

**Environmental
Resources
Management**

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23 July 2012

Mr. Matt McClincy
Oregon Department of Environmental Quality
Northwest Region
2020 Southwest 4th Avenue, Suite 400
Portland, Oregon 97201-4987

Subject: Arkema Portland Groundwater Source Control Measure
Groundwater Barrier Wall Final Design
ECSI No. 398

Dear Matt:

On behalf of Legacy Site Services, LLC (LSS), agent for Arkema Inc., ERM-West, Inc. (ERM) is submitting the attached Final Design drawings, specifications, and Construction Quality Assurance Plan for the Groundwater Source Control Measure Groundwater Barrier Wall (GWBW) at the Arkema, Inc. site in Portland, Oregon. These documents are being submitted for review by the Oregon Department of Environmental Quality in accordance with Order on Consent No. LQVC-NWR-08-04 dated 31 October 2008, and the *Groundwater Source Control Measure Design and Implementation Work Plan* dated June 2009.

Design drawings are included as **Attachment A**, specifications are included as **Attachment B**, and the Construction Quality Assurance Plan is included as **Attachment C**. Other required documents common to both the Groundwater and Stormwater source control measures, including the Erosion and Sediment Control Plan and Communication Plan, have been previously submitted to, and approved by, the ODEQ. Additional plans that apply to the implementation of the Groundwater Source Control Measure, and specifically the Groundwater Extraction and Treatment (GWET) System, will be submitted as part of the GWET System Final Design. These plans include the Performance Monitoring Plan and the Operation and Maintenance Plan.

The GWBW Final Design includes updates to specifications and drawings based on agency comments on GWBW and Groundwater Extraction and Treatment (GWET) System Pre-Final Designs, agency-approved changes to Storm Water Source Control Measures, and permit conditions specified in the NDPES General Construction Storm Water 1200-C permit. Changes to the specifications presented in the GWBW Pre-Final are indicated in a "red-line" version of the specifications included as **Attachment D** (electronic only).

As discussed with ODEQ, the slurry mix testing required of the GWBW construction contractor is still underway. The final slurry mix testing report, including a final slurry mix design recommendation, will be submitted in early August as an addendum to this Final Design.

If you have any questions, please contact me at (503) 488-5011 or Todd Slater (LSS) at (610) 594-4430.

Sincerely,



Brendan Robinson, P.E.
Senior Engineer



Erik C. Ipsen, P.E.
Partner

BAR/eci/lrc/158363
Attachments

cc: Todd Slater, Retia/LSS
Tom Gainer, ODEQ
Henning Larsen, ODEQ
Sean Sheldrake, EPA
Steve Parkinson, JPZ Law
Karen Traeger, LSS
David Livermore, Integral
Lance Peterson, CDM

Attachment A
Groundwater Barrier Wall Final
Design Drawings

GROUNDWATER SOURCE CONTROL MEASURE -
GROUNDWATER BARRIER WALL
FOR
ARKEMA INC.
PORTLAND, OREGON

JULY 2012

PREPARED FOR:

LEGACY SITE SERVICES LLC
468 THOMAS JONES WAY
EXTON, PENNSYLVANIA 19341

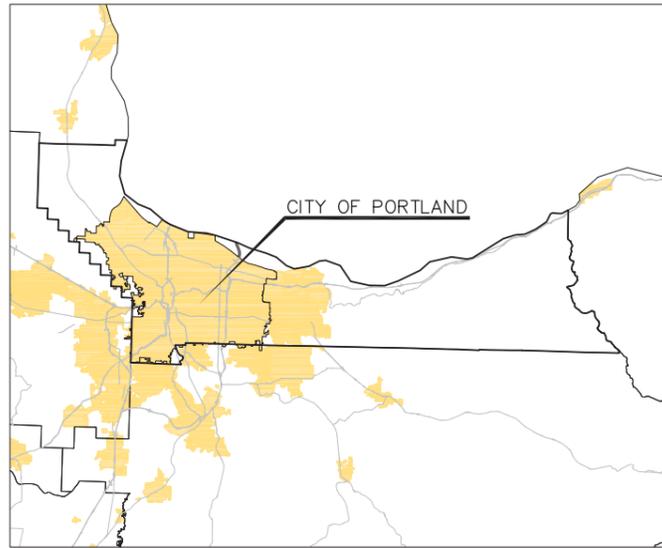


Brendan Robinson, P.E.
Oregon Professional Engineer License No. 784986 PE

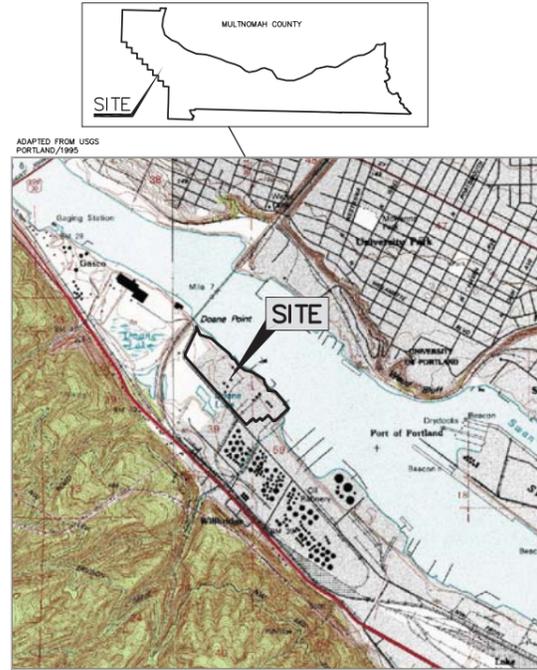
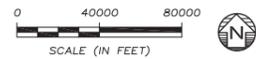
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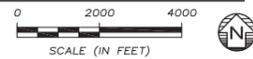
Environmental Resources Management, Inc.
ERM-West, Inc.
1001 SW 5th Avenue, Suite 1010
Portland, Oregon 97204



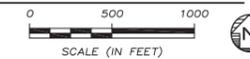
MULTNOMAH COUNTY
OREGON



SECTION 59
T.1N / R.1E
CITY OF PORTLAND, MULTNOMAH COUNTY, OREGON
SITE LOCATION MAP



SITE VICINITY MAP



GENERAL NOTES

1. SCALES ARE AS NOTED ON EACH DRAWING.
2. THE GENERAL NOTES AND LEGEND ON THIS SHEET APPLY TO ALL DRAWINGS, UNLESS OTHERWISE NOTED.
3. GROUND SURFACE ELEVATIONS SHOWN ARE BASED ON A LIDAR SURVEY PERFORMED BY I-TEN ASSOCIATES IN 2001 AND A BATHY METRIC SURVEY PERFORMED BY DAVID EVANS AND ASSOCIATES IN 2004. ELEVATIONS SHOWN ARE IN FEET ABOVE MEAN SEA LEVEL (AMSL), NAVD 88. HORIZONTAL CONTROL IS BASED ON OREGON STATE PLANE COORDINATE SYSTEM, NAD 83.
4. EXISTING CONTOUR LINES ARE SHOWN AT 2-FOOT INTERVALS, UNLESS OTHERWISE NOTED.
5. CONTRACTOR SHALL ENSURE THAT CONSTRUCTION ACTIVITIES DO NOT INTERFERE WITH SITE ACTIVITIES AT ANY TIME.
6. CONTRACTOR SHALL COMPLY WITH ALL REQUIREMENTS OF SITE HEALTH AND SAFETY THROUGHOUT CONSTRUCTION.
7. IN THE EVENT THAT THE DRAWINGS AND TECHNICAL SPECIFICATIONS CONFLICT, THE DRAWINGS SHALL TAKE PRECEDENCE OVER THE SPECIFICATIONS.
8. BENCHMARKS, MONUMENTS, AND PROPERTY MARKERS SHALL BE PROTECTED AT ALL TIMES AND SHALL NOT BE DISTURBED BY CONSTRUCTION ACTIVITIES.
9. CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING THE OREGON UTILITY NOTIFICATION CENTER AT 1-800-332-2344 THREE DAYS PRIOR TO THE START OF ANY EXCAVATION WORK.
10. CONTRACTOR SHALL CONTRACT AN APPROVED PRIVATE UTILITY LOCATOR FOR MARKOUT OF OWNER UTILITIES.
11. THE 100-YEAR FLOOD PLAIN DELINEATION (ELEVATION 32.5 FEET AMSL) WAS OBTAINED FROM THE FEMA FLOOD INSURANCE STUDY, CITY OF PORTLAND OREGON, DATE NOVEMBER 26, 2010

LIST OF DRAWINGS

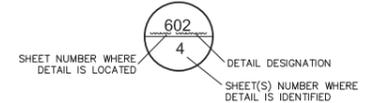
SHEET NO.	TITLE
1	COVER SHEET
2	LOCATION MAPS, GENERAL NOTES, LIST OF DRAWINGS, ABBREVIATIONS, AND LEGEND
3	EXISTING SITE PLAN
3	SITE LAYOUT PLAN
4	EROSION AND SEDIMENT CONTROL PLAN
5	GROUNDWATER BARRIER WALL PROFILE
6	DETAILS
7	DETAILS

LEGEND

- ⊕ MONITORING WELL LOCATION
- ◆ MONITORING WELL TO BE ABANDONED
- ⊙ BORING LOCATION
- ⊕ GWBW/UTILITY INTERSECTION
- ⊕ HYDRANT
- GROUND SURFACE CONTOUR (2 FT. INTERVAL)
- TOP OF RIVER BANK (APPROX. 35 FT. AMSL)
- FLOODPLAIN BOUNDARY (APPROX. 31 FT. AMSL)
- EDGE OF WATER (15.93 FT. AMSL ON 5/3/06)
- SF — SF — SILT FENCE
- LDB — LIMIT OF DISTURBANCE
- X — X — EXISTING CHAIN LINK FENCE
- X — X — PROPOSED CHAIN LINK FENCE
- — — — — PARCEL/PROPERTY BOUNDARY
- ▨ SMALL DEBRIS/FRAGMENTS/FILL
- ▨ HISTORICAL BORING REFUSAL/LARGE DEBRIS
- ▨ TEST TRENCH (PREVIOUSLY EXCAVATED BY OTHERS)
- ▨ CLEARANCE TRENCH
- SD — SD — INDUSTRIAL STORMWATER DRAIN
- DS — DS — DOMESTIC SEWER
- W — W — CITY WATER LINE
- RW — RW — RIVER WATER LINE
- S — S — STEAM LINE
- DW — DW — DOMESTIC WATER LINE
- E — E — OVERHEAD ELECTRIC/UTILITY LINE
- B — B — BRINE LINE
- > — < — RAILROAD TRACK
- > — < — INGRESS/EGRESS ROUTE

ABBREVIATIONS

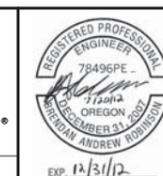
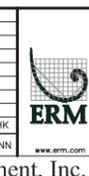
- CL CENTERLINE
- NOM NOMINAL
- DIA. DIAMETER
- R.O.W. RIGHT OF WAY
- EX EXISTING
- N.I.C. NOT IN CONTRACT
- TYP TYPICAL
- WSE WATER SURFACE ELEVATION
- INV INVERT
- STL STEEL
- MIN MINIMUM
- DWG DRAWING
- ELEV ELEVATION
- GAL GALLONS
- CY CUBIC YARDS



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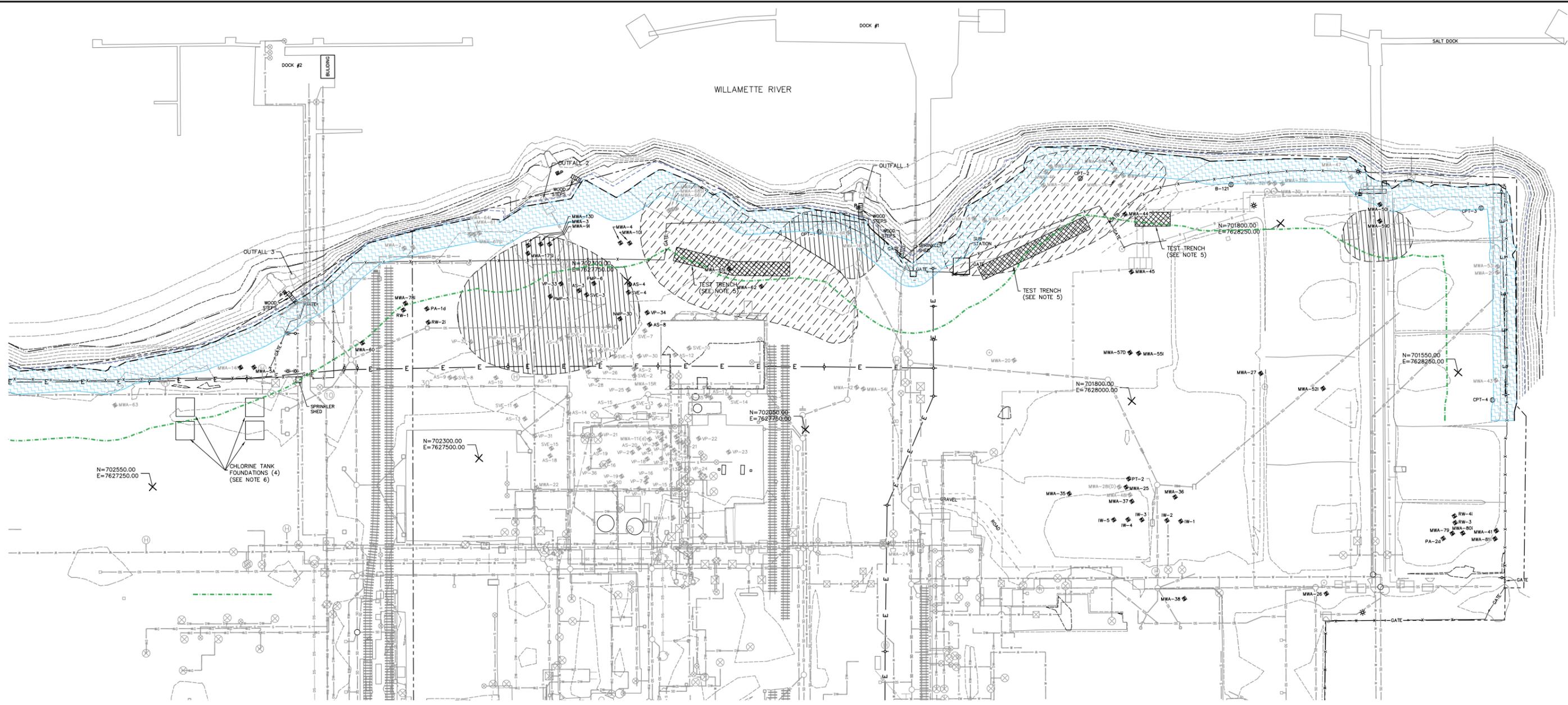
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REV.	DATE	DESCRIPTION	BY	CHK	
DRAWN BY	RMK	CADD Review	JJE	CHECKED BY	SL-ANN



GROUNDWATER SOURCE CONTROL MEASURE			
ARKEMA INC. PORTLAND, OREGON			
LOCATION MAPS, GENERAL NOTES, LIST OF DRAWINGS, ABBREVIATIONS, AND LEGEND			
SCALE	AS NOTED	PROJECT NUMBER	SHEET
DATE	07/20/2010	0116759	1
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Environmental Resources Management, Inc.

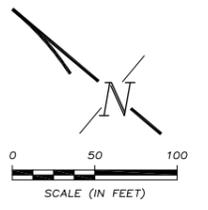


LEGEND

- ⊕ MONITORING WELL LOCATION
- ⊕ MONITORING WELL TO BE ABANDONED
- ⊙ BORING LOCATION
- ⊕ UTILITY RISER/POWER OUTLET
- ⊕ OVERHEAD UTILITY SYMBOLS
- GROUND SURFACE CONTOUR (2 FT. INTERVAL)
- TOP OF RIVER BANK (APPROX. 35 FT. NAVD88)
- FLOODPLAIN BOUNDARY (APPROX. 32.5 FT. NAVD88)
- ORDINARY HIGH WATER MARK
- 50-FOOT OFFSET LANDWARD OF GREENWAY SETBACK
- GREENWAY SETBACK
- EXISTING CHAIN LINK FENCE
- PARCEL/PROPERTY BOUNDARY
- SMALL DEBRIS/FRAGMENTS/FILL (SEE NOTE 4)
- HISTORICAL BORING REFUSAL/LARGE DEBRIS (SEE NOTE 4)
- TEST TRENCH (PREVIOUSLY EXCAVATED BY OTHERS) (SEE NOTE 5)
- INDUSTRIAL STORMWATER DRAIN
- DOMESTIC SEWER
- CITY WATER LINE
- RIVER WATER LINE
- STEAM LINE
- DOMESTIC WATER LINE
- E OVERHEAD ELECTRIC/UTILITY LINE
- BRINE LINE
- RAILROAD TRACK

NOTES:

1. THE LOCATION OF EXISTING UTILITIES IS APPROXIMATE. THE CONTRACTOR SHALL VERIFY THE EXACT LOCATION OF ALL EXISTING UTILITIES PRIOR TO THE START OF WORK.
2. IT IS THE CONTRACTOR'S RESPONSIBILITY TO FIELD VERIFY ACTUAL SITE CONDITIONS PRIOR TO THE START OF ANY WORK. THERE IS NO WARRANTY OR GUARANTEE ON THE COMPLETENESS OR CORRECTNESS OF THE EXISTING CONDITION INFORMATION. ANY DISCREPANCY FOUND SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE ENGINEER PRIOR TO THE START OF WORK.
3. AS OF THE DATE THESE DRAWINGS WERE PREPARED, THE ONLY UTILITIES THAT ARE REPORTEDLY ACTIVE ON SITE ARE THE OVERHEAD ELECTRIC LINES AND DESIGNATED STORM DRAINS. THE STORM DRAINS ARE EXPECTED TO BE ABANDONED PRIOR TO INSTALLATION OF THE GROUNDWATER BARRIER WALL AS PART OF THE STORMWATER SOURCE CONTROL MEASURE. UTILITIES THAT ARE ANTICIPATED TO BE ACTIVE AT THE TIME OF GROUNDWATER BARRIER WALL CONSTRUCTION ARE INDICATED USING A BOLD LINE TYPE.
4. FILL MATERIALS COMPRISE THE UPPER 25 FEET OF THE SUBSURFACE ALONG THE RIVER BANK, BASED ON PRIOR DRILLING AND SUBSURFACE ACTIVITIES. AREAS WITH CONCRETE AND BRICK FRAGMENTS AND OTHER SMALL DEBRIS HAVE BEEN ENCOUNTERED, AS DESIGNATED HEREIN (SMALL DEBRIS/FRAGMENTS/FILL). LARGER DEBRIS AND REFUSAL DURING INVESTIGATION HAVE ALSO BEEN ENCOUNTERED IN THE GENERAL AREAS DEPICTED HEREIN (HISTORICAL BORING REFUSAL/LARGE DEBRIS). THESE AREAS ARE PRESENTED FOR REFERENCE PURPOSES BASED ON OBSERVATIONS FROM THE NEARBY BORING AND WELL LOCATIONS.
5. THREE TEST TRENCHES WERE EXCAVATED TO A DEPTH OF 20 FEET IN THE LOCATIONS SHOWN. ANY LARGE DEBRIS ENCOUNTERED WAS REMOVED; THE EXCAVATED MATERIALS WERE REPLACED IN THE TRENCH. REFERENCE THE SUBSURFACE DEBRIS INVESTIGATION REPORT ATTACHED TO THE TECHNICAL SPECIFICATIONS FOR FURTHER INFORMATION ON THE TEST TRENCHES.
6. THE CHLORINE TANK FOUNDATIONS CONSIST OF REINFORCED CONCRETE PILE CAPS 20 FT LONG, 20 FT WIDE, AND 2.25 FT THICK. THE PILE CAPS ARE PRESENT FROM APPROXIMATELY 8 TO 10 FT BELOW GROUND SURFACE (BGS). REINFORCED CONCRETE PILES EXTEND FROM THE PILE CAP TO BEDROCK.



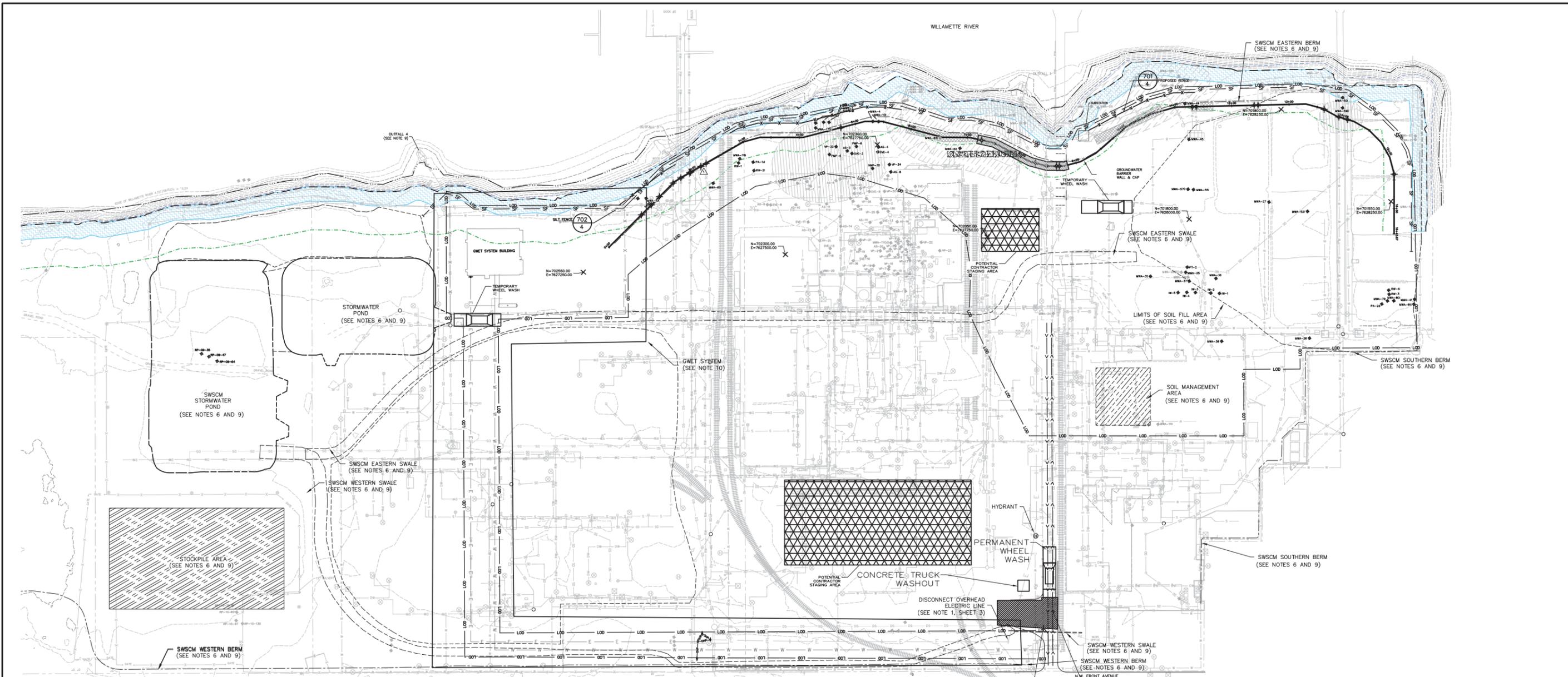
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 Environmental Resources Management, Inc.



GROUNDWATER SOURCE CONTROL MEASURE			
ARKEMA INC. PORTLAND, OREGON			
EXISTING SITE PLAN			
SCALE AS NOTED	PROJECT NUMBER 0116759	SHEET 2	REV. 0
DATE 07/20/2010			

REVISIONS TO BE MADE ON THE CADD FILE ONLY



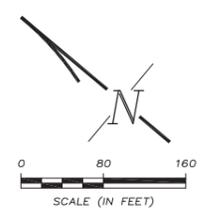
- LEGEND**
- ⊕ GWBW/UTILITY INTERSECTION
 - ⊕ HYDRANT
 - GROUND SURFACE CONTOUR (2 ft. INTERVAL)
 - - - - - TOP OF RIVER BANK (APPROX. 35 FT. NAVD88)
 - - - - - FLOODPLAIN BOUNDARY (APPROX. 32.5 FT. NAVD88)
 - - - - - EDGE OF WATER (15.93 FT. NAVD88 ON 5/3/06)
 - - - - - SF - SF SILT FENCE
 - - - - - LDD LIMIT OF DISTURBANCE
 - - - - - EXISTING CHAIN LINK FENCE
 - - - - - PROPOSED CHAIN LINK FENCE
 - - - - - PARCEL/PROPERTY BOUNDARY
 - - - - - SMALL DEBRIS/FRAGMENTS/FILL
 - - - - - HISTORICAL BORING REFUSAL/LARGE DEBRIS
 - - - - - TEST TRENCH (PREVIOUSLY EXCAVATED BY OTHERS)
 - - - - - CLEARANCE TRENCH
 - - - - - EXISTING IMPERVIOUS SURFACE
 - - - - - INDUSTRIAL STORMWATER DRAIN
 - - - - - DOMESTIC SEWER
 - - - - - CITY WATER LINE
 - - - - - RIVER WATER LINE
 - - - - - STEAM LINE
 - - - - - DOMESTIC WATER LINE
 - - - - - OVERHEAD ELECTRIC/UTILITY LINE
 - - - - - BRINE LINE
 - - - - - RAILROAD TRACK
 - - - - - INGRESS/EGRESS ROUTE
 - - - - - GREENWAY SETBACK BUFFER
 - - - - - ORDINARY HIGH WATER MARK

- NOTES:**
- FOR GRAPHICAL PURPOSES, THE SILT FENCE AND LIMIT OF DISTURBANCE ARE SHOWN SEPARATELY. DURING CONSTRUCTION ACTIVITIES, THE SILT FENCE WILL SERVE AS THE LIMIT OF DISTURBANCE.
 - CONTRACTOR SHALL VISUALLY MONITOR THE EXISTING STORMWATER OUTFALLS (I.E. OUTFALLS 1 THROUGH 4) AND OTHER POTENTIAL CONDUITS ENCOUNTERED AND TERMINATED DURING GROUNDWATER BARRIER WALL CONSTRUCTION ON A DAILY BASIS AND IMMEDIATELY AFTER A SIGNIFICANT RAIN EVENT (E.G. GREATER THAN 0.5 INCHES OVER 24 HOURS) TO ENSURE THAT A RELEASE OF SLURRY OR OTHER MATERIAL DOES NOT OCCUR. ANY RELEASES SHALL BE STOPPED IMMEDIATELY.
 - EROSION CONTROL DEVICES SHALL BE MAINTAINED UNTIL PERMANENT COVER IS ESTABLISHED AND APPROVED BY THE ENGINEER. UPON ESTABLISHMENT OF PERMANENT COVER THE CONTRACTOR SHALL REMOVE THE EROSION CONTROLS.
 - THE CONTRACTOR MAY SUBMIT AN ALTERNATIVE LOCATION(S) FOR THE STAGING AREA FOR REVIEW AND APPROVAL BY THE ENGINEER. IF THE STAGING AREA IS RE-LOCATED, THE LIMIT OF DISTURBANCE WILL ALSO BE ADJUSTED, ACCORDINGLY.
 - NEITHER SLURRY OR SEDIMENT-LADEN SURFACE WATER SHALL BE PERMITTED TO FLOW BEYOND THE SILT FENCE (LIMIT OF DISTURBANCE) LOCATED ALONG THE CREST OF THE RIVER BANK. THE CONTRACTOR SHALL VISUALLY INSPECT AND VERIFY THE PROPER WORKING ORDER OF THE SILT FENCE AND OTHER CONTROLS ON A DAILY BASIS. REPAIRS OF THE EROSION CONTROLS SHALL BE PERFORMED IMMEDIATELY UPON INSPECTION.
 - THE STORMWATER SOURCE CONTROL MEASURE (SWSCM) INCLUDES THE INSTALLATION AND CONSTRUCTION OF SWALES, BERMS, DETENTION BASINS, AND CONVEYANCE PIPING. THE CONSTRUCTION OF THE SWSCM AND ITS COMPONENTS IS OUTSIDE OF THE SCOPE OF THE GWBW CONTRACTOR. HOWEVER, PORTIONS OF THE SWSCM MAY BE CONSTRUCTED CONCURRENTLY WITH GWBW CONSTRUCTION. THE CONTRACTOR SHALL COORDINATE WITH THE SWSCM CONTRACTOR TO MINIMIZE POTENTIAL CONFLICTS TO THE EXTENT PRACTICABLE.

- DISTURBED AREAS SHALL BE SURFACED WITH CLEAN CRUSHED STONE, MEETING THE REQUIREMENTS OF SECTION 0232 OF THE TECHNICAL SPECIFICATIONS, LEVELED WITH THE EXISTING SURROUNDING GRADE.
- SITE SOIL CLASSIFICATION: 50A-URBAN LAND, 0 TO 3 PERCENT SLOPES.
- DRAINAGE OF THE SITE SURFACE WATER RUNOFF WILL BE ACCOMPLISHED WITH A SERIES OF CONVEYANCES THAT WILL ULTIMATELY DISCHARGE TO OUTFALL 4. CONSTRUCTION OF THE CONVEYANCE SYSTEMS AND ASSOCIATED INFRASTRUCTURE WILL BE PERFORMED UNDER A SEPARATE CONTRACT. HOWEVER, THE GWBW CONTRACTOR SHALL PROTECT THE INSTALLED SWSCM FEATURES AND ENSURE THAT CONSTRUCTION ACTIVITIES DO NOT INTERFERE WITH OR IMPEDE THEIR OPERATION.
- THE GWET SYSTEM INCLUDES THE INSTALLATION AND CONSTRUCTION OF EXTRACTION WELLS, CONVEYANCE PIPING, TREATMENT BUILDING, AND UTILITY LINES. THE CONSTRUCTION OF THE GWET SYSTEM AND ITS COMPONENTS IS OUTSIDE OF THE SCOPE OF THE GWBW CONTRACTOR. HOWEVER, PORTIONS OF THE GWET SYSTEM WILL BE CONSTRUCTED CONCURRENTLY WITH GWBW CONSTRUCTION. THE CONTRACTOR SHALL COORDINATE WITH THE GWET SYSTEM CONTRACTOR TO MINIMIZE POTENTIAL CONFLICTS TO THE EXTENT PRACTICABLE.

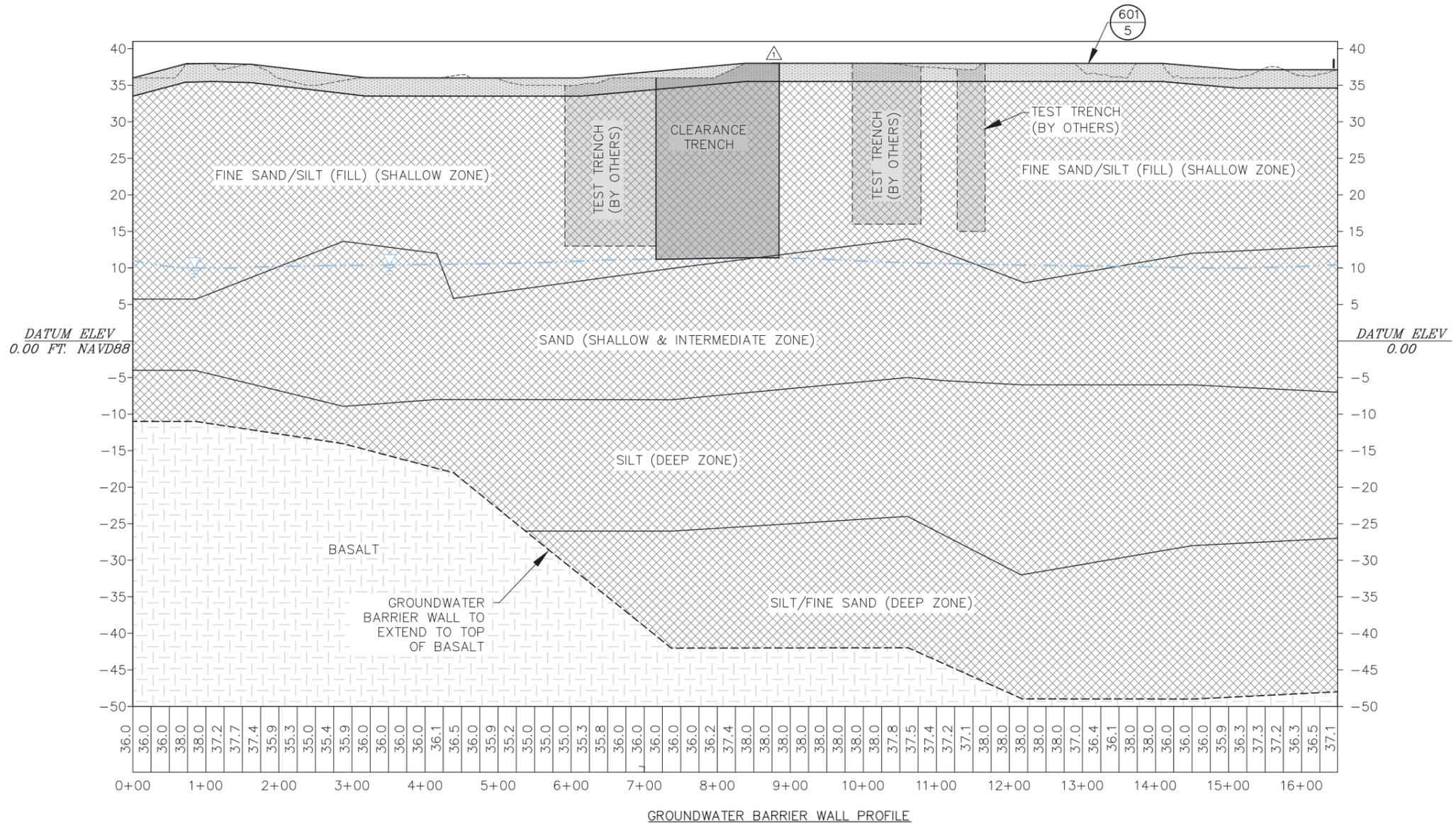
- CITY OF PORTLAND EROSION AND SEDIMENT CONTROL NOTES:**
- APPROVAL OF THIS EROSION, SEDIMENT AND POLLUTION CONTROL PLAN (ESPCP) DOES NOT CONSTITUTE AN APPROVAL OF PERMANENT ROAD OR DRAINAGE DESIGN (E.G., SIZE AND LOCATION OF ROADS, PIPES, RESTRICTORS, CHANNELS, RETENTION FACILITIES, UTILITIES, ETC.).
 - THE IMPLEMENTATION OF THIS ESPCP AND THE CONSTRUCTION, MAINTENANCE, REPLACEMENT, AND UPGRADING OF THESE ESPCP FACILITIES IS THE RESPONSIBILITY OF THE CONTRACTOR UNTIL ALL CONSTRUCTION IS COMPLETED AND APPROVED AND VEGETATION/LANDSCAPING IS ESTABLISHED.
 - THE BOUNDARIES OF THE CLEARING LIMITS SHOWN ON THIS PLAN SHALL BE CLEARLY FLAGGED IN THE FIELD PRIOR TO CONSTRUCTION. DURING THE CONSTRUCTION PERIOD, NO DISTURBANCE BEYOND THE FLAGGED CLEARING LIMITS SHALL BE PERMITTED. THE FLAGGING SHALL BE MAINTAINED BY THE CONTRACTOR FOR THE DURATION OF CONSTRUCTION.
 - THE ESPCP FACILITIES SHOWN ON THIS PLAN MUST BE CONSTRUCTED IN CONJUNCTION WITH ALL CLEARING AND GRADING ACTIVITIES, AND IN SUCH A MANNER AS TO INSURE THAT SEDIMENT, SLURRY, AND SEDIMENT LADEN WATER DO NOT ENTER THE DRAINAGE SYSTEM, ROADWAYS, OR VIOLATE APPLICABLE WATER STANDARDS.
 - THE ESPCP FACILITIES SHOWN ON THIS PLAN ARE THE MINIMUM REQUIREMENTS FOR ANTICIPATED SITE CONDITIONS. DURING THE CONSTRUCTION PERIOD, THESE ESPCP FACILITIES SHALL BE UPGRADED AS NEEDED FOR UNEXPECTED STORM EVENTS AND TO ENSURE THAT SEDIMENT, SLURRY, AND SEDIMENT-LADEN WATER DO NOT LEAVE THE SITE.
 - THE ESPCP FACILITIES SHALL BE INSPECTED DAILY BY THE CONTRACTOR AND MAINTAINED AS NECESSARY TO ENSURE THEIR CONTINUED FUNCTIONING.
 - THE ESPCP FACILITIES ON INACTIVE SITES SHALL BE INSPECTED AND MAINTAINED A MINIMUM OF ONCE A MONTH OR WITHIN THE 24 HOURS FOLLOWING A STORM EVENT.
 - THE DECONTAMINATION PAD/TIRE WASH SHALL BE INSTALLED IN THE LOCATION DEPICTED HEREIN AT THE BEGINNING OF CONSTRUCTION AND MAINTAINED FOR THE DURATION OF THE PROJECT. ADDITIONAL MEASURES MAY BE REQUIRED TO ENSURE THAT ALL ADJACENT OFF SITE PAVED AREAS ARE KEPT CLEAN FOR THE DURATION OF THE PROJECT.

- SEQUENCE OF CONSTRUCTION:**
- INSTALL DECONTAMINATION PAD/TIRE WASH AND SILT FENCE.
 - IDENTIFY, CUT, AND CAP OR PLUG UTILITIES INTERSECTING GROUNDWATER BARRIER WALL ALIGNMENT.
 - EXCAVATE AND BACKFILL CLEARANCE TRENCH AND SEGREGATE LARGE DEBRIS.
 - INSTALL GROUNDWATER BARRIER WALL.
 - TRANSPORTATION AND DISPOSAL OF EXCESS SPOILS AND LARGE DEBRIS.
 - INSTALL GROUNDWATER EXTRACTION AND TREATMENT (GWET) SYSTEM BUILDING AND UTILITIES.
 - STABILIZE DISTURBED AREAS/RESTORE SITE.
 - FOLLOWING STABILIZATION OF ALL DISTURBED AREAS, ALL EROSION AND SEDIMENT CONTROL DEVICES SHALL BE REMOVED, AS APPROVED BY THE ENGINEER.



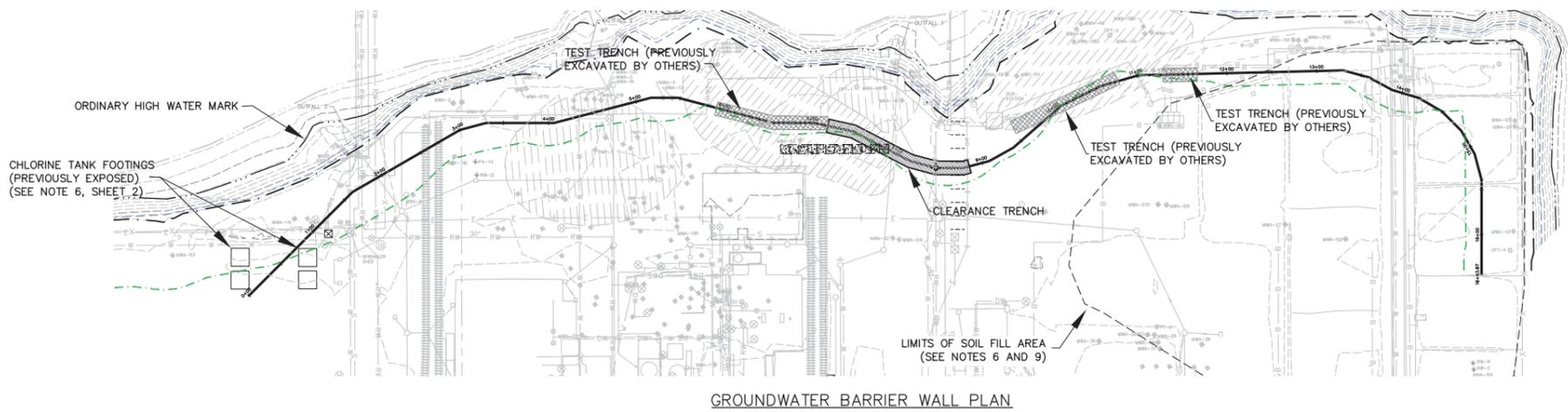
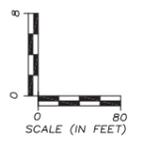
0 01/05/11 ISSUED FOR CLIENT REVIEW LAG BR REV. DATE DESCRIPTION BY CHK DRAWN BY RMK CADD Review FGB CHECKED BY SL-ANN www.erm.com			GROUNDWATER SOURCE CONTROL MEASURE ARKEMA INC. PORTLAND, OREGON	
Environmental Resources Management, Inc.			EROSION AND SEDIMENT CONTROL PLAN SCALE: AS NOTED PROJECT NUMBER: 0116759 SHEET: 4 REV: 0 DATE: 07/20/2010	

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- LEGEND**
- EXISTING GRADE
 - PROPOSED FINAL GRADE (APPROXIMATE)
 - EXISTING GROUNDWATER ELEVATION
 - TOP OF BASALT (BEDROCK)
 - [Pattern] BARRIER WALL CAP (2.5' THICK TYP.)
 - [Pattern] BARRIER WALL (TO BEDROCK)
 - [Pattern] TEST TRENCH (PREVIOUSLY EXCAVATED BY OTHERS)
 - [Pattern] CLEARANCE TRENCH

- NOTES:**
1. THE HYDROGEOLOGIC ZONES ARE PAIRED WITH THEIR CORRESPONDING GEOLOGIC MATERIAL DESCRIPTION. THE INTERFACES DEPICT THE TRANSITION BETWEEN GEOLOGIC MATERIALS FOR THE PURPOSE OF BARRIER WALL CONSTRUCTION AND DO NOT NECESSARILY CORRESPOND TO THE TRANSITION BETWEEN HYDROGEOLOGIC ZONES.
 2. EXCESS EXCAVATED MATERIAL NOT USED DURING PREPARATION OF THE BARRIER WALL MIX SHALL BE DISPOSED AT AN APPROVED OFF SITE FACILITY OR SPREAD AND GRADED IN DISTURBED AREAS AS APPROVED BY THE ENGINEER. GRADED MATERIAL SHALL BE COVERED WITH A MINIMUM SIX (6) INCHES OF CLEAN CRUSHED STONE.

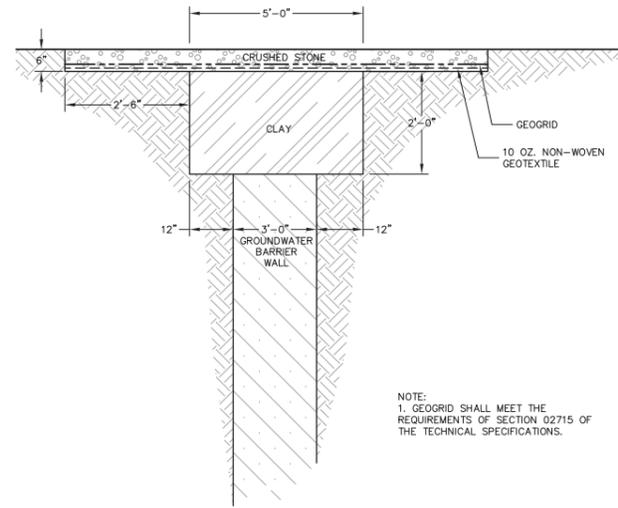


2	7/11/12	FINAL DESIGN	FAK	BR
1	01/23/12	ADDENDUM NO. 9	RMK	DQ
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Environmental Resources Management, Inc.

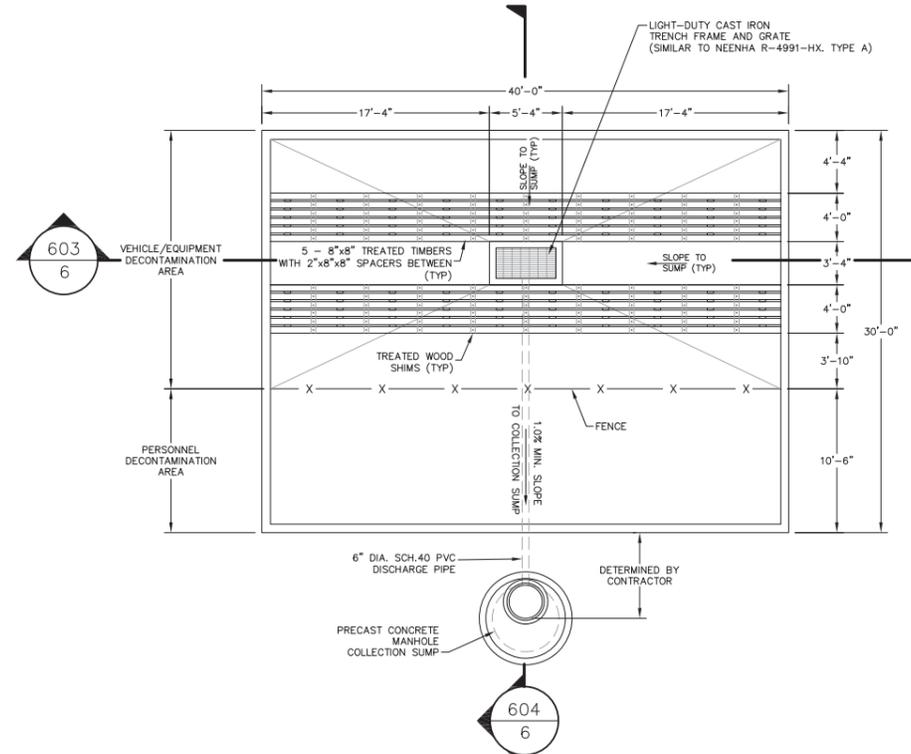


GROUNDWATER SOURCE CONTROL MEASURE			
ARKEMA INC. PORTLAND, OREGON			
GROUNDWATER BARRIER WALL PROFILE			
SCALE	PROJECT NUMBER	SHEET	REV.
AS NOTED	0116759	5	0
DATE	07/20/2010		

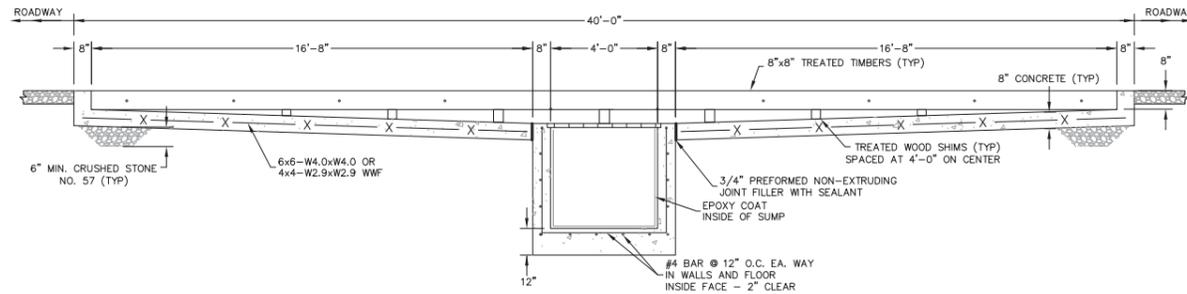


NOTE:
1. GEOGRID SHALL MEET THE REQUIREMENTS OF SECTION 02715 OF THE TECHNICAL SPECIFICATIONS.

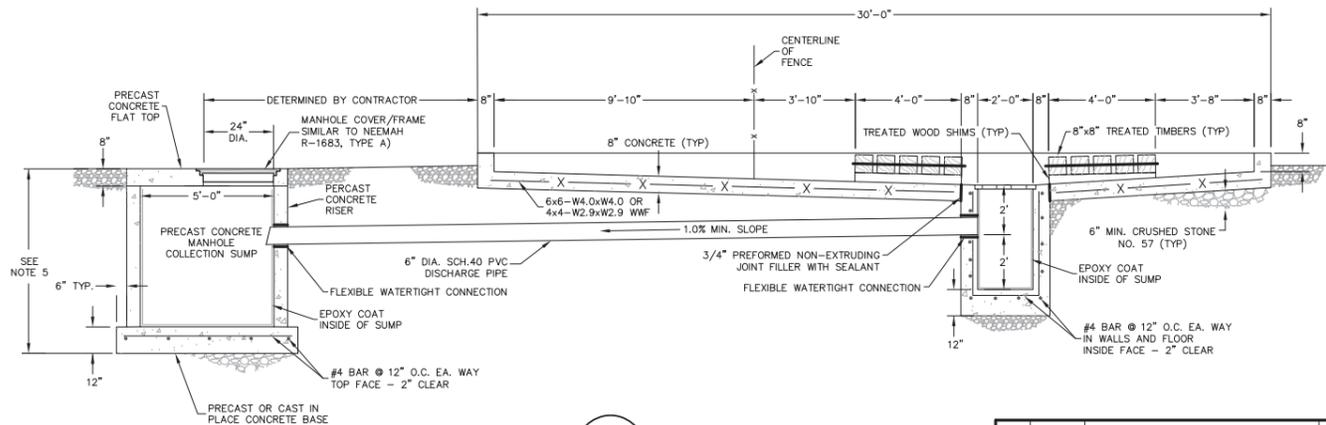
601 GROUNDWATER BARRIER WALL CAP DETAIL
3,4,5 SCALE: NONE



602 DECONTAMINATION PAD PLAN
4 SCALE: NONE



603 DECONTAMINATION PAD SECTION
6 SCALE: NONE



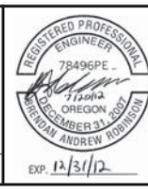
604 DECONTAMINATION PAD SECTION
6 SCALE: NONE

- NOTES:
- SEE DRAWING NO.1 FOR GENERAL NOTES AND LEGEND.
 - THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING THE DECONTAMINATION PAD THROUGHOUT THE DURATION OF THE PROJECT AND FOR DEMOLITION AND DISPOSAL OF THE DECONTAMINATION PAD AT THE CONCLUSION OF THE PROJECT.
 - THE CONTRACTOR SHALL HAVE THE OPTION OF ADJUSTING THE SIZE OF THE DECONTAMINATION PAD SHOWN AS NEEDED FOR SPECIFICALLY PLANNED EQUIPMENT AND VEHICLES. ALL ADJUSTMENTS MUST BE SUBMITTED TO THE ENGINEER FOR APPROVAL TO WORKING DAYS PRIOR TO DECONTAMINATION PAD CONSTRUCTION.
 - THE CONTRACTOR SHALL PROVIDE A SUMP PUMP IN THE PRECAST MANHOLE COLLECTION SUMP FOR DISCHARGE OF COLLECTED DECONTAMINATION WATER INTO AN ABOVE-GROUND STORAGE TANK, OR SIMILAR CONTAINMENT, AS APPROVED BY THE ENGINEER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR DETERMINING THE SIZE AND LOCATION OF THE STORAGE TANK AND REQUIRED PUMP.
 - THE CONTRACTOR SHALL BE RESPONSIBLE FOR DETERMINING THE DEPTH AND CONFIGURATION OF THE MANHOLE COLLECTION SUMP REQUIRED TO CONTAIN THE ANTICIPATED VOLUME OF DECONTAMINATION WATER. THE CONTRACTOR SHALL SUBMIT THE PLANNED DEPTH AND CONFIGURATION, INCLUDING THE LOCATION OF THE DISCHARGE PIPE, TO THE ENGINEER FOR REVIEW PRIOR TO CONSTRUCTION OF THE DECONTAMINATION PAD.
 - MANHOLE BASE SLABS MAY BE PRECAST OR CAST IN PLACE CONCRETE.
 - 8" X 8" TREATED TIMBERS SHALL BE BOLTED TOGETHER AND ATTACHED TO TIMBER SHIMS AND CONCRETE SLAB.
 - REINFORCING STEEL F_y = 60 KSI.
 - THE MINIMUM CLEAR COVER OF CONCRETE OVER REINFORCING STEEL SHALL BE 3" FOR CONCRETE PLACED DIRECTLY AGAINST SOIL.

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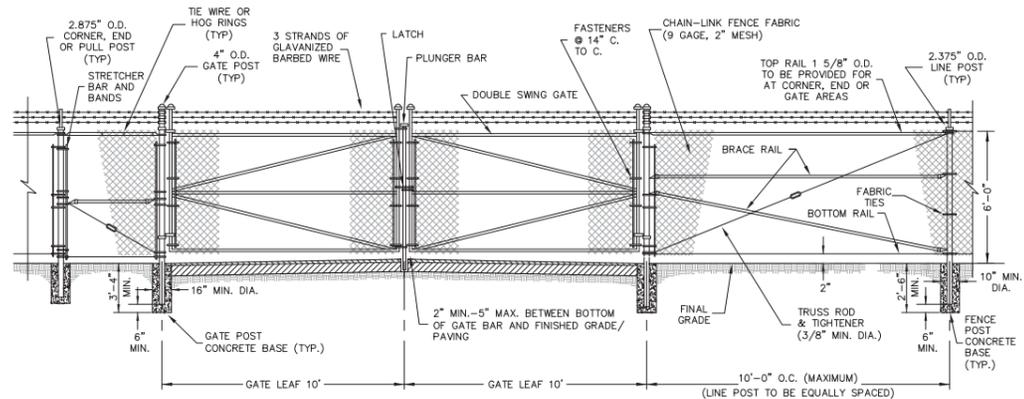
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DRAWN BY	RMK	CADD Review	FGB	CHECKED BY	SL-ANN



GROUNDWATER SOURCE CONTROL MEASURE			
ARKEMA INC. PORTLAND, OREGON			
DETAILS			
SCALE	AS NOTED	PROJECT NUMBER	SHEET
DATE	07/20/2010	0116759	6
REV.			0

Environmental Resources Management, Inc.

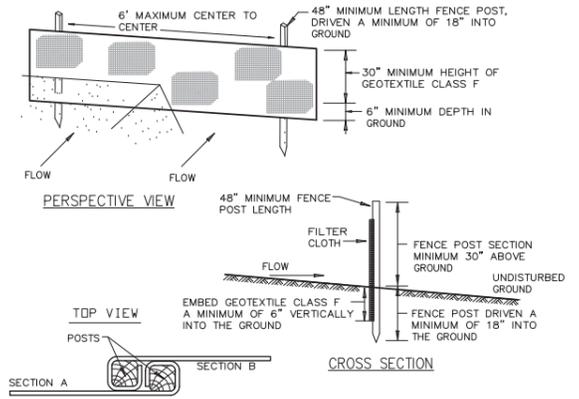
GATE POST SCHEDULE	
GATE LEAF WIDTH (NOMINAL)	OUTSIDE DIMENSION (NOMINAL)
6' OR LESS	2.875" O.D. 2.5" SQ.
MORE THAN 6' TO 13'	4.0" O.D.
MORE THAN 13' TO 18'	6.625" O.D.
MORE THAN 18'	8.625" O.D.



SECURITY FENCE WITH VEHICLE GATE DETAIL
N.T.S.

- NOTES:
- FENCE-CHAIN LINK FENCE SHALL INCLUDE 3-STRAND BARBED WIRE ON SINGLE OUTRIGGER.
 - THE CONTRACTOR SHALL HAVE THE OPTION OF NOT USING CONCRETE FENCE POST FOUNDATIONS IN TEMPORARY FENCING. ALL MODIFICATIONS SHALL BE APPROVED BY THE ENGINEER.
 - WIRE TIES, RAILS, POSTS, AND BRACES SHALL BE CONSTRUCTED ON THE SECURE SIDE OF THE FENCE ALIGNMENT. CHAIN-LINK FABRIC SHALL BE PLACED ON THE OPPOSITE SIDE OF THE SECURE AREA.
 - C-SECTION POSTS SHALL BE INSTALLED SO THAT THE VOID INSIDE THE POST IS COMPLETELY FILLED WITH CONCRETE UP TO THE TOP OF THE FOUNDATION.
 - SWING GATES SHALL BE CONSTRUCTED WITH DROP RODS, PADLOCKS, LATCH ASSEMBLY, AND GATE KEEPERS, EXCEPT AS NOTED.
 - ALL GATE FRAMES SHALL BE A MINIMUM 1.90" NOMINAL (ROUND) OR 2.00" NOMINAL (SQUARE). GATE FRAMES SHALL BE OF WELDED CONSTRUCTION OR SHALL BE ASSEMBLED USING HEAVY FITTINGS. AT CONTRACTOR'S OPTION, A WELDED HORIZONTAL BRACE MAY BE USED IN LIEU OF TRUSS RODS TO BRACE ALL WELDED GATE FRAMES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROPER RIGID CONSTRUCTION OF ALL GATES SUPPLIED.
 - STEEL POSTS SHALL BE IN ACCORDANCE WITH THE SCHEDULE ON THIS DRAWING.
 - GATE POSTS SHALL BE IN ACCORDANCE WITH THE SCHEDULE ON THIS DRAWING.

STEEL POST SCHEDULE	
USE AND SECTION	MINIMUM OUTSIDE DIMENSIONS (NOMINAL)
FABRIC 72" TO 96"	
CORNER, END & PULL POSTS	
TUBULAR - ROUND	2.875" O.D.
TUBULAR - SQUARE	2.50" SQ.
C-SECTION (ROLL-FORMED)	3.50" x 3.50"
LINE POSTS	
TUBULAR - ROUND	2.375" O.D.
H-SECTION	2.25" x 1.70"
C-SECTION (ROLL-FORMED)	2.25" x 1.70"
TOP, BOTTOM & BRACE RAILS	
TUBULAR - ROUND	1.66" O.D.
TUBULAR - SQUARE	1.50" O.D.
H-SECTION	1.625" x 1.50"
C-SECTION (ROLL-FORMED)	1.625" x 1.25"



JOINING TWO ADJACENT SILT FENCE SECTIONS

CONSTRUCTION SPECIFICATIONS

- THE FILTER FABRIC SHALL BE PURCHASED IN A CONTINUOUS ROLL CUT TO THE LENGTH OF THE BARRIER TO AVOID USE OF JOINTS. WHEN JOINTS ARE NECESSARY, FILTER CLOTH SHALL BE SPICED TOGETHER ONLY AT A SUPPORT POST, WITH A MINIMUM 6-INCH OVERLAP, AND BOTH ENDS SECURELY FASTENED TO THE POST, OR OVERLAP 2 INCH X 2 INCH POSTS AND ATTACH AS SHOWN ON DETAIL.
- THE FILTER FABRIC FENCE SHALL BE INSTALLED TO FOLLOW THE CONTOURS WHERE FEASIBLE. THE FENCE POSTS SHALL BE SPACED A MAXIMUM OF 6 FEET APART AND DRIVEN SECURELY INTO THE GROUND A MINIMUM OF 18 INCHES.
- THE FILTER FABRIC SHALL HAVE A MINIMUM VERTICAL BURIAL OF 6 INCHES. ALL EXCAVATED MATERIAL FROM FILTER FABRIC FENCE INSTALLATION, SHALL BE BACKFILLED AND COMPACTED, ALONG THE ENTIRE DISTURBED AREA.
- STANDARD OR HEAVY DUTY FILTER FABRIC FENCE SHALL HAVE MANUFACTURED STITCHED LOOPS FOR 2 INCH X 2 INCH POST INSTALLATION. STITCHED LOOPS SHALL BE INSTALLED ON THE UP HILL SIDE OF THE SLOPED AREA.
- FILTER FABRIC FENCES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFUL PURPOSE, BUT NOT BEFORE THE UPSLOPE AREA HAS BEEN PERMANENTLY PROTECTED AND STABILIZED.
- FILTER FABRIC FENCES SHALL BE INSPECTED BY CONTRACTOR IMMEDIATELY AFTER EACH RAINFALL AND AT LEAST DAILY DURING PROLONGED RAINFALL. ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY.

701 SECURITY FENCE WITH VEHICLE GATE DETAIL
3,4 SCALE: NONE

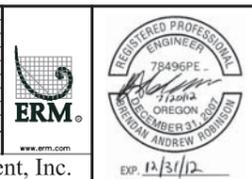
702 SILT FENCE DETAIL
4 SCALE: NONE

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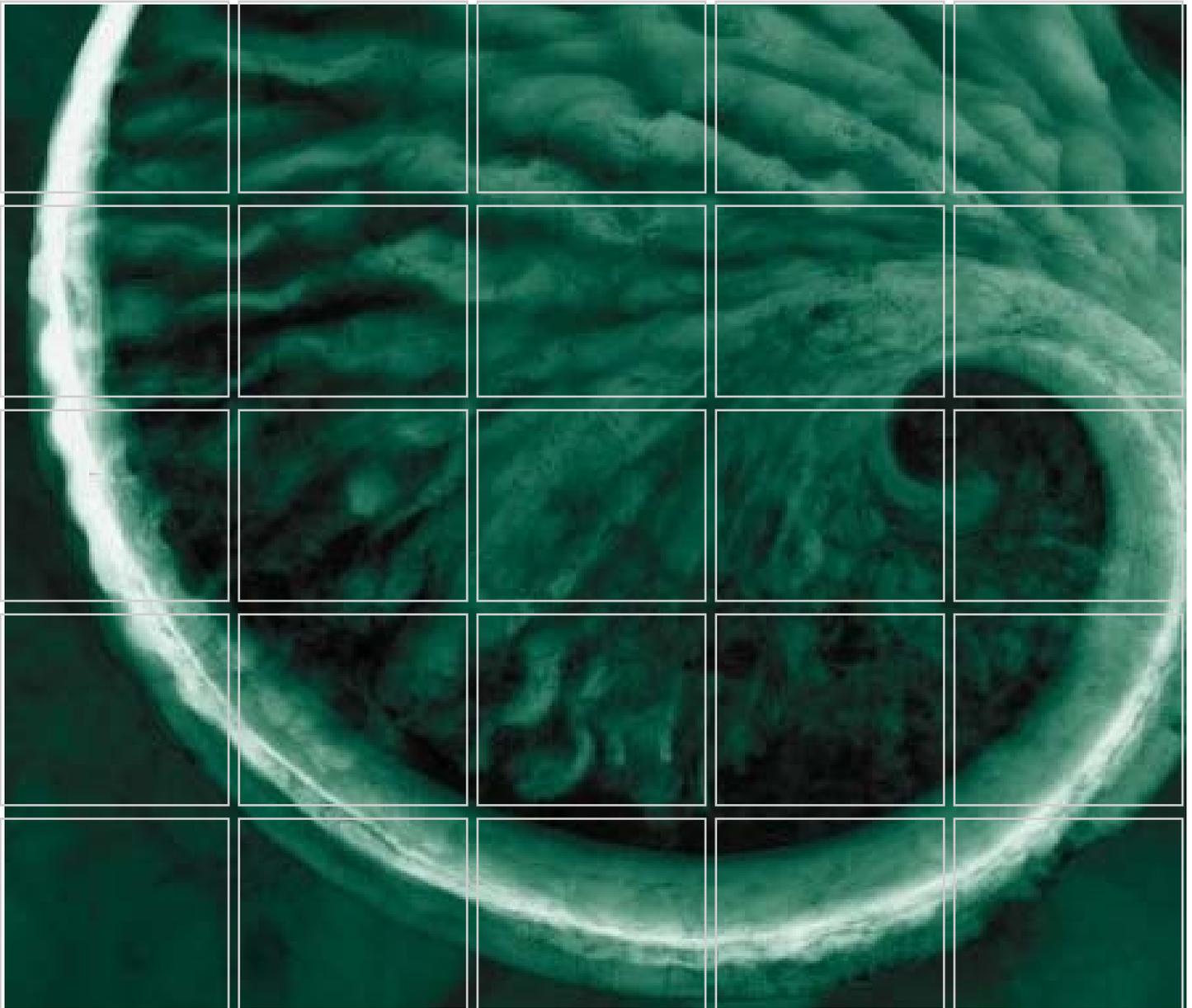
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GROUNDWATER SOURCE CONTROL MEASURE			
ARKEMA INC. PORTLAND, OREGON			
EROSION AND SEDIMENT CONTROL DETAILS			
SCALE: AS NOTED	PROJECT NUMBER: 0116759	SHEET: 7	REV: 0
DATE: 07/20/2010			

Environmental Resources Management, Inc.

Attachment B
Groundwater Barrier Wall Final
Design Specifications



Technical Specifications

**Groundwater Barrier Wall Final Design
Groundwater Source Control Measure
Former Arkema Facility
Portland, Oregon**

July 2012

Prepared for:
Legacy Site Services
LLC

www.erm.com

Delivering sustainable solutions in a more competitive world



Legacy Site Services LLC

Technical Specifications: *Groundwater
Barrier Wall Final Design Groundwater
Source Control Measure,
Former Arkema Facility,
Portland, Oregon*

July 2012

Project No. 0158363



Brendan Robinson, P.E.

Project Manager

Erik Ipsen, P.E.

Partner-in-Charge

Environmental Resources Management

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*Division 1 – General
Requirements*

01010 – Summary of Work

DIVISION 1 – GENERAL REQUIREMENTS

01010 SUMMARY OF WORK

PART 1 - GENERAL

1.01 DEFINITIONS

A. Whenever the following terms are used in these Specifications, it is understood that they represent the following:

1. **OWNER:**
Arkema Inc.
6400 Northwest Front Avenue
Portland, Oregon 97210
2. **OWNER'S AGENT**
Legacy Site Services LLC
468 Thomas Jones Way
Suite 150
Exton, Pennsylvania, 19341
3. **ENGINEER:**
ERM-West, Inc.
1001 SW 5th Ave, Suite 1010
Portland, Oregon 97204
(503) 488-5282
4. **CONTRACTOR:**
The individual, firm, partnership, or corporation which is determined to be the successful Bidder.

During implementation of the project, the OWNER or OWNER'S AGENT reserves the right to select a Representative to serve the role as ENGINEER, as referenced throughout these Technical Specifications. If the Representative is different than the ENGINEER listed above, the Representative would fulfill all requirements of the ENGINEER as noted in these Technical Specifications.

1.02 SITE CONDITIONS

A. General

There will be no payment for any extras as a consequence of the CONTRACTOR's misunderstanding the descriptions contained in the Contract, Specifications and Drawings. The CONTRACTOR shall inspect the Site and request answers to all questions that relate to the Work, its execution, and other details prior to submitting a Bid.

01010
SUMMARY OF WORK

B. Site Access and Work Areas

Drawings, as referenced in these Specifications, depict the location of the Site and describe the types of access roads that lead to the Site. It is the CONTRACTOR's sole responsibility to use and maintain present access beyond the location depicted on the Drawings. Any access roadways, storage areas, Work areas or other areas that the CONTRACTOR must use are the CONTRACTOR's sole responsibility to keep passable at all times at its cost. The CONTRACTOR shall understand that certain access roadways must be used by the OWNER'S AGENT to maintain access to Work areas; the CONTRACTOR shall cooperate with others in the establishment and maintenance of these common access roadways. Further, access to the Site by the CONTRACTOR through areas other than the dedicated points as indicated on the Drawings is prohibited, unless otherwise previously approved by the OWNER'S AGENT.

C. Site Conditions

The Site is a former chemical facility that has been decommissioned and currently is not actively used for any industrial purposes. Drawings, as referenced in these Specifications, depict the location of various Site features, including an office building, groundwater monitoring and extraction wells, electric utility substation, docks, and other features that may affect the Work. It is the CONTRACTOR's sole responsibility to keep these areas protected and passable at all times at no additional cost to the OWNER'S AGENT.

D. Security

The OWNER'S AGENT has instituted security measures for the facility including perimeter chain-link fence and locking gates. The CONTRACTOR shall comply with all site security measures and procedures during work.

E. Night and Sunday Work

Unless otherwise specifically authorized by ENGINEER or OWNER'S AGENT, no Work shall be done between the hours of 6:00 p.m. and 7:00 a.m. or on Sunday, except as necessary for the proper care of and protection of Work already performed. If it shall become necessary to perform Work at night or on Sunday, the ENGINEER or OWNER'S AGENT shall be informed at least forty-eight (48) hours in advance of the beginning of performance of such Work. Only such Work shall be done at night as can be done satisfactorily and in a safe first-class manner. Good lighting and all other necessary facilities for carrying out and inspecting

01010
SUMMARY OF WORK

the Work shall be provided and maintained by the CONTRACTOR at all points where such Work is being done. Amount of lighting required shall be approved by the ENGINEER or OWNER'S AGENT.

F. Work in Bad Weather

During freezing, stormy or inclement weather, no Work shall be done except such as can be done satisfactorily and in a manner to secure safe first-class construction throughout. Material backfill and compaction shall not be undertaken during freezing, heavy precipitation, or otherwise inclement weather, as determined by the ENGINEER or OWNER'S AGENT.

1.03 CODES AND STANDARDS

The Work shall conform to all local, state and federal codes, comply with standards referenced in these Specifications, and adhere to regulatory requirements presented in Section 01060-REGULATORY REQUIREMENTS AND RESPONSIBILITY TO THE PUBLIC, which are described elsewhere in these Specifications. The latest issue shall be used unless specifically noted otherwise.

1.04 SCOPE OF WORK

A. The Scope-of-Work shall include, but not be limited to, furnishing all labor, materials, methods, services, tools, machinery and equipment necessary for the construction of the Work as specified in these Specifications and the following Drawings:

Drawing No.	Drawing
-	Cover Sheet
1	Location Maps, General Notes, List of Drawings, Abbreviations, and Legend
2	Existing Site Plan
3	Site Layout Plan
4	Erosion and Sediment Control Plan
5	Vertical Barrier Wall Profile
6	Details
7	Details

B. The CONTRACTOR shall supply all necessary materials except those specifically designated as furnished by the OWNER, the ENGINEER or OWNER'S AGENT, or furnished by others.

01010
SUMMARY OF WORK

- C. The Work covered under this Contract shall include, but is not limited to, the following items:
1. Mobilization/demobilization.
 2. Furnishing temporary field offices, along with temporary electrical power, telephone communications, separate men and women sanitary facilities, and potable water, as needed.
 3. Preparing the Site for Work, including but not limited to, staging and stockpile area, health and safety provisions, installation of erosion and sediment controls, coordination with utility authorities for disconnection and/or temporary rerouting of utilities, removal of segments of the perimeter security fence, installation of a temporary security fence, and other preparatory work.
 4. Survey and layout of the groundwater barrier wall alignment.
 5. Disconnection and removal of power lines and cutting, capping, and/or plugging of abandoned utilities.
 6. Excavation of the clearance trench and management of the materials, including sampling, testing, backfilling and compacting, and/or transportation and disposal. Supplemental backfill, i.e., clean common fill, may also be required to return the Site to existing grade.
 7. Preparation of the working surface along the groundwater barrier wall alignment and installation of the groundwater barrier wall.
 8. Management, sampling, testing, transportation, and on-site disposal of excess spoils from groundwater barrier wall installation.
 9. Installing a clay cap on top of the groundwater barrier wall.
 10. Maintaining continuous operation of affected utilities for duration of work activities, including temporary rerouting of utility services, as required.
 11. Health and safety activities and nuisance (i.e. dust and odor) control, including air monitoring and suppression.
 12. Site restoration, including grading, placement of crushed stone, and installation of a permanent chain link fence.
 13. Protection of the Willamette River, the electric substation, all existing groundwater monitoring and extraction wells, and other structures and Site features.
 14. Miscellaneous sitework, including site cleanup, site restoration, and permanent stabilization of all areas disturbed during construction.
 15. Other Work indicated within these Contract Documents, or as otherwise required for complete and proper groundwater barrier wall installation.

01010
SUMMARY OF WORK

1.05 QUALITY ASSURANCE:

- A. All work shall be in accordance with Section 01400 – QUALITY CONTROL and the Construction Quality Assurance/Quality Control (CQA/QC) Plan.
- B. The CONTRACTOR warrants in presenting a Bid that all Work will be performed to the highest standards. The CONTRACTOR further warrants that defects that are the result of the CONTRACTOR’s methods, workmanship, or protection of Work will be corrected, removed, and/or replaced at the CONTRACTOR’s expense immediately. Further, the CONTRACTOR shall warrant all Work and repairs for one year after the completion and acceptance of the Work or repairs.

1.06 COOPERATION

- A. There may be other Engineers and/or Contractors, OWNER personnel and/or Regulators present at the Site. The CONTRACTOR shall make every effort reasonably possible to cooperate with all authorized outside personnel. Any disputes shall be settled by and at the sole discretion of the OWNER’S AGENT.
- B. All construction activities shall be carried out in such a manner that there shall be absolutely no possibility of interruption of any operations occurring in the remaining portions of the facility.
- C. The ENGINEER or OWNER’S AGENT may conduct intermittent quality control air and odor monitoring during work. The CONTRACTOR shall be responsible for conducting any required actions based upon the results of either the CONTRACTOR or the ENGINEER or OWNER’S AGENT’S sampling and monitoring activities.

1.07 CARE AND STORAGE OF MATERIALS

- A. The CONTRACTOR shall unload, inspect, and store all equipment and material items delivered, to the project site for its Work, including items supplied by the OWNER, the ENGINEER or OWNER’S AGENT, or furnished by others. Materials shall be stored on-site only in areas designated by the ENGINEER or OWNER’S AGENT for that purpose.
- B. The CONTRACTOR shall replace, at its sole expense, all OWNER, ENGINEER or OWNER’S AGENT, furnished by others, and/or CONTRACTOR-furnished materials damaged by the CONTRACTOR or the CONTRACTOR’s Subcontractors during unloading and storage, damaged by weather, or other related causes.

01010
SUMMARY OF WORK

- C. Special attention shall be paid to instructions issued by the manufacturer for handling and storage of materials and/or equipment. These instructions shall be followed in every respect.
- D. The CONTRACTOR shall be solely responsible for all security of equipment and material items delivered to the Site for its Work, including items supplied by the OWNER, the ENGINEER or OWNER'S AGENT, or furnished by others. Replacement of any equipment or material shall be at the sole expense of the CONTRACTOR.
- E. The CONTRACTOR shall exercise care in the handling, moving, storing, and transporting of the equipment. The integrity of the equipment shall not be compromised at any time. The CONTRACTOR shall be responsible for any damage to the equipment and shall repair or replace, at the OWNER' AGENT's discretion, the damaged equipment at no additional cost to the OWNER, ENGINEER or OWNER'S AGENT.

1.08 CONTRACTOR'S RESPONSIBILITIES AND WORK

- A. The CONTRACTOR shall furnish all construction equipment, machines, tools, materials, field sanitary facilities, security, protection of Work, other services, supplies, labor, and supervision that are necessary to complete the Work and requirements as described or implied in these Specifications and Drawings.
- B. The CONTRACTOR shall provide all transportation for the items included in Part 1.08A of this Section from its headquarters or other locations to and from the Site.
- C. The CONTRACTOR shall furnish all housing, travel, required training, personal safety equipment, and related allowances required by its employees to meet the minimum standards of the OWNER or OWNER'S AGENT and the Site Health and Safety Plan. No housing facilities shall be permitted on the Site.
- D. Neither the CONTRACTOR nor any of its employees shall drive or park any vehicle anywhere on the Site, except at such locations as shown or as specifically approved by the OWNER'S AGENT.
- E. The CONTRACTOR shall comply with all site security measures and procedures for the duration of work activities.
- F. The CONTRACTOR shall provide sufficient workers and supervisory personnel to maintain Work progress so that the various areas of Work will be completed in accordance with the schedule or sequence defined elsewhere in these Specifications. If, in the opinion of the OWNER'S

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SUMMARY OF WORK

AGENT, the Work is behind schedule or is improperly staffed, the OWNER'S AGENT will direct the CONTRACTOR to increase its complement of supervisors, workmen, or equipment so as to comply with the schedule. The CONTRACTOR shall discharge any such directives promptly and without expectation of additional compensation. If the CONTRACTOR fails to discharge any of these directives, the ENGINEER or OWNER'S AGENT may arrange for such directives to be discharged at the sole cost of the CONTRACTOR.

- G. The CONTRACTOR shall make all overtime, premium, and incentive payments to the CONTRACTOR's employees that may be required to complete the Work in accordance with the schedule. No exceptions shall be allowed for lack of performance, late material deliveries, or interference with other contractors possibly employed at the Site or with the OWNER's authorized personnel.
- H. There is no applicable sales tax in the state of Oregon; therefore the CONTRACTOR should not include sales tax in its Bid.
- I. The CONTRACTOR shall obtain any state, county, or local building permits required in the performance of its Work, except as provided by the ENGINEER or OWNER'S AGENT.
- J. Prior to a Contract award any questions or assistance the CONTRACTOR may request shall be directed to the ENGINEER or OWNER'S AGENT. A copy of each question should be submitted to LSS.
- K. By submitting a Bid for the Work, the CONTRACTOR acknowledges to be entirely familiar with the requirements prescribed by the State of Oregon that relate to the Work, with regulations prescribed by the United States Environmental Protection Agency (USEPA), with the rules and regulations of OSHA, and with local conditions, including weather, availability of supplies, and logistics. The CONTRACTOR further acknowledges itself to be entirely qualified to perform the Work described by these Specifications and the Drawings.
- L. The CONTRACTOR shall maintain the site of its activities free of refuse and debris at all times at their expense. The CONTRACTOR shall, promptly comply with any directives from the OWNER, or it's AGENT, regarding housekeeping. The CONTRACTOR shall provide the appropriate containers at convenient locations for the disposal of disposable personnel protection equipment and other items of trash. Upon completion of the Work and before final payment, the CONTRACTOR shall completely remove all tools, equipment, supplies, materials, structures, and debris from the Site and leave the premises clean. Debris shall be removed to the designated on-site disposal location, as approved

01010
SUMMARY OF WORK

by the ENGINEER or OWNER'S AGENT. Refuse shall be accumulated for a minimum of weekly disposal.

M. The CONTRACTOR shall be responsible for all engineering and corresponding support required to perform the scope of work established in the Contract Documents, including but not limited to design and/or verification of shoring, bracing, demonstration of equivalent materials, or other such matters that require engineering expertise.

N. Safety

1. It is the CONTRACTOR's responsibility to perform all Work in a safe manner, and meet all applicable federal, state and local laws and those requirements imposed by the OWNER or OWNER'S AGENT. The CONTRACTOR shall submit a Site Health and Safety Plan (HASP) to the ENGINEER or OWNER'S AGENT for review. The plan shall meet, or exceed, all requirements specified in the Contract Documents and federal, state, and local regulations.
2. All employees and subcontractors working on-site with intrusive activities, who may be exposed to hazardous substances, health hazards, or safety hazards and their supervisors and management responsible for the Site will receive training meeting the requirements of 29 CFR 1910.120.

O. Environmental Protection

All Work to be performed by the CONTRACTOR as a part of this project is regulated by the Oregon Department of Environmental Quality (ODEQ). By acceptance of the terms of the Contract, the CONTRACTOR acknowledges that it is familiar with the rules and regulations of the ODEQ. The CONTRACTOR further acknowledges familiarity with, and accepts as a condition of this Contract, all of the terms, stipulations, and commitments pertaining to the Work. Questions concerning the permits or regulations shall be referred to the ENGINEER or OWNER'S AGENT; the ENGINEER or OWNER'S AGENT'S decision in all cases shall be final.

P. Project Offices

The CONTRACTOR may locate the project office in the on site office building if office space is deemed necessary. The CONTRACTOR may utilize the utilities available at the office building, including electric, water, telecommunications, and sanitary facilities.

Q. Utilities

01010
SUMMARY OF WORK

1. Electrical Power

Electrical power is available on site; however, the CONTRACTOR is responsible for all coordination with the OWNER'S AGENT and power company, as well as establishing all connections to the source. If connected to the existing power source on site, the OWNER'S AGENT will be responsible for the cost of usage.

2. Telecommunications

Telecommunications (telephone, data) service is available within the office building; however, the CONTRACTOR shall be responsible for establishing all connections to the service.

3. Water Supply

Water service is available on site; however, the CONTRACTOR is responsible for all coordination with the OWNER'S AGENT and water company, as well as establishing all connections to the source. If connected to the existing water supply source on site, the OWNER'S AGENT will be responsible for the cost of usage. The CONTRACTOR shall be responsible for determining if the available water service is sufficient for the work activities, including groundwater barrier wall construction and dust control.

4. Sanitary Facilities

Sanitary facilities are available within the office building. Chemical-type sanitary facilities shall be provided near the points of Work for CONTRACTOR personnel on the project if deemed necessary. Separate sanitary facilities are required for men and women, and shall be cleaned daily and adequately serviced.

1.09 TERMS AND CONDITIONS

If the Technical Specifications conflict with the OWNER'S or OWNER'S AGENT'S Terms and Conditions, the Terms and Conditions shall supersede the Technical Specifications.

1.10 CLEAN FUELS AND EQUIPMENT TECHNOLOGIES

- A. CONTRACTOR, including all Subcontractors, shall follow federal, state, and local equipment and vehicle idling regulations and shall comply with a five (5) minute maximum idling time, whichever is more restrictive. Additionally, no unattended idling shall occur. Exceptions to these

01010
SUMMARY OF WORK

requirements shall be allowed for weather, safety concerns, and where implementation may actually slow work and/or increase emissions.

- B. The CONTRACTOR shall use clean technologies and/or fuels on all diesel equipment to the extent practicable and/or feasible. The preference is for clean diesel technologies, but alternate fuels, such as biodiesel or natural gas powered vehicles, can also be considered. These alternate fuels shall be used where they are available and within a reasonable distance to the Site. For equipment retrofits, the CONTRACTOR shall employ the Best Available Control Technology (BACT) on off-road and on-road diesel powered equipment used at the Site. Examples of clean diesel technologies include diesel particulate filters and diesel oxidation catalysis. For alternative fuel usage, the CONTRACTOR shall use at least a B20 blend (i.e., 20 percent biodiesel and 80 percent petrodiesel) or higher in the equipment engines used at the Site.
- C. The CONTRACTOR shall provide a discussion of the proposed clean fuel and equipment technologies in their bid.

PART 2 - PRODUCTS

2.01 REGISTERED TRADE NAMES

- A. Products are referenced and specified throughout these Specifications by registered trade names. This does not constitute a recommendation of these products to the exclusion of other products. Equivalent products may be used upon receiving approval of the ENGINEER or OWNER'S AGENT.
- B. The reference to registered trade names establishes a standard of required function, dimension, appearance and quality of the required equipment, materials or products.

PART 3 - EXECUTION

(not used)

END OF SECTION

01014 – Work Sequence

01014
WORK SEQUENCE

PART 1 - GENERAL

1.01 CONSTRUCTION SCHEDULE

- A. A Construction Schedule shall be submitted with the Bid for approval. The schedule shall include sequence and dates of construction operations for all major stages of Work, order and delivery of materials and equipment, and estimated milestones for substantial and final completion. The Construction Schedule shall be subject to review and acceptance by the ENGINEER or OWNER'S AGENT. The Construction Schedule shall incorporate and meet, at a minimum, Project Milestones as identified in these Specifications and Drawings. The CONTRACTOR can provide alternates to the Construction Schedule in order to expedite the overall project schedule. Any alternates must be approved in writing by the ENGINEER or OWNER'S AGENT prior to formal acceptance as part of the Construction Schedule. Revisions to the Construction Sequence by the CONTRACTOR shall not be made until approved by the ENGINEER or OWNER'S AGENT. Changes in the approved schedule shall not be allowed without written approval. If the construction progress does not adhere to the schedule as approved or revised, measures shall be taken by CONTRACTOR to make up for the lost time to assure completion of the Work in accordance with the schedule. The schedule shall be created using Microsoft Project or Primavera, and shall include all appropriate task designations (Predecessor, Successor, Lag, Lead, Slack, Resources, etc.).
- B. Certain aspects of the construction are weather dependent. The ENGINEER or OWNER'S AGENT may, therefore, suspend operations at any time, when in its sole judgment, the conditions are unsuitable for the proper performance of the Work. No measures, aside from those provided elsewhere in the Construction Documents, shall be provided for such suspension of Work or costs associated with them. The CONTRACTOR shall account for typical delays in the schedule associated with normal levels of inclement weather as determined by the average monthly precipitation and temperatures for the period of times specified in the proffered construction schedule.
- C. The Contractor shall be responsible for meeting the project schedule established at the preconstruction meeting. If at anytime during implementation of the Work, the OWNER, ENGINEER, OWNER'S AGENT, or CONTRACTOR determines that the Work is behind schedule, the CONTRACTOR shall make every reasonable effort; i.e., additional manpower, equipment, or work hours, to make-up the lost time.

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WORK SEQUENCE

1.02 WEATHER

- A. The CONTRACTOR shall take all necessary precautions to prepare for adverse weather so that the Work may be properly performed and be satisfactory in all respects. When required, protection shall be provided by use of tarpaulins, shelters, silt fencing, straw bales, or other approved means. During cold weather, materials shall be preheated, if required, and the materials and structure into which they are to be incorporated shall be kept sufficiently warm so that a proper bond shall take place and a proper curing, aging, or drying shall result. Heating shall be by a method approved by the ENGINEER or OWNER'S AGENT and shall result in a moist or a dry atmosphere according to the particular requirements of the Work being protected. The ENGINEER or OWNER'S AGENT may suspend operations at any time when, in its sole judgment, the conditions are unsuitable or the proper precautions are not being taken.
- B. Delays to the schedule caused by adverse weather conditions shall be identified as a request for schedule extension submitted by the CONTRACTOR to the ENGINEER or OWNER'S AGENT within one (1) day of the termination of the event. Adverse weather that does not delay the schedule for which no extension of time is required shall not necessitate such a request. Weather delays may be made up through extended Work times with the approval of the OWNER or OWNER'S AGENT. The CONTRACTOR shall receive no additional financial compensation as a result of adverse weather conditions.

1.03 PROGRESS REPORTS

- A. The CONTRACTOR shall submit to the ENGINEER or OWNER'S AGENT every two (2) weeks following written issuance of a Notice to Proceed, or more frequently if requested by the OWNER, ENGINEER or OWNER'S AGENT, a report, in form and substance satisfactory to the OWNER, or its AGENT, stating the progress being made in fulfillment of this Contract, and indicating the progress to date with respect to the Construction Schedule. Included with the report shall be an updated schedule indicating scheduled durations, scheduled start dates, scheduled completion dates, actual durations, actual start dates and actual completion dates of construction activities identified in the initial approved Construction Schedule. If the Schedule indicates that the CONTRACTOR is behind schedule, a written plan indicating the corrective measures to be implemented to make up lost time shall be submitted with the updated Schedule.

PART 2 - PRODUCTS

(not used)

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WORK SEQUENCE

PART 3 - EXECUTION

(not used)

END OF SECTION

01014
WORK SEQUENCE

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01040 – Control and Inspection

01040
CONTROL AND INSPECTION

PART 1 - GENERAL

1.01 ENGINEER'S AUTHORITY

- A. The OWNER'S AGENT may appoint a Representative during the life of the Contract as specified in Section 01010 – SUMMARY OF WORK, who will observe the Work in progress on behalf of the OWNER'S AGENT. The Representative shall have authority to: (1) act on behalf of the OWNER'S AGENT to the extent expressly provided in the Contract or otherwise in writing; (2) stop the Work whenever such stoppage may be necessary, in its sole discretion, to prevent improper execution of the Work, or otherwise to protect the interests of the OWNER'S AGENT; (3) determine the amount, quality, acceptability and fitness of all Work, materials and equipment required by the Contract; and, (4) decide all questions which arise in relation to the Work, the execution thereof, and the fulfillment of the Contract Documents.
- B. The OWNER'S AGENT shall be the sole judge of the intent and meaning of the Contract, and the ENGINEER or OWNER'S AGENT shall be the sole judge of the intent and meaning of the Specifications and Drawings, and its decisions thereon, and its interpretation thereof shall be final, conclusive and binding on all parties.
- C. The CONTRACTOR shall proceed without delay to perform the Work as specified by the Contract Documents or as directed by the ENGINEER or OWNER'S AGENT and shall comply with such directions.
- D. Any doubts to the meaning of, or any obscurity as to the wording of the Contract, Specifications, and Drawings shall be explained, and all directions and explanations requisite or necessary to complete, explain, or make definite any of the provisions of the Contract, Specifications or Drawings and to give them due effect shall be given by the ENGINEER or OWNER'S AGENT.

1.02 INSPECTORS

- A. Inspectors employed by the ENGINEER or OWNER'S AGENT shall be authorized to inspect all Work performed and all materials and/or equipment furnished. Such inspection may extend to all or any part of the Work and to the preparation or manufacture of the materials to be used. In case of a dispute arising between the CONTRACTOR and the Inspector as to materials furnished or the manner of performing the Work, the Inspector shall have the authority to reject materials or suspend the Work until the question at issue can be referred to and decided by the ENGINEER or OWNER'S AGENT. The Inspector shall not be authorized to revoke, alter, enlarge, relax, or release any requirements of

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CONTROL AND INSPECTION

the Contract, Specifications or Drawings, nor to approve or accept any portion of the Work, nor to issue instructions contrary to the Contract, Specifications, and Drawings. The Inspector shall in no case act as foreman or perform other duties for the CONTRACTOR, or interfere with the management of the Work by the CONTRACTOR. Any advice which the Inspector gives the CONTRACTOR shall in no way be construed as binding on the ENGINEER, OWNER'S AGENT, or the OWNER in any way or releasing the CONTRACTOR from the fulfillment of the terms of the Contract.

1.03 INSPECTION

- A. The CONTRACTOR shall, at the CONTRACTOR's expense when requested, provide the ENGINEER or OWNER'S AGENT with ladders, lights, tools, labor, samples and other facilities as may be necessary for inspecting material and Work.
- B. Imperfect materials or Work which may be detected, shall be replaced or corrected immediately on the requirement of the ENGINEER or OWNER'S AGENT notwithstanding that it may have been previously overlooked and included in a partial payment. Materials condemned or rejected by the ENGINEER or OWNER'S AGENT shall be marked and shall, on its demand, be removed at once to a satisfactory distance from the Work. If not removed within twenty-four (24) hours after receipt of written notice from the ENGINEER or OWNER'S AGENT, it may be removed by the ENGINEER or OWNER'S AGENT and the cost of removal shall be charged to the CONTRACTOR and deducted from any payment due or which may become due to it.
- C. If Work to be done away from the construction site is to be inspected on behalf of the ENGINEER or OWNER'S AGENT during its fabrication, manufacture, excavation, processing, or testing, or before shipment, the CONTRACTOR shall give notice to the ENGINEER or OWNER'S AGENT of the place and time where such fabrication, manufacture, excavation, processing, testing, or shipping is to be done. Such notices shall be in writing and delivered to the ENGINEER or OWNER'S AGENT ten (10) days prior to initiation of such activity so that the necessary arrangements for the inspection can be made.

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CONTROL AND INSPECTION

1.04 CONTRACTOR'S EQUIPMENT AND WORK FORCE

- A. All machinery and equipment to be used shall be of sufficient size and in proper operating condition to accomplish the Work as described herein and shall be such as to produce a satisfactory quality of Work. A competent foreman or Superintendent shall be present at all times during the progress of the Work with authority to act for the CONTRACTOR and coordinate with the ENGINEER or OWNER'S AGENT. A workforce of sufficient size with the required experience and ability shall be employed at all times to assure that the Work is executed in a satisfactory and workmanlike manner.
- B. Unless otherwise expressly provided, the means and the methods of construction are at the option of the CONTRACTOR. Only adequate and safe procedures, methods, structures and equipment shall be used. The ENGINEER or OWNER'S AGENT'S approval, or failure to exercise its right thereon, shall not relieve the CONTRACTOR of obligations to accomplish the result intended by the Contract, nor shall such create a cause of action for damages or extras.
- C. If the ENGINEER or OWNER'S AGENT at any time gives notice, in writing, to the CONTRACTOR that an employee is, in its opinion, incompetent, unfaithful, disorderly, discourteous, careless, unobservant of instructions, or in any way a detriment to the satisfactory progress of the Work, such employee shall be immediately removed from and not again allowed upon the Site. Likewise, equipment and machinery deemed inadequate and unsatisfactory shall be removed from the Site when such written notice is received by the CONTRACTOR.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

(not used)

END OF SECTION

01040
CONTROL AND INSPECTION

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01050 – Field Engineering

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FIELD ENGINEERING

PART 1 - GENERAL

1.01 DESCRIPTION

Primary Line and Grade Measurements

- A. Baselines and benchmarks have been established by the ENGINEER or OWNER'S AGENT by means of suitable marks as provided on the Drawings. All points must be carefully preserved and, if destroyed by the CONTRACTOR, the cost of replacing the points will be charged against the CONTRACTOR.
- B. The CONTRACTOR shall employ a competent surveyor registered in the State of Oregon and require said surveyor to establish all lines, elevations, reference marks, batterboards, etc. needed by the CONTRACTOR, ENGINEER, or OWNER'S AGENT during the progress of the Work, and from time to time to verify such marks by instrument or other appropriate means.
- C. Surveyor shall provide survey control for each stage of construction, and provide survey "As-Built" documentation for various components of construction. The Surveyor shall furnish all labor, materials, tools, supervision, transportation, and equipment necessary to perform the project surveying Work as specified herein for the groundwater barrier wall and associated Work, as shown on the Drawings.

1.02 QUALIFICATIONS

- A. The surveyor, in the opinion of the ENGINEER or OWNER'S AGENT, shall have a proven record of successful performance on projects of similar magnitude. Prior to acceptance by the OWNER, OWNER'S AGENT and/or ENGINEER, the surveyor will be required to submit a Survey Plan describing qualifications of the survey crew chief, other key personnel, instrumentation to be used, accuracy and precision required, type of grid system to be used, and a description of the other survey points required to establish grades, layout, quantities, and required "As-Built" and certifications. The Plan must also provide the Surveyor's commitment to meet the project schedule and provide the required "As-Built" documentation as expeditiously as possible, and in accordance with the requirements imposed by the project schedule.

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FIELD ENGINEERING

1.03 SURVEY REQUIREMENTS

- A. The Surveyor shall locate survey control points prior to starting site Work. The ENGINEER or OWNER'S AGENT shall be promptly notified in writing of any discrepancies discovered before or during construction. The survey datums are to include NAVD88 and Oregon State Plane North (NAD 83/91).

- B. The Surveyor shall maintain lines and levels, layout, and locate the Work utilizing recognized engineering survey practices. A complete and accurate log of control and survey Work must be maintained. The Surveyor shall establish, at a minimum, a 50-foot by 50-foot (ft) survey grid for construction and "As-Built" documentation. The spacing of the grid shall be reduced in areas of steep slopes, grade change, ditches, impoundments, and other structuring to assure adequate control and accurate "As-Built". The plan grid shall be approved by the ENGINEER or OWNER'S AGENT. The Surveyor shall provide, at a minimum, a detailed survey for the following components:
 - 1. The excavation extents of the clearance trench, including the lateral limits.
 - 2. The bottom and top elevations and horizontal alignment of the groundwater barrier wall at a minimum of 25 foot intervals and at each bend. (The top elevation of the groundwater barrier wall is similar to the bottom elevation of the clay layer.)
 - 3. All other items that the CONTRACTOR requires to complete the Work and establish quantities for payment.
 - 4. All other reasonable items associated with the Work requested by the ENGINEER or OWNER'S AGENT.
 - 5. The top of the clay layer and the final elevation of the crushed stone surface above the groundwater barrier wall.

- C. The detailed topographic survey shall extend to a minimum of 100 ft in all directions beyond the limits of disturbance.

- D. All locations/stations should be surveyed to include both horizontal coordinates (accuracy 0.1 ft) and vertical elevation (accuracy 0.01 ft).

1.04 CONTRACTOR ENGINEERING REQUIREMENTS

The CONTRACTOR shall provide all necessary engineering, support and coordination necessary to perform the scope of work. These services include, but

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FIELD ENGINEERING

are not limited to, all work associated with obtaining permits, preparing shop drawings and submittals, providing engineering and licensed certification (P.E. stamp) for alternate designs, performing quality control, conducting monitoring and maintenance activities, performing inspections, and any other required activities.

1.05 CONSTRUCTION TOLERANCES

- A. Construction tolerances shall be as provided in the various Sections of these Specifications, and as given below.
- B. All minimum thicknesses specified within these Contract Documents shall be met with no exception. The construction tolerances on final contours shall be within two tenths of one foot below to five tenths of one foot above (-0.2 to +0.5) the specified grades as they appear on the Drawings, or as otherwise approved by the ENGINEER or OWNER'S AGENT. No additional payments for actual thicknesses of specified soil layers greater than that required will be approved.
- C. No surveying will be allowed between one hour before sunset and one hour after sunrise, unless approved by the ENGINEER or OWNER'S AGENT.
- D. The ENGINEER or OWNER'S AGENT shall be permitted at all times to check the lines, elevations, reference marks, batterboards, etc. set by the CONTRACTOR, who will correct any errors in lines, elevations, reference marks, batterboards, etc. disclosed by such check. Such a check will not be construed to be an approval of the CONTRACTOR's work and shall not relieve or diminish in any way the responsibility of the CONTRACTOR for the accurate and satisfactory construction and completion of the entire Work. In order to verify the construction, the ENGINEER or OWNER'S AGENT shall be supplied with survey information at the time of surveying.
- E. The CONTRACTOR shall be aware of the surveying activities and shall account for them in the construction schedule.
- F. The groundwater barrier wall shall be constructed in the location depicted on the Drawings. The as-built horizontal alignment shall vary no more than five (5) feet in any direction from that depicted on the Drawings. Additionally, the groundwater barrier wall shall extend to the basalt interface, as depicted on the Drawings. If applicable, the CONTRACTOR shall present modified alignments as alternatives with their bid.

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FIELD ENGINEERING

1.06 RECORD DOCUMENTATION

At the completion of the Work the CONTRACTOR shall have its Surveyor prepare “As-Built” drawings showing the location of all Work installed, including that Work installed by the OWNER or OWNER’S AGENT (if any) and submit the “As-Built” drawings to the ENGINEER or OWNER’S AGENT for review. “As-Built” drawings shall also be provided to the ENGINEER or OWNER’S AGENT in electronic format (AutoCAD). “As-Built” drawings shall include the various Work components discussed herein. Certification of the “As-Built” drawings by the registered Surveyor is required. Submittals of these “As-Built” drawings shall conform to requirements of Section 01300 – SUBMITTALS.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

(not used)

END OF SECTION

*01150 – Measurement and
Payment (To be included in
Contract)*

01200 – Project Meetings

01200
PROJECT MEETINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Pre-Construction Conference

1. Before issuance of the Notice to Proceed, a Pre-Construction Conference will be held to discuss items of significance, including
 - a. construction schedule;
 - b. work sequence;
 - c. responsible personnel;
 - d. construction quality control;
 - e. procedures for handling shop drawings, schedules, “as-built” drawings, and other submissions;
 - f. processing Applications for Payment;
 - g. procedures for field decisions and Site Work Order Requests;
 - h. procedures for measurement of completed work for payment applications;
 - i. preparation of record documents;
 - j. applicable safety, health, environmental, security, fire protection, and operating requirements of the facility;
 - k. use of premises;
 - l. office, work, and storage areas;
 - m. equipment and product deliveries;
 - n. housekeeping; and,
 - o. working hours.
2. Among those present at the Pre-Construction Conference shall be the OWNER’S AGENT, the ENGINEER, the CONTRACTOR and CONTRACTOR’s Superintendent and major Subcontractors. All CONTRACTOR’s employees and subcontractor may attend, at the CONTRACTOR’s discretion.
3. The ENGINEER or OWNER’S AGENT will arrange for and organize the Pre-Construction Conference to be held at the site.

B. Progress Meetings

1. During the course of the Contract, progress meetings will be organized and conducted by the ENGINEER or OWNER’S AGENT to discuss the progress of the Contract at a frequency of at least every week, or more frequently at the discretion of the ENGINEER or OWNER’S AGENT. The CONTRACTOR, its Superintendent, dedicated Safety Officer, and the Construction

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PROJECT MEETINGS

Quality Control (CQC) Manager shall attend these meetings. The CONTRACTOR shall be fully responsible for any and all of the subcontractors and shall be responsible for subcontractor attendance and/or input into the meetings. The ENGINEER will take the minutes of the progress meetings and a copy will be furnished to the CONTRACTOR, OWNER, and OWNER'S AGENT. These meetings may, at the ENGINEER or OWNER'S AGENT'S discretion, be increased if progress is not satisfactory or if coordination problems should arise.

2. The construction schedule, as submitted under Section 01014 - WORK SEQUENCE, shall be updated for each progress meeting. The updated schedule shall be furnished to the ENGINEER or OWNER'S AGENT listing all parts of Work and providing the planned start and completion date for each part of Work. The schedule completion date shall conform to the contract completion date.

C. Weekly Progress Schedule

The CONTRACTOR's Site Superintendent shall submit on a weekly basis to the ENGINEER or OWNER'S AGENT a schedule of anticipated Work for the following week. This schedule shall be submitted by 12 p.m. (noon) on each Friday, and shall be updated as necessary if the CONTRACTOR's anticipated Work is altered.

D. Health and Safety Meetings

A safety tailgate meeting shall be held on a daily basis prior to commencement of work for that day. At the meeting, site controls and activities scheduled for the day shall be discussed.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

(not used)

END OF SECTION

01300 – Submittals

01300
SUBMITTALS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Materials, equipment, workmanship, design and arrangement of all Work performed under this Contract shall be subject to the approval of the ENGINEER or OWNER'S AGENT.
- B. Work Included:
 - 1. Procedures for submittal to the ENGINEER or OWNER'S AGENT, a List of Submittals, certificates and affidavits, samples for testing, material test results, Shop Drawings, operation and maintenance literature and other miscellaneous data for approval.
 - 2. Procedures for turnover of the CONTRACTOR-prepared As-Built drawings and/or Record Documents.
- C. The CONTRACTOR is required to review all submittals and certify the completeness, accuracy, and content prior to submitting to the ENGINEER or OWNER'S AGENT.

PART 2 - PRODUCTS

2.01 LIST OF SUBMITTALS

- A. Within ten (10) calendar days after the Contract is awarded, the CONTRACTOR shall furnish the ENGINEER or OWNER'S AGENT with a List of Submittals.
- B. The List of Submittals shall indicate all products which the CONTRACTOR believes will be incorporated in the Work. Omission from this list of any equipment, material, or product required by the Specifications shall not relieve the CONTRACTOR of the Contract requirements for providing the equipment, materials, or products and completing the associated Work as specified. Each such omission discovered by the ENGINEER or OWNER'S AGENT shall be brought to the CONTRACTOR's attention for the purpose of revising the List of Submittals. The ENGINEER or OWNER'S AGENT reserves the right to make any revisions to the List of Submittals after award of the Contract, as necessary.

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SUBMITTALS

- C. For each entry of the List of Submittals, reference to the Specifications shall be made, along with an indication of the type of submittal(s) which the CONTRACTOR plans to make to the ENGINEER or OWNER'S AGENT. More than one type of submittal may be required. The ENGINEER or OWNER'S AGENT shall approve the types of submissions offered, or request additional or alternative submissions. Types of submissions are listed below:
1. Sample for testing, approval or filing.
 2. Chain of Custody.
 3. Sampling and analytical methods used.
 4. Testing and sample analysis results.
 5. Certificate(s) and Accompanying Affidavit.
 6. Shop Drawing.
 7. Miscellaneous Data.
- D. For each item on the List of Submittals, the CONTRACTOR shall indicate the proposed source of supply or manufacturer for that entry.
- E. The ENGINEER or OWNER'S AGENT will review the CONTRACTOR's proposed source of supply or manufacturer for each entry and note any exceptions taken, and then return the List of Submittals to the CONTRACTOR within fourteen (14) calendar days.
- F. The following conditions apply concerning exceptions:
1. No reference to a particular source of supply or manufacturer in the Contract Documents shall not relieve the CONTRACTOR of the obligation to fulfill, all requirements of the Specifications.
 2. No exception to a particular manufacturer shall be construed by the CONTRACTOR as obligating the ENGINEER or OWNER'S AGENT to approve a Shop Drawing for a product from that manufacturer.

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SUBMITTALS

3. Subsequent to rejection of a particular source of supply or manufacturer, the CONTRACTOR shall submit to the ENGINEER or OWNER'S AGENT for approval a different source of supply or manufacturer for that product within seven (7) calendar days after notification of such rejection. The entire List of Submittals shall be resubmitted.
4. As an alternative to rejecting a particular source of supply for equipment, materials, or products, the ENGINEER or OWNER'S AGENT reserves the option to alter the type of submittal required for that product.

2.02 SAMPLES

- A. If the ENGINEER or OWNER'S AGENT so requires, either prior to or after commencement of the Work, the CONTRACTOR shall submit samples of materials for such special tests, or for file purposes, as the ENGINEER or OWNER'S AGENT deems necessary to demonstrate that they conform to the Specifications. Such samples shall be furnished, taken, stored, packed and shipped by the CONTRACTOR as directed.
- B. All samples shall be packed so as to reach their destination in good condition, and shall be labeled to indicate the material represented, the name of the Work and location for which the material is intended, and the name of the CONTRACTOR submitting the sample. To ensure consideration of samples, the CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT by letter that the samples have been shipped and shall properly describe the same in the letter; the letter shall have a copy of the Chain of Custody attached. The Letter of Notification and Chain of Custody shall be enclosed with the samples.
- C. The CONTRACTOR shall submit data and samples, or place its orders sufficiently early to permit consideration, inspection, testing, and approval before the materials and equipment are needed for incorporation into the Work. The consequences of CONTRACTOR failure to do so shall be the CONTRACTOR's sole responsibility.
- D. In order to demonstrate the proficiency of workmen or to facilitate the choice among several textures, type finishes, surfaces, etc., the CONTRACTOR shall provide such samples of workmanship as may be required.
- E. When required, the CONTRACTOR shall furnish to the ENGINEER or OWNER'S AGENT triplicate sworn copies of manufacturer's shop or mill tests or reports from independent testing laboratories relative to the materials, equipment performance ratings, and concrete data.

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SUBMITTALS

- F. The cost of samples, sample testing, and analysis associated with the approval of proposed materials and/or methods shall be borne in their entirety by the CONTRACTOR.

2.03 CERTIFICATES, AFFIDAVITS, AND WARRANTIES

- A. Where specified in the Specifications that a certificate, affidavit, or warranty be submitted to the ENGINEER or OWNER'S AGENT for a particular material, product or product component, such submittals shall be made in accordance with the following:
1. Equipment, Materials, and Products: A Certificate of Compliance shall indicate that the equipment, material, product, or product component complies with the requirements of the Specifications, and it shall be accompanied by test results and/or other technical data substantiating such compliance. The certificate shall be supplied by the material supplier or product component manufacturer.
 2. Installation: A Certificate of Compliance shall indicate that the equipment or system has been properly installed in compliance with manufacturer's instructions and is ready to be operated. The certificate shall be supplied by the equipment or system manufacturer or manufacturer's representative.
 3. Equipment, materials, products and their installation shall be warranted in accordance with these Construction Documents. All warranties shall be submitted for review prior to delivery of the equipment, materials or products to the Site and must be acceptable to the OWNER or OWNER'S AGENT. Limited warranties shall not be acceptable to the OWNER or OWNER'S AGENT unless specifically agreed to by the OWNER or OWNER'S AGENT in writing.
- B. Each certificate shall include a signed sworn statement by an official of the company originating the certificate attesting to the truth and accuracy of all information contained in the certificate. If such attestation of truth and accuracy cannot be included in the certificate itself, it must be provided as an affidavit accompanying the certificate.

2.04 SHOP DRAWINGS

- A. Five (5) copies of each Shop Drawing, certified correct for construction, shall be submitted for the review of the ENGINEER or OWNER'S AGENT as soon as possible after approval of the List of Submittals and with due regard to the sequence in which such information will be

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SUBMITTALS

required. This includes, but is not limited to, clay materials, mix reagents, slurry mix, silt fence material, topsoil, dense graded aggregate, soil materials, borrow materials, bentonite, details of any deviation which the CONTRACTOR proposes from the details as indicated on the Drawings and Construction Sequence, and any details not specifically indicated on the Drawings. It is the CONTRACTOR's responsibility to provide finished Shop Drawings for approval, based on field measurements of actual conditions, indicating how he proposes to install the Work and the equipment, materials, and products being furnished under the Contract. Copies of project Drawings will not be accepted for submission as Shop Drawings.

- B. Shop Drawings shall be submitted in proper sequence with due regard to the time required for the reviewing, approving and transmittal. Shop Drawings for a particular component shall be submitted complete at least 21 days prior to the anticipated date of furnishing or installations of the particular component.
- C. The CONTRACTOR may submit manufacturer's literature as a substitute for, or supplement to, the Shop Drawings, provided the literature is explicit with regard to details of the items to be furnished Samples and/or visual representation of the material shall accompany product data whenever available. Drawings, specifications and manufacturers literature shall bear the name and address of the manufacturer or fabricator, and be clear, detailed, and complete. Catalog numbers of materials or equipment will not suffice.
- D. Shop Drawing submissions shall be made to the ENGINEER or OWNER'S AGENT by the CONTRACTOR only. Any data prepared by Subcontractors and Suppliers shall be submitted through the CONTRACTOR upon review by the CONTRACTOR.
- E. All Shop Drawings covering related items, of equipment material, and products or integrated systems of equipment, material, and products shall be submitted at the same time so that their complete installation can be adequately reviewed. No partial submissions will be considered when it is necessary to meet the material delivery times required by the Contract, the ENGINEER or OWNER'S AGENT may approve partial submissions when accompanied by sufficient data to allow the ENGINEER or OWNER'S AGENT to determine the effect on the final design of other facilities being furnished under this Contract.
- F. Shop Drawings shall be submitted to the ENGINEER or OWNER'S AGENT which have been checked and stamped with the approval of the CONTRACTOR. The CONTRACTOR's stamp shall include, but not be limited to, the submittal date, contract number, project name, submittal

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SUBMITTALS

number, corresponding specification and paragraph number and CONTRACTOR's company name, signature and a notation that the Shop Drawing had been reviewed by the CONTRACTOR and is in conformance with the referenced specification section. Two (2) copies of the Shop Drawings and data submitted by the CONTRACTOR for approval shall be returned by the ENGINEER or OWNER'S AGENT to the CONTRACTOR with comments such as, "No Exceptions Noted", "Exceptions Noted", or "Returned for Resubmission". The CONTRACTOR shall correct the original drawings and data, if required, and resubmit five (5) copies of the revised Shop Drawings and data. Two (2) copies of such revisions, reviewed by the ENGINEER and OWNER, or its AGENT, shall be returned to the CONTRACTOR.

1. All Shop Drawings shall be numbered in chronological order utilizing 001, 002, etc. as the format.
 2. All Shop Drawings, when practical, shall be limited in size to 22" x 34", and have borderlines set back ½" on top, bottom, and right-hand side of the sheet. When the scale to which the drawings must be made for clarity, and the size of the equipment assembly of arrangement, make it impractical to prepare the drawings in 22" x 34" format, larger sheet sizes may be used.
 3. The CONTRACTOR shall revise its original Shop Drawings to reflect any and all changes made to the equipment, materials, or products in the field during construction. When the equipment, materials or products have been finally accepted, the CONTRACTOR shall submit five (5) copies of any Shop Drawing or data which have been so corrected. These copies shall be added by the ENGINEER or OWNER'S AGENT to the bound sets or data submitted as specified below.
- G. At the time of each submission, the CONTRACTOR shall, in writing, notify the ENGINEER or OWNER'S AGENT of any deviation that the Shop Drawings have from the requirements of these Specifications. Failure to note deviations shall not excuse the CONTRACTOR from complying with the requirements of the Specifications.
- H. No equipment, materials, or products for which Shop Drawings have been submitted for approval shall be delivered to the project site or incorporated into the Work until the CONTRACTOR has received copies of such reviewed drawings or until the ENGINEER or OWNER'S AGENT has authorized CONTRACTOR in writing to do so.

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SUBMITTALS

- I. The review of the CONTRACTOR's submitted data by the ENGINEER or OWNER'S AGENT is for general conformance only. Although the ENGINEER or OWNER'S AGENT may review submitted data in detail, such review is an effort to discover errors and omissions in the CONTRACTOR's submissions and to assist the CONTRACTOR in coordinating and expediting its Work. It shall in no way relieve the CONTRACTOR of its obligation and responsibility to coordinate the Work or to relieve it of its responsibility in fulfilling the purpose and intent of the Contract.
- J. Once submitted, all Shop Drawings become the property of the OWNER and OWNER'S AGENT.

2.05 CONSTRUCTION "AS-BUILT" DRAWINGS

- A. The CONTRACTOR shall maintain at the Site a complete set of project Drawings as issued with the Construction Documents. Project Drawings shall be updated by the CONTRACTOR to show any and all deviations made by it during construction. These drawings shall be labeled 'AS-BUILT' with 1/2" high block letters, and submitted to the ENGINEER or OWNER'S AGENT at the completion of the project within seven (7) days after issuance of a Certificate of Substantial Completion by the ENGINEER or OWNER'S AGENT. All such revisions shall be marked every week to keep the Drawings set current during the construction process and prior to any item becoming inaccessible for an "As-Built" drawing to be performed.
- B. The CONTRACTOR's set of project Drawings showing changes made during construction shall be available to the ENGINEER or OWNER'S AGENT throughout the construction period, and shall be delivered to the ENGINEER or OWNER'S AGENT according to the requirements of Paragraph 2.05 A, above.
- C. Electronic format drawings shall be in AutoCAD format.

2.06 MISCELLANEOUS DATA

Any other submittal required by these Specifications, but not directly addressed under this Section, shall be submitted in accordance with the requirements for Shop Drawings.

PART 3 - EXECUTION

3.01 GENERAL

During the Pre-Construction Conference, procedures for handling Shop Drawings and other submissions shall be established.

3.02 ALTERNATIVES TO SPECIFIED PRODUCTS

- A. The Specifications may indicate the name of a manufacturer, a trade name, or a material to be used in the Contract. Reference made to a particular product of the manufacturer is made to identify a particular design, quality, construction arrangement, or style.
- B. Where the CONTRACTOR proposes to use a substitute product for that specified, it shall submit to the ENGINEER or OWNER'S AGENT, for approval, complete information on such substitute product including all necessary redesign of the structure, equipment, or any other part of these Specifications requiring modification as a result of the use of the requested substitute. All such redesign and all new drawings and detailing required as a result thereof shall be prepared by the CONTRACTOR at its own expense, including regulatory permit acquisition for the modifications. Requests for additional money for such substitution will not be considered. All proposed modifications to Oregon Department of Environmental (ODEQ) approved final design and work plan elements must be approved by ODEQ.
- C. If the CONTRACTOR proposes to provide products as "equals" to those specified, it shall be its responsibility to furnish complete, specific detailed information to the ENGINEER or OWNER'S AGENT for approval from the manufacturer or supplier of the product proposed to be provided in which the requirements of these Specifications are shown to be met. This shall consist of a point-by-point comparison of the Specification requirements which the product proposed to be provided. In the event the Specifications mention a manufacturer, a point-by-point comparison of the product specified and that proposed to be provided shall be furnished by the CONTRACTOR. The burden of responsibility in furnishing this information is with the CONTRACTOR. If incomplete or irrelevant data is submitted as evidence of compliance with this subparagraph, the request for approval to provide this specific substitute shall not be considered. The request for approval by the CONTRACTOR to the ENGINEER or OWNER'S AGENT for a substitute product shall also be in accordance with Section 01400 – QUALITY CONTROL.

END OF SECTION

01400 – Quality Control

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PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included

1. Where applicable in the Contract Documents, the minimum acceptable quality of equipment, materials, and workmanship has been defined either by a manufacturer's name and product identification, or by reference to recognized industry standards. Standards, testing protocol, inspection procedures, and additional requirements are referenced in these Contract Documents.
2. To ensure that the necessary materials and equipment are furnished, procedures are established herein to allow the CONTRACTOR to obtain approval by the ENGINEER or OWNER'S AGENT for Work which will be in complete accordance with the Contract Documents; and for substitutions to be reviewed by the ENGINEER or OWNER'S AGENT, or accepted thereby if sufficient data for unqualified approval are submitted by the CONTRACTOR.
3. For products which do not differ significantly from those specified in the referencing Section, or are, in the CONTRACTOR's judgment, of equal or higher quality, the submission of the Materials List as specified in Section 01300 - SUBMITTALS and its approval by the ENGINEER or OWNER'S AGENT, shall provide the basis for quality control. Actual quality control during manufacture shall be maintained by the approval of the Shop Drawings and by the final submissions of the manufacturer's Certificates of Compliance, and the Testing and Inspection Services; specified herein.
4. If the CONTRACTOR proposes to provide products as "equals" to those specified in the referencing Section on which the design is based, it shall be its responsibility to furnish complete, specific, detailed information to the ENGINEER or OWNER'S AGENT for approval, in which the requirements of the Contract Documents are shown to be met.
 - a. These data shall be prepared or approved by the manufacturer of the proposed product, and shall include a point-by-point comparison between the features of the proposed product and the corresponding features of the product specified in the Contract Documents as the one on which the design is based. The features of the product

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specified shall be those of the manufacturer's model specified (including all standard catalog features and any specified options) which were published on the date of the Invitation for Bids.

- b. If applicable, the CONTRACTOR shall also furnish a description of the changes in structures and other equipment which will have to be made because of the proposed substitution.
- c. The burden of responsibility for furnishing these data, documentation, engineering, and certifications for substitute products is with the CONTRACTOR.
- d. A request to furnish the substitute product shall not be considered if incomplete or irrelevant data are submitted as evidence of compliance with the requirements.

1.02 QUALITY CONTROL

A. Qualification of Manufacturer/Installer

- 1. The manufacturer/installer shall be regularly engaged in the business of manufacturing material, installing and/or equipment of the type required by the referencing Section.
- 2. The manufacturer/installer shall be one of those specified by name in the referencing Section, or must be specifically approved by the ENGINEER or OWNER'S AGENT.
 - a. Requests for approval of a manufacturer/installer not named in the referencing Section shall be submitted to the ENGINEER or OWNER'S AGENT, accompanied by the following information:
 - 1) List of at least five (5) installations of material and/or equipment of comparable size and capacity, and operating under anticipated service conditions; showing location, installation date, model, capacity, and service.
 - 2) If the manufacturer/installer cannot list five (5) installations; list all those which have been made, if fewer than five (5).

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- 3) Complete literature, technical, and performance data describing the proposed equipment.
 - 4) The manufacturer's standard installation, operating, and maintenance instruction bulletins for the proposed equipment.
- b. The ENGINEER or OWNER'S AGENT shall notify the CONTRACTOR, in writing, that the manufacturer selected by the CONTRACTOR is approved; or shall request further data to justify the selection. Upon the approval of the manufacturer, the CONTRACTOR shall update the Materials List and submit this to the ENGINEER or OWNER'S AGENT.
- c. If the ENGINEER or OWNER'S AGENT requests additional data on the actual performance of the equipment or system, the CONTRACTOR shall submit evidence that the equipment or system proposed has been installed and has been in operation for a period prior to the date of Invitation for Bids, and that at least two (2) years of such service are considered satisfactory by the operating superintendents of the facilities in which installed. The service and operating conditions for the equipment or system shall be as similar to those described in these Contract Documents, as is practical.
- 1) The ENGINEER or OWNER'S AGENT shall review the experience record of the equipment or system proposed to be installed by the CONTRACTOR, and shall advise the CONTRACTOR, in writing, as to whether or not it appears to be suitable for installation under this Contract.
- d. If acceptable evidence of satisfactory experience with the proposed material and/or equipment cannot be furnished, but the CONTRACTOR still elects to provide it, the ENGINEER or OWNER'S AGENT may accept the installation, but to protect the OWNER's and OWNER'S AGENT's interest in the event that the material and/or equipment does not meet the intended use requirements the CONTRACTOR shall submit a bond or deposit in the amount of the portion of the total Contract price represented by the material and installation cost, including overhead profit of the material and/or equipment being

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proposed. The period of time for which the bond or deposit shall remain in effect shall be two (2) years after final acceptance of the Work. The bond or deposit shall be used by the OWNER or OWNER'S AGENT to pay for its costs to replace the material and/or equipment with that of an alternative manufacturer or supplier, if the material and/or equipment when installed does not perform in accordance with the intended use, in the judgment of the OWNER or OWNER'S AGENT.

- 1) The original material and/or equipment which has been replaced shall become the property of the CONTRACTOR, who shall promptly remove it from the site.
 - 2) The CONTRACTOR shall be given reasonable opportunity to modify the equipment furnished, if necessary, so that it will be acceptable to the OWNER, ENGINEER, or OWNER'S AGENT. Continuous operation in accordance with time for such modifications shall be maintained.
 - 3) The decision of the OWNER or OWNER'S AGENT with respect to replacing unsatisfactory equipment shall be final.
- e. Neither approval by the ENGINEER or OWNER'S AGENT of the CONTRACTOR's selection of a particular manufacturer or system supplier, nor accepting the CONTRACTOR's selection together with the posting of a bond or deposit in lieu of satisfactory evidence of experience, shall obligate the ENGINEER or OWNER'S AGENT to approve details on the Working Drawing submissions from that manufacturer which are not in conformance with the requirements of the Contract Documents.
- f. Neither approval by the ENGINEER or OWNER'S AGENT of the CONTRACTOR's selection of a particular manufacturer, equipment supplier, or installer, nor accepting the CONTRACTOR's selection together with the posting of a bond or deposit in lieu of satisfactory evidence of experience, shall relieve the CONTRACTOR of its obligations to fulfill all requirements of the Contract Documents.

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3. When so specified in the referencing Section, the manufacturer of the equipment or supplier of the system shall furnish, as requested by the ENGINEER or OWNER'S AGENT, and at no additional cost to the OWNER or OWNER'S AGENT, the services of a qualified Technical AGENT to advise the ENGINEER or OWNER'S AGENT and the CONTRACTOR in the installation and operation of the equipment or system, and to certify to the ENGINEER or OWNER'S AGENT, in writing, that the equipment or system is properly installed and ready to be operated.

B. Installation Requirements

1. The CONTRACTOR shall provide at least one person who shall be present at all times during the installation of the items of equipment furnished under the referencing Section who is thoroughly familiar with the type of materials being installed and with the manufacturer's recommended methods of installation and operation, and who shall direct all the Work performed on the equipment item being installed, at no additional cost to the OWNER's AGENT.
2. The person providing the above service need not be an authorized representative of the manufacturer except when the warranty of the manufacturer shall be voided if not installed by an authorized representative. The Certificate of Compliance required by Section 01300-SUBMITTALS must be issued by the manufacturer of the equipment or supplier of the system.

C. Codes and Standards

1. Equipment and installation shall comply with all pertinent federal, state and local codes and regulations.
2. Materials, equipment, and installation shall comply with:
 - a. The minimum standards of the governmental agency or industry standardizing organization publishing standards applicable to such Work.
 - b. The requirements of specific standards listed in the referencing Section.
 - c. Where the standards of several organizations (including the manufacturer's own published standards) are applicable to the same Work, the Work may be done in accordance with any such other standards that require an equal or higher quality construction for the specified service than those

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listed in the referencing Section. The selection of such an alternate standard to the one specified shall be subject to the approval of the ENGINEER or OWNER'S AGENT.

3. Where any provisions of pertinent codes or standards are in conflict with the requirements of the Contract Documents, the provisions requiring greater safety or operability, or higher quality construction for the specified service shall govern, unless specific exemptions to such provisions are made in the referencing Section. The final determination shall be made by the ENGINEER or OWNER'S AGENT.
 4. If the mandatory standards of governmental agencies are revised subsequent to the date of issue of the Invitation to Bid, but are made applicable to the Work under this Contract, the CONTRACTOR shall advise the ENGINEER or OWNER'S AGENT as to the additional cost or reduction in costs required to comply with such revisions, and a Change Order will be issued to cover such costs or the CONTRACTOR issue a credit in the event the change required by the governmental agency results in a cost reduction. The cost of rework required for Work not complying with such revised regulations, but installed after the effective date of such code revisions, will be at the CONTRACTOR's expense.
 5. The CONTRACTOR shall document construction and installation activities. At a minimum, installation records shall contain the minimum information: time, place, installer, personnel, equipment used or required, testing performed, test locations, results of testing, installation percent completed, duration, conflicts, resolution to conflicts, safety requirements/actions, site conditions, weather, and all other information required to document the proper installation and certification.
- D. At the discretion of the ENGINEER or OWNER'S AGENT, the CONTRACTOR shall make available any materials related to the Work, including but not limited to soils, granular materials, clay, mix reagents, or soil-mix backfill, for confirmation quality control sampling by the ENGINEER or OWNER'S AGENT.

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PART 2 - PRODUCTS

2.01 DESIGN

- A. The design of certain items at the site, as shown in the Contract Documents, is based on the performance and dimensions of specific equipment items as furnished by particular manufacturers.
1. When the performance or dimensions of such items are proprietary, and furnished only by one particular manufacturer, the referencing Section will state the design is based on a particular model of that manufacturer.
 - a. The CONTRACTOR may furnish and install corresponding products produced by an alternate manufacturer; either one named as an alternate in the referencing Section, or any other one selected by the CONTRACTOR and approved or accepted by the ENGINEER or OWNER'S AGENT on the basis of the information supplied as requested in Part I of this Section.
 - b. The CONTRACTOR shall furnish the ENGINEER or OWNER'S AGENT with those data on the particular model of the alternate manufacturer which are required to demonstrate that the proposed equipment or system is at least equivalent in performance in the specified service to the equipment or system on which the design is based. The ENGINEER's or OWNER'S AGENT'S evaluation will include a determination of the ability of the proposed equipment to meet the requirements of these Drawings, and a comparison of the costs of Operation and Maintenance. If the CONTRACTOR proposes a modification to the Contract Price due to the substitute equipment, this will also be evaluated by the ENGINEER or OWNER'S AGENT.
 - c. Approval by the ENGINEER or OWNER'S AGENT of the proposed substitution will not be capriciously withheld.
 - d. The design of the facilities associated with the equipment or system for which a substitution is proposed may be affected by such substitution. The size of the building or supporting structure, the size and arrangement of piping and wiring, the specification for associated equipment, the necessary controls, and the service requirements will have to be reconsidered by the CONTRACTOR. The

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CONTRACTOR shall be completely responsible for the necessary engineering, redesign and certification of all facilities affected by the substitution, and shall prepare the revisions to the Drawings required by such substitution. These revisions shall be submitted to the ENGINEER or OWNER'S AGENT for approval, in accordance with the provisions in Section 01300 – SUBMITTALS, including the specific notice as to the details in which the substitute design differs from the requirements of the Contract Documents. All such redesign and all new drawings and detailing required as a result thereof shall be prepared by the CONTRACTOR, or its Subcontractors, at its own expense. Requests for additional payment for such substitution will not be considered unless made a part of the final request for approval of the substitution itself.

2.02 MATERIALS

- A. All materials, including those not specifically described or specified, but required for a complete and proper installation of Work shall be new, first quality of their respective kinds, and subject to the approval of the ENGINEER or OWNER'S AGENT.
- B. All materials shall be in accordance with details and samples as specified in the referencing Section; and submitted and approved in accordance with Section 01300-SUBMITTALS.

2.03 INTERCHANGEABILITY

- A. All products of the same size and type and performing the same function shall be, insofar as practical, the products of one manufacturer.
 - 1. Details in the Shop Drawing submissions of the several equipment manufacturers shall be coordinated so that items such as lubricating fittings, for example, are identical on all equipment items requiring the same grade of lubricant.

PART 3 - EXECUTION

3.01 INSTALLATION CONDITIONS

- A. Inspection
 - 1. Prior to any Work on a specific equipment unit or material installation, the CONTRACTOR shall carefully inspect the existing and previously installed Work, and verify that all Work is

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in such a condition that the installation of new Work may properly commence and be carried out to a proper and timely completion.

2. The CONTRACTOR shall verify that each item of Work shall be installed in accordance with all pertinent codes and regulations, the approved design, and the referenced standards.
3. The ENGINEER or OWNER'S AGENT shall periodically inspect the Work to provide quality assurance in accordance with these Contract Documents.

B. Discrepancies

1. In the event of discrepancies, the CONTRACTOR shall immediately notify the ENGINEER or OWNER'S AGENT, in writing, of such conditions.
2. The CONTRACTOR shall not proceed with installation in areas of discrepancy until such discrepancies have been corrected in a manner acceptable to the ENGINEER or OWNER'S AGENT.
3. For any unexpected features arising during the progress of Work and not fully covered herein, the Specifications shall be interpreted by the ENGINEER, or its AGENT, or OWNER'S AGENT to require first-class workmanship and materials, and such interpretation shall be accepted by the CONTRACTOR.

3.02 INSTALLATION

- A. The CONTRACTOR shall install each equipment item in strict accordance with the manufacturer's instructions, unless specifically directed otherwise by the ENGINEER or OWNER'S AGENT. The CONTRACTOR shall not void the manufacturer's guarantee.
- B. In the event of discrepancies between the Contract Documents and the equipment manufacturer's formal installation instructions, as submitted for the actual units supplied, the CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT, in writing, of such discrepancies. The CONTRACTOR shall obtain the equipment manufacturer's approval in writing for any changes required to suit the site conditions, and so advise the ENGINEER or OWNER'S AGENT.

END OF SECTION

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*01430 – Environmental
Protection*

PART 1 - GENERAL

1.01 DESCRIPTION

The CONTRACTOR shall perform all Work in such manner as to minimize the polluting of air, water, or land, and shall, within reasonable limits, control noise and minimize the generation and disposal of solid waste materials, as well as other pollutants. Disposal of waste materials shall comply with all applicable federal, state, county, and environmental regulations.

1.02 PRE-CONSTRUCTION WALK-THROUGH

Prior to the start of any on-site construction activities, the CONTRACTOR and the ENGINEER or OWNER'S AGENT shall make a joint condition survey of the Site after which the CONTRACTOR shall prepare a brief report indicating on a layout plan the condition of structures, fences, equipment, stored product and materials, and items near the Work areas and access route(s) as applicable. This report will be signed by both the ENGINEER or OWNER'S AGENT, and the CONTRACTOR upon mutual agreement as to its accuracy and completeness.

1.03 PROTECTION OF LAND AREAS AND UTILITIES

- A. Except for any Work, or storage area and access routes specifically assigned for the use of the CONTRACTOR, the land areas outside the limits of disturbance performed shall be preserved in their present condition.
- B. The CONTRACTOR shall confine its construction activities to areas defined for Work on the Drawings or specifically assigned for its use within the designated disturbed area. Storage and related areas and access required temporarily by the CONTRACTOR in the performance of the Work shall be coordinated with the ENGINEER or OWNER'S AGENT.
- C. The Work includes excavation and other activities near, and at, the location of utilities, both subsurface and overhead. For any utility designated on the Drawings for abandonment, the CONTRACTOR shall confirm, via inspection and confirmation from the ENGINEER and the OWNER'S AGENT, that the particular utility is not being used. For all active utilities, the CONTRACTOR shall perform all work in accordance with any requirements stipulated by each specific utility. Work shall also be conducted in accordance with all local and state requirements.

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ENVIRONMENTAL PROTECTION

- D. It is the responsibility of the CONTRACTOR to contact the specific utility when working near utility poles. The CONTRACTOR shall coordinate with the utility to ensure adequate, temporary support and protection of the utility poles when working near the poles. The CONTRACTOR shall also coordinate with the utility for any temporary re-routing of the utility or shielding of the utility during the Work.

1.04 PROTECTION OF SURROUNDING AREAS

- A. Except for trees, shrubs and other vegetation marked on the Drawings to be removed; the CONTRACTOR shall not deface, injure or destroy trees, shrubs, or vegetation nor remove or cut them without special authority. No ropes, cables, or guys shall be fastened to or attached to any existing nearby trees for anchorages.
- B. The CONTRACTOR shall not damage or compromise the integrity of any infrastructure, equipment, materials, or other items not designated for removal or any Work. Any damage to items within or outside the Work area that are not designated for dismantling shall be restored or replaced in kind at no additional cost to the OWNER'S AGENT.

1.05 PROTECTION OF WATER RESOURCES

- A. The CONTRACTOR shall control the disposal of fuels, oils, bitumens, calcium chloride, acids, alkalies, pesticides, herbicides, rodenticides, or other harmful materials, both on- and off-site, and shall comply with applicable federal, state, and local laws concerning the pollution of rivers and streams. Special measures shall be taken to prevent chemicals, fuels, oils, greases, bituminous materials, herbicides, and insecticides from entering public waters.
- B. Water used in on-site material processing and other waste waters shall not be allowed to re-enter public waters. These waters and decontamination water or fluids shall be contained and disposed at an appropriate facility in accordance with all federal, state and local requirements.
- C. Water accumulating within any excavation containing potentially impacted materials shall be removed/dewatered in accordance with these Specifications. Water shall be disposed in accordance with Section 01500 – TEMPORARY FACILITIES AND CONTROLS.

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ENVIRONMENTAL PROTECTION

1.06 WASTE DISPOSAL

- A. The CONTRACTOR shall place all general debris and waste; i.e., paper, trash, etc., in a storage container provided by the CONTRACTOR for subsequent disposal by the CONTRACTOR. Soil, sediment, contact water or demolition debris is not considered general debris, but rather, waste that shall be managed as required in the Contract Documents, including Section 02250 – TRANSPORTATION AND DISPOSAL OF MATERIALS. If any waste material is dumped in unauthorized areas, the CONTRACTOR shall remove the material and restore the area to the condition of the adjacent undisturbed areas. Where directed, ground and/or floor areas contaminated by CONTRACTOR operations shall be excavated and/or cleaned, disposed as approved, and replaced with suitable fill material at no additional expense to the OWNER'S AGENT.
- B. No material shall be burned on the project site. It shall be the responsibility of the CONTRACTOR to provide disposal of all waste materials in accordance with all state and county regulations.

1.07 DUST CONTROL

- A. The CONTRACTOR shall maintain all excavations, stockpiles, access roads, waste areas, off-site roadways and all other work areas free from excess dust to such reasonable degree as to avoid causing a hazard or nuisance to others.
- B. Approved temporary methods for dust control consist of sprinkling of water or a dilute solution of water with a biodegradable surfactant (less than 0.05 percent). Chemical treatment, tents, windscreens, or similar methods will be considered for dust control. Approval of such temporary methods must be granted by the ENGINEER or OWNER'S AGENT prior to initiation.
- C. Dust control shall be performed as the Work proceeds and whenever a dust nuisance, hazard, or exceedance of predefined action levels occurs, or as otherwise directed by the ENGINEER or OWNER'S AGENT.

1.08 CORRECTIVE ACTION

The CONTRACTOR shall, upon receipt of a notice in writing from the ENGINEER or OWNER'S AGENT of any non-compliance with the foregoing provisions, take immediate corrective action in accordance with any and all federal, state, or local laws. If the CONTRACTOR fails or refuses to comply promptly, the ENGINEER or OWNER'S AGENT may issue an order stopping all or part of the work until satisfactory corrective action has been taken.

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ENVIRONMENTAL PROTECTION

1.09 POST-CONSTRUCTION CLEANUP OR OBLITERATION

The CONTRACTOR shall, unless otherwise instructed in writing by the ENGINEER or OWNER'S AGENT, obliterate all signs of temporary construction facilities such as temporary access roads, Work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other vestiges of construction prior to final acceptance of the Work. Any disturbed soil areas shall be graded and filled and the entire area stabilized with aggregate or seeded with permanent vegetation, as indicated on the Drawings.

1.10 EROSION CONTROL

- A. Surface drainage from cuts and fills, within the construction limits, whether or not completed, and from excavated areas shall be graded to control erosion within acceptable limits.
- B. Temporary control measures shall be provided and maintained throughout construction. Such measures shall include, but not be limited to silt fence, straw bales, drainage swales, and stabilized construction entrance(s). No additional payment will be considered or approved for repair or maintenance of the erosion control measures or for erosion repair.
- C. The area of bare soil, exposed at any one time by construction operations shall be minimized to the satisfaction of the ENGINEER or OWNER'S AGENT.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

(not used)

END OF SECTION

*01500 – Temporary Facilities and
Controls*

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TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 FIELD CONDITIONS AND MEASUREMENTS

- A. The CONTRACTOR shall base all measurements, both horizontal and vertical, from established benchmarks and monuments. The CONTRACTOR shall be responsible for field verification of all dimensions and conditions at the Site. The ENGINEER or OWNER'S AGENT shall provide to the CONTRACTOR both coordinates and elevations for monuments as shown on the Drawings.
- B. Should the CONTRACTOR discover any discrepancy between actual conditions and those indicated, which prevent following good practice or the intent of the Specifications and Drawings, the CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT, request clarification and instructions, and shall not proceed with Work until the CONTRACTOR has received the same from the ENGINEER or OWNER'S AGENT; provided that such wait does not unduly delay the progress of the Work.
- C. No claims shall be made for extra payment or extensions of the Contract completion time if the CONTRACTOR fails to notify the ENGINEER or OWNER'S AGENT of any discrepancy before proceeding with that aspect of that Work.

1.02 SUBMITTALS

In accordance with Section 01300 – SUBMITTALS and the Construction Quality Assurance/Quality Control (CQA/QC) Plan.

1.03 ACCESS AND DRAINAGE

- A. The CONTRACTOR shall keep all natural drainage and water courses unobstructed or provide equal courses effectively placed, and prevent accumulations of surface water. The CONTRACTOR shall construct, grade, and stabilize access roads and provide temporary mobilization, parking, storage and staging areas for its use during construction within the areas shown on the Drawings.
- B. Access roads and mobilization, parking, and storage areas shall be maintained in a stable and smooth condition throughout the life of the Contract.

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TEMPORARY FACILITIES AND CONTROLS

1.04 TEMPORARY SANITARY FACILITIES

The CONTRACTOR shall furnish and maintain the necessary temporary self-contained chemical type sanitary facilities in accordance with all applicable regulations. They shall be located near the points of Work and shall be cleaned daily and adequately serviced. The use of these facilities shall be available for the CONTRACTOR's employees as well as the OWNER'S AGENT and ENGINEER representatives and other project personnel on the Site. Separate sanitary facilities are required for men and women; these facilities must be clearly marked and reasonably maintained in a sanitary condition.

1.05 CONTRACTOR STORAGE AREA

- A. A storage area shall be designated by the ENGINEER or OWNER'S AGENT on the project site for use by the CONTRACTOR for storage of materials, tools, equipment, office and other items necessary for construction. The exact limits of the storage area will be designated in the field by the ENGINEER or OWNER'S AGENT. The CONTRACTOR shall be fully responsible for the preparation of this area, its maintenance, and its security including fencing, watchmen, and other means of security. Under no circumstances will the OWNER, OWNER'S AGENT, or ENGINEER be responsible for the security of any property belonging to the CONTRACTOR, its Subcontractors or any of its Work forces. The CONTRACTOR shall, upon completion of the project, return the storage area(s) to the original condition. All disturbed areas shall be repaired and covered with surface materials that match the existing adjacent materials; i.e., concrete, topsoil and grass, asphalt, etc.
- B. The fueling or servicing of any necessary equipment shall take place within the contractor storage area. Portable fueling methods shall be used unless otherwise approved by the ENGINEER or OWNER'S AGENT.

1.06 STAGING AREAS, STORAGE AND FIELD OFFICES

- A. The CONTRACTOR may, during the course of this project, stage construction, store materials, or erect temporary field offices only within the Limits of Disturbance shown on the Drawings or as otherwise approved by the ENGINEER or OWNER'S AGENT.
- B. Requirements for the field offices and utilities are specified in Section 01010 - SUMMARY OF WORK.

1.07 HANDLING AND DISPOSAL OF SITE WATER

- A. The CONTRACTOR shall furnish all labor, materials, and equipment necessary for the proper handling, collection, and on-site transport of

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TEMPORARY FACILITIES AND CONTROLS

water accumulated that is generated from stormwater, groundwater, dust control operations, or otherwise.

- B. Any stormwater or other ponded water encountered within the areas of excavation or disturbance with potentially impacted material exposed during construction activities shall be collected and transported in accordance with these Specifications.
- C. All waste fluids generated by the CONTRACTOR from decontamination activities, or otherwise, shall be properly contained, managed, and transported by the CONTRACTOR to an approved on-site storage location.
- D. The CONTRACTOR shall take the necessary measures; i.e., divert runoff from the work area, to minimize the quantity of water generated for disposal.

1.08 TRUCKING

- A. All trucks bringing to or removing from the Site, soil, loose materials or debris shall be loaded in a manner so as to prevent the dropping of materials on public or private off-site streets or roadways.
- B. At all points where trucks leave the project site and enter adjacent paved roadways, the CONTRACTOR shall provide and maintain a crew or other means necessary to prevent any mud or loose material from being carried onto such adjacent paved roadways.
- C. In the event that soil, loose materials or debris are deposited on to public or private streets or roadways on the egress side of the equipment decontamination station, the following actions shall take place:
 - 1. The truck shall return and go through the decontamination station again before proceeding off-site.
 - 2. No additional loads shall leave the site until the decontamination procedures are reviewed and necessary changes implemented to ensure that dropping or tracking of material and debris beyond the decontamination station does not occur.
 - 3. The soil, loose materials or deposited debris is to be immediately removed to avoid additional tracking and exposure.

1.09 EQUIPMENT DECONTAMINATION

- A. The CONTRACTOR shall decontaminate any equipment or materials that have contacted potentially hazardous substances (if any) prior to leaving

TEMPORARY FACILITIES AND CONTROLS

the area. Decontamination activities shall be performed in a designated location over a contained area such that all materials and contact water are properly contained. All decontaminated residual materials and contact water shall be tested and properly disposed in accordance with Part 1.08 of this Section.

- B. The CONTRACTOR shall provide all wash water required for the decontamination of equipment and personnel.
- C. Personnel decontamination procedures shall be followed by the CONTRACTOR as specified in the CONTRACTOR's Health and Safety Plan.
- D. Any solids and soils/sediments generated from the decontamination activities shall be considered impacted and disposed in accordance with Section 02250 – TRANSPORTATION AND DISPOSAL OF MATERIALS.

1.10 SECURITY

- A. Security for the purpose of this project will be defined as precautionary measures to ensure that equipment, tools, and materials are safe from vandalism, theft, or damage. The CONTRACTOR is responsible for the security of all equipment used and/or stored on the Site.
- B. The right of access to this Work area, whether it is in preparation or progress, shall be extended to the OWNER, OWNER'S AGENT and ENGINEER, as well as local authorities.
- C. The entrance of persons and vehicles into the Site shall only be permitted for authorized persons with proper identification.
- D. A list of authorized persons shall be maintained, and a copy submitted to the ENGINEER or OWNER'S AGENT upon request.
- E. CONTRACTOR is responsible for security of work progress and equipment until acceptance of work by the ENGINEER, OWNER'S AGENT and OWNER.

1.11 EROSION AND SEDIMENT CONTROL MEASURES

- A. Adequate control of erosion and sediment of both a temporary and permanent nature on areas disturbed by the Work shall be provided under this Specification and/or subject to the approval of the ENGINEER or OWNER'S AGENT. During the pre-construction walk-through, the CONTRACTOR and the ENGINEER or OWNER'S AGENT shall review

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TEMPORARY FACILITIES AND CONTROLS

the Erosion and Sediment Control Plan and details and shall determine additional specific sediment and erosion control requirements. All erosion and sediment control measures shall be provided and maintained until the Site is fully stabilized, as approved by the ENGINEER. Maintenance includes, but is not limited to, the clearing and removal of sediment accumulation in the ditches and silt fence; repair of any damaged or fallen erosion and sediment control components; and all other activities required to ensure proper performance of erosion and sediment control measures.

- B. Erosion control shall comply with all applicable State of Oregon and City of Portland regulations.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

(not used)

END OF SECTION

01500
TEMPORARY FACILITIES AND CONTROLS

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01600 – Material and Equipment

01600
MATERIAL AND EQUIPMENT

PART 1 - GENERAL

1.01 EQUIPMENT AND PRODUCTS SPECIFIED

- A. In various detailed Sections of these Specifications, certain items of equipment, materials, or products are specified by proprietary name or trade name and shall be used without exception. It is to be understood that these items are to be furnished by the CONTRACTOR as indicated in this Section and no substitutes will be allowed.
- B. In the various detailed Sections of these Specifications where any item of equipment or product is specified by proprietary name or trade name, with the addition of such expressions as "or equal", it is to be understood that equal quality equipment or products of either a manufacturer named or a manufacturer not named which meet the detailed requirements of the Specifications are subject to the approval of the ENGINEER or OWNER'S AGENT as to the equality thereof and in accordance with Section 01400 - QUALITY CONTROL.

1.02 STORAGE AND MAINTENANCE OF EQUIPMENT

- A. All equipment, materials, and products provided and Work performed under this Contract shall be protected from damage before and after installation. The CONTRACTOR shall be responsible for Work, equipment, materials, and products until inspected, tested, and finally accepted in accordance with this Section, the Contract Documents and all applicable warranties.
- B. During construction, and at the end of each working day or other period, the open ends of Work shall be effectively closed with temporary covers or plugs to prevent the entry of foreign material.
- C. Where permanent equipment called for under this Contract is installed before the erection of adequate protective structures, the CONTRACTOR without additional compensation therefore, shall provide approved, effective, and durable covers for fully protecting such equipment against damage from the elements or from any other causes.
- D. All machinery, equipment, piping, and accessories and appurtenances shall be adequately supported and safeguarded against all damage or injury during performance of Work under this Contract. The CONTRACTOR shall be responsible for all damage or injury resulting from its operations and shall repair such damage immediately and to the satisfaction of the ENGINEER or OWNER'S AGENT.

01600
MATERIAL AND EQUIPMENT

- E. The CONTRACTOR shall store and protect equipment, materials, and products in accordance with the manufacturer's recommendations and the requirements specified in these Specifications and shall submit the manufacturer's storage and maintenance instructions to the ENGINEER or OWNER'S AGENT prior to delivery.
- F. The CONTRACTOR shall make all arrangements and provisions necessary for the storage of equipment, materials, and products. All excavated material, construction equipment, and materials and equipment to be incorporated into the Work shall be placed so as not to injure any part of the Work or existing facilities, and so that free access can be achieved at all times to all parts of the Work and to all public utility installations in the vicinity of the Work. Equipment, materials, and products shall be kept neatly and compactly stored in locations that will cause a minimum of inconvenience to other contractors, public travel, adjoining owners, tenants, occupants, and the ENGINEER or OWNER'S AGENT'S personnel.
- G. Areas available on the project site for storage of equipment, materials, and products shall be as shown, specified, or designated and approved by the ENGINEER or OWNER'S AGENT. All equipment, materials, and products must be consigned to the CONTRACTOR directly. No delivery of equipment, materials, and products will be accepted by the ENGINEER or OWNER'S AGENT, and all expenses incurred by the ENGINEER or OWNER'S AGENT in handling equipment, materials, and products which have been consigned or directed to the ENGINEER or OWNER'S AGENT will be charged to the CONTRACTOR.
- H. Equipment, materials, and products which are to become the property of the OWNER and OWNER'S AGENT shall be stored to facilitate their inspection and ensure preservation of the quality and fitness of the Work, including proper protection against damage by freezing and moisture. They shall be placed inside storage areas, unless otherwise shown, specified, or acceptable to the ENGINEER or OWNER'S AGENT.
- I. CONTRACTOR shall be fully responsible for loss or damage to stored equipment, materials, and products.
- J. Any equipment, materials, or products which, in the opinion of the ENGINEER or OWNER'S AGENT, have been damaged due to improper storage and/or handling and is unfit for its specified or intended use shall be properly removed from the site or Work. The CONTRACTOR shall receive no compensation for the damaged equipment, material, or product or its removal or replacement.

01600
MATERIAL AND EQUIPMENT

- K. All materials delivered and stored on-site shall bear the manufacturer's trade names, labels, stamps, or other suitable identification clearly marked in a conspicuous place.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

(not used)

END OF SECTION

01600
MATERIAL AND EQUIPMENT

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01700 – Contract Closeout

01700
CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 DESCRIPTION

A. Clean-Up

Upon completion of the Work and before a Certificate of Substantial Completion is issued by the ENGINEER or OWNER'S AGENT to the CONTRACTOR, the Work site, storage areas, and other areas occupied by the CONTRACTOR during construction shall be cleaned, and all surplus and discarded materials, false Work, and rubbish placed thereon by the CONTRACTOR shall be removed by the CONTRACTOR. No separate payment will be made for clean-up as all such costs shall be included in the Bid.

B. Warranties and Guarantees

All Warranties and Guarantees shall be submitted to the ENGINEER or OWNER'S AGENT prior to the performance of Work or the delivery of materials to the Site. These Warranties and Guarantees will be referred to the OWNER or OWNER'S AGENT for review and approval of the Terms and Conditions. Upon completion of the Work and before a Certificate of Substantial Completion is issued by the ENGINEER or OWNER'S AGENT to the CONTRACTOR, all final Warranties and Guarantees shall be submitted to the ENGINEER or OWNER'S AGENT.

C. Record Documentation and "As-Built" Drawings

1. Upon Completion of the Work and before a Certificate of Substantial Completion is issued by the ENGINEER or OWNER'S AGENT to the CONTRACTOR, all "As-Built" documentation shall be completed and submitted to the ENGINEER or OWNER'S AGENT.
2. Project record documents include, but are not limited to the following:
 - a. Drawings;
 - b. Specifications;
 - c. Addenda;
 - d. Site Work Orders, field orders, and other modifications to the Contract,
 - e. Approved Shop Drawings;
 - f. Product data and samples;
 - g. Warranties and Guarantees;

01700
CONTRACT CLOSEOUT

- h. “As-Built” documentation; and,
 - i. Other approved documents submitted by the CONTRACTOR in compliance with these Specifications.
- 3. CONTRACTOR shall maintain, at the Site, one set of the following record documents; and record actual revisions to the Work.
 - a. Contract Drawings;
 - b. Specifications;
 - c. Addenda;
 - d. Change Orders and other Modifications to the Contract; and,
 - e. Reviewed Shop Drawings, product data, and samples.
- 4. CONTRACTOR shall store Record Documents separately from documents used for construction.
- 5. CONTRACTOR shall record information concurrent with construction progress.
- 6. Specifications: CONTRACTOR shall legibly mark and record at each product section the description of actual products installed, including the following:
 - a. Manufacturer’s name and product model and number;
 - b. Product substitutions or alternates utilized; and,
 - c. Changes made by Addenda and modifications.
- 7. Record Documents and Shop Drawings: CONTRACTOR shall legibly mark each item to record actual construction, including:
 - a. Field changes of dimension and detail.
 - b. Details not included on the Drawings.
- 8. CONTRACTOR shall submit the documents to the ENGINEER or OWNER’S AGENT with the claim for final Application of Payment.
- 9. CONTRACTOR shall maintain a daily log of Work performed/completed.
- 10. CONTRACTOR shall maintain a workers log.

01700
CONTRACT CLOSEOUT

1.02 CLOSEOUT PROCEDURES

- A. When the CONTRACTOR considers that the Work is substantially complete, it shall submit a written request that certifies that the Contract Documents have been reviewed, the Work has been inspected, and that Work is complete in accordance with the Contract Documents and is ready for the ENGINEER's or OWNER'S AGENT'S final inspection.
- B. CONTRACTOR shall provide to the ENGINEER or OWNER'S AGENT "As-Built" documentation, all submittals in accordance with Section 01300 - SUBMITTALS of the Technical Specifications, Warranties and Guarantees, and other submittals required by these Specifications or governing authorities prior to, or concurrent with the request for Certification of Substantial Completion.
- C. ENGINEER or OWNER'S AGENT shall, within a reasonable time after receipt of a written request from the CONTRACTOR, conduct an inspection to determine the status of completion. If ENGINEER or OWNER'S AGENT, determines that the Work is not complete, it shall notify CONTRACTOR in writing giving the reasons thereof. The CONTRACTOR shall remedy the deficiencies noted and submit a certification to the ENGINEER or OWNER'S AGENT for re-inspection.
- D. The CONTRACTOR shall submit project Record Documents to the ENGINEER or OWNER'S AGENT with the claim for final Application for Payment.
- E. Evidence of payment and release of liens shall be provided by the CONTRACTOR in accordance with the requirements provided in the Contract Documents, and is required prior to final payment.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

(not used)

END OF SECTION

01700
CONTRACT CLOSEOUT

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01740 – Warranties and Bonds

01740
WARRANTIES AND BONDS

PART 1- GENERAL

1.01 PROJECT MAINTENANCE AND WARRANTY

- A. Maintain in good repair the improvements covered by these Drawings and Specifications during the life of the Contract.
- B. Indemnify the OWNER and OWNER'S AGENT against any repairs which may become necessary to any part of the work performed and to items of equipment and systems procured of or furnished under this Contract, arising from defective workmanship or materials used therein, for a period of one (1) year after acceptance from the final date of final resolution of the OWNER'S AGENT accepting work.
- C. The CONTRACTOR shall not be obligated to make replacements which become necessary because of ordinary wear and tear, or as a result of improper operation or maintenance, or to perform any work which is normally performed by a maintenance crew during operation.
- D. In the event of multiple failures of major consequences prior to the expiration of the one-year warranty described above, the affected construction of installation shall be removed/disassembled, inspected, and repaired, modified or replaced as necessary to prevent further occurrences. As related components which may have been damaged or rendered non-serviceable as a consequence of the failure shall be replaced. A new twelve (12) month warranty against defective or deficient design, workmanship, and materials shall commence on the day that the item is reassembled and placed back into operation. As used herein, multiple failures shall be interpreted to mean two (2) or more successive failures of the same kind in the same item or failures of the same kind in two (2) or more items. Major failures may include, but are not limited to, an inadequate GWBW, including sand or slurry pockets, sloughing, subsidence, a non-vertical wall, non-continuous wall, or other deficiencies that would cause any part of the GWBW to not comply with the requirements herein; cracked or settled GWBW cap; failed erosion and sediment controls; or other occurrences that would result in any portion of the project to not comply with these Technical Specifications or Drawings. Should multiple failures occur in a given time, all products of the same size and type shall be disassembled, inspected, modified, or replaced, as necessary, and rewarranted for one year.
- E. The CONTRACTOR shall, at his own expense, furnish all labor, materials, tools, and equipment required and shall make such repairs and removals or shall perform such work or reconstruction as may be made necessary by any structural or functional defect or failure resulting from neglect, faulty workmanship, or faulty materials, in any part of the Work

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WARRANTIES AND BONDS

performed. Such repair shall also include refilling of trenches, excavations or embankments which show settlement or erosion after backfilling or placement.

- F. Except as noted on the Drawings or as specified, all structures such as embankments and fences shall be returned to their original condition prior to the completion of the Contract. Any and all damage to any facility not designated for removal, resulting from the CONTRACTOR's operations, shall be promptly repaired by the CONTRACTOR at no cost to the OWNER or OWNER'S AGENT.

- G. In the event the CONTRACTOR fails to proceed to remedy the defects of which he has been notified within fifteen (15) days of the date of such notice, the OWNER/OWNER'S AGENT reserves the right to cause the required materials to be procured and the work to be done, as described in the Drawings and Specifications, and to hold the CONTRACTOR and the sureties on his bond liable for the cost and expense thereof.

- H. Notice to the CONTRACTOR for repairs and reconstruction will be made in the form of a registered letter addressed to the CONTRACTOR at the contract-designated office.

- I. Neither the foregoing paragraphs nor any provision in the Contract Documents, nor any special guarantee time limit implies any limitation of the CONTRACTOR's liability with the law of the State of Oregon.
 - 1. Upon completion of the Work and before a Certificate of Substantial Completion is issued by the ENGINEER or OWNER'S AGENT to the CONTRACTOR, the Work site, storage areas, and other areas occupied by the CONTRACTOR during construction shall be cleaned, and all surplus and discarded materials, false Work, and rubbish placed thereon by the CONTRACTOR shall be removed by the CONTRACTOR. No separate payment will be made for clean-up as all such costs shall be included in the Bid.

PART 2- PRODUCTS

(not used)

PART 3- EXECUTION

(not used)

END OF SECTION

Division 2 – Site Work

02110 - Site Clearing

DIVISION 2 – SITE WORK

02110 SITE CLEARING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The Work covered by this Section consists of furnishing all equipment, tools, and labor necessary for clearing and grubbing of trees, brush, vegetation, and perishable material of whatever nature; Site preparation activities; removing existing structures, including concrete pads, footing, foundations, abandoned utilities, chain-link fence, railroad tracks, and other features; disconnection and removal of the overhead power line; capping and abandoning the designated subsurface utilities; abandoning the designated groundwater monitoring wells; and, preparing the Site for Work. All Work shall be performed in accordance with the limits set forth in the Drawings.
- B. Clearing of vegetation shall only occur to the extent that it is necessary to perform the Work. All materials that are cleared and/or removed shall be stockpiled on-site in accordance with the Contaminated Material Management Plan and addenda.

1.02 MATERIALS OWNERSHIP

Except for materials to be stockpiled for later reuse, CONTRACTOR shall temporarily store cleared materials in roll-off containers provided by the CONTRACTOR until such time that the materials are stockpiled on-site in accordance with the Contaminated Material Management Plan and addenda.

1.03 SUBMITTALS

In accordance with the provisions of these Contract Documents.

1.04 QUALITY ASSURANCE

- A. All materials procedures, operations, and methods shall be in strict conformance with the Drawings and Specifications, and shall be subjected to strict quality control monitoring as detailed in these Contract Documents and the Construction Quality Assurance/Quality Control (CQA/QC) Plan.
- B. The CONTRACTOR shall comply with all requirements of the Oregon Department of Environmental Quality (ODEQ), and other federal, state, and county regulatory agencies controlling environmental reviews and safety during construction.

02110
SITE CLEARING

PART 2 – PRODUCTS

(not used)

PART 3 – EXECUTION

3.01 PREPARATION

- A. The CONTRACTOR shall protect and maintain benchmarks and survey control points from disturbance during construction.
- B. The CONTRACTOR shall retain the services of a private utility locator for utility clearance at the Site prior to initiation of any ground disturbance at the Site including clearing, grading, and grubbing. Identified utilities shall be clearly identified with marking paint on the ground surface. Private utility clearance shall be used as an aid to identify private utilities located at the Site and shall not be used as a comprehensive survey of private site utilities. CONTRACTOR shall be responsible for supplemental means of utility identification and shall proceed with caution when performing the Work in a manner that will allow field identification of utilities not previously marked.
- C. Provide erosion control measures to prevent soil erosion and discharge of soil/sediment-bearing water runoff or airborne dust to adjacent properties and the Willamette River.
- D. Protect existing vegetation and structures to remain against damage.

3.02 SURFACE DEBRIS

- A. Prior to issuance of a Notice-to-Proceed, the OWNER'S AGENT will salvage any desired materials from the work areas, and so inform the CONTRACTOR.
- B. All unsalvaged surface debris, rubble, and other deleterious materials of a manmade nature that may be encountered within the limits of disturbance shall be removed and stockpiled on-site in accordance with all federal, state and local regulations.

3.03 CLEARING AND GRUBBING

- A. Clearing and grubbing shall be performed within the limits of disturbance as indicated on the Drawings and only in those areas that require

02110
SITE CLEARING

construction activity, such as excavation, filling, removal activities, and construction access. Clearing and grubbing shall be performed in such a fashion as to minimize as much as possible the overall disturbance to the Site.

- B. In the areas to be cleared and grubbed, all trees, stumps, roots, brush, and other vegetation and objectionable organic material shall be removed. Material to be grubbed shall be removed to a depth of not less than 6 inches below the surface elevation of the ground.
- C. All trees, logs, brush, crops, grasses, and debris of all kinds, both standing and fallen, shall be cleared, grubbed, and disposed in accordance with Part 3.06 of this Section without damage to adjoining property.
- D. Areas outside of the limits of clearing shall be protected from damage and no equipment or materials shall be stored or Work performed in those areas. Wherever possible, equipment and materials shall be stored in an area of the site with a stabilized surface as indicated on the Drawings.

3.04 REMOVAL OF EXISTING STRUCTURES

- A. The CONTRACTOR shall disconnect and remove necessary sections of the overhead power line as presented on the Drawings to ensure that the Work is conducted in a safe manner. The CONTRACTOR shall coordinate with the appropriate utility prior to disconnection. If excavation is to be required, it shall be in accordance with Section 02200 – EARTHWORK of these Specifications.
- B. The CONTRACTOR shall remove existing chain-link fencing, as necessary, to facilitate installation of the groundwater barrier wall. The CONTRACTOR shall install a temporary security fence in accordance with Section 02831 – CHAIN LINK FENCES AND GATES to maintain a continuous, secure perimeter throughout construction.
- C. The CONTRACTOR shall remove segments of railroad track, as necessary, to facilitate installation of the groundwater barrier wall.
- D. The CONTRACTOR shall remove sections of asphalt or concrete pavement, as necessary, to facilitate installation of the groundwater barrier wall. Saw cutting, or other approved method, shall be used to achieve a neat and uniform section for removal.

3.05 UTILITY ABANDONMENT

- A. The CONTRACTOR shall cut and cap and/or plug (isolate) all subsurface utilities intersecting the proposed groundwater barrier wall alignment.

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SITE CLEARING

The segment of the pipeline intersecting the groundwater barrier wall shall be cut and removed to facilitate barrier wall construction. The remaining ends of the upgradient and downgradient segments of the pipe shall be capped and/or plugged to form a water tight seal prohibiting future flow into the pipe ends. These utilities include unused process lines, storm sewer drains, water lines, steam, and other pipelines. Known utilities within the vicinity of the proposed groundwater barrier wall are depicted on the Drawings.

- B. Utility pipes designated for removal shall be tapped and the contents inspected prior to cutting and removing the segment of pipe. If liquids are present, the CONTRACTOR shall drain the pipe to facilitate capping and/or plugging the pipe. The CONTRACTOR shall capture and store all recovered liquids in an appropriate container and transport the container to the designated on-site storage location.
- C. Releases to the subsurface or surrounding work area of liquids recovered from the piping will be immediately remediated by the CONTRACTOR. Excessive release will be remediated by the CONTRACTOR with no additional cost to the OWNER'S AGENT.
- D. Pipe tapping and dismantlement will be performed with non-sparking methods and equipment to prevent explosion and fire. Pipe tapping, drainage, and dismantlement will be performed in accordance with protocols prepared by the CONTRACTOR and approved by the ENGINEER.
- E. Dismantling and removal of piping shall be conducted in a manner as to prevent the migration of dust, fluids, contaminants, and debris outside of the work area.
- F. The utilities shall be abandoned in a manner that prohibits slurry and soil-bentonite backfill from entering the conduits during groundwater barrier wall installation.

3.06 WELL ABANDONMENT

- A. The CONTRACTOR shall abandon groundwater monitoring wells in accordance with OAR Section 690 Division 240. The groundwater monitoring wells to be abandoned are designated on the Construction Drawings.
- B. CONTRACTOR shall inspect the entire length of the well and remove all equipment such as pumps, pressure lines, etc. that may obstruct the placement and performance of the sealing agent.

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SITE CLEARING

- C. Wells shall be abandoned by completely redrilling the borehole to a minimum of the original diameter. All casing, annular sealing material, drill cuttings, debris, and filter pack material shall be removed prior to sealing. Grout slurries shall be placed from the bottom up by a tremie pipe to avoid segregation or dilution of the sealant. The discharge end of the tremie pipe shall be submerged in the grout to avoid breaking the seal while filling the annular space.
- D. The CONTRACTOR shall record the specifics of the abandonment, such as location and procedure, and submit the abandonment report to the ENGINEER and to other appropriate agencies.
- E. Well sealant shall be PureGold®, or approved equivalent, consisting of a smooth grout slurry mixed from granular sodium bentonite.

3.06 DISPOSAL OF MATERIALS

- A. General refuse and construction debris that accumulates during the course of construction shall be disposed in separate containers supplied by the CONTRACTOR. Refuse shall be accumulated and disposed periodically.
- B. All trees, brush, limbs, and other yard waste materials shall be chipped directly into designated containers provided by the CONTRACTOR for disposal on-site. No chipping equipment shall discharge directly to the ground. Chipping equipment shall be supplied by the CONTRACTOR.

END OF SECTION

02110
SITE CLEARING

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02200 – Earthwork

02200
EARTHWORK

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Work covered by this Section consists of furnishing all materials, labor, tools, equipment and transportation necessary for all construction as it pertains to the excavating, handling, stockpiling, backfilling, compacting and grading of earthwork. The Work includes all hauling, stockpiling, covering, wetting or drying, dewatering, conditioning, compacting and other operations pertaining thereto for constructing and preparing the earthwork complete in accordance with these Specifications and Drawings, or as directed by the ENGINEER or OWNER'S AGENT.
- B. The Work shall include, but not be limited to, the following activities:
1. Construction of earthen berms, ditches and/or swales, and other measures for management of surface water flow;
 2. Hauling, conditioning, stockpiling, and management of soils removed for installation of the clearance trench and groundwater barrier wall;
 3. Excavations and backfilling of soils or trench spoils associated with any portion of the Work required herein, including the clearance trench;
 4. Furnishing, preparing, hauling, testing, placing, and compacting common fill;
 5. Furnishing, preparing, hauling, testing, placing, and compacting clay;
 6. Site grading;
 7. Stockpiling and managing materials throughout Work;
 8. Dust control; and,
 9. Dewatering, transportation, and on-site management, storage, and discharge of any accumulated stormwater runoff and groundwater within excavations.
- C. No soils, debris, or liquids shall be removed from the Site unless otherwise instructed or approved by the ENGINEER or OWNER'S AGENT. The CONTRACTOR shall store, characterize, decontaminate, transport, dispose of, and otherwise manage all materials in accordance with these Specifications and the Contaminated Material Management Plan, (CMMP), included as Attachment 1.
- D. All soil types shall consist of materials approved by the ENGINEER or OWNER'S AGENT from off-site sources or from the clearance trench excavation, as approved for reuse. During construction, the construction area shall be well drained. No materials shall be backfilled when either the material or the surfaces on which it is to be placed are frozen, subject

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EARTHWORK

to standing water, or excessively wet or soft, unless otherwise specified by the ENGINEER or OWNER'S AGENT. When the Work is interrupted by heavy precipitation or freezing temperatures, fill operations shall not be resumed until the ENGINEER or OWNER'S AGENT determines that the moisture content, density and integrity of the previously-placed soils are as specified.

- E. All soils shall be removed to the limits and depths as specified on the Drawings and Specifications.

1.02 DEFINITIONS

- A. "Common Fill" includes all soils utilized as supplemental fill to backfill excavations or construct earthen berms or other engineered structures, as required.
- B. "Clay" includes those clean soils required for the low permeability layer of the soil cap to be installed above the groundwater barrier wall. The soil shall exhibit a laboratory-tested permeability of less than or equal to 1×10^{-5} centimeters per second (cm/sec).
- C. "Trench Spoils" includes all excavated materials generated from the excavation of the clearance trench.
- D. "Impacted Spoils" includes those soils existing within the extent of the clearance trench, groundwater barrier wall, or elsewhere that are observed to be contaminated, as determined by the ENGINEER or OWNER'S AGENT.
- E. "Obstructive Debris" includes those materials encountered during the Work that would interfere or obstruct the installation of the groundwater barrier wall.
- F. "Subbase" includes the existing soil or materials which have been prepared as a foundation for common fill, aggregate, or other fill material.

1.03 REFERENCES

- A. ASTM D-422 Particle-Size Analysis of Soils
- B. ASTM D-698 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5 Pound Rammer and 12-inch Drop
- C. ASTM D-2216 Standard Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures

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EARTHWORK

- D. ASTM D-2487 Classification of Soils for Engineering Purposes
 - E. ASTM D-6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
 - F. ASTM D-4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils
 - G. ASTM D-2974 Organic Content of Soils
 - H. ASTM D-1556 Test Method for Density of Soil In Place by Sand-Cone Method
 - I. ASTM D-1557 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 Pound Rammer and 18-Inch Drop
 - J. ASTM D-5084 Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
 - K. EPA 9095-A Paint Filter Liquids Test
- 1.04 QUALITY ASSURANCE
- A. All materials, procedures, operations, and methods shall be in strict conformance with the Drawings and Specifications, and shall be subject to strict quality control monitoring as detailed herein and in the Construction Quality Assurance/Quality Control (CQA/QC) Plan. The backfilled soils shall conform exactly to the Drawings and Specifications, except as otherwise authorized in writing by the ENGINEER or OWNER'S AGENT.
 - B. The CONTRACTOR shall comprehend and anticipate construction quality assurance activities by the ENGINEER or OWNER'S AGENT, or others, and account for these activities in the installation schedule.
- 1.05 SUBMITTALS
- A. The CONTRACTOR shall submit to the ENGINEER or OWNER'S AGENT for review a Work Plan proposing methods of excavation, separation of materials (i.e., obstructive debris from trench spoils), backfilling and compaction in the clearance trench, proper staging, conditioning, dewatering, and sequencing for the various portions of the Work. Review shall be for method only. The CONTRACTOR shall remain fully responsible for the adequacy and safety of the methods proposed.

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EARTHWORK

- B. The CONTRACTOR shall submit to the ENGINEER or OWNER'S AGENT a stockpiling and staging plan for all Work, including soils, trench spoils, obstructive debris, and other materials prior to the commencement of earthwork activities. The plan shall indicate the location and contents of each stockpile. Generalized locations for soil stockpiles are as designated on the Drawings; the final stockpiling plan is subject to the approval of the ENGINEER or OWNER'S AGENT.
- C. The CONTRACTOR shall submit a 50-pound sample from each of the off-site borrow sources proposed to furnish the required quantity of fill materials. The samples shall be submitted to the ENGINEER or OWNER'S AGENT no less than two (2) weeks prior to the anticipated placement of any soil materials.
- D. The CONTRACTOR shall submit the location of all off-site borrow sources and the results of the tests listed below to the ENGINEER or OWNER'S AGENT no less than two (2) weeks prior to the anticipated placement of any soil materials.
- E. The CONTRACTOR shall submit the results of the ASTM tests listed below for each borrow pit location and designated fill classification to verify that the soil materials meet the technical requirements of this Section.

PARAMETER	ASTM TEST METHOD	FREQUENCY FOR CQC TESTING	FILL CLASSIFICATION
Moisture Content	D-2216	One per 2,000 cy or each change in Material Type	Common Fill and Clay
Soil Classification	D-2487	One per 2,000 cy or each change in Material Type	Common Fill and Clay
Particle-Size Analysis with Hydrometer	D-422	One per 2,000 cy or each change in Material Type	Common Fill and Clay
Atterberg Limits	D-4318	One per 2,000 cy or each change in Material Type	Common Fill and Clay
Modified Proctor	D-1557	One per 2,000 cy or each change in Material Type	Common Fill and Clay
Standard Proctor	D-698	One per 2,000 cy or each change in Material Type	Trench Spoils
Hydraulic Conductivity	D-5084	One per 2,000 cy or each change in Material Type	Clay

02200
EARTHWORK

The test results shall be submitted to the ENGINEER or OWNER'S AGENT no less than one week prior to the anticipated placement of any general fill materials furnished from off-site.

1.06 SOIL TESTING

- A. Prior to the general placement of the fill, and during such placement, the ENGINEER or OWNER'S AGENT shall select areas within the limits of the fill for testing the degree of compaction obtained. The CONTRACTOR shall be responsible for the cost of all quality control testing. The CONTRACTOR shall cooperate fully to allow the ENGINEER or OWNER'S AGENT to perform supplemental quality assurance testing.
- B. Payment for any in-place quality assurance testing verification will be made by the OWNER or OWNER'S AGENT. If the results are unsatisfactory, all costs involved in correcting deficiencies in compacted materials to the satisfaction of the ENGINEER or OWNER'S AGENT and any additional costs for retesting will be borne by the CONTRACTOR.
- C. The testing frequency required in Paragraph 1.05 of this Section may be increased at the discretion of the ENGINEER or OWNER'S AGENT when visual observation or construction performance indicates a potential problem.

PART 2 – MATERIALS

2.01 COMMON FILL SOILS

Common fill soils shall consist of mineral soil substantially free from organic materials, loam, wood, trash, and other objectionable materials which may be compressible or which cannot be properly compacted. Common fill soils shall not contain stones larger than two (2) inches in largest diameter and shall be classified according to the Unified Soil Classification System (USCS) as SM, SC, SC-SM, ML-CL, ML, or CL. Common fill soils shall have a maximum plasticity index of 40. Common fill soils shall not contain granite blocks, broken concrete, masonry, rubble, or other similar materials. It shall have physical properties such that it can readily spread and be compacted during filling. Snow, ice, and frozen soil shall not be permitted. Common fill soils shall be used as backfill for excavated areas. Common fill soils shall be procured from a commercial soil borrow site.

2.02 CLAY

Clay soils shall consist of mineral soil substantially free from organic materials, loam, wood, trash, and other objectionable materials which may be compressible

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or which cannot be properly compacted. The material shall be classified according to the Unified Soil Classification System (USCS) as SM, SC, ML, CL, ML-CL, MH, or CH. The material shall have a minimum plasticity index of 10; 100 percent of the particles having a dimension less than two (2) inches; a maximum of 10 percent of the particles, by weight, greater than 0.75 inches in greatest dimension; and, a minimum of 25 percent of the particles, by weight, having a maximum dimension less than 0.002 millimeters. Clay soil shall not contain granite blocks, broken concrete, masonry rubble, sound rock, or other similar materials. Snow, ice, and frozen soil shall not be permitted. The clay soil shall have a maximum laboratory-tested hydraulic conductivity of 1×10^{-5} cm/sec. Clay shall be procured from a commercial soil borrow site.

PART 3 – EXECUTION

3.01 GENERAL

- A. Prior to earthwork activities, the Site shall be prepared in accordance with Section 02110 – SITE CLEARING.
- B. Wet, soft, frozen or otherwise unsuitable subgrade, shall be allowed to dry, prior to any grading or backfilling activities, and as approved by the ENGINEER or OWNER'S AGENT. If a firm subgrade foundation is not achieved, the subbase soils shall be excavated and backfilled with common fill soils so that fill materials will ultimately be placed on a firm foundation.
- C. All excavations shall be cut accurately within the lines and limits shown on the Drawings or otherwise as directed by the ENGINEER or OWNER'S AGENT. All roots, stumps, rock and foreign matter in the sides and bottom of excavations shall be removed. Excavations and filling shall conform to the slope, grade, and shape of the section shown. Care shall be taken not to excavate below the grades indicated, unless otherwise approved by the ENGINEER or OWNER'S AGENT. Excessive excavation shall be backfilled to grade with suitable fill material as directed by the ENGINEER or OWNER'S AGENT with no additional cost to the OWNER/OWNER'S AGENT. Any required shoring activities shall be conducted in accordance with local, state and federal codes, and as approved by the ENGINEER or OWNER'S AGENT. All trenches ditches, and structures excavated under this Section shall be maintained until final acceptance of the Work.
- D. Neighboring on-site and off-site structures, utilities, roadways, sidewalks, the Willamette River, and other facilities shall be protected from damage caused by settlement, lateral movement, undermining, wash-out and other hazards created by the earthwork operations or delivery of fill materials.

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The CONTRACTOR shall be responsible for retaining engineering services required to perform the scope of work established in the Contract Documents, including, but not limited to, design and/or verification of groundwater barrier wall alternatives; engineered shoring, bracing, and support; or, other such matters that require engineering expertise. Associated drawings and calculations shall be prepared and sealed by an Oregon Professional Engineer retained by the CONTRACTOR (herein referred to as CONTRACTOR's Engineer).

E. Pumping and Drainage

1. At all times during construction, and up to the point of actual turnover to OWNER'S AGENT, the CONTRACTOR shall provide and maintain proper equipment and facilities to prevent all surface-water from entering excavations, and keep such excavations dry so as to obtain a satisfactory undisturbed subgrade foundation condition until the fill soils to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural levels. Where required, design of an appropriate dewatering system will be the responsibility of the CONTRACTOR, submitted to the ENGINEER or OWNER'S AGENT for review prior to commencing Work.
2. Dewatering shall be conducted in such a manner as to remove all water associated with the naturally occurring groundwater table and surface water runoff that has entered the depressed areas.
3. Water entering the limits of the work area from surface runoff shall be re-directed, via berms or ditches, around the perimeter of the excavation, and discharged to stable ground such that no erosion occurs at the point of discharge.
4. Groundwater, or surface water that enters an excavation, shall not be discharged, or permitted to flow, off-site. These fluids that are collected during dewatering operations shall be contained. If the fluids are not re-used in the GWBW trench, they shall be tested and disposed in accordance with these Specifications, or as approved by the ENGINEER or OWNER'S AGENT.
5. Removal of dewatering equipment shall be accomplished after the system is no longer required; the material and equipment constituting the system shall be removed by the CONTRACTOR.

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6. All precautions necessary to preclude the accidental discharge of fuel, oil, etc., shall be taken in order to prevent adverse effects on surface water or groundwater quality.
 7. Prior to backfilling stockpiled or off-site common borrow, the areas to be backfilled shall be fully excavated as required and rough graded in accordance with the Contract Documents. Wherever directed by the ENGINEER or OWNER'S AGENT, any soft boggy, organic, or otherwise unsuitable material shall be excavated so that backfill material will be placed on a firm foundation. The use of explosives shall not be permitted in the performance of site excavation.
 8. The CONTRACTOR shall be responsible for maintaining a dry excavation at all times and shall be responsible for providing the necessary equipment to maintain dry excavations. The CONTRACTOR is advised that any water removed from excavations shall be managed as contaminated water, unless otherwise approved by the ENGINEER or OWNER'S AGENT.
 9. Groundwater, or surface water that enters an excavation, shall not be discharged, or permitted to flow, off-site. These fluids that are collected during dewatering operations shall be contained. If the fluids are not re-used in the GWBW trench, they shall be transported to the designated on-site storage location.
- F. If the moisture content of any fill material is outside the accepted range to be returned to the excavation, the soil shall be wetted or dried, as appropriate.
1. Fill material that is too wet to permit compaction shall be removed and stockpiled, or spread and allowed to dry. Drying may be assessed by disking, harrowing, or pulverizing until moisture content is reduced to a satisfactory level.
 2. Fill material that is too dry shall be wetted uniformly so as to prevent free water appearing on the surface during or subsequent to compaction operations.
- G. Any delays in progress due to the necessary wetting or drying of soil are the responsibility of the CONTRACTOR.
- H. Soils placed in fill areas shall be graded to smooth true lines, strictly conforming to grades indicated on the Drawings, or otherwise approved by the ENGINEER or OWNER'S AGENT.

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- I. The CONTRACTOR shall subcontract a Professional Land Surveyor registered in the State of Oregon to certify that all soil material has been placed to the lines, grades, and elevations presented on the Drawings. The CONTRACTOR may use in-house personnel for the certifications, provided the certification is performed by a surveyor registered in the State of Oregon.
- J. Fill materials shall be placed in such a manner as to facilitate drainage at all times. Ponding of surface-water runoff shall not be permitted.
- K. If compaction or other tests indicate that any portion of the Work does not meet the specified requirements, then the CONTRACTOR shall remove that section, replace and recompact at no additional cost to the OWNER or OWNER'S AGENT. Determinations of the extent of removal and the acceptability of the in-place fill materials shall be made by the ENGINEER or OWNER'S AGENT.
- L. If significant precipitation causes wet conditions, placement and compaction activities shall be terminated until the conditions have dried sufficiently to continue according to the ENGINEER or OWNER'S AGENT.
- M. Equipment or vehicles shall not be allowed to travel in a single track or form ruts. Any ruts or irregularities formed shall be scarified and re-compacted by the CONTRACTOR at its expense as required and directed by the ENGINEER or OWNER'S AGENT.
- N. Prior to backfilling fill materials, the areas shall be prepared in accordance with the Specifications. The existing soils shall be proof-rolled to achieve a compact, uniform grade, and the surface shall be free of stones, roots, or other debris.
- O. Inspection
 - 1. Prior to implementing any of the Work in this Section, the CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the Work of this Section may properly commence without adverse impact.
 - 2. If the CONTRACTOR has any concerns regarding the installed Work of other Sections, CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT in writing. Failure to notify the ENGINEER or OWNER'S AGENT prior to conducting Work within this or other Sections will be construed as CONTRACTOR's acceptance of the related Work of all other applied Sections.

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- P. The CONTRACTOR shall protect on-going and completed work from precipitation, excessive heat, freezing, and other elements to avoid compromising the integrity of prior Work. Prior Work affected by such conditions shall be repaired by the CONTRACTOR at no additional cost to the OWNER or OWNER'S AGENT.
- Q. The CONTRACTOR shall provide erosion-control measures to prevent erosion or displacement of soils, or other Work materials, and discharge of sediment-laden runoff or airborne dust to adjacent properties or water bodies.

3.02 TRENCH SPOILS DEWATERING AND CONDITIONING

- A. Conditioning of excess spoils generated during groundwater barrier wall installation shall be performed, as necessary, to meet the moisture requirements for on-site disposal of non-liquid waste; i.e., pass the Paint Filter Liquids Test, and/or achieve non-hazardous characterization, at the direction of the ENGINEER or OWNER'S AGENT, in accordance with the CMMP. Conditioning may include air drying, blending with clean soils, blending with reagents; e.g. lime or cement kiln dust (CKD), or other conditioning methods approved by the ENGINEER or OWNER'S AGENT. The CONTRACTOR shall submit the methods for conditioning to the ENGINEER or OWNER'S AGENT for review prior to commencement of Work. All conditioning shall be performed in the area of the spoils to be conditioned or on a designated area lined with a minimum 30-mil PVC geomembrane. No conditioning shall be performed in an area where impacted spoils could intermingle with clean or other materials.
- B. The CONTRACTOR shall condition the excavated materials, as necessary, using the methods described in Part 3.02 A, to enable proper management; i.e., handling, hauling, and disposal of the materials and to ensure that the materials to be disposed are solids rather than liquids. The CONTRACTOR shall perform a Paint Filter Liquids Test in accordance with the USEPA's test method, Method 9095A. In accordance with this method, if any portion of the test materials collect in the cylinder during the 5-minute test period, the material is deemed to contain free liquids, and therefore, the CONTRACTOR shall further condition the materials and re-test.
- C. The CONTRACTOR shall include in the Work Plan, as required in Part 1.05 A, the procedure for conditioning of the waste materials for review and approval by the ENGINEER or OWNER'S AGENT. Acceptable methods for conditioning include, but are not limited to, air drying, mixing

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with soil, mixing with lime, and mixing with other agents, as approved by the ENGINEER or OWNER'S AGENT.

3.03 EXCAVATION

- A. A clearance trench shall be excavated in the location depicted on the Drawings to facilitate installation of the groundwater barrier wall. The clearance trench shall have a minimum bottom width of three feet.
- B. Excavation shall be made to the depths shown on the Drawings. Care shall be exercised when removing soil as to prevent over-excavation.
- C. All excavation activities shall be conducted in compliance with all applicable OSHA regulations. All excavations shall be conducted in a safe and stable manner. The slopes of the excavation shall be stable at all times. The CONTRACTOR is responsible for the design and installation of temporary shoring, if required.
- D. If unsuitable subgrade materials are uncovered during excavation or otherwise, it shall be removed, stockpiled for conditioning, disposal, replaced, compacted, and graded with common fill, as required and approved by the ENGINEER or OWNER'S AGENT.
- E. Unsuitable subgrade materials shall be removed and managed as directed in Paragraph 3.06 of this Section.
- F. Excavation of materials shall be accomplished using properly sized hydraulic excavators or equivalent. The equipment will operate so as to eliminate the potential for spreading contamination onto uncontaminated areas or surfaces.
- G. Obstructive debris encountered during clearance trench excavation and groundwater barrier wall construction shall be segregated and stockpiled on-site, in accordance with the CMMP. Obstructive debris includes those materials that, in the opinion of the ENGINEER or OWNER'S AGENT, may impact or obstruct the construction of the groundwater barrier wall (e.g. objects with a dimension greater than the thickness of the groundwater barrier wall).
- H. Impacted spoils encountered during clearance trench excavation and groundwater barrier wall construction shall be segregated and stockpiled on-site, in accordance with the CMMP. Impacted spoils include those materials that exhibit visual gross contamination, as determined by the ENGINEER or OWNER'S AGENT. The CONTRACTOR shall stage impacted spoils on minimum 30-mil PVC geomembrane.

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3.04 APPROVAL OF SUBGRADE

- A. CONTRACTOR shall notify ENGINEER or OWNER'S AGENT when excavations have reached required subgrade, or when the waste materials have been removed, to the extent practical, from a specific location.
- B. If ENGINEER or OWNER'S AGENT determines that unsatisfactory soil materials are present, the CONTRACTOR shall continue excavation and replace with acceptable backfill material, as directed.
- C. Where accessibility permits; i.e., all locations except on side slopes equivalent to three (3) horizontal to one (1) vertical or steeper, proof-roll subgrade, including all waste materials, with heavy loaded tandem to identify soft pockets and areas of excess yielding, otherwise, compact subgrade by other methods approved by ENGINEER or OWNER'S AGENT. Clearance trench spoils shall be backfilled and compacted in accordance with the procedures presented in Paragraph 3.05 of this Section.
- D. CONTRACTOR shall reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the ENGINEER or OWNER'S AGENT.

3.05 BACKFILLING

- A. With the exception of large debris and impacted soils, as determined by the ENGINEER or OWNER'S AGENT, trench spoils removed during clearance trench excavation shall be placed back in the excavation and compacted as specified in Part 3.05 F of this Section. It is the CONTRACTOR's responsibility to compact the trench spoils to the extent necessary, but at a minimum compliant with Part 3.05 F, to ensure that sloughing, sliding, or buckling will not occur during subsequent groundwater barrier wall installation through the backfill.
- B. Final grade shall be backfilled to the contours and elevations indicated on the Drawings, or as directed by the ENGINEER or OWNER'S AGENT. Grading and placement of the various materials shall be in conformity with the tolerances specified in this Specification.
- C. Common Fill
 - 1. Common fill material shall meet the requirements of Part 2.01 of this Section.
 - 2. Common fill material used as supplemental fill to backfill the clearance trench shall be placed and compacted as specified in Part

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3.05 F of this Section; otherwise, common fill shall be placed and compacted as specified below.

3. Common fill shall be placed in a maximum loose lift of approximately nine (9) inches resulting in a maximum compacted lift of approximately six (6) inches. Compaction shall be accomplished by designated compaction equipment with a minimum weight of 40,000 lbs. Compaction equipment weighing less than 40,000 lbs may be used if the CONTRACTOR can demonstrate that the equipment can achieve the required compaction results and the equipment is approved by the ENGINEER or OWNER'S AGENT.
4. Common fill shall be compacted to 90 percent of maximum dry density obtainable, as determined by ASTM D-1557. The fill shall be compacted within a range of 1 percent below to 3 percent above the optimum moisture content, as determined by ASTM D-1557.
5. A maximum 5 percent of all field moisture content test results are permitted outside the specified range. The outliers are, however, not permitted to be concentrated in one lift or one area, and no moisture content shall be less than 2 percent or more than 4 percent of the optimum moisture content. The areal extent is at the discretion of the ENGINEER or OWNER'S AGENT.
6. A maximum 5 percent of all field dry density test results are permitted outside the specified range. The outliers are, however, not permitted to be concentrated in one lift or one area, and no dry density less than 87 percent as determined by ASTM D-1557 is permitted. The areal extent is at the discretion of the ENGINEER or OWNER'S AGENT.
7. If the criteria set forth in (4) and (5) of this part have been exceeded, the CONTRACTOR shall remove the failing common fill and replace, compact and grade new, acceptable fill at no cost to the OWNER'S AGENT.

E. Clay

1. Clay material shall meet the requirements of Part 2.02 of this Section.
2. The maximum final compacted thickness of each lift of clay material shall be six (6) inches. Compaction shall be accomplished with a sheepsfoot roller or similar equipment approved by the

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ENGINEER or OWNER'S AGENT. The final grade of all clay material shall be uniform.

3. Clay shall be compacted to 90 percent of maximum dry density obtainable, as determined by ASTM D-1557. The fill shall be compacted within a range of 1 percent below to 3 percent above the optimum moisture content, as determined by ASTM D-1557.
4. A maximum 5 percent of all field moisture content test results are permitted outside the specified range. The outliers are, however, not permitted to be concentrated in one lift or one area, and no moisture content shall be less than 2 percent or more than 4 percent of the optimum moisture content. The areal extent is at the discretion of the ENGINEER or OWNER'S AGENT.
5. A maximum 5 percent of all field dry density test results are permitted outside the specified range. The outliers are, however, not permitted to be concentrated in one lift or one area, and no dry density less than 87 percent as determined by ASTM D-1557 is permitted. The areal extent is at the discretion of the ENGINEER or OWNER'S AGENT.
6. If the criteria set forth in (4) and (5) of this part have been exceeded, the CONTRACTOR shall remove the failing clay and replace, compact and grade new, acceptable clay at no cost to the OWNER or OWNER'S AGENT.

F. Trench Spoils

1. Prior to excavation and backfill of the clearance trench, the CONTRACTOR shall select an area, with the approval of the ENGINEER or OWNER'S AGENT, to construct a minimum 15-foot long by 15-foot wide by 12-inch thick compaction test pad. The purpose of the test pad is to evaluate the compactive effort required when placing the trench spoils in the clearance trench. A test pad shall be constructed for each source or change in materials.
2. The CONTRACTOR shall test the in-place density and moisture content of the test pad by nuclear methods in accordance with ASTM D-6938. The CONTRACTOR shall conduct a minimum of one density and moisture content test.
3. If the test results meet or exceed the criteria set forth herein, backfilling of the clearance trench may commence. If the test results fail, the test pad shall be removed and reconstructed by modified construction techniques, as approved by the ENGINEER

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or OWNER'S AGENT. The reconstructed test pad shall be retested in accordance with this Section.

4. The trench spoils shall be placed in a maximum loose lift of approximately 12 inches. Compaction shall be accomplished using a tamping plate attachment on an excavator or backhoe bucket, or as otherwise approved by the ENGINEER or OWNER'S AGENT.
5. The trench spoils shall be compacted to a minimum of 90 percent of the maximum dry density obtainable, as determined by ASTM D-698.
6. Upon meeting or exceeding the criteria set forth herein, the trench spoils shall be placed and compacted using the same equipment and methodology as that required in construction of the test pad.

3.06 EXCESS MATERIALS

- A. All general waste or debris (i.e. material not designated for on-site disposal in the CMMP) shall be containerized on-site and periodically disposed off-site in accordance with these Specifications.
- B. Suitable materials, as determined by tests discussed in these Specifications, shall be classified and stockpiled in approved areas for immediate or future use.
- C. Stockpiles shall be graded to drain; no surface-water ponding is permitted on stockpiles. Stockpiles shall be covered with plastic sheeting or other material to preserve the soil integrity. Proper erosion controls; i.e., silt fence, shall be installed at the perimeter of the stockpile.
- D. Stockpiles that are not used for more than 14 days shall be covered as discussed in Paragraph 3.06 C, or be temporarily vegetated in accordance with these Specifications.
- E. Obstructive debris, excess or impacted spoils, and other unsuitable materials that are not replaced as backfill into the clearance trench shall be stockpiled on a minimum 30-mil geomembrane that is continuously seamed. The material shall also be covered to provide a protective envelope to prevent contact with any precipitation or surface water runoff. Obstructive debris and excess or impacted spoils shall be disposed on-site, as approved by the ENGINEER or OWNER'S AGENT. All activities shall comply with the Contaminated Material Management Plan.

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3.07 GRADING

- A. Uneven areas and low spots which may develop in the backfilling operations shall be eliminated via minor excavations or placement of appropriate fill materials. Levels, profiles and contours of the final site configuration shall be maintained as established on the Drawings.
- B. The areas to be backfilled shall be uniformly graded to within the limits of grading under this Section. A smooth finished surface shall result within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades to the satisfaction of the ENGINEER or OWNER'S AGENT.
- C. Constructed slopes shall be blended into existing undisturbed areas gradually in order to provide neat, clean transition zones. Feathering of constructed slopes into existing grades shall be accomplished to promote natural drainage and to eliminate possible surface-water ponding.
- D. The right is reserved by the ENGINEER or OWNER'S AGENT to make minor adjustments or revisions in lines or grades if found necessary as the Work progresses, due to discrepancies on the Drawings or in order to obtain satisfactory construction. Any suspected discrepancies shall be reported to the ENGINEER or OWNER'S AGENT as soon as detected.

3.08 CRITERIA AND TOLERANCES

- A. Compaction and moisture criteria and tolerances are discussed in Part 3.05 of this Section.
- B. Final soil grades shall be within two tenths of one (0.2) foot below to five tenths of one (0.5) foot above (-0.2 to +0.5) the grades and contours indicated on Drawings, or as indicated by changed field conditions, and approval by the ENGINEER or OWNER'S AGENT. Regardless of the final grade tolerance, the thickness of each specified layer shall meet the minimum thickness.
- C. In recognition of the moisture-density relationship of soils, the ENGINEER or OWNER'S AGENT may direct that the compaction and moisture content tolerances be modified if required by variabilities in the soils. This decision, if required, will be based on the ENGINEER or OWNER'S AGENT interpretation of the laboratory analysis for each soil.
- D. No additional payment shall be made for quantities of soils placed in excess of that amount required to achieve the minimum specified thickness.

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3.09 FIELD QUALITY CONTROL

- A. The CONTRACTOR shall test the in-place density and moisture content of the common fill soils by nuclear methods in accordance with ASTM D-6938 and these Specifications. The testing shall be conducted at a frequency not less than three tests per lift per area of interest. Every 25th nuclear density test shall be verified in accordance with ASTM D-1556 and ASTM D-2216. All test locations shall be recorded and provided on the “As-Built” Drawings.
- B. The CONTRACTOR shall test the in-place density and moisture content of the clay plug material by nuclear methods in accordance with ASTM D-6938 and these Specifications. Tests must be conducted every 50 lineal feet on each lift. The density and moisture content results shall be verified in accordance with ASTM D-1556 and ASTM D-2216, respectively. A minimum of three verification tests shall be conducted for each soil material type as determined by the ENGINEER or OWNER’S AGENT. Failing tests shall be repeated. Continued test failure will require re-working of the material prior to re-testing and acceptance. All test locations shall be recorded and provided on the “As-Built” Drawings.
- C. The CONTRACTOR shall provide field control; i.e., grade stakes, to determine layer thickness. The ENGINEER OR OWNER’S AGENT shall perform verifying thickness measurements in the field in accordance with quality assurance activities.
- D. The CONTRACTOR shall provide a minimum of 24 hours notice to the ENGINEER or OWNER’S AGENT when each compacted lift is ready for testing.
- E. The CONTRACTOR shall provide access and repair any damage to subgrade caused by correctly performed tests, and cooperate in other ways necessary to permit the ENGINEER or OWNER’S AGENT to conduct testing when and where he/she desires and as expeditiously as possible.
- F. Fill material shall not be placed over a lift which has not been tested and accepted by the ENGINEER or OWNER’S AGENT.
- G. All placement operations shall comply with all requirements of these Specifications.

END OF SECTION

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02232 – *Granular Materials*

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GRANULAR MATERIALS

PART 1 - GENERAL

1.01 DESCRIPTION

Work covered by this Section consists of furnishing all labor, materials, tools, equipment and incidentals necessary for obtaining and placing the granular components as indicated on the Drawings and specified herein.

1.02 DEFINITIONS

“Dense-Graded Aggregate (DGA)” includes all aggregate utilized for stabilization of disturbed areas and construction of access roads, if necessary.

1.03 REFERENCES

- A. AASHTO T 27 Sieve Analysis of Fine and Coarse Aggregates
- B. ASTM D-1556 Test Method for Density of Soil In Place by Sand-Cone Method
- C. ASTM D-1557 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 Pound Rammer and 18-Inch Drop
- D. ASTM D-6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- E. 2005 Oregon Department of Environmental Quality Erosion and Sediment Control Manual
- F. 2008 Oregon Standard Specifications for Construction, Volume 2

1.04 QUALITY ASSURANCE

All materials, procedures, operations, and methods shall be in strict conformance with the Drawings and these Specifications, and shall be subject to strict quality control monitoring as detailed herein and in the Construction Quality Assurance/Quality Control (CQA/QC) Plan. The placed granular materials shall conform exactly to the Drawings and these Specifications, except as otherwise authorized in writing by the ENGINEER or OWNER'S AGENT.

GRANULAR MATERIALS**1.05 SUBMITTALS**

- A. The CONTRACTOR shall submit the location of all borrow pits to the ENGINEER or OWNER'S AGENT no less than two weeks prior to the anticipated placement of any granular materials.
- B. The CONTRACTOR shall submit a 50-pound sample from each of the suppliers proposed to furnish the required quantity of granular materials. The samples shall be submitted to the ENGINEER or OWNER'S AGENT no less than two weeks prior to the anticipated placement of any granular materials.
- C. Dense-Graded Aggregate
 - 1. The CONTRACTOR shall submit the results of the particle-size analysis for dense-graded aggregate conducted in accordance with AASHTO T 27 for every 2,500 cubic yards of materials imported to the Site, with a minimum of three (3) tests required.
 - 2. The CONTRACTOR shall submit the results of a Modified Proctor for dense-graded aggregate conducted in accordance with ASTM D-1557 for every 5,000 cubic yards of materials imported to the Site, with a minimum of two (2) tests required.
 - 3. The test results shall verify that the material meets the technical requirements of these Specifications. The test results shall be submitted to the ENGINEER or OWNER'S AGENT no less than one week prior to the anticipated placement of granular materials.

1.06 DELIVERY

The CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT one (1) week in advance of delivery of all granular materials. The CONTRACTOR shall stockpile granular materials only at a location approved by the OWNER and/or ENGINEER or OWNER'S AGENT.

PART 2- MATERIALS**2.01 GRANULAR MATERIALS**

- A. Dense-Graded Aggregate
 - 1. Aggregate shall consist of hard, strong, durable particles that are free of any materials, roots, trees, stumps, concrete, construction debris, other organic matter, and deleterious materials. Aggregate shall be procured from a commercial borrow site.

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GRANULAR MATERIALS

2. The aggregate shall meet the gradation requirements set forth by the Oregon Standard Specifications for Construction for ¾-inch dense-graded aggregate as given below and as determined by AASHTO T 27.

Dense Graded Aggregate ¾ inch to 0

Sieve Size	Percent Passing (by weight)
1"	100
¾"	90-100
½"	-
3/8"	55-75
¼"	40-60
No. 10	*

* Of the fraction passing the ¼-inch sieve, 40% to 60% shall pass the No. 10 sieve

PART 3 - EXECUTION

3.01 INSPECTION

- A. The CONTRACTOR shall verify that finished grades, slopes, and elevations are level with the existing grades and conform to the specified requirements. Misgraded Work shall be corrected at no additional cost to the OWNER or OWNER'S AGENT. CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT immediately if a specified grade, slope or elevation appears inconsistent with the others specified.
- B. At the beginning of each day's Work, the ENGINEER or OWNER'S AGENT will inspect the previously placed granular materials and institute whatever corrective action, if any, that the ENGINEER or OWNER'S AGENT deems appropriate, at no extra cost to the OWNER or OWNER'S AGENT, unless the action requested is clearly beyond the scope of this Contract. This may include, but is not limited to the removal of unsuitable granular materials.

3.02 PLACEMENT OF GRANULAR MATERIALS

- A. Dense-graded aggregate shall be used to stabilize access and on-site roadways, as necessary. Any additional roadways required to ensure access to all areas of the Work shall be constructed as deemed necessary by the CONTRACTOR.

GRANULAR MATERIALS

- B. Granular materials shall be placed, not dumped, to the limits and grades shown on the Drawings.
- C. Material shall be placed in a maximum loose lift of 9-inches resulting in a maximum compacted lift of 6 inches. Compaction shall be accomplished with a minimum of 4 passes with the designated compaction equipment. The type and weight of compaction equipment shall be submitted by the CONTRACTOR in writing and accepted by the ENGINEER or OWNER'S AGENT.
- D. Dense-graded aggregate shall be compacted to 95 percent of maximum dry density obtainable, as determined by ASTM D-1557. The fill shall be compacted within a range of 0 percent below to 4 percent above the optimum moisture content as determined by ASTM D-1557.
- E. A maximum 5 percent of all field moisture content test results are permitted outside the specified range. The outliers are, however, not permitted to be concentrated in one lift or one area, and no moisture content shall be less than 2 percent or more than 4 percent of the optimum moisture content. The areal extent is at the discretion of the ENGINEER or OWNER'S AGENT.
- F. A maximum 5 percent of all field dry density test results are permitted outside the specified range. The outliers are, however, not permitted to be concentrated in one lift or one area, and no dry density less than 87 percent as determined by ASTM D-1557 is permitted. The areal extent is at the discretion of the ENGINEER or OWNER'S AGENT.
- E. The subbase materials shall be compacted and proof-rolled or otherwise, to observe any soil pumping or insufficient compaction as determine by the ENGINEER or OWNER'S AGENT.

3.03 CRITERIA AND TOLERANCES

- A. Final grades shall be within two tenths of one (0.2) foot below to five tenths of one (0.5) foot above (-0.2 to +0.5) the grades and contours indicated on the Drawings, or as dictated by changed field conditions, and approval by the ENGINEER or OWNER'S AGENT. Regardless of the final grade tolerances, the thickness of the granular materials shall meet the minimum thickness as stated in each application.
- B. No additional payment will be made for quantities of granular materials placed in excess of that amount required to achieve the minimum specified thickness.

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3.04 FIELD QUALITY CONTROL

- A. The CONTRACTOR shall test the in-place density and moisture content of the dense-graded aggregate by nuclear methods in accordance with ASTM D-6938 and these Specifications. The testing shall be conducted at a frequency not less than four (4) tests per acre per lift. Every 25th nuclear density test shall be verified in accordance with ASTM D-1556 and ASTM D-2216. All test locations shall be recorded and provided on the “As-Built” Drawings.

- A. The ENGINEER or OWNER’S AGENT will perform thickness measurements in the field to determine compliance with these Specifications.

- B. CONTRACTOR shall comply with all quality assurance requirements specified herein.

END OF SECTION

02242 - *Groundwater Barrier
Wall*

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GROUNDWATER BARRIER WALL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Work covered by this Section consists of furnishing all labor, materials, tools, and equipment necessary for constructing the soil-reagent groundwater barrier wall (GWBW) that meets or exceeds the requirements specified herein and presented on the Drawings.
- B. The GWBW construction shall occur in three distinct phases, as follows:
 - 1. Laboratory Phase: the CONTRACTOR shall perform a bench-scale study with the proposed reagent-soil mixes to refine the final mix.
 - 2. Field Phase: prior to full-scale implementation of the GWBW, the CONTRACTOR shall construct and evaluate a test section of the GWBW to verify performance and in-place characteristics.
 - 3. Full-Scale Phase: complete construction of the GWBW in accordance with these Specifications and Drawings.

1.02 REFERENCES

- A. ASTM C143: Standard Test Method for Slump of Hydraulic Cement Concrete
- B. ASTM C150: Standard Specifications for Portland Cement
- C. ASTM D421: Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants
- D. ASTM D422: Standard Test Method for Particle-Size Analysis of Soils
- E. ASTM D698: Test Method for Laboratory Compaction Characteristics of Soil Using Standard Proctor Effort
- F. ASTM D1556 : Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
- G. ASTM D1633 : Standard Test Method for Compressive Strength of Molded Soil-Cement Cylinders
- H. ASTM D2216 : Standard Test Method for Laboratory Determination of Moisture Content of Soil and Rock

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- I. ASTM D4016: Standard Test Method for Viscosity of Chemical Grouts by Brookfield Viscometer
- J. ASTM D4318 : Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils
- K. ASTM D4380 : Standard Test Method for Density of Bentonite Slurries
- L. ASTM D5084 : Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
- M. ASTM D6938 : Standard Test Method for In-Place Density and Water Content of Soil and Soil Aggregate by Nuclear Methods (Shallow Depth)
- N. ASTM D7100: Standard Test Method for Hydraulic Conductivity Compatibility Testing of Soils with Aqueous Solutions
- O. EPA 160.1: Test Method for Total Dissolved Solids
- P. EPA 200.7: Test Method for Dissolved Metals
- Q. EPA 215.1: Test Method for Calcium Concentration
- R. EPA 242.1: Test Method for Magnesium Concentration
- S. EPA 273.1: Test Method for Sodium Concentration
- T. EPA 418.1: Test Method for Total Recoverable Hydrocarbons
- U. EPA 8240: Test Method for VOC's
- V. EPA 9040: Test Method for pH
- W. EPA 9090: Test Method for Chemical Compatibility
- X. SW-846 9045A: pH Test for Slurry
- Y. USP NF X VII: Free Swell Test
- Z. API Specification 13A: Drilling Fluid Materials
- AA. API RP 13B-1: Recommended Practice for Field Testing Water-Based Drilling Fluids

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GROUNDWATER BARRIER WALL

1.03 DEFINITIONS

The terms used in this Section are defined as follows:

- A. The “Groundwater Barrier Wall” is a low permeability hydraulic barrier installed through the existing ground or prepared working surface using one of several methods, including the slurry method of excavation, deep soil mixing, or jet grouting.
- B. The “Slurry Method of Excavation” consists of excavating a vertical walled trench (soil-bentonite slurry trench) and at the same time keeping the trench filled with a bentonite slurry mixture. The purpose of the slurry is to support the walls of the trench and prevent movement of groundwater.
- C. “Deep Soil Mixing” consists of constructing overlapping wall panels by inserting and withdrawing a multi-shaft mixing apparatus at consecutive locations.
- D. “Jet Grouting” consists of constructing overlapping wall panes by injecting low permeability grout at consecutive locations.
- E. “Bentonite” is an ultrafine natural clay whose principal mineral constituent is sodium cation montmorillonite.
- F. “Bentonite Slurry” is a colloidal mixture of bentonite and water.
- G. “Soil-Bentonite (S-B) Backfill” is a homogeneous mixture of material produced by mixing soil with bentonite slurry and additional dry bentonite, as necessary, which is placed into the excavated trench to complete the soil-bentonite slurry trench.
- H. The “Ground Water Level” is the piezometric level of the ground water as determined from piezometers and wells.
- I. The “Working Surface” is the top of the stripped and/or prepared natural ground from which the groundwater barrier wall shall be constructed.
- J. The “Confining Stratum” is the soil stratum or rock unit to which the bottom of the groundwater barrier wall is excavated.
- K. The “Groundwater Barrier Wall Cap” is the section of fill that is placed above the groundwater barrier wall and extends the wall to final grade. The geometry of the groundwater barrier wall cap is depicted on the Drawings and shall be constructed in accordance with Section 02200 – EARTHWORK.

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GROUNDWATER BARRIER WALL

1.04 WORK BY CONTRACTOR

- A. A groundwater barrier wall (GWBW) shall be constructed along the alignment specified on the Construction Drawings to form a continuous hydraulic barrier along the riverbank, as specified on the Construction Drawings. The GBW shall be constructed with a soil-bentonite, or other approved reagent mix, utilizing an appropriate construction methodology to meet, or exceed, the specified requirements herein. Construction methods may include slurry wall, jet grouting, deep soil mixing, continuous trenching, or other appropriate technique to achieve the minimum GBW dimensions and a maximum in-place coefficient of permeability for the completed wall of 1×10^{-6} cm/sec. The GBW shall have the depth and minimum width specified in Part 3.04 of this Section. The wall shall extend to the top of the basaltic bedrock, as depicted in the Construction Drawings.
- B. The CONTRACTOR shall furnish the necessary plant, labor, materials, tools, equipment, services, utilities, and the water required to construct the GBW in accordance with these Specifications.
- C. The CONTRACTOR shall furnish and install all supplementary or miscellaneous items, appurtenances, and devices (including, but not limited to, chisel, bore, excavate, or key-in the wall) that are not specifically indicated but which are necessary to complete the installation of the GBW. The CONTRACTOR shall take all necessary steps to install a barrier wall with a maximum, in-place permeability of the completed wall of 1×10^{-6} cm/sec. Specific concerns or omissions are the responsibility of the CONTRACTOR to identify during the bidding process and acknowledge with the bids.
- D. The CONTRACTOR shall be responsible for controlling all storm-water runoff and providing run-on controls during the GBW construction to assure compliance with the existing storm-water runoff system and the requirements of the ODEQ. This work includes, but shall not be limited to, all trenching, excavations, drilling, mixing, and product storage.
- E. Subsurface utilities that intersect the GBW shall be cut, capped, and/or grouted, as indicated on the Drawings. The overhead power line shall be disconnected and removed to facilitate construction of the GBW. The CONTRACTOR shall verify and protect all other buried and above-ground utilities during construction of the GBW. In the event that a utility line not identified for abandonment is damaged during construction, the CONTRACTOR shall immediately notify the ENGINEER or OWNER'S AGENT and the affected utility so that damaged items can be repaired at the CONTRACTOR's expense.

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- F. The CONTRACTOR shall remove objectionable material from the area of the GWBW operations on an as-needed basis in accordance with Paragraph 3.02(A)(1) of this Section. This includes unforeseen buried debris encountered along the alignment of the GWBW. Disposal of an unforeseen material shall be the responsibility of the CONTRACTOR. The CONTRACTOR is responsible for handling materials and placing it in the appropriate containers to be provided by the CONTRACTOR on the Site. The CONTRACTOR is responsible for disposal of debris generated by the CONTRACTOR in order to perform the work, and shall dispose of the materials appropriately.
- G. The CONTRACTOR shall be responsible for connecting to the OWNER'S AGENT's service water supply for GWBW construction activities. Such connections shall assure that water is available in the volumes deemed adequate, but not excessive by the OWNER'S AGENT. The OWNER's service water supply is located on-site. The CONTRACTOR is responsible for transporting the water to the necessary GWBW construction area as well as providing the means for filling any water-carrying vehicles. Chemical analyses on the service water supply are presented in the Supplemental Information section of the Contract Documents for CONTRACTOR's reference. The CONTRACTOR is responsible for assuring chemical compatibility of the water supply with the hydraulic isolation wall products and construction activities.
- H. The CONTRACTOR shall take precautions to assure that all groundwater extracted from the trench and used for construction activities, including run-off, is prohibited from leaving the Site. Run-off of the groundwater from the Site shall not be permitted.
- I. The CONTRACTOR is solely responsible for the security of the CONTRACTOR's equipment, materials, and the constructed products at the Site at all times throughout the construction period.

1.05 QUALITY CONTROL AND ASSURANCE

- A. All materials, procedures, operations, quality control and methods of construction are the responsibility of the CONTRACTOR, and shall be in strict conformance with the Drawings and Specifications. The Work shall be subjected to strict quality assurance (QA) and quality control (QC) monitoring by the OWNER or OWNER'S AGENT and the CONTRACTOR, respectively, as provided in Section 01400 – QUALITY CONTROL of the Specifications and in the Construction Quality Assurance/Quality Control (CQA/QC) Plan. The installed GWBW shall

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conform to the Drawings and Specifications, except where changes are authorized in writing by the ENGINEER or OWNER'S AGENT.

B. ENGINEER or OWNER'S AGENT Responsibilities:

1. Review product data and samples.
2. On delivery, inspect products jointly with CONTRACTOR.
3. Conduct QA testing, as deemed necessary. The QA testing shall in no way relieve the CONTRACTOR of the responsibility of performing tests necessary to meet the QC requirements.

C. CONTRACTOR's Responsibilities:

1. Arrange for and deliver information for "Record Drawings", product data, samples, and all testing results and certifications to the OWNER'S AGENT or their Representative in a timely manner. All QC samples and testing shall be referenced to the GWBW alignment station and depth at which the sample was obtained or test was conducted.
2. Receive and unload products at site; inspect for completeness or damage, jointly with the OWNER'S AGENT and repair or replace items damaged after receipt.
3. Install and test the test wall section to document construction methods and demonstrate that material mixes are acceptable and that the proposed technology shall meet the minimum hydraulic isolation wall specifications.
4. Conduct QC testing in accordance with Section 01400, the CQA/QC Plan, and Part 4.0 of this Section as necessary to control the hydraulic isolation wall installation quality.
5. The CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT whenever the trench excavation or GWBW installation is near the design depth to allow for inspections. The ENGINEER or OWNER'S AGENT shall observe any cuttings from the bottom of the GWBW for continuity.
6. The CONTRACTOR shall cooperate with the ENGINEER or OWNER'S AGENT during any inspections or QA testing. The CONTRACTOR shall provide, at no additional cost, labor and

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materials to 1) measure the lines and grades associated with the Work and 2) collect samples for QA testing.

7. The CONTRACTOR shall submit to the ENGINEER or OWNER'S AGENT on a regular schedule (as noted) the following items:
 - a. Soundings and As-built Profile (daily): a record of the soundings taken during construction, including depth of trench/GWBW, backfill slope (for slurry wall construction), and other construction-related information obtained at the beginning and end of each day. The CONTRACTOR shall use the soundings to generate the as-built profile.
 - b. Reagent Slurry Mix (daily): quantities, proportions, properties and admixtures shall be submitted. The report shall include the mix from the plant and the mix in the trench.
 - c. Construction Methodologies and Techniques: Any modifications to the approach presented in the Work Plan shall be submitted to the ENGINEER or OWNER'S AGENT.

1.06 CONTRACTOR QUALIFICATIONS

The CONTRACTOR shall maintain full-time supervisory personnel, competent in the hydraulic isolation wall technology, on-site during construction to control the Work. The site superintendent and key personnel shall have not less than five (5) years experience in the technology, shall have participated in the construction of not less than five (5) projects of similar scope and magnitude, including two (2) with a similar or greater depth, and shall have successfully installed a minimum area of 1,000,000 square feet. Qualifications for these individuals shall be provided at the time of bidding (see Part 1.08 for submittal requirements), and shall be subject to the approval of the OWNER or OWNER'S AGENT.

1.07 HEALTH AND SAFETY

- A. The CONTRACTOR shall develop and implement the CONTRACTOR's site-specific Health and Safety Plan (HASP) for all GWBW activities to protect on-site personnel. Hazardous waste materials may be disturbed during the Work and contact with waste, waste liquids, and/or waste gases is expected.
- B. The CONTRACTOR shall provide adequate health and safety personal protective equipment (PPE) for employees, the OWNER or OWNER'S

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AGENT, representatives of the ODEQ or other regulatory agencies, and others who might be affected by the on-site activities.

- C. Work procedures shall conform with all applicable EPA, OSHA, ODEQ, State of Oregon, local government, and other federal and state and county regulations (latest editions).

1.08 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. All materials shall be delivered in undamaged, unopened containers bearing the manufacturer's original label and shall be handled to prevent contamination, segregation, or damage.
- B. The storage location of all materials shall not interfere with construction activities or OWNER's daily plant operations and shall be approved by the ENGINEER or OWNER'S AGENT.
- C. Bentonite, hydrophilic sealing material and similar materials shall be stored in weathertight enclosures to protect against dampness and contamination.

1.09 SUBMITTALS

- A. The CONTRACTOR shall submit qualifications of key project personnel, including superintendent and primary equipment operator(s), with their bid. The following information shall be submitted to the ENGINEER or OWNER'S AGENT for the superintendent, primary equipment operator(s), and other key personnel:
 - 1. Name, address, and telephone number of customer and point of contact for projects forming the experience record;
 - 2. Contract number, contract amount, date of award, and date of completion of the projects forming the experience;
 - 3. GWBW length and depth; and,
 - 4. Description of the method of construction and equipment used.
- B. The CONTRACTOR shall submit qualifications, company name, and key contact of the CONTRACTOR's QC Laboratory with their bid. The laboratory shall have previous experience with slurry wall materials, experienced laboratory technicians, and modern permeability testing equipment.

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C. The CONTRACTOR shall submit a detailed work plan describing the proposed GWBW construction methodology, procedures, equipment, and schedules. The work plan shall include, but not be limited to:

1. Construction, maintenance, and removal of working platforms, mixing pads, and haul roads;
2. Equipment set-up and site use layout, including storage areas, haul roads, mixing pads, and work platform locations and dimensions;
3. Equipment specifications, including maximum depth capability of excavator, number and type of backfill mixing equipment, and specifications of slurry mixing equipment;
4. Procedure for water-bentonite slurry mixing, transportation, and re-circulation;
5. Procedure for trench excavation and backfilling;
6. Material properties, sources, and (manufacturer's) certificates of quality;
7. Control of drainage, spills, wastes, etc.; and,
8. Clean-up, spoils disposal, and slurry disposal.

D. Quality Control Plan

The CONTRACTOR shall submit a quality control plan with details of the personnel, responsibilities, inspections, and organization for ensuring the quality of construction required by these Specifications. The plan shall provide a table listing testing methods, frequencies, and minimum acceptable values. The plan shall explain the methods and locations for obtaining samples for testing and reporting schedules. Copies of quality control forms shall be submitted for review and approval.

E. The CONTRACTOR shall submit the results of the Laboratory Phase and the proposed mix design to the ENGINEER or OWNER'S AGENT within 48 hours of receipt of the report from the laboratory.

F. The CONTRACTOR shall submit the results of the Field Phase to the ENGINEER or OWNER'S AGENT within 48 hours of completion.

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- G. The results of all QC testing required by these Specifications shall be furnished to the ENGINEER or OWNER'S AGENT. The CONTRACTOR shall furnish records of all observations, measurements, and tests performed, identified with the location, date, and time of testing. These records shall be furnished no later than 24 hours after the observation, measurement, or test is performed.
- H. A record of the soundings taken during construction, including the depth of the GWBW and backfill slope (if applicable), shall be submitted to the ENGINEER or OWNER'S AGENT by noon of the day following the date of the measurement.
- I. The CONTRACTOR shall submit a 50-pound sample from each of the off-site borrow sources proposed to furnish the required quantity of fill materials. The samples shall be submitted to the ENGINEER or OWNER'S AGENT no less than two (2) weeks prior to the anticipated placement of any soil materials.

1.10 SUBSURFACE CONDITIONS

- A. Subsurface investigations have been conducted during prior work activities. Boring location maps and corresponding boring logs are provided in the Supplemental Information section of the Technical Specifications. Neither the OWNER, OWNER'S AGENT, nor ENGINEER assumes responsibility for interpretation or deductions made from the borings or logs. Local variations may exist in the subsurface materials between boring locations. Soils classifications presented on the logs are the result of field observations. Geotechnical tests were conducted on selected boring locations and are presented in the Supplemental Information section.
- B. Geologic cross sections are presented in the Supplemental Information section to provide a general description of the existing conditions observed from prior subsurface investigations. Fill materials comprise the upper zone along the alignment of the GWBW. Debris, i.e., concrete and rubble, has been observed within the fill materials. The geologic cross section presents the elevations of the fill materials, native materials, water table and basalt rock.
- C. Analytical test results of the groundwater and subsurface materials (fill and native soils) are provided in the Supplemental Information section. The CONTRACTOR shall consider this information to assess any potential affect of the constituents on the GWBW.

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- D. Test excavations were conducted in specific locations to observe and remove any large debris located within the fill materials. An additional clearance trench is required under this contract to remove any remaining debris. The locations of the test excavations are presented on Drawing No. 2 and a summary of the observations and findings from the subsurface debris investigation are presented as Attachment 3. The clearance trench requirements specified under this contract are described herein and on the Drawings.
- E. Groundwater contour maps for the hydrogeologic units that will be encountered during GWBW installation are presented in the Supplemental Information section.

1.11 MIX DESIGN TESTING

- A. Slurry materials testing was conducted during preparation of the Focused Feasibility Study. For reference purposes, the Slurry Materials Testing Report is presented as Attachment 2. The report and associated results are presented for informational purposes only and shall not be construed as a recommendation of the appropriate mix design. The CONTRACTOR is responsible for providing a GWBW mix design that meets the performance-based design requirements of this Section.
- B. The CONTRACTOR shall perform bench-scale testing during the Laboratory Phase to determine the appropriate reagent(s) and mix. This study may refine the mixes evaluated in the Slurry Materials Testing Report, or consider alternative reagents and/or mix percentages. It is the CONTRACTOR's responsibility to ensure that the final mix meets the performance requirements defined herein.

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PART 2 – PRODUCTS

2.01 MIX REAGENT

- A. The GWBW shall be constructed using a reagent mix that was evaluated in the Laboratory Phase and demonstrates compliance with the requirements specified herein. Typical reagents include bentonite and/or other alternative reagents.
- B. Alternative reagents may be proposed by the CONTRACTOR but are subject to approval by the ENGINEER, OWNER'S AGENT, or OWNER. CONTRACTOR is responsible for demonstrating performance to the satisfaction of the ENGINEER, OWNER'S AGENT, or OWNER. Approval of the alternate reagents in the Laboratory Phase will not constitute approval for subsequent phases.

2.02 BENTONITE - Slurry Wall, Jet Grouting, and Deep Soil Mixing Applications

- A. Bentonite shall be a premium grade, high-swelling, sodium-cation montmorillonite bentonite that meets or exceeds the standards of the American Petroleum Institute (API) as contained in API Specifications 13-A (Spec 13-A), Section 5 (not chemically treated) and Table 02242-1. Bentonite that does not meet the specifications shall be promptly removed from the Site at no additional cost to the OWNER or OWNER'S AGENT.
- B. Bentonite shall be protected from moisture during transportation and storage.
- C. The material shall have been manufactured to function in the presence of water soluble contaminants without losing its filtrate control properties.

2.03 WATER - Slurry Wall, Jet Grouting, and Deep Soil Mixing Applications

- A. The OWNER/OWNER'S AGENT will provide the water supply for the CONTRACTOR's use to manufacture all slurries and/or grout. CONTRACTOR shall be responsible for all water connections and transport to the Work site.
- B. It shall be the responsibility of the CONTRACTOR to assure that the resulting slurry and/or grout meet the standards and requirements of this Specification. The CONTRACTOR shall verify chemical analysis for pH, hardness, and salt content for the OWNER/OWNER'S AGENT-provided water supply. If the CONTRACTOR elects to use an alternative water source, it is the CONTRACTOR'S responsibility to obtain chemical analysis for pH, hardness, and salt content for both the OWNER/OWNER'S AGENT-provided service water supply and the alternative water supply to

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verify the chemical compatibility of the alternative water supply with the GWBW products. The water supply is expected to be substantially clean, fresh, and free from oil, acid, alkali, or other deleterious substances; the water shall comply with Table 02242-1. If the water supply is deemed inappropriate, an alternate source shall be investigated by the CONTRACTOR to verify chemical compatibility. The test results shall indicate that the bentonite, when mixed with the water, will yield the required parameters. It shall be the responsibility of the CONTRACTOR to add bentonite as necessary to meet the slurry viscosity and to have stable excavation.

2.04 SLURRY - Soil-Bentonite Slurry Wall Application

- A. Base Product: the slurry supporting the sides of the trench and for wetting the backfill material shall consist of a stable colloidal suspension of bentonite in water.
- B. The bentonite utilized in the slurry shall conform to the requirements outlined in Part 2.02 of this Section.
- C. The water utilized in the slurry shall conform to the requirements outlined in Part 2.03 of this Section.
- D. Initial Slurry Mixture:
 - 1. At the time of introducing slurry into the trench, the slurry mixture shall consist of a minimum of five (5) percent bentonite per unit weight of water. The initial slurry mixture shall comply with the requirements specified in Table 02242-1.
 - 2. The CONTRACTOR shall add additional bentonite to make the slurry denser or more viscous than the limits specified herein, if deemed necessary by the ENGINEER or OWNER'S AGENT.
 - 3. Admixtures to alter the characteristics of the slurry in the trenches, including but not limited to softening agents, dispersants, retarders or plugging/bridging agents, shall not be permitted, unless otherwise approved by the ENGINEER or OWNER'S AGENT.
 - 4. A record of mixed bentonite slurry quantities and proportions shall be maintained. Adjustments to the slurry mixture shall be noted.
- E. Slurry Mixture in Trench:

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1. The bentonite slurry in the trench shall comply with the requirements specified in Table 02242-1. A record of in-trench bentonite slurry properties shall be maintained. Adjustments to the slurry shall be recorded.
2. The bentonite must be fully hydrated and the slurry must be homogeneous. Slurry with balls of partially wetted clay will be rejected by the ENGINEER or OWNER'S AGENT at the trench.

2.05. SOIL-REAGENT BACKFILL

- A. The CONTRACTOR shall design the soil-reagent backfill mixture to achieve a maximum, in-place permeability of 1×10^{-6} cm/sec, as determined by ASTM D-5084.
- B. The material for trench backfilling shall be composed of fresh slurry, trench slurry, reagents (including bentonite and/or approved alternatives), and trench spoils and/or selected soils obtained from a designated off-site borrow source. Trench spoils or borrow soil shall be friable and free from roots, organic matter, refuse, rubble, debris, concrete, boulders, frozen materials, or other deleterious materials.
- C. The soil-reagent mixture shall be thoroughly mixed and is required to have the following minimum percent passing gradation limits:

<u>U.S. Standard Sieve</u>	<u>Percent Passing</u>
3 inch	100
No. 200	15

These requirements shall be evaluated by the CONTRACTOR for consistency with the criteria required to obtain the minimum coefficient of permeability specified in Paragraph 2.05 A of this Section. If the soil-reagent mixture does not meet the required gradation limits, the CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT immediately and present a rationale for use of the gradation or propose any necessary changes to the soil-reagent mix design to ensure that the minimum coefficient of permeability is obtained. Any change to the soil reagent mix design, or any use of soil-reagent backfill not meeting the required gradation limits, must be approved by the ENGINEER or OWNER'S AGENT.

- D. Soil excavated from the trench (trench spoils) may be used as backfill provided it is mixed to be homogeneous and meets the Specifications. If excavated soil does not meet the Specifications, borrow material from other sources shall be added to the excavated soils, thoroughly mixed with the

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excavated soils to a homogeneous mixture and used as backfill. Soil removed from the trench which may not be suitable for mixing and returning to the trench for any reason shall be disposed of as provided in Section 02250 – TRANSPORTATION AND DISPOSAL OF MATERIALS of the Specifications. Any contaminated items excavated must be loaded into appropriate containers supplied by CONTRACTOR for recycling or disposal.

- E. Borrow material to be used as part of the backfill shall come from an accepted source. The CONTRACTOR shall not change the borrow source for the duration of the Work without prior written acceptance from the ENGINEER or OWNER'S AGENT.
- F. The soil-reagent backfill may be mixed in-situ or ex-situ, permitted the performance criteria of the GWBW are met. Trench spoils removed from the trench may be mixed with the reagent(s) along side the trench on the landward side of the excavation. Alternatively, trench spoils may be transported to a central staging or mixing area. Precautions shall be taken to ensure that excess water and fluids from the excavated material, or any stormwater or fluid runoff from the mixing area, will be directed back to the trench, or managed accordingly to prevent the water or fluids from leaving the Site. Collecting, pumping, or transporting this fluid is the CONTRACTOR's responsibility. The trench spoils must be screened and/or mixed, if necessary, to meet the screen specifications outlined above.
- G. The CONTRACTOR shall increase the reagent content and mixing operations, as needed, and account for any variations in the in-situ soil properties to achieve the specified performance criteria.
- H. For determining compliance with the permeability specification, after 28 days of curing, no value of the in-situ backfill coefficient of permeability shall exceed 1×10^{-6} cm/sec for the length of the GWBW. The CONTRACTOR shall obtain two (2) undisturbed samples of the soil-reagent backfill from each of four (4) locations for permeability testing.. From each location one (1) sample must be taken from the ground surface to mid-depth and one (1) sample must be taken from mid-depth to the bottom of the GWBW. Of the four locations, one (1) must be with in the Chlorate Area and one (1) must be within the Acid Plant Area. All locations for permeability sampling shall be approved by the ENGINEER or OWNER'S AGENT. If QA tests by the ENGINEER or OWNER'S AGENT or QC tests by the CONTRACTOR indicate that non-compliance exists, all work shall cease until the source of the problem is determined. The CONTRACTOR shall not be paid extra to replace any portions of the soil-reagent wall that do not meet these Specifications. Any in-place portions of the GWBW that do not meet these Specifications shall be replaced at no additional cost.

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- I. Admixtures: Admixtures shall not be used except as approved in writing by the ENGINEER or OWNER'S AGENT and shall be submitted with the bid if anticipated before the start of work.
- J. The CONTRACTOR shall conduct quality control testing on the soil-reagent backfill, including particle size analysis, permeability, slump, and density. The soil-reagent backfill mixture shall comply with the requirements specified in Table 02242-1.

PART 3 – EXECUTION

3.01 LABORATORY PHASE

- A. Prior to construction of the GWBW, the CONTRACTOR shall perform a bench scale study to select the specific mix reagents and percentages required to meet the Specifications. The bench scale study shall also include an evaluation of the long-term compatibility of the selected GWBW mix.
- B. The CONTRACTOR shall provide all personnel, equipment, and materials to perform the Laboratory Phase. The CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT ten (10) days prior to commencing the Laboratory Phase and shall provide interim updates and data throughout the process.
- C. The OWNER'S AGENT will provide the CONTRACTOR with representative samples of site soil, groundwater, and potable water (i.e. mix water) for use in the Laboratory Phase.
- D. The Laboratory Phase shall consist of the following:
 - 1. Testing of site soil and mix water as indicated in Table 02242-2.
 - 2. Selection of a minimum of two (2) proven and commercially available reagents for use in creating slurry and/or soil-reagent mixes; at least one of the reagents shall be bentonite. Compatibility testing of reagents shall be performed as indicated in Table 02242-2.
 - 3. Compatibility testing of water-reagent slurries shall be performed as indicated in Table 02242-2. The ultimate water-reagent slurry mix selected shall meet the requirements in Table 02242-1 and be deemed compatible by the ENGINEER or OWNER'S AGENT.
 - 4. Soil-reagent backfill mixes at varying reagent concentrations shall be prepared by combining site soil with water-reagent slurries.

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Compatibility testing of backfill mixes shall be performed as indicated in Table 02242-2. A minimum of five (5) different soil-reagent backfill mixes shall be evaluated.

5. The ultimate soil-reagent backfill mix selected shall exhibit a maximum long-term permeability of 5×10^{-7} cm/sec.
- E. The CONTRACTOR shall provide the results to the ENGINEER or OWNER'S AGENT for review and approval prior to Field Phase implementation. If the mixes do not meet the required specifications, the CONTRACTOR shall review the procedures with the ENGINEER or OWNER'S AGENT and perform another Laboratory Phase. Any supplemental Laboratory Phase shall be performed at no additional cost to the OWNER or OWNER'S AGENT.
- F. An initial mix design study was previously performed to determine the potential range of reagents applicable to the Site. The results of this study are presented as Attachment 2 for CONTRACTOR consideration.
- G. The CONTRACTOR shall provide the source (i.e. supplier) and product data for all reagents proposed for use in the Laboratory Phase.

3.02 FIELD PHASE

- A. A Test Wall Section is required to demonstrate that the materials, mixture methods, and installation methods are adequate to meet the Specifications. Materials and procedures for the test section shall be the same as intended for the installation of the permanent GWBW. The Field Phase shall not be conducted when weather conditions are unsuitable for proper performance of the work, as determined by the ENGINEER or OWNER'S AGENT.
- B. The Test Wall Section shall be located along the alignment of the permanent GWBW at a location approved by the ENGINEER or OWNER'S AGENT. The location of the test wall will be recommended by the ENGINEER or OWNER'S AGENT at the Pre-Bid meeting. The length of the Test Wall Section varies depending on the technology adopted, but in no instance shall be shorter than 25 feet, and shall be constructed to the full depth as specified on the Drawings.
- C. The Test Wall Section shall meet the requirements and shall be subjected to verification testing as specified in Table 02242-1. The Test Wall Section shall exhibit a maximum, in-place permeability of 1×10^{-6} cm/sec, as determined by ASTM D-5084.

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- D. The CONTRACTOR shall provide the results to the ENGINEER or OWNER'S AGENT for review and approval prior to Full-Scale implementation. If the Test Wall Section does not meet the required specifications, the CONTRACTOR shall review the procedures with the ENGINEER or OWNER'S AGENT and perform another Field Phase that complies with all the requirements of Part 3.02. The additional Field Phase shall be performed at no additional cost to the OWNER or OWNER'S AGENT.
- E. The CONTRACTOR shall provide all personnel, equipment, and materials to perform the Field Phase. The CONTRACTOR shall document the methods, materials, and equipment used during the Field Phase. The ENGINEER or OWNER'S AGENT shall be present to observe the Field Phase process.

3.03 GROUNDWATER BARRIER WALL CONSTRUCTION

- A. A GWBW shall be constructed to the lines, grades, depth, and cross-section indicated on the Drawings. The GWBW shall have vertical walls, have a minimum width of 36 inches, have a maximum in-place permeability of 1×10^{-6} cm/sec. and extend to the top of the basalt bedrock.
- B. Site Preparation: Prior to GWBW construction, the area on both sides of the wall alignment shall be prepared as shown on the Construction Drawings and as specified herein.
1. A clearance trench shall be constructed in the locations and to the depth indicated on the Drawings to remove debris prior to GWBW construction. Debris and other obstructions shall be segregated and stockpiled for subsequent on-site disposal by the CONTRACTOR. Reference Section 02200 – EARTHWORK for excavation and backfilling requirements associated with the clearance trench.
 2. The GWBW location shall be accurately staked by the CONTRACTOR prior to construction. The GWBW shall be located along the alignment presented on the Drawings. With the exception of the segment of GWBW between stations 0+00 and 1+60, the constructed GWBW alignment shall vary no more than five (5) feet laterally from the alignment presented on the Drawings. If the CONTRACTOR prefers an alternative layout that varies more than five (5) feet horizontally from the alignment presented on the Drawings, the CONTRACTOR shall submit both the base layout and the alternative layout with their bid. The segment of GWBW between stations 0+00 and 1+60 shall follow exactly the alignment presented on the Drawings.

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3. The CONTRACTOR shall prepare the working surface from which to construct the GWBW, including but not limited to clearing, removal of existing structures, utility abandonment and re-routing, well abandonment and disposal of unsuitable materials, in accordance with Section 02110 – SITE CLEARING.
 4. Grade:
 - a. The longitudinal grade of the working surface shall not exceed one (1) percent, unless otherwise approved by the ENGINEER or OWNER'S AGENT.
 - b. In the event that the static ground water table is encountered at a depth of three (3) feet, or less, below the designated working surface, the CONTRACTOR shall raise the working surface with approved fill material to maintain a three-foot separation between the working grade and the water table.
 - c. The working surface shall be graded to ensure that the GWBW excavation/installation equipment produces a vertical trench.
 - d. The CONTRACTOR shall provide and maintain gravity drainage control along the working surface. Controls shall prohibit surface water flow into the excavated trench.
 5. The CONTRACTOR shall maintain the working surface free of excessive amounts of debris and slurry.
 6. The CONTRACTOR shall prepare and maintain a temporary work/staging area at a remote location from the GWBW to support installation of the GWBW, including mixing operations, material storage, equipment storage, and other ancillary activities.
- C. Equipment: The CONTRACTOR shall furnish the necessary plant, tools and equipment for efficient construction of the hydraulic isolation wall.
1. Excavation and Drilling Equipment: The equipment used for construction of the GWBW shall be capable of performing excavation and/or drilling operations to the required depth of the GWBW and shall be approved by the ENGINEER, OWNER'S AGENT and/or OWNER. Excavating equipment shall be capable of excavating the minimum trench width in a single pass while minimizing raveling of the trench sides during use.
 2. Preparation and Placement Equipment: The slurry or grout plant shall include the necessary equipment such as a mixer, a mechanically agitated sump, pumps, valves, hoses, supply lines, and

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small tools; all as may be required to adequately mix and supply slurry or grout to the GWBW location in a continuous manner. A backup system shall be designed to supply sufficient slurry or grout in case substantial slurry or grout loss occurs. Storage ponds or containers shall be constructed above grade (no excavation). All slurry held in storage shall be agitated or recirculated to maintain a homogenous mix. Mixing of slurry or grout shall continue until all particles are thoroughly mixed and the resulting mixture is homogenous. The location of the slurry or grout plant and storage areas shall be approved by the ENGINEER or OWNER'S AGENT.

3. Backfill Mixing and Placing: Equipment for mixing and placing backfill may consist of suitable earthmoving or grading equipment, such as bulldozers, blade graders, backhoes, or blenders such as a pug mill, that are capable of thoroughly mixing the backfill materials into a homogeneous blend meeting the required properties. Clods shall be broken to a four-inch maximum size by the backfill preparation equipment and methods employed. Deleterious materials, debris, and oversized particles shall be removed from the backfill before approval for placement.
 4. Decontamination Area:
 - a. All equipment utilized in GWBW construction shall pass through the decontamination area for cleaning prior to leaving the Site in accordance with applicable regulations.
 - b. All water from the decontamination area shall be containerized and stored on-site in accordance with Section 02250 – TRANSPORTATION AND DISPOSAL OF MATERIALS.
- D. Personnel: The CONTRACTOR shall provide all workers' PPE in accordance with 29 CFR and OSHA, and with the level of knowledge necessary to implement health and safety procedures. The CONTRACTOR shall designate a health and safety officer for the project who is responsible for maintaining worker's compliance with established health and safety procedures.
- E. Construction:
1. The CONTRACTOR shall have equipment capable of excavating or drilling to the required depths. The CONTRACTOR shall measure and record the distances to the bedrock with the ENGINEER or OWNER'S AGENT every 20 feet along the wall alignment. The CONTRACTOR shall remove all loose material from the bedrock

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surface so that a clean surface exists. The GWBW shall extend to the basaltic bedrock interface. Achievement of the design depth shall be determined in the field by the ENGINEER or OWNER'S AGENT based on refusal of the excavating equipment and visual exam of the excavated material.

2. In areas where materials unsuitable for incorporation into the GWBW are removed, as determined by the ENGINEER, the material shall be placed in containers by the CONTRACTOR for disposal.
3. At the intersection of two (2) straight line segments, the GWBW shall extend a minimum of five (5) feet beyond the outside of the intersection through all depths. If the GWBW overlaps into a previously completed segment, the GWBW shall extend a minimum of 10 feet into the previously placed segment through all depths. There will be no additional payments for excavation of installed GWBW to make tie-ins.
4. Upon completion of the GWBW and prior to placement of the cap over the wall, no vehicular traffic should cross the GWBW without prior acceptance by the ENGINEER or OWNER'S AGENT. If access is needed before the wall has "set up" properly, the CONTRACTOR shall provide a temporary bridge for crossing a completed GWBW section so as not to disturb the completed GWBW. If a temporary crossing bridge is required, the CONTRACTOR shall install a minimum 1-inch thick steel plate, overlapped sufficiently so that no gaps and/or cracks are apparent and to permit traffic to proceed normally across it.
5. No blasting is permitted for construction of the GWBW.
6. Stability:
 - a. The CONTRACTOR is responsible for ensuring and maintaining the stability of the Work area at all times during all operations, including excavations, drilling, backfilling, injections, and the results of such activities to the adjacent areas, such as the riverbank.
 - b. The CONTRACTOR shall control all surcharges from all excavation, drilling, injection, grading, backfilling, mixing and other equipment, waste, berm construction, stockpiles, and any other loading situations that may affect GWBW construction stability.

F. Capping:

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1. The surface of the backfill shall not be allowed to desiccate prior to placing the final cap. A temporary cover shall be used to protect the backfill prior to placing the final cap. The temporary cover shall consist of at least one (1) foot of uncompacted backfill placed within one (1) day after the backfill is placed. After a minimum of one (1) week, the temporary cover shall be removed. Any depressions or settlement shall be repaired by placing additional backfill or the permanent cap.
2. Upon removal of the temporary cover and before desiccation of the backfill surface can occur, the GWBW shall be covered with a clay cap meeting the requirements of Section 02200 – EARTHWORK and in accordance with the details depicted on the Drawings.

G. Post-Construction of GWBW:

1. Upon completion of backfilling and grading operations, all remaining excavated material, residual slurry or grout, and mixed backfill shall be removed and disposed by the CONTRACTOR in accordance with Section 02250 – TRANSPORTATION AND DISPOSAL OF MATERIALS and the appropriate ODEQ regulations.
2. All disturbed areas shall be cleaned, leveled, and returned to the original condition as directed by the ENGINEER or OWNER'S AGENT.

3.04 SOIL-REAGENT SLURRY WALL CONSTRUCTION

- A. Equipment: The CONTRACTOR shall furnish the necessary plant, tools and equipment for efficient excavation of the trench, mixing and placing of slurry, and transporting, mixing, and placing backfill material. Equipment shall be capable of excavating the minimum 36-inch wide trench in one pass and to a minimum depth of 90 feet.
- B. Slurry Placement:
 1. The CONTRACTOR shall maintain the stability of the excavated trench at all times. The excavated trench above the slurry level shall be maintained to prevent cave-in. The CONTRACTOR is responsible for maintaining slurry densities and levels to ensure stable conditions within any excavations.

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2. The CONTRACTOR shall provide all personnel, equipment and material to maintain the slurry level at all times during the trench construction, after hours, weekends, and holidays included.
3. It is the CONTRACTOR's sole responsibility to ensure that the mixing of any reagents/backfill/slurries do not affect the stability of any open excavations. In the event of sloughing, sliding or other failure of a trench wall prior to completion of backfilling, the CONTRACTOR shall re-excavate the trench, remove all material displaced into the trench, and take corrective action to prevent further deterioration, at the CONTRACTOR's expense.
4. The CONTRACTOR is responsible for testing and maintaining the initial slurry mix and the slurry in the trench, at the frequencies specified in Table 02242-1, to meet the requirements specified herein.
5. The CONTRACTOR shall ensure that the slurry sand content is not excessive and dropping out of the slurry to the bottom of the trench affecting the overall performance of the trench.
6. Slurry shall be introduced into the trench at the time excavation begins. The level of the slurry in the open trench shall be maintained at least three (3) feet above the water table and no more than two (2) feet below the working surface until the placement of the reagent mix backfill is complete, unless otherwise approved by the ENGINEER or OWNER'S AGENT.
7. Slurry shall not be diluted by surface water.
8. The level of the slurry in the trench shall be routinely monitored throughout the day; the level of slurry shall be monitored and recorded each morning and evening. Any noticeable difference in the elevation of the slurry may indicate a loss of slurry through the formation or cave-ins. Corrective action shall be taken to address any noticeable change in the elevation of the slurry.

C. Trench Excavation:

1. The width of the hydraulic isolation wall shall be equal to or greater than 36 inches.
2. The CONTRACTOR shall ensure that no loose material, cuttings, or debris are left in the bottom of the trench before slurry backfilling commences and employ appropriate equipment to verify cleaning of the trench bottom. The CONTRACTOR shall remove from the

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trench any slurry which contains excessive suspended solids as indicated by a slurry unit weight exceeding 85 pcf or within 15 pcf of the unit weight of the backfill mixture. The removal of this slurry or materials from the bottom of the trench shall be done with suitable equipment. Upon these removal activities, the trench shall be sounded immediately before placing backfill, and the soundings shall be compared to the trench excavation soundings to verify the bottom.

3. At a minimum, soundings shall be taken each morning and each evening and compared to monitor for cave-ins or excessive settlement. Corrective action, including trench bottom cleaning, shall be taken to address soundings that indicate these conditions. The trench bottom shall be cleaned by using an excavator bucket, air lift pump, or other approved equipment to ensure removal of sand, gravel, sediment, and other material left in the trench or settled out of the slurry. Cleaning shall not remove material from the walls of the trench.
4. The CONTRACTOR shall conduct Work to avoid damage to utilities and other structures. Excavation equipment shall remain a safe distance (at least 20 feet or as determined in the HASP) from the overhead utilities.
5. The excavation shall begin at the working surface and shall provide a vertical (within two (2) percent) continuous 36-inch minimum width trench to the required depth along the centerline of the excavation. The toe of the slope of the trench excavation shall not precede the toe of the reagent backfill slope by less than 30 feet or more than 100 feet.
6. A lead-in trench is required at the start of the GWBW and at the intersection of two segments. The lead-in trench shall commence far enough away from the GWBW and ramp down to the full depth of the GWBW at a slope which avoids segregation of backfill particles.
7. Trench spoils that are suitable for backfill mixture may be stockpiled adjacent to, or remote from, the trench for processing. Care shall be taken to ensure that unprocessed spoils do not re-enter the trench. Any spoils or excavated materials that are not used in the backfill process shall be disposed on-site at approved locations.

D. Backfill requirements:

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1. Bentonite, or other reagents, shall be added and mixed uniformly and homogeneously with soil backfill such that the soil-reagent backfill mixture meets the criteria presented in Table 02242-1.
 2. The soil-reagent backfill shall be thoroughly mixed, via disking, harrowing, bulldozing, blading, or other approved methods, into a homogeneous mass, free from large lumps or clods of soil or pockets of fines, sand or gravel. Occasional lumps/clods of up to three (3) inches in their largest dimension will be permitted.
 3. All particles shall be coated with slurry. Sluicing with water is not permitted.
 4. If mixing occurs along the trench, heavy equipment, i.e., bulldozers, shall not operate in a back and forth fashion parallel to the open trench. Unmixed materials shall not be permitted to flow into the trench. Excess slurry shall not flow beyond the limits of Work.
- E. Backfill Placement:
1. At the beginning of the excavation, the initial layer of backfill shall be placed from one location only. If a lead-in trench is not excavated, the initial backfill shall be placed by lowering the material to the bottom of the trench by means of a clamshell bucket, tremie methods, or other approved equipment until the backfill emerges from below the slurry surface and achieves its natural angle of repose. A lead-in trench shall start at a point outside the limits of the GWBW to allow the soil-reagent backfill face to form prior to reaching the full depth of the required GWBW. The slope of the lead-in trench shall be excavated to prohibit sliding, sloughing, buckling, or other failures which could trap pockets of material or otherwise affect the performance of the wall. Free dropping of soil-reagent backfill through the slurry is not permitted at anytime throughout construction.
 2. The point of trench backfilling shall progress towards the areas of active excavation. Backfilling operations shall proceed in such a manner that the slope of the initial backfill will be maintained. The new backfill material shall be allowed to slide down the slope of the previously placed backfill and shall be placed in such a manner that the pockets of slurry shall not be trapped during subsequent backfilling.

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3. Care shall be exercised during mixing and backfilling to ensure that the backfill flows and displaces the slurry in the trench and to ensure that a uniform and homogenous trench is constructed.
4. The CONTRACTOR shall backfill continuously in the direction of the excavation from the beginning of the trench to the end of the trench, unless approved otherwise by the ENGINEER or OWNER'S AGENT.
5. Backfilling shall occur so that no pockets of slurry are present in the completed GWBW. The backfill shall not be deposited in any manner that will cause segregation.
6. No payments will be made for the portion of trenches which lie outside of the limits of work.
7. No mixing or placing of soil-reagent backfill shall occur when the air temperature is below 30 degrees Fahrenheit.

3.05 JET GROUTING CONSTRUCTION

- A. Any jet grout hole lost or damaged as the result of mechanical failure of equipment, inadequacy of grout supplies, or improper drilling or injection procedures shall be backfilled with cement grout and replaced by another hole, drilled and injected by the CONTRACTOR at no additional cost to the OWNER'S AGENT. The replacement hole shall be in a location that maintains the integrity of the wall.
- B. Jet grout injection and jet monitor rotation and extraction rates shall be sufficient to produce grout columns/panels meeting the minimum diameter, depth, overlap, and material property requirements specified herein, and to assure that the completed wall achieves the minimum permeability specifications. The CONTRACTOR shall determine and provide with the bid recommended row numbers, diameters, spacing, overlaps, pressures, construction and verification methods, and other necessary information to the ENGINEER or OWNER'S AGENT to demonstrate compliance in order to meet the performance standards.
- C. Jet grout mix shall be proportioned and injected so that the grout column produced meets the following requirements:
 1. Coefficient of permeability not to exceed 1×10^{-6} cm/sec; and,
 2. Additional tests specified in Table 02242-1.

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- D. Equipment for mixing, holding, and pumping grout shall be in a secure location and shall be operated to minimize spillage of material. No material will be allowed to enter storm drains or other drainage courses.
- E. The CONTRACTOR shall use the same equipment, materials, and procedures as determined satisfactory in the Test Wall Section to perform jet grouting of the remaining wall alignment.
- F. The wall shall consist of, at a minimum, a single row of overlapping jet grout columns/panels with a minimum diameter of 36 inches. The minimum overlap shall be the greater of 1/8 of the column diameter/panel width or six inches. Multiple rows may, at the discretion of the CONTRACTOR, be employed to assure meeting the minimum performance standards.
- G. Upon completion of backfilling and grading operations, all remaining excavated material, residual slurry or grout, and mixed backfill shall be removed and disposed by the CONTRACTOR in accordance with Section 02250 – TRANSPORTATION AND DISPOSAL OF MATERIALS and the appropriate ODEQ regulations.

3.06 DEEP SOIL MIXING (DSM) CONSTRUCTION

- A. Equipment: The DSM rig shall consist of a series of overlapping mixing shafts capable of creating a wall with a minimum thickness of 36 inches.
- B. Alignment:
 - 1. The auger flights and mixing blades between the shafts of the DSM rig shall be overlapped to achieve continuity in the stabilized soil column.
 - 2. The placement of strokes shall be controlled by the use of a template or other approved means to gauge the distance between strokes.
 - 3. The vertical alignment of the auger stroke shall be controlled by the DSM equipment operator.
- C. Shaft speed: The mixing shaft speed shall be adjusted to accommodate a constant rate of mixing shaft penetration based on the degree of drilling difficulty.
- D. Penetration Rate: The penetration rate of the mixing shafts shall be maintained in the range of 1 to 8 vertical ft/minute during both penetration and withdrawal, unless otherwise demonstrated during the Test Wall Section.

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- E. Grout: The grout injection rate per vertical foot of column shall be adjusted to the requirements of the design mix, as proposed by the CONTRACTOR.
- F. The resulting soil column wall shall not exceed an in-place coefficient of permeability of 1×10^{-6} cm/sec and shall comply with Table 02242-1. The materials, equipment, mix design, construction method, and verification methods shall be submitted to the ENGINEER or OWNER'S AGENT with the bid to demonstrate assurance for meeting the performance standards.
- G. The CONTRACTOR shall determine the overlap of successive auger locations to ensure a continuous GWBW that meets the required specifications. The ENGINEER or OWNER'S AGENT shall evaluate the data provided by the CONTRACTOR to confirm that the appropriate overlap is being implemented; a minimum overlap of 30 percent is required between successive auger locations. If insufficient overlap is observed or the GWBW does not meet the performance requirements, the CONTRACTOR shall reprocess the area at no additional cost to the OWNER or OWNER'S AGENT.
- H. Upon completion of backfilling and grading operations, all remaining excavated material, residual slurry or grout, and mixed backfill shall be removed and disposed by the CONTRACTOR in accordance with Section 02250 – TRANSPORTATION AND DISPOSAL OF MATERIALS and the appropriate ODEQ regulations.

PART 4 - QUALITY CONTROL AND QUALITY ASSURANCE

4.01 DEFINITIONS

- A. The CONTRACTOR shall be responsible to construct a GWBW which meets these Specifications, and conduct all QC tests as necessary to demonstrate that the construction of the GWBW meets the Specifications. The CONTRACTOR shall provide quality control inspectors, as needed, to ensure proper quality control of the project and to obtain quality control samples as required herein and on Table 02242-1.
- B. The ENGINEER or OWNER'S AGENT will be responsible for QA testing.

4.02 QUALITY CONTROL OF DELIVERED PRODUCTS

- A. Bentonite:
 - 1. The CONTRACTOR shall supply to the ENGINEER or OWNER'S AGENT, for each designated load of bentonite, the bentonite

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manufacturer's certifications and laboratory test results that demonstrate that the bentonite meets the Specifications.

2. The CONTRACTOR shall supply to the ENGINEER or OWNER'S AGENT samples of bentonite as required by the Specifications or as requested by the ENGINEER or OWNER'S AGENT.
3. The CONTRACTOR shall keep a log of bentonite deliveries that includes: date, source, time of delivery, weight and laboratory quality control test results supplied by the Manufacturer.
4. It shall be the responsibility of the CONTRACTOR to verify that the bentonite delivered meets the Specifications.

B. Other Reagents:

1. The CONTRACTOR shall supply to the ENGINEER or OWNER'S AGENT, for each designated load of reagent, the reagent manufacturer's certifications and laboratory test results that demonstrate that the reagent meets the Specifications.
2. The CONTRACTOR shall supply to the ENGINEER or OWNER'S AGENT samples of reagent as required by the Specifications or as requested by the ENGINEER or OWNER'S AGENT.
3. The CONTRACTOR shall keep a log of reagent deliveries that includes: date, source, time of delivery, weight and laboratory quality control test results supplied by the Manufacturer.
4. It shall be the responsibility of the CONTRACTOR to verify that the reagent delivered meets the Specifications.

4.03 QUALITY CONTROL OF SOIL-REAGENT SLURRY TRENCH

- A. The submittals and tests for reagent and water shall meet the requirements outlined in Table 02242-1.
- B. Soil-Reagent Backfill Material:
 1. The CONTRACTOR shall obtain samples of the soil-bentonite backfill as required by these Specifications and as deemed necessary to achieve the performance requirements specified in Table 02242-1. The test results shall be supplied to the ENGINEER or OWNER'S AGENT as soon as possible.

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2. Permeability:
 - a. The CONTRACTOR shall collect bulk and undisturbed samples of the soil-bentonite backfill at the frequencies specified in Table 02242-1 for laboratory permeability testing by a third-party laboratory to be procured by the CONTRACTOR. The tests shall be constant-head type permeability tests performed under a back pressure of 25 psi. During the saturation phase of the flexible wall permeability test, the difference between the chamber pressure and the back pressure shall not exceed 5 psi. The back pressure must be applied in small increments, with adequate time between increments to allow equalization of pore water pressure throughout the specimen. Typically, chamber pressure is about 7 psi and a chamber pressure and back pressure shall be in increment maintaining the back pressure at about 5 psi less than the chamber pressure. The imposed hydraulic gradient shall be less than 12 to minimize consolidation of the sample during testing. No additional consolidation stresses shall be applied to the test specimen other than that resulting from the imposed hydraulic gradient. Maximum turnaround times for quality control testing shall be required to be within one (1) week. The test results shall be provided to the ENGINEER or OWNER'S AGENT as soon as possible.
 - b. The in-place coefficient of permeability of the soil-bentonite backfill shall be as specified in Table 02242-1.
 3. The CONTRACTOR shall run additional tests as necessary to construct a GWBW that meets the Specifications. The CONTRACTOR shall split samples with the ENGINEER or OWNER'S AGENT, at the ENGINEER or OWNER'S AGENT request, to verify test results.
- C. Bentonite Slurry: The submittals and tests for initial slurry and in-trench slurry shall meet the requirements specified in Table 02242-1.
- D. The Test Wall Section shall be 100 feet in length.

4.04 QUALITY CONTROL OF JET GROUTING

- A. Submittals and tests for reagents shall meet the requirements outlined in Table 02242-1.

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- B. Prior to construction, ten (10) pre-production test columns, or a minimum of 25 feet in wall length, shall be constructed in site soils to evaluate the CONTRACTOR's proposed methods and the grout mix's ability to produce grout columns meeting the required depth and diameter. After evaluation of the test columns, modifications in the jet grout production procedures may be required to assure achieving the minimum performance requirements for the wall. Significant modifications will require a re-installation of the Test Wall Section, and subsequent re-testing.
- C. The CONTRACTOR shall conduct quality control tests on the jet grouting technology as specified in Table 02242-1

4.05 QUALITY CONTROL OF DEEP SOIL MIXING

- A. Submittals and tests for reagents shall meet the requirements outlined in Table 02242-1.
- B. The Test Wall Section shall be a minimum of 25 feet in length.
- C. The CONTRACTOR shall conduct quality control tests on the Deep Soil Mixing technology as specified in Table 02242-1

4.06 QUALITY CONTROL OF CLAY CAP

The CONTRACTOR shall test the in-place density and moisture content of the clay cap material in accordance with Section 02200 – EARTHWORK.

4.07 SOUNDINGS

- A. Soundings shall be taken every 20 feet along the GWBW centerline using a weighted tape, cable, or other device. Soundings shall be recorded to the nearest 0.5 feet. Soundings shall record the following:
 - 1. Bottom of Excavation: The bottom elevation of the GWBW shall be determined subject to approval by the ENGINEER or OWNER'S AGENT.
 - 2. Bottom of Excavation Prior to Backfilling: Soundings shall be used to monitor for sidewall collapse and accumulation of sediments.
 - 3. Profile of Backfill Slope: The backfill slope and trench bottom, if applicable, shall be sounded at the beginning and end of each shift and converted to an as-built drawing. This drawing shall be reviewed daily as an indication of trench collapse, excessive settlement or sloughing.

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4.08 AS-BUILT PROFILE

An as-built profile of the trench bottom, backfill slopes, including descriptions of materials encountered in the trench, and bottom of trench shall be continuously maintained by the CONTRACTOR. This profile shall indicate the extent of excavation and the backfill profile at the beginning and end of each work day or shift, as determined from the soundings. The daily profile drawing shall be in AutoCAD 2010. Materials encountered in the GWBW and bottom of the GWBW shall be described at a maximum interval of 20 lineal feet. The CONTRACTOR shall furnish profile drawings and records of all observations, measurements, and tests performed, identified with the location, date, and time of testing. These records shall be furnished to the ENGINEER or OWNER'S AGENT no later than 24 hours after the tests, measurements, and/or observations are made.

4.09 CONFIRM CONFINING LAYER

The ENGINEER or OWNER'S AGENT will determine when the top of bedrock has been reached. One method the ENGINEER or OWNER'S AGENT may consider for determining when the target depth has been achieved is the inability of the CONTRACTOR's equipment to advance more than six (6) inches in depth over a length of 20 lineal feet in a 30 minute period.

4.10 REJECTED GROUNDWATER BARRIER WALL SECTION

If the required quality control parameters are not achieved for a given sample, the corresponding section of GWBW will be rejected. The deficient section limits will be determined by the ENGINEER or OWNER'S AGENT. If tests fail to meet the specified requirements, the ENGINEER or OWNER'S AGENT reserves the right to require additional sampling and testing at the CONTRACTOR's expense. For failed/rejected sections, the CONTRACTOR shall remove and replace the GWBW within the limits specified by the ENGINEER or OWNER'S AGENT at no additional cost to the OWNER or OWNER'S AGENT.

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TABLE 02242-1 QUALITY CONTROL TESTING

Technology	Construction Phase	Component	Parameter	Test Method	Frequency	Acceptance Criteria	
Soil-Bentonite Slurry Wall	Pre-Construction	Bentonite	Free Swell Test	USP NF XVII	Once per borrow source	16 cm ³ minimum	
			YP/PV Ratio	API 13A	Once each truck or railcar shipment	3 minimum	
			Plastic Viscosity	API 13A	Once per borrow source	10 minimum	
			Filtrate Loss	API 13A	Once each truck or railcar shipment	15 cm ³ maximum	
			Moisture Content	ASTM D2216	Once each truck or railcar shipment	10% maximum	
			Viscometer	API 13A	Once per borrow source	30 minimum @ 600 rpm	
		Residue > 75 um	API 13A	Once per borrow source	4% maximum		
		Mix Water	pH	API RP 13B-1	Once per source	6 to 8	
			Total Dissolved Solids	EPA 600	Once per source	500 mg/L maximum	
		Soil Backfill (Imported Soil Backfill Only)	Hardness	API RP 13B-1	Once per source	50 mg/L maximum	
	Particle Size Analysis		ASTM D422	Once every 500 cy	100% passing 3 in, minimum 15% passing No. 200		
	Initial Slurry	Soil Backfill (Imported Soil Backfill Only)	Moisture Content	ASTM D2216	Once every 500 cy	For record	
			Atterberg Limits	ASTM D4318	Once every 500 cy	LL > 30, PI > 10	
		Soil-Bentonite Backfill	Viscosity	API RP 13B-1	Twice per 8-hour shift	40 marsh seconds minimum	
			Density	ASTM D4380	Twice per 8-hour shift	64 pcf minimum and > 15 pcf less than the backfill	
			Filtrate Loss	API RP-13B-1	Twice per 8-hour shift	<25 cm ³ in 30 minutes @ 100 psi	
		In-Trench Slurry	pH	API RP 13B-1	Twice per 8-hour shift	6 to 9	
			Viscosity	API RP 13B-1	Twice per 8-hour shift	40 marsh seconds minimum	
			Density	ASTM D4380	Twice per 8-hour shift	64 to 85 pcf and > 15 pcf less than the backfill	
		Construction	Soil-Bentonite Backfill	Particle Size Analysis	ASTM D422	One per day or one every 200 lineal feet at alternating 25 vertical foot intervals	100% passing 3 in, minimum 15% passing No. 200
				Atterberg Limits	ASTM D4318	One per day or one every 200 lineal feet at alternating 25 vertical foot intervals	LL > 30, PI > 10
	Soil-Bentonite Backfill		Permeability	ASTM D5084	One per day or one every 200 lineal feet at alternating 25 vertical foot intervals	1 x 10 ⁻⁶ cm/sec maximum	
			Slump	ASTM C143	Twice per 8-hour shift	4 to 6 inches	
Density			ASTM D4380	Twice per 8-hour shift	At least 15 pcf greater than the in-trench slurry		
Post-Construction	Soil-Bentonite Backfill	Permeability	ASTM D5084	One undisturbed sample from the ground surface to mid-depth and one from mid-depth to the bottom in the Chlorate Area and in the Acid Plant Area	1 x 10 ⁻⁶ cm/sec maximum		
Deep Soil Mixing	Pre-Construction	Bentonite	Free Swell Test	USP NF XVII	Once per borrow source	16 cm ³ minimum	
			YP/PV Ratio	API 13A	Once each truck or railcar shipment	3 minimum	
			Plastic Viscosity	API 13A	Once per borrow source	10 minimum	
			Filtrate Loss	API 13A	Once each truck or railcar shipment	15 cm ³ maximum	
			Moisture Content	ASTM D2216	Once each truck or railcar shipment	10% maximum	
			Viscometer	API 13A	Once per borrow source	30 minimum @ 600 rpm	
	Residue > 75 um	API 13A	Once per borrow source	4% maximum			
	Mix Water	pH	API RP 13B-1	Once per source	6 to 8		
		Total Dissolved Solids	EPA 600	Once per source	500 mg/L maximum		
	Construction	Column Mold	Permeability	ASTM D5084	One per day or one every 200 lineal feet at alternating 25 vertical foot intervals	1 x 10 ⁻⁶ cm/sec maximum	
Hardness							API RP 13B-1
Post-Construction	Cured Core	Permeability	ASTM D5084	One undisturbed sample from the ground surface to mid-depth and one from mid-depth to the bottom in the Chlorate Area and in the Acid Plant Area	1 x 10 ⁻⁶ cm/sec maximum		
Jet Grouting	Pre-Construction	Bentonite	Free Swell Test	USP NF XVII	Once per borrow source	16 cm ³ minimum	
			YP/PV Ratio	API 13A	Once each truck or railcar shipment	3 minimum	
			Plastic Viscosity	API 13A	Once per borrow source	10 minimum	
			Filtrate Loss	API 13A	Once each truck or railcar shipment	15 cm ³ maximum	
			Moisture Content	ASTM D2216	Once each truck or railcar shipment	10% maximum	
			Viscometer	API 13A	Once per borrow source	30 minimum @ 600 rpm	
	Residue > 75 um	API 13A	Once per borrow source	4% maximum			
	Mix Water	pH	API RP 13B-1	Once per source	6 to 8		
		Total Dissolved Solids	EPA 600	Once per source	500 mg/L maximum		
	Construction	Column Mold	Permeability	ASTM D5084	One per day or one every 200 lineal feet at alternating 25 vertical foot intervals	1 x 10 ⁻⁶ cm/sec maximum	
Hardness							API RP 13B-1
Post-Construction	Cured Core	Permeability	ASTM D5084	One undisturbed sample from the ground surface to mid-depth and one from mid-depth to the bottom in the Chlorate Area and in the Acid Plant Area	1 x 10 ⁻⁶ cm/sec maximum		

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GROUNDWATER BARRIER WALL

TABLE 02242-2 LABORATORY PHASE REQUIREMENTS

Component	Parameter	Test Method	Notes
Reagent	Moisture Content	ASTM D2216	Select a minimum of two (2) reagents
	Residue > 75 um	API 13A	
Mix Water	pH	API RP 13B-1	Once per source
	Total Dissolved Solids	EPA 600	
	Hardness	API RP 13B-1	
Soil Backfill	Particle Size Analysis	ASTM D422	Contractor will be provided with two (2) composite soil sample - one from the Chlorate Area and one from the Acid Plant Area
	Moisture Content	ASTM D2216	
	Atterberg Limits	ASTM D4318	
Water-Reagent Slurry	Reagent to Water Ratio	-	Contractor will be provided with a sample of site mix water, chloride-impacted groundwater, and organics-impacted groundwater. The contractor shall prepare a slurry with each reagent considered at the same reagent to water ratio using each type of water. Slurries prepared with impacted groundwater shall utilize a solution consisting of 85% site mix water and 15% impacted groundwater. The most severe water type shall be selected by the engineer and contractor and shall be used to prepare any additional water-reagent slurries deemed necessary by the contractor.
	Free Swell	USP NF XVII	
	Filtrate Loss	API 13A	
	Viscometer	API 13A	
	Sedimentation	API RP 13B-1	
	YP/PV Ratio	API 13A	
	Viscosity	API RP 13B-1	
	Density	API RP 13B-1	
pH	ASTM D4380		
Soil-Reagent Backfill	Reagent Content	-	Contractor shall prepare a minimum of five (5) mixes using the most severe groundwater and corresponding soil identified in the slurry stage and test for permeability (ASTM D5084), slump, and density. The contractor shall select two (2) mixes for long-term compatibility testing (ASTM D7100) and particle size analysis. The two selected mixes shall also be prepared using the other groundwater and corresponding soil type and tested for permeability (ASTM D5084) and long-term compatibility (ASTM D7100). Long-term compatibility testing shall include analysis of the pH and electrical conductivity of the influent and effluent.
	Permeability	ASTM D5084	
	Particle Size Analysis	ASTM D422	
	Slump	ASTM C143	
	Density	ASTM D4380	
Permeability (long-term compatibility)	ASTM D7100		

END OF SECTION

*02250 – Transportation and
Disposal of Materials*

TRANSPORTATION AND DISPOSAL OF MATERIALS

PART 1 - GENERAL

1.01 DESCRIPTION

The CONTRACTOR shall furnish all labor, materials, tools, and equipment, required to transport all concrete/asphalt debris, piping, spoils, liquids, and other waste materials for on-site disposal as specified in these Contract Documents. All concrete/asphalt debris, piping, spoils, liquids, and other waste materials, other than general refuse and sanitary wastes, shall be contained and/or disposed on-site, in accordance with these Specifications and the Contaminated Material Management Plan (Attachment 1).

1.02 REGULATORY REQUIREMENTS

- A. All concrete/asphalt and other general construction debris, piping, and spoils shall be disposed at approved on-site locations. All liquids generated during performance of the Work shall be containerized and stored at approved on-site locations. All disposal and storage shall be in accordance with the Contaminated Material Management Plan (Attachment 1) and all federal, state, and local regulations.
- B. All concrete/asphalt debris, piping, and other general construction debris shall be cleaned and properly decontaminated prior to disposal on-site.

1.03 TRANSPORTATION

- A. The CONTRACTOR shall be responsible for transporting concrete/asphalt debris, piping, spoils, liquids, and other waste materials to the appropriate on-site location for disposal.
- B. The CONTRACTOR shall be responsible for all sampling and testing required by the ENGINEER or OWNER'S AGENT.
- C. The CONTRACTOR shall provide all necessary traffic controls at the ingress and egress location along Northwest Front Avenue, such as flagmen, during trucking operations, or as otherwise directed by the ENGINEER or OWNER'S AGENT.
- D. No queuing of trucks shall be permitted on Northwest Front Avenue. Any queuing of trucks that occurs on-site shall not interfere with daily traffic.

1.04 SUBMITTALS

- A. In accordance with Section 01300 – SUBMITTALS and the Construction Quality Assurance/Quality Control (CQA/QC) Plan.

TRANSPORTATION AND DISPOSAL OF MATERIALS

- B. The CONTRACTOR shall be responsible for performing any tests (e.g. Paint Filter Liquids Test EPA Method 9095A) required to ensure the materials are suitable for disposal on-site. The CONTRACTOR shall submit copies of results of any tests performed.
- C. The CONTRACTOR shall not commence with the disposal of concrete/asphalt debris, piping, spoils, liquids, and other waste materials until the ENGINEER or OWNER'S AGENT has approved the submitted information.
- D. For each waste material stream disposed, the CONTRACTOR shall submit documentation to the ENGINEER or OWNER'S AGENT identifying, at a minimum, the origin of the material, the quantity of the material (tons, cubic yards, units, etc.), and the date and location of where the material was disposed.

1.05 OFF-SITE TRANSPORTATION AND DISPOSAL

- A. It is not anticipated that any concrete/asphalt debris, piping, spoils, or liquids will be disposed off-site as part of the Work. However, if the ENGINEER or OWNER'S AGENT determines that off-site disposal of waste materials is desirable, the following minimum requirements shall apply.
 - 1. The concrete/asphalt debris, piping, spoils, liquids, and other waste materials removed shall be cleaned and properly decontaminated (or contained in the case of contaminated soils and liquids) sufficient for transportation in accordance with these Specifications and all federal, state, and local regulations.
 - 2. The CONTRACTOR shall comply with all applicable regulatory requirements and all federal, state, or local laws, codes, and ordinances which govern the transportation and disposal of material to be removed from the Site. Materials transported off-site shall meet the ODEQ off-site disposal policy and comply with all applicable regulations.
 - 3. The CONTRACTOR shall obtain any and all permits required for transport and disposal and comply with all applicable requirements.
 - 4. Unless directed by the OWNER'S AGENT to dispose material at a particular facility, the CONTRACTOR shall be responsible for locating disposal facilities; e.g., solid waste disposal facility,

TRANSPORTATION AND DISPOSAL OF MATERIALS

hazardous waste disposal facility, etc., which shall accept all materials removed from the Site to be disposed, including materials generated from site clearing and grubbing or other activities performed within the areas of Work, as applicable.

5. The CONTRACTOR shall submit written documentation certifying that the disposal facility is in compliance with all regulations and permits, and is willing to accept the material. A copy of the most recent inspection report shall be submitted to the ENGINEER or OWNER'S AGENT verifying that the facilities have no violations or other environmental conditions that affect the satisfactory operation of the facility.
6. The CONTRACTOR shall submit results of any tests performed at the disposal facility by the disposal facility prior to waste acceptance. The CONTRACTOR shall be responsible for performing any test required by the receiving facility prior for the disposal of materials.
5. The disposal facility shall be approved by the ENGINEER or OWNER'S AGENT. The disposal facility shall be in compliance with all current federal and state regulations governing construction and operation of an appropriate waste disposal facility.
6. In the event that the identified and approved facilities cease to accept the stated materials or the facility ceases operations or the OWNER'S AGENT rejects the facility, it is the CONTRACTOR's responsibility to locate an alternate approved and permitted facility for accepting materials. The CONTRACTOR is responsible for making the necessary arrangements to utilize the facility and the alternate facility must be approved in writing by the OWNER'S AGENT in the same manner and with the same requirements as the original facility before the concrete/asphalt debris, spoils, waste materials, impacted water, or other materials, are removed from the Site.
7. The CONTRACTOR shall prepare and submit to the ENGINEER or OWNER'S AGENT information regarding transporting materials from the Site, including type of trucks and/or trailers, method of transportation, the transport route to the facility, the anticipated number of trips, and the proposed types and locations of necessary traffic control devices to be used by the CONTRACTOR. The CONTRACTOR shall also list all federal, state, and local regulations that must be complied with and all permits that must be obtained.

TRANSPORTATION AND DISPOSAL OF MATERIALS

8. The CONTRACTOR shall submit copies of weigh tickets or other receipts provided by the disposal facility to the ENGINEER or OWNER'S AGENT as evidence of the arrival and disposal of the material at the disposal site, including any salvaging, recycling, or recovery. The documentation submitted to the ENGINEER or OWNER'S AGENT shall, at a minimum, identify the origin of the material, the quantity of the material (tons, cubic yards, units, etc.), the identification of the transport vehicle, type of material, and the date the material was disposed at the facility.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

3.01 GENERAL

- A. No vehicle shall leave the Site unless it is in a clean condition, free of loose dirt or loose material on tailgates, axles, wheels, etc.
- B. No vehicle shall leave the Site unless the materials being transported are secure and tightly covered/tarped or contained so that no material, dust, or water is able to drop off, blow off, or leak out. Trucks shall be lined at the discretion of the ENGINEER or OWNER'S AGENT.
- C. Loading and transportation of concrete/asphalt debris, piping, spoils, liquids, and other waste materials shall be conducted in a manner as to eliminate all dust.
- D. All personnel, equipment, and trucks shall enter and exit the Site from Northwest Front Avenue. Prior to exiting the Site all decontamination requirements of these Specifications and the Site Health and Safety Plan shall be met.
- E. In the event that the materials being transported are dropped or spilled from the truck during transportation, the CONTRACTOR shall take the following steps.
 1. If contents are spilled on-site, the CONTRACTOR shall immediately notify the ENGINEER or OWNER'S AGENT. The CONTRACTOR is responsible for immediate removal of the waste materials and cleaning the area to the satisfaction of the ENGINEER or OWNER'S AGENT.

TRANSPORTATION AND DISPOSAL OF MATERIALS

2. If contents are spilled off-site, the CONTRACTOR shall immediately notify the ENGINEER, OWNER'S AGENT, OWNER, and the appropriate authorities; i.e., local fire and police departments. The appropriate clean up activities shall be coordinated without delay with these authorities.
 3. If contents are spilled, the truck shall return and go through the decontamination station again before proceeding off-site.
 4. If contents are spilled, no additional loads shall leave the site until the decontamination procedures are reviewed and necessary changes implemented to ensure that dropping or tracking of material and debris beyond the decontamination station does not occur.
 5. The CONTRACTOR shall bear full responsibility for any required clean up of all spilled material. All clean up and remediation activities associated with spilled materials shall be performed at no extra cost to the OWNER or OWNER'S AGENT.
- F. The CONTRACTOR shall be responsible for managing, handling, conditioning, transporting, and disposing of all waste materials, in accordance with these Specifications and the Contaminated Material Management Plan (CMMP), included as Attachment 1

3.02 OFF-SITE TRANSPORTATION AND DISPOSAL

- A. It is not anticipated that any concrete/asphalt debris, piping, spoils, or liquids will be disposed off-site as part of the Work. However, if the ENGINEER or OWNER'S AGENT determines that off-site disposal of some waste materials is desirable, the following minimum requirements shall apply.
1. No material shall exit the Site unless it has been analyzed and documented (e.g., manifest), as necessary.
 2. No material, except dewatering and decontamination liquids, shall exit the Site that fails the Paint Filter Liquid Test, EPA Method 9095A.
 3. The CONTRACTOR shall maintain at the Site a log of vehicles leaving the Site with waste materials. The log shall indicate the vehicle identification number, date and time of departure, contents of the truck, and approximate volume or quantity of material carried.

02250
TRANSPORTATION AND DISPOSAL OF MATERIALS

END OF SECTION

*02290 – Soil Erosion and
Sediment Control*

02290
SOIL EROSION AND SEDIMENT CONTROL

PART 1- GENERAL

1.01 DESCRIPTION

- A. The Work covered by this Section consists of furnishing all materials, equipment, tools and labor to construct, maintain, and remove soil erosion and sediment control systems.
- B. The Work to be performed includes, but is not limited to the installation or construction of silt fence, permanent seeding, and any other controls necessary as specified herein, shown on the Drawings, or required to eliminate the potential for sediment-laden surface water to flow beyond the limits of disturbance.

1.02 REFERENCES

- A. 2005 Oregon Department of Environmental Quality Erosion and Sediment Control Manual
- B. 2008 Portland Erosion and Sediment Control Manual

1.03 QUALITY ASSURANCE

- A. All materials, procedures, operations, and methods shall be in strict conformance with the Drawings and these Specifications, and shall be subject to strict quality control monitoring as detailed herein. The installed erosion and sediment controls shall conform exactly to the Drawings and these Specifications, except as otherwise authorized in writing by the ENGINEER or OWNER'S AGENT.
- B. The CONTRACTOR shall comprehend and anticipate quality assurance activities and account for these activities in the installation schedule.
- C. The CONTRACTOR shall periodically inspect and maintain proper erosion and sediment control measures throughout the duration of the project, including weekends and holidays. All erosion and sediment controls shall be maintained as necessary for rainfalls one-half inch (1/2") or greater.

1.04 SUBMITTALS

Product data shall be submitted as indicated in these Contract Documents.

SOIL EROSION AND SEDIMENT CONTROL

PART 2 - PRODUCTS

2.01 SOIL EROSION AND SEDIMENT CONTROL MATERIALS

Silt Fence: The CONTRACTOR shall supply silt fence to control surface-water runoff and sediment in locations indicated on the Drawings. As specified in the Portland Erosion and Sediment Control Manual, silt fence material shall be heavy-duty fabric and shall retain 85 percent of the soil by weight. The fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0 to 120 degrees Fahrenheit.

The CONTRACTOR shall submit the manufacturer's product data to the ENGINEER or OWNER'S AGENT for approval.

PART 3 - EXECUTION

3.01 TRANSPORTATION, HANDLING AND STORAGE

Materials shall be handled in such a manner as to prevent damage to the material. Materials shall not be dropped or dragged over the ground. Any materials damaged shall be replaced at no expense to the OWNER or OWNER'S AGENT.

3.02 EROSION AND SEDIMENT CONTROL STRUCTURES

Silt Fence: The CONTRACTOR shall install silt fence in accordance with the Specifications and installation instructions provided by the manufacturer, as shown on the Drawings, or as directed by the ENGINEER or OWNER'S AGENT. Presiding authority shall be as follows, in descending order: ENGINEER or OWNER'S AGENT direction, Drawings, Specifications, manufacturer's installation instructions. The CONTRACTOR shall maintain the silt fence until permanent cover is established, and the entire Site is stabilized, as approved by the ENGINEER or OWNER'S AGENT.

END OF SECTION

02711 - Geotextile

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the manufacture, storage, delivery, installation, and testing of the geotextile portions of this project, including installation as herein specified and as shown on the Drawings.
- B. The CONTRACTOR shall perform the installation of the geotextiles in conjunction with all necessary construction, as depicted on the Drawings.

1.02 REFERENCES

- A. ASTM D-5261 Measuring Mass Per Unit Area of Geotextiles
- B. ASTM D-3776 Mass Per Unit Area (Weight) of Fabric
- C. ASTM D-4491 Water Permeability of Geotextiles by the Permittivity Method.
- D. ASTM D-4533 Trapezoid Tearing Strength of Geotextiles.
- E. ASTM D-4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
- F. ASTM D-4751 Determining Apparent Opening Size of a Geotextile.
- G. ASTM D-6241 Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile- Related Products Using a 50-mm Probe

1.03 QUALITY ASSURANCE

All materials, procedures, operations, and methods shall be in strict conformance with the Drawings and Specifications and shall be subject to strict quality control monitoring as detailed herein. The installed geotextiles shall conform exactly to the Drawings and Specifications, except as otherwise authorized in writing by the ENGINEER or OWNER'S AGENT.

02711
GEOTEXTILE

1.04 SUBMITTALS

- A. Prior to shipment of any geotextile materials, the CONTRACTOR shall submit the necessary information on the geotextile to document compliance with these Specifications.
- B. The geotextile manufacturer shall replace any material that is rejected because it does not comply with these Specifications.
- C. Upon delivery to the site, the CONTRACTOR and the ENGINEER or OWNER'S AGENT shall inspect the physical condition of the material. If the protective wrapping is damaged, or if damage is suspected, the material shall be replaced.

PART 2-PRODUCTS

2.01 GEOTEXTILE MATERIAL

- A. General Requirements
 - 1. Unless otherwise noted on the Drawings, geotextile suppliers shall furnish materials whose "Minimum Average Roll Values", as defined by the Federal Highway Administration (FHWA), meet or exceed the criteria specified in Table 02711-1. The geotextiles provided by the supplier shall meet or exceed the property value specified and shall be stock products; i.e., unless authorized, the supplier shall not furnish products specially, manufactured to meet the specifications of this project.
 - 2. The supplier shall furnish test results for the design criteria, as well as written certification that the materials meet the specifications in accordance with these Contract Documents.
 - 3. The geotextile material shall also perform the following:
 - a. Retain its structure during handling, placement and long-term service;
 - b. The material shall be capable of withstanding direct exposure to sunlight for 30 days with no measurable deterioration; and,
 - c. The material shall be chemically compatible with the materials that will be in contact with it.

02711
GEOTEXTILE

B. Labeling

1. The geotextile shall be supplied wrapped in relatively impermeable and opaque protective covers.
2. The geotextile shall be marked or tagged with the following information:
 - a. Manufacturer's name;
 - b. Product identification;
 - c. Lot number;
 - d. Roll number; and,
 - e. Roll dimensions.
3. Additionally, if any special placement is required, it shall be so marked on the textile material; e.g., "This Side Up", or "This Side Against Soil to be Retained".

2.02 TRANSPORTATION, HANDLING, AND STORAGE

- A. Transportation of the CONTRACTOR-supplied geotextile materials is the responsibility of the CONTRACTOR.
- B. Handling, storage, and care of the CONTRACTOR-supplied geotextile materials prior to and following installation at the site is the responsibility of the CONTRACTOR. The CONTRACTOR shall provide adequate storage space at the site.
- C. During shipment and storage, geotextiles shall be protected from ultraviolet light exposure, precipitation, or other inundation, mud, dirt, dust, punctures, cutting or any other damaging or deleterious conditions. Any additional storage procedures required by the geotextile manufacturer shall be the CONTRACTOR's responsibility.

PART 3-EXECUTION

3.01 HANDLING AND PLACEMENT

- A. The CONTRACTOR shall handle all geotextiles in such a manner as to ensure that they are not damaged in any way.
- B. In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

02711
GEOTEXTILE

C. Inspection:

Prior to implementing any of the Work in this Section, the installed Work of all other Sections shall be complete to the point where the Work of this Section may properly commence without adverse impact.

- D. During placement, care shall be taken not to entrap in the geotextile stones, excessive dust, or moisture that could cause damage.
- E. An examination of the geotextile over the entire surface, after installation, will be conducted by the ENGINEER or OWNER'S AGENT to ensure that no potentially harmful foreign objects, such as needles, are present. Any foreign objects so encountered shall be removed or the geotextile shall be replaced.
- F. The geotextile shall only be cut using a geotextile cutter or other methods approved by the ENGINEER or OWNER'S AGENT.
- G. After unwrapping the geotextile from its opaque wrapping, the geotextile shall not be left exposed for longer than 14 days, unless approved by the ENGINEER or OWNER'S AGENT.

3.02 SEAMS AND OVERLAPS

- A. If seams are required, all geotextiles shall be overlapped 6 inches.
- B. The CONTRACTOR shall pay particular attention at seams to ensure that no foreign material is inadvertently inserted beneath a geotextile.

3.03 REPAIR

- A. Any holes or tears in the geotextile shall be repaired by one of the following methods:
1. Liestering a patch made from the same geotextile over the affected area, with a minimum of 1 foot overlap in all directions.
 2. Sewing a patch made from the same geotextile over the affected area with a minimum of 6 inch overlap in all directions.

02711
GEOTEXTILE

3.04 PLACEMENT OF OVERLYING MATERIALS

- A. The CONTRACTOR shall place all overlying materials located on top of the geotextile in such a manner as to ensure:
1. No damage of the geotextile or underlying layers;
 2. Minimal slippage between the geotextile and the underlying layers; and,
 3. No excess tensile stresses in the geotextile.
- B. Equipment shall not be driven directly on the geotextile.

Table 02711-1

REQUIRED PROPERTY VALUES FOR NON-WOVEN GEOTEXTILES

PROPERTIES	QUALIFIER	SPECIFIED VALUE	TEST METHOD
Polymer Composition	Minimum	95% weight polypropylene or polyester	----
Fabric Weight	Minimum	10 oz/sq yd	ASTM D-5261
Puncture Strength	Minimum	700 lbs	ASTM D-6241
Grab Tensile Strength	Minimum	250 lbs	ASTM D-4632
Grab Tensile Elongation	Minimum	50 %	ASTM D-4632
Trapezoidal Tear Strength	Minimum	100 lbs	ASTM D-4533
Flow Rate	Minimum	75 gpm/sq ft	ASTM D-4491
Permittivity	Minimum	0.8 sec ⁻¹	ASTM D-4491
Apparent Opening Size (A.O.S.)	Maximum	Sieve Size: 100	ASTM D-4751

END OF SECTION

02711
GEOTEXTILE

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02715 - Geogrid

PART 1 – GENERAL

1.01 DESCRIPTION

The CONTRACTOR shall furnish all materials, equipment, and labor necessary for installing geogrid reinforcement to the lines and grades designated on the Drawings.

1.02 REFERENCES

- A. ASTM D-4355 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
- B. ASTM D-4759 Standard Practice for Determining the Specification Conformance of Geosynthetics
- C. ASTM D-5732 Standard Test Method for Stiffness of Nonwoven Fabrics Using the Cantilever Test
- D. ASTM D-5818 Standard Practice for Exposure and Retrieval of Samples To Evaluate Installation Damage of Geosynthetics
- E. ASTM D-6637 Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method
- F. EPA 9090 Test Method for Determining the Chemical Waste Compatibility of Synthetic Liners
- G. GRI-GG2 Geogrid Junction Strength

1.03 DELIVERY, STORAGE, AND HANDLING

- A. CONTRACTOR shall inspect the geogrid upon delivery to ensure that the proper material has been received.
- B. Geogrid shall be stored above -20°F (-29°C) and shall be shielded from direct exposure to sunlight.
- C. CONTRACTOR shall prevent excessive mud, wet cement, epoxy, and like materials, which may affix themselves to the geogrid, from contacting the geogrid material.
- D. Rolled geogrid material may be laid flat or stood on end for storage.

1.04 QUALITY ASSURANCE

- A. All materials, procedures, operations, and methods shall be in strict conformance with these Specifications, and shall be subject to strict quality control monitoring as detailed herein. The installed geogrid shall conform exactly to the Specifications, except as otherwise authorized in writing by the ENGINEER or OWNER'S AGENT.
- B. The CONTRACTOR shall comprehend and anticipate CQA activities and account for these activities in the installation schedule.

1.05 SUBMITTALS

- A. In accordance with these Contract Documents.
- B. The Manufacturer and the Fabricator shall provide, two weeks prior to delivery, samples and Certificates of Compliance that the material is in accordance with these Specifications and is suitable for use.
- C. The Manufacturer of the geogrid shall provide recommendations for overlapping, cable-tying, and general installation recommendations.
- D. The CONTRACTOR shall provide, two weeks prior to installation, Shop Drawings showing anchoring details and other details pertinent to the installation of the geogrid under this contract.
- E. The CONTRACTOR shall list all equipment, tools, materials, protective clothing, and labor to be provided prior to the start of installation to ensure the timely completion of all installations.
- F. The manufacturer shall submit to the ENGINEER or OWNER'S AGENT, two weeks prior to delivery, data on the physical and chemical properties of the materials with reference to appropriate ASTM testing methods utilized in obtaining the data and the following information on the raw materials:
 - 1. Origin and production date of the resin;
 - 2. A copy of the quality control certificates issued by the resin supplier;
 - 3. Reports of tests conducted by the Manufacturer to verify that the material is in conformance with all requirements identified in this Section; and,
 - 4. Certification that no reclaimed polymer is added to the resin.
- G. The CONTRACTOR shall transport, handle, and store the geogrid as necessary to maintain the integrity of the geogrid prior to its installation.

PART 2 – PRODUCTS

2.01 DEFINITIONS

- A. Geogrid: A high density polyethylene (HDPE) grid structure manufactured for use as a subbase reinforcement layer for roadways installed over soft soils or other unstable materials.
- B. Biaxial Geogrid: A geogrid which has been manufactured with high junction strength and high tensile strength and modules in two directions, along the roll length and across the roll width.
- C. Direction of Geogrid: Refers to the orientation in which the geogrid is used for a particular project, which is along the machine direction (roll direction) for biaxial geogrid.
- D. MD: Machine direction.
- E. CMD: Cross-machine direction.
- F. All slack shall be mechanically removed from the placed geogrids before any material (e.g., aggregate base course) is placed on top of it.
- G. All information pertaining to placement of aggregate on top of the geogrid is included in Section 02232 – GRANULAR MATERIALS.

2.02 ACCEPTABLE MANUFACTURERS

- A. The Tensar Corporation, Morrow, Georgia.
- B. A manufacturer of equivalent products, pre-approved by the ENGINEER or OWNER'S AGENT.

2.03 MATERIALS

- A. The geogrid shall:
 - 1. Be model BX1500 manufactured by Tensar Corporation, or an approved equivalent.
 - 2. Be a biaxially-oriented grid structure.
 - 3. Be composed of high density polyethylene (HDPE).
 - 4. Have aperture geometry and rib and junction cross-sections sufficient to permit mechanical interlock with the material being supported.
 - 5. Have high continuity of tensile strength through all ribs and junctions of the grid structure.

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GEOGRID

6. Maintain its reinforcement and interlock capabilities under repeated dynamic loads while in service.
7. Be resistant to ultraviolet degradation, to damage under normal construction practices, and to all forms of biological or chemical degradation typically encountered at similar sites.

B. Labeling

1. Geogrid shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers.
2. Geogrid and rolls shall be marked or tagged with the following information:
 - a) Manufacturer's name;
 - b) Product identification;
 - c) Lot number;
 - d) Roll number; and,
 - e) Roll dimensions.
3. Additionally, if any special placement is required, it shall be so marked on the geogrid material, e.g., "This Side Up", or "This Side Against Soil to be Retained".

- C. The geogrid shall conform in all respects to the property requirements listed in Table 02715-1.

PART 3 - EXECUTION

3.01 EXAMINATION

The CONTRACTOR shall check the geogrid upon delivery to verify that the proper material has been received. The geogrid shall be inspected by the Contractor to be free of flaws or damage occurring during manufacturing, shipping, or handling.

3.02 PREPARATION

The subgrade soil shall be prepared as indicated on the Construction Drawings or as directed by the ENGINEER or OWNER'S AGENT.

3.03 INSTALLATION

- A. The geogrid shall be laid at the proper alignment as shown on the Construction Drawings.

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GEOGRID

- B. The geogrid shall be installed in accordance with the installation guidelines provided by the Manufacturer or as directed by the ENGINEER or OWNER'S AGENT.
- C. The geogrid may be temporarily secured in place with ties, staples, pins, sand bags or backfill as required by fill properties, fill placement procedures or weather conditions or as directed by the ENGINEER or OWNER'S AGENT.

3.04 GRANULAR FILL PLACEMENT OVER GEOGRID

- A. Granular fill material shall be placed in lifts and compacted as directed under Section 02232 – GRANULAR MATERIALS. Granular fill material shall be placed, spread, and compacted in such a manner that minimizes the development of wrinkles in the geogrid and/or movement of the geogrid.
- B. A minimum loose fill thickness of 12 inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid. When underlying substrate is trafficable with minimal rutting, rubber-tired equipment may pass over the geogrid reinforcement at slow speeds (less than 10 mph) when integrally-formed geogrids are used. When woven, multi-layer or welded-strip geogrids are used, rubber-tired equipment shall not be allowed to pass directly on the geogrid. Sudden braking and sharp turning movements shall be avoided.

3.05 INSPECTION

- A. The OWNER, ENGINEER or OWNER'S REPRESENTATIVE may randomly inspect geogrid before, during and after (using test pits) installation.
- B. Any damaged or defective geogrid (i.e. frayed coating, separated junctions, separated layers, tears, etc.) will be repaired/replaced in accordance with Part 3.06 of this Section.

3.06 REPAIR

- A. Any roll of geogrid damaged before, during and after installation shall be replaced by the CONTRACTOR at no additional cost to the OWNER or OWNER'S AGENT.
- B. Proper replacement shall consist of replacing the affected area adding three (3) feet of geogrid to either side of the affected area.

3.07 PROTECTION

Follow the Manufacturer's recommendations regarding protection from exposure to sunlight.

**Table 02715-1
Geogrid Properties**

Property	Test Method	Units	Value¹
<i>Index Properties</i>			
Aperture Dimensions ²	ASTM D-4759		
MD		in	1.0 (nom)
XMD		in	1.2 (nom)
Rib Thickness ²	ASTM D-4759		
MD		in	0.07 (nom)
XMD		in	0.07 (nom)
Tensile Strength @ 2% Strain ³	ASTM D-6637		
MD		lb/ft	580
XMD		lb/ft	690
Tensile Strength @ 5% Strain ³	ASTM D-6637		
MD		lb/ft	1,200
XCMD		lb/ft	1,370
Ultimate Tensile Strength ³	ASTM D-6637		
MD		lb/ft	1,850
XMD		lb/ft	2,050
<i>Structural Integrity</i>			
Junction Efficiency ⁴	GRI-GG2	%	93
Flexural Stiffness ⁵	ASTM D-5732	mg-cm	2,000,000
Aperture Stability ⁶		m-N/deg	0.75
<i>Durability</i>			
Resistance to Installation Damage ⁷	ASTM D-5818 ASTM D-6637	%SC/%SW/%GP	95/93/90
Resistance to Long-Term Degradation ⁸	EPA 9090	%	100
Resistance to UV Degradation ⁹	ASTM D-4355	%	100

Notes:

1. Unless indicated otherwise, values shown are minimum average roll values (MARV) determined in accordance with ASTM D-4759. The row labeled MD represents results from testing the product in the machine direction. The row labeled XMD represents results from testing the product in the cross-machine (transverse) direction.
2. Nominal dimensions.
3. True resistance to elongation when initially subjected to a load determined in accordance with ASTM D-6637 without deforming test materials under load before measuring such resistance or employing “secant” or “offset” methods of tangent measurement so as to overstate tensile properties.
4. Load transfer capability determined in accordance with GRI-GG2 and expressed as a percentage of ultimate tensile strength.
5. Resistance to bending force determined in accordance with ASTM D-5732, using specimens of width two ribs wide, with transverse ribs cut flush with exterior edges of longitudinal ribs (as a “ladder”), and of length sufficiently long to enable measurement of the overhang dimension. The overall flexural stiffness is calculated as the square root of the product of MD and XMD flexural stiffness values.
6. Resistance to in-plane rotational movement measured by applying a 20 kg-cm (2 m-N) moment to the central junction of a 9 inch x 9 inch specimen restrained at its perimeter in accordance with U.S. Army Corps of Engineers Methodology for measurements for torsional rigidity.
7. Resistance to loss of load capacity or structural integrity when subjected to mechanical installation stress in clayey sand (SC), well graded sand (SW), and crushed stone classified as poorly graded gravel (GP). The geogrid shall be sampled in accordance with ASTM D-5818 and load capacity shall be determined in accordance with ASTM D-6637.
8. Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments in accordance with EPA 9090 immersion testing.
9. Resistance to loss of load capacity or structural integrity when subjected to 500 hours of ultraviolet light and aggressive weathering in accordance with ASTM D-4355.

END OF SECTION

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GEOGRID

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*02831 – Chain Link Fences and
Gates*

02831
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Work covered by this Section consists of installing a permanent, 6-foot high chain link security fence with three strands of barbed wire as required to replace the sections of fence that were removed to enable performance of the Work, as shown on the Drawings. Temporary, 6-foot high chain link security fence with three strands of barbed wire shall be provided, as necessary, to ensure a continuous, secure perimeter exists around the entire Site at all times.
- B. Portions of the existing fence will remain in place; some existing fence may need to be replaced due to the loss of integrity and functionality.
- C. The Work includes, but is not limited to, installing new fence posts, and appurtenances within the locations where the segment of fence is required to be removed. The new fence shall be connected to the existing fence to provide a continuous perimeter security fence following construction of the groundwater barrier wall. Additionally, signs containing the words “NO TRESPASSING” shall be installed on the new and existing fence at maximum 100 foot intervals.
- D. During Work, the perimeter of the entire Site shall be secure with existing fence and/or temporary fence at all times; barricades, building walls, and other temporary measures may be considered.

1.02 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.):
 - RR-F-191K/GEN Fencing, Wire and Post Metal (and Gates, Chain Link Fence Fabric, and Accessories) (General Specification)
 - RR-F-19 1/1d Fencing, Wire and Post, Metal (Chain-Link Fence Fabric) (Detail Specification)
 - BR-F- 19 1/2d Fencing, Wire and Post, Metal (Chain-Link Fence Gates) (Detail Specification)
 - RR-F-19 1/3d Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces) (Detail Specification)
 - RR-F- 19 1/4d Fencing, Wire and Post, Metal (Chain-Link Fence Accessories) (Detail Specification)

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CHAIN LINK FENCES AND GATES

C. American Society for Testing and Materials (ASTM) Publications:

- ASTM A 123 Zinc (Hot Galvanized) Coatings of Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strips.
ASTM F 567 Installation of Chain-Link Fence.
ASTM A 120 Pipe, Steel, Black and Hot-dipped Zinc-coated (Galvanized) welded and Seamless, for Ordinary Uses.
ASTM C 94 Ready-mixed Concrete.
ASTM B 429 Framework.
ASTM A 569 Steel Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial Quality.
ASTM A 570 Steel, Sheet & Strip, Carbon, Hot-Rolled Structural Quality.

D. Underwriters Laboratories (UL) Inc. Publication:

- UL 467 Grounding and Bonding Equipment

1.03 QUALITY CONTROL

- A. In accordance with Section 01400 – QUALITY CONTROL.
- B. Installation of the chain link fence shall be accomplished by an installation contractor, approved by the manufacturer, having a minimum of three (3) years experience in the satisfactory performance of similar work.

1.04 SUBMITTALS

- A. In accordance with Section 01300 – SUBMITTALS.
- B. Specific work history of the chain link fence installer shall be provided.
- C. The CONTRACTOR'S submittals shall include a plan layout; spacing of components; and a schedule of components.
- D. The CONTRACTOR shall submit manufacturer's installation instructions to the ENGINEER or OWNER'S AGENT a minimum of two (2) weeks prior to fence installation.

02831
CHAIN LINK FENCES AND GATES

PART 2 - PRODUCTS

2.01 GENERAL

- A. All new materials shall conform to Fed. Spec. RR-F-191 and detailed specifications forming the various parts thereto. Chain link security fence shall be constructed at the locations and alignment shown on the Drawings. All chain link security fence materials shall be the standard product of one manufacturer who is regularly engaged in the manufacture of chain link security fencing. Products which differ only in nonessential details from those specified herein will be acceptable. Drawings shall be submitted for any deviations to the ENGINEER or OWNER'S AGENT or its authorized representative.
- B. Delivery, Storage and Protection: Materials shall be delivered to the Site in an undamaged condition. Materials shall be carefully stored off the ground to provide proper protection against oxidation caused by ground contact.
- C. Storage and Protection of Existing Fence Materials: Materials obtained through the removal of existing chain link fence(s) to be reused shall be stored and protected as stated in paragraph B above. All materials stored for reuse shall be cleaned and recoated as necessary in accordance with the following specifications at the discretion of the ENGINEER or OWNER'S AGENT prior to storage.
- D. Temporary Fence: The temporary fence shall be 6-foot high, chain link fence that provides continuous security when abutted to the existing fence or other structures. The post shall be secured, i.e., in concrete or other means approved by the ENGINEER or OWNER'S AGENT.

2.02 POSTS, RAILS, AND BRACES

- A. Fed. Spec. RR-F- 191/3 galvanized steel, 1.8 ounce per square foot, except as modified herein.
- B. Post Braces and Truss Rods: For each gate, corner, pull or end post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment. Truss rods shall be 3/8 inch diameter.
- C. Intermediate Posts: C-section line posts of the same dimension as H-post, 0.120 inch wall thickness, and fabricated from steel conforming to ASTM A570, Grade 33 may be furnished in lieu of H- or round posts.

CHAIN LINK FENCES AND GATES

- D. Posts, Braces, Rails, and Gate Frames: Steel pipe manufactured from steel conforming to ASTM A 569, cold-rolled. Steel pipe shall be of the same external dimension and minimum wall thickness as Class 1 - steel pipe as listed in Fed. Spec. RR-F-191/3. Post, brace, nail and gate frame sizes shall be as indicated on the Drawings.
- E. Barbed Wire Support Arms: All posts shall be provided with pressed copper-bearing galvanized steel extension arms. All end posts shall be provided with heavy malleable iron extension arms. All extension arms shall be heavily coated with zinc by the hot-dip process. Each extension arm shall be sized to carry three strands of 12-1/2 GA, 4 PT, Class III barbed wire at an angle of 45 degrees, the upper strand 12 inches out from the fence line and 12 inches above the top of the fabric. Arms shall be the type that allow top rail to pass through their bases to form a continuous brace. Barbed wire arms shall be of sufficient strength to withstand a weight of 250 pounds applied at the outer or the top strand of barbed wire.
- F. Barbed Wire: Barbed wire shall be of the four-point pattern, composed of three strands of No. 12-1/2 gauge copper-bearing steel wire, Class III with large hard temper barbs spaced a maximum of 5 inches apart, and shall be heavily galvanized by the hot-dip process.

2.03 CHAIN-LINK FABRIC

- A. Fed. Spec. RR-F-191/1; Type I, 1.2 ounces per square foot coating, or Type II, 0.40 ounce per square foot coating, and shall be 9-gauge wire woven in a 2-inch mesh. Fabric width shall be as indicated.
- B. Attach fabric by method standard with the manufacturer, except that welding will not be permitted.

2.05 CONCRETE

- A. ASTM C 94, using 3/4 inch maximum-size aggregate, and having minimum compressive strength of 3,000 psi at 28 days.

2.06 COMPONENTS

- A. Top, bottom, and upright gate frame members shall be minimum 1 5/8-inch O.D. steel pipe.
- B. Fence fabric shall be 1.75-inch diamond mesh, galvanized steel wire, interwoven 9-gauge thick with top selvage twisted tight and bottom selvage knuckle and closed.

CHAIN LINK FENCES AND GATES

- C. Caps shall be galvanized steel sized to post dimension.
 - D. All sleeves, bands, clips, rail bends, tensions, bars, fasteners and fittings shall be galvanized steel.
 - E. Tension Wire shall have a minimum tensile strength of 75,000 psi, zinc-coated for use with zinc-coated fabric and aluminum coated for use with aluminum-coated fabric. Minimum weight of aluminum coating shall be 0.40 ounce of aluminum per square foot of wire.
 - F. Tie Wire shall be nine gauge galvanized steel wire for attaching fabric to rails, braces, and intermediate posts.
 - G. Hog Rings shall be nine gauge (minimum) galvanized steel wire for attaching fabric to bottom reinforcing wires.
 - H. Padlocks shall be Fed. Spec. FF-P-101, type EPB, 1-3/4-inch size, with chain. All padlocks shall be keyed alike.
- 2.07 FINISHES

- A. Frame components shall be galvanized at a rate of 1.8 ounces per square foot in accordance with ASTM A 123.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. CONTRACTOR shall install framework, fabric, gates, and accessories in accordance with ASTM F 567 and as shown on the Drawings.
- B. The fence shall be installed on previously prepared surfaces to line and grade indicated. Fence installation shall be as specified and in accordance with the fence manufacturer's written installation instructions.
- C. Excavation for concrete-embedded items shall be of the dimensions indicated. Post holes shall be cleared of loose materials. Spoil material shall be spread where directed by the ENGINEER or OWNER'S AGENT. The ground surface irregularities, along the fence line and in areas not being altered by area grading, shall be eliminated to the extent necessary to maintain a 2-inch clearance between the bottom of the fabric and finish grade.
- D. CONTRACTOR shall provide 6-foot nominal height fence with line posts not exceeding 10 feet, center-to-center.

CHAIN LINK FENCES AND GATES

- E. All posts shall be set plumb and in alignment in concrete floorings with top of footing a minimum of two inches above finished grade. Posts shall be set in concrete a minimum of 40 inches and top of concrete shall be sloped for water runoff. Concrete shall be thoroughly compacted as to be free of voids and finished in a dome. Concrete shall cure 3 days prior to installation of fabric. Straight runs between braced posts shall not exceed 500 feet.
- F. Each gate and corner post shall be braced back to adjacent line post with horizontal brace and rail and diagonal truss rods.
- G. Contractor shall furnish center and bottom brace rails on corner posts and gate leaves.
- H. Tension wire shall be used to secure the top of the fence except at gate locations, end posts, and corners.
- I. Bottom tension wire shall be installed before installing chain-link fabric and shall be pulled taut.
- J. Post caps shall be of the design as required to accommodate the top rail. Post caps shall be installed as recommended by the manufacturer.
- K. Supporting arms shall be of the design as required to accommodate the top rail. Supporting arms shall be installed as recommended by the manufacturer.
- L. Top rail shall be installed at all gate locations, end posts, and corners only before installing chain-link fabric and shall pass through intermediate post caps. Expansion coupling shall be provided and spaced a maximum of 100 feet on center.
- M. Fabric shall be placed two inches above finished grade and mechanically pulled taut and secured to the top rail or tension wire and bottom wire close to both sides of each post and at intervals of not more than 24 inches on center. Fabric shall be secured to line posts using ties at the top and bottom at intervals of not more than 15 inches. Fabric shall be secured to end, corner, pull, and gate posts for the full length by integrally weaving to fastening loops or by using stretcher bars and bands. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.
- N. Padlocks shall be furnished for gate openings and shall have chains that are securely attached to the gate or gate posts. Padlocks shall be keyed alike and five keys shall be provided by the CONTRACTOR to the ENGINEER or OWNER'S AGENT.

CHAIN LINK FENCES AND GATES

- O. Barbed Wire: Each extension arm shall carry three strands of barbed wire at an angle of 45 degrees, the upper strand 12 inches out from the fence line and 12 inches above the top of the fabric. Install three strands on the extension arms at the top of the fence and over gates. The extension arms shall be installed so that they are pointing to the exterior of the perimeter created by the fence.

3.02 TEMPORARY CHAIN LINK SECURITY FENCE

- A. Temporary, 6-foot high chain link security fence shall be provided, as necessary, to ensure a continuous, secure perimeter exists around the entire Site at all times.
- B. The temporary fence shall be securely connected to the existing fence so that the existing and temporary fences form a continuous barrier.

3.03 RELOCATION OF EXISTING CHAIN LINK SECURITY FENCE AND GATES

- A. The removal of existing fence designated for relocation or temporary removal shall be in accordance with the requirements hereinbefore specified for removal thereof. All fence materials to be reinstalled in the Work shall be jointly inspected by the CONTRACTOR and the ENGINEER or OWNER'S AGENT prior to dismantling or removal by the CONTRACTOR. An agreement briefly setting forth the current condition of the fence and gates to be reinstalled shall be prepared by the CONTRACTOR and signed by the CONTRACTOR and the ENGINEER or OWNER'S AGENT after the pre-construction walk-through.
- B. Reinstallation shall be as specified under paragraph 3.01 of this Section. The CONTRACTOR shall supply such new parts conforming to the requirements of this Section as are necessary to complete the installation of the relocated fences and gates.

3.04 GROUNDING

- A. Fence fabric shall be grounded at each site of every gate, at points 150 feet each side of overhead power-transmission lines, at intervals of every 1,000 to 1,500 feet of length when fences are located in isolated places, and every 500 to 750 feet when in close proximity (100 feet or less) to public roads, highways, and buildings. Fence shall be grounded at locations where the fence alignment changes more than 15 degrees.

CHAIN LINK FENCES AND GATES

- B. Each fence post to be grounded shall be connected to a ground electrode consisting of a 3/4-inch diameter copper-dad steel ground rod 10 feet long, driven not less than 11 feet into the ground with rod located at the fence line or as near the fence line as is practical. Ground rods shall conform to UL 467. Connection of fence post to ground electrode shall be made below grade with not less than No. 4 AWG stranded-copper wire with TW insulation by approved clamp-type fitting of copper on fence post and electrode. Each gate panel shall be bonded with a flexible bond strap to its gate post.

END OF SECTION

*02901 – Miscellaneous Work and
Site Cleanup*

02901
MISCELLANEOUS WORK AND SITE CLEANUP

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. CONTRACTOR shall furnish all labor, materials, equipment, and incidentals required to perform miscellaneous Work not specified in other Sections, but necessary for the proper completion of the Work as shown on the Drawings.
- B. When applicable, the CONTRACTOR shall perform the Work in accordance with other Sections of these Specifications. When no applicable specification exists, the CONTRACTOR shall perform the Work in accordance with established industry practice or as directed by the ENGINEER or OWNER'S AGENT.
- C. The Work of this Section includes, but is not limited to, the following:
 - 1. Cleanup.
 - 2. Incidental work.
 - 3. Restoration of disturbed areas.
 - 4. Restoring easement and right-of-ways.
 - 5. Temporary facilities.
 - 6. Protection of existing equipment, underground and aboveground utilities, including significant gas supply lines, monitoring wells, materials and structures that are designated to remain.

PART 2 - PRODUCTS

2.01 MATERIALS

Materials required for this section shall be the same quality of materials that are to be restored. Where possible, the CONTRACTOR may use existing materials that are removed subject to the approval of the ENGINEER or OWNER'S AGENT.

02901
MISCELLANEOUS WORK AND SITE CLEANUP

PART 3 - EXECUTION

3.01 CLEANUP

- A. The CONTRACTOR shall remove all construction material, waste, buildings, equipment and other debris remaining on the project, except as otherwise specified, as a result of construction operations and shall restore the site of the Work to a neat and orderly condition.
- B. During the course of the Work, the CONTRACTOR shall keep the site of operations in as clean and neat a condition as is possible. CONTRACTOR shall dispose of all residuals resulting from the Work that are not otherwise re-used or replaced.
- C. At the completion of the Work, the CONTRACTOR shall:
 - 1. Remove waste materials, rubbish, tools, equipment, machinery, and surplus materials.
 - 2. Remove grease, dust, stains, labels, and other deleterious or foreign materials from the Site.
 - 3. Repair, patch, and touch up marred or otherwise damaged surfaces.
 - 4. Prior to transferring the completed project, conduct an inspection of surfaces, and all Work areas, to verify that the areas affected by the Work have been restored to an OSHA-compliant condition.
- D. In order to prevent environmental pollution arising from the construction activities related to the performance of this project, the CONTRACTOR and Subcontractors shall comply with all applicable federal, state and local laws and regulations concerning waste material disposal, as well as the specific requirements stated in this Section and elsewhere in these Specifications.
- E. The CONTRACTOR is advised that the disposal of excess excavated material in wetlands, stream corridors, and floodplains is strictly prohibited. Any violation of this restriction by the CONTRACTOR, or any Subcontractor or employee, will be brought to the immediate attention of the responsible regulatory agencies, with a request that appropriate action be taken against the offending parties. The CONTRACTOR shall remove the fill and restore the area impacted without additional cost to the OWNER/OWNER'S AGENT.

02901
MISCELLANEOUS WORK AND SITE CLEANUP

3.02 INCIDENTAL WORK

CONTRACTOR shall perform all incidental work not otherwise specified, but necessary for the proper completion of the Work as specified and as shown on the Drawings.

3.03 RESTORATION OF DISTURBED AREAS

The CONTRACTOR shall be responsible for restoring and stabilizing all disturbed areas prior to demobilizing from the site. Stabilization and restoration shall be conducted in accordance with the Drawings and Technical Specifications and shall ensure that sediment laden surface water will not enter drainageways, streams, rivers or other water conveyance systems.

3.04 RESTORING EASEMENTS AND RIGHT-OF-WAYS

Existing vegetated surfaces damaged by construction shall be replaced. The CONTRACTOR shall restore the areas with an equivalent depth and quality of loam, seed and fertilizer as necessary to produce a stand of grass at least equal to that existing prior to construction. These areas shall be maintained and re-seeded, if necessary, until the Work has been completed and accepted. Any additional Work required to restore property to the original condition shall be performed by the CONTRACTOR.

3.05 PROTECTION OF EXISTING UNDERGROUND AND ABOVEGROUND UTILITIES AND OTHER INFRASTRUCTURE

- A. Utilities (telephone, sewer, culverts, etc.) and other infrastructure may exist within, or adjacent to, the project area. These items shall be maintained and protected at all times. Locations of these items may or may not be shown on the Drawings. Prior to starting work the CONTRACTOR shall be responsible for identifying these items and providing proper protection such that the integrity is not compromised nor the daily operations of the facilities affected. Any damage to such facilities as a direct result of CONTRACTOR operations will be the sole responsibility of the CONTRACTOR to repair and/or replace at no cost to the OWNER/ OWNER'S AGENT.
- B. The CONTRACTOR shall cooperate with the OWNER/ OWNER'S AGENT, and other organizations; i.e., utility companies, and shall not allow plant or utility service to be disrupted or relocated without the permission of the ENGINEER or OWNER'S AGENT and the written permission of the utility owner.

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MISCELLANEOUS WORK AND SITE CLEANUP

- C. In the event that an existing structure or utility not already identified for relocation must be relocated in order to avoid a conflict with the Work, the CONTRACTOR shall notify the ENGINEER, OWNER'S AGENT and the OWNER promptly.

END OF SECTION

Attachment 1
Contaminated Material
Management Plan

APPENDIX B

CONTAMINATED MATERIAL MANAGEMENT PLAN

**CONTAMINATED MATERIAL MANAGEMENT PLAN
FOR
STORMWATER SOURCE CONTROL MEASURES**

**Former Arkema Inc. Facility
Portland, Oregon**

Prepared for
Legacy Site Services LLC
468 Thomas Jones Way
Exton, PA 19341-2528

Prepared by
The logo for Integral Consulting Inc. features the word "integral" in a blue, lowercase, sans-serif font. A thin, curved line starts from the bottom of the letter "i" and sweeps upwards and to the right, ending under the letter "l". Below the word "integral", the words "consulting inc" are written in a smaller, blue, lowercase, sans-serif font.
319 SW Washington St
Suite 1150
Portland, OR 97204

September 30, 2011

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Attachment A PID and FID Specifications

Attachment B Headspace Screening for VOCs

FIGURES

Figure 1. Soil Staging Areas

ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
CMM	contaminated material management
DEQ	Oregon Department of Environmental Quality
FID	flame ionization detector
LDPE	low-density polyethylene
LSS	Legacy Site Services LLC
PID	photo-ionization detector
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
SCM	source control measure

1 INTRODUCTION

On behalf of Legacy Site Services LLC (LSS), agent for Arkema Inc., Integral Consulting Inc. has prepared this contaminated materials management (CMM) plan in support of the implementation of the stormwater source control measures (SCMs) at the former Arkema Portland Plant (the site) located at 6400 NW Front Avenue, Portland, Oregon. This CMM plan is prepared pursuant to the Order on Consent, requiring SCMs, issued by the Oregon Department of Environmental Quality (DEQ), signed October 31, 2008 (DEQ No. LQVC-NWR-08-04), and the new stormwater Mutual Agreement and Order No. WQ/I-NWR-10-175 executed by DEQ and LSS on August 4, 2010. Refer to the contract documents for all locations and details of the work.

The CMM plan describes the procedures for the management and handling of site soil and other materials excavated for the stormwater SCM. The elements of this CMM plan include:

- Soil excavation, handling, and screening
- Debris and other material handling and screening
- Soil stockpiling
- Transportation and offsite disposal
- Handling and disposal of other waste streams.

In order to be comprehensive, this plan addresses the handling of all material to be excavated as part of the installation of the stormwater SCMs, regardless of the existence of contamination. All soil and debris excavated during the installation of the SCMs will be managed and used as fill or temporarily stockpiled onsite until the final site remedy or properly characterized and disposed of in accordance with all state and federal regulations at an appropriate offsite disposal facility.

2 SOIL EXCAVATION, SCREENING, AND HANDLING

A summary of the onsite soil excavation, screening, and handling procedures is provided in this section.

2.1 SOIL EXCAVATION

The contractor will be responsible for the proper handling of all excavated material generated during the course of construction. Soil, and possibly other debris, will be generated during the excavation for the following elements of the stormwater SCMs:

- Channels
- Detention basin
- Sand filter.

Handling and screening procedures outlined in this plan apply to all materials excavated during stormwater SCMs construction. This section discusses the handling and screening of soil. The following section of the plan discusses the segregation and handling of debris and other material.

2.2 SOIL SCREENING

While the alignment and locations of the channels and basins were selected to avoid, to the extent feasible, areas with observed elevated DDT concentrations, as a precaution, monitoring and screening of the excavated soil will be conducted to allow for the segregation and handling of these materials.

Soil and debris excavated from the east¹ and west channels, detention basin, and sand filter will be field screened to determine if they will be immediately used as fill material or placed in Stockpile Areas 1 or 2 for additional characterization. Soil and debris will be visually inspected for contamination, such as free product, dark staining, pink or white soil staining indicative of elevated DDT contamination, or odors. Soil and debris that exhibit pink or white staining will be treated as State-only pesticide residue and placed in Stockpile Area 1. DEQ representatives will be notified when field observations indicate the possible presence of unanticipated contaminated material.

¹ Except for the portions of the east channel transecting the old Caustic Tank Farm and the Acid Plant area, which are assumed to be contaminated. The soil and debris from these areas will automatically be placed in Stockpile Area 1 for additional characterization.

Soil² will also be screened with a photo-ionization detector (PID) equipped with an 11.7 eV lamp and/or a flame ionization detector (FID) during soil excavation activities. Specifications and response factors for the selected PID and FID meters are presented in Attachment A. Each location of excavation of soil will be screened periodically using the PID and/or FID meter within 6 in. of the freshly excavated soil, approximately every 30 minutes. The soil will be considered potentially contaminated if the meter reading is 10 parts per million (ppm) over background levels for 10 seconds. If this threshold is exceeded, headspace testing for volatile organic compounds (VOCs) will be conducted on a representative sample of this material in accordance with site-specific operating procedure 1 (Attachment B). If the headspace reading is 10 ppm or higher, the soil will be considered potentially contaminated with VOCs. The field screener shall note that erratic meter responses may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case headspace data will be discounted. As previously noted, DEQ representatives will be notified when field screening indicates the possible presence of unanticipated contaminated material. Soils that do not pass field screening tests will be placed in Stockpile Area 2.

Air monitoring will also be conducted during all excavation activities for health and safety purposes in accordance with the site health and safety plan (Appendix H of the Design Report).

All other soils (i.e., with no white or pink staining, not from former Acid Plant area or old Caustic Tank Farm, and passes field screening test) will be used as fill throughout the site as per the Drawings.

2.3 SOIL HANDLING

If the soil is temporarily staged adjacent to the excavation, the soil staging area will consist of a temporarily constructed, bermed area lined with plastic sheeting. The temporarily staged soil will also be covered with 6-mil low-density polyethylene (LDPE) sheeting at the end of each work day. Potential fugitive dust will be mitigated by ensuring that excavated soil remains covered or sufficiently moist until it is transported to the soil fill or stockpile area as described in Specification Section 01355 – Environmental Pollution Control.

Based on Remedial Investigation soil sample data, soil and debris from the east drainage channel excavation transecting the former Acid Plant area will be considered to potentially contain elevated DDT concentrations. Soil and debris from the old Caustic Tank Farm area that are excavated for the east channel may contain elevated concentrations of DDT and oil and diesel-range petroleum hydrocarbons. In addition, any soils and debris excavated from other areas of the site that are visually observed to have a pink or white color will be considered to

² Except for the portions of the east channel transecting the old Caustic Tank Farm and the Acid Plant area, which are assumed to be contaminated. The soil and debris from these areas will automatically be placed in Stockpile Areas 1 and 2 for additional characterization.

potentially contain elevated DDT concentrations. All of these soils will be treated as State-only pesticide residue and stored in Stockpile Area 1 for additional characterization. LSS will develop a Resource Conservation and Recovery Act (RCRA) characterization and management plan after stockpiling has been completed to determine the nature of the hazardous waste and provide a plan for managing the waste. The plan will be submitted to DEQ for review and approval.

All soil and debris with headspace screening results exceeding the criteria stated above will be considered potentially contaminated with VOCs. These materials will be stored in Stockpile Area 2 for additional characterization. LSS will develop a characterization and management plan for the waste in Stockpile Area 2 and submit it to DEQ for approval.

The soil in Stockpile Areas 1 and 2 will be managed in accordance with 40 Code of Federal Regulations (CFR) 265.250, 265.251, and 265.253 through 265.260 (without the leachate collection system). In accordance with the above-referenced CFRs, the soils will be capped as described in Section 4. No liquid wastes or free liquids will be placed in Stockpile Areas 1 and 2. No leachate will be generated from the stockpile since the soils are not expected to be saturated and the soil piles will be capped. The final disposition of temporarily stockpiled soil is outlined in Section 4 of this CMM plan.

3 DEBRIS AND OTHER MATERIAL SCREENING AND HANDLING

Excavated materials may include debris and other material. Examples of debris and other material include: concrete, asphalt, rebar, construction material, construction debris, demolition debris, and other non-soil materials. This section of the CMM plan addresses the screening and handling of these materials.

3.1 DEBRIS AND OTHER MATERIAL SCREENING

Debris and other excavated non-soil material will be visually/olfactorily inspected for contamination, such as free product, dark staining, attached soil, or odors. If this inspection indicates that the debris or other material is contaminated, then the debris will be stockpiled separately as described in Section 4.

3.2 DEBRIS AND OTHER MATERIAL HANDLING

Debris will be handled in the same manner as the excavated soils around the debris; however, debris may be segregated from excavated soil within the designated stockpile areas. If the debris is temporarily staged adjacent to the excavation, the debris staging area will consist of a temporarily constructed, bermed area lined with plastic sheeting. Potential fugitive dust will be mitigated by ensuring that excavated debris or other materials remain covered or sufficiently moist until transported to the stockpile area, as described in Specification Section 01355 – Environmental Pollution Control.

Debris and other materials that are suspected to be or identified as contaminated will be staged separately from other soil and debris. The final disposition of temporarily stockpiled debris is outlined in Section 4 of this plan.

4 MATERIAL SEGREGATION AND STOCKPILING

Excavation and screening of soil during the stormwater SCMs construction will generate the following materials:

- Soil/fill
- Soil and debris with potentially elevated concentrations of DDT
- Debris and other material/fill
- Potentially contaminated debris and other material.

All excavated material will remain onsite and be stockpiled or used as fill.³ All soil stockpiles will be covered with 6-mil LDPE sheeting at the end of each work day. Areas of the site that will be used for fill or to stockpile soil are shown on Figure 1.

Fill areas consist of low-elevation depressions that are located throughout Lots 2, 3, and 4, as identified on Figure 1. These areas will be filled to prevent ponding and to promote drainage into the new SCMs system. Two fill areas (former Salt Pads and area adjacent to the sand filter) have been identified for potential use during SCMs construction. Soil, debris, and other material will be placed in the appropriate stockpile areas as follows:

- Soil and debris to be treated as a State-only pesticide residue: Stockpile Area 1 (northern Salt Pad; estimated 300 yd³)
- Soil and debris potentially contaminated with VOCs: Stockpile Area 2 (northern Salt Pad; estimated 50 yd³)
- Soil and debris without contamination: Stockpile Area 3 (unpaved portion of Lot 2).

Stockpile Areas 1 and 2 will be placed on a physical subbasin feature within the northern Salt Pad area as shown on Figure 1. Stockpile Area 3 consists of an unpaved area in Lot 2. Stockpile Area 3 is reserved for potential use and, if needed, will be delineated by the field engineer, and the limits of the stockpile area will be demarcated with berms by the contractor.

Debris and other material with visual contamination can be taken to the decontamination area and be decontaminated as per Specification Section 01355 – Environmental Pollution Control and following the decontamination be stockpiled with clean debris. If this material is not decontaminated, it shall be stockpiled and handled in the same manner as the potentially contaminated soil.

³ Except for demolition debris from the former DDT process building, which will be transported to an appropriate offsite disposal facility. If necessary, this material will be stockpiled within the footprint of the former DDT process building during demolition activities prior to disposal. Any stockpiled material will be covered daily with 6-mil LDPE sheeting.

Most of the soil and debris volume is not anticipated to be contaminated. An estimated 15,000 yd³ of uncontaminated material will be placed in fill areas or in Stockpile Area 3, if needed. Soil Stockpile Area 3 will not exceed 6 ft height above the surrounding grade. Once all soil and other debris have been placed in Stockpile Area 3 and fill areas, each of the areas will be covered with a temporary cap to prevent erosion and vegetation growth. The cap will consist of 6-mil plastic sheeting between two layers of geotextile fabric. Crushed rock will be placed over the liner to provide weighting and an armored surface for the cap.

Potentially contaminated materials will be placed in Stockpile Areas 1 and 2. Prior to the placement of any soil in Stockpile Areas 1 and 2, the condition of the northern Salt Pad area will be assessed and any cracking will be sealed with a liquid sealant, following the temporary capping protocol in Specification Section 02510 – Temporary Environmental Cap. Soil in Stockpile Areas 1 and 2 will be placed on a heavy duty plastic (minimum 20 mil), tear-resistant (fiber-reinforced) plastic liner. After the filling and subsequent characterization sampling activities are completed and it is determined that soil can remain onsite, the soil and debris in Stockpile Areas 1 and 2 will be capped with a 6-mil plastic sheeting between two layers of geotextile fabric to prevent breaching of the cap. Crushed rock will be placed over the liner to provide weighting and an armored surface for the cap. The cap will be constructed in accordance with Specification Section 02510 – Temporary Environmental Cap. Stockpile Areas 1 and 2 will be separated by berms and capped separately from adjacent Salt Pad fill areas.

Some small aboveground structures on the former DDT manufacturing building foundation will be demolished as part of the stormwater SCMs. Demolition debris from the former DDT manufacturing building will be assumed to contain U061 hazardous waste and will be transported to an appropriate offsite disposal facility. If necessary, this material will be stockpiled within the footprint of the former DDT process building during demolition activities prior to disposal. Any stockpiled material will be covered daily with 6-mil LDPE sheeting.

5 TRANSPORTATION AND OFFSITE DISPOSAL

No transport or offsite disposal of generated soil or debris is anticipated as part of this work except for demolition debris from some small aboveground structures on the former DDT manufacturing building foundation. However, other materials may be transferred offsite if LSS, in consultation with DEQ, determines offsite transportation and disposal of some of the excavated or other materials (e.g., Stockpile 1) encountered during stormwater SCMs construction is desirable. The following minimum requirements will apply to the transportation and offsite disposal of soil and debris.

5.1 TRANSPORTATION

The Contractor will be responsible for transportation of all materials to an appropriate offsite disposal facility, as specified in Specification Section 02250 – Transportation and Disposal of Materials. A properly licensed waste hauler, depending on the type of waste, will be used to transport all waste materials. No queuing of trucks shall be permitted on NW Front Avenue during waste hauling operations. All loads will be covered prior to leaving the site. No waste will be permitted to leave the site unless it has been properly manifested, in accordance with all applicable regulations and disposal facility requirements.

5.2 OFFSITE DISPOSAL

Waste facilities that may be used for offsite disposal will be identified to the LSS and DEQ prior to commencement of the work. These facilities must be approved by LSS. These facilities will meet the environmental, grading, safety and health requirements of the state, county, and local political subdivision where located. All disposal facilities will be legally licensed and permitted. Disposal facilities with significant RCRA violations or compliance problems (such as facilities known to be releasing hazardous constituents into groundwater, surface water, soil, or air) will not be used.

6 HANDLING AND DISPOSAL OF OTHER WASTE STREAMS

Other waste streams that will be generated during the stormwater SCM work include:

- Decontamination water
- Solid wastes
- Sanitary wastes.

Each of these waste streams will be managed in accordance with applicable federal, state, and local regulations and as described below and in Specification Section 02250 – Transportation and Disposal of Materials.

6.1 DECONTAMINATION WATER

To the extent possible, truck traffic will be restricted to paved areas of the site to minimize the need for equipment decontamination. Water generated from the cleaning of construction and excavation equipment and/or from the cleaning of debris that may be encountered during soil excavation will be containerized and stored onsite. Once the stormwater treatment systems are completed, equipment decontamination water will be treated through the available treatment systems (detention basin/sand filtration). This water shall be subject to primary treatment (e.g., settling via baker tank or similar) prior to discharge to the stormwater treatment system. In the event that offsite disposal of decontamination water is desired, the containerized decontamination water will be sampled and disposed of offsite in accordance with Specifications Section 01355 – Environmental Pollution Protection Control.

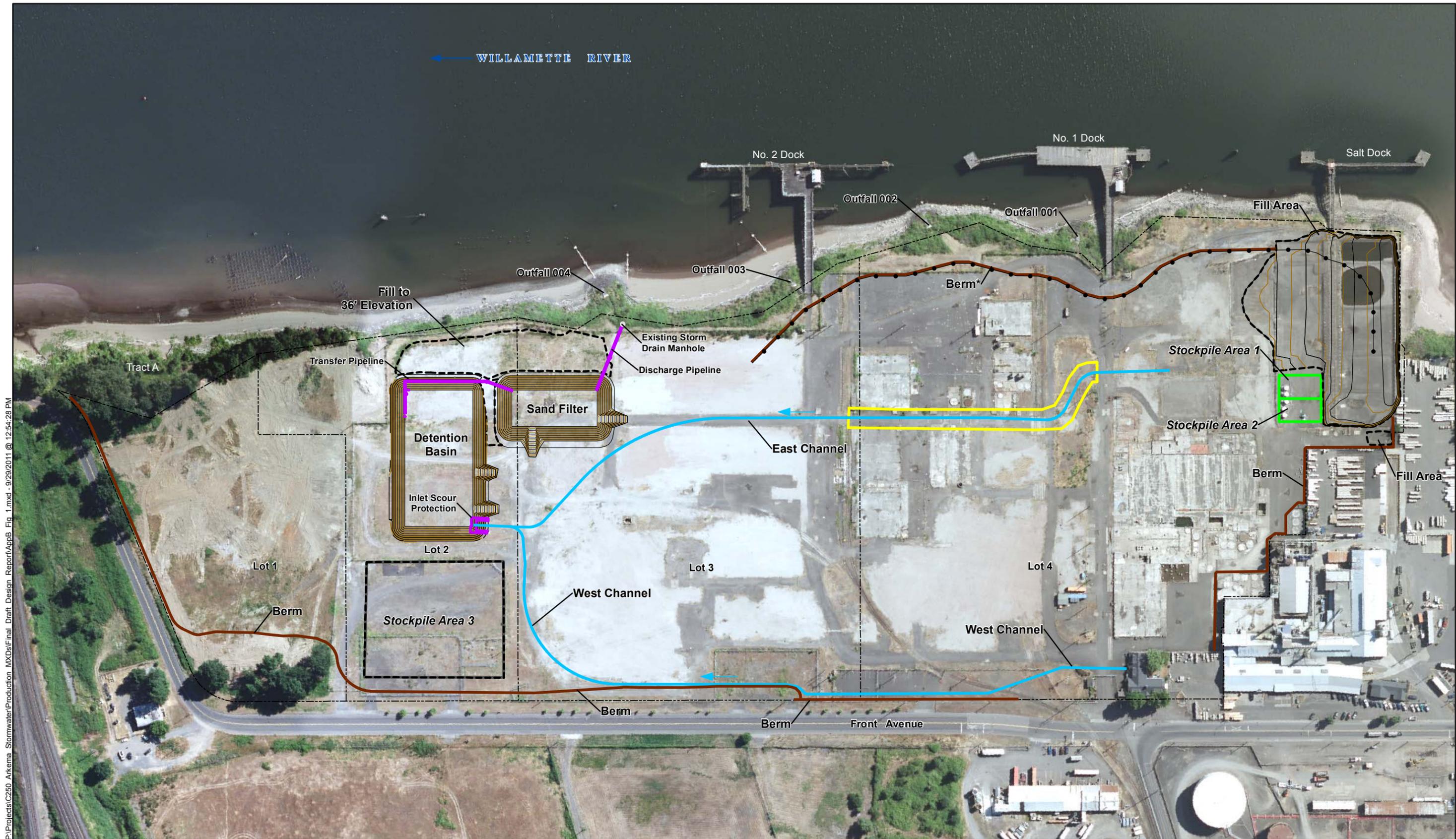
6.2 SOLID WASTES

All solid waste, including waste paper, garbage, and other non-hazardous debris, will be double-bagged in plastic garbage bags and placed in a solid waste dumpster provided by the Contractor.

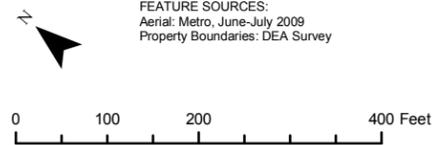
6.3 SANITARY WASTES

The Contractor will be required to provide a sanitary portable restroom facility. Cleaning of the restroom and disposal of the restroom waste will be conducted by a licensed and bonded sanitary restroom provider and in accordance with a schedule that is based on the number of onsite workers. The sanitary restroom waste disposal and cleaning will occur at a minimum of once per week.

FIGURES



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FEATURE SOURCES:
Aerial: Metro, June-July 2009
Property Boundaries: DEA Survey

Map Features

- Channel
- Berm
- Detention Basin/Sand Filter Feature
- Areas to be Filled

- Potential DDT Containing Areas
- Excavated Soils for Stockpile Area 1
- Additional Stockpile Area

- Barrier Wall
- Property and Lot Boundary

*Berm follows alignment of proposed groundwater barrier wall and cap.

Figure 1
Soil Staging Areas
Contaminated Material Management Plan
Stormwater Source Control Measures

ATTACHMENT A

PID AND FID SPECIFICATIONS



MiniRAE 3000

Portable Handheld VOC Monitor

The MiniRAE 3000 is the most advanced handheld volatile organic compound (VOC) monitor on the market. Its photoionization detector's (PID) extended range of **0 to 15,000 ppm** makes it an ideal instrument for applications from industrial hygiene to leak detection and HazMat.

The **RF modem allows real-time data transmissions** with a base controller located up to 500 feet away from the MiniRAE 3000 (or two miles with optional RAELink3 portable modem). A personal computer can be used as the base station for a MiniRAE 3000 system. The standard ProRAE Remote software is capable of monitoring the input of up to 64 remotely located monitors, including MiniRAE 3000, AreaRAE, etc.



Key Features

- **Proven PID technology**
The patented sensor provides the following unique features:
 - 3-second response time
 - Extended range up to 15,000 ppm with improved linearity
 - Humidity compensation with integral humidity and temperature sensors
- **Real-time wireless data transmission** with built-in RF modem or Bluetooth
- **Designed for simple service** Easy access to lamp and sensor in seconds without tools
- **Big graphic display** for easy overview of gas type, Correction Factor and concentration
- **Field-interchangeable battery pack** replaced in seconds without tools
- **Integrated flashlight** for better view in dark conditions
- **User-friendly screens, including dataplot chart view**
- **Integrated RAE Systems Correction Factors list for more than 200 compounds** to measure more chemicals than any other PID
- **Multi-language support** with 12 languages encoded
- **Rugged housing** withstands use in harsh environments
 - IP67 waterproof design for easy cleaning and decontamination in water
 - Strong protective removable rubber boot

Additional Advantages

- View real-time sensor data and alarm status at headquarters or command center
- Automatic lamp type recognition
- Duty-cycling™ lamp and sensor auto-cleaning technology
- Tough, flexible inlet Flexi-Probe™
- 3 large keys operable with 3 layers of gloves
- Strong, built-in sample pump draws up to 100 feet (30m) horizontally or vertically
- Loud, 95dB audible alarm
- Bright red flashing visual alarm
- Interchangeable drop-in lithium-ion and alkaline battery packs
- Charging cradle doubles as an external battery charger
- Compatible with AutoRAE™ calibration station
- ProRAE Remote software simultaneously controls and displays readings for up to 64 remote detectors
- License-free, ISM band RF transmission with communication range up to 500 feet (2 miles with optional RAELink3 modem)
- Optional RAELink3 modem provides GPS capability to track and display readings from remote detectors and provide up to 2 miles' long-distance transmission
- Datalogging with up to 6 months of data at one-minute intervals
- 3-year 10.6eV lamp warranty



Wireless



AutoRAE Compatible

ver1_05.07

www.raesystems.com



ATEX



IECEX



MiniRAE 3000

Specifications*

Detector Specifications

Size	10" L x 3.0" W x 2.5" H (25.5 cm x 7.6 cm x 6.4 cm)
Weight	26 oz (738 g)
Sensors	Photoionization sensor with standard 10.6 eV or optional 9.8 eV or 11.7 eV lamps
Battery	<ul style="list-style-type: none">• Rechargeable, external field-replaceable Lithium-Ion battery pack• Alkaline battery adapter
Operating Hours	16 hours of operation (12 hours with alkaline battery)
Display Graphic	4 lines, 28 x 43 mm, with LED backlight for enhanced display readability
Keypad	1 operation and 2 programming keys, 1 flashlight on/off
Direct Readout	<ul style="list-style-type: none">• Instantaneous reading• VOCs as ppm by volume• High values• STEL and TWA• Battery and shutdown voltage• Date, time, temperature
Alarms	<ul style="list-style-type: none">• 95 dB (at 30 cm) buzzer and flashing red LED to indicate exceeded preset limits• High: 3 beeps and flashes per second• Low: 2 beeps and flashes per second• STEL and TWA: 1 beep and flash per second• Alarms latching with manual override or automatic reset• Additional diagnostic alarm and display message for low battery and pump stall
EMI/RFI	Highly resistant to EMI/RFI Compliant with EMC Directive 89/336/EEC
IP Rating	<ul style="list-style-type: none">• IP67 unit off and without flexible probe• IP65 unit running
Datalogging	Standard 6 months at one-minute intervals
Calibration	Two-point or three-point calibration for zero and span. Calibration memory for 8 calibration gases, alarm limits, span values and calibration dates
Sampling Pump	<ul style="list-style-type: none">• Internal, integrated flow rate at 400 cc/mn• Sample from 100' (30m) horizontally and vertically
Low Flow Alarm	<ul style="list-style-type: none">• Auto pump shutoff at low-flow condition
Communication	<ul style="list-style-type: none">• Download data and upload instrument set-up from PC through charging cradle or optional Bluetooth™• Wireless data transmission through built-in RF modem
Frequency	902 to 928 MHz (license-free), 2.400 to 2.4835 GHz (license-free), 433 MHz, 869 MHz
RF Range	Up to 500' (900 MHz, 433 Mhz, 869 Mhz), extendable with RAELink3 Repeater to 2 miles
Hazard Area Approval	<ul style="list-style-type: none">• US and Canada: UL, cUL, Classified as Intrinsically Safe for use in Class I, Division I Groups A, B, C, D• Europe: ATEX II 1G EEx ia IIC T4 (pending)• IECEx: II 1G EEx ia IIC T4 (pending)
Temperature	-4° to 113° F (-20° to 50° C)
Humidity	0% to 95% relative humidity (non-condensing)
Attachments	Durable bright yellow rubber boot with belt clip
Warranty	Lifetime on non-consumable components (per RAE Systems Standard Warranty), 3-year warranty for 10.6 eV lamp, 1 year for pump and battery

*Specifications are subject to change

Sensor Specifications

Gas Monitor	Range	Resolution	Response Time T90
VOCs	0 to 999.9 ppm	0.1 ppm	< 3 s
	1000 to 15,000 ppm	1 ppm	< 3 s

Monitor only includes:

- MiniRAE 3000 Monitor, Model PGM-7320
- Wireless communication module built in, as specified
- Datalogging with ProRAE Studio Package for Windows™ 95, 98, 2000, NT, ME & XP
- Charging/download adapter
- RAE UV lamp, as specified
- Flex-I-Probe™
- External filter
- Rubber boot with belt clip and straps
- Alkaline battery adapter
- Lamp-cleaning kit
- Tool kit
- Lithium-ion (Li-ion) battery with universal AC/DC charger and international plug kit
- Operation CD-ROM
- Operation & Maintenance manual
- Soft leather case

Monitor with accessories kit adds:

- Hard transport case with pre-cut foam padding
- Charging/download cradle
- 5 Porous metal filters and O-rings
- Organic vapor zeroing kit
- Gas outlet port adapter and tubing

Optional calibration kit adds:

- 100 ppm isobutylene calibration gas, 34L
- Calibration regulator and flow controller

Optional Guaranteed Cost of Ownership Program:

- 4-year repair and replacement guarantee
- Annual maintenance service

DISTRIBUTED BY:

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CORRECTION FACTORS, IONIZATION ENERGIES, AND CALIBRATION CHARACTERISTICS

Correction Factors and Ionization Energies

RAE Systems PIDs can be used for the detection of a wide variety of gases that exhibit different responses. In general, any compound with ionization energy (IE) lower than that of the lamp photons can be measured.* The best way to calibrate a PID to different compounds is to use a standard of the gas of interest. However, correction factors have been determined that enable the user to quantify a large number of chemicals using only a single calibration gas, typically isobutylene. In our PIDs, correction factors can be used in one of three ways:

- 1) Calibrate the monitor with isobutylene in the usual fashion to read in isobutylene equivalents. Manually multiply the reading by the correction factor (CF) to obtain the concentration of the gas being measured.
- 2) Calibrate the unit with isobutylene in the usual fashion to read in isobutylene equivalents. Call up the correction factor from the instrument memory or download it from a personal computer and then call it up. The monitor will then read directly in units of the gas of interest.
- 3) Calibrate the unit with isobutylene, but input an equivalent, "corrected" span gas concentration when prompted for this value. The unit will then read directly in units of the gas of interest.

* Some inorganic compounds like H_2O_2 and NO_2 give weak response at photon energies well above those of their ionization energies. The term "ionization energy" replaces the old term "ionization potential."

Example 1:

With the unit calibrated to read isobutylene equivalents, the reading is 10 ppm with a 10.6 eV lamp. The gas being measured is butyl acetate, which has a correction factor of 2.6. Multiplying 10 by 2.6 gives an adjusted butyl acetate value of 26 ppm. Similarly, if the gas being measured were trichloroethylene (CF = 0.54), the adjusted value with a 10 ppm reading would be 5.4 ppm.

Example 2:

With the unit calibrated to read isobutylene equivalents, the reading is 100 ppm with a 10.6 eV lamp. The gas measured is m-xylene (CF = 0.43). After downloading this factor, the unit should read about 43 ppm when exposed to the same gas, and thus read directly in m-xylene values.

Example 3:

The desired gas to measure is ethylene dichloride (EDC). The CF is 0.6 with an 11.7 eV lamp. During calibration with 100 ppm isobutylene, insert 0.6 times 100, or 60 at the prompt for the calibration gas concentration. The unit then reads directly in EDC values.

Conversion to mg/m^3

To convert from ppm to mg/m^3 , use the following formula:

$$\text{Conc. (mg/m}^3\text{)} = \frac{[\text{Conc. (ppmv)} \times \text{mol. wt. (g/mole)}]}{\text{molar gas volume (L)}}$$

For air at 25 °C (77 °F), the molar gas volume is 24.4 L/mole and the formula reduces to:

$$\text{Conc. (mg/m}^3\text{)} = \text{Conc. (ppmv)} \times \text{mol. wt. (g/mole)} \times 0.041$$

For example, if the instrument is calibrated with a gas standard in ppmv, such as 100 ppm isobutylene, and the user wants to display to read in mg/m^3 of hexane, whose m.w. is 86 and CF is 4.3, the overall correction factor would be $4.3 \times 86 \times 0.041$ equals 15.2.

Correction Factors for Mixtures

The correction factor for a mixture is calculated from the sum of the mole fractions X_i of each component divided by their respective correction factors CF_i :

$$CF_{\text{mix}} = 1 / (X_1/CF_1 + X_2/CF_2 + X_3/CF_3 + \dots X_i/CF_i)$$

Thus, for example, a vapor phase mixture of 5% benzene and 95% n-hexane would have a CF_{mix} of $CF_{\text{mix}} = 1 / (0.05/0.53 + 0.95/4.3) = 3.2$. A reading of 100 would then correspond to 320 ppm of the total mixture, comprised of 16 ppm benzene and 304 ppm hexane.

For a spreadsheet to compute the correction factor and TLV of a mixture see the appendix at the end of the CF table.

TLVs and Alarm Limits for Mixtures

The correction factor for mixtures can be used to set alarm limits for mixtures. To do this one first needs to calculate the exposure limit for the mixture. The Threshold Limit Value (TLV) often defines exposure limits. The TLV for the mixture is calculated in a manner similar to the CF calculation:

$$TLV_{\text{mix}} = 1 / (X_1/TLV_1 + X_2/TLV_2 + X_3/TLV_3 + \dots X_i/TLV_i)$$

In the above example, the 8-h TLV for benzene is 0.5 ppm and for n-hexane 50 ppm. Therefore the TLV of the mixture is $TLV_{\text{mix}} = 1 / (0.05/0.5 + 0.95/50) = 8.4$ ppm, corresponding to 8.0 ppm hexane and 0.4 ppm benzene. For an instrument calibrated on isobutylene, the reading corresponding to the TLV is:

$$\text{Alarm Reading} = TLV_{\text{mix}} / CF_{\text{mix}} = 8.4 / 3.2 = 2.6 \text{ ppm}$$

A common practice is to set the lower alarm limit to half the TLV, and the higher limit to the TLV. Thus, one would set the alarms to 1.3 and 2.6 ppm, respectively.

Calibration Characteristics

a) **Flow Configuration.** PID response is essentially independent of gas flow rate as long as it is sufficient to satisfy the pump demand. Four main flow configurations are used for calibrating a PID:

- 1) **A pressurized gas cylinder (Fixed-flow regulator):** The flow rate of the regulator should match the flow demand of the instrument pump or be slightly higher.
- 2) **A pressurized gas cylinder (Demand-flow regulator):** A demand-flow regulator better matches pump speed differences, but results in a slight vacuum during calibration and thus slightly high readings.
- 3) **A collapsible gas bag:** The instrument will draw the calibration gas from the bag at its normal flow rate, as long as the bag valve is large enough. The bag should be filled with enough gas to allow at least one minute of flow (~ 0.6 L for a MiniRAE, ~0.3 L for MultiRAE).
- 4) **The T (or open tube) method:** The T method uses a T-junction with gas flow higher than the pump draw. The gas supply is connected to one end of the T, the instrument inlet is connected to a second end of the T, and excess gas flow escapes through the third, open end of the T. To prevent ambient air mixing, a long tube should be connected to the open end, or a high excess rate should be used. Alternatively, the instrument probe can be inserted into an open tube slightly wider than the probe. Excess gas flows out around the probe.

The first two cylinder methods are the most efficient in terms of gas usage, while the bag and T methods give slightly more accurate results because they match the pump flow better.

- b) **Pressure.** Pressures deviating from atmospheric pressure affect the readings by altering gas concentration and pump characteristics. It is best to calibrate with the instrument and calibration gas at the same pressure as each other and the sample gas. (Note that the cylinder pressure is not relevant because the regulator reduces the pressure to ambient.) If the instrument is calibrated at atmospheric pressure in one of the flow configurations described above, then 1) pressures slightly above ambient are acceptable but high pressures can damage the pump and 2) samples under vacuum may give low readings if air leaks into the sample train.
- c) **Temperature.** Because temperature effects gas density and concentration, the temperature of the calibration gas and instrument should be as close as possible to the ambient temperature where the unit will be used. We recommend that the temperature of the calibration gas be within the instrument's temperature specification (typically 14°-113° F or -10°- 45° C). Also, during actual measurements, the instrument should be kept at the same or higher temperature than the sample temperature to avoid condensation in the unit.
- d) **Matrix.** The matrix gas of the calibration compound and VOC sample is significant. Some common matrix components, such as methane and water vapor can affect the

VOC signal. PIDs are most commonly used for monitoring VOCs in air, in which case the preferred calibration gas matrix is air. For a MiniRAE, methane, methanol, and water vapor reduce the response by about 20% when their concentration is 15,000 ppm and by about 40% at 30,000 ppm. Despite earlier reports of oxygen effects, RAE PID responses with 10.6 eV lamps are independent of oxygen concentration, and calibration gases in a pure nitrogen matrix can be used. H₂ and CO₂ up to 5 volume % also have no effect.

- e) **Concentration.** Although RAE Systems PIDs have electronically linearized output, it is best to calibrate in a concentration range close to the actual measurement range. For example, 100 ppm standard gas for anticipated vapors of 0 - 250 ppm, and 500 ppm standard for expected concentrations of 250 - 1000 ppm.
- f) **Filters.** Filters affect flow and pressure conditions and therefore all filters to be used during sampling should also be in place during calibration. Using a water trap (hydrophobic filter) greatly reduces the chances of drawing water aerosols or dirt particles into the instrument. Regular filter replacements are recommended because dirty filters can adsorb VOCs and cause slower response time and shifts in calibration.

Table Abbreviations:

- CF** =Correction Factor (multiply by reading to get corrected value for the compound when calibrated to isobutylene)
- NR** =No Response
- IE** =Ionization Energy (values in parentheses are not well established)
- C** =Confirmed Value; all others are preliminary or estimated values and are subject to change
- ne** =Not Established ACGIH 8-hr. TWA
- C##** =Ceiling value, given where 8-hr.TWA is not available

Disclaimer:

Actual readings may vary with age and cleanliness of lamp, relative humidity, and other factors. For accurate work, the instrument should be calibrated regularly under the operating conditions used. The correction factors in this table were measured in dry air at room temperature.

Updates:

The values that are indicated by a "plus" sign in the "C" columns are confirmed values; all others are preliminary and subject to change. Watch for updates of this table on the Internet at <http://www.raesystems.com>

IE data are taken from the CRC Handbook of Chemistry and Physics, 73rd Edition, D.R. Lide (Ed.), CRC Press (1993) and NIST Standard Ref. Database 19A, NIST Positive Ion Energetics, Vers. 2.0, Lias, et.al., U.S. Dept. Commerce (1993). Exposure limits (8-h TWA and Ceiling Values) are from the 1997 ACGIH TLVs and BEIs, Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. ACGIH, Cincinnati, OH 1997.

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Acetaldehyde		75-07-0	C ₂ H ₄ O	NR	+	6	+	3.3	+	10.23	C25
Acetic Acid	Ethanoic Acid	64-19-7	C ₂ H ₄ O ₂	NR	+	22	+	2.6	+	10.66	10
Acetic Anhydride	Ethanoic Acid Anhydride	108-24-7	C ₄ H ₆ O ₃	NR	+	6.1	+	2.0	+	10.14	5
Acetone	2-Propanone	67-64-1	C ₃ H ₆ O	1.2	+	1.1	+	1.4	+	9.71	500
Acetonitrile	Methyl cyanide, Cyanomethane	75-05-8	C ₂ H ₃ N					100		12.19	40
Acetylene	Ethyne	74-86-2	C ₂ H ₂					2		11.40	ne
Acrolein	Propenal	107-02-8	C ₃ H ₄ O	42	+	3.9	+	1.4	+	10.10	0.1
Acrylic Acid	Propenoic Acid	79-10-7	C ₃ H ₄ O ₂			12	+	2.0	+	10.60	2
Acrylonitrile	Propenenitrile	107-13-1	C ₃ H ₃ N			NR	+	1.2	+	10.91	2
Allyl alcohol		107-18-6	C ₃ H ₆ O			2.4	+	1.7		9.67	2
Allyl chloride	3-Chloropropene	107-05-1	C ₃ H ₅ Cl			4.3		0.7		9.9	1
Ammonia		7664-41-7	H ₃ N	NR	+	9.7	+	5.7	+	10.16	25
Amyl acetate	mix of n-Pentyl acetate & 2-Methylbutyl acetate	628-63-7	C ₇ H ₁₄ O ₂	11	+	2.3	+	0.95	+	<9.9	100
Amyl alcohol	1-Pentanol	75-85-4	C ₅ H ₁₂ O			5				10.00	ne
Aniline	Aminobenzene	62-53-3	C ₇ H ₇ N	0.50	+	0.48	+	0.47	+	7.72	2
Anisole	Methoxybenzene	100-66-3	C ₇ H ₈ O			0.8				8.21	ne
Arsine	Arsenic trihydride	7784-42-1	AsH ₃			1.9	+			9.89	0.05
Benzaldehyde		100-52-7	C ₇ H ₆ O					1		9.49	ne
Benzene		71-43-2	C ₆ H ₆	0.55	+	0.53	+	0.6	+	9.25	0.5
Benzonitrile	Cyanobenzene	100-47-0	C ₇ H ₅ N			1.6				9.62	ne
Benzyl alcohol	α-Hydroxytoluene, Hydroxymethylbenzene, Benzenemethanol	100-51-6	C ₇ H ₈ O	1.4	+	1.1	+	0.9	+	8.26	ne
Benzyl chloride	α-Chlorotoluene, Chloromethylbenzene	100-44-7	C ₇ H ₇ Cl	0.7	+	0.6	+	0.5	+	9.14	1
Benzyl formate	Formic acid benzyl ester	104-57-4	C ₈ H ₈ O ₂	0.9	+	0.73	+	0.66	+		ne
Boron trifluoride		7637-07-2	BF ₃	NR		NR		NR		15.5	C1
Bromine		7726-95-6	Br ₂	NR	+	1.30	+	0.74	+	10.51	0.1
Bromobenzene		108-86-1	C ₆ H ₅ Br			0.6		0.5		8.98	ne
2-Bromoethyl methyl ether		6482-24-2	C ₃ H ₇ OBr			0.84	+			~10	ne
Bromoform	Tribromomethane	75-25-2	CHBr ₃	NR	+	2.5	+	0.5	+	10.48	0.5
Bromopropane, 1-	n-Propyl bromide	106-94-5	C ₃ H ₇ Br	150	+	1.5	+	0.6	+	10.18	ne
Butadiene	1,3-Butadiene, Vinyl ethylene	106-99-0	C ₄ H ₆	0.8		0.85	+	1.1		9.07	2
Butadiene diepoxide, 1,3-	1,2,3,4-Diepoxybutane	298-18-0	C ₄ H ₆ O ₂	25	+	3.5	+	1.2		~10	ne
Butane		106-97-8	C ₄ H ₁₀			67	+	1.2		10.53	800
Butanol, 1-	Butyl alcohol, n-Butanol	71-36-3	C ₄ H ₁₀ O	70	+	4.7	+	1.4	+	9.99	C50
Butanol, t-	tert-Butanol, t-Buty alcohol	75-65-0	C ₄ H ₁₀ O	6.9	+	2.9	+			9.90	100
Butene, 1-	1-Butylene	106-98-9	C ₄ H ₈			0.9				9.58	ne
Butoxyethanol, 2-	Butyl Cellosolve, Ethylene glycol monobutyl ether	111-76-2	C ₆ H ₁₄ O ₂	1.8	+	1.2	+	0.6	+	<10	25
Butyl acetate, n-		123-86-4	C ₆ H ₁₂ O ₂			2.6	+			10	150
Butyl acrylate, n-	Butyl 2-propenoate, Acrylic acid butyl ester	141-32-2	C ₇ H ₁₂ O ₂			1.6	+	0.6	+		10
Butylamine, n-		109-73-9	C ₄ H ₁₁ N	1.1	+	1.1	+	0.7	+	8.71	C5
Butyl cellosolve	see 2-Butoxyethanol	111-76-2									
Butyl hydroperoxide, t-		75-91-2	C ₄ H ₁₀ O ₂	2.0	+	1.6	+			<10	1
Butyl mercaptan	1-Butanethiol	109-79-5	C ₄ H ₁₀ S	0.55	+	0.52	+			9.14	0.5
Carbon disulfide		75-15-0	CS ₂	4	+	1.2	+	0.44		10.07	10
Carbon tetrachloride	Tetrachloromethane	56-23-5	CCl ₄	NR	+	NR	+	1.7	+	11.47	5
Carbonyl sulfide	Carbon oxysulfide	463-58-1	COS							11.18	
Cellosolve	see 2-Ethoxyethanol										
CFC-14	see Tetrafluoromethane										
CFC-113	see 1,1,2-Trichloro-1,2,2-trifluoroethane										
Chlorine		7782-50-5	Cl ₂					1.0	+	11.48	0.5
Chlorine dioxide		10049-04-4	ClO ₂	NR	+	NR	+	NR		10.57	0.1
Chloro-1,3-butadiene, 2-	Chloroprene	126-99-8	C ₄ H ₅ Cl					3			10

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Chlorobenzene	Monochlorobenzene	108-90-7	C ₆ H ₅ Cl	0.44	+	0.40	+	0.39	+	9.06	10
Chloro-1,1-difluoroethane, 1-	(R-142B)	75-68-3	C ₂ H ₃ ClF ₂			NR		NR		12.0	ne
Chlorodifluoromethane	HCFC-22, R-22	75-45-6	CHClF ₂	NR		NR		NR		12.2	1000
Chloroethane	Ethyl chloride	75-00-3	C ₂ H ₅ Cl	NR	+	NR	+	1.1	+	10.97	100
Chloroethanol	Ethylene chlorhydrin	107-07-3	C ₂ H ₅ ClO							10.52	C1
Chloroethyl ether, 2-	bis(2-chloroethyl) ether	111-44-4	C ₄ H ₈ Cl ₂ O	8.6	+	3.0	+				5
Chloroethyl methyl ether, 2-	Methyl 2-chloroethyl ether	627-42-9	C ₃ H ₇ ClO			3					ne
Chloroform	Trichloromethane	67-66-3	CHCl ₃	NR	+	NR	+	3.5	+	11.37	10
Chloropicrin			CCl ₃ NO ₂	NR	+	~400	+	7	+	?	0.1
Chlorotoluene, o-	o-Chloromethylbenzene	95-49-8	C ₇ H ₇ Cl			0.5		0.6		8.83	50
Chlorotoluene, p-	p-Chloromethylbenzene	106-43-4	C ₇ H ₇ Cl					0.6		8.69	ne
Crotonaldehyde	<i>trans</i> -2-Butenal	123-73-9 4170-30-3	C ₄ H ₆ O	1.5	+	1.1	+	1.0	+	9.73	2
Cumene	Isopropylbenzene	98-82-8	C ₉ H ₁₂	0.58	+	0.54	+	0.4	+	8.73	50
Cyanogen bromide		506-68-3	CNBr	NR		NR		NR		11.84	ne
Cyanogen chloride		506-77-4	CNCl	NR		NR		NR		12.34	C0.3
Cyclohexane		110-82-7	C ₆ H ₁₂	3.3	+	1.4	+	0.64	+	9.86	300
Cyclohexanol	Cyclohexyl alcohol	108-93-0	C ₆ H ₁₂ O					1.1		9.75	50
Cyclohexanone		108-94-1	C ₆ H ₁₀ O	1.0	+	0.9	+	0.7	+	9.14	25
Cyclohexene		110-83-8	C ₆ H ₁₀			0.8	+			8.95	300
Cyclohexylamine		108-91-8	C ₆ H ₁₃ N			1.2				8.62	10
Cyclopentane		287-92-3	C ₅ H ₁₀					0.6		10.51	600
Decane		124-18-5	C ₁₀ H ₂₂	4.0	+	1.4	+	0.35	+	9.65	ne
Diacetone alcohol	4-Methyl-4-hydroxy-2-pentanone	123-42-2	C ₆ H ₁₂ O ₂			0.7					50
Dibromochloromethane	Chlorodibromomethane	124-48-1	CHBr ₂ Cl	NR	+	5.3	+	0.7	+	10.59	ne
Dibromoethane, 1,2-	EDB, Ethylene dibromide, Ethylene bromide	106-93-4	C ₂ H ₄ Br ₂	NR	+	1.7	+	0.6	+	10.37	ne
Dichlorobenzene, o-	1,2-Dichlorobenzene	95-50-1	C ₆ H ₄ Cl ₂	0.54	+	0.47	+	0.38	+	9.08	25
Dichlorodifluoromethane	CFC-12	75-71-8	CCl ₂ F ₂			NR	+	NR	+	11.75	1000
Dichloroethane, 1,2-	EDC, 1,2-DCA, Ethylene dichloride	107-06-2	C ₂ H ₄ Cl ₂			NR	+	0.6	+	11.04	10
Dichloroethene, 1,1-	1,1-DCE, Vinylidene chloride	75-35-4	C ₂ H ₂ Cl ₂			0.9				9.79	5
Dichloroethene, c-1,2-	c-1,2-DCE, <i>cis</i> -Dichloroethylene	156-59-2	C ₂ H ₂ Cl ₂			0.8				9.66	200
Dichloroethene, t-1,2-	t-1,2-DCE, <i>trans</i> -Dichloroethylene	156-60-5	C ₂ H ₂ Cl ₂			0.45	+	0.34	+	9.65	200
Dichloro-1-fluoroethane, 1,1-	R-141B	1717-00-6	C ₂ H ₃ Cl ₂ F	NR	+	NR	+	2.0	+		ne
Dichloromethane	see Methylene chloride										
Dichloropentafluoropropane	AK-225, mix of ~45% 3,3-dichloro-1,1,1,2,2-pentafluoro-3-propane (HCFC-225ca) & ~55% 1,3-Dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb)	442-56-0 507-55-1	C ₃ HCl ₂ F ₅	NR	+	NR	+	25	+		ne
Dichloropropane, 1,2-		78-87-5	C ₃ H ₆ Cl ₂					0.7		10.87	75
Dichloro-1-propene, 1,3-		542-75-6	C ₃ H ₄ Cl ₂	1.3	+	0.96	+			<10	1
Dichloro-1-propene, 2,3-		78-88-6	C ₃ H ₄ Cl ₂	1.9	+	1.3	+	0.7	+	<10	ne
Dichloro-1,1,1-trifluoroethane, 2,2-	R-123	306-83-2	C ₂ HCl ₂ F ₃	NR	+	NR	+	10.1	+	11.5	ne
Dichlorvos	Vapona; O,O-dimethyl O-dichlorovinyl phosphate	62-73-7	C ₄ H ₇ Cl ₂ O ₄ P			0.9	+			<9.4	0.1
Dicyclopentadiene	DCPD, Cyclopentadiene dimer	77-73-6	C ₁₀ H ₁₂	0.57	+	0.48	+	0.43	+	8.8	5
Diesel Fuel #1		68334-30-5	m.w. 226			0.9	+				11
Diesel Fuel #2		68334-30-5	m.w. 216			0.7	+	0.4	+		11
Diethylamine		109-89-7	C ₄ H ₁₁ N			1	+			8.01	5
Diethylaminopropylamine, 3-		104-78-9	C ₇ H ₁₈ N ₂			1.3					ne

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Diethylmaleate		141-05-9	C ₈ H ₁₂ O ₄			4					ne
Diethyl sulfide	see Ethyl sulfide										
Diisopropylamine		108-18-9	C ₆ H ₁₅ N	0.84	+	0.74	+	0.5	+	7.73	5
Diketene	Ketene dimer	674-82-8	C ₄ H ₄ O ₂	2.6	+	2.0	+	1.4	+	9.6	0.5
Dimethylacetamide, N,N-	DMA	127-19-5	C ₄ H ₉ NO	0.87	+	0.8	+	0.8	+	8.81	10
Dimethylamine		124-40-3	C ₂ H ₇ N			1.5				8.23	5
Dimethyl carbonate	Carbonic acid dimethyl ester	616-38-6	C ₃ H ₆ O ₃	NR	+	~70	+	1.7	+	~10.5	ne
Dimethyl disulfide	DMDS	624-92-0	C ₂ H ₆ S ₂	0.2	+	0.20	+	0.21	+	7.4	ne
Dimethyl ether	see Methyl ether										
Dimethylethylamine	DMEA	598-56-1	C ₄ H ₁₁ N	1.1	+	1.0	+	0.9	+	7.74	~3
Dimethylformamide, N,N-	DMF	68-12-2	C ₃ H ₇ NO			0.8				9.13	10
Dimethylhydrazine, 1,1-	UDMH	57-14-7	C ₂ H ₈ N ₂			0.8	+	0.8	+	7.28	0.01
Dimethyl methylphosphonate	DMMP, methyl phosphonic acid dimethyl ester	756-79-6	C ₃ H ₉ O ₃ P	NR	+	4.3	+	0.74	+	10.0	ne
Dimethyl sulfate		77-78-1	C ₂ H ₆ O ₄ S	~23		~20	+	2.3	+		0.1
Dimethyl sulfide	see Methyl sulfide										
Dimethyl sulfoxide	DMSO, Methyl sulfoxide	67-68-5	C ₂ H ₆ OS			1.4	+			9.10	ne
Dioxane, 1,4-		123-91-1	C ₄ H ₈ O ₂			1.3				9.19	25
Dioxolane, 1,3-	Ethylene glycol formal	646-06-0	C ₃ H ₆ O ₂	4.0	+	2.3	+	1.6	+	9.9	20
Dowtherm A	see Therminol		C ₃ H ₆ O ₂								
DS-108F Wipe Solvent	Ethyl lactate/Isopar H/ Propoxypropanol ~7:2:1	97-64-3 64742-48-9 1569-01-3	m.w. 118	3.3	+	1.6	+	0.7	+		ne
Epichlorohydrin	ECH Chloromethyloxirane, 1-chloro2,3-epoxypropane	106-89-8	C ₂ H ₅ ClO	~200	+	8.5	+	1.4	+	10.2	0.5
Ethane		74-84-0	C ₂ H ₆			NR	+	15	+	11.52	ne
Ethanol	Ethyl alcohol	64-17-5	C ₂ H ₆ O			12	+	8		10.47	1000
Ethanolamine	MEA, Monoethanolamine	141-43-5	C ₂ H ₇ NO	5.6	+	1.6	+			8.96	3
Ethene	Ethylene	74-85-1	C ₂ H ₄			10	+	3		10.51	ne
Ethoxyethanol, 2-	Ethyl cellosolve, Ethylene glycol monoethyl ether	110-80-5	C ₄ H ₁₀ O ₂			1.3				9.6	5
Ethyl acetate		141-78-6	C ₄ H ₈ O ₂			4.6	+			10.01	400
Ethyl acrylate		140-88-5	C ₅ H ₈ O ₂			2.4	+	1.0	+	<10.3	5
Ethylamine		75-04-7	C ₂ H ₇ N			0.8				8.86	5
Ethylbenzene		100-41-4	C ₈ H ₁₀	0.52	+	0.52	+	0.51	+	8.77	100
Ethylene glycol	1,2-Ethanediol	107-21-1	C ₂ H ₆ O ₂			16	+	6	+	10.16	C100
Ethylene glycol dimethyl ether	1,2-Dimethoxyethane, Monoglyme	110-71-4	C ₄ H ₁₀ O ₂	1.1		0.86		0.7		9.2	ne
Ethylene oxide	Oxirane, Epoxyethane	75-21-8	C ₂ H ₄ O			13	+	3.5	+	10.57	1
Ethyl ether	Diethyl ether	60-29-7	C ₄ H ₁₀ O			1.1	+			9.51	400
Ethyl 3-ethoxypropionate	EEP	763-69-9	C ₇ H ₁₄ O ₃	1.2	+	0.75	+				ne
Ethyl formate		109-94-4	C ₃ H ₆ O ₂					1.9		10.61	100
Ethyl hexyl acrylate, 2-	Acrylic acid 2-ethylhexyl ester	103-11-7	C ₁₁ H ₂₀ O ₂			1.1	+	0.5	+		ne
Ethyl (S)-(-)-lactate	Ethyl lactate, Ethyl (S)-(-)- see also DS-108F hydroxypropionate	687-47-8 97-64-3	C ₅ H ₁₀ O ₃	13	+	3.2	+	1.6	+	~10	ne
Ethyl mercaptan	Ethanethiol	75-08-1	C ₂ H ₆ S	0.60	+	0.56	+			9.29	0.5
Ethyl sulfide	Diethyl sulfide	352-93-2	C ₄ H ₁₀ S			0.5	+			8.43	ne
Formaldehyde	Formalin	50-00-0	CH ₂ O					0.6		10.87	C0.3
Formic acid		64-18-6	CH ₂ O ₂	NR	+	NR	+	9	+	11.33	5
Furfural	2-Furaldehyde	98-01-1	C ₅ H ₄ O ₂			0.92	+	0.8	+	9.21	2
Furfuryl alcohol		98-00-0	C ₅ H ₆ O ₂			0.80	+			<9.5	10
Gasoline #1		8006-61-9	m.w. 72			0.9	+				300
Gasoline #2, 92 octane		8006-61-9	m.w. 93	1.3	+	1.0	+	0.5	+		300
Glutaraldehyde	1,5-Pentanedial, Glutaric dialdehyde	111-30-8	C ₅ H ₈ O ₂	1.1	+	0.8	+	0.6	+		C0.0 5
Halothane	2-Bromo-2-chloro-1,1,1- trifluoroethane	151-67-7	C ₂ HBrClF ₃					0.6		11.0	50
HCFC-22	see Chlorodifluoromethane										

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
HCFC-123	see 2,2-Dichloro-1,1,1-trifluoroethane										
HCFC-141B	see 1,1-Dichloro-1-fluoroethane										
HCFC-142B	see 1-Chloro-1,1-difluoroethane										
HCFC-134A	see 1,1,1,2-Tetrafluoroethane										
HCFC-225	see Dichloropentafluoropropane										
Heptane, n-		142-82-5	C ₇ H ₁₆	45	+	2.8	+	0.60	+	9.92	400
Hexamethyldisilazane, 1,1,1,3,3,3-	HMDS	999-97-3	C ₆ H ₁₉ NSi ₂			0.2	+	0.2	+	~8.6	
Hexane, n-		110-54-3	C ₆ H ₁₄	350	+	4.3	+	0.54	+	10.13	50
Hexanol, 1-	Hexyl alcohol	111-27-3	C ₆ H ₁₄ O	9	+	2.5	+	0.55	+	9.89	ne
Hexene, 1-		592-41-6	C ₆ H ₁₂			0.8				9.44	30
Hydrazine		302-01-2	H ₄ N ₂	>8	+	2.6	+	2.1	+	8.1	0.01
Hydrazoic acid	Hydrogen azide		HN ₃							10.7	
Hydrogen	Synthesis gas	1333-74-0	H ₂	NR	+	NR	+	NR	+	15.43	ne
Hydrogen cyanide	Hydrocyanic acid	74-90-8	HCN	NR	+	NR	+	NR	+	13.6	C4.7
Hydrogen peroxide		7722-84-1	H ₂ O ₂	NR	+	NR	+	NR	+	10.54	1
Hydrogen sulfide		7783-06-4	H ₂ S	NR	+	3.3	+	1.5	+	10.45	10
Iodine		7553-56-2	I ₂	0.1	+	0.1	+	0.1	+	9.40	C0.1
Iodomethane	Methyl iodide	74-88-4	CH ₃ I	0.21	+	0.22	+	0.26	+	9.54	2
Isoamyl acetate	Isopentyl acetate	123-92-2	C ₇ H ₁₄ O ₂	10.1		2.1		1.0		<10	100
Isobutane	2-Methylpropane	75-28-5	C ₄ H ₁₀			100	+	1.2	+	10.57	ne
Isobutanol	2-Methyl-1-propanol	78-83-1	C ₄ H ₁₀ O	19	+	3.8	+	1.5		10.02	50
Isobutene	Isobutylene, Methyl butene	115-11-7	C ₄ H ₈	1.00	+	1.00	+	1.00	+	9.24	ne
Isobutyl acetate		110-19-0	C ₆ H ₁₂ O ₂			2.6					150
Isobutyl acrylate	Isobutyl 2-propenoate, Acrylic acid Isobutyl ester	106-63-8	C ₇ H ₁₂ O ₂			1.5	+	0.60	+		ne
Isoflurane	1-Chloro-2,2,2-trifluoroethyl difluoromethyl ether, forane	26675-46-7	C ₃ H ₂ ClF ₅ O							~11.7	ne
Isooctane	2,2,4-Trimethylpentane	540-84-1	C ₈ H ₁₈			1.2				9.86	ne
Isopar E Solvent	Isoparaffinic hydrocarbons	64741-66-8	m.w.121	1.7	+	0.8	+				ne
Isopar G Solvent	Photocopier diluent	64742-48-9	m.w. 148			0.8	+				ne
Isopar K Solvent	Isoparaffinic hydrocarbons	64742-48-9	m.w. 156	0.9	+	0.5	+	0.27	+		ne
Isopar L Solvent	Isoparaffinic hydrocarbons	64742-48-9	m.w. 163	0.9	+	0.5	+	0.28	+		ne
Isopar M Solvent	Isoparaffinic hydrocarbons	64742-47-8	m.w. 191			0.7	+	0.4	+		ne
Isopentane	2-Methylbutane	78-78-4	C ₅ H ₁₂			8.2					ne
Isophorone		78-59-1	C ₉ H ₁₄ O					3		9.07	C5
Isoprene	2-Methyl-1,3-butadiene	78-79-5	C ₅ H ₈	0.69	+	0.63	+	0.60	+	8.85	ne
Isopropanol	Isopropyl alcohol, 2-propanol, IPA	67-63-0	C ₃ H ₈ O	500	+	6.0	+	2.7		10.12	400
Isopropyl acetate		108-21-4	C ₅ H ₁₀ O ₂			2.6				9.99	250
Isopropyl ether	Diisopropyl ether	108-20-3	C ₆ H ₁₄ O			0.8				9.20	250
Jet fuel JP-4	Jet B, Turbo B, Wide cut type aviation fuel	8008-20-6 + 64741-42-0	m.w. 115			1.0	+	0.4	+		ne
Jet fuel JP-5	Jet 5, Kerosene type aviation fuel	8008-20-6 + 64747-77-1	m.w. 167			0.6	+	0.5	+		15
Jet fuel JP-8	Jet A-1, Kerosene type aviation fuel	8008-20-6 + 64741-77-1	m.w. 165			0.6	+	0.3	+		15
Limonene, D-	(R)-(+)-Limonene	5989-27-5	C ₁₀ H ₁₆			0.33	+			~8.2	ne
Kerosene C10-C16	petro.distillate – see Jet Fuels	8008-20-6									
MDI	- see 4,4'-Methylenebis(phenylisocyanate)										
Mesitylene	1,3,5-Trimethylbenzene	108-67-8	C ₉ H ₁₂	0.36	+	0.35	+	0.3	+	8.41	ne
Methane	Natural gas	74-82-8	CH ₄	NR	+	NR	+	NR	+	12.51	ne
Methanol	Methyl alcohol, carbinol	67-56-1	CH ₄ O	NR	+	NR	+	2.5	+	10.85	200
Methoxyethanol, 2-	Methyl cellosolve, Ethylene glycol monomethyl ether	109-86-4	C ₃ H ₈ O ₂	4.8	+	2.4	+	1.4	+	10.1	5
Methoxyethoxyethanol, 2-	2-(2-Methoxyethoxy)ethanol Diethylene glycol monomethyl ether	111-77-3	C ₇ H ₁₆ O	2.3	+	1.2	+	0.9	+	<10	ne

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Methyl acetate		79-20-9	C ₃ H ₆ O ₂	NR	+	6.6	+	1.4	+	10.27	200
Methyl acrylate	Methyl 2-propenoate, acrylic acid methyl ester	96-33-3	C ₄ H ₆ O ₂			3.7	+	1.2	+	(9.9)	2
Methylamine	Aminomethane	74-89-5	CH ₅ N			1.2				8.97	5
Methyl bromide	Bromomethane	74-83-9	CH ₃ Br	110	+	1.7	+	1.3	+	10.54	1
Methyl t-butyl ether	MTBE, <i>tert</i> -Butyl methyl ether	1634-04-4	C ₅ H ₁₂ O			0.9	+			9.24	40
Methyl cellosolve	see 2-Methoxyethanol										
Methyl chloride	Chloromethane	74-87-3	CH ₃ Cl	NR	+	NR	+	0.74	+	11.22	50
Methylcyclohexane		107-87-2	C ₇ H ₁₄	1.6	+	0.97	+	0.53	+	9.64	400
Methylene bis(phenyl-isocyanate), 4,4'	MDI, Mondur M		C ₁₅ H ₁₀ N ₂ O ₂	Very slow ppb level response						0.005	
Methylene chloride	Dichloromethane	75-09-2	CH ₂ Cl ₂	NR	+	NR	+	0.89	+	11.32	25
Methyl ether	Dimethyl ether	115-10-6	C ₂ H ₆ O	4.8	+	3.1	+	2.5	+	10.03	ne
Methyl ethyl ketone	MEK, 2-Butanone	78-93-3		0.86	+	0.9	+	1.1	+	9.51	200
Methylhydrazine	Monomethylhydrazine, Hydrazomethane	60-34-4	C ₂ H ₆ N ₂	1.4	+	1.2	+	1.3	+	7.7	0.01
Methyl isobutyl ketone	MIBK, 4-Methyl-2-pentanone	108-10-1	C ₆ H ₁₂ O	0.9	+	0.8	+	0.6	+	9.30	50
Methyl isocyanate	CH ₃ NCO	624-83-9	C ₂ H ₃ NO	NR	+	4.6	+	1.5		10.67	0.02
Methyl isothiocyanate	CH ₃ NCS	551-61-6	C ₂ H ₃ NS	0.5	+	0.45	+	0.4	+	9.25	ne
Methyl mercaptan	Methanethiol	74-93-1	CH ₄ S	0.65		0.54		0.66		9.44	0.5
Methyl methacrylate		80-62-6	C ₅ H ₈ O ₂	2.7	+	1.5	+	1.2	+	9.7	100
Methyl nonafluorobutyl ether	HFE-7100DL	163702-08-7, 163702-07-6	C ₅ H ₃ F ₉ O			NR	+	~35	+		ne
Methyl-1,5-pentane-diamine, 2- (coats lamp)	Dytek-A amine, 2-Methyl pentamethylenediamine	15520-10-2	C ₆ H ₁₆ N ₂			~0.6	+			<9.0	ne
Methyl propyl ketone	MPK, 2-Pentanone	107-87-9	C ₅ H ₁₂ O			0.93	+	0.79	+	9.38	200
Methyl-2-pyrrolidinone, N-	NMP, N-Methylpyrrolidone, 1-Methyl-2-pyrrolidinone, 1-Methyl-2-pyrrolidone	872-50-4	C ₅ H ₉ NO	1.0	+	0.8	+	0.9	+	9.17	ne
Methyl salicylate	Methyl 2-hydroxybenzoate	119-36-8	C ₈ H ₈ O ₃	1.3	+	0.9	+	0.9	+	~9	ne
Methylstyrene, α-	2-Propenylbenzene	98-83-9	C ₉ H ₁₀			0.5				8.18	50
Methyl sulfide	DMS, Dimethyl sulfide	75-18-3	C ₂ H ₆ S	0.49	+	0.44	+	0.46	+	8.69	ne
Mineral spirits	Stoddard Solvent, Varsol 1	8020-83-5, 8052-41-3, 68551-17-7	m.w. 144			0.7	+	0.39	+		100
Mineral Spirits - Viscor 120B	Calibration Fluid, b.p. 156-207°C	8052-41-3	m.w. 142	1.0	+	0.7	+	0.3	+		100
Mustard	HD, Bis(2-chloroethyl) sulfide	505-60-2, 39472-40-7, 68157-62-0	C ₄ H ₈ Cl ₂ S			0.6					0.0005
Naphthalene	Mothballs	91-20-3	C ₁₀ H ₈	0.45	+	0.42	+	0.40	+	8.13	10
Nitric oxide		10102-43-9	NO	~6		5.2	+	2.8	+	9.26	25
Nitrobenzene		98-95-3	C ₆ H ₅ NO ₂	2.6	+	1.9	+	1.6	+	9.81	1
Nitroethane		79-24-3	C ₂ H ₅ NO ₂					3		10.88	100
Nitrogen dioxide		10102-44-0	NO ₂	23	+	16	+	6	+	9.75	3
Nitromethane		75-52-5	CH ₃ NO ₂					4		11.02	20
Nitropropane, 2-		79-46-9	C ₃ H ₇ NO ₂					2.6		10.71	10
Nonane		111-84-2	C ₉ H ₂₀			1.4				9.72	200
Octane, n-		111-65-9	C ₈ H ₁₈	13	+	1.8	+			9.82	300
Pentane		109-66-0	C ₅ H ₁₂	80	+	8.4	+	0.7	+	10.35	600
Peracetic acid	Peroxyacetic acid, Acetyl hydroperoxide	79-21-0	C ₂ H ₄ O ₃	NR	+	NR	+	2.3	+		ne
Peracetic/Acetic acid mix	Peroxyacetic acid, Acetyl hydroperoxide	79-21-0	C ₂ H ₄ O ₃			50	+	2.5	+		ne
Perchloroethene	PCE, Perchloroethylene, Tetrachloroethylene	127-18-4	C ₂ Cl ₄	0.69	+	0.57	+	0.31	+	9.32	25
PGME	Propylene glycol methyl ether, 1-Methoxy-2-propanol	107-98-2	C ₆ H ₁₂ O ₃	2.4	+	1.5	+	1.1	+		100

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
PGMEA	Propylene glycol methyl ether acetate, 1-Methoxy-2-acetoxypropane, 1-Methoxy-2-propanol acetate	108-65-6	C ₆ H ₁₂ O ₃	1.65	+	1.0	+	0.8	+		ne
Phenol	Hydroxybenzene	108-95-2	C ₆ H ₆ O	1.0	+	1.0	+	0.9	+	8.51	5
Phosgene in Nitrogen	Dichlorocarbonyl	75-44-5	CCl ₂ O	NR	+	NR	+	7	+	11.2	0.1
Phosphine		7803-51-2	PH ₃	28		3.9	+	1.1	+	9.87	0.3
Photocopier Toner	Isoparaffin mix					0.5	+	0.3	+		ne
Picoline, 3-	3-Methylpyridine	108-99-6	C ₆ H ₇ N			0.9				9.04	ne
Pinene, α-		2437-95-8	C ₁₀ H ₁₆			0.31	+	0.47		8.07	ne
Pinene, β-		18172-67-3	C ₁₀ H ₁₆	0.38	+	0.37	+	0.37	+	~8	100
Piperylene, isomer mix	1,3-Pentadiene	504-60-9	C ₅ H ₈	0.76	+	0.69	+	0.64	+	8.6	100
Propane		74-98-6	C ₃ H ₈			NR	+	1.8	+	10.95	2500
Propanol, n-	Propyl alcohol	71-23-8	C ₃ H ₈ O			5		1.7		10.22	200
Propene	Propylene	115-07-1	C ₃ H ₆	1.5	+	1.4	+	1.6	+	9.73	ne
Propionaldehyde	Propanal	123-38-6	C ₃ H ₆ O			1.9				9.95	ne
Propyl acetate, n-		109-60-4	C ₅ H ₁₀ O ₂			3.5				10.04	200
Propylene carbonate		108-32-7	C ₄ H ₆ O ₃			62	+	1	+	10.5	ne
Propylene glycol	1,2-Propanediol	57-55-6	C ₃ H ₈ O ₂	18		5.5	+	1.6	+	<10.2	ne
Propylene oxide	Methyloxirane	75-56-9	C ₃ H ₆ O	~240		6.6	+	2.9	+	10.22	20
		16088-62-3									
		15448-47-2									
Propyleneimine	2-Methylaziridine	75-55-8	C ₃ H ₇ N	1.5	+	1.3	+	1.0	+	9.0	2
Propyl mercaptan, 2-	2-Propanethiol, Isopropyl mercaptan	75-33-2	C ₃ H ₈ S	0.64	+	0.66	+			9.15	ne
Pyridine		110-86-1	C ₅ H ₅ N	0.78	+	0.7	+	0.7	+	9.25	5
Pyrrolidine (coats lamp)	Azacyclohexane	123-75-1	C ₄ H ₉ N	2.1	+	1.3	+	1.6	+	~8.0	ne
RR7300 (PGME/PGMEA)	70:30 PGME:PGMEA (1-Methoxy-2-propanol:1-Methoxy-2-acetoxypropane)	107-98-2	C ₄ H ₁₀ O ₂ / C ₆ H ₁₂ O ₃			1.4	+	1.0	+		ne
Sarin	GB, Isopropyl methylphosphonofluoridate	107-44-8	C ₄ H ₁₀ FO ₂ P			~3					
		50642-23-4									
Stoddard Solvent - see Mineral Spirits		8020-83-5									
Styrene		100-42-5	C ₈ H ₈	0.45	+	0.40	+	0.4	+	8.43	20
Sulfur dioxide		7446-09-5	SO ₂			NR	+	NR	+	12.32	2
Sulfur hexafluoride		2551-62-4	SF ₆	NR		NR		NR		15.3	1000
Sulfuryl fluoride	Vikane	2699-79-8	SO ₂ F ₂	NR		NR		NR		13.0	5
Tabun	Ethyl N, N-dimethylphosphoramidocyanidate	77-81-6	C ₅ H ₁₁ N ₂ O ₂ P			0.8					15ppt
Tetrachloroethane, 1,1,1,2-		630-20-6	C ₂ H ₂ Cl ₄					1.3		~11.1	ne
Tetrachloroethane, 1,1,2,2-		79-34-5	C ₂ H ₂ Cl ₄	NR	+	NR	+	0.60	+	~11.1	1
Tetraethyllead	TEL	78-00-2	C ₈ H ₂₀ Pb	0.4		0.3		0.2		~11.1	0.008
Tetraethyl orthosilicate	Ethyl silicate, TEOS	78-10-4	C ₈ H ₂₀ O ₄ Si			0.7	+	0.2	+	~9.8	10
Tetrafluoroethane, 1,1,1,2-	HFC-134A	811-97-2	C ₂ H ₂ F ₄			NR		NR			ne
Tetrafluoroethene	TFE, Tetrafluoroethylene, Perfluoroethylene	116-14-3	C ₂ F ₄			~15				10.12	ne
Tetrafluoromethane	CFC-14, Carbon tetrafluoride	75-73-0	CF ₄			NR	+	NR	+	>15.3	ne
Tetrahydrofuran	THF	109-99-9	C ₄ H ₈ O	1.9	+	1.7	+	1.0	+	9.41	200
Tetramethyl orthosilicate	Methyl silicate, TMOS	681-84-5	C ₄ H ₁₂ O ₄ Si	10	+	1.9	+			~10	1
Therminol VP-1	Dowtherm,3:1 Diphenyl oxide:	101-84-8	C ₁₂ H ₁₀ O			0.4	+				ne
	Biphenyl	92-52-4	C ₁₂ H ₁₀								
Toluene	Methylbenzene	108-88-3	C ₇ H ₈	0.54	+	0.50	+	0.51	+	8.82	50
Tolyene-2,4-diisocyanate	TDI, 4-Methyl-1,3-phenylene-2,4-diisocyanate	584-84-9	C ₉ H ₆ N ₂ O ₂	1.4	+	1.4	+	2.0	+		0.002
Trichlorobenzene, 1,2,4-	1,2,4-TCB	120-82-1	C ₆ H ₃ Cl ₃	0.7	+	0.46	+			9.04	C5
Trichloroethane, 1,1,1-	1,1,1-TCA, Methyl chloroform	71-55-6	C ₂ H ₃ Cl ₃			NR	+	1	+	11	350
Trichloroethane, 1,1,2-	1,1,2-TCA	79-00-5	C ₂ H ₃ Cl ₃	NR	+	NR	+	0.9	+	11.0	10
Trichloroethene	TCE, Trichloroethylene	79-01-6	C ₂ HCl ₃	0.62	+	0.54	+	0.43	+	9.47	50

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Trichlorotrifluoroethane, 1,1,2-	CFC-113	76-13-1	C ₂ Cl ₃ F ₃			NR		NR		11.99	1000
Triethylamine	TEA	121-44-8	C ₆ H ₁₅ N	0.95	+	0.9	+	0.65	+	7.3	1
Triethyl borate	TEB; Boric acid triethyl ester, Boron ethoxide	150-46-9	C ₆ H ₁₅ O ₃ B			2.2	+	1.1	+	~10	ne
Triethyl phosphate	Ethyl phosphate	78-40-0	C ₆ H ₁₅ O ₄ P	~50	+	3.1	+	0.60	+	9.79	ne
Trifluoroethane, 1,1,2-		430-66-0	C ₂ H ₃ F ₃					34		12.9	ne
Trimethylamine		75-50-3	C ₃ H ₉ N			0.9				7.82	5
Trimethylbenzene, 1,3,5-	- see Mesitylene	108-67-8									25
Trimethyl borate	TMB; Boric acid trimethyl ester, Boron methoxide	121-43-7	C ₃ H ₉ O ₃ B			5.1	+	1.2	+	10.1	ne
Trimethyl phosphate	Methyl phosphate	512-56-1	C ₃ H ₉ O ₄ P			8.0	+	1.3	+	9.99	ne
Trimethyl phosphite	Methyl phosphite	121-45-9	C ₃ H ₉ O ₃ P			1.1	+		+	8.5	2
Turpentine	Pinenes (85%) + other diisoprenes	8006-64-2	C ₁₀ H ₁₆	0.4	+	0.3	+			~8	100
Undecane		1120-21-4	C ₁₁ H ₂₄			2				9.56	ne
Varsol – see Mineral Spirits											
Vinyl acetate		108-05-4	C ₄ H ₆ O ₂	1.5	+	1.2	+	1.0	+	9.19	10
Vinyl bromide	Bromoethylene	593-60-2	C ₂ H ₃ Br			0.4				9.80	5
Vinyl chloride	Chloroethylene, VCM	75-01-4	C ₂ H ₃ Cl			2.0	+	0.6	+	9.99	5
Vinylidene chloride - see 1,1-Dichloroethene											
Vinyl-2-pyrrolidinone, 1-	NVP, N-vinylpyrrolidone, 1-ethenyl-2-pyrrolidinone	88-12-0	C ₆ H ₉ NO	1.0	+	0.8	+	0.9	+		ne
Viscor 120B - see Mineral Spirits	Viscor 120B Calibration Fluid										
Xylene, m-	1,3-Dimethylbenzene	108-38-3	C ₈ H ₁₀	0.50	+	0.43	+	0.40	+	8.56	100
Xylene, o-	1,2-Dimethylbenzene	95-47-6	C ₈ H ₁₀	0.57	+	0.59	+	0.69		8.56	100
Xylene, p-	1,4-Dimethylbenzene	106-42-3	C ₈ H ₁₀			0.45	+	0.62	+	8.44	100
None				1		1		1			
Undetectable				1E+6		1E+6		1E+6			

Appendix I:

Example of Automatic Calculation of Correction Factors, TLVs and Alarm Limits for Mixtures

(Calculations performed using Excel version of this database, available on request)

Compound	CF 9.8 eV	CF 10.6 eV	CF 11.7eV	Mol. Frac	Conc ppm	TLV ppm	STEL Ppm
Benzene	0.55	0.53	0.6	0.01	1	0.5	2.5
Toluene	0.54	0.5	0.51	0.06	10	50	150
Hexane, n-	300	4.3	0.54	0.06	10	50	150
Heptane, n-	45	2.8	0.6	0.28	50	400	500
Styrene	0.45	0.4	0.42	0.06	10	20	40
Acetone	1.2	1.1	1.4	0.28	50	750	1000
Isopropanol	500	6	2.7	0.28	50	400	500
None	1	1	1	0.00	0	1	
Mixture Value:	2.1	1.5	0.89	1.00	181	56	172
TLV Alarm Setpoint when Calibrated to Isobutylene:	26 ppm	37 ppm	62 ppm		ppm	ppm	ppm
STEL Alarm Setpoint, same Calibration	86 ppm	115 ppm	193 ppm				

MicroFID™

Photovac is **MORE**
than instruments.



Photovac delivers
PROVEN solutions.



FLAME IONIZATION MONITOR

SUPERIOR VOC

Detection



For accurate, reliable detection of VOCs, the Photovac MicroFID is the right choice in flame ionization detection. At just 8.1 lb. (3.7 kg.), the MicroFID is the smallest and lightest datalogging Flame Ionization Detector (FID) available.

Easy to learn and use

The MicroFID is easy to use. One tutor key prompts you through basic operations. Critical data is displayed and logged in less than 3 seconds within the concentration range of 0.5 -50,000 PPM. A simple two-step calibration holds for a full workday.

Designed for field use

The MicroFID is completely self-contained in a single hand-held package, so transportation and operation are simplified. The MicroFID's ergonomic design includes a built-in handle and a rubberized keypad that can be used while wearing protective equipment.

The MicroFID has an integrated, refillable fuel gas (hydrogen) mini-cylinder to allow up to 12 hours of field operation. The sample air serves as the oxygen source to start the flame. Replaceable and rechargeable battery packs operate for 15 hours.

Dependable results

With a wide linear range, the MicroFID responds to almost all VOCs. The flame ionization detector is stable and virtually immune to possible interferences such as water vapor.

Datalogging flexibility

Monitor fugitive emissions with ease and confidence with the MicroFID. Using the built-in datalogger, sample points can be recorded. In Interval Mode, the MicroFID records the date, time and minimum, average and maximum readings during user-selectable intervals. Or use the datalogger in U.S. EPA Method 21 Mode with Background, Sample and Difference readings. The data can then be down-loaded to a PC using Windows HyperTerminal and any Windows-based software package can be used for data management.

Intrinsically Safe

The MicroFID is classified as Intrinsically Safe in both North America [Class I, Division 1, Groups A, B, C, and D] and Europe [Ex nA II T5] for potentially hazardous environments.

Rely on results that measure up

For trouble-free measurement of soil gases where the response factor consistency of a FID is mandatory, or where methane must be included in the total reading, the MicroFID has no equal. Make EPA Method 21 Fugitive Emissions Monitoring easy with the smallest and lightest FID, the MicroFID.

**Detect up to 50,000 PPM VOCs including methane
CONFIDENTLY AND RELIABLY**

MicroFID

Solutions



- Leak Detection and Repair (U.S. EPA Method 21)
- Landfill monitoring
- Natural gas leak detection
- Petroleum products tank entry
- Emergency response
- Soil headspace screening
- Hazardous waste site delineation
- Solvent storage and piping
- Confined space pre-entry
- Underground storage tanks (UST)
- Transportation vessels
- Storage tank maintenance
- OSHA Compliance
- EPA Compliance
- Remediation efficiency

INDUSTRIES &



Applications

Fugitive Emissions/EPA Method 21

When calibration to methane is a must and detection levels range to 10,000 PPM or more, the MicroFID is the right choice in Method 21 compliance.

The MicroFID meets or exceeds all Method 21 instrument requirements while giving the convenience of the smallest and lightest datalogging FID.

Landfill Monitoring

In landfill monitoring, the detection of methane may be required, or exclusion of methane from the readings may be required. The MicroFID does respond well to methane, and when equipped with a charcoal filter can be used to obtain non-methane Total VOC. The manual datalogging mode does this calculation for the user. The filter is placed on the MicroFID and a background reading is taken. The filter is then removed and a sample reading is taken. The MicroFID automatically subtracts the background from the sample and records the Difference, or the non-methane VOC reading.

Emergency Response -- HAZMAT

In HazMat applications, it is possible that the spilled material may not be known. Since the MicroFID responds relatively equally to a wide variety of compounds, it is suitable to situations that can be quite different.

Natural Gas Pipeline Leak Detection

In North America, Natural Gas is composed almost entirely of Methane. The MicroFID is the detector of choice for this application. The MAX feature combined with the user adjustable, audible alarm make it easy to pinpoint leaks. Automated datalogging with selectable recording intervals make record keeping simple.

Arson Investigations (Accelerants)

Quite simply, the MicroFID is the detector to use for this application because anything that will burn will be detected. MicroFID's optional 6' telescoping extension wand allows the user to reach into areas that otherwise would be inaccessible.

Tank Entry Petroleum Products

Since Petroleum products are mixtures of Aromatics, Alkenes and Alkanes, either detector would be suitable. The MicroFID will respond almost equally to the short chain Alkanes and the more toxic Aromatics.

Soil/Water Jar Headspace Screening

The range of the MicroFID is from 0.5 to 50,000 PPM with manual datalogging capacity to allow independent storage of the Background, Sample, and calculated Difference from each jar. This convenient feature condenses the data to one line per jar sample.

MicroFID



MicroFID

Detectable Compounds

Saturated Hydrocarbons - Methane, Ethane, Propane, n-Hexane

Aromatics - Benzene, Toluene, Naphthalene

Unsaturated Hydrocarbons -Acetylene, Ethylene, 1,3-Butadiene

Chlorinated Hydrocarbons- Vinyl Chloride, Chloroform, Trichloroethylene, Methylene Chloride

Ketones - Acetone, Methyl Ethyl Ketone, Methyl Isobutyl Ketone

Alcohols - Methanol, Ethanol, Isopropanol, n-Butanol

Please note: This list provides examples of the types of compounds detectable by the MicroFID. Please contact Photovac Technical Support for details on specific compound detection.

For further information on Photovac products, or to arrange a product demonstration, please contact a Photovac representative near you, email us at admin@photovac.com or contact Photovac, Inc.

Specifications

Size
43.4 cm (17.1") long, 9.8 cm (3.85") wide, 18.8 cm (7.4") high

Weight
8.1 lb (3.7 kg)

Keypad
16-key, fixed function

Display
2-line, 16-character LCD with alphanumeric readout

Hydrogen Cylinder Discharge
Greater than 12 hours

Hydrogen Cylinder Capacity
9.2 liters

Battery Capacity
15 hours (snap-on replacement)

Serial Output
RS – 232, 1200-19200 baud with no parity, for tabular and graphic printouts and connection to a Windows® compatible computer.

Audio Output
On Alarm, LoBatt and NoFlm

Analog Output
0 to 1 volt full scale

Operating Temperature Range
41°F to 105°F (5°C to 45°C)

Operating Humidity
0-100% Relative Humidity (non-condensing)

Operating Concentration Range
0.5 PPM to 2000 PPM methane equivalent (Low Range)
10 PPM to 50,000 PPM methane equivalent (High Range)

Detection Limit
0.5 PPM methane

Accuracy
Methane (after calibration with zero air and 500 PPM methane gas): within ± 0.5 PPM or ± 10% of actual methane concentration (0.5 PPM to 2000 PPM range).

Response Time
Less than 3 seconds

Intrinsic Safety
Class I, Division 1, Groups A, B, C, & D
CENELEC Certified according to EN50021, EEx nA II T5, Demko No. 00Y127355X



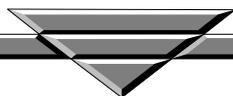
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TechTIPs

The latest from Photovac

Volume 3, Number 2



MicroFID Response Factors

<u>Compound</u>	<u>Response Factor</u>	<u>Compound</u>	<u>Response Factor</u>
Acetaldehyde	6.9 ^C	Epichlorohydrin	2.4 ^L
Acetone	2.7 ^G	Ethanol	5.2 ^C
Acetonitrile (Methyl Cyanide)	1.0 ^C	Ethyl Acrylate	2.7 ^C
Acrolein (2-Propenal)	6.9 ^C	Ethylbenzene	1.0 ^L
Acrylonitrile (Vinyl Cyanide)	1.3 ^C	Ethyl Cellosolve (2-Ethoxyethanol)	4.3 ^L
Allyl Chloride (3-Chloro-1-Propene)	2.7 ^C	Ethyl Chloride (Chloroethane)	1.9 ^C
Aniline (Benzenamine)	3.0 ^L	Ethyl Mercaptan (Ethanethiol)	3.7 ^L
Benzene	0.7 ^C	Ethylene	2.2 ^G
Benzyl Chloride (Chloromethyl Benzene)	1.2 ^L	Ethylene Dibromide (1,2-Dibromoethane)	2.0 ^L
Bromoform (Tribromomethane)	7.2 ^L	Ethylene Dichloride (1,2-Dichloroethane)	1.7 ^C
1,3-Butadiene	2.7 ^C	n-Heptane	1.3 ^L
iso-Butane	1.8 ^G	n-Hexane	1.6 ^G
n-Butane	1.9 ^G	Isobutylene	2.2 ^C
n-Butanol	2.6 ^L	Isoprene (2-Methyl-1,3-Butadiene)	2.2 ^L
n-Butyl Mercaptan (Butanethiol)	2.6 ^L	Isopropanol	2.4 ^C
Carbon Tetrachloride	25.9 ^C	Methanol	23.8 ^L
Chlorobenzene	0.8 ^C	Methyl Bromide (Bromomethane)	3.9 ^C
Chloroform (Trichloromethane)	3.5 ^L	Methyl Ethyl Ketone (2-Butanone)	1.9 ^C
Cumene (Isopropyl Benzene)	1.0 ^L	Methyl Isobutyl Ketone	1.9 ^L
Cyclohexane	1.4 ^C	Methyl Methacrylate	2.8 ^L
1,2-Dichlorobenzene (ortho-)	0.7 ^L	Methyl tert-Butyl Ether (MTBE)	2.0 ^C
cis-1,2-Dichloroethylene	2.6 ^C	Methyl Cellosolve (2-Methoxyethanol)	9.1 ^L
trans-1,2-Dichloroethylene	2.7 ^C	Methylene Chloride (Dichloromethane)	1.4 ^C
N,N-Dimethylformamide (DMF)	2.3 ^L	n-Nonane	1.1 ^L
1,4-Dioxane	4.6 ^C	iso-Octane (2,2,4-Trimethylpentane)	1.2 ^L

<u>Compound</u>	<u>Response Factor</u>	<u>Compound</u>	<u>Response Factor</u>
n-Pentane	1.6 ^L	1,1,2-Trichloroethane	1.7 ^L
Propane	1.8 ^G	Trichloroethylene (TCE)	2.8 ^C
Propionaldehyde (Propanal)	3.6 ^C	Triethylamine	1.1 ^L
Propylene	2.6 ^G	Vinyl Acetate	4.4 ^L
Propylene Dichloride (1,2-DCP)	2.0 ^C	Vinyl Bromide	1.5 ^C
Propylene Oxide	2.5 ^C	Vinyl Chloride (Chloroethylene)	2.1 ^C
Styrene	1.2 ^L	Vinylidene Chloride (1,1-DCE)	2.6 ^C
1,1,2,2-Tetrachloroethane	1.8 ^L	ortho-Xylene	1.1 ^L
Tetrachloroethylene (Perchloroethylene)	2.9 ^C	meta-Xylene	1.2 ^L
Toluene	0.9 ^C	para-Xylene	1.2 ^L
1,1,1-Trichloroethane	1.4 ^C		
1,2,4 Trichlorobenzene	1.1		

This list of *MicroFID* Response Factors was determined at (nominally) 500 PPM, based on a 500 PPM Methane calibration. Methane RF = 1.0. The following formula was used for calculation of Response Factors:

$$\text{Response Factor} = \frac{\text{Actual Concentration}}{\text{MicroFID Response}}$$

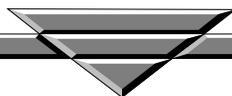
A Response Factor less than 1.0 indicates a compound response better than that of Methane. A Response Factor greater than 1.0 indicates a lower response than that of Methane.

When using Response Factors, results are expected to be accurate to +/- 10 PPM or +/- 25%, whichever is greater.

Standards used for determination of *MicroFID* Response Factors were derived from a variety of sources as referenced below:

- C - Certified gas cylinder, +/- 2% analytical accuracy (Isobutylene +/- 5% analytical accuracy)
- G - From standard prepared by dilution of neat gas into Zero Air, accuracy unknown
- L - From standard prepared by addition of neat liquid to Zero Air, accuracy unknown

For further information contact your area representative or Photovac:



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ATTACHMENT B

HEADSPACE SCREENING FOR VOCs

SITE-SPECIFIC OPERATING PROCEDURE SSOP-1: HEADSPACE SCREENING FOR VOCs

Scope and Application

The purpose of this site-specific operating procedure is to present a standard method for headspace screening of excavated soils for volatile organic compounds. The headspace screening data will be used to determine if soils need to be segregated and placed in Stockpile Area 3 for additional characterization.

Soil and other debris will be generated during the excavation work for the following elements of the stormwater source control measure:

- Channels
- Detention basin
- Sand filter.

Each bucket load of soil/debris will be screened initially using a photo-ionization detector (PID) or flame ionization detector (FID) meter within 6 inches of the freshly excavated soil¹. The soil will be considered potentially contaminated if the meter reading is 10 parts per million over background levels for 10 seconds. If this threshold is exceeded, headspace testing will be initiated in accordance with the procedures presented below.

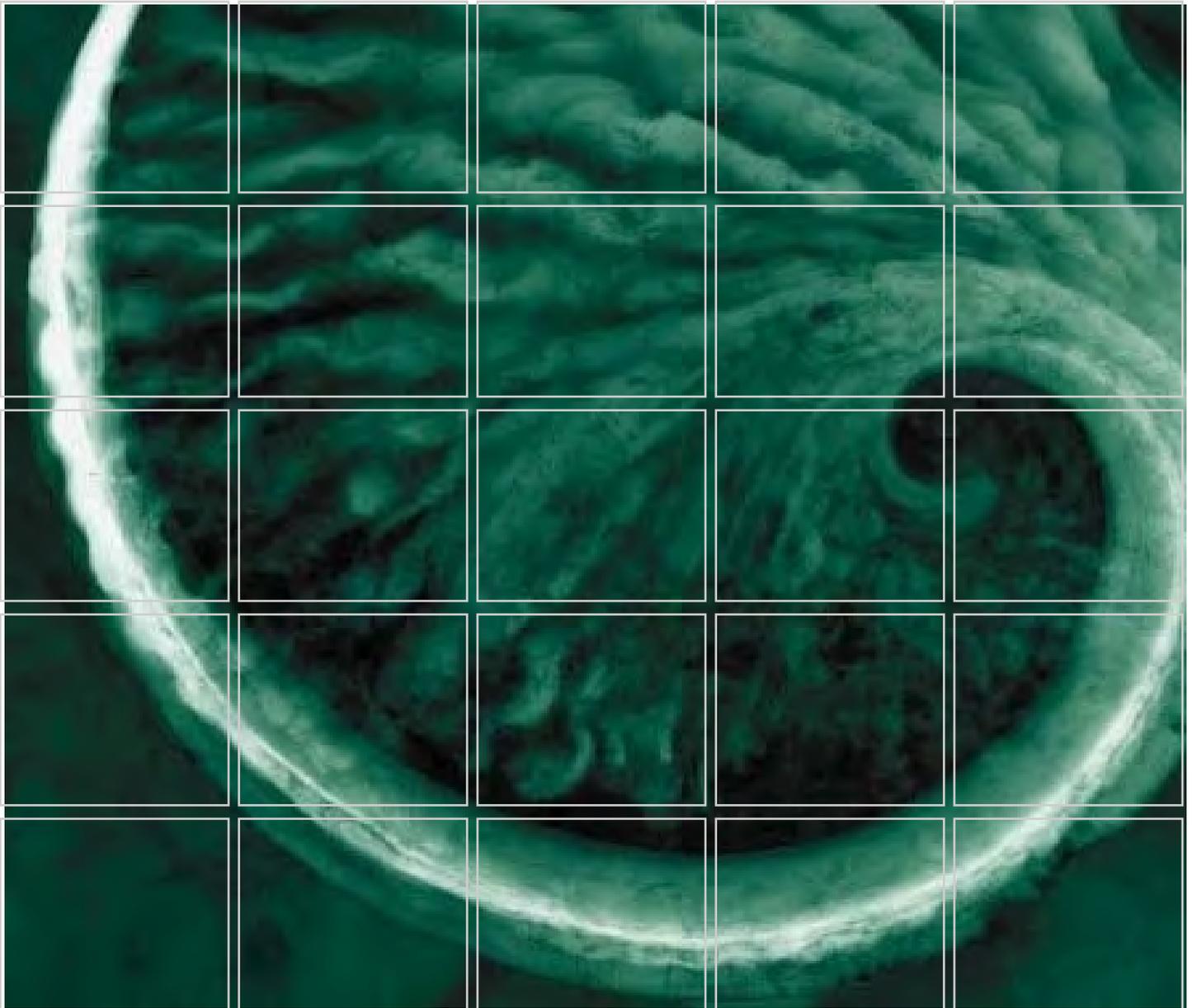
Headspace Screening Procedures

1. Partially fill a clean sample jar with soil to be screened (one third to half full). Collect the soil sample from a freshly uncovered location to minimize volatilization.
2. Cover the jar with clean aluminum foil and tightly seal the jar lid.
3. Allow headspace vapors to accumulate in the jar for at least 10 minutes, but no more than 60 minutes.

¹ Except for the portions of the east channel transecting the old Caustic Tank Farm and the Acid Plant Area, which are assumed to be contaminated. The soil and debris from these areas will automatically be placed in Stockpile Areas 1 and 2 for additional characterization.

4. Shake or agitate the soil jar for 15 seconds at the beginning and end of the headspace development period. Temperatures of the headspace must be warmed to at least 40 degrees F.
5. Calibrate the vapor meter (FID or PID with an 11.7 eV lamp) in accordance with the manufacturer's recommendations at the temperature that will be used for the field screening.
6. After headspace development, insert the meter's sampling probe to a point about one-half the headspace depth. The sample jar opening will be minimized.
7. Record the highest meter reading in the site logbook or sampling form. The highest reading generally occurs within 2-5 seconds after the probe is inserted.

Attachment 2
Slurry Materials Testing Report



DRAFT Slurry Materials Testing Report

Arkema, Inc. Facility
Portland, Oregon

March 2008

Prepared for:
Legacy Site Services LLC

www.erm.com

Legacy Site Services LLC

DRAFT Slurry Materials Testing
Report
Arkema, Inc. Facility
Portland, Oregon

March 2008

Project No. 0063837

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1 Site Layout and Sampling Locations

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- 2 Groundwater Field Parameter and Analytical Results*
- 3 Clay Additive Index Property Results*
- 4 Native Soil Classification and Index Property Results*
- 5 Slurry Mix Test Results*
- 6 Slurry Backfill Mixture Test Results*

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1.0 INTRODUCTION

ERM-West, Inc. (ERM) has prepared this report on behalf of Legacy Site Services LLC (LSS) to summarize the results of slurry materials testing performed in support of the Groundwater Source Control Interim Remedial Measure (IRM) at the Arkema Inc. (Arkema) facility located in Portland, Oregon (the "Site").

The primary purpose of the slurry materials testing was to perform pre-design testing and investigations as part of the Focused Feasibility Study (FFS) for the planned groundwater barrier wall (GWBW). Some of the data obtained by this task will also aid in the geotechnical engineering analysis and design of the groundwater extraction system.

The testing described in this report was designed to evaluate the performance and feasibility of a ground water barrier wall constructed using vibrated-beam slurry wall technology or slurry trench GBW construction technology. In addition, ground water and soil data obtained can be useful in evaluating the feasibility and effectiveness of a sheet pile barrier wall technology for possible use to construct a GBW.

The sampling and testing was conducted in accordance with *Scope of Work for Geotechnical Investigation and Slurry Compatibility Testing in Support of the Groundwater Source Control Interim Remedial Measure*, ERM, 23 March 2007. Additional soil sampling and testing were approved by the Oregon Department of Environmental Quality (ODEQ) on 30 April 2007.

1.1 BACKGROUND INFORMATION

The Site history is documented in the *Uplands Remedial Investigation Report Lots 3 & 4 and Tract A* (RI report) (ERM 2005). A brief description of the historical activities and sources of groundwater impacts are provided below.

1.1.1 Site Background

The Site is located at 6400 N.W. Front Avenue in Portland, Oregon, along the west bank of the Willamette River, at approximately river mile 7.5. The Site occupies approximately 55 acres. The surface is generally flat, with surface elevations of approximately 25 to 39 feet North American

Vertical Datum 1988 (NAVD88), except for the relatively steep river bank adjacent to the river.

The site operated as a sodium chlorate plant between 1941 and 2001. For the most part, the plant manufactured chlorine, sodium hydroxide, hydrogen, hydrochloric acid, and sodium chlorate. Other products and processes were added and discontinued over time, including: dichlorodiphenyltrichloroethane (DDT), ammonia, and ammonium perchlorate. All plant have been decommissioned and demolished, with the exception of the main office building on the site.

The Site is consists of four lots of land (Figure 1). The majority of prior industrial activity occurred on the two southernmost lots (i.e., Lots 3 and 4). Limited plant historical activity has occurred on the two northernmost lots (i.e., Lots 1 and 2). Additional information regarding historical activities occurring on each lot is presented in the RI report.

Affected groundwater is divided into two areas, the Acid Plant Area and Chlorate Area, based on the previous manufacturing activities that occurred in each area.

The Acid Plant Area is the part of the Site in which DDT was manufactured. The soil and groundwater in the Acid Plant area is affected predominantly by organic constituents, most notably by chemical monochlorobenzene (MCB). MCB has been found in both dissolved phase and as a separate phase dense non-aqueous phase liquid (DNAPL) (ERM, 2005).

The Chlorate Area is the part of the Site in which chlorate was manufactured and in which solid salt was received, stored, and dissolved during processing. The Chlorate Area is located in the southern part of the Site. Soil and groundwater in the Chlorate Area is generally affected by chloride, perchlorate, and hexavalent chromium.

1.1.2 *Hydrogeology*

This section provides a summary of the hydrogeology of the Site. A full description of the hydrogeology of the Site is presented in the RI Report and the FFS.

Groundwater occurs in five zones beneath the Site: a shallow unconfined upper zone (the Shallow Zone) and two confined to semi-confined lower zones (the Intermediate Zone and the Deep Zone), a gravel alluvium zone (the Gravel Zone), and basalt bedrock (the Basalt). The gravel zone is

laterally discontinuous at the Site, and is only present in the region of Lots 1 and 2. Groundwater at the Site flows towards the Willamette River in the Shallow, Intermediate, Deep, and Basalt Zones. There is no evidence of cross-gradient groundwater flow northwards from Lots 3 and 4 to Lots 1 and 2.

The shallow unconfined groundwater zone is present in the fill and upper sand alluvium to a maximum depth of 38 feet below ground surface. A thin discontinuous silt horizon separates the Shallow Zone from the Intermediate Zone throughout most of the Site and is referred to as the Shallow-Intermediate Silt. The Intermediate Zone comprises the upper portion of the semi-confined to confined zone at the Site and is characterized by sand alluvium. The Intermediate Zone occurs at depths between 36 to 50 feet below ground surface.

The interval between the Intermediate Zone and the underlying bedrock basalt is the Deep Zone. This zone consists of predominately fine grained deposits. The top of the Deep Zone occurs at approximately 40 to 50 feet below ground surface throughout the Site. The thickness of the Deep Zone ranges from approximately 5 to 45 feet and is generally controlled by the topography of the basalt bedrock at the Site (i.e. the top surface of the Deep Zone is relatively level compared to the varying elevation of the bottom surface at the Basalt).

The entire Site is underlain by basalt bedrock. The top of the basalt occurs at depths ranging between 47 and 105 feet below ground surface. The shallowest occurrence of basalt is near the river bank at a location north of the boundary between Lot 2 and Lot 3. A shallow ridge of basalt extends along the river bank to the southeastern corner of the Site, with the basalt contact deepening to the southwest toward Front Avenue.

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2.0 FIELD PROCEDURES

Field sampling was performed in accordance with the procedures outlined in the *Scope of Work for Geotechnical Investigation and Slurry Compatibility Testing in Support of the Groundwater Source Control Interim Remedial Measure* (ERM 2007). Those procedures address soil and groundwater sample collection techniques, documentation, and quality assurance/quality control protocols.

Soil, groundwater, and Site potable water samples were collected, documented, and submitted to the Sierra Testing Laboratories, Inc. (STL) laboratory located in El Dorado Hills, California for slurry materials testing. Groundwater samples were collected, documented, and submitted to the TestAmerica Laboratories, Inc. (TA) laboratory located in Portland, Oregon, for chemical analytical analysis.

2.1 WATER SAMPLING AND FIELD TESTING

Representative samples of organics-affected (OA) groundwater were collected from MWA-67si, a monitoring well screened in the Shallow Zone in the Acid Plant Area of the Site. Representative samples of chloride-affected (CA) ground water were collected from MWA-30, a monitoring well screened in the Shallow Zone in the Chlorate Area of the Site. Each sample was split for chemical analysis and for use in the slurry materials testing. Groundwater sampling locations were based on the proximity to the corresponding CA and OA soil sampling locations near the proposed GWBW route.

Groundwater samples for use in the slurry compatibility testing were collected in pre-cleaned, one-gallon polyethylene cube-containers, using a submersible pump (i.e. a "Whale" Pump) and disposable polyethylene tubing. A minimum of three well volumes was purged prior to sample collection. Field test measurements of pH, specific conductance, dissolved oxygen, and redox potential were recorded during sample collection.

Samples submitted to the analytical laboratory were collected in pre-cleaned, appropriately preserved sampling containers. The groundwater samples were analyzed for specific gravity; total suspended solids, total dissolved solids, specific conductance, oil and grease, total organic carbon, and total organic halogens.

Site potable water was collected directly from the on site public water supply source (i.e. the City of Portland public water supply), for by the sully materials testing laboratory use as slurry mix water source.

2.2 *SOIL SAMPLING AND FIELD TESTING*

A cone penetrometer testing (CPT) rig was used in four locations (CPT-1 through CPT-4) to collect data used for stratigraphic and lithologic interpretation (e.g., soil behavior type, soil strength characteristics, and depth to refusal, interpreted when at a depth corresponding to prior data as the depth to the top of the basalt). The parameters measured and recorded while pushing the CPT tool into the formation included tip resistance, sleeve friction, and formation pore pressure. The CPT drilling locations are shown on Figure 1. The results of the CPT drilling are discussed in Groundwater Barrier Wall Geotechnical Evaluation Report (ERM, 2008).

Mud rotary drilling was implemented to collect representative samples from locations near the projected groundwater barrier wall route. The samples were collected for slurry compatibility testing, for soil strength testing, and to verify the interpretation of the CPT data. ERM collected organics affected (OA) soil and chloride affected (CA) soil from borings B-120 and B-121 respectively (Figure 1).

At each location, ERM collected continuous representative samples of the soil from the ground surface to the total depth of each boring. The total depth of each of the two borings was at the contact with basalt. ERM obtained disturbed soil samples at 2-foot depth intervals using a California sampler. A Standard Penetration Test (SPT) was performed at intervals in accordance with ASTM D1586 to evaluate in situ soil strength. SPT tests were performed at intervals of five feet or less from the ground surface to the basalt contact. Disturbed soil samples were collected from the SPT sampler. In addition, soil samples were collected at apparent cohesive soil intervals (i.e. in the Shallow-Intermediate Silt Zone) using Shelby tubes to allow examination and, if practical, testing of the undisturbed soil (Groundwater Barrier Wall Geotechnical Evaluation Report (ERM, 2008).

The boring logs and soil sample collection logs are included in Appendix A. A summary of the lithology encountered in each boring is shown in Table 1.

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The lithologic unit contact depths and thicknesses observed the CPTs and in B-210 and B-121 are in the range of those expected along the proposed GWBW route.

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3.0 *SLURRY MATERIALS TESTING PROCEDURES AND RESULTS*

The slurry materials testing measured properties of slurry and slurry backfill components and mixtures important to evaluation of potential for performance of a soil-slurry GWBW including:

- Properties of representative samplers of materials (i.e. slurry mix water, clay and clay-cement slurry additives, and discrete-interval and depth-composite native soil) that may be used to make slurry and slurry backfill mixtures, including appropriate control sample testing; and
- properties of various mixtures of clay and slurry mix water to make slurry mixtures.

The procedures used and the results of the slurry materials testing are described below.

3.1 *GROUNDWATER SAMPLING RESULTS*

On 6 April 2007, groundwater samples were collected from monitoring wells MWA-30 and MWA-67si. The field parameter and analytical results are presented in Table 2.

Monochlorobenze (MCB) was detected in MWA-67si at a concentration of 198,000 µg/L. This level of MCB is consistent with previous detections of MCB from this and other monitoring wells in the Acid Plant Area. Other VOCs, including carbon tetrachloride, chloroform, and tetrachloroethene were detected in this groundwater sample. The chlorinated pesticide DDT was also detected. These compounds have previously been detected in this and surrounding monitoring wells (ERM 2007). Moderate concentrations of chloride, TDS, arsenic, chromium, iron, and manganese were detected, that were within the range of concentrations previously detected in the Acid Plant Area. The groundwater sample from MWA-67si was considered representative of typical organics affected (OA) groundwater conditions.

Significant chloride and TDS concentrations (39,400 mg/L and 66,000 mg/L respectively) were detected in the sample collected from MWA-30.

These levels of chloride and TDS have been previously observed in MWA-30 and other proximate wells in the Chlorate Area. The concentrations of VOCs, arsenic, chromium, iron, and manganese detected in the MWA-30 groundwater sample are within the range of concentrations observed within the Chlorate Area (ERM 2007). The groundwater sample from MWA-30 was considered representative of typical chloride affected (CA) groundwater conditions.

3.2 SLURRY COMPONENT MATERIALS TESTING

Slurry and slurry backfill component materials tested included slurry mix water, slurry clay additives, and discrete interval and composite native soil samples.

3.2.1 Slurry Mix Water Sample Testing

Site potable water samples were analyzed with a portable test meter at the laboratory for the following parameters:

- pH ; and
- Specific conductance.

3.2.2 Clay Additive Testing

Three proven and commercially available slurry additives were considered as GWBW slurry components:

- Bentonite clay powder (BPM Materials, Inc., “Bara-kade” product supplied by the manufacturer in commercial packaging was used for the testing);
- Attapulgite clay powder (Floridin, Inc. “Florigel H-Y” product supplied by the manufacturer in commercial packaging was used for the testing); and
- Specialty clay-cement material (local formulation Liquid Earth Support, Inc. “Impermix” product supplied by the manufacturer was used for the testing);

The material specifications and material safety data sheets for each of the commercial clay additives used (bentonite and attapulgite) are included in Appendix B.

The clay-cement additive was not analyzed for index properties because of its necessary activity on mixture and suitability of mixed and cured testing to demonstrate effectiveness of clay-cement additive.

The bentonite and attapulgite clay additive samples mixed with deionized water (control sample) and analyzed for the following index properties:

- Water content in accordance with ASTM D2216;
- Atterberg limits in accordance with ASTM D4318; and
- Free swell in accordance with ASTM D5890.

The bentonite and attapulgite clay additives were mixed with deionized water (DI), organics affected groundwater (OGW), and chloride affected groundwater (CGW) and then analyzed for Atterberg limits. The results are presented in Table 3.

The index properties (moisture content, free swell) of the commercial clay slurry products received at the laboratory were in the same range of values published by the commercial manufacturers for those respective products (presented in Appendix B).

The Atterberg limits for both clay additives decreased when site groundwater was used to mix the slurry when compared to DI. The greatest effect on the index properties was observed when the CGW was used as mix water. The greatest decrease in index properties was observed in the bentonite clay additive.

Both clay additive products made adequate clay slurry with adequate slurry index properties as described below.

3.2.3 *Soil Sample Testing*

Representative soil samples from each of the four lithologic zones were analyzed for the following parameters:

- Water content in accordance with ASTM D2216;
- Atterberg limits in accordance with ASTM D4318; and
- Particle size distribution in accordance with ASTM D422, including hydrometer.

The results of the native soil characterization testing are shown in Table 4.

Individual soil samples had index properties typical of a range of sandy to clayey soil. Most of the soil samples, which were collected from the Shallow Zone and the Intermediate Zone, were found to have index properties typical of a sandy silt or silty sand.

Composite soil samples had index properties that were typical of sandy silt with some clay.

ERM used the results of these analyses to classify the discrete soil samples and to verify that the composite samples made by mixing discrete interval soil samples are reasonably representative of the type of soil expected as confirmed by the subsequent testing of the composite soil samples.

3.2.4 *Clay Slurry Mixture Testing*

This task included evaluation of both the clay-water slurry mixtures that could be used to support an open trench during construction of a GWBW at the Site. .

To evaluate the slurry mix, bentonite and attapulgite clay additives were mixed (at a ratio of least 5% by weight clay additive) with each of four slurry mix waters:

- laboratory-grade deionized (DI) water (as a control);
- site potable water (probable slurry mix water source at the Site);
- a mixture of 85% site potable water with 15% OGW groundwater (representative of a reasonable worst case for slurry in a slurry trench excavated in the part of the Site with organics-affected ground water and soil); and
- a mixture of 85% site potable water with 15% CGW groundwater (representative of a reasonable worst case for slurry in a slurry trench excavated in the part of the Site with chloride-affected ground water and soil).

The amount of each clay additive was adjusted to produce a slurry mixture that achieved the following target acceptance criteria after mixing and, to evaluate stability of the mixture, at intervals in the subsequent day:

- slurry unit weight between 64.5 and 69.0 pounds per cubic foot (pcf) when tested in accordance with API RP 13B-1; and
- slurry Marsh funnel viscosity greater than or equal to 40 seconds when tested in accordance with API RP 13B-1.

Each clay-mix water slurry was mixed using a suitable high-shear mechanical mixer (i.e. not using diffused air injection) and in order to achieve thorough mixing, at a low speed that keeps solids in suspension without entraining air or forming bubbles in or on the surface of the mixture. The mixtures were continuously mixed at low speed during initial mixing and throughout the subsequent testing.

Each mixture was tested immediately after mixing and at 24 hours for the following parameters:

- pH by portable instrument; and
- specific conductance by portable instrument.

Each mixture was tested immediately after mixing and at intervals of 0.5, 1, 2, 4, 8, and 24 hours after mixing for the following parameters:

- unit weight in accordance with API RP 13B-1;
- Marsh funnel viscosity in accordance with API RP 13B-1;

The results of the slurry mix testing are presented in Table 5.

In general, both clay additive products made adequate clay slurry with adequate slurry index properties.

The results of the slurry mix testing indicate that bentonite clay made adequate clay slurry when mixed with each of the four slurry mix water samples.

The testing showed that it was necessary to increase the amount of bentonite in the mixture containing CGW in order for the slurry to meet the target acceptance criteria.

Attapulgit clay made adequate slurry at a mix ratio of 6% by weight when mixed with site potable water. However, it was necessary to increase the amount of attapulgit in the mixtures containing site

groundwater in order for the mixtures to achieve the target acceptance criteria.

ERM used the results of the slurry mix testing to identify the weight ratio of clay additive appropriate for making slurry used to adjust the range of soil-slurry mixtures for the subsequent slurry backfill testing.

3.3 *CLAY SLURRY BACKFILL TESTING*

This task included testing mixtures of soil and clay slurry to measure the ability of the components to make an effective and stable low permeability soil-slurry backfill achieving the target slump and unit weight acceptance criteria and to measure the resulting hydraulic conductivity of each mixture using a range of unaffected and affected water as permeants.

Four test mixtures were prepared by mixing each of the two composite soil samples (i.e. the OA composite soil sample from the Acid Plant area and the CA composite soil sample from the Chlorate Plant area) mixed with each of the two clay slurry mixtures (i.e. bentonite slurry and attapulgite slurry). A fifth mixture was prepared by mixing an aliquot of DNAPL affected soil, collected from shallow-intermediate silt during a re-drilling attempt of B-120, with the bentonite clay slurry mixture.

Each mixture was prepared at rates necessary to achieve the following target acceptance criteria for slurry backfill mixture unit weight and slump after mixing:

- Unit weight 15 pcf greater than the corresponding slurry unit weight when tested in accordance with API RP 13B-1; and
- Slump between 4 and 6 inches when tested in accordance with ASTM C143.

Where practical, the mixtures were designed to also achieve secondary quality criteria:

- Particle sizes passing the No. 200 U.S. Standard sieve are greater than or equal to 30% and more than 15% of the particle sizes are smaller than 0.002 mm when tested in accordance with ASTM D422 (including hydrometer); and
- Water content between 25% and 35% when tested in accordance with ASTM D2216.

Each slurry back-fill mixture was placed in a hydraulic conductivity test cell and subjected to hydraulic conductivity in accordance with ASTM D5084. Each of the four composite soil slurry backfill mixtures was tested using DI water as a control permeant.

Each of the composite soil slurry backfill mixtures and the DNAPL affected soil slurry mixture were subjected to hydraulic conductivity testing using the corresponding affected groundwater (i.e. OGW was used a permeant for OA and DA soil slurry mixtures). This testing was designed to represent a reasonable worst case scenario exposure of each clay additive to affected soil and similarly affected groundwater.

The slurry backfill mixtures hydraulic conductivity testing results are shown in Table 6.

All composite soil slurry backfill mixtures achieved the target acceptance criteria for slump and unit weight criteria, with the exception of the DNAPL-affected (DA) soil slurry mixture, which had a slump of 7 inches instead of the 4- to 6-inch slump target. It was not practical to repeat the testing due to the very limited quantity of DNAPL-affected soil available from sampling the relatively thin layer, indicated in some past sampling to have DNAPL.

Hydraulic conductivity test results were generally greater in samples tested with site groundwater as permeant compared to the samples tested with DI water as permeant (i.e. control samples). All the samples tested with site groundwater had hydraulic conductivities within a range of approximately 10^{-8} to 10^{-9} cm/sec.

3.4

CLAY-CEMENT SLURRY TESTING

Two pairs of soil-clay-cement slurry backfill mixtures were prepared by adding aliquots of a clay-cement additive (Liquid Earth Support, Inc. "Impermix" supplied by the manufacturer) to aliquots of each of the two composite soil mixtures and each of the two correspondingly affected ground water samples (i.e. an aliquot of CA composite soil sample mixed with CGW and, separately, an aliquot of OA composite soil sample mixed with OGW, making a total of two slurry backfill mixtures and making a total of four test specimens):

- "Impermix" at the supplier's recommended water:additive mix ratio;

- CA or OA composite soil sample at 15% of the “Impermix” mix weight;
- Site PW at 90% of the “Impermix” supplier’s recommended total water:additive mix ratio; and
- CGW (for the mixture with CA soil) or OGW (for the mixture with OA soil) at 10% of the “Impermix” supplier’s recommended total water:additive mix ratio).

The “Impermix” test specimens were mixed, molded, and cured in accordance with the “Impermix” supplier’s instructions approved by ERM. As recommended by the “Impermix” supplier, each of the “Impermix” test specimens was cured for approximately 60 days after mixing prior to extruding, preparing, and subjecting the test specimen to hydraulic conductivity testing.

Each “Impermix” test specimen was placed in a hydraulic conductivity test cell and subjected to hydraulic conductivity testing in accordance with ASTM D5084. One of each of the two types “Impermix” test specimens (OA or CA soil) were tested using DI water as a control permeant. The remaining two samples were tested using the corresponding site groundwater as permeant (i.e. OGW was used in the specimen made with OA soil, CGW was used in the specimen made with CA soil)

The results of the clay-cement hydraulic testing are shown in Table 6.

All “Impermix” clay-cement slurry test specimens made a cured soil-slurry backfill sample with hydraulic conductivity suitable for construction of a plastic concrete GWBW with a suitable low hydraulic conductivity of approximately 10^{-8} cm/sec.

SUMMARY AND CONCLUSIONS

The slurry materials testing laboratory confirmed receipt of the samples and performed testing in stages. Testing included:

- Clay additive index testing (clay-cement additive was not subjected to index testing because of its necessary activity on mixture and suitability of mixed and cured testing to demonstrate effectiveness of clay-cement additive);
- Slurry mix sample index testing;
- Individual and composite sample classification testing of native soil used to make slurry backfill samples;
- Slurry backfill mix sample index testing; and
- Hydraulic conductivity and related index testing of slurry backfill mixtures (tests were done after curing for clay-cement slurry mixtures as the mixture makes a plastic concrete material).

Analysis of the test results lead to the following conclusions:

- The index properties of the commercial clay slurry products received at the laboratory were in the same range of values published by the commercial manufacturers for those respective products.
- Plasticity and swell-related properties of clay additives were somewhat adversely affected by affected ground water compared to results of testing with deionized water;
- Both clay additive products made adequate clay slurry with slurry index properties that achieved the target acceptance criteria for unit weight and viscosity;
- Individual soil samples had index properties typical of a range of sandy to clayey soil. Most of the soil samples, which were collected from the Shallow Zone and the Intermediate Zone, were found to have index properties typical of a sandy silt or silty sand.
- Composite soil samples had index properties that were typical of sandy silt with some clay.

- Mixtures of either of the two composite soil samples with either of the two clay slurries made soil-slurry backfill samples that achieved the target acceptance criteria for slump and unit weight and were found to have suitably low hydraulic conductivity needed for construction of an effective GWBW at the Site.
- Mixtures of the DNAPL-affected soil sample with the bentonite clay slurry sample made a soil-slurry backfill sample that achieved the target acceptance criteria for unit weight and marginally exceeded the target acceptance criteria for slump and was found to have a suitably low and stable hydraulic conductivity, indicating that DNAPL had no significant adverse effect on the effectiveness of a slurry wall made with similar materials..
- Cured mixtures of both of the two composite soil samples with the clay-cement additive made a cured clay-cement slurry backfill sample that was found to have a suitably low hydraulic conductivity needed for construction of an effective GWBW at the site.

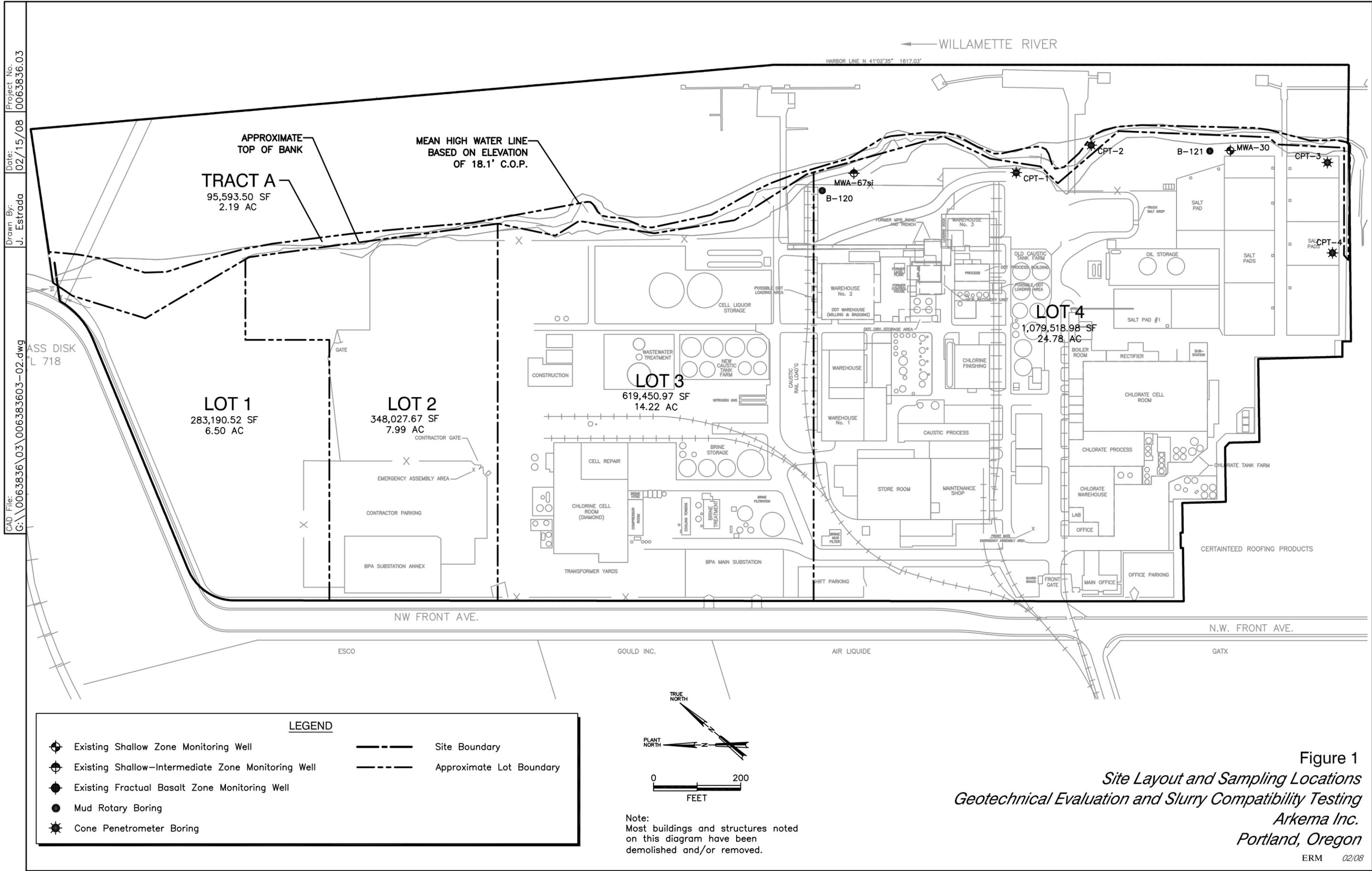
5.0

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Figures



Project No. 0063836.03
Date: 02/15/08
Drawn By: J. Estrada

CAD File: G:\0063836\03\006383603-02.dwg

Figure 1
Site Layout and Sampling Locations
Geotechnical Evaluation and Slurry Compatibility Testing
Arkema Inc.
Portland, Oregon

Tables

Table 1
Soil Boring Summary
Soil and Slurry Compatibility Testing
Arkema, Inc.
Portland, Oregon

Boring	Units	B-120	B-121
Location		Acid Plant Area	Chlorate Area
Contaminants		Organics	Chloride
Surface Elevation	(ft amsl)	35.81	38.35
Lithologic Depths¹			
Fill (Silty Sand/Sandy Silt)	(ft bgs)	23	26
Shallow Zone (Silty Sand)	(ft bgs)	34	29
Shallow-Intermediate (Silt)	(ft bgs)	35	31
Intermediate Zone (Sand with Silt)	(ft bgs)	45	44
Deep Zone (Sandy Silt)	(ft bgs)	50.5	87
Total Depth Drilled	(ft bgs)	50.5	87

Notes:

¹ - Depth to bottom of lithologic unit

ft = Feet

amsl = Above Mean Sea Level (NAVD 88)

bgs = Below Ground Surface

Table 2
Groundwater Field Parameter and Analytical Results
Soil and Slurry Compatibility Testing
Arkema, Inc.
Portland, Oregon

Analyte	Units	MWA-67si	MWA-30
Field Parameters			
pH		5.16	7.04
Temperature	(deg. C)	17.04	16.59
Specific Conductance	(mS/cm)	10.14	80
ORP	(mV)	-112.5	-197.3
Dissolved Oxygen	(mg O ₂ /L)	0.36	0.25
Metals			
Arsenic	mg/L	0.0105	0.0185
Chromium	mg/L	0.0306	0.388
Iron	mg/L	25.6	7.32
Manganese	mg/L	3.26	0.886
Pesticides			
DDT	ug/L	0.664	ND (<0.0481)
VOCs			
Benzene	ug/L	ND (<90)	0.13
Carbon Disulfide	ug/L	ND (<140)	0.25
Carbon Tetrachloride	ug/L	1220	ND (<0.06)
Chlorobenzene	ug/L	198000	0.9
Chloroform	ug/L	1910	4.15
Naphthalene	ug/L	ND (<90)	0.92
Tetrachloroethene	ug/L	2080	ND (<0.11)
Toluene	ug/L	ND (<110)	0.65
1,2,4-Trimethylbenzene	ug/L	ND (<80)	0.09
o-Xylene	ug/L	ND (<70)	0.14
Methane	ug/L	NA	13.9
Inorganic			
Chloride	mg/L	2730	39400
Perchlorate	ug/L	ND (<4000)	ND (<80)
Conventional Parameters			
Oil & Grease	mg/L	ND (<4.85)	ND (<4.85)
Total Dissolved Solids	mg/L	9150	66000
Total Organic Carbon	mg/L	67	12.6
Total Suspended solids	mg/L	ND (<10)	ND (<10)
Specific Gravity		1.01	1.05

Notes

ND = Not Detected

NA = Not Analyzed

DDT = dichlorodiphenyltrichloroethane

ORP = Oxidation-Reduction Potential

Table 3
Clay Additive Index Property Results
Soil and Slurry Compatibility Testing
Arkema, Inc.
Portland, Oregon

Clay Additive	Moisture Content ¹	Mix Water	Free Swell mL/2g	Atterberg Limits		
	%			LL	PL	PI
Bentonite	12.4	DI	12.0	426	45	381
		OGW	----	283	39	244
		CGW	----	109	41	68
Attapulgate	6.2	DI	6.0	243	94	149
		OGW	----	242	87	155
		CGW	----	175	91	84

Notes:

¹ - Material as supplied by manufacturer

DI = Deionized Water

CGW = Chloride affected groundwater

OGW = Organics affected groundwater

Table 4
Native Soil Classification and Index Property Results
Soil and Slurry Compatibility Testing
Arkema, Inc.
Portland, Oregon

Soil		OA Soil	OA Soil	OA Soil	CA Soil	OA Soil	CA Soil
Aquifer		Shallow	Shallow-Intermediate Silt	Intermediate	Deep	----	----
Sample ID		OA Soil, ST2, B120	OA Soil, S-IB2, B120	OA Soil, IT2, B120	OA Soil, DB2, B121	OA Soil, Full Depth	CA Soil, Full Depth
Depth	(ft bgs)	28-34	34-35	41-44	67-72	Full Depth	Full Depth
Material Description		Silty Sand	Silt	Poorly Graded Sand with Silt	Sandy Silt	Silty Sand	Sandy Silt
USCS Classification		SM	ML	SP-SM	ML	SM	ML
Unit Weight	lb/ft3 (Dry)	87	66.2	83.9	94		
	lb/ft3 (Dry)	114.7	104.1	112.1	123.1		
Moisture Content	%	31.8	57.4	33.7	31	8.9	9
Particle Size, Incl. Hydrometer	%<#40	92.7	99.7	96.9	99.8	81.8	93.8
	%<#200	16.6	97.3	9.2	61.9	45.6	52.5
	% Silt	10.7	80.5	3.2	48.5	39.3	37.9
	% Clay	5.9	16.8	6	13.4	6.3	14.6
Atterberg Limits	LL	NV	NV	NV	NV	21	NV
	PL	NP	NP	NP	NP	NP	NP
	PI	NP	NP	NP	NP	NP	NP
pH	DI	4.95	5.47	9.97	6.8		
	CaCl	3	3.24	7.03	6.05		

Notes:

lb/ft³ = Pounds per cubic foot

% = Percent

ft bgs = feet below ground surface

DI = Deionized Water

CaCl = Calcium Chloride

PW = Site Potable Water

CGW = Chloride affected groundwater

OGW = Organics affected groundwater

CA = Chloride Affected Soil

OA = Organics Affected Soil

Missing Data

Table 5
Slurry Mix Test Results
Soil and Slurry Compatibility Testing
Arkema, Inc.
Portland, Oregon

Clay Additive	Mix Water	% Clay	Time	Mud Balance Viscosity	Marsh Funnel Viscosity	pH	SC (uS/cm)
			(Hours)	(lbs/ft ³)	(sec)		
Bentonite	DI water	7.5%	0	65.2	35.8	9.87	760
			0.5	65.2	36.0		
			1	65.0	37.0		
			2	64.5	37.0		
			4	64.2	37.5		
			8	64.5	37.5		
			24	64.8	38.0	9.75	810
			72	67.2	40.2	9.82	783
	PW water	6.1%	0	67.2	40.2		
			0.5	67.0	40.5		
			1	66.9	41.2		
			2	66.8	41.4		
			4	67.0	41.3		
			8	67.2	41.4		
			24	67.4	41.6		
			48	67.4	41.5		
	85% PW water and 15% OGW	6.2%	0	66.5	35.0	8.81	327
			0.5	66.5	36.0		
			1	67.0	36.0		
			2	65.0	36.0		
			4	64.5	37.0		
			8	64.3	38.0		
			24	63.7	41.0		
			48	64.0	41.0		
	85% PW water and 15% CGW	9.0%	0	66.5	36.0	8.43	16940
			0.5	66.5	36.0		
			1	66.7	37.0		
			2	66.0	38.0		
4			65.1	39.0			
8			65.6	41.0			
24			66.8	44.0			
48			67.0	45.0			
Attapulgate	DI water	6.0%	0	66.2	30.0	10.03	110
			0.5	66.0	30.0		
			1	65.9	31.0		
			2	65.4	33.0		
			4	65.0	33.0		
			8	65.0	32.0		
			24	64.9	32.0	9.85	110
			72	67.2	36.0	9.87	142
	PW water	6.0%	0	67.2	36.0		
			0.5	67.3	36.0		
			1	67.6	37.0		
			2	67.7	37.0		
			4	68.0	39.0		
			8	68.1	40.0		
			24	68.1	41.0		
			48	68.1	41.0		
	85% PW water and 15% OGW	14.3%	0	67.0	37.0	9.31	207
			0.5	67.0	37.0		
			1	66.8	39.0		
			2	66.4	39.0		
			4	67.3	39.0		
			8	67.5	39.0		
			24	67.7	40.0		
			48	67.9	40.0		
	85% PW water and 15% CGW	14.2%	0	67.9	41.0	9.26	212
			0.5	67.9	41.0	9.29	14910
			1	67.1	53.0		
			0.5	67.1	53.0		
1			67.7	60.0			
2			68.0	63.0			
4			68.2	65.0			
8			68.0	65.0			
24	67.7	64.0					
48	67.8	64.0					
72	67.9	64.0	9.27	15010			

Notes:
 lb/ft³ = Pounds per cubic foot
 % = Percent
 ft bgs = feet below ground surface
 DI = Deionized Water
 PW = Site Potable Water
 CGW = Chloride affected groundwater
 OGW = Organics affected groundwater
 CA = Chloride Affected Soil
 OA = Organics Affected Soil

Table 6
Slurry Backfill Mixture Test Results
Soil and Slurry Compatibility Testing
 Arkema, Inc.
 Portland, Oregon

Sample Location	Units	Chlorate Area	Acid Plant Area	Chlorate Area	Acid Plant Area	Acid Plant Area	Chlorate Area	Acid Plant Area
Boring ID		B-121	B-120	B-121	B-120	B-120	B-121	B-120
Affected Soil Type		CA	OA	CA	OA	DA	CA	OA
Sample ID		CA-A-PW	OA-A-PW	CA-B-PW	OA-B-PW	DA-B-PW	Impermix/CAsoil	Impermix/OAsoil
Soil Interval		Full Depth Composite	Full Depth Composite	Full Depth Composite	Full Depth Composite	Shallow-Intermediate Silt	Full Depth Composite	Full Depth Composite
Clay Additive		Attapulgite	Attapulgite	Bentonite	Bentonite	Bentonite	Clay-Cement	Clay-Cement
Mix Water		PW	PW	PW	PW	PW	90% PW & 10% CGW	90% PW & 10% OGW
Unit Weight	(lbs/ft ³)	109.1	111.2	109.5		109.2	----	----
Slump	(inches)	5.9	5.7	5.5		7.0	----	----
Particle Size, Incl. Hydrometer	%<#40	98.1	86.0	94.1	87.9	----	----	----
	%<#200	78.0	44.9	53.8	38.6	----	----	----
	% Silt	57.7	28.1	43.1	24.8	----	----	----
	% Clay	20.3	16.8	10.7	13.8	----	----	----
Mixture Moisture Content ¹	%	47.8	39.7	43.7	31.7	43.4	----	----
DI Permeant								
Pre-Test Moisture Content ²	%	31.9	27	31.1	24.9	----	143.8	135.1
Unit Weight (Dry)	lbs/ft ³	96.5	100.7	93.9	102.7	----	31.8	32.3
Flow Volume	cc	6	4.25	11.8	2.75	----	0.72	1.05
Height	cm	5.13	5.31	4.19	6.27	----	7.7	8.2
Diameter	cm	5.08	5.08	5.08	5.08	----	7.54	7.62
Water Mass	lbs	30.8	27.2	29.2	25.6	----	45.7	43.6
Void Ratio		0.49	0.44	0.47	0.41	----	0.73	0.70
Cell Volume	cc	104.0	107.6	84.9	127.1	----	343.8	374.0
Void Volume	cc	51.3	46.9	39.7	52.1	----	252.0	261.5
Flow Vol/Cell Volume		0.117	0.091	0.297	0.053	----	0.003	0.004
Hydraulic Conductivity	cm/sec	2.34E-07	1.89E-07	1.25E-07	2.48E-07	----	1.33E-08	1.77E-08
CGW Permeant								
Pre-Test Moisture Content ²	%	30.4	----	29.6	----	----	161.4	----
Unit Weight (Dry)	lbs/ft ³	96.2	----	98.3	----	----	29.7	----
Flow Volume	cc	3.4	----	1.65	----	----	0.78	----
Height	cm	5	----	4.95	----	----	7.62	----
Diameter	cm	5.08	----	5.08	----	----	7.62	----
Water Mass	lbs	29.2	----	29.1	----	----	47.9	----
Void Ratio		0.47	----	0.47	----	----	0.77	----
Cell Volume	cc	101.3	----	100.3	----	----	347.5	----
Void Volume	cc	47.5	----	46.8	----	----	267.0	----
Flow Vol/Cell Volume		0.105	----	0.106	----	----	0.029	----
Hydraulic Conductivity	cm/sec	7.85E-08	----	3.93E-08	----	----	5.19E-08	----
OGW Permeant								
Pre-Test Moisture Content ²	%	----	26.3	----		35.1	----	126.3
Unit Weight (Dry)	lbs/ft ³	----	101.1	----		76	----	34.4
Flow Volume	cc	----	1.85	----		2.1	----	0.34
Height	cm	----	5.05	----		6.45	----	7.75
Diameter	cm	----	5.08	----		5.08	----	7.62
Water Mass	lbs	----	26.6	----	0.0	----	----	43.4
Void Ratio		----	0.43	----	0.00	----	----	0.70
Cell Volume	cc	----	102.4	----	0.0	----	----	353.4
Void Volume	cc	----	43.6	----	0.0	----	----	246.1
Flow Vol/Cell Volume		----	0.116	----	#DIV/0!	----	----	0.031
Hydraulic Conductivity	cm/sec	----	3.76E-08	----		1.70E-08	----	1.78E-08

Notes:

¹ - Moisture content measured immediately after mixing

² - Moisture content measured after sample extruded, pressurised, and allowed to dewater

lb/ft³ = Pounds per cubic foot

% = Percent

---- = Not Analyzed

DI = Deionized Water

PW = Site Potable Water

CGW = Chloride affected groundwater

OGW = Organics affected groundwater

CA = Chloride Affected Soil

OA = Organics Affected Soil

DA = Dense Non-Aqueous Phase Liquid Affected Soil

Missing Data

Appendix A
Boring Logs

BOREHOLE LOG

Project Number: 0063836.02

Total Depth: 50.50'

Project Name: Arkema, Inc.

Borehole Dia.: 10.00in (HSA), 5.88in (Mud Rotary)

Location: Portland, Oregon

Logged By: B. Robinson

Contractor: Boart Longyear

Initial Water Level: ~25.00'

Drilling Method: Hollow Stem Auger/Mud Rotary

Date(s): 04/04/07 - 04/05/07

Sampling Method: California/Split Spoon/Shelby Tube

Depth (ft)	Graphic Log	USCS Code	Bulk Sample	Sample Recovery	Blow Count	Soil Description and Observations
0-5		SM	HAND DUG			1.0" Gravel surface, underlain by Geotextile. GRAVELLY SANDY SILT (SM): dark brown to black, slightly moist.
5-10		ML		CA 50% SPT 72%	0 1 2 3 4 5 6 7 8 9 10	GRAVELLY SANDY SILT (ML): dark yellow brown, fine to medium gravel, fine to coarse sand, moist (fill).
10-15				CA 15% SPT 55%	10 11 12 13	SANDY SILT (ML): fine to coarse sand, wet. Some fine gravel.
15-20				CA 40% SPT 100%	14 15 16 17	SANDY GRAVELLY SILT (ML): dark yellow brown, fine to coarse sand, fine to coarse gravel, soft (fill).
20-25		SP		CA 65% SPT 44%	18 19 20 21 22 23 24 25	SAND (SP): dark brown to yellow brown, fine grained, trace fines, moist. Wet below 25.0'. 2.0" thick SILTY SAND at 25.0', some red staining. 1.0" thick SANDY SILT at 26.0'. Heaving sand at 26.0'.
25-30				CA 70% SPT 70%	26 27 28 29 30	
30-35				CA 75% SPT 61%	31 32 33 34 35	SAND (SP): dark gray brown to dark gray, fine to medium grained, occasional silt lenses (0.25-1.0" thick), medium dense, sweet odor becoming stronger with depth, slight sheen at 33.0', wet.
35-40		ML		CA 67% SPT 78%	36 37 38 39 40	SILT (ML): dark olive brown, with fine silt, soft, moist.
40-45		SP		CA 67%	41 42 43 44 45	SAND (SP): dark gray, fine to medium grained, trace to some silt, medium dense, sweet odor, wet.
45-50		ML		SHEL THIN WALL	PUSH PUSH 2	SILT (ML): observed on tooling, poor recovery.
50		SP		SAMP	2 4	SAND (SP): fine grained, trace silt, loose, rotten egg odor, wet.

BOREHOLE LOG

Project Number: 0063836.02

Total Depth: 50.50'

Project Name: Arkema, Inc.

Borehole Dia.: 10.00in (HSA), 5.88in (Mud Rotary)

Location: Portland, Oregon

Logged By: B. Robinson

Contractor: Boart Longyear

Initial Water Level: ~25.00'

Drilling Method: Hollow Stem Auger/Mud Rotary

Date(s): 04/04/07 - 04/05/07

Sampling Method: California/Split Spoon/Shelby Tube

Depth (ft)	Graphic Log	USCS Code	Bulk Sample	Sample Recovery	Blow Count	Soil Description and Observations
45		ML SP ML		SPT SPT 67% CA 75% SPT 75% CA 83%	7 7 10 5 5 7 6 4 3 13 20 13	SILT (ML): olive brown, soft, moist to wet. SAND (SP): very fine grained, some silt, medium dense, wet.
50				SHEL CA 75%	PUSH 8 2 50/5	SANDY SILT (ML): olive brown, very fine sand, soft, wet. Total Depth - 50.5' bgs (Basalt chips in shoe)
55						
60						
65						
70						
75						

BOREHOLE LOG

Project Number: 0063836.02

Total Depth: 87.00'

Project Name: Arkema, Inc.

Borehole Dia.: 10.00in (HSA), 5.88in (Mud Rotary)

Location: Portland, Oregon

Logged By: B. Robinson

Contractor: Boart Longyear

Initial Water Level: ~27.00'

Drilling Method: Hollow Stem Auger/Mud Rotary

Date(s): 04/04/07 - 04/05/07

Sampling Method: California/Split Spoon/Shelby Tube

Depth (ft)	Graphic Log	USCS Code	Bulk Sample	Sample Recovery	Blow Count	Soil Description and Observations
45.00		ML	CA	83%	10	SANDY SILT (ML): yellow brown and light brown, very fine sand, medium dense, moist.
45.00			SPT	83%	17	
45.00			CA	87%	15	SANDY CLAYEY SILT (ML): olive brown, fine sand, soft, wet.
45.00			SPT	33%	20	
45.00			CA	66%	20	SILTY SAND (SM): olive gray, fine sand, loose to medium dense, wet.
45.00			SPT	50%	25	
45.00			SHEL	PUSH	34	
45.00			CA	83%	7	CLAYEY SILT (ML): light yellow brown, some fine sand, wet.
45.00			SPT	77%	7	
45.00			CA	42%	7	SANDY SILT (ML): dark olive brown, fine sand, some clay, loose to medium dense, wet.
45.00			SPT	100%	7	
45.00			CA	75%	14	No clay below 67.0', loose.
45.00			SPT	100%	14	
45.00			CA	88%	14	6.0" thick SILT at 70.0', some fine sand, trace clay, grading to SILTY SAND (SM): medium dense to dense.
45.00			SPT	88%	14	
45.00			SHEL	PUSH	14	2.0" thick CLAYEY SILT at 72.0'.
45.00			CA	75%	14	
45.00			SPT	89%	14	SANDY SILT/SILTY SAND (ML/SM): dark gray, alternating layers, some carbonized organics, medium dense, unconsolidated, rotten egg odor, wet.
45.00			CA	88%	14	
45.00			SPT	94%	16	
45.00			CA	83%	20	
45.00			SPT	88%	23	
45.00			CA	83%	18	
45.00			SPT	94%	4	
45.00			CA	83%	22	
45.00			SPT	88%	40	
45.00			CA	83%	46	
45.00			SPT	88%	50	
45.00			CA	83%	13	

BOREHOLE LOG

Project Number: 0063836.02

Total Depth: 87.00'

Project Name: Arkema, Inc.

Borehole Dia.: 10.00in (HSA), 5.88in (Mud Rotary)

Location: Portland, Oregon

Logged By: B. Robinson

Contractor: Boart Longyear

Initial Water Level: ~27.00'

Drilling Method: Hollow Stem Auger/Mud Rotary

Date(s): 04/04/07 - 04/05/07

Sampling Method: California/Split Spoon/Shelby Tube

Depth (ft)	Graphic Log	USCS Code	Bulk Sample	Sample Recovery	Blow Count	Soil Description and Observations
85		SP		SPT 15 89% 17 SHEL PUSH CA 17 83% 43 43 40 SPT 9 77% 23 25 CA 28 42% 28 50/5		Occasional layers of fine SAND WITH SILT. SAND (SP): fine sand, with some silt, dense, wet. Some thin lenses of CLAYEY SILT at 86.0-87.0'. Total Depth - 87.0' bgs. Basalt chips in shoe.
90						
95						
100						
105						
110						
115						



SIERRA TESTING LABORATORIES, INC.
 GEOTECHNICAL AND MATERIALS TESTING SERVICES

5040 Robert J. Mathews, Suite 1 El Dorado Hills, CA 95762
 PH: 916.939.3460 / FX 916.939.3507

Laboratory Test Request

Project Name: Arkema Soil and Slurry Compatibility
 Project Location: Portland, Oregon
 Client Name: ERM
 Client Project No.: 63836-03
 Client Contact: Brendan Robinson

STL Job No.: _____
 Date Received: _____
 Tests Listed By: _____
 Results Due By: _____
 Disposal Date: _____

Sample Type Code:
 ST - shelby, BT - brass, BG - baggie, BK - bulk
 SS - stainless, AL - acetate, CC - cylinder

Test Legend:
 Ordered Prepared Completed Printed

Sample ID	Depth	Sample Type	Moisture Content - D2216	Moisture & Density - D2937	Atterberg Limit - D4318	Sieve Analysis - D422 / C136	Compaction - D1557 / D698	Consolidation - D2435	Permeability - D5084 / D2434	Unconfined Compression - D2166	Direct Shear (D.S.) - D3090	Triaxial Shear (UU) - D2850	Triaxial Shear (CU) - D4767	STL Sample Number	Notes
B-121 5-10	5-10	BG													
B-121 10-15.5	10-15.5	BG													
B-121 15.5-19	15.5-19	BG													
B-121 19-25	19-25	BG													
B-121 25-27	25-27	BG													
B-121 27-29	27-29	BG													
B-121 29-31	29-31	BG													
B-121 31-32	31-32	SS													
B-121 32-39	32-39	BG													
B-121 39-44	39-44	BG													
B-121 44-49	44-49	BG													
B-121 49-50	49-50	SS													
B-121 51-53	51-53	BG													
B-121 53-59	53-59	BG													
B-121 59-60	59-60	SS													

P.3

916-939-6641

Apr 05 07 12:47P

Appendix B
Clay Additive Manufacturer
Specification Sheets



BARA-KADE[®] SP Slurry Trench and Soil Sealing Grade – 200 Mesh

Created: 05/20/98
 Category: Product Data Sheet

A high quality, untreated sodium bentonite used in slurry wall construction, soil sealing, and other hydraulic barriers. This product meets all API 13A Section 10 specifications for an untreated bentonite. Due to its fine particle size, it is primarily used with pugmill mixing methods for soil/bentonite liner projects.

Typical Physical Properties*

	TYPICAL	SPECIFICATION
SCREEN ANALYSIS		
Dry Screen, percent minus 200 mesh	77	
Wet Screen, percent plus 200 mesh	2	

SLURRY PROPERTIES (6% Suspension)		
Viscosity, FANN [®] 600 rpm	22	
Apparent Viscosity, cps	11	
Yield - 42 gal bbl of 15 cps slurry/ton	84	
Filter cake, in.	3/32	
Plastic Viscosity (PV)	8	
Yield Point, lb./100 ft ²	6	
Filtrate, 30 minutes @ 100 psi, ml	11	
Marsh Funnel, seconds/quart	36	

SLURRY PROPERTIES (6.7% SUSPENSION), API 13A, Sec. 5		
Yield Point/Plastic Viscosity Ratio	1.3	1.5 max
Plastic Viscosity	16	10.0 min
Filtrate Loss, 30 minutes at 100 psi	10	12.5 max

OTHER PROPERTIES		
Moisture, percent	9	
Swell Index (ml)	28	
Plate Water Absorption, wt % @ 20° C/18 hr	850	
Specific Gravity	2.7	
pH, 6% suspension	9.2	
Bulk Density (lbs per ft ³) uncompacted	49	
Bulk Density (lbs per ft ³) compacted	72	

* The typical physical values listed are not to be construed as rigid specifications.
 BARA-KADE and FANN are registered trademarks of Halliburton Energy Services, Inc.
 Revision Date: August 30, 2004

Because the conditions of use of this product are beyond the seller's control, the product is sold without warranty either express or implied and upon condition that purchaser make its own test to determine the suitability for purchaser's application. Purchaser assumes all risk of use and handling of this product. This product will be replaced if defective in manufacture or packaging or if damaged. Except for such replacement, seller is not liable for any damages caused by this product or its use. The statements and recommendations made herein are believed to be accurate. No guarantee of their accuracy is made, however.



MATERIAL SAFETY DATA SHEET

Product Trade Name: **BARA-KADE® BENTONITE**

Revision Date: 31-Mar-2005

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: BARA-KADE® BENTONITE
Synonyms: None
Chemical Family: Mineral
Application: Additive
Manufacturer/Supplier: BPM Minerals LLC
3000 N Sam Houston Parkway East
Houston, TX 77032
Telephone: (281) 871-7900
Fax: (281) 871-7940
Emergency Telephone: (800) 666-9260 or (713) 753-3000
Prepared By: Chemical Compliance
Telephone: 1-580-251-4335

2. COMPOSITION/INFORMATION ON INGREDIENTS

SUBSTANCE	CAS Number	PERCENT	ACGIH TLV-TWA	OSHA PEL-TWA
Crystalline silica, cristobalite	14464-46-1	0 - 1%	0.05 mg/m ³	1/2 x 10 mg/m ³ - %SiO ₂ + 2
Crystalline silica, tridymite	15468-32-3	0 - 1%	0.05 mg/m ³	1/2 x 10 mg/m ³ - %SiO ₂ + 2
Crystalline silica, quartz	14808-60-7	1 - 5%	0.05 mg/m ³	10 mg/m ³ - %SiO ₂ + 2
Bentonite	1302-78-9	60 - 100%	Not applicable	Not applicable

More restrictive exposure limits may be enforced by some states, agencies, or other authorities.

3. HAZARDS IDENTIFICATION

Hazard Overview

CAUTION! - ACUTE HEALTH HAZARD

May cause eye and respiratory irritation.

DANGER! - CHRONIC HEALTH HAZARD

Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposures below recommended exposure limits. Wear a NIOSH certified, European Standard EN 149, or equivalent respirator when using this product. Review the Material Safety Data Sheet (MSDS) for this product, which has been provided to your employer.

4. FIRST AID MEASURES

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Ingestion	Under normal conditions, first aid procedures are not required.
Notes to Physician	Treat symptomatically.

5. FIRE FIGHTING MEASURES

Flash Point/Range (F):	Not Determined
Flash Point/Range (C):	Not Determined
Flash Point Method:	Not Determined
Autoignition Temperature (F):	Not Determined
Autoignition Temperature (C):	Not Determined
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined

Fire Extinguishing Media All standard firefighting media.

Special Exposure Hazards Not applicable.

Special Protective Equipment for Fire-Fighters Not applicable.

NFPA Ratings: Health 0, Flammability 0, Reactivity 0
HMIS Ratings: Flammability 0, Reactivity 0, Health 0*

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures Use appropriate protective equipment. Avoid creating and breathing dust.

Environmental Precautionary Measures None known.

Procedure for Cleaning / Absorption Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

7. HANDLING AND STORAGE

Handling Precautions	This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.
Storage Information	Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Do not reuse empty container.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls	Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits listed in Section 2.
Respiratory Protection	Wear a NIOSH certified, European Standard EN 149, or equivalent respirator when using this product.
Hand Protection	Normal work gloves.
Skin Protection	Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Solid
Color:	Various
Odor:	Odorless
pH:	8-10
Specific Gravity @ 20 C (Water=1):	2.65
Density @ 20 C (lbs./gallon):	Not Determined
Bulk Density @ 20 C (lbs/ft3):	50-70
Boiling Point/Range (F):	Not Determined
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (F):	Not Determined
Freezing Point/Range (C):	Not Determined
Vapor Pressure @ 20 C (mmHg):	Not Determined
Vapor Density (Air=1):	Not Determined
Percent Volatiles:	Not Determined
Evaporation Rate (Butyl Acetate=1):	Not Determined
Solubility in Water (g/100ml):	Insoluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (lbs./gallon):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	Not Determined

10. STABILITY AND REACTIVITY

Stability Data:	Stable
Hazardous Polymerization:	Will Not Occur

Conditions to Avoid	None anticipated
Incompatibility (Materials to Avoid)	Hydrofluoric acid.
Hazardous Decomposition Products	Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).
Additional Guidelines	Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure	Eye or skin contact, inhalation.
Inhalation	<p>Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A).</p> <p>Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).</p>
Skin Contact	May cause mechanical skin irritation.
Eye Contact	May cause eye irritation.
Ingestion	None known
Aggravated Medical Conditions	Individuals with respiratory disease, including but not limited to asthma and bronchitis, or subject to eye irritation, should not be exposed to quartz dust.
Chronic Effects/Carcinogenicity	<p>Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.</p> <p>Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to <u>IARC Monograph 68, Silica, Some Silicates and Organic Fibres</u> (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2).</p> <p>There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.</p>

Other Information For further information consult "Adverse Effects of Crystalline Silica Exposure" published by the American Thoracic Society Medical Section of the American Lung Association, American Journal of Respiratory and Critical Care Medicine, Volume 155, pages 761-768 (1997).

Toxicity Tests

Oral Toxicity: Not determined
Dermal Toxicity: Not determined
Inhalation Toxicity: Not determined
Primary Irritation Effect: Not determined
Carcinogenicity Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997).
Genotoxicity: Not determined
Reproductive / Developmental Toxicity: Not determined

12. ECOLOGICAL INFORMATION

Mobility (Water/Soil/Air) Not determined
Persistence/Degradability Not determined
Bio-accumulation Not Determined

Ecotoxicological Information

Acute Fish Toxicity: TLM96: 10000 ppm (Oncorhynchus mykiss)
Acute Crustaceans Toxicity: Not determined
Acute Algae Toxicity: Not determined

Chemical Fate Information Not determined
Other Information Not applicable

13. DISPOSAL CONSIDERATIONS

Disposal Method Bury in a licensed landfill according to federal, state, and local regulations.
Contaminated Packaging Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

Land Transportation

DOT
Not restricted

Canadian TDG
Not restricted

ADR Not restricted

Air Transportation

ICAO/IATA Not restricted

Sea Transportation

IMDG

Not restricted

Other Shipping Information

Labels: None

15. REGULATORY INFORMATION

US Regulations

US TSCA Inventory All components listed on inventory.

EPA SARA Title III Extremely Hazardous Substances Not applicable

EPA SARA (311,312) Hazard Class Acute Health Hazard
Chronic Health Hazard

EPA SARA (313) Chemicals This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).

EPA CERCLA/Superfund Reportable Spill Quantity For This Product Not applicable.

EPA RCRA Hazardous Waste Classification If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.

California Proposition 65 The California Proposition 65 regulations apply to this product.

MA Right-to-Know Law One or more components listed.

NJ Right-to-Know Law One or more components listed.

PA Right-to-Know Law One or more components listed.

Canadian Regulations

Canadian DSL Inventory All components listed on inventory.

WHMIS Hazard Class D2A Very Toxic Materials (Crystalline silica)

16. OTHER INFORMATION

The following sections have been revised since the last issue of this MSDS
Not applicable

Additional Information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Material Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.

Disclaimer Statement

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

*****END OF MSDS*****

Floridin

UNIQUE CLAY MINERALS FOR ENVIRONMENTAL APPLICATIONS

FLORIGEL® H-Y

(Attapulgite Clay)

FOR SLURRY TRENCH CUT OFF WALLS

APPLICATIONS

Forms the slurry to stabilize the open trench and is added to the backfill to reduce the permeability of the final wall.

BENEFITS

- A 4-5% clay slurry will:
 1. Result in a minimum Marsh Funnel viscosity of 40 sec.
 2. Result in a slurry density of 64.1 pcf in fresh water.
 3. Allow salt water to be used as the make up water.
 4. Suspend a 20/30 mesh sand better than sodium bentonite.
- When 2% clay is added to the backfill in slurry form, the permeability is reduced by about a factor of 25.
- In either of the above applications, FLORIGEL® H-Y is more stable than sodium bentonite when in contact with saturated chlorinated hydrocarbons and with:
 1. High conductance fluids - high electrolyte concentration and low dielectric constant.
 2. Fluids with increased cation valence.
 3. Basic organic fluids and concentrated organic acids.
 4. Polar and non-polar organic fluids.The better stability of FLORIGEL® H-Y in contact with the above fluids results from its spicular particle shape, versus plate shaped particles for bentonite, and FLORIGEL® H-Y's lower cation exchange capacity.

PHYSICAL PROPERTIES (Typical Values)

Free Moisture, %	13.4
Bulk Density (loose), pcf	42.3
Specific Gravity	2.55
Cation Exchange Capacity, meq/100 gm	20-30
pH - Fresh Water	9.8
Salt Water	8.8
Liquid Limit, %	351
Plasticity Index, %	253
Expansion Index per ASTM D4829-88; 50% saturation	368
Minimum Coef. of Permeability in Water at Optimum Moisture Content of 35.5% (Clay Only), cm/sec	10^{-8} - 10^{-9}
Viscosity (High Shear Mixed)	
API yield, bbls/ton	135
At 4½% clay concentration - distilled water	
Marsh Funnel, sec	40
FANN Viscometer	
Apparent Viscosity, cps	24
Plastic Viscosity, cps	6
Yield Point, lb/100 sq. ft.	35
Water Loss, cc - Fresh Water	110
Sea Water	100

Screen Analysis, %		
-50 mesh		97
-100 mesh		82
-200 mesh		50
-324 mesh		32
Dispersed Particles Size Distribution, %		
Clay:	10 - 60 x 10 ⁻⁴ mm	88
Silt:	6 - 80 x 10 ⁻³ mm	7
Sand:	8 - 500 x 10 ⁻² mm	5

USED IN THE FOLLOWING PROJECTS:

1. A chemical plant along the Texas Gulf Coast was situated over saline ground water with an inorganic chloride background of 3,000-32,000 ppm. Chlorinated hydrocarbon concentrations of 3,300 ppm existed. Backfill admixtures with 2% bentonite were 8 times more permeable than non dispersed FLORIGEL® H-Y, and 17 times more permeable than chemically dispersed FLORIGEL® H-Y; thus, FLORIGEL® H-Y was used for the slurry and backfill admixture.
2. A clay barrier around an old landfill in San Francisco Bay was leaking a toxic leachate into the Bay. The leachate destroyed both conventional and treated sodium bentonite, but did not effect attapulgite clay. The contractor, GeoCon Inc., used FLORIGEL® H-Y both for the slurry and backfill additive to construct a 40' deep by 5' wide wall with a maximum permeability of 10⁻⁷ cm/sec.
3. The owner of a landfill had constructed a lagoon and accepted a variety of hazardous wastes. Leachates with the following analysis showed up in several monitoring wells.

<u>Compound</u>	<u>Concentration - ppb</u>
Phenolics	10,500-26,000
Phenol	18,000-74,000
Ethylene Chloride	0-40
Acetone	2,600-5,700
Benzene	190-1,100
Toluene	1,300-5,200
Xylene & Ethylbenzene	90-7,100
Gasoline	13,000-65,000

Contact with this leachate caused serious cracks with standard and "contaminant resistant" bentonite, but not with FLORIGEL® H-Y. The permeability of 1.5-4.5% bentonite admixtures with the backfill actually increased as the bentonite content increased. Also, the slurry made with bentonite flocculated and fell out of suspension. The project was successfully constructed by GeoCon Inc. using attapulgite clay for the slurry and backfill admixture.

MINERAL DESCRIPTION

TYPICAL CHEMICAL ANALYSIS*, %

Attapulgite Mineral	Si as SiO ₂	66.2	Ca as CaO	2.9
Hydrous Magnesium Aluminum Silicate	Mg as MgO	9.7	P as Pa ₂ O ₅	1.0
Fuller's Earth	Al as Al ₂ O ₃	11.7	K as K ₂ O	1.1
Spicular Structure	Fe as Fe ₂ O ₃	4.0	C as CO ₂	2.6

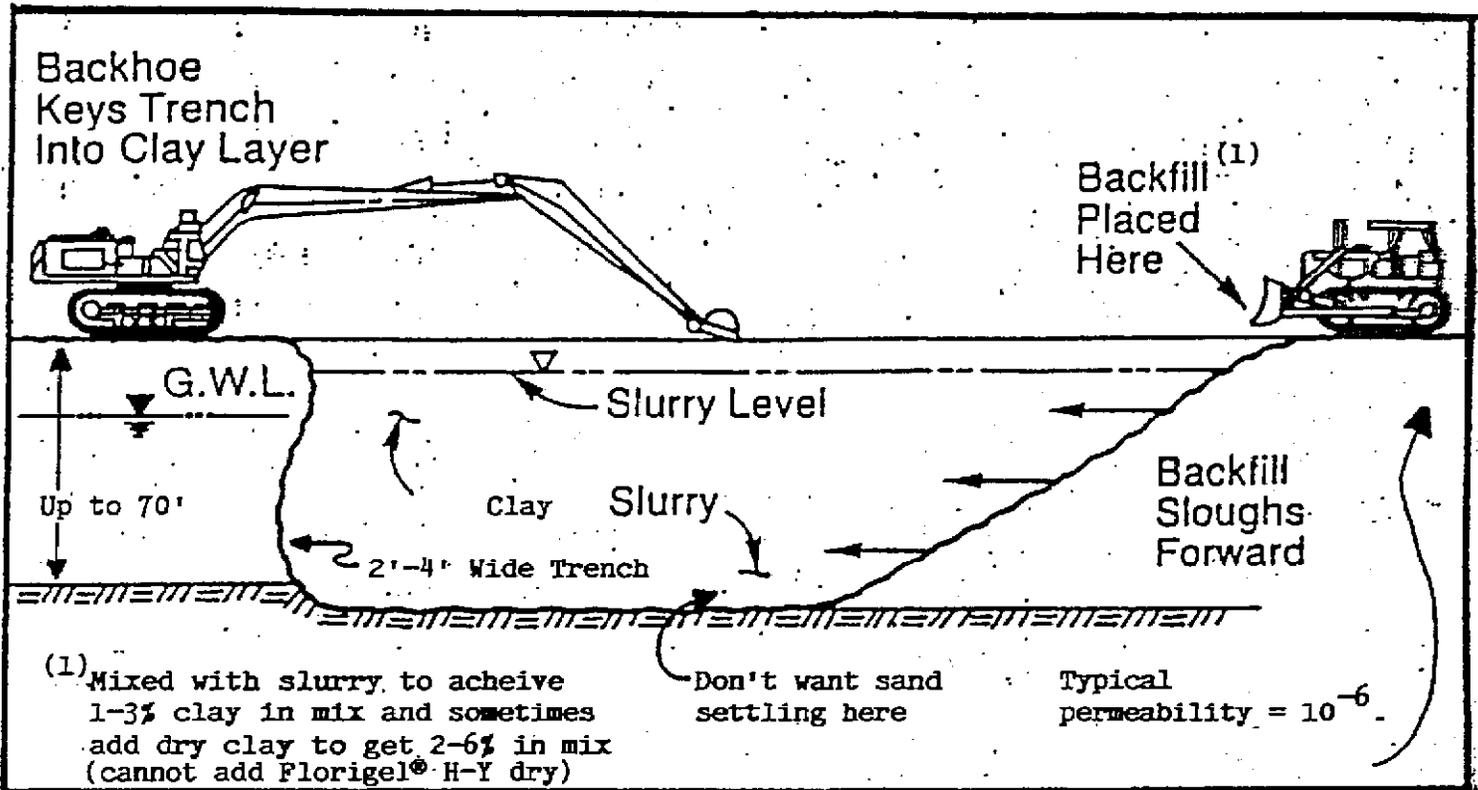
*Although the elements are reported as oxides they are actually present as complex aluminosilicates.

AVAILABLE from Quincy, FL, in 50 lb. bags, bulk bags, and bulk.

This information is based on data believed to be accurate but no warranty of accuracy is to be implied. Manner of use is the sole risk and liability of the user.

9/02/93

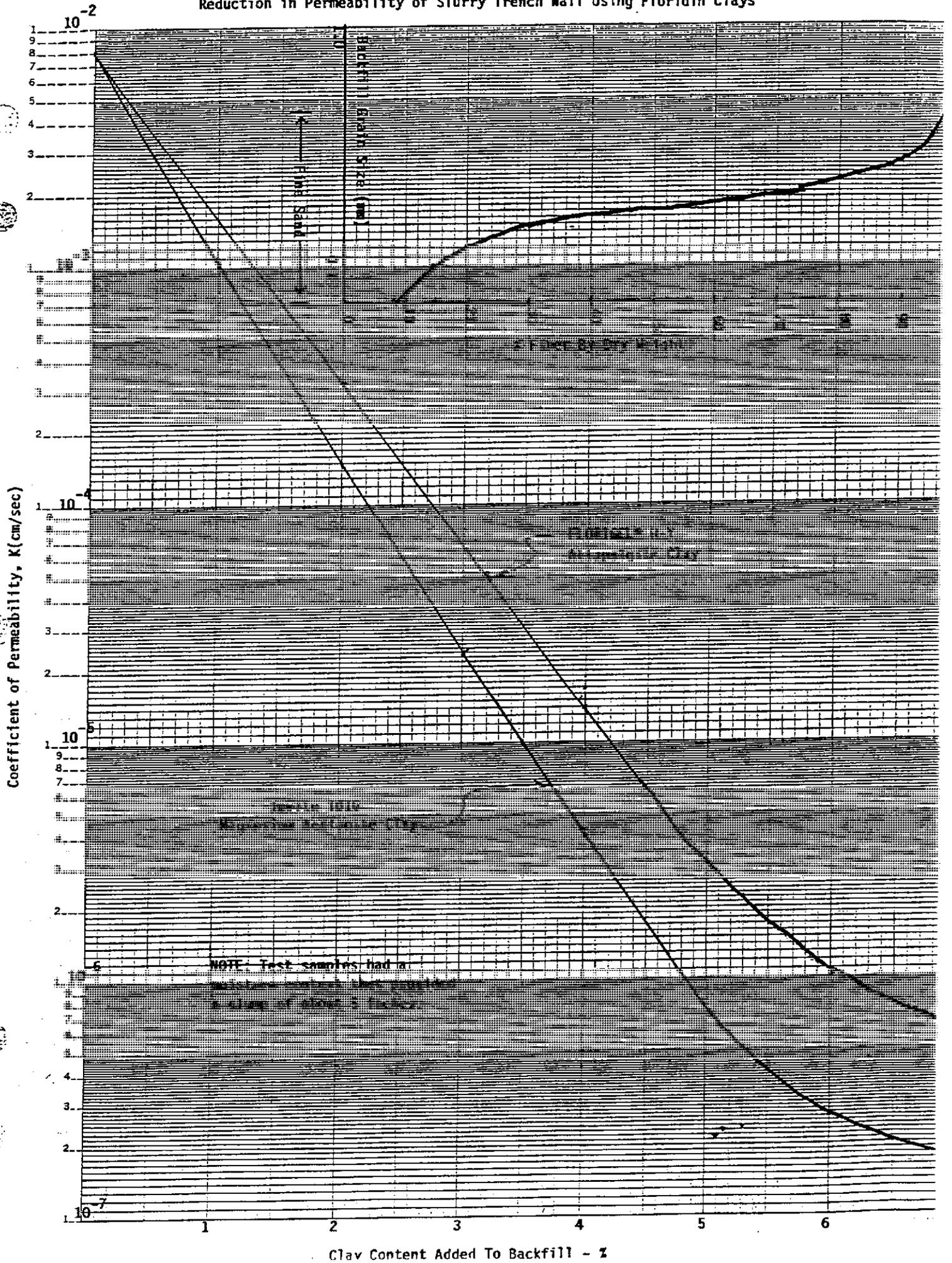
SLURRY TRENCH CUTOFF WALLS



Clay Performance Criteria & Phase I Ardaman Results on Florigel® H-Y, Sepiogel A, Invite 1016 (saponite) and Sodium Bentonite

1. Sufficient slurry density to prevent trench walls from sloughing or collapsing - 64 pcf min. Requires 4½ - 5% clay.
2. Sufficient viscosity to maintain uniform density for 2-3 days (keep clay in suspension). Marsh Funnel must be about 40 sec. Requires usages of 3% H-Y, 4% Sep A, 5% Invite 1016, and 6% bentonite.
3. Plastic viscosity must be less than 20cps so that slurry can be pumped, will mix well in backfill, and backfill will displace. All are 2-10 cps at 6% concentration.
4. Yield stress must be high enough to suspend sand particles. H-Y the best and Invite 1016 & bentonite the worst, but all satisfactory.
5. No aging problem for all clays for 7 days - degeneration of slurry or viscosity increasing to level affecting workability.
6. Best results require high shear mixture of H-Y & Sep A, 24 hour hydration of bentonite, and some of both for Invite 1016. (see back).

Reduction in Permeability of Slurry Trench Wall Using Floridin Clays



Appendix C
Materials Testing Laboratory
Reports

SWELL INDEX OF CLAY COMPONENTS OF GEOSYNTHETIC CLAY LINERS

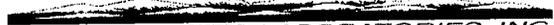
Swell Index, mL /2 g
12.0

Test Method: ASTM D5890-06

SAMPLE IDENTIFICATION: Bentonite Clay
SAMPLE DESCRIPTION: - #100 Bentonite Clay

LABORATORY NO. :

PROJECT NUMBER: 07-167 June 12, 2007


SIERRA TESTING LABORATORIES, INC.
GEOTECHNICAL AND MATERIALS TESTING SERVICES

5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762
Phone: (916) 939-3460 FAX: (916) 939-3507

**Arkema Portland Harbor Site
Portland Oregon**

SLURRY MIX TEST RESULTS

Sample Name: Attapulgite with PW H2O

Mix Proportions: PW H₂O _ 3304.4 ml + Attapulgite _ 209.4 g

Initial pH Reading: 9.87
Initial Conductivity Reading (uS): 142

<u>Time (hrs)</u>	<u>Density (pcf)</u>	<u>Marsh (sec)</u>
0.0	67.2	36.0
0.5	67.3	36.0
1.0	67.6	37.0
2.0	67.7	37.0
4.0	68.0	39.0
8.0	68.1	40.0
24.0	68.1	41.0
48.0	68.1	41.0
72.0	68.1	41.0

Final pH Reading: 9.81
Final Conductivity Reading (uS): 141

Notes:

Conductivity - Range 10-19990 uS, Resolution 10 uS, Accuracy +/- 0.5%
pH - Range 0.00 to 14.00, Resolution 0.01pH, Accuracy +/- 0.02pH

Test Method: Multi Meter (Extech 341450)

PROJECT NUMBER:

07-167

September 21, 2007


SIERRA TESTING LABORATORIES, INC.
GEOTECHNICAL AND MATERIALS TESTING SERVICES

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**Arkema Portland Harbor Site
Portland, Oregon**

SLURRY MIX TEST RESULTS

Sample Name: Bentonite with PW H2O + 15% CGW

Mix Proportions: PW _ 2550 ml + CGW _ 450 ml + Bentonite _ 300 g

Initial pH Reading: 8.43
Initial Conductivity Reading (uS): 16940

<u>Time (hrs)</u>	<u>Density (pcf)</u>	<u>Marsh (sec)</u>
0.0	66.5	36.0
0.5	66.5	36.0
1.0	66.7	37.0
2.0	66.0	38.0
4.0	65.1	39.0
8.0	65.6	41.0
24.0	66.8	44.0
48.0	67.0	45.0
72.0	67.1	45.0

Final pH Reading: 8.40
Final Conductivity Reading (uS): 16900

Notes:

Conductivity - Range 10-19990 uS, Resolution 10 uS, Accuracy +/- 0.5%
pH - Range 0.00 to 14.00, Resolution 0.01pH, Accuracy +/- 0.02pH

Test Method: Multi Meter (Extech 341450)

PROJECT NUMBER:

07-167

December 19, 2007


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Portland, Oregon**

SLURRY MIX TEST RESULTS

Sample Name: Attapulgite with PW H2O + 15% OGW

Mix Proportions: PW _ 2550 ml + OGW _ 450 ml + Attapulgite _ 500 g

Initial pH Reading: 9.31
Initial Conductivity Reading (uS): 207

<u>Time (hrs)</u>	<u>Density (pcf)</u>	<u>Marsh (sec)</u>
0.0	67.0	37.0
0.5	67.0	37.0
1.0	66.8	39.0
2.0	66.4	39.0
4.0	67.3	39.0
8.0	67.5	39.0
24.0	67.7	40.0
48.0	67.9	40.0
72.0	67.9	41.0

Final pH Reading: 9.26
Final Conductivity Reading (uS): 212

Notes:

Conductivity - Range 10-19990 uS, Resolution 10 uS, Accuracy +/- 0.5%
pH - Range 0.00 to 14.00, Resolution 0.01pH, Accuracy +/- 0.02pH

Test Method: Multi Meter (Extech 341450)

PROJECT NUMBER:

07-167

December 18, 2007


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**Arkema Portland Harbor Site
Portland, Oregon**

SLURRY MIX TEST RESULTS

Sample Name: Attapulgate with DI H2O

Mix Proportions: DI H₂O _ 2893.1 ml + Attapulgate _ 184.7 g

Initial pH Reading: 10.03
Initial Conductivity Reading (uS): 110

<u>Time (hrs)</u>	<u>Density (pcf)</u>	<u>Marsh (sec)</u>
0.0	66.2	30.0
0.5	66.0	30.0
1.0	65.9	31.0
2.0	65.4	33.0
4.0	65.0	33.0
8.0	65.0	32.0
24.0	64.9	32.0

Final pH Reading: 9.85
Final Conductivity Reading (uS): 110

Notes:

Conductivity - Range 10-19990 uS, Resolution 10 uS, Accuracy +/- 0.5%
pH - Range 0.00 to 14.00, Resolution 0.01pH, Accuracy +/- 0.02pH

Test Method: Multi Meter (Extech 341450)

PROJECT NUMBER:

07-167

July 18, 2007


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GEOTECHNICAL AND MATERIALS TESTING SERVICES

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**Arkema Portland Harbor Site
Portland, Oregon**

SLURRY MIX TEST RESULTS

Sample Name: Bentonite with DI H2O

Mix Proportions: DI H₂O _ 3702.5 ml + Bentonite _ 300 g

Initial pH Reading: 9.87
Initial Conductivity Reading (uS): 760

<u>Time (hrs)</u>	<u>Density (pcf)</u>	<u>Marsh (sec)</u>
0.0	65.2	35.8
0.5	65.2	36.0
1.0	65.0	37.0
2.0	64.5	37.0
4.0	64.2	37.5
8.0	64.5	37.5
24.0	64.8	38.0

Final pH Reading: 9.75
Final Conductivity Reading (uS): 810

Notes:

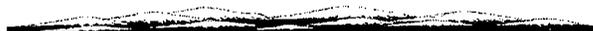
Conductivity - Range 10-19990 uS, Resolution 10 uS, Accuracy +/- 0.5%
pH - Range 0.00 to 14.00, Resolution 0.01pH, Accuracy +/- 0.02pH

Test Method: Multi Meter (Extech 341450)

PROJECT NUMBER:

07-167

July 18, 2007


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**Arkema Portland Harbor Site
Portland, Oregon**

SLURRY MIX TEST RESULTS

Sample Name: Bentonite with PW H2O

Mix Proportions: PW H₂O _ 3098.4 ml + Bentonite _ 200.3 g

Initial pH Reading: 9.82
Initial Conductivity Reading (uS): 783

<u>Time (hrs)</u>	<u>Density (pcf)</u>	<u>Marsh (sec)</u>
0.0	67.2	40.2
0.5	67.0	40.5
1.0	66.9	41.2
2.0	66.8	41.4
4.0	67.0	41.3
8.0	67.2	41.4
24.0	67.4	41.6
48.0	67.4	41.5
72.0	67.4	41.6

Final pH Reading: 9.61
Final Conductivity Reading (uS): 874

Notes:

Conductivity - Range 10-19990 uS, Resolution 10 uS, Accuracy +/- 0.5%
pH - Range 0.00 to 14.00, Resolution 0.01pH, Accuracy +/- 0.02pH

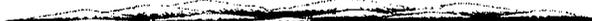
Test Method: Multi Meter (Extech 341450)

PROJECT NUMBER:

07-167

September 21, 2007

**Arkema Portland Harbor Site
Portland, Oregon**


SIERRA TESTING LABORATORIES, INC.
GEOTECHNICAL AND MATERIALS TESTING SERVICES

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Phone: (916) 939-3460 FAX: (916) 939-3507

SLURRY MIX TEST RESULTS

Sample Name: Attapulgate with PW H2O + 15% CGW

Mix Proportions: PW _ 2550 ml + CGW _ 450 ml + Attapulgate _ 500 g

Initial pH Reading: 9.29
Initial Conductivity Reading (uS): 14910

<u>Time (hrs)</u>	<u>Density (pcf)</u>	<u>Marsh (sec)</u>
0.0	67.1	53.0
0.5	67.1	53.0
1.0	67.7	60.0
2.0	68.0	63.0
4.0	68.2	65.0
8.0	68.0	65.0
24.0	67.7	64.0
48.0	67.8	64.0
72.0	67.9	64.0

Final pH Reading: 9.27
Final Conductivity Reading (uS): 15010

Notes: _____

Conductivity - Range 10-19990 uS, Resolution 10 uS, Accuracy +/- 0.5%
pH - Range 0.00 to 14.00, Resolution 0.01pH, Accuracy +/- 0.02pH

Test Method: Multi Meter (Extech 341450)

PROJECT NUMBER:

07-167

December 18, 2007


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**Arkema Portland Harbor Site
Portland, Oregon**

SLURRY MIX TEST RESULTS

Sample Name: Bentonite with PW H2O

Mix Proportions: PW H₂O _ 3151.4 ml + Bentonite _ 201.7 g

Initial pH Reading: 9.75
Initial Conductivity Reading (uS): 760

<u>Time (hrs)</u>	<u>Density (pcf)</u>	<u>Marsh (sec)</u>
0.0	65.2	37.0
0.5	64.8	37.5
1.0	65.0	38.0
2.0	64.8	37.0
4.0	64.9	38.0
8.0	65.2	38.0
24.0	65.0	38.5

Final pH Reading: 9.54
Final Conductivity Reading (uS): 830

Notes:

Conductivity - Range 10-19990 uS, Resolution 10 uS, Accuracy +/- 0.5%
pH - Range 0.00 to 14.00, Resolution 0.01pH, Accuracy +/- 0.02pH

Test Method: Multi Meter (Extech 341450)

PROJECT NUMBER:

07-167

July 18, 2007


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**Arkema Portland Harbor Site
Portland, Oregon**

SLURRY MIX TEST RESULTS

Sample Name: Bentonite with PW H2O + 15% OGW

Mix Proportions: PW _ 2550 ml + OGW _ 450 ml + Bentonite _ 200 g

Initial pH Reading: 8.81
Initial Conductivity Reading (uS): 327

<u>Time (hrs)</u>	<u>Density (pcf)</u>	<u>Marsh (sec)</u>
0.0	66.5	35.0
0.5	66.5	36.0
1.0	67.0	36.0
2.0	65.0	36.0
4.0	64.5	37.0
8.0	64.3	38.0
24.0	63.7	41.0
48.0	64.0	41.0
72.0	64.1	42.0

Final pH Reading: 8.77
Final Conductivity Reading (uS): 316

Notes:

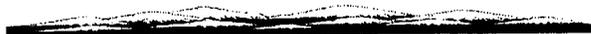
Conductivity - Range 10-19990 uS, Resolution 10 uS, Accuracy +/- 0.5%
pH - Range 0.00 to 14.00, Resolution 0.01pH, Accuracy +/- 0.02pH

Test Method: Multi Meter (Extech 341450)

PROJECT NUMBER:

07-167

December 19, 2007


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**Arkema Portland Harbor Site
Portland, Oregon**

HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Impermix/OA/DI, 6/26/07 Sample Depth, ft.: N/A
 Visual Description: N/A Sample Type: Cast Cylinder
 Remarks: 45 Day Test , DI water permeant

TEST RESULTS

Permeability, cm/sec.: 1.77E-08 Average Hydraulic Gradient: 4.1
 Effective Cell Pressure, psi: 10

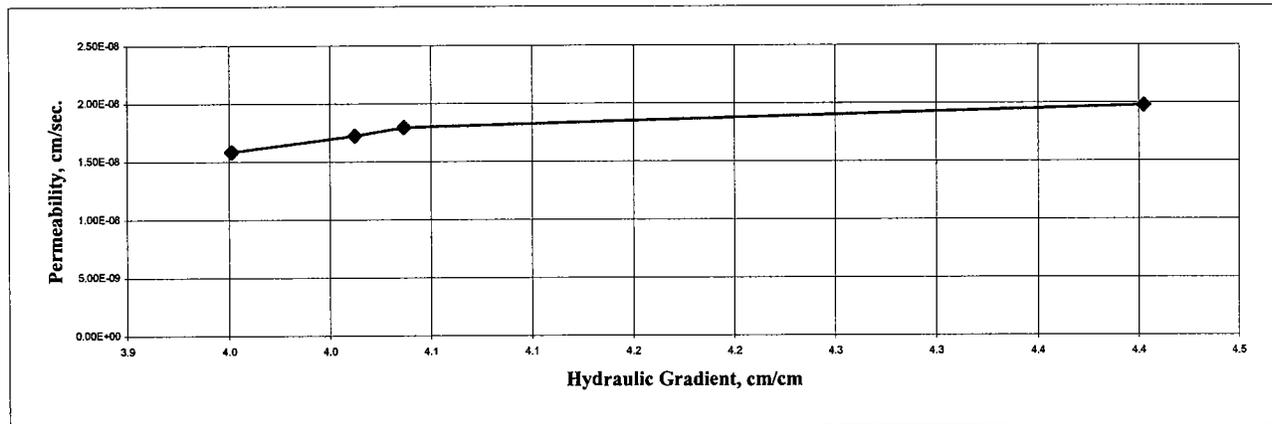
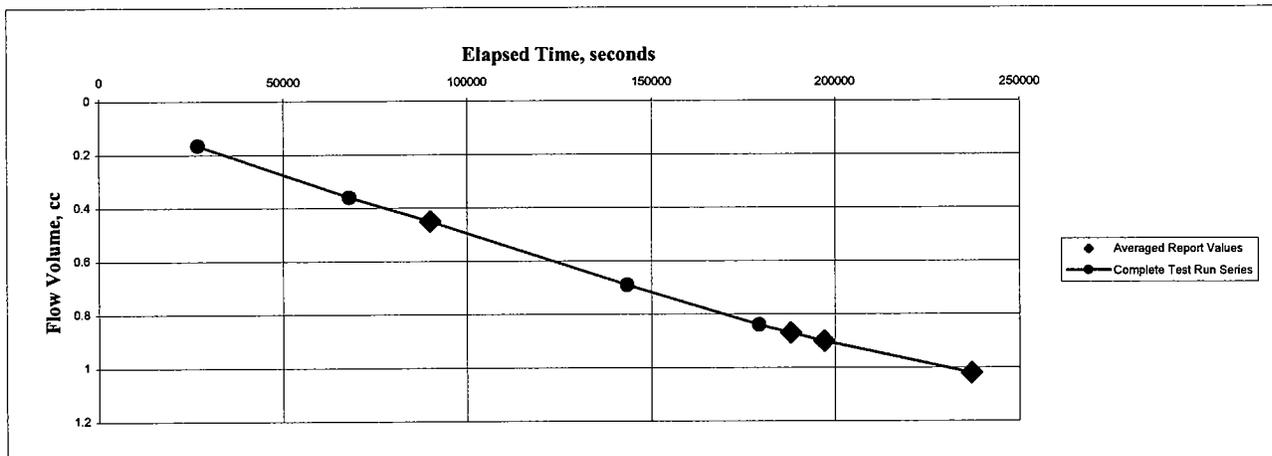
TEST SAMPLE DATA

Before Test

Specimen Height, cm: 8.20
 Specimen Diameter, cm: 7.62
 Dry Unit Weight, pcf: 32.3
 Moisture Content, % 135.1
 Specific Gravity, Assumed
 Percent Saturation:

After Test

Specimen Height, cm: 8.20
 Specimen Diameter, cm: 7.62
 Dry Unit Weight, pcf: 32.3
 Moisture Content, % 136.1



Test Method: ASTM D5084 Method C

PROJECT NUMBER: 07-167 August 10, 2007

Arkema Portland Harbor Site
 Portland, Oregon



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HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Impermix/CAsoil, 6/26/07 Sample Depth, ft.: N/A
 Visual Description: N/A Sample Type: Cast Cylinder
 Remarks: 45 Day Test , CGW Permeant

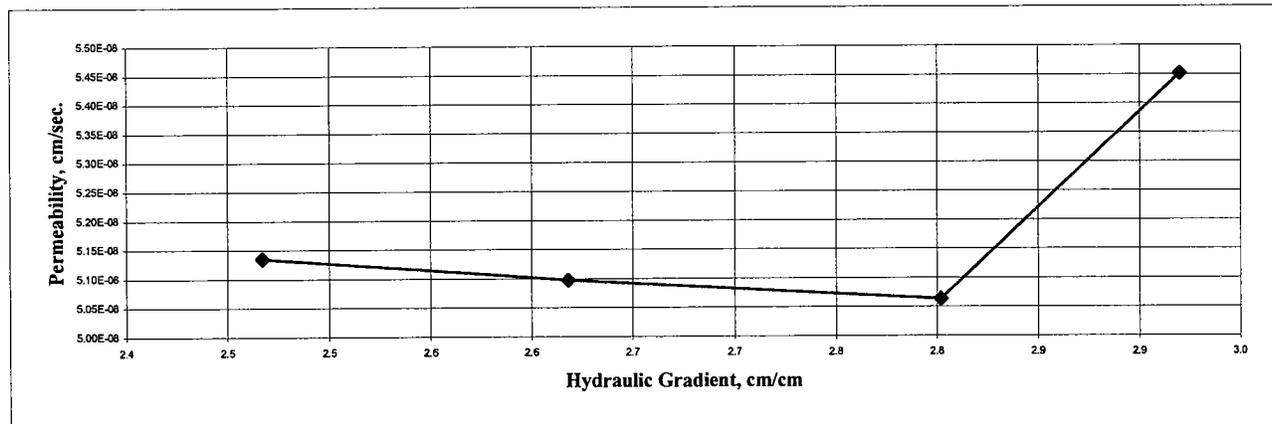
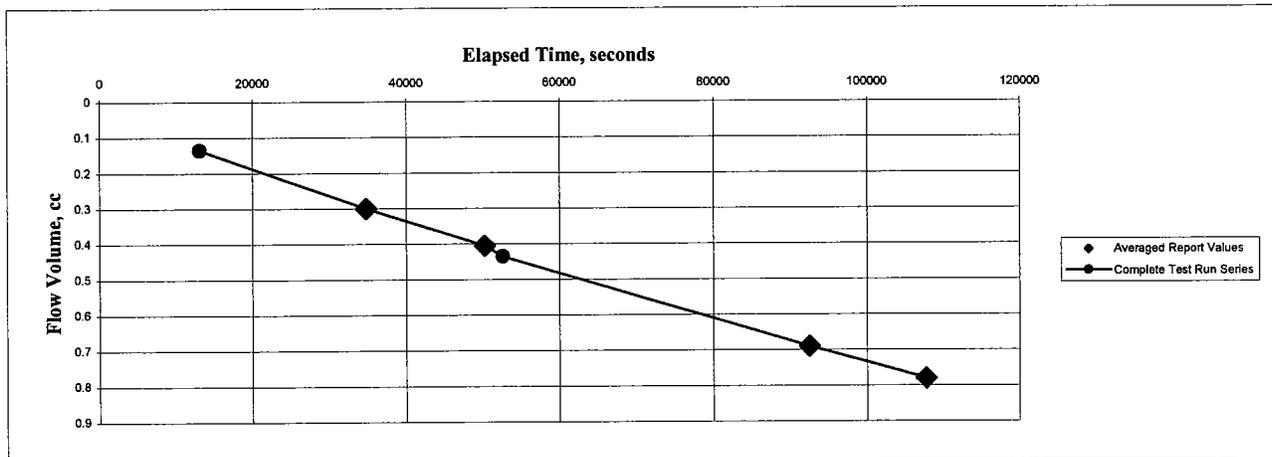
TEST RESULTS

Permeability, cm/sec.: **5.19E-08** Average Hydraulic Gradient: **2.7**
 Effective Cell Pressure, psi: 10

TEST SAMPLE DATA

Before Test
 Specimen Height, cm: 7.62
 Specimen Diameter, cm: 7.62
 Dry Unit Weight, pcf: 29.7
 Moisture Content, % 161.4
 Specific Gravity, Assumed
 Percent Saturation:

After Test
 Specimen Height, cm: 7.62
 Specimen Diameter, cm: 7.62
 Dry Unit Weight, pcf: 29.7
 Moisture Content, % 162.6



Test Method: ASTM D5084 Method C

PROJECT NUMBER: 07-167 August 10, 2007

**Arkema Portland Harbor Site
 Portland, Oregon**



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HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Impermix/CAsoil, 6/26/07 Sample Depth, ft.: N/A
 Visual Description: N/A Sample Type: Cast Cylinder
 Remarks: 45 Day Test , DI water permeant

TEST RESULTS

Permeability, cm/sec.: 1.33E-08 Average Hydraulic Gradient: 4.4
 Effective Cell Pressure, psi: 10

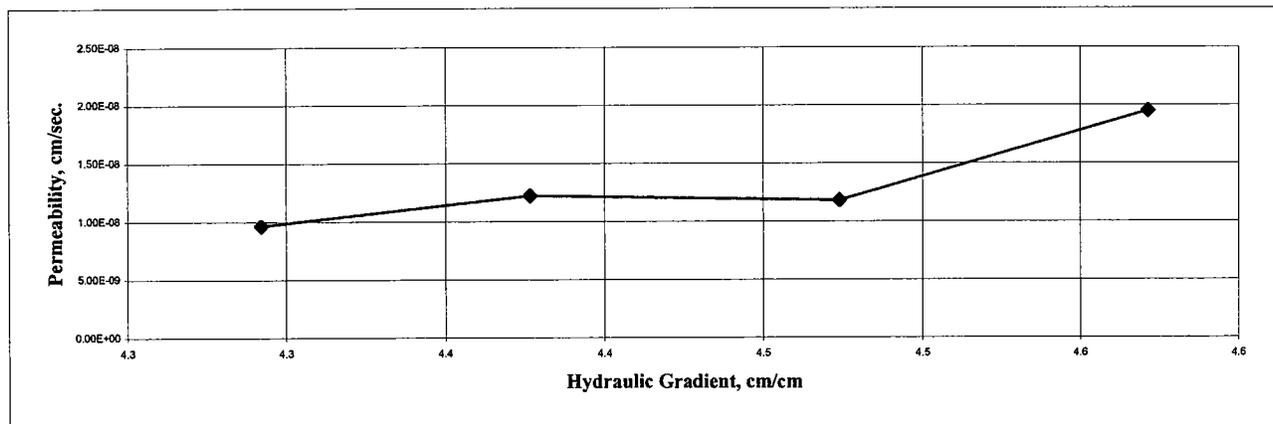
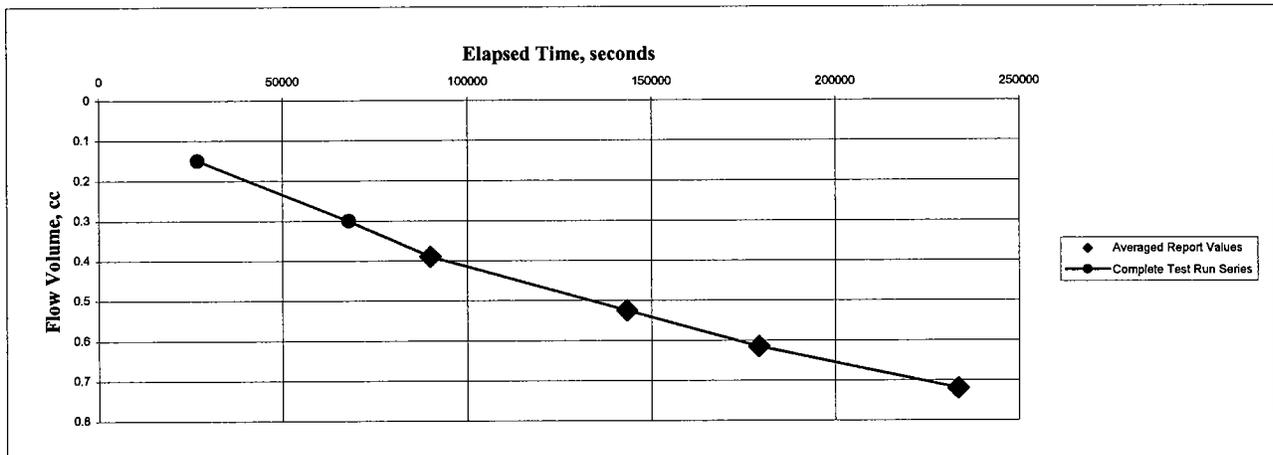
TEST SAMPLE DATA

Before Test

Specimen Height, cm: 7.70
 Specimen Diameter, cm: 7.54
 Dry Unit Weight, pcf: 31.8
 Moisture Content, % 143.8
 Specific Gravity, Assumed
 Percent Saturation:

After Test

Specimen Height, cm: 7.70
 Specimen Diameter, cm: 7.54
 Dry Unit Weight, pcf: 32.3
 Moisture Content, % 144.7



Test Method: ASTM D5084 Method C

PROJECT NUMBER: 07-167 August 10, 2007



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**Arkema Portland Harbor Site
 Portland, Oregon**

HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Impermix/OA, 6/26/07 Sample Depth, ft.: N/A
 Visual Description: N/A Sample Type: Cast Cylinder
 Remarks: 45 Day Test , OGW permeant

TEST RESULTS

Permeability, cm/sec.: 1.78E-08 Average Hydraulic Gradient: 3.3
 Effective Cell Pressure, psi: 10

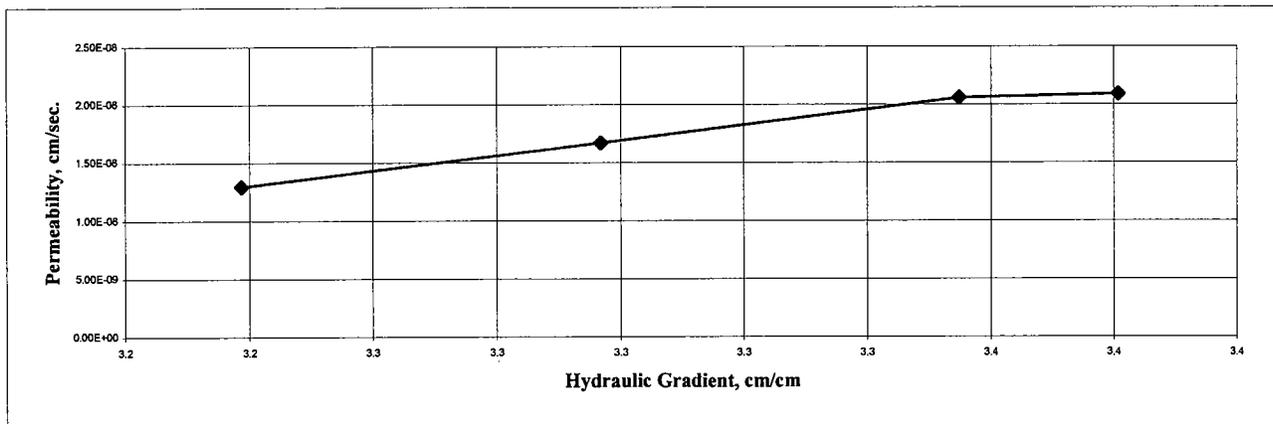
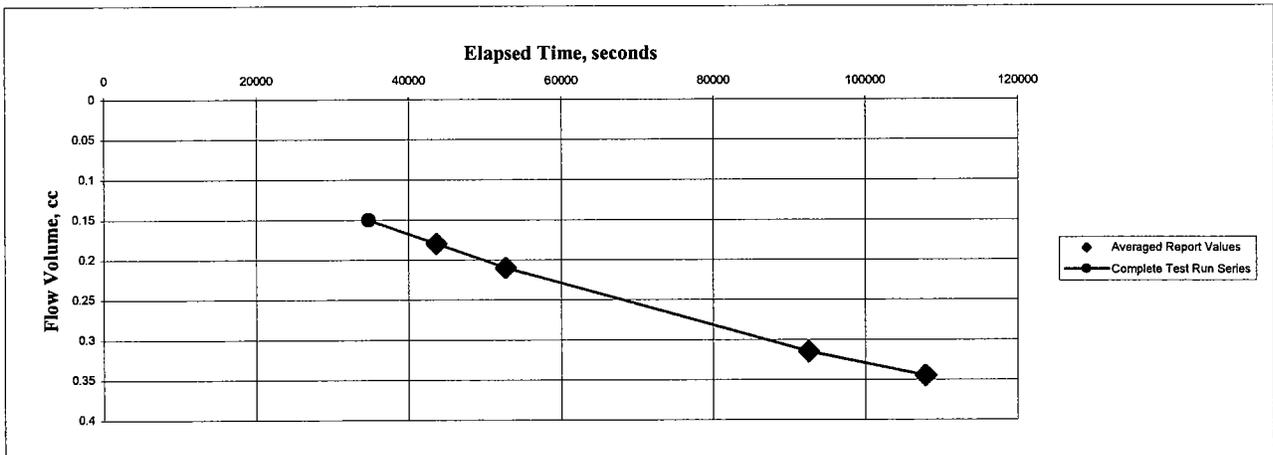
TEST SAMPLE DATA

Before Test

Specimen Height, cm: 7.75
 Specimen Diameter, cm: 7.62
 Dry Unit Weight, pcf: 34.4
 Moisture Content, % 126.3
 Specific Gravity, Assumed
 Percent Saturation:

After Test

Specimen Height, cm: 7.75
 Specimen Diameter, cm: 7.62
 Dry Unit Weight, pcf: 34.4
 Moisture Content, % 127.0



Test Method: ASTM D5084 Method C

PROJECT NUMBER: 07-167 August 10, 2007



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Arkema Portland Harbor Site
 Portland, Oregon

SLURRY MIX DESIGN PARAMETERS

<u>Sample Identification</u>	<u>Mix No.</u>	<u>Slump (in.)</u>	<u>Wet Unit Weight (pcf)</u>
DA-B-PW	#5	7.00	109.2

Test Method: ASTM C 143 and API 13B

PROJECT NUMBER: 07-167 October 24, 2007


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**Arkema Portland Harbor Site
Portland, Oregon**

HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Mix #5-DA w/Bentonite/PW Sample Depth, ft.: N/A
 Visual Description: N/A Sample Type: Slurry Sample
 Remarks: OGW Water permeant

TEST RESULTS

Permeability, cm/sec.: $1.70E-08$ Average Hydraulic Gradient: 8.9
 Effective Cell Pressure, psi: 10

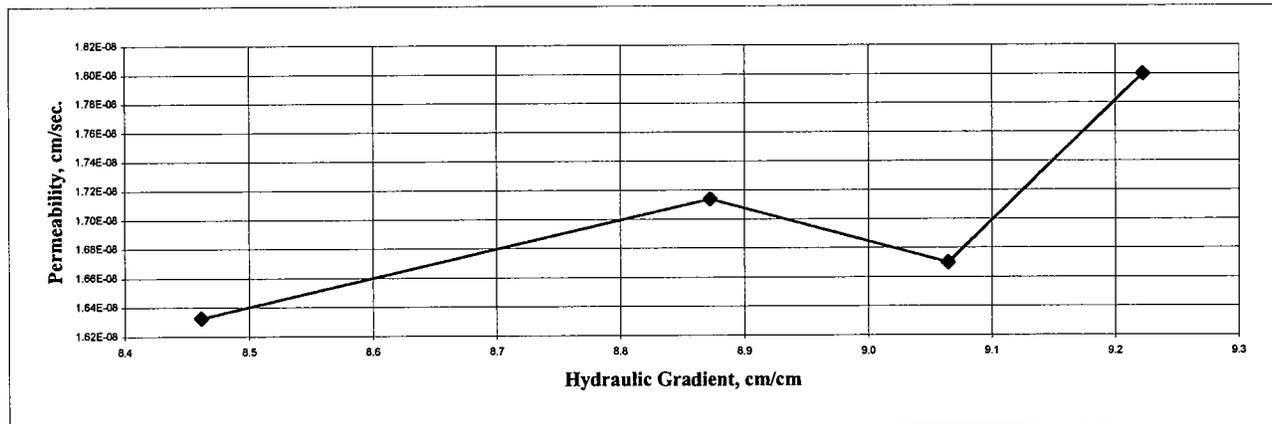
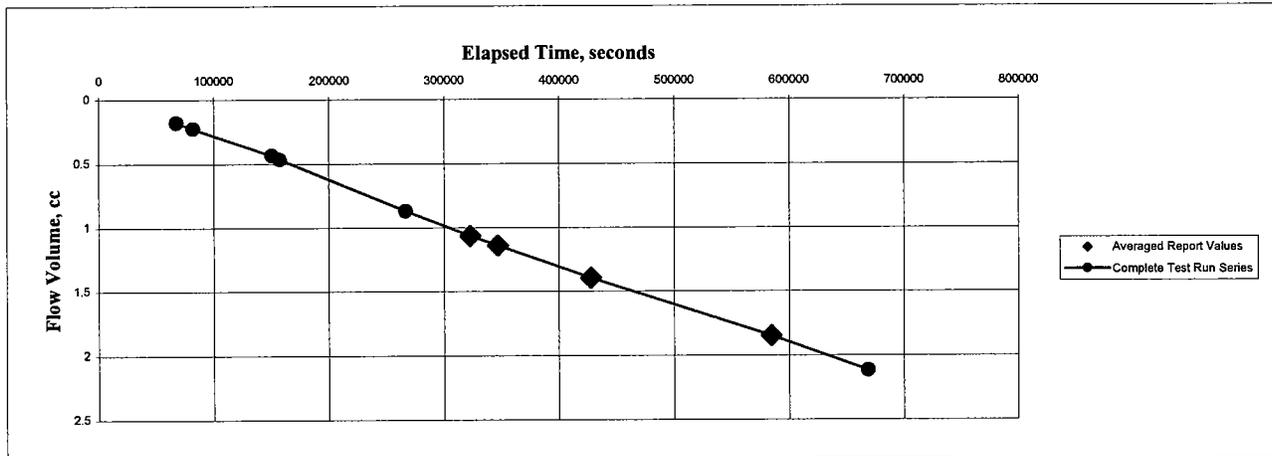
TEST SAMPLE DATA

Before Test

Specimen Height, cm: 6.45
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 76.0
 Moisture Content, % 35.1
 Specific Gravity, Assumed
 Percent Saturation:

After Test

Specimen Height, cm: 5.72
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 87.5
 Moisture Content, % 33.9



Test Method: ASTM D5084 Method C

PROJECT NUMBER: 07-167 January 11, 2007

Arkema Portland Harbor Site
 Portland, Oregon



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SLURRY MIX DESIGN PARAMETERS

<u>Sample Identification</u>	<u>Mix No.</u>	<u>Slump (in.)</u>	<u>Wet Unit Weight (pcf)</u>
OA-A-PW	4	5.70	111.2

Test Method: ASTM C 143 and API 13B

PROJECT NUMBER: 07-167 June 22, 2007



5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762
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Arkema Portland Harbor Site
Portland, Oregon

HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Mix #4-OA w/Attapulgite/PW Sample Depth, ft.: N/A
 Visual Description: N/A Sample Type: Slurry Sample
 Remarks: OGW Water permeant

TEST RESULTS

Permeability, cm/sec.: 3.76E-08 Average Hydraulic Gradient: 2.3
 Effective Cell Pressure, psi: 10

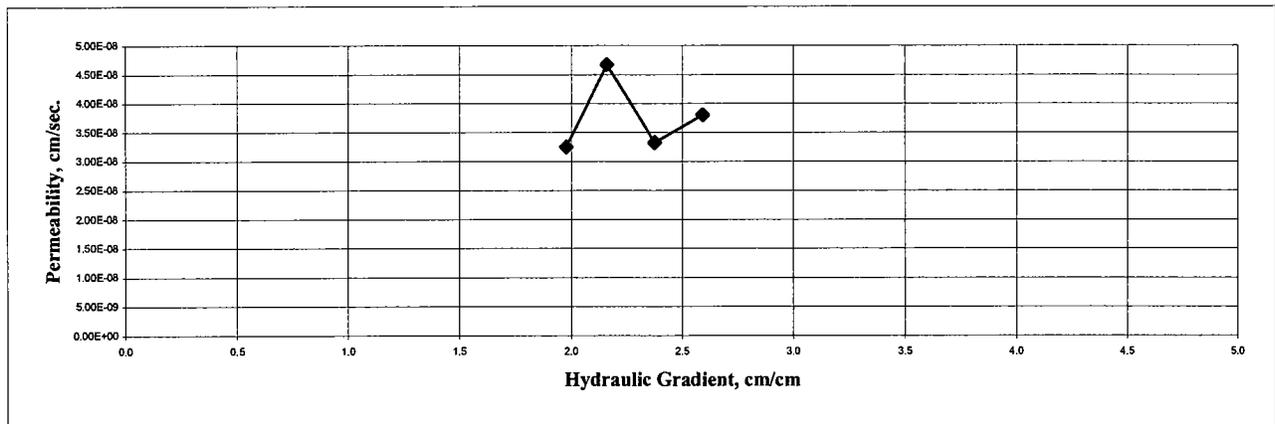
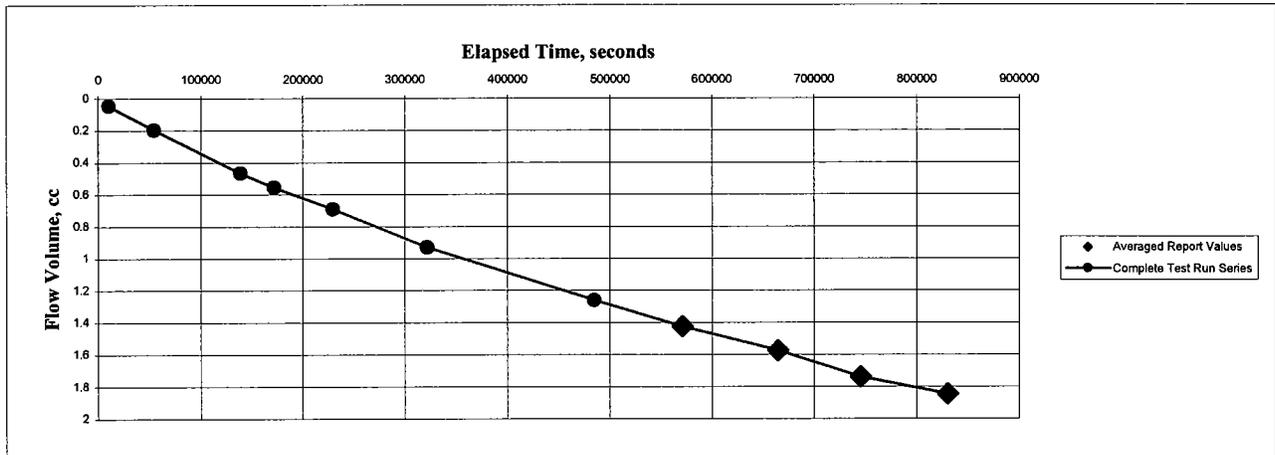
TEST SAMPLE DATA

Before Test

Specimen Height, cm: 5.05
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 101.1
 Moisture Content, % 26.3
 Specific Gravity, Assumed
 Percent Saturation:

After Test

Specimen Height, cm: 4.88
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 112.6
 Moisture Content, % 23.8



Test Method: ASTM D5084 Method C

PROJECT NUMBER: 07-167 October 20, 2007



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Arkema Portland Harbor Site
 Portland, Oregon

HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Mix #2-OA w/Bentonite/PW Sample Depth, ft.: N/A
 Visual Description: N/A Sample Type: Slurry Sample
 Remarks: DI Water permeant

TEST RESULTS

Permeability, cm/sec.: 2.84E-08 Average Hydraulic Gradient: 9.3
 Effective Cell Pressure, psi: 10

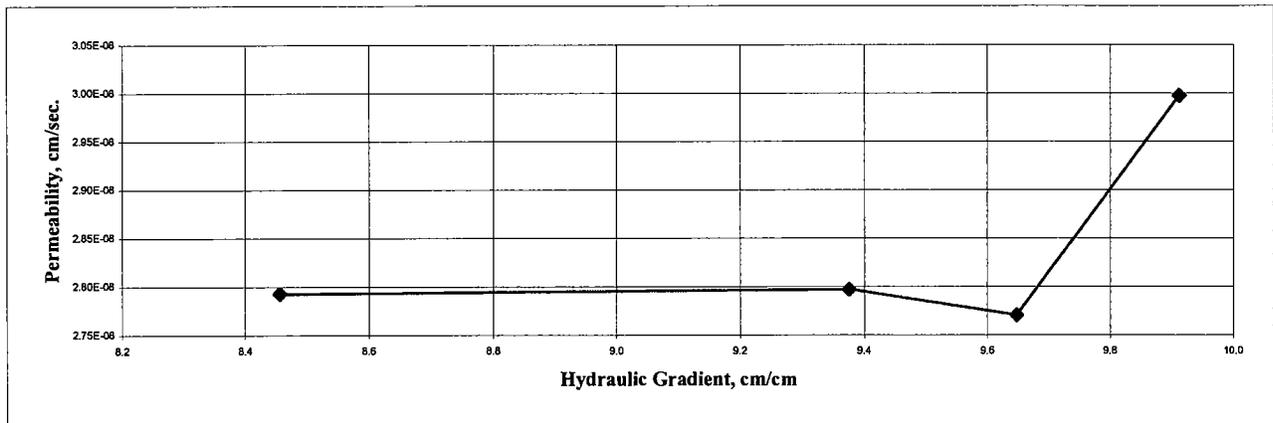
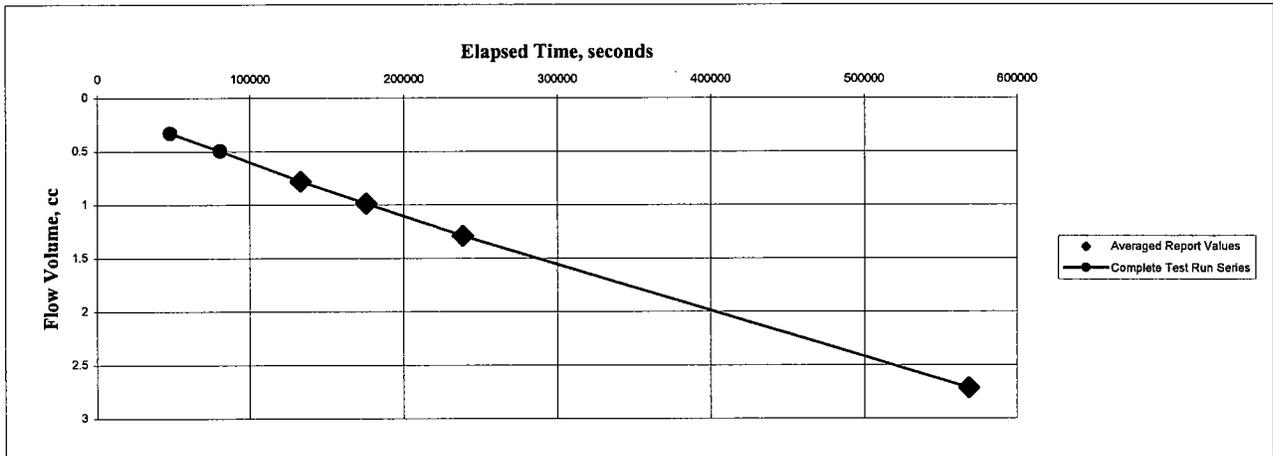
TEST SAMPLE DATA

Before Test

Specimen Height, cm: 6.27
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 102.7
 Moisture Content, % 24.9
 Specific Gravity, Assumed
 Percent Saturation:

After Test

Specimen Height, cm: 6.25
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 103.2
 Moisture Content, % 24.0



Test Method: ASTM D5084 Method C

PROJECT NUMBER: 07-167 October 20, 2008

Arkema Portland Harbor Site
 Portland, Oregon



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SLURRY MIX DESIGN PARAMETERS

<u>Sample Identification</u>	<u>Mix No.</u>	<u>Slump (in.)</u>	<u>Wet Unit Weight (pcf)</u>
OA-A-PW	4	5.70	111.2

Test Method: ASTM C 143 and API 13B

PROJECT NUMBER: 07-167 June 22, 2007



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Arkema Portland Harbor Site
Portland, Oregon

MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

<u>Sample Identification</u>	<u>Depth, ft.</u>	<u>Wet Unit Weight, lb/ft.³</u>	<u>Dry Unit Weight, lb/ft.³</u>	<u>Moisture Content, %</u>
OA-A-PW				39.7

Test Method: ASTM D2216, ASTM D2937

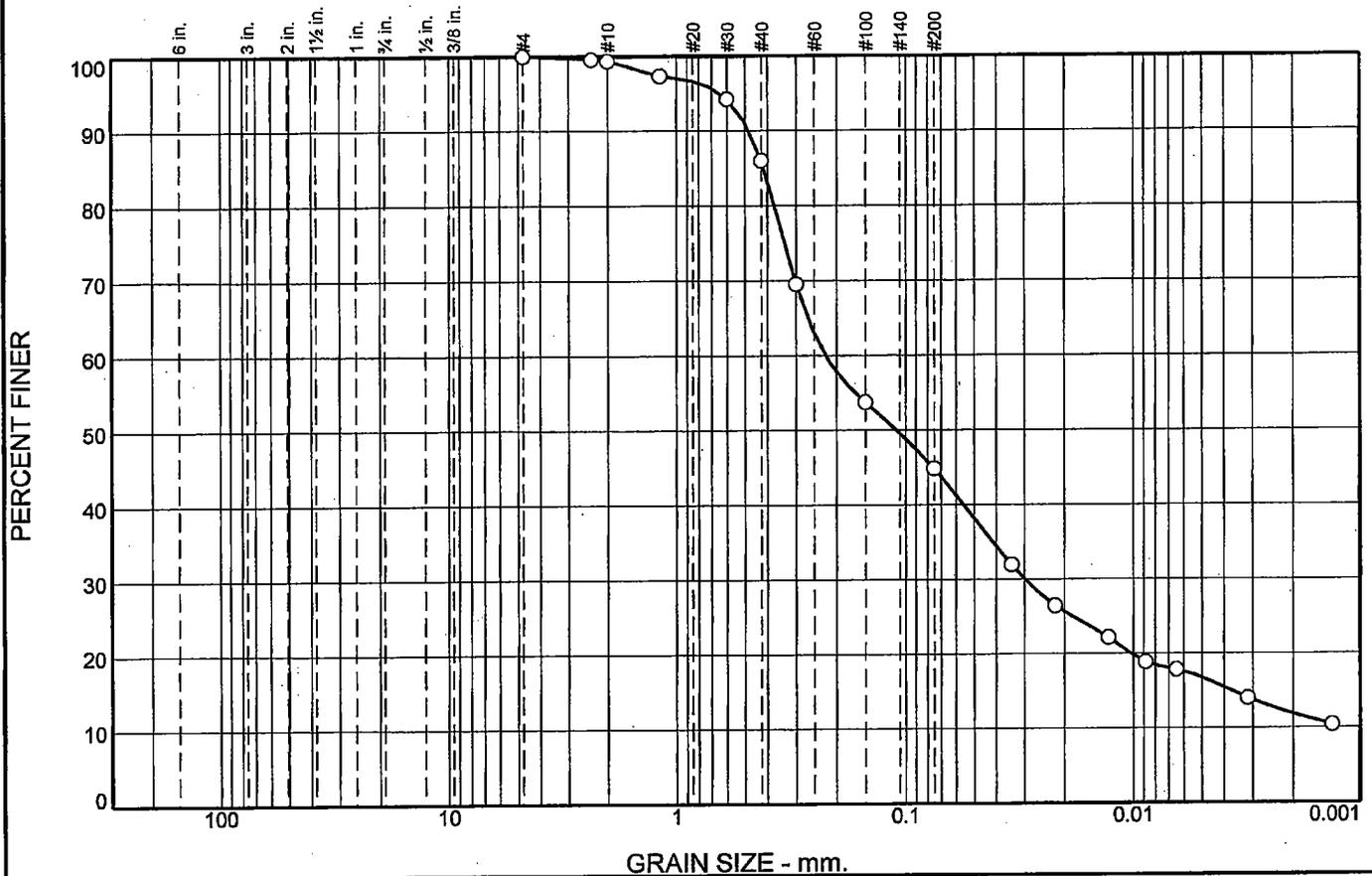
PROJECT NUMBER: 07-167 October 20, 2007


SIERRA TESTING LABORATORIES, INC.
GEOTECHNICAL AND MATERIALS TESTING SERVICES

5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762
Phone: (916) 939-3460 FAX: (916) 939-3507

**Arkema Portland Harbor Site
Portland, Oregon**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.7	13.3	41.1	28.1	16.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.6		
#10	99.3		
#16	97.3		
#30	94.2		
#40	86.0		
#50	69.6		
#100	53.8		
#200	44.9		
0.0341 mm.	32.0		
0.0219 mm.	26.5		
0.0128 mm.	22.2		
0.0088 mm.	18.9		
0.0064 mm.	17.9		
0.0032 mm.	14.0		
0.0013 mm.	10.4		

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D₈₅= 0.4146 D₆₀= 0.2228 D₅₀= 0.1096
D₃₀= 0.0297 D₁₅= 0.0037 D₁₀=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

* (no specification provided)

Sample No.: Mix #4 Source of Sample: Mix #4, Slurry Backfill Date:
Location: OA w/Attapulgite/PW Elev./Depth:

SIERRA TESTING LABS, INC. El Dorado Hills, CA	Client: ERM Project: Arkema Portland Harbor Site Portland, OR Project No: 07-167
--	---

Figure

HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Mix #4-OA w/ Attapulgite/PW Sample Depth, ft.: N/A

Visual Description: N/A

Sample Type: Slurry Sample

Remarks: DI Water permeant

TEST RESULTS

Permeability, cm/sec.: 1.89E-07

Average Hydraulic Gradient: 10.7

Effective Cell Pressure, psi: 10

TEST SAMPLE DATA

Before Test

Specimen Height, cm: 5.31

Specimen Diameter, cm: 5.08

Dry Unit Weight, pcf: 100.7

Moisture Content, % 27.0

Specific Gravity, Assumed

Percent Saturation:

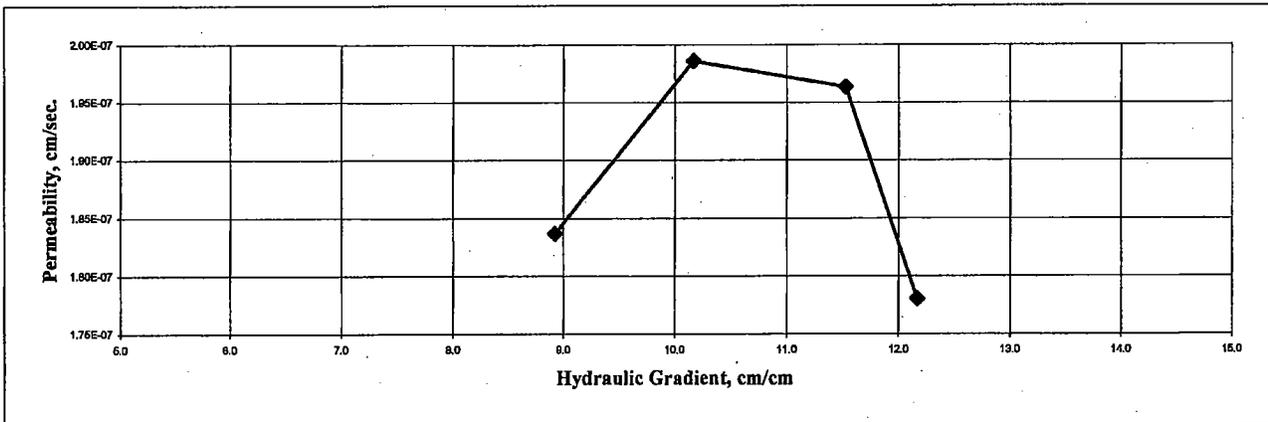
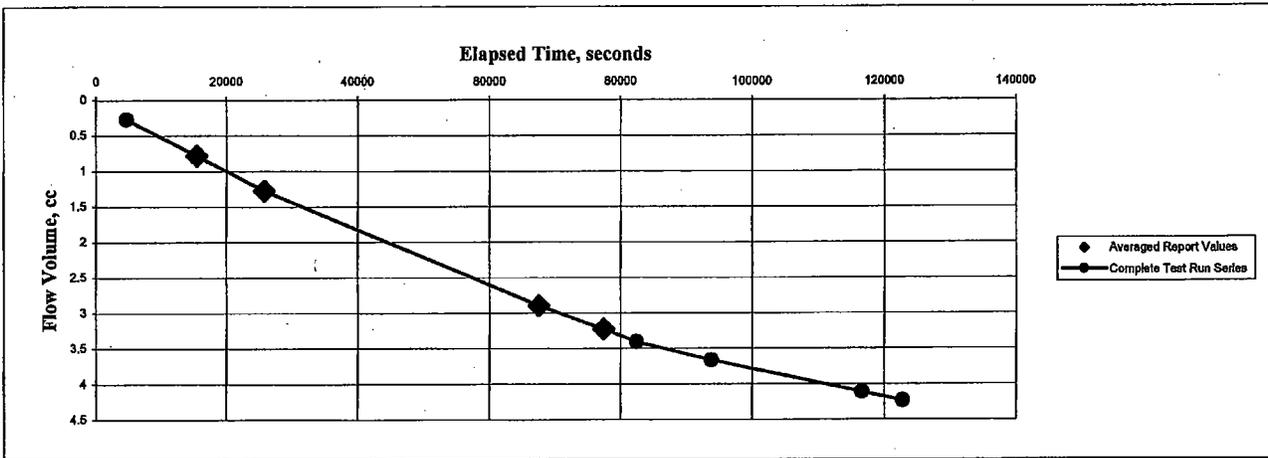
After Test

Specimen Height, cm: 5.21

Specimen Diameter, cm: 5.08

Dry Unit Weight, pcf: 104.7

Moisture Content, % 24.4



Test Method: ASTM D5084 Method C

PROJECT NUMBER: 07-167

October 20, 2007

Arkema Portland Harbor Site
Portland, Oregon



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HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Mix #4-OA w/Attapulgite/PW Sample Depth, ft.: N/A
 Visual Description: N/A Sample Type: Slurry Sample
 Remarks: OGW Water permeant

TEST RESULTS

Permeability, cm/sec.: 3.76E-08 Average Hydraulic Gradient: 2.3
 Effective Cell Pressure, psi: #VALUE!

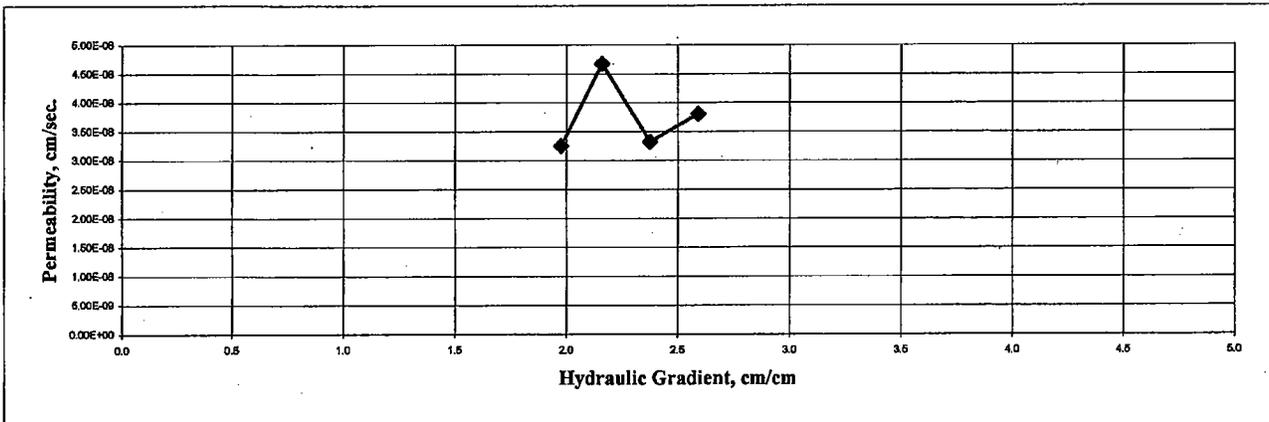
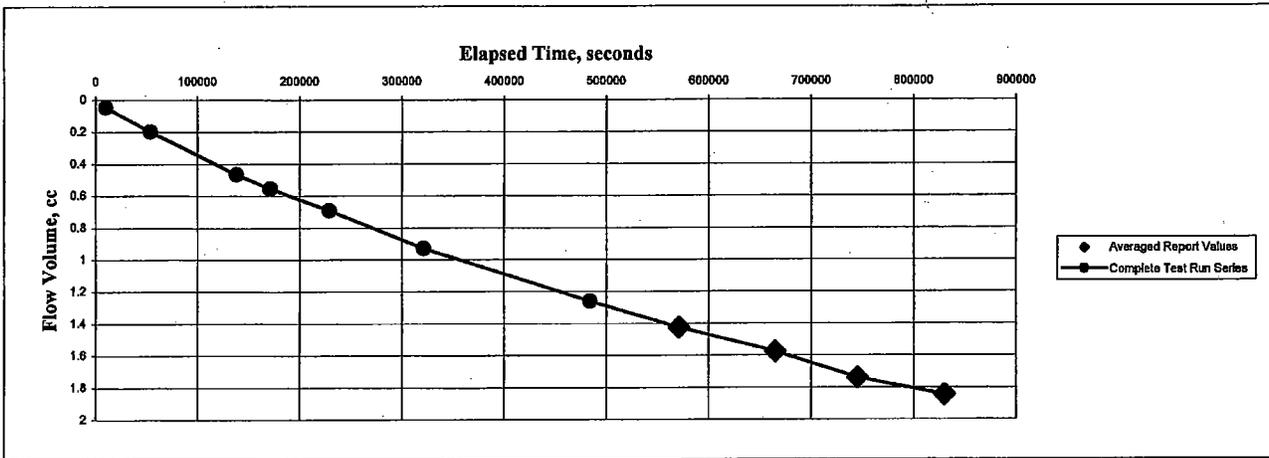
TEST SAMPLE DATA

Before Test

Specimen Height, cm: 5.05
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 101.1
 Moisture Content, % 26.3
 Specific Gravity, Assumed
 Percent Saturation:

After Test

Specimen Height, cm: 4.88
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 112.6
 Moisture Content, % 23.8



Test Method: ASTM D5084 Method C

PROJECT NUMBER: 07-167 October 20, 2007



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Arkema Portland Harbor Site
 Portland, Oregon

SLURRY MIX DESIGN PARAMETERS

<u>Sample Identification</u>	<u>Mix No.</u>	<u>Slump (in.)</u>	<u>Wet Unit Weight (pcf)</u>
CA-B-PW	1	5.50	109.5

Test Method: ASTM C 143 and API 13B

PROJECT NUMBER: 07-167

June 22, 2007


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GEOTECHNICAL AND MATERIALS TESTING SERVICES

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Arkema Portland Harbor Site
Portland, Oregon

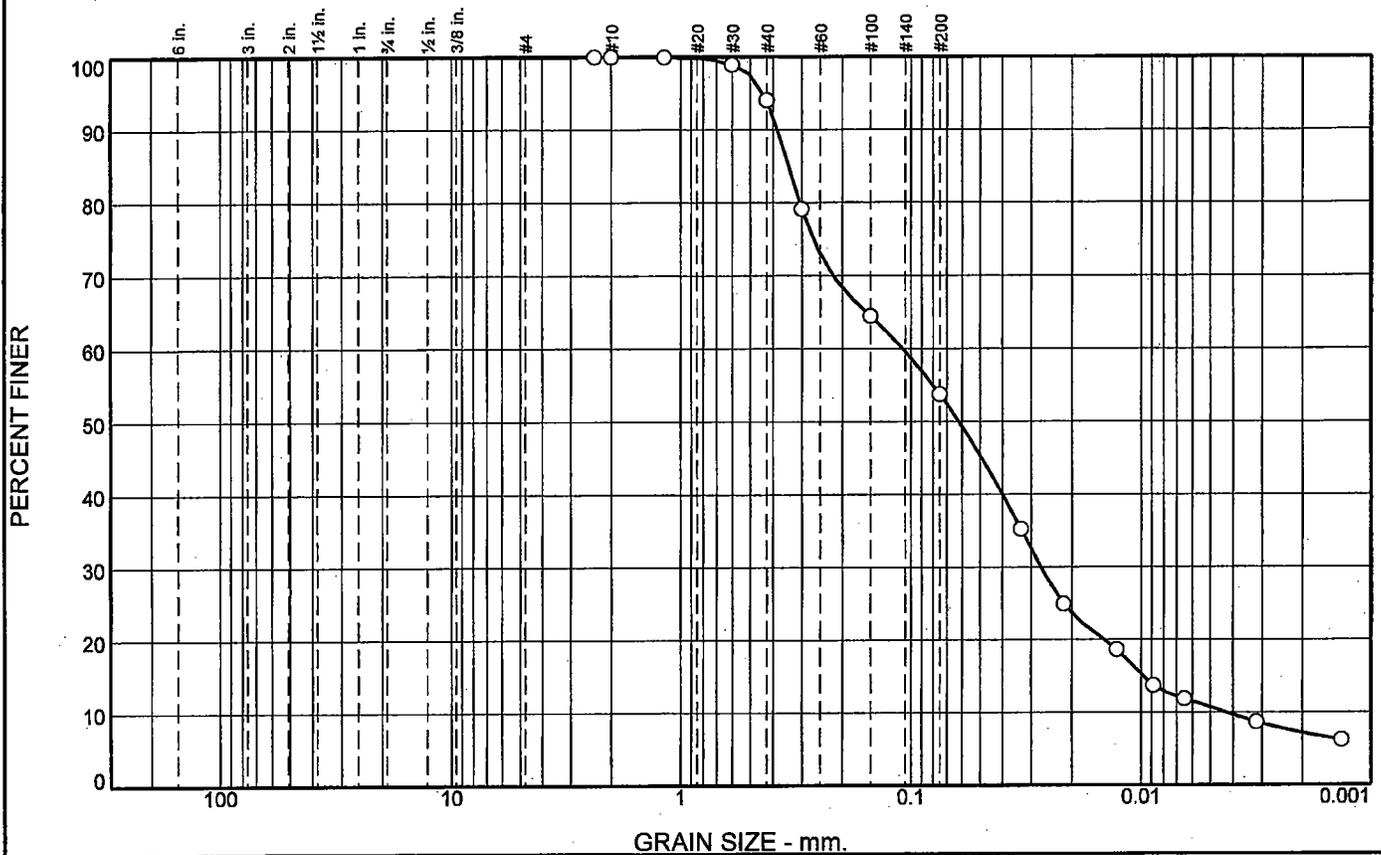
MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

<u>Sample</u> <u>Identification</u>	<u>Depth, ft.</u>	<u>Wet Unit</u> <u>Weight, lb/ft.³</u>	<u>Dry Unit</u> <u>Weight, lb/ft.³</u>	<u>Moisture</u> <u>Content, %</u>
CA-B-PW				43.7

Test Method: ASTM D2216, ASTM D2937

PROJECT NUMBER: 07-167	October 18, 2007	Arkema Portland Harbor Site Portland, Oregon
 <p style="font-size: small;">SIERRA TESTING LABORATORIES, INC. GEOTECHNICAL AND MATERIALS TESTING SERVICES</p> <p>5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762 Phone: (916) 939-3460 FAX: (916) 939-3507</p>		

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	5.9	40.3	43.1	10.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#8	100.0		
#10	100.0		
#16	100.0		
#30	99.0		
#40	94.1		
#50	79.1		
#100	64.5		
#200	53.8		
0.0332 mm.	35.3		
0.0217 mm.	25.0		
0.0128 mm.	18.7		
0.0088 mm.	13.7		
0.0065 mm.	11.9		
0.0032 mm.	8.7		
0.0013 mm.	6.2		

Soil Description

Slurry Backfill Sample

Atterberg Limits

PL= LL= PI=

Coefficients

D₈₅= 0.3420 D₆₀= 0.1084 D₅₀= 0.0618
D₃₀= 0.0271 D₁₅= 0.0098 D₁₀= 0.0043
C_u= 25.25 C_c= 1.58

Classification

USCS= AASHTO=

Remarks

Specific gravity assumed to be 2.70.

* (no specification provided)

Sample No.: Mix #1 Source of Sample: Mix #1, Slurry Backfill Date: 10/19/07
Location: CA w/Bentonite/PW Elev./Depth:

SIERRA TESTING LABS, INC. El Dorado Hills, CA	Client: ERM Project: Arkema Portland Harbor Site Portland, OR Project No: 07-167 Figure
--	--

Tested By: MPW Checked By: CW

HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Mix #1-CA w/Bentonite/PW Sample Depth, ft.: N/A
 Visual Description: N/A Sample Type: Slurry Sample
 Remarks: DI Water permeant

TEST RESULTS

Permeability, cm/sec.: $1.25E-07$ Average Hydraulic Gradient: 6.1
 Effective Cell Pressure, psi: 10

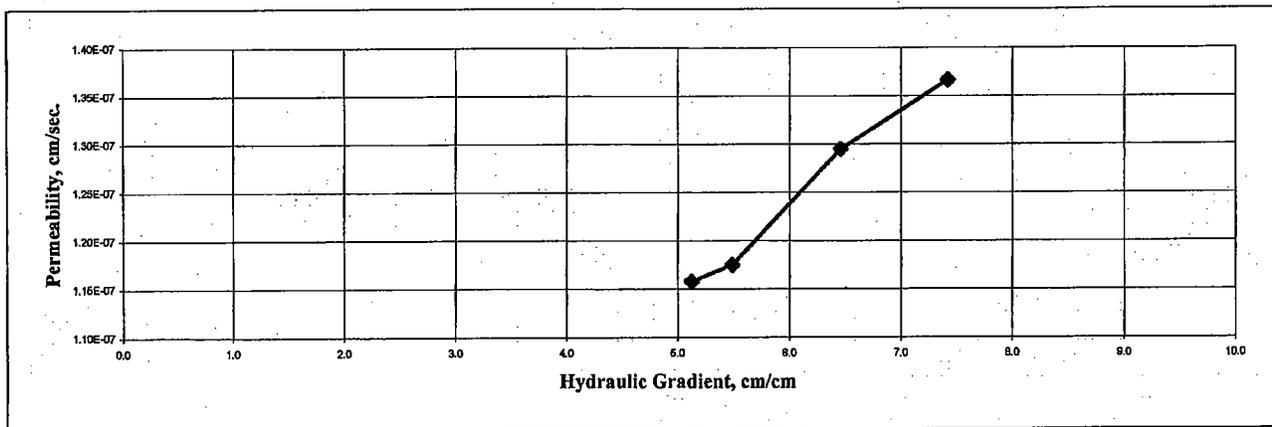
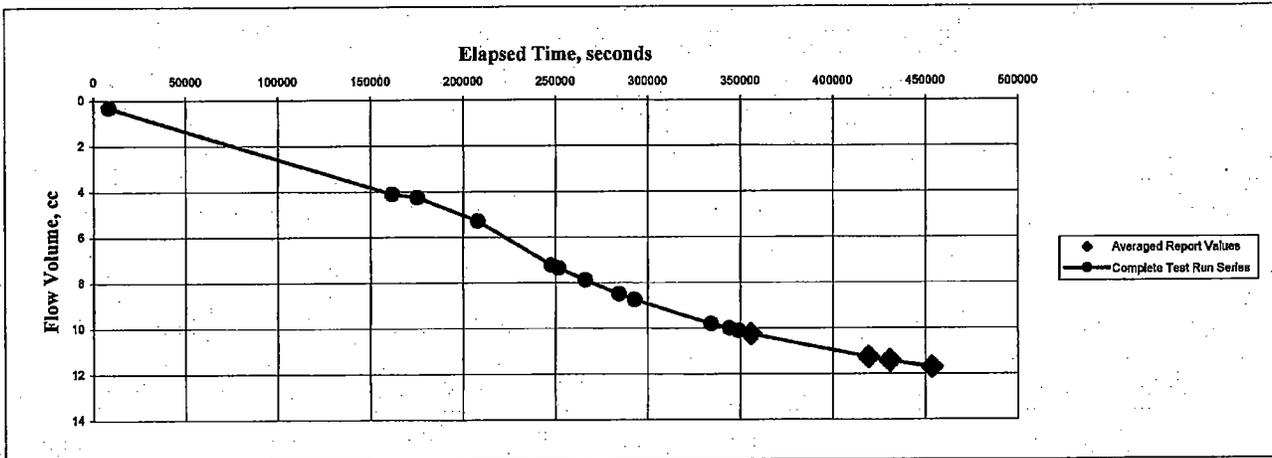
TEST SAMPLE DATA

Before Test

Specimen Height, cm: 4.19
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 93.9
 Moisture Content, % 31.1
 Specific Gravity, Assumed
 Percent Saturation:

After Test

Specimen Height, cm: 4.01
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 102.1
 Moisture Content, % 27.3



Test Method: ASTM D5084 Method C

PROJECT NUMBER: 07-167 October 19, 2007

Arkema Portland Harbor Site
 Portland, Oregon



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HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Mix #1-CA w/Bentonite/PW Sample Depth, ft.: N/A
 Visual Description: N/A Sample Type: Slurry Sample
 Remarks: CGW permeant

TEST RESULTS

Permeability, cm/sec.: 3.93E-08 Average Hydraulic Gradient: 2.3
 Effective Cell Pressure, psi: 10

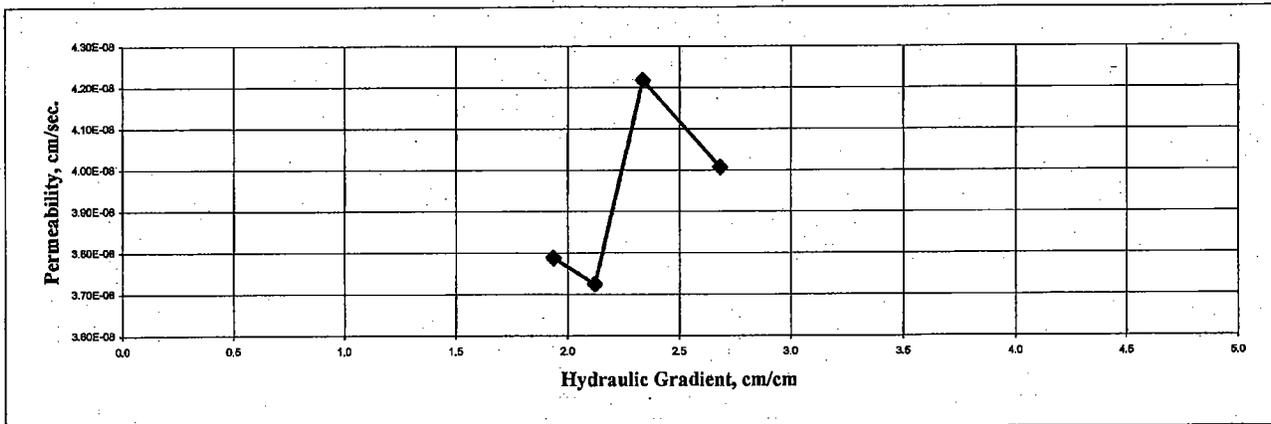
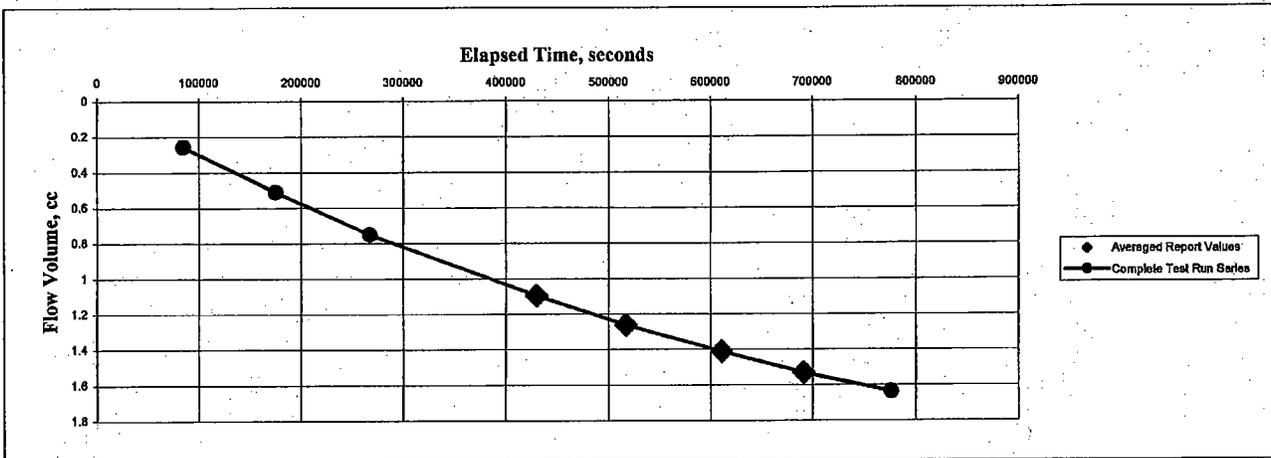
TEST SAMPLE DATA

Before Test

Specimen Height, cm: 4.95
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 98.3
 Moisture Content, % 29.6
 Specific Gravity, Assumed
 Percent Saturation:

After Test

Specimen Height, cm: 4.90
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 103.4
 Moisture Content, % 27.0



Test Method: ASTM D5084 Method C

PROJECT NUMBER: 07-167 October 20, 2007



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Arkema Portland Harbor Site
 Portland, Oregon

SLURRY MIX DESIGN PARAMETERS

<u>Sample Identification</u>	<u>Mix No.</u>	<u>Slump (in.)</u>	<u>Wet Unit Weight (pcf)</u>
CA-A-PW	3	5.90	109.1

Test Method: ASTM C 143 and API 13B

PROJECT NUMBER: 07-167 June 22, 2007



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Arkema Portland Harbor Site
Portland, Oregon

MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

<u>Sample</u> <u>Identification</u>	<u>Depth, ft.</u>	<u>Wet Unit</u> <u>Weight, lb/ft.³</u>	<u>Dry Unit</u> <u>Weight, lb/ft.³</u>	<u>Moisture</u> <u>Content, %</u>
CA-A-PW				47.8

Test Method: ASTM D2216, ASTM D2937

PROJECT NUMBER: 07-167	October 20, 2007
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Portland, Oregon**



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HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Mix #3-CA w/Attapulgite/PW Sample Depth, ft.: N/A
 Visual Description: N/A Sample Type: Slurry Sample
 Remarks: DI Water permeant

TEST RESULTS

Permeability, cm/sec.: 2.34E-07 Average Hydraulic Gradient: 6.4
 Effective Cell Pressure, psi: 10

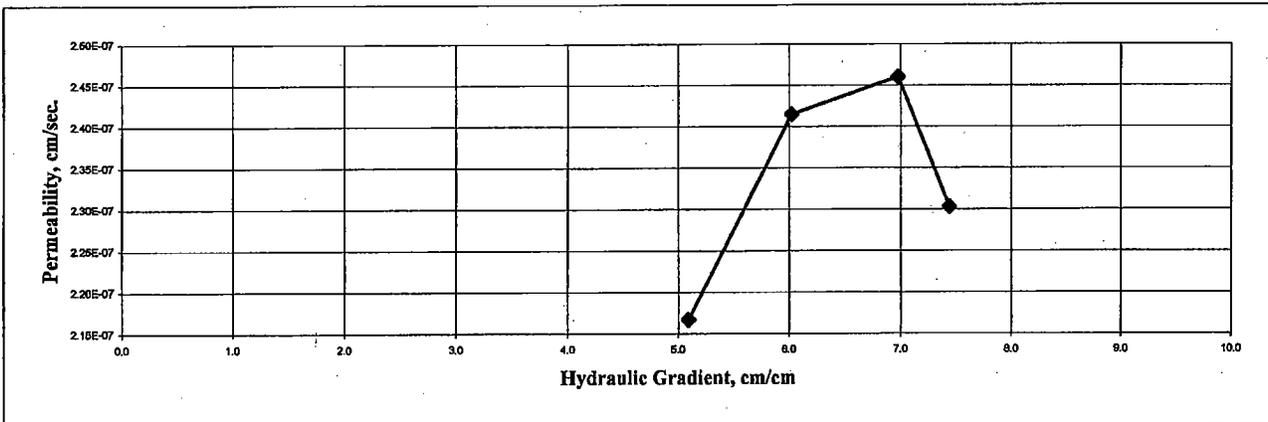
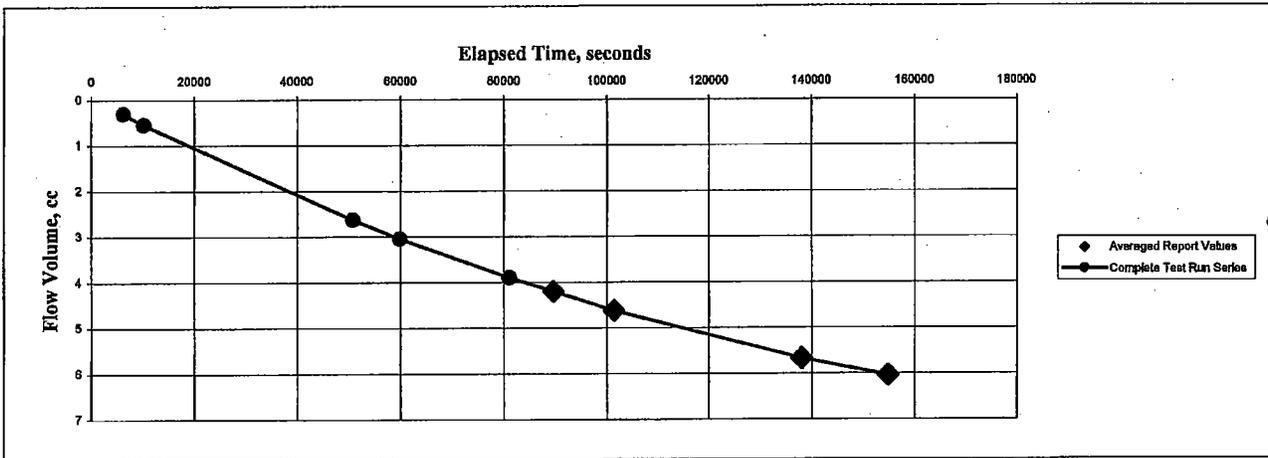
TEST SAMPLE DATA

Before Test

Specimen Height, cm: 5.13
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 96.5
 Moisture Content, % 31.9
 Specific Gravity, Assumed
 Percent Saturation:

After Test

Specimen Height, cm: 5.13
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 96.5
 Moisture Content, % 28.4



Test Method: ASTM D5084 Method C

PROJECT NUMBER: 07-167 October 20, 2007



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Arkema Portland Harbor Site
 Portland, Oregon

HYDRAULIC CONDUCTIVITY TEST REPORT

SAMPLE DATA

Sample Identification: Mix #3-CA w/Attapulgite/PW Sample Depth, ft.: N/A
 Visual Description: N/A Sample Type: Slurry Sample
 Remarks: CGW Water permeant

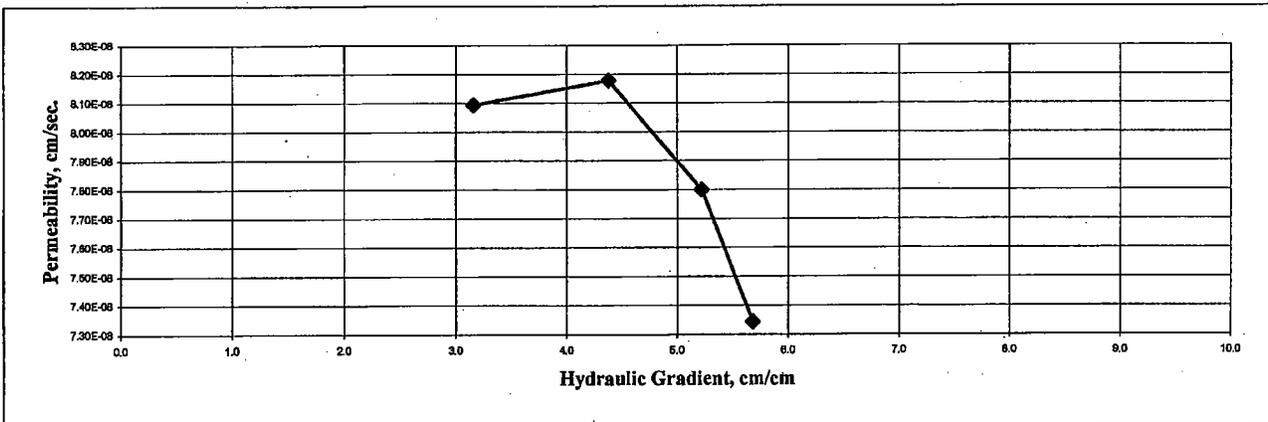
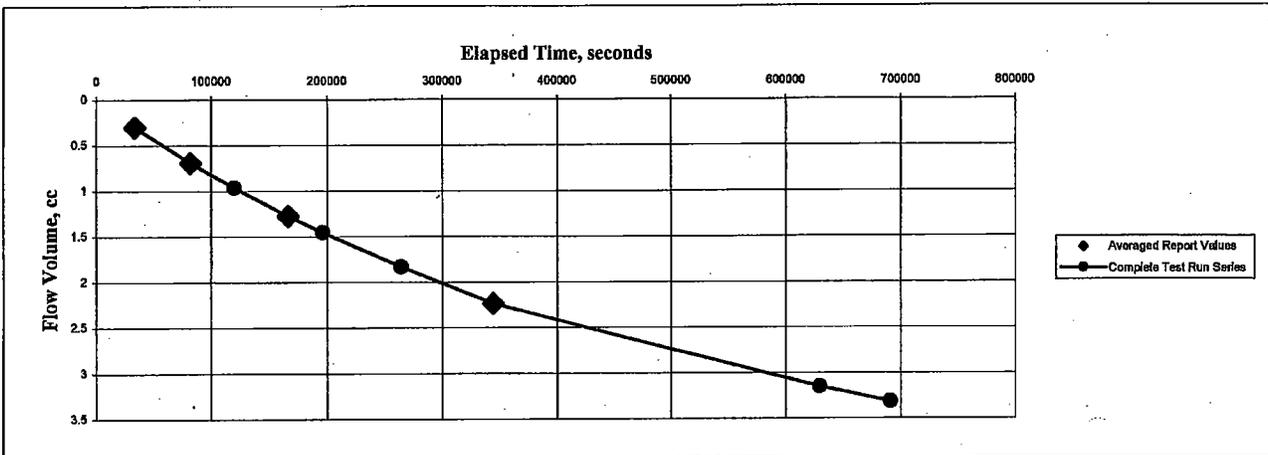
TEST RESULTS

Permeability, cm/sec.: 7.85E-08 Average Hydraulic Gradient: 4.6
 Effective Cell Pressure, psi: 20

TEST SAMPLE DATA

Before Test
 Specimen Height, cm: 5.00
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 96.2
 Moisture Content, % 30.4
 Specific Gravity, Assumed
 Percent Saturation:

After Test
 Specimen Height, cm: 4.98
 Specimen Diameter, cm: 5.08
 Dry Unit Weight, pcf: 98.7
 Moisture Content, % 28.2



Test Method: ASTM D5084 Method C

PROJECT NUMBER: 07-167 October 20, 2007

Arkema Portland Harbor Site
 Portland, Oregon

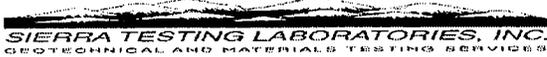


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MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

<u>Sample Identification</u>	<u>Depth, ft.</u>	<u>Wet Unit Weight, lb/ft.³</u>	<u>Dry Unit Weight, lb/ft.³</u>	<u>Moisture Content, %</u>
OA-B/PW				31.7

Test Method: ASTM D2216, ASTM D2937

PROJECT NUMBER: 07-167	October 20, 2007	
 <small>SIERRA TESTING LABORATORIES, INC. GEOTECHNICAL AND MATERIALS TESTING SERVICES</small>		Arkema Portland Harbor Site Portland, Oregon
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MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

<u>Sample Identification</u>	<u>Depth, ft.</u>	<u>Wet Unit Weight, lb/ft.³</u>	<u>Dry Unit Weight, lb/ft.³</u>	<u>Moisture Content, %</u>
DA-B-PW				43.4

Test Method: ASTM D2216, ASTM D2937

PROJECT NUMBER: 07-167	November 24, 2007	Arkema Portland Harbor Site Portland, Oregon
 <small>SIERRA TESTING LABORATORIES, INC. GEOTECHNICAL AND MATERIALS TESTING SERVICES</small>		
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SPECIFIC GRAVITY, pH & CONDUCTIVITY

<u>Sample Location</u>	<u>Sample I.D.</u>	<u>Specific Gravity</u>	<u>pH</u>	<u>Conductivity, (uS)</u>
Site Potable Water	PW	1.003	7.02	40.0
Site Groundwater	CGW	1.048	7.37	Beyond Scale
Site Groundwater	CGW	-	-	19450.0
Site Groundwater	OGW	1.017	3.75	11780.0

Notes

1 part CGW mixed with 5 parts distilled water in order for instrument to obtain a reading
 Conductivity - Range 10-19990 uS, Resolution 10 uS, Accuracy +/- 0.5%
 pH - Range 0.00 to 14.00, Resolution 0.01pH, Accuracy +/- 0.02pH

Test Method: Multi Meter (Extech 341450)

PROJECT NUMBER: 07-167 June 12, 2007



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 Phone: (916) 939-3460 FAX: (916) 939-3507

**Arkema Portland Harbor Site
 Portland, Oregon**

SWELL INDEX OF CLAY COMPONENTS OF GEOSYNTHETIC CLAY LINERS

Swell Index, mL /2 g
6.0

Test Method: ASTM D5890-06

SAMPLE IDENTIFICATION: Atapulgitic Clay
SAMPLE DESCRIPTION: - #100 Atapulgitic Clay

LABORATORY NO. :

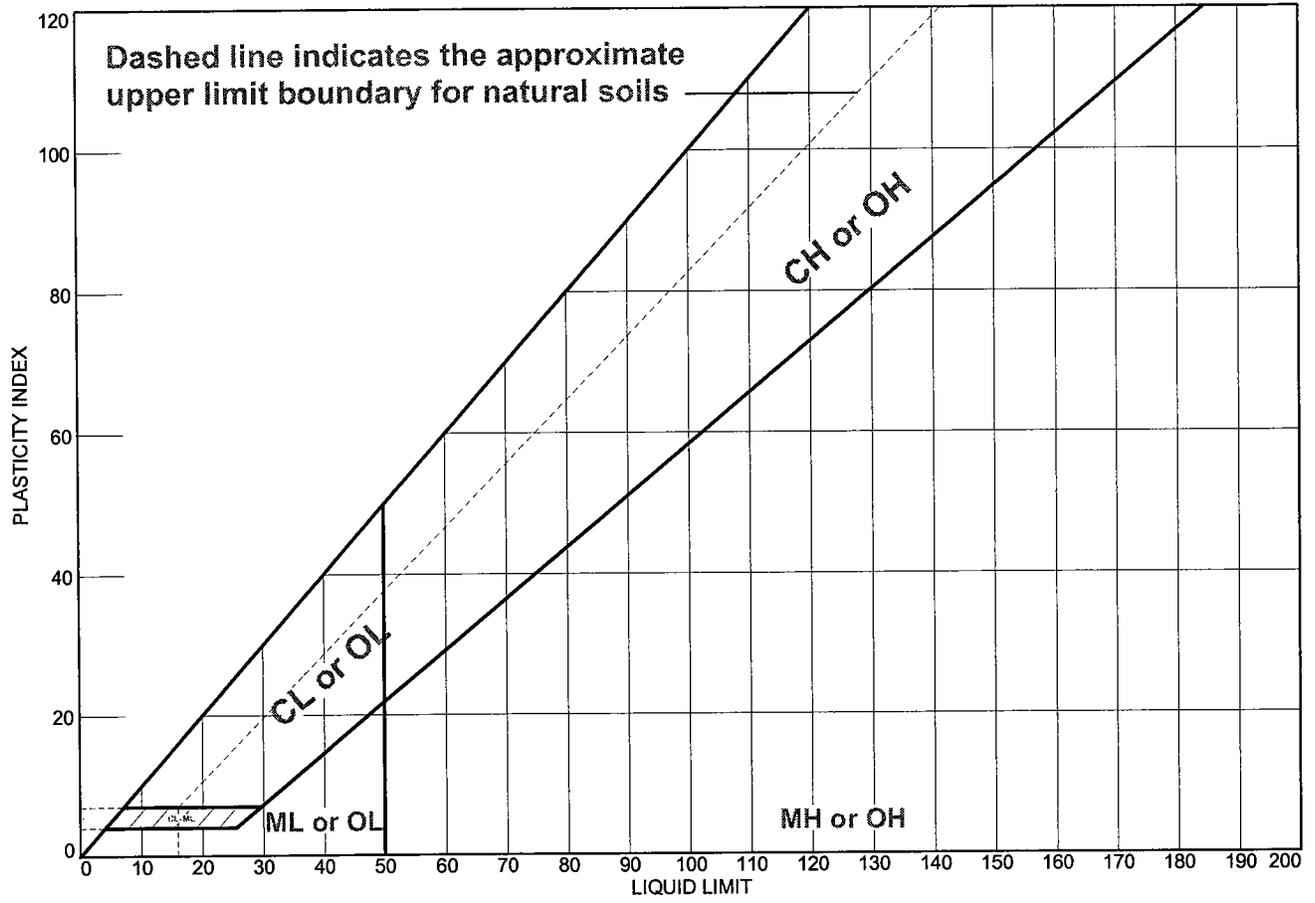
PROJECT NUMBER: 07-167 June 12, 2007



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Arkema Portland Harbor Site
Portland Oregon

LIQUID AND PLASTIC LIMITS TEST REPORT



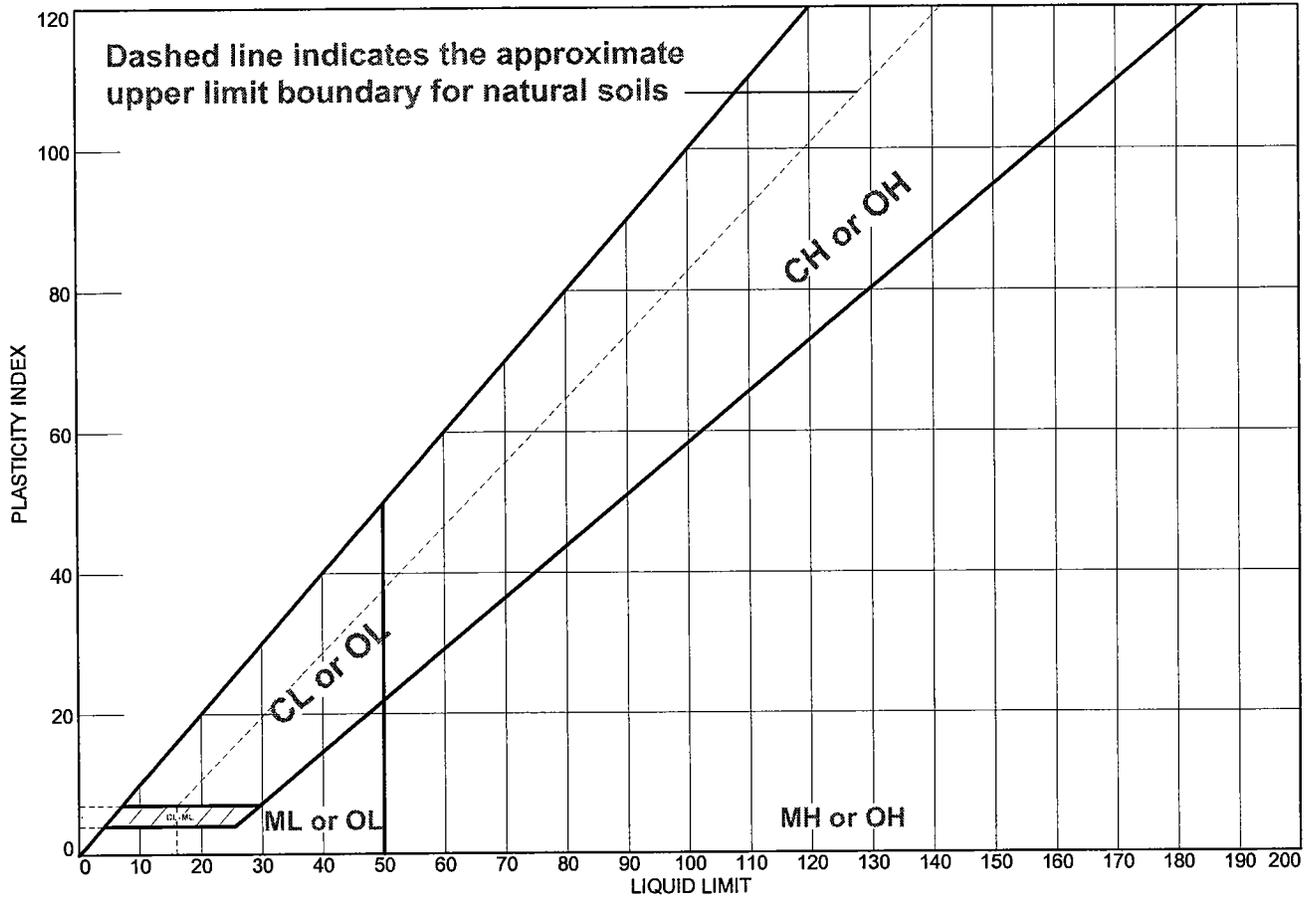
MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
● Bentonite w/OGW	283	39	244			

<p>Project No. 07-167 Client: ERM</p> <p>Project: Arkema Portland Harbor Site Portland, OR</p> <p>● Location: Bentonite w/OGW Sample Number: 6/12/07</p>	<p>Remarks: ● Section 14</p>
<p>SIERRA TESTING LABS, INC.</p> <p>El Dorado Hills, CA</p>	

Figure

Tested By: MG **Checked By:** CMW

LIQUID AND PLASTIC LIMITS TEST REPORT



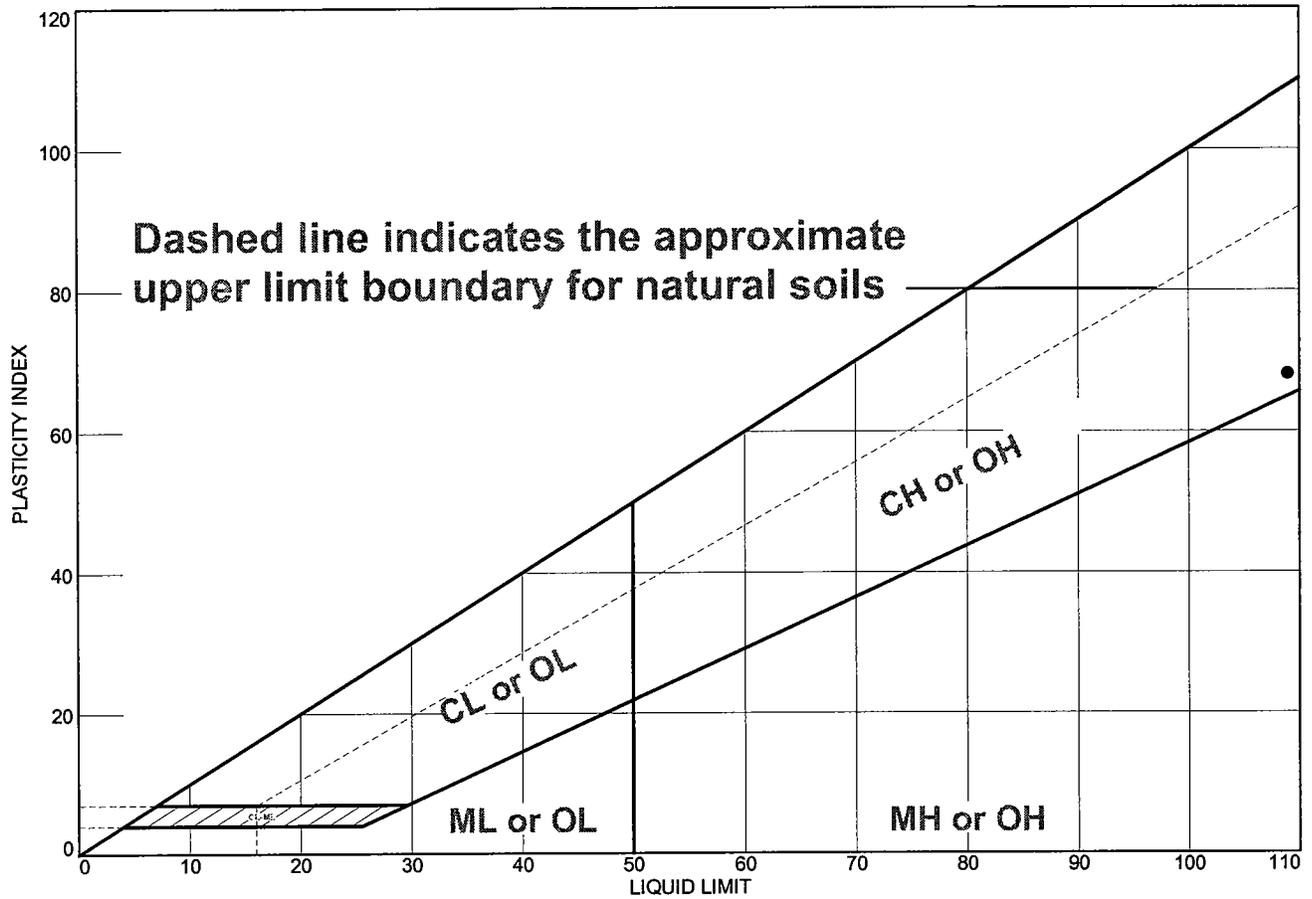
MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
● Attapulgite w/DI Water	243	94	149			

<p>Project No. 07-167 Client: ERM</p> <p>Project: Arkema Portland Harbor Site Portland, OR</p> <p>● Location: Attapulgite w/DI Water Sample Number: 6/12/07</p>	<p>Remarks:</p> <p>● Section 14</p>
<p>SIERRA TESTING LABS, INC.</p> <p>El Dorado Hills, CA</p>	

Figure

Tested By: MG **Checked By:** CMW

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Bentonite w/CGW	109	41	68			

Project No. 07-167 **Client:** ERM
Project: Arkema Portland Harbor Site
 Portland, OR
● Location: Bentonite w/CGW **Sample Number:** 6/12/07

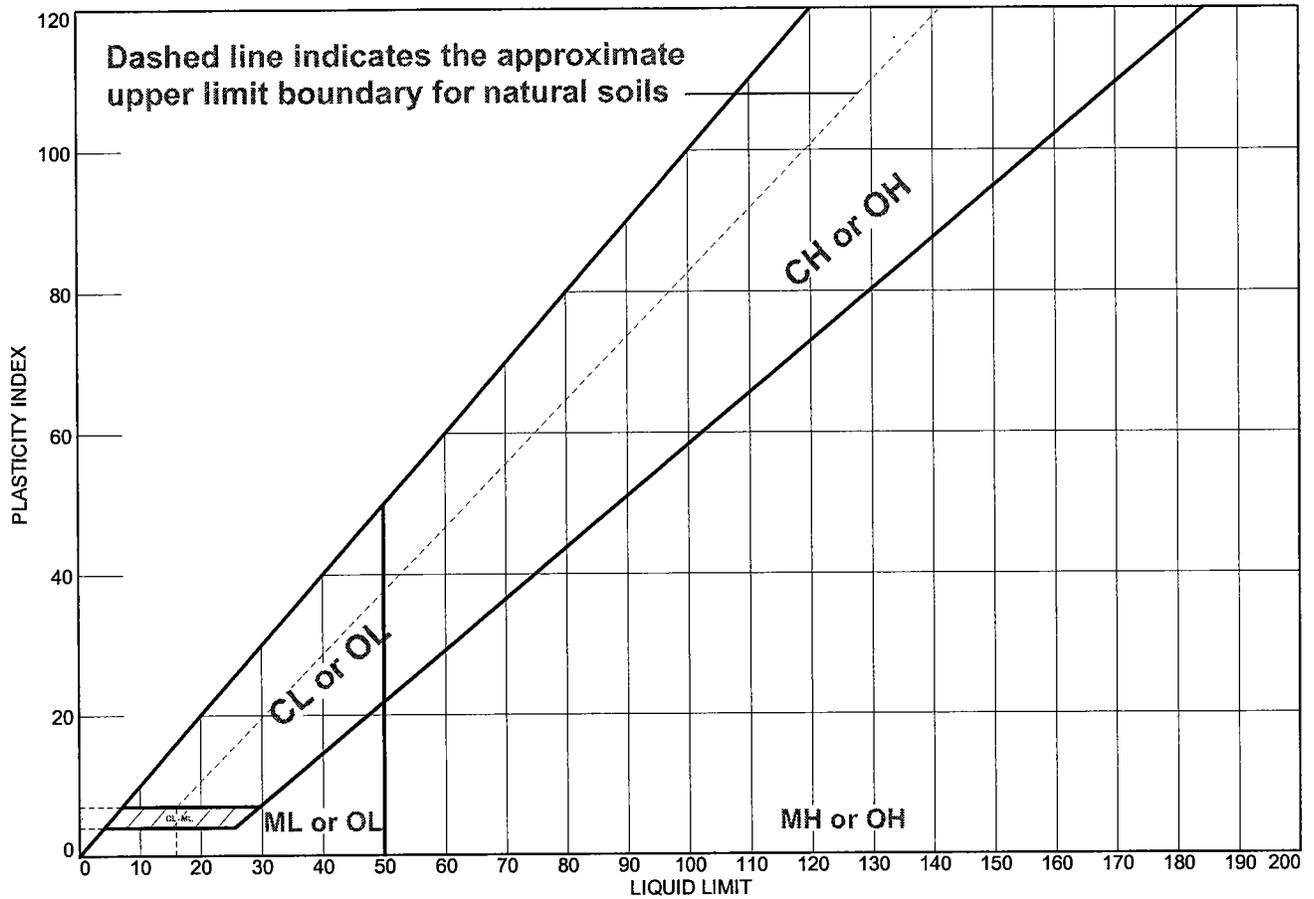
SIERRA TESTING LABS, INC.
 El Dorado Hills, CA

Remarks:
 ● Section 14

Figure

Tested By: MG **Checked By:** CMW

LIQUID AND PLASTIC LIMITS TEST REPORT



MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
● Attapulgite w/OGW	242	87	155			

Project No. 07-167 **Client:** ERM
Project: Arkema Portland Harbor Site
 Portland, OR
 ● **Location:** Attapulgite w/OGW **Sample Number:** 6/12/07

SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Remarks:

● Section 14

Figure

Tested By: AM Checked By: CMW

MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

<u>Sample Identification</u>	<u>Depth, ft.</u>	<u>Wet Unit Weight, lb/ft.³</u>	<u>Dry Unit Weight, lb/ft.³</u>	<u>Moisture Content, %</u>
Bentonite				12.4
Attapulgite				6.2
Clay Cement				N/A

Test Method: ASTM D2216, ASTM D2937

PROJECT NUMBER: 07-167	June 12, 2007	Arkema Portland Harbor Site
 <p style="font-size: small;">SIERRA TESTING LABORATORIES, INC. GEOTECHNICAL AND MATERIALS TESTING SERVICES</p>		
5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762 Phone: (916) 939-3460 FAX: (916) 939-3507		

MOISTURE CONTENT & pH VALUES

<u>Sample Identification</u>	<u>Depth, ft.</u>	<u>Moisture Content, %</u>	<u>pH, Using Distilled Water</u>	<u>pH, Using Calcium Chloride</u>
OA Soil, ST2, B120	28-34	31.8	4.95	3.00
OA Soil, S-IB2, B120	34-35	56.8	5.47	3.24
OA Soil, IT2, B120	41-44	31.3	9.97	7.03
OA Soil, DB2, B121	67-72	28.1	6.80	6.05

Notes

pH - Range 0.00 to 14.00, Resolution 0.01pH, Accuracy +/- 0.02pH

Test Method: ASTM D2216, pH Meter (Extech 341450-P)

PROJECT NUMBER: 07-167 June 12, 2007



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Phone: (916) 939-3460 FAX: (916) 939-3507

**Arkema Portland Harbor Site
Portland, Oregon**

MOISTURE CONTENT & pH VALUES

<u>Sample Identification</u>	<u>Depth, ft.</u>	<u>Moisture Content, %</u>	<u>pH, Using Distilled Water</u>	<u>pH, Using Calcium Chloride</u>
OA Soil, ST2, B120	28-34	31.8	4.95	3.00
OA Soil, S-IB2, B120	34-35	56.8	5.47	3.24
OA Soil, IT2, B120	41-44	31.3	9.97	7.03
OA Soil, DB2, B121	67-72	28.1	6.80	6.05

Test Method: ASTM D2216, pH Meter (Extech 341450-P)

PROJECT NUMBER: 07-167 June 12, 2007



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**Arkema Portland Harbor Site
Portland, Oregon**

MOISTURE CONTENT & UNIT WEIGHT TEST RESULTS

Sample <u>Identification</u>	<u>Depth, ft.</u>	Wet Unit <u>Weight, lb/ft.³</u>	Dry Unit <u>Weight, lb/ft.³</u>	Moisture <u>Content, %</u>
OA Soil, ST2, B120	28-34	114.7	87.0	31.8
OA Soil, S-IB2, B120	34-35	104.1	66.2	57.4
OA Soil, IT2, B120	41-44	112.1	83.9	33.7
OA Soil, DB2, B121	67-72	123.1	94.0	31.0

Test Method: ASTM D2216, ASTM D2937

PROJECT NUMBER: 07-167	June 12, 2007	Arkema Portland Harbor Site Portland, Oregon	
 <p style="font-size: small;">SIERRA TESTING LABORATORIES, INC. GEOTECHNICAL AND MATERIALS TESTING SERVICES</p> <p>5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762 Phone: (916) 939-3460 FAX: (916) 939-3507</p>			

MOISTURE CONTENT TEST RESULTS

Sample <u>Identification</u>	<u>Depth, ft.</u>	Wet Unit <u>Weight, lb/ft.³</u>	Dry Unit <u>Weight, lb/ft.³</u>	Moisture <u>Content, %</u>
OA Soil, Full Depth	Composite			9.0
CA Soil, Full Depth	Composite			8.9

Test Method: ASTM D2216

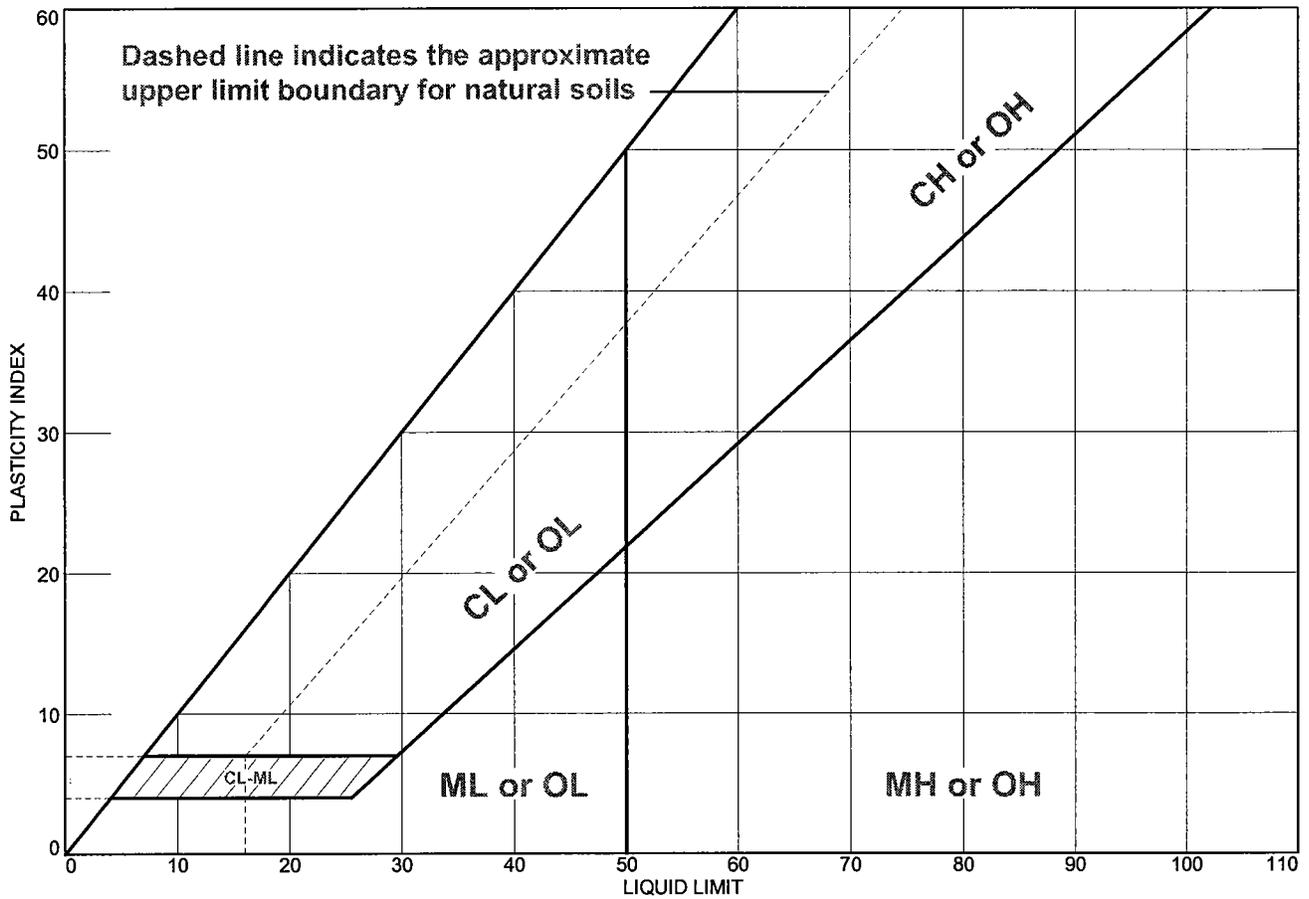
PROJECT NUMBER:	07-167	June 22, 2007
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**Arkema Portland Harbor Site
Portland, Oregon**



5040 Robert J. Mathews Blvd., El Dorado Hills, CA 95762
Phone: (916) 939-3460 FAX: (916) 939-3507

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	sandy silt	NV	NP	NP	93.8	52.5	ML
■	silty sand	21	NP	NP	81.8	45.6	SM

Project No. 07-167 **Client:** ERM
Project: Arkema Portland Harbor Site
 Portland, OR
 ● **Location:** CA Soil Full Depth Composite, B121 **Sample Number:** 6/12/07
 ■ **Location:** OA Soil Full Depth Composite, B120 **Sample Number:** 6/12/07

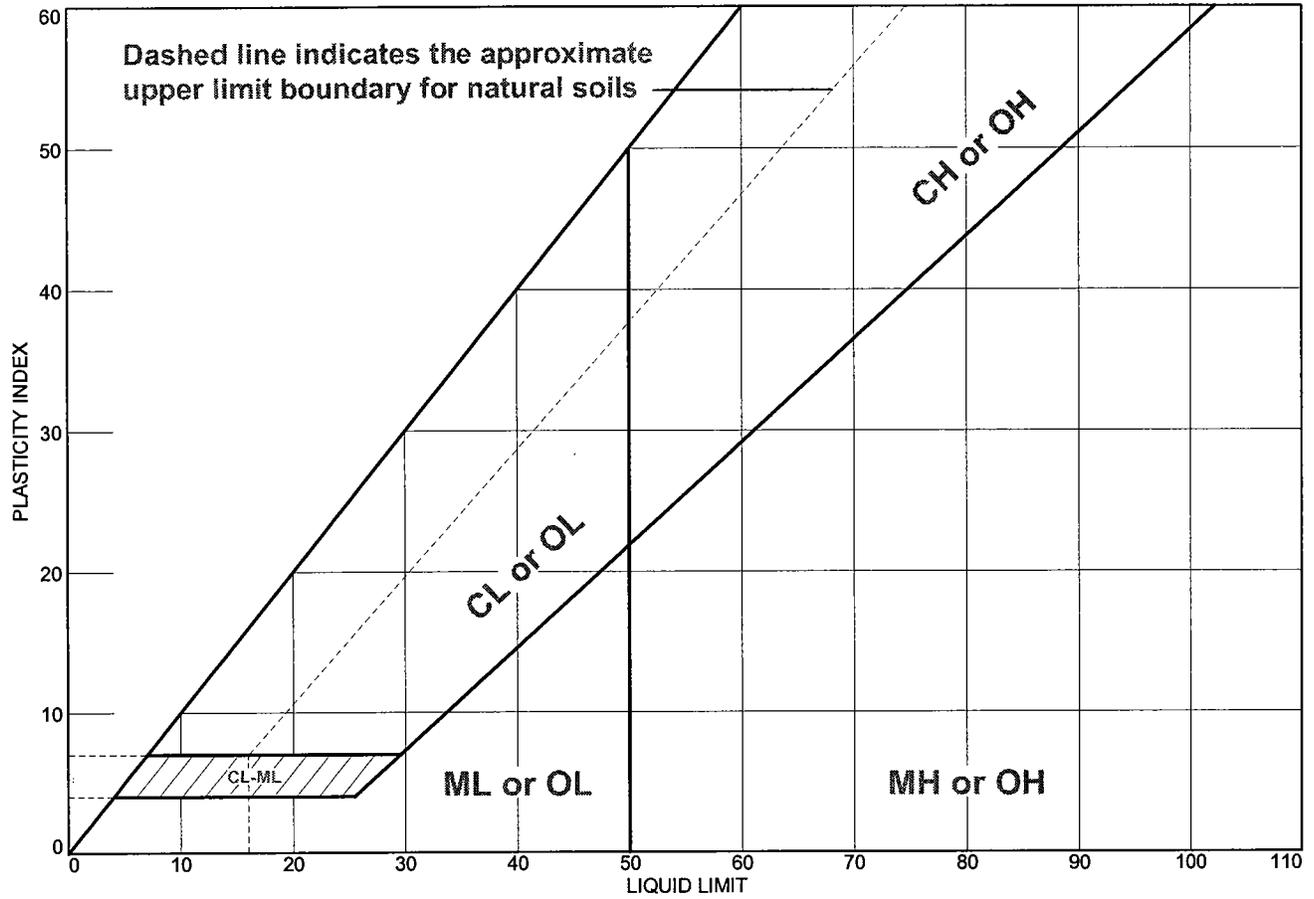
SIERRA TESTING LABS, INC.
 El Dorado Hills, CA

Remarks:

Figure

Tested By: MS MG Checked By: MN

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	sandy silt	NV	NP	NP	99.8	61.9	ML
■	silt	NV	NP	NP	99.7	97.3	ML
▲	poorly graded sand with silt	NV	NP	NP	96.9	9.2	SP-SM
◆	silty sand	NV	NP	NP	92.7	16.6	SM

Project No. 07-167 **Client:** ERM

Project: Arkema Portland Harbor Site
Portland, OR

● **Location:** OA Soil DB2 B121 **Depth:** 67-72.0 **Sample Number:** 6/12/07
 ■ **Location:** OA Soils S-IB2 B120 **Depth:** 34-35.0 **Sample Number:** 6/12/07
 ▲ **Location:** OA Soil IT2 B120 **Depth:** 41-44.0 **Sample Number:** 6/12/07
 ◆ **Location:** OA Soil ST2 B120 **Depth:** 28-34.0 **Sample Number:** 6/12/07

Remarks:

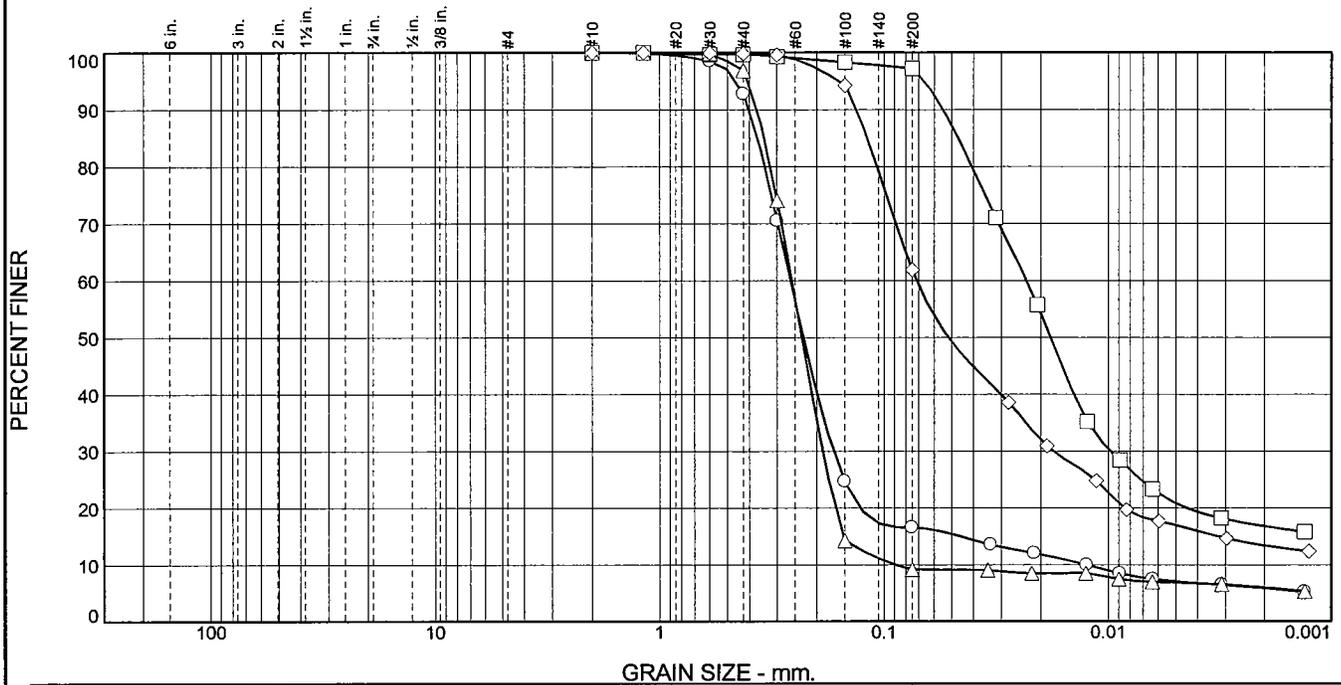
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

Tested By: ○ AM □ MG △ MS ◆ MS **Checked By:** CMW

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	0.0	7.3	76.1	10.7	5.9
□	0.0	0.0	0.3	2.4	80.5	16.8
△	0.0	0.0	3.1	87.7	3.2	6.0
◇	0.0	0.0	0.2	37.9	48.5	13.4

	LL	PL	D85	D60	D50	D30	D15	D10	Cc	Cu
○	NV	NP	0.3670	0.2620	0.2296	0.1685	0.0457	0.0126	8.60	20.79
□	NV	NP	0.0469	0.0231	0.0181	0.0098				
△	NV	NP	0.3428	0.2584	0.2334	0.1883	0.1521	0.0892	1.54	2.90
◇	NV	NP	0.1192	0.0716	0.0518	0.0176	0.0032			

Material Description	USCS	AASHTO
○ silty sand	SM	A-2-4(0)
□ silt	ML	A-4(0)
△ poorly graded sand with silt	SP-SM	A-3
◇ sandy silt	ML	A-4(0)

Project No. 07-167 **Client:** ERM
Project: Arkema Portland Harbor Site

○ **Location:** OA Soil ST2 B120 **Depth:** 28-34.0 **Sample Number:** 6/12/07
 □ **Location:** OA Soils S-IB2 B120 **Depth:** 34-35.0 **Sample Number:** 6/12/07
 △ **Location:** OA Soil IT2 B120 **Depth:** 41-44.0 **Sample Number:** 6/12/07
 ◇ **Location:** OA Soil DB2 B121 **Depth:** 67-72.0 **Sample Number:** 6/12/07

Remarks:

SIERRA TESTING LABS, INC.
 El Dorado Hills, CA

Figure

Tested By: ○ PD □ PD/MG △ PD/MG ◇ PD/AM Checked By: MN

Appendix D
Analytical Testing Laboratory
Reports

April 26, 2007 '

Brendan Robinson '
ERM - Portland '
101 SW Main St. Suite 804 '
Portland, OR 97204 '

RE: Arkema-2007-STL/Legacy '

Enclosed are the results of analyses for samples received by the laboratory on 04/06/07 16:50.
The following list is a summary of the Work Orders contained in this report, generated on 04/26/07
17:18.

If you have any questions concerning this report, please feel free to contact me.

<u>Work Order</u>	<u>Project</u>	<u>ProjectNumber</u>
PQD0258	Arkema-2007-STL/Legacy	63836.02

TestAmerica - Portland, OR



Darrell Auvil, Project Manager

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ERM - ortlandP	Project Name: Arkema-2007-STL/Le cyP	Report Created:
101 SW Main St. Suite 804	Project Number: 63836.02	04/26/07 17:18
Portland, OR 97204	Project Manager: Brendan Robinson	

ANALYTICAL REPORT FOR SAMPLES

Sample IDP	Laboratory IDP	MatrixP	Date SampledP	Date ReceivedP
MWA-67si-040607	PQD0258-01	Water	04/06/07 09:35	04/06/07 16:50
MWA-30-040607	PQD0258-02	Water	04/06/07 10:21	04/06/07 16:50
B-120 35-37	PQD0258-03	Soil	04/05/07 12:00	04/06/07 16:50
B-121 27-29	PQD0258-04	Soil	04/05/07 12:00	04/06/07 16:50
B-120 34-35	PQD0258-05	Soil	04/05/07 12:00	04/06/07 16:50
B-120 41-44	PQD0258-06	Soil	04/05/07 12:00	04/06/07 16:50
B-120 46-50	PQD0258-07	Soil	04/05/07 12:00	04/06/07 16:50
B-121 29-31	PQD0258-08	Soil	04/05/07 12:00	04/06/07 16:50
B-121 32-39	PQD0258-09	Soil	04/05/07 12:00	04/06/07 16:50
B-121 62-65	PQD0258-10	Soil	04/05/07 12:00	04/06/07 16:50
MWA-67si-040607	PQD0258-11	Other wet	04/06/07 09:35	04/06/07 16:50
MWA-30-040607	PQD0258-12	Other wet	04/06/07 10:21	04/06/07 16:50

TestAmerica - Portland, OR



Darrell Auvil, Project Manager

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ERM - ortlandP

101 SW Main St. Suite 804
Portland, OR 97204

Project Name: **Arkema-2007-STL/Le cyP**

Project Number: 63836.02

Project Manager: Brendan Robinson

Report Created:

04/26/07 17:18

Analytical Case Narrative

TestAmerica - Portland, OR

PQD0258

1.0 DESCRIPTION OF CASE '

Two water and eight soil samples were received on April 6th, 2007 at a temperature of 4.8 and 5.9 °C for the two coolers received. '

2.0 PREPARATIONS AND ANALYSIS '

The two water samples PQD0258-1 and 2, (MWA-67si-040607 and MWA-30-040607 respectively) were requested for specific gravity by method SM2710F. This method is designed for oil samples not water samples. To enable reporting, these two samples were logged in twice, once as our sample numbers PQD0258-1 and 2 and again as PQD0258-11 and 12. These are the same samples, we simply had to log them in as "water" (samples 1 & 2) matrix for other tests and again as "other wet" (samples 11 & 12) matrix to report the specific gravity '

No additional anomalies, discrepancies, or issues were associated with sample preparation, analysis and quality control other than those already qualified in the data and described in the Notes and Definitions page at the end of this report.

TestAmerica - Portland, OR



Darrell Auvil, Project Manager

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ERM - ortlandP	Project Name: Arkema-2007-STL/Le cyP	Report Created:
101 SW Main St. Suite 804	Project Number: 63836.02	04/26/07 17:18
Portland, OR 97204	Project Manager: Brendan Robinson	

Oil and Grease Analysis per EPA Method 1664
TestAmerica - Portland, OR

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	BatchP	repared	Analyzed	Notes
PQD0258-01 (MWA-67si-040607)P										
		WaterP					Sampled: 04/06/07 09:35P			
Oil & Grease	EPA 1664	ND		4.85	mg/l	1x	7040470	04/11/07 14:45	04/12/07 09:17	
PQD0258-02 (MWA-30-040607)P										
		WaterP					Sampled: 04/06/07 10:21P			
Oil & Grease	EPA 1664	ND		4.85	mg/l	1x	7040470	04/11/07 14:45	04/12/07 09:17	

TestAmerica - Portland, OR



Darrell Auvil, Project Manager

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ERM - ortlandP	Project Name: Arkema-2007-STL/Le cyP	Report Created:
101 SW Main St. Suite 804	Project Number: 63836.02	04/26/07 17:18
Portland, OR 97204	Project Manager: Brendan Robinson	

Conventional Chemistry Parameters per APHA/EPA Methods
 TestAmerica - Portland, OR

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	BatchP	Prepared	Analyzed	Notes
PQD0258-01 (MWA-67si-040607)P										
		WaterP						Sampled: 04/06/07 09:35P		
Total Dissolved SolidsP	EPA 160.1	9150P		10.0	mg/l	1x	7040392	04/10/07 09:25	04/10/07 15:50	
Total Organic CarbonP	EPA 9060	67.0P		1.00	"	"	7040807	04/18/07 22:54	04/19/07 03:30	
Total Suspended Solids	EPA 160.2	ND		10.0	"	"	7040416	04/10/07 11:35	04/10/07 16:25	
PQD0258-02 (MWA-30-040607)P										
								Sampled: 04/06/07 10:21P		
Total Dissolved SolidsP	EPA 160.1	66000P		10.0	mg/l	1x	7040392	04/10/07 09:25	04/10/07 15:50	
Total Organic CarbonP	EPA 9060	12.6P		1.00	"	"	7040807	04/18/07 22:54	04/19/07 03:30	
Total Suspended Solids	EPA 160.2	ND		10.0	"	"	7040416	04/10/07 11:35	04/10/07 16:25	
PQD0258-03 (B-120 35-37)P										
								Sampled: 04/05/07 12:00P		
pHP	150.1/9040A	5.06P			pH Units	1x	7040338	04/09/07 09:56	04/09/07 10:15	
QD0258-04 (B-121 27-29)P										
								Sampled: 04/05/07 12:00P		
pHP	150.1/9040A	8.19P			pH Units	1x	7040338	04/09/07 09:56	04/09/07 10:15	
QD0258-05 (B-120 34-35)P										
								Sampled: 04/05/07 12:00P		
pHP	150.1/9040A	4.76P			pH Units	1x	7040662	04/16/07 12:32	04/16/07 13:30	
QD0258-06 (B-120 41-44)P										
								Sampled: 04/05/07 12:00P		
pHP	150.1/9040A	10.2P			pH Units	1x	7040662	04/16/07 12:32	04/16/07 13:30	A-01P
QD0258-07 (B-120 46-50)P										
								Sampled: 04/05/07 12:00P		
pHP	150.1/9040A	8.18P			pH Units	1x	7040662	04/16/07 12:32	04/16/07 13:30	
QD0258-08 (B-121 29-31)P										
								Sampled: 04/05/07 12:00P		
pHP	150.1/9040A	8.81P			pH Units	1x	7040662	04/16/07 12:32	04/16/07 13:30	
QD0258-09 (B-121 32-39)P										
								Sampled: 04/05/07 12:00P		
pHP	150.1/9040A	7.57P			pH Units	1x	7040662	04/16/07 12:32	04/16/07 13:30	

TestAmerica - Portland, OR



Darrell Auvil, Project Manager

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ERM - ortlandP	Project Name: Arkema-2007-STL/Le cyP	Report Created:
101 SW Main St. Suite 804	Project Number: 63836.02	04/26/07 17:18
Portland, OR 97204	Project Manager: Brendan Robinson	

Conventional Chemistry Parameters per APHA/EPA Methods
TestAmerica - Portland, OR

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	BatchP	repared	Analyzed	Notes
PQD0258-10 (B-121 62-65)P										
		SoilP				Sampled: 04/05/07 12:00P				
pHP	150.1/9040A	7.29			pH Units	1x	7040662	04/16/07 12:32	04/16/07 13:30	

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Darrell Auvil, Project Manager

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ERM - ortlandP	Project Name: Arkema-2007-STL/Le cyP	Report Created:
101 SW Main St. Suite 804	Project Number: 63836.02	04/26/07 17:18
Portland, OR 97204	Project Manager: Brendan Robinson	

Physical Parameters per APHA/ASTM/EPA Methods
 TestAmerica - Portland, OR

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	BatchP	repared	Analyzed	Notes
PQD0258-03 (B-120 35-37)P										
		SoilP						Sampled: 04/05/07 12:00P		
SalinityP	SM 2520 B	0.300P		0.100	N/A	1x	7040711	04/17/07 10:45	04/17/07 13:04	
QD0258-04 (B-121 27-29)P										
SalinityP	SM 2520 B	2.49P		0.0996	N/A	1x	7040711	04/17/07 10:45	04/17/07 13:04	
QD0258-05 (B-120 34-35)P										
SalinityP	SM 2520 B	0.797P		0.0996	N/A	1x	7040711	04/17/07 10:45	04/17/07 13:04	
QD0258-06 (B-120 41-44)P										
SalinityP	SM 2520 B	1.48P		0.0986	N/A	1x	7040711	04/17/07 10:45	04/17/07 13:04	
QD0258-07 (B-120 46-50)P										
SalinityP	SM 2520 B	0.589P		0.0982	N/A	1x	7040711	04/17/07 10:45	04/17/07 13:04	
QD0258-08 (B-121 29-31)P										
SalinityP	SM 2520 B	138P		0.0986	N/A	1x	7040711	04/17/07 10:45	04/17/07 13:04	
QD0258-09 (B-121 32-39)P										
SalinityP	SM 2520 B	2.89P		0.0996	N/A	1x	7040711	04/17/07 10:45	04/17/07 13:04	
QD0258-10 (B-121 62-65)P										
SalinityP	SM 2520 B	292P		0.0996	N/A	1x	7040711	04/17/07 10:45	04/17/07 13:04	
QD0258-11 (MWA-67si-040607)P										
Specific GravityP	SM 2710F	1.01P		0.00100	N/A	1x	7040677	04/16/07 17:37	04/16/07 17:45	
QD0258-12 (MWA-30-040607)P										
Specific GravityP	SM 2710F	1.05P		0.00100	N/A	1x	7040677	04/16/07 17:37	04/16/07 17:45	

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Darrell Auvil, Project Manager

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ERM - ortlandP	Project Name: Arkema-2007-STL/Le cyP	Report Created:
101 SW Main St. Suite 804	Project Number: 63836.02	04/26/07 17:18
Portland, OR 97204	Project Manager: Brendan Robinson	

ercent Dry Weight (Solids) per Standard Methods
TestAmerica - Portland, OR

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	BatchP	repared	Analyzed	Notes
PQD0258-03 (B-120 35-37)P										
		SoilP							Sampled: 04/05/07 12:00P	
% SolidsP	NCA SOP	73.7P		0.00	% by Weight	1x	7040321	04/07/07 08:53	04/07/07 08:53	
QD0258-04 (B-121 27-29)P										
		SoilP							Sampled: 04/05/07 12:00P	
% SolidsP	NCA SOP	75.4P		0.00	% by Weight	1x	7040321	04/07/07 08:53	04/07/07 08:53	

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Darrell Auvil, Project Manager

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ERM - ortlandP	Project Name: Arkema-2007-STL/Le cyP	Report Created:
101 SW Main St. Suite 804	Project Number: 63836.02	04/26/07 17:18
Portland, OR 97204	Project Manager: Brendan Robinson	

General Chemistry ParametersP
TestAmerica - Nashville, TN

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	BatchP	reparedP	AnalyzedP	Notes
QD0258-01 (MWA-67si-040607)P		WaterP			Sampled: 04/06/07 09:35P					
Total Org nic HalidesP	SW846 9020B	39.8P		0.0100	mg/L	1x	7040914	04/09/07 10:09	04/21/07 00:45	
QD0258-02 (MWA-30-040607)P		WaterP			Sampled: 04/06/07 10:21P					
Total Org nic HalidesP	SW846 9020B	9.36P		0.0100	mg/L	1x	7040914	04/09/07 10:09	04/21/07 00:45	

TestAmerica - Portland, OR



Darrell Auvil, Project Manager

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ERM - ortlandP	Project Name: Arkema-2007-STL/Le cyP	Report Created:
101 SW Main St. Suite 804	Project Number: 63836.02	04/26/07 17:18
Portland, OR 97204	Project Manager: Brendan Robinson	

Oil and Grease Analysis per EPA Method 1664 - Laboratory Quality Control ResultsP
 TestAmerica - Portland, OR

QC Batch: 7040470	Water preparation Method: O&G prep CE
--------------------------	--

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	Source ResultP	Spike AmtP	% RECP	(Limits)P	%P RPD!	(Limits)P	AnalyzedP	Notes
Blank (7040470-BLK1)P										Extracted: 04/11/07 11:50P				
Oil & Grease	EPA 1664	ND	---	5.00	mg/l	1x	--	--	--	--	--	--	04/12/07 09:17	
LCS (7040470-BS1)P										Extracted: 04/11/07 11:50P				
Oil & Grease	EPA 1664	39.0	---		mg/l	1x	--	40.2	97.0%	(78-114)	--	--	04/12/07 09:17	
Matrix Spike (7040470-MS1)P				QC Source: QD0206-01P				Extracted: 04/11/07 11:50P						
Oil & Grease	EPA 1664	33.5	---		mg/l	1x	0.396	40.2	82.3%	(78-114)	--	--	04/12/07 09:17	

TestAmerica - Portland, OR



Darrell Auvil, Project Manager

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ERM - ortlandP	Project Name: Arkema-2007-STL/Le cyP	Report Created:
101 SW Main St. Suite 804	Project Number: 63836.02	04/26/07 17:18
Portland, OR 97204	Project Manager: Brendan Robinson	

Conventional Chemistry Parameters per APHA/EPA Methods - Laboratory Quality Control ResultsP
 TestAmerica - Portland, OR

QC Batch: 7040338 Soil reparation Method: General reparationP

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	Source ResultP	Spike AmtP	% RECP	(Limits)P	%P RPD!	(Limits)P	AnalyzedP	Notes
Duplicate (7040338-DUP1)P										Extracted: 04/09/07 09:56P				
pH	150.1/9040A	6.62	---		pH Units	1x	--	--	--	--	--	(25)	04/09/07 10:15	R2

QC Batch: 7040392 Water reparation Method: General reparationP

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	Source ResultP	Spike AmtP	% RECP	(Limits)P	%P RPD!	(Limits)P	AnalyzedP	Notes
Blank (7040392-BLK1)P										Extracted: 04/10/07 09:25P				
Total Dissolved Solids	EPA 160.1	ND	---	10.0	mg/l	1x	--	--	--	--	--	--	04/10/07 15:50	

LCS (7040392-BS1)P										Extracted: 04/10/07 09:25P				
Total Dissolved Solids	EPA 160.1	102	---	10.0	mg/l	1x	--	100	102%	(80-120)	--	--	04/10/07 15:50	

Duplicate (7040392-DUP1)P										QC Source: QD0258-01P					Extracted: 04/10/07 09:25P				
Total Dissolved Solids	EPA 160.1	9150	---	10.0	mg/l	1x	9150	--	--	--	0.00%	(20)	04/10/07 15:50						

QC Batch: 7040416 Water reparation Method: General reparationP

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	Source ResultP	Spike AmtP	% RECP	(Limits)P	%P RPD!	(Limits)P	AnalyzedP	Notes
Blank (7040416-BLK1)P										Extracted: 04/10/07 11:35P				
Total Suspended Solids	EPA 160.2	ND	---	10.0	mg/l	1x	--	--	--	--	--	--	04/10/07 16:25	

LCS (7040416-BS1)P										Extracted: 04/10/07 11:35P				
Total Suspended Solids	EPA 160.2	49.0	---	10.0	mg/l	1x	--	50.0	98.0%	(80-120)	--	--	04/10/07 16:25	

Duplicate (7040416-DUP1)P										QC Source: QD0258-01P					Extracted: 04/10/07 11:35P				
Total Suspended Solids	EPA 160.2	ND	---	10.0	mg/l	1x	ND	--	--	--	0.00%	(20)	04/10/07 16:25						

TestAmerica - Portland, OR



Darrell Auvil, Project Manager

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ERM - ortlandP	Project Name: Arkema-2007-STL/Le cyP	Report Created:
101 SW Main St. Suite 804	Project Number: 63836.02	04/26/07 17:18
Portland, OR 97204	Project Manager: Brendan Robinson	

Conventional Chemistry Parameters per APHA/EPA Methods - Laboratory Quality Control ResultsP
 TestAmerica - Portland, OR

QC Batch: 7040662 Soil reparation Method: General reparationP

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	Source ResultP	Spike AmtP	% RECP	(Limits)P	%P RPD!	(Limits)P	AnalyzedP	Notes
Duplicate (7040662-DUP1)P			QC Source: QD0258-05			Extracted: 04/16/07 12:32P								
pH	150.1/9040A	4.76	---		pH Units	1x	4.76	--	--	--	0.00%	(25)	04/16/07 13:30	

QC Batch: 7040807 Water reparation Method: General reparationP

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	Source ResultP	Spike AmtP	% RECP	(Limits)P	%P RPD!	(Limits)P	AnalyzedP	Notes
Blank (7040807-BLK1)P			QC Source: QD0258-01P			Extracted: 04/18/07 22:54P								
Total Organic Carbon	EPA 9060	ND	---	1.00	mg/l	1x	--	--	--	--	--	--	04/19/07 03:30	
LCS (7040807-BS1)P			QC Source: QD0258-01P			Extracted: 04/18/07 22:54P								
Total Organic Carbon	EPA 9060	21.7	---	1.00	mg/l	1x	--	20.0	108%	(85-115)	--	--	04/19/07 03:30	
Duplicate (7040807-DUP1)P			QC Source: QD0258-01P			Extracted: 04/18/07 22:54P								
Total Organic Carbon	EPA 9060	65.9	---	1.00	mg/l	1x	67.0	--	--	--	1.66%	(20)	04/19/07 03:30	
Matrix Spike (7040807-MS1)P			QC Source: QD0258-01P			Extracted: 04/18/07 22:54P								
Total Organic Carbon	EPA 9060	91.6	---	1.01	mg/l	1x	67.0	25.3	97.2%	(75-125)	--	--	04/19/07 03:30	
Matrix Spike Dup (7040807-MSD1)P			QC Source: QD0258-01P			Extracted: 04/18/07 22:54P								
Total Organic Carbon	EPA 9060	92.1	---	1.01	mg/l	1x	67.0	25.3	99.2%	(75-125)	0.544%	(20)	04/19/07 03:30	

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Darrell Auvil, Project Manager

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ERM - ortlandP	Project Name: Arkema-2007-STL/Le cyP	Report Created:
101 SW Main St. Suite 804	Project Number: 63836.02	04/26/07 17:18
Portland, OR 97204	Project Manager: Brendan Robinson	

Physical Parameters per APHA/ASTM/EPA Methods - Laboratory Quality Control ResultsP
 TestAmerica - Portland, OR

QC Batch: 7040677 Other wet reparation Method: Oil Qual.

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	Source ResultP	Spike AmtP	% RECP	(Limits)P	%P RPD	(Limits)P	AnalyzedP	Notes
Duplicate (7040677-DUP1)P			QC Source: QD0258-11			Extracted: 04/16/07 17:16P								
Specific Gravity	SM 2710F	1.01	---	0.00100	N/A	1x	1.01	--	--	--	0.00%	(10)	04/16/07 17:45	

QC Batch: 7040711 Soil reparation Method: General reparationP

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	Source ResultP	Spike AmtP	% RECP	(Limits)P	%P RPD	(Limits)P	AnalyzedP	Notes
Blank (7040711-BLK1)P			QC Source: QD0258-11			Extracted: 04/17/07 10:45P								
Salinity	SM 2520 B	ND	---	0.100	N/A	1x	--	--	--	--	--	--	04/17/07 13:04	
LCS (7040711-BS1)P			QC Source: QD0258-03P			Extracted: 04/17/07 10:45P								
Salinity	SM 2520 B	340	---	0.100	N/A	1x	--	350	97.1%	(80-120)	--	--	04/17/07 13:04	
Duplicate (7040711-DUP1)P			QC Source: QD0258-03P			Extracted: 04/17/07 10:45P								
Salinity	SM 2520 B	0.295	---	0.0982	N/A	1x	0.300	--	--	--	1.68%	(20)	04/17/07 13:04	

TestAmerica - Portland, OR



Darrell Auvil, Project Manager

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ERM - ortlandP	Project Name: Arkema-2007-STL/Le cyP	Report Created:
101 SW Main St. Suite 804	Project Number: 63836.02	04/26/07 17:18
Portland, OR 97204	Project Manager: Brendan Robinson	

ercent Dry Weight (Solids) per Standard Methods - Laboratory Quality Control ResultsP
 TestAmerica - Portland, OR

QC Batch: 7040321 Soil reparation Method: Dry Weight

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	Source ResultP	Spike AmtP	% RECP	(Limits)P	%P RPD!	(Limits)P	AnalyzedP	Notes
Duplicate (7040321-DUP1)P			QC Source: QD0007-09			Extracted: 04/07/07 08:53P								
% Solids	NCA SOP	80.0	---	0.00	% by Weight	1x	80.0	--	--	--	0.00%	(20)	04/07/07 08:53	
Duplicate (7040321-DUP2)P			QC Source: QD0251-01			Extracted: 04/07/07 08:53P								
% Solids	NCA SOP	78.7	---	0.00	% by Weight	1x	78.1	--	--	--	0.765%	(20)	04/07/07 08:53	

TestAmerica - Portland, OR



Darrell Auvil, Project Manager

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ERM - ortlandP	Project Name: Arkema-2007-STL/Le cyP	Report Created:
101 SW Main St. Suite 804	Project Number: 63836.02	04/26/07 17:18
Portland, OR 97204	Project Manager: Brendan Robinson	

General Chemistry Parameters - Laboratory Quality Control ResultsP
 TestAmerica - Nashville, TN

QC Batch: 7040914 **Water preparation Method: NO REP**

Analyte	MethodP	ResultP	MDL*P	MRL	Units	DilP	Source ResultP	Spike AmtP	% RECP	(Limits)P	%P RPD!	(Limits)P	AnalyzedP	Notes	
Blank (7040914-BLK1)P										Extracted: 04/09/07 10:09P					
Total Organic Halides	SW846 9020B	ND	---	0.0100	mg/L	1x	--	--	--	--	--	--	04/21/07 00:45		
LCS (7040914-BS1)P										Extracted: 04/09/07 10:09P					
Total Organic Halides	SW846 9020B	269	---		ug/L	1x	--	250	108%	(90-110)	--	--	04/21/07 00:45		
Duplicate (7040914-DUP1)P										QC Source: NQD0368-02P		Extracted: 04/09/07 10:09P			
Total Organic Halides	SW846 9020B	0.0219	---	0.0100	mg/L	1x	ND	--	--	--		(37)	04/21/07 00:45		
Matrix Spike (7040914-MS1)P										QC Source: NQD0368-05P		Extracted: 04/09/07 10:09P			
Total Organic Halides	SW846 9020B	117	---		ug/L	1x	7.36	100	110%	(69-134)	--	--	04/21/07 00:45		
Matrix Spike Dup (7040914-MSD1)P										QC Source: NQD0368-05P		Extracted: 04/09/07 10:09P			MNR3
Total Organic Halides	SW846 9020B	0.00	---	TIC	ug/L	1x	7.36	100	-7%	(69-134)		(37)	04/21/07 00:45		

TestAmerica - Portland, OR



Darrell Auvil, Project Manager

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ERM - ortlandP

101 SW Main St. Suite 804
Portland, OR 97204

Project Name: **Arkema-2007-STL/Le cyP**

Project Number: 63836.02

Project Manager: Brendan Robinson

Report Created:

04/26/07 17:18

Notes and Definitions

Report Specific Notes:

- A-01 - Outside of calibration
- MNR3 - Insufficient sample received to meet method QC requirements.
- R2 - The RPD exceeded the acceptance limit.

Laboratory Reporting Conventions:

- DET - Analyte DETECTED at or above the Reporting Limit. Qualitative Analyses only.
- ND - Analyte NOT DETECTED at or above the reporting limit (MDL or MRL, as appropriate).
- NR/NA - Not Reported / Not Available
- dry - Sample results reported on a Dry Weight Basis. Results and Reporting Limits have been corrected for Percent Dry Weight.
- wet - Sample results and reporting limits reported on a Wet Weight Basis (as received). Results with neither 'wet' nor 'dry' are reported on a Wet Weight Basis.
- RPD - RELATIVE PERCENT DIFFERENCE (RPDs calculated using Results, not Percent Recoveries).
- MRL - METHOD REPORTING LIMIT. Reporting Level at, or above, the lowest level standard of the Calibration Table.
- MDL* - METHOD DETECTION LIMIT. Reporting Level at, or above, the statistically derived limit based on 40CFR, Part 136, Appendix B. *MDLs are listed on the report only if the data has been evaluated below the MRL. Results between the MDL and MRL are reported as Estimated Results.
- Dil - Dilutions are calculated based on deviations from the standard dilution performed for an analysis, and may not represent the dilution found on the analytical raw data.
- Reporting Limits - Reporting limits (MDLs and MRLs) are adjusted based on variations in sample preparation amounts, analytical dilutions and percent solids, where applicable.
- Electronic Signature - Electronic Signature added in accordance with TestAmerica's *Electronic Reporting and Electronic Signatures Policy*. Application of electronic signature indicates that the report has been reviewed and approved for release by the laboratory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

TestAmerica - Portland, OR



Darrell Auvil, Project Manager

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TEST AMERICA SAMPLE RECEIPT CHECKLIST

Received By: (applies to temp at receipt) **Logged-in By:** **Unpacked/Labeled By:**
 Date: 4/6/07 Date: 4/6 Date: 4/6 Work Order No. PQ D0258
 Time: 16:00 Initials: SM Initials: SM Client: ERM
 Initials: RM Project: Atofinq

Container Type: _____ **COC Seals:** _____ **Packing Material:** _____
 ___ Cooler _____ Ship. Container _____ Name _____
 ___ Box _____ On Bottles _____ Date _____
 ___ None/Other _____ None None/Other Other _____

Refrigerant: _____ **Received Via: Bill#** _____
 ___ Gel Ice Pack _____
 Loose Ice _____
 ___ None/Other _____
 ___ Fed Ex _____ Client _____
 ___ UPS TA Courier _____
 ___ DHL _____ Mid Valley _____
 ___ Senvoy _____ TDP _____
 ___ GS _____ Other _____

Cooler Temperature (IR): 4.8, 5.9 °C Plastic Glass (circle one) Frozen filters, Tedlars and aqueous Metals exempt

Temperature Blank? _____ °C or NA Trip Blank? _____ Y or N or NA

Sample Containers: _____ **ID** _____ **ID** _____
 Intact? Y or N _____ Metals Preserved? _____ Y or N or NA
 Provided by NCA? _____ Y or N _____ Client QAPP Preserved? _____ Y or N or NA
 Correct Type? _____ Y or N _____ Adequate Volume? _____ Y or N
 #Containers match COC? _____ Y or N (NOD) Water VOAs: Headspace? _____ Y or N or NA
 IDs/time/date match COC? _____ Y or N _____ Comments: _____
 Hold Times in hold? _____ Y or N _____

PROJECT MANAGEMENT

Is the Chain of Custody complete? _____ Y or N If N, circle the items that were incomplete
 Comments, Problems _____

Total access set up? _____ Y or N
 Has client been contacted regarding non-conformances? _____ Y or N If Y, _____ / _____ Date Time
 PM Initials: _____ Date: _____ Time: _____

PA DO 258

PROJECT #		PROJECT NAME				REQUESTED PARAMETERS																	
63336-02		Soil and Slurry Compositibility Study				# OF CONTAINERS	SOIL	WATER	GAS	Specific Gravity	Total Suspended Solids	Total Dissolved Solids	Oil and Grease	Total Organic Carbon	Total Organic Halides	pH	Salt Content						
SAMPLER (PRINT NAME)		(SIGNATURE)		RECEIVING LABORATORY																			
Brendan Robinson				Test America																			
SAMPLE I.D.	DATE	TIME	LOG #	LOG #	SAMPLING METHOD	PRESERVED	WZ	SAMPLING VOLUME															
MWA-6751-040607	4/6/07	0935		X	Bluettes Pump	Asso'n	Y	2750ml	6		X	X	X	X	X	X							
MWA-30-040607	4/6/07	1021		X	"	"	Y	2750ml	6		X	X	X	X	X	X							
B-120 35-37	4/5/07			X	Split Spoon	-	Y	8oz	2	X							X	X					
B-121 27-29	4/2/07			X	split spoon	-	Y	8oz	2	X							X	X					
B-120 34-35	4/2/07						Y	8oz	1	X							X	X					
B-120 41-44	4/2/07						Y	8oz	1	Y							X	X					
B-120 46-50	4/2/07						Y	8oz	1	X							X	X					
B-121 29-31	4/2/07						Y	8oz	1	X							X	X					
B-121 32-39	4/2/07						Y	8oz	1	X							X	X					
B-121 62-65	4/2/07						Y	8oz	1	X							X	X					
RELINQUISHED BY (SIGNATURE)			DATE	TIME	RECEIVED BY			DATE	TIME	FIELD REMARKS													
			4/6/07	16:00				4/6	16:00	<div style="border: 1px solid black; padding: 10px; text-align: center;"> <h3>Revised COC</h3> <p>4/10/07 DWB</p> <p>Date Initial</p> </div>													
RELINQUISHED BY (SIGNATURE)			DATE	TIME	RECEIVED BY			DATE	TIME														
								lab	16:40														
RELINQUISHED BY (SIGNATURE)			DATE	TIME	RECEIVED BY			DATE	TIME														
REMARKS ON SAMPLE RECEIPT										ERM REMARKS										SEND REPORT TO:			
<input type="checkbox"/> BOTTLE INTACT <input type="checkbox"/> CUSTODY SEALS <input type="checkbox"/> CHILLED <input type="checkbox"/> PRESERVED <input type="checkbox"/> SEALS INTACT <input type="checkbox"/> SEE REMARKS																				Brendan Robinson			

408,500

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*Attachment 3
Subsurface Debris Investigation
Report*

**Environmental
Resources
Management**

101 SW Main Street
Suite 804
Portland, OR 97214
(503) 488-5282
(503) 488-5142 (fax)
www.erm.com



29 July 2010

Via Electronic Mail

Mr. Matt McClincy
Oregon Department of Environmental Quality
Northwest Region
2020 Southwest Fourth Avenue
Suite 400
Portland, Oregon 97201-4987

Subject: Subsurface Debris Investigation
Technical Memorandum
Arkema Inc., Portland Facility

Dear Mr. McClincy:

This technical memorandum was prepared by ERM-West, Inc. (ERM) on behalf of Legacy Site Services, LLC (LSS) to summarize the subsurface debris investigation results at the Arkema Inc., facility (the site) in Portland, Oregon. The subsurface debris investigation was conducted in support of the Groundwater Barrier Wall (GWBW) design, as part of the Groundwater Source Control Measure (SCM) implementation. The work was completed on 26 through 28 April 2010 in accordance with the work plan letter submitted to the Oregon Department of Environmental Quality on 12 April 2010.

Background

LSS intends to design, permit, and implement a Groundwater SCM at the site to mitigate migration of constituents of concern in groundwater into the Willamette River. The Groundwater SCM will consist of a GBW coupled with a groundwater extraction and treatment system to maintain the hydraulic gradient necessary to mitigate contaminant migration in groundwater around the barrier wall and into the river. The GBW consists of a slurry wall set back from the top of the

riverbank and extending along the southeastern boundary of the site and north to Dock 2 (Figure 1).

Previous investigations and historical data indicate that fill material was placed to a maximum depth of approximately 20 feet in the proposed location of the GWBW. The fill material consists primarily of soil from historical placement of dredge spoils. The fill reportedly also contains demolition debris such as bricks and concrete. Drill rigs have encountered refusal at nearly 20 locations in the vicinity of the planned slurry wall (Figure 1). Refusal at each location was within the fill material, and it is believed to be related to the presence of concrete and construction debris.

Areas of refusal within the fill layer are primarily located between an area just south of Dock 1 and halfway between Docks 1 and 2 (Figure 1). Historical information indicated that obstructions were located at depths less than 20 feet below ground surface (bgs). The subsurface debris investigation was performed in order to supplement historical data by excavating potential debris within the fill material along the alignment of the proposed slurry wall.

In addition, further geotechnical information about the fill material was required to facilitate design of the slurry wall. This information was needed to update the slope stability analysis, determine the final slurry wall alignment, and more accurately estimate the amount and feasibility of debris removal required during slurry wall installation. A greater understanding of the fill material will ultimately result in reducing uncertainty with respect to construction of the GWBW.

The specific objectives of this investigation were as follows:

- Revise the conceptual alignment of the slurry wall based on the selected construction method of traditional slurry wall trenching;
- Identify the location of potential obstructions along the alignment of the slurry wall based on subsurface utility maps and locations of historical borings with refusal;
- Observe subsurface obstructions to determine if debris will interfere with slurry wall installation, and remove observed obstructions, if possible;

- Observe the steepness of excavation sidewall slopes to refine assumptions for the required pre-clearance excavation, and associated costs during slurry wall installation; and
- Obtain geotechnical parameters of the fill material in order to update the slope stability assessment.

The field procedures for the investigation are presented below.

Field Procedures

The subsurface debris investigation was conducted from 26 through 28 April 2010. The investigation included the completion of three test trenches along the proposed GWBW alignment. Field activities are discussed below.

Utility Location

Buried utility overlays were compiled based on available historical site plans. These overlays were used to identify areas in which buried utilities were more likely to be encountered during the investigation, and to delineate areas requiring excavation of utilities during slurry wall construction.

Prior to field activities, the trenching locations were marked in the field for inspection and approval by a facility representative familiar with utilities at the site. No active utilities were anticipated to be encountered during trenching activities, as all underground utilities in the area were abandoned during plant demolition in 2004. The only active underground utilities in vicinity of the proposed trenching locations are storm water discharge drains. The only active aboveground utilities are electrical power lines mounted to poles. As per previous subsurface investigations at the site, abandoned and active utilities were identified using the compiled utility overlay map and by discussion with a facility representative.

Trenching Methods

Three test trenches were excavated in areas where drill rigs have historically encountered refusal along the slurry wall alignment (Figure 1). These locations include the area to the south of Dock 1 and the area between Docks 1 and 2.

Trenches were excavated by Berner Construction using an excavator. Test Trenches 1 and 2 each extended slightly more than 100 feet in length, and Trench 3 extended approximately 30 feet. Each trench was excavated in several stages. The total length of each trench was based on the amount and nature of obstructions encountered, as well as the amount of trench sidewall sloughing. The test trenches were excavated to the maximum trench depth practicable, up to a maximum of 22 feet bgs. Obstructions that could adversely impact the slurry wall construction encountered during excavation activities were observed, documented, and removed.

The trenches were backfilled by backhoe and bucket-compacted in lifts. Trenching was implemented in stages such that excavation and backfilling were completed within one work day. No excavated soil was left at grade overnight. The excavated areas were resurfaced with imported, clean, crushed rock.

Excavated Material Management

The excavated soil staging areas were lined with plastic sheeting and bermed. The first approximately 20 linear feet of excavated material was laid on the plastic sheeting linearly adjacent to the test pit. Soil from the remaining 20-foot sections of each trench was placed in the previously excavated section and bucket-compacted in lifts. The final section of the trench was filled with the material excavated from the initial 20 linear feet of trenching. Potential fugitive dust was mitigated by ensuring that the excavated soil remained sufficiently moist until it was backfilled.

The trench locations were selected in order to avoid known areas with potentially gross contamination (i.e. Acid Plant non-aqueous phase liquid area). The excavated material was visually surveyed for gross contamination such as free product, dark staining, or very strong odors. No indications of gross contamination were observed in any of the excavated material.

Several large pieces of concrete were removed from the trenches. The concrete pieces were cleaned by pressure washing with water within the lined and bermed staging area. The large pieces of concrete debris were stored on existing concrete pads for later off-site disposal.

Field Observations

The following information was recorded during trenching activities:

- Visual changes in fill material with depth bgs;
- Obstructions, including size, location, and material;
- Sidewall slope characteristics, such as amount of sloughing;
- Buried utilities encountered; and
- Organic vapors using a photoionization detector.

The field observations are summarized on the attached Figures 2, 3, and 4, which show the trench profiles and plan views. No organic vapors were detected in any of the materials excavated during the investigation.

Trench 1

Trench 1 was approximately 120 feet long, between 7 and 12 feet wide, and was completed between Dock 1 and Dock 2, as shown on Figure 1. A profile of Trench 1 is presented on Figure 2. The fill material located beneath the rail spur at the southern end of the trench consisted of light-brown, fine, sandy silt. This material extended approximately 25 feet north from the southern end of the trench and contained one large piece of concrete. The fill material to the north of the rail spur consisted of approximately 6 inches to 1 foot of asphalt and/or crushed rock surface underlain by 2 to 3 feet of brown, clayey, silt fill with little debris. This was underlain by between 6 and 19 feet of dark brown to gray or black silty clay intermixed with debris and woody material, followed by 1 to 10 feet of dark brown to black wet, organic, silty clay, and then 1 to 10 feet of brown silty clay. Several large chunks of concrete were removed from the excavation at 15 to 22 feet bgs and at the south end of the excavation.

Trench 2

Trench 2 was approximately 110 feet long, between 8 and 11 feet wide, and was completed south of Trench 1 and Dock 1, as shown on Figures 1 and 3. The material excavated along the entire length of the trench consisted of 3 to 6 inches of asphalt, underlain by 1 to 1½ feet of

crushed rock, and 17 feet of brown, medium-grained, silty, sand fill. No debris was encountered in the fill material.

Trench 3

Trench 3 was approximately 30 feet long, between 7 and 11 feet wide, and was completed approximately 30 feet south of Trench 2, as shown on Figures 1 and 4. The material excavated along the entire length of the trench consisted of 3 to 6 inches of asphalt, 1 to 1½ feet crushed rock, and 7 feet of brown, medium-grained, silty sand fill. No debris was encountered in the fill material. Two 10-inch diameter cast iron pipes were encountered in the trench at a depth of approximately 7 feet. The pipes were determined to be the former brine line pipes from the two southeastern salt pads. During plant operations, these brine lines were used to transfer brine solution to a sump and then to the chlorine cells rooms for processing. Following plant demolition in 2004, the line from the sump to the chlorine cell room was re-routed to the storm water system. The former brine lines from the salt pads currently collect storm water and discharge it to the storm water system. One of these salt pad storm water lines was damaged during the trench excavation. This line was plugged and abandoned in place. Storm water that had accumulated in the salt pads was then re-routed to another portion of the storm water system by removing part of the berms on the salt pads.

Geotechnical Samples

Bulk samples representative of the fill material were collected during the investigation. Two of the samples were collected from Trench 1 and one sample from Trench 2. Sampling locations are shown on Figures 2 and 3 respectively. One sample from Trench 1 (T1 90'N, 18'D) and one sample from Trench 2 (T2 10'N, 10'N) were submitted for geotechnical testing for the following parameters using the American Society for Testing and Materials (ASTM) guidelines outlined below.

- Moisture (ASTM D-2216);
- Grain-size analysis (ASTM D-422);
- Atterberg Limits (ASTM D-4318);
- Classification (ASTM D-2487); and
- Shear Strength, Triaxial CU (ASTM D-4767).

The geotechnical testing results are presented in the geotechnical laboratory report, included as Attachment A. The geotechnical analytical results will be used to confirm the current slope stability calculations and refine the GWBW alignment, including setback. The results of the slope stability analysis and final GWBW alignment will be presented in the Groundwater SCM Pre-Final Design described in the June 2009 *Draft Groundwater Source Control Design and Implementation Work Plan, Arkema Inc. Facility, Portland, Oregon.*

If you have any questions or require additional information, please feel free to contact us at (503) 488-5282.

Sincerely,



Brendan Robinson, P.E.
Project Manager

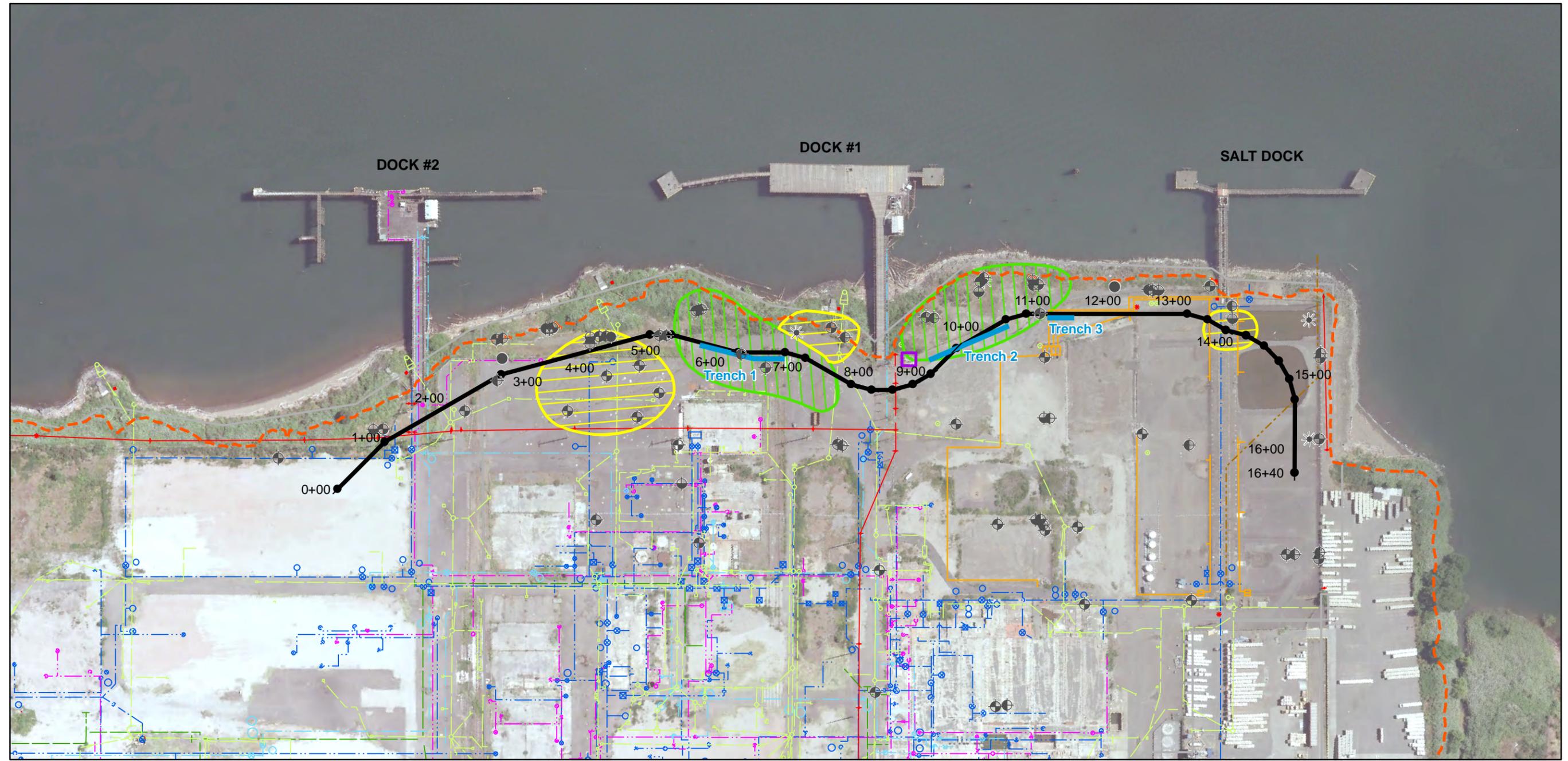


Erik C. Ipsen, P.E.
Partner

BAR/ECI/ssh/0114499
Attachments

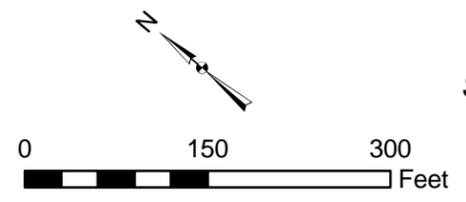
cc: Todd Slater/LSS
Henning Larsen/DEQ
Tom Gainer/DEQ
Sean Sheldrake/EPA
David Livermore/Integral
Larry Patterson

Figures



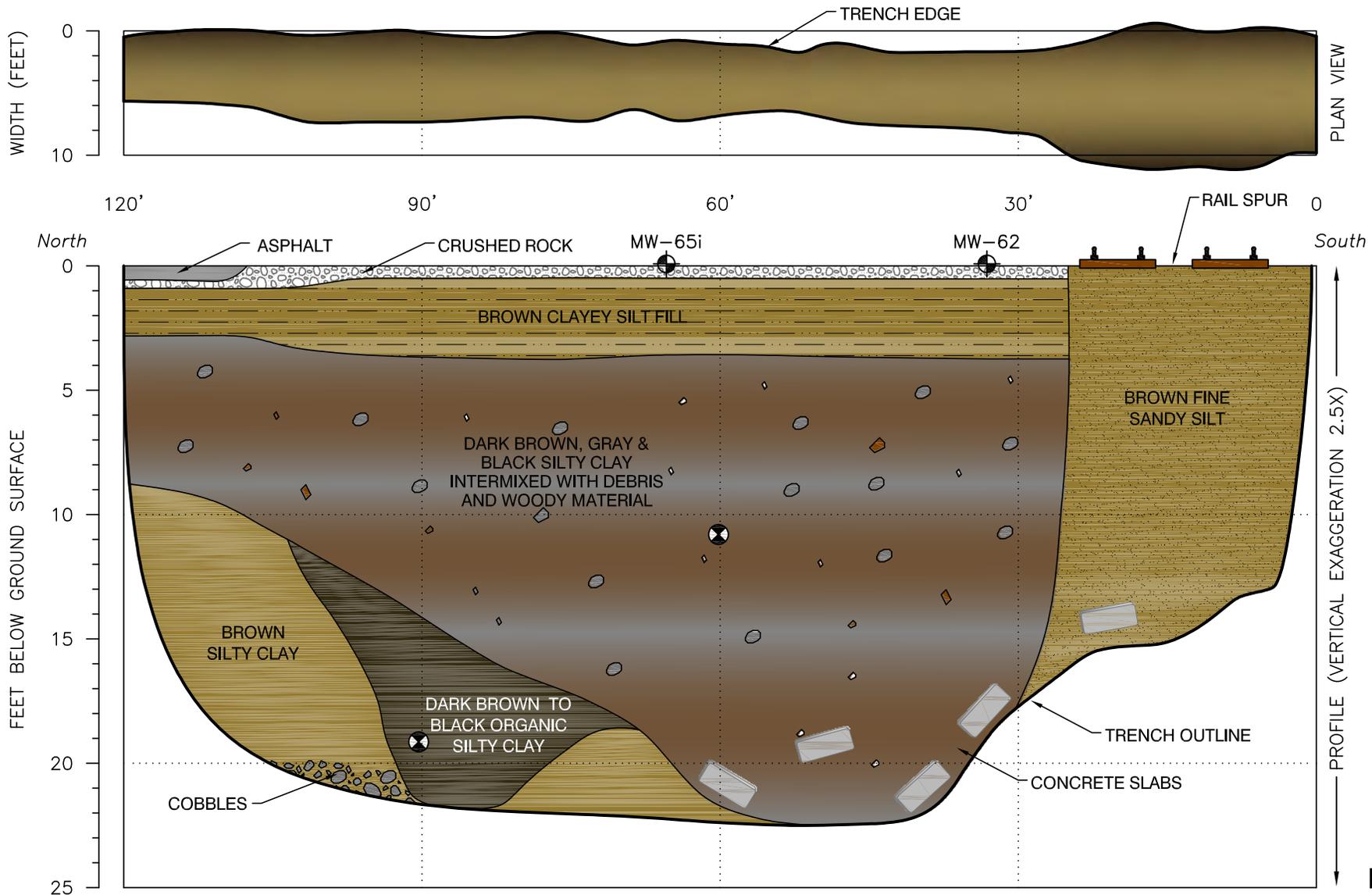
Legend

- | | | | |
|-----------------------------|---|----------------------------------|----------------------------------|
| Existing Monitoring Wells | ● Mud Rotary Boring | ∟ Parcel and Property Boundaries | — Steam Line |
| ⊕ Shallow Zone | ⊛ CPT Boring Location | — Brine Line | — Domestic Water Line |
| ⊕ Shallow-Intermediate Zone | — Proposed Barrier Wall Alignment | — 24" Abandoned Steel | — Electric Power Line (Overhead) |
| ⊕ Intermediate Zone | — Debris Investigation Trench Location | — Industrial Stormwater Drain | □ Electrical Substation |
| ⊕ Deep Zone | — Top of Bank (35 ft Contour or defined break in grade) | — Domestic Sewer | |
| ⊕ Gravel Zone | Areas of Subsurface Debris | — City Water Line | |
| ● Basalt Zone | ⊕ Soft Debris | — River Water Line | |
| | ⊕ Refusal/Concrete Debris | | |



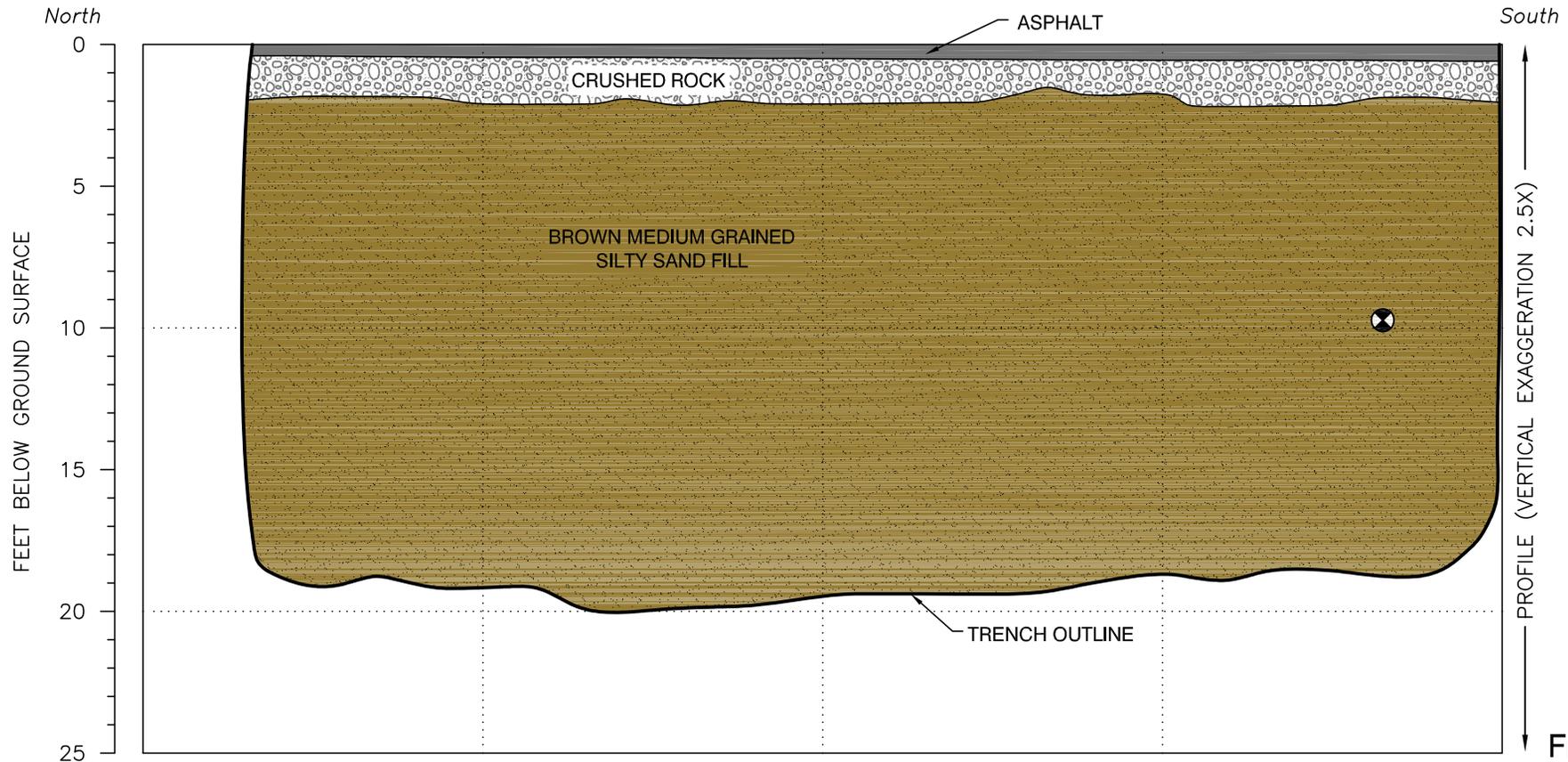
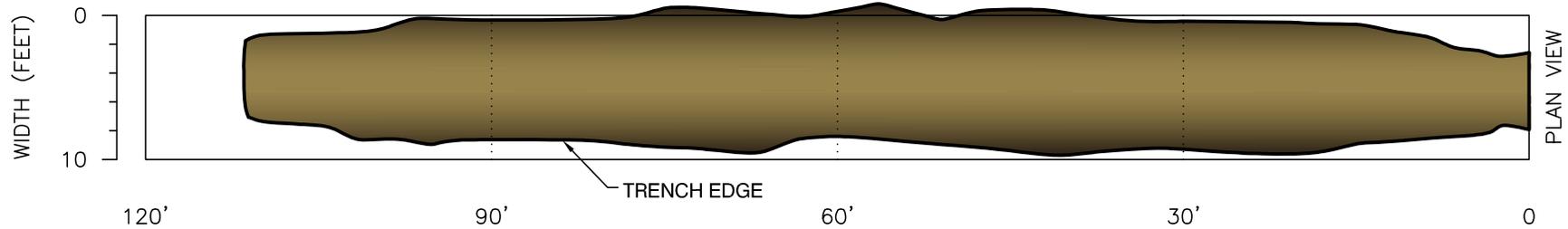
Data Sources: Aerial Photo: City of Portland, June 2008
 Utility locations approximate, from Arkema facility maps.

Figure 1
 Trenching Locations
 Subsurface Debris Investigation
 Arkema Inc. Facility
 Portland, Oregon



- LEGEND**
- ⊕ MONITORING WELL LOCATION
 - ⊗ GEOTECHNICAL SAMPLE LOCATION

Figure 2
Trench 1 Cross Section
LSS Subsurface Debris Investigation
Portland, Oregon



LEGEND
⊗ GEOTECHNICAL SAMPLE LOCATION

Figure 3
Trench 2 Cross Section
LSS Subsurface Debris Investigation
Portland, Oregon

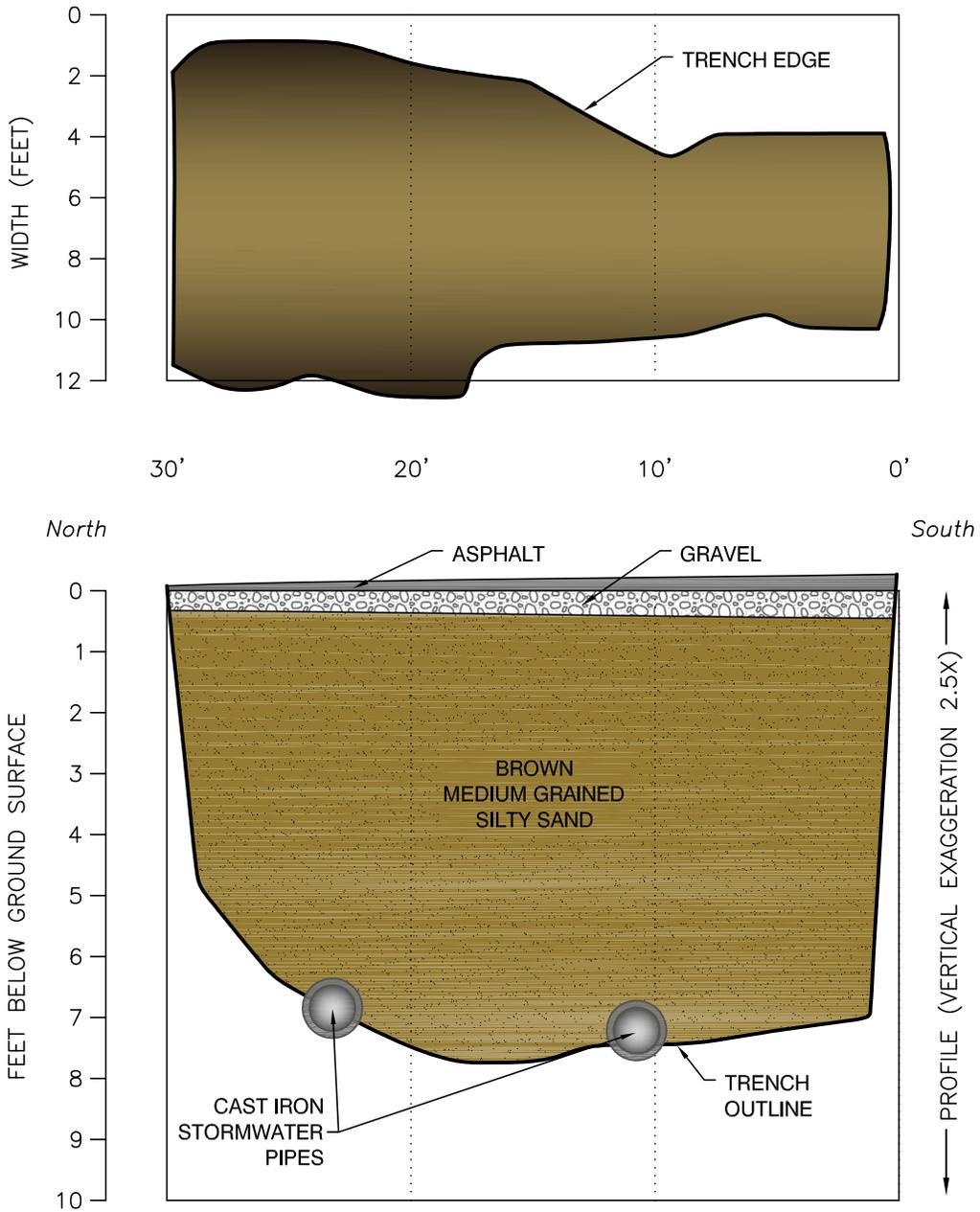


Figure 4
Trench 3 Cross Section
LSS Subsurface Debris Investigation
Portland, Oregon

Attachment A
Geotechnical Analytical Report



May 25, 2010
File No. P1701-05-02

Mr. Brendan Robinson
ERM West
101 SW Main Street, Suite 804
Portland, Oregon 97204

SUBJECT: AREKMA, 6400 NW FRONT AVENUE
PORTLAND, OREGON
GEOTECHNICAL LABORATORY TEST RESULTS

Dear Mr. Robinson:

Geocon Northwest is pleased to submit the enclosed geotechnical laboratory test results of samples submitted by ERM for the above-referenced project. The samples were identified as:

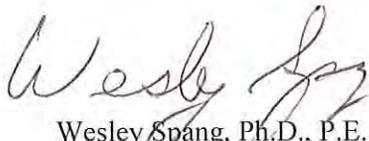
T1,90'N,18'D; T2,10'N, 10'D

The requested geotechnical laboratory tests and confining pressures for direct shear and triaxial shear tests were provided by representatives of ERM West.

The following pages present the results of the geotechnical laboratory testing.

Please contact the undersigned if you have any questions regarding this information.

Sincerely,
Geocon Northwest, Inc.


Wesley Spang, Ph.D., P.E.
Principal Engineer

ATTERBERG LIMITS TEST RESULTS

Sample Number	Liquid Limit	Plastic Limit	Plasticity Index	USCS
T1 90'N 18'D	30	22	8	ML

SHEAR STRENGTH TEST RESULTS

Sample Number	Shear Test	Cohesion (psf)*	Friction Angle (degrees)*
T1 90'N 18'D	TxCU	70	33
T2 10'N 10'D	DS	103	43

Tx CU - Triaxial shear, consolidated undrained with pore pressure
Effective stress strength values obtained at maximum principal stress ratio

DS – Direct Shear
Strength values obtained at maximum shear stress

* Cohesion and friction angle obtained from best-fit analysis of data

MOISTURE TEST RESULTS

Sample Number	Moisture Content (%)
T1 90'N 18'D	31.4
T2 10'N 10'D	7.9

SOIL CLASSIFICATION

Sample Number	USCS Classification
T1 90'N 18'D	ML
T2 10'N 10'D	SP-SM

TRIAXIAL SHEAR STRENGTH - CU TEST

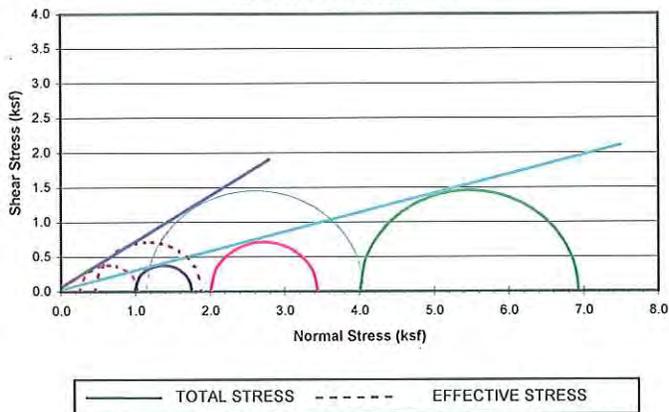
ASTM D4767

Project Name: Arkema
 Project Number: P1701-05-02
 Sample Number: T190N 18'D

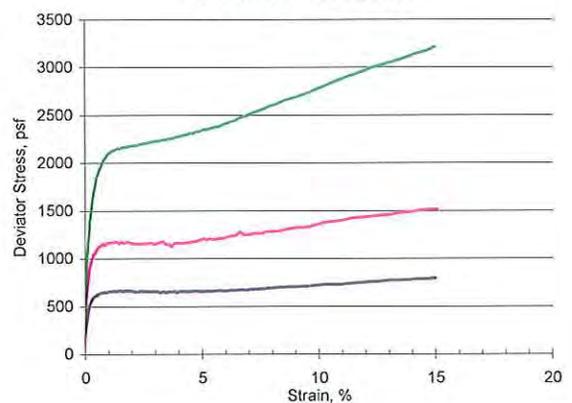
SAMPLE ID: 1 2 3

INITIAL CONDITIONS AT START OF TEST		HEIGHT (in.)	5.00	5.00	5.00
		DIAMETER (in.)	2.42	2.42	2.42
		MOISTURE CONTENT (%)	18.0	17.9	18.1
		SATURATION (%)	70.2	69.0	63.2
		DRY DENSITY (pcf)	85.1	85.1	84.9
AFTER SATURATION		DRY DENSITY (pcf)	84.1	83.9	84.4
AFTER CONSOLIDATION		DRY DENSITY (pcf)	83.7	86.3	89.8
		DRY DENSITY (pcf)	83.6	86.4	90.0
		MOISTURE CONTENT (%)	26.1	24.7	24.3
		SATURATION (%)	96.4	99.4	99.4
		STRAIN RATE (%/min)	0.0167	0.0168	0.0166
SHEAR TEST CONDITIONS		CELL PRESSURE (psf)	11060	13450	15520
		INITIAL BACK PRESSURE (psf)	10070	11440	11510
		INITIAL EFF CONFINING PRESS (psf)	990	2010	4010
		TOTAL MAJOR PRIN STR AT FAIL (psf)	1760	3450	6930
		EFF MAJOR PRIN STR AT FAIL (psf)	1030	1900	4060
		PORE PRESSURE AT FAIL (psf)	730	1550	2870
		EFF MINOR PRIN STR AT FAIL (psf)	260	460	1140

MOHR'S CIRCLES



STRESS-STRAIN



Strength Parameters: At maximum principal stress ratio

	<u>TOTAL</u>	<u>EFFECTIVE</u>
ϕ , degrees	15.4	33.3
c, psf	40	70



GEOCON

Arkema

P1701-05-02

Date: Monday, May 10, 2010

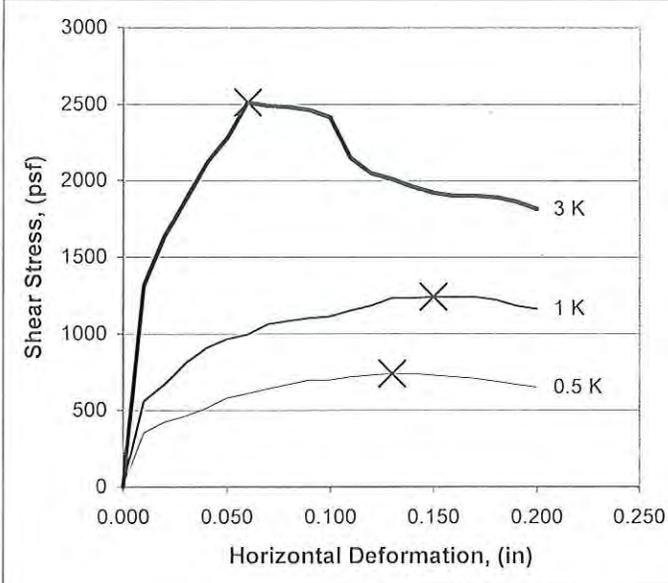
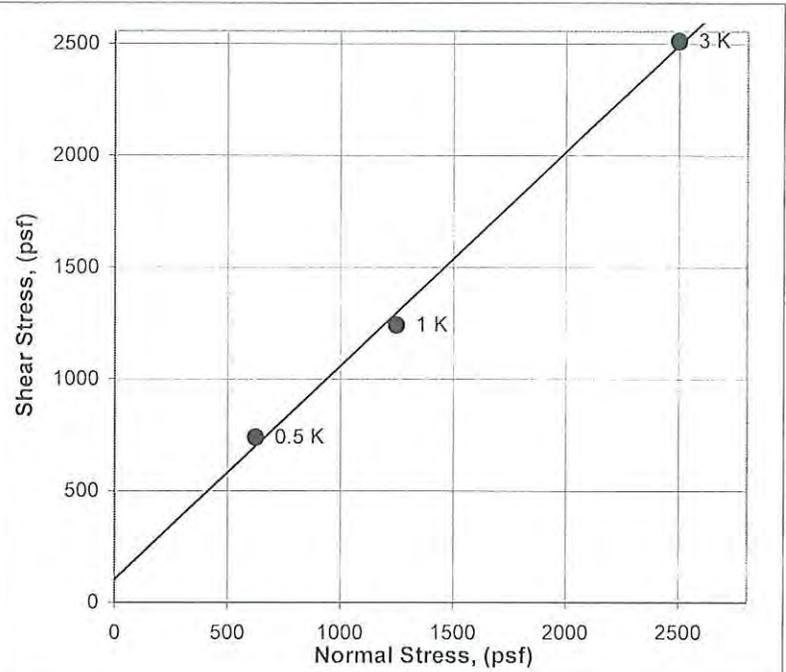
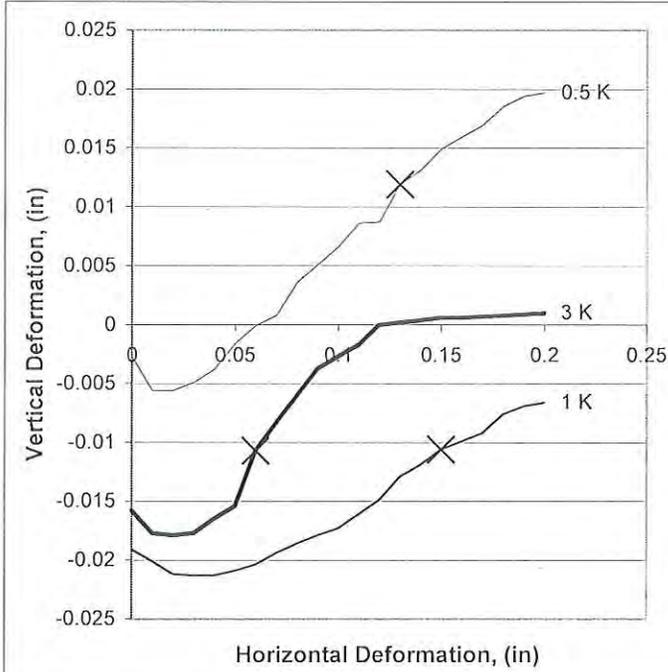
By: Tom G.

Sample No.: T2 10'N 10'D

Natural or Remold: Remolded

Description: SM

Remarks:



ϕ (Degrees)	43.7
c (psf)	103
Tan ϕ	0.956
Method	Calc

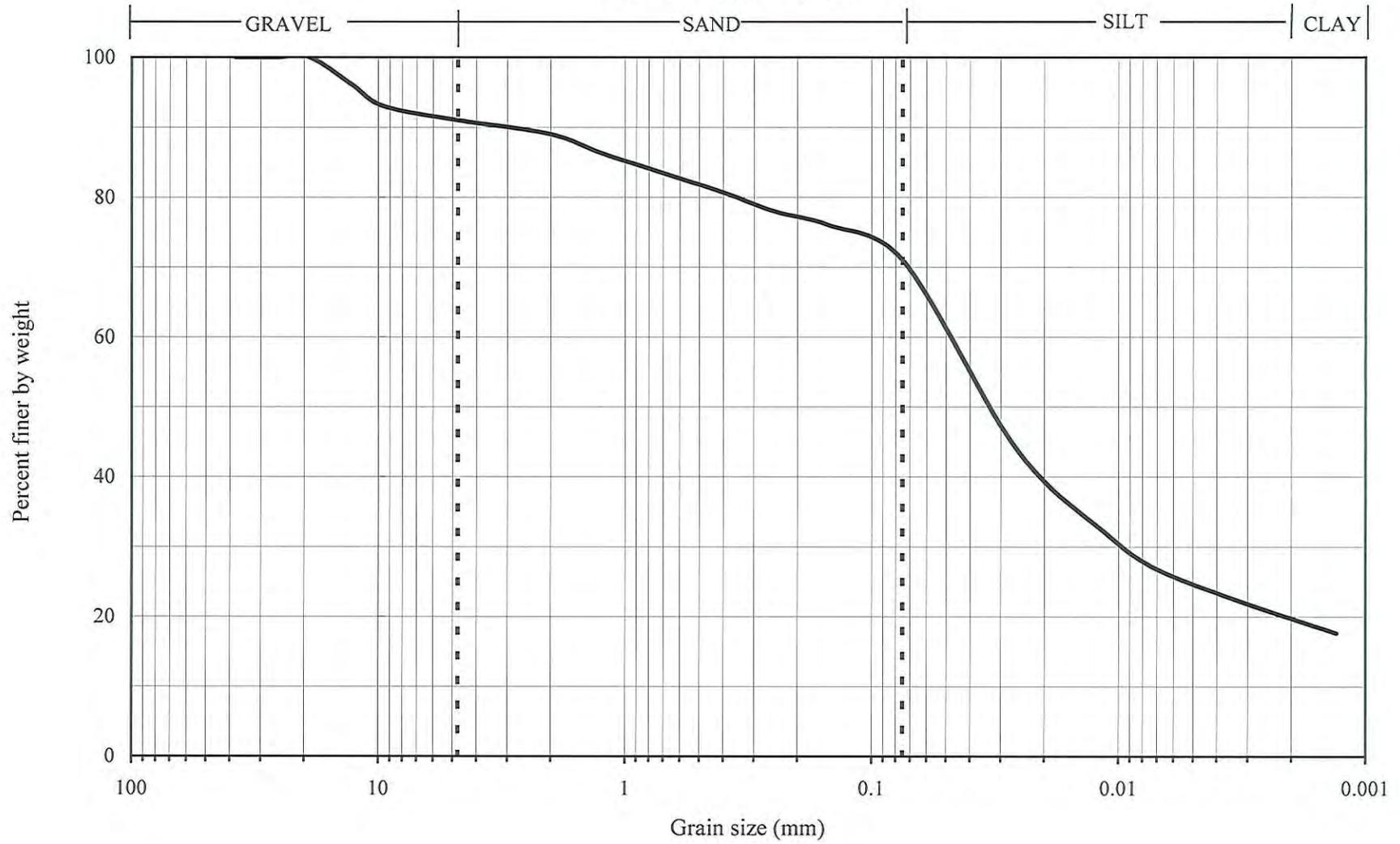
	Load	0.5 K	1 K	3 K
INITIAL				
Water Content		8.0%	8.6%	9.5%
Dry Density (pcf)		103.4	102.8	101.8
Saturation*		35.3%	37.5%	40.1%
Height (inches)		1.00	1.00	1.00
AFTER TEST				
Water Content		21.8%	14.4%	21.0%
Dry Density (pcf)		101.5	103.4	101.7
FAILURE				
Normal Stress (psf)		625	1250	2500
Failure Stress (psf)		739	1241	2512
Failure Definition		Max	Max	Max
Displacement (in)		0.13	0.15	0.06
Rate (in/min)		0.0100	0.0100	0.0100

* Degree of saturation calculated with a specific gravity of 2.65

Grain Size Distribution (ASTM D1140 and D 422)

Arkema ERM

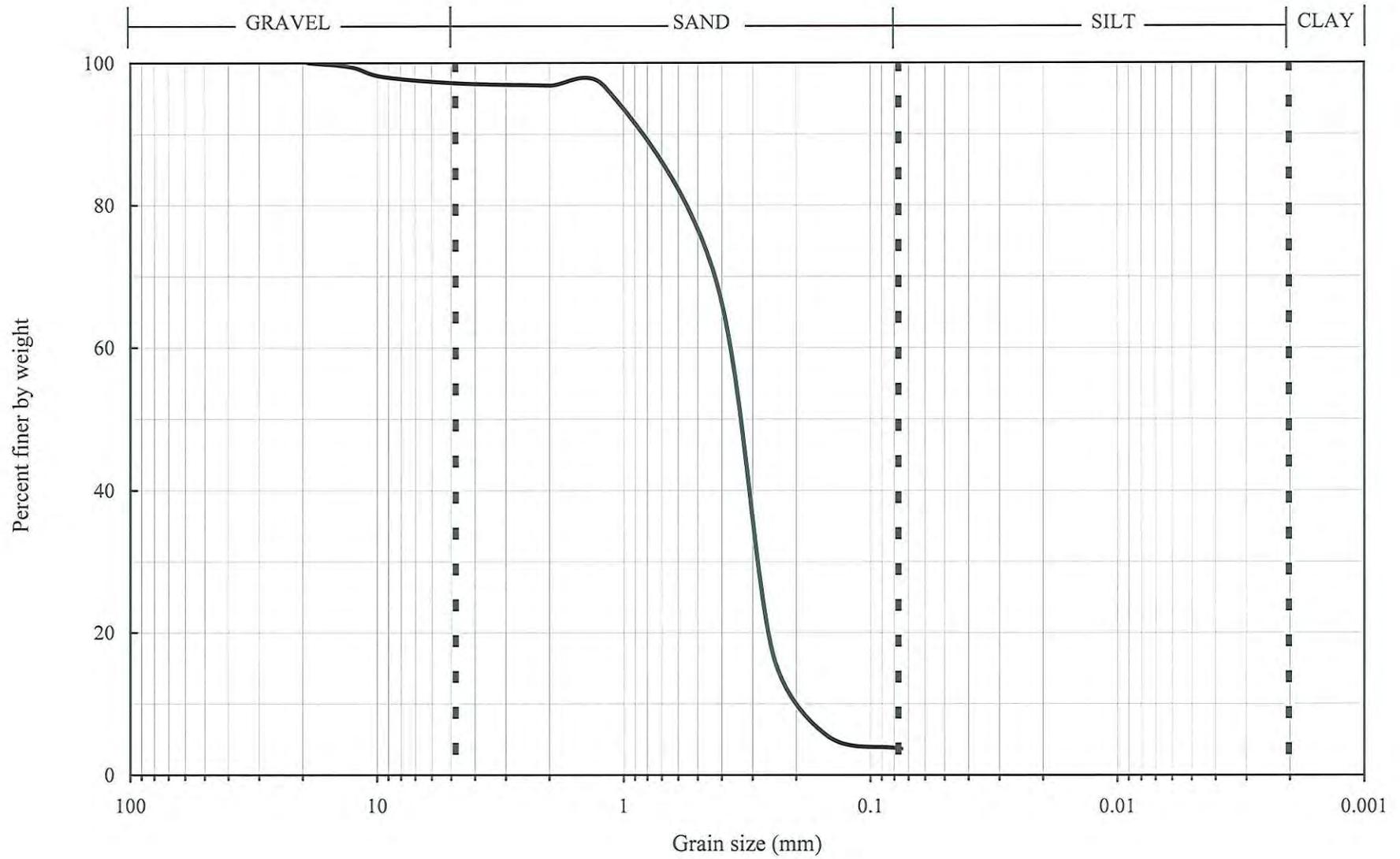
T1-90'N Depth = 18 feet



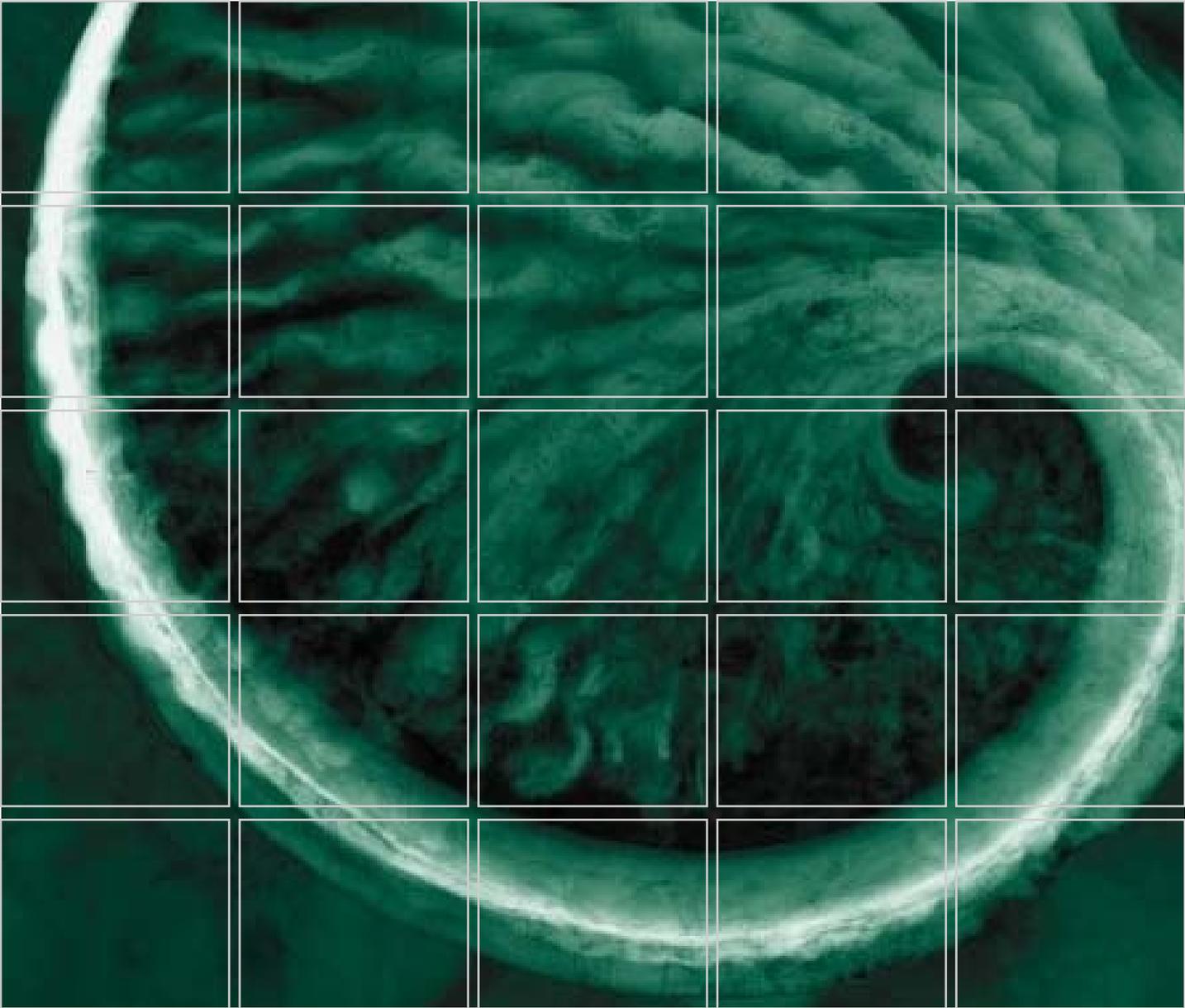
Grain Size Distribution (ASTM D1140 and D 422)

Arkema ERM

Sample T2-10'N Depth = 10 feet



Attachment C
Construction Quality Assurance
Plan



Attachment C: Construction Quality Assurance Plan

Groundwater Barrier Wall Final Design
Groundwater Source Control Measure
Former Arkema Facility
Portland, Oregon

July 2012

Prepared for:
Legacy Site Services
LLC

www.erm.com



Retia USA, LLC/ Legacy Site Services LLC

Construction Quality
Assurance/Quality Control Plan
- Groundwater Source Control
Measure

*Arkema Inc. Facility
Portland, Oregon*

July 2012

Project Number: 158363



Brendan Robinson, P.E.
Project Manager



Erik Ipsen, P.E.
Partner-in-Charge

Environmental Resources Management
1001 SW 5th Avenue
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(503) 488-5142

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1.0 CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL PLAN

1.1 PURPOSE

On behalf of Legacy Site Services LLC (LSS), agent for Arkema Inc., ERM-West, Inc. (ERM), has prepared this Construction Quality Assurance/Quality Control (CQA/QC) Plan for the former Arkema Inc. Portland Plant (the site) located at 6400 NW Front Avenue in Portland, Oregon. This CQA/QC Plan has been prepared pursuant to the Order on Consent requiring source control measures and a feasibility study issued by the Oregon Department of Environmental Quality (ODEQ), signed 31 October 2008 (DEQ No. LQVC-NWR-08-04).

The purpose of this document is to present the CQA/QC requirements for construction of the Groundwater Source Control Measure (GW SCM) Groundwater barrier wall (GWBW) and the related construction certification report. This CQA/QC Plan defines the various management and inspection staff personnel directly responsible for the construction quality control (CQC) activities, as well as construction quality assurance (CQA) activities, including position descriptions, responsibilities, and experience requirements. In addition, this CQA/QC Plan addresses specific quality assurance and quality control (QA/QC) testing requirements for each of the various components of the GBW construction. During construction, contractors, vendors, and others involved in the implementation of the GBW, will be required to provide supplemental supporting documents. These supplemental requirements will be outlined in the technical specifications provided in the Final Design package submittal.

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2.0

POSITION RESPONSIBILITIES

The construction contractor will be responsible for the quality of construction in the finished product and for compliance with the construction documents, drawings, and specifications. The Project Engineer will have ultimate responsibility for the oversight of construction and for conformance with the construction drawings, specifications, and quality assurance requirements. The complete construction, design, and CQA team organization is presented on Figure 1.

The CQC team members will be employed by the construction contractor. Therefore, specific positions, and their associated descriptions and responsibilities, will be set forth by the contractor procured. However, the construction contract documents require that the contractor assign an individual to manage the CQC team and that the individual will not be directly involved in supervising construction activities.

2.1

CONSTRUCTION QUALITY ASSURANCE TEAM

The CQA team will solely participate in the quality assurance function and will not be involved in any other aspect of the construction effort. This team will, however, possess all of the credentials, capabilities, and experience of an independent design/construction oversight team. The duties and responsibilities of each position are described below. One individual or entity may perform multiple CQA responsibilities.

Project Engineer - The Project Engineer is responsible for overall implementation and management of the CQA/QC Plan and will supervise the preparation of the construction certification report. The Project Engineer will be independent of the construction contractor, but directly accountable to LSS for the successful completion of the work. The duties and responsibilities of the Project Engineer include the following:

- Review and approve shop drawings.
- Provide support to the CQA Manager in interpreting the meaning and intent of the construction plans and specifications and in the performance and supervision of the CQA testing program.
- Provide consultation and technical support to LSS.
- Identify, as appropriate and in coordination with the CQA Manager, discrepancies or deficiencies in project work. Any deficiencies deemed by the Project Engineer to require immediate attention will be reported to LSS immediately.
- Sign, certify, and seal the construction certification report as a Professional Engineer registered in the state of Oregon, who attests to the quality of the work being certified. The report will include the results of all CQA and CQC

testing and deviations from the construction plans and specifications. In addition, the report will include "as-built" drawings, daily inspection reports, photographs, and other applicable documents.

- Prepare the final "as-built" drawings indicating the features constructed and the existing location of all features.
- Make recommendations to LSS regarding the approval of construction subcontractors and material vendors.
- Evaluate the contractor's project schedule.
- Review and make recommendations to LSS regarding any delays to the project schedule.
- Review and evaluate change orders proposed by the contractor, owner, designer, or CQA team. All change orders will require a signature indicating approval from all above-referenced parties as well as the ODEQ.
- Provide other technical support to LSS as required.

CQA Manager - The CQA Manager will be assigned to the site on a full-time basis, and will report directly to the Project Engineer. The duties and responsibilities of the CQA Manager include the following:

- Perform and/or oversee all CQA testing activities.
- Coordinate CQA activities with the Construction Manager and the Project Engineer.
- Review contractor invoices and recommend payment schedule to the Project Engineer.
- Maintain copies of all CQA and CQC testing results and certifications.
- Prepare and distribute weekly construction reports to the Project Engineer and LSS.
- Provide input on the construction certification report.

The general purpose of the CQA Manager is to ensure that the contractor provides a full, complete, and properly constructed product in accordance with all plans and specifications. The primary duties of the CQA Manager are to verify that all QA and QC tests required under the construction contract are performed, and assure that all installed equipment and materials have passed the required tests. The CQA Manager will complete material and equipment tests and maintain reports of testing results, any failures, and any corrective actions employed to obtain acceptable test results. All test data, reporting data, and contractor submissions will be included in the construction certification report. The CQA Manager shall be permitted to suspend construction activities under conditions such as inclement weather, where they believe the integrity of the GWBW or any of its components will be compromised.

Geotechnical CQA Manager - The Geotechnical CQA Manager will be on site during all earthwork operations requiring quality assurance testing, including excavation and site preparation, and construction of the GWBW and cap. They will oversee the activities of the Field CQA Inspectors and coordinate the testing programs of the CQA Laboratory.

CQA Laboratory - The CQA Laboratory will be an entity independent of both LSS and the construction contractor, located either on site or off site. It will be responsible for conducting tests on soil materials and soil-reagent mixes to ensure conformance with the contract plans and specifications. The CQA Laboratory will not analyze soils or soil-reagent mixes provided by any party involved with the supply of materials, the construction contractor, or subcontractors. The CQA Laboratory will report directly to the CQA Manager.

Field CQA Inspectors - Field CQA Inspectors will report directly to the CQA Manager and will be present during all major construction activities. The duties and responsibilities of this position include the following:

- Visually inspect materials imported to the site for conformance with contract specifications and for variations from tests completed prior to the materials being delivered to the site.
- Obtain samples for geotechnical CQA testing.
- Observe field sampling and testing performed by the contractor's CQC staff, and review test results.
- Observe and record observations regarding the storage and handling of equipment and materials.
- Independently verify quantity calculations.
- Prepare daily reports documenting all contractor activities.
- Assist with the generation of soil volume placement estimates.

- Assist with the preparation of "as-built" drawings.

2.2

CONSTRUCTION QUALITY CONTROL TEAM

Key positions in the construction contractor's CQC team will be delineated in the construction contract; e.g., Contractor Superintendent, Contractor CQC Manager, etc. Other CQC positions and responsibilities will be assigned at the discretion of the procured contractor. The construction contractor's CQC team will be subject to the review and approval of the CQA Manager before site mobilization is authorized. Team members may be employed directly by the contractor, or as subcontracted firms or individuals. One individual or entity may perform multiple CQC responsibilities. The CQC team will consist of the following positions, or equivalent:

Contractor Superintendent - The construction Contractor Superintendent will have overall responsibility for implementing the CQC program, including appointment of a CQC Manager, and providing daily construction reports documenting testing and construction activities. The daily reports will be provided to the CQA Manager. The CQC Manager may not be the construction Contractor Superintendent and must be approved by the Project Engineer.

CQC Manager - The CQC Manager will be responsible for overseeing all quality control testing performed by the contractor and providing contractor certification reports to the CQA Manager. Other related duties will include coordinating shop drawing submittals, providing required samples, and coordinating work and testing with the CQA Manager. The CQC Manager will provide daily construction reports which document all testing and describe construction activities performed at the site. The CQC daily report will be provided to the construction Contractor Superintendent and a copy provided to the CQA Manager. The CQC Manager will report directly to the construction Contractor Superintendent.

CQC Laboratory - The CQC Laboratory will be an independent, qualified, soils and materials testing laboratory retained by the contractor. The laboratory will conduct tests on representative soils and soil-reagent mixes at the source facilities of materials brought on site, in the field during activities conducted at the site, and/or at the laboratory to determine compliance with construction contract documents.

Field CQC Inspectors - Field CQC Inspectors will report directly to the CQC Manager and will be present during all major construction activities. The duties and responsibilities of this position include the following:

- Conduct field testing on samples of slurry and soil-reagent backfill to control construction of the GWBW.
- Visually inspect materials imported to the site for conformance with contract

specifications and for variations from tests completed prior to the materials being delivered to the site.

- Perform moisture-density relationship tests on constructed soils to ensure that compaction and moisture content are in conformance with construction specifications.
- Obtain samples for geotechnical CQC testing.
- Observe and record observations regarding the storage and handling of equipment and materials.
- Prepare daily reports documenting all contractor activities.
- Assist the Construction Manager in the generation of soil volume placement estimates.
- Assist with the preparation of "as-built" drawings.

Land Surveyor - The survey crew will consist of a qualified land surveyor and assistants. The land surveyor will identify and establish initial horizontal and vertical control for the construction contractor and will provide the required surveying for the preparation of certified "as-built" drawings for inclusion in the construction certification report." The land surveyor must be licensed in the state of Oregon and certify all "as-built" drawings and thicknesses, as required in the technical specifications. The survey crew will report directly to the CQC Manager.

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3.0 **LEVEL OF EXPERIENCE**

3.1 **CONSTRUCTION QUALITY ASSURANCE TEAM**

Project Engineer - The Project Engineer will be a Professional Engineer registered in the state of Oregon. The Project Engineer will have a thorough knowledge and familiarity with the project and demonstrated experience in the design and construction of various types of groundwater barrier walls (i.e., soil-bentonite slurry wall, deep soil mixing, jet grouting). In addition, they will have experience in earthwork. The Project Engineer will have a minimum of 10 years experience in civil engineering design and construction and a minimum of five years of experience in groundwater barrier wall design and/or construction.

CQA Manager - The CQA Manager will have experience in civil construction projects including earthwork, and soils and materials testing. The CQA Manager will have a thorough familiarity with the project and testing requirements, and have directly-applicable experience in the testing of materials used to construct groundwater barrier walls. The CQA Manager will have a minimum of five years of experience in materials testing or an equivalent. The CQA Manager will be certified for operation of a nuclear density gauge.

Geotechnical CQA Manager - The Geotechnical CQA Manager will have a working knowledge of field and laboratory geotechnical testing protocols and procedures for a wide variety of soils. They must have a minimum of three years of experience performing and overseeing earthwork operations associated with groundwater barrier wall construction, and one year as a geotechnical inspector.

CQA Laboratory - The CQA Laboratory will have experience in testing soils, soil-reagent mixes, and other construction materials, and will be familiar with related American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), and other construction materials testing standards.

Field CQA Inspectors - Field CQA Inspectors will have experience and/or training in both the testing and inspection of earthwork, granular materials, groundwater barrier walls, concrete, and other site improvements. The inspectors that perform soil, slurry, and soil-reagent backfill testing will have a minimum of one year experience performing the required tests, including familiarity with the use and application of sand cones, Marsh funnels, filter presses, slump cones, scales, ovens, Shelby-tube sampling, nuclear density gauges, levels and tripods, and will be certified for operation of a nuclear density gauge.

3.2 **CONSTRUCTION QUALITY CONTROL TEAM**

Construction Contractor Superintendent - The construction Contractor Superintendent will be trained in the areas of landfill/civil/earthwork construction and engineering. The Superintendent will have demonstrated

experience in earthwork projects and groundwater barrier wall construction, and will have a familiarity with the project. The Superintendent will have a minimum of 10 years experience in the construction field.

CQC Manager - The CQC Manager will have a working knowledge of civil engineering, earthwork, and construction materials testing. The CQC Manager will have demonstrated experience with earthwork projects and groundwater barrier wall construction. The CQC Manager will have a minimum of five years experience in construction and materials testing.

Field CQC Inspectors - Field CQC Inspectors will have experience and/or training in both the testing and inspection of earthwork, granular materials, groundwater barrier walls, concrete, and other site improvements. The inspectors that perform soil, slurry, and soil-reagent backfill testing will have a minimum of one year experience performing the required tests, including familiarity with the use and application of sand cones, Marsh funnels, filter presses, slump cones, scales, ovens, Shelby-tube sampling, nuclear density gauges, levels and tripods, and will be certified for operation of a nuclear density gauge.

CQC Laboratory - The CQC Laboratory will be an independent laboratory subject to the approval of the CQA Manager. The CQC Laboratory will have a minimum of three years experience in testing soils, soil-reagent mixes, and other construction materials, and will be familiar with ASTM, AASHTO and other applicable test standards.

Land Surveyor - The Land Surveyor will have at least five years experience as a crew chief in performing topographic surveys, and must be a professional land surveyor registered in the state of Oregon.

4.0 *QUALITY ASSURANCE AND QUALITY CONTROL TESTING*

QA/QC testing will be conducted for each of the major items under construction. The components of the GWBW construction subject to QA/QC testing include the following:

- GWBW – soil-bentonite slurry wall, jet grouting, and deep soil mixing;
- General earthwork - common fill, clay, and trench spoils test pad; and
- Granular materials.

Each component is discussed separately below.

4.1 *SOIL-BENTONITE SLURRY WALL*

4.1.1 *Bentonite*

4.1.1.1 *Pre-Construction*

- The contractor must submit the name of the bentonite supplier, the source of bentonite, and a sample to the CQA Manager prior to construction, in accordance with the Specifications.
- The contractor must submit the results of the following tests: free swell (USP NF XVII), plastic viscosity (API 13A), viscometer (API 13A), and residue larger than 75 micrometers (μm) (API 13A) for each proposed source of bentonite.
- The contractor must submit the results of the following tests: YP/PV ratio (API 13A), filtrate loss (API 13A), and moisture content (ASTM D2216) for each truck or railcar shipment of bentonite.
- The contractor must supply samples of bentonite, as required by the contract specifications, or as requested by the CQA Manager.

4.1.1.2 *Construction*

- The contractor must supply, for each designated load of bentonite, the bentonite manufacturer's certifications and laboratory test results that demonstrate that the bentonite meets contract specifications.
- The contractor shall keep a log of bentonite deliveries that includes: date, source, time of delivery, weight, and laboratory quality control test results supplied by the manufacturer.

4.1.1.3 *Post-Construction*

- No testing required.

4.1.2 *Mix Water*

4.1.2.1 *Pre-Construction*

- The contractor must submit the results of the following tests: pH (API RP 13B-1), total dissolved solids (EPA 600), and hardness (API RP 13B-1) for each proposed source of water.

4.1.2.2 *Construction*

- No testing required.

4.1.2.3 *Post-Construction*

- No testing required.

4.1.3 *Slurry (Initial and In-Trench)*

4.1.3.1 *Pre-Construction*

- No testing required.

4.1.3.2 *Construction*

- The contractor must submit the results of the following tests for slurry prior to placement in the trench: viscosity (API RP 13B-1), density (ASTM D4380), filtrate loss (API RP 13B-1), and pH (API RP 13B-1) (must be performed twice per 8-hour shift).
- The contractor must submit the results of the following tests for in-trench slurry: viscosity (API RP 13B-1) and density (ASTM D4380). The slurry shall be sampled at least twice per 8-hour shift (near the beginning and end of each shift) at two depths; approximately two feet below the slurry surface and approximately two feet above the bottom of the trench. The samples shall be taken within five feet of the toe of the soil-bentonite backfill slope. Additional samples shall be obtained at the request of the Project Engineer.

4.1.3.3 *Post-Construction*

- No testing required.

4.1.4 *Soil-Bentonite Backfill*

4.1.4.1 *Pre-Construction*

- The contractor shall obtain samples of soil imported to the site for use in the soil-bentonite backfill, as required by contract specifications, and as deemed necessary by the Project Engineer to achieve the performance requirements of

the wall. The contractor must submit results of the following tests performed once for every 500 cubic yards of imported soil: particle size analysis (ASTM D422), moisture content (ASTM D2216), and Atterberg limits (ASTM D4318).

4.1.4.2

Construction

- The contractor shall obtain samples of the soil-bentonite backfill as required by the contract specifications and as deemed necessary by the Project Engineer to achieve the performance requirements of the wall. The contractor must submit results of the following tests performed once per day or once every 200 lineal feet of installed GWBW at 25 vertical foot intervals: particle size analysis (ASTM D422), Atterberg limits (ASTM D4318), and permeability (ASTM D5084).
- The contractor shall test the slump (ASTM C143) and density (ASTM D4380) of the soil-bentonite backfill twice per 8-hour shift.
- The coefficient of permeability of the soil-bentonite backfill must be verified to be less than 1×10^{-6} centimeters per second (cm/sec).
- The contractor shall take soundings every 20 feet along the GWBW centerline. Soundings shall record the bottom of the excavation and the backfill slope and be recorded to the nearest 0.5 feet.
- The contractor shall maintain a continuous as-built profile of the trench bottom and backfill slopes, including descriptions of materials encountered in the trench.
- The contractor shall confirm that the GWBW extends to the confining layer, as required by the contract specifications, using methods approved by the Project Engineer.

4.1.4.3

Post-Construction

- The contractor shall obtain undisturbed samples of the soil-bentonite backfill, as required by contract specifications, and as deemed necessary by the Project Engineer to achieve the performance requirements of the wall. At a minimum, one undisturbed sample of the backfill shall be taken from between the ground surface and mid-depth, and one sample from between mid-depth and the trench bottom in four sample locations. One of these sample locations must be within the Chlorate Area and one must be within the Acid Plant Area. Continuous coring shall be used to visually confirm uniform GWBW composition that is free of voids. The contractor shall test these samples for permeability (ASTM D5084).
- The coefficient of permeability of the soil-bentonite backfill must be verified to be less than 1×10^{-6} centimeters per second (cm/sec).

4.2 JET GROUTING AND DEEP SOIL MIXING

4.2.1 Bentonite

4.2.1.1 Pre-Construction

- The contractor must submit the name of the bentonite supplier, the source of bentonite, and a sample to the CQA Manager prior to construction, in accordance with the technical specifications.
- The contractor must submit the results of the following tests: free swell (USP NF XVII), plastic viscosity (API 13A), viscometer (API 13A), and residue larger than 75 µm (API 13A) for each proposed source of bentonite.
- The contractor must submit the results of the following tests: YP/PV ratio (API 13A), filtrate loss (API 13A), and moisture content (ASTM D2216) for each truck or railcar shipment of bentonite.
- The contractor must supply samples of bentonite, as required by contract specifications, or as requested by the CQA Manager.

4.2.1.2 Construction

- The contractor must supply, for each designated load of bentonite, the bentonite manufacturer's certifications and laboratory test results that demonstrate that the bentonite meets contract specifications.
- The contractor shall keep a log of bentonite deliveries that includes: date, source, time of delivery, weight, and laboratory quality control test results supplied by the manufacturer.

4.2.1.3 Post-Construction

- No testing required.

4.2.2 Soil-Reagent Matrix

4.2.2.1 Pre-Construction

- No testing required.

4.2.2.2 Construction

- The contractor shall obtain samples of the uncured soil-reagent matrix, as required by contract specifications, and as deemed necessary by the Project Engineer to achieve the performance requirements of the wall. At a minimum, one sample of the soil-reagent matrix shall be taken per day or one sample for each 200 lineal feet of installed groundwater barrier wall at 25

vertical-foot intervals. The contractor shall test these samples for permeability (ASTM D-5084).

- The coefficient of permeability of the soil-reagent matrix must be verified to be less than 1×10^{-6} centimeters per second (cm/sec).

4.2.2.3

Post-Construction

- The contractor shall obtain samples of the cured soil-reagent matrix, as required by contract specifications, and as deemed necessary by the Project Engineer to achieve the performance requirements of the wall. At a minimum, one undisturbed sample of the soil-reagent matrix shall be taken from between the ground surface and mid-depth of the trench, and one sample from between mid-depth and the trench bottom in four sample locations. One of these sample locations must be within the Chlorate Area and one must be within the Acid Plant Area. Continuous coring shall be used to visually confirm uniform GBW composition that is free of voids. The contractor shall test these samples for permeability (ASTM D-5084).
- The coefficient of permeability of the soil-reagent matrix must be verified to be less than 1×10^{-6} centimeters per second (cm/sec).

4.3

GENERAL EARTH WORK - COMMON FILL

4.3.1

Pre-Construction

- The contractor shall submit the locations of all borrow sources to the CQA Manager no less than two weeks prior to the anticipated placement of any soil materials.
- The contractor shall submit a 50-pound sample from each of the proposed borrow sources. The samples shall be submitted to the CQA Manager no less than two weeks prior to the anticipated placement of any soil material.
- The contractor shall submit with each sample the sample location, a sketch of the sample location, depth of the sample, a description of the soil, the sampling methodology, and estimated available quantity of soil.
- The contractor shall submit the results of the following tests performed once every 2,000 cubic yards or a minimum of one set of results.: particle-size analyses with hydrometer (ASTM D422), moisture content and density relationship (ASTM D1557), Atterberg limits (ASTM D4318), soil classification (ASTM D2487), and moisture content (ASTM D2216). The test results shall verify that the soils meet the contract specifications and shall be submitted to the CQA Manager no less than one week prior to the anticipated placement of any soil materials.

- The CQA Manager, or designee, shall inspect each proposed borrow source and obtain one sample for independent analysis for particle-size distribution.
- A summary report shall be prepared by the CQA Manager and shall include: a summary of laboratory test data, drawings depicting sample and test locations, a summary of sampling methods, and a brief letter certifying that the available volume of soil meets or exceeds regulatory and construction criteria.

4.3.2

Construction

- The contractor shall test the in-place density and moisture content of all common-fill material in accordance with ASTM D6938, and the contract technical specifications. Three tests must be conducted per lift, per area of interest. The common fill will be compacted to 90 percent of the maximum Modified Proctor Density (ASTM D1557), and every 25th nuclear density test and moisture test must be verified in accordance with ASTM D1556 and ASTM D2216, respectively.
- The CQC Manager shall obtain a sample of common-fill material if they note any change in the color, consistency, or texture of the material. The sample shall be tested in accordance with ASTM D422, ASTM D1557, ASTM D4318, ASTM D2487, and ASTM D2216, by the Geotechnical CQC Laboratory.
- The soils shall be placed using loose lifts, 9 inches in thickness or less, to achieve uniform compaction at a maximum thickness of 6 inches. The maximum clod size shall not exceed the lift thickness.
- If test results indicate that the in-place common-fill material does not meet the required specifications, the material shall be removed, replaced, and re-tested at the contractor's expense.
- The final grade of all common-fill soils shall be smooth and even, and measure to within two-tenths of a foot below to five-tenths of a foot above (-0.2 to +0.5) the grades and contours indicated on the Drawings. All thicknesses and "as-built" drawings are required to be certified by the Land Surveyor.

4.3.3

Post-Construction

- The in-place common-fill material shall be protected from rain, drying, desiccation, and erosion.
- Any and all defective areas, as defined by the CQA Manager, shall be removed, repaired, and re-tested at the contractor's expense.
- Prior to the placement of any covering material, the common-fill material shall be inspected and approved by the CQA and CQC Managers. The

common-fill material shall be inspected for cracks, holes, defects, or other features that may be detrimental to structural performance, as determined by the CQA Manager.

4.4 GENERAL EARTHWORK - CLAY

4.4.1 *Pre-Construction*

- The contractor shall submit the locations of all borrow sources to the CQA Manager no less than two weeks prior to the anticipated placement of any soil materials.
- The contractor shall submit a 50-pound sample from each of the proposed borrow pits. The samples shall be submitted to the CQA Manager no less than two weeks prior to the anticipated placement of any soil materials.
- The contractor shall submit with each sample the sample location, a sketch of the sample location, depth of the sample, a description of the soil, the sampling methodology, and estimated available quantity of soil.
- The contractor shall submit the results of the following tests: particle-size analysis with hydrometer (ASTM D422), moisture content (ASTM D2216), Atterberg limits (ASTM D4318), moisture content and density relationship (ASTM D1557), soil classification (ASTM D2487), and permeability (ASTM D5084). The test results shall verify that the soil meets contract specifications, including a laboratory permeability less than or equal to 1×10^{-5} cm/sec. The test results shall be submitted to the CQA Manager no less than one week prior to the anticipated placement of any clay soil furnished from off site.
- The CQA Manager, or designee, shall inspect each proposed borrow source and obtain one sample for independent analyses of particle-size distribution.
- A summary report shall be prepared by the CQA Manager and shall include: a summary of laboratory test data, drawings depicting sample and test locations, a summary of sampling methods, and a brief letter certifying that the available volume of soil meets or exceeds regulatory and construction criteria.

4.4.2 *Construction*

- The contractor shall test the in-place density and moisture content of all clay material in accordance with ASTM D6938, and technical specifications. Tests shall be conducted every 50 lineal feet on each lift. The clay shall be compacted to 90 percent of the maximum Modified Proctor Density (ASTM D-1557), and nuclear density tests and moisture tests shall be verified in

accordance with ASTM D1556 and ASTM D2216, respectively. A minimum of three verification tests shall be conducted for each soil material type.

- The CQC Manager shall obtain a sample of clay if any change in the color, consistency, or texture of the material is noted. The sample shall be tested in accordance with ASTM D422, ASTM D2216, ASTM D2487, ASTM D1557, ASTM D5084, and ASTM D4318, by the Geotechnical CQC Laboratory.
- If test results indicate that the in-place material does not meet the required specifications, the material shall be removed, replaced, and re-tested at the contractor's expense.
- The final grade of all clay material shall be smooth and even, and measure to within two-tenths of a foot below to five-tenths of a foot above (-0.2 to +0.5) the grades and contours indicated on the Drawings. All thicknesses and "as-built" drawings are required to be certified by the CQC Surveyor.

4.4.3 *Post-Construction*

- The in-place material shall be protected from rain, drying, desiccation, and erosion.
- Any and all defective areas, as defined by the CQA Manager, shall be removed, repaired, and re-tested at the contractor's expense.
- Prior to the placement of any covering material, the clay material shall be inspected and approved by the CQA and CQC Managers. The clay material shall be inspected for cracks, holes, defects, or other features that may be detrimental to the structural performance, as determined by the CQA Manager.

4.5 *GENERAL EARTH WORK - TRENCH SPOILS TEST PAD*

4.5.1 *Pre-Construction*

- No testing required.

4.5.2 *Construction*

- The contractor shall test the in-place density and moisture content of the trench spoils test pad in accordance with ASTM D6938, and the technical specifications. A minimum of one in-place density and moisture content test shall be conducted per test pad. The trench spoils shall be compacted to 90 percent of the maximum Standard Proctor Density (ASTM D698).
- The trench spoils shall be placed using loose lifts, 12 inches in thickness or less.

- If test results indicate that the trench spoils test pad does not meet the required specifications, the test pad shall be removed and reconstructed using modified construction techniques.
- The final grade of all trench spoils shall be smooth and even, and measure to within two-tenths of a foot below to five-tenths of a foot above (-0.2 to +0.5) the grades and contours indicated on the Drawings. All thicknesses and "as-built" drawings are required to be certified by the CQC Surveyor.

4.5.3 *Post-Construction*

- The in-place trench spoils shall be protected from rain, drying, desiccation, and erosion.
- Any and all defective areas, as defined by the CQA Manager, shall be removed, repaired, and re-tested at the contractor's expense.
- Prior to the placement of any covering material, the trench spoils shall be inspected and approved by the CQA and CQC Managers. The trench spoils shall be inspected for cracks, holes, defects, or other features that may be detrimental to the structural performance, as determined by the CQA Manager.

4.6 *GRANULAR MATERIALS*

4.6.1 *Pre-Construction*

- The contractor shall submit the location of all borrow sources to the CQA Manager no less than two weeks prior to the anticipated placement of any granular materials.
- The contractor shall submit a 50-pound sample from each of the proposed borrow sources. The samples shall be submitted to the CQA Manager no less than two weeks prior to the anticipated placement of any granular materials.
- The contractor shall submit with each sample the sample location, a sketch of the sample location, depth of the sample, a description of the granular material, the sampling methodology, and estimated available quantity of granular material.
- The contractor shall submit the results of the particle-size analyses (AASHTO T 27) conducted for every 1,000 cubic yards of granular material imported to the site. The test results shall be submitted to the CQA Manager no less than one week prior to the anticipated placement of any granular materials.
- The CQA Manager, or designee, shall inspect each potential borrow source and obtain one sample for independent analysis of particle-size distribution.

4.6.2

Construction

- If test results indicate that the in-place material does not meet the specifications, the material shall be removed, replaced, and retested at the contractor's expense.
- The final grade of the granular material shall be measured to within two-tenths of a foot below to five tenths of a foot above (-0.2 to +0.5) the grades and contours indicated on the Drawings. All thicknesses and "as-built" drawings are required to be certified by the CQC Surveyor.

4.6.3

Post-Construction

- The CQA Manager shall perform thickness measurements in the field to check compliance with contract specifications. All thicknesses are required to be certified by the CQC Surveyor.

5.0

CONSTRUCTION CERTIFICATION REPORT

The Construction Certification Report will be prepared by the Project Engineer and submitted to the ODEQ. The report will be assembled and submitted within 45 days following completion of the GWBW, and will include the following information:

- Results of CQA and CQC testing;
- Documented deviations from the Final Design;
- Record or "as-built" drawings, including:
 - Plan views with test locations;
 - Cross sections; and
 - Necessary details;
- Daily reports;
- Site photographs;
- A statement of certification and compliance, signed and stamped by the supervising Professional Engineer registered in the state of Oregon, for GWBW components including:
 - The groundwater barrier wall; and
 - The clay cap; and
- The professional land surveyor certification for the GWBW location.

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6.0

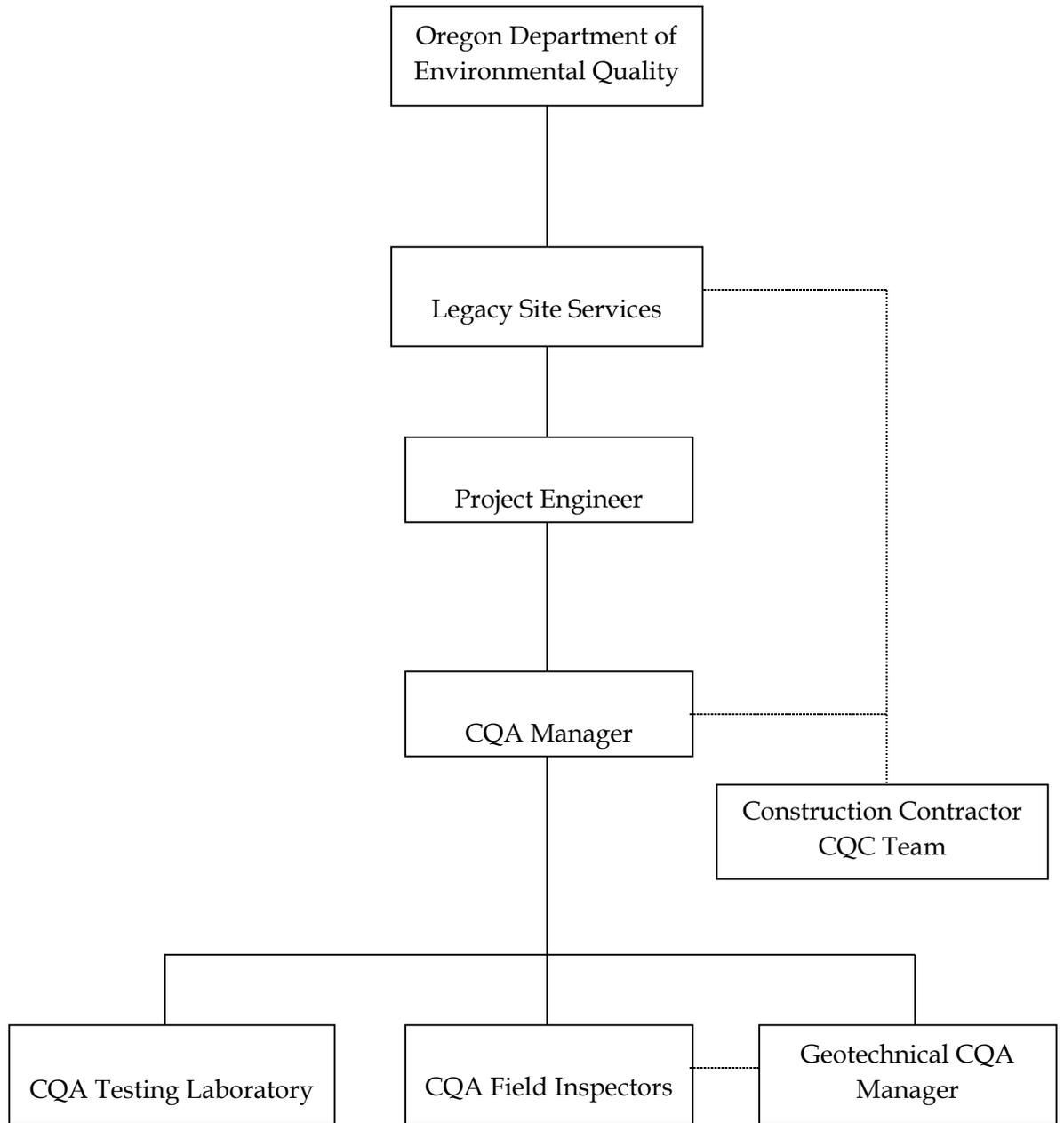
CONTINGENCY PLAN

During construction of the GBW components, construction difficulties may occur. The following is a list of potential construction difficulties and contingent solutions:

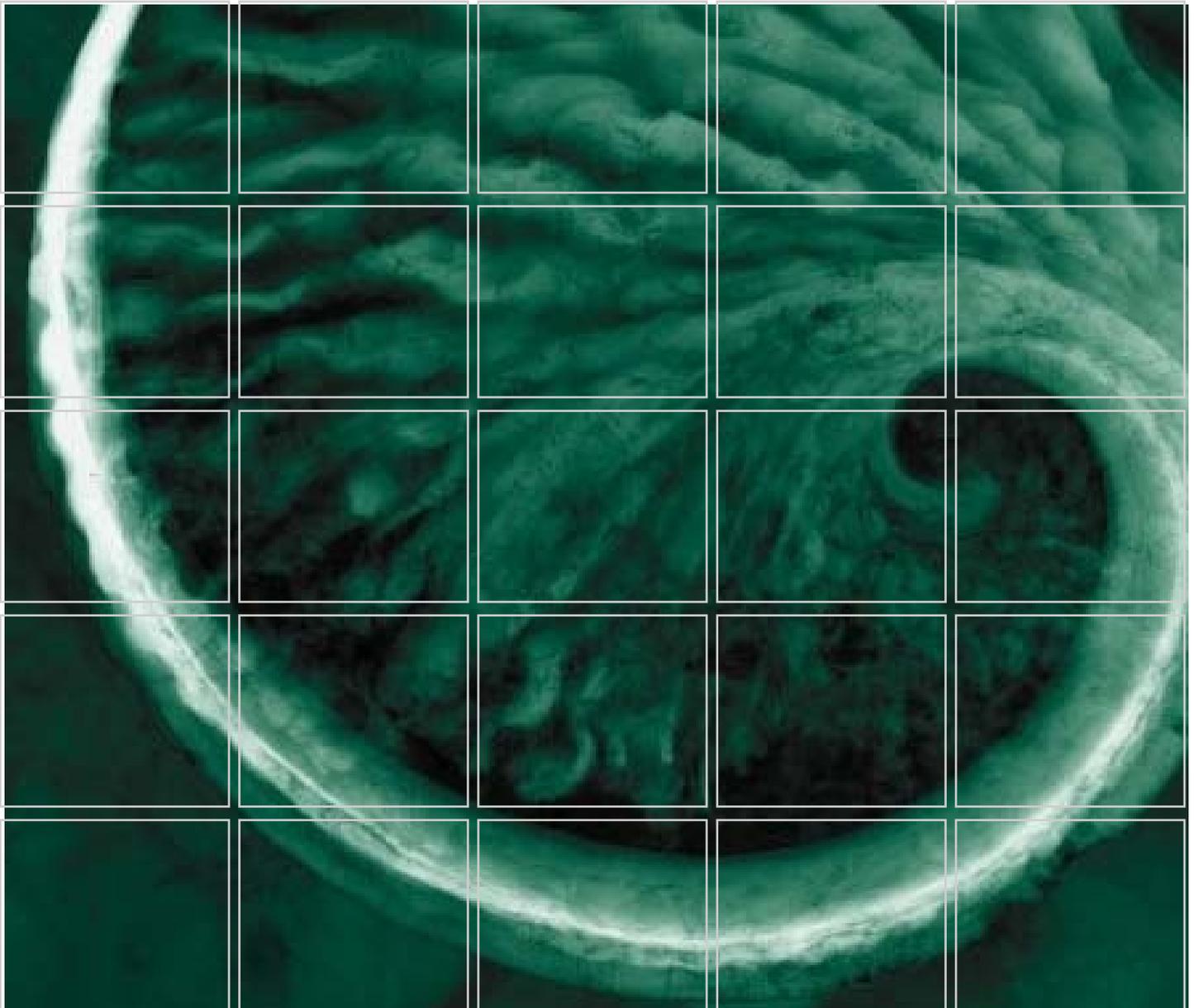
- Trench instability - Slurry elevation within the trench can be increased to bring the slurry closer to the ground surface and/or slurry density can be increased.
- High permeability lenses within the trench - Trench segments containing high permeability lenses can be re-excavated and filled with soil-bentonite backfill or grouted.
- Soil materials too wet - Soil can be disked or harrowed and allowed to dry until the appropriate moisture content is obtained.
- Soil materials too dry - Moisture can be added with the addition of water and thorough mixing, via disking.
- Erosion of newly placed soil - Eroded areas will be repaired immediately and will be maintained until granular materials are placed. Additional soil will be placed and compacted in affected areas. Extra silt fences will be installed as necessary to retard/redirect flows. Erosion mats, riprap or other controls will also be evaluated on a case-by-case basis.
- Inclement weather impeding the progress of the work - In the event that weather makes work difficult or affects the integrity of the work (i.e., freezing conditions during soil placement), work will be suspended until weather conditions permit.
- Stormwater ditches, ponds, and culverts clog with sediments - All excess sediment will be removed from ditches and culverts, as necessary, for proper operation.
- Cover system soils may settle - Any significant settlement will be repaired immediately through the addition of fill material.

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FIGURE 1 - PROJECT ORGANIZATION CHART



Attachment D
Groundwater Barrier Wall Final
Design Specifications – Redline
Version



Attachment D Technical Specifications REDLINE

Groundwater Barrier Wall Final Design
Groundwater Source Control Measure
Former Arkema Facility
Portland, Oregon

Prepared for:
Legacy Site Services
LLC

July 2012

www.erm.com



Legacy Site Services LLC

*Technical Specifications: Groundwater
Barrier Wall Final Design Groundwater
Source Control Measure,
Former Arkema Facility,
Portland, Oregon*

July 2012

Project No. 0158363



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*Division 1 – General
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DIVISION 1 – GENERAL REQUIREMENTS

01010 SUMMARY OF WORK

PART 1 - GENERAL

1.01 DEFINITIONS

A. Whenever the following terms are used in these Specifications, it is understood that they represent the following:

1. OWNER:
Arkema, Inc.
6400 Northwest Front Avenue
Portland, Oregon 97210
2. OWNER'S AGENT
Legacy Site Services, LLC
468 Thomas Jones Way
Suite 150
Exton, Pennsylvania, 19341
3. ENGINEER:
ERM-West, Inc.
~~1001401 SW 5th Ave~~ ~~Main Street~~, Suite ~~1010804~~
Portland, Oregon ~~97204~~~~97213~~
(503) 488-5282
4. CONTRACTOR:
The individual, firm, partnership, or corporation which is determined to be the successful Bidder.

During implementation of the project, the OWNER or OWNER'S AGENT reserves the right to select a Representative to serve the role as ENGINEER, as referenced throughout these Technical Specifications. If the Representative is different than the ENGINEER listed above, the Representative would fulfill all requirements of the ENGINEER as noted in these Technical Specifications.

1.02 SITE CONDITIONS

A. General

There will be no payment for any extras as a consequence of the CONTRACTOR's misunderstanding the descriptions contained in the Contract, Specifications and Drawings. The CONTRACTOR shall inspect the Site and request answers to all questions that relate to the Work, its execution, and other details prior to submitting a Bid.

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B. Site Access and Work Areas

Drawings, as referenced in these Specifications, depict the location of the Site and describe the types of access roads that lead to the Site. It is the CONTRACTOR's sole responsibility to use and maintain present access beyond the location depicted on the Drawings. Any access roadways, storage areas, Work areas or other areas that the CONTRACTOR must use are the CONTRACTOR's sole responsibility to keep passable at all times at its cost. The CONTRACTOR shall understand that certain access roadways must be used by the OWNER'S AGENT to maintain access to Work areas; the CONTRACTOR shall cooperate with others in the establishment and maintenance of these common access roadways. Further, access to the Site by the CONTRACTOR through areas other than the dedicated points as indicated on the Drawings is prohibited, unless otherwise previously approved by the OWNER'S AGENT.

C. Site Conditions

The Site is a former chemical facility that has been decommissioned and currently is not actively used for any industrial purposes. Drawings, as referenced in these Specifications, depict the location of various Site features, including an office building, groundwater monitoring and extraction wells, electric utility substation, docks, and other features that may affect the Work. It is the CONTRACTOR's sole responsibility to keep these areas protected and passable at all times at no additional cost to the OWNER'S AGENT.

D. Security

The OWNER'S AGENT has instituted security measures for the facility including perimeter chain-link fence and locking gates. The CONTRACTOR shall comply with all site security measures and procedures during work.

E. Night and Sunday Work

Unless otherwise specifically authorized by ENGINEER or OWNER'S AGENT, no Work shall be done between the hours of 6:00 p.m. and 7:00 a.m. or on Sunday, except as necessary for the proper care of and protection of Work already performed. If it shall become necessary to perform Work at night or on Sunday, the ENGINEER or OWNER'S AGENT shall be informed at least forty-eight (48) hours in advance of the beginning of performance of such Work. Only such Work shall be done at night as can be done satisfactorily and in a safe first-class manner. Good lighting and all other necessary facilities for carrying out and inspecting

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the Work shall be provided and maintained by the CONTRACTOR at all points where such Work is being done. Amount of lighting required shall be approved by the ENGINEER or OWNER'S AGENT.

F. Work in Bad Weather

During freezing, stormy or inclement weather, no Work shall be done except such as can be done satisfactorily and in a manner to secure safe first-class construction throughout. Material backfill and compaction shall not be undertaken during freezing, heavy precipitation, or otherwise inclement weather, as determined by the ENGINEER or OWNER'S AGENT.

1.03 CODES AND STANDARDS

The Work shall conform to all local, state and federal codes, comply with standards referenced in these Specifications, and adhere to regulatory requirements presented in Section 01060-REGULATORY REQUIREMENTS AND RESPONSIBILITY TO THE PUBLIC, which are described elsewhere in these Specifications. The latest issue shall be used unless specifically noted otherwise.

1.04 SCOPE OF WORK

A. The Scope-of-Work shall include, but not be limited to, furnishing all labor, materials, methods, services, tools, machinery and equipment necessary for the construction of the Work as specified in these Specifications and the following Drawings:

Drawing No.	Drawing
-	Cover Sheet
1	Location Maps, General Notes, List of Drawings, Abbreviations, and Legend
2	Existing Site Plan
3	Site Layout Plan
4	Erosion and Sediment Control Plan
5	Vertical Barrier Wall Profile
6	Details
7	Details

B. The CONTRACTOR shall supply all necessary materials except those specifically designated as furnished by the OWNER, the ENGINEER or OWNER'S AGENT, or furnished by others.

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- C. The Work covered under this Contract shall include, but is not limited to, the following items:
1. Mobilization/demobilization.
 2. Furnishing temporary field offices, along with temporary electrical power, telephone communications, separate men and women sanitary facilities, and potable water, as needed.
 3. Preparing the Site for Work, including but not limited to, staging and stockpile area, health and safety provisions, installation of erosion and sediment controls, coordination with utility authorities for disconnection and/or temporary rerouting of utilities, removal of segments of the perimeter security fence, installation of a temporary security fence, and other preparatory work.
 4. Survey and layout of the groundwater barrier wall alignment.
 5. ~~Disconnection and removal~~ Re-routing of power lines and cutting, capping, and/or plugging of abandoned utilities.
 6. Excavation of the clearance trench and management of the materials, including sampling, testing, backfilling and compacting, and/or transportation and disposal. Supplemental backfill, i.e., clean ~~common~~ structural fill, may also be required to return the Site to existing grade.
 7. Preparation of the working surface along the groundwater barrier wall alignment and installation of the groundwater barrier wall.
 8. Management, sampling, testing, transportation, and on-site disposal of excess spoils from groundwater barrier wall installation.
 9. Installing a clay cap on top of the groundwater barrier wall.
 10. Maintaining continuous operation of affected utilities for duration of work activities, including temporary rerouting of utility services, as required.
 11. Health and safety activities and nuisance (i.e. dust and odor) control, including air monitoring and suppression.
 12. Site restoration, including grading, placement of crushed stone, and installation of a permanent chain link fence.
 13. Protection of the Willamette River, the electric substation, all existing groundwater monitoring and extraction wells, and other structures and Site features.
 14. Miscellaneous sitework, including site cleanup, site restoration, and permanent stabilization of all areas disturbed during construction.
 15. Other Work indicated within these Contract Documents, or as otherwise required for complete and proper groundwater barrier wall installation.

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1.05 QUALITY ASSURANCE:

- A. All work shall be in accordance with Section 01400 – QUALITY CONTROL and the Construction Quality Assurance/Quality Control (CQA/QC) Plan.
- B. The CONTRACTOR warrants in presenting a Bid that all Work will be performed to the highest standards. The CONTRACTOR further warrants that defects that are the result of the CONTRACTOR’s methods, workmanship, or protection of Work will be corrected, removed, and/or replaced at the CONTRACTOR’s expense immediately. Further, the CONTRACTOR shall warrant all Work and repairs for one year after the completion and acceptance of the Work or repairs.

1.06 COOPERATION

- A. There may be other Engineers and/or Contractors, OWNER personnel and/or Regulators present at the Site. The CONTRACTOR shall make every effort reasonably possible to cooperate with all authorized outside personnel. Any disputes shall be settled by and at the sole discretion of the OWNER’S AGENT.
- B. All construction activities shall be carried out in such a manner that there shall be absolutely no possibility of interruption of any operations occurring in the remaining portions of the facility.
- C. The ENGINEER or OWNER’S AGENT may conduct intermittent quality control air and odor monitoring during work. The CONTRACTOR shall be responsible for conducting any required actions based upon the results of either the CONTRACTOR or the ENGINEER or OWNER’S AGENT’S sampling and monitoring activities.

1.07 CARE AND STORAGE OF MATERIALS

- A. The CONTRACTOR shall unload, inspect, and store all equipment and material items delivered, to the project site for its Work, including items supplied by the OWNER, the ENGINEER or OWNER’S AGENT, or furnished by others. Materials shall be stored on-site only in areas designated by the ENGINEER or OWNER’S AGENT for that purpose.
- B. The CONTRACTOR shall replace, at its sole expense, all OWNER, ENGINEER or OWNER’S AGENT, furnished by others, and/or CONTRACTOR-furnished materials damaged by the CONTRACTOR or the CONTRACTOR’s Subcontractors during unloading and storage, damaged by weather, or other related causes.

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- C. Special attention shall be paid to instructions issued by the manufacturer for handling and storage of materials and/or equipment. These instructions shall be followed in every respect.
- D. The CONTRACTOR shall be solely responsible for all security of equipment and material items delivered to the Site for its Work, including items supplied by the OWNER, the ENGINEER or OWNER'S AGENT, or furnished by others. Replacement of any equipment or material shall be at the sole expense of the CONTRACTOR.
- E. The CONTRACTOR shall exercise care in the handling, moving, storing, and transporting of the equipment. The integrity of the equipment shall not be compromised at any time. The CONTRACTOR shall be responsible for any damage to the equipment and shall repair or replace, at the OWNER'S AGENT's discretion, the damaged equipment at no additional cost to the OWNER, ENGINEER or OWNER'S AGENT.

1.08 CONTRACTOR'S RESPONSIBILITIES AND WORK

- A. The CONTRACTOR shall furnish all construction equipment, machines, tools, materials, field sanitary facilities, security, protection of Work, other services, supplies, labor, and supervision that are necessary to complete the Work and requirements as described or implied in these Specifications and Drawings.
- B. The CONTRACTOR shall provide all transportation for the items included in Part 1.08A of this Section from its headquarters or other locations to and from the Site.
- C. The CONTRACTOR shall furnish all housing, travel, required training, personal safety equipment, and related allowances required by its employees to meet the minimum standards of the OWNER or OWNER'S AGENT and the Site Health and Safety Plan. No housing facilities shall be permitted on the Site.
- D. Neither the CONTRACTOR nor any of its employees shall drive or park any vehicle anywhere on the Site, except at such locations as shown or as specifically approved by the OWNER'S AGENT.
- E. The CONTRACTOR shall comply with all site security measures and procedures for the duration of work activities.
- F. The CONTRACTOR shall provide sufficient workers and supervisory personnel to maintain Work progress so that the various areas of Work will be completed in accordance with the schedule or sequence defined elsewhere in these Specifications. If, in the opinion of the OWNER'S

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AGENT, the Work is behind schedule or is improperly staffed, the OWNER'S AGENT will direct the CONTRACTOR to increase its complement of supervisors, workmen, or equipment so as to comply with the schedule. The CONTRACTOR shall discharge any such directives promptly and without expectation of additional compensation. If the CONTRACTOR fails to discharge any of these directives, the ENGINEER or OWNER'S AGENT may arrange for such directives to be discharged at the sole cost of the CONTRACTOR.

- G. The CONTRACTOR shall make all overtime, premium, and incentive payments to the CONTRACTOR's employees that may be required to complete the Work in accordance with the schedule. No exceptions shall be allowed for lack of performance, late material deliveries, or interference with other contractors possibly employed at the Site or with the OWNER's ~~authorized personnel~~ authorized personnel.
- H. There is no applicable sales tax in the state of Oregon; therefore the CONTRACTOR should not include sales tax in its Bid.
- I. The CONTRACTOR shall obtain any state, county, or local building permits required in the performance of its Work, except as provided by the ENGINEER or OWNER'S AGENT.
- J. Prior to a Contract award any questions or assistance the CONTRACTOR may request shall be directed to the ENGINEER or OWNER'S AGENT. A copy of each question should be submitted to LSS.
- K. By submitting a Bid for the Work, the CONTRACTOR acknowledges to be entirely familiar with the requirements prescribed by the State of Oregon that relate to the Work, with regulations prescribed by the United States Environmental Protection Agency (USEPA), with the rules and regulations of OSHA, and with local conditions, including weather, availability of supplies, and logistics. The CONTRACTOR further acknowledges itself to be entirely qualified to perform the Work described by these Specifications and the Drawings.
- L. The CONTRACTOR shall maintain the site of its activities free of refuse and debris at all times at their expense. The CONTRACTOR shall, promptly comply with any directives from the OWNER, or it's AGENT, regarding housekeeping. The CONTRACTOR shall provide the appropriate containers at convenient locations for the disposal of disposable personnel protection equipment and other items of trash. Upon completion of the Work and before final payment, the CONTRACTOR shall completely remove all tools, equipment, supplies, materials, structures, and debris from the Site and leave the premises clean. Debris shall be removed to ~~the designated on-site disposal location, as locations,~~

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~~off the Site that are selected by the CONTRACTOR, and are permitted to receive the debris to be disposed, and prior~~ approved by the ENGINEER or OWNER'S AGENT. Refuse shall be accumulated for a minimum of weekly disposal.

- M. The CONTRACTOR shall be responsible for all engineering and corresponding support required to perform the scope of work established in the Contract Documents, including but not limited to design and/or verification of shoring, bracing, demonstration of equivalent materials, or other such matters that require engineering expertise.
- N. Safety
1. It is the CONTRACTOR's responsibility to perform all Work in a safe manner, and meet all applicable federal, state and local laws and those requirements imposed by the OWNER or OWNER'S AGENT. The CONTRACTOR shall submit a Site Health and Safety Plan (HASP) to the ENGINEER or OWNER'S AGENT for review. The plan shall meet, or exceed, all requirements specified in the Contract Documents and federal, state, and local regulations.
 2. All employees and subcontractors working on-site with intrusive activities, who may be exposed to hazardous substances, health hazards, or safety hazards and their supervisors and management responsible for the Site will receive training meeting the requirements of 29 CFR 1910.120.
- O. Environmental Protection

All Work to be performed by the CONTRACTOR as a part of this project is regulated by the Oregon Department of Environmental Quality (ODEQ). By acceptance of the terms of the Contract, the CONTRACTOR acknowledges that it is familiar with the rules and regulations of the ODEQ. The CONTRACTOR further acknowledges familiarity with, and accepts as a condition of this Contract, all of the terms, stipulations, and commitments pertaining to the Work. Questions concerning the permits or regulations shall be referred to the ENGINEER or OWNER'S AGENT; the ENGINEER or OWNER'S AGENT'S decision in all cases shall be final.

01010
SUMMARY OF WORK

P. Project Offices

The CONTRACTOR may locate the project office in the on site office building if office space is deemed necessary. The CONTRACTOR may utilize the utilities available at the office building, including electric, water, telecommunications, and sanitary facilities.

Q. Utilities

1. Electrical Power

Electrical power is available on site; however, the CONTRACTOR is responsible for all coordination with the OWNER'S AGENT and power company, as well as establishing all connections to the source. If connected to the existing power source on site, the OWNER'S AGENT will be responsible for the cost of usage.

2. Telecommunications

Telecommunications (telephone, data) service is available within the office building; however, the CONTRACTOR shall be responsible for establishing all connections to the service.

3. Water Supply

Water service is available on site; however, the CONTRACTOR is responsible for all coordination with the OWNER'S AGENT and water company, as well as establishing all connections to the source. If connected to the existing water supply source on site, the OWNER'S AGENT will be responsible for the cost of usage. The CONTRACTOR shall be responsible for determining if the available water service is sufficient for the work activities, including groundwater barrier wall construction and dust control.

4. Sanitary Facilities

Sanitary facilities are available within the office building. Chemical-type sanitary facilities shall be provided near the points of Work for CONTRACTOR personnel on the project if deemed necessary. Separate sanitary facilities are required for men and women, and shall be cleaned daily and adequately serviced.

1.09 TERMS AND CONDITIONS

01010
SUMMARY OF WORK

If the Technical Specifications conflict with the OWNER'S or OWNER'S AGENT'S Terms and Conditions, the Terms and Conditions shall supersede the Technical Specifications.

1.10 CLEAN FUELS AND EQUIPMENT TECHNOLOGIES

- A. CONTRACTOR, including all Subcontractors, shall follow federal, state, and local equipment and vehicle idling regulations and shall comply with a five (5) minute maximum idling time, whichever is more restrictive. Additionally, no unattended idling shall occur. Exceptions to these requirements shall be allowed for weather, safety concerns, and where implementation may actually slow work and/or increase emissions.
- B. The CONTRACTOR shall use clean technologies and/or fuels on all diesel equipment to the extent practicable and/or feasible. The preference is for clean diesel technologies, but alternate fuels, such as biodiesel or natural gas powered vehicles, can also be considered. These alternate fuels shall be used where they are available and within a reasonable distance to the Site. For equipment retrofits, the CONTRACTOR shall employ the Best Available Control Technology (BACT) on off-road and on-road diesel powered equipment used at the Site. Examples of clean diesel technologies include diesel particulate filters and diesel oxidation catalysis. For alternative fuel usage, the CONTRACTOR shall use at least a B20 blend (i.e., 20 percent biodiesel and 80 percent petrodiesel) or higher in the equipment engines used at the Site.
- C. The CONTRACTOR shall provide a discussion of the proposed clean fuel and equipment technologies in their bid.

PART 2 - PRODUCTS

2.01 REGISTERED TRADE NAMES

- A. Products are referenced and specified throughout these Specifications by registered trade names. This does not constitute a recommendation of these products to the exclusion of other products. Equivalent products may be used upon receiving approval of the, ~~the~~ ENGINEER or OWNER'S AGENT.
- B. The reference to registered trade names establishes a standard of required function, dimension, appearance and quality of the required equipment, materials or products.

PART 3 - EXECUTION

(not used)

01010
SUMMARY OF WORK

END OF SECTION

01014 – Work Sequence

01014
WORK SEQUENCE

PART 1 - GENERAL

1.01 CONSTRUCTION SCHEDULE

- A. A Construction Schedule shall be submitted with the Bid for approval. The schedule shall include sequence and dates of construction operations for all major stages of Work, order and delivery of materials and equipment, and estimated milestones for substantial and final completion. The Construction Schedule shall be subject to review and acceptance by the ENGINEER or OWNER'S AGENT. The Construction Schedule shall incorporate and meet, at a minimum, Project Milestones as identified in these Specifications and Drawings. The CONTRACTOR can provide alternates to the Construction Schedule in order to expedite the overall project schedule. Any alternates must be approved in writing by the ENGINEER or OWNER'S AGENT prior to formal acceptance as part of the Construction Schedule. Revisions to the Construction Sequence by the CONTRACTOR shall not be made until approved by the ENGINEER or OWNER'S AGENT. Changes in the approved schedule shall not be allowed without written approval. If the construction progress does not adhere to the schedule as approved or revised, measures shall be taken by CONTRACTOR to make up for the lost time to assure completion of the Work in accordance with the schedule. The schedule shall be created using Microsoft Project or Primavera, and shall include all appropriate task designations (Predecessor, Successor, Lag, Lead, Slack, Resources, etc.).
- B. Certain aspects of the construction are weather dependent. The ENGINEER or OWNER'S AGENT may, therefore, suspend operations at any time, when in its sole judgment, the conditions are unsuitable for the proper performance of the Work. No measures, aside from those provided elsewhere in the Construction Documents, shall be provided for such suspension of Work or costs associated with them. The CONTRACTOR shall account for typical delays in the schedule associated with normal levels of inclement weather as determined by the average monthly precipitation and temperatures for the period of times specified in the proffered construction schedule.
- C. The Contractor shall be responsible for meeting the [project](#) schedule established [at the preconstruction meeting for equipment delivery](#). If, at anytime during implementation of the Work, the OWNER, ENGINEER ~~, or~~ OWNER'S AGENT, or CONTRACTOR determines that the Work is behind schedule, the CONTRACTOR shall make every reasonable effort; i.e., additional manpower, equipment, or work hours, to make-up the lost time.

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WORK SEQUENCE

1.02 WEATHER

- A. The CONTRACTOR shall take all necessary precautions to prepare for adverse weather so that the Work may be properly performed and be satisfactory in all respects. When required, protection shall be provided by use of tarpaulins, shelters, silt fencing, straw bales, or other approved means. During cold weather, materials shall be preheated, if required, and the materials and structure into which they are to be incorporated shall be kept sufficiently warm so that a proper bond shall take place and a proper curing, aging, or drying shall result. Heating shall be by a method approved by the ENGINEER or OWNER'S AGENT and shall result in a moist or a dry atmosphere according to the particular requirements of the Work being protected. ~~Ingredients for concrete and mortar shall be sufficiently heated so that the mixture shall be warm throughout when used.~~ The ENGINEER or OWNER'S AGENT may suspend operations at any time when, in its sole judgment, the conditions are unsuitable or the proper precautions are not being taken.
- B. Delays to the schedule caused by adverse weather conditions shall be identified as a request for schedule extension submitted by the CONTRACTOR to the ENGINEER or OWNER'S AGENT within one (1) day of the termination of the event. ~~Adverse weather that does not delay the schedule for which no extension of time is required shall not necessitate such a request. Adverse weather for which no extension of time is required shall not necessitate such a request and shall be deemed the responsibility of the CONTRACTOR to make up the scheduled time to compensate for any lost time. No time extensions will be awarded without proper and timely notification to the ENGINEER or OWNER'S AGENT. Time extensions will be awarded by OWNER or OWNER'S AGENT at its sole discretion based on a comparison with the prior average conditions in the vicinity of the site as defined in Part 1.01 of this Section; the CONTRACTOR shall anticipate and initially factor into its schedule normally occurring weather conditions, for which no time extensions shall be awarded. The methodology for determination of variations from the average shall be determined by the OWNER and ENGINEER or OWNER'S AGENT.~~ Weather delays may be made up through extended Work times with the approval of the OWNER or OWNER'S AGENT. The CONTRACTOR shall receive no additional financial compensation as a result of adverse weather conditions.

1.03 PROGRESS REPORTS

- A. The CONTRACTOR shall submit to the ENGINEER or OWNER'S AGENT every two (2) weeks following written issuance of a Notice to Proceed, or more frequently if requested by the OWNER, ENGINEER or OWNER'S AGENT, a report, in form and substance satisfactory to the

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WORK SEQUENCE

OWNER, or its AGENT, stating the progress being made in fulfillment of this Contract, and indicating the progress to date with respect to the Construction Schedule. Included with the report shall be an updated schedule indicating scheduled durations, scheduled start dates, scheduled completion dates, actual durations, actual start dates and actual completion dates of construction activities identified in the initial approved Construction Schedule. If the Schedule indicates that the CONTRACTOR is behind schedule, a written plan indicating the corrective measures to be implemented to make up lost time shall be submitted with the updated Schedule.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

(not used)

END OF SECTION

01014
WORK SEQUENCE

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01040 – Control and Inspection

01040
CONTROL AND INSPECTION

PART 1 - GENERAL

1.01 ENGINEER'S AUTHORITY

- A. The OWNER'S AGENT may appoint a Representative during the life of the Contract as specified in Section 01010 – SUMMARY OF WORK, who will observe the Work in progress on behalf of the OWNER'S AGENT. The Representative shall have authority to: (1) act on behalf of the OWNER'S AGENT to the extent expressly provided in the Contract or otherwise in writing; (2) stop the Work whenever such stoppage may be necessary, in its sole discretion, to prevent improper execution of the Work, or otherwise to protect the interests of the OWNER'S AGENT; (3) determine the amount, quality, acceptability and fitness of all Work, materials and equipment required by the Contract; and, (4) decide all questions which arise in relation to the Work, the execution thereof, and the fulfillment of the Contract Documents.
- B. The OWNER'S AGENT shall be the sole judge of the intent and meaning of the Contract, and the ENGINEER or OWNER'S AGENT shall be the sole judge of the intent and meaning of the Specifications and Drawings, and its decisions thereon, and its interpretation thereof shall be final, conclusive and binding on all parties.
- C. The CONTRACTOR shall proceed without delay to perform the Work as [specified by the Contract Documents or as](#) directed, ~~instructed, determined or decided~~ by the ENGINEER or OWNER'S AGENT and shall comply with such directions, ~~instructions, determinations or decisions~~.
- D. Any doubts to the meaning of, or any obscurity as to the [wording](#) of the Contract, Specifications, and Drawings shall be explained, and all directions and explanations requisite or necessary to complete, explain, or make definite any of the provisions of the Contract, Specifications or Drawings and to give them due effect shall be given by the ENGINEER or OWNER'S AGENT.

1.02 INSPECTORS

- A. Inspectors employed by the ENGINEER or OWNER'S AGENT shall be authorized to inspect all Work performed and all materials and/or equipment furnished. Such inspection may extend to all or any part of the Work and to the preparation or manufacture of the materials to be used. In case of a dispute arising between the CONTRACTOR and the Inspector as to materials furnished or the manner of performing the Work, the Inspector shall have the authority to reject materials or suspend the Work until the question at issue can be referred to and decided by the ENGINEER or OWNER'S AGENT. The Inspector shall not be

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CONTROL AND INSPECTION

authorized to revoke, alter, enlarge, relax, or release any requirements of the Contract, Specifications or Drawings, nor to approve or accept any portion of the Work, nor to issue instructions contrary to the Contract, Specifications, and Drawings. The Inspector shall in no case act as foreman or perform other duties for the CONTRACTOR, or interfere with the management of the Work by the CONTRACTOR. Any advice which the Inspector gives the CONTRACTOR shall in no way be construed as binding on the ENGINEER, OWNER'S AGENT, or the OWNER in any way or releasing the CONTRACTOR from the fulfillment of the terms of the Contract.

1.03 INSPECTION

- A. The CONTRACTOR shall, at the CONTRACTOR's expense when requested, provide the ENGINEER or OWNER'S AGENT with ladders, lights, tools, labor, samples and other facilities as may be necessary for inspecting material and Work.
- B. Imperfect materials or Work which may be detected, shall be replaced or corrected immediately on the requirement of the ENGINEER or OWNER'S AGENT notwithstanding that it may have been previously overlooked and included in a partial payment. Materials condemned or rejected by the ENGINEER or OWNER'S AGENT shall be marked and shall, on its demand, be removed at once to a satisfactory distance from the Work. If not removed within twenty-four (24) hours after receipt of written notice from the ENGINEER or OWNER'S AGENT, it may be removed by the ENGINEER or OWNER'S AGENT and the cost of removal shall be charged to the CONTRACTOR and deducted from any payment due or which may become due to it.
- C. If Work to be done away from the construction site is to be inspected on behalf of the ENGINEER or OWNER'S AGENT during its fabrication, manufacture, excavation, processing, or testing, or before shipment, the CONTRACTOR shall give notice to the ENGINEER or OWNER'S AGENT of the place and time where such fabrication, manufacture, excavation, processing, testing, or shipping is to be done. Such notices shall be in writing and delivered to the ENGINEER or OWNER'S AGENT ten (10) days prior to initiation of such activity so that the necessary arrangements for the inspection can be made.

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CONTROL AND INSPECTION

1.04 CONTRACTOR'S EQUIPMENT AND WORK FORCE

- A. All machinery and equipment to be used shall be of sufficient size and in proper operating condition to accomplish the Work as described herein and shall be such as to produce a satisfactory quality of Work. A competent foreman or Superintendent shall be present at all times during the progress of the Work with authority to act for the CONTRACTOR and coordinate with the ENGINEER or OWNER'S AGENT. A workforce of sufficient size with the required experience and ability shall be employed at all times to assure that the Work is executed in a satisfactory and workmanlike manner.
- B. Unless otherwise expressly provided, the means and the methods of construction are at the option of the CONTRACTOR. Only adequate and safe procedures, methods, structures and equipment shall be used. The ENGINEER or OWNER'S AGENT'S approval, or failure to exercise its right thereon, shall not relieve the CONTRACTOR of obligations to accomplish the result intended by the Contract, nor shall such create a cause of action for damages or extras.
- C. If the ENGINEER or OWNER'S AGENT at any time gives notice, in writing, to the CONTRACTOR that an employee is, in its opinion, incompetent, unfaithful, disorderly, discourteous, careless, unobservant of instructions, or in any way a detriment to the satisfactory progress of the Work, such employee shall be immediately removed from and not again allowed upon the Site. Likewise, equipment and machinery deemed inadequate and unsatisfactory shall be removed from the Site when such written notice is received by the CONTRACTOR.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

(not used)

END OF SECTION

01040
CONTROL AND INSPECTION

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01050 – Field Engineering

PART 1 - GENERAL

1.01 DESCRIPTION

Primary Line and Grade Measurements

- A. Baselines and benchmarks have been established by the ENGINEER or OWNER'S AGENT by means of suitable marks as provided on the Drawings. All points must be carefully preserved and, if destroyed by the CONTRACTOR, the cost of replacing the points will be charged against the CONTRACTOR.
- B. The CONTRACTOR shall employ a competent surveyor registered in the State of Oregon and require said surveyor to establish all lines, elevations, reference marks, batterboards, etc. needed by the CONTRACTOR, ENGINEER, or OWNER'S AGENT during the progress of the Work, and from time to time to verify such marks by instrument or other appropriate means.
- C. Surveyor shall provide survey control for each stage of construction, and provide survey "As-Built" documentation for various components of construction. The Surveyor shall furnish all labor, materials, tools, supervision, transportation, and equipment necessary to perform the project surveying Work as specified herein for the groundwater barrier wall and associated Work, as shown on the Drawings.

1.02 QUALIFICATIONS

- ~~AA.~~ ~~The CONTRACTOR shall employ the services of a competent Surveyor registered in the State of Oregon acceptable to the OWNER, OWNER'S AGENT and/or ENGINEER.~~
- B. The surveyor, in the opinion of the ENGINEER or OWNER'S AGENT, shall have a proven record of successful performance on projects of similar magnitude. Prior to acceptance by the OWNER, OWNER'S AGENT and/or ENGINEER, the surveyor will be required to submit a Survey Plan describing qualifications of the survey crew chief, other key personnel, instrumentation to be used, accuracy and precision required, type of grid system to be used, and a description of the other survey points required to establish grades, layout, quantities, and required "As-Built" and certifications. The Plan must also provide the Surveyor's commitment to meet the project schedule and provide the required "As-Built" documentation as expeditiously as possible, and in accordance with the requirements imposed by the project schedule.

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FIELD ENGINEERING

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01050
FIELD ENGINEERING

1.03 SURVEY REQUIREMENTS

- A. The Surveyor shall locate survey control points prior to starting site Work. The ENGINEER or OWNER'S AGENT shall be promptly notified in writing of any discrepancies discovered before or during construction. The survey datums are to include NAVD88 and Oregon State Plane North (NAD 83/91).
- B. The Surveyor shall maintain lines and levels, layout, and locate the Work utilizing recognized engineering survey practices. A complete and accurate log of control and survey Work must be maintained. The Surveyor shall establish, at a minimum, a 50-foot by 50-foot (ft) survey grid for construction and "As-Built" documentation. The spacing of the grid shall be reduced in areas of steep slopes, grade change, ditches, impoundments, and other structuring to assure adequate control and accurate "As-Built". The plan grid shall be approved by the ENGINEER or OWNER'S AGENT. The Surveyor shall provide, at a minimum, a detailed survey for the following components:
1. The excavation extents of the clearance trench, including the lateral limits.
 2. The bottom and top elevations and horizontal alignment of the groundwater barrier wall at a minimum of 25 foot intervals and at each bend. (The top elevation of the groundwater barrier wall is similar to the bottom elevation of the clay layer.)
 3. All other items that the CONTRACTOR requires to complete the Work and establish quantities for payment.
 4. All other reasonable items associated with the Work requested by the ENGINEER or OWNER'S AGENT.
 5. The top of the clay layer and the final elevation of the crushed stone surface above the groundwater barrier wall.
- C. The detailed topographic survey shall extend to a minimum of 100 ft in all directions beyond the limits of disturbance.
- D. All locations/stations should be surveyed to include both horizontal coordinates (accuracy 0.1 ft) and vertical elevation (accuracy 0.01 ft).

1.04 CONTRACTOR ENGINEERING REQUIREMENTS

The CONTRACTOR shall provide all necessary engineering, support and coordination necessary to perform the scope of work. These services include, but

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FIELD ENGINEERING

are not limited to, all work associated with obtaining permits, ~~including, but not limited to, the NPDES 1200-C Construction Stormwater Permit~~, preparing shop drawings and submittals, providing engineering and licensed certification (P.E. stamp) for alternate designs, performing quality control, conducting monitoring and maintenance activities, performing inspections, and any other required activities.

1.05 CONSTRUCTION TOLERANCES

- A. Construction tolerances shall be as provided in the various Sections of these Specifications, and as given below.
- B. All minimum thicknesses specified within these Contract Documents shall be met with no exception. The construction tolerances on final contours shall be within two tenths of one foot below to five tenths of one foot above (-0.2 to +0.5) the specified grades as they appear on the Drawings, or as otherwise approved by the ENGINEER or OWNER'S AGENT. No additional payments for actual thicknesses of specified soil layers greater than that required will be approved.
- C. No surveying will be allowed between one hour before sunset and one hour after sunrise, unless approved by the ENGINEER or OWNER'S AGENT.
- D. The ENGINEER or OWNER'S AGENT shall be permitted at all times to check the lines, elevations, reference marks, batterboards, etc. set by the CONTRACTOR, who will correct any errors in lines, elevations, reference marks, batterboards, etc. disclosed by such check. Such a check will not be construed to be an approval of the CONTRACTOR's work and shall not relieve or diminish in any way the responsibility of the CONTRACTOR for the accurate and satisfactory construction and completion of the entire Work. In order to verify the construction, the ENGINEER or OWNER'S AGENT shall be supplied with survey information at the time of surveying.
- E. The CONTRACTOR shall be aware of the surveying activities and shall account for them in the construction schedule.
- F. The groundwater barrier wall shall be constructed in the location depicted on the Drawings. The as-built horizontal alignment shall vary no more than five (5) feet in any direction from that depicted on the Drawings. Additionally, the groundwater barrier wall shall extend to the basalt interface, as depicted on the Drawings. If applicable, the CONTRACTOR shall present modified alignments as alternatives with their bid.

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FIELD ENGINEERING

1.06 RECORD DOCUMENTATION

At the completion of the Work the CONTRACTOR shall have its Surveyor prepare “As-Built” drawings showing the location of all Work installed, including that Work installed by the OWNER or OWNER’S AGENT (if any) and submit the “As-Built” drawings to the ENGINEER or OWNER’S AGENT for review. “As-Built” drawings shall also be provided to the ENGINEER or OWNER’S AGENT in electronic format (AutoCAD). “As-Built” drawings shall include the various Work components discussed herein. Certification of the “As-Built” drawings by the registered Surveyor is required. Submittals of these “As-Built” drawings shall conform to requirements of Section 01300 – SUBMITTALS.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

(not used)

END OF SECTION

01200 – Project Meetings

01200
PROJECT MEETINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Pre-Construction Conference

1. Before issuance of the Notice to Proceed, a Pre-Construction Conference will be held to discuss items of significance, including
 - a. construction schedule;
 - b. work sequence;
 - c. responsible personnel;
 - d. construction quality control;
 - e. procedures for handling shop drawings, schedules, “as-built” drawings, and other submissions;
 - f. processing Applications for Payment;
 - g. procedures for field decisions and Site Work Order Requests;
 - h. [procedures for measurement of completed work for payment applications](#) ~~preparation of record documents~~;
 - i. [preparation of record documents](#);
 - ji. applicable safety, health, environmental, security, fire protection, and operating requirements of the facility;
 - kj. use of premises;
 - lk. office, work, and storage areas;
 - ml. equipment and product deliveries;
 - nm. housekeeping; and,
 - on. working hours.
2. Among those present at the Pre-Construction Conference shall be the OWNER’S AGENT, the ENGINEER, the CONTRACTOR and CONTRACTOR’s Superintendent and major Subcontractors. All CONTRACTOR’s employees and subcontractor may attend, at the CONTRACTOR’s discretion.
3. The ENGINEER or OWNER’S AGENT will arrange for and organize the Pre-Construction Conference [to be held at the site.](#)

B. Progress Meetings

1. During the course of the Contract, progress meetings will be organized and conducted by the ENGINEER or OWNER’S AGENT to discuss the progress of the Contract at a frequency of at least every ~~weektwo (2) weeks~~, or more frequently at the discretion of the ENGINEER or OWNER’S AGENT. The CONTRACTOR, its Superintendent, dedicated Safety Officer, and the Construction

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PROJECT MEETINGS

Quality Control (CQC) Manager shall attend these meetings. The CONTRACTOR shall be fully responsible for any and all of the subcontractors and shall be responsible for subcontractor attendance and/or input into the meetings. The ENGINEER will take the minutes of the progress meetings and a copy will be furnished to the CONTRACTOR, OWNER, and OWNER'S AGENT. These meetings may, at the ENGINEER or OWNER'S AGENT'S discretion, be increased if progress is not satisfactory or if coordination problems should arise.

2. The construction schedule, as submitted under Section 01014 - WORK SEQUENCE, shall be updated for each progress meeting. The updated schedule shall be furnished to the ENGINEER or OWNER'S AGENT listing all parts of Work and providing the planned start and completion date for each part of Work. The schedule completion date shall conform to the contract completion date.

~~3. A special meeting shall be held when and if a problem or deficiency is present or likely to occur. The attendees at this meeting shall be specific to the incident. The purpose of the meeting shall be to define and resolve the problem or Work deficiency.~~

C. Weekly Progress Schedule

The CONTRACTOR's Site Superintendent shall submit on a weekly basis to the ENGINEER or OWNER'S AGENT a schedule of anticipated Work for the following week. This schedule shall be submitted by 12 p.m. (noon) on each Friday, and shall be updated as necessary if the CONTRACTOR's anticipated Work is altered.

D. Health and Safety Meetings

A safety tailgate meeting shall be held on a daily basis prior to commencement of work for that day. At the meeting, site controls and activities scheduled for the day shall be discussed.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

01300 – Submittals

01300
SUBMITTALS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Materials, equipment, workmanship, design and arrangement of all Work performed under this Contract shall be subject to the approval of the ENGINEER or OWNER'S AGENT.
- B. Work Included:
 - 1. Procedures for submittal to the ENGINEER or OWNER'S AGENT, a List of Submittals, certificates and affidavits, samples for testing, material test results, Shop Drawings, operation and maintenance literature and other miscellaneous data for approval.
 - 2. Procedures for turnover of the CONTRACTOR-prepared As-Built drawings and/or Record Documents.
- C. The CONTRACTOR is required to review all submittals and certify the completeness, accuracy, and content prior to submitting to the ENGINEER or OWNER'S AGENT.

PART 2 - PRODUCTS

2.01 LIST OF SUBMITTALS

- A. Within ten (10) calendar days after the Contract is awarded, the CONTRACTOR shall furnish the ENGINEER or OWNER'S AGENT with a List of Submittals.
- B. The List of Submittals shall indicate all products which the CONTRACTOR believes will be incorporated in the Work. Omission from this list of any equipment, material, or product required by the Specifications shall not relieve the CONTRACTOR of the Contract requirements for providing the equipment, materials, or products and completing the associated Work as specified. Each such omission discovered by the ENGINEER or OWNER'S AGENT shall be brought to the CONTRACTOR's attention for the purpose of revising the List of Submittals. The ENGINEER or OWNER'S AGENT reserves the right to make any revisions to the List of Submittals after award of the Contract, as necessary.

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SUBMITTALS

- C. For each entry of the List of Submittals, reference to the Specifications shall be made, along with an indication of the type of submittal(s) which the CONTRACTOR plans to make to the ENGINEER or OWNER'S AGENT. More than one type of submittal may be required. The ENGINEER or OWNER'S AGENT shall approve the types of submissions offered, or request additional or alternative submissions. Types of submissions are listed below:
1. Sample for testing, approval or filing.
 2. Chain of Custody.
 3. Sampling and analytical methods used.
 4. Testing and sample analysis results.
 5. Certificate(s) and Accompanying Affidavit.
 6. Shop Drawing.
 7. Miscellaneous Data.
- D. For each item on the List of Submittals, the CONTRACTOR shall indicate the proposed source of supply or manufacturer for that entry.
- E. The ENGINEER or OWNER'S AGENT will review the CONTRACTOR's proposed source of supply or manufacturer for each entry and note any exceptions taken, and then return the List of Submittals to the CONTRACTOR within fourteen (14) calendar days.
- F. The following conditions apply concerning exceptions:
1. No reference to a particular source of supply or manufacturer in the Contract Documents shall not relieve the CONTRACTOR of the obligation to fulfill, all requirements of the Specifications.
 2. No exception to a particular manufacturer shall be construed by the CONTRACTOR as obligating the ENGINEER or OWNER'S AGENT to approve a Shop Drawing for a product from that manufacturer.

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SUBMITTALS

3. Subsequent to rejection of a particular source of supply or manufacturer, the CONTRACTOR shall submit to the ENGINEER or OWNER'S AGENT for approval a different source of supply or manufacturer for that product within seven (7) calendar days after notification of such rejection. The entire List of Submittals shall be resubmitted.
4. As an alternative to rejecting a particular source of supply for equipment, materials, or products, the ENGINEER or OWNER'S AGENT reserves the option to alter the type of submittal required for that product.

2.02 SAMPLES

- A. If the ENGINEER or OWNER'S AGENT so requires, either prior to or after commencement of the Work, the CONTRACTOR shall submit samples of materials for such special tests, or for file purposes, as the ENGINEER or OWNER'S AGENT deems necessary to demonstrate that they conform to the Specifications. Such samples shall be furnished, taken, stored, packed and shipped by the CONTRACTOR as directed.
- B. All samples shall be packed so as to reach their destination in good condition, and shall be labeled to indicate the material represented, the name of the Work and location for which the material is intended, and the name of the CONTRACTOR submitting the sample. To ensure consideration of samples, the CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT by letter that the samples have been shipped and shall properly describe the same in the letter; the letter shall have a copy of the Chain of Custody attached. The Letter of Notification and Chain of Custody shall be enclosed with the samples.
- C. The CONTRACTOR shall submit data and samples, or place its orders sufficiently early to permit consideration, inspection, testing, and approval before the materials and equipment are needed for incorporation into the Work. The consequences of CONTRACTOR failure to do so shall be the CONTRACTOR's sole responsibility.
- D. In order to demonstrate the proficiency of workmen or to facilitate the choice among several textures, type finishes, surfaces, etc., the CONTRACTOR shall provide such samples of workmanship as may be required.
- E. When required, the CONTRACTOR shall furnish to the ENGINEER or OWNER'S AGENT triplicate sworn copies of manufacturer's shop or mill tests or reports from independent testing laboratories relative to the materials, equipment performance ratings, and concrete data.

01300
SUBMITTALS

- F. The cost of samples, sample testing, and analysis associated with the approval of proposed materials and/or methods shall be borne in their entirety by the CONTRACTOR.

2.03 CERTIFICATES, AFFIDAVITS, AND WARRANTIES

- A. Where specified in the Specifications that a certificate, affidavit, or warranty be submitted to the ENGINEER or OWNER'S AGENT for a particular material, product or product component, such submittals shall be made in accordance with the following:
1. Equipment, Materials, and Products: A Certificate of Compliance shall indicate that the equipment, material, product, or product component complies with the requirements of the Specifications, and it shall be accompanied by test results and/or other technical data substantiating such compliance. The certificate shall be supplied by the material supplier or product component manufacturer.
 2. Installation: A Certificate of Compliance shall indicate that the equipment or system has been properly installed in compliance with manufacturer's instructions and is ready to be operated. The certificate shall be supplied by the equipment or system manufacturer or manufacturer's representative.
 3. Equipment, materials, products and their installation shall be warranted in accordance with these Construction Documents. All warranties shall be submitted for review prior to delivery of the equipment, materials or products to the Site and must be acceptable to the OWNER or OWNER'S AGENT. Limited warranties shall not be acceptable to the OWNER or OWNER'S AGENT unless specifically agreed to by the OWNER or OWNER'S AGENT in writing.
- B. Each certificate shall include a signed sworn statement by an official of the company originating the certificate attesting to the truth and accuracy of all information contained in the certificate. If such attestation of truth and accuracy cannot be included in the certificate itself, it must be provided as an affidavit accompanying the certificate.

2.04 SHOP DRAWINGS

- A. Five (5) copies of each Shop Drawing, certified correct for construction, shall be submitted for the review of the ENGINEER or OWNER'S AGENT as soon as possible after approval of the List of Submittals and with due regard to the sequence in which such information will be

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required. This includes, but is not limited to, clay materials, mix reagents, slurry mix, silt fence material, topsoil, dense graded aggregate, soil materials, borrow materials, bentonite, details of any deviation which the CONTRACTOR proposes from the details as indicated on the Drawings and Construction Sequence, and any details not specifically indicated on the Drawings. It is the CONTRACTOR's responsibility to provide finished Shop Drawings for approval, based on field measurements of actual conditions, indicating how he proposes to install the Work and the equipment, materials, and products being furnished under the Contract. Copies of project Drawings will not be accepted for submission as Shop Drawings.

- B. Shop Drawings shall be submitted in proper sequence with due regard to the time required for the reviewing, approving and transmittal. Shop Drawings for a particular component shall be submitted complete at least 21 days prior to the anticipated date of furnishing or installations of the particular component.
- C. The CONTRACTOR may submit manufacturer's literature as a substitute for, or supplement to, the Shop Drawings, provided the literature is explicit with regard to details of the items to be furnished Samples and/or visual representation of the material shall accompany product data whenever available. Drawings, specifications and manufacturers literature shall bear the name and address of the manufacturer or fabricator, and be clear, detailed, and complete. Catalog numbers of materials or equipment will not suffice.
- D. Shop Drawing submissions shall be made to the ENGINEER or OWNER'S AGENT by the CONTRACTOR only. Any data prepared by Subcontractors and Suppliers shall be submitted through the CONTRACTOR upon review by the CONTRACTOR.
- E. All Shop Drawings covering related items, of equipment material, and products or integrated systems of equipment, material, and products shall be submitted at the same time so that their complete installation can be adequately reviewed. No partial submissions will be considered when it is necessary to meet the material delivery times required by the Contract, the ENGINEER or OWNER'S AGENT may approve partial submissions when accompanied by sufficient data to allow the ENGINEER or OWNER'S AGENT to determine the effect on the final design of other facilities being furnished under this Contract.
- F. Shop Drawings shall be submitted to the ENGINEER or OWNER'S AGENT which have been checked and stamped with the approval of the CONTRACTOR. The CONTRACTOR's stamp shall include, but not be limited to, the submittal date, contract number, project name, submittal

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number, corresponding specification and paragraph number and CONTRACTOR's company name, signature and a notation that the Shop Drawing had been reviewed by the CONTRACTOR and is in conformance with the referenced specification section. Two (2) copies of the Shop Drawings and data submitted by the CONTRACTOR for approval shall be returned by the ENGINEER or OWNER'S AGENT to the CONTRACTOR with comments such as, "No Exceptions Noted", "Exceptions Noted", or "Returned for Resubmission". The CONTRACTOR shall correct the original drawings and data, if required, and resubmit five (5) copies of the revised Shop Drawings and data. Two (2) copies of such revisions, reviewed by the ENGINEER and OWNER, or its AGENT, shall be returned to the CONTRACTOR.

1. All Shop Drawings shall be numbered in chronological order utilizing 001, 002, etc. as the format.
 2. All Shop Drawings, when practical, shall be limited in size to 22" x 34", and have borderlines set back ½" on top, bottom, and right-hand side of the sheet. When the scale to which the drawings must be made for clarity, and the size of the equipment assembly of arrangement, make it impractical to prepare the drawings in 22" x 34" format, larger sheet sizes may be used.
 3. The CONTRACTOR shall revise its original Shop Drawings to reflect any and all changes made to the equipment, materials, or products in the field during construction. When the equipment, materials or products have been finally accepted, the CONTRACTOR shall submit five (5) copies of any Shop Drawing or data which have been so corrected. These copies shall be added by the ENGINEER or OWNER'S AGENT to the bound sets or data submitted as specified below.
- G. At the time of each submission, the CONTRACTOR shall, in writing, notify the ENGINEER or OWNER'S AGENT of any deviation that the Shop Drawings have from the requirements of these Specifications. Failure to note deviations shall not excuse the CONTRACTOR from complying with the requirements of the Specifications.
- H. No equipment, materials, or products for which Shop Drawings have been submitted for approval shall be delivered to the project site or incorporated into the Work until the CONTRACTOR has received copies of such reviewed drawings or until the ENGINEER or OWNER'S AGENT has authorized CONTRACTOR in writing to do so.

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- I. The review of the CONTRACTOR's submitted data by the ENGINEER or OWNER'S AGENT is for general conformance only. Although the ENGINEER or OWNER'S AGENT may review submitted data in detail, such review is an effort to discover errors and omissions in the CONTRACTOR's submissions and to assist the CONTRACTOR in coordinating and expediting its Work. It shall in no way relieve the CONTRACTOR of its obligation and responsibility to coordinate the Work or to relieve it of its responsibility in fulfilling the purpose and intent of the Contract.
- J. Once submitted, all Shop Drawings become the property of the OWNER and OWNER'S AGENT.

2.05 CONSTRUCTION "AS-BUILT" DRAWINGS

- A. The CONTRACTOR shall maintain at the Site a complete set of project Drawings as issued with the Construction Documents. Project Drawings shall be updated by the CONTRACTOR to show any and all deviations made by it during construction. These drawings shall be labeled 'AS-BUILT' with 1/2" high block letters, and submitted to the ENGINEER or OWNER'S AGENT at the completion of the project within seven (7) days after issuance of a Certificate of Substantial Completion by the ENGINEER or OWNER'S AGENT. All such revisions shall be marked every week to keep the Drawings set current during the construction process and prior to any item becoming inaccessible for an "As-Built" drawing to be performed.
- B. The CONTRACTOR's set of project Drawings showing changes made during construction shall be available to the ENGINEER or OWNER'S AGENT throughout the construction period, and shall be delivered to the ENGINEER or OWNER'S AGENT according to the requirements of Paragraph 2.05 A, above.
- C. Electronic format drawings shall be in AutoCAD format.

2.06 MISCELLANEOUS DATA

Any other submittal required by these Specifications, but not directly addressed under this Section, shall be submitted in accordance with the requirements for Shop Drawings.

PART 3 - EXECUTION

3.01 GENERAL

During the Pre-Construction Conference, procedures for handling Shop Drawings and other submissions shall be established.

3.02 ALTERNATIVES TO SPECIFIED PRODUCTS

- A. The Specifications may indicate the name of a manufacturer, a trade name, or a material to be used in the Contract. Reference made to a particular product of the manufacturer is made to identify a particular design, quality, construction arrangement, or style.
- B. Where the CONTRACTOR proposes to use a substitute product for that specified, it shall submit to the ENGINEER or OWNER'S AGENT, for approval, complete information on such substitute product including all necessary redesign of the structure, equipment, or any other part of these Specifications requiring modification as a result of the use of the requested substitute. All such redesign and all new drawings and detailing required as a result thereof shall be prepared by the CONTRACTOR at its own expense, including regulatory permit acquisition for the modifications. Requests for additional money for such substitution will not be considered. [All proposed modifications to Oregon Department of Environmental \(ODEQ\) approved final design and work plan elements must be approved by ODEQ.](#)
- C. If the CONTRACTOR proposes to provide products as "equals" to those specified, it shall be its responsibility to furnish complete, specific detailed information to the ENGINEER or OWNER'S AGENT for approval from the manufacturer or supplier of the product proposed to be provided in which the requirements of these Specifications are shown to be met. This shall consist of a point-by-point comparison of the Specification requirements which the product proposed to be provided. In the event the Specifications mention a manufacturer, a point-by-point comparison of the product specified and that proposed to be provided shall be furnished by the CONTRACTOR. The burden of responsibility in furnishing this information is with the CONTRACTOR. If incomplete or irrelevant data is submitted as evidence of compliance with this subparagraph, the request for approval to provide this specific substitute shall not be considered. The request for approval by the CONTRACTOR to the ENGINEER or OWNER'S AGENT for a substitute product shall also be in accordance with Section 01400 – QUALITY CONTROL.

END OF SECTION

01400 – Quality Control

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PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included

1. Where applicable in the Contract Documents, the minimum acceptable quality of equipment, materials, and workmanship has been defined either by a manufacturer's name and product identification, or by reference to recognized industry standards. Standards, testing protocol, inspection procedures, and additional requirements are referenced in these Contract Documents.
2. To ensure that the necessary materials and equipment are furnished, procedures are established herein to allow the CONTRACTOR to obtain approval by the ENGINEER or OWNER'S AGENT for Work which will be in complete accordance with the Contract Documents; and for substitutions to be reviewed by the ENGINEER or OWNER'S AGENT, or accepted thereby if sufficient data for unqualified approval are submitted by the CONTRACTOR.
3. For products which do not differ significantly from those specified in the referencing Section, or are, in the CONTRACTOR's judgment, of equal or higher quality, the submission of the Materials List as specified in Section 01300 - SUBMITTALS and its approval by the ENGINEER or OWNER'S AGENT, shall provide the basis for quality control. Actual quality control during manufacture shall be maintained by the approval of the Shop Drawings and by the final submissions of the manufacturer's Certificates of Compliance, and the Testing and Inspection Services; specified herein.
4. If the CONTRACTOR proposes to provide products as "equals" to those specified in the referencing Section on which the design is based, it shall be its responsibility to furnish complete, specific, detailed information to the ENGINEER or OWNER'S AGENT for approval, in which the requirements of the Contract Documents are shown to be met.
 - a. These data shall be prepared or approved by the manufacturer of the proposed product, and shall include a point-by-point comparison between the features of the proposed product and the corresponding features of the product specified in the Contract Documents as the one on which the design is based. The features of the product

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specified shall be those of the manufacturer's model specified (including all standard catalog features and any specified options) which were published on the date of the Invitation for Bids.

- b. If applicable, the CONTRACTOR shall also furnish a description of the changes in structures and other equipment which will have to be made because of the proposed substitution.
- c. The burden of responsibility for furnishing these data, documentation, engineering, and certifications for substitute products is with the CONTRACTOR.
- d. A request to furnish the substitute product shall not be considered if incomplete or irrelevant data are submitted as evidence of compliance with the requirements.

1.02 QUALITY CONTROL

A. Qualification of Manufacturer/Installer

- 1. The manufacturer/installer shall be regularly engaged in the business of manufacturing material, installing and/or equipment of the type required by the referencing Section.
- 2. The manufacturer/installer shall be one of those specified by name in the referencing Section, or must be specifically approved by the ENGINEER or OWNER'S AGENT.
 - a. Requests for approval of a manufacturer/installer not named in the referencing Section shall be submitted to the ENGINEER or OWNER'S AGENT, accompanied by the following information:
 - 1) List of at least five (5) installations of material and/or equipment of comparable size and capacity, and operating under anticipated service conditions; showing location, installation date, model, capacity, and service.
 - 2) If the manufacturer/installer cannot list five (5) installations; list all those which have been made, if fewer than five (5).

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- 3) Complete literature, technical, and performance data describing the proposed equipment.
 - 4) The manufacturer's standard installation, operating, and maintenance instruction bulletins for the proposed equipment.
- b. The ENGINEER or OWNER'S AGENT shall notify the CONTRACTOR, in writing, that the manufacturer selected by the CONTRACTOR is approved; or shall request further data to justify the selection. Upon the approval of the manufacturer, the CONTRACTOR shall update the Materials List and submit this to the ENGINEER or OWNER'S AGENT.
- c. If the ENGINEER or OWNER'S AGENT requests additional data on the actual performance of the equipment or system, the CONTRACTOR shall submit evidence that the equipment or system proposed has been installed and has been in operation for a period prior to the date of Invitation for Bids, and that at least two (2) years of such service are considered satisfactory by the operating superintendents of the facilities in which installed. The service and operating conditions for the equipment or system shall be as similar to those described in these Contract Documents, as is practical.
- 1) The ENGINEER or OWNER'S AGENT shall review the experience record of the equipment or system proposed to be installed by the CONTRACTOR, and shall advise the CONTRACTOR, in writing, as to whether or not it appears to be suitable for installation under this Contract.
- d. If acceptable evidence of satisfactory experience with the proposed material and/or equipment cannot be furnished, but the CONTRACTOR still elects to provide it, the ENGINEER or OWNER'S AGENT may accept the installation, but to protect the OWNER's and OWNER'S AGENT's interest in the event that the material and/or equipment does not meet the intended use requirements the CONTRACTOR shall submit a bond or deposit in the amount of the portion of the total Contract price represented by the material and installation cost, including overhead profit of the material and/or equipment being

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proposed. The period of time for which the bond or deposit shall remain in effect shall be two (2) years after final acceptance of the Work. The bond or deposit shall be used by the OWNER or OWNER'S AGENT to pay for its costs to replace the material and/or equipment with that of an alternative manufacturer or supplier, if the material and/or equipment when installed does not perform in accordance with the intended use, in the judgment of the OWNER or OWNER'S AGENT.

- 1) The original material and/or equipment which has been replaced shall become the property of the CONTRACTOR, who shall promptly remove it from the site.
 - 2) The CONTRACTOR shall be given reasonable opportunity to modify the equipment furnished, if necessary, so that it will be acceptable to the OWNER, ENGINEER, or OWNER'S AGENT. Continuous operation in accordance with time for such modifications shall be maintained.
 - 3) The decision of the OWNER or OWNER'S AGENT with respect to replacing unsatisfactory equipment shall be final.
- e. Neither approval by the ENGINEER or OWNER'S AGENT of the CONTRACTOR's selection of a particular manufacturer or system supplier, nor accepting the CONTRACTOR's selection together with the posting of a bond or deposit in lieu of satisfactory evidence of experience, shall obligate the ENGINEER or OWNER'S AGENT to approve details on the Working Drawing submissions from that manufacturer which are not in conformance with the requirements of the Contract Documents.
- f. Neither approval by the ENGINEER or OWNER'S AGENT of the CONTRACTOR's selection of a particular manufacturer, equipment supplier, or installer, nor accepting the CONTRACTOR's selection together with the posting of a bond or deposit in lieu of satisfactory evidence of experience, shall relieve the CONTRACTOR of its obligations to fulfill all requirements of the Contract Documents.

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3. When so specified in the referencing Section, the manufacturer of the equipment or supplier of the system shall furnish, as requested by the ENGINEER or OWNER'S AGENT, and at no additional cost to the OWNER or OWNER'S AGENT, the services of a qualified Technical AGENT to advise the ENGINEER or OWNER'S AGENT and the CONTRACTOR in the installation and operation of the equipment or system, and to certify to the ENGINEER or OWNER'S AGENT, in writing, that the equipment or system is properly installed and ready to be operated.

B. Installation Requirements

1. The CONTRACTOR shall provide at least one person who shall be present at all times during the installation of the items of equipment furnished under the referencing Section who is thoroughly familiar with the type of materials being installed and with the manufacturer's recommended methods of installation and operation, and who shall direct all the Work performed on the equipment item being installed, at no additional cost to the OWNER's AGENT.
2. The person providing the above service need not be an authorized representative of the manufacturer except when the warranty of the manufacturer shall be voided if not installed by an authorized representative. The Certificate of Compliance required by Section 01300-SUBMITTALS must be issued by the manufacturer of the equipment or supplier of the system.

C. Codes and Standards

1. Equipment and installation shall comply with all pertinent federal, state and local codes and regulations.
2. Materials, equipment, and installation shall comply with:
 - a. The minimum standards of the governmental agency or industry standardizing organization publishing standards applicable to such Work.
 - b. The requirements of specific standards listed in the referencing Section.
 - c. Where the standards of several organizations (including the manufacturer's own published standards) are applicable to the same Work, the Work may be done in accordance with any such other standards that require an equal or higher quality construction for the specified service than those

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listed in the referencing Section. The selection of such an alternate standard to the one specified shall be subject to the approval of the ENGINEER or OWNER'S AGENT.

3. Where any provisions of pertinent codes or standards are in conflict with the requirements of the Contract Documents, the provisions requiring greater safety or operability, or higher quality construction for the specified service shall govern, unless specific exemptions to such provisions are made in the referencing Section. The final determination shall be made by the ENGINEER or OWNER'S AGENT.
 4. If the mandatory standards of governmental agencies are revised subsequent to the date of issue of the Invitation to Bid, but are made applicable to the Work under this Contract, the CONTRACTOR shall advise the ENGINEER or OWNER'S AGENT as to the additional cost or reduction in costs required to comply with such revisions, and a Change Order will be issued to cover such costs or the CONTRACTOR issue a credit in the event the change required by the governmental agency results in a cost reduction. The cost of rework required for Work not complying with such revised regulations, but installed after the effective date of such code revisions, will be at the CONTRACTOR's expense.
 5. The CONTRACTOR shall document construction and installation activities. At a minimum, installation records shall contain the minimum information: time, place, installer, personnel, equipment used or required, testing performed, test locations, results of testing, installation percent completed, duration, conflicts, resolution to conflicts, safety requirements/actions, site conditions, weather, and all other information required to document the proper installation and certification.
- D. At the discretion of the ENGINEER or OWNER'S AGENT, the CONTRACTOR shall make available any materials related to the Work, including but not limited to soils, granular materials, clay, mix reagents, or soil-mix backfill, for confirmation quality control sampling by the ENGINEER or OWNER'S AGENT.

PART 2 - PRODUCTS

2.01 DESIGN

- A. The design of certain items at the site, as shown in the Contract Documents, is based on the performance and dimensions of specific equipment items as furnished by particular manufacturers.
1. When the performance or dimensions of such items are proprietary, and furnished only by one particular manufacturer, the referencing Section will state the design is based on a particular model of that manufacturer.
 - a. The CONTRACTOR may furnish and install corresponding products produced by an alternate manufacturer; either one named as an alternate in the referencing Section, or any other one selected by the CONTRACTOR and approved or accepted by the ENGINEER or OWNER'S AGENT on the basis of the information supplied as requested in Part I of this Section.
 - b. The CONTRACTOR shall furnish the ENGINEER or OWNER'S AGENT with those data on the particular model of the alternate manufacturer which are required to demonstrate that the proposed equipment or system is at least equivalent in performance in the specified service to the equipment or system on which the design is based. The ENGINEER's or OWNER'S AGENT'S evaluation will include a determination of the ability of the proposed equipment to meet the requirements of these Drawings, and a comparison of the costs of Operation and Maintenance. If the CONTRACTOR proposes a modification to the Contract Price due to the substitute equipment, this will also be evaluated by the ENGINEER or OWNER'S AGENT.
 - c. Approval by the ENGINEER or OWNER'S AGENT of the proposed substitution will not be capriciously withheld.
 - d. The design of the facilities associated with the equipment or system for which a substitution is proposed may be affected by such substitution. The size of the building or supporting structure, the size and arrangement of piping and wiring, the specification for associated equipment, the necessary controls, and the service requirements will have to be reconsidered by the CONTRACTOR. The

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CONTRACTOR shall be completely responsible for the necessary engineering, redesign and certification of all facilities affected by the substitution, and shall prepare the revisions to the Drawings required by such substitution. These revisions shall be submitted to the ENGINEER or OWNER'S AGENT for approval, in accordance with the provisions in Section 01300 – SUBMITTALS, including the specific notice as to the details in which the substitute design differs from the requirements of the Contract Documents. All such redesign and all new drawings and detailing required as a result thereof shall be prepared by the CONTRACTOR, or its Subcontractors, at its own expense. Requests for additional payment for such substitution will not be considered unless made a part of the final request for approval of the substitution itself.

2.02 MATERIALS

- A. All materials, including those not specifically described or specified, but required for a complete and proper installation of Work shall be new, first quality of their respective kinds, and subject to the approval of the ENGINEER or OWNER'S AGENT.
- B. All materials shall be in accordance with details and samples as specified in the referencing Section; and submitted and approved in accordance with Section 01300-SUBMITTALS.

2.03 INTERCHANGEABILITY

- A. All products of the same size and type and performing the same function shall be, insofar as practical, the products of one manufacturer.
 - 1. Details in the Shop Drawing submissions of the several equipment manufacturers shall be coordinated so that items such as lubricating fittings, for example, are identical on all equipment items requiring the same grade of lubricant.

PART 3 - EXECUTION

3.01 INSTALLATION CONDITIONS

- A. Inspection
 - 1. Prior to any Work on a specific equipment unit or material installation, the CONTRACTOR shall carefully inspect the existing and previously installed Work, and verify that all Work is

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in such a condition that the installation of new Work may properly commence and be carried out to a proper and timely completion.

2. The CONTRACTOR shall verify that each item of Work shall be installed in accordance with all pertinent codes and regulations, the approved design, and the referenced standards.
3. The ENGINEER or OWNER'S AGENT shall periodically inspect the Work to provide quality assurance in accordance with these Contract Documents.

B. Discrepancies

1. In the event of discrepancies, the CONTRACTOR shall immediately notify the ENGINEER or OWNER'S AGENT, in writing, of such conditions.
2. The CONTRACTOR shall not proceed with installation in areas of discrepancy until such discrepancies have been corrected in a manner acceptable to the ENGINEER or OWNER'S AGENT.
3. For any unexpected features arising during the progress of Work and not fully covered herein, the Specifications shall be interpreted by the ENGINEER, or its AGENT, or OWNER'S AGENT to require first-class workmanship and materials, and such interpretation shall be accepted by the CONTRACTOR.

3.02 INSTALLATION

- A. The CONTRACTOR shall install each equipment item in strict accordance with the manufacturer's instructions, unless specifically directed otherwise by the ENGINEER or OWNER'S AGENT. The CONTRACTOR shall not void the manufacturer's guarantee.
- B. In the event of discrepancies between the Contract Documents and the equipment manufacturer's formal installation instructions, as submitted for the actual units supplied, the CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT, in writing, of such discrepancies. The CONTRACTOR shall obtain the equipment manufacturer's approval in writing for any changes required to suit the site conditions, and so advise the ENGINEER or OWNER'S AGENT.

END OF SECTION

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QUALITY CONTROL

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*01430 – Environmental
Protection*

PART 1 - GENERAL

1.01 DESCRIPTION

The CONTRACTOR shall perform all Work in such manner as to minimize the polluting of air, water, or land, and shall, within reasonable limits, control noise and minimize the generation and disposal of solid waste materials, as well as other pollutants. Disposal of waste materials shall comply with all applicable federal, state, county, and environmental regulations.

1.02 PRE-CONSTRUCTION WALK-THROUGH

Prior to the start of any on-site construction activities, the CONTRACTOR and the ENGINEER or OWNER'S AGENT shall make a joint condition survey of the Site after which the CONTRACTOR shall prepare a brief report indicating on a layout plan the condition of structures, fences, equipment, stored product and materials, and items near the Work areas and access route(s) as applicable. This report will be signed by both the ENGINEER or OWNER'S AGENT, and the CONTRACTOR upon mutual agreement as to its accuracy and completeness.

1.03 PROTECTION OF LAND AREAS AND UTILITIES

- A. Except for any Work, or storage area and access routes specifically assigned for the use of the CONTRACTOR, the land areas outside the limits of disturbance performed shall be preserved in their present condition.
- B. The CONTRACTOR shall confine its construction activities to areas defined for Work on the Drawings or specifically assigned for its use within the designated disturbed area. Storage and related areas and access required temporarily by the CONTRACTOR in the performance of the Work shall be coordinated with the ENGINEER or OWNER'S AGENT.
- C. The Work includes excavation and other activities near, and at, the location of utilities, both subsurface and overhead. For any utility designated on the Drawings for abandonment, the CONTRACTOR shall confirm, via inspection and confirmation from the ENGINEER and the OWNER'S AGENT, that the particular utility is not being used. For all active utilities, the CONTRACTOR shall perform all work in accordance with any requirements stipulated by each specific utility. Work shall also be conducted in accordance with all local and state requirements.

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ENVIRONMENTAL PROTECTION

- D. It is the responsibility of the CONTRACTOR to contact the specific utility when working near utility poles. The CONTRACTOR shall coordinate with the utility to ensure adequate, temporary support and protection of the utility poles when working near the poles. The CONTRACTOR shall also coordinate with the utility for any temporary re-routing of the utility or shielding of the utility during the Work.

1.04 PROTECTION OF SURROUNDING AREAS

- A. Except for trees, shrubs and other vegetation marked on the Drawings to be removed; the CONTRACTOR shall not deface, injure or destroy trees, shrubs, or vegetation nor remove or cut them without special authority. No ropes, cables, or guys shall be fastened to or attached to any existing nearby trees for anchorages.
- B. The CONTRACTOR shall not damage or compromise the integrity of any infrastructure, equipment, materials, or other items not designated for removal or any Work. Any damage to items within or outside the Work area that are not designated for dismantling shall be restored or replaced in kind at no additional cost to the OWNER'S AGENT.

1.05 PROTECTION OF WATER RESOURCES

- A. The CONTRACTOR shall control the disposal of fuels, oils, bitumens, calcium chloride, acids, alkalis, pesticides, herbicides, rodenticides, or other harmful materials, both on- and off-site, and shall comply with applicable federal, state, and local laws concerning the pollution of rivers and streams. Special measures shall be taken to prevent chemicals, fuels, oils, greases, bituminous materials, herbicides, and insecticides from entering public waters.
- B. Water used in on-site material processing and other waste waters shall not be allowed to re-enter public waters. These waters and decontamination water or fluids shall be contained and disposed at an appropriate facility in accordance with all federal, state and local requirements.
- C. Water accumulating within any excavation containing potentially impacted materials shall be removed/dewatered in accordance with these Specifications. Water shall be disposed in accordance with Section 01500 – TEMPORARY FACILITIES AND CONTROLS.

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ENVIRONMENTAL PROTECTION

1.06 WASTE DISPOSAL

- A. The CONTRACTOR shall place all general debris and waste; i.e., paper, trash, etc., in a storage container provided by the CONTRACTOR for subsequent disposal by the CONTRACTOR. Soil, sediment, contact water or demolition debris is not considered general debris, but rather, waste that shall be managed as required in the Contract Documents, including Section 02250 – TRANSPORTATION AND DISPOSAL OF MATERIALS. If any waste material is dumped in unauthorized areas, the CONTRACTOR shall remove the material and restore the area to the condition of the adjacent undisturbed areas. Where directed, ground and/or floor areas contaminated by CONTRACTOR operations shall be excavated and/or cleaned, disposed as approved, and replaced with suitable fill material at no additional expense to the OWNER'S AGENT.
- B. No material shall be burned on the project site. It shall be the responsibility of the CONTRACTOR to provide disposal of all waste materials in accordance with all state and county regulations.

1.07 DUST CONTROL

- A. The CONTRACTOR shall maintain all excavations, stockpiles, access roads, waste areas, off-site roadways and all other work areas free from excess dust to such reasonable degree [b1] as to avoid causing a hazard or nuisance to others.
- B. Approved temporary methods for dust control consist of sprinkling of water or a dilute solution of water with a biodegradable surfactant (less than 0.05 percent). Chemical treatment, tents, windscreens, or similar methods will be considered for dust control. Approval of such temporary methods must be granted by the ENGINEER or OWNER'S AGENT prior to initiation.
- C. Dust control shall be performed as the Work proceeds and whenever a dust nuisance, hazard, or exceedance of predefined action levels occurs, or as otherwise directed by the ENGINEER or OWNER'S AGENT.

1.08 CORRECTIVE ACTION

The CONTRACTOR shall, upon receipt of a notice in writing from the ENGINEER or OWNER'S AGENT of any non-compliance with the foregoing provisions, take immediate corrective action in accordance with any and all federal, state, or local laws. If the CONTRACTOR fails or refuses to comply promptly, the ENGINEER or OWNER'S AGENT may issue an order stopping all or part of the work until satisfactory corrective action has been taken.

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ENVIRONMENTAL PROTECTION

1.09 POST-CONSTRUCTION CLEANUP OR OBLITERATION

The CONTRACTOR shall, unless otherwise instructed in writing by the ENGINEER or OWNER'S AGENT, obliterate all signs of temporary construction facilities such as temporary access roads, Work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other vestiges of construction prior to final acceptance of the Work. Any disturbed soil areas shall be graded and filled and the entire area stabilized with aggregate or seeded with permanent vegetation, as indicated on the Drawings.

1.10 EROSION CONTROL

- A. Surface drainage from cuts and fills, within the construction limits, whether or not completed, and from excavated areas shall be graded to control erosion within acceptable limits.
- B. Temporary control measures shall be provided and maintained throughout construction. Such measures shall include, but not be limited to silt fence, straw bales, drainage swales, and stabilized construction entrance(s). No additional payment will be considered or approved for repair or maintenance of the erosion control measures or for erosion repair.
- C. The area of bare soil, exposed at any one time by construction operations shall be minimized to the satisfaction of the ENGINEER or OWNER'S AGENT.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

(not used)

END OF SECTION

*01500 – Temporary Facilities and
Controls*

01500
TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 FIELD CONDITIONS AND MEASUREMENTS

- A. The CONTRACTOR shall base all measurements, both horizontal and vertical, from established benchmarks and monuments. The CONTRACTOR shall be responsible for field verification of all dimensions and conditions at the Site. The ENGINEER or OWNER'S AGENT shall provide to the CONTRACTOR both coordinates and elevations for monuments as shown on the Drawings.
- B. Should the CONTRACTOR discover any discrepancy between actual conditions and those indicated, which prevent following good practice or the intent of the Specifications and Drawings, the CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT, request clarification and instructions, and shall not proceed with Work until the CONTRACTOR has received the same from the ENGINEER or OWNER'S AGENT; provided that such wait does not unduly delay the progress of the Work.
- C. No claims shall be made for extra payment or extensions of the Contract completion time if the CONTRACTOR fails to notify the ENGINEER or OWNER'S AGENT of any discrepancy before proceeding with that aspect of that Work.

1.02 SUBMITTALS

In accordance with Section 01300 – SUBMITTALS and the Construction Quality Assurance/Quality Control (CQA/QC) Plan.

1.03 ACCESS AND DRAINAGE

- A. The CONTRACTOR shall keep all natural drainage and water courses unobstructed or provide equal courses effectively placed, and prevent accumulations of surface water. The CONTRACTOR shall construct, grade, and stabilize access roads and provide temporary mobilization, parking, storage and staging areas for its use during construction within the areas shown on the Drawings.
- B. Access roads and mobilization, parking, and storage areas shall be maintained in a stable and smooth condition throughout the life of the Contract.

01500
TEMPORARY FACILITIES AND CONTROLS

1.04 TEMPORARY SANITARY FACILITIES

The CONTRACTOR shall furnish and maintain the necessary temporary self-contained chemical type sanitary facilities in accordance with all applicable regulations. They shall be located near the points of Work and shall be cleaned daily and adequately serviced. The use of these facilities shall be available for the CONTRACTOR's employees as well as the OWNER'S AGENT and ENGINEER representatives and other project personnel on the Site. Separate sanitary facilities are required for men and women; these facilities must be clearly marked and reasonably maintained in a sanitary condition.

1.05 CONTRACTOR STORAGE AREA

A. A storage area shall be designated by the ENGINEER or OWNER'S AGENT on the project site for use by the CONTRACTOR for storage of materials, tools, equipment, office and other items necessary for construction. The exact limits of the storage area will be designated in the field by the ENGINEER or OWNER'S AGENT. The CONTRACTOR shall be fully responsible for the preparation of this area, its maintenance, and its security including fencing, watchmen, and other means of security. Under no circumstances will the OWNER, OWNER'S AGENT, or ENGINEER be responsible for the security of any property belonging to the CONTRACTOR, its Subcontractors or any of its Work forces. The CONTRACTOR shall, upon completion of the project, return the storage area(s) to the original condition. All disturbed areas shall be repaired and covered with surface materials that match the existing adjacent materials; i.e., concrete, topsoil and grass, asphalt, etc.

B. The fueling or servicing of any necessary equipment shall take place within the contractor storage area. Portable fueling methods shall be used unless otherwise approved by the ENGINEER or OWNER'S AGENT.

1.06 STAGING AREAS, STORAGE AND FIELD OFFICES

A. The CONTRACTOR may, during the course of this project, stage construction, store materials, or erect temporary field offices only within the Limits of Disturbance shown on the Drawings or as otherwise approved by the ENGINEER or OWNER'S AGENT.

B. Requirements for the field offices and utilities are specified in Section 01010 - SUMMARY OF WORK.

1.07 HANDLING AND DISPOSAL OF SITE WATER

A. The CONTRACTOR shall furnish all labor, materials, and equipment necessary for the proper handling, collection, and on-off-site transport of

TEMPORARY FACILITIES AND CONTROLS

water accumulated that is generated from stormwater, groundwater, dust control operations, or otherwise.

- B. Any stormwater or other ponded water encountered within the areas of excavation or disturbance with potentially impacted material exposed during construction activities shall be collected and transported in accordance with these Specifications.
- C. All waste fluids generated by the CONTRACTOR from decontamination activities, or otherwise, shall be properly contained, managed, and transported by the CONTRACTOR to an approved [on-site storage location](#)~~disposal facility~~.
- D. The CONTRACTOR shall take the necessary measures; i.e., divert runoff from the work area, to minimize the quantity of water generated for disposal.

1.08 TRUCKING

- A. All trucks bringing to or removing from the Site, soil, loose materials or debris shall be loaded in a manner so as to prevent the dropping of materials on public or private off-site streets or roadways.
- B. At all points where trucks leave the project site and enter adjacent paved roadways, the CONTRACTOR shall provide and maintain a crew or other means necessary to prevent any mud or loose material from being carried onto such adjacent paved roadways.
- C. [In the event that soil](#)~~Soil~~, loose materials or debris [are](#) deposited on [to public or private streets or the](#) roadways [on the egress side of the equipment decontamination station, the following actions](#)~~due to contract activities~~ shall [take place](#):
 1. [The truck shall return and go through the decontamination station again before proceeding off-site.](#)
 2. [No additional loads shall leave the site until the decontamination procedures are reviewed and necessary changes implemented to ensure that dropping or tracking of material and debris beyond the decontamination station does not occur.](#)
 3. [The soil, loose materials or deposited debris is to be immediately removed to avoid additional tracking and exposure](#)~~daily~~.

1.09 EQUIPMENT DECONTAMINATION

TEMPORARY FACILITIES AND CONTROLS

- A. The CONTRACTOR shall decontaminate any equipment or materials that have contacted potentially hazardous substances (if any) prior to leaving the area. Decontamination activities shall be performed in a designated location over a contained area such that all materials and contact water are properly contained. All decontaminated residual materials and contact water shall be tested and properly disposed in accordance with Part 1.08 of this Section.
- B. The CONTRACTOR shall provide all wash water required for the decontamination of equipment and personnel.
- C. Personnel decontamination procedures shall be followed by the CONTRACTOR as specified in the CONTRACTOR'S Health and Safety Plan.
- D. Any solids and soils/sediments generated from the decontamination activities shall be considered impacted and disposed in accordance with Section 02250 – TRANSPORTATION AND DISPOSAL OF MATERIALS.

1.10 SECURITY

- A. Security for the purpose of this project will be defined as precautionary measures to ensure that equipment, tools, and materials are safe from vandalism, theft, or damage. The CONTRACTOR is responsible for the security of all equipment used and/or stored on the Site.
- B. The right of access to this Work area, whether it is in preparation or progress, shall be extended to the OWNER, OWNER'S AGENT and ENGINEER, as well as local authorities.
- C. The entrance of persons and vehicles into the Site shall only be permitted for authorized persons with proper identification.
- D. A list of authorized persons shall be maintained, and a copy submitted to the ENGINEER or OWNER'S AGENT upon request.
- E. CONTRACTOR is responsible for security of work progress and equipment until acceptance of work by the ENGINEER, OWNER'S AGENT and OWNER.

1.11 EROSION AND SEDIMENT CONTROL MEASURES

- A. Adequate control of erosion and sediment of both a temporary and permanent nature on areas disturbed by the Work shall be provided under this Specification and/or subject to the approval of the ENGINEER or

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TEMPORARY FACILITIES AND CONTROLS

OWNER'S AGENT. During the pre-construction walk-through, the CONTRACTOR and the ENGINEER or OWNER'S AGENT shall review the Erosion and Sediment Control Plan and details and shall determine additional specific sediment and erosion control requirements. All erosion and sediment control measures shall be provided and maintained until the Site is fully stabilized, as approved by the ENGINEER. Maintenance includes, but is not limited to, the clearing and removal of sediment accumulation in the ditches and silt fence; repair of any damaged or fallen erosion and sediment control components; and all other activities required to ensure proper performance of erosion and sediment control measures.

- B. Erosion control shall comply with all applicable State of Oregon [and City of Portland](#) regulations.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

(not used)

END OF SECTION

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TEMPORARY FACILITIES AND CONTROLS

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01600 – Material and Equipment

01600
MATERIAL AND EQUIPMENT

PART 1 - GENERAL

1.01 EQUIPMENT AND PRODUCTS SPECIFIED

- A. In various detailed Sections of these Specifications, certain items of equipment, materials, or products are specified by proprietary name or trade name and shall be used without exception. It is to be understood that these items are to be furnished by the CONTRACTOR as indicated in this Section and no substitutes will be allowed.
- B. In the various detailed Sections of these Specifications where any item of equipment or product is specified by proprietary name or trade name, with the addition of such expressions as “or equal”, it is to be understood that equal quality equipment or products of either a manufacturer named or a manufacturer not named which meet the detailed requirements of the Specifications are subject to the approval of the ENGINEER or OWNER’S AGENT as to the equality thereof and in accordance with Section 01400 - QUALITY CONTROL.

1.02 STORAGE AND MAINTENANCE OF EQUIPMENT

- A. All equipment, materials, and products provided and Work performed under this Contract shall be protected from damage before and after installation. The CONTRACTOR shall be responsible for Work, equipment, materials, and products until inspected, tested, and finally accepted in accordance with this Section, the Contract Documents and all applicable warranties.
- B. During construction, and at the end of each working day or other period, the open ends of Work shall be effectively closed with temporary covers or plugs to prevent the entry of foreign material.
- C. Where permanent equipment called for under this Contract is installed before the erection of adequate protective structures, the CONTRACTOR without additional compensation therefore, shall provide approved, effective, and durable covers for fully protecting such equipment against damage from the elements or from any other causes.
- D. All machinery, equipment, piping, and accessories and appurtenances shall be adequately supported and safeguarded against all damage or injury during performance of Work under this Contract. The CONTRACTOR shall be responsible for all damage or injury resulting from its operations and shall repair such damage immediately and to the satisfaction of the ENGINEER or OWNER’S AGENT.

01600
MATERIAL AND EQUIPMENT

- E. The CONTRACTOR shall store and protect equipment, materials, and products in accordance with the manufacturer's recommendations and the requirements specified in these Specifications and shall submit the manufacturer's storage and maintenance instructions to the ENGINEER or OWNER'S AGENT prior to delivery.
- F. The CONTRACTOR shall make all arrangements and provisions necessary for the storage of equipment, materials, and products. All excavated material, construction equipment, and materials and equipment to be incorporated into the Work shall be placed so as not to injure any part of the Work or existing facilities, and so that free access can be achieved at all times to all parts of the Work and to all public utility installations in the vicinity of the Work. Equipment, materials, and products shall be kept neatly and compactly stored in locations that will cause a minimum of inconvenience to other contractors, public travel, adjoining owners, tenants, occupants, and the ENGINEER or OWNER'S AGENT'S personnel.
- G. Areas available on the project site for storage of equipment, materials, and products shall be as shown, specified, or designated and approved by the ENGINEER or OWNER'S AGENT. All equipment, materials, and products must be consigned to the CONTRACTOR directly. No delivery of equipment, materials, and products will be accepted by the ENGINEER or OWNER'S AGENT, and all expenses incurred by the ENGINEER or OWNER'S AGENT in handling equipment, materials, and products which have been consigned or directed to the ENGINEER or OWNER'S AGENT will be charged to the CONTRACTOR.
- H. Equipment, materials, and products which are to become the property of the OWNER and OWNER'S AGENT shall be stored to facilitate their inspection and ensure preservation of the quality and fitness of the Work, including proper protection against damage by freezing and moisture. They shall be placed inside storage areas, unless otherwise shown, specified, or acceptable to the ENGINEER or OWNER'S AGENT.
- I. CONTRACTOR shall be fully responsible for loss or damage to stored equipment, materials, and products.
- J. Any equipment, materials, or products which, in the opinion of the ENGINEER or OWNER'S AGENT, have been damaged due to improper storage and/or handling and is unfit for its specified or intended use shall be properly removed from the site or Work. The CONTRACTOR shall receive no compensation for the damaged equipment, material, or product or its removal or replacement.

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MATERIAL AND EQUIPMENT

- K. All materials delivered and stored on-site shall bear the manufacturer's trade names, labels, stamps, or other suitable identification clearly marked in a conspicuous place.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

(not used)

END OF SECTION

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MATERIAL AND EQUIPMENT

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01700 – Contract Closeout

PART 1 - GENERAL

1.01 DESCRIPTION

A. Clean-Up

Upon completion of the Work and before a Certificate of Substantial Completion is issued by the ENGINEER or OWNER'S AGENT to the CONTRACTOR, the Work site, storage areas, and other areas occupied by the CONTRACTOR during construction shall be cleaned, and all surplus and discarded materials, false Work, and rubbish placed thereon by the CONTRACTOR shall be removed by the CONTRACTOR. No separate payment will be made for clean-up as all such costs shall be included in the Bid.

B. Warranties and Guarantees

All Warranties and Guarantees shall be submitted to the ENGINEER or OWNER'S AGENT prior to the performance of Work or the delivery of materials to the Site. These Warranties and Guarantees will be referred to the OWNER or OWNER'S AGENT for review and approval of the Terms and Conditions. Upon completion of the Work and before a Certificate of Substantial Completion is issued by the ENGINEER or OWNER'S AGENT to the CONTRACTOR, all -final Warranties and Guarantees shall be submitted to the ENGINEER or OWNER'S AGENT.

C. Record Documentation and "As-Built" Drawings

1. Upon Completion of the Work and before a Certificate of Substantial Completion is issued by the ENGINEER or OWNER'S AGENT to the CONTRACTOR, all "As-Built" documentation shall be completed and submitted to the ENGINEER or OWNER'S AGENT.
2. Project record documents include, but are not limited to the following:
 - a. Drawings;
 - b. Specifications;
 - c. Addenda;
 - d. Site Work Orders, field orders, and other modifications to the Contract,
 - e. Approved Shop Drawings;
 - f. Product data and samples;
 - g. Warranties and Guarantees;

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CONTRACT CLOSEOUT

- h. “As-Built” documentation; and,
 - i. Other approved documents submitted by the CONTRACTOR in compliance with these Specifications.
- 3. CONTRACTOR shall maintain, at the Site, one set of the following record documents; and record actual revisions to the Work.
 - a. Contract Drawings;
 - b. Specifications;
 - c. Addenda;
 - d. Change Orders and other Modifications to the Contract; and,
 - e. Reviewed Shop Drawings, product data, and samples.
- 4. CONTRACTOR shall store Record Documents separately from documents used for construction.
- 5. CONTRACTOR shall record information concurrent with construction progress.
- 6. Specifications: CONTRACTOR shall legibly mark and record at each product section the description of actual products installed, including the following:
 - a. Manufacturer’s name and product model and number;
 - b. Product substitutions or alternates utilized; and,
 - c. Changes made by Addenda and modifications.
- 7. Record Documents and Shop Drawings: CONTRACTOR shall legibly mark each item to record actual construction, including:
 - a. Field changes of dimension and detail.
 - b. Details not included on the Drawings.
- 8. CONTRACTOR shall submit the documents to the ENGINEER or OWNER’S AGENT with the claim for final Application of Payment.
- 9. CONTRACTOR shall maintain a daily log of Work performed/completed.
- 10. CONTRACTOR shall maintain a workers log.

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CONTRACT CLOSEOUT

1.02 CLOSEOUT PROCEDURES

- A. When the CONTRACTOR considers that the Work is substantially complete, it shall submit a written request that certifies that the Contract Documents have been reviewed, the Work has been inspected, and that Work is complete in accordance with the Contract Documents and is ready for the ENGINEER's or OWNER'S AGENT'S final inspection.
- B. CONTRACTOR shall provide to the ENGINEER or OWNER'S AGENT "As-Built" documentation, all submittals in accordance with Section 01300 - SUBMITTALS of the Technical Specifications, Warranties and Guarantees, and other submittals required by these Specifications or governing authorities prior to, or concurrent with the request for Certification of Substantial Completion.
- C. ENGINEER or OWNER'S AGENT shall, within a reasonable time after receipt of a written request from the CONTRACTOR, conduct an inspection to determine the status of completion. If ENGINEER or OWNER'S AGENT, determines that the Work is not complete, it shall notify CONTRACTOR in writing giving the reasons thereof. The CONTRACTOR shall remedy the deficiencies noted and submit a certification to the ENGINEER or OWNER'S AGENT for re-inspection.
- D. The CONTRACTOR shall submit project Record Documents to the ENGINEER or OWNER'S AGENT with the claim for final Application for Payment.
- E. Evidence of payment and release of liens shall be provided by the CONTRACTOR in accordance with the requirements provided in the Contract Documents, and is required prior to final payment.

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

(not used)

END OF SECTION

01700
CONTRACT CLOSEOUT

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01740 – Warranties and Bonds

01740
WARRANTIES AND BONDS

PART 1- GENERAL

1.01 PROJECT MAINTENANCE AND WARRANTY

- A. Maintain in good repair the improvements covered by these Drawings and Specifications during the life of the Contract.
- B. Indemnify the OWNER and OWNER'S AGENT against any repairs which may become necessary to any part of the work performed and to items of equipment and systems procured of or furnished under this Contract, arising from defective workmanship or materials used therein, for a period of one (1) year after acceptance from the final date of final resolution of the OWNER'S AGENT accepting work.
- C. The CONTRACTOR shall not be obligated to make replacements which become necessary because of ordinary wear and tear, or as a result of improper operation or maintenance, or to perform any work which is normally performed by a maintenance crew during operation.
- D. In the event of multiple failures of major consequences prior to the expiration of the one-year warranty described above, the affected construction of installation shall be removed/disassembled, inspected, and repaired, modified or replaced as necessary to prevent further occurrences. As related components which may have been damaged or rendered non-serviceable as a consequence of the failure shall be replaced. A new twelve (12) month warranty against defective or deficient design, workmanship, and materials shall commence on the day that the item is reassembled and placed back into operation. As used herein, multiple failures shall be interpreted to mean two (2) or more successive failures of the same kind in the same item or failures of the same kind in two (2) or more items. Major failures may include, but are not limited to, an inadequate GWBW, including sand or slurry pockets, sloughing, subsidence, a non-vertical wall, non-continuous wall, or other deficiencies that would cause any part of the GWBW to not comply with the requirements herein; cracked or settled GWBW cap; failed erosion and sediment controls; or other occurrences that would result in any portion of the project to not comply with these Technical Specifications or Drawings. Should multiple failures occur in a given time, all products of the same size and type shall be disassembled, inspected, modified, or replaced, as necessary, and rewarranted for one year.
- E. The CONTRACTOR shall, at his own expense, furnish all labor, materials, tools, and equipment required and shall make such repairs and removals or shall perform such work or reconstruction as may be made necessary by any structural or functional defect or failure resulting from neglect, faulty workmanship, or faulty materials, in any part of the Work

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WARRANTIES AND BONDS

performed. Such repair shall also include refilling of trenches, excavations or embankments which show settlement or erosion after backfilling or placement.

- F. Except as noted on the Drawings or as specified, all structures such as embankments and fences shall be returned to their original condition prior to the completion of the Contract. Any and all damage to any facility not designated for removal, resulting from the CONTRACTOR's operations, shall be promptly repaired by the CONTRACTOR at no cost to the OWNER or OWNER'S AGENT.
- G. In the event the CONTRACTOR fails to proceed to remedy the defects of which he has been notified within fifteen (15) days of the date of such notice, the OWNER/OWNER'S AGENT reserves the right to cause the required materials to be procured and the work to be done, as described in the Drawings and Specifications, and to hold the CONTRACTOR and the sureties on his bond liable for the cost and expense thereof.
- H. Notice to the CONTRACTOR for repairs and reconstruction will be made in the form of a registered letter addressed to the CONTRACTOR at the contract-designated office.
- I. Neither the foregoing paragraphs nor any provision in the Contract Documents, nor any special guarantee time limit implies any limitation of the CONTRACTOR's liability with the law of the State of Oregon.
 - 1. Upon completion of the Work and before a Certificate of Substantial Completion is issued by the ENGINEER or OWNER'S AGENT to the CONTRACTOR, the Work site, storage areas, and other areas occupied by the CONTRACTOR during construction shall be cleaned, and all surplus and discarded materials, false Work, and rubbish placed thereon by the CONTRACTOR shall be removed by the CONTRACTOR. No separate payment will be made for clean-up as all such costs shall be included in the Bid.

PART 2- PRODUCTS

(not used)

PART 3- EXECUTION

(not used)

END OF SECTION

Division 2 – Site Work

02110 - Site Clearing

DIVISION 2 – SITE WORK

02110 SITE CLEARING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The Work covered by this Section consists of furnishing all equipment, tools, and labor necessary for clearing and grubbing of trees, brush, vegetation, and perishable material of whatever nature; Site preparation activities; removing existing structures, including concrete pads, footing, foundations, abandoned utilities, chain-link fence, railroad tracks, and other features; ~~disconnection and removal of temporarily re-routing~~ the overhead power line; capping and abandoning the designated subsurface utilities; abandoning the designated groundwater monitoring wells; and, preparing the Site for Work. All Work shall be performed in accordance with the limits set forth in the Drawings.
- B. Clearing of vegetation shall only occur to the extent that it is necessary to perform the Work. All materials that are cleared and/or removed shall be stockpiled on-site in accordance with the Contaminated Material Management Plan and addenda~~taken to an approved off-site disposal facility.~~

1.02 MATERIALS OWNERSHIP

Except for materials to be stockpiled for later reuse, CONTRACTOR shall temporarily store cleared materials in roll-off containers provided by the CONTRACTOR until such time that the materials are stockpiled on-site in accordance with the Contaminated Material Management Plan and addenda~~transported to an off-site disposal facility.~~

1.03 SUBMITTALS

- ~~A. In accordance with the provisions of these Contract Documents.~~
- ~~B. Prior to undertaking clearing and grubbing and Site preparation activities, the CONTRACTOR shall provide the ENGINEER or OWNER'S AGENT with the name and address of the facility to where cleared and grubbed and other waste material will be taken.~~

1.04 QUALITY ASSURANCE

- A. All materials procedures, operations, and methods shall be in strict conformance with the Drawings and Specifications, and shall be subjected to strict quality control monitoring as detailed in these Contract

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SITE CLEARING

Documents and the Construction Quality Assurance/Quality Control (CQA/QC) Plan.

- B. The CONTRACTOR shall comply with all requirements of the Oregon Department of Environmental Quality (ODEQ), and other federal, state, and county regulatory agencies controlling environmental reviews and safety during construction.

PART 2 – PRODUCTS

(not used)

PART 3 – EXECUTION

3.01 PREPARATION

- A. The CONTRACTOR shall protect and maintain benchmarks and survey control points from disturbance during construction.
- B. The CONTRACTOR shall retain the services of a private utility locator for utility clearance at the Site prior to initiation of any ground disturbance at the Site including clearing, grading, and grubbing. Identified utilities shall be clearly identified with marking paint on the ground surface. Private utility clearance shall be used as an aid to identify private utilities located at the Site and shall not be used as a comprehensive survey of private site utilities. CONTRACTOR shall be responsible for supplemental means of utility identification and shall proceed with caution when performing the Work in a manner that will allow field identification of utilities not previously marked.
- C. Provide erosion control measures to prevent soil erosion and discharge of soil/sediment-bearing water runoff or airborne dust to adjacent properties and the Willamette River.
- D. Protect existing vegetation and structures to remain against damage.

3.02 SURFACE DEBRIS

- A. Prior to issuance of a Notice-to-Proceed, the OWNER'S AGENT will salvage any desired materials from the work areas, and so inform the CONTRACTOR.

02110
SITE CLEARING

- B. All unsalvaged surface debris, rubble, and other deleterious materials of a manmade nature that may be encountered within the limits of disturbance shall be removed and stockpiled on~~disposed off~~-site in accordance with all federal, state and local regulations.

3.03 CLEARING AND GRUBBING

- A. Clearing and grubbing shall be performed within the limits of disturbance as indicated on the Drawings and only in those areas that require construction activity, such as excavation, filling, removal activities, and construction access. Clearing and grubbing shall be performed in such a fashion as to minimize as much as possible the overall disturbance to the Site.
- B. In the areas to be cleared and grubbed, all trees, stumps, roots, brush, and other vegetation and objectionable organic material shall be removed. Material to be grubbed shall be removed to a depth of not less than 6 inches below the surface elevation of the ground.
- C. All trees, logs, brush, crops, grasses, and debris of all kinds, both standing and fallen, shall be cleared, grubbed, and disposed in accordance with Part 3.06 of this Section without damage to adjoining property.
- D. Areas outside of the limits of clearing shall be protected from damage and no equipment or materials shall be stored or Work performed in those areas. Wherever possible, equipment and materials shall be stored in an area of the site with a stabilized surface as indicated on the Drawings.

3.04 REMOVAL OF EXISTING STRUCTURES

- A. The CONTRACTOR shall disconnect and remove necessary sections of the temporarily re-route the overhead power line as presented on the Drawings to ensure that uninterrupted electrical service during installation of the groundwater barrier wall. The power line currently extends to the west and north from Dock 1 and shall be temporarily re-routed to enable the performance of the Work is conducted in a safe manner. The CONTRACTOR shall coordinate with the appropriate utility prior to disconnection. re-routing. If excavation is to be required, it shall be in accordance with Section 02200 – EARTHWORK of these Specifications.
- B. The CONTRACTOR shall remove existing chain-link fencing, as necessary, to facilitate installation of the groundwater barrier wall. The CONTRACTOR shall install a temporary security fence in accordance with Section 02831 – CHAIN LINK FENCES AND GATES to maintain a continuous, secure perimeter throughout construction.

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SITE CLEARING

- C. The CONTRACTOR shall remove segments of railroad track, as necessary, to facilitate installation of the groundwater barrier wall.
- D. The CONTRACTOR shall remove sections of asphalt or concrete pavement, as necessary, to facilitate installation of the groundwater barrier wall. Saw cutting, or other approved method, shall be used to achieve a neat and uniform section for removal.

3.05 UTILITY ABANDONMENT

- A. The CONTRACTOR shall cut and cap and/or plug (isolate) all subsurface utilities intersecting the proposed groundwater barrier wall alignment. The segment of the pipeline intersecting the groundwater barrier wall shall be cut and removed to facilitate barrier wall construction. The remaining ends of the upgradient and downgradient segments of the pipe shall be capped and/or plugged to form a water tight seal prohibiting future flow into the pipe ends. These utilities include unused process lines, storm sewer drains, water lines, steam, and other pipelines. Known utilities within the vicinity of the proposed groundwater barrier wall are depicted on the Drawings.
- B. Utility pipes designated for removal shall be tapped and the contents inspected prior to cutting and removing the segment of pipe. If liquids are present, the CONTRACTOR shall drain the pipe to facilitate capping and/or plugging the pipe. The CONTