTE)

SCTE 77	Specification for Underground Enclosure Integrity

E. Underwriters Laboratories (UL)

	Electrical Appliance and Utilization Equipment Directory
	Electrical Construction Materials Directory
UL 1	Standard for Flexible Metal Electrical Conduit
UL 6	Electrical Rigid Metal Conduit-Steel
UL 50	Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 360	Standard for Liquid-Tight Flexible Metal Conduit
UL 467	Grounding and Bonding Equipment
UL 498	Standard for Attachment Plugs and Receptacles
UL 508A, 2013	Standard for Industrial Control Panels
UL 510	Standard for Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	Metallic Outlet Boxes
UL 514B	Conduit, Tubing, and Cable Fittings

UL 514C	Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 651A	Schedule 40 & 80 High Density Polyethylene (HDPE) Conduit

1.3 SUBMITTALS

A. See the Contract Statement of Work for the submittal process.

B. Approval Required.

1. Handholes.

1.4 QUALITY ASSURANCE

A. The Seller shall comply with the following Quality Assurance requirements, in addition to those of the Contract Statement of Work.

B. Comply with the NEC for components and installation.

C. Rigid steel conduit. Verify the following:

1. Each length is marked with manufacturer name, UL label, and “Rigid Metal Conduit” or “Rigid Steel Conduit.”

D. Conduit fittings/metallic outlet boxes/terminal boxes (rigid, stainless steel). Verify the following:

1. Check one lot or container and verify each item has, at a minimum, the UL symbol and that the shipping label or the container for which the items are shipped contains the manufacturers name, the UL listing, and the type of items shipped. If the item is not marked with the UL symbol or manufacturer name, visually inspect the shipping carton of the item to ensure it is in accordance with the UL and manufacturer published data.

2. Check one lot or container and verify item size is in accordance with product description.

3. Verify external coating for each item is uniform (rigid steel only) and no damage exists.

4. Verify material used is ferrous metal (rigid or malleable iron only) by performing magnetic test.

E. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.

F. Cabinets containing assembled control systems shall be designed, constructed, and listed or labeled to the UL 508A Standard, as applicable.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, protect, and handle products according to manufacturer instructions and NECA 1.

PART 2 PRODUCTS

2.1 SUBSTITUTIONS

A. Alternate products may be accepted, in accordance with the requirements of the Contract Statement of Work.

2.2 COATINGS

A. Provide products with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic that is suitable for the environment in which the product will be installed and used.

2.3 RIGID METAL CONDUIT AND FITTINGS

A. Furnish Rigid Metal Conduit (RMC) that meets the requirements of UL 6 and NEMA C80.1.

B. Material: Hot-dip galvanized, with chromated protective layer.

C. Furnish zinc-plated, threaded, malleable iron fittings and conduit bodies that meet the requirements of UL 514B and NEMA FB1.

2.4 PLASTIC-COATED STEEL CONDUIT AND FITTINGS

A. Furnish polyvinyl chloride (PVC) exterior coated, urethane interior coated, RMC that meets the requirements of NEMA RN 1.

B. Use factory-fabricated elbows.

C. Furnish 40 mils PVC exterior coated, urethane interior coated, zinc-plated, threaded, malleable iron fittings and conduit bodies meeting the requirements of UL 514B.

D. Interior finish: Urethane coating, 2 mils nominal thickness.

E. Threads: Hot-dipped galvanized and factory coated with urethane.

F. Bendable without damage to either interior or exterior coating.

2.5 RIGID NON-METALLIC CONDUIT AND FITTINGS

A. Furnish RNC that conforms to UL 651, UL 651A, NEMA TC2, NEMA TC 3, NEMA TC 6 and 8, and NEMA TC 7.

B. Furnish non-metallic, solvent-welded socket fittings that meet the requirements of UL 651, NEMA TC 3, and NEMA TC 9.

2.6 FLEXIBLE METAL CONDUIT AND FITTINGS

A. Furnish galvanized steel flexible metal conduit that meets the requirements of UL 1 and UL 360 for 105°C insulated conductors.

B. Material: Galvanized steel, with an extruded PVC jacket.

C. Furnish zinc-plated malleable iron fittings that meet the requirements of UL 514B and NEMA FB1. Furnish insulated throat connectors.

2.7 LIQUID-TIGHT FLEXIBLE METAL CONDUIT AND FITTINGS

A. Furnish liquid-tight flexible metal conduit that meets the requirements of UL 360.

B. Furnish zinc-plated malleable iron or zinc-plated steel liquid-tight fittings that meet the requirements of UL 514B and NEMA FB1. Furnish insulated throat connectors.

C. Furnish galvanized steel flexible metal conduit that meets the requirements of UL 1 and the NEC.

2.8 INSULATING BUSHINGS

A. Provide NRTL-listed insulating bushings with 105°C rated insulation.

B. Manufacturer: O-Z/Gedney, Type B or SB.

2.9 GROUNDING BUSHINGS

A. Provide NRTL-listed, galvanized malleable iron, 150°C rated insulated throat grounding bushings with lay-in type ground cable lugs.

B. Manufacturer: O-Z/Gedney, Type BLG.

2.10 EXPANSION FITTINGS

A. Furnish NRTL-listed expansion fittings with hot dipped galvanized malleable iron body, factory-installed packing, and a bonding jumper.

B. Manufacturer: O-Z/Gedney, Type AX, TX, or EXE with Type BJ bonding jumper.

C. Lubricant and Sealant.

1. Lubricant and Sealant for Conduit Thread: Conductive compound providing anti-seize and corrosion protection. Thomas and Betts Corporation "KOPR-SHIELD®[14]," or approved substitute.

2.11 PROTECTION TAPE AND CONDUIT SEALANT

A. Furnish pressure-sensitive, 10 mil thick, PVC-based tape for corrosion protection of metal conduit and fittings. Manufacturer: 3M, Type 50.

B. Furnish plastic insulating tape that complies with UL 510.

C. Furnish electrical color-coding tape that complies with UL 510.

D. Furnish sealing compound for conduit: "Sealex" by Porcelain Products Company or "Duct Seal" by Gardner-Bender.

2.12 RACEWAY MEASURING TAPE

A. Furnish raceway measuring tape with permanently printed measurements in 1-ft increments and minimum 1,200 lb average breaking strength.

2.13 WIREWAY

A. Provide NRTL-listed, wireway with covers, elbows, tees, hangers, and fittings required for a complete system. Wireway shall be rated for environment to be installed.

2.14 OUTLET BOXES

A. Provide outlet boxes selected for specific installations using the guidance in NEMA OS 3 and the requirements of this Section.

B. Exterior mounted enclosures (terminal boxes) shall be NEMA ICS 6, NEMA Type 4, unless shown otherwise on the Drawings.

C. For dry locations, provide galvanized steel outlet boxes that comply with UL 514A.

1. For luminaire outlets use 4-in. x 1 1/2-in. deep (minimum) boxes with fixture stud attachment as required to support luminaires.

2. For surface outlet boxes in EMT raceway systems, use 4-in. x 2 1/8-in. deep square boxes. Provide deeper boxes or multiple gang boxes as required to fit devices. Provide square surface covers that match the installed device and have not less than two holes for securing the device to the cover.

[14] KOPR-SHIELD is a registered trademark of Jet-Lube, Inc., Houston, Texas.

D. For damp or wet locations and for surface-mounted RMC or IMC raceway systems, provide outlet boxes that comply with UL 498, UL 514A, UL 514B, UL 514C, and NEMA FB1.

1. For lighting fixture outlets use 4-in. x 2 1/16-in. deep (minimum) round cast malleable iron boxes with threaded hubs.

2. For surface wall-mounted outlets, use 4 11/16 square, 2 11/16-in. deep cast malleable iron boxes with threaded hubs. Provide multiple gang boxes as required to fit devices. Provide gasketed cast malleable iron or cast copper-free aluminum covers that match the installed device and have not less than two holes for securing the device to the cover.

E. For all entries into NEMA ICS 6, Type 4 enclosures: Type CGB for exposed cable, and Myers type watertight fittings or sealing-type locknuts for conduits.

2.15 PULL AND JUNCTION BOXES

A. Metallic boxes (terminal boxes) shall be NEMA 250 or UL 50, Type 4, 16 or 14 gage steel.

B. For dry locations in clean, non-contamination environments, use galvanized sheet steel pull and junction boxes that comply with UL 50, Type 1 and the NEC as to size and construction. Use boxes not less than 4-in. square x 1 1/2-in. deep with screw-secured covers. Provide larger boxes as required by the number and size of conduits and conductors.

C. For dry locations in dusty environments, use galvanized steel pull and junction boxes that comply with UL 50, Type 12 and the NEC as to size and construction. Use boxes not less than 6-in. square x 4-in. deep with gasketed covers. Provide larger boxes as required by the number and size of conduits and conductors.

D. For damp or wet, non-corrosive locations, in conduit runs up to 3/4-in. trade size, provide 4 11/16-in. square, 2 11/16-in. deep (min.) cast malleable iron pull and junction boxes with threaded hubs and gasketed cast malleable iron or cast copper-free aluminum covers.

E. For damp or wet, non-corrosive locations, in conduit runs 1-in. trade size and larger, provide galvanized sheet-steel pull and junction boxes and covers that comply with UL 50, Type 4.

F. For damp or wet, non-corrosive locations that are subject to hose-directed water, provide pull and junction boxes and covers that comply with UL 50, Type 4.

G. For in-ground, non-metallic handholes, provide products that are NRTL-listed to SCTE 77.

1. Material: Polymer concrete.

2. Minimum SCTE 77 load rating:

   a. Located in sidewalks: Tier 8.

   b. Located in driveways, parking lots, and off-roadway locations: Tier 22.

3. Size: As shown on Drawings.

4. Cover: Non-skid cover with stainless steel cover bolts.

5. Identification: Permanent mark or logo on cover prominently identifying the function of the enclosure in accordance with NEC requirements.

6. Manufacturer: Quazite®[15] "Style PC, PG, or PT." or as shown on Drawings.

H. Provide connection points for equipment grounding conductors in each box.

I. For all entries into NEMA ICS 6, Type 4 enclosures: Type CGB for exposed cable, and Myers type watertight fittings or sealing-type locknuts for conduits.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive raceways and boxes for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Scaled dimensions on the Drawings show desired and approximate locations of equipment. Actual locations, distances, and levels shall be governed by field conditions.

3.3 GENERAL

A. Perform work in accordance with NFPA 70, the Specifications, and the Drawings. Fasten equipment to structural members or metal supports attached to structure or to concrete surfaces

B. Install complete systems of raceways and boxes for wiring systems.

C. Install raceways and boxes according to the NEC, the manufacturer instructions, and requirements in this Section.

D. Raceway termination points and box locations shown on the Drawings are in approximate locations, unless dimensioned.

[15] Quazite is a registered trademark of Hubbell Incorporated, Shelton, Connecticut.

E. Raceway routing is shown on the Drawings in approximate locations, unless dimensioned. Coordinate routing with structure and with work of other trades. Route as required for a complete wiring system.

F. Ground and bond raceways and boxes as required in Section 26 05 26, "Grounding and Bonding for Electrical Systems," and UL 467.

G. Support raceways and boxes in accordance with the requirements of the NEC, Section 26 05 29, "Hangers and Supports for Electrical Systems," and NEMA OS 1.

H. Identify raceways and boxes as required in Section 26 05 53, "Identification for Electrical Systems."

I. Arrange raceway and boxes to maintain headroom and present neat appearance.

J. Install knockout closures in unused openings in boxes or raceways.

3.4 CONDUIT INSTALLATION

A. For low-voltage wiring systems (less than 1000 volts) use conduit materials according to the NEC and the following:

1. Outdoors

   a. Direct buried: Use plastic-coated RMC, minimum 1-in. diameter.

   b. Outdoors - exposed: Use RMC or liquid-tight flexible metal conduit where subject to vibration or flexibility is required.

   c. Outdoors - concealed: Use RMC for concealed outdoor work. Do not use bare RMC or IMC in direct contact with earth.

2. Connection to vibrating equipment (including hydraulic, pneumatic, or electric solenoid or motor-driven equipment) - Use a minimum of 24-in.; maximum length as determined by the NEC:

   a. Outdoors: Use liquid tight flexible metal conduit.

B. Use 3/4-in. above ground or larger conduit to enclose multiple conductors larger than 12 AWG.

C. Install conduits with a minimum of bends in the shortest practical distance, considering the type of building construction and obstructions.

D. Use specified fitting for conduit, except that threaded hubs and sealing type locknuts shall be used outdoors and locations where moisture is present. Use couplings where required. Do not use running threads.

E. Use conduit hubs to fasten conduit to boxes in damp and wet locations.

F. Use galvanized steel locknuts and insulated bushings for attachment to enclosures, except threaded hubs or sealing type locknuts shall be used outdoors or where moisture is present. Use watertight fittings for entries into NEMA 4 enclosures. Use sealing locknuts into bottoms of NEMA 4 enclosures.

G. Install insulating bushings or connectors with an insulated throat to protect conductors or cables at conduit terminations.

H. Join nonmetallic conduit using cement, as recommended by manufacturer. Wipe nonmetallic conduits dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

I. Install plastic-coated RMC and fittings according to the NEC and manufacturer instructions. Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

J. Make elbows, offsets, and bends uniform and symmetrical. Bend conduit with approved bending devices.

K. Do not use RNC 90 degree elbows larger than 2-in. trade size; use plastic-coated RMC, tape-wrapped RMC.

L. Maintain the following minimum clearances between conduit and surfaces with temperatures exceeding 104°F (40°C):

   1. 6 in. at perpendicular crossings.

   2. 12 in. between parallel runs.

M. Cut ends square, ream, and remove burrs. Conduit shall be clean, dry, and free of debris. Immediately after installation, plug or cap exposed ends with standard accessories until wires are installed.

N. Avoid moisture traps in conduit system; provide junction boxes with drain fitting at low points in conduit system.

O. Install corrosion protection tape on metal conduits and fittings in contact with soil using half-lapped wrappings.

P. Install grounding bushings at the following locations:

   1. At every entry to enclosures on metallic conduits containing circuits rated 100 amperes and higher.

   2. On metallic conduits entering enclosures through concentric, eccentric, or oversize knockouts.

   3. On metallic conduits that terminate to a metallic enclosure without effective electrical connection, such as locknuts or threaded bushings.

Q. Install conduit-measuring tape in empty raceways. Leave not less than 12 in. of slack at each end of the tape. Secure each end of tape.

3.5 FIRESTOPPING

A. Install an NRTL approved firestop system at each electrical penetration in a fire-rated wall, floor, or partition.

B. At least two days prior to firestopping installation, notify WRPS Construction Representative so that arrangements can be made for inspection during installation.

3.6 PULL AND JUNCTION BOX INSTALLATION

A. Install pull and junction boxes as shown on the Drawings and as required for splices, taps, wire pulling, and compliance with regulatory requirements.

B. Install pull boxes as required to comply with limits on conduit bends and distance between pull points in Paragraph 3.4, “Conduit Installation.”

C. Install bedding material for in-ground handholes in accordance with manufacturer installation instructions. Place top of handholes flush with top of finished grade.

3.7 WIREWAY INSTALLATION

A. Install wireways at locations indicated on the Drawings.

B. Mount plumb and level.

3.8 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Repair damage to galvanized finishes with zinc-rich paint, recommended by manufacturer.

C. Repair damage to paint finishes with matching touch-up coating recommended by the manufacturer.

3.9 FIELD QUALITY CONTROL

A. For conduits, junction boxes, associated fittings and supports, verify appropriate torque values are in accordance with manufacturer recommendations.

B. Provide final protection and maintain conditions to ensure that coatings and finishes are without damage or deterioration at final inspection.

END OF SECTION 26 05 33

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Component identification tags.

B. Equipment nameplates.

C. Wire markers.

D. Voltage markers.

E. Warning signs.

F. Working space labels.

G. Underground warning tape.

H. Arc Flash labels.

I. Conduit labels.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American National Standards Institute (ANSI)

ANSI Z535.1	Safety Colors
ANSI Z535.2	Environmental and Facility Safety Signs
ANSI Z535.3	Criteria for Safety Symbols
ANSI Z535.4	Product Safety Signs and Labels
ANSI Z535.5	Safety Tags and Barricade Tapes (for Temporary Hazards)

B. Code of Federal Regulations (CFR)

29 CFR 1910.145	Danger and Caution Specifications

C. Hanford Documents

TFC-ENG-STD-12, E-2	Tank Farm Equipment Identification Numbering and Labeling Standard

D. International Standards Organization (ISO)

ISO 3864	Graphical Symbols Package

E. National Fire Protection Association (NFPA)

NFPA 70, 2017	National Electrical Code (NEC)
NFPA 70E	Standard for Electrical Safety in the Workplace

F. Underwriters Laboratories (UL)

UL 969	Standard for Marking and Labeling Systems

1.3 SUBMITTALS

A. See the Contract Statement of Work for the submittal process.

B. Approval Required

1. Catalog Data: Submit manufacturer catalog literature for each product.

2. Submit electrical identification schedule including list of wording, symbols, letter size, color-coding, tag number, location, and function.

3. Samples:

   a. Submit two samples of each type of printed identification products applicable to project.

   b. Submit two nameplates illustrating materials and engraving quality.

4. Manufacturer Installation Instructions: Submit installation instructions, indicating special procedures and installation requirements.

1.4 QUALITY ASSURANCE

A. Conform to requirements of the NEC, NFPA 70E, and 29 CFR 1910.145.

B. Conform to applicable requirements of ANSI Z535.1, Z535.2, Z535.3, Z535.4, and Z535.5.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Subcontract Documents, Shop Drawings, and manufacturer wiring diagrams, with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

PART 2 PRODUCTS

2.1 SUBSTITUTIONS

A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work.

2.2 COMPONENT IDENTIFICATION TAGS

A. Furnish component identification tags as specified and scheduled on the Drawings and consistent with the labeling format in TFC-ENG-STD-12.

B. Provide tags made of materials shown on the Drawings, and consistent with the requirements in TFC-ENG-STD-12.

2.3 EQUIPMENT NAMEPLATES

A. Furnish equipment nameplates at each switchboard; disconnect switches, distribution panel, and transformers as specified on the Drawings.

B. Equipment nameplates: Laminated plastic, as shown on Drawings. Engraved nomenclature sharp and clear. Engraved manufacturer standard nameplates may be used if equal in quality and legibility.

C. Attachment:

1. NEMA 4 and 4X Enclosures: One-part clear room temperature vulcanizing adhesive.

2. All Other Enclosures: Stainless steel screws, unless otherwise noted on Drawings.

D. Post conductor color code on each panelboard, switchboard, switchgear assembly, motor control center (MCC). Use typewritten, adhesive-backed labels.

E. Coordinate equipment nameplate schedule with equipment numbering scheme provided by WRPS Construction Representative.

2.4 WIRE MARKERS

A. Provide wire markers for power circuit wires.

B. Furnish split sleeve or heat-shrinkable sleeve, wire markers.

C. Locate a wire marker on each conductor at each switchboard, disconnect switches, terminal box, distribution panel, transformer, pull boxes, junction boxes, and each load connection.

D. Provide typewritten lettering on wire markers for as-built branch circuit or feeder circuit number.

E. Manufacturer: LEM Products, Inc., Brady, Panduit.

2.5 VOLTAGE MARKERS

A. Furnish voltage markers for each switchboard; disconnect switches, terminal box, distribution panel, transformer, and cabinets.

B. Provide flexible pressure sensitive vinyl markers with minimum 1-in. x 4-in. orange background and black letters.

C. Provide voltage markers with lettering indicating the highest voltage present:

1. 480Y/277 and 480 V system: 480 V.

2. 120/240V and 240V systems: 240V.

D. Manufacturer: Electromark, LEM Products, Inc.

2.6 WARNING SIGNS

A. Furnish warning signs for each switchboard, disconnect switches, terminal box, distribution panel, transformer, pull boxes, and cabinets.

B. Use warning signs that conform to ANSI Z535.2, Z535.4 and 29 CFR 1910.145.

C. Provide minimum 2-in. x 4-in. warning signs.

D. Provide warning signs with format and lettering as follows:

1. Signal word: DANGER

2. Signal word panel color: Red with safety alert symbol.

3. Word message:
   Keep Out!
   Hazardous voltage inside.
   Will shock, burn, or cause death.

4. Safety symbol: ISO 3864 “lightning bolt” in yellow triangle.

E. Materials:

1. Use flexible, pressure sensitive, polyester base with polyester overlaminate.

F. Manufacturer: Seton Name Plate Co., Safety Label Solutions, Hazard Communication Systems, Electromark.

2.7 WORKING SPACE LABELS

A. Provide labels indicating required working clearance at electrical equipment that is likely to require examination, adjustment, servicing, or maintenance while energized.

B. Material:

1. Use polyester label stock that is NRTL-recognized to UL 969 and has a high-adhesion adhesive back.

2. Use printing ribbon recommended by the label stock manufacturer.

3. Use a suitable thermal transfer process label-printing machine to generate labels and enter the application-specific information.

4. Outdoor labels shall be suitable for a high-UV environment.

C. Minimum dimensions: 3 1/2-in. x 1 1/4-in.

D. Use the following label design:

NOTICE
Keep area in front of this electrical equipment clear for #-#/# feet. OSHA-NEC regulations.

1. Signal word: “NOTICE” in 24-point minimum white italic letters on safety blue panel.

2. Word message: 16-point minimum black or safety blue letters on white background.

a. Word message for 151 to 600 Volt equipment with exposed live parts on one side of the working space and no live or grounded parts on the other side of the working space: “Keep area in front of this electrical equipment clear for 3 feet OSHA-NEC regulations.”

b. Word message for 151 to 600 Volt equipment with exposed live parts on one side of the working space and grounded parts on the other side of the working space: “Keep area in front of this electrical equipment clear for 3 1/2 feet OSHA-NEC regulations.”

c. Word message for 151 to 600 Volt equipment with exposed live parts on both sides of the working space: “Keep area in front of this electrical equipment clear for 4 feet OSHA-NEC regulations.”

d. Word message for 0 to 150 Volt equipment with exposed live parts on one side of the working space and live or grounded parts on the other side of the working space: “Keep area in front of this electrical equipment clear for 3 feet OSHA-NEC regulations.”

E. Manufacturer: Brother, Seton, Brady

2.8 UNDERGROUND WARNING TAPE

A. Furnish underground warning tape for underground cables, conduits and duct banks.

B. Use 6-in. wide, 0.004-in. thick, polyethylene detectable underground warning tape black lettering and the following background colors:

1. Electric: Red

C. Provide lettering that indicates the type service buried below.

1. Electric: “CAUTION ELECTRIC LINE BURIED BELOW”

D. Manufacturer: Utility Safeguard, LLC, Detectable Terra Tape, Reef Industries, Inc.

2.9 ARC FLASH LABELS

A. Install arc flash labels on electrical equipment as required by NEC.

2.10 CONDUIT LABELING

A. Conduit metal tags shall be affixed to all numbered conduit. Conduit numbers are shown on Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive identification products for compliance with installation tolerances and other conditions affecting performance of the identification products. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION - GENERAL

A. Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

B. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install electrical identification products only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

E. Clean surface where electrical identification product is to be placed.

F. Use manufacturer recommended adhesive for engraved tags and nameplates.

G. Place electrical identification products centered and parallel to equipment lines.

3.3 COMPONENT IDENTIFICATION TAGS

A. Install component identification tag, as indicated on the Drawings, on the front of each piece of electrical equipment including switchboards, MCCs, distribution panels, transformers, and variable frequency drives.

B. Position tags so they can be read from floor or ground.

3.4 EQUIPMENT NAMEPLATES

A. Install equipment nameplate or nameplates, as indicated on the Drawings, on the front of each piece of electrical equipment including switchboards, MCCs, distribution panels, and transformers.

B. Position nameplates so they can be read from floor or ground.

3.5 WIRE MARKERS

A. Install wire markers on power conductors at each appearance in locations such as pull boxes, junction boxes, switchboards, MCCs, distribution panels, transformers, and load connections.

B. Position markers so they can be read from the front of the enclosure.

3.6 VOLTAGE MARKERS

A. Install voltage markers at the following locations and position markers so they can be read from floor or ground:

1. Front of each freestanding low-voltage switchboard section.

2. Front of each switchboard, MCC, distribution panel, and transformers.

3. Cover of each pull box containing low-voltage conductors.

3.7 WARNING SIGNS

A. Install warning signs at the following locations and position signs so they can be read from floor or ground:

1. Front of each switchboard disconnect switches, terminal box, distribution panel, transformer, pull boxes, and cabinets.

3.8 WORKING SPACE LABELS

A. Install working space labels in front of switchboards, MCCs, distribution panels, and transformers.

B. Any other equipment likely to require examination, adjustment, servicing, or maintenance while energized.

3.9 UNDERGROUND WARNING TAPE

A. For trenches 12-in. or less from top of conduit to top of finished grade, install underground warning tape in trench, 6-in. above conduit.

B. For trenches greater than 12-in. from top of conduit to top of finished grade, install underground warning tape in trench, 12-in. minimum above conduit.

C. Where conduits are 6-in. or less below grade, warning tape is not required.

END OF SECTION 26 05 53

SECTION 26 22 13

LOW VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. General-purpose dry-type low-voltage transformers

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American National Standards Institute

ANSI C84.1-2016	Electric Power Systems and Equipment – Voltage Ratings

B. National Electrical Manufacturers Association (NEMA)

NEMA TP 1	Guide for Determining Energy Efficiency for Distribution Transformers
NEMA TP 2	Standard Test Method for Measuring the Energy Consumption of Distribution Transformers
NEMA TP 3	Standard for the Labeling of Distribution Transformer Efficiency

C. National Fire Protection Association (NFPA)

NFPA 70, 2017	National Electrical Code (NEC)

D. Underwriters Laboratories (UL)

	Electrical Appliance and Utilization Equipment Directory
UL 486A-486B	Wire Connectors
UL 1561	Dry-Type General Purpose and Power Transformers

1.3 SUBMITTALS

A. See the Contract Statement of Work for the submittal process.

B. Approval Required: None

1.4 QUALITY ASSURANCE

A. Comply with the NEC for components and installation.

B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.

C. Provide products that comply with the following industry standards:

1. NEMA TP 1

2. NEMA TP 2

3. NEMA TP 3

4. UL 1561

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, protect, and handle products according to manufacturer instructions.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work.

2.2 GENERAL

A. Transformers shall be NRTL-listed to UL 1561 and shall be tested and labeled according to NEMA TP 1, NEMA TP 2, and NEMA TP 3.

B. The efficiency of each transformer shall be NEMA TP 1, Class I when tested in accordance with NEMA TP 2. Transformer efficiency shall be indicated on a label that conforms to NEMA TP 3.

C. Transformer coils may be aluminum or copper with continuous wound construction and shall be impregnated with non-hygroscopic, thermosetting varnish. Terminations shall be brazed or welded to the coil conductor.

D. Transformer cores shall be constructed of a high grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities shall be kept well below the saturation point.

E. The core and coil shall be bolted to the base of the enclosure, isolated by means of rubber vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and the enclosure. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.

F. The core of the transformer shall be visibly grounded to the enclosure by a flexible grounding conductor sized following applicable UL and NEC Standards.

G. The transformer enclosure shall be ventilated and shall be fabricated of a heavy gauge, sheet steel construction. The entire enclosure shall be finished using a process consisting of degreasing, cleaning and phosphatizing followed by electrostatic deposition of polymer polyester powder and baking cycle to provide a uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be light or medium grey.

H. Transformers shall be suitable for rack or floor mounting. Provide mounting accessories required for installation.

I. Provide weather shields for transformers installed outdoors.

J. Provide transformer manufacturer transformer lug kits with compression type equipment lugs and hardware for connecting conductors to transformer terminals.

K. Provide factory assembled and tested, energy-efficient, general-purpose, air-cooled, two-winding, dry-type transformers with voltage and kVA ratings, as indicated on the Drawings.

L. General-purpose transformers 15 kVA and larger shall be 150°C temperature rise above 40°C ambient. The maximum temperature of the top of the enclosure shall not exceed 50°C rise above a 40°C ambient.

M. Transformers 15 kVA and larger shall have a minimum of two 2.5% full capacity above normal and four 2.5% full capacity below normal primary taps.

N. Manufacturers:

1. Square D Class 7400 Type “EE.”

2. Eaton/Cutler-Hammer “DS-3” and “DT-3.”

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive transformers for compliance with installation tolerances and other conditions affecting performance of the control system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install dry-type transformers where indicated on the Drawings and according to manufacturer instructions. Manufacturer installation instructions shall be available at the construction site.

B. Arrange equipment to provide adequate spacing for access, replacement, and for cooling air circulation. Locate the front and rear of each ventilated transformer at least 6-in. from the wall or any obstruction to allow proper air circulation.

C. Make conduit connections to transformer enclosure, only at locations designated by the manufacturer installation instructions.

D. Connect conductors to transformer terminals using transformer manufacturer lug kits. Tighten electrical connectors and terminals according to manufacturer published torque-tightening values. Where manufacturer torque values are not furnished, use those specified Section 26 05 19, “Low Voltage Electrical Power Conductors and Cables, “Attachment 1, “Recommended Tightening Torque per UL 486A-486B.”

E. Bond transformers and ground systems served by transformers according to Section 26 05 26, “Grounding and Bonding for Electrical Systems.”

F. Identify transformers and install warning signs according to Section 26 05 53, “Identification for Electrical Systems.”

3.3 FIELD QUALITY CONTROL

A. Clean, inspect, test, adjust, and energize transformers in accordance with manufacturer instructions.

1. Inspect each transformer for physical damage, proper connection and grounding, and proper anchorage.

2. Keep records of inspections, tests, and adjustments in the work package or fabrication document.

B. Coordinate inspections and tests with those required by other sections.

C. After completing installation, cleaning, and testing, touch-up scratches and mars on finish to match original finish.

D. Measure primary and secondary voltages and phase rotation, and make preliminary tap adjustments. The system nominal, minimum, and maximum are per ANSI C84.1-2016. After normal operating loads have been energized, adjust taps to provide the following voltage at points of use; record voltages and tap settings.

System Nominal Voltage	Minimum Load Voltage	Maximum Load Voltage
480Y/277	456Y/263	504Y/291
120/240	114/228	126/252

END OF SECTION 26 22 13

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Panelboards for feeder and branch circuit loads.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. National Electrical Manufacturer's Association (NEMA)

NEMA AB 3	Molded Case Circuit Breakers and their Application
NEMA PB 1	Panelboards
NEMA PB 1.1	General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 volts or less

B. National Fire Protection Association (NFPA)

NFPA 70, 2017	National electrical Code (NEC)

C. NSF International/American National Standards Institute (ANSI)

NSF/ANSI 49	Biosafety Cabinetry: Design, Construction, Performance, and Field Certification

D. Underwriters Laboratories (UL)

UL 50	Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 67	Panelboards
UL 486A-486B	Wire Connectors
UL 489	Molded Case Circuit Breakers

1.3 SUBMITTALS

A. See the Contract Statement of Work for the submittal process.

B. Approval Required: None.

1.4 QUALITY ASSURANCE

A. Comply with the NEC for components and installation.

B. Furnish products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.

C. Comply with NEMA PB 1, NEMA PB 1.1, and NEMA AB 3.

D. Comply with UL 67, UL 50, and UL 489.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards according to manufacturer instructions.

1.6 EXTRA MATERIALS

A. Furnish spare keys of each type for panelboard cabinet locks.

PART 2 PRODUCTS

2.1 SUBSTITUTIONS

A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work.

2.2 DISTRIBUTION PANELBOARDS

A. Furnish panelboards as indicated on the Drawings and specified in this Section.

B. Panelboards shall be UL 67 listed and shall conform to NEMA PB1.

C. Furnish panelboard cabinets for surface mounting as indicted on the Drawings.

1. Furnish outdoor enclosures as indicated below:

    a. NEMA 4/4X or 3R: rated rain tight minimum.

2. Cabinets shall be not less than 20-in. wide.

3. Furnish steel cabinets constructed according to UL 50 requirements.

4. NEMA 12 and NEMA 4 boxes shall have end walls welded and sealed.

D. Furnish trim fronts that meet the strength and rigidity requirements of UL 50.

1. Each panelboard trim front shall include a door.

2. Fronts shall have NSF/ANSI 49 medium gray enamel electro-deposited over cleaned, phosphatized steel.

3. Furnish a panelboard circuit directory card in a metal frame mounted inside the panelboard door. The directory card shall include spaces for circuit numbers and sufficient spaces to allow each circuit to be described in sufficient detail to be distinguished from all others.

a. Furnish cylindrical tumbler-type locks for doors. Furnish sliding vault locks with 3-point latching for enclosures more than 48-in. high. Key all lock assemblies alike. Furnish two keys with each lock, plus spares as required in Paragraph 1.6.

E. Equip panelboards with mounting brackets, bus connections, and necessary appurtenances, for the future installation of circuit breakers as scheduled on the Drawings.

F. Furnish panelboards having NRTL-listed short circuit current ratings, not less than the available fault current indicated on the Drawings.

G. Furnish thermal-magnetic circuit breakers that meet the requirements of UL 489 and NEMA AB 3.

1. Furnish circuit breakers of the type, rating, and features as indicated on the Drawings.

2. Do not use tandem circuit breakers.

3. Furnish multi-pole breakers with a common trip.

4. Furnish bolt-on type circuit breakers or circuit breakers that connect to the panel bus through positive gripping connector jaws, and are secured by an independent mechanical locking device.

5. Furnish UL Class A ground fault interrupter circuit breakers or UL Class B equipment protection circuit breakers where scheduled on Drawings.

6. Furnish circuit breakers with provisions for connecting the size and number of conductors indicated on the Drawings. Refer to Section 26 05 19, “Low Voltage Electrical Power Conductors and Cables,” for conductor connection requirements.

H. Furnish a permanently-installed handle lock-off device for each circuit breaker.

1. Furnish handle lock-off device that will accept a 1/4-in. padlock shackle.

2. Securely attach the device to the circuit breaker case; the attachment shall not depend on a friction fit or the presence of the panelboard front for the handle lock-off device to remain in place and be functional.

I. Manufacturers:

1. Eaton:

a. 480Y/277 V: “PRL3a” and “PRL4”

b. 120/240 V: “PRL1a” and “PRL2a”

2. Square D:

a. 480Y/277 V: “NF” and “I-LINE”

b. 120/240 V: “NQ” and “I-Line”

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards where indicated on the Drawings and according to manufacturer instructions, NEMA PB 1.1, and the NEC. Have the manufacturer installation instructions available at the construction site.

B. Furnish supports in accordance with the requirements of Section 26 05 29, “Hangers and Supports for Electrical Systems.”

C. Position panelboards so the top circuit breaker handle is not more than 6 feet – 7 in. above the surface of the working space in front of the panelboard.

D. Ground and bond panelboards as required in Section 26 05 26, “Grounding and Bonding for Electrical Systems.”

3.3 IDENTIFICATION

A. Furnish typed circuit directories for each branch circuit panelboard.

1. Install a plastic-laminated copy of the panel schedule Drawings on the inner side of the panelboard door.

B. Identify panelboards and install warning signs and arc-flash warning labels, as required in Section 26 05 53, “Identification for Electrical Systems.”

3.4 FIELD QUALITY CONTROL

A. Clean, inspect, test, and energize panelboards in accordance with manufacturer instructions. Exercise each circuit breaker three times to verify smooth mechanical operation.

B. Coordinate inspections and tests with those required by other sections.

C. Visual and Mechanical Inspection: Include the following listed inspections and related work.

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of the Drawings and panelboard schedules.

2. Exercise and perform operational tests of mechanical components and other operable devices, in accordance with manufacturer instruction manual.

3. Check panelboard mounting, area clearances, and alignment and fit of components.

4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer instructions for torque values and Section 26 05 19, “Low Voltage Electrical Power Conductors and Cables, “Attachment 1, “Recommended Tightening Torque per UL 486A-486B.”

5. Perform visual and mechanical inspection for overcurrent protective devices.

D. Electrical Tests: Include the following listed items performed in accordance with manufacturer instruction.

1. Ground continuity test ground bus to system ground.

E. After completing installation, cleaning, and testing, touch-up scratches and mars on finish to match original finish.

END OF SECTION 26 24 16

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Receptacles.

B. Snap switches.

C. Wall plates.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. Federal Specifications (FS)

B. National Electrical Contractors Association (NECA)

NECA 1	Standard for Good Workmanship in Electrical Contracting

C. National Electrical Manufacturers Association (NEMA)

NEMA ICS 4	Application Guideline for Terminal Blocks
NEMA WD 1	General Requirements for Wiring Devices
NEMA WD 6	Wiring Devices—Dimensional Specifications

D. National Fire Protection Association (NFPA)

NFPA 70, 2017	National Electrical Code (NEC)

E. Underwriters Laboratories (UL)

UL 20	General Use Snap Switches
UL 498	Electrical Attachment Plugs and Receptacles
UL 508A, 2013	Standard for Safety for Industrial Control Equipment

UL 943	Ground Fault Circuit Interrupters
UL 1059	Standard for Terminal Blocks
UL 1449	Standard for Transient Voltage Surge Suppressors

1.3 SUBMITTALS

A. See the Contract Statement of Work for the submittal process.

B. Approval Required

1. Not Used.

1.4 QUALITY ASSURANCE

A. The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work.

B. Comply with the NEC.

C. Furnish products listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environments in which installed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, protect, and handle products according to manufacturer instructions and NECA 1.

PART 2 PRODUCTS

2.1 SUBSTITUTIONS

A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work.

2.2 RECEPTACLES

A. Provide back and side wired, screw pressure terminal, straight-blade, and locking type, receptacles as indicated on the Drawings. Receptacles shall meet the performance and design requirements of UL 498. Receptacle configurations shall be in accordance with NEMA WD 6.

B. For 120-volt receptacles connected to individual branch circuits, provide straight-blade NEMA 5-20R, 20 amperes, 125 volts, grounding duplex receptacles. Receptacle mounting strap, ground terminal, and ground contacts shall be formed from one piece of brass alloy. Manufacturer: Hubbell “HBL5362” or equal.

C. For GFCI receptacles connected to individual branch circuits, provide straight-blade NEMA 5-20R, 20 amperes, 125 volts, grounding, “feed through” type, self-testing GFCI, duplex receptacle that meet the requirements of UL 943. Provide units that can be installed in a 2 3/4-in. deep outlet box without an adapter. Manufacturer: Hubbell “GFR5362ST” or equal.

D. Provide straight-blade and twist lock receptacles for special applications as indicated on the Drawings.

E. Provide 480 VAC, 3 wire, 4 pole, receptacles, amperage as shown on Drawings. Manufacturer: Crouse Hinds.

2.3 SNAP SWITCHES

A. Provide single pole, double pole, three-way, four-way and illuminated handle snap switches as indicated on the Drawings.

B. Switches shall be rated 20 amperes, 120-277 volts AC, back and side wired, screw pressure terminal, quiet type AC switch with yoke grounding screw. Switches shall meet the performance and design requirements of UL 20.

C. Manufacturer: Hubbell “HBL1220” series.

2.4 WALL PLATES

A. For GFCI receptacles in damp or wet locations provide weatherproof, in use covers. Manufacturer: Hubbell “WP26E.”

B. Provide single, multi-gang, and combination type wall plates that mate and match with corresponding wiring devices.

C. Use metal plate-securing screws to match plate finish.

D. Terminal Blocks

1. Terminal Blocks shall meet the requirements of UL 1059 or NEMA ICS 4.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify outlet boxes are installed per Drawings.

B. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

C. Clean debris from outlet boxes before installing devices.

3.2 INSTALLATION

A. Install products following manufacturer instructions. Have the manufacturer installation instructions available at the construction site.

B. Install devices plumb, level, and secure.

C. Except as otherwise indicated on the Drawings, mount devices with long dimension vertical, and grounding point of receptacles on top. Group adjacent switches and receptacles under single, multi-gang wall plates.

D. Do not use the duplex/split-wire break-off tabs in receptacles as circuit conductors for connecting downstream devices.

E. Install galvanized steel plates on outlet boxes and junction boxes on surface mounted outlets.

3.3 GROUNDING

A. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

3.4 IDENTIFICATION

A. Identify wiring devices with circuit number as required in Section 26 05 53, “Identification for Electrical Systems.”

3.5 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects before installing.

B. Operate each operable device at least six times with circuit energized; verify proper operation.

C. Test 20-ampere receptacles for proper polarity and ground continuity using an NRTL-listed test device that impresses a momentary current of at least 15 amperes on the branch circuit conductors and equipment grounding path.

D. Test ground-fault circuit interrupter receptacle operation according to manufacturer recommendations.

E. Replace damaged or defective wiring devices.

3.6 CLEANING AND ADJUSTING

A. Clean devices prior to and after installation. Replace stained or damaged wall plates or devices.

B. Adjust devices and wall plates to be flush and level as required.

END OF SECTION 26 27 26

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Safety switches.

B. Fuses and circuit breakers.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. National Electrical Manufacturers Association (NEMA)

NEMA FU 1	Low Voltage Cartridge Fuses
NEMA KS 1	Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

B. National Fire Protection Association (NFPA)

NFPA 70, 2017	National Electrical Code (NEC)

C. Underwriters Laboratories (UL)

UL 50	Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 248	Low-Voltage Fuses

1.3 SUBMITTALS

A. See the Contract Statement of Work for the submittal process.

B. Approval Required.

1. Not Used.

1.4 QUALITY ASSURANCE

A. Comply with the NEC for components and installation.

B. Provide safety switches that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.

C. Comply with the following standards as applicable:

1. NEMA KS 1
2. UL 50
3. NEMA FU 1
4. UL 248

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store safety switches, enclosed circuit breakers, and fuses according to the manufacturer written instructions.

1.6 EXTRA MATERIALS

A. Provide one spray can of touch-up paint that matches finish of switches.

PART 2 PRODUCTS

2.1 SUBSTITUTIONS

A. Alternate products may be accepted. Follow the guidelines set forth in the Contract Statement of Work.

2.2 SAFETY SWITCHES

A. Provide NRTL-listed, NEMA Type 1, 3R/12 or 4 Heavy Duty safety switches with ratings and number of poles as indicated on the Drawings or as required by the NEC suitable for the environment into which it is being installed.

B. Each safety switch shall have an equipment ground bar.

C. Each safety switch shall have provisions for padlocking in the OFF position.

D. Manufacturer: Square D “Class 3110” or Cutler-Hammer “DH” Series.

2.3 FUSES

A. Provide NEMA FU 1 and UL 248 fuses with type, voltage, and current ratings as indicated on Drawings.

B. Manufacturer as shown on Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install safety switches and fuses where indicated on the Drawings, according to manufacturer instructions, and the NEC.

B. Ground and bond safety switches as required in Section 26 05 26, "Grounding and Bonding for Electrical Systems."

C. Install conduits as required in Section 26 05 33, "Raceways and Boxes for Electrical Systems."

D. Install conductors as required in Section 26 05 19, "Low Voltage Electrical Power Conductors and Cables."

   1. Tighten electrical connectors and terminals to the manufacturer published torque values.

3.2 IDENTIFICATION

A. Identify safety switches and install warning signs and arc-flash warning labels as required in Section 26 05 53, "Identification for Electrical Systems."

B. Mark floor in front of safety switches to show NEC required working space according to Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. Clean interior and exterior of safety switches.

B. Verify proper torque of accessible bus connections and mechanical fasteners after installing safety switches, document in work package or fabrication document.

C. Safety Switches, 600 Volts Maximum

   1. Visual and Mechanical Inspection:

      a. Proper blade alignment.

      b. Proper operation of switch operating handle.

      c. Adequate mechanical support for each fuse.

      d. Proper contact-to-contact tightness between fuse clip and fuse.

      e. Manufacturer phase barrier material installed and in place.

      f. Verify fuse sizes and types correspond to the Drawings.

g. Perform mechanical operational test and verify mechanical interlocking system operation and sequencing.

D. Molded and Insulated Case Circuit Breakers

1. Visual and Mechanical Inspection:

a. Proper mounting.

b. Proper conductor size.

c. Feeder designation according to the Drawings.

d. Cracked casings.

e. Operate breaker to verify smooth operation.

f. Compare frame size and trip setting with panelboard schedules or one-line diagram.

g. Verify that terminals are suitable for 75°C rated insulated conductors.

E. After completing installation, cleaning, and testing, touch-up scratches and mars on finish to match original finish.

END OF SECTION 26 28 16

SECTION 26 29 13

ENCLOSED CONTROLLERS

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. AC motor control devices rated 1000V or less that are not integral parts of equipment or motor control centers.

B. Manual motor controllers for fractional horsepower motors.

C. Magnetic motor controllers, full-voltage, non-reversing.

D. Combination magnetic motor controllers, full-voltage, non-reversing.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. National Electrical Manufacturers Association (NEMA)

NEMA ICS 2	Controllers, Contactors and Overload Relays Rated 600 V
NEMA ICS 6	Industrial Control and Systems: Enclosures

B. National Fire Protection Association (NFPA)

NFPA 70, 2017	National Electrical Code (NEC)

C. Underwriters Laboratories (UL)

UL 486A-486B	Wire Connectors
UL 489	Molded-Case Circuit Breakers, Molded-Case Switches, Circuit Breaker Enclosures
UL 508	Industrial Control Equipment

1.3 SUBMITTALS

A. See the Contract Statement of Work for the submittal process.

B. Catalog Data: Submit manufacturer technical data for each type of motor controller and starter, including data proving that materials comply with specified requirements. . Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

C. Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

D. Operation and maintenance instructions.

E. Test and Inspection Records: Submit records of inspections, tests, and adjustments performed under Field Quality Control.

F. Wiring diagrams: Submit the following listed diagrams for each type of enclosed controller supplied.

   1. Wiring diagram showing the relative locations of controller components and terminals.

   2. Elementary diagram with components arranged in a “ladder” format to show sequence of operation of the devices.

1.4 QUALITY ASSURANCE

A. Comply with the NEC for components and installation.

B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, protect, and handle products according to manufacturer instructions.

1.6 COORDINATION

A. Coordinate the features of each enclosed controller with the ratings and characteristics of the supply circuit, the motor, the required control sequence, the duty cycle of the load, the pilot devices, and control circuit affecting controller functions. Provide controllers that are horsepower-rated to suit the motor controlled.

1.7 SERVICE CONDITIONS

A. Enclosed controllers shall perform satisfactorily in the following service conditions without mechanical or electrical damage or degradation of operating characteristics:

   1. Operating ambient temperature of -25°F to 115°F.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work.

2.2 GENERAL

A. Provide enclosed controllers that are NRTL-listed to UL 508 and have a short circuit withstand rating that exceeds the fault current available at the controller line terminals.

B. Provide enclosed controllers that conform to the requirements of NEMA ICS 2.

C. Provide enclosures in accordance with NEMA ICS 6 with Type as required to meet conditions of installation.

2.3 FRACTIONAL HORSEPOWER MANUAL MOTOR CONTROLLERS

A. Provide general purpose, Class A, manually-operated, full-voltage controllers for AC fractional horsepower motors.

B. Provide starter with thermal overload unit, red pilot light, and toggle operator.

C. Provide handle guard with provision for locking in the OFF position.

D. Manufacturers:

1. Allen-Bradley “Bulletin 600”
2. Eaton “Type MS”
3. Siemens “Class SMF”
4. Square D “Class 2510 Type F”

2.4 CIRCUIT BREAKER TYPE COMBINATION MAGNETIC MOTOR CONTROLLERS, NON-REVERSING

A. Provide combination magnetic motor controllers with motor circuit protector disconnect and controller in a common enclosure.

B. Motor circuit protector shall conform to UL 489 with an integral instantaneous magnetic trip in each pole.

1. Trip units shall be calibrated to coordinate with the actual locked-rotor current of the connected motor and the controller overload relays.
2. Provide motor circuit protectors that are factory assembled with the controller, interlocked with unit cover or door, and arranged to disconnect the controller.

3. Motor circuit protector shall have a color-coded externally operated handle. Operating handle shall give positive visual indication of ON-OFF with red and black color-coding. Include provisions for padlocking handle in the OFF position.

4. Provide motor circuit protectors rated 600 volts when used on 480-volt systems.

C. Provide general purpose, Class A, magnetic, full-voltage, non-reversing controllers for AC induction motors rated in horsepower.

D. Coil shall be of the encapsulated type. Coil operating voltage shall be 24 volts, 60 Hz.

E. Provide controllers of size and number of poles as indicated on the Drawings.

F. Contacts shall be totally enclosed, double-break, silver-cadmium-oxide power contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring.

G. Wiring shall be straight through with all terminals clearly marked.

H. Provide solid-state overload units with the following listed characteristics for motors rated up to 100 full-load amperes.

1. NEMA Class 30 tripping characteristics.

2. Field selectable motor full load current.

3. Ambient temperature insensitive.

4. Phase loss and phase unbalance protection.

5. Manual reset after time delay.

6. Integral current transformers.

I. Provide two sets of NEMA ICS 2 field convertible auxiliary contacts in addition to the seal-in contact.

J. Provide cover mounted, heavy duty, 22 mm or 30 mm, metal operator, oil tight pilot devices as listed below with NEMA ICS 2, Form Z, A600 rated contacts

1. Selector Switches, Rotary type as scheduled on the Drawings:

a. HAND-OFF-AUTO or ON-OFF-AUTO selector switch, if controller is connected to automatic control system or may be in the future.

b. ON-OFF selector switch, if controller is not connected to automatic control system.

2. Push buttons as scheduled on the Drawings:

    a. Flush, momentary-contact START pushbutton.

    b. Flush, momentary-contact STOP pushbutton.

3. Push-to-test LED-type indicating lights:

    a. Red RUNNING pilot light.

    b. Green STOPPED pilot light.

    c. Additional pilot lights as indicated on the Drawings.

4. Provide legend plates for pushbuttons, pilot lights, and selector switches.

K. Provide externally operable manual reset operator.

L. Provide a control power transformer in each motor starter. The transformer shall have 24-volt secondary and sufficient capacity to operate starter coil and all connected pilot, indicating and control devices, plus 20% spare capacity. Provide fused primary and secondary. Bond un-fused leg of secondary to enclosure. Provide fuses or fuse holders with blown fuse indication.

M. Manufacturer:

1. Allen-Bradley “Bulletin 513”

2. Siemens “Class 18”

3. Square D “Class 8539 Type S”

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive equipment for compliance with installation tolerances and other conditions affecting performance of the control system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install motor control equipment where indicated on the Drawings and according to manufacturer instructions. Manufacturer installation instructions shall be available at the construction site.

B. Mount with operating mechanism 5 feet above concrete sidewalk or as indicated on the Drawings.

C. Install enclosed controllers plumb.

D. Remove temporary blocking of moving parts from controllers.

E. Set overload relays or install overload heater elements in motor controllers to match installed motor characteristics.

F. Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

G. Arrange equipment to provide adequate spacing for access, replacement, and for cooling air circulation.

H. Make conduit connections to enclosure, only at locations designated by the manufacturer installation instructions.

I. Connect conductors to terminals and label field wiring in accordance with the Drawings. Tighten electrical connectors and terminals according to manufacturer published torque-tightening values. Where manufacturer torque values are not furnished, use those specified Section 26 05 19, “Low Voltage Electrical Power Conductors and Cables,” Attachment 1, “Recommended Tightening Torque per UL 486A-486B.”

J. Bundle and train wiring in enclosures.

K. Bond and ground equipment according to Section 26 05 26, “Grounding and Bonding for Electrical Systems.”

L. Identify equipment and install warning signs according to Section 26 05 53, “Identification for Electrical Systems.”

3.3 FIELD QUALITY CONTROL

A. Clean, inspect, test, adjust, and energize equipment in accordance with manufacturer instructions.

B. Inspect each controller for physical damage, proper connection and grounding, and proper anchorage to supports.

C. Verify that the proper overloads are installed and set for the motor nameplate full load current and duty.

D. Coordinate inspections and tests with those required by other sections.

E. Perform the following tests.

   1. Verify that voltages at controllers are within plus or minus 10% of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).

   2. Verify that correct voltage is present at control transformer primary and secondary.

3. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.

4. Test continuity of each circuit.

5. Test each motor for phase rotation.

6. Test and adjust controls, remote monitoring, and safety interlocks. Replace damaged and malfunctioning controls and equipment.

F. Enclosed controllers will be considered defective if they do not pass tests and inspections.

G. Keep records of inspections, tests, and adjustments. Prepare Test and Inspection Report, and submit in accordance with Submittal requirements.

H. After completing installation, cleaning, and testing, touch-up scratches and mars on finish to match original finish.

END OF SECTION 26 29 13

SECTION 26 56 00

EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Exterior luminaires and accessories.

B. Lighting controls.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American Society of Civil Engineers (ASCE)

ASCE 7, 2010	Minimum Design Loads for Buildings and Other Structures

B. Architectural Aluminum Manufacturers Association (AAMA)

AAMA 611	Voluntary Specification for Anodized Architectural Aluminum
AAMA 2605	Superior Performing Coatings

C. ASTM International (ASTM)

ASTM A123/A123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

D. Hanford Documents

TFC-ENG-STD-06, D-2	Design Loads for Tank Farm Facilities

E. Illuminating Engineering Society of North America (IESNA)

	Lighting Handbook

F. International Code Council (ICC)

IBC, 2015	International Building Code

G. National Fire Protection Association (NFPA)

NFPA 70, 2017	National Electrical Code (NEC)

H. Underwriters Laboratories (UL)

UL 1598	Luminaires

1.3 SUBMITTALS

A. See the Contract Statement of Work for the submittal process.

B. Approval Required.

1. Catalog Data: Lighting Fixtures.

1.4 QUALITY ASSURANCE

A. Comply with the following codes and standards:

1. NEC for components and installation.
2. International Building Code.
3. ASCE 7.

B. Provide luminaires listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environments in which installed.

C. Use manufacturers that are experienced in manufacturing luminaires and lamps, similar to those indicated for this Project and have a record of successful in-service performance.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products according to the manufacturer written instructions.

B. Retain factory-applied pole wrappings on metal poles until right before installation.

1.6 SERVICE CONDITIONS

A. International Building Code and ASCE 7 and TFC-ENG-STD-06, Rev. D-2 design wind conditions:

1. Exposure Category: C
2. Basic Wind Speed: 110 mph (3-second gust at 33-feet above ground, mean recurrence interval of 50 years)
3. Importance Factor: 1.0

B. Ambient temperature:

1. -25°F to 115°F

1.7 DEFINITIONS

A. Unless otherwise specified or indicated, terms used in this Section are as defined in the NEC or the IESNA Lighting Handbook.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work.

2.2 FINISHES

A. Furnish luminaires and accessories with finishes, as scheduled, that are resistant to fading, chalking, and other changes due to aging and exposure to heat and ultraviolet light. Acceptable finishes for metals are as listed.

1. Hot-dipped galvanized steel: ASTM A123/A123M.

2. Brushed natural aluminum.

3. Anodized aluminum: AAMA 611, Class I.

4. Powder coated aluminum: Fluorocarbon polymer powder coating per AAMA 2605, over chrome phosphate conversion coated aluminum.

5. Powder coated steel: Fluorocarbon polymer powder coating per AAMA 2605 over zinc phosphate conversion coated shot-blasted steel.

B. Reject luminaires and accessories with finish having runs, streaks, stains, and defects.

C. Replace luminaires and accessories showing evidence of yellowing, fading, chalking, and other changes indicating failure during warranty period.

D. Use stainless steel for exposed hardware.

2.3 EXTERIOR LUMINAIRES

A. Furnish exterior luminaires that comply with requirements specified on the Drawings.

B. Luminaires shall be NRTL-listed as conforming to UL 1598.

C. Luminaire photometric characteristics shall be based on IESNA-approved methods for photometric measurements performed by a recognized photometric laboratory.

D. Luminaire housing shall be primarily metal.

1. Metal parts shall be free from burrs and sharp corners and edges.

2. Sheet metal components shall be fabricated from corrosion-resistant aluminum, formed and supported to prevent sagging and warping.

3. Exposed fasteners shall be stainless steel.

E. Provide lenses, fabricated from materials that are UV-stabilized to be resistant to yellowing and other changes due to aging or exposure to heat and ultraviolet radiation.

F. Doors shall have resilient gaskets that are heat-resistant and aging-resistant to seal and cushion lens and refractor.

2.4 LIGHTING CONTROL EQUIPMENT

A. Furnish photoelectric relays or timers to control exterior lighting as indicated on the Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, spaces, and surfaces to receive exterior luminaires and poles for compliance with installation tolerances and other conditions affecting performance of the product. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install products in accordance with manufacturer instructions and the Drawings.

B. Locations of luminaires and poles shown on the Drawings are diagrammatic unless coordinates, dimensions, or angles are shown. Coordinate luminaire locations with building finishes and building structure. Obtain approval for location changes through WRPS Construction Representative.

C. Set luminaires plumb, square, level and secure.

D. Install surface mounted luminaires directly to exterior wall, building structural steel, or an outlet box that is supported from structure.

E. Install lamps in each luminaire.

F. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

G. Adjust luminaires that require field adjustment or aiming, in accordance with the Drawings.

3.3 LIGHTING CONTROL SYSTEM

A. Install exterior lighting control system components in accordance with manufacturer instructions.

3.4 FIELD QUALITY CONTROL

A. Inspect each installed lighting unit for damage. Replace damaged luminaires and components.

B. Verify proper voltage at equipment served.

C. Test installed luminaires for proper operation.

1. Provide instruments to make and record test results.

2. Replace or repair malfunctioning luminaires and components and then re-test.

3. Repeat procedure until all luminaires operate properly.

D. Replace inoperative luminaires.

E. Lighting Systems Testing

1. Test lighting system after pole-mounted lighting fixtures are installed.

3.5 ADJUSTING AND CLEANING

A. Clean each luminaire inside and out, including plastics and glassware. Use methods and materials recommended by manufacturer.

B. Aim adjustable luminaires, as indicated on the Drawings, to provide required light intensities or as directed by the WRPS Construction Representative.

C. Adjust exterior lighting controls to obtain the following performance, unless otherwise indicated on the Drawings or directed by the WRPS Construction Representative:

1. “ON” at sunset, “OFF” at sunrise.

END OF SECTION 26 56 00

SECTION 31 15 21

GEOTEXTILE

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. This Specification Section defines the minimum requirements for the material, shipping, handling, storage, installation and inspection of non-woven geotextiles in accordance with the Design Drawings and as specified herein for the following listed uses.

1. Geotextile as specified on Design Drawings.

B. The work shall include, but not be limited to, the following listed items.

1. Manufacture, shipping, handling, and storage of geotextile.
2. Inspection and acceptance of surfaces to be lined.
3. Placement and seaming geotextile.
4. Visual inspection of the completed installation.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawing and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. Section 31 90 05 – Earthwork and Soil-Bentonite Mixture.

B. Section 31 90 20 – Geosynthetic Drainage Material.

C. Section 31 90 22 – High Density Polyethylene Geomembrane Liner.

D. Section 31 90 25 – Geosynthetic Clay Liner (GCL)

E. Section 31 90 99 – Construction Quality Assurance

F. ASTM International (ASTM)

ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4873	Standard Guide for Identification Storage and Handling of Geosynthetic Rolls and Samples

ASTM D5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles
ASTM D6241	Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

G. Industrial Fabrics Association International (IFAI)

Field Sewing of Geotextiles by V. Diaz and B. Myles, 1989.

H. Washington Administrative Code (WAC)

WAC 173-303-650	Surface Impoundments

1.3 SUBMITTALS

A. See the Contract Statement of Work for submittal procedures.

B. Contractor shall submit the following data:

1. Manufacturer literature providing Specifications on the geotextile(s) that will be supplied.
2. Manufacturer certification that geotextile(s) to be supplied comply with the requirements of this technical Specification.
3. Manufacturer Quality Control (MQC) and Construction Quality Control Plans. The MQC plan shall state the frequency that index tests are performed on the geotextile during manufacturing.
4. Four samples of each geotextile material, each at least 24 in. by 24 in. and three samples of each material seamed in accordance with Manufacturer recommendations (minimum seam length 24 in.) shall be submitted.

1.4 QUALITY ASSURANCE

A. Quality assurance procedures shall be conducted in accordance with this Section and Section 31 90 99. Where conflict between sections exists, the more stringent requirement shall apply.

B. Materials and construction procedures shall be subject to inspection and testing by a Testing Service employed by the Contractor. Such inspections and tests will not relieve the Contractor of responsibility for providing materials and installation in compliance with specified requirements.

C. Contractor shall give Purchaser reasonable notice of starting new work. Work shall not be done outside the agreed regular working hours without prior approval by Purchaser.

D. The Purchaser reserves the right, at any time before final acceptance, to reject materials or workmanship not complying with specified requirements. The Contractor shall correct the deficiencies that the inspections and tests have indicated are not in compliance to the Specifications.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging:

1. Deliver geotextiles to the project site in rolls, each wrapped securely with a protective covering installed at the manufacturing facility. The covering shall prevent the entrance of water, vermin, and dirt, and shall be adequate for protection against ultraviolet exposure.

2. The packaging shall not interfere with handling of the rolls either by slings or by using the central core upon which the geotextile is wound.

B. Labeling: Attach or adhere a tag to the protective cover identifying the listed following.

1. Manufacturer and product name/number.

2. Date of manufacture of geotextile.

3. Roll identification number.

4. Contractor order number (matching Bill of Lading).

5. Mass per unit area of geotextile.

6. Width, length, and square yard area of the roll.

7. Details of labeling rolls shall conform to ASTM D4873.

C. Storage:

1. The material shall be stored off the ground on pallets or in an equivalent manner.

2. Rolls of geotextile shall be stored in such a manner that cores are not crushed, the geotextile not damaged, and as required to provide protection from exposure to ultraviolet light, inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious condition.

PART 2 PRODUCTS

2.1 GEOTEXTILE MATERIALS

A. Geotextiles shall be non-woven, needle punched fabric.

B. The geotextile shall be colored (non-white) or otherwise treated to prevent the occurrence of snow blindness of handling personnel.

Geotextiles used for soil separators, or for protection for a geomembrane, shall meet the requirements as noted in Table 1, at a minimum, as tested by manufacturer.

Table 1. Non-Woven Geotextile Index Test Minimum Requirements for Soil Separator and Protection for Geomembrane.

Property	ASTM Test	Minimum Average Roll Value (MARV)
Mass Per Unit Area – oz/sq. yd. (g/m^2)	D5261	10.0 (339)
Grab Tensile Strength – lbs (kN), min.	D4632	200 (0.890)
Grab Tensile Elongation – %, min.	D4632	50
Static Puncture Strength – lbs (kN), min.	D6241	700(3.115)

PART 3 EXECUTION

3.1 ACCEPTANCE AND STORAGE AT THE PROJECT SITE

A. Handling of Rolls:

1. The method of off-loading the geotextiles at the project site shall not cause any damage to the geotextile, its core, or its protective covering.

2. Any protective covering that is accidentally damaged or stripped off of a roll shall be immediately repaired, or the roll shall be moved to an enclosed facility until the repair can be made.

B. Storage at the Project Site:

1. Purchaser will provide on-site storage space in a location near where the geotextile will be placed, such that on-site transportation and handling are minimized. The Contractor shall be responsible for protecting the stored material from theft and vandalism. The storage location will be outside. Interior storage space will be made available, if possible.

C. Inspection Upon Delivery:

1. Upon delivery of the materials to the project site, the Contractor shall conduct a visual inspection of all rolls of geotextile for damage or defects. This inspection

shall be done without unrolling any rolls unless damage to the inside of a roll is found or suspected.

2. Any damage or defects shall be noted and immediately reported to Purchaser, the Manufacturer, and the carrier that transported the material. Any roll, or portion thereof, which, in the judgment of Purchaser, is seriously damaged, shall be removed from the project site and replaced with complying material at no additional cost to Purchaser.

3.2 GENERAL PLACEMENT REQUIREMENTS

A. The Contractor shall not remove the protective covering from the geotextile rolls to be deployed, until immediately prior to deployment, to ensure that geotextiles are not excessively exposed to ultraviolet degradation. Geotextiles exposed to the elements (without protective covering) for more than 14 days shall be removed from the Project Site.

B. During handling, the geotextiles shall be handled in such a manner that the material is not damaged in any way. Damaged material shall not be used.

C. All necessary precautions shall be taken to prevent damage to the subsoil or underlying layers upon which the geotextile is to be placed. For subsoil layer, construction equipment can be used if excess rutting is not created. The maximum allowable rut depth is 1in.

D. On slopes, the geotextile shall be securely anchored at the top and then rolled down the slope in such a manner as to continually keep the geotextile sheet in tension and keep the geotextile free of wrinkles and folds.

E. All deployed geotextile shall be temporarily weighted with sand bags, old tires, or the equivalent to provide resistance to wind uplift. Such weights shall be installed during deployment and shall remain until replaced with cover material. Grade pins, stakes, or similar methods of temporarily securing the geotextile shall not be used. Uplifted material can be reused only if approved by Purchaser.

F. Geotextiles shall only be cut using an upward cutting hook blade. If geotextiles are cut in place, special care shall be taken to protect other geosynthetics from damage that could be caused by cutting the geotextiles.

G. During placement of geotextiles, care shall be taken not to entrap, in or beneath the geotextile, stones, excessive dust, or moisture that could damage the underlying geomembrane or cause clogging of drains or filters, or hamper subsequent seaming.

H. Unused portions of rolls or cut sections shall be protected from the elements by recovering with the protective covering. Geotextiles exposed to the elements for more than 14 days shall be removed from the Project Site.

3.3 INSTALLATION OF GEOTEXTILES INSIDE THE BASIN

A. Seam Layout:

1. Seaming on the floor: Successive panels of the geotextile shall be continuously sewn (i.e., spot seaming is not allowed) or continuously heat bonded in accordance with manufacturer recommendations on the floor and interior slopes flatter than 10H:1V (10%).

2. Seaming on side slopes: On slopes steeper than 10H:1V (10%), all geotextiles shall be continuously sewn (i.e., spot sewing and heat bonding are not allowed). All seams shall be vertical (parallel with the slope). No horizontal seams (across the slope) shall be permitted on side slopes.

B. Seaming:

1. Splicing by overlapping seams shall not be performed.

2. Sewing shall be done using polyester or heat-set UV stabilized polypropylene sewing thread with chemical and ultraviolet light resistance properties equal to or exceeding the values specified in Table 1. The thread color shall contrast with the color of the geotextile to assist in visual inspection of the seam. Thread size or denier number of the thread shall be determined by the Contractor in accordance with the manufacturer recommendations.

3. Seams shall be “prayer” or “flat” seams. Seams shall be formed by mating the edges of the geotextile panels and sewing the panels together with continuous stitches located a minimum of 6 in. from the mated edges.

4. Sewing procedures shall conform to the latest procedures recommended by the Geotextile Manufacturer.

5. Unless otherwise approved by the Purchaser, stitching shall be one row (SSa 1) of stitching using a Type 401 two-thread locking chain stitch as described in the IFAI with a minimum of 5 stitches per inch, or the seam shall be heat bonded. Thread strength shall be selected by the Contractor, but shall develop at least 100% of the geotextile fabric index properties when sewn in seam.

6. Alternate seaming methods proposed by the Contractor shall be submitted to the Purchaser for approval.

C. Seam Tests:

1. Seam sampling and testing is not required.

D. Repair of Holes or Tears:

1. All holes or tears in a geotextile shall be repaired by patching.

2. The patch material shall be the same geotextile material as the damaged geotextile.

3. Care shall be taken to remove any soil, object, and/or other material that penetrated or tore the geotextile.

E. Patches on Slopes:

1. On slopes, a patch made from the same geotextile shall be sewn into place. Should any tear exceed 10% of the width of the roll, that roll shall be removed from the slope and replaced.

F. Patches on the Floor:

1. On the floor, a patch shall be sewn into place.

G. Requirements for Sewn Patches:

1. The patch shall extend a minimum of 12 in. beyond any portion of the damaged geotextile.

2. The patch shall be sewn by hand or machine so as not to accidentally shift out of position or be moved during any backfilling or covering.

3. The thread shall be the same as specified for sewing seams.

4. The repair shall be made to the satisfaction of the Purchaser.

H. Inspection During Construction and After Installation:

1. Visual examinations shall be conducted to ensure that 100% of the seams are sewn or heat bonded as required.

2. After installation is complete, a visual examination of the geotextile shall be carried out over the entire surface of the geotextile to verify that no potentially harmful foreign objects, such as broken needles, are present. The inspection shall also look for uniformity, damage, and imperfections (e.g., holes, cracks, thin spots, or foreign materials).

3. When sewing seams, the Contractor shall perform continuous inspection during the seaming process using an in-line metal detector with an adequate sweep rate to determine the presence of broken needles. If the presence of broken needles is indicated, a needle removal system, using magnets, shall be implemented.

I. Backfill or Covering:

1. Prior to backfilling or covering, Contractor shall ensure inspection required per this Section has been performed and documented in accordance with quality assurance requirements.

2. Soil backfilling or covering of the geotextile by another geosynthetic material shall be done within a time period that prevents damage to the geotextile material due to environmental exposure.

3. The overlying material shall be deployed in such a manner that excessive tensile stress is not placed on the geotextile.

4. If backfill is to cover the geotextile, the placement of the material shall be done in such a manner that the geotextile is not shifted from its intended position and underlying materials are not exposed or damaged. On side slopes, this requires soil backfill to proceed from the bottom of the slope upward.

5. If a geosynthetic material is to cover the geotextile, both the geotextile and the newly deployed geosynthetic material shall not be damaged in the process.

6. Geotextiles shall be covered and protected from environmental exposure in an expeditious manner which limits the total environmental exposure for the material to no more than 14 days.

END OF SECTION 31 15 21

SECTION 31 23 33

TRENCHING AND BACKFILLING

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. This Specification Section is to define the minimum requirements for trenching and backfilling underground lines, piping, and conduit.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. ASTM International (ASTM)

ASTM D653	Standard Terminology Relating to Soil, Rock, and Contained Fluids
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D2487	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

B. Code of Federal Regulations (CFR)

29 CFR 1926	Safety and Health Regulations for Construction

C. Hanford Documents

TFC-ENG-STD-06, D-2	Design Loads for Tank Farm Facilities
TFC-ESHQ-S-STD-30	Implementation of DOE-0344, Rev. 4-3, Excavating, Trenching, and Shoring

D. Section 31 90 99 – Construction Quality Assurance

E. Washington Administrative Code (WAC)

WAC 173-303-650	Surface Impoundments

F. Washington State Department of Transportation (WSDOT)

WSDOT M 41-10	Standard Specifications for Road, Bridge, and Municipal Construction 2020

1.3 SUBMITTALS

A. See the Contract Statement of Work for submittal procedures.

B. Approval Required

1. Qualifications for Testing Agency (field inspector).

2. Shoring Plan (if required): Design of shoring shall be sealed by a professional engineer registered in the State of Washington.

3. Contractor shall submit a list of proposed materials for use as backfill.

C. Approval Not Required

1. Competent person: Before excavation and in writing, submit identity of individual designated Competent Person as defined in 29 CFR 1926.650 and as required by the approved safety and health program.

1.4 QUALITY ASSURANCE

A. Quality assurance procedures shall be conducted in accordance with this Section and Section 31 90 99. Where conflict between sections exists, the more stringent requirement shall apply.

B. Provide survey control to avoid unauthorized over-excavation.

C. Deliverable Documentation: The following documents and records, required by this Section, shall be delivered to Construction Document Control.

1. Backfill Permit

2. Excavation Permit

3. In-Place Density Tests

4. Soil Compaction Test Report

5. Utility Location Marker Verification

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Contract Statement of Work for general requirements.

1.6 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.

2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

C. Borrow Material: Material from required excavations or from designated borrow areas on or near site.

D. Completed Course: A course or layer that is ready for next layer or next phase of work.

E. Fill: Soil materials used to raise existing grades.

F. Lift: Loose (un-compacted) layer of material.

G. Prepared Ground Surface (Subgrade): Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

H. Selected backfill material: Materials available on-site that WRPS Construction Representative determines to be suitable for specific use.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, curbs, or other man-made stationary features constructed above or below the ground surface.

J. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

K. Utilities: New or existing on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.7 PERMITS

A. As required by WRPS work control process.

1.8 SITE CONDITIONS

A. Do not place backfill or fill on frozen ground.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

PART 2 PRODUCTS

2.1 MATERIALS

A. Use materials free of frozen particles, lumps, organic matter, and trash for backfill and fill, bedding, and stabilization.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487, or a combination of these groups; free of rock or gravel larger than 3 in. in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2% of optimum moisture content at time of compaction. However, the moisture content of granular soil shall not be used as a criterion to deem it unsatisfactory or satisfactory.

D. Base Course: Top course conforming to WSDOT M 41-10, Section 9-03.9(3), “Crushed Surfacing Base Course.”

E. Initial and Final Backfill and Fill: Import or obtain and process material as required from excavation or locations designated by the WRPS Construction Representative to provide satisfactory soil meeting the requirements herein.

1. Backfill for Final Backfill using excavation (in-situ) material approved Borrow Material or approved 5/8 minus crushed rock.

2. Use of any other imported material will require WRPS Construction Representative approval.

3. Bedding Course and Initial Backfill (minimum initial backfill height must cover top of pipe): Soil Class 1 crushed rock per ASTM D2487 with $\leq$ 15% sand, maximum 25% passing the 3/8-in sieve and maximum 5% passing No. 200 sieve.

F. Location Marker: 3-in. wide, detectable plastic tape imprinted with warning such as “CAUTION - BURIED INSTALLATION BELOW” at maximum 4-ft intervals. “Terra Tape Sentry Line 620” with “Terra Clips,” both by Reef Industries, or approved substitute.

G. General Stabilization: Crushed rock with maximum fragment size of 3/4 in.

PART 3 EXECUTION

3.1 PREPARATION

A. The Contractor shall prepare a "Backfill Permit" (see Attachment 1), and obtain approval from the WRPS Construction Representative prior to commencing backfill.

B. Protect structures, utilities, sidewalks, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation and trenching.

C. Protect and maintain erosion and sedimentation controls during excavation and trenching operations.

D. Protect subgrades and foundation soils from freezing temperature and frost. Remove temporary protection before placing subsequent materials.

3.2 EXCAVATION/TRENCHING

A. Excavation/Trenching work shall comply with TFC-ESHQ-S-STD-30 and 29 CFR 1926.

B. Excavation/Trenching shall be defined to mean any hand digging or machine digging below original grade. These requirements constitute the need for an excavation permit.

C. Notify WRPS Construction Representative before excavation.

D. Locate and expose underground utilities using subsurface scanning and hand tools, or other methods approved by the WRPS Construction Representative.

E. If cultural properties (e.g., bones and artifacts) are encountered, stop excavation and notify the WRPS Construction Representative. Obtain approval before resuming excavation.

F. If unexpected debris is encountered, stop excavation and notify the WRPS Construction Representative. Obtain approval before resuming excavation.

G. Excavation of contaminated soil will be administered in accordance with Contractor procedures and programs.

H. Excavate and establish protective systems in accordance with the approved safety and health program.

3.3 SECTIONS AND ELEVATIONS

A. Excavate as required to properly install the conduit and piping to the elevations and in accordance with the sections provided on the Drawings.

B. Trench bottoms (Subgrade). Excavate and shape trench bottoms to be uniform and even. Remove projecting stones and sharp objects along trench subgrade. Allow for pipe or conduit bedding as indicated. Over excavation for conduit bedding is not required if soil is free of projecting stones, sharp objects, and unsatisfactory materials.

C. In-Situ Soils

1. Salvage excavated soil for use as backfill and fill material. If salvaged excavated soil is reused as Initial Backfill (Bedding Course), it may require processing to meet the requirements set forth herein.

2. Provide sample of salvaged soil for use as Initial Backfill and Final Backfill to Testing Agency to determine laboratory compaction characteristics in accordance with ASTM D698.

3. Dispose of contaminated and excess soil in accordance with Construction Waste Management Plan.

4. If stabilization of the subgrade is required because of excavation, site conditions or unsatisfactory soil, following over excavation or other attempts to stabilize the soil to the satisfaction of the WRPS Construction Representative, provide a compacted 3-in thick layer of General Stabilization material prior to placing Bedding Course.

D. Shoring

1. If conditions require shoring, a Shoring Plan shall be submitted to WRPS for approval. Reference TFC-ESHQ-S-STD-30 for responsibilities and implementation requirements.

2. Design of shoring shall be in accordance with TFC-ENG-STD-06, Section 3.7.

3.4 SUBGRADE INSPECTION

A. Compact subgrade and visually inspect to identify soft pockets and areas of excess yielding. Subgrade shall be compacted to at least 95% of the maximum dry density and within 2% of the optimum moisture content as determined by the standard Proctor test ASTM D698. Maintaining the optimum moisture criterion is not required for granular materials.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by WRPS Construction Representative.

C. Test and inspect subgrade materials as required for compaction and suitability requirements as applicable.

3.5 STORAGE OF SOIL MATERIALS

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Stockpile borrowed soil materials and excavated soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water.

C. Do not stockpile excavated soil materials adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

D. Do not stockpile excavated materials near or over existing facilities, adjacent property, if weight of stockpiled material could induce excessive settlement.

3.6 BACKFILL AND FILL PREPARATION

A. The Contractor shall prepare a Backfill Permit (see Attachment 1) and obtain approval from the WRPS Construction Representative.

B. Remove debris and organic material from area to be backfilled or filled.

C. Do not backfill by sluicing or flooding.

D. Allow concrete to cure at least seven days before placing backfill against concrete.

E. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

F. Do not place fill or backfill, if fill, backfill material is frozen or if completed course is frozen.

G. Obtain WRPS Construction Representative approval before proceeding with backfilling and filling. Backfill and fill activities shall be witnessed and tested by a Qualified Installation Inspector (Testing Agency) or a Qualified Registered Professional Engineer (QRPE) hired by the Contractor.

3.7 BACKFILL AND FILL

A. Perform backfilling and filling in accordance with an approved compaction procedure (for example, Attachment 2) prepared by the Contractor.

B. Place material in even, loose layers not more than 8-in. thick when using heavy self-propelled compaction equipment or 3-in. thick when using light walk-behind trench compaction equipment, in a manner that avoids segregation, and compact each lift to specified density prior to placing succeeding lifts.

C. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

D. Perform work in presence of WRPS Construction Representative.

E. Perform in-place testing and adjust compaction method, if required to meet the minimum compaction requirements.

F. Obtain WRPS Construction Representative approval before proceeding with backfilling and filling.

3.8 UTILITY BACKFILL AND FILL - FOUNDATIONS

A. Under Structures: A minimum of 6 in. of Base Course is required immediately below concrete footings, pipe anchors and other concrete structures.

B. Compact each layer uniformly to 98% of maximum density and within 2% of optimum moisture content, as determined by specified compaction tests in Paragraph 3.10. Moisture content of fill and backfill shall not be an acceptance criterion for granular material.

3.9 FINISH GRADING AND STABILIZATION

A. Grade each area disturbed by work to blend into existing contours. Slope area to drain away from structures. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Rake each area to remove surface cobbles larger than 3 in. Dispose of excess material and debris as directed.

C. Stabilize (permanent erosion protection) disturbed areas with surface material in accordance with Section 31 90 05, “Earthwork and Soil-Bentonite Mixture.”

D. After finish grading and stabilization, remove surface markers and flags.

3.10 FIELD INSPECTIONS AND TESTS

A. Testing Agency: Contractor shall engage a qualified geotechnical/soils engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrade and each fill or backfill lift. Proceed with subsequent work moving only after test results for previously completed work complies with requirements.

C. Compaction Testing

1. Test compacted backfill and fill at the following intervals.

    a. Backfill and fill: one test per layer every 75 linear feet of trench, each layer shall not exceed 8 in. thickness.

    b. Subgrade: one test per every 75 linear feet.

2. Perform compaction testing in accordance with the following standards. Provide report required by each standard.

    a. Laboratory compaction control test: ASTM D698.

    b. In-place density testing: ASTM D6938.

    c. Fill and Backfill: Each lift shall be compacted uniformly to at least 98% of maximum density as established by the laboratory compaction control tests.

    d. Subgrade: Shall be compacted uniformly to at least 95% of maximum density as established by the laboratory compaction control tests.

    e. Visually inspect material (Subgrade, Fill, and Backfill) for suitability prior to and during placement or compaction.

3. Buried Pipe and Utility Location Marker Verification

    a. Prior to completion of backfill, perform random surveillance to verify buried utility marker tape has been installed and record results.

SECTION 31 23 33 – ATTACHMENT 1

BACKFILL PERMIT FORM

Key to Backfill Permit Form

Item #	Description
1.	Permit No. – Sequential number, developed by the Project; i.e., “5-0001.”
2.	Self-explanatory.
3.	Project title.
4.	Example – “22337 Release 5.”
5.	Describe location of the backfill; i.e. “W-211 Piping between Route Marker (or location) XX and XX or Conduit run 001, between Handhole-005 and Handhole-006.”
6.	Enter the applicable Drawings that show the backfill location.
7.	Enter any other reference documents.
8.	Discipline Foreman signature, signifying that their work in the excavation to be backfilled is complete. “N/A” will be entered if given discipline is not applicable to the specified backfill area.
9.	Quality Signature, signifying that all the quality requirements for the backfill area have been met prior to backfill and backfill may commence.
10.	Field work supervisor signature, signifying that the all contract requirements for the backfill area have been met and backfill may commence.
11.	Enter backfill requirements, typically construction Specification reference.
12.	“Construction Representative,” this signature would be from the Construction Group, signifying that they agree that all of the requirements for the backfill area have been met and permission to proceed with backfill is granted.
13.	Date that “Construction Representative” signed off the form.
14.	Initial and date that the applicable discipline foreman, quality and field work supervisor signed the form.

BACKFILL PERMIT

(2) Project or Work Package No.:	(3) Title:		(4) Contract No.:
(5) Description of Backfill Work	Approvals		(14) Date
(6) Drawings:	(8) Electrical		
	(8) Piping		
	(8) Carpentry		
	(8) Concrete		
(7) Reference	(8) Layout		
	(8) Other		
	(8) Other		
	(9) Quality		
	(10) FWS		
(11) Backfill Requirements	Authorization to Proceed by		
	(12) WRPS Construction Representative		(13) Date

(1) No.:

SECTION 31 23 33 – ATTACHMENT 2

EXAMPLE PROCEDURE FOR BACKFILL AND COMPACTION OF 5/8 MINUS CRUSHED ROCK

PURPOSE

This procedure identifies a process for placement and compaction of 5/8 minus crushed rock backfill by a controlled method. This procedure also defines the degree of compactive effort required to produce acceptable in-place densities as an alternative to performing density tests with a nuclear density gauge.

SCOPE

This procedure defines the requirements for placement and compaction of 5/8 minus crushed rock backfill including inspection methods to verify the acceptability of the compacted backfill within Tank Farm areas defined on project Drawings. The compaction details in this were taken from American Electric test plan 54891-006-TP-001.

In-place testing of compacted backfill by use of the nuclear density gauge is not required for this procedure. Random periodic visual observation and monitoring of the backfill operation and compactive effort shall be the basis for acceptance.

PROCEDURE

Compaction of 5/8 minus crushed rock backfill shall be controlled by adherence to this procedure and defined compactive effort within established variables as defined below.

Keep materials free of frozen particles, lumps, organic matter, and debris. Ensure that the area to be backfilled is not frozen and the backfill material does not contain frozen material.

Backfilling by means of sluicing or flooding with water is not permitted.

Backfill material shall be placed in loose uniform lifts not to exceed 6 in. in depth.

If needed, water shall be added and mixed with the backfill material before it is compacted to achieve optimum moisture content.

Optimum moisture content shall be approximately 9.5% and may vary as much as plus or minus 1.5%. The addition of water shall be such that the material is easily compactable by mechanical manipulation as defined in this procedure.

Backfill shall be brought up in layers. Each layer shall be compacted full width and length by use of a Wacker, model BS 50-2 or model WP 1550 AW manufactured by Wacker Corporation or equivalent. All equipment used shall be in good working order capable of performing to manufacturer standards.

The compactive effort for each layer of backfill shall be as follows:

If a Wacker BS 50-2 or equivalent is used, a minimum of four complete passes shall be made.

If a Wacker WP 1550 or equivalent is used, a minimum of two complete passes shall be made.

One complete pass shall be defined as full rotation over the area being compacted. At a minimum, a rotation shall be once over and once back across the area being compacted. The rate of equipment travel shall be approximately 15 lineal feet per minute.

Water shall be added as necessary between individual passes to maintain the moisture content within the optimum range.

Bring up backfill material evenly on each side of walls, structures, and pipeline in order to avoid damaging or displacing them by unbalanced loading. Obtain written approval from the WRPS Construction Representative for variations from this process that may result in uneven load distribution.

If backfill material is to be placed against or on top of newly poured concrete, ensure that the concrete curing period has been achieved and concrete design strength achieved as required by ACI 301. Backfill material shall not be placed against foundation walls before the curing period is completed, unless written approval from the WRPS Construction Representative is obtained on the Backfill Permit.

INSPECTION

Control of backfill placement, optimum moisture content, and compactive effort shall be accomplished by visual surveillance. Surveillances shall be performed by a trained and qualified soils technician.

Personnel performing oversight and surveillance of the backfill operations shall possess a thorough working knowledge of earthwork and soils relative to material types and classification, excavation methods and procedures, material gradation, fill and backfill operations, compaction equipment and methods, and moisture control. Oversight personnel shall have received training to perform visual surveillances of backfill operations.

Verification that soil moisture content is within the specified range shall be accomplished by visual and physical examination of the wetted material.

The oversight person shall visually observe the backfill and compaction operation to verify adherence to this procedure. Type of compaction equipment, use of equipment, depth of lifts, number of passes, and rate of travel shall be observed. Surveillances shall be documented on surveillance reports.

The frequency of surveillances for backfill operations shall as a minimum be at the beginning of backfilling for a project or job and at least daily thereafter while work is in progress.

END OF SECTION 31 23 33

SECTION 31 90 05

EARTHWORK AND SOIL-BENTONITE MIXTURE

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. This Specification Section defines the material and installation requirements for earthwork and soil-bentonite mixture for basin lining in accordance with the Design Drawings and as specified herein.

B. The work may include, but not be limited to, the following listed items.

1. Supply, install, maintain and removal of sediment and erosion control facilities for construction.
2. Hiring Testing Agency for field and laboratory testing and inspection.
3. Dust Control during the construction period.
4. Earth excavation.
5. Preparation of the subgrade to receive fill, including clearing and grubbing.
6. Placement and compaction of general and structural fills.
7. Inspection and approval of surfaces to be lined.
8. Supply of soil-bentonite liner materials from an offsite or onsite (if available) borrow area.
9. Mixing, placement and compaction of the soil-bentonite liner.
10. Visual inspection of the completed soil-bentonite liner.
11. Construct a test pad at least 20 ft by 40 ft in plan and 1.5 ft thick to validate the materials and construction methods result in a compacted low permeability liner in accordance with this Specification.
12. Preparation of subgrade to be lined.
13. Excavation and backfill for concrete structures.
14. Disposal of excess or unsuitable excavated material, if required.
15. Placement of erosion protection on exterior slopes.
16. Placement and compaction of dike crest (roadway) material.
17. Offsite disposal of debris.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

A. Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

B. ASTM International (ASTM)

ASTM D422	Test Method for Particle Size Analysis of Soils.
ASTM D698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.
ASTM D1140	Test Method for Amount of Material in Soils Finer than the No. 200 Sieve.
ASTM D2487	Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
ASTM D4318	Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
ASTM D5890	Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners

C. Section 31 90 99 – Construction Quality Assurance

D. Washington State Department of Transportation (WSDOT)

WSDOT M 41-10	Standard Specifications for Road, Bridge, and Municipal Construction 2020.

E. Washington Administrative Code (WAC)

WAC 173-303-650	Surface Impoundments

1.3 SUBMITTALS

A. Contractor shall submit Drawings and data as specified. Contractor Drawings and Data shall be submitted via electronic medium in a format compatible for importing into specified information systems of the Purchaser.

B. The Contractor shall submit, for Purchaser review, catalog data on all compaction equipment and proofrolling equipment planned for use on the project.

C. Contractor shall submit list of all materials planned for use as part of Earthwork and soil-bentonite mixture.

D. Contractor shall submit Safety Data Sheets for all materials to be imported to the site.

1.4 QUALITY ASSURANCE

A. Quality assurance procedures shall be conducted in accordance with this Section and Section 31 90 99. Where conflict between sections exists, the more stringent requirement shall apply.

B. Inspection Before Working: The Contractor shall examine the areas and conditions under which earthwork is to be done and notify the Purchaser in writing of conditions detrimental to the proper and timely completion of the work.

C. Material, placing procedures, and installations are subject to inspection and tests conducted by the Testing Service (Testing Agency) hired by Contractor. Such inspections and tests shall not relieve Contractor of responsibility for providing material and placement in compliance with this Specification. The Purchaser reserves the right, at any time before final acceptance, to reject material not complying with the specified requirements.

D. The Contractor shall correct all deficiencies in earthwork and soil-bentonite liner installation that inspections, laboratory, and field tests have indicated do not comply with the Specifications. The Contractor shall perform additional tests, at his expense, as may be necessary to reconfirm any noncompliance of the original work, and as may be necessary to show compliance of corrected work.

E. The Contractor shall promptly correct errors or flaws in the work or material identified during construction and which prevent proper installation. The Contractor shall make immediate substitution of the noncomplying material or shall make field changes to make the noncomplying material acceptable. The correction or substitution shall be performed at no cost to the Purchaser.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Contract Statement of Work for general requirements.

1.6 GEOTECHNICAL DATA AND TOPOGRAPHY

A. Geotechnical Data:

1. Geotechnical data is not available at the project location. Nearby geotechnical data (Tank Farm Area) is available from the Purchaser upon request. Purchaser assumes no responsibility for the accuracy of the available upon request for use at the project site.

2. The Contractor may be permitted to make his own soil investigations. If permitted, investigations shall be performed at no cost to the Purchaser.

B. Topography:

1. Topographic data for the existing site condition is provided on the Design Drawings.

2. The Contractor may be permitted to make his own topography assessment or check the existing survey data. Any additional surveying of the project site shall be at no cost to the Purchaser.

1.7 LINE AND GRADES

A. The Contractor shall lay out lines and grades from the existing monuments and benchmarks on the Project Site. Design Drawings show the location of existing monuments, or this information will be provided by the Purchaser.

B. The Purchaser reserves the right to verify correctness of lines and grades during progress of the work. Such verification by Purchaser shall not relieve the Contractor of responsibility as herein specified.

C. The Contractor shall notify the Purchaser of any difference in location of existing construction and conditions from those indicated wherever such difference might affect his work.

D. The Contractor shall preserve and maintain benchmarks and reference points established on the Project site. Should Contractor, during prosecution of the work, destroy or remove any benchmark or reference point established by the Purchaser, the cost of reestablishing the bench mark or reference point shall be borne by the Contractor.

1.8 DUST CONTROL

A. The Contractor shall be responsible for controlling dust caused by the grading and soil-bentonite mixing operation, in compliance with any dust control permit obtained by the Purchaser.

B. Clean water shall be applied uniformly and lightly to prevent muddy, slippery, or other hazardous conditions. Water utilized for dust control shall not compromise the integrity of the prepared surfaces, installed materials, or materials to be used as part of the earthwork. The application shall be frequent enough to adequately control the dust nuisance. However, excessive application that would affect compacting operations shall be avoided.

1.9 TEMPORARY SEDIMENT CONTROL DURING CONSTRUCTION

A. The Contractor shall be responsible for developing, submitting, providing, installing, and removing temporary facilities for the control of sediment in site area runoff during construction in accordance with site, local, state, and federal requirements.

1.10 EROSION CONTROL

A. The Contractor shall be responsible for temporary protection of graded areas against erosion and for correction of erosion, which occurs.

B. Temporary erosion control measures shall be applied to completed slopes, ditches, and other disturbed areas not subject to additional construction activities, within 30 days of completion of the grading activity.

C. Slopes, ditches or other disturbed areas, which will be exposed for more than 30 days without a permanent cover because they will be subject to additional future construction activities, shall be provided with temporary erosion protection. Included are cut and fill slopes, pond dikes, and spoils disposal areas.

PART 2 PRODUCTS

2.1 DESCRIPTION OF EARTHWORK

A. Earthwork includes constructing dikes, excavating the basin area, lining the interior of the dikes and bottom of the basin with soil-bentonite mixture, final grading, and permanent erosion protection.

B. The soil-bentonite liner shall be constructed using suitable onsite material, which will be required to be mixed with imported bentonite material to obtain the requirements set forth herein. Contractor shall notify the Purchaser if the onsite material is not suitable for mixing or if an alternative imported soil material is proposed for use in the soil-bentonite mixture. The soil-bentonite mixture will be covered with a geomembrane after installation and acceptance by the Purchaser.

C. The top of the dikes shall be surfaced with crushed rock as specified herein.

D. The exterior slope of exterior dikes shall be covered with permanent erosion protection as specified herein.

2.2 MATERIAL FOR DIKES, GENERAL AND STRUCTURAL FILLS

A. Definitions:

1. “Dike Fill” is fill for basin dikes.

2. “General Fill” is fill that does not support structures. “General Fill” includes fill around the inlet and discharge structure where it is not part of the dikes.

3. “Structural Fill” is fill placed beneath equipment, walls, retaining walls, inlet and outlet structures, pump stations, and other similar structures sensitive to settlement. “Structural Fill” is also fill placed in the upper 3 ft beneath roads, fill supporting buried structures such as drainage manholes, electrical manholes, and vaults where they are not incorporated in the dikes.

B. Satisfactory Fill Material:

1. Granular Material:

a. Granular material is suitable for use as “Dike Fill,” “General Fill,” and “Structural Fill” if it contains not more than 1% organic or other deleterious material, is free of excess moisture, and has a maximum particle size of 3 in.

b. Acceptable granular material are soils classified as coarse-grained (granular) soils in the Unified Soil Classification System, ASTM D2487. Classifications are GW, GP, GM, GC, SW, SP, SM or SC, or combinations of these such as SP-SC.

c. Restrictions on the use of poorly graded sand (SP) or silty sand (SM) material are as follows: No material with a silt content of greater than 15% shall be used for “Dike Fill” or “Structural Fill” nor shall it be used for fill behind retaining walls or within 12 in. of the surface of ditches or slopes.

d. Permanent Erosion Protection for Exterior Slopes of Dikes: WSDOT M 41-10, Section 9-03.9(2) Permeable Ballast or an approved equivalent.

e. Dike Crest (Roadway) Material: WSDOT M 41-10, Section 9-03.9(3) Crushed Surfacing Base Course.

2. Cohesive Material:

a. Cohesive material is suitable for use as “Dike Fill,” “General Fill,” and “Structural Fill” if it contains not more than 1% organic or other deleterious material, has a maximum particle size of 3 in., has a liquid limit of less than 40 and a plasticity index of less than 20.

b. Acceptable cohesive material comes from soils that are classified as fine-grained soils in the Unified Soil Classification System, ASTM D2487. Classification is CL.

C. Unsatisfactory Fill Material:

1. Material unsatisfactory for use as either a “Dike Fill”, “General Fill,” or a “Structural Fill” is as follows:

a. Soils classified as silt or organic soils in the Unified Soil Classification System, ASTM D2487. Classifications are ML, MH, PT, OL and OH.

b. Clay soils classified as CH with a liquid limit greater than 50.

c. Rock material without a soil matrix in which nesting of rocks could occur.

d. Material classified as CL-ML (Plasticity Index of 4 to 7) shall not be used to construct Pond Dikes. However, limited amounts of that material may be blended with CL material to meet the limits of cohesive material listed above and used for "General Fill."

2.3 MATERIAL FOR SOIL-BENTONITE LINER

A. Suitable onsite material for use in soil-bentonite mixing are granular materials classified in accordance with the Unified Soil Classification System, ASTM D2487 as SW, SP, SM or SC (or combinations of these such as SP-SC) and cohesive material classified as CL. Onsite material mixed with bentonite shall meet the minimum requirements established in this Section. Contractor shall verify any existing material onsite from borrow sources is suitable, if used.

B. Imported Bentonite Material: Bentonite imported to the site for use in mixing to develop the soil-bentonite mixture shall be sodium bentonite with a free swell of at least 22 millimeters as determined by ASTM D5890.

C. Imported materials proposed as an alternative to the soil-bentonite mixture shall be approved by the Purchaser prior to use and shall meet the material requirements established herein.

D. Material Requirements:

1. Contractor shall demonstrate, through test program, that material requirements are met. Contractor shall submit test program for Purchaser acceptance.

2. Materials mixed from onsite and imported bentonite for use as the soil-bentonite liner or any imported material proposed as alternate to the soil-bentonite liner shall meet requirements shown below.

No.	Test	Item	ASTM	Requirement
1	Atterberg Limits	Liquid Limit Plasticity Index	D4318 D4318	40% minimum 15% minimum
2	Gradation	Retained on the 3/8 in. sieve	D422	10% maximum
3	Permeability	Permeability	D5084	$1x10^{-7}$ cm/sec maximum

3. Soil-bentonite shall be free from trash, vegetation, organic matter, hard lumps of earth, and frozen, corrosive, or perishable material.

4. Soil-bentonite shall not contain any earth particles or pieces of rock greater than 3/4-in. in any dimension.

5. Soils amended with additives such as cement or asphalt shall not be used as liner materials.

E. Source of Liner Material:

1. Material shall be obtained from an approved borrow source.

2. Materials shall not be borrowed from any source until it has been qualified for use by the Purchaser.

2.4 RESTRICTIONS ON THE USE OF MATERIAL FOR ANY PURPOSE

A. Any material that is frozen, contains an excessive amount of organic material or trash, or contains large rocks, shall be considered unsatisfactory for use as fill.

B. Material placed by previous construction shall be considered unsatisfactory for use as fill unless they meet the requirements for satisfactory material.

PART 3 EXECUTION

3.1 DEMOLITION AND STRIPPING

A. General:

1. The work required is shown on the design Drawings. No work shall be performed outside of the designated area without prior written approval of the Purchaser.

2. All work incidental to excavation or fill work will not be specifically indicated on the design Drawings but shall be performed as part of the work.

B. Demolition:

1. Demolition and removal of existing rip rap, organics, and minor items that are incidental to the earthwork may be required. The Contractor shall identify any such items during his pre-bid walkdown. The Contractor shall demolish such items as required as part of the performance of the work.

2. All waste resulting from demolition work shall be disposed of by the Contractor in an offsite disposal area.

C. Stripping:

1. All tap roots shall be removed to a depth of at least 3 ft below the prepared subgrade level.

3.2 EXCAVATION

A. Classification of Excavation:

1. Excavation is classified as follows:

    a. Earth excavation.

    b. Rock excavation.

2. Earth excavation shall consist of removal of all material encountered which can be excavated using common earthmoving equipment.

3. Rock excavation shall consist of the excavation of boulders 1/2 cubic yard in volume or greater, all rock in ledges, and bedded and conglomerated deposits so firmly cemented that they cannot be removed by common earthmoving equipment.

B. Earth Excavation:

1. Excavation within the limits of grading shall be performed to the lines and grades indicated on the design Drawings.

2. Excavated material shall be used for fill unless it is classified as unsatisfactory.

3. Excavations shall not be carried below grades indicated on the design Drawings without approval of the Purchaser. Over excavations shall be refilled with compacted satisfactory fill material to the proper grade at Contractor expense.

4. If unsatisfactory material is encountered at the bottom of an excavation (subgrade level), this material shall be removed to a depth as directed by the Testing Agency, following approval from the Purchaser, and backfilled to the proper grade with compacted satisfactory fill material.

5. Excavation shall be performed in a sequence that will provide proper drainage at all times. Excavations shall be kept free of standing water while construction is in progress.

C. Rock Excavation:

1. No rock excavation is anticipated for this project.

D. Stockpile of Material:

1. Stockpile areas shall be properly prepared by clearing, grubbing, and stripping.

2. Stockpile excavated, borrowed, or imported material that is suitable for use until material is needed at a location approved by the Purchaser.

3. Stockpile materials without intermixing. Place, grade, and shape stockpiles to drain surface water.

4. Do not stockpile material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

5. Do not stockpile material near or over existing facilities or adjacent property, if weight of stockpiled material could induce excessive settlement.

E. Disposal of Excess Soil Material:

1. Excess excavated material shall be placed in a designated onsite stockpile or disposal area as directed by Purchaser.

2. After completion of earthwork operations, all disposal and stockpile areas shall be dressed to drain properly and control erosion.

3.3 PREPARATION OF SUBGRADE TO RECEIVE FILL

A. Removal of Unsatisfactory Material:

1. Any material, which is unsatisfactory for use, shall be removed and placed in a disposal area approved by the Purchaser. The subgrade soils shall be inspected and tested by the Testing Agency and approved by the Purchaser prior to the start of construction.

B. Preparation of Sloping Areas and Hillsides:

1. If fill is to be placed on an original hillside or an existing embankment with a slope of between 5 and 20%, the original ground shall be scarified to provide a bond between the ground and the fill to be placed thereon and the first layer of fill shall be placed, blended, and compacted.

2. If fill is to be placed on an existing hillside or embankment which has a slope of greater than 20%, the fill shall be keyed at the toe of the slopes of the original hillside or existing fill and shall be continuously benched to key the fill to the underlying ground to ensure that new work is constructed on a firm foundation free of loose or disturbed material.

3. Keys at the toe shall be approximately 10 ft wide by 1 ft deep.

4. Benches on the slope shall be a minimum of 1 ft deep normal to the slope and about 10 ft wide. Benches shall slope 2% downhill and shall be horizontal longitudinally following the natural contours. Material excavated from benches may be mixed with new fill and compacted.

C. Compaction and Proofrolling:

1. Extent: The subgrade of areas to receive fill shall be compacted and proofrolled prior to placing the fill. The subgrade shall be compacted to a minimum degree of compaction specified in Table 1. Compaction shall be performed using suitable equipment for the type of soil present. Proofrolling shall consist of furnishing and operating heavy pneumatic tired compaction equipment for testing the stability of subgrade prior to receiving the fill. The intent is to locate any unstable areas. Compaction and proofrolling shall be performed in the presence of the Testing Agency to allow for observation of unstable areas.

2. Proofrolling Equipment: The equipment used for proofrolling shall be equipment such as a fully loaded water wagon having a gross weight of not less than 25 tons, smooth drum vibratory roller with gross weight of at least 20 tons or a pneumatic-tired roller having not less than 4 pneumatic wheels. Under working conditions, the equipment shall deliver a compression of not less than 100 pounds per square inch.

3. Operation: Compact the surface of the subgrade to be proofrolled. Proofroll the surface by making a minimum of two coverages with the compaction equipment at a speed of not greater than 5 mph. Each succeeding trip of the proofroll equipment shall be offset by, not greater than, one half the equipment width. Make additional passes over areas of suspected instability.

4. Failure: The subgrade shall be considered failed if, under the action of proofrolling, the subgrade yields, pumps, or is otherwise unstable. Yielding is defined as rutting of more than 1 in. measured from the top of the construction grade to the bottom of the rut.

5. Remedial Action: Remove all failed areas a minimum depth of 1 ft or deeper, as directed by the Testing Agency and approved by the Purchaser and moisture condition, and replace or replace with satisfactory fill compacted as specified in Table 1 of this Section.

3.4 PLACEMENT OF DIKE, GENERAL AND STRUCTURAL FILLS

A. Moisture Content:

1. If the material is too dry, cut areas shall be pre-wetted to raise the moisture content. If the material is too wet, both cut and fill areas may require wind rowing or blending to dry the material. The moisture content shall be within the range of (-) 2 to (+) 2% of optimum moisture content at the time of compaction. The moisture content of granular material shall not be used as an acceptance criterion for fill or backfill.

2. Fill material, which contains excessive moisture, shall not be compacted unless the material has dried and the moisture content is within the specified limits.

3. Fill material, which is too dry, shall have moisture added and then be blended so that the moisture content is uniform throughout the thickness prior to compaction.

4. Moisture control shall be applied to the upper 6 in. of the undercut subgrade soils.

B. Thickness:

1. Material shall be placed in horizontal layers in thicknesses compatible with the material being placed, equipment being used, and the compaction requirements.

2. Unless otherwise approved by the Purchaser, the loose thickness shall not exceed the following:

    a. 8 in. maximum loose lift thickness for compaction by self-propelled equipment.

    b. 3 in. maximum loose lift thickness for compaction by hand-operated equipment.

    c. These lift thicknesses may be increased if the results of a test section prove that a thicker loose lift can be compacted to the required specified densities. In no case shall the maximum loose lift thickness exceed 12 in.

C. Placement:

1. Each layer of fill shall be evenly spread and moistened or aerated, as required, to achieve the required moisture content.

2. Large continuous areas shall be uniformly filled to cover the entire length and width of the area to be filled before the next higher layer of material is placed.

3. The top surface of each layer shall be approximately level, but shall have sufficient crown or cross fall to provide adequate drainage of water at all times during the construction period. The crown or crossfall shall be at least 1 in 50 (2%) but no greater than 1 in 20 (5%).

4. Fill slopes steeper than 20% (i.e., 5 horizontal to 1 vertical) shall be overfilled a minimum of 6 in. beyond the face of the slope, measured horizontally, and then cut back and trimmed to the required line and grade to expose a smooth surface uniformly compacted to the required density. Installing the fill slope to lines and grades shown on the design Drawings and then running over the surface with compaction equipment is not acceptable.

D. Compacting:

1. Equipment:

a. Each layer of fill shall be compacted by tamping, sheepsfoot roller, pneumatic-tired roller, smooth drum steel-wheeled roller, or other mechanical means acceptable to the Purchaser, that will produce the specified compaction and as appropriate for the material being compacted.

b. At locations where it would be impractical because of inaccessibility to use self-propelled compacting equipment, fill layers shall be compacted using hand directed compaction equipment.

c. When soils are used that develop a densely packed surface as a result of spreading or compacting equipment, the surface of each layer of fill shall be sufficiently roughened after compaction, to ensure bonding of the succeeding layer.

2. Inspection and Testing:

a. All work is subject to inspection and testing by a Testing Service (Testing Agency). The Testing Agency and the Owner shall have access to the work at all times.

b. Each layer of compacted fill shall be tested by the Testing Agency and approved by the Purchaser before proceeding with the next layer.

c. It is the responsibility of the Contractor to request inspection or testing prior to proceeding with further work that would make parts of the work inaccessible for inspection.

d. If the fill material fails to meet the required density, the material shall be removed and replaced or reworked, altering the construction method as necessary to obtain the required density and compaction. Sufficient time shall be allotted between lifts for the necessary testing of the soils.

3. Compaction Densities:

a. The degree of compaction shall be expressed as a percentage of the maximum laboratory dry density obtained at optimum moisture content in accordance with ASTM D698.

b. Compaction requirements are specified in Table 1.

E. Exceptions:

1. Permanent protection for erosion on exterior slopes of dikes does not require density testing, nor is it subject to moisture condition restrictions. Material shall be spread evenly and uniformly on the surface to be protected to the lines and grade indicated on the design Drawings.

3.5 PREPARATION AND PLACEMENT OF SOIL-BENTONITE LINER

A. Blending and Conditioning of Material:

1. Selection and Blending:

a. Selective use of material or blending of soil-bentonite materials may be required to produce the required quality and uniformity. The soil shall be mixed and blended to produce as homogeneous a soil as possible. Methods such as cutting across zones of stratification and sieving out and crushing large clods shall be followed as necessary.

b. Material shall not be blended in-place. Material shall be blended at a location onsite approved by the Purchaser and transported to the basin for placement.

2. Conditioning:

a. If a change in moisture content is required then conditioning shall be as follows:

i. If a change of less than 2% is required then the change may be accomplished after the mixture is in-place at the site, but before it is compacted.

ii. If a change of more than 2% is required then conditioning shall be done at the borrow source or blending location. Corrective moisture content of more than 2% is not permitted at the site.

3. If a substantial change in moisture content is required, it shall be done so that moistening or drying occurs uniformly throughout the soil. Materials shall be mixed and blended with appropriate equipment, as necessary, so that the soil is uniform and homogeneous as to material and moisture content and so that clods are thoroughly wetted.

B. Weather Related Restrictions on Placement:

1. Placement and compaction operations during periods of rainfall, snowfall, high winds, or when the air temperature drops below 30°F is not permitted.

2. Material shall not be placed on frozen ground or on surfaces having visual signs of ponded water, frost, or snow.

3. Frozen material shall not be incorporated into the soil-bentonite mixture.

4. Before resuming material placement after freezing weather, the surfaces to receive liner fill shall be verified to be in conformance with the Specification requirements. Previously placed soil-bentonite liner material shall be scarified to a depth of 4 in. and be recompacted to the Specification requirements prior to placement of subsequent lifts. The surfaces to receive fill shall be approved by the Purchaser prior to placement of a new lift.

C. Placement:

1. On the nearly horizontal surfaces (crowned or sloped for drainage), the material shall be placed and compacted in nearly horizontal uniform lifts.

2. On side slopes 2-1/2 horizontal to 1 vertical and flatter, the liner material shall be placed and compacted in uniform lifts parallel to the slope.

3. The maximum size of hard clods prior to compaction shall be 3/4 in. This shall be determined by visual inspection. If the maximum clod size exceeds 3/4 in., additional mixing and blending shall be provided as required to reduce clods to that size or the larger clods shall be sieved out.

4. The maximum loose thickness of a lift shall be 8 in. when heavy self-propelled compaction equipment is used and 3 in. when walk behind hand operated equipment is used.

D. Moisture:

1. Prior to compaction, the moisture content of the soil-bentonite shall be adjusted to between +0% and +4% “wet” of the optimum moisture content determined in accordance with ASTM D698.

2. Changes in moisture content of up to 2% may be accomplished at the compaction location (the basin).

E. Compaction:

1. Equipment:

a. Sheepsfoot roller: The Contractor shall use sheepsfoot rollers of adequate weight to achieve compaction densities specified herein and to achieve the kneading action necessary to break down clods blended in liner materials, and eliminate voids. Sheepsfoot rollers shall conform to the following:

i. Have long thin feet capable of fully penetrating a loose lift and blending and compacting the bottom of the lift directly into the top of the previous lift.

ii. Have a roller weight of not less than 50,000 lb and a minimum weight of 3,000 lb per linear foot of roller. A roller with a weight of 4,000 to 5,000 lb per linear foot is preferred.

iii. The area of each foot shall be such that the foot contact pressure is not less than 300 psi, preferably 400-500 psi.

b. Breakdown roller: The breakdown roller used for fine finishing shall be a heavy wheel roller with 18,000 to 25,000 lb wheel loads and tire inflation pressures in excess of 65 psi.

c. Smooth drum roller: The smooth drum roller used for compaction and fine finishing shall be a 3-axle tandem roller with a minimum weight in the range of 15 to 20 tons. Heavy rollers with a weight over 20 tons are acceptable.

d. Compaction equipment shall pass over the area a sufficient number of times to maximize compaction. Passes shall be made as necessary to blend the soil, break up clods, and obtain the specified degree of compaction.

e. The soil-bentonite shall be compacted to at least the minimum dry density specified in Table 1.

f. If a compacted lift fails to meet the specified density, the soil-bentonite shall either be compacted further or removed and replaced. If a density/moisture content test of the soil-bentonite fails to meet Specifications, the soil-bentonite shall be scarified, the moisture content adjusted, and the material recompacted for an area extending from the failed test to one-half the distance to the nearest passing tests, in all directions. The Contractor shall alter compaction methods of subsequent work as necessary to obtain the specified compaction. The recompacted area shall then be retested for conformance with Specifications.

F. Fine Finishing:

1. After the soil-bentonite liner has been brought to its final thickness and lift compaction is complete, the surface shall be fine finished as follows:

a. The surface shall be smoothed using a rubber-tired breakdown roller or a heavy steel smooth drum roller to provide protection against over moistening during a rainfall and provide a smooth surface so that Construction Quality Control Tests can be made. The last two passes on the surface shall be made using a heavy smooth steel drum roller.

b. Visually inspect the surface, remove clods and stones that would be retained on a 3/4 in. sieve.

c. Irregularities such as desiccation cracks and holes shall be corrected. Soil from irregularities, which cannot be corrected in-place, shall be removed and replaced with acceptable material.

d. Shape the lining and form a flat uniform working surface free of bumps, ridges, gullies, holes, ruts, desiccation cracks, or pockets of non-cohesive material.

2. The finished compacted surface of the soil-bentonite liner shall be placed to the locations and elevations shown on the design Drawings. Tolerances shall be as shown in Table 2 of this Section.

G. Protection and Final Inspection of Liner:

1. Contractor shall provide and document a post-installation inspection to look for imperfections including lenses, cracks, channels, root holes, or other structural nonuniformities that may cause an increase in the permeability of the liner.

2. The Contractor shall make provisions to protect the liner until the geomembrane is in place. Protection shall be provided against over-moistening or erosion during rainfall, or cracking resulting from desiccation or freezing.

3. If soft spots, subsidence, or cracks larger than 1 in. wide or 2 in. deep occur in the soil-bentonite liner prior to placement of the protective cover, the Contractor shall be responsible for blading down the lining material to the unaffected soil and then preparing and recompacting the disturbed soil to meet the requirements specified herein.

3.6 PREPARATION OF SUBGRADE BENEATH GEOMEMBRANE LINER

A. Intersections Between Planes:

1. Intersections between planes shall be rounded as specified below to provide a firm bearing without abrupt change:

a.	Intersection of Slope	Radius of Rounding
b.	Side slope and bottom plane	3 feet minimum
c.	Side slope and top of dike or grade	6 in. minimum
d.	Intersection of two bottom planes (planes sloped at 10% or less)	Straight line is acceptable

B. Responsibility:

1. The Contractor shall be responsible for preparing the surface of the subgrade beneath a geomembrane liner prior to placement of the liner. The subgrade is subject to inspection and acceptance by the Purchaser.

C. Inspection:

1. The Contractor shall verify and document:

a. Lines, grades, and slopes are in conformance with the design Drawings.

b. Surface has been graded and rolled such that it is free of irregularities, protrusions, loose soil, and abrupt changes in grade.

c. The surface is free of debris, clods, stones, roots, and organic material.

d. No settlement has occurred.

e. There are no side slope failures.

f. There are no moisture seeps, puddling, or ponding.

g. There are no soft spots.

D. Certification:

1. The installer of the geomembrane liner, Geomembrane Installer, and who is a subcontractor to Contactor shall provide written certification that the surface is acceptable. The acceptance shall be recorded and copies of the certification given to both the Contractor and the Purchaser.

2. Only as much surface as will be lined the following day shall be inspected, certified, and documented as acceptable.

3.7 EXCAVATION AND BACKFILLING CONCRETE STRUCTURES

A. Excavation and Shaping:

1. Excavate as required to form, pour, and construct the structure as shown on the design Drawings.

2. Excavations shall be adequately drained to prevent ponding or otherwise softening of the adjacent soils while open.

B. Backfilling:

1. Backfilling shall be performed evenly on both sides of the structure.

2. Backfilling shall not be performed until concrete has reached at least seven days of curing time and achieved 75% of the specified compressive strength.

3. Backfill shall be performed using satisfactory granular “Structural Fill” material and be placed/compacted in accordance with “Structural Fill” requirements.

3.8 GRADING TOLERANCES

A. The acceptable deviation from lines and grades indicated on the design Drawings shall be as shown in Table 2.

B. Slopes shall be finished in conformance with the lines and grades shown on the design Drawings. When completed, the average plane of a slope shall conform to the slope indicated on the design Drawings and no point on the completed slope shall vary from the designated plane by more than 6 in. measured at right angles to the slope.

3.9 CLEAN-UP

A. All waste, excess soil materials shall be disposed of in an onsite disposal area as directed by the Purchaser and stabilized to prevent erosion.

B. Debris generated by the demolition and stripping work shall be hauled off site and disposed of in accordance with local, state and federal regulatory requirements.

Table 1. Medium Degree of Compaction.

MINIMUM DEGREE OF COMPACTION	
AREA	**ASTM D 698 (percent)**
Subgrade	95
Pond Dike	98
Soil-Bentonite Liner	95
General Fill	95
Structural Fills	98
Permanent Erosion Protection for Exterior Dike Slopes	--
Dike Crest (Roadway)	98

Table 2. Acceptable Deviation.

ACCEPTABLE DEVIATION		
Type of Installation Excavation or Fill	**Maximum Acceptable Deviation From Line (ft)**	**Maximum Acceptable Deviation From Grade* (ft)**
Earthwork		
Dike	±0.5	+0.2 to -0.0
Subgrade	±0.3	±0.2
General Fill	±0.5	±0.2
Structural Fill	±0.3	±0.2
Soil-Bentonite Liner	±0.3	+0.2 to -0.0
Surfacing		
Permanent Erosion Protection	±0.3	+0.2 to -0.0
Dike Crest (Roadway)	±0.3	+0.2 to -0.0

* After initial settlement has taken place. Initial settlement is that settlement that will occur up to the time of determination and acceptance of final grade elevation as approved by Purchaser.

END OF SECTION 31 90 05

SECTION 31 90 20

GEOSYNTHETIC DRAINAGE MATERIAL

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. This Specification Section is to define the minimum requirements for material and installation of geosynthetic drainage material to be installed in accordance with the Design Drawings, and as specified herein.

B. The term geosynthetic drainage material is used generically herein to represent geonet core material and geotextiles.

C. The work shall include, but not be limited to, the following items:

1. Manufacture, shipping, handling, and storage of geosynthetic drainage material.

2. Inspection and acceptance of surfaces to be lined.

3. Placement and joining geosynthetic drainage material.

4. Visual inspection of the completed geosynthetic drainage material.

D. Qualifications:

1. Manufacturer:

    a. The Manufacturer shall be approved by the Purchaser, unless otherwise stated herein.

2. Contractor:

    a. The Contractor shall be approved by the Manufacturer for installation of Manufacturer products.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. Section 31 15 21 – Geotextile.

B. Section 31 90 05 – Earthwork and Soil-Bentonite Mixture.

C. Section 31 90 99 – Construction Quality Assurance

D. ASTM International (ASTM)

ASTM D1505	Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D4218	Standard Test Method for Determination of Carbon Black Content of Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D4716	Test Method for Determining the (In-Place) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic using Constant Head
ASTM D5199	Test Method for Measuring Normal Thickness of Geotextiles and Geomembranes
ASTM D6364	Standard Test Method for Determining Short-Term Compression Behavior of Geosynthetics
ASTM D7005	Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites
ASTM D7179	Standard Test Method for Determining Geonet Breaking Force

E. Washington Administrative Code (WAC)

WAC 173-303-650	Surface Impoundments

1.3 SUBMITTALS

A. Contractor shall submit the following Drawings and data at least 30 days prior to use. Contractor Drawings and data shall be submitted via electronic medium in a format compatible for importing into the Purchaser information systems specified by the Purchaser.

B. Submittals with the Bid Proposal:

1. Geosynthetic drainage material:

    a. Certification of Compliance from the Manufacturer, signed by its authorized representative, indicating that the material meets the criteria specified herein.

    b. Identification and manufacturer cut sheet for the material selected.

    c. Manufacturer Quality Control and Quality Assurance Policies and Procedures.

2. Warranty:

   a. Written warranties from the Manufacturer and the Contractor covering the quality of the material and workmanship as applicable.

   b. The minimum period of warranty for materials shall be 20 years with the first year non-prorated. The minimum period of warranty for installation shall be 5 years with the first year non-prorated.

   c. Warranty conditions proposed, including limits of liability, will be evaluated by the Purchaser in approving the Manufacturer and the Contractor.

3. Contractor or Contractor Subcontracted Installer:

   a. Installer name, address and telephone number.

   b. Installer qualifications.

4. Testing Laboratory:

   a. Name, address, and telephone number of the off-site, testing laboratory that will perform the testing and inspection services specified herein.

   b. Laboratory qualifications.

C. Submittals after Award of the Contract:

1. Geosynthetic drainage material:

   a. Copy of the raw material producer certificates describing the origin and identification of the raw materials.

   b. Copy of the raw material producer Quality Control certificates.

   c. Copy of the Manufacturer Quality Control certificates on tests performed on the material and a summary of results of the tests.

   d. Certification by Manufacturer that the properties of the manufactured material meet Specification requirements and are guaranteed by the Manufacturer.

2. Installation Data:

   a. Proposed layout for each installation.

   b. Manufacturer recommended procedures for joining material if different from this Specification.

c. Manufacturer recommended procedures for repairing damaged geosynthetic drainage material sections and joining material if different from this Specification.

D. Submittals after Construction is Complete:

1. Contractor:

a. As-built panel layout.

b. Drawing showing location of repairs and type of repairs made.

c. Location of tests.

d. Results of tests.

1.4 QUALITY ASSURANCE

A. Quality assurance procedures shall be conducted in accordance with this Section and Section 31 90 99. Where conflict between sections exists, the more stringent requirement shall apply.

B. Materials and construction procedures shall be subject to inspection by the Construction Quality Assurance (CQA) Testing Service employed by the Contractor.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Unloading and storage of materials shall be the responsibility of the Contractor.

2. The unloading and other handling of materials shall be performed by the Contractor to ensure that the material is handled with care and not damaged.

B. Packaging:

1. Deliver material to the project site in rolls, each wrapped securely with a protective covering installed at the manufacturing facility. The covering shall prevent the entrance of water, vermin, and dirt, and shall be adequate for protection against ultraviolet exposure.

2. The packaging shall not interfere with handling of the rolls either by slings or by using the central core upon which the material is wound.

C. Labeling: Attach or adhere a tag to the protective cover identifying the listed following.

1. Manufacturer and product name/number.

2. Date of manufacture.

3. Roll identification number.

4. Contractor order number (matching Bill of Lading).

5. Width, length, and square yard area of the roll.

6. Details of labeling rolls shall conform to ASTM D4873.

D. Storage:

1. The material shall be stored off the ground on pallets or in an equivalent manner.

2. Rolls shall be stored in such a manner that cores are not crushed, the material not damaged, and as required to provide protection from exposure to ultraviolet light, inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious condition.

3. The Purchaser shall provide on-site storage space in a location near the area of work such that on-site transportation and handling are minimized. The Contractor shall be responsible for protecting stored material from theft and vandalism.

4. The rolls of the material shall be placed on a smooth surface, free of rocks and standing water.

E. Inspection:

1. Upon delivery of the material to the project site, the Contractor shall conduct a visual inspection of all rolls for damage or defects. This inspection shall be done without unrolling any rolls, unless damage to the inside of a roll is found or suspected.

2. Any damage or defects shall be noted and immediately reported to the Purchaser, the Manufacturer, and to the carrier that transported the material. Any roll or portion thereof, which, in the judgement of the Purchaser, is seriously damaged, shall be removed from the project site and replaced with complying material at no additional cost to the Purchaser.

PART 2 PRODUCTS

2.1 GEOSYNTHETIC DRAINAGE MATERIAL

1. Geosynthetic drainage material composites are acceptable for use provided the material requirements set forth herein are provided.

2. Geosynthetic drainage material “core only” materials (products not including the two-sided geotextile) are acceptable for use following approval by Purchaser. Contractor shall provide and install geotextile meeting the requirements of Section 31 15 21, “Geotextile,” on both sides of the geosynthetic drainage material core. Contractor shall submit Manufacturer and product for Purchaser review.

B. General Requirements:

1. The core shall be profiled to provide planar water flow.

2. The HDPE formulation shall consist of a minimum of 97% of polyethylene resin, with the balance being carbon black and additives. No fillers, extenders, or other materials shall be mixed into the formulation.

3. Reground or reworked polymer, that is previously processed HDPE in chip form, is acceptable if it meets the minimum material requirements of this Specification.

4. No amount of "recycled" or "reworked" material that has seen prior use in another product shall be added to the formulation.

C. Material Requirements:

1. Product shall meet the requirements of Table 1 as tested by manufacturer.

Table 1. Minimum Material Requirements.

Property	Value	Test Method	Minimum Manufacturer Test Frequency
Geosynthetic Drainage Material (HDPE Core)	-----	-----	-----
Density	0.94 g/cm^3 (min.)	ASTM D1505	50,000 ft.^{2}
Carbon Black	2 to 3%	ASTM D4218	50,000 ft.^{2}
Thickness (minimum)	0.200 in. (min.)	ASTM D5199	50,000 ft.^{2}
Tensile Strength - Machine Direction	100 lbs/in	ASTM D7179	50,000 ft.^{2}
Transmissivity	12.5 gal/min/ft	ASTM D4716	100,000 ft.^{2}
Compressive Strength	120 lbs/in^2	ASTM D6364	100,000 ft.^{2}
Geosynthetic Drainage Material (Composite)	----	----	-----
Transmissivity	4.8 gal/min/ft	ASTM D4716	100,000 ft.^{2}
Ply Adhesion	1.0 lb/in	ASTM D7005	50,000 ft.^{2}
Geotextile	----	----	-----
Requirements per Section 31 15 21			

PART 3 EXECUTION

3.1 PREPARATION OF SURFACES TO BE LINED

A. General:

1. The Contractor shall be responsible for preparing and maintaining the surfaces to be lined as specified in Section 31 90 05, "Earthwork and Soil-Bentonite Mixture" prior to placement of the geosynthetic drainage material.

2. The Contractor shall confirm the conditions of the finished surfaces to be lined, prior to placement of the geosynthetic drainage material.

B. Preparation of Concrete Surfaces:

1. All portions of concrete walls, curbs, and foundations that will come in contact with the geosynthetic drainage material shall be free of sharp edges or rough spots that can puncture or abrade the product. Where necessary, the concrete shall be ground smooth by the Contractor.

3.2 INSTALLATION OF GEOSYNTHETIC DRAINAGE MATERIAL

A. General Requirements:

1. In the presence of wind, all geosynthetic drainage material shall be weighted with sand bags or the equivalent. Weights shall be installed during deployment and shall remain in place until deployment of the cover material.

2. The geosynthetic drainage material shall not be welded to geomembrane liners utilized on the project.

3. The geosynthetic drainage material shall only be cut using scissors or other cutting tools approved by the Manufacturer. Cutting, trimming, and other similar activities shall not damage the underlying liner system materials. Contractor shall not leave tools and debris in the geosynthetic drainage material.

4. All necessary precautions shall be taken to prevent damage to underlying liner system materials during placement of the geosynthetic drainage material.

5. During placement of geosynthetic drainage material, care shall be taken not to entrap dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the adjacent installed products. If dirt or excessive dust is entrapped in the geosynthetic drainage material, it shall be cleaned and all dirt removed prior to placement of other products. Care shall be taken in the handling of sand bags, to prevent rupture or damage of the sand bag.

B. Placement of Geosynthetic Drainage Material:

1. On slopes, the geosynthetic drainage material shall be secured at the top and then rolled down the slope in such a manner as to continuously keep the material

in tension. If necessary, the material shall be positioned, by hand, after unrolling to minimize wrinkles, to the extent practical.

2. The geosynthetic drainage material shall be placed on side slopes with no horizontal seams along the slope and so that the long dimension is parallel to the slope.

3. No horizontal seam shall be located within 5 ft of the toe of a slope.

4. The geosynthetic drainage material shall be positioned on the slopes so that adjacent pieces are placed nominally 1/4” apart to allow for expansion.

5. Geosynthetic drainage material placed in the corners of the side slope shall be cut to eliminate excessive overlap of material.

6. When more than one layer of geosynthetic drainage material is installed, the overlaps shall be staggered and the layers tied together.

C. Joining Geosynthetic drainage material:

1. Adjacent panels of geosynthetic drainage material sides and end laps shall be joined using white or yellow self-locking straps or in accordance with manufacturer recommendations. Metal fastening devices are not allowed.

2. Adjacent panels on slopes shall be joined at maximum 5-ft centers.

D. Protection:

1. The Contractor shall be responsible for protection of geosynthetic drainage material layer during installation, and shall be responsible for repair of any damage to the geosynthetic drainage material or other installed material caused during installation.

E. Repair:

1. Where geonet is damaged, remove section the full width of the roll and replace with new material.

3.3 ANCHORING

A. Geosynthetic drainage material shall be anchored at the top of the slope per the Design Drawings.

B. Anchorage during installation shall be the responsibility of the Contractor and shall be done in a manner to prevent damage to the liner system.

END OF SECTION 31 90 20

SECTION 31 90 22

HIGH DENSITY POLYETHYLENE GEOMEMBRANE LINER

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. This Specification Section defines the minimum requirements for material and installation of High Density Polyethylene (HDPE) Non-Textured Geomembrane to be used as the double liner for the bottom and side slopes of the basin in accordance with the Design Drawings, and as specified herein.

B. The work shall include, but not be limited to, the following listed items.

1. Manufacture, shipping, handling, and storage of geomembrane materials.
2. Inspection and acceptance of surfaces to be lined.
3. Placement and field seaming of geomembrane.
4. Crest anchorage and attachment of the geomembrane to structures and penetrations.
5. Non-destructive field testing of geomembrane seams.
6. Removal of samples of geomembrane seams and transportation to a testing laboratory for destructive testing.
7. Repair of defective geomembrane seams.
8. Repair of defects in the geomembrane and locations where samples were taken.
9. Visual inspection of the completed geomembrane liner.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. Section 31 15 21 – Geotextile.

B. Section 31 90 05 – Earthwork and Soil-Bentonite Mixture.

C. Section 31 90 99 – Construction Quality Assurance

D. ASTM International (ASTM)

ASTM D638	Test Method for Tensile Properties of Plastics
ASTM D792	Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1004	Test Method for Tear Resistance of Plastic Film and Sheeting
ASTM D1505	Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D1603	Test Method for Carbon Black Content in Olefin Plastics
ASTM D3895	Test Method for Oxidative-Induction Time in Polyolefins by Differential Scanning Calorimetry
ASTM D4218	Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D4833	Test Method for Index Puncture Resistance of Geomembranes and Related Products
ASTM D5199	Test Method for Measuring Nominal Thickness of Geosynthetics
ASTM D5397	Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
ASTM D5596	Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D5641	Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
ASTM D5721	Standard Practice for Air-Oven Aging of Polyolefin Geomembranes
ASTM D5820	Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
ASTM D5885	Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
ASTM D6365	Standard Practice for Nondestructive Testing of Geomembrane Seams Using the Spark Test

ASTM D6392	Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

E. Geosynthetic Research Institute (GRI)

GRI GM6	Pressurized Air Channel Test for Dual Seamed Geomembrane
GRI GM10	The Stress Crack Resistance of HDPE Geomembrane Sheet
GRI GM13	Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
GRI GM14	Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes

F. Washington Adminstrative Code (WAC)

WAC 173-303-650	Surface Impoundments

G. Hanford Documents

TFC-ENG-STD-06, D-2	Design Loads for Tank Farm Facilities

1.3 SUBMITTALS

A. See Contract Statement of Work for submittal procedures.

B. Submittals with the Bid Proposal:

1. HDPE Geomembrane Material:

a. Certification of Compliance from the Manufacturer of the HDPE geomembrane sheeting signed by its authorized representative, indicating that the material meets the criteria specified herein.

b. One representative sample of each type of geosynthetic material.

c. Manufacturer Quality Control and Quality Assurance Policies and Procedures.

2. Warranty:

a. Written warranties from the Manufacturer and the Contractor covering the quality of the material and workmanship as specified.

b. The minimum period of warranty for materials shall be 20 years with first year non-prorated. The minimum period of warranty for installation shall be 5 years with the first year non-prorated.

c. Warranty conditions proposed, including limits of liability, will be evaluated by the Purchaser in approving the liner Manufacturer and the Contractor.

3. Geomembrane Installer (as applicable):

a. Name, address and telephone number.

b. Qualifications.

c. Subcontractor or supplier indentification and qualifications.

4. Testing Laboratory:

a. Name, address, and telephone number of the off-site, testing laboratory that will perform destructive testing on cut samples of field seams.

b. Laboratory qualifications.

C. Submittals After Award of the Contract:

1. Geomembrane Resin:

a. Manufacturers signed Certificate that the resin meets Specification requirements.

b. Manufacturers signed Certification of the origin of the resin and that all resin is from the same manufacturer (Contractor name, identification brand name, and number).

c. Copies of Manufacturer and resin supplier QA/QC certificates. Certificates shall include a summary report of test results conducted to verify the quality of the resin used in each batch used to manufacture geomembrane for this project. At a minimum, the report shall include tests on specific gravity, melt flow index, and percent carbon black.

2. Geomembrane Sheeting:

a. Signed certification that the properties of the manufactured sheeting meet Specification requirements and are guaranteed by the Manufacturer.

b. Statement certifying that no post-consumer resin (PCR) has been added to the formulation.

c. Copy of all of the geomembrane Manufacturer Quality Assurance certificates. The certificates shall include documents of test results.

3. Extrudate Resins or Rod for Seaming Geomembranes:

   a. Certification that all extrudate is the same resin type as the geomembrane and was obtained from the same resin supplier as the resin used to manufacture the geomembranes.

4. Installation Data:

   a. Proposed geomembrane panel layout for each installation.

   b. Manufacturer recommended procedures for making and testing seams if different from this Specification.

   c. Manufacturer recommended procedures for repairing damaged geomembrane sections and seams if different from this Specification.

   d. Manufacturer details of geomembrane liner anchorage, and attachment to structures and penetrations if different from this Specification and the details on the Design Drawings.

D. Submittals After Construction is Complete:

1. Contractor:

   a. As-built panel layout.

   b. Drawing showing location of repairs and type of repairs made.

   c. Location of destructive tests.

   d. Results of destructive tests.

   E. Results of non-destructive tests.

1.4 QUALITY ASSURANCE

A. Quality assurance procedures shall be conducted in accordance with this Section and Section 31 90 99. Where conflict between sections exists, the more stringent requirement shall apply.

B. Materials and construction procedures shall be subject to inspection by the CQA Testing Service employed by the Contractor.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Unloading and storage of materials shall be the responsibility of the Contractor.

2. The unloading and other handling of materials shall be performed by the Contractor to ensure that the material is handled with care and not damaged.

B. Packaging:

1. Deliver material to the project site in rolls, each wrapped securely with a protective covering installed at the manufacturing facility. The covering shall prevent the entrance of water, vermin, and dirt, and shall be adequate for protection against ultraviolet exposure.

2. The packaging shall not interfere with handling of the rolls either by slings or by using the central core upon which the material is wound.

C. Labeling: Attach or adhere a tag to the protective cover identifying the listed following.

1. Manufacturer and product name/number.

2. Date of manufacture.

3. Roll identification number.

4. Contractor order number (matching Bill of Lading).

5. Width, length, and square yard area of the roll.

6. Details of labeling rolls shall conform to ASTM D4873.

D. Storage:

1. The material shall be stored off the ground on pallets or in an equivalent manner.

2. Rolls shall be stored in such a manner that cores are not crushed, the material not damaged, and as required to provide protection from exposure to ultraviolet light, inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious condition.

3. The Purchaser shall provide on-site storage space in a location near the area of work such that on-site transportation and handling are minimized. The Contractor shall be responsible for protecting stored material from theft and vandalism.

4. The rolls of the material shall be placed on a smooth surface, free of rocks and standing water.

E. Inspection:

1. Upon delivery of the material to the project site, the Contractor shall conduct a visual inspection of all rolls for damage or defects. This inspection shall be done without unrolling any rolls, unless damage to the inside of a roll is found or suspected.

2. Any damage or defects shall be noted and immediately reported to the Purchaser, the Manufacturer, and to the carrier that transported the material.

Any roll or portion thereof, which, in the judgement of the Purchaser, is seriously damaged, shall be removed from the project site and replaced with complying material at no additional cost to the Purchaser.

PART 2 PRODUCTS

2.1 HIGH DENSITY POLYETHYLENE GEOMEMBRANE

A. HDPE Geomembrane - General Requirements:

1. The HDPE geomembrane shall be manufactured from first quality, virgin resin. Blending of resins shall not be allowed. No recycled or reworked geomembrane may be used except edge trim generated during the manufacturing process (no more than 10%). No PCR of any type shall be added to the formulation.

2. The resin used to produce the geomembrane shall include carbon black, antioxidants, and heat stabilizers, and otherwise be formulated to resist chemical and ultraviolet degradation.

3. The geomembrane shall be free of plasticizers.

4. The geomembrane shall be free of leachable additives.

5. During manufacture, each roll of geomembrane shall be continuously monitored across the width to assure uniformity of thickness. Thickness measurements shall meet the requirements for Non-Textured Geomembrane (see Table 1).

6. Supply geomembrane as single-ply continuous sheet with no factory seams and in rolls with minimum 15 ft width. Maximize roll length to provide largest manageable sheet with fewest field seams.

7. The geomembrane shall be free from dirt, oil, foreign matter, scratches, cracks, creases, bubbles, blisters, pits, tears, holes, pores, pinholes, voids, undispersed raw material, any sign of contamination or other defects that may affect serviceability, and shall be uniform in color, thickness, and surface texture.

8. The geomembrane shall be capable of being seamed in the field to yield seams that are as resistant to waste liquids as the sheeting.

9. The geomembrane shall be manufactured in the United States or Canada.

10. Geomembrane shall incorporate a conductive layer designed such that conductive elements do not advesly impact the durability, weldability or water tight nature of the geomembrane.

B. HDPE Non-Textured Geomembrane:

1. HDPE Non-Textured Geomembrane shall meet the requirements of Table 1 as tested by manufacturer.

Table 1. High Density Polyethylene Non-Textured.

GEOMEMBRANE REQUIREMENTS[1]

Property	Test Method	Polyethylene Base Compound	Geomembrane Minimum Average Roll Value	Testing Frequency by Manufacturer
Nominal thickness, mil	--	--	60	---
Resin Properties				
Oxidative Induction Time (OIT), minimum average minutes Standard OIT or	D3895	100	--	200,000 lbs. of Resin
High Pressure OIT	D5885	400		200,000 lbs. of Resin
Oven Aging at 85° C	D5721	--		
Standard OIT (min avg), percent retained after 90 days or	D3895	55		one per formulation
High Pressure OIT (min avg), percent retained after 90 days	D5885	80		one per formulation
High Pressure OIT (min avg), percent retained after 1600 Hrs.	D5885	50		one per formulation
Analytical Properties				
Density of base resin, g/cc minimum	D1505/D792	0.940	-- --	200,000 lbs. of Resin
Carbon black content, %	D1603 or D4218	2.0-3.0	--	20,000 lbs. of Resin
Carbon black dispersion for 10 different views	D5596	All 10 in Categories 1,2 & 3		45,000 lbs. of Resin

Property	Test Method	Polyethylene Base Compound	Geomembrane Minimum Average Roll Value	Testing Frequency by Manufacturer
Mechanical Properties				
Thickness, mils Average Lowest individual of 10 values	D5199		-- -- --	One per roll
Tensile properties, in each direction (minimum):	D638 (Type IV Specimen at 2 ipm)			
Tensile stress at yield, ppi minimum Elongation at yield, % minimum Tensile stress at break, ppi minimum Elongation at break, % minimum 2" gage length			-- -- -- --	20,000 lbs. of Resin 20,000 lbs. of Resin 20,000 lbs. of Resin 20,000 lbs. of Resin
Tear resistance, lb (minimum avg)	D1004		--	45,000 lbs. of Resin
Puncture resistance, lb. (minimum avg)	D4833	--		45,000 lbs. of Resin
Bonded seam strength[2] Shear strength, ppi Peel adhesion (fusion), ppi Peel adhesion (extrusion), ppi	D6392		-- -- -- --	
Environmental and Aging Effect on Properties				
Stress Crack Resistance, hours (min)	D5397		--	per GRI GM10

NOTES: 1) Requirements shown in this table meet the minimum requirements of GRI Standard GM13, April 11, 2011 except for bonded seam strength. 2) Seam requirements.

C. Panel Layout:

1. Prior to manufacture of the geomembrane, a panel layout of the surface to be lined shall be made. Each panel to be used for the installation shall be given a numeric or alphanumeric identification number.

2. The panel identification number shall be related in writing to the manufacturing roll number that identifies the resin type, batch number, and date of manufacturer.

3. The panel layout shall be made considering the following requirements:

   a. Panel lengths shall include slope gain and anchorage.

   b. Perpendicular tie-ins shall be made a minimum of 5 ft beyond the toe of the slope.

   c. A minimum of 6-in. overlap shall be allowed at double fusion welded seams.

   d. All field seams on slopes shall be oriented parallel to the slope (oriented along, not across the slope).

   e. The number of seams in corners or odd shaped geometric locations shall be minimized.

D. Packaging and Shipping:

1. The geomembrane shall be shipped to the project site in rolls. No material shall be folded.

2. A label shall be attached or adhered to each roll of the geomembrane identifying the following:

   a. Manufacturer.

   b. Product Identification, which can be traced back to the origin of the base material (resin supplier name, resin production plant, resin brand name type, resin brand number, and production date of the resin).

   c. Date of manufacture of the geomembrane.

   d. Roll identification number.

   e. Geomembrane thickness and type.

f. Roll dimensions (length and width).

g. Batch number.

h. Order number.

i. Panel number.

E. Packaging and Transportation:

1. Packaging and transportation shall be the responsibility of the manufacturer, who shall retain responsibility until the geomembrane is accepted at the site by the Contractor.

PART 3 EXECUTION

3.1 ONSITE HANDLING AND STORAGE

A. Receipt/Unloading:

1. Unloading and storage of materials shall be the responsibility of the Manufacturer.

2. The unloading and other handling of materials shall be performed by the Manufacturer to ensure that the material is handled with care and not damaged.

B. Storage:

1. The Purchaser shall provide on-site storage space in a location near the area to be lined, such that on-site transportation and handling are minimized. The Manufacturer shall be responsible for protecting stored material from theft and vandalism.

2. The rolls of geomembrane shall be placed on a smooth surface free of rocks and standing water.

C. Inspection:

1. Upon delivery of the material to the project site, the Contractor shall conduct a visual inspection of all rolls of geomembrane for damage or defects. This inspection shall be done without unrolling any rolls unless damage to the inside of a roll is found or suspected.

2. Any damage or defects shall be noted and immediately reported to the Purchaser, the Manufacturer, and to the carrier that transported the material. Any roll or portion thereof, which, in the judgement of the Purchaser, is seriously damaged, shall be removed from the project site and replaced with complying material at no additional cost to the Purchaser.

3.2 PREPARATION OF SURFACES TO BE LINED

A. General:

1. The Contractor shall be responsible for preparing and maintaining the surfaces to be lined as specified in Section 31 90 05, "Earthwork and Soil-Bentonite Mixture" prior to placement of the geomembrane.

2. The Contractor shall confirm the conditions of the finished surfaces to be lined prior to placement of the liner.

B. Grading Requirements:

1. The subgrade surface on which a lining is to be placed shall be graded to elevations shown on the Design Drawings. Tolerances shall be as specified in Section 31 90 05.

C. Preparation of Concrete Surfaces:

1. All portions of concrete walls, curbs, and foundations that will come in contact with a geomembrane shall be free of sharp edges or rough spots that can puncture or abrade the geomembrane. Where necessary, the concrete shall be ground smooth by the Contractor. Where specified on the Design Drawings, one or more layers of geomembrane scuff strips shall be placed between the concrete and the geomembrane to act as a protective layer for the liner.

D. Subgrade Acceptance:

1. Subgrade below base layer (secondary liner) shall be prepared and accepted in accordanc with Section 31 90 05 Article 3.6 of this specificaiton.

2. Prior to place any geomembrane the substrat shall be free of debris, sharp/angular objects, abrubpt transitions, free moisture, or other conditins that could damage the liner material or lead to questionalbe installation and seaming.

E. Geotextile:

1. See Section 31 15 21, "Geotextile" regarding installation, inspection, and acceptance of a geotextile used to protect the geomembrane liner.

F. Geosynthetic Clay Liner:

1. See Section 31 90 25, "Geosynthetic Clay Liner (GCL)" regarding installation, inspection, and acceptance of a GCL prior to installation of an overlying geomembrane liner.

3.3 FIELD PLACEMENT OF THE GEOMEMBRANE LINER

A. General Requirements:

1. Placement Procedure: The placement procedure used for the geomembrane liner shall include the conditions listed below.

2. Weather:

   a. Geomembrane shall not be placed when the air temperature is above 104°F or below 41°F, unless it can be demonstrated to the approval of the Purchaser by trial welds, that acceptable welds can be made at the prevailing temperature. Trial welds shall be as described in Paragraph 3.3.B.3.

   b. Geomembrane shall not be placed when there is any rainfall or snowfall, in the presence of excessive moisture due to fog or dew, in ponded water, on a frozen subgrade, or during high winds.

3. Panel Layout:

   a. The panels shall be placed in accordance with the approved panel layout Drawing prepared by the Contractor to ensure that they are placed in the proper direction for seaming.

   b. If panels are installed in a location other than indicated on the panel layout Drawing, the revised location shall be indicated on an "as-built" layout Drawing. The “as built” record Drawing shall be submitted to the Purchaser at the completion of the project.

4. Panel Deployment:

   a. Only the panels that can be anchored and seamed together in one shift shall be unrolled.

   b. Unroll and layout panels in as close to the final position as possible. Pulling geomembrane panels should be minimized to reduce the chance of permanent tension.

   c. The methods and equipment used to deploy the panels shall not damage the geomembrane or the supporting surface.

   d. Wrinkles shall be minimized. However, enough slack shall be provided in all directions so that there will be no tension (bridging) in the geomembrane at the lowest expected operating temperature. The design minimum operating air temperature is -35° F.

5. Precautions to Prevent Wind Damage:

   a. If possible, work shall be oriented in the direction of the prevailing wind.

   b. Provide adequate temporary loading and/or anchoring of the geomembrane by the use of sandbags, tires or other means that will not damage the geomembrane, to prevent uplift of the geomembrane by wind.

6. Other Precautions to Prevent Damage:

   a. Protection of the geomembrane from damage, due to foot traffic on the slopes, shall be provided.

   b. Provisions of facilities for safe entrance and egress of employees from sloped depressions is required.

   c. Temporary equipment ramps shall not be constructed on the geomembraegeomembrane liner. Equipment shall not operate directly on a geomembrane liner.

7. Replacement of Damaged Geomembrane:

   a. Any area of a panel, which, in the judgement of the Purchaser, becomes seriously damaged (torn, twisted, or crimped permanently), shall be replaced at no additional cost to the Purchaser.

B. Field Seaming:

1. Method of Seaming:

   a. The primary welding procedure for seams shall be double wedge fusion welding.

   b. Extrusion welding shall be used only for repairs, detail work, and for seaming where double wedge fusion welding is not possible.

   c. The rods used for extrusion welding shall be the same type of resin as the geomembrane, unless otherwise approved by the Purchaser.

   d. The use of solvents or adhesives is not permitted.

2. General Requirements for Seaming:

   a. On slopes steeper than ten horizontal to one vertical, seams shall be oriented parallel to the line of maximum slope (oriented up and down, not across the slope). No seams oriented across the slope shall be used unless approved by the Purchaser.

   b. Seams parallel to the toe of the slope shall be located a minimum of 5 ft from the slope.

   c. Seams on the floor of the pond shall be overlapped so that the upslope sheet is positioned above the downslope sheet.

   d. Seams at sheet corners shall be completed with a patch having a minimum dimension of 24 in., and extrusion welded to the parent sheets. Panel seams shall be designed to allow a maximum of 3 panels or layers intersecting within a 2 ft radius of other seams.

e. All cross seams between the two rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of geomembrane.

3. Trial Welds Prior to Beginning Seaming:

a. Trial welds are required for pre-qualification of personnel, equipment and procedures for making seams on identical geomembrane material, under the same climatic conditions as the actual field production seams, will be made.

b. Trial welds shall be made as follows:

i. Prior to each seaming period.

ii. Every 4 to 5 hours (i.e., at the beginning of the work shift and after the lunch break).

iii. Whenever personnel or equipment are changed.

iv. When climatic conditions result in wide changes in geomembrane temperature.

v. When requested by CQA Inspector for any seaming crew or piece of welding equipment, if problems are suspected.

c. Once qualified by passing a trial weld, welding technicians shall not change parameters without performing another trial weld.

d. Trial welds shall be made on both double wedge fusion welds and on extrusion welds.

e. A test strip shall be prepared by joining two pieces of geomembrane; each piece shall be at least 6 in. wide. The length of double wedge fusion-welded seams shall be a minimum of 10 ft long. The length of an extrusion-welded seam shall be a minimum of 4 ft long. The CQA Inspector shall witness the fabrication of each test strip.

f. All test welds shall be tested by destructive testing. Testing can be done as soon as the seam cools.

g. A minimum of six 1-in. wide (or larger as required by applicable ASTM test method) sample strips shall be cut from each test strip, two from each end, and two from the middle. The location of each sample shall be selected by the CQA Inspector. Three test strips shall be tested in peel and three test strips shall be tested in shear at 2 in. per minute using a field tensiometer. The CQA Inspector shall witness all tests.

h. If any of the test specimens fail, a new test strip shall be fabricated and the tests repeated for the new strip. If additional specimens fail, the seaming apparatus and the seamer shall not be accepted and shall not be used for seaming, until the deficiencies are corrected and successful trial welds have been achieved.

i. The trial weld is considered acceptable if, when tested for peel adhesion and shear strength using the field tensiometer, all six specimens meet the criteria specified in Table 1, respectively, for both the peel and shear under Bonded Seam Strength, or the three specimens exhibit Film Tear Bond (yielding of the parent material before seam failure). In the case of double wedge fusion welded seams, both welds must pass in order to be considered acceptable.

j. If the specimens pass the tests, production-seaming operations can begin.

k. The Contractor shall document all data on each trial weld, including:

   i. Date,

   ii. Time,

   iii. Operator,

   iv. Machine number,

   v. Ambient temperature,

   vi. Operating temperature,

   vii. Speed setting, and

   viii. Pass/Fail designation.

4. Preparation for Seaming:

   a. Prior to seaming, the surface of the geomembrane shall be wiped with a clean cloth to ensure that it is clean and free from moisture, grease, dust, dirt, and debris of any kind before seam welding is started.

   b. The panels shall be adjusted so that the seams are aligned to eliminate wrinkles and fish mouths. Where necessary, fish mouths and wrinkles shall be cut to achieve flat overlap.

5. Seaming:

   a. Seaming shall be performed in accordance with the Manufacturer accepted procedure.

   b. Double Wedge Fusion Welds:

      i. The panels shall be overlapped a minimum of 4 in. prior to welding.

      ii. Vehicle mounted automated hot wedge welding apparatus shall be used to make the seam.

   c. Extrusion Fillet Welding:

      i. Geomembrane overlap shall be a minimum of 3 in. for extrusion welding.

      ii. Geomembrane panels shall be temporarily bonded using a hot air device prior to extrusion welding.

      iii. The edge of the geomembrane to be fillet welded shall be pre-beveled before heat tacking the seam in place.

      iv. The seam overlap shall be ground (abraded) no more than one hour prior to welding.

      v. Grinding shall be performed in accordance with the Manufacturer instructions in a manner that does not damage the geomembrane.

      vi. Grinding shall not extend more than 1/4 in. past the area to be covered with extrudate during welding.

      vii. All grind marks shall be covered with extrudate.

      viii. Geomembrane overlap shall be a minimum of 3 in. for extrusion welding.

C. Non-Destructive Field Testing – Geomembrane:

1. General:

a. All non-destructive field-testing shall be performed and documented by the Contractor.

b. The CQA Inspector shall observe all non-destructive test procedures.

c. 100% of the seam length shall be tested using non-destructive procedures to check the continuity of the field seams. Non-destructive testing is not meant to qualify seam strength.

d. Air pressure testing shall be performed in accordance with ASTM D5820 and GRI GM 6.

e. Vacuum Box testing shall be performed in accordance with ASTM D5641 and as specified herein.

f. Continuity testing shall be performed as seaming progresses or as soon as a suitable length of seam is available, not at the completion of all field seaming.

2. Double Wedge Fusion-Welded Seams:

a. Double fusion-welded seams shall be tested using air pressure testing.

b. The procedure for testing shall be as specified in GRI GM 6 for the type and thickness of geomembrane in use.

c. The following test pressures are applicable to both smooth and textured HDPE. After an initial 2-minute pressure stabilization period, the pressure shall be maintained between 24 and 30 psi for 40 mil HDPE, 27 and 30 psi for 60 mil HDPE, and 30 and 35 psi for 80 and 100 mil HDPE. The pressure shall be sustained for a minimum of 5 minutes. The loss of pressure shall not exceed a maximum of 3 psi in 5 minutes. If the pressure does not stabilize in the first two minutes or the pressure loss exceeds the loss specified, the seam test shall be considered a failure.

d. The leak or suspected leak shall be located and repaired.

e. The repaired seam shall be re-tested, as required, until all leaks are identified, and repaired, and the seam passes a subsequent air pressure test.

f. When the geometry of a double wedge fusion-weld makes air testing impossible or impractical, vacuum testing may be used to test the seam.

3. Extrusion Welded Seams:

    a. Extrusion welded seams shall be tested using vacuum chamber testing in accordance with ASTM D5641.

    b. The completed seam shall exhibit no leakage when tested between 4 and 8 psi minimum vacuum for approximately 10 seconds.

    c. If leaks are discovered during testing, they shall be located, marked, and repaired.

    d. The repaired area shall be re-tested and exhibit no leakage.

4. Inaccessible Seams:

    a. Where extrusion welded seam locations make use of vacuum box testing impractical, then the electric wire method of testing shall be used, or the seam shall be cap stripped as approved by the Purchaser.

    b. If cap stripping is approved by the Purchaser, the seams shall be cap stripped as described in Paragraph 3.4.D, with strips of the same type and thickness of geomembrane being installed. The cap stripping shall be performed in the presence of the Purchaser.

    c. The electric wire test method shall consist of placing a 24 gauge copper wire 1/8 in. beneath the top sheet overlap of the two sheets prior to welding with the extruder. The wire shall be imbedded in the seam. After welding, a holiday spark detector, operating at 20,000 volts, shall be connected to one end of the wire and slowly moved over the length of the seam. A seam defect between the probe and the embedded wire shall result in an audible alarm indicating where the defect is located.

5. Test Reports:

    a. Test reports for all air pressure tests shall contain all data specified in ASTM D5820 and GRI GM 6.

    b. Test reports for vacuum box testing shall contain all the data specified in ASTM D5641.

    c. Test reports for spark testing shall contain all of the data specified in ASTM D6365.

    d. Test reports for other types of non-destructive tests shall contain at a minimum for each test:

        i. Location,

        ii. Type of test,

        iii. Test parameters,

iv. Test data,

v. Test number,

vi. Name of tester, and

vii. Outcome of the test.

D. Destructive Testing – Geomembrane:

1. Testing:

a. Destructive testing shall be performed by a laboratory employed by the Contractor on samples cut from production welds in the field.

b. Samples shall be taken by the Contractor to the laboratory and tested for shear strength and peel adhesion. For double wedge seam samples, both welds shall be tested for peel adhesion.

c. The laboratory that will perform testing shall be identified by the Contractor with the bid proposal and agreed-to in writing by the Purchaser.

2. Location and Frequency:

a. Test locations shall be determined after seaming. The location where the test samples shall be taken shall be marked by the CQA Inspector. Locations may be prompted by the appearance of excessive heating, contaminations, offset welds, or a suspected defect. Destructive test samples for each type of weld shall be taken at a minimum average frequency of one per every 500 linear feet of seam length. At a minimum 1 test sample of each type weld will be taken each morning and each afternoon welding is performed. Additional samples shall be obtained whenever repairs or modifications are made to the welding equipment.

b. The Method of Attributes described in GRI GM 14 may be exercised to minimize the number of test samples taken if more than 100 destructive seam samples will be required based on the sampling strategy given in Paragraph 3.3.D.2.a.

c. Each sample location shall be numbered and marked with permanent identification, and the location of the sample and the locations shall be indicated on a plan Drawing prepared and maintained by the Contractor. The following shall be recorded for each sample:

i. Date and time;

ii. Ambient temperature;

iii. Seam number and location;

iv. Welding apparatus used;

v. Name of master seamer;

vi. Reason for taking the sample;

vii. Size of sample;

viii. Test results; and

ix. Name of tester.

d. Samples shall be cut by the Contractor. The CQA Inspector shall witness test sample cutting.

e. Test samples shall be cut every shift and taken by the Contractor to the laboratory the same day that the sample is prepared. Three samples for shear and peel tests of each tested trial weld shall be collected.

3. Sample Size:

a. The minimum sample size shall be 12 in. wide with a seam 16 in. long centered length-wise in the sample. As agreed to with Purchaser, a sample may be increased in size to accommodate the requirements of the testing laboratory.

4. Field Testing:

a. A 1-in. wide specimen shall be cut from each end of each sample for field-testing.

b. Each 1-in. wide specimen shall be tested with a field tensiometer for peel adhesion or shear strength.

c. The CQA Inspector shall witness each field test.

d. A test is considered acceptable if a specimen meets the criteria for both peel and shear under Bonded Seam Strength or, exhibits Film Tear Bond. For double wedge fusion-welds, both welds must pass the test. If either sample fails the field test, it shall be assumed that the seam will not pass the specified laboratory testing and the sample shall be given a fail designation.

5. Laboratory Testing:

a. Full size (12-in. minimum length) samples shall be taken to a laboratory for testing.

b. Samples shall be tested for shear strength and peel adhesion in accordance with ASTM D6392. Five specimens shall be tested for each test method. Three sample specimens shall be collected for testing of the trial welds. All samples shall meet minimum requirements for shear strength and peel adhesion

6. Test Results:

    a. Verbal test results shall be given to the Contractor within 24 hours of receipt of the samples. Written results shall follow within one week.

    b. All test locations shall be marked with a pass/fail designation on the liner and on the Drawing maintained by the Contractor for submittal to the Purchaser after construction is complete.

7. Re-Testing if Failure Occurs:

    a. If a seam fails testing, one additional sample shall be taken 10 ft on each side of the location of the failed test. Additional samples shall continue to be taken at 10-ft intervals until tests show that seam strength is adequate and the zone in which the seam requires reconstruction is identified.

    b. All passing seams shall be bounded by two locations from which samples passing laboratory destructive tests have been taken.

    c. The entire seam length failing strength tests shall be reconstructed at no additional cost to the Purchaser.

    d. If the length of reconstructed seam exceeds 150 ft, a sample shall be taken of the reconstructed seam every 150 ft and shall pass destructive testing.

E. Inspection – Geomembrane:

1. After seaming is complete, the Contractor and the CQA Inspector shall conduct a detailed walk-down to visually check all seams and non-seam areas of the geomembrane. The inspection shall look for imperfections including verification of tight seams and joints, defects, holes, blisters, tears, and signs of damage.

2. All defects, holes, blisters, tears, signs of damage during installation, areas of undispersed carbon and holes from destructive or non-destructive testing shall be marked and repaired.

3.4 REPAIR OF DEFECTS AND SEAMS - GEOMEMBRANE

A. Patching:

1. Patching shall be used to repair large holes, tears, and destructive sample locations.

2. All patches shall be round, oval, or shall have rounded corners.

3. All patches shall be made of the base geomembrane material and shall extend a minimum of 3 in beyond the edges of the defect.

4. Patches shall be extrusion-welded to the base sheet.

B. Grinding and Welding:

1. Grinding and welding shall be used to repair sections of extruded fillet seams with small defects.

C. Spot Welding:

1. Spot welding shall be used to repair small tears, pinholes, or other minor localized flaws.

D. Capping:

1. Capping shall be used to repair lengths of extrusion-welded seams with large defects and to repair double wedge fusion-welded seams.

2. Cap strips shall be made with strips of the same type and thickness of geomembrane being installed. Strips shall extend a minimum of 6 in. beyond the weld, and shall have rounded corners.

3. Cap strips shall be extrusion-welded to the base sheet.

E. Cut Out and Replacement:

1. When approved by the Purchaser, a length of defective seam may be cut out and replaced with a strip of new material seamed into place.

F. Verification of Repairs:

1. All repairs shall be non-destructive tested using one of the procedures described in Paragraph 3.3.3.

2. Repairs that pass the non-destructive test shall be deemed acceptable.

3. Repairs of a seam in excess of 150 ft in length shall have one destructive seam test per 150 ft in length.

3.5 CREST ANCHOR

A. Attachment to Concrete

1. Geomembrane shall be attached to concrete ring wall using batten strips and post installed anchorages, in accordance with details on the Design Drawing.

END OF SECTION 31 90 22

SECTION 31 90 25

GEOSYNTHETIC CLAY LINER

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. This Specification Section defines the minimum requirements for material and installation of a Geosynthetic Clay Liner (GCL) in accordance with the Design Drawings and as specified herein.

B. The work shall include, but not be limited to, the following listed items.

1. Manufacturing, shipping, handling, and storage of GCL.
2. Preparation and inspection of surfaces to be lined.
3. Placement and seaming of GCL.
4. Sealing around penetrations.
5. Patching and repairs.
6. Visual inspection of the completed GCL.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

GeneralDrawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. ASTM International (ASTM)

ASTM D4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Method
ASTM D5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles
ASTM D5887	Standard Test Method for Measurement of Index Flux through Saturated Geosynthetic Clay Liner Specimens using a Flexible Wall Permeameter
ASTM D5889	Standard Practice for Quality Control of Geosynthetic Clay Liners

ASTM D5890	Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
ASTM D5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
ASTM D5993	Standard Test Method for Measuring Mass per Unit of Geosynthetic Clay Liners
ASTM D6243	Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by Direct Shear Method
ASTM D6496	Standard Test Method for Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
ASTM D6768	Standard Test Method for Tensile Strength of Geosynthetic Clay Liners

B. Washington Adminstrative Code (WAC)

WAC 173-303-650	Surface Impoundments

C. Section 31 15 21 – Geotextile.

D. Section 31 90 22 – High Density Polyethylene Geomembrane Liner.

E. Section 31 90 99 – Construction Quality Assurance

1.3 SUBMITTALS

A. See Contract Statement of Work for submittal procedures.

B. Submittals with the Bid Proposal:

1. GCL Material:

   a. Copies of the Manufacturer catalog data describing the GCL material proposed for use on this project.

   b. Copies of Manufacturer QA certificates on tests performed on the material and a summary of results after the tests.

   c. Certification of Compliance from the Manufacturer of the GCL, signed by its authorized representative, stating that the liner material meets the Specification requirements and that those requirements are guaranteed by the Manufacturer.

   d. Manufacturer Quality Control and Quality Assurance Policies and Procedures.

C. Submittals Upon Shipment:

1. Four representative samples of the GCL.

2. Manufacturer QA/QC certificates with each shipment of GCL. The QA/QC certificates shall include:

   a. GCL lot and roll numbers with corresponding shipping information.

   b. Manufacturer test data for raw materials used in GCL production, including at a minimum, mass per unit area data and tensile test data.

   c. Manufacturer test data for the finished GCL product, including at a minimum, clay mass per unit area data and tensile testing data.

   d. Certificates of analyses for the bentonite clay used in GCL production.

D. Submittals After Construction is Complete:

1. Contractor:

   a. Drawing showing location of repairs and type of repairs made.

   b. Drawing showing the layout and seams of the GCL.

1.4 QUALITY ASSURANCE

A. Quality assurance procedures shall be conducted in accordance with this Section and Section 31 90 99. Where conflict between sections exists, the more stringent requirement shall apply.

B. Materials and construction procedures shall be subject to inspection and testing by a Testing Service employed by the Contractor, where specified. Such inspections and tests will not relieve Contractor of the responsibility for providing materials and placing procedures in compliance with the contract requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Contract Statement of Work for general requirements.

B. Packing and Shipping:

1. The finished GCL shall be completely wrapped and adequately secured with a durable polyethylene protective cover, in order to provide protection from ultraviolet degradation of the Primary Backing Material (PBM) and excessive loss of moisture during shipping and storage.

2. The GCL shall be shipped to the project site in rolls.

3. A label shall be attached or adhered to each roll of the GCL identifying the following:

a. Manufacturer;

b. Product Identification (brand name, product code);

c. Date of Manufacture;

d. Roll Identification Number;

e. Panel Number;

f. GCL Thickness;

g. Roll Dimensions (length, width, and height);

h. Lot Number; and

i. Order Number.

C. The GCL shall be stenciled throughout each roll with the product name and name of the Manufacturer, which can be cross-referenced to the roll number marked on the label and to the production and quality control data sheets.

D. Unloading:

1. Handling and unloading shall be the responsibility of the Contractor

2. Upon arrival at the site, the rolls of the GCL shall be carefully unloaded by the Contractor in accordance with Manufacturer recommendations.

E. Storage:

1. To the extent possible, the Purchaser will provide on-site storage space in a location near the area to be lined such that on-site transportation and handling are minimized.

2. The Contractor shall be responsible for protection of materials from theft and vandalism.

3. The rolls of GCL shall be stored horizontally in their original, unopened, wrapped cover in a clean, dry area. The material shall be stored off the ground on pallets or plywood in small stacks not to exceed five rolls in height. The rolls shall be covered with a heavy, protective tarpaulin or plastic sheeting, or enclosed within a storage facility. Care shall be used to keep the GCL clean and free from debris prior to installation.

4. Rolls shall be stacked in a manner recommended by the Manufacturer that prevents them from sliding or rolling from the stacks.

5. Any rolls that come in contact with moisture, while in storage, shall be set aside by the Contractor and be evaluated by the Testing Agency and Manufacturer for

use. Damaged rolls shall also be set aside and inspected to determine suitability of the material for use.

F. Inspection:

1. Upon delivery of the material to the project site, the Contractor shall conduct a visual inspection of the polyethylene sleeves of all rolls of GCL for damage, rips, or tears. Sleeve damage shall be repaired immediately with tape or additional plastic sheeting.

2. Any damage shall be noted and immediately reported to the Purchaser, the Manufacturer, and to the carrier that transported the material. Any roll or portion thereof, which, in the judgement of the Purchaser, is seriously damaged, shall be removed from the project site and replaced with complying material at no additional cost to the Purchaser.

PART 2 - PRODUCTS

2.1 GEOSYNTHETIC CLAY LINER

A. GCL General Requirements:

1. The GCL shall be a needle-punched GCL. The GCL shall be manufactured by placing a uniform layer of high-swell sodium bentonite encapsulated between two geotextiles and then needle punching through both layers of the geotextile and the bentonite to push fibers from the non-woven geotextile cap through the bentonite layer and embed them in the geotextile scrim on the other side.

2. The upper and lower support materials shall protect the bentonite, but shall be sufficiently porous to allow bentonite flow-through to create a positive bentonite-to-bentonite seal at the seams.

3. The support materials used in the manufacturing shall not interfere with the swelling, self-healing, or low permeability characteristics of the GCL.

4. The GCL shall be fabricated such that bentonite will not be displaced when the liner is cut.

5. 6 in. and 9 or 12 in. overlap marks shall be marked longitudinally on both edges of the geotextile cap, by the Manufacturer, to assist in obtaining the proper overlap. The lines shall be printed in easily visible, non-toxic ink.

B. GCL Material Specifications:

1. The GCL materials shall meet the following listed requirements.

a. Sodium Bentonite: The bentonite utilized in the manufacture of the GCL, as well as any accessory bentonite provided for seaming and detail work, shall be Wyoming-grade sodium bentonite with the properties listed in the following table as tested by manufacturer.

Property (2)	Test Method	Value	Min Testing Frequency (1)
Free Swell	ASTM D5890	24 ml/2g min	1/100,000 lb
Fluid Loss	ASTM D5891	18 ml (max A.R.V.)	1/100,000 lb
Moisture Content	ASTM D4643	12% max	1/100,000 lb

NOTES: (1) In accordance with ASTM D5889. (2) Properties of the base bentonite prior to incorporation into the final GCL product.

b. Geosynthetic Clay Liner: The finished GCL manufactured using a non-woven cap and a woven scrim shall have the following properties as tested by manufacturer:

Property	ASTM Method	Value	Min Testing Frequency (1)
Geotextile Properties			
Non-Woven Cap	D5261	6.0 oz/yd^2	1/200,000 SF
Woven Scrim	D5261	3.1 oz/yd^2	1/200,000 SF
Finished GCL Properties			
Bentonite Mass/Area (psf)	D5993	0.75 lb/ft^2 MARV at 0% moisture	1/40,000 SF
Hydrated Internal Shear Strength	D6243	500 psf typical	Periodic
Tensile Strength	D6768	30 lbs	1/40,000 SF
Peel Strength (2)	D6496	3.5 lb/in	1/40,000 SF
Index Flux at 5 psi maximum effective confining stress and 2 psi head	D5887	1×10^{-8} m^3/m^2/sec maximum	1/week
Hydraulic Conductivity (5 psi effective confining stress and 2 psi head)	D5887	$<5 \times 10^{-9}$ cm/sec maximum	1/week

NOTES: (1) In accordance with ASTM D5889. (2) Machine (warp) direction of primary backing.

2.2 BENTONITE SEALING COMPOUND AND GRANULAR BENTONITE

A. The Bentonite Sealing Compound (BSC) and Granular Bentonite (GB) shall be supplied by the Manufacturer and shall be comprised of the same bentonite used in the manufacturing of the GCL. The BSC shall be a mixture of non-aqueous liquid suspension agents that creates a paste-like texture. The GB shall be furnished in 50 lb bags.

B. The suspension agents used in the manufacture of the BSC shall be non-toxic, water-soluble, and shall not restrict the ability of the bentonite to swell and absorb water upon hydration.

PART 3 - EXECUTION

3.1 PREPARATION OF SURFACES TO BE LINED

A. The Contractor shall be responsible for verifying the line and grade of the surface to be lined, prior to placement of the GCL.

B. The Contractor shall provide written certification to the Purchaser that the surface on which the GCL is to be installed is acceptable.

C. The surface upon which the GCL is to be placed shall be free of standing water and maintained in a firm, clean, and smooth condition during liner installation.

3.2 FIELD PLACEMENT OF THE GCL LINER

A. Weather:

1. A GCL shall not be placed during a rainfall or snowfall, in ponded water, or during high winds.

B. Panel Layout:

1. The panels shall be placed in accordance with the manufacturer recommendations to ensure that they are placed in the proper direction for overlapping.

2. Panels shall be rolled out in continuous sheets from the top of the dike elevation to the bottom of the basin, with no horizontal seam on the slope. Vertical seams shall be parallel to the slope and shall not directly overlap seams of underlaying geosynthetic materials. Seams perpendicular to the slope direction (horizontal seams) shall only be present in the basin floor, where required.

3. An as-built record Drawing of the panel layout shall be submitted to the Purchaser at the completion of the project.

3.3 PANEL DEPLOYMENT

A. The rolls of GCL shall be brought to the area to be lined and set up such that the GCL roll is fully supported across its length. A core bar or spreader bar shall not flex or bend excessively when a full roll is lifted.

B. Deploy only as much GCL as can be covered by the end of the day or in a reasonably short time, in the event of precipitation. Alternatively, protect the GCL from all environmental exposure until the liner is adequately covered.

C. The cap material (non-woven geotextile) shall face upwards. The GCL shall be placed over the prepared surface in such a manner as to assure minimum handling.

D. Installation shall begin at a high elevation and proceed to a low elevation. At the high elevation, the GCL shall be adequately anchored to ensure the material is properly installed and does not cause damage or disturbance to the underlying geosynthetics.

E. Pulling GCL panels shall be minimized to reduce the chance of permanent tension.

F. Wrinkles shall be minimized. However, enough slack shall be provided in all directions so that there will be no tension (bridging) in the geomembrane at the lowest expected operating temperature. The design minimum operating air temperature is -35° F.

3.4 PRECAUTIONS TO PREVENT WIND DAMAGE

A. If possible, work shall be oriented in the direction of the prevailing wind.

B. Provide adequate temporary anchoring of the edges of the exposed sheets using sandbags, tires, or other means that will not damage the GCL, to prevent uplift of the GCL by wind.

3.5 OTHER PRECAUTIONS TO PREVENT DAMAGE

A. Protection of the GCL from damage due to foot traffic on the slopes shall be provided.

B. Provisions of facilities for safe entrance and egress of employees from sloped depressions shall be provided.

C. Equipment shall not be operated on the GCL.

3.6 FIELD SEAMING

A. General Requirements for Seaming:

1. Horizontal seams shall not be located within 5 ft of the slope.

2. On slopes, all runs shall be continuous with the long dimension of all panels oriented parallel to the slope.

3. Panels placed on the bottom require no particular orientation.

4. Once the first run has been laid, adjoining runs shall be laid with a 9-in. minimum overlap on the longitudinal seams and 12-in. overlap on end seams, unless more stringent recommendations are provided by the manufacturer.

5. The edges of GCL panels shall be adjusted to smooth out wrinkles, creases, or “fish mouths” in order to maximize contact with the underlying panel.

6. If the air temperature is higher than 85°F and the humidity is low, contraction may occur soon after placement when no confining stress has been placed over the GCL. To allow for the possibility of contraction under these conditions, the seam overlap shall be increased to a minimum of 12 in. on longitudinal seams and 36 in. on end seams, or to 4% of the distance to the next parallel seams, whichever is greater.

B. Seaming:

1. Seaming shall be performed in accordance with the Manufacturer accepted procedure.

2. All seams shall be formed by executing a bentonite-enhanced overlap to ensure that a continuous seal is achieved.

3. The side of the overlying panel shall be pulled back to expose and examine the overlap areas. Seam overlap areas shall be clean, free from moisture, and free from dust and debris of any kind before seaming is started. Any contamination shall be removed.

4. A fillet of dry granular bentonite shall be poured in a continuous manner along the overlap zone (between the edge of the panel and the 6-in. line) at a rate of at least 1/4 pound per linear foot.

5. Seam overlap on the bottom shall be placed such that the direction of flow is from the top sheet to the bottom sheet to form a shingle effect and prevent flow into the seam.

3.7 INSPECTION

A. After seaming is complete, the Contractor shall conduct a detailed walkdown to visually check all seams and non-seam areas of the GCL. Contractor shall notify the Purchaser of this inspection prior to performing and of results after completion.

B. All defects, holes, blisters, tears, and signs of damage during installation shall be marked for repair.

3.8 PATCHING AND REPAIRS

A. Patching shall be used to repair small defects, blisters, holes, and tears.

B. All dirt and debris present in the patched area shall be removed.

C. All patches shall be round, oval, or shall have rounded corners.

D. All patches shall be made of the base GCL and shall extend a minimum of 12 in. beyond the edges of the defect. Accessory bentonite shall be placed around the perimeter of the affected area at a rate of 1/2 pound per lineal foot prior to placing the patch. Adhesive, such as wood glue, may be used if necessary to secure the patch.

3.9 PROTECTIVE COVER

A. The GCL shall be covered as soon as practical to prevent damage or mechanical or environmental means. Precautions shall be taken to prevent damage to the GCL by preventing heavy equipment traffic.

B. To prevent premature hydration or contraction, only the amount of GCL that can be installed, inspected, repaired, and covered (protected) in the same day shall be installed.

C. Any leading edge or panels of GCL left unprotected shall be covered with a heavy, waterproofing tarp that is adequately secured and protected with sand bags or other ballast.

END OF SECTION 31 90 25

SECTION 31 90 52

LEACHATE COLLECTION AND REMOVAL SYSTEM FOR A LINED POND

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. The components and dimensions in the LCRS is shown on the design Drawings. The work shall include, but not be limited to, the following items.

1. Select bedding material.
2. Granular drainage layer.
3. Coarse aggregate bedding.
4. Perforated leachate collection pipes.
5. Solid cleanout pipes and covers.
6. Solid single wall leachate pipe.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawing and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American National Standards Institute (ANSI)

ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI/AWWA C110/A21.10	American National Standard for Ductile-Iron and Gray-Iron Fittings, 3-in. through 48-in., for Water and Other Liquids

B. ASTM International (ASTM)

ASTM C88	Test Method for Soundness of Aggregates by the Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131	Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C136	Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142	Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM D2434	Standard Test Method for Permeability of Granular Soils (Constant Head)
ASTM D2464	Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes
ASTM D2657	Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3350	Specification for Polyethylene Plastic Pipe and Fittings Material
ASTM F714	Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

C. Section 31 90 99 – Construction Quality Assurance

D. National Sanitation Foundation International (NSF)

NSF Listings - Plastics and Plumbing System Components

E. Washington Adminstrative Code (WAC)

WAC 173-303-650 Surface Impoundments

F. Washington Department of Transpotation (WSDOT)

Standard Specifications for Road, Bridge and Municipal Construction (2020) M 41-10

1.3 SUBMITTALS

A. See Contract Statement of Work for submittal procedures.

B. HDPE Pipe:

1. Manufacturer literature providing Specifications of the pipes that will be supplied.

2. Manufacturer signed certification that pipe to be supplied complies with the requirements of this Specification.

3. Statement that no reclaimed polymer has been added to the resin.

4. Copies of Pipe Manufacturer Quality Assurance certificates on tests performed during fabrication.

C. Premanufactured Appurtenances:

1. Certification that the manufactured manholes, cleanouts, plugs, or other appurtenances meet the requirements of these Specifications.

2. Copies of the following:

   a. Name of Manufacturer.

   b. Manufacturer catalog or model number.

   c. Physical dimensions.

3. Manufacturers QA certificates on tests performed during fabrication.

D. Coarse Aggregate Bedding:

	Property	ASTM Test	Data Required
1.	Particle Size Analysis	C136 C117	Sieve Analysis Percent Pass No. 200 Seive
2.	Soundness of Aggregate by use of Sodium Sulfate or Magnesium Sulfate	C88	Percent Loss
3.	Percent with One Crushed Face	(1)	Percent with at least one crushed face
4.	Resistance to Degradation in the Los Angeles Machine	C131	Percent Loss
5.	Clay Lumps and Friable Particles in Aggregate	C142	Percent

Notes: (1) Physical count of number of stones in a random 5-lb sample divided by the total number of stones. Percent shall be the average of two samples.

E. Gravel Drainage Layer Material:

1. Contractor shall provide a detailed plan of how the granular drainage layer will be spread and compacted. The plan shall include equipment planed, method of placement, conveyors, etc.

2. The following material data shall be submitted for approval of Gravel Drainage Layer Material.

	Property	ASTM Test (1)	Data Required
1.	Classification of Material	D2487	Classification
2.	Particle Size Analysis	C136 C117	Sieve Analysis Percent Pass No. 200 Seive
3.	Hydraulic Conductivity	D2434	Hydraulic Conductivity
4.	Soundness of Aggregate by use of Sodium Sulfate or Magnesium Sulfate	C88	Percent Loss
5.	Resistance to Degradation in the Los Angeles Machine	C131	Percent Loss
6.	Clay Lumps and Friable Particles in Aggregate	C142	Percent

Notes: (1) Test results shall be provided on two random samples taken from each borrow or stock pile area. If processing of material is required to meet Specifications, the tests shall be performed on processed material.

F. Pipe Inspections:

1. Visual Examination: Logs indicating the location of each joint that did not pass visual examination and the work done to correct improper fusion weld shall be prepared.

1.4 QUALITY ASSURANCE

A. Quality assurance procedures shall be conducted in accordance with this Section and Section 31 90 99. Where conflict between sections exists, the more stringent requirement shall apply.

B. Materials and construction procedures shall be subject to inspection and testing by the CQA Testing Service employed by the Contractor. Activities shall be performed as described in sections referenced in Paragraph 102. Such inspections and tests shall not relieve the Contractor of the responsibility of providing materials and placement in compliance with this Section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Contract Statement of Work for general requirements.

PART 2 MATERIALS

2.1 PIPE

A. Pipe Materials:

1. Leachate Collection and Recovery System (See Table 1).

B. Fittings:

1. All fittings shall be prefabricated and manufactured by the same manufacturer as the pipe.

Table 1. Gravity Leachate System Piping.

Item:	**Gravity Leachate System Piping**
Service:	Underground within a pond.
Location:	Solid Wall and Perforated High Density Polyethylene, Thermal Butt Welded Joints (1)
Material:	NSF listed and approved
Listing:	Maximum Working Temperature – Ambient
Rating:	Maximum Working Pressure – Atmospheric

Item	ASTM	Size	Remarks
Pipe(1)	ASTM F714, Pipe Grade PE 3408 Resin	2" – 24"	SDR 11 (160 psi)
Joints	Not Applicable	All	Thermal Butt Fusion Welded
Fittings (2) (30°, 45°, 60°, and 90° bends)	ASTM D3261	2" – 8"	SDR 11 (120 psi) (reduced pressure) Injection molded butt fittings from same resins as pipe.
		10" – 24"	SDR 11 (120 psi) Mitered fittings fabricated from angular cut sections of pipe.
Fittings (2) Tees, Wyes and Reducers	Not Applicable	4" - 6" 8" - 24"	SDR 11 (160 psi) SDR 11 (120 psi) Mitered fittings fabricated from angular cut sections of pipe.
Cleanout	Not Applicable	4" – 12"	Lockable Cap

Approved Manufacturers of Pipe and Fittings		
Manufacturer	**Trade Name**	**Size Range, Inches**
Chevron Philips Chemical Company	Performance Pipe	1/2” to 54”
KWH Pipe	Sclairpipe	3” to 154”
Others as Approved by the Purchaser	---	---

Notes: (1) Solid or perforated pipe shall be provided as specified on the Design Drawing. Perforated pipe shall be perforated in accordance with the details shown on the Design Drawing. (2) Fittings are reduced pressure rating fittings.

C. Coarse Aggregate Bedding Material:

1. The bedding material for the leachate collection pipe shall be washed gravel or washed crushed coarse aggregate. Crushed slag or Portland cement concrete shall not be used. The material gradation shall be as follows:

Sieve Size	Percent Passing By Weight
1"	100
3/4"	90 - 100
1/2"	50 - 75
#4	0 - 8

2. The physical requirements of the bedding material shall conform to the following requirements:

Test	ASTM	Requirement
Los Angeles Abrasion	C131	Maximum percent loss:50
Soft Particles	C136	Percent Maximum: 7.0

3. Material specified in the State DOT Standard Specifications, which meets the requirements specified above, may be used if acceptable to the Purchaser.

D. Gravel Drainage Layer:

1. Gravel Drainage Layer Material (Leachate Collection Layer):

a. The gravel drainage layer material shall be washed rounded natural gravel that meet the following listed requirements.

i. The material shall be classified as GP in the Unified Soil Classification System, ASTM D2487 that is rounded natural washed gravel. Crushed products are not allowed.

ii. % in.%Material shall conform to WSDOT M41-10 9-03.12(5) Gravel Backfill for Drywells gradation, or an approved equal.

iii. The material shall have a permeability of greater than 1 x 10^{-1} cm/sec when tested in accordance with ASTM D2434.

iv. The material shall be free from all organic material and deleterious material.

v. Material shall exhibit a maximum loss of 50% per the LA Abrasion Test ASTM C131.

vi. Maximum soft particles of 5% per ASTM C136.

vii. Maximum percent loss of 12% after 5 cycles per ASTM C88.

PART 3 EXECUTION

3.1 INSTALLATION AND TESTING OF HDPE PIPE

A. Joints for High Density Polyethylene (HDPE) Pipe:

1. HDPE pipe shall be joined together by the thermal butt fusion method in accordance with Procedure 2, ASTM D2657. Fittings shall be fabricated to provide a smooth inside surface. The hot plate butt fusion procedure shall be performed using apparatus recommended by the pipe Manufacturer and which complies with ASTM D2657.

3.2 BENT STRAP TEST

A. Test Requirements:

1. A bent strap test shall be made on each diameter of pipe prior to the start of joint welding procedures. A test joint shall be made and a specimen cut from the joint and destructively tested to confirm fusion joint integrity, operator procedure, and fusion machine setup (fusion parameters, including temperature and pressure).

2. Additional bent strap tests may be required by the Purchaser during the joint welding process if it is found that the joints of unacceptable quality are being made. These tests shall be used to adjust fusion machine settings and/or operator procedures as required. Test joints shall be prepared at no additional cost to the Purchaser.

B. Test Procedure:

1. Using waste pieces of pipe, a joint shall be prepared and then butt fusion welded and allowed to cool to ambient temperature.

2. A test strap shall be cut from the specimen:

a. The width of the strap shall be 1 1/2 times the pipe wall thickness, but not less than 1-in.

b. The length of the strap on each side of the fusion weld shall be 15 times the pipe wall thickness, but not less than 6-in.

3. The cut shall be bent so that the ends of the strap touch. If any separation, cracks, or voids are observed, the fusion is unacceptable and indicates poor fusion quality.

4. If failure occurs, fusion procedures or machine set-up shall be changed and a new trial fusion weld and new bent strap specimen prepared and tested.

5. The Testing Service shall witness all bent strap tests.

6. Field fusion of pipe shall not proceed until a test joint has passed the bent strap test and visual inspection indicates that the fusion beads and “V” groove are the correct size.

3.3 HDPE PIPE TESTING

A. Leachate Collection System Pipe:

1. All perforated and solid wall pipe shall be visually inspected during installation to ensure that all joints are made properly. Perforated pipe shall be visually inspected to ensure that the pipe has been placed with the perforations facing down. No pressure or air test is required. Visual inspections shall be as described in Paragraph 304.

3.4 VISUAL INSPECTION OF HDPE PIPE DURING INSTALLATION

A. General:

1. The Contractor shall visually inspect all pipes during installation for surface damage and weld quality.

B. Surface Damage:

1. Surface damage to a pipe that occurs during handling or installation shall be minimized. The maximum acceptable depth of damage is 10% of wall thickness of the pipe. If excessive damage occurs, the damaged portions of pipe shall be cut out and replaced. Deep, sharp notches may be filled with extudite and dressed smooth.

2. Butt fuse on misalignment shall not exceed 10% of the pipe wall thicknesses. Misaligned butt fusions shall be cut out and redone.

C. Butt Fusion Joint Weld Quality:

1. All butt fusion welded joints shall be visually inspected to ensure joint quality. The size and shape of the fusion beads shall be used as an indicator of joint quality. Specifically:

    a. The double bead width shall be 2 to 2 1/2 times the height of the bead measured from the pipe surface.

    b. Both beads shall be uniform in size and shape around the joint.

2. The depth of the "V" between the two beads shall not be more than half the bead height.

3. If the "V" groove is too deep, a "cold" fusion may have occurred (uneven heating or insufficient heating time or excessive pressure during heating or excessive pressure during joining). A non-uniform bead shape around the pipe indicates uneven heating.

4. A joint with cold fusion or a non-uniform bead is a poor quality joint that shall be removed (cut out) and remade.

3.5 LEACHATE COLLECTION AND CLEANOUT PIPE INSTALLATION

A. Perforated leachate collection piping and solid wall cleanout pipes shall be installed according to the elevations and locations indicated on the Design Drawings.

B. The maximum vertical variation from the correct profile and section shall not exceed +0.1 ft. The slope of the pipe shall not vary from the specified slopes by more than +0.1%. The Contractor shall regrade any area that does not meet the specified tolerances.

C. Perforated pipe shall have two rows of 1/2-in. diameter perforations spaced 5 or 6 in. apart along the length of each pipe. The perforations shall face down in the collection and cleanout trenches.

D. The Contractor shall provide hydraulic jet cleaning of all pipelines following installation. The jet cleaning shall verify that the pipe is intact and unobstructed. Defects in the pipeline identified by the cleaning process shall be repaired by the Contractor.

3.6 INSTALLATION OF LEACHATE SYSTEM PIPES OUTSIDE OF THE BASIN

A. Bedding and backfill for gravity pipe, and pressure pipe shall be in accordance with Section 31 23 33, "Trenching and Backfilling."

3.7 INSTALLATION OF GRANULAR MATERIALS

A. Prior to the installation of any granular materials, the underlying liner or leachate collection system components shall be inspected for defects, defective seams/joints, holes, blisters, tears, and signs of damage. Identified areas shall be marked for repair and repaired prior to installation of granular materials.

B. Granular Materials:

1. Granular materials include coarse aggregate leachate pipe bedding and drainage gravel material.

C. Acceptable Placement Methods:

1. Acceptable placement methods include:

a. Using a crane to place material from outside of the basin.

b. Material conveyor (or light weight equipment) moving material into a pond to the point of use.

D. Placement of Materials:

1. Under no circumstances, shall there be direct equipment travel over a geomembrane or other geosynthetic liner components.

2. Temporary ramps for equipment shall not be constructed in the basin after an HDPE liner has been installed.

3. Transport aggregate material to inside of basin by air with crane or other approved low/no contact procedure.

4. Work shall be performed in a manner that avoids pinching or tearing the HDPE geomembrane liners.

5. Compaction is not required.

6. No travel over piping shall be allowed without sufficient protection of the piping.

7. Material placement over the HDPE liners during periods of warm weather can cause wrinkling in the liner. The wrinkling effect can cause damage to the liners. Placement of granular materials shall be halted when the air temperature is greater than 85°F or less than 40°F.

8. When drainage layer material is being placed, remove all rocks, stones, roots, and other debris that remain in the material and that could cause damage to a liner.

E. Placement of Leachate Collection System Coarse Aggregate Pipe Bedding:

1. Pipe bedding shall be placed under and around pipes and in the collection sumps to the thickness shown on the Design Drawings.

2. Piping shall be installed over an initial layer of pipe bedding. After the pipe is installed, pipe bedding shall be hand placed beneath the haunches and above the pipe and compacted to ensure complete and uniform support of the pipe.

F. Placement of Drainage Gravel Material:

1. Each of the materials shall be placed to the thickness shown on the Design Drawings.

2. Installation of the materials shall not begin until installation of the secondary liner system is complete, inspected, and the Contractor is released in writing to proceed.

3. Each of the materials shall be placed and maintained to a uniform thickness, free of ruts and irregularities.

4. The drainage gravel layer shall be fine graded using equipment with low ground pressures.

G. Report Damage:

1. If damage occurs to the geomembrane or portion of the LCRS while placing the soil cover, the Contractor shall report it to the Purchaser immediately so that repairs can be performed without delay.

2. Repairs to an HDPE geomembrane or geocomposite shall be made as specified in the Section 31 90 22, “High-Density Polyethylene Geomembrane Liner.” Repairs to components of the LCRS shall be repaired as specified herein.

3. The Contractor shall perform all repair work at no additional cost to the Purchaser.

END OF SECTION 31 90 52

SECTION 31 90 99

CONSTRUCTION QUALITY ASSURANCE

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. This Section covers the minimum monitoring, sampling, testing, and documenting activities and requirements for the Construction Quality Assurance (CQA) work.

B. The CQA Agency shall be objective, competent and shall disclose possible conflicts of interest so that objectivity can be confirmed.

C. The work may include, but not be limited to, the following items:

1. The CQA Agency shall develop a CQA Plan (CQAP) for review, submittal, and implementation that is in full compliance with applicable state and federal regulations.

    a. At a minimum, the CQAP shall comply with the requirements of the US EPA Technical Guidance Document – Construction Quality Assurance For Hazardous Waste Land Disposal Facilities (EPA/530-SW-86-03l - October 1986) and the WAC 173-303-335 and all other related WAC requirements.

2. Identify and document tests required, test frequency, test methods.

3. Develop test reporting procedures.

4. Develop procedures to address non-compliant test results in a timely manner.

5. The CQA Agency shall perform all tests and inspections required by CQAP and this Specification.

6. CQA Agency inspector(s) shall be on site any time the Contractor is actively performing site work.

7. Prepare and submit a final CQA Report that documents all tests and inspections in a logical format.

8. Prepare and submit certification of compliance per WAC 173-303-335.

9. The CQA Agency shall coordinate with the Contractor and Purchaser to ensure the implementation of the CQAP.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

A. ASTM International (ASTM)

ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C511	Standard Specification for Mixing Rooms, Moist Cabinets, Moist Rooms and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM D422	Standard Test Method for Particle-Size Analysis of Soils (withdrawn)
ASTM D698	Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12400 ft-lbf/ft3)
ASTM D854	Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D2167	Standard Test Methods for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2216	Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

ASTM D3740	Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D4253	Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D5641	Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
ASTM D5820	Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
ASTM D6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
ASTM D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil- Aggregate by Nuclear Methods (Shallow Depth)
ASTM E329	Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

B. Geosynthetic Research Institute (GRI)

GRI GM6	Practice for Pressurized Air Channel Test for Dual Seamed Geomembranes
GRI GM14	Guide for Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes

C. USEPA

EPA/530-SW-86-031	Technical Guidance Document – Construction Quality Assurance For Hazardous Waste Land Disposal Facilities

D. Washington Administrative Code (WAC)

WAC 173-303-335	Construction Quality Assurance Program

WAC 173-303-640	Dangerous Waste Regulations Washington State
WAC 173-303-650	Surface Impoundments

1.3 SUBMITTALS

A. CQA Agency shall submit plans, reports, and data via electronic medium in a format compatible for importing into the Purchaser information systems specified by the Purchaser.

B. The CQA Agency shall submit with its bid, at a minimum, the following requested listed information.

1. List of subcontractors.

2. Quality Control Manual.

3. Proposed CQAP and CQA Report template and/or proposed tables of contents. As an alternate, a CQAP and CQA Report from a similar project may be submitted.

4. Company and personnel qualifications.

5. Letter certified by the responsible engineer that the CQA Agency and all applicable subcontractors comply with ASTM C1077, ASTM D3740, and ASTM E329, as applicable to the work that each agency will perform.

C. Contractor shall submit Material Safety Data Sheets for all materials two weeks prior to materials being be transported to the site.

D. The CQA Agency shall prepare and submit, for review, a complete CQAP within four weeks of project award. The CQA Agency shall incorporate Purchasers comments on draft CQAP and resubmit at least three weeks prior to Contractor mobilizing to the site.

E. The CQA Agency shall submit the final report within three weeks of completion of the subject work.

F. The CQA Agency shall submit all interim reports and tests within three working days of completion of test or work to which the inspection pertains.

1.4 QUALITY ASSURANCE

A. The CQA Agency and all applicable subcontractors shall fully comply with the requirements of ASTM C1077, ASTM D3740, and ASTM E329, as applicable to the work that each agency will perform.

B. Each laboratory and field report shall present all data items required by the applicable ASTM standard.

C. The following qualifications are required for the personnel performing quality assurance activities as employees or subcontractors of the CQA Agency. All personnel performing quality assurance work is referred to throughout this Specification as CQA Agency; the CQA Agency shall verify and document that all individuals performing any CQA activities have the appropriate qualifications. Documentation shall be available to Purchaser and provided in the final CQA report.

1. CQA Certifying Engineer – Shall be a registered professional civil engineer in the State of Washington with at least ten years of experience in design/construction/permitting/licensing (at least five years of which is CQA experience as a certifying engineer on landfill or ponds with compacted clay and/or geomembrane liner systems), a minimum of 10 similar successful projects and certified at least 500,000 sf of installed liner materials.

2. All CQA Inspectors – Shall have adequate formal academic training and sufficient practical and technical experience needed to execute record review and inspection activities conducted at the project site and perform all required laboratory and field-testing. This includes a demonstrated knowledge of the various aspects of the type of work being conducted and the applicable test methods. Different inspectors, each with specialized knowledge and experience, shall be employed for different portions of the work.

D. The Lead CQA Inspector for earthwork shall have at least five years working experience as Earthwork Inspector or testing technician, with at least 5 successful similar projects and at least 100,000 sf of installed liner material where acting as lead CQA Inspector.

E. All CQA Inspectors for earthwork shall be knowledgeable in:

1. Field practices relating to construction techniques used for the type of earthwork being performed.

2. Construction and compaction equipment.

3. Codes and regulations specified herein concerning material installation.

4. Observation procedures for earthwork construction.

5. Sampling and earthwork testing procedures.

6. Testing equipment.

7. Certified in the safe use, transportation, or nuclear density gauges.

8. Trained in emergency procedures if the nuclear density gauges is suspected of damage.

9. Documentation procedures.

10. Site safety.

F. The lead CQA Field Inspector for geosynthetics shall have at least five years CQA experience as a field inspector on projects with a geomembrane lining system including two years as CQA Inspector.

G. All Geosynthetic Liner and Floating Cover Inspectors shall be knowledgeable in:

1. Field practices relating to construction techniques used for the type of material to be used.
2. Construction, deployment, seaming, and testing equipment for materials to be used.
3. All welding equipment and the correct operating procedures for seaming.
4. All codes and regulations concerning material and equipment installation.
5. Observation procedures for installation of all elements of the materials.
6. Non-destructive seam testing procedures and failure criteria.
7. Sampling for destructive testing of samples of seams and laboratory testing procedures.
8. Testing equipment.
9. Documentation procedures for field and laboratory tests.
10. Site safety.

H. The CQA Piping Inspector shall be knowledgeable in:

1. Field practices relating to construction techniques used to install piping that will be used for the Leak/LDRS.
2. Pipe joining equipment and accessories and the correct method for welding pipe.
3. Codes and regulations concerning trench excavations.
4. Trenching, bedding, and backfill procedures.
5. Observation procedures for installation of pipe.
6. Testing procedures and failure criteria for visual inspection of welds.
7. Testing equipment.
8. Documentation procedures.
9. Site safety.

I. The CQA Concrete Inspector shall be appropriately certified by the American Concrete Institute (ACI) and be knowledgeable in:

1. Field practices relating to construction techniques used for the forming, reinforcement, and placement of concrete.

2. Sampling procedures for concrete.

3. Testing procedures for concrete

4. Documentation procedures.

5. Site safety.

J. The CQA Electrical and Mechanical Inspector shall be knowledgeable in:

1. Field practices related to techniques used for installation of electrical and mechanical equipment that will be installed at the site.

2. Equipment and accessories required for the installation of the equipment.

3. All codes and regulations related to electrical equipment installation.

4. All codes and regulations related to installation of pumps and pressure piping systems.

5. Observation procedures.

6. Testing equipment.

7. Testing procedures for pumps.

8. Documentation procedures.

9. Site Safety.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Contract Statement of Work for general requirements.

PART 2 PRODUCTS

Not Applicable.

PART 3 EXECUTION

3.1 GENERAL

A. The CQA Agency shall provide an onsite representative(s) that will provide input and provide daily field reports, which shall include activities completed and number of personnel onsite.

B. A supervisor vested with authority to make decisions binding on the CQA Agency shall be assigned to the task to resolve problems as they arise so as not to delay completion of the work.

C. The CQA Agency shall maintain the necessary labor force for the work to ensure the on time completion of the work, without significant delays to the Contractor.

D. The CQA Agency shall bear all costs that are incurred in procuring and/or maintaining the necessary labor force for the work, including but not limited to such items as overtime, bonus or premium time, etc.

E. The CQA Agency personnel shall be competent, capable, qualified, and able to perform the duties required to the satisfaction of the Purchaser.

F. The CQA Agency shall perform the work in a safe manner utilizing the Purchaser safety policies and procedures as a minimum in accordance with this Specification and the Design Drawings.

3.2 PREPARATION OF CQA PLAN

A. The CQA Agency shall develop for review, submittal, and implementation a CQAP that is in full compliance with this Specification and state and federal regulations.

B. At a minimum, the CQAP shall comply with the requirements of the US EPA Technical Guidance Document – Construction Quality Assurance For Hazardous Waste Land Disposal Facilities (EPA/530-SW-86-031 - October 1986) and the Washington Administrative code (WAC) 173-303-335 and all other related WAC requirements.

C. The CQAP shall include, but not be limited to:

1. Identify and define the responsibility and authority of plan participants.

2. Identify and provide details for required project meetings.

3. Develop inspection check list forms, test report requirements, and reporting procedures.

4. Identify and document tests required, test frequency, test methods for each of the following construction activities:

    a. Preconstruction material certifications, tests, and mix designs.

    b. Grading and preparation of subgrade.

    c. Procuring, mixing, placing, compacting, and protecting the soil bentonite liner material.

    d. Cast-in-place and pre-cast concrete elements associated with anchor ring wall, cover system, and catch basin.

    e. Procuring, storying, deploying and seaming (as applicable) geosynthetic products including but not limited to:

        i. Geotextiles,

        ii. Geosynthetic drainage materials,

        iii. Geosynthetic clay liners (GCL), and

        iv. Geomembranes.

    f. Mechanical and electrical systems associated with Leak Collection and Removal System.

    g. Other elements determined critical to the construction of LERF Basin 41 and associated structures.

3.3 EARTHWORK - REQUIREMENTS FOR VISUAL OBSERVATIONS AND TESTING

A. General Visual Observations

1. At a minimum of twice daily, observe and record the weather conditions (i.e., temperature, humidity, precipitation, and wind speed and wind direction) to ensure that they are acceptable for the work being performed.

2. Measure and record the total precipitation received each work day and non-work times (overnight and days off).

3. If the weather becomes unacceptable for work underway, discuss adverse conditions with Contractor. Record conversation and action items to minimize non-compliant work products (stopping the installation until conditions again become favorable, additional sand bags for deployed geosynthetic panels).

4. For earthwork, record type and size of compaction equipment in use:

   a. For sheepsfoot rollers, record the drum diameter and length, empty and ballasted weight, arrangement of feet, length and face area of feet, and the yoking arrangement.

   b. For rubber-tired rollers, record the tire inflation pressure, spacing of tires, and empty and ballasted wheel loads.

   c. For vibratory rollers, record the static weight, imparted dynamic force, operating frequency of vibration, and drum diameter and length.

   d. For hand tampers, record make, model number, size, and compactive effort.

5. For earthwork, observe and record compactive effort, uniformity of compaction, and scarification and connection between compacted lifts. Record number of passes of a roller by type, size, and weight of roller.

6. For proofrolling, record the type, size, and weight of compaction equipment or other vehicles used for proofrolling.

B. Inspection and Testing of the Subgrade

1. Visual observations of subgrade shall include:

   a. Visual Observations as required by Article 3.2 a.

   b. Observe stripping and removal of topsoil and removal of all organic and undesirable material (including CCR in areas where it is being removed down to natural subgrade).

   c. Observe that there are no moisture seeps, puddling, or ponding.

   d. Observe proofrolling to identify yielding areas, and observe removal of material from areas that fail under proofrolling.

   e. Observe compaction of the subgrade prior to placement of fill. Inspect for any settlement due to soft areas in the subgrade.

   f. Verify measurements and determine that the depth and slope of an excavation meets design requirements and that there are no sidewall failures from moisture seeps.

2. Laboratory Tests - As specified in Table 1 of this Section.

3. Field Tests - As specified in Table 2 of this Section.

4. Acceptance Criteria - Acceptance Criteria are specified in the Installation Specification Section 31 90 05, "Earthwork and Soil-Bentonite Mixture."

C. Soil/Bentonite Liner Prequalification Testing

1. Using site soil and bentonite, provided by Contractor from Contractor selected sources, perform mixing studies to develop a curve of hydraulic conductivity to blending ratio. A minimum of 4 blending ratios shall be selected by Contractor and tested CQA Agency. For each blending ratio the following qualification testing is required:

a. Moisture-Density Relationship per ASTM D698 (standard Proctor).

b. Hydraulic conductivity testing per ASTM D5084. Tests shall be performed on mixed samples compacted to 95% of the dry density determined by the standard Proctor. Compaction shall be at the optimum moisture determined by the standard Proctor.

c. Atterberg Limits per ASTM D4318.

d. Gradation with hydrometer per ASTM D422.

2. Soil/Bentonite Liner Test Pad Testing:

a. Testing of a fill pad constructed by the Contractor to verify that the specified density, moisture content, and hydraulic conductivity can be achieved before a full size liner is built. The pad shall be at least 1.5 ft thick, 20 ft wide, and 40 ft long.

b. The mixed soil/bentonite material and construction practice, which is used for construction of the test pad, shall follow the same procedures, as closely as possible, to the full size liner. Hydraulic conductivity testing shall be performed on the test pad to confirm the desired hydraulic conductivity specified in the Specification Section 31 90 05, Earthwork for CCR Impoundment Closure & General Earthwork.

c. Test pad testing activities include visual observations and laboratory, as specified herein.

i. Perform each of the lab tests indicated in Table 1 on 1 sample from each lift of the of the test pad.

ii. Perform each of the field tests indicated in Table 2 once for each lift of the test pad.

D. Inspection and Testing for Soil/Bentonite Liner Placement and Compaction

1. Visual Observations listed in Article 3.2.

2. Observe removal of roots, rocks, rubbish, or out-of-Specification soil.

3. Observe and record changes in soil characteristics necessitating a change in construction procedures.

4. Observe adequate clod size reduction for clay soils prior to mixing.

5. Observe spreading of bentonite for uniformity.

6. Determine the quantity of bentonite placed prior to mixing. Compare paced quantity to target quantity for soil quantity to be mixed.

7. Observe mixing for uniformity and duration.

8. Observe placement procedures for proper liner thickness.

9. Observe procedures to be followed to adjust the soil bentonite mixture moisture content to obtain uniform moisture content.

10. Observe procedures followed to adjust the moisture content in the event of significant moisture variations during construction.

11. Observe and record final finishing procedures and timely placement of protective cover.

12. Observe and record that final grade is consistent with the design grade specified on the Design Drawings.

13. Laboratory Tests as specified in Table 1 of this Specification Section.

14. Field Tests as specified in Table 2 of this Specification Section.

E. Soil Bentonite Liner Post Construction Testing

1. A soil moisture content determination shall be made every seven days until placement of the overlying component. Final moisture tests shall be made within 24 hours of placement of the overlying component. At a minimum, five tests shall be made per lift.

2. At the time of testing, the CQA Agency shall note the presence or absence of desiccation cracks and any remedial measures taken to remove those features.

3.4 GEOSYNTHETICS - REQUIREMENTS FOR VISUAL OBSERVATIONS AND TESTING

A. Provisions included herein are applicable to all geosynthetic materials including geotextiles, geosynthetic drainage materials, liners, GCL, and floating cover. Contractor shall ensure that requirements set forth herein and in respective technical material Specification Section are met and documented accordingly.

B. Visual Observations – the following items shall be observed and documented. Any nonconformances shall be made known to the Contractor, Purchaser, and Engineer as soon as practical.

1. Observe that each roll or panel is marked with the following information:

    a. Name of Manufacturer;

    b. Product identification (brand name, product code);

    c. Identification number;

    d. Product thickness or composition;

    e. Manufacturing batch code or lot code;

    f. Date of manufacture;

    g. Order number;

    h. Physical dimensions (length, width, and total weight); and

    i. Panel/roll number (where applicable).

2. Review and document the Quality Control certificates on each roll or panel to verify that the material received onsite meets the Technical Specifications. Take the identifying labels from each delivered product and save them for future reference.

3. Recommend rejection of products that do not have the required documentation and ensure that the rolls are removed from the site.

4. Observation of Manufactured Rolls or Panels:

    a. Observe all manufactured products upon delivery to the site.

    b. Ensure that packaging is secure and that no damage has occurred.

    c. If damage to packaging has occurred, inspect exposed surfaces and note and identify any damage or repairable flaws. **Note**: This visual observation shall be conducted without unpackaging, unless the extent of surface damage indicates that internal damage may be present.

    d. If damage to packaging only has occurred, document repair of the packaging.

    e. If damage to the product has occurred, document that the damage or flaws are repaired or that the damaged material is wasted and removed from the site.

    f. Report all damage to the Purchaser.

g. Observe the ground surface of the storage area to ensure that it is dry, relatively level, smooth, and free of rocks, holes, and debris.

5. Prior to placement of any geosynthetic layers:

   a. Review and verify the appropriate number of tests have been performed, reports received, and that they are compliant with the applicable Specifications.

   b. Note that if Contractor chooses to proceed with a subsequent material prior to completion of laboratory tests, they do so at their own risk. Any costs or schedule delays resulting in reworking any lower layers that were not tested or failed to achieve the required criteria shall be borne solely by the Contractor.

   c. Review surveyor records to ensure that the elevations of the subgrade are within $\pm$ 0.2 ft of the elevations shown on the Design Drawing and that the actual thickness of lower layer is compliant with the design documents.

   d. Visually inspect the bedding surface to ensure that it meets the requirements of the Specifications. Confirm and document that it is compacted, free from clods of soil, rocks larger than specified, roots, sudden or sharp changes in grade and standing water.

6. During placement of any geosynthetic layers:

   a. Observe that the Contractor geosynthetic placement plan is being followed and unrolling or unpackaging is in accordance with manufacturer recommendations. Note where the plan is not being followed and document the Contractor reasons for not following the plan. As each panel or roll is placed, visually inspect the geosynthetic for tears, punctures, and thin spots. The CQA Inspector shall traverse the material in such a way that the entire surface is inspected. Any defects shall be documented on a Drawing and marked on the geomembrane for repair.

   b. Document that the location of the seams meet the Specification and manufacturer requirements for seaming.

   c. Document the location of any seams that do not meet the Specification or manufacturer requirements for seaming.

   d. At the time of placement, make measurements to confirm that required overlap of adjacent geosynthetic has been achieved, that proper temporary anchorage is being used (e.g., sand bags or tires), and that the geosynthetic is being placed in a relaxed (nonstressed) state.

   e. Document any material damage, degradation, or hydration from adverse weather conditions, equipment, inadequate temporary anchoring, or rough handling. Mark the location of damage on the geomembrane for repair and on a Drawing.

f. Document improper placement (if the placement plan is not followed) and, as a result, inadequate coverage with the available materials or an excess number of field seams.

g. Document inadequate overlap resulting in poor quality seams.

h. Document nonwelded/seamed or cut products.

i. Document repair of damage. Documentation shall include location, type, and method of repair.

7. Trial Welds Prior to Beginning Geomembrane Seaming:

a. Observe that trial welds are being made at the frequency specified.

b. Observe fabrication of test strips and note that test strips are fabricated correctly.

c. Specify where samples are to be cut from the test strips and witness all destructive tests.

d. Observe documentation of results of the destructive tests.

e. Audit documentation of each trial weld received.

8. Geomembrane Seaming and Seam Repair:

a. Observe that the geomembrane is free from dirt, dust, and moisture.

b. Observe that the seaming materials and seam welding equipment are as specified.

c. Observe that a firm foundation is available for seaming.

d. Observe that geomembrane overlap and panel adjustment are correct prior to seaming.

e. For extrusion welding, observe that the geomembrane is pre-beveled, properly abraded, and that the panels are temporarily bonded.

f. Observe that grind marks are covered with extrudite.

g. Observe weather conditions (e.g., temperature, humidity, wind) to ensure that they are acceptable for seaming.

h. Observe temperatures, pressures, and speed of seaming to ensure that they are as specified. Gages and dials on seaming equipment shall be checked and readings recorded.

i. Observe that the geomembrane is not damaged by equipment or personnel during the seaming process.

j. Observe that no solvents or adhesives are used.

9. Mechanical Anchorage System:

a. Special inspection of post-installed anchors shall be provided as required by ICC Reports for product installed. The Engineer of Record may require pullout or shear tests, in addition to Special Inspection to determine the adequacy of the anchors. A field-testing program shall be established and performed in accordance with appropriate ASTM test standards. Field tests shall be non-destructive when at all possible.

b. Verify and document the age and strength tests results of the concrete anchor ring wall.

c. Verify and document that the materials for the mechanical anchorage comply with design documents, including but not limited to:

i. Anchor bolts – material, diameter, and length.

ii. Batten plate – material, width, thickness, and prepunched/drilled holes are smooth edges, properly located, and spaced.

iii. Other hardware – washers and other miscellaneous hardware are compliant with design requirements.

d. Verify and document that the installation of post-installed anchor bolts is in accordance with manufacturer requirements, including but not limited to, depth and diameter of drilled hole, cleanliness of hole, mixing of adhesives or expansion methods.

e. Verify and document the spacing on post-installed anchors for the batten system.

f. Verify and document that no sharp features are present that could damage the liner or cover material.

g. Verify and document the liner/cover is protected from the top of anchor bolts.

h. Verify and document the anchor bolts are properly tightened.

i. Verify and document any supplemental sealing such as caulking or tape closures.

10. Where the Design Drawings specify penetrations (e.g., structures and pipes) in the geomembrane (liner or cover), CQA inspection personnel shall ensure that the seals around such penetrations are of sufficient strength and are

impermeable. Specific inspections that shall be made on all seals and anchors include:

a. Observations and tests to ensure that the sealing systems (i.e., pipe boots) have been installed as specified (are leak free) and in the proper location(s).

b. Observations to ensure that all objects that are placed adjacent to the geomembrane (i.e., batten bars) are smooth and free of objects or conditions that may damage the membrane.

c. Observations to ensure that all seals and anchors are complete.

C. Tests – the tests shall be performed and documented or observed and documented. Any nonconformances shall be made known to the Contractor, Purchaser, and Engineer as soon as practical.

1. All geomembrane laboratory tests shall be performed by laboratories that are appropriately accredited by the Geosynthetic Accreditation Institute-Laboratory Accreditation Program (GAI-LAP).

2. Geomembrane Production Seam Testing: Non-destructive geomembrane production seam testing: Activities to be observed and documented include the following list.

a. Observe that 100% of the seam lengths are tested using non-destructive procedures.

b. Observe that testing is performed as seaming progresses.

c. Observe that the correct procedures are used for testing each type of seam.

d. Observe all non-destructive test procedures.

e. For air pressure testing, observe that the equipment, procedures, and air pressure meet specified requirements. Observe that all testing is properly documented.

f. For vacuum box testing, observe that testing is being performed correctly.

g. For conductive elements testing, observe that the testing is being performed correctly.

h. For inaccessible seams, observe that a procedure acceptable to the Purchaser is used to test the seams.

i. Observe that all leaks are marked, recorded as to location, and repaired.

j. Observe that repairs are made in accordance with approved techniques.

k. Observe that all repairs are re-tested and that no leakage is present.

l. Review leakage data for possible patterns. Make suggestions if data shows a consistent pattern of failure of a particular machine or crew.

m. Audit documentation of testing prepared to make sure that the location of leaks is identified on the Drawings.

3. Destructive:

a. Destructive seam testing shall be performed at the specified frequencies.

b. The CQA Inspector shall specify the location where each sample shall be taken and record data for each sample.

c. The CQA Inspector shall designate any additional test locations that may be necessary. These locations may be based on the suspicion of contamination by dirt or moisture, change in seaming materials, increase in failed nondestructive tests, and other causes that could result in unacceptable seams.

d. Facilitate the required laboratory testing.

e. Audit and document the results of laboratory testing on seam samples. Note any sample that does not pass and identify the location on the geomembrane for repair in the field and on the Drawings.

4. Repair of Failed Seams:

a. For field seams that fail, the seam can either be reconstructed between the failed and any previous passed seam location or the installer can go on either side of the failed seam location (10-ft minimum), take another sample, test it, and if it passes, reconstruct the seam between the two locations. If it fails, the process shall be continued. In all cases, acceptable seams must be bounded by two passed test locations. The CQA Inspector shall document the procedure used and results of tests.

b. Document that repairs are made. Documentation shall include location, type, and method of repair.

c. Air pressure testing shall be performed in accordance with ASTM D5820 and GRI GM6.

d. Vacuum Box testing shall be performed in accordance with ASTM D5641 and as specified herein.

e. Continuity testing shall be performed as seaming progresses or as soon as a suitable length of seam is available, not at the completion of all field seaming.

5. Double Wedge Fusion Welded Seams:

a. Double fusion-welded seams shall be tested using air pressure testing.

b. The procedure for testing shall be as specified in GRI GM6 for the type and thickness of geomembrane in use.

c. The following test pressures are applicable to both smooth and textured HDPE. After an initial 2-minute pressure stabilization period, the pressure shall be maintained between 24 and 30 psi for 40 mil HDPE, 27 and 30 psi for 60 mil HDPE, and 30 and 35 psi for 80 and 100 mil HDPE. The pressure shall be sustained for a minimum of 5 minutes. The loss of pressure shall not exceed a maximum of 3 psi in 5 minutes. If the pressure does not stabilize in the first two minutes or the pressure loss exceeds the loss specified, the seam test shall be considered a failure.

d. The leak or suspected leak shall be located and repaired.

e. The repaired seam shall be re-tested as required until all leaks are identified and repaired, and the seam passes a subsequent air pressure test.

f. When the geometry of a double wedge fusion-weld makes air testing impossible or impractical, vacuum testing may be used to test the seam.

6. Extrusion Welded Seams:

a. Extrusion welded seams shall be tested using vacuum chamber testing in accordance with ASTM D5641.

b. The completed seam shall exhibit no leakage when tested between 4 and 8 psi minimum vacuum for approximately 10 seconds.

c. If leaks are discovered during testing, they shall be located, marked, and repaired.

d. The repaired area shall be re-tested and exhibit no leakage.

7. Inaccessible Seams:

a. Where extrusion welded seam locations make use of vacuum box testing impractical, then the electric wire method of testing shall be used, or the seam shall be cap stripped as approved by the Purchaser.

b. If cap stripping is approved by the Purchaser, the seams shall be cap stripped as described in Paragraph 3.4.D, with strips of the same type and thickness of geomembrane being installed. The cap stripping shall be performed in the presence of the Purchaser.

c. The electric wire test method shall consist of placing a 24 gauge copper wire 1/8 in. beneath the top sheet overlap of the two sheets prior to welding with the extruder. The wire shall be imbedded in the seam.

After welding, a holiday spark detector, operating at 20,000 volts, shall be connected to one end of the wire and slowly moved over the length of the seam. A seam defect between the probe and the embedded wire shall result in an audible alarm indicating where the defect is located.

8. Test Reports:

   a. Test reports for all air pressure tests shall contain all data specified in ASTM D5820 and GRI GM6.

   b. Test reports for Vacuum Box testing shall contain all the data specified in ASTM D5641.

   c. Test reports for other types of non-destructive tests shall contain at a minimum for each test:

      i. Location,

      ii. Type of test,

      iii. Test parameters,

      iv. Test data,

      v. Test number,

      vi. Name of tester, and

      vii. Outcome of the test.

D. Destructive Testing – Geomembrane:

1. Testing:

   a. Destructive testing shall be performed by a laboratory employed by the Contractor on samples cut from production welds in the field.

   b. Samples shall be taken to a laboratory and tested for shear strength and peel adhesion. For double wedge seam samples, both welds shall be tested for peel adhesion.

   c. The laboratory that will perform testing shall be identified with the bid proposal and agreed-to in writing by the Purchaser.

2. Location and Frequency:

   a. Test locations shall be determined after seaming. The location where the test samples shall be taken shall be marked by the CQA Inspector. Locations may be prompted by the appearance of excessive heating, contaminations, offset welds, or a suspected defect. Destructive test samples shall be taken at a minimum average frequency of one per every 500 linear ft of seam length.

b. The Method of Attributes described in GRI GM14 may be exercised to minimize the number of test samples taken if more than 100 destructive seam samples will be required based on the sampling strategy given in Paragraph 3.3.D.2a.

c. Each sample location shall be numbered and marked with permanent identification and the location of the sample, and the locations shall be indicated on a plan Drawing prepared and maintained by the Contractor. The following shall be recorded for each sample:

    i. Date and time,

    ii. Ambient temperature,

    iii. Seam number and location,

    iv. Welding apparatus used,

    v. Name of master seamer,

    vi. Reason for taking the sample,

    vii. Size of sample,

    viii. Test results, and

    ix. Name of tester.

d. Samples shall be cut by the installer. The CQA Inspector shall witness test sample cutting.

e. Test samples shall be cut every shift and taken to the approved laboratory the same day that the sample is prepared.

3. Sample Size:

    a. The minimum sample size shall be 12 in. wide with a seam 16 in. long centered length-wise in the sample. As agreed to with Purchaser, a sample may be increased in size to accommodate the requirements of the testing laboratory.

4. Field Testing:

    a. A 1-in. wide specimen shall be cut from each end of each sample for field-testing.

    b. Each 1-in. wide specimen shall be tested with a field tensiometer for peel adhesion or shear strength.

c. The CQA Inspector shall witness each field test.

d. A test is considered acceptable if a specimen meets the criteria for both peel and shear under Bonded Seam Strength or, exhibits Film Tear Bond. For double wedge fusion welds, both welds must pass the test. If either sample fails the field test, it shall be assumed that the seam will not pass the specified laboratory testing and the sample shall be given a fail designation.

5. Laboratory Testing:

a. Full size (12-in. minimum length) samples shall be taken to a laboratory for testing.

b. Samples shall be tested for shear strength and peel adhesion in accordance with ASTM D6392. Five specimens shall be tested for each test method. All samples shall meet minimum requirements for shear strength and peel adhesion

6. Test Results:

a. Verbal test results shall be given to the Contractor within 24 hours of receipt of the samples. Written results shall follow within one week.

b. All test locations shall be marked with a pass/fail designation on the liner and on the Drawing maintained by the Contractor for submittal to the Purchaser after construction is complete.

7. Re-Testing if Failure Occurs:

a. If a seam fails testing, one additional sample shall be taken 10 ft on each side of the location of the failed test. Additional samples shall continue to be taken at 10-ft intervals until tests show that seam strength is adequate and the zone in which the seam requires reconstruction is identified.

b. All passing seams shall be bounded by two locations from which samples passing laboratory destructive tests have been taken.

c. The entire seam length failing strength tests shall be reconstructed at no additional cost to the Purchaser.

d. If the length of reconstructed seam exceeds 150 ft, a sample shall be taken of the reconstructed seam every 150 ft and shall pass destructive testing.

E. Inspection – Geomembrane:

1. After seaming is complete, the Contractor and the CQA Inspector shall conduct a detailed walk-down to visually check all seams and non-seam areas of the geomembrane.

2. All defects, holes, blisters, tears, signs of damage during installation, areas of undispersed carbon, and holes from destructive or non-destructive testing shall be marked and repaired.

3.5 LEAK COLLECTION AND REMOVAL SYSTEM - REQUIREMENTS FOR VISUAL OBSERVATIONS AND TESTING

A. Preconstruction activities shall include inspection and documentation of all materials including the following:

1. Observations for geosynthetic drainage materials and geotextile materials as required in prior section.

2. Observations and auditing of laboratory test results provided by the Contractor to ensure that the coarse aggregate used for the sump, trench, and side slope risers is the specified gradation and quality, is washed, and meets strength requirements.

3. Observations to ensure that the pipes are of the specified size and strength, are constructed of the specified material, and that pipe perforations for perforated pipe are as specified.

4. Observations to ensure that all prefabricated structures (e.g., structures and sumps) are as specified on the Design Drawings.

5. Observations to ensure that the material is not damaged during the installation process and that underlying geomembrane is not damaged.

B. Inspections and tests required during installation of the leak collection and removal system include:

1. Inspect all materials, as they are unrolled to ensure that there are no flaws or damage.

2. Observations to ensure that geosynthetic drainage materials and geotextiles are placed according to the placement plan and that seams are made as specified.

3. Observations that geosynthetic drainage materials and geotextile coverage is specified on the Design Drawings or Specifications and that overlapping or seaming of geosyntheic drainage materials and geotextile is as specified.

4. Measurements to ensure that the specified material overlap is achieved.

5. Observations to ensure that all materials are free from wrinkles and folds.

6. Observations and tests, when required, to ensure that seams are made according to Technical Specifications.

7. Observations to ensure that the material is not damaged during the installation process and that underlying geomembrane is not damaged.

8. Observations and measurements to ensure that the correct size and length of perforated and solid sump collection pipe is used, that perforations for perforated pipe are as specified, that the end of the perforated pipe is sealed, that the specified fittings are being used, that the pipe is jointed as specified, and that the pipe is installed at the location and elevation shown on the Design Drawings.

9. Inspect the coarse aggregate to ensure that it has not been contaminated during transportation and handling. Recommend rejection when contaminated coarse aggregate is received.

10. Make measurements to ensure the correct thickness and extent of coarse aggregate is installed.

11. Observations to ensure that placement of the coarse aggregate did not damage or displace the sump collection pipe.

12. Observations and measurements to ensure that the specified size pipes are placed at the specified locations.

13. Observations to ensure that perforated pipe is placed correctly.

14. Measurements to ensure that the horizontal and vertical position and slope are within tolerances required by the Technical Specifications.

15. Document the as-built location of all pipes.

16. Observations to ensure that the pipe is joined by using the hot plate thermal butt fusion method as required by the Technical Specifications and that the equipment used for welding is as recommended by the Manufacturer.

17. Observation to ensure that the joining method described in the Technical Specifications is followed.

18. Observations and documentation that the test joints required by the Technical Specifications are made and that the joints meet the project requirements.

19. Observations to ensure that cleanouts are installed as specified.

20. Observations to ensure that the placement of drainage layer materials under, around, and over the pipe is as specified on the Design Drawings.

21. Perform compaction tests and observations to ensure that backfilling and compaction are completed as specified on the Design Drawings and in the Technical Specifications, and that in the process, the pipe network is not damaged.

22. Observe that all the pipes are cleaned by jet cleaning after installation is complete and document that all pipes are intact and not obstructed.

23. Document the location of defective or clogged pipe.

24. Document repair by the Contractor and re-cleaning.

3.6 REGULATORY REQUIREMENTS

A. The CQA Agency shall, at all times, be solely responsible for complying with all applicable laws, ordinances, regulations and codes, including those relating to safety.

3.7 PROTECTION OF PROPERTY

A. The CQA Agency shall take adequate precautions to protect the liner system components (installed or stockpiled) existing structures, fences, pavements, above ground utilities and underground utilities and to avoid damage thereto. The CQA Agency shall, at its own expense, repair any damage caused by its operations.

B. The CQA Agency shall conduct safety training of all its personnel (including any subcontractors) in accordance with the Purchaser safety requirements.

3.8 MEETINGS

A. The CQA Agency shall document each meeting and distribute copies of meeting minutes to all responsible parties.

B. A preconstruction meeting will be organized by the Purchaser and attended by the Purchaser, the Contractor (including responsible field supervisors for earthwork, geosynthetics, electrical, and mechanical systems), the CQA Agency, and any other party designated by the Purchaser. At Contractor discretion, separate preconstruction meetings may be held for earthwork, geosynthetics, mechanical, and electrical work.

C. The purpose of the preconstruction meeting(s) will be to review the project schedule, discuss critical work sequencing, designation of critical work sequencing, designation of responsible personnel, project coordination, and any outstanding questions regarding scope of work. Other topics to be covered during the meeting include:

  a. Requirements of Design Drawings, Installation Specification, and CQA Specification.

  b. The CQAP and the responsibilities of each party.

  c. The lines of authority and communication.

  d. Procedure for submittal of manufacturer QA documents for CQA Agency review.

  e. Procedures for examination of materials delivered to the site.

  f. Location of materials storage area(s).

  g. Field and laboratory test requirements and sample sizes.

  h. Procedures for observance of field tests.

i. Coordination between the Contractor and the CQA Agency to obtain timely field samples and tests.

j. Procedure for handling construction deficiencies, repairs, and retesting.

k. Work area security and safety requirements of the work site.

l. Site visits.

D. Progress meetings shall be scheduled and conducted by the Contractor on a weekly basis (minimum). The meetings shall be attended by the Purchaser, the Contractor, and the CQA Agency. If needed, daily meetings shall be held to review the work schedule, work completed, results of tests, and to discuss potential construction problems.

E. Additional meetings between the Purchaser, the Contractor, and the CQA Agency shall be held immediately after a work deficiency is identified or a problem arises. These meetings shall be used to define and resolve the problem.

1. Possible solutions to the problem shall be discussed, involving, if necessary, the Engineer and Owner for review. Once an acceptable solution has been selected, it shall be implemented, provided it does not conflict with or require a change to the Design Drawings, in which case, the solution shall be submitted to the Owner and Engineer for a more formal review with issuance of updated Drawings as required.

2. The Engineer will resolve unexpected conditions or unanticipated problems during construction, which may require changes to the permitted design. Changes from the permitted design shall require approval of the Owner and Engineer to ensure that the original design objectives are maintained. All changes shall meet the requirements of the permitting agency.

3.9 PERFORMANCE AUDITS AND DOCUMENTATION BY PROFESSIONAL ENGINEER

A. At a minimum, the CQA Certifying Engineer shall conduct the following listed reviews and performance audits.

1. Full review and audit of results of preconstruction testing or Contractor material certificates used to qualify earthwork materials for construction use.

2. Full review and audit of manufacturer certificates that qualify geosynthetic materials for use in the liner and piping systems.

3. Weekly audit of reports and test data sheets during and after construction of the earthwork until completion of work.

4. Weekly audit of reports and test data sheets during and after installation of geosynthetic liners, pipes, etc., until completion of the work.

3.10 CQA OBSERVATIONS AND DOCUMENTATION

A. Daily Records shall include:

1. Inspection data sheets.
2. Data sheets listing the number of types of construction equipment in use by the Contractor and construction equipment data.
3. Problem identification reports.
4. Corrective action reports.
5. Problem identification reports and corrective action reports shall include detailed descriptions of materials and/or workmanship that do not meet a specified design, and shall be cross-referenced to specific inspection data sheets where the problem was identified and corrected.

B. Testing Records shall include:

1. Material shipping and manufacturer Quality Control (QC) data sheets.
2. Data sheets describing field samples taken.
3. Laboratory data sheets.
4. Field test data sheets.
5. Notes, charts, Drawing, or sketches identifying the location and elevation of field tests, location of failures and repairs or retests, and where samples were obtained.
6. Non-destructive test reports including location of failures, records of repairs, and results of retests.

C. Photographic Records shall include:

1. Photographs, each with a unique identifying number.
2. Chart indicating the location from which each photograph was taken.
3. Summary list giving the data and time of each photograph.

D. All records shall, at a minimum, bear the following:

1. Unique identifying sheet number.
2. The date.
3. Project name, project number, and location.
4. Descriptive remarks.
5. Data sheets for tests.
6. Written text descriptions for visual observations
7. Signature of the preparer of designated authority.

3.11 REPORTS

A. An index or summary report shall be prepared listing all records and reports. The index shall be assembled in chronological framework for recording and identifying all reports.

B. Acceptance Report: All reports and data sheets shall be assembled and summarized into an Acceptance Report in order to verify that the materials and construction procedures comply with the specified design. At a minimum, this report shall contain all. The acceptance Report shall be prepared by the CQA Inspector and updated on a daily basis.

C. Draft Construction Documentation Report:

1. All inspection reports, test data sheets, problem identification reports, corrective action reports, material certificates, records and meeting notes, executive summary, index listing, and any other means of documentation used throughout the project shall be assembled and summarized into a Draft Construction Documentation Report in order to verify that the materials and construction procedures comply with the Design Drawings, this Specification Section and the installation Specification, the CQAP, and permit requirements.

2. The Draft Final Construction Documentation Report shall be prepared by the CQA Agency onsite staff, updated on a daily basis, and stored on site for review by the Purchaser or Engineer when required.

3. Within three weeks of completion of the installation work, the CQA Agency shall submit the Draft (unsigned) Final Construction Documentation Report to the Purchaser and Engineer for review and approval. The Purchaser and Engineer shall be given two weeks to provide comments on the Draft Construction Documentation Report for CQA Agency consideration.

D. Final Report: A Final Report shall be prepared by the CQA Engineer. The Final Report shall contain all data sheets, testing records, manufacturer data sheets, reports, and photographs concerning items that were installed and tested. This report shall contain evidence that the CQAP was implemented as proposed and that construction proceeded in accordance with the Design Drawings, Specifications, and permit requirements.

3.12 CERTIFICATION AND SUBMITTAL OF FINAL REPORT

A. The CQA Engineer shall certify the Final Report stating that the pond was constructed in conformance with the permit application approved by the State Permitting Agency and any Design Engineer/Purchaser approved modifications that were also approved by the State Permitting Agency.

B. The original and seven copies of the report shall be submitted to the Purchaser and one copy shall be submitted to each Contractor.

C. The Purchaser shall be responsible for submittal of copies of the Final Report to the State Permitting Agency. The original of the Final Report shall be stored at the plant site in a manner, which will allow easy access while still protecting the report from damage. All documentation shall be maintained throughout the entire active operating life and post closure maintenance period of the pond.

TABLE 1
EARTHWORK LABORATORY TESTS - MINIMUM FREQUENCY OF TEST (1)

No.	Type of Fill or Backfill	Moisture Content	Atterberg Limits LL and PI (2)	Grain Size (3)	Moisture Density Curve	Hydraulic Conductivity
		ASTM D2216	ASTM D4318	ASTM D422	ASTM D698, or ASTM D4253 and D4254 (5)	ASTM D5084 (6)
1	Subgrade to receive fill	---	---	---	1 per acre Minimum 2	---
2	Embankment fill	1 per 500 cubic yards per location.	1 per 500 cubic yards per location.	1 per 500 cubic yards per location.	1 per 500 cubic yards per location.	---
3	Structural bedding beneath structures and structural backfill	1 per 100 cubic yards per location.	1 per 100 cubic yards per location.	1 per 100 cubic yards per location.	1 per 100 cubic yards	---
4	Culvert or pipe trench bedding and backfill	1 per 100 cubic yards	1 per 100 cubic yards	1 per 100 cubic yards	1 per 100 cubic yards	---
5	Crushed rock surfacing	1 per 500 cubic yards per location	---	(4)	1 per 500 cubic yards per location	---
6	Soil bentonite mix - Liner	3 per acre per lift.	3 per acre per lift	3 per lift	2 per lift	2 per lift

Notes:

(1) Multiple requirements are given for some tests, such as number of tests per acre and one test per a given number of cubic yards. The requirement that results in the most Testing shall be used. All tests shall be performed for any change in material.
(2) Liquid Limit and Plasticity Index.
(3) Sieve Analysis on. For soil bentonite mixer – liner, include one hydrometer test for every second sieve analysis.
(4) Not required if certification is received from the Contractor on gradation. If no certification is received, then perform gradation tests at the rate of one per 500 cubic yards.
(5) The effectiveness of the compactive effort as measured by field tests shall be compared to laboratory compaction data and Specification requirements. Forms used to record Data from field tests shall also contain cross-reference to Specification requirements.
(6) The appropriate test shall be selected based on the permeability and/or hydraulic conductivity requirements for the material.

TABLE 2
EARTHWORK FIELD TESTS - MINIMUM FREQUENCY OF TEST

No.	Type of Fill or Backfill	Wet and Dry Density	Moisture Content	Lift Thickness Uncompacted	Lift Thickness Compacted
		ASTM D1556, D2167 or D6938	ASTM D6938 or ASTM D2216		
1	Subgrade to receive fill	5 per acre of prepared subgrade	5 per acre of prepared subgrade	---	---
2	Embankment fill	1 per acre per lift. 1 per 500 cubic yards	1 per acre per lift. 1 per 500 cubic yards	5 per acre per lift	5 per acre per lift
3	Bedding beneath structures and structural backfill	1 per 100 cubic yards / 1 per structure	1 per 100 cubic yards / 1 per structure	1 per structure	1 per structure
4	Culvert or pipe trench bedding and backfill	1 per 150 linear feet per lift 1 per 100 cubic yards	1 per 150 linear feet per lift 1 per 100 cubic yards	1 per 150 linear feet per lift	1 per 150 linear feet per lift
5	Road subgrade (compacted)	1 per 150 feet of road	1 per 150 feet of road	---	1 per 200 feet of road
6	Crushed rock surfacing	1 per 150 feet of road	1 per 150 feet of road	1 per 150 feet of road	1 per 150 feet of road
7	Soil bentonite mix - Liner	4 per acre per lift	4 per acre per lift	4 per acre per lift	4 per acre per lift

Notes:

(1) Multiple requirements are given for some tests. For example, number of tests per acre per lift and one test per a given number of cubic yards. The requirement that results in the most frequent testing shall be used.
(2) See Table 3 for additional requirements for field density tests.
(3) See Table 4 for acceptance criteria.

TABLE 3
EARTHWORK VERIFICATION AND CALIBRATION PARAMETERS

Test Requiring Verification	Frequency of Verification Test
Nuclear In-Place Density and Nuclear In-Place Moisture Content, ASTM D6938.	After meeting ASTM initial calibration test requirements, one rubber balloon (ASTM D2167) or sand cone (ASTM D1556) density and moisture content verification per 10 nuclear density tests.
"Quick" Moisture Content Test using Microwave, gas stove, frying pan, infrared oven, etc.	One standard oven-dry moisture content (ASTM D2216) test per 10 quick tests.
Lift thickness measured using a shaft or shovel to dig hole.	One lift thickness verified by surveying every acre - lifts for general fill areas and 1 per 500 feet of road.

Notes:

(1) A standard block test as required by ASTM D6938 shall be performed at the start of each day on each Nuclear apparatus that will be used that day. At the start of earthwork construction, a series of five Nuclear tests and five sand cone or rubber balloon tests shall be performed on a compacted test strip to calibrate the Nuclear apparatus. During construction, one Nuclear readings performed during each day shall be verified using a sand cone (ASTM D1556) or rubber balloon (ASTM D2167) density and moisture content test for each apparatus used that day. The average wet density and moisture content for each apparatus shall be computed for every ten tests. If variations greater than those permitted by the ASTM occur, corrections shall be applied to all future tests for the apparatus until the next set of 10 tests isperformed.

TABLE 4
EARTHWORK TEST RESULT ACCEPTANCE CRITERIA

Test	Acceptance Criteria
Gradation	Average of results of any ten consecutive grain size tests shall be within the specified limits. A minimum of 90% of all tests shall be within the specified limits for the soil bentonite material. For all other material, not less than 80% shall meet Specification requirements.
Atterberg Limits	Average of results of any ten consecutive liquid limit tests shall be above the minimum specified or below the maximum specified, whichever is required. Average of results of any ten consecutive plasticity index determinations shall be within the range specified. A minimum of 90% of all tests shall be within specified limits for the soil bentonite material. For all other material, not less than 80% of tests shall meet Specification requirements.
Density and Moisture Content	The results of all tests shall meet the minimum requirements. If requirements are not met, the soil shall be recompacted within the required moisture content.
Hydraulic Conductivity	The results of all tests shall indicate a hydraulic conductivity equal to or less than the specified maximum hydraulic conductivity.
Lift Thickness	Uncompacted and compacted thicknesses shall be within tolerances specified.

END OF SECTION 31 90 99

SECTION 33 47 16.13

MECHANICALLY TENSIONED FLOATING BASIN COVER SYSTEM

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. This Section includes designing, fabricating, furnishing, installing, and inspecting a new mechanical tensioned floating cover system and appurtenant work as depicted on the Drawings and specified in this Section.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Where a date is given for referenced standards, that edition shall be used. Where no date is given for referenced standards, the latest edition shall be used.

A. ASTM International (ASTM)

ASTM A240/A240M	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D413	Standard Test Methods for Rubber Property – Adhesion to Flexible Substrate
ASTM D471	Standard Test Method for Rubber Property – Effect of Liquids
ASTM D746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D751	Standard Test Methods for Coated Fabrics
ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1149	Standard Test Methods for Rubber Deterioration – Cracking in an Ozone Controlled Environment
ASTM D1204	Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature

ASTM D1785	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2136	Standard Test Method for Coated Fabrics – Low-Temperature Bend Test
ASTM D2240	Standard Test Method for Rubber Property – Durometer Hardness
ASTM D2467	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM E838	Practice for Performing Accelerated Outdoor Weathering Using Concentrated Natural Sunlight

B. Section 31 90 22 – High-Density Polyethylene Geomembrane Liner

C. Section 31 90 99 – Construction Quality Assurance

D. Washington Administrative Code (WAC)

WAC 173-303-650	Surface Impoundments

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the submittals section, and the following special provisions provided herein.

B. The Contractor shall submit the proposed designer names and qualifications with bid.

C. The Contractor shall submit the proposed material supplier names and qualifications with bid.

D. The Contractor shall submit the proposed fabricator names and qualifications with bid.

E. The Contractor shall submit their qualifications with bid.

F. Qualifications for the Contractor, designer, fabricator, and manufacturer shall include the following listed information.

1. Project names, which are the basis of qualification.
2. The project site location.
3. Brief description of each project (size, type of project, completion date, etc.).
4. Type(s) of materials provided, which shall address material thickness, scrim reinforcement, special compounding requirements or deviations from the manufacturer conventional product, colors, etc.
5. The current name, mailing address, and phone number of the Owner.

6. Name of current contact person or Owner representative most knowledgeable of each project.

G. Cover Protection Plan:

1. The Contractor shall submit, for Owner Representative approval, a written plan that addresses Contractor measures to protect the geomembrane liner prior to starting work.

2. The protection plan shall address, at a minimum, Contractor proposed method to protect the geomembrane liner, the stockpile and storage locations of materials within the reservoir, methods for moving and deploying materials, methods of providing ingress and egress, etc.

H. Shop Drawings:

1. The Contractor shall submit, for Owner Representative approval, shop Drawings showing the floating cover panel layout with proposed size, number, position, weight, and sequence of placing all factory fabricated panels; indicating the location and overlap of all field joints and the direction of all factory joints on each panel.

2. The Contractor shall submit, for Owner Representative approval, shop Drawings showing the fabrication of mechanically tensioned towers and accessories, floating cover accessories, sequence of placing all factory-fabricated panels, and indicate the location and overlap of all field joints.

3. If the Contractor proposes alternate design details, seaming procedures, or methods of construction that are different from those shown on the Drawings and stated in the Specifications, complete shop Drawings and other pertinent information shall be submitted for Owner Representative approval. Such proposed alternates shall not be used unless approved in writing by Owner Representative prior to the Contractor starting that portion of work.

4. Approval of any alternate design, method, or procedure proposed by the Contractor may be granted only if, in Owner Representative sole opinion, such proposal will produce an end result equal to or better than the design, method, or procedure shown in the Drawings or Specifications.

5. The Contractor shall provide all additional details required but not provided in the Drawings or Specifications. Those details provided by the Contractor shall be subject to the review and approval of Owner Representative prior to commencement of work.

I. Samples:

1. Prior to ordering floating cover material, four 8-in. by 10-in. samples shall be submitted to the Owner Representative for approval.

J. Material Safety Data Sheets (MSDS):

1. MSDS for all cleaners, solvents, caulks, adhesives, and other chemicals proposed for use shall be submitted to the Owner Representative for review.

2. A copy of all MSDS shall be posted on the Contractor job bulletin board at all times.

K. Certified Testing Laboratories:

1. The name of Contractor proposed certified testing laboratory shall be submitted to the Owner Representative for approval a minimum of ten working days prior to any material testing.

2. The laboratory shall be certified by the Geosynthetic Research Institute (GRI).

L. Manufacturer Quality Assurance Plan:

1. The Contractor shall submit the geomembrane manufacturer Quality Assurance Plan (QAP) for the Owner Representative review and approval.

2. Prior to Contractor submittal to the Owner Representative, the Contractor shall have reviewed and approved the manufacturer QAP.

3. The manufacturer QAP plan shall be approved in writing by the Owner Representative prior to manufacturing floating cover materials.

M. Fabricator Quality Assurance Plan:

1. The Contractor shall submit the geomembrane fabricator QAP for the Owner Representative review and approval.

2. Prior to Contractor submittal to the Owner Representative, the Contractor shall have reviewed and approved the fabricator QAP.

3. The fabricator QAP shall be approved in writing by the Owner Representative prior to fabricating the fabric-reinforced material into panels.

N. Contractor Quality Assurance Plan:

1. Prior to installing floating cover materials, the Contractor shall submit a job-specific QAP covering installation for the Owner Representative review and approval.

2. The Contractor QAP shall be approved in writing by the Owner Representative prior to starting any on-site geomembrane installation work.

O. Contractor final QA report, including material manufacturer and fabricator final QA reports.

1.4 QUALITY ASSURANCE

A. Quality assurance procedures shall be conducted in accordance with this Section and Section 31 90 99. Where conflict between sections exists, the more stringent requirement shall apply.

B. Quality Assurance Plan:

1. The Contractor shall thoroughly review and comprehend the project Drawings and Specifications prior to the development of the job specific QAP. The Contractor QAP shall be in accordance with the project Specifications. Any deviations or conflicts with the project Specifications shall be clearly marked, immediately brought to the Owner Representative attention, and shall not be used without Owner Representative prior written consent.

2. The Contractor QAP shall state how the following items shall be accomplished and shall include sample forms to be used to document each QA activity. The major heading and subheadings list those tasks, at a minimum, which shall be included in the QAP. The Contractor shall include any additional pertinent information and topics.

3. Materials:

    a. Monitor and document the unloading, handling, and on-site storage of fabricated panels and other materials.

    b. Monitor material, process, and equipment certifications required by the Specifications to ensure their adequacy and timely submittal. The Owner Representative shall be notified of any deviations.

    c. Label, package, and ship test samples to a testing laboratory for Specification compliance testing.

4. Deployment/Installation:

    a. Evaluate and document the suitability of weather conditions to insure proper installation.

    b. Monitor and document placement and condition of all panels while being placed.

    c. Monitor and document the proper installation of panels in accordance with approved shop Drawings.

    d. Perform overall visual observations of entire geomembrane surface to locate and document all damage and defects.

    e. Monitor and record the repair of all damage, defects, and all destructive testing.

5. Seaming:

a. Monitor and document trial seaming procedure and test results to evaluate seaming personnel and equipment.

b. Monitor and document seaming procedure.

c. Devise seam identification numbering system unique to each seam such that the seam location, seaming crew, equipment used, date, time, and weather conditions are properly documented.

d. Include a list of all equipment, with pertinent technical information, to be used for seaming.

e. Describe in detail each seaming procedure the Contractor proposes to use in executing the work. Before using, each seaming procedure shall be approved by the Owner Representative. The seaming procedures shall include cleaning of material to be seamed, cleaners/solvents, preheating, adhesives, seaming temperatures, seaming rate, and dwell pressure.

f. Indicate adverse weather or other conditions that could limit or halt seaming operations.

g. Describe measures to account for and compensate for temperature changes in ambient air or material that may affect seam quality.

h. Describe equipment calibration frequency and procedure.

6. Seam Testing Samples:

a. Monitor and document nondestructive testing of seams.

b. Select locations for destructive seam samples, when selection is not made by the Owner Representative.

c. Monitor and document the cutting of seam test samples and patching of test sample holes, if required.

d. Utilizing the test seam identification numbering system, document the location, seaming crew, equipment used, date, time, and weather conditions for each test sample.

e. Label, package, and ship test samples to a testing laboratory for Specification compliance testing.

f. Interpret all laboratory test results on material and seam compliance with Specifications.

g. Distribute five of the certified laboratory test results with interpretation to the Owner Representative.

h. Monitor and document the repair of all rejected seams.

i. Monitor and document destructive and nondestructive testing of repaired seams.

C. Field Seaming Demonstration:

1. Following the submittal of the QAP and prior to Owner Representative approval, the Contractor shall conduct a field demonstration for the Owner Representative, demonstrating the seaming procedures, equipment usage, calibration procedures, and all other aspects of the proposed seaming methods.

2. The Contractor shall conduct on-site seam strength tests in compliance with the requirements stated in this Section.

3. The Contractor shall provide seaming demonstration for each type of seaming method proposed (e.g., hot air, wedge welder, adhesive, etc.).

4. At least four 25-ft long demonstration seams shall be made for each type of panel-to-panel seaming system proposed.

5. Each demonstration seam shall include a tee joint where three layers of material are bonded together.

6. Samples may be taken from the demonstration seams and tested by the Owner Representative.

7. Approval of the QAP will be contingent upon the results of the demonstration test samples.

D. Execution of the Quality Assurance Plan:

1. Upon Owner Representative written approval of the Contractor QAP, the Contractor shall implement and continuously monitor the QAP, as described above, through an active and ongoing QA Program.

2. The Owner Representative will continuously monitor the Contractor approved QA Program for compliance.

3. The Contractor quality assurance manager shall report directly to an off-site senior management employee whom shall have no production responsibilities that could infringe upon the execution of the Contractor QAP.

4. The QA Program shall include, but not necessarily be limited to, the above specified items and the following listed items

a. Review of all contract Drawings and Specifications for clarity, completeness, and to acquire a thorough knowledge of project materials and construction procedure requirements.

b. Review, revise as deemed necessary, and approve the geomembrane manufacturer QAP.

c. Review, revise as deemed necessary, and approve the geomembrane fabricator QAP.

d. Continuous review and revision, as necessary, of the QAP for thoroughness, adequacy, and feasibility.

e. Use special job specific and task specific forms or logs for monitoring all activities involved with the QAP. Job specific forms shall include the project name and minimum test values for each specific test (e.g., shear, peel, breakaway peel, etc.).

f. Maintain logs summarizing all daily activities.

g. Interpret all laboratory test results on materials and seams for compliance with Specifications.

h. Distribute five copies of certified laboratory test results with interpretation to the Owner Representative.

E. Quality Assurance Final Report: At the completion of the installation and prior to final acceptance of all work by the Owner Representative, a final QA report shall be submitted to the Owner Representative. The Owner Representative shall have the opportunity to review and comment on a draft report at the 80% completion prior to the issuance of the final report. The Contractor shall positively address all of the Owner Representative comments prior to the issuance of the final report. The QA report shall include, but not necessarily be limited to, the following listed items.

1. A brief description of the project, including the project name, type of facility, location, design engineer, material supplier(s), shop fabricator(s), subcontractors, and the Contractor superintendent.

2. Detailed description of floating cover system, including, area, and type of materials installed.

3. Copy of floating cover Drawing and Specifications with as-built mark ups.

4. Record of daily activities, including all special problems and associated resolutions encountered during the project.

5. Copies of all field and laboratory, destructive and nondestructive test results, with interpretations.

6. Copies of all standard forms and logs completed as part of the QAP.

7. Copy of approved shop Drawings and Contractor provided details.

8. Copy of QA record Drawings indicating panel numbers, seam identification numbers, seaming dates, location of defects, type of defect, repairs, repair dates, and location of all samples.

9. Statement from the Contractor certifying the floating cover has been installed in accordance with project Drawings and Specifications.

10. The Contractor, fabricators, and manufacturer approved QA plans.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage, and handling shall be in accordance with the following special requirements:

1. Packing and Shipping:

a. Each factory-fabricated panel shall be individually packaged. Floating cover panels shall packaged and shipped in accordance with manufacturer recommendations. Each panel shall be packaged and shipped in a manner to protect and prevent damage during shipment and storage. Each enclosure shall be prominently marked in the same fashion as the panel within.

2. Storage and Protection:

a. Packaged factory-fabricated panels shall be stored in their original unopened condition, on a flat and clean surface, in a dry area, and protected from direct sunlight under an opaque, light colored heat-reflective cover.

b. Sand for sand-filled tubes shall be stored on a clean, paved area or tarpaulin to prevent contamination, and shall be covered with a tarpaulin and maintained in a dry condition until used.

1.6 REGULATORY REQUIREMENTS

A. The Contractor shall obtain permits and comply with all regulations from all regulatory agencies as required for the use of solvents, adhesives, and other chemicals.

B. The Contractor shall ensure that their employees, subcontractors, and others exposed to solvents, adhesives, and other chemicals comply with limitations for exposure and handling in accordance with OSHA, and other regulatory agency regulations.

1.7 QUALIFICATIONS

A. Specialty Contractor:

1. The work shall be performed by a specialty Contractor who shall have been regularly engaged in the design and installation of flexible fabric-reinforced geomembrane floating covers for a minimum period of five years immediately prior to the bid opening date, and shall have installed not less than ten million square feet of flexible fabric-reinforced geomembrane material. Specialty Contractor shall have at least three installations of mechanically tensioned floating covers within the past five years.

B. Project Manager:

1. The Contractor shall assign to the project, a project manager who shall have been regularly engaged in the installation of flexible fabric-reinforced geomembrane floating covers for a minimum period of four years, immediately prior to the bid opening date, and shall have installed not less than one million square feet of flexible fabric-reinforced geomembrane material.

C. Superintendent:

1. The Contractor shall assign, exclusively to the project, a superintendent who shall have served in a similar capacity for not less than four years and not less than one million square feet of experience in the installation of flexible fabric-reinforced geomembrane floating covers. Superintendent shall have at least two installations of mechanically tensioned floating covers within the past four years.

2. The only experience of the superintendent that will be considered as qualifying is on projects where the superintendent was full time at the point of installation directly overseeing and supervising the labor and the work. Time spent in a field office does not qualify.

3. If the superintendent is deemed not qualified by the Owner Representative, the Contractor shall not employ such superintendent on this project. Any superintendent employed by the Contractor shall be discharged if their performance on the work is determined by the Owner Representative to be unsatisfactory.

4. Any superintendent substituted for a superintendent originally assigned by the Contractor shall meet the same minimum requirements specified herein.

D. Quality Assurance Manager

1. The Contractor shall assign, exclusively to the project, a quality assurance manager who shall have served in a similar capacity on at least three prior fabric- reinforced geomembrane installations involving a total of not less than 1 million square feet.

1.8 PROJECT/SITE CONDITIONS

A. Safety Requirements:

1. Construction personnel shall be trained in and be instructed on the use of barrier creams or gloves, as necessary, for working with the solvents and cleaning agents. All used cloths impregnated with solvent shall be kept separately in metal containers with close-fitting lids suitable for use, as necessary, and in compliance with the requirements of the International Fire Code (IFC), local Fire Marshal, and Hanford site-specific safety requirements. No personnel from either the Contractor or Hanford will be permitted to smoke or have open flames without a hot work permit anywhere within the work zone. Any personnel

within 50 ft of an open solvent container will be required to be trained in the use of appropriate approved breathing apparatus and wear appropriate breathing apparatus when necessary.

B. No equipment or material will be permitted to leave the site until inspected and certified by WRPS for safe removal.

1.9 GUARANTEE AND WARRANTY

A. Prior to manufacturing the floating cover material, the Contractor shall submit a written material warranty from the manufacturer for WRPS review and approval.

B. The material shall be warranted in writing by the manufacturer against manufacturing defects or workmanship and against deterioration due to ozone, ultraviolet rays, or other than normal weather aging. Vandalism, acts of animals, and acts of God are excluded. The warranty shall be limited to the replacement of material only. Installation labor is not included in the material warranty.

C. The material warranty shall be prorated for 20 years.

D. The material warranty period shall not commence until the material has been installed by the Contractor and accepted by WRPS.

E. The material manufacturer shall perform site inspections during the floating cover fabrication and on-site installation to verify the material has not been damaged because of the fabrication or installation, and no part of the material warranty has been voided.

F. The Contractor shall warrant and guarantee that all work shall be free of deficiencies and defects for a period of one year after the date of final acceptance of the work by WRPS.

G. The warranties and guarantees specified herein are not the only ones involved in the Contract, and are in addition to those specified elsewhere in the project Specifications.

PART 2 PRODUCTS

2.1 MATERIALS

A. Floating Cover Composition:

1. The membrane material shall be manufactured from a composition of high quality ingredients, suitably compounded, Chlorosulfonated Polyethelene (CSPE). Zinc compounds of all kinds, including zinc oxide, and zinc stearate, are prohibited. Dusting agents of all kinds are prohibited on the finished product. Fillers and necessary processing aids can be whatever material is deemed proper to facilitate processing the compound, but the finished compound shall be certified in writing by the manufacturer to have the following property values listed in the following table as tested by manufacturer:

Property	Test Method	Test Value
Specific Gravity	ASTM D792	1.45 ± 0.03
Tensile Strength	ASTM D412	1,000 psi min.
Elongation @ Break	ASTM D412	250% min.
Water Absorption	ASTM D471 (7 days @ 70°F)	5% max.
Temperature Brittleness	ASTM D746 (30-mil unreinforced)	-40°F no failures
Ozone Resistance	ASTM D1149 (3ppm @ 30% strain @ 104°F, 72 hrs.)	No effect
Heat Age Tensile Strength	ASTM D412 (14 days @ 212°F)	1,000 psi min.

2. The Owner Representative, at their discretion, may have a representative at the manufacturer facility during the production of the geomembrane for the project. The Contractor shall notify the Owner Representative no less than two weeks in advance of starting manufacturing so that shop inspection may be arranged. Verification shall consist of witnessing the mixing and weighing operations and quantifying the portion of banbury charge weight is CSPE polymer. The Owner Representative will not require any information regarding the chemical constituents comprising the remaining compound or other information considered proprietary by the manufacturer.

3. The fabric reinforcing scrim shall be 10 by 10 plain weave, 1000 warp/1000 fill denier polyester with yarn strands having a twist of 2 to 2 1/2 turns per inch in the fill direction. The reinforcing scrim shall create an open-type weave that permits strike-through of the CSPE. A 9 by 9, 1000 denier polyester weft-insertion scrim is considered an equal.

4. The floating cover composite geomembrane material shall consist of thoroughly bonded, fabric-reinforced CSPE synthetic rubber sheeting with an overall nominal thickness of 60-mils. All composite geomembrane materials shall be manufactured by the calendaring process, and shall be uniform in color, thickness, size, and surface texture. The fabric shall be totally encapsulated between the three plies of CSPE as follows:

   a. Top Layer (geomembrane) – CSPE Top Layer shall be 15-mil minimum thickness and black color.

   b. Scrim Layer – Scrim Layer shall be located between geomembrane Top Layer and Middle Layer. Scrim compositions shall be as described below.

   c. Middle Layer (geomembrane) - CSPE Middle Layer shall be 15-mil minimum thickness and black color.

d. Bottom Layer (geomembrane) – Bottom Layer shall be 15-mil minimum thickness and blue color.

5. The edge of the fabric shall be between 1/8 in. and 1/2 in. from the edge of the CPSE encapsulation on either side. Exposed fabric along longitudinal edges of roll stock, or indications of delamination will not be permitted. The composite membrane material shall be a flexible, durable, watertight product free of pinholes, blisters, and contaminates, and shall not delaminate in a water-based environment.

6. The selection of stocked raw materials and the adjustment of manufacturing parameters within tolerances shall be performed accordingly to minimize the quantity of extractables that may leach from the completed, installed, and in- service geomembrane reservoir floating cover.

7. All floating cover material and floating cover accessories shall be provided from a single supplier.

8. The finished color of the fabric-reinforced sheet shall be black top side/ blue bottom side. The color shall not vary between sheets.

9. The material manufacturer shall certify in writing prior to manufacturing material that the fabric-reinforced CSPE has the following material propertyvalues as tested by manufacturer:

Property	Test Method	Floating Cover	Floating Cover Accessories
Total Plies		4	3
Thickness Total Overall Over Scrim (top/bottom)	ASTM D751 Optical Method	 60 mils (nom.) 55 mils (min.) 15 / 30	 45 mils (nom.) 41 mils (min.) 15 / 15
Plies - Reinforcing		1	1
Scrim (threads/inch, denier)		10x10, 1000d	10x10, 1000d
Breaking Strength (minimum)	ASTM D751 Grab Method	250 lbs.	250 lbs
Elongation at Break (% min.) fabric membrane	ASTM D751 Grab Method	 15% 30%	 15% 30%
Tear Strength (min.)	ASTM D751 Tongue Tear	90 lbs.	80 lbs
Hydrostatic Resistance (minimum)	ASTM D751 Method A Procedure 1	375 psi.	375 psi
Puncture Resistance (minimum)	FTMS 101B, Method 2031	250 lbs.	225 lbs.
Ply Adhesion (minimum)	ASTM D413 Machine Method, Type A	10 lbs./in.	10 lbs/in

Property	Test Method	Floating Cover	Floating Cover Accessories
Ozone Resistance	ASTM D1149 1/8" bent loop, 100 pphm, 104°F, 7 days, 7x magnification	No cracks	No cracks
Low Temperature Flexibility	ASTM D2136 1/8" mandrel, 4 hrs., -40° F	No cracks	No cracks
Dimensional Stability (maximum)	ASTM D1204 (1 hr. @ 212°F)	2%	2%
EMMAQUA Weathering Resistance	ASTM E838 (un-backed) 5 million langleys (5751 MJ/m^2)	No cracks	No cracks

10. During manufacturing, the material manufacturer shall test the fabric-reinforced CSPE material at a frequency of not less than every 50,000 sf of membrane produced. The manufacturer shall certify that the physical properties of the finished sheet meet or exceed the Specifications and submit certified test reports to validate conformance.

11. CSPE roll goods shall be inspected by the manufacturer for pinholes, undispersed solids, voids in coverage commonly referred to as fish eyes, scrim displacement, and other non-standard conditions.

12. All floating cover material and floating cover accessories shall be provided from a single supplier.

B. Use of CSPE: Unless otherwise indicated, all CSPE material used in the floating cover appurtenances shall be the same type of fabric-reinforced CSPE as that used for the floating cover membrane.

C. Floating Cover Membrane Accessories:

1. Sand-filled tubes, float wraps, doublers, tabs, and other membrane applications shall be nominal 45-mil thick, 3-ply membrane consisting of 2 plies of CSPE and 1 ply of scrim, as specified above.

2. Floating cover membrane accessory materials shall be the same color as the floating cover membrane.

3. Nonstructural patches, doublers, and other unreinforced material applications, where noted, shall be 40-mil thick, unreinforced CSPE membrane material.

D. Floats:

1. Floats shall be rigid, extruded, closed-cell, polyethylene foam planks weighing 2.3 pounds per cubic foot ±10%. The floats shall be:

a. Ethafoam 220 by Dow Chemical Company,

b. Polyplank PLK (2.2 pcf) by Pactiv Corp.,

c. Or approved equal.

2. Individual float dimensions from the factory shall be minimum 2-in. thickness by the full width specified for the application shown on the Drawings by maximum length commercially available.

3. Built-up floats for the total finished thickness specified on the Drawings shall be achieved by laminating individual float layers. Vertical joints in individual float layers shall be staggered a minimum 12 in. Each layer shall be fully heat-bonded to the adjacent layers.

4. Polyethylene foam floats shall be fully encased in the same fabric-reinforced material as that used for the floating cover membrane, unless noted otherwise.

E. Access Hatches:

1. Access hatch frames and covers shall be fabricated from stainless steel in accordance with the requirements of ASTM A240/A240M, Type 304L, or approved equivalent.

F. Sand-Filled Tubes:

1. Sand-filled tubes shall be fabricated from floating cover membrane accessory CSPE material.

2. Sand-filled tubes shall be of sufficient length and lay-flat width to produce the finished length and diameter shown on the Drawings. The overall tube length shall include extra material required to seal the ends of the tube.

3. Sand-filled tubes shall be filled with pea gravel and sand mixture.

a. Pea gravel shall be washed, clean, rounded, and dry with 100% passing 1/2 in. sieve and 90%-100% passing a 3/8-in. sieve.

b. Sand shall be washed, clean, dry, even graded sand with 100% passing a No. 4 sieve and not more than 30% passing a No. 30 sieve.

c. The percent passing the No. 200 sieve shall be limited to a maximum of 3%.

4. Attachment:

a. Oblong stainless steel grommets shall be installed in the attachment tabs material as shown on the Drawings. Holes in the attachment tabs shall be punched using spur-setting dies with cutter to properly suit the grommet size. The grommets shall be seated so that the entire rim is firmly gripping the membrane material all the way around the grommet. No loose or sharp edges around the grommet shall be permitted. Grommets shall be manufactured by:

i. Stimpson Co.,

ii. Rome Fastener Corp.,

iii. Or approved equal.

b. Attachment straps shall be black, double-face weave, medium weight or heavier, Dacron webbing with black Delrin (Acetal) standard cam buckles as shown on the Drawings. Ends of the Dacron webbing shall be heat seared to prevent raveling.

c. The webbing and cam buckle assembly shall have compatible components and shall be capable of supporting a sustained 100-pound tensile load without the webbing pulling out of the buckle.

d. Dacron webbing shall be sewn to the attachment end of the cam buckle with #207 or stronger, bonded, silicone treated, black, polyester thread.

G. Rainwater Removal Pump Sumps:

1. Rainwater removal sump tank and lid shall be constructed from HDPE UV resistance and rated for outdoor exposure. The size of sump tank and perforations shall be as shown on the Drawings.

2. PVC pipe shall conform to the applicable requirements of ASTM D1785. PVC fittings shall be socket type conforming to the requirements of ASTM D2467 and shall be of the same material as the pipe. PVC pipe and fittings shall be solvent welded unless otherwise noted.

3. Pipe and fittings shall be dimensionally round, true, homogeneous, and free from cracks, defects, blisters, indentations, wrinkles, and foreign inclusions.

4. Pipe and fittings shall have the following information printed indelibly in ink, or molded thereon: Manufacturer lot or control number, manufacturer name or trademark, grade, and size. Printed markings shall be of sufficient permanence to withstand normal handling during installation.

H. Tension Tower System:

1. Structural steel tuing meeting ASTM A500 Grade B requirments and hot dip galvanized in accordance with ASTM A12. Zinc coating shall be at least 2.8 ounces per square foot of surface. Welding and fabrication shall be in accordance with approved submittal.

2. Pulleys and weights: shall utilize cast aluminum tower cap, galvanized wire rope, 3 inch sheaves with bronze bushings and cast iron tension weights.

I. Rope:

1. Rope shall be 100% Dacron or three strand, twisted, polypropylene.

2. Rope shall be suitable for marine use.

3. Rope size shall be as shown on the Drawings.

J. Rubber Gaskets:

1. Rubber gaskets shall have a durometer hardness of 35 ± 5, as tested by the Type A durometer, in accordance with ASTM D2240.

K. Water Elevation Markers:

1. Water elevation grid markers shall be the manufacturer standard nominal 36-mil or 45-mil, 10x10, 1000 denier scrim reinforced potable grade material consisting of 1-ply of scrim and 2 plies of CSPE. Water elevation grid markers shall be a contrasting color as indicated on the Drawings.

L. Accessories:

1. All accessories, hose clamps, and other miscellaneous hardware required for the floating cover shall be stainless steel, Type 316 or Type 316L, if welding is required.

M. Repair Float Logs:

1. The Contractor shall provide (8) 12-in. diameter by 4 1/2-ft long repair float logs. Repair log shall be octagonal in cross section.

2. The repair float logs shall be built up from rigid, closed-cell polyethylene foam and fully encased in fabric-reinforced floating cover CSPE material.

3. Each end of the repair float log shall have a tab of fabric-reinforced floating cover material fully bonded to the float encasement material. The outstanding leg of the tab shall have a 1-in. diameter brass grommet centered in the tab.

4. The repair float logs shall be neatly stored and protected on pallets at the site to the satisfaction of the Owner Representative.

N. Rainwater Enhancement Sand-Filled Tubes:

1. In addition to the permanent sand-filled tubes shown on the Drawings, the Contractor shall furnish 2-in. diameter x 8-ft long sand-filled tubes.

2. Quantity of rainwater enhancement sand-filled tubes supplied by Contractor shall be coordinated with Owner to establish the number required for operation.

3. The rainwater enhancement sand-filled tubes shall not be initially installed on the floating cover, but shall be neatly stored and protected on pallets at the site to the satisfaction of the Owner Representative. The rainwater enhancement sand-filled tubes shall be deployed on the floating cover on an as-needed basis at field-determined locations. These tubes shall be used to direct ponded rainwater to rainwater collection troughs and to remove incidental slack in the floating cover.

O. Sandbags:

1. Sandbags shall contain a minimum of 40 pounds and a maximum of 60 pounds of sand. The sand gradation shall be 100% passing a No. 8 sieve.

2. Double bags shall be utilized. Both bags shall be made of 6-mil minimum solid (non-woven) polyethylene with ultraviolet inhibitors sufficient to guarantee a minimum life of 12 months. Each bag shall be tied off separately. Wire ties will be permitted on the inner bag. Twine or black nylon cable ties with a minimum tensile strength of 30 pounds shall be used on the outer bag.

P. Patches:

1. All patches shall be CSPE materials.

2. Structural patches shall be the same fabric-reinforced floating cover CSPE material.

3. Non-structural patches shall be 40-mil unreinforced CSPE material.

Q. Adhesives:

1. All seaming, sealing, and high-solids adhesives shall be suitable for use in potable water applications, shall satisfy all regulatory requirements, and shall be in accordance with the CSPE manufacturer recommendations.

2. High-solids adhesive shall be black, UV resistant, and shall contain at least 14% CSPE compound by weight.

R. Cleaning Solvents:

1. Solvents for cleaning contact surfaces of factory and field joints and other surfaces shall be suitable for the intended use, subject to the approval of the Owner Representative.

2. Solvents for cleaning contact surfaces of field joints and other surfaces shall satisfy the recommendations of the fabric-reinforced CSPE manufacturer, subject to the approval of the Owner Representative.

2.2 FABRICATION

A. Individual sheets of fabric-reinforced CSPE shall be factory-fabricated into large panels by an experienced fabricator regularly engaged in fabricating fabric-reinforced geomembrane for a minimum period of five years, immediately prior to award of the contract. Such fabricator shall be approved by the geomembrane manufacturer.

B. Other experience relevant to fabrication that does not meet the above requirements may be considered. WRPS opinion, as to the acceptability of all experience, shall be final and conclusive.

C. Machine-made factory seams shall be made with hot air or hot wedge welding techniques and shall be as shown on the Drawing.

D. Factory seams shall develop a minimum of 90% of the specified tensile strength of the parent material, when tested in accordance with ASTM D751. All factory seams shall provide a bond between sheets sufficiently strong so that failure of the seam will not occur in the plane of the bonded surface.

E. Factory seams shall be fully bonded on the top side, including encapsulated edges so that no loose edge is present on the top side of the fabricated panel.

F. All factory-fabricated panels shall be fabricated such that the materials are rolled. Accordion folded panels shall not be permitted. Roll widths shall be not less than 30 ft, nominal. "Wall papering" in the field, meaning the installation with manufacturer roll stock material, shall not be permitted.

G. Factory-fabricated sections or panels shall be given prominent, unique indelible identifying markings in accordance with the approved panel layout Drawings, and shall indicate the proper direction for unrolling to facilitate their layout and positioning in the field.

H. Horizontal factory-made and field-made seams will not be permitted on the reservoir slope, except for factory roll stock splices, which shall be offset by at least 5 ft from such splices in adjacent roll stock in the same panel. Rollstock splices will not be permitted on either outside edge of a panel. Roll stock splices shall only be permitted in the center rolls of fabricated panels.

I. All factory seams shall be staggered as required to ensure that no more than three layers of membrane meet at a joint.

J. Fish mouths, pleats, folds, wrinkles, and similar defects shall not be permitted in any seams.

K. Where fabric-reinforced CSPE has been cut and thus exposes the fabric, the cut edge shall be solvent wiped and sealed with a high-solids adhesive to encapsulate the fabric, as shown on the Drawings. This requirement applies to all cut edges of fabric-reinforced material, including patches for structural repairs on the top side of the floating cover.

L. The Contractor may have portions of the floating cover and appurtenances fabricated in the factory. The factory fabrication may include, but not necessarily be limited to, sand tubes, straps, and float wrap. Factory seams for all such items shall comply with the requirements shown on the Drawings.

M. Equipment Calibration:

   1. The seaming equipment shall be calibrated in accordance with the fabricator QAP by testing trial seam samples, but shall not be less than at the beginning of each shift, every four hours, and at any significant environmental changes.

2. Shop seam samples shall be collected and tested in accordance with the Quality Control provisions stated in Part 3 - Execution (peel strength, breakaway peel strength, and tensile strength). The shop seam verification testing shall be performed by in-house personnel or laboratory. The Contractor shall submit the daily calibration test results to the Owner Representative as part of the final QA report. No shop seaming shall be performed until all test samples have been tested and passed.

PART 3 EXECUTION

3.1 PREPARATION

A. Protection:

1. Under no circumstances shall the floating cover or installed HDPE liner be subjected to rough treatment or have sandbags, equipment, or other material dragged across or thrown upon its surface. Neither materials nor workers or others shall slide down slopes on top of the floating cover or the installed HDPE liner.

2. Scuffed surfaces resulting from abuse or inadvertent damage of any kind by the Contractor employees, or inadvertent damage caused by the Owner Representative personnel overseeing the work, shall be repaired in accordance with the Specifications.

3. All persons walking on the floating cover material and the installed HDPE liner shall wear smooth, rubber-soled shoes. Shoes with patterns in relief (like those popularly known as "sneakers") that could pick up rocks and debris will not be permitted.

4. The Contractor shall protect the floating cover and installed HDPE liner by deploying a 22-ounce nonwoven geotextile in all high foot traffic areas. This provision shall be included in the Contractor Protection Plan.

5. No wheeled vehicles will be permitted on the installed HDPE liner or on the floating cover material. Miscellaneous equipment with pneumatic tires may be permitted with prior written approval from the Owner Representative.

6. Scissors and utility knives used in the work shall have blades with rounded points. Marking pens or pencils used for identifying areas requiring work shall not contain wax, oil, or grease.

7. Tarpaulins of reinforced CSPE, about 10 ft by 10 ft in size, shall be spread out on the installed HDPE liner and floating cover material as a work area for storing soiled rags, tools, gasoline-driven equipment, or aggressive chemicals. Under no circumstances shall gasoline-driven engines or cans of gasoline or solvents be placed directly on the installed HDPE liner or floating cover material, or be stored within the reservoir overnight.

8. The Contractor shall take all precautionary measures required to protect the floating cover and installed HDPE liner. This shall include, but not be limited to, the geomembrane material itself, all field and factory seams, attachments at the anchor curb at top of slope, and the underwater seals to structures.

9. The Contractor shall conduct his work to minimize the movement of fugitive dusts from the site boundaries by using suitable Reasonably Available Control Measures.

B. Damage and Repairs to Installed Liner:

1. If damage occurs to the liner while placing the floating cover, the Contractor shall report it to the Purchaser immediately so that repairs can be performed without delay.

2. Repairs to liner components shall be made as specified in this Specification.

3. The Contractor shall perform all repair work at no additional cost to the Purchaser.

4. The Contractor shall coordinate all floating cover panel deployment and other work with WRPS personnel.

3.2 INSTALLATION

A. Panels:

1. The Contractor shall identify and repair any damage or defects to panels that occurred during shipping, unloading, storage, and installation.

2. Panels of floating cover material shall be carefully placed on the bottom and slopes of the reservoir in accordance with approved shop Drawings, and in such a manner as to assure minimum handling.

3. During installation of the floating cover, the Owner Representative shall have complete authority to order an immediate stoppage of the work because of inclement weather, the use of improper installation procedures, or any other reason that may result in a defective floating cover installation.

4. Seaming shall keep pace with the placement and spreading of panels such that panels will not be laid out unless they can be seamed the same day.

5. Floating cover material panels shall be deployed in sufficient time to allow panels to shrink, because of panel stretch during the manufacturing and/or fabrication process, prior to field seaming. The Contractor shall account for the panel stretch during the manufacturing process when ordering panel lengths.

6. Prior to punching holes in an individual floating cover panel to attach it to the anchor studs and prior to seaming it to previously installed adjacent floating cover panels, the Contractor shall straighten and pull taut, in both directions, the panel being installed, in order to remove wrinkles as much as possible. If

seaming equipment lifts the material off the substrate and leaves slack material along the seam, wherever possible the wrinkle so formed shall also be pulled out before the material is punched for anchor studs or seamed to adjacent panels. The Contractor shall continuously make every effort to remove all wrinkles in the floating cover.

B. Temporary Anchorage:

1. Sandbags shall be used as necessary to hold the floating cover material in position during installation, in order to protect it from damage or displacement due to wind.

2. During any discontinuity of the work exceeding 4 hours in length, the leading (unseamed) edges of all panels shall be secured with sandbags at not more than 3 ft on center. The Contractor shall be responsible for maintaining closer spacing as necessary to protect the work during all weather conditions.

3. Sandbags placed on slope shall be tied off at the top of slope to prevent their shifting or sliding down the slope.

4. Bags that are split, torn, or otherwise losing their contents shall immediately be removed from the reservoir area, and any spillage shall immediately be cleaned up.

C. Heat Seaming:

1. Machine-made heat seams shall be used on all field seams wherever practical.

2. Machine-made heat seams shall be made using hot air or hot wedge welding equipment. All machine heat seaming equipment shall be equipped with gauges that monitor voltage and temperature.

3. Hand-held heat seaming equipment may be used where machine-made heat seams are not practical and for miscellaneous seaming as approved by the Owner Representative.

4. All seaming shall comply with these Specifications and the Contractor QAP.

5. Contact surfaces to be seamed shall be cleaned with water and wiped dry with a cloth until all foreign matter, dust, dirt, and water has been removed. Only clean, colorfast, lint-free, cotton cloths shall be used in the work. Solvent wipe may be necessary, based on field conditions. Cleaning of the contact surfaces shall not be completed more than 10 minutes ahead of seaming. When conditions are adverse to proper workmanship such as high winds, or other conditions increase the probability of dirt or other foreign material being deposited on the contact surfaces, the time between cleaning and seaming shall be reduced as necessary to produce acceptable seams.

6. The Contractor shall follow immediately behind the heat seaming equipment, while the material is still hot from the initial seam, bonding the top edge of the

seam. The top edge of the seam shall be "stitched" by manually rolling the seam area with firm pressure with a 2-in. wide roller. Joints where three layers of membrane meet shall also be stitched to seal the potential leak path along the edge of the middle layer.

7. In the event a CSPE panel has been laid out and not seamed for a period of three days or more, the contact surfaces shall be solvent scoured and buffed to ensure a positive bond at the seam. The scouring procedure shall consist of hand buffing the contact surfaces with stainless steel scouring pads soaked in solvent to effectively penetrate and remove the oxidation layer. This scouring procedure shall be applicable to all panel-to-panel seams, patches, and seams for attachment of accessories.

8. Care shall be taken to avoid damaging the cover with the seaming equipment. The Contractor shall take the necessary precautionary measures to ensure the floating cover is not bonded to the underlying composite geomembrane liner during the seaming process.

D. Adhesive Seaming:

1. Adhesive may be used to make seams where heat seaming is impractical and for minor repairs, as approved by the Owner Representative.

2. Adhesive seaming shall comply with the manufacturer recommendations and the Contractor approved QAP.

3. Use of adhesives and solvents shall comply with the applicable regulatory requirements.

4. Contact surfaces of material to be seamed shall be wiped with a cloth until all foreign matter, dust, and dirt has been removed. Contact surfaces shall then be washed with clean cloths soaked with solvent to remove surface cure. Only clean, white, lint-free, cotton cloths shall be used in the work. When a cloth is more colored than white, it shall be removed and replaced. Surface cure is removed when the CSPE cover turns shiny and slick when wet and dull when dry. Removal of surface cure shall not be completed more than ten minutes ahead of seaming. When conditions are adverse to proper workmanship, such as high heat or winds, or when other conditions increase the probability of dirt or other foreign material being deposited on the contact surfaces, the time between washing and seaming may be reduced as necessary to produce acceptable seams.

5. Immediately before seaming, the contact surfaces of the floating cover material shall be heated to a warm (100ºF minimum) and dry condition with an electric heat gun, in accordance with the manufacturersmanufacturers printed recommendations.

6. Adhesive shall be liberally applied, by brush or roller, to one of the contact surfaces over a length of approximately 2 ft and the two contact surfaces shall then be immediately brought together. Adhesive shall be glistening with the appearance of moisture at the time the contact surfaces are brought together,

without any sign of drying (surface skinning). In applying the adhesive, care shall be taken to "tie-in" to the end of the seam previously completed so that leak paths or weak points in the seam do not occur at seam start and stop increments.

7. As soon as the contact surfaces are brought together, the seam shall be “stitched” by manually rolling the seam area with a 2-in. wide roller in a direction perpendicular to the seam, with firm pressure. A small amount of adhesive shall extrude and appear at the top edge of the seam to indicate that a sufficient amount of adhesive has been applied.

8. In the event a CSPE cover panel has been laid out and not seamed for a period of three days or more, the contact surfaces shall be solvent scoured and buffed to ensure a positive bond at the seam. The scouring procedure shall consist of hand buffing the contact surfaces with stainless steel scouring pads soaked in solvent to effectively penetrate and remove the oxidation layer. This scouring procedure shall be applicable to all panel-to-panel seams, patches, and seams for attachment of accessories.

9. Care shall be taken to avoid damaging the composite geomembrane liner with the seaming equipment. The Contractor shall take the necessary precautionary measures to ensure the floating cover is not bonded to the underlying composite geomembrane liner during the seaming process.

E. Joinings:

1. Panels to be joined in the field shall be lapped as shown on the Drawings. After the initial seal of the lap joint has been made, all exposed free edges of the floating cover shall be resealed, using hand-held equipment, to eliminate all free edges. The top edge of all seams shall be fully bonded. Loose edges will not be allowed on the top side of the floating cover.

2. Butt joints shall be used only where lap joints are not possible and as approved by the Owner Representative. Butt joints shall be formed using joint cover strips made from the same fabric-reinforced floating cover material, continuous in length, and as shown on the Drawings. The joint cover strip shall be centered over the butt joint and shall be fully bonded across its entire width. Butt joints shall be installed in accordance with the same procedures for lap joints specified herein.

3. All seams, field and factory, shall be staggered a minimum of 12 in. to ensure that no more than three layers of material meet at a joint.

4. Where three layers of material occur at a "T" joint (field seams, factory seams, and rollstock splices), care shall be taken to seal the small leak path that would otherwise occur along the edge of the middle layer. The upper layer shall be heated and rolled to conform or "step-down" and seal the leak path. In addition, the area shall be solvent wiped and sealed with a high-solids adhesive and then covered with a 4-in. round 40-mil minimum unreinforced CSPE patch. The

center of the patch shall be placed at the intersection of the edges of the top and middle layers of the membrane.

5. Seam preparation shall be in accordance with the requirements stated herein, the manufacturer printed recommendations, and the applicable regulatory requirements.

6. Care shall be taken to avoid fishmouths, wrinkles, pleats, folds, and tucks in seams. Any such defects shall be prevented by tugging on the seam just completed, in the opposite direction from which the seam is progressing, during the seaming process. The Contractor seaming crew shall give continuous attention to the elimination of all such defects to prevent their occurrence. Regardless of the location or cause of such defects, they shall be slit out far enough from the seam to dissipate the defect.

7. The slit edges shall then be lapped and field seamed. Wherever the lap width is less than 2 1/2 in., the defect shall be repaired with a joint cover strip made from the same fabric-reinforced floating cover material.

8. Field seams shall not be made if the ambient temperature or humidity would result in inferior seams.

9. Where fabric-reinforced CSPE material has been cut and thus exposes the fabric, the cut edge, if exposed to view after installation, shall be solvent wiped and sealed with a high-solids adhesive. Specifically, the acceptable treatment options for the cut and exposed fabric at the various locations shall conform to the following table.

Location of Exposed Fabric	**Treatment**		**No Treatment**
	Cap Strip	**High-Solids Adhesive Seal**	
Floating Cover in general		X	
Sand Tubes			X
Tension Attachment Tabs		X	
Field Seams: • Cover in general (with cut scrim)		X	
Hatch: • Float Wrap • Cut Openings • Reinforced Joint Cover Strip			 X X X
Walkways		X	
Structural patches		X	
Nonstructural patches			X
Cut edges along anchor curb at top of slope			X

F. Water Elevation Markers:

1. Water elevation markers shall be installed on top of the floating cover at the locations shown on the Drawings.

2. Location of water elevation markers shall be established by a licensed surveyor. The Contractor shall be responsible for coordination and cost associated with the surveyor services.

3. The water elevation markers shall be fully bonded across the entire contact surface and shall be installed in accordance with the requirements of this Section.

4. After the initial seal has been made, all loose edges of the water elevation marker material shall be resealed, using the same procedure, to eliminate all free edges. The cut edges of the water elevation markers shall be solvent-wiped and sealed with a high-solids adhesive.

5. After the water elevation marker is fully bonded to the floating cover, the top CSPE surface of the water elevation marker shall be solvent wiped to remove all dirt or excess adhesive, which may have been spread on top of the marker during the process, to insure the top surface of the water elevation marker material remains clean and contrasting color.

G. Anchorage and Fastenings:

1. Floating cover material shall be anchored at the concrete anchor curb as shown on the Drawings.

2. The floating cover material at the top of slope anchor curb shall be installed on the anchor studs by either of the following listed methods.

   a. Anchor bolt holes shall be neatly punched using a tool that removes the material to form a neat hole 1/8-in. less in diameter than the penetrating stud diameter. The floating cover material shall be forced over the stud in such a manner to prevent damage to the cover or the stud.

   b. The floating cover material may be forced onto the anchor studs using a pipe section with an inside diameter slightly larger than the anchor stud diameter (1/2-in., schedule 40 pipe for 1/2-in. anchor studs), thus punching the floating cover material around the anchor stud. This method will result in no removal of floating cover material at the anchor bolts.

3. Oversized, cut, or irregular shaped holes will not be allowed.

4. Anchor bolt holes created by any other means shall not be accepted, unless specifically approved by the Owner Representative.

H. Tension System:

1. Install towers and attach tensioning cables to cover and tower in accordance with approved submittals.

I. Rope:

1. The rope shall be installed in the hem at the top of slope cover attachment, as shown on the Drawings, such that the rope hem is installed snug to the attachment bar.

J. Walkway Steps:

1. Walkway steps shall be fully seamed to the top of the floating cover, as shown on the Drawings.

2. Walkway steps shall be laid flat and parallel to the slope. Puckered or skewed walkway steps shall not be acceptable.

K. Sand-Filled Tubes:

1. After installation of sand-filled tubes on floating cover, all sand tubes shall be punctured with an awl on both sides at 12 in. on center to create “dimensionless” holes to allow saturation of the sand when the tubes are submerged in rainwater. The use of a blade for this purpose is not permitted. This work shall be witnessed by the Owner Representative.

3.3 REPAIRS

A. Punctures, cuts, tears, abrasions, and similar damage or abuse to the fabric-reinforced floating cover material shall be repaired to the satisfaction of the Owner Representative.

B. All repairs shall be considered either structural or non-structural.

1. Non-structural repairs shall be defined as pinholes and abrasions, where the scrim is intact and has not been cut or otherwise damaged.

2. Structural repairs shall be defined as all other defects.

C. Non-structural repairs shall be performed using CSPE patches as described in Part 2. Patches shall be cut from flat unwrinkled material. Patches shall be of sufficient size to extend a minimum of 2 in. beyond the limits of any puncture, pinhole, or abrasion.

D. Patches for structural repairs shall be cut from flat, unwrinkled floating cover material, and shall be free of defects, field seams, and factory seams. Patches shall be of sufficient size to extend a minimum of 3 in. in all directions beyond the limits of any puncture, cut, tear, or abrasion.

E. All patches shall be neat in appearance with corners rounded to a minimum 1-in. radius.

F. Patches shall be applied as specified previously for heat seaming or adhesive seaming. The parent material shall be carefully pulled and held flat in the area to be patched as to provide an acceptable surface to receive the patch.

G. All patches shall be fully bonded across their entire width.

3.4 QUALITY ASSURANCE / QUALITY CONTROL

A. The Contractor QA/QC testing shall keep pace with the deployment and seaming operations to identify all problems at the earliest possible point in time and documented daily.

B. Equipment Calibration:

1. The seaming equipment shall be calibrated by testing trial seam samples in accordance with the Contractor QAP, but shall not be less than at the beginning of each shift, every four hours, and any significant environmental changes.

2. Field seam samples shall be collected and tested in accordance with the provisions stated herein (peel strength, breakaway peel strength, and tensile strength). The field seam calibration verification testing may be performed by on-site personnel. The Contractor shall submit the daily calibration test results to the Owner Representative as part of the final QA report.

3. The testing equipment shall be calibrated at least once every 12 months by an agency certified to conduct such calibration, and a label attesting to such calibration shall be affixed to the testing equipment.

4. No daily field seaming shall be performed until all the calibration samples have been tested and passed.

C. Seam Testing:

1. The Contractor shall have tests performed by a third party, at their own expense. All testing shall be performed to ensure that the CSPE shop seams and field seams meet the following listed requirements.

   a. Peel Strength Test:

      i. Factory and field test samples shall be tested for peel strength in accordance with the requirements of ASTM D413, Machine Method, Type A.

      ii. A minimum of five test specimens shall be tested from each test sample.

   b. Breakaway Peel Strength Test:

      i. The breakaway peel strength of a seam in 180-degree peel is the minimum level at which the seam separation is deemed acceptable and that portion of the seam that separates below the stated minimum required breakaway peel strength is not considered part of the seam.

ii. Factory and field seams shall be tested in 180-degree peel by static test in which a weight is suspended from a 1-in. wide seam specimen and held for a minimum of 5 seconds.

iii. For heat seams, a 21-pound weight shall be suspended immediately after the seam has been allowed to cool.

iv. For adhesive seams, a 15-pound weight shall be suspended after 12 days.

v. The effective seam width shall be determined by measuring the scrim-to-scrim overlap of the seam following the breakaway peel strength static test.

vi. A minimum of five test specimens shall be tested from each test sample.

c. Tensile Strength Test:

i. Specimens from any given factory or field seam test sample shall be 4 in. wide, with a length equal to the specified seam width plus 9 in.

ii. Factory and field test samples shall be tested in accordance with the requirements of ASTM D751 (modified method).

iii. A minimum of five test specimens shall be tested from each test sample.

2. A seam shall be deemed acceptable if ALL the specimens from each test seam sample location satisfy all of the following listed requirements.

a. The effective seam width is equal to or greater than the minimum width specified on the Drawings, as measured at the conclusion of the breakaway peel strength test.

b. A minimum peel strength equal to or greater than 21 pounds per inch of seam width.

c. Failure by delamination from the scrim rather than in the plane of the seam.

d. A minimum seam tensile strength equal to 90% of the value specified for the parent material.

3. Test results not meeting these requirements shall be cause for rejection of the seam from which the test sample was taken.

D. Test Samples:

1. Samples of factory and field seams shall measure not less than 14 in. wide by 72 in. long with the seam parallel to the 36-in. side, and down the middle of the sample.

2. A minimum of five test specimens for each of the above tests (peel strength, breakaway peel strength, and tensile strength) shall be taken from each test sample.

3. All test samples shall be provided by the Contractor at their expense.

4. Field and factory seam samples shall be numbered, dated, and identified as to the personnel making the seam from which the sample is taken, the seaming method being used, and the temperature and weather conditions at the time of seaming. Each test sample shall be keyed to its general location on the seam from which it is taken by appropriate notes or markings on a Drawing, furnished by the Contractor, for future reference.

E. Testing of Factory Seams During Fabrication:

1. The Contractor shall have the fabricator provide and have tested, by a GRI-accredited laboratory, samples of factory seams taken from the fabricated panels at the factory.

2. One test sample per 5,000 linear feet of rollstock-to-rollstock shop seams, or one test sample per panel, whichever yields the greater number of samples, is required. Each sample shall be tested for all of the above tests (peel strength, breakaway peel strength, and tensile strength).

3. The certified test results of specimens from each sample shall be submitted to the Owner Representative for review and approval prior to installation of panels represented by that sample.

4. Patching of sampled seams may be done in the field after installation of the affected panel, at Contractor option.

F. Testing of Field Seams During Field Installation:

1. The Contractor shall test samples of field seams taken from installed fabricated panels.

2. One test sample per 500 ft of panel-to-panel field seam shall be tested for the above tests (peel strength, breakaway peel strength, and tensile strength).

3. If any test results are not satisfactory, the Owner Representative, at their discretion, may require that additional sampling and testing be done at Contractor expense.

G. In addition to all sampling and testing described above, WRPS may, at their discretion, require the Contractor to provide WRPS with additional samples of any field or factory seam, for testing by WRPS, at WRPS expense.

H. The testing laboratory and the Contractor shall certify all test results. Five copies of the certifications and test results shall be submitted to the Owner Representative.

I. Air-Lance Testing:

1. Prior to performing air lance testing, the Contractor shall check the seams and patches with a metal probe (such as a wire 1/16-in. maximum diameter with the point slightly rounded).

2. All factory seams, field seams, joint cover strips, doublers, and patches shall be air-lance tested. Air-lance tests shall be performed in the field by the Contractor in the presence of the Owner Representative during daylight hours. Leak paths or suspect areas revealed by these inspections shall be marked and repaired.

3. The air-lance shall have a 1/8-in. diameter orifice. Pressure at the orifice shall be between 60 and 80 psi. The jet of air shall be directed at the edge of seams and patches to affect the lifting of unbonded edges. The air-lance testing shall be done in a manner to allow the Contractor QA/QC personnel sufficient time to observe and document any leaks or suspect areas. No defects found during probing shall be repaired until the defect is tested by air-lancing.

4. Field probing and air-lance tests of factory seams shall be required, even if those seams have previously been air-lance tested in the factory.

J. Post-Installation Inspection:

1. After installation is complete, the Contractor and the CQA Inspector (Testing Agency) shall conduct a detailed walk-down to visually check all seams and non-seam areas of the cover. The inspection shall look for imperfections including verification of tight seams and joints, defects, holes, blisters, tears, and signs of damage.

2. All defects, holes, blisters, tears, signs of damage during installation, areas of undispersed carbon, and holes from destructive or non-destructive testing shall be marked and repaired.

3.5 CLEANUP

A. Cleanup within and around the reservoir shall be the ongoing responsibility of the Contractor throughout the course of the work. Particular care shall be taken to ensure that no dirt, scrap material, trash, tools, or other unwanted materials are trapped between the composite geomembrane liner and the floating cover.

3.6 POST-CONSTRUCTION REPAIRS

A. In addition to any other requirement specified in the contract documents, after the 11th month of the 12-month guarantee period, and prior to the end of said guarantee period, the Contractor shall contact WRPS and arrange a joint inspection of the floating cover. The Contractor shall make repairs and adjustments to the floating cover or its appurtenances as required to correct defects or problems that are evident or discovered during said inspection, or are otherwise covered under the guarantee or any warranty, and which have been determined by WRPS to be necessary. The guarantee shall continue in effect until this joint inspection is conducted and all required repairs and adjustments discovered are made, or until the end of the 12th month, whichever is later.

END OF SECTION 33 47 16.13

SECTION 40 05 10

ERECTION OF PIPING

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Requirements for installing above ground and below ground piping including appurtenances, fittings, thermocouple wells, in line instruments, piping specialty items, valves, pipe supports, auxiliary steel and other accessories specified on project Drawings, design Drawings, data sheets, and/or other documents.

B. For stainless steel piping, work shall include, but not be limited to the following:

1. Receive, unload, store, protect, remove from storage, erect, and install, including pipe supports, fabricated piping, and appurtenances. All erection work shall be performed per the design Drawings and documents.

2. Cut into existing pipe systems, when specified on the design Drawings or documents.

3. Furnish necessary welding rod including rod required for training welders and for field erection of large bore piping and tubing.

4. Select the type and quantity of welding rod required for field erection of all piping.

5. Perform all NDE as required by applicable code.

6. Perform hydrostatic or pneumatic testing as specified or per the applicable code.

7. All temporary piping required for hydrostatic testing shall remain the property of the installation Contractor.

C. For underground buried non-metallic pipe, work shall include, but not be limited to the following:

1. Receive, unload, store, protect, remove from storage, erect and install, underground buried non-metallic pipe and appurtenances. All erection work shall be performed per the design Drawings and documents.

2. Cut into existing pipe systems, when specified on the design Drawings or documents.

3. Perform hydrostatic or pneumatic testing as specified or per the applicable code.

D. The project-specific materials and equipment quantities and attributes are shown on the project Drawings, equipment list, data sheets, valve design tables, piping specialty list, piping design tables, pipe line list, piping specialty list, valve list, instrument list and/or other documents.

E. Testing of completed piping installations/modifications.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. Section 05 50 00, Metal Fabrication

B. Section 09 91 00, Painting

C. Section 22 08 13, Testing for Piping

D. Section 40 41 00, Heat Tracing for Process Piping and Equipment

E. Section 40 42 13, Thermal Insulation for Piping and Equipment

F. American Society of Mechanical Engineers (ASME)

ASME B1.1	Unified Inch Screw Threads, UN and UNR Thread Form
ASME B31.3	Process Piping

G. ASTM International (ASTM)

ASTM A36	Standard Specification For Carbon Structural Steel
ASTM A312/A312M	Standard Specification For Seamless, Welded, And Heavily Cold Worked Austenitic Stainless Steel Pipes

H. American National Standards Institute (ANSI)

ANSI B16.5	Pipe Flanges And Flanged Fittings Nps 1/2 Through Nps 24 Metric/Inch Standard –Revision Of ASME B16.5–1996
ANSI B16.34	Valves – Flanged, Threaded, And Welding End

I. American Welding Society (AWS)

AWS D1.1	Structural Welding – Steel

J. Washington Adminstrative Code (WAC)

WAC 173-303-640	Dangerous Waste Regulations Washington State (NOTE: This requirement only applies to the EMF and 242-A condensate lines into Basin 41. WAC 173-303-640 does not apply to inter-basin transfer piping.)

1.3 SUBMITTALS

A. Submit the following documents and other documents as required, for review in accordance with submittal requirements.

1. Test results,

2. Erection Drawings, and

3. As built Drawings.

1.4 QUALITY ASSURANCE

A. Comply with all requirements of ASME B31.3 or other designated piping code, as applicable.

B. Specified Products and Substitutions:

1. Mention of products or components by name as products of certain manufacturers is made to ensure that the proper quality and/or type are provided. Products of other manufacturers may be offered as substitutes with the bid proposal if the installation Contractor furnishes proof to the engineers that the proposed substitute products are equal to or better than the specified products in quality, performance, design, and suitability for the intended use. Any purchase of proposed substitute products by the installation Contractor prior to acceptance by the engineers, will be at the risk of the installation Contractor.

1.5 DELIVERY, HANDLING, AND STORAGE

A. The installation Contractor shall obtain complete information from the manufacturer regarding the number of pieces and size in which the equipment will be shipped and the date of shipment of each item.

B. The installation Contractor shall be responsible for the equipment and material to be unloaded and/or erected from the time of their arrival at the site, until the work is accepted in its entirety by purchaser, except during such time as said equipment or material are removed from the control of the installation Contractor by specific instructions of purchaser. If said equipment or material arrives at the site after the award of contract, but before the arrival of the installation Contractor on the job site, the installation Contractor shall have complete responsibility for the equipment or material while they are being unloaded and handled for him by others.

C. Upon receipt of equipment shipment, the installation Contractor shall check quantities against invoices for shortages and inspect for visible damage. Before offloading any equipment, the installation Contractor shall immediately notify the purchaser when material has been lost or damaged during shipment. The installation Contractor shall make the shipment available for inspection by the carrier before moving or unloading. Purchaser reserves the right to inspect materials during and after unloading to verify shop workmanship and determine if any corrective work will be necessary.

D. Upon arrival of the equipment and material at the project site, the installation Contractor shall ensure that each seal on equipment connections and piping ends is intact. If cap, plug, or other type of seal is missing upon arrival of the equipment or material, it shall be cleaned immediately of all foreign material and resealed. The installation Contractor shall maintain seals during the course of the work, except where otherwise necessary.

E. During the storage period, all stored material and equipment shall be periodically inspected for tightness of seals.

F. Equipment and material stored outdoors shall be above grade and protected against dirt, fly ash and inclement weather conditions up to the time of field fabrication or erection; all temporary material for such protection shall be furnished by the installation Contractor.

G. The installation Contractor shall be responsible for paying any demurrage accumulated on cars due to failure to unload equipment from cars. Any handling of such cars on plant property beyond the point of delivery of the cars by the delivering carrier shall be at the expense of the installation Contractor.

H. The installation Contractor shall maintain records, for the control of receipt, protection, and disbursement of purchaser equipment and material. A record shall be made of all equipment and material that is received and accepted or rejected. The record shall be agreed upon with the purchaser.

I. The installation Contractor shall unload and store all spare parts, spare supplies, and maintenance tools furnished with the equipment. Maintenance tools shall not be used for the erection work, unless otherwise permitted by the purchaser.

J. Welding rod shall be packaged in appropriate durable containers to limit exposure to elements known to be detrimental to the life and quality of the product.

K. Buried Pipe:

1. Piping placed in storage shall be stored off the ground using padded bolsters and plain timbers under the uncoated ends. Suitable wedges shall be used to preclude rolling. Pipe shall be stored on flat, well-drained ground whenever possible.

PART 2 PRODUCTS

2.1 COMPONENTS

A. Piping, Appurtenances, and Accessories:

1. Provide all necessary miscellaneous piping, vents, drains, and piping accessories and appurtenances indicated on Design Drawings (except where specifically indicated to the contrary on project Drawings or lists), including, but not limited to, fittings, pipe supporting elements, bypasses for piping and specialties, insulation supports, pipe saddles for insulation protection, unions, couplings, pipe flanges, gaskets, bolting, and nozzles.

2. Provide such other miscellaneous piping, vents and drains, pump gland and packing connections, and appurtenances, which may not be shown on the Design Drawings but which may be required to complete the work and to make the piping system and equipment function properly.

B. Manufacturer: All components shall be of manufacturer and type indicated in this Specification or on the design Drawings, shall be of material suitable for the pressure-temperature conditions in each case, and shall be acceptable to the consulting engineers.

C. Miscellaneous Appurtenances: Install various instruments, controls, and other appurtenances, such as float cages, level-trolls, gauge glasses, remote level indicators, high and low water level alarms, safety valves, relief valves, control valves, etc., furnished by others. Provide all pipe, fittings, and valves required for proper installation of the foregoing appurtenances.

D. Miscellaneous Piping for Appurtenances: Provide all interconnecting piping, unions, and valves required in conjunction with all regulating, flow control, pressure-reducing, and float and pilot valves, whether such valves and accessories are furnished by purchaser or the installation Contractor, except where such piping is specifically noted to be furnished by others.

E. Temporary Strainers: Provide a temporary strainer, including differential pressure gauge, and replacement spool pieces, if required, in the suction line to pumps where called for in this Specification or on the Drawings. Strainer shall be as detailed on the Drawings, and if not detailed on the Drawings, it shall be of design and type acceptable to the consulting engineers. Remove strainers and, if required, replace with spool pieces when so instructed by the consulting engineers.

2.2 FABRICATION REQUIREMENTS

A. Shop Fabricated Piping:

1. It is the responsibility of the shop fabricator to coordinate with the installation Contractor for field specific fit-up requirements.

2. The installation Contractor shall review the pipe spool Drawings. It is the responsibility of the installation Contractor to give feedback to the engineer regarding field fit-up requirements.

3. It is the responsibility of the installation Contractor to review and evaluate the location of the field welds on the Drawings, and to give feedback to the consulting engineers whenever field weld location needs to be relocated.

B. The installation Contractor may set up a temporary piping fabrication shop on the project site for field-routed piping.

C. Protection of Field Fabricated Materials:

1. Materials shall be provided with protection against damage, corrosion, and internal contamination in accordance with the following:

a. All materials and equipment shall be packaged, packed, or prepared in a manner that will ensure arrival at destination in satisfactory condition. Procedure and details shall be submitted to purchaser for review prior to start of shipment.

b. All openings in piping and equipment furnished by the installation Contractor shall be securely plugged, capped, or otherwise blanked off, sealed with tape, and suitably protected against damage and entry of foreign materials and moisture. For shop-fabricated piping, this shall be done as soon as possible after shop cleaning.

c. Weld ends on all valves, fittings, pipes, nozzles, etc., shall be capped and sealed with suitable, firmly attached protectors.

d. Protectors for beveled ends designed for backing ring or consumable insert shall have a plywood or hardboard liner disc held securely against the beveled end. Protectors for other weld ends may be metal caps without liner discs. Protectors shall not be welded to the weld end.

e. All flanged connections and loose flanges shall be provided with suitable full-face flange protectors bolted in place and sealed.

f. All protectors for openings and all braces, brackets, spacers, ties, bindings, and other shipping, packaging, and packing materials and appurtenances used for protection in shipping, storing, and handling of nonferrous piping and materials shall be of such design, type, and/or arrangement as to prohibit contact between ferrous and nonferrous materials.

PART 3 EXECUTION

3.1 GENERAL

A. Completeness of Work: It shall be the responsibility of the installation Contractor to furnish the services of all trades necessary to complete the work covered by this Specification. All systems shall be placed in successful service by the installation Contractor to the satisfaction of the consulting engineers.

3.2 PREPARATION

A. Removal and Relocation of Present Work: Remove, relocate, and modify any present piping requiring such work, as indicated.

B. Connections to Present Work: Remove blind flanges on existing piping to which the work connects, cut or burn openings and weld to present piping, install and remove such temporary and permanent blind flanges, pipe plugs, shutoff valves, etc., as may be necessary during the progress of the work, and do all other similar work as may be reasonably required to complete the work. All cut-ins or connections made to existing systems shall be done only at such times as purchaser may designate. As a safety measure, the installation Contractor shall determine that a system, or portion thereof, is shut down or isolated, and all hold card procedures have been implemented, before cutting in or making connection thereto.

3.3 ERECTION OF PIPING

A. Erection of the piping, including valves, pipe-supporting elements, and appurtenances, shall be done in an orderly and workmanlike manner and shall be scheduled to suit the requirements of the project. In addition to other applicable requirements specified herein, the following specific piping system erection requirements shall apply:

1. Minimum of joints: Throughout the entire system there shall be as few joints as possible.

2. Diagrammatic connections: Any connections that are indicated only diagrammatically on the design Drawings shall be installed in a neat and workmanlike manner, subject to acceptance by purchaser.

B. Alignment and Drainage:

1. Piping shall be erected to preserve accurate alignment. The installation Contractor shall check field measurements and allowance for makeup lengths or “closures” as may be necessary for accurate alignment and assembly, prior to fabrication and installation.

2. Pipe runs in which drainage is required shall be properly pitched to points of drainage.

C. Terminals: Where the work connects to equipment or piping furnished in place by others, such connections shall be made by the installation Contractor, who shall properly complete the connections, in each case.

D. Closure: All piping shall be worked into place and the closing weld made without springing or forcing. It is the responsibility of the installation Contractor to maintain surveillance of the piping system during erection to ensure that no stress from misalignment is imposed, and that dimensional requirements are met. Any discrepancies shall be noted to purchaser representative. This should include a review of the piping supports in the field to ensure that they are properly located and adjusted to the design position. Neutral points shall be maintained.

E. Miscellaneous Small Connections: All openings for vents, drains, instruments, controls, and other similar connections made after the piping system is erected shall be drilled and the internal area cleaned out. No burning will be permitted.

F. Clearance for Insulation: Piping shall be installed with suitable clearance being allowed for insulation where pipes cross or run in parallel, or where pipes run close to equipment or building structures.

G. Attachments for insulation, pipe supporting elements, and handling where attachments to piping furnished by others and erected by the installation Contractor are required, but not furnished and/or installed by others; the installation Contractor shall furnish and/or install such attachments.

H. Cutting, Drilling, etc., of Building Structure:

1. The installation Contractor shall do all necessary cutting or patching of concrete.

2. The installation Contractor shall furnish and/or install anchors and/or anchoring facilities. Where details are not shown on the Drawings, the installation Contractor shall submit details to purchaser for review and acceptance.

3. The installation Contractor shall perform all necessary drilling of building structural steel required to complete the work. Drilling shall be strictly in accordance with the details on the design Drawings. Burning of holes in steel will not be permitted.

I. Temporary Support:

1. The installation Contractor shall furnish and install temporary supports or bracing as required, such as at the following times.

   a. During hydrostatic testing or leak testing by the installation Contractor, to prevent undue stress on the permanent piping supports of the system and to withstand the weight of water without excessive deformation.

2. The installation Contractor shall remove any/all temporary supports, anchors, and bracing furnished by others, as well as that furnished by the installation Contractor, from piping erected by the installation Contractor, at the following times.

   a. All temporary facilities for aboveground piping, after final and successful field leak testing.

J. Flanged Joints:

1. Contact face finish: Contact faces shall be as set forth in the piping design tables referenced the design Drawings for each particular service. All raised face flanges shall have serrated facing. Contact faces for all male and female, and tongue and groove faced flanges shall have smooth tool finish, unless otherwise indicated.

2. Gaskets:

   a. Gaskets for all joints shall be of such inside dimensions that no portions will project into the ports of valves, pipes, or fittings. Gaskets for male and female joints, and for tongue and groove joints, shall fit into the female or groove facing with approximately 1/32 in. clearance. Gaskets for raised-face joints shall extend to within 1/16 in. of the bolts. Plain-faced flanged joints shall have full-face gaskets with holes for bolts, unless otherwise indicated.

b. Gaskets shall be as set forth in the piping design table for each particular service.

c. Spiral-wound metal gaskets shall be of manufacturer and style set forth in the pipe design tables.

i. When ordering spiral-wound metal gaskets, the installation Contractor shall specify complete joint data for each specific application, including:

- Service (fluid to be handled by piping) and operating pressures and temperatures.
- Flange material and pressure class.
- Type of flange facings.
- Bolting materials.

3. Studs:

a. All alloy steel studs shall have identification marks at one end, covering material, class, etc. Studs for low-temperature and high-temperature work shall not be interchanged when installing.

b. All steel bolts shall have Class 2a fit threads, and all nuts for steel bolts shall have Class 2b fit threads, per ASME B1.1.

4. Thread compound: Threads of all bolts and studs shall be painted with a suitable thread compound before joint is made up. The compound shall be suitable for the operating temperatures involved.

5. Faces of flanges and gaskets shall be wiped clean when making up all flanged joints.

6. Contact faces of all flanged joints shall come squarely together and particular care shall be exercised in pulling up flanged joints to prevent any overstressing of flanges, bolts, or studs.

7. No permanent fillers shall be used between flanges, except where specifically indicated on the Design Drawings.

K. Pipe Supports:

1. Unless otherwise indicated, the installation Contractor shall provide all engineered and standard supports, anchors, guides, braces, and snubbers as required for the entire piping system (including valves, vessels, and other associated piping components) furnished and/or erected by him. This shall include all necessary structural steel (auxiliary steel or supplemental steel) to connect to purchaser steel in place, unless otherwise indicated.

2. Welding of pipe support lugs or supplemental steel to purchaser structural steel in place shall be in accordance with AWS D1.1.

L. Protection:

1. For piping that is field fabricated by the installation Contractor, all openings of the fabricated piping and remaining cut pipe shall be provided with protectors, as soon as possible after cleaning. Protectors shall remain in place until removal is necessary for connection thereto.

2. If connections to piping erected by the installation Contractor are to be made by others, the installation Contractor shall ensure that the associated terminal connections are provided with protectors. Where such terminals are located in an area where they may be subject to damage from other operations at the project site or constitute a hazard, the installation Contractor shall provide barricades and/or warning signs around the terminals.

3. The installation Contractor shall, at the end of each working day, ensure that all remaining openings in piping erected and all new openings made existing piping are provided with temporary protectors.

3.4 FIELD WELDING

A. It is the responsibility of the installation Contractor to review and evaluate the location of the field welds on the Drawings, and to give a feedback to the consulting engineers whenever field weld location needs to be relocated.

B. Field welds in piping systems requiring a high degree of cleanliness and a relatively smooth contour at the inside of the welded joint shall be made using the gas tungsten arc process for the first welding pass. The remaining weld passes shall be made using one of the processes listed previously. All gas tungsten arc welds shall be made with the addition of filler metal.

C. Welding filler metal chemistry shall match that of the base material, unless otherwise specified. Similar metallurgical properties, i.e., yield strength equal to or greater than base metal, equal or better corrosion-erosion resistance, and equal or better thermal properties shall be produced.

D. The application of heat to correct weld distortion and dimensional deviations in austenitic stainless steels is prohibited.

E. Preparation of weld ends and fit-up shall be in accordance with the requirements of ANSI/ASME standards. Base metals for butt weld joints shall be prepared by machining or mechanized oxygen cutting. In specific instances where the use of the above equipment is impractical, written permission from the Owner must be secured if hand oxygen cutting is to be substituted. All slag, irregularities, and thermally affected areas shall be removed from oxygen cut ends and hand ends shall be ground smooth.

F. Backing rings shall not be used in any piping system without prior written approval of the Owner. Backing rings, where allowed by Owner, shall be of the flat split ring type. The material of the backing rings shall be compatible with the composition of the pipe with which it is used.

G. Welding pre-heat and interpass temperature shall be maintained in accordance with the requirements of the applicable code. Electric or gas heat sources, which provide a uniform application of heat over the weld area, shall be used in accordance with ANSI/ASME B31.3.

H. Stress relieving of all welds shall be performed in accordance with the requirements of the applicable piping code. All welding zones, bends, and hot-formed sections shall be fully stress relieved as required by the applicable code.

I. Wherever possible, stress relieving shall be performed by slowly heating the entire assembly to the specified temperature, holding the temperature for the required length of time, and then allowing the assembly to cool. Where this procedure is impractical, local stress relieving may be employed.

J. Pipe bending shall be used only when specifically required or where the use of elbows is impractical. All bends shall be smooth, without buckles and truly circular. The allowable flattening, as determined by the difference between the minor and major axes, shall not be greater than 5% of the nominal diameter. Allowance shall be made for thinning of the pipe wall in accordance with the requirements of ASME B31.3 to assure that minimum wall thickness after bending is not less than the minimum wall thickness required.

K. All lugs, ears, and other attachments for support of piping shall be welded to the piping. Attachments for piping systems that must be stress relieved shall be welded to the pipe prior to final stress relieving. Attachments on shop fabricated piping which must be stress relieved shall be shop welded to the piping.

L. Field-welding on pressure parts shall be stress relieved as required by applicable codes.

M. The installation Contractor shall submit welding procedures, stress-relieving procedures, and procedure qualification records to the Owner for review and approval prior to performing any welding.

N. Any combustible material or electric cables beneath or adjacent to welding operations shall be protected against sparks, splatter, and molten material. The installation Contractor shall ensure that safe conditions exist prior to and during any welding in areas where coal dust and/or gas may be present. The installation Contractor shall be responsible for supplying any portable ventilation or other equipment necessary to ensure that safe conditions exist and are maintained.

O. All welds that have been made by the installation Contractor for temporary attachment shall be properly removed and the surfaces of the present work shall be finished clean and smooth. Appropriate NDE shall be implemented to verify there are no resultant defects.

P. Fiberglass Joints:

1. Joints in fiberglass reinforced plastic piping shall be as required by the application. All joints shall be made by certified joiners or bonders. Copies of certifications shall be made available to the Owner upon request. Individuals shall be trained and certified by the manufacturer for the specific pipe brand, type of joint, and pipe sizes to be used.

3.5 FIELD QUALITY CONTROL

A. Inspection and Testing:

1. The piping components (including valves), fabricated piping, and the installation of the piping shall be tested and/or inspected in accordance with the applicable requirements of the governing code(s).

2. Components furnished by the installation Contractor: Per the requirements of the applicable ASTM or ASME material and ANSI dimensional Specifications, and the governing code.

3. Leak testing of piping systems: Prior to initial operation, the installation Contractor shall perform a leak test on each part of the system erected at the operating pressure and temperature in accordance with the requirements of the following unless otherwise indicated in this Specification:

   a. Hydrostatic test: The following systems shall be given a hydrostatic test per ASME B31.3.

   b. All outdoor, as well as indoor, piping buried in the earth or encased in concrete, except drains and vents operating at atmospheric conditions.

4. Initial service leak test: All piping not hydrostatically or pneumatically tested, including any portions of piping under the preceding paragraphs having the specified hydrostatic or pneumatic test waived by purchaser representative.

5. Test pressures and temperatures: As set forth in ASME B31.3 or the applicable piping code and as follows:

6. Water used for the hydrostatic tests shall in no case be less than 70°F or greater than 125°F for all systems.

7. The hydrostatic test pressures shall in no case exceed the adjusted pressure-temperature rating for 100°F as given in the ANSI standard for steel pipe flanges and flanged fittings (ANSI B16.5) and the ANSI standard for steel valves (ANSI B16.34) for the material and pressure standard involved.

8. Water used for hydrostatic testing of stainless steel piping shall be potable and not have a chloride content exceeding 100 mg/liter. The minimum temperature of the water used for hydrostatic testing shall be 70°F.

9. Where piping installed by the installation Contractor connects to new piping installed by others, leak testing of the system shall include the testing of such piping installed by others, unless otherwise indicated.

10. Notify WRPS Construction Representative at least 24 hours (1 working day) in advance to arrange for onsite witnessing of the above described testing (a hold/witness point) by an Independent Qualified Installation Inspector (IQII), or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640. (**Note**: This requirement only applies to the EMF and 242-A Condensate Lines into Basin 41. WAC 173-303-640 does not apply to inter-basin transfer piping.)

B. Temporary Field Testing Facilities and Services:

1. The installation Contractor shall furnish, install, and remove blind flanges, pipe plugs, caps, spools, etc., and make all temporary connections necessary for field test by the installation Contractor.

2. The installation Contractor shall disconnect and reconnect assemblies where it is necessary for tests by the installation Contractor. Equipment, with pressure limitations lower than the test pressure to be used, and instruments shall be protected by the installation Contractor against any damaging effects of hydrostatic and pneumatic tests.

3. The installation Contractor shall furnish hand or power driven pumps and all other necessary equipment, including heaters and piping connections and valves from the source of test medium, for making field tests by the installation Contractor.

4. The installation Contractor shall provide the necessary temporary piping and connections, with valves and blind flanges, and related parts as may be required for filling and draining the piping systems and equipment that will be tested by the installation Contractor.

5. The installation Contractor shall fill the systems and equipment that are to be hydrotested with water. After testing is completed, the installation Contractor shall drain the water and dispose of it in accordance with all federal, state, and local regulations. The water used for hydrostatic testing shall be demineralized water, condensate, service water, or construction water, as directed by purchaser representative.

6. In conjunction with leak testing of the piping, the installation Contractor shall do all gagging of associated safety and relief valves required for the leak testing and shall remove gagging at the completion of the testing.

C. Documentation and Test Reports: Documentation and test reports shall be in accordance with the governing code and the following list.

1. The installation Contractor shall submit a complete report to purchaser/engineer covering the test results and inspector interpretation of test findings and their disposition.

2. Each test report shall include data identifying each system (or portion thereof), test method, test number, date of test, Contractor name, contract number, purchaser name, and project and unit identification.

D. Performance Test: After the piping system and all equipment installed by the installation Contractor are put in service; purchaser will run a preservice check test to ascertain that the system and all the appurtenances are performing satisfactorily. The installation Contractor shall arrange to have his authorized representative present to assist and witness these tests.

3.6 ADJUSTMENTS AND TIGHTNESS

A. The installation Contractor shall remedy all leaks in the piping system and appurtenances erected by the installation Contractor that may develop during testing and initial operation and shall retain the necessary field crew on the project after the main erection work is completed to perform, at no addition to the contract price, the following work as required to prepare the piping system for continuous operation:

1. Recheck all bolted assemblies where necessary.

2. Readjust tension of bolted assemblies in accordance with temperature rise.

3. Adjust pipe-supporting elements erected by the installation Contractor.

4. Install and remove temporary strainers for cleanout and checking.

5. Perform such additional blowout, cleaning, and flushing of piping as may be required.

6. Exercise all valves to ensure proper operation.

B. All piping installed by the installation Contractor shall be tight at the maximum working pressures and temperatures.

END OF SECTION 40 05 10

SECTION 40 40 00

PROCESS PIPING

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. General requirements for tube, pipe, piping components, materials, fittings, valves, flanges, and installation of process piping systems applicable to ASME B31.3.

B. Testing of completed piping installations/modifications.

C. Normal Fluid Service:

1. Process Liquid (water, leachate, condensate, and caustic.)

2. Leachate.

3. Vent/Drain.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American National Standards Institute (ANSI)

ANSI B18.22.1	Flat Washers

B. American Society of Mechanical Engineers (ASME)

ASME B&PVC, 2017	Boiler and Pressure Vessel Code
Section V	Nondestructive Examination
Section IX	Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operations
ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	Pipe Threads, General Purpose (Inch)
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.9	Factory-Made Wrought Buttwelding Fittings
ASME B16.11	Forged Fittings, Socket-Welding and Threaded

ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ASME B31.3, 2016	Process Piping

C. American Welding Society (AWS)

AWS D1.1/D1.1M, 2015	Structural Welding Code – Steel

D. ASTM International (ASTM)

ASTM A182	Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A312/A312M	Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM D2296	Standard Specification for Continuity of Quality of Electrical Insulating Polybutene Oil for Capacitors
ASTM D2683	Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D2996	Standard Specification for Filamen-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D2997	Standard Specification for Centrifugally Cast “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D3261	Standard Specification for Butt heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

E. Hanford Document

HNF-27957	200 Area ETF, Load-In, and LERF Pipe Class Specification

F. Manufacturers Standardization Society (MSS)

MSS SP-97	Integrally Reinforced Forged Branch outlet Fittings – Socket Welding, Threaded, and Buttwelding Ends

G. Washington Adminstrative Code (WAC)

WAC 173-303-640	Dangerous Waste Regulations Washington State (**Note**: This requirement only applies to the EMF and 242-A condensate lines into Basin 41. WAC 173-303-640 does not apply to inter-basin transfer piping.)

1.3 SUBMITTALS

A. See contract Statement of Work for submittal procedures.

B. Action Submittals – Materials:

1. Catalog Data: Include the Manufacturer name, model number, parts list, and brief description of equipment and its basic operational features.

2. Design Data, Evaluations, and Calculations: An item may be considered unlisted due to its component type or its material of construction. Such items shall adhere to the items below, respectively.

   a. Items that are unlisted due to component type shall be in accordance with ASME B31.3, paragraph 326.1.2 for metallic or A326.1 for non-metallic piping components.

   b. Items that are unlisted due to material of construction shall be in accordance with ASME B31.3, paragraph 323.1.2 for metallic or A323.1 for non-metallic piping components.

C. Action Submittals – Fabrication:

1. Qualifications.

   a. Manufacturer Qualifications are required when specified items are not supplied (see Submittals in Paragraph 1.4.B.2).

   b. Installer Qualifications.

   c. Test, Nondestructive Examination (NDE), and Inspection Qualifications Records - subcontractor and supplier inspectors are required to have certifications and experience commensurate with the examinations or inspections.

   d. Examiner Qualifications/Certifications.

2. Welder and Bonding Qualifications.

3. Welder and Bonding Qualification Records.

4. Welding Procedure Specifications (WPS).

5. Bonding Procedure Specifications (BPS).

6. Welding and Bonding Procedure Qualification Record (WPQR).

D. Test and Inspection Plan:

1. The supplier shall provide an Inspection and Test Plan and Procedures for review and approval. All inspections and tests, including inspection and testing forms, logs shall be documented and submitted for review and approval.

2. Subcontractor shall provide a Field Test, Inspection Plan, and Procedures for installed process piping and ancillary equipment.

E. Test Reports:

1. Factory Acceptance Test Report.

2. NDE Test Reports.

3. Field Test and Inspection Report.

F. Certifications:

1. Instrument Calibration Certificates for equipment used during the Factory Acceptance Test.

2. Certified Material Test Reports for metallic and non-metallic piping and components required by the code of record specified below:

   a. ASTM A312/A312M.

   b. ASTM D2996.

3. Certificate of Compliance to show compliance to the applicable codes and standards as identified in this Specification.

1.4 QUALITY ASSURANCE

A. Material Control Procedure:

1. Work shall be performed in accordance with an approved Material Control Procedure. This procedure shall describe the control methods and documentation used to handle and monitor the use of controlled materials (piping component, fasteners, and welding filler rod and other components).

2. The procedure shall follow manufacturer requirements for receiving, storage, handling, and preservation to minimize deterioration.

3. Segregation of carbon steel and stainless steel material and tools shall be maintained throughout fabrication.

4. The procedure shall also address procurement through processing and final assembly.

5. Subcontractor and suppliers must provide protection against the weather, acceleration forces, airborne contamination, and physical damage for the equipment procured under this Specification.

B. Inspection, Testing, and NDE:

1. The supplier shall perform inspection and testing to verify the conformance of the item to the specified requirements defined in Part 2 of this Section, as well as any supplier requirements as defined as part of the suppliers Quality Assurance (QA)/Quality Control program.

2. The supplier shall provide an Inspection and Test Plan indicating all testing and inspection functions to be performed, including hold points during fabrication and assembly, as well as during the Factory Acceptance Testing.

3. All inspection and testing functions shall be performed by qualified personnel using qualified procedures in accordance with specified requirements.

4. Hold points are required during the fabrication process to allow inspection, verification, or approval by WRPS before the supplier does further work. Hold points shall be identified within the Inspection and Test Plan, with provisions for WRPS review and acceptance. WRPS has the right to waive Hold Points at their discretion.

5. Inspection Records: The supplier shall appropriately record, submit, and maintain records documenting the inspection and/or test, then submit the completed Inspection Record as part of the QA Document Package. The status of all planned and executed inspection and testing activities shall be logged and traceable to ensure that the required inspection and testing have been performed, and any items that have failed inspection or testing are not inadvertently installed or implemented.

C. Qualifications:

1. Welder and Bonder Qualifications Subcontractor shall provide documentation that all personnel have passed relevant qualification tests per ASME B31.3 for joining processes involved, and that welding and bonding certification is current.

   a. Metallic Pipe: Welders and brazers shall be qualified in accordance with ASME B31.3 Section 328.2.

   b. Non-Metallic Pipe: Bonders shall be qualified in accordance with ASME B31.3 Section A328.2.

c. Steel Support Welding (not touching the pressure boundary): Qualify processes and operators to AWS D1.1/D1.1M.

2. Qualification of Examination Personnel:

a. Personnel performing other examination shall be certified in accordance with Contractor written practice. Personnel performing nondestructive examination to the requirements of ASME B31.3 shall be qualified and certified for the method to be utilized following a procedure as described in ASME B&PVC, Section V, Article 1, T-120 (e) or (f).

b. Certifications of examination personnel shall be maintained for Owners Inspector review.

c. Examination records including examiner qualifications and procedures shall be retained for at least five years per ASME B31.3, Section 346.3.

3. Owner Inspector shall be qualified in accordance with ASME B31.3 Section 340 and Construction Management – Field Engineering. WRPS shall act for DOE to designate Owner Inspectors or Representatives.

4. Manufacturer Qualifications:

a. Must have a minimum of five years of experience.

b. Must have maintenance service based within 200 miles radius of installation.

1.5 DELIVERY, STORAGE, AND HANDLING

1.6 ENVIRONMENTAL REQUIREMENTS

A. All piping shall be designed to operate in the environmental conditions specified in project requirements documents.

PART 2 PRODUCTS

2.1 THREADED JOINTS AND FASTENERS

A. Threaded joints: Unless otherwise noted, all threaded joints shall be NPT (tapered threads) complying with ASME B1.20.1. The threaded joint assembly shall be in accordance with ASME B1.20.1, 3.1.9 “Wrench-Tight Engagement between External and Internal Taper Threads.”

B. Fasteners are to be in accordance with ASME B1.1, UNS Classes 1A (external) and 1B (internal) uncoated, unless otherwise specified.

2.2 PRODUCT OPTIONS AND SUBSTITUTIONS

A. See contract Statement of Work for substitution procedures.

B. Proposal of unlisted components is strongly discouraged and will be evaluated in accordance with the contract Statement of Work. Substitutions will be allowed only if the subcontractor can demonstrate that the product can meet the same code requirements of the item specified in the design. Costs associated with evaluation of unlisted components shall be the responsibility of the subcontractor.

C. If an unlisted component alternate is proposed, the manufacturer must submit Design Data in accordance with Paragraph 1.4.B.2.

2.3 SEISMIC PERFORMANCE REQUIREMENTS

A. The piping and supports shall remain in place without separation of any parts when subjected to the design basis earthquake as represented by the seismic forces derived from the criteria indicated on the Drawings.

2.4 PIPING/TUBING/FITTINGS

A. 150 LB. 304L Stainless Steel Pipeline (ASME B31.3):

1. LERF Pipe Class M-10 (see Attachment 1).

B. 150 LB. Reinforced Thermosetting Resin Pipe (RTRP) (ASME B31.3):

1. LERF Pipe Class M-18 (see Attachment 2).

C. High Density Polyethylene (HDPE) (ASME B31.3):

1. LERF Pipe Class M-36 (see Attachment 3).

PART 3 EXECUTION

3.1 GENERAL

A. Piping Systems: Fabricate, inspect, examine, and test in accordance with ASME B31.3.

B. Piping systems include all piping components (including pressure retaining portions of instruments), pipe fixtures, clamps and supports, instrument, and mounting plates and their attachment to structural framework.

3.2 TAGGING & MARKING

A. To facilitate identification and assembly in the field, each pipe spool shall be conspicuously marked on the outside surface of each end with a spool piece identification number as identified in the isometric Drawing, Drawing, or line list.

B. Permanently attached barcode stickers are an acceptable alternative.

C. For austenitic stainless steel and nonferrous alloys, the marking paint required for piece numbers or color-coding shall contain no harmful metal or metal salts such as zinc, lead, or copper that cause corrosive attack upon heating. Marking materials shall contain no halides. Markings shall not be water-soluble.

D. Bond Identification:

1. Prepare bond identification Drawings, which show relative position of each pressure containing bond and each attachment bond to pressure retaining components.

2. Assign bond number to each pressure containing bond and each attachment bond to pressure retaining components as made. Record bond number on bond identification Drawing as bond is made.

3. Place identification symbol of bonder and bond number adjacent to each bond upon completion.

4. Do not reuse bond numbers. If bond is completely replaced, assign new number.

E. Nameplates shall be attached by seal welding, permanent adhesive, or stainless steel wire. Nameplates shall include:

1. Purchase order number,

2. Manufacturer name and address,

3. Identification number,

4. Size,

5. Pressure class (if applicable),

6. Fluid Service, and

7. System Application(s).

3.3 PREPARATION

A. Pre-Assembly:

1. Verify materials are correct before assembly, in accordance with the accepted Material Control Procedure.

2. Fastener materials shall be free of nicks, burrs, chips, dirt, and damage (inspect threads, shank, and nuts). All damaged fasteners must be replaced.

B. Cleaning:

1. After fabrication and NDE is complete and before connecting piping into existing system, clean piping internal surfaces mechanically or by flushing as follows.

a. Mechanical Cleaning: Clean interior of carrier piping system utilizing a soft bare foam pig (swab), or similar. Do not exceed the maximum operating pressure specified in the pipe codes.

b. Water Flushing:

i. Obtain direction for disposal of flushing water from WRPS prior to proceeding.

ii. Flush piping with water until effluent is clean and contains no visible particulate matter. Duration of flush shall be at least minute. Flushing pressure shall not exceed maximum operating pressure specified in pipe codes. Flushing water supply shall have sufficient capacity to produce flow velocity of 3 ft/sec minimum in largest pipe size. Flow if line shall not exceed 5 ft/sec.

c. Cap lines to maintain cleanliness.

3.4 FABRICATION

A. Piping shall be fabricated in accordance with the provided Drawings.

B. Welded and Bonded Joints:

1. Welding and bonding procedures, pre-weld and pre-bond cleaning, and weld/bond dimensions, shall be per contract Statement of Work.

2. Unless noted otherwise on the isometric Drawing, field fit-up welds/bonds shall include 6 in. of pipe beyond the length required.

3. Weld joints shall meet the approved WPS joint requirements. Bond joints shall meet the approved BPS joint requirements.

3.5 ERECTION

A. Install all piping shown on the construction Drawings per manufacturer recommended procedures and this Section.

B. Deviations from locations identified on the Drawings must be approved by WRPS and documented for incorporation into as-built Drawings.

C. Route piping in an orderly manner and maintain gradient. Route parallel and perpendicular to walls and equipment to allow service and maintenance.

D. Install piping to maintain headroom and ensure that it does not interfere with use of space or take more space than is necessary. Piping shall not block access to manholes, access covers, etc.

E. Group piping whenever practical at common elevations.

F. Wedges shall not be used to laterally contain or position pipe for closure fit-ups.

G. Valves shall be placed to permit easy operation and access and be installed upright where possible. Valve stems shall be upright or horizontal, not inverted.

H. Identification and/or traceability marks of piping components shall not be removed or hidden by surface treatment, coating, or subdividing during installation unless other identification methods are implemented to ensure that all markings are properly transferred and traceability documentation is maintained for the components. Installer must verify that items are correct for the installation and have legible identification markings.

I. Flanged Connections:

1. Contact Face Finish: Contact faces shall be as set forth in the Piping Design Tables referenced on the Design Drawings for each particular service. All raised face flanges shall have serrated facing. Contact faces for all male and female, and tongue and groove faced flanges shall have smooth tool finish, unless otherwise indicated.

J. Gaskets:

1. Gaskets for all joints shall be of such inside dimensions that no portions will project into the ports of valves, pipes, or fittings. Gaskets for male and female joints, and for tongue and groove joints, shall fit into the female or groove facing with approximately 1/32 in. clearance. Gaskets for raised-face joints shall extend to within 1/16 in. of the bolts. Plain-faced flanged joints shall have full-face gaskets with holes for bolts, unless otherwise indicated.

2. Gaskets shall be as set forth in the Piping Design Table for each particular service.

3. Spiral-wound metal gaskets shall be of manufacturer and style set forth in the Pipe Design Tables.

4. When ordering spiral-wound metal gaskets, the Installation Contractor shall specify complete joint data for each specific application, including:

   a. Service (fluid to be handled by piping) and operating pressures and temperatures.

   b. Flange material and pressure class.

   c. Type of flange facings.

   d. Bolting materials.

K. Studs:

1. All alloy steel studs shall have identification marks at one end, covering material, class, etc. Studs for low-temperature and high-temperature work shall not be interchanged when installing.

2. All steel bolts shall have Class 2A fit threads, and all nuts for steel bolts shall have Class 2B fit threads, per ASME B1.1.

L. Thread Compound:

1. Threads of all bolts and studs shall be painted with a suitable thread compound before joint is made up. The compound shall be suitable for the operating temperatures involved. For high-temperature service, special high-temperature thread compound must be used.

2. Faces of flanges and gaskets shall be wiped clean when making up all flanged joints.

3. Contact faces of all flanged joints shall come squarely together and particular care shall be exercised in pulling up flanged joints to prevent any overstressing of flanges, bolts, or studs.

4. No permanent fillers shall be used between flanges, except where specifically indicated on the design Drawings.

M. Field Welding/Bonding:

1. Cut pipe using methods that result in clean straight cuts. Cut nonmetallic pipe in accordance with manufacturer recommendations.

2. Keep piping systems clean. Once fabrication has started, plug or cap ends of piping when installation is not in progress to prevent entry of dirt of other foreign material. Cap or plug openings in fabrication pipe section until installation of piping system. Cap ends if work is not to be performed on pipe or spool within 4 hours, or, if due to environmental conditions, debris or water can enter pipe.

3. Protect outdoor welding or bonding operation from rain and wind by using barriers.

4. Complete piping welds or bonds before making tie-in welds or bonds to fixed items.

5. Adhesive minimum cure times and temperatures shall be in accordance with manufacturer recommendations.

6. Prevent movement of adhesive bonded joints until adhesive has hardened.

7. It is the responsibility of the Installation Contractor to review and evaluate the location of the field welds/bonds on the Drawings, and to give a feedback to the Consulting Engineers whenever field weld/bond location needs to be relocated.

8. Welding filler metal chemistry shall match that of the base material, unless otherwise specified. Similar metallurgical properties, i.e., yield strength equal to or greater than base metal, equal or better corrosion-erosion resistance, and equal or better thermal properties shall be produced.

9. The application of heat to correct weld distortion and dimensional deviations in austenitic stainless steels is prohibited.

10. Preparation of weld ends and fit-up shall be in accordance with the requirements of ANSI/ASME standards. Base metals for butt weld joints shall be prepared by machining or mechanized oxygen cutting. In specific instances where the use of the above equipment is impractical, written permission from the Owner must be secured if hand oxygen cutting is to be substituted. All slag, irregularities, and thermally affected areas shall be removed from oxygen cut ends and hand ends shall be ground smooth.

11. Backing rings shall not be used in any piping system without prior written approval of the Owner. Backing rings, where allowed by Owner, shall be of the flat split ring type. The material of the backing rings shall be compatible with the composition of the pipe with which it is used.

12. Welding pre-heat and interpass temperature shall be maintained in accordance with the requirements of the applicable code. Electric or gas heat sources, that provide a uniform application of heat over the weld area, shall be used in accordance with ANSI/ASME B31.1 Section 131.

13. Stress relieving of all welds shall be performed in accordance with the requirements of the applicable piping code. All welding zones, bends, and hot-formed sections shall be fully stress relieved as required by the applicable code.

14. Wherever possible, stress relieving shall be performed by slowly heating the entire assembly to the specified temperature, holding the temperature for the required length of time, and then allowing the assembly to cool. Where this procedure is impractical, local stress relieving may be employed.

15. Pipe bending shall be used only when specifically required or where the use of elbows is impractical. All bends shall be smooth, without buckles, and truly circular. The allowable flattening, as determined by the difference between the minor and major axes, shall not be greater than 5% of the nominal diameter. Allowance shall be made for thinning of the pipe wall in accordance with the requirements of Paragraph 102.4.5 of ASME B31.1 to assure that minimum wall thickness after bending is not less than the minimum wall thickness required.

16. All lugs, ears, and other attachments for support of piping shall be welded to the piping. Attachments for piping systems that must be stress relieved shall be welded to the pipe prior to final stress relieving. Attachments on shop fabricated piping which must be stress relieved shall be shop welded to the piping.

17. Field-welding on pressure parts shall be stress relieved as required by applicable codes.

18. The Installation Contractor shall submit welding procedures, stress-relieving procedures, and procedure qualification records to the Owner for review and approval prior to performing any welding.

19. Any combustible material or electric cables beneath or adjacent to welding operations shall be protected against sparks, splatter, and molten material. The Installation Contractor shall ensure that safe conditions exist prior to and during any welding in areas where coal dust and/or gas may be present. The Installation Contractor shall be responsible for supplying any portable ventilation or other equipment necessary to ensure that safe conditions exist and are maintained.

20. All welds that have been made by the Installation Contractor for temporary attachment shall be properly removed and the surfaces of the present work shall be finished clean and smooth. Appropriate NDE shall be implemented to verify there are no resultant defects.

N. Non-metallic Joints:

1. Joints in RTRP and HDPE piping shall be as required by the application. All joints shall be made by certified joiners or bonders. Copies of certifications shall be made available to the Owner upon request. Individuals shall be trained and certified by the manufacturer for the specific pipe brand, type of joint, and pipe sizes to be used

O. Threaded Joints:

1. Compound or lubricant used on bolt threads shall be suitable for the service conditions and shall not react unfavorably with either the service fluid or the piping material. Reference manufacturer recommendations for suitable compounds and lubricants. Lubricant for stainless steel shall contain no chloride.

P. The threaded joint assembly shall be in accordance with ASME B1.20.1 3.1.9 "Wrench-Tight Engagement between External and Internal Taper Threads."

Q. Final Assembly Cleaning:

1. Subcontractor shall be responsible for the cleanliness and integrity of the system. Internal and external of pipe, tube, and components shall be free of loose scale, sand, dirt, paint, metal chips, filings, flux, slag, weld spatter, mill scale, rust, grease, oil, waxes, or other contaminants that are easily seen with the unaided eye.

2. Consult manufacturer recommendation for the use of acids and cleaning agents to prevent damage. Cleaning agents used with stainless steel systems shall contain no more than 50 ppm halide content.

3. Ensure safeguards are taken to protect personnel from hazards of cleaning, which may include but not be limited to flying particulates, corrosive chemicals, and harmful vapors.

4. A suitable chemical and/or mechanical cleaning method shall be used, if necessary, to clean all surfaces.

3.6 INSULATION INSTALLATION

A. Follow Section 40 42 13, "Thermal Insulation for Piping and Equipment," as applicable.

3.7 EXAMINATION, TESTING, AND INSPECTION

A. For the purposes of this Section, the subcontractor (constructor) is responsible for all tasks identified as examination and testing. CWI activities are considered examination. Owner Inspector activities are considered inspection.

B. Examination:

1. Pipe examinations shall be performed after fabrication, after required heat treatment, and before leak testing.

2. Both the extent of examination and acceptance criteria shall be in accordance with ASME B31.3, paragraph 341 Examination and Section A341 Examination for non-metallic systems, as applicable.

3. When pneumatic testing is planned 100% of all threaded, bolted, and other mechanical joints shall be examined.

4. Any items rejected because of defects shall be repaired, replaced, and examined per this Section and ASME B31.3.

5. Methods of examination shall be per ASME B31.3 Section 344.

6. In-process examination of welds may replace radiographic or ultrasonic volumetric analysis for all welding per ASME B31.3, Section 344.7.

7. Notify WRPS Construction Representative at least 24 hours (1 working day) in advance to arrange for onsite witnessing of the above described testing (a hold/witness point) by an Independent Qualified Installation Inspector (IQII), or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640. (**Note**: This requirement only applies to the EMF and 242-A condensate lines into Basin 41. WAC 173-303-640 does not apply to inter-basin transfer piping.)

C. Testing:

1. Pressure test piping system per Section 22 08 13, "Testing for Piping."

a. Pressure testing is applicable to stainless steel piping (M-10) and the RTRP piping (M-18). No pressure testing shall be conducted on the HDPE piping (M-36)

D. Inspection:

1. Owner Inspector shall have access to any and all design, fabrication, manufacture, heat treatment, assembly, erection, examination, testing, records, documentation or other project information or activities to verify that all required examinations and testing have been completed and to inspect the piping to the extent necessary to be satisfied that it conforms to all applicable examination requirements of the Code and of the engineering design and to perform the role defined in ASME B31.3.

2. Owner Inspector is the final authority on acceptance of the project examination or test.

SECTION 40 40 00 – ATTACHMENT 1

LERF PIPE CLASS M-10

150 LB. 304L Stainless Steel Pipeline (ASME B31.3)

1. **SERVICE**
   Process piping used at the Liquid Effluent Retention Facility (LERF), including the following services:
   LCH (Leachate) PC (Process)
   VE (Vent) DR (Drain)
2. **GENERAL**
3. **MAXIMUM OPERATING CONDITIONS**

Service	PC	LCH	VE/DR
Temperature (°F):	150	150	150
Pressure (PSIG):	150	100	50

4. **PIPE CLASS SPECIFICATION**

Pipe	**1/2" Thru 2"**	**3" Thru 4"**
Construction	Welded or Seamless	
Material	Stainless Steel, ASTM A312, Grade TP 304L	
Schedule	40S	10S/40S (as specified on drawing)
All Fittings	**1/2" Thru 2"**	**3" Thru 4"**
Type:	Socket Welded/Threaded (as specified on drawing)	Butt Welded
Material:	ASTM A182 Gr F 304L	ASTM A403 WP-S 304L
Dimension:	ASME B16.11	ASME B16.9
Branch Connections		
Instrument, Vent, Drain, and Branch:	Use socket welded or threaded tees for pipe sizes 2" and less. For larger pipe sizes, use butt-welded tees for connection of equal size up to two sizes smaller. Otherwise, use Sockolets®[16], Weldolets®[16], or Thredolets®[16] as applicable.	
Dimension:	ASME B16.9 or B16.11 for tees, MSS SP-97 for O-Lets. Weldolets to be ASTM A182 F304L, same schedule as pipe.	
Pipe Runs	**1/2" Thru 2"**	**3" Thru 4"**
Type:	Socket Couplings	Butt Weld
Unions	**2" (DR only)**	**½" Thru 4" (All Other Services)**
Type:	Class 3000 Threaded, 304 Stainless Steel	None
Flanges	**All Sizes**	
Type:	Raised Face Weld Neck	
Material:	Class 150 Forged Stainless Steel, ASTM A182, Grade F 304L	
Dimension:	ASME B16.5	
ASME Rating:	150 LB	
Gaskets	**All Sizes**	
Type:	1/8" Thick Garlock 3700 Compressed Fiber Sheet.	
Dimension:	ASME B16.21	
Bolting	**All Sizes**	
Type:	Continuously Threaded Stud Bolt with two nuts	
Stud:	Stainless Steel, ASTM A193, Grade B8 CL2	
Nut:	Heavy Hex, ASTM A194, Grade 8	
Washer:	Standard Stainless Steel, ANSI B18.22.1	

[16] Sockolet, Weldolet, and Thredolet are registered trademark of Bonney Foreg & Tool Works Corporation, Allentown, Pennsylvania.

SECTION 40 40 00 – ATTACHMENT 2

LERF PIPE CLASS M-18

150 LB. Reinforced Thermosetting Resin Pipe (RTRP) (ASME B31.3)

1. **SERVICE**

   Process piping used at the Liquid Effluent Retention Facility (LERF), including the following services:

   PC (Process)
   DR (Drain)

2. **GENERAL**
   - Double containment piping is utilized where no secondary containment (such as catch basin) is provided.
   - Carrier and containment pipe is Conley Double Containment FRP Pipe utilizing Conley Aromatic amine cured epoxy resin.

3. **MAXIMUM OPERATING CONDITIONS**

Service	PC	DR
Temperature (°F):	150	150
Carrier pipe pressure (PSIG):	150	50
Containment pipe pressure (PSIG):	50	—

4. **PIPE CLASS SPECIFICATION**

Pipe			
Construction	Filament Wound Fiberglass-Reinforced Thermosetting Epoxy Resin Pressure Pipe		
Material	ASTM D2996, Type 1, Grade 1, Class F (RTRP-11FW)		
Minimum Reinforced Wall Thickness	**1”**	**3” and 4”**	**6” and 8”**
	0.120”	0.100”	0.110”
ASTM D2996 Designation Codes:	**All Sizes**		
	RTRP-11FW1-2113		
All Fittings	**All Sizes**		
Type:	Filament Wound with Integral Socket. Inner and Outer Carrier/Containment Fittings as a Single Unit When Double Containment is Required		
Material:	Same as Pipe		
Rating:	Same working pressure as pipe		
Dimension:	Non-Standardized		
Flanges	**All Sizes**		
Type:	Flat Face, Filament Wound with Integral Sockets		
Material:	Fiberglass-Reinforced Thermosetting Resign w/pressure rating equal or greater to piping material		
Dimension:	ASME B16.5		
ASME Rating:	150 LB		
Note:	Flanges shall be from same manufacturer and resin system as pipe		
Gaskets	**All Sizes**		
Type:	3/16” Thick Full-Face EPDM Sheet with hardness of 50-70 durometer on Shore A scale.		
Dimension:	ASME B16.21		
Bolting	**All Sizes**		
Type:	Bolts or Studs		
Stud:	Alloy Steel, ASTM A193, Grade B8 CL2		
Nut:	Heavy Hex, ASTM A194, Grade 8		
Washer:	Standard Stainless Steel, ANSI B18.22.1		

SECTION 40 40 00 - ATTACHMENT 3

LERF PIPE CLASS M-36

High Density Polyethylene (HDPE) (ASME B31.3)

1. SERVICE

Process piping used at the Liquid Effluent Retention Facility (LERF), including the following services:

RB-R (Retention Basin Riser) RB-SR (Retention Basin Sample Riser)
LCH-R (Leachate Riser) Anchor Pipes

2. GENERAL

- The following information shall be continuously marked on the pipe or spaced at intervals not exceeding 5-ft:

  1. Name and trademark of pipe manufacturer
  2. Nominal pipe size
  3. Standard dimensional ratio (SDR)
  4. PE 340820B
  5. Manufacturer standard reference
  6. A production code from which the date and place of manufacturer can be determined.

3. MAXIMUM OPERATING CONDITIONS

Service	
Temperature (°F):	120
Pressure (PSIG):	0

4. PIPE CLASS SPECIFICATION

Pipe	1 ½" Thru 6"		10" Thru 14"
Construction	High-Density Polyethylene Pipe		
Material	ASTM D3350, Material Designation Code PE340820B		
Schedule	SDR 11		SDR 26
All Fittings	**1 ½" Thru 4"**	**6" Thru 10"**	**14"**
Type:	Molded Socket	Molded Butt	Fabricated
Material:	HDPE (same as pipe) per ASTM D3350		
Rating:	160 PSIG	160 PSIG	120 PSIG
Dimension:	ASTM D2683 or ASTM D3261		
Flanges	**All Sizes**		
Type:	Flange Adapter End with Metal Backing Ring, Forged Stainless Steel, ASTM A182 Grade F316. ASTM D2683 or ASTM D3261.		
Material:	HDPE (Same as Pipe) Flange Adapter		
Dimension:	ASME B16.5		
ASME Rating:	150 LB		
Note:	Flanges shall be from same manufacturer and resin system as pipe		
Gaskets	**All Sizes**		
Type:	3/16" Full-Face Teflon-Bonded EPDM w/hardness of 50 to 70 durometer on the Shore A scale		
Dimension:	ASME B16.5		
Bolting	**All Sizes**		
Type:	Bolts or Studs		
Stud:	Alloy Steel, ASTM A193, Grade B8 CL2		
Nut:	Heavy Hex, ASTM A194, Grade 8		
Washer:	Standard Stainless Steel, ANSI B18.22.1		

END OF SECTION 40 40 00

SECTION 40 41 00

HEAT TRACING FOR PROCESS PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. Installation and testing of heat tracing for process piping and equipment.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American National Standards Institute (ANSI) / American Society of Mechanical Engineers (ASME)

ANSI/ASME A13.1	Scheme for the Identification of Piping Systems

B. National Electrical Contractors Association (NECA)

NECA 1	Standard Practices of Good Workmanship in Electrical Construction
NECA 202	Standard for Installing and Maintaining Industrial Heat Tracing Systems

C. National Fire Protection Association (NFPA)

NFPA 70, 2017	National Electrical Code (NEC)

1.3 SUBMITTALS

A. See the Statement of Work for the submittal process.

B. Approval Required:

1. Submit test procedures to be used with acceptance criteria prior to testing.

2. Submit records of inspections, tests, and adjustments described in 3.3.

C. Approval not required:

1. Catalog Data: Submit manufacturer technical data for each type of heat trace cable, power terminal box, thermostat, temperature sensor, end seal, and

accessories shown on Drawings. Provide catalog sheets showing voltage, current, power ratings, operating characteristics, and enclosure details.

2. Include rated capacities, operating characteristics, specialties, and accessories.

3. Operation and maintenance instructions.

4. Test and Inspection Records: Submit records of inspections, tests, and adjustments performed under Field Quality Control.

1.4 QUALITY ASSURANCE

A. Comply with the NEC for components and installation.

B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory for the application, installation condition, and the environment in which installed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, protect, and handle products according to manufacturer instructions.

1.6 SERVICE CONDITIONS

B. Enclosed controllers shall perform satisfactorily in the following service conditions without mechanical or electrical damage or degradation of operating characteristics:

1. Operating ambient temperature of -25 to 115 degrees F.

PART 2 **PRODUCTS**

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work.

2.2 MATERIALS

A. General:

1. Furnish electric heat tracing system in accordance with the Drawing with all components, controls, and accessories required for a complete and operating system.

B. Self-Regulating, Parallel-Resistance Heating Cable System.

1. 5 W/ft Self-Regulating Heat Trace Cable, 120V. Raychem 5BTV1-CT.

2. 5 W/ft Self-Regulating Heat Trace Cable, 240V. Raychem 5BTV2-CT.

3. End Seal Kit. Raychem E-150.

4. Power Connection box with Red Indicating Light. Raychem JBM-100-L-A.

5. Splice Kit. Raychem S-150.

6. Tee, above grade. Raychem T-100.

7. Glass Tape. Raychem GS-54.

8. Markers: Furnish hose markers with the words “ELECTRIC TRACED” printed with UV-stable black ink on a durable yellow background. Meet the requirements of the ANSI/ASME A13.1. Provide materials and styles that are suitable for outdoor environments.

PART 3 **EXECUTION**

3.1 PREPARATION AND EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Surfaces to receive heat tracing shall be cleaned of all dirt, oil, scale, rust, and other foreign matter, and shall be dry and free of frost during installation of heat trace cable.

C. Ensure surfaces in contact with electric heating cables are free of burrs and sharp protrusions.

3.2 INSTALLATION

A. Install heating cable according to the manufacturer instructions, and in accordance with NECA 202.

B. Install heating cable across valves, instruments, flexible piping, and pipefittings in a manner to allow for replacement of components and with slack cable to allow for movement without damage to cable.

C. Install heating cables after piping has been tested and before insulation is installed.

D. Waterproof all terminations and electrical connections.

E. Set field adjustable switches and thermostats.

F. Attach heating cable directly to piping using the heating cable manufacturer adhesive backed glass fiber tape.

G. Connect wiring in accordance with Section 26 05 19, “Low Voltage Electrical Power Conductors and Cables.”

H. Ground equipment in accordance with Section 26 05 26, “Grounding and Bonding for Electrical Systems.”

I. Notify Buyer prior to backfilling or installing insulation on the hose. Obtain approval from Buyer prior to beginning backfill or covering hose.

J. Perform examination on connecting of heating cable before application of insulation and jacketing over joints and other materials and components.

K. Install warning signs along piping system, at intervals not exceeding 20 ft, with the words "ELECTRIC TRACED." Install labels so they will be visible during normal operations. Also install warning signs on or adjacent to equipment in the piping system that requires periodic servicing.

3.3 FIELD QUALITY CONTROL

A. Clean, inspect, test, adjust, and energize equipment in accordance with manufacturer instructions.

B. Inspect each heat trace cable and device for physical damage, proper connection and grounding, and proper anchorage to supports.

C. Coordinate inspections and tests with those required by other sections.

D. Perform tests after heat trace cable installation and before covering.

E. Note ambient temperature at heat trace sensor during tests.

F. Perform the following listed tests.

1. Test cable for continuity and insulation resistance before energizing.
2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
3. Test for continuity, insulation resistance, and input power before backfilling or covering cables.

G. Cables and devices will be considered defective if they do not pass tests and inspections. Remove and replace defective heating cables and devices, and retest.

H. Protect installed heating cables and devices from damage during construction. Remove and replace heating cables or devices damaged during construction, and retest.

I. Keep records of inspections, tests, and adjustments. Prepare Test and Inspection Report, and submit in accordance with Submittal requirements.

END OF SECTION 40 41 00

SECTION 40 42 13

THERMAL INSULATION FOR PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY OF WORK

This section prescribes the minimum requirements for thermal insulation for piping and equipment.

The project specific materials, quantities, and attributes are shown on the Project Drawings, equipment list, data sheets, and/or other documents.

The work shall include, but not be limited to the following:

A. Installation of insulation and blanketing/jacketing on both the double encased FRP piping (unburied and buried), and catch basin stainless steel piping. Heat tracing layout and requirements under insulation is as indicated on the desing Drawings.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawing and general provisions of the Contract Statement of Work apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American Society of Mechanical Engineers (ASME)

ASME B31.3	Process Piping Code

B. ASTM International (ASTM)

ASTM C552	Standard Specification for Cellular Glass Thermal Insulation
ASTM C1729	Standard Specification for Aluminum Jacketing Insulation

1.3 SUBMITTALS

A. See the Contract Statement of Work for the submittal process.

B. Insulation Samples: A sample of each type of pipe and equipment insulation, together with thermal efficiency tables or curves based on a recognized authority, shall be submitted to the Owner for their information, if requested.

1.4 QUALITY ASSURANCE

It shall be Contractor responsibility to ensure that all insulation and lagging is properly applied and secured, so that it will not come loose or unduly deteriorate under the operating conditions to which it will be subjected.

The workers employed by the Contractor in the application of the materials shall be skilled in their work and under the direction of expert foremen. Workmanship and finish shall be of the highest quality and must be acceptable to the client.

In the event of variance between the general requirements delineated in this Section and the particular requirements set forth in the Specification, the Specification shall take precedence.

Contractor shall be solely responsible for advising the Purchaser to remedy any conflicts between the Specification and Contractor design, including performance and levels of quality. Contractor agrees that its obligations, liabilities, and warranties shall not be diminished or extinguished due to its meeting the requirements of the Specification.

A. Substitutions:

1. Mention of material by name or products of certain manufacturers in the Specification, Design Drawing, etc., is made to ensure that the proper quality and/or type is provided. No substitutions for said items will be permitted unless approval is granted in writing by the Purchaser.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Contract Statement of Work for general requirements.

1.6 DESIGN REQUIREMENTS:

A. Piping System Drawings:

1. Certain small piping systems (or smaller sized pipe runs) are only shown diagrammatically, or may be called for to terminate at a certain point not shown physically on the Drawings. Contractor shall furnish and install insulation for any such piping in order to complete the system whether shown physically or not.

PART 2 PRODUCTS

2.1 SUBSTITUTES

A. See Contract Statement of Work for substitution approvals.

2.2 MATERIAL REQUIREMENTS

A. Insulating materials shall be as specified for each particular application.

B. The use of asbestos in any insulating materials, cloths, tapes, etc., is prohibited.

C. All insulating materials shall be new and suitable for the purpose intended and shall be of such durability as to be capable of giving effective service for the life of the plant under normal operating conditions.

D. Contractor shall not install any damaged insulation. Insulation that is damaged during its installation shall be removed and replaced by Contractor at their expense.

E. All insulating materials, adhesives, finishes, etc. shall be received in the manufacturer unopened cartons and shall be kept dry and protected against the elements during storage and during all stages of application.

F. All insulating materials shall conform to the respective requirements of the applicable ASTM Specifications. All references to the ASTM Specifications are to the latest issue in each case.

G. Catch basin stainless steel piping insulation:

1. Fiber encased blankets. Ceramic blanket (Cerablanket), 2400 Deg. F classification temperature, covered with white fiberglass fabric impregnated with silicone rubber (Armatex SF17) to a finished weight of approximately 17 ounces per square yard, and fasten in place with Bergen hooks, washers, and stainless-steel wire.

H. Double encased FRP (buried and non-buried) piping insulation:

1. Molded, sectional, cellular glass pipe insulation meeting requirements of ASTM C552, complete with factory applied metal jacketing similar to Pittsburg Corning FOAMGLASS with Pittwrap pre-jacketing. Metal jacketing shall be painted white.

I. Piping insulation thickness:

1. Maximum thickness is 2 in. of insulation with a thermal conductivity of 0.28 Btu-in/(hr-ft^2-R) at 50 °F or less.

2. Minimum thickness of insulation with a thermal conductivity of 0.28 Btu-in/(hr-ft^2-R) at 50 °F is listed below in Table 2-1.

Table 2-1. Minimum Insulation Thickness with Associated Pipe Sizes.

Pipe Size	Minimum Allowed Insulation Thickness
1/2"	¼"
1"	½"
1-1/2"	½"
3"	1"
4"	1"
6"	2"
8"	2"

2.3 SOURCE QUALITY CONTROL

A. Contractor shall prepare and submit an Inspection and Test Plan for review and acceptance by the Purchaser. The plan shall address all examination, testing, and submittal of documentation required by the governing code.

2.4 FINISH REQUIREMENTS

A. All painting and coating of insulation shall be in accordance with Section 09 91 00, "Painting," or as approved by the Purchaser.

PART 3 EXECUTION

3.1 GENERAL

A. Insulation shall not be applied to piping until all piping tests have been completed, subject to the approval of the Purchaser. Insulation shall not be applied on flanged joints until approval is given by the Purchaser.

3.2 PREPARATION

A. Before insulation is applied on any piping or equipment, the surfaces to be insulated shall be cleaned and wire brushed, if necessary, to remove any accumulation adhering to the surfaces. A stainless steel brush shall be used on any stainless steel piping requiring brushing. Additionally, any surface where adhesion to the surface is used as a means to support the insulation, the surface shall be free of all oil film.

3.3 INSTALLATION

A. Insulation Fastening Wire:

1. Fastening wires for pipe and equipment insulation shall be in accordance with the following:

a. Single-layer insulation applications shall be fastened with 16 gauge or heavier galvanized steel wire.

B. Joints:

1. All insulation shall be laid with tightly butted joints.

2. All forms of insulation shall present a smooth even surface so that no joints or wire grooves will appear on the finished surface.

C. Fabric Encased Blankets:

1. Blankets shall be tufted on 6-in. centers, starting 3 in. back from the edge. Tufting shall be performed by the following method:

   a. No. 16 BWG Type 300 series stainless steel wire shall be looped through two double eyelet washers and the blanket in a sandwich-like manner. The wire shall be of sufficient length so that its free ends can be twisted together and bent down flat against the washer. In addition, blanket fastening devices, consisting of either 1/8 in. 300 series stainless steel closed rings, (lacing eyes), or an extra double eyelet washer shall be secured to the washers and wires located 3 in. back from the blanket edge.

   b. All blankets shall have square edges with seams that are fourfold and stapled and/or stitched continuously with a Type 300 series stainless steel wire. Seams sewn with hog rings are not acceptable.

   c. Filler material shall consist of blanket insulation.

   d. Packing with loose or bulk filler is not acceptable.

D. Removable Covers for Valves and Fittings:

1. Removable, reusable covers for valves, expansion joints, flanges, instruments, etc., shall be provided to accommodate maintenance. Removable covers shall be of the Fabric Encased Blankets type.

END OF SECTION 40 42 13

SECTION 40 70 00

INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY OF WORK

A. This section covers the work necessary to procure, install, adjust, document, test, and support startup of systems.

B. Instrument Data Sheets are provided in Appendix A of this Section.

1.2 RELATED DOCUMENTS / CODES AND STANDARDS

Drawingss and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. Factory Mutual Research (FM Global)

	Approval Guide, 2010 Edition

B. Hanford Document

TFC-ENG-STD-12	Tank Farm Equipment Identification Numbering and Labeling Standard

C. National Fire Protection Association (NFPA)

NFPA 70, 2017	National Electrical Code (NEC)

D. Underwriters Laboratories (UL)

UL 508A, 2013	Standard for Industrial Control Panels

1.3 SUBMITTALS

A. Submit the following in accordance with the provisions of the Contract Statement of Work.

1. Catalog Data: All Instrumentation including support equipment. Compression connectors; indicate installation tools and dies that will be used.

2. Manufacturer Installation Instructions: For each instrument, and/or control component, submit detailed installation, operations, and maintenance information.

3. Certifications that items furnished are not counterfeit or misrepresented.

4. Certificates of conformance for supplied items.

5. NIST-traceable Factory Certificate of Calibration for each instrument.

B. In general, partial submittals will not be accepted. Where partial submittals are anticipated, coordinate these requirements with the Buyer Technical Representative (BTR). Prior to submission of any submittals, provide a summary of the anticipated submittals to be provided. Examples of acceptable partial submittals are:

1. Early purchase of long lead items.

2. Components, device data sheets, and catalog cuts.

3. Fabrication Drawings.

C. Project Record Documents: Submit project record documents including specified certifications, calibration reports, and all field test and inspection reports.

1.4 QUALITY ASSURANCE

The Seller shall comply with the following Quality Assurance (QA) requirements in addition to those of the Contract Statement of Work.

A. Comply with the NEC for components and installation.

B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application and environment in which installed.

1. If a product is not listed by an NRTL (e.g., UL or FM) and if an NRTL is not available, submit vendor literature to Buyer for approval. Literature shall include product Specification and description of intended application.

C. All control panels/enclosures shall be UL 508A listed, labeled, and fabricated per the Design Drawings.

D. Certificates of Conformance (C of Cs) for all materials and equipment shall:

1. Identify the purchased material or equipment.

2. The quantity of purchased material or equipment.

3. Identify the purchase order number.

4. Identify the specific procurement requirements, such as codes, standards, and other Specifications.

5. Be signed or otherwise authenticated by a person who is responsible for the QA function.

6. Each C of C shall be unique for each shipment.

1.5 DELIVER, STORAGE, AND HANDLING

A. Receive, store, protect, and handle products according to manufacturer instructions.

PART 2 PRODUCTS

2.1 GENERAL

A. Instrumentation and Controls, electrical components, terminals, wires, and enclosures shall be UL recognized or UL listed; or

B. Provide products that are listed and labeled by a NRTL agency for the application and environment in which installed.

2.2 CLEANLINESS AND FOREIGN MATERIAL EXCLUSION

A. The Seller is responsible for ensuring items provided are free from foreign material during manufacturing, shipment, storage, and installation.

B. The Seller shall demonstrate established Cleanliness and Foreign Material Exclusion practices to ensure that new, repaired, or refurbished parts and equipment delivered under this Order are free from oil or grease (not being used as a preservative or protective coating), machine tailings, dirt, mill scale, weld splatter, residue, broken or loose parts, contaminants, or other foreign material that may adversely affect the operation of the item(s) provided or may be introduced into connecting equipment and systems. Other examples of foreign material include loose fasteners, debris resulting from machining or other manufacturing processes, and tags or labels used in the manufacturing process.

C. Seller is responsible for ensuring, via inspection or other means, that no foreign material or contaminants are present, including internal surfaces and cavities of the equipment.

D. Additional measures shall be taken by the Seller to prevent foreign material from entering the equipment, including protective devices such as caps, plugs, or covers. Protective devices shall ensure material compatibility with the protected item (e.g., protective devices containing halogens or heavy metals should not be used on stainless steel items).

E. Protective devices such as caps and plugs shall be clearly visible. Protective devices made of clear materials are prohibited. Protective devices that have been painted over during production processes shall be replaced or otherwise made clearly visible. Seller shall provide any protective devices needed for routine maintenance such as dust covers, end caps, plugs, or blanking flanges.

F. Precautions shall also be taken to ensure foreign material is not introduced during packaging and shipping. If the equipment is shipped with other parts (such as seals, gaskets, lubricants, or mounting hardware), precautions should be taken to ensure smaller items cannot be introduced into openings or cavities of larger parts and equipment. Where appropriate, every item included with shipment should be identified in the packing list or by other means. If desiccants or other preservatives are used to protect the item(s), the affected part of equipment shall be clearly labeled or tagged with information including the type of preservative, its location, and any special instructions pertaining to its removal prior to installation or other applicable information such as quantity of desiccant packages.

2.3 PRODUCT OPTIONS AND SUBSTITUTES

A. Refer to the Contract Statement of Work.

2.4 ENCLOSURES

A. Connections to enclosures (e.g., conduit) shall maintain the enclosure NEMA rating.

2.5 RACEWAYS

A. Conduit and Boxes per the Drawings and Section 26 05 33, "Raceways and Boxes for Electrical Systems."

2.6 INSTRUMENTATION

A. Instrumentation shall be per the attached Instrument Data sheets.

2.7 INSTRUMENTATION WIRE

A. Provide NRTL-listed instrumentation wiring as shown on the Drawings (Cable Schedule TBD).

2.8 IDENTIFICATION PRODUCTS/LABELING

A. Instruments shall be labeled per the Instrument Data Sheets and the design Drawings.

B. The nominal label size is NH (1.5 x 3 in.). Labels may be larger or smaller when warranted by installation requirements.

1. Tags shall show the following:

    a. Equipment Identification Number

2. Tag attachment wire: Tags shall be attached using a 0.063 in. 7 x 7 strand cable or other approved method.

C. For on-site fabricated labels, unless otherwise specified, laser-engraved stainless steel shall be used. See TFC-ENG-STD-12 for additional details.

PART 3 EXECUTION

3.1 GENERAL

A. Ensure installation Lockout/Tagout in place where required prior to installation.

B. Procure and install new instruments, displays, indicators enclosures, and associated components, conduit, cables, and accessories in accordance with the Drawings, Data Sheets, and manufacturer instructions.

C. Install Government Furnished Equipment in accordance with the Drawings.

D. Remove/modify/relocate existing instruments, enclosures, and associated components, conduit, cables, and accessories in accordance with the Drawings.

E. Attach identification tags or nameplates to instruments with wire or as shown on the Drawings. Cable and conductor labels shall be installed per design Drawings.

F. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

G. Install and terminate cables to the instruments, terminal boxes, enclosures, and panels as shown on the Drawings.

H. At the end of each workday, remove materials, scraps, and debris from interior and exterior of equipment, the worksite, and the facility.

3.2 INSTALLATION OF INSTRUMENTS & CONTROLS

A. Install instruments per the Drawing and the manufacturer directions.

B. Instruments shall be grounded in accordance with the NEC and as shown on the Drawings.

C. Tubing shall be supported as shown on the design Drawings.

D. Before formal testing, performs inspections and support informal testing to ensure that items being tested will respond correctly, e.g., valve control switch opens and closes a valve as expected.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Install in accordance with the NEC, the Drawings, this Section, and Division 26.

B. General Requirements for Instrumentation Wiring and Cabling:

1. Terminate all conductors; no cable shall contain un-terminated elements unless shown on the Drawings. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.

2. Cables/wires may not be spliced.

3. Route and train conductors to terminal points without exceeding manufacturer limitations on bending radii.

4. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.

5. Do not nick conductors when removing insulation.

6. Do not cut conductor strands to fit into connectors, splices, adapters, or terminals.

7. Make connections using clean connection surfaces.

8. Cold-Weather Installation: Install only if temperature is within manufacturer operating temperature range.

9. Pulling Cable: Hand pull all instrumentation cables; or follow manufacturer instructions for allowable cable tension

3.4 INSTALLATION OF TUBING

A. Tubing Support: Support tubing as shown on design Drawings.

B. Install tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.

C. Tubing and Conduit Bends:

1. Tool-formed without flattening, and of same radius.

2. Bend Radius: Equal to or larger than conduit and tubing manufacturer recommended minimum bend radius.

3. Slope instrument connection tubing in accordance with installation details.

4. Do not run liquid-filled instrument tubing immediately over or within a 3-ft plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.

5. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.

6. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.

7. Blow debris from inside of tubing.

8. Make up and install fittings in accordance with manufacturer recommendations. Verify make up of tube fittings with manufacturer inspection gauge.

9. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.

10. Run tubing in a workmanship-like manner to allow but not be limited to clear access to doors, controls and control panels; and to allow for easy removal of equipment.

11. Provide separate support for components in tubing runs.

12. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.

13. Keep tubing and conduit runs at least 12 in. from hot pipes.

14. Locate and install tubing raceways in accordance with manufacturer recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.

15. Securely attach tubing raceways to building structural members.

3.5 ELECTRICAL

A. For low-voltage wiring and cabling, comply with requirements in Section 26 05 26, “Grounding and Bonding for Electrical Systems.”

B. Wiring connected to instrumentation, controls, enclosures and assemblies, including power wiring shall be in accordance with requirements in Section 26 05 19, “Low Voltage Electrical Power Conductors and Cables.”

C. Electrical Raceways: As specified in Section 26 05 33, “Raceway and Boxes for Electrical Systems.”

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling according to Section 26 05 19, and per the installation Drawings. Individual wires in paired cables do not need individual labels.

3.7 FIELD QUALITY CONTROL

A. Testing:

1. Perform testing per this Section.

2. Furnish equipment and calibrated instruments required to perform testing.

3. Participate in Construction Acceptance Test and Acceptance Test Procedure performance.

a. BTR may actively participate in many of the tests.

b. BTR reserves right to test or retest specified functions.

c. BTR decision will be final regarding acceptability and completeness of testing.

B. Perform Tests and Inspections.

C. Tests and Inspections:

1. Visually inspect all installed items per Section 26 05 02, “Basic Electrical Requirements.”

2. Observe conductors and cables during the installation process.

   a. Reject and replace entire reels, rolls, or boxes containing conductors or cables with material or manufacturing defects.

   b. Reject and replace cable or conductor segments that have been kinked, dented, or otherwise damaged during handling or installation.

3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

D. After installation of wires and cables and before electrical circuit is energized, show product capability and compliance with requirements and verify by documented inspections and tests.

E. Perform the Following Inspections:

1. Inspect conductors and cables for:

   a. Freedom from material defect or physical damage.

   b. Correct conductor size, material, and insulation type.

   c. Correct color-coding and identification.

2. Inspect connections for:

   a. Correct connector size and type according to the Specifications.

   b. The use of the correct compression dies and the correct number of crimps on compression connectors in accordance with the connector manufacturer instructions.

3. Inspect Shielded Instrumentation Cables for:

   a. Proper shield grounding.

   b. Proper terminations.

   c. Proper circuit identification.

4. Inspect Control Cables for:

   a. Proper termination.

   b. Proper circuit identification.

F. Perform the Following Tests:

1. Before connecting instrumentation wiring conductors, use a megohm meter in a 1-minute test to verify the insulation integrity of each conductor with respect to ground and other conductors in the same raceway.

   a. Use 500-volts DC to test instrumentation wiring and conductors.

   b. For shielded cables, leave shields connected to ground, measure, and record resistances between each conductor and its related shield.

   c. Insulation test values shall be in accordance with manufacturer published test data. In absence of such data, insulation resistances over 10 megohms are acceptable.

2. Prior to connecting conductors to equipment, test continuity to ensure proper circuit is identified to facilitate correct connection of each power circuit conductor and each control circuit conductor.

   a. Verify continuity of every wire from end to end; continuity check of vendor-supplied cables is not required if received as pre-wired assembly. Resistance shall be 10 ohms maximum. Document test results.

   b. Verify wires are connected after testing, in accordance with Drawings.

3. Test the equipment and wiring for continuity and unintentional grounds, and verify proper phase sequence and voltage at equipment served before attempt is made to operate equipment.

G. Document data for each measurement. Document tests data indicating wire/cable identity, time/date of test, witness name and test results, at a minimum. Print data for submittals in a summary report that is organized for easy retrieval of data.

H. Remove and replace defective, incorrect, or improperly installed conductors and connectors. Re-inspect and re-test replacement conductors and connectors.

I. Prepare test and inspection reports.

J. Submit test and inspection records to the Buyer Technical Representative.

SECTION 40 70 00 - ATTACHMENT 1

INSTRUMENT DATA SHEETS

Sargent & Lundy

MAGNETIC FLOWMETERS

NO	BY	DATE	REVISION
F-101	KC Veach	4/1/2020	0

SHEET 1 OF 1		
SPEC. NO. RPP-SPEC-63632		REV. 0
CONTRACT		DATE 4/1/2020
REQ.	P.O.	
BY KJV	CHK'D MFG	APPR.

	No.								
	1	Meter Tag No.			FE-41-1				
	2	Service			Leachate Pump Discharge				
	3	Location			Pump P-41 Discharge				
METERING ELEMENT	4	CONN's.	Line Size, Sched.		1/2 inch Sch 40				
	5		Line Material		316L SS				
	6		Connection Type		Wafer				
	7		Connection Mat'ls.		150lb flange RF, 316L SS				
	8	METER	Tube Material		MFR STD				
	9		Liner Material		ETFE				
	10		Electrode Type		Wafer				
	11		Electrode Matl.		MFR STD				
	12		Meter Casing		316 SS				
	13		Power Supply	Elect. Code	24VDC				
	14		Grounding, Type & Matl.		Chassis, 316L SS				
	15		Enclosure Class		NEMA 4X				
	16								
	17	FLUID	Fluid		LERF Basin Leachate				
	18		Max. Flow, Units		10. 4gpm				
	19		Max. Velocity, Units		11 ft./s				
	20		Norm. Flow	Min. Flow	N/A	3.2 gpm			
	21		Max. Temp.	Min. Temp.	100°F	>32°F			
	22		Max. Press.	Min. Press.	60psig	0psig			
	23		Min. Fluid Conductivity		25 uS/cm				
	24		Vacuum Possibility		none				
	25								
ASSOCIATED INSTRUMENT	26	Instrument Tag Number			FIT-41-1/ FQI-41-1				
	27	Function			Transmitter				
	28	Mounting			Mounted to I/O rack				
	29	Enclosure Class			NEMA 4X				
	30	Length Signal Cable			100 ft. (note 3)				
	31	Type Span Adjustment							
	32	Power Supply			24V DC, 2 Watts				
	33	TRANS.	4-20mA		4-20 mA				
	34				0-15 gpm				
	35	DISPLAY	Scale Size	Range					
	36		Chart Drive	Speed					
	37		Chart Range	Chart No.					
	38		Integrator						
	39	CONTR.	Modes	Output	N/A				
	40		Action	Auto-Man.	N/A				
	41								
	42	ALARM	Contact No.	Form	N/A				
	43		Rating	Elec. Code	N/A				
	44		Action		N/A				
	45	Manufacturer			Rosemount				
	46	Meter Model Number			8711-TSA-005-R-5-N0-DT				
	47	Instrument Model Number			8712E-S-R-2-A-1-N0				

Notes:
1. All level Flow meters shall require stainless steel tags.
2. All electrical equipment shall be NRTL listed.
3. Vendor cable # is 08712-0752-0001
4. Transmitter Features a local display that provides flow or totalizer.
5. All electrical equipment shall be rated NEMA 4X and operate between -25°F-115°F.

F-101.docx

Based on ISA Form S20.23
Last Saved 5/4/2020

Sargent & Lundy	MAGNETIC FLOWMETERS				SHEET 1 OF 1	
					SPEC. NO. RPP-SPEC-63632	REV. 0
	NO	BY	DATE	REVISION	CONTRACT	DATE 4/1/2020
	F-102	KC Veach	4/1/2020	0		
					REQ. P.O.	
					BY KJV / CHK'D MFG	APPR.

	No.				Value			
	1	Meter Tag No.			FE-P41-4-1			
	2	Service			Basin 41 Pump Effluent			
	3	Location			Pump P-41 Discharge			
METERING ELEMENT	4	CONN's.	Line Size, Sched.		2 inch Sch 40			
	5		Line Material		316L SS			
	6		Connection Type		Wafer			
	7		Connection Mat'ls.		150lb flange RF, 316L SS			
	8	METER	Tube Material		MFR STD			
	9		Liner Material		ETFE			
	10		Electrode Type		Wafer			
	11		Electrode Matl.		MFR STD			
	12		Meter Casing		316 SS			
	13		Power Supply	Elect. Code	24 VDC			
	14		Grounding, Type & Matl.		Chassis, 316L SS			
	15		Enclosure Class		NEMA 4X			
	16							
	17	FLUID	Fluid		LERF Basin Effluent			
	18		Max. Flow, Units		175 gpm			
	19		Max. Velocity, Units		16.7 ft./s			
	20		Norm. Flow	Min. Flow	N/A	55 gpm		
	21		Max. Temp.	Min. Temp.	100°F	>32°F		
	22		Max. Press.	Min. Press.	60psig	0psig		
	23		Min. Fluid Conductivity		25 uS/cm			
	24		Vacuum Possibility		none			
	25							
ASSOCIATED INSTRUMENT	26	Instrument Tag Number			FIT-41-2			
	27	Function			Transmitter			
	28	Mounting			Mounted to I/O rack			
	29	Enclosure Class			NEMA 4X			
	30	Length Signal Cable			100 ft. (note 3)			
	31	Type Span Adjustment						
	32	Power Supply			24V DC, 2 Watts			
	33	TRANS.	4-20mA		4-20 mA			
	34				0-180 gpm			
	35	DISPLAY	Scale Size	Range				
	36		Chart Drive	Speed				
	37		Chart Range	Chart No.				
	38		Integrator					
	39	CONTR.	Modes	Output	N/A			
	40		Action	Auto-Man.	N/A			
	41							
	42	ALARM	Contact No.	Form	N/A			
	43		Rating	Elec. Code	N/A			
	44		Action		N/A			
	45	Manufacturer			Rosemount			
	46	Meter Model Number			8711-TSA-020-R-5-N0-DT			
	47	Instrument Model Number			8712E-S-R-2-A-1-N0			

Notes:
1. All level Flow meters shall require stainless steel tags.
2. All electrical equipment shall be NRTL listed.
3. Vendor cable # is 08712-0752-0001
4. Transmitter Features a local display that provides flow or totalizer.
5. All electrical equipment shall be rated NEMA 4X and operate between -25°F-115°F.

Based on ISA Form S20.23
F-102.docx Last Saved 5/4/2020

Sargent & Lundy	LEACHATE LEVEL (CAPACITANCE TYPE)				SHEET 1 OF 1	
					SPEC. NO. RPP-SPEC-63760	REV. 0
	NO	BY	DATE	REVISION	CONTRACT	DATE 4/1/2020
	L-101	KC Veach	4/1/2020	0		
					REQ. P.O.	
					BY KJV	CHK'D MFG / APPR.

GENERAL	1.	Tag Number		LIT-41-1/ LE-41-1				
	2.	Service		Water				
	3.	Line No./Vessel No.		LERF Basin 41				
	4.	Application		Leachate Level				
	5.	Function		Continuous level measurement				
	6.	Fail Safe						
PROBE	7.	Model Number		700-0005-036-BA0-35283.9-2743.2-N				
	8.	Tag Number		LE-41-1				
	9.	Orientation		15° off horizontal				
	10.	Style		Flexible cable				
	11.	Material		316L SS				
	12.	Sheath		PFA				
	13.	Insertion Length		120 ft.				
	14.	Active Length		9 ft.				
	15.	Gland Size & Mat'l.		3/4 -inch CGB				
	16.	Process Connection		1-inch NPT				
	17.	Conduit Connection		3/4-inch NPT				
TRANS.	18.	Output		4-20mA				
	19.	Tag Number		LIT-41-1				
	20.	Accuracy		0.25 span				
	21.	Model Number		UP1101-00D0-ZZZ-0				
	22.	Location		4-inch Leachate Riser				
	23.	Power Supply		LOOP,24V DC, 2.3W				
	24.	Conduit Connection		3/4-inch NPT				
	25.	Range		0-25 ft				
	26.	Enclosure Class		NEMA 4X				
OPTIONS	27.	Compensation Cable		N/A				
	28.	Local Indicator		yes				
	29.	I/P Transducer		N/A				
	30.	Cote shield cable		380-0100-012				
	31.	Termination kit		389-0001-006				
SERVICE	32.	Upper Fluid		Water				
	33.	Conductivity range		25-8000 uS/cm				
	34.	Lower Fluid		N/A				
	35.	Dielectric Constant		N/A				
	36.	Pressure Max.	Min	1psig	0psig			
	37.	Temp. Max.	Min	110°F	32°F			
	38.	Moisture		Yes				
	39.	Material Buildup		None				
	40.	Vibration		None				
	41.	Manufacturer		DrexelBrook				

Notes:
1. All level transmitters shall require stainless steel tags.
2. All electrical equipment shall be NRTL listed.
3. Parts numbers are located on lines 7,19,28,29.
4. All equipment shall be able to operate in ambient temperatures of -25°F to 115°F.

Based on ISA Form S20.27

Sargent & Lundy	MAIN BASIN CONT LEVEL MEASUREMENT (Pressure transducer)				SHEET 1 OF 1	
					SPEC. NO. RPP-SPEC-63760	REV. 0
	NO	BY	DATE	REVISION	CONTRACT	DATE 4/1/2020
	L-102	KC Veach	4/01/2020	0		
					REQ. P.O.	
					BY KJV / CHK'D MFG	APPR.

GENERAL	1.	Tag Number	LT-41-2				
	2.	Service	Water				
	3.	Line No./Vessel No.	LERF Basin 41				
	4.	Application	Main Basin Level				
	5.	Function	Continuous level measurement				
	6.	Fail Safe	None				
PROBE	7.	Model Number	N/A				
	8.	Tag Number	LT-41-2				
	9.	Orientation	15° off horizontal				
	10.	Style	N/A				
	11.	Material	316 SST				
	12.	Sheath	Polyurethane				
	13.	Insertion Length	`90ft				
	14.	Active Length	N/A				
	15.	Gland Size & Mat'l.	N/A				
	16.	Process Connection	N/A				
	17.	Conduit Connection	N/A				
TRANS.	18.	Output	4-20Ma				
	19.	Tag Number	LT-41-2				
	20.	Accuracy	0.15% full scale output				
	21.	Model Number	517ACGTL100DHTG				
	22.	Location	Basin 41 North Sample Riser				
	23.	Power Supply	24V DC				
	24.	Conduit Connection	N/A				
	25.	Range	0-27 ft.				
	26.	Enclosure Class	N/A				
OPTIONS	27.	Compensation Cable	N/A				
	28.	Local Indicator	N/A				
	29.	I/P Transducer	N/A				
	30.	Signal Lights	N/A				
	31.	Field replaceable Breather Tube Filter.	11Z5017681				
SERVICE	32.	Upper Fluid	Water				
	33.	Conductivity range	25-8000 uS/cm				
	34.	Lower Fluid	N/A				
	35.	Dielectric Constant	N/A				
	36.	Pressure Max. / Min	12psig	0psig			
	37.	Temp. Max. / Min	120°F	32°F			
	38.	Moisture	Yes				
	39.	Material Buildup	None				
	40.	Vibration	None				
	41.	Manufacturer	Viatran				
	42.						

Notes:
1. All level transmitters shall require stainless steel tags.
2. All electrical equipment shall be NRTL listed..
3. All equipment shall be able to operate in ambient temperatures of -25°F to 115°F.

Based on ISA Form S20.27

Sargent & Lundy

LEACHATE PUMP LEVEL CONTROL

NO	BY	DATE	REVISION
L-103	KC VEACH	4/01/2020	0

SHEET 1 OF 1	
SPEC. NO. RPP-SPEC-63760	REV. 0
CONTRACT	DATE 4/1/2020
REQ.	P.O.
BY KJV	CHK'D MFG
APPR.	

Section	No.	Item		Value	
GENERAL	1.	Tag Number		See lines 8,28.	
	2.	Service		Water	
	3.	Line No./Vessel No.		LERF Basin 41	
	4.	Application		Leachate level High	
	5.	Function		Point Level Detection	
	6.	Fail Safe		None	
PROBE	7.	Model Number		6013-SW-120	
	8.	Tag Number		LEL-41-3, LEH-41-3	
	9.	Orientation		15° off horizontal	
	10.	Style		Flexible Cable	
	11.	Material		303 SS	
	12.	Sheath		vinyl	
	13.	Insertion Length		`110ft	
	14.	Inactive Length		N/A	
	15.	Gland Size & Mat'l.		N/A	
	16.	Process Connection		N/A	
	21.	Conduit Connection		N/A	
SWITCH	22.	Type		SPDT Induction relay	
	23.	Quantity and Form		1	
	24.	Rating: Volts		1hp @ 230 VAC single phase	
	25.	Amps		N/A	
	26.	Load Type		120 VAC	
	27.	Contacts:		2 NO	
	28.	Tag Number		LY-41-3	
	29.	Model Number		1500-C-L1-S9-OC-X	
TRANS.	30.	Output		N/A	
	31.	Tag Number		N/A	
	32.	Conduit Connection		N/A	
	33.	Model Number		N/A	
	34.	Location		N/A	
	35.	Power Supply		N/A	
	36.	Range		N/A	
	37.	Enclosure Class		N/A	
OPTIONS	38.	Compensation Cable		N/A	
	39.	Local Indicator		N/A	
	40.	I/P Transducer		N/A	
	41.	Signal Lights		N/A	
	42.				
SERVICE	43.	Upper Fluid		Water	
	44.	Dielectric Constant		25-8000 uS/cm	
	45.	Lower Fluid		N/A	
	46.	Dielectric Constant		N/A	
	47.	Pressure Max.	min	1psig	0psig
	48.	Temp. Max.	**min**	100°F	>32°F
	49.	Moisture		yes	
	50.	Material Buildup		N/A	
	51.	Vibration		Yes	
		Manufacturer		B/W controls	

Notes:
1. All level switches shall require stainless steel tags.
2. All electrical equipment shall be NRTL listed.
3. All electrical equipment shall be rated NEMA 4X and operate between -25°F-115°F.

Based on ISA Form S20.27

Sargent & Lundy

LEVEL SWITCH

SHEET	1	OF	1
SPEC. NO. RPP-SPEC-63760		REV. 0	
CONTRACT		DATE 4/1/2020	
REQ.	P.O.		
BY KJV	CHK'D MFG	APPR.	

NO	BY	DATE	REVISION
LD-101	KC Veach	4/1/2020	0

1	BODY OR FITTING		47	TRANSMITTER w/wo SWITCHES Continued	
2	Body/Fitting type		48	Integral indicator style	N/A
3	Process conn nominal size	1" Rating	49	Readout variables	N/A
4	Process conn termn type	Male Style NPT	50	Readout units	N/A
5	Packing gland nom rating	MFR STD	51	Signal termination type	N/A
6	Mounting orientation	NPT Pipe thread Mount.	52	Cert/Approval type	FM
7	Flow Straightener type		53	Mounting location/type	N/A
8	Body/Fitting material	316L SS	54	Failure/Diagnostic action	None
9	Flange material	n/a	55	Calibration mode	N/A
10	Compression ferrule material	n/a	56	Measurement compensation	N/A
11			57	Enclosure material	316L SS
12			58	Area Class (Transmitter)	☒ Non-Haz, Class___ Div___ Grp___
13	SENSING ELEMENT		59	PERFORMANCE CHARACTERISTICS	
14	Sensor type	Level	60	Max press at design temp	100psig At 120°F
15	Temperature LRL	>32°F URL 120°F	61	Min working temperature	32°F Max 120°F
16	Minimum flow span	N/A Max N/A	62	Flow rate accuracy	N/A
17	Qty sensors per element	1	63	Temperature accuracy	N/A
18	Extension/Support dia	n/a	64	Flow repeatability	± 0.5% rdg
19	Max/Fixed insertion lg	30mm	65	Max flow response time	3 seconds minimum
20	Wetted material	316L SS	66	Min ambient working temp	-25°F Max 115°F
21	Extension/Support material	316L SS	67	Contacts ac rating	115vac At max 6amp
22	Area Class (Sensor)	☒ Non-Haz, Class___ Div___ Grp___	68	Contacts dc rating	24vdc At max 6amp
23			69	Max sensor to receiver lg	N/A
24	LEAD WIRE AND EXTENSION		70		
25	Extension type	None	71	ACCESSORIES	
26	Cable length	n/a	72	Sensor cleaning system	N/A
27	Max cable operating temp	n/a	73	Flow straightener	N/A
28	Signal termination type	n/a	74	Enclosure heating kit	N/A
29	Cable jacket material	n/a	75	Calibrator/Configurator	
30			76		
31	CONNECTION HEAD		77	SPECIAL REQUIREMENTS	
32	Housing type	316L SS	78	Custom Tag	Yes
33	Enclosure type no/class	Nema 4x	79	Reference specification	
34	Mounting location/type	NPT Pipe thread Mount.	80	Special preparation	
35	Enclosure material	316L SS	81	Compliance standard	
36			82	Calibration report	
37	TRANSMITTER w/wo SWITCHES		83	Software configuration	
38	Housing type	Explosion proof	84	Hanford Class	☒ GS ☐ SS ☐ SC
39	Aux input signal type		85	PHYSICAL DATA	
	Output signal type	Analog DC	86	Estimated weight	
41	Enclosure type no/class	NEMA 4x	87	Face-to-face dimension	5.40"
42	Local operator interface	None	88	Overall height	4.83"
43	Digital communication std	n/a	89	Removal clearance	
44	Signal power source	LOOP, 24V DC	90	Signal conn nominal size	Style
45	Qty of input sensors	Mfr std	91	Mfr reference dwg	
46	Contacts arrangement	DPDT Quantity 1	92		

93	CALIBRATION AND TEST		INPUT OR TEST			OUTPUT OR SCALE	
94	TAG NO/FUNCTIONAL IDENT	MEAS/SIGNAL/SCALE	LRV	URV	ACTION	LRV	URV
95	LDS-41-4	Flow setpoint 1-Output					
96	LDS-41-5	Flow setpoint 1-Output					
97	LDS-41-6	Flow setpoint 1-Output					
98	LDS-41-7	Flow setpoint 1-Output					
99	LDS-41-8	Flow setpoint 1-Output					
100	LDS-42-3	Flow setpoint 1-Output					
101							
102							
103		Flow setpoint 1-Output					
104		Flow setpoint 2-Output					
105							

106	COMPONENT IDENTIFICATIONS		
107	COMPONENT TYPE	MANUFACTURER	MODEL NUMBER
108	Level Switch	FCI	FLT93S-1B-1A201E-4CC00-00
109			
110			
111			

Notes:
1. All level switches shall require stainless steel tags.
2. All electrical equipment shall be NRTL listed.
3. All electrical equipment shall be rated NEMA 4X and operate between -25°F-115°F.
4.

Based on 2001 ISA

LVN/A Sargent & Lundy Engineering Services, Inc.	CONTROL VALVE DATA SHEET				SHEET 1 OF 2 SPEC. NO. RPP-SPEC-63760 REV. 0
	NO	BY	DATE	REVISION	CONTRACT / DATE 4/1/2020
	LV-101	KC Veach	4/1/2020	0	
					REQ. P.O.
					BY KJV / CHK'D MFG / APPR.

1	Fluid Water	P&ID/ Tag	H-2-88766-6/ LV-P41-4-1	Crit Press PC			
	SERVICE CONDITIONS	Units	Max	Norm	Min	Shut-Off	
2	Flow Rate	GPM	180	75	0	40	
3	Inlet Pressure	Psig	60		2		
4	Outlet Pressure						
5	Inlet Temperature	°F	120	ambient	32		
6	Spec Wt/Spec Grav/Mol Wt					—	
7	Viscosity/Spec Heats Ratio					—	
8	Vapor Pressure P_V					—	
9	* Required C_V					—	
10	* Travel	%	90		0	0	
11	Allowable/* Predicted SPL	dBA	/	/	/	—	
12							

No.	Section	Item	No.	Section	Item
13	LINE	Pipe Line Size In 4 inch	53	ACTUATOR	* Type Electric
14		& Schedule Out 4 inch	54		* Mfr & Model Bray 700501-113GO536/K
15		Pipe Line Insulation Heat Trace	55		* Size Eff Area
16	VALVE BODY/BONNET	* Type Split-V	56		On/Off N/A Modulating 0-90°
17		* Size 4 Inch ANSI Class 150	57		Spring Action Open/Close None
18		Max Press/Temp 100 psig/ 120°F	58		* Max Allowable Pressure 100psig
19		* Mfr & Model N/A	59		* Min Required Pressure 0psig
20		* Body/Bonnet Matl 316 SS	60		Available Air Supply Pressure: N/A
21		* Liner Material/ID MFR STD	61		Max N/A Min N/A
22		End In Flange	62		* Bench Range N/A / N/A
23		Connection Out Flange	63		Actuator Orientation horizontal
24		Flg Face Finish Raised Face	64		Handwheel Type Manual
25		End Ext/Matl 316 SS	65		Air Failure Valve N/A Set at N/A
26		* Flow Direction Bi-Directional	66		
27		* Type of Bonnet MFR STD	67	POSITIONER	Input Signal 4-20mA
28		Lub & Iso Valve N/A Lube N/A	68		* Type Electric
29		* Packing Material MFR STD	69		* Mfr & Model N/A
30		* Packing Type MFR STD	70		* On Incr Signal Output Incr/Decr
31			71		Gauges N/A By-pass N/A
32	TRIM	* Type MFR STD	72		* Cam Characteristic Proprietary
33		* Size MFR STD Rated Travel MFR STD	73		
34		* Characteristic MFR STD	74	SWITCHES	Type SPDT Quantity 1
35		* Balanced/Unbalanced N/A	75		* Mfr & Model N/A
36		* Rated C_V F_L X_T	76		Contacts/Rating None (dry contacts)
37		* Plug/Ball/Disk Material 316 SS	77		Actuation Points 3° prior to travel limit switch
38		* Seat Material Tek-Fill	78		
39		* Cage/Guide Material N/A	79	AIR SET	* Mfr & Model N/A
40		* Stem Material 316 SS	80		* Set Pressure N/A
41			81		Filter N/A Gage N/A
42			82		
43	SPECIALS/ACCESSORIES	NEC Class N/A Group N/A Div N/A	83	TESTS	* Hydro Pressure N/A
44		NEMA 4x	84		ANSI/FCI Leakage Class N/A
45			85		
46			86		

No.	Specials/Accessories	Rev	Date	Revision	Orig	App
47						
48						
49						
50						
51						

* Information supplied by manufacturer unless already specified.
LV-101.docx

Based on ISA Form S20.50, Rev. 1
Last Saved 5/4/2020

Sargent & Lundy Engineering Services, Inc.	CONTROL VALVE DATA SHEET (Cont.)	Sheet 2 of 2

Notes:
1. All level switches shall require stainless steel tags.
2. All electrical equipment shall be NRTL listed.
3. All electrical equipment shall be rated NEMA 4X and operate between -20°F-115°F.

* Information supplied by manufacturer unless already specified.
LV-101.docx

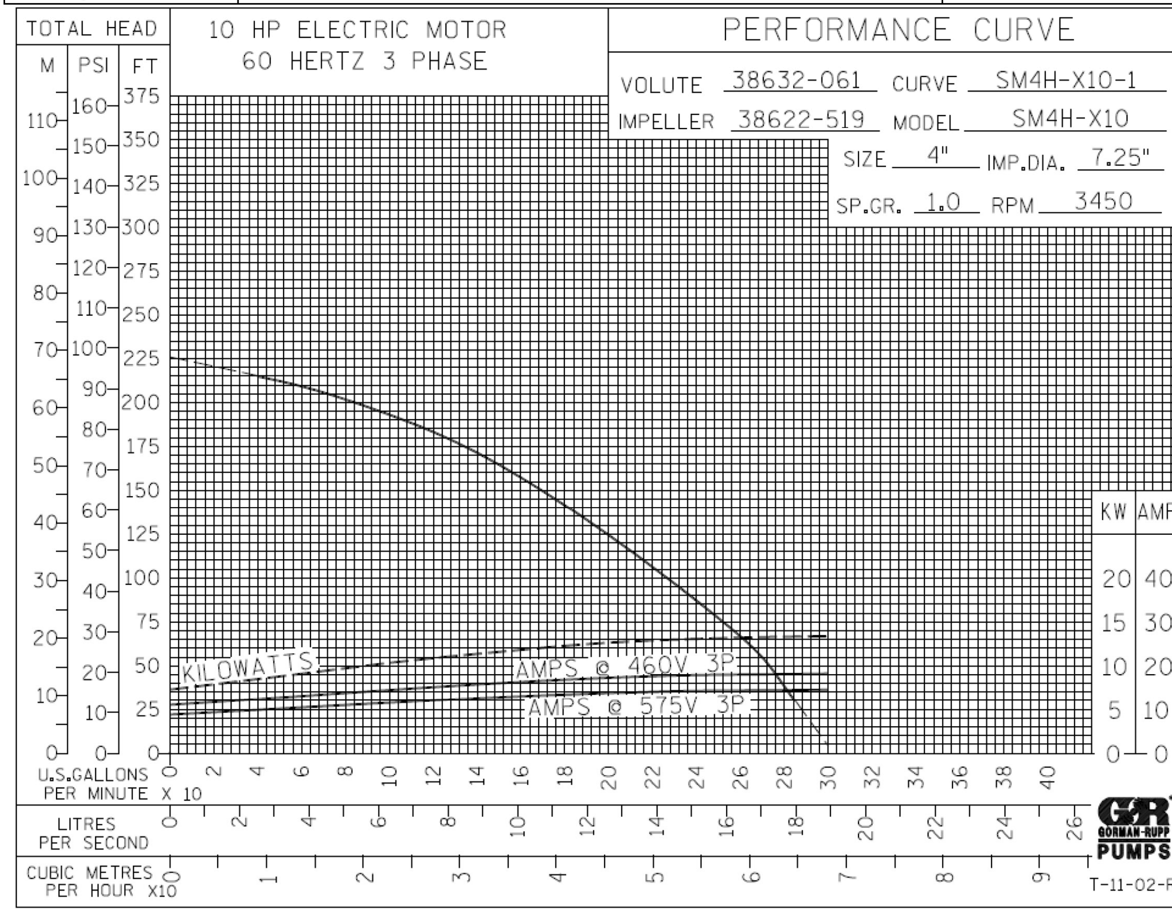
Based on ISA Form S20.50, Rev. 1
Last Saved 5/4/2020

Sargent & Lundy	MAIN BASIN PUMP				SHEET 1 OF 2	
					SPEC. NO. RPP-SPRC-63632	REV. 0
	NO	BY	DATE	REVISION	CONTRACT	DATE 4/1/2020
	P-101	KC Veach	04/01/2020	0		
					REQ. P.O.	
					BY KJV	CHK'D PMD / APPR.

GENERAL	1.	Type of Pump:	Submersible
	2.	Manufacturer:	Gorman-Rupp
	3.	Model No.:	SM4H65-X10
	4.	Equipment No.:	N/A
FLUID DATA	5.	Fluid Pumped:	water
	6.	Specific Gravity:	1 SpG
	7.	Solids (wt%):	N/A
	8.	Pumping Temperature (°F):	60°F
	9.	Viscosity @ Pumping Temperature (cP):	1 cP
	10.	Vapor Pressure @ Pumping Temp. (psia):	N/A
DESIGN DATA	11.	Design Capacity (gpm):	107
	12.	Differential Pressure (psid):	83.0
	13.	Differential Pressure (ft):	191.7
	14.	NPSH Available (ft):	N/A
	15.	Total Discharge Pressure (psig):	80.4
	16.	Pump Speed (rpm):	3450 rpm
	17.	Efficiency (%):	N/A
	18.	Brake Horsepower (bhp):	10
MECHANICAL DATA	19.	Material – Case:	316 SS
	20.	Material – Impeller, Piston, Diaphragm:	CD4Mcu SS
	21.	Seal Type:	CD4Mcu SS
	22.	Suction Nozzle (Size/Rating):	4 inch
	23.	Discharge Nozzle (Size/Rating):	4 inch
DRIVER	24.	Driver Horsepower (hp):	10.0 HP
	25.	Motor Type:	electric
UTILITY	26.	Electric:	460/575 Volt, 60Hz, 17/13.6 Full Load Amps, 13.45 kw (max)
	27.	VFD:	☐ Yes ☒ No
	28.	Area Classification:	
	29.	Code of Regulation:	

Notes:
1.

Sargent & Lundy	PUMPS (Cont.)	Sheet 2 of 2



Sargent & Lundy	LEACHATE PUMP				SHEET 1 OF 2	
					SPEC. NO. RPP-SPEC-63632	REV. 0
	NO	BY	DATE	REVISION	CONTRACT	DATE 4/1/2020
	P-101	KC Veach	04/01/2020	0		
					REQ. P.O.	
					BY KJV	CHK'D PMD	APPR.

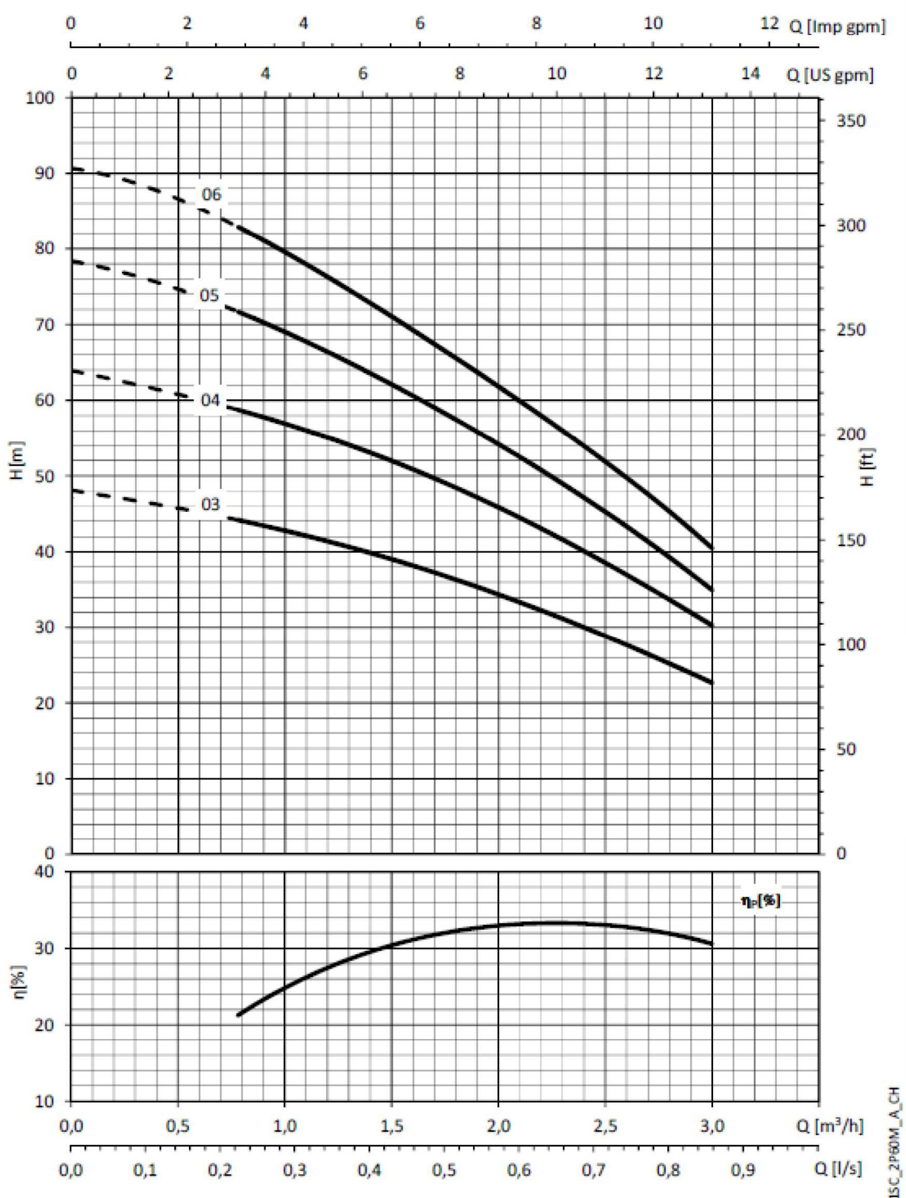
GENERAL	1.	Type of Pump:	Close-coupled submersible
	2.	Manufacturer:	Lowara
	3.	Model No.:	1SC3/05/6 C L40
	4.	Equipment No.:	N/A
FLUID DATA	5.	Fluid Pumped:	water
	6.	Specific Gravity:	1 SpG
	7.	Solids (wt%):	N/A
	8.	Pumping Temperature (°F):	60°F
	9.	Viscosity @ Pumping Temperature (cP):	1 cP
	10.	Vapor Pressure @ Pumping Temp. (psia):	N/A
DESIGN DATA	11.	Design Capacity (gpm):	10.4
	12.	Differential Pressure (psid):	0.782
	13.	Differential Pressure (ft):	112.6
	14.	NPSH Available (ft):	N/A
	15.	Total Discharge Pressure (psig):	0.79
	16.	Pump Speed (rpm):	3500
	17.	Efficiency (%):	34
	18.	Brake Horsepower (bhp):	1/2
MECHANICAL DATA	19.	Material – Case:	304 SST
	20.	Material – Impeller, Piston, Diaphragm:	technopolymer
	21.	Seal Type:	
	22.	Suction Nozzle (Size/Rating):	5 inch
	23.	Discharge Nozzle (Size/Rating):	1.25 inch
DRIVER	24.	Driver Horsepower (hp):	0.75
	25.	Motor Type:	
UTILITY	26.	Electric:	50kw, 60hz, single phase,
	27.	VFD:	☐ Yes ☒ No
	28.	Area Classification:	
	29.	Code of Regulation:	

Notes:
1.

Sargent & Lundy	PUMPS (Cont.)	Sheet 2 of 2

1SC SERIES - SINGLE PHASE VERSION
OPERATING CHARACTERISTICS

1SC	~ 3500 [rpm]	ISO 9906:2012 - Grade 3B



END OF SECTION 40 70 00

END OF SPECIFICATION

Attachment 4 Supplement
REVISED 20 July 2020
20-ECD-0032

Supporting Information

(43 Pages Including Cover Sheet)

DOCUMENT RELEASE AND CHANGE FORM

Prepared For the U.S. Department of Energy, Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

Release Stamp

DATE: Jun 10,2020
HANFORD RELEASE

1. **Doc No:** RPP-IQRPE-50063 **Rev.** 00

2. **Title:**
Independent Qualified Registered Professional Engineer Design Assessment Report for Liquid Effluent Retention Facility (LERF) Basin 41

3. **Project Number:** ☐N/A
T1P226

4. **Design Verification Required:**
☐Yes ☒No

5. **USQ Number:** ☒ N/A
RPP-27195

6. **PrHA Number** **Rev.** ☒ N/A

Clearance Review Restriction Type: public

7. **Approvals**

Title	Name	Signature	Date
Clearance Review	Ayers, Lynn M	*Ayers, Lynn M*	06/10/2020
Design Authority	Wilson, Nathaniel W	*Wilson, Nathaniel W*	06/09/2020
Checker	Wilson, Nathaniel W	*Wilson, Nathaniel W*	06/09/2020
Document Control Approval	Scales, Anthony	*Scales, Anthony*	06/10/2020
Environmental Protection	Wall, Jeremy M	*Wall, Jeremy M*	06/09/2020
Originator	Greenhalgh, Aaron M	*Greenhalgh, Aaron M*	06/09/2020
Other Approver	Roosendaal, Gene D	*Roosendaal, Gene D*	06/09/2020
Responsible Manager	Smith, Gregory E	*Smith, Gregory E*	06/10/2020

8. **Description of Change and Justification**

Initial release of document. This Independent Qualified Registered Professional Engineer Design Assessment Report was created by Meier Architecture Engineering and provided to WRPS under submittal 64658-032-SUB-002-001.

9. **TBDs or Holds** ☒N/A

10. **Related Structures, Systems, and Components**

a. **Related Building/Facilities** ☐N/A	b. **Related Systems** ☐N/A	c. **Related Equipment ID Nos. (EIN)** ☒N/A
ETF FACILITIES LERF FACILITIES	ETF LERF	

11. **Impacted Documents – Engineering** ☒N/A

Document Number	Rev.	Title

12. **Impacted Documents (Outside SPF):**

N/A

13. **Related Documents** ☒N/A

Document Number	Rev.	Title

14. **Distribution**

Name	Organization
Blaak, Whitney S	COGNIZANT SYSTEM ENGINEERING
Demiter, Scott M	ETF OPERATIONS
Foster, Jim	242-A/AW/ETF OPERATIONS
Goessmann, Glen E	ENGINEERING PROGRAMS
Greenhalgh, Aaron M	TANK FARM PROJECTS ENGINEERING
Halgren, Dale L	ETF ENGINEERING
Harris, John W	SAFETY PROGRAM SERVICES RC/P
Joslyn, Cameron C	ETF ENGINEERING
McFerran, Brandon E	242-A/AW/ETF OPERATIONS
McShane, Michael P	ENGINEERING PROGRAMS
O'Meara, Sean P	ETF ENGINEERING
Roosendaal, Gene D	TFP PROJECT MANAGEMENT
Rutherford, Wally	ETF ENGINEERING
Shultz, Milton V	NUCLEAR SAFETY
Smith, Gregory E	TANK FARM PROJECTS ENGINEERING
Smoot, Bill R	TFP RADCON
Thompson, Suzette A	RCRA PERMITTING
Wall, Jeremy M	RETRVL & CLOSURE/PROJ ENV CMPL
Wilson, Nathaniel W	ETF PROJECTS ENGINEERING

Figure 1. Technical Report Checklist.

Report Number RPP-IQRPE-50063 Revision: 0

Report Title: IQRPE Design Assessment Report for LERF Basin 41

The following checklist is used by checkers to ensure technical reports are complete and in compliance with engineering procedures (i.e., TFC-ENG-DESIGN-C-25). This checklist is also applicable to ECNs that revise these types of documents. DRCF required approvers vary according to the type of document being released. Required approvers are identified in SPF.

Item No.	Yes	No	N/A	Item
				Version/Format
1			✓	If revising an existing report, are the changes being made against the current revision in SPF?
2	✓			Is the Document Release and Change Form (DRCF) properly filled out?
3	✓			Are all of the pages properly labeled with Report Number, Revision Number, and Sequential Page Number?
4	✓			Are the Subject and Purpose clearly stated and do they meet the end users' needs?
				References
5	✓			Are all References properly documented within the report and can they be easily verified within Document Control, online, or within the library, etc.? If reference documents are not readily available, are they attached?
6	✓			Have the correct design bases documents been identified (e.g., codes, standards, DOE Orders, TOC standards, regulatory requirements, etc.)?
				Open Items/Input
7	✓			Is there a reference/source for each input?
8	✓			Do the identified references/sources fully support the inputs?
9			✓	Are all assumptions used to support the report individually listed and numbered?
10			✓	Is there a justification written for each assumption that includes a technical basis?
11			✓	Do the justifications adequately support the assumptions?
12			✓	If the report has open items, TBDs, and/or HOLDs, is there a method identified to track them?
				Results/Conclusion
13	✓			Are the results of the report consistent with the input and assumptions?
14		✓		Do the results of the report affect any other technical documents?
15	✓			Do the results substantiate the conclusion?
				Approvals
16	✓			Does the DRCF identify the method of verification and checking and does it have a signature block for the verifier/checker?

Item No.	Comments
	N/A

Checker: Nathaniel Wilson [signature] 6/9/2020

Print Name **Signature** **Date**

RPP-IQRPE-50063
Revision 0

Independent Qualified Registered Professional Engineer Design Assessment Report for Liquid Effluent Facility (LERF) Basin 41

Prepared by

A.M. Greenhalgh
Washington River Protection Solutions, LLC

Date Published
June 2020

Prepared for the U.S. Department of Energy
Office of River Protection

Contract No. DE-AC27-08RV14800

Independent Qualified Registered Professional Engineer Design Assessment Report For Liquid Effluent Retention Facility (LERF) Basin 41

IQRPE Design Assessment Report No. DA-334426-01 Rev. 0

Prepared By

Meier Architecture • Engineering
12 W. Kennewick Ave.
Kennewick, WA 99336

At the request of

Washington River Protection Solutions
Richland, Washington 99352

Meier Project No. 20-8600
WRPS Subcontract No. 64658, Release 032

June 2, 2020

TABLE OF CONTENTS

Tables

Figures

1.0 INTRODUCTION

The Code of Federal Regulations (CFR) 40 CFR 264.192, *Design and Installation of New Tank Systems or Components*, and Washington Administrative Code (WAC) 173-303-640(3), *Design and Installation of New Tank Systems or Components*, provide a set of requirements for owner/operators of dangerous waste tank systems. This Design Assessment Report is prepared for Washington River Protection Solutions, LLC (WRPS), to meet the Washington Department of Ecology (Ecology) review, by an Independent Qualified Registered Professional Engineer (IQRPE) to certify that the proposed tank system will have sufficient structural integrity and is acceptable for storing and treating dangerous waste per 40 CFR 264.192(a) and WAC 173-303-640(3)(a). Also, the IQRPE is to certify that surface impoundments dikes will have structural integrity and will not fail per 40 CFR 264.226(c), *Monitoring and Inspection*, and WAC 173-303-650(4)(c), *Surface Impoundments*. 40 CFR 264.192(a) and WAC 173-303-640(3)(a) have identical requirements for tank system. Similarly 40 CFR 264.226(c) and WAC 173-303-650(4)(c) have identical requirements for surface impoundments dikes.

IP-334426-01, *IQRPE Inspection Plan for LERF Basin 41*, identifies the IQRPE inspections required for procurement, fabrication, testing, installation, and tightness testing of the tank system in accordance with WAC 173-303-640(3) associated with the LERF Basin 41 Project, and review of surface impoundments dikes for structural integrity in accordance with WAC 173-303-650(4)(c).

An IQRPE Installation Assessment Report for LERF Basin 41 will be prepared for WRPS by an IQRPE to certify that the tank system installations are in accordance with 40 CFR 264.192(b)-(f), and WAC 173-303-640(3)(c)-(g), and surface impoundments to have structural integrity in accordance with 40 CFR 264.226(c) and WAC 173-303-650(4)(c).

The IQRPE maintains “independence” at all times. However, comments by others are considered by the IQRPE during the preparation of reports and plans. Only the IQRPE can implement changes to the master IQRPE documents.

1.1 PROJECT DESCRIPTION

1.1.1 Background

The Liquid Effluent Retention Facility (LERF) is a treatment, storage, and disposal (TSD) unit serving generators of radiological dangerous effluents on the Hanford site. LERF is permitted under the *Resource Conservation and Recovery Act* (RCRA) of 1976 for the storage and treatment of liquid mixed waste effluents through pH and flow equalization. Functionally, LERF serves as a collection point and must be capable of feeding the Effluent Treatment Facility (ETF) for final treatment and disposal of liquid effluent. There are three (3) operating basins at LERF with a fourth basin (Basin 41) that was excavated in the 1990’s. The LERF Basin Project is to complete Basin 41 design and installation of associated equipment, piping, and tie-ins in order to provide LERF with more capacity. This capacity increase is needed in the future due to projected increases in 242-A Evaporator campaigns and liquid effluent that will be coming from the Waste Treatment Plant (WTP) when it becomes operational. The Basin 41 Project is further described in MT-50497, *Liquid Effluent Retention Facility (LERF) Basin 41.*

Design of the new Basin 242AL-41 (Basin 41) is to ensure there is sufficient storage capacity for future LERF operations consisting of:

- Continuous Operations:
  - Effluent Management Facility (EMF)/WTP Effluent.
  - 242-A Evaporator Condensate.
  - IDF Leachate.
- Intermittent Operations:
  - Feed to ETF.
  - Tanker/Load-In from ETF.
  - Groundwater.
  - LERF Cover Water.
  - Basin Recirculation or Basin-to-Basin Transfers.

IQRPE design assessment scoping of LERF Basin 41 to comply with WAC 173-303-640, *Tank Systems*, and WAC 173-303-650 applicable code requirement boundaries are depicted in Figure 1:

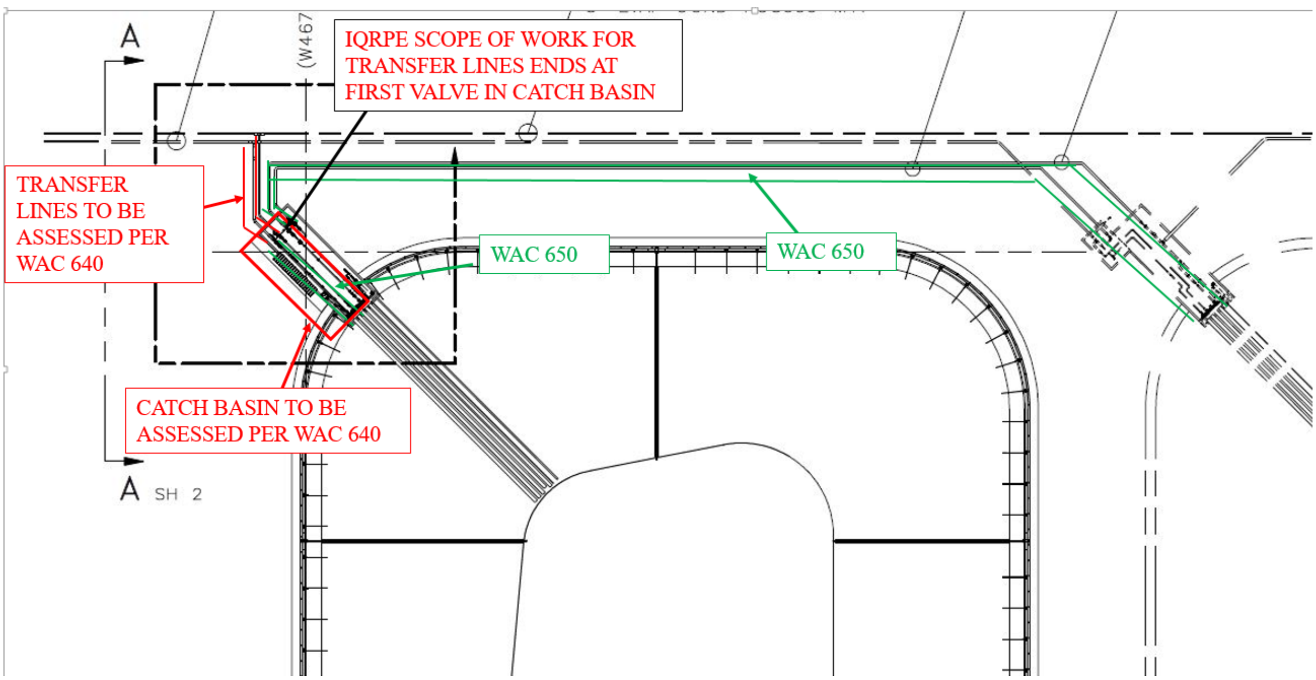


Figure 1: LERF Basin 41- Scoping Diagram Showing WAC 173-303-640 and WAC 173-303-650 Boundaries

<u>WAC 173-303-640</u>

The IQPRE scope to support the design and installation of Basin 41 tank system components under WAC 173-303-640 includes the following:

- 4”-60M-008-M18 primary piping with 8” encasement piping from 4”-WTP-001-M17 piping tie-in point to valve 60M-41-1 in catch basin. Also included is the 8” ENCL-M17 encasement drain piping 1”-60M-012-M10 up to ball valve 60M-41-7 (H-2-88766, Sheet 6, *P&ID LERF Basin & ETF Influent Evaporator*).

- 3”-60M-009-M18 primary piping with 6” encasement piping from 3”-EVAP COND-PC5000-M17 piping tie-in point to valve 60M-41-2 in catch basin. Also included is the 6” ENCL-M17 encasement drain piping 1”-60M-013-M10 up to ball valve 60M-41-8 (H-2-88766, Sheet 6).
- Catch Basin Leak Detector System (LDS 41-8).
- 242AL-41 catch basin concrete structure and coating system.

<u>WAC 173-303-650</u>

The IQRPE scope to support the design and installation of Basin 41 surface impoundment components under WAC 173-303-650 includes the assessment of the dike including that portion of any dike which provides freeboard and has structural integrity. The certification must establish, in particular, that the dike:

- Will withstand the stress of the pressure exerted by the types and amounts of wastes to be placed in the impoundment; and
- Will not fail due to scouring or piping, without dependence on any liner system included in the surface impoundment construction.

The installation of LERF Basin 41 will occur on the Hanford Nuclear Waste Site in the 200 East Area.

1.1.2 IQRPE Scope

Meier Architecture • Engineering (Meier) provided an IQRPE to perform the design assessment per WRPS Statement of Work (SOW) No. 334426, *IQRPE Support for Liquid Effluent Retention Facility (LERF) Basin 41*. The scope includes a review of the design, installation, and testing activities for equipment. The Tank System equipment described in Section 1.1.1 above is to be certified under WAC 173-303-640. Certification to WAC 173-303-650 for LERF Basin 41 is limited to the structural stability of the dikes.

A review of design documents (drawings, calculations, specifications, etc.) was completed by the IQRPE. Fabrication and installation inspections will be completed by the IQRPE at a later date. Included within the scope of the IQRPE review are various technical evaluations covering areas dealing with potential waste leak paths, thermal expansion, water hammer, and freeze protection issues associated with the LERF Basin 41 Project.

The IQRPE performed the design assessment to the requirements of 40 CFR 264.192; WAC 173-303-640(3); 40 CFR 264.226(c) and WAC 173-303-650(4)(c) for LERF Basin 41.

This IQRPE design assessment takes credit for the following previously issued IQRPE Design Assessment and Installation Assessment Reports that cover the previously installed components of the Waste Transfer System (WTS).

- RPP-25153, Volume 3: *IQRPE DST System Integrity Assessment - Waste Compatibility*. This report reviews the past, current, and projected future contents of the Hanford double-shell tanks (DSTs), materials of construction of the DSTs and ancillary equipment, and possible mechanisms of corrosion to reach conclusions and recommendations about waste compatibility with the existing equipment.
- RPP-27591, Volume 2: *IQRPE DST System Integrity Assessment - Pipeline Integrity*. This report assesses design standards, hazardous waste compatibility, existing corrosion

protection measures, past pipeline integrity assessments, and results of leak test, internal inspection, and examinations necessary to support the overall DST System Integrity Assessment.

- RPP-RPT-58441, *Double-Shell Tank System Integrity Assessment Report (DSTAR)*. This report assesses the overall integrity for the waste storage tanks, pits, vaults, and buried piping using the DST System configuration as of 2016.

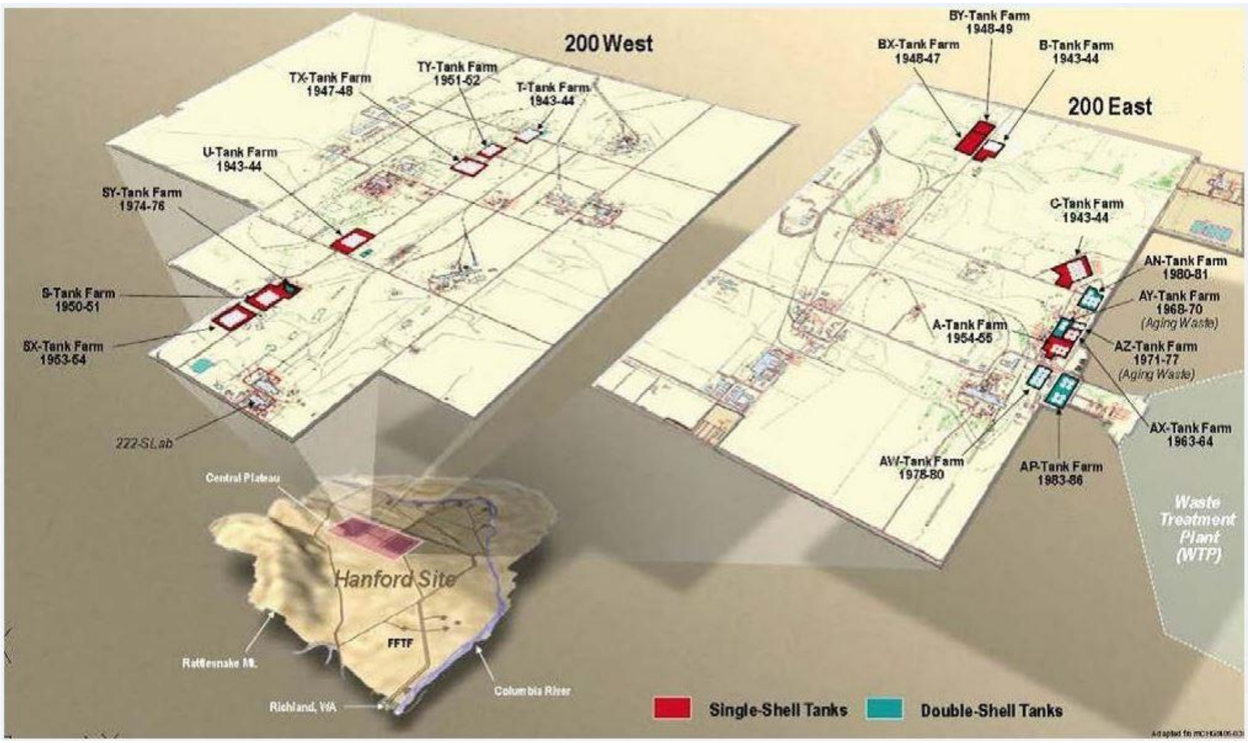


Figure 2: Hanford Map Showing the Location of the 200 East and West Areas

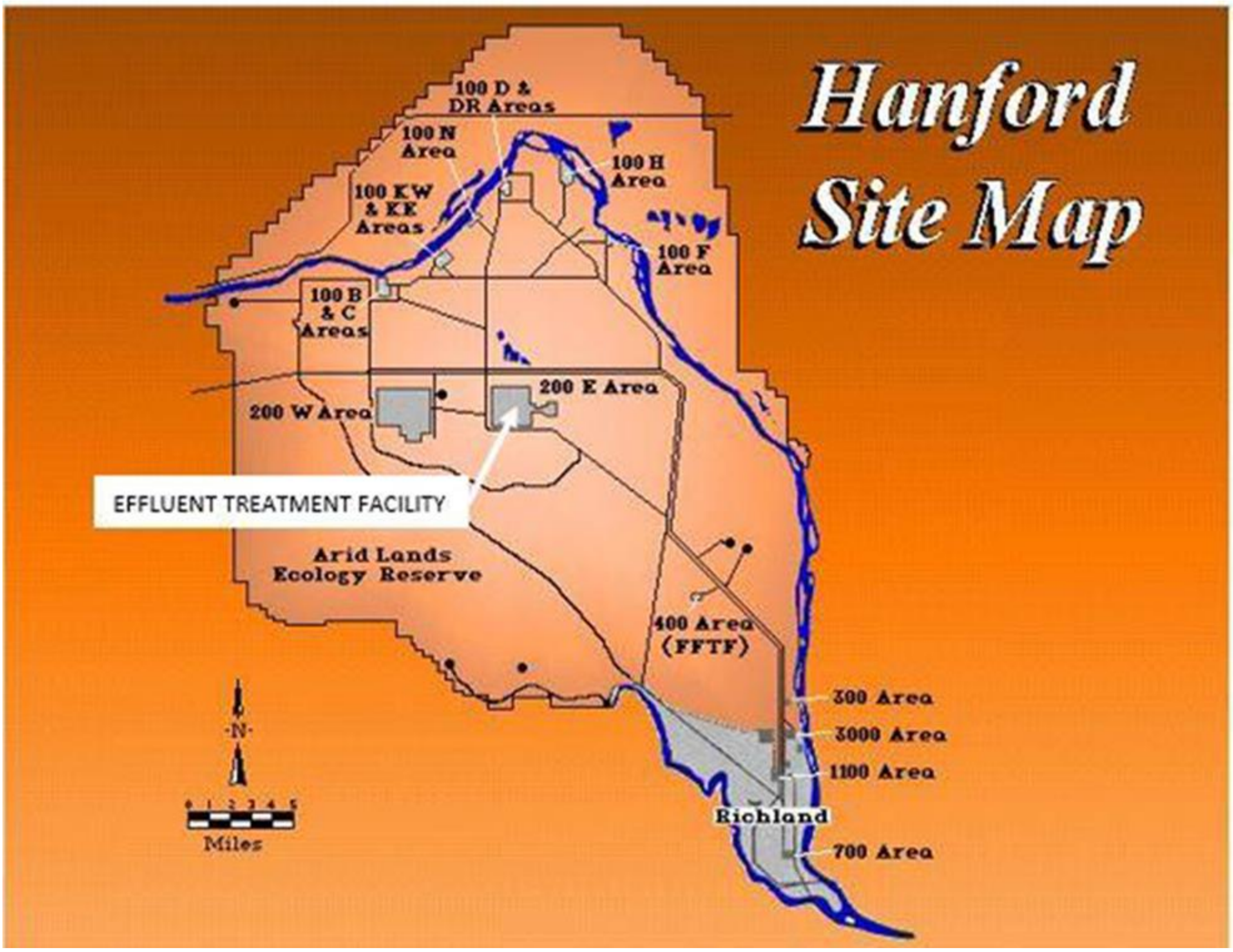


Figure 3: **Hanford Site Map Showing the Location of Basin 41**

Figure 4: Aerial Photograph Showing LERF Basin 41 (ETF in Foreground)

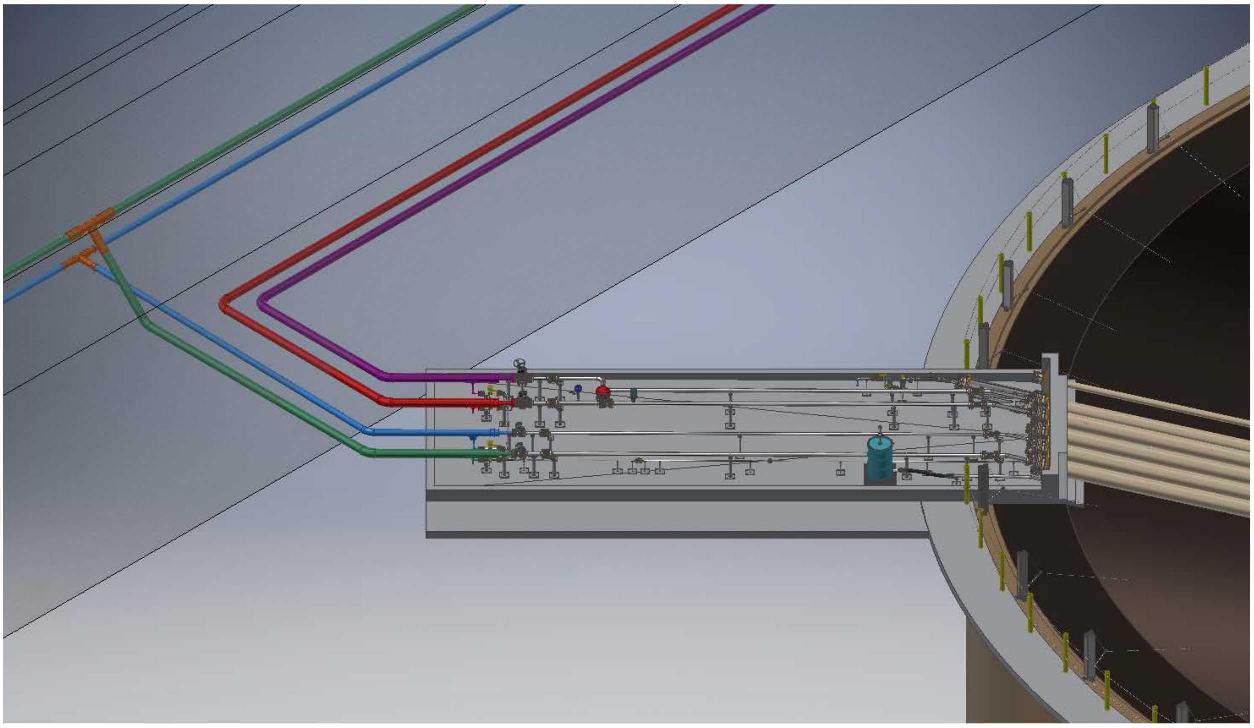


Figure 5: Catch Basin 41 Piping Interface Overview

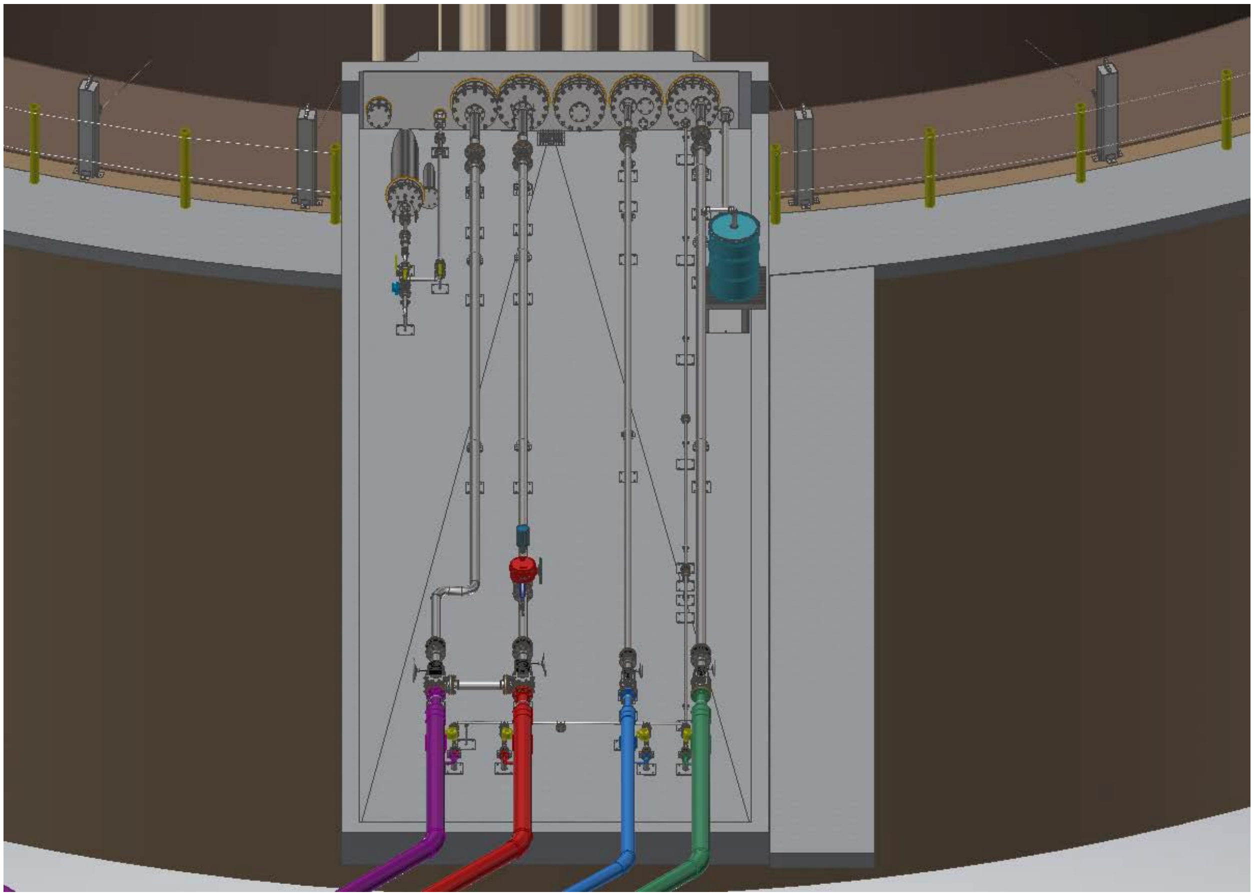


Figure 6: Catch Basin 41 Piping Detail

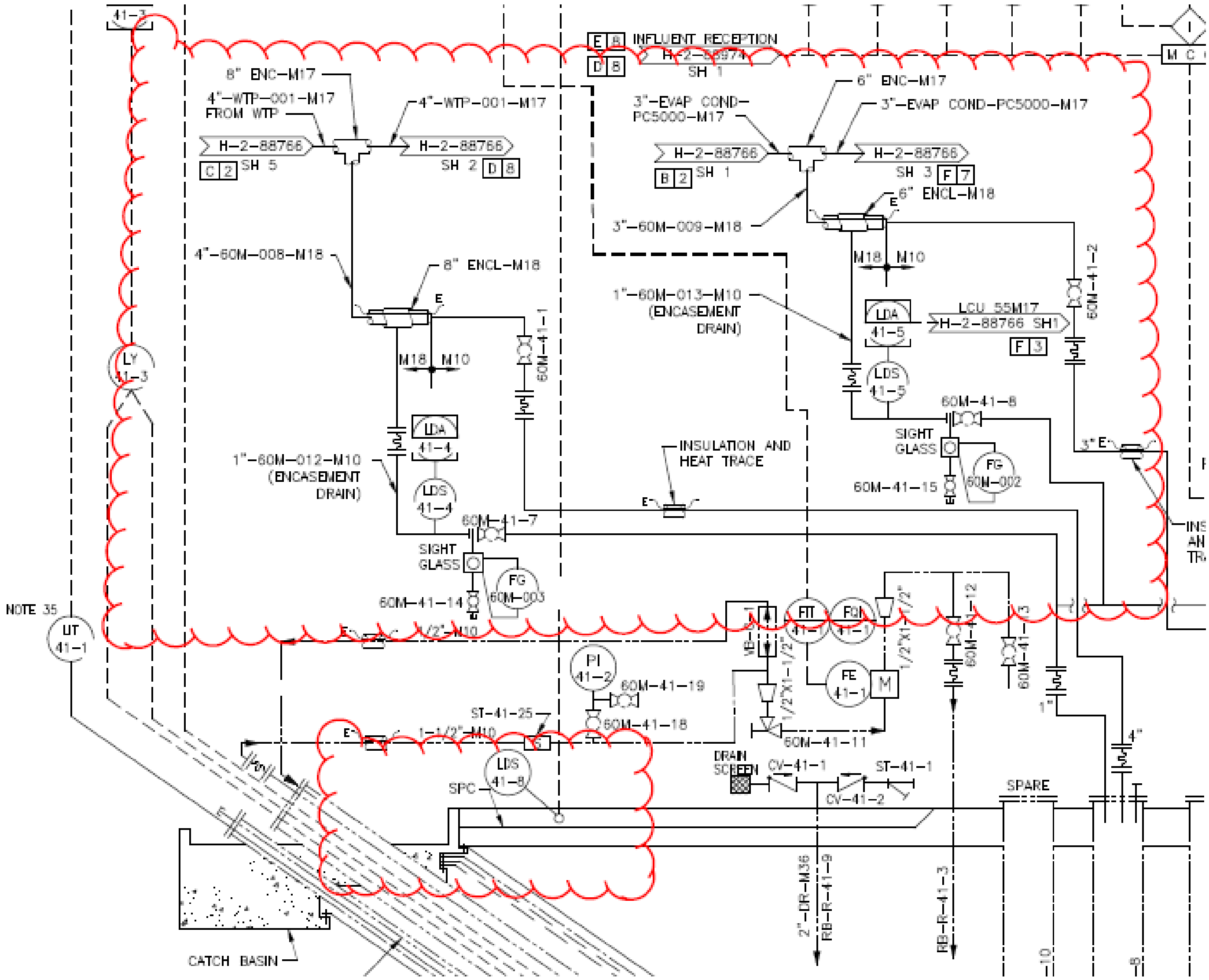


Figure 7: LERF Basin 41 P&ID Clouded Area Shows IQRPE Scope (H-2-88766, Sheet 6)

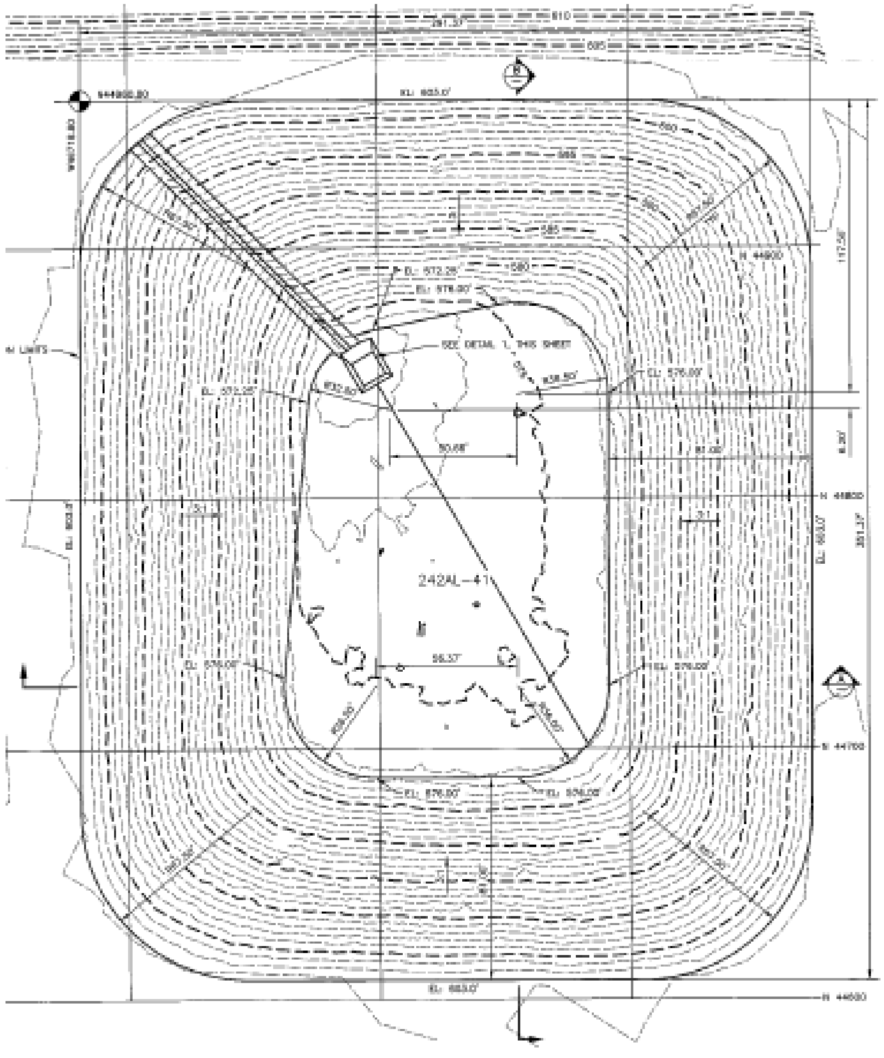


Figure 8: LERF Basin 41 Civil Excavation Plan (H-2-838748, Sheet 1)

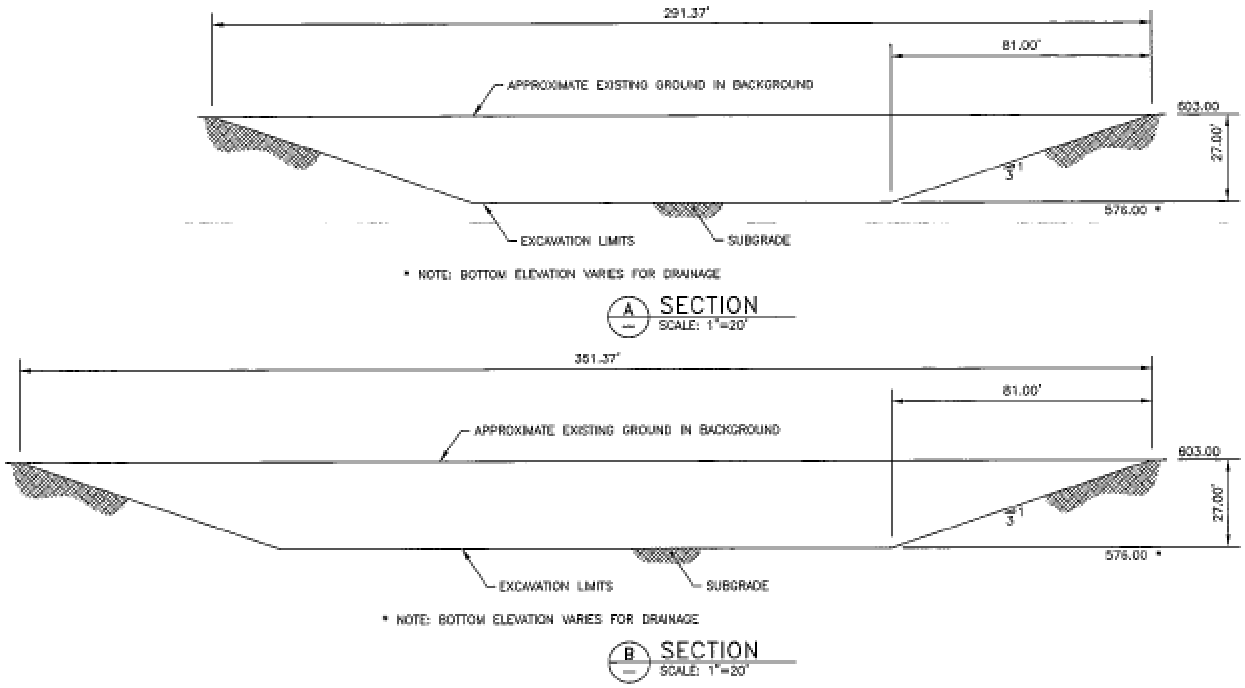


Figure 9: LERF Basin 41 Excavation Section Views showing Dike (H-2-838748, Sheet 1)

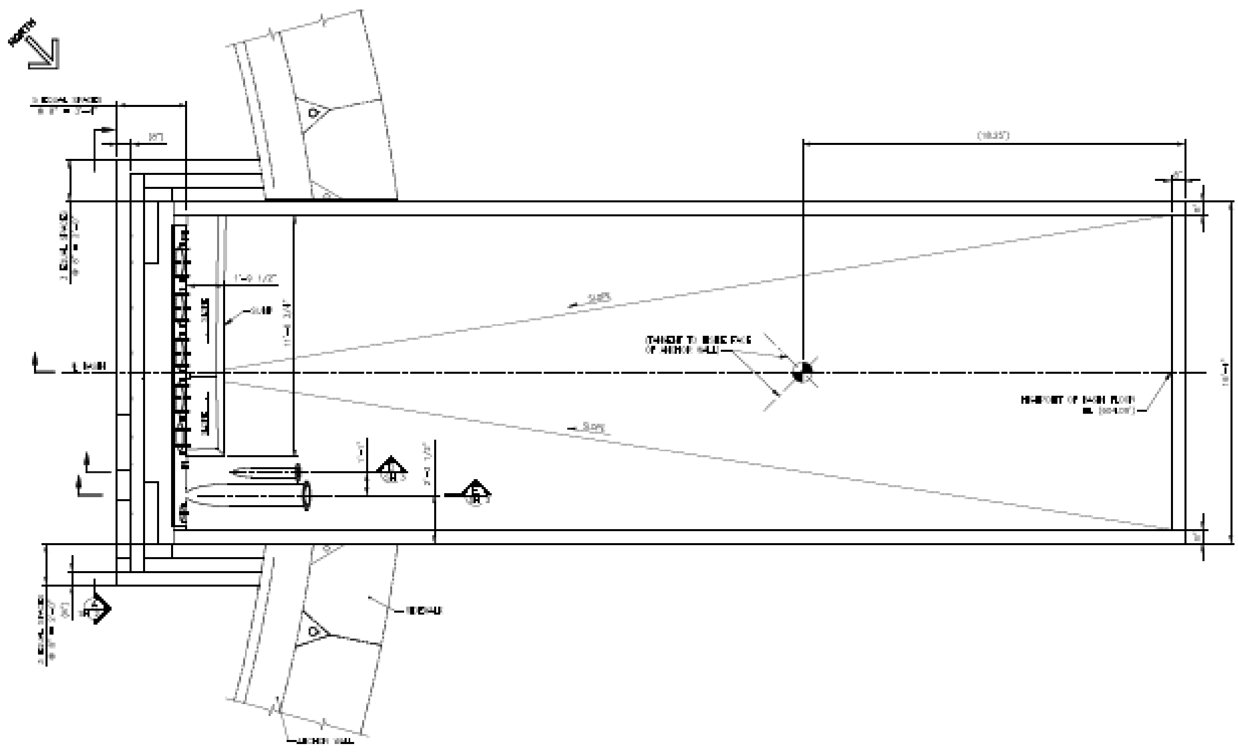


Figure 10: LERF Basin 41 Catch Basin Plan View (H-2-838751, Sheet 1)

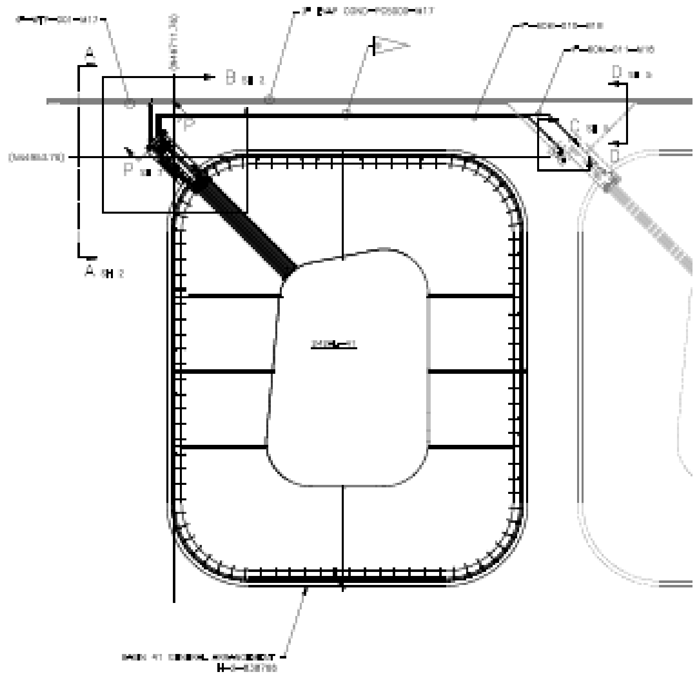


Figure 11: LERF Basin 41 Mechanical General Arrangement (H-2-838765, Sheet 1)

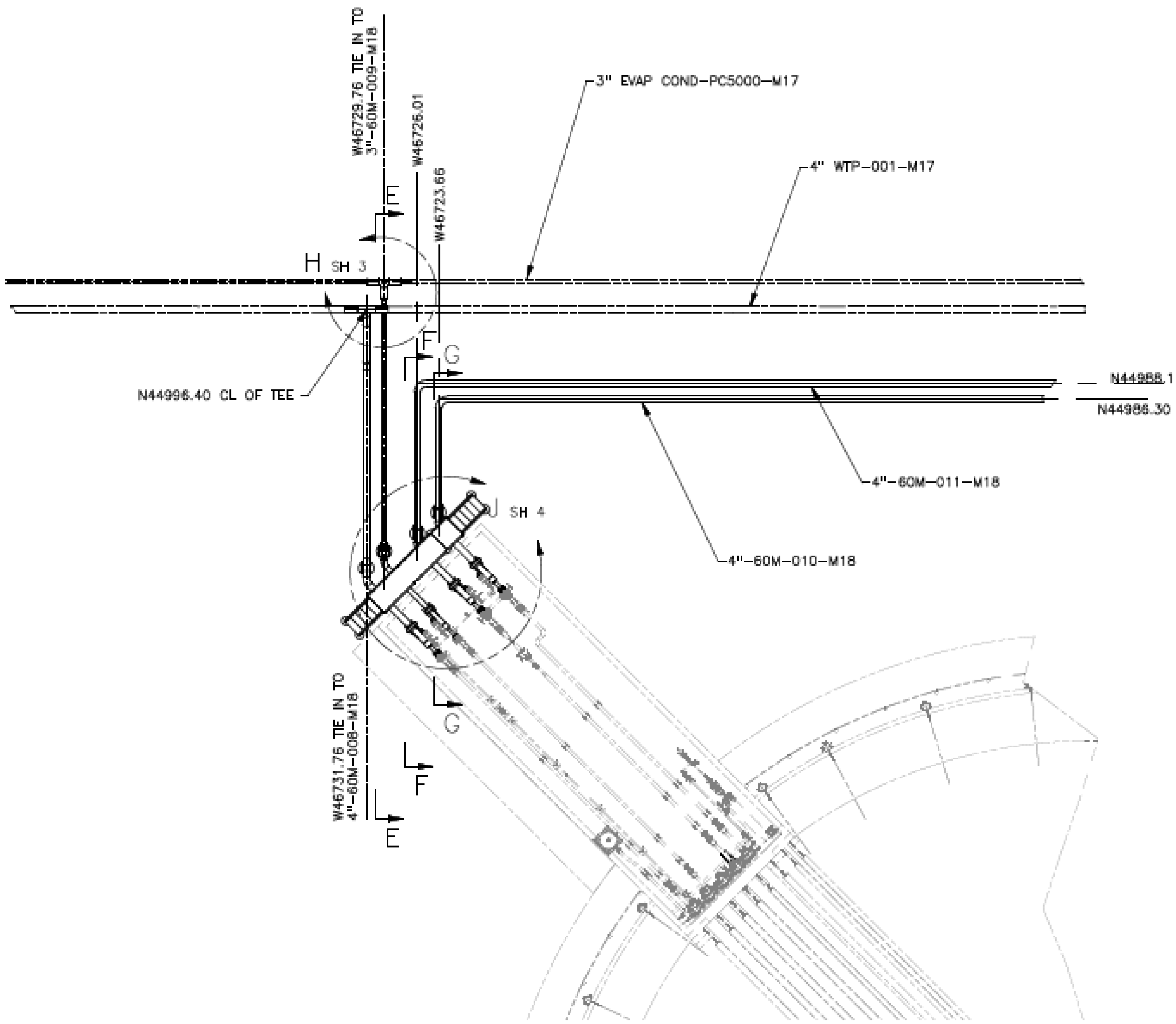


Figure 12: LERF Basin 41 Piping Detail-B (H-2-838765, Sheet 2)

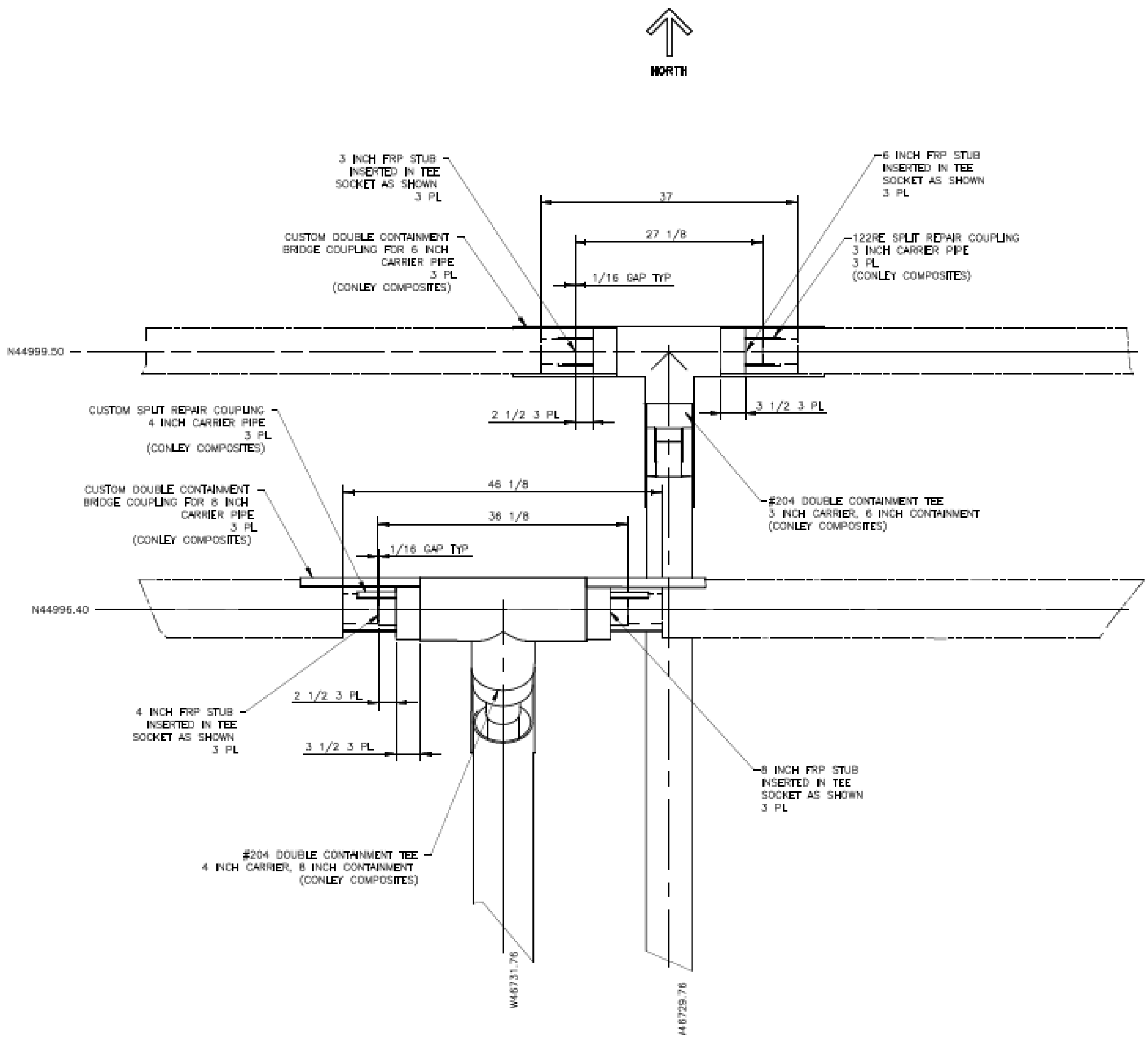


Figure 13: LERF Basin 41 Piping Detail-H (H-2-838765, Sheet 3)

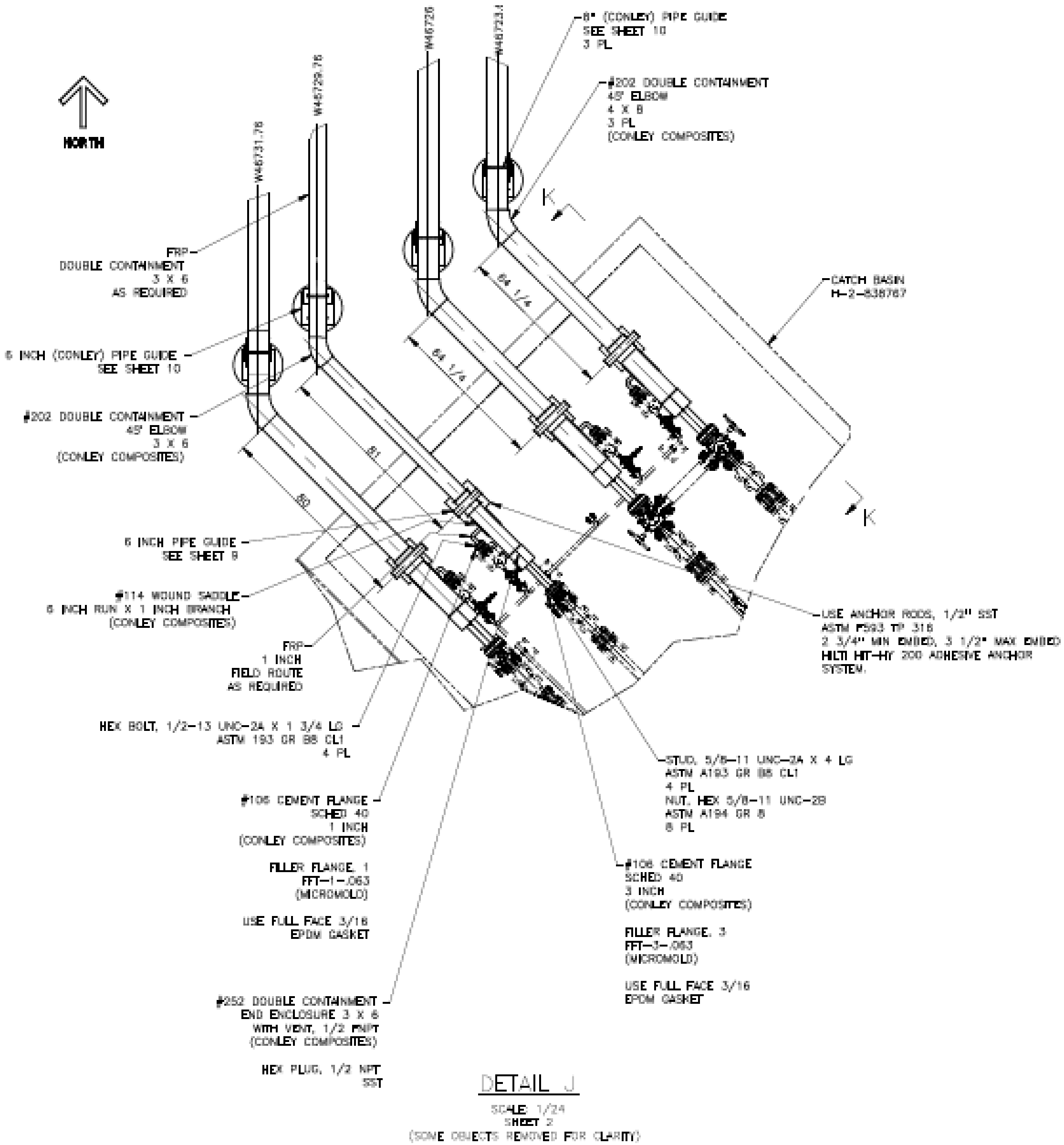


Figure 14: LERF Basin 41 Piping Detail-J (H-2-838765, Sheet 4)

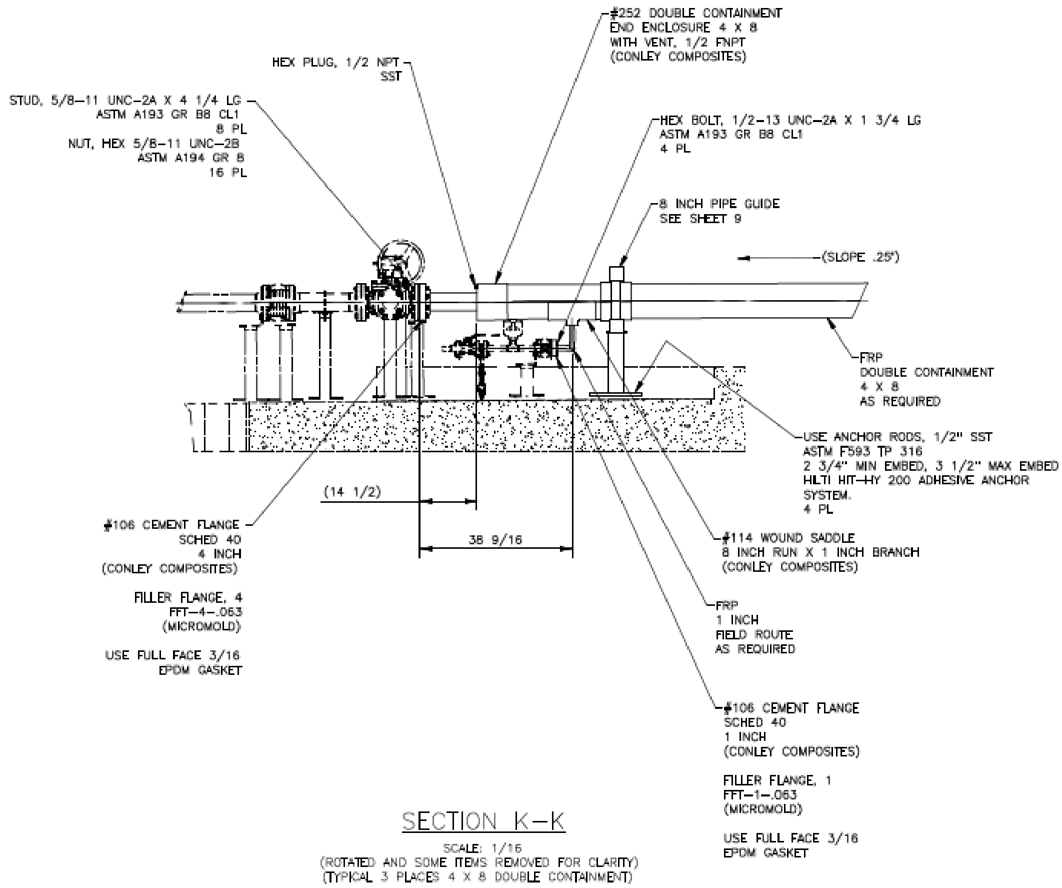


Figure 15**: LERF Basin 41 Piping Section K-K (H-2-838765, Sheet 4)**

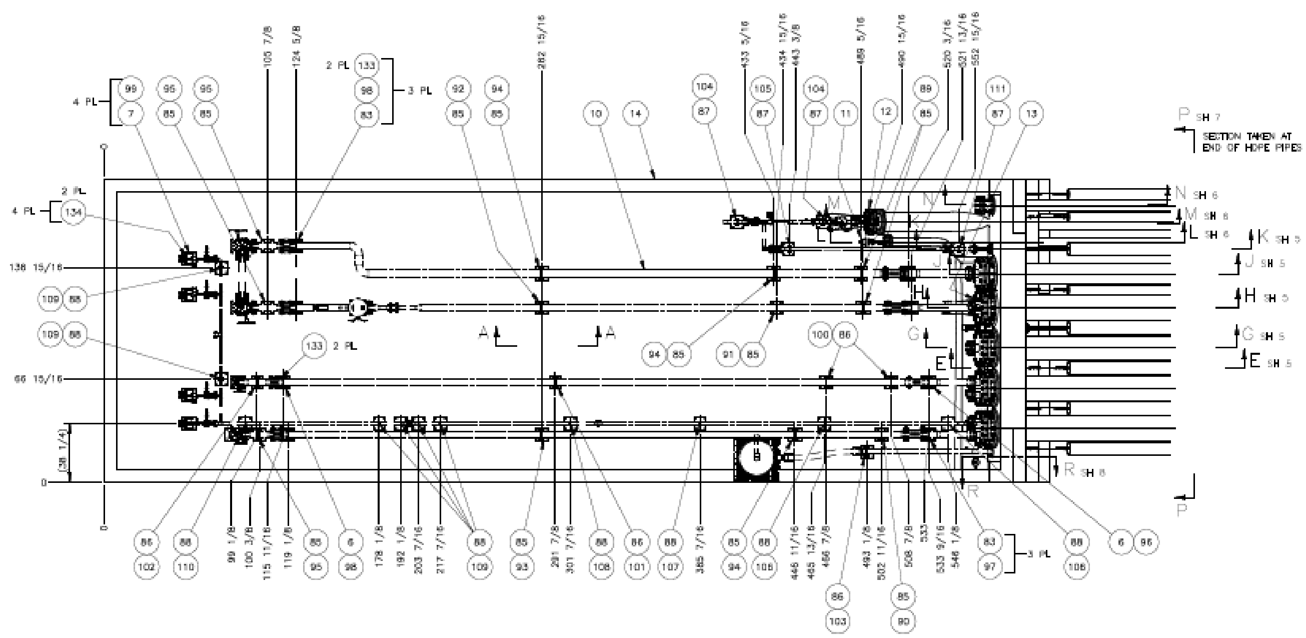


Figure 16: LERF Basin 41 Catch Basin Assembly (H-2-838767, Sheet 3)

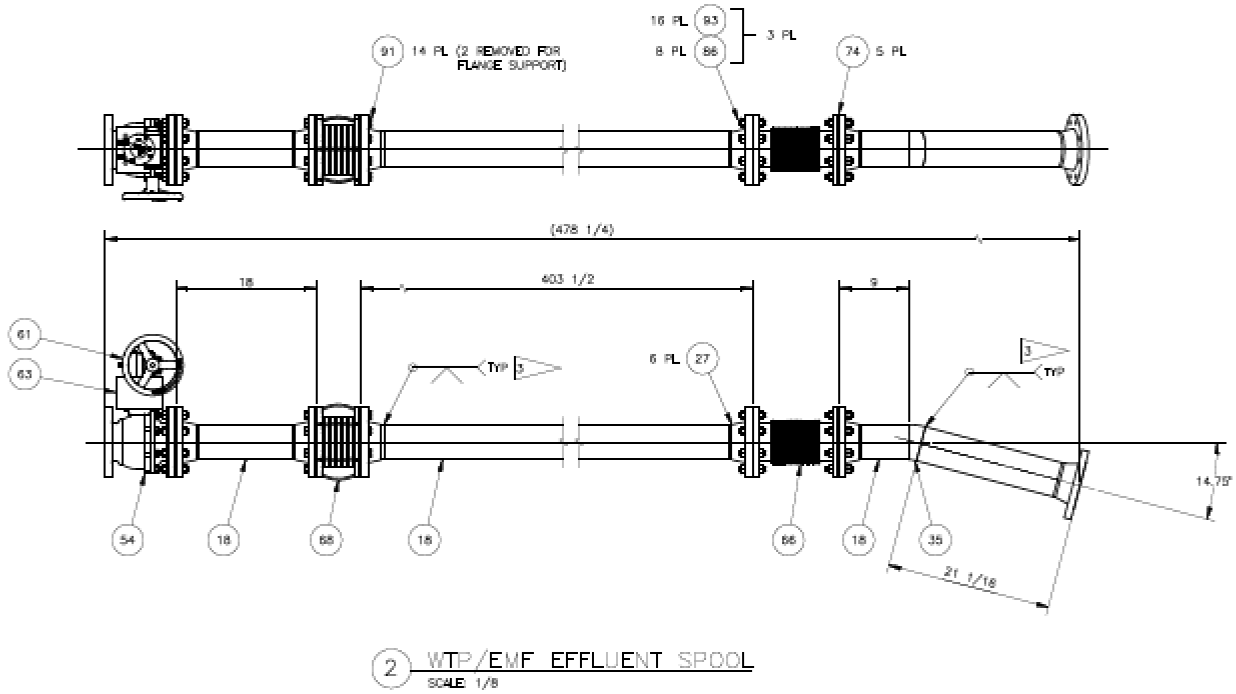


Figure 17: WTP/EMF Effluent Interface Ball Valve (H-2-838771, Sheet 4)

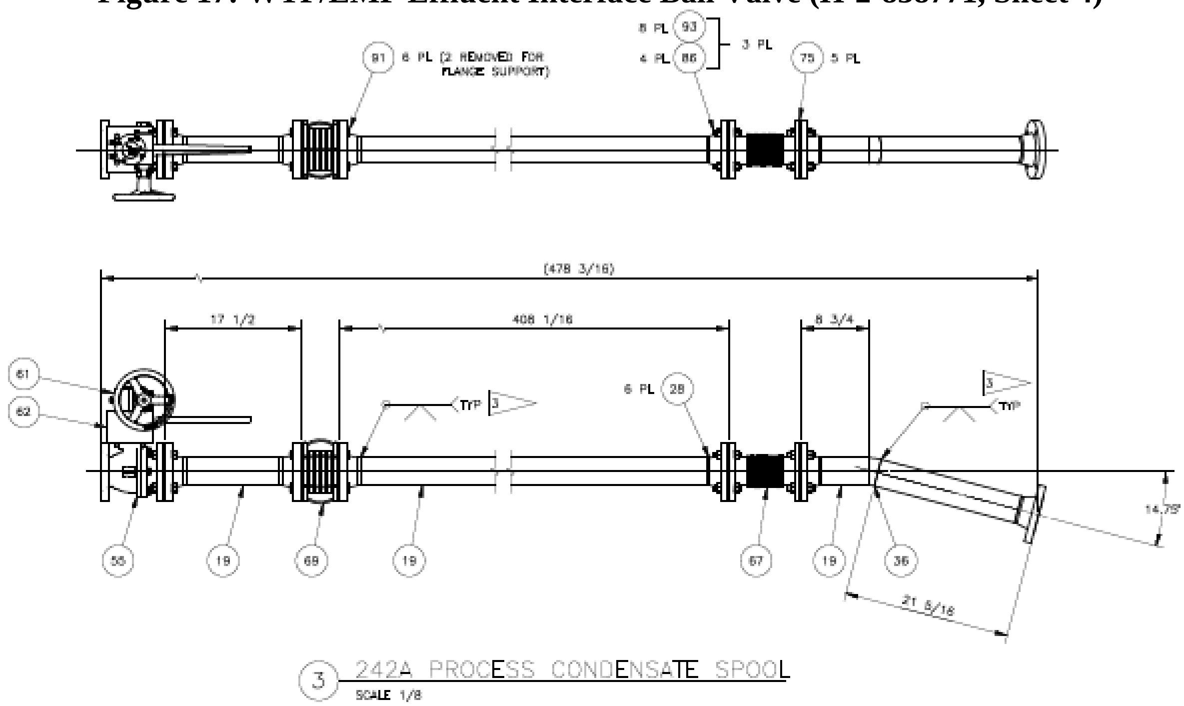


Figure 18: 242A Process Condensate Interface Ball Valve (H-2-838771, Sheet 4)

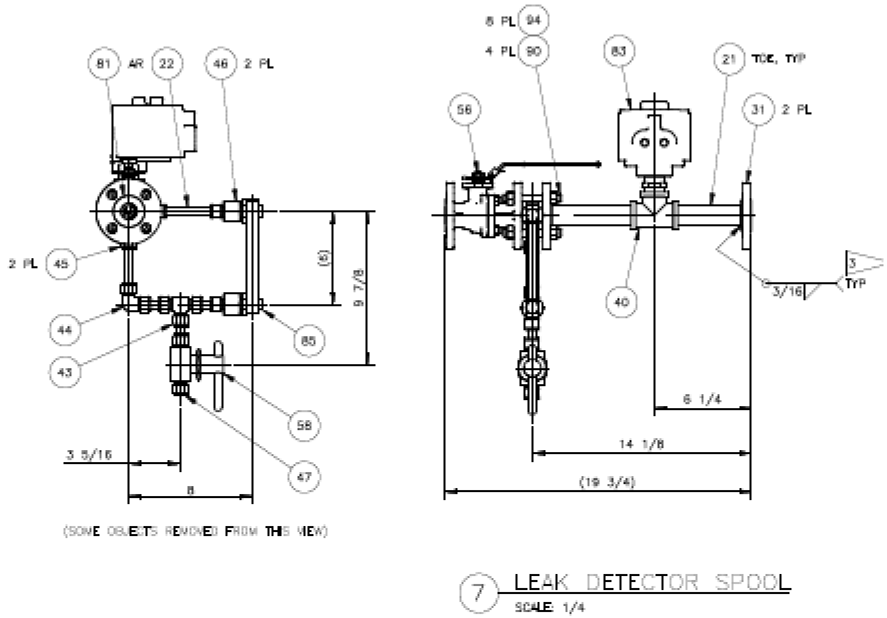


Figure 19: Encasement Leak Detector Pipe Spool (H-2-838771, Sheet 8)

1.2 DESIGN REVIEW REQUIREMENTS

Many of the components required for the transfer of dangerous or mixed waste are regulated by 40 CFR 264.192 and WAC 173-303-640(3) tank system requirements. The CFR and WAC codes require an IQRPE review of the design of these components prior to installation. Certification to WAC 173-303-650 for LERF Basin 41 is limited to the structural stability of the dikes. As a basis for the IQRPE certification, a review is performed on a final version of the document design package as prepared and reviewed by WRPS. Documents such as drawings, calculations, Engineering Change Notices (ECNs), Engineering Design Transmittals (EDTs), Technical Evaluations, and specifications included in the design review package that are marked as final, and have signatures of the preparer, checker, and approver, are reviewed by the IQRPE as a completed document. All other documents will be reviewed as preliminary or supportive information.

The IQRPE maintains "independence" at all times. However, comments by others are considered by the IQRPE during the preparation of reports and plans. Only the IQRPE can implement changes to the master IQRPE documents.

1.3 DESIGN OVERVIEW FOR LERF BASIN 41 PROJECT

This Design Assessment Report is prepared for the Owner and Ecology by an IQRPE to certify that the proposed tank system will have sufficient structural integrity and is acceptable for storing and treating dangerous waste per 40 CFR 264.192(a) and WAC 173-303-640(3)(a); and Surface Impoundments per 40 CFR 264.226(c) and WAC 173-303-650(4)(c).

The specific components included as part of this IQRPE design assessment for the LERF Basin 41 Project are listed below:

- Transfer Piping:
  - 4"-60M-008-M18
  - 3"-60M-009-M18
- Encasement Piping Drains:
  - 1"-60M-012-M10
  - 1"-60M-013-M10
- Encasement and Catch Basin Leak Detector System.
- Catch basin concrete structure and coating system (242AL-41).
- Basin 41 Dike.

1.3.1 Transfer Piping

Double containment piping (4 X 8) is 4"-60M-008-M18 primary/carrier piping with 8" encasement piping is a waste transfer piping. Carrier and encasement pipe is Conley Double Containment FRP Pipe® utilizing Conley Aromatic® amine cured epoxy resin in accordance with pipe class M-18 listed in construction specification RPP-SPEC-63632, *LERF Basin 41 Construction Specification*. IQRPE scope of 4"-60M-008-M18 pipe run is from 4"-WTP-001-M17 piping tie-in point to ball valve 60M-41-1 (H-14-838771, *LERF Basin 41 Catch Basin Piping Assembly*, Sheet 4) in the catch basin only. Encasement piping is capped using #252 double containment end enclosure about 14½" before the ball valve flanged connection.

The second double containment waste transfer piping (3 X 6) is 3"-60M-009-M18 primary/carrier piping with 6" encasement piping. Carrier and containment pipe is Conley Double Containment

FRP Pipe® utilizing Conley Aromatic® amine cured epoxy resin in accordance with pipe class M-18 listed in construction specification RPP-SPEC-63632. IQRPE scope of 3”-60M-009-M18 pipe run is only from 3”-EVAP COND-PC5000-M17 piping tie-in point to valve 60M-41-2 (H-14-838771, Sheet 4) in catch basin. Encasement piping is capped using #252 double containment end enclosure about 14½” before the ball valve flanged connection.

Both of these pipes are installed partially in the berm and partially above ground using saddle supports and sloped towards the catch basin. Pipes are procured and installed in accordance with construction specification RPP-SPEC-63632. See P&ID H-2-88766, Sheet 6, and H-2-838765, *LERF Basin 41 Mechanical General Arrangement* for piping layout and piping details.

1.3.2 Encasement Piping Drains

Any leakage from transfer piping 4”-60M-008-M18 and 3”-60M-009-M18 is collected in their respective containment piping. Because transfer piping is sloped towards the catch basin, any collected liquid waste is transferred to the basin upper liner via 1” fiberglass reinforced plastic (FRP) pipe and flanged to 1”-60M-012-M10 and 1”-60M-013-M10 respectively. Encasement drain piping is ASTM A312, Grade TP 304L piping in accordance with pipe Class M-10 listed in construction specification RPP-SPEC-63632.

IQRPE scope of encasement drain 1”-60M-012-M10 and 1” FRP piping run is from 8” ENCL-M17 (encasement pipe for 4”- 60M-008-M18) tie-in point to valve 60M -41-7 in catch basin only.

IQRPE scope of encasement drain 1”-60M-013-M10 and 1” FRP piping run is from 6” ENCL-M17 (encasement pipe for 3”- 60M-009-M18) tie-in point to valve 60M -41-8 in catch basin only.

Both these encasement pipes drain to the catch basin liner. Encased piping is procured and installed in accordance with construction specification RPP-SPEC-63632. See P&ID H-2-88766, Sheet 6; H-2-838765, Sheet 4; and H-2-838771, Sheet 8, for piping layout and piping details.

1.3.3 Encasement and Catch Basin Leak Detector System

There are three (3) leak detectors in the scope of this design assessment as listed below:

- LDS 41-4 for encasement pipe 1”-60M-012-M10 for any leakage detected in the 8” ENCL-M17 encasement pipe and will alarm locally (H-2-88766, Sheet 6; H-2-838776, Sheet 1, and H-2-838776).
- LDS 41-5 for encasement pipe 1”-60M-013-M10 for any leakage detected in the 6” ENCL-M17 encasement pipe and will alarm locally (H-2-88766, Sheet 6 and H-2-838776, Sheet 1).
- LDS 41-8 is a catch basin leak detector alarm and connected to a control room and will activate when liquid level in the catch basin reaches the preset level. (H-2-88766, Sheet 6 and H-2-838776, Sheet 1).

1.3.4 Catch Basin Concrete Structure and Coating System (242AL-41)

Catch basin concrete structure (242AL-41) is an open top concrete structure (51’-0” long by 16’-4” wide) as shown on drawing H-2-838751, Sheets 1-4, *LERF Basin 41 Structural Catch Basin Details*. The catch basin is constructed of concrete and its surface is coated in accordance with RPP-SPEC-63632 (Section 09 85 50, *Chemical Resistant Decontaminable Coatings*). Finish coat, siloxane, a high performance engineered silicone-epoxy coating system, is intended for use as the top coat in the catch basin. The top coat is the material expected to provide secondary containment for piping in the catch basin. The siloxane coating material was evaluated in RPP-RPT-62215, *LERF Basin 41 Material Compatibility with Wastewater*, and found to be suitable for use over the 30 years design life.

The catch basin is used for tie-in to the WTP/EMF and the 242-A condensate transfer lines terminating at the new isolation valves installed within Basin 41 catch basin. There are other piping systems installed in the catch basin as part of the overall LERF Basin 41 Project which are not part of this design assessment. The catch basin is used as a secondary containment for any leakage from WTP/EMF and 242-A condensate portions of non-encased piping and drain piping system. (H-2-88766, Sheet 6 and H-2-838767, Sheet 3, *LERF Basin 41 Catch Basin Assembly*).

1.3.5 LERF Basin 41 Dike

The dike of LERF Basin 41 was originally constructed in the 1990 time frame to the requirements of W-105-C4, *Construction Specification for Soil/Bentonite Liner System for 242-A Evaporator Cond Interim Retention Basin*. The construction of the dike will be completed in accordance with RPP-SPEC-63632. The dike consists of the four (4) sloped walls of the basin as shown in drawing H-2-838748, *LERF Basin 41 Civil Excavation Plan*. The dike is 81 feet wide and height of 27 feet with 3:1 slope as shown on Drawing H-2-838748, Sheet 1.

Typical dike crest consists of 4” depth top roadway material between finished grade and subgrade surface as shown on drawing H-2-838749, Sheet 1, *LERF Basin 41 Civil Bottom Liner*. The dike is provided with slope erosion protection consisting of 3” depth top permanent erosion protection between the finished grade and subgrade surface as shown on drawing H-2-838749, Sheet 1.

1.4 SCOPE OF IQRPE DESIGN ASSESSMENT

This IQRPE design assessment includes a comprehensive review of the LERF Basin 41 Project design package per 40 CFR 264.192, WAC 173-303-640(3), 40 CFR 264.226(c), and WAC 173-303-650(4)(c).

1.4.1 Portions of LERF Basin 41 Project Included in Scope for IQRPE Certification

Documents included in this design review for the LERF Basin 41 Project include:

- Calculations.
- Procurement Specifications.
- Technical Specifications.
- Design and Fabrication Drawings.
- ECNs.
- P&IDs.

A list of documents reviewed by the IQRPE as part of this Design Assessment Report is included in Section 4.0.

1.4.2 Portions of the LERF Basin 41 Project Not Included in Scope for IQRPE Certification

This IQRPE review was limited only to LERF Basin 41 Project components and no other systems or components were evaluated.

2.0 ASSESSMENT SUMMARY

As described in Section 1.1.2, systems within the IQRPE scope of this assessment is adequately designed to prevent failure caused by corrosion or by structural loads imposed by the system's intended service. The system design complies with the applicable requirements of 40 CFR 264.192, WAC 173-303-640(3), 40 CFR 264.226(c), and WAC 173-303-650(4)(c).

Design documents that were reviewed as part of this assessment are referenced in Section 4.0.

2.1 CODES, STANDARDS, AND REGULATIONS

The codes, standards, and regulations specifically used during the preparation of this certification are referenced, as necessary, throughout this report.

RPP-SPEC-63602, *LERF Basin 41 Engineering Design Code of Record Specification*, lists the codes and standards used to design, construct, operate, and decommission the LERF Basin 41 Project. The materials used in the project were evaluated in RPP-RPT-62215, *LERF Basin 41 Material Compatibility with Wastewater*. A complete list of applicable references is contained in Section 4.0.

2.2 BASIS OF DESIGN

The primary operating characteristics of the LERF Basin 41 Project is presented in Table 1.

Table 1: LERF Basin 41 Project Major Components Operating Characteristics

Equipment	Operating Characteristic
Transfer Piping 4"-60M-008-M18 with 8" Encasement	• Transfers EMF/WTP waste from 4"-WTP-001-M17 piping to tie-in point to ball valve 60M-41-1 in catch basin. • Carrier pipe maximum operating pressure is 150 psig at 150 °F temperature per RPP-SPEC-63632, Attachment 2, LERF Pipe Class M-18. • Encasement pipe maximum operating pressure is 50 psig at 150 °F temperature per RPP-SPEC-63632, Attachment 2, LERF Pipe Class M-18.
Transfer Piping 3"-60M-009-M18 with 6" Encasement	• Transfers 242-A Evaporator condensate waste from 3" EVAP COND-PC5000-M17 piping to tie-in point to ball valve 60M-41-2 in catch basin. • Carrier pipe maximum operating pressure is 150 psig at 150 °F temperature per RPP-SPEC-63632, Attachment 2, LERF Pipe Class M-18.

Table 1: LERF Basin 41 Project Major Components Operating Characteristics

Equipment	Operating Characteristic
	• Encasement pipe maximum operating pressure is 50 psig at 150 °F temperature per RPP-SPEC-63632, Attachment 2, LERF Pipe Class M-18.
Encasement Drain Piping 1”-60M-012-M10 1”-60M-013-M10	• 1”-60M-012-M10 connects 8” ENCL-M17 encasement pipe for 4”-60M-008-M18 to ball valve 60M-41-7 in catch basin. • 1”-60M-013-M10 connects 6” ENCL-M17 encasement pipe for 3”-60M-009-M18 to ball valve 60M-41-8 in catch basin. • Encasement drain piping maximum operating pressure is 50 psig at 150 °F temperature per RPP-SPEC-63632, Attachment 1, LERF Pipe Class M-10.

2.2.1 Structural Design Standards

The 40 CFR 264.192 and WAC 173-303-640(3) require that an IQRPE certify that the proposed tank system will have sufficient structural integrity and is acceptable for storing and treating dangerous waste. This assessment must show, in accordance with 40 CFR 264.192(a) and WAC 173-303-640(3)(a), that the foundation, structural support, seams, connections, and pressure controls are adequately designed and that the tank system has sufficient structural strength, compatibility with the waste to be stored and treated, and corrosion protection to ensure that it will not collapse, rupture, or fail. The 40 CFR 264.226(c) and WAC 173-303-650(4)(c) require that an IQRPE certify that the surface impoundment’s dike including that portion of any dike which provides freeboard, has structural integrity.

Mechanical calculation RPP-CALC-63780, *LERF Basin 41 Buried Piping Analysis*, was performed in accordance with piping code requirements in ASME B31.3, *Process Piping*. The calculation utilized the International Organization for Standardization’s (ISO) code for glass-reinforced plastics (GRP) piping, ISO 14692, *Petroleum and Natural Gas Industries - Glass-reinforced Plastics (GRP) Piping* as a supplemental verification of system flexibility, as well as a means to determine support and anchor loads. Ecology Publication 94-114, *Guidance for Assessing and Certifying Tank Systems that Store and Treat Dangerous Waste*, defines backfill requirements to provide structural support to prevent excessive settlement and corrosion.

Calculations include the following areas as applicable:

- Pipe wall thickness calculations for pressure.
- Stress calculations for sustained loads due to pressure, dead load, and other sources.
- Stress calculations for displacements such as those associated with thermal loads.
- Stress calculations for occasional loads such as pressure, weight, earthquake, and wind loads.
- Stress calculations for transients such as water hammer.

WAC 173-303-650(4)(c) requirements for LERF Basin 41 were evaluated in RPP-CALC-63752, *LERF Basin 41 Evaluation of Dike Stability and Erosion*. The calculation was performed in accordance with DOE-STD-1020-2016, *Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities*, International Building Code (IBC) 2015 and American Society of Civil Engineers (ASCE) 7-10, *Minimum Design Loads for Buildings and Other Structures*, to evaluate the following:

- Global slope stability.
- Internal slope stability.
- Structural stability.
- Erosion stability.

The following subsections highlight the IQRPE structural design standard review for transfer piping and the LERF Basin 41 dike for the LERF Basin 41 Project, and also identify any specific exceptions to this IQRPE certification as they relate to the structural review.

2.2.2 Transfer Piping System

LERF Basin 41 piping will be procured, constructed, and tested in accordance with construction specification RPP-SPEC-63632. The drawing and analysis (H-2-838765, RPP-CALC-63780 and P&ID H-2-88766, Sheet 6) were reviewed for structural issues.

Calculation RPP-CALC-63780 concluded that the maximum stress demand-to-capacity ratio (DCR) among all associated buried transfer piping is 0.80 for the combined stress due to gravity, pressure, and thermal loadings. It also stated that among the existing regions of piping that were modeled for the sake of determining representative stresses on newly-connected piping, the maximum stress DCR is 0.83 for the occasional stress due to seismic loads. Given that all stress DCRs associated with this supplemental analysis are less than 1.0, the subject piping was found to perform acceptably under anticipated loadings per ISO 14692 requirements and other Hanford standards cited in the calculation.

RPP-SPEC-63632 details how backfilling will be conducted in the construction and installation phases. This eliminated any need for further evaluation of additional backfill requirements.

The IQRPE concludes that the appropriate structural considerations to meet 40 CFR 264.192 and WAC 173-303-640(3) for the LERF Basin 41 Project have been made.

2.2.3 LERF Basin 41 Dike Structural Analysis

The LERF Basin 41 dike will be constructed in accordance with construction specification RPP-SPEC-63632. Drawing H-2-838748 and RPP-CALC-63752 were reviewed for structural analysis to check that the LERF Basin 41 dike meets the following requirements listed in WAC 173-303-650(4)(c):

- Will withstand the stress of the pressure exerted by the types and amounts of wastes to be placed in the impoundment; and
- Will not fail due to scouring or piping, without dependence on any liner system included in the surface impoundment construction.

The IQRPE concludes that the appropriate structural considerations for Surface Impoundments to meet 40 CFR 264.226(c) and WAC 173-303-650(4)(c) for LERF Basin 41 Project have been made.

2.2.3.1 Structural Design Exceptions

Based on the above review, there are no IQRPE Certification exceptions to the structural design standards review.

2.2.3.2 Structural Design Assessment Conclusion

The IQRPE concurs that this design basis meets the requirements of 40 CFR 264.192, WAC 173-303-640(3)(a), 40 CFR 264.226(c), and WAC 173-303-650(4)(c) for the LERF Basin 41 Project.

2.2.4 Waste Compatibility

Regulations located in 40 CFR 264.192(a) and WAC 173-303-640(3)(a) require tank systems be compatible with the wastes transported or otherwise handled.

This section documents the waste compatibility and corrosion investigation of two (2) transfer piping systems designed for installation as part of the LERF Basin 41 Project. Components investigated were piping materials. Piping materials were obtained from RPP-SPEC-63632 and referenced drawings in Table 2.

The materials of construction for those components of the LERF Basin 41 Installation Project in contact with tank waste are summarized in Table 2 below:

Table 2: LERF Basin 41 Project Piping Materials of Construction

Item	Drawing Location	Description	Item #	Component Materials / Notes
Transfer Piping: 4"-60M-008-M18 with 8" Encasement 3"-60M-009-M18 with 6" Encasement	H-2-838765, Sheets 3 and 4 RPP-SPEC-63632	#204 Double Containment Tee	N/A	Conley Composites FRP (ASTM D2996, Type 1, Grade 1, Class F, *Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe)*
		Custom Double Containment Tee Bridge Repair Coupling	N/A	Conley Composites FRP (ASTM D2996, Type 1, Grade 1, Class F)
		#122RE Split Repair Coupling	N/A	Conley Composites FRP (ASTM D2996, Type 1, Grade 1, Class F)
		FRP Pipe	N/A	FRP (ASTM D2996, Type 1, Grade 1, Class F)
		#202 Double Containment 45º Elbow	N/A	Conley Composites FRP (ASTM D2996, Type 1, Grade 1, Class F)
		#252 Double Containment End Enclosure	N/A	Conley Composites FRP (ASTM D2996, Type 1, Grade 1, Class F)
		#106 Cement Flange	N/A	Conley Composites FRP (ASTM D2996, Type 1, Grade 1, Class F)
		3/16" Full Face Gasket	N/A	Ethylene Propylene Diene Monomer (EPDM)
		#114 Wound Saddle	N/A	Conley Composites FRP (ASTM D2996, Type 1, Grade 1, Class F)
		Filler Flange	N/A	Micromold
Isolation Valves: 60M-41-1 60M-41-2	H-2-838771, Sheets 2 and 4	4" Ball Valve	54	Flowtek, Stainless Steel
		3" Ball Valve	55	Flowtek, Stainless Steel
Leak Detector Spool	H-2-838771, Sheets 1, 2 and 8	1" Pipe	21	304L Stainless Steel
		1" Flange	31	304L Stainless Steel
		Pipe Tee	40	304L Stainless Steel
		Tube Fitting	43,44, 45, 46, 47	Swagelok –Stainless Steel
		½" Valve	58	Swagelok –Stainless Steel
		Flexswitch	83	FCI, FLT93S Stainless Steel
Catch Basin (Secondary containment for carrier piping with no encasement)	H-2-838751, RPP-SPEC-63632	Catch Basin	N/A	Concrete structure. Catch basin is applied with chemical resistant de-contaminable coatings per RPP-SPEC-63632, Section 09 85 50. Coatings are as listed below: • Field Primer: Amerlock 2/400 • Concrete Surfacer: Nu-Klad 114A • Primer and Base Coating: Amerlock 400 • Intermediate &Finish Coating: PSX 700 Siloxane

2.2.4.1 Anticipated Chemistry and Controls

All primary pipe and valve component materials in contact with liquid waste are austenitic stainless steel, and FRP. EPDM is used as gasket material between the FRP pipe spool flanges. EPDM is traditionally used as gasket material in other parts of Tank Farms due to its exceptional mechanical properties and radiation resistance. Based on tank waste processing experience at Hanford, all metallic and nonmetallic materials in contact with waste are adequate for service. LERF Basin 41 catch basin is coated with a chemical resistant de-contaminable coating as described above in Table 2.

The catch basin's siloxane coating material along with the basin primary liner, gaskets, double containment piping and fittings, and floating cover were evaluated in RPP-RPT-62215, *LERF Basin 41 Material Compatibility with Wastewater*. The materials used for these items were found to be suitable for use over the design life of the project.

2.2.4.2 Waste Compatibility Exceptions

Based on the above review, there are no IQRPE Certification exceptions to the anticipated waste compatibility or corrosion issues with the LERF Basin 41 Project materials of construction.

2.2.4.3 Waste Compatibility Assessment Conclusion

The IQRPE concurs that this design basis meets the requirements of 40 CFR 264.192 and WAC 173-303-640(3)(a).

2.2.5 Pressure Control System

40 CFR 264.192(a) and WAC 173-303-640(3)(a) require that an IQRPE certify that the proposed tank system has been designed with appropriate pressure control systems. The various components of the LERF Basin 41 Project were evaluated for pressure control issues and the details are presented in the sections listed below.

2.2.5.1 Transfer Piping

Pressure requirements for transfer piping system (H-2-838765, Sheets 3 and 4) are established in construction specification RPP-SPEC-63632. The maximum operating pressure for 3" and 4" LERF Pipe Class M-18 primary piping assemblies is 150 psig at 150 °F. Similarly, the maximum operating pressure for 6" and 8" LERF Pipe Class M-18 containment piping assemblies is 50 psig at 150 °F.

The transfer piping assemblies are required to undergo acceptance pressure testing after field installation in accordance with ASME B31.3 and construction specification RPP-SPEC-63632. The results will be documented in the inspection report documents.

Calculation RPP-CALC-63780 analyzed the piping for conformance to pressure rating requirements per ASME B31.3. Water hammer analysis was evaluated as part of the transient load evaluation. Evaluation of occasional loads due to transient pressures such as water hammer analyses was not performed since new piping and components being installed as part of this Project's scope have a pressure capacity greater than or equal to that of the existing system. This calculation concluded that the new piping was sufficiently strong to handle all existing transient pressures from existing transient initiators. Calculation also evaluated the new transient initiators and concluded that they will introduce negligible transient pressures. No overpressure protection is required for the installation of the new transfer piping system.

The IQRPE concludes that the appropriate pressure control considerations for LERF Basin 41 transfer piping have been made.

2.2.5.2 Encasement Drain Piping

Pressure requirements for the encasement drain piping system (H-2-838765, Sheet 4, and H-2-838771, Sheet 8) are established in construction specification RPP-SPEC-63632. The maximum operating pressure rating for 1”- 60M-012-M10 and 1”- 60M-013-M10 is defined in LERF Pipe Class M-10 drain piping assemblies is 50 psig at 150 °F.

The encasement piping assemblies are required to undergo acceptance pressure testing in accordance with ASME B31.3 and construction specification RPP-SPEC-63632. The results will be documented in Inspection Reports.

The IQRPE concludes that the appropriate pressure control considerations for LERF Basin 41 encasement piping have been made.

2.2.5.3 Pressure Control System Exceptions

Based on the above review, there are no IQRPE certification exceptions to the pressure control system review for the LERF Basin 41 Project.

2.2.5.4 Pressure Control System Assessment Conclusion

The IQRPE concurs that this design basis meets the requirements of 40 CFR 264.192 and WAC 173-303-640(3)(a).

2.2.6 Secondary Containment System

40 CFR 264.193 and WAC 173-303-640(4) require that an IQRPE certify that the proposed tank system has been designed with an appropriate secondary containment system. Secondary containment for tank systems that store, accumulate, or treat dangerous waste must be designed and installed to meet the requirements of 40 CFR 264.193(b) and WAC 173-303-640(4)(b). Secondary containment for LERF Basin 41 is accomplished by encasement piping for 3” and 4” primary (carrier) piping. Secondary containment for small sections of the transfer piping and encasement drain piping, where there no secondary containment piping installed, is provided by the catch basin.

Two (2) leak detectors (LDS 41-4 and LDS 41-5) are installed for monitoring the leak in the encasement drain piping systems.

The catch basin is used as secondary containment for carrier piping with no encasement. Siloxane a high performance engineered silicone-epoxy coating system is intended for use as the top coat in the catch basin. The top coat is the material expected to provide secondary containment for piping in the catch basin. Siloxane coating material has been evaluated in RPP-RPT-62215 for the intended use.

The catch basin is provided with one (1) leak detector (LDS 41-8) to detect any non-encased piping leakage in the catch basin (H-2-838751, Sheet 1). The catch basin floor is sloped towards the location where LDS 41-8 is installed (H-2-838776, Sheet 1).

Leak detector placement is consistent with generally accepted engineering practices to provide timely detection of any leakage from the primary pathway into the secondary containment.

Conclusions from the review of the design standards for the LERF Basin 41 Project are summarized below:

- The LERF Basin 41 Project components are designed to prevent any migration of wastes out of the secondary containment system to the soil, groundwater, or surface water at any time during the use of the tank system.
- The system is constructed of materials that are compatible with the waste to be placed in the system.
- The system has been specified to have sufficient strength to withstand stresses due to static head during a release, pressure gradients, climatic conditions, and other stresses resulting from daily operations.
- A leak detection system for liquids has been provided.
- The system is sloped or otherwise designed or operated to drain and remove liquids resulting from leaks, spills, or precipitation.

The IQRPE concludes that the appropriate secondary containment considerations have been made.

2.2.6.1 Secondary Containment System Exceptions

There are no exceptions to the IQRPE certification of the secondary containment review assessment**.**

2.2.6.2 Secondary Containment System Assessment Conclusion

The IQRPE concurs that this design basis meets the requirements of 40 CFR 264.193(b) and WAC 173-303-640(4)(b).

2.2.7 Ancillary Equipment Design

40 CFR 264.192 and WAC 173-303-640(3) requires that an IQRPE certify that the proposed tank system has been designed with appropriate ancillary equipment in accordance with the requirements of 40 CFR 264.192(e), and WAC 170-303-640(3)(f) and (4)(f). WAC 173-303-040, *Definitions*, defines "Ancillary Equipment" as any device including, but not limited to, such devices as piping, fittings, flanges, and valves that is used to distribute, meter, or control the flow of dangerous waste from its point of generation to a storage or treatment tank(s), between dangerous waste storage and treatment tanks to a point of disposal on-site, or to a point of shipment for disposal off-site. A review of the ancillary equipment design is normally part of the IQRPE review. The scope of this review includes components listed as in-scope in Section 1.3 and as described in the review sections. Piping, fittings, flanges, and valves have been evaluated by the IQRPE throughout this report, which includes all ancillary equipment in-scope for this design assessment. No other ancillary equipment was identified.

2.2.7.1 Ancillary Equipment System Exceptions

Based on the above review, there are no IQRPE certification exceptions to the ancillary equipment design review.

2.2.7.2 Ancillary Equipment System Assessment Conclusion

The IQRPE concurs that this design basis meets the requirements of 40 CFR 264.192 and WAC 173-303-640(3).

2.2.8 P&ID Review

P&ID details for the LERF Basin 41 Project are depicted on H-2-88766, Sheet 6.

The IQRPE concludes that the appropriate P&ID review has been made.

2.2.9 Corrosion Assessment

40 CFR 264.192 and WAC 173-303-640(3) require an IQRPE corrosion assessment of only the external portion of the primary containment that is in direct contact with soil or water.

Double containment piping 4”-60M-008-M18 primary carrier piping with 8” encasement piping and 3”-60M-008-M18 primary carrier piping with 6” encasement piping is LERF Pipe Class M-18 listed in construction specification RPP-SPEC-63632. Carrier and containment pipe is Conley Double Containment FRP Pipe® utilizing Conley Aromatic® amine cured epoxy resin in accordance with pipe class M-18 listed in construction specification RPP-SPEC-63632.

Per RPP-CALC-63780, design input #9, states that corrosion-erosion allowance for FRP pipe is neglected since the pipe has a corrosion barrier (inner liner) which has a thickness of 0.060".

Piping is installed partially in the berm and partially above ground using saddle supports (H-2-838765, Sheet 4).

Additional aspects of corrosion are discussed in the Waste Compatibility, Section 2.2.4.

The IQRPE concludes that appropriate corrosion considerations have been made.

2.2.9.1 Corrosion Assessment Exceptions

Based on the above requirements, there are no IQRPE certification exceptions to the corrosion assessment review for LERF Basin 41 Project.

2.2.9.2 Corrosion Assessment Conclusion

The IQRPE concurs that this design basis meets the requirements of 40 CFR 264.192 and WAC 173-303-640(3).

2.2.10 Recommended Inspection Schedule

Per the requirements of WAC 173-303-640(2)(e), “a schedule for conducting integrity assessments over the life of the tank to ensure that the tank retains its structural integrity and will not collapse, rupture, or fail. The schedule must be based on the results of past integrity assessments, age of the tank system, materials of construction, characteristics of the waste, and any other relevant factors." Because there are new elements and the existing Basin 41 dike, this assessment has two (2) parts.

New Elements

The new elements include:

- 4"-60M-008-M18 primary piping with 8" encasement piping from 4"-WTP-001-M17 piping tie-in point to valve 60M-41-1 in catch basin. Also included is the 8" ENCL-M17 encasement drain piping 1"-60M-012-M10 up to ball valve 60M-41-7 (H-2-88766, Sheet 6).
- 3"-60M-009-M18 primary piping with 6" encasement piping from 3"-EVAP COND-PC5000-M17 piping tie-in point to valve 60M-41-2 in catch basin. Also included is the 6" ENCL-M17 encasement drain piping 1"-60M-013-M10 up to ball valve 60M-41-8 (H-2-88766, Sheet 6).
- Catch Basin Leak Detector System (LDS 41-8).
- 242AL-41 catch basin concrete structure and coating system.

Because these are new elements, no prior integrity assessments have been completed. Since these elements are expected to be installed in 2021, the age of these elements is new. The materials of construction are compatible with the waste as detailed in Section 2.2.4 of this report. The characteristics of the wastewater is covered in RPP-RPT-62215. Additionally, corrosion is evaluated in Section 2.2.9 of this report. RPP-RPT-62215 used a design life of 30 years for material evaluation. To allow time for an integrity assessment, it is recommended that a complete Integrity Assessment Report be completed of the above tank elements 15 years after initial installation or first contact with waste, whichever is later. The later date applies since it is our assessment that the life for FRP piping and other elements is based on first contact with waste rather than date of installation.

LERF Basin 41 Dike

Per WAC 173-303-650, only the structural aspects of the Basin 41 dike are addressed. Therefore, based on the SOW No. 334426, "the schedule must be based on the results of past integrity assessments, age of the tank system, materials of construction, characteristics of the waste, and any other relevant factors" of the Basin 41 dike structure. The Basin 41 dike was excavated in the 1990's along with Basins 42, 43, and 44. No prior integrity assessments have been completed for Basin 41. The age of the dike is the earthen construction materials which were placed in the 1990s. Since there is a liner, the materials of dike are not expected to be in contact with waste. As such, the earthen materials of the dike have not been assessed for compatible with the wastes. The characteristics of the wastewater is covered in RPP-RPT-62215. Because the compatibility of the dike materials with the waste is unknown, it is recommended that an inspection be completed of the entire dike system covered by WAC 173-303-650 and the liner based on the life of the liner or 15 years after first contact with waste, whichever is later. Since the liner is protected from environmental conditions such as ultraviolet (UV) light, the later date applies since it is our assessment that the life for the liner and other elements is based on first contact with waste rather than date of installation. Additionally, although not assessed, it is unlikely that the wastewater would have any detrimental effect on the earthen materials of the dike.

Note: It is anticipated that these new elements of the tank system and LERF Basin 41 dike as described above will be evaluated as part of the entire system and will be included in the overall

IQRPE Integrity Assessment Report for this system in accordance with the interval for integrity assessment established by the operator for the system as long as the scheduled integrity assessment falls within the recommended period provided above.

3.0 DESIGN REVIEW ASSESSMENT CERTIFICATIONS

The IQRPE Support to the LERF Basin 41 Project, as previously described, has been reviewed by the IQRPE and was assessed to be in compliance with the applicable sections of 40 CFR 264.192, WAC 173-303-640(3), 40 CFR 264.226(c), and WAC 173-303-650(4)(c). These results are based on a review of the applicable codes, standards, and documents.

A listing of the IQRPE, Professional Engineers, and other engineers who participated in the preparation of this design assessment report is provided below:

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The certifications below are in accordance with the requirements of 40 CFR 270.11(d), *Signatories to Permit Applications and Reports,* and WAC 173-303-810(13)(a), *Certifications.*

Report Lead IQRPE:

40 CFR 270.11(d)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

WAC 173-303-810(13)(a)

I certify under penalty of the law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

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June 2, 2020
Date

4.0 REFERENCES

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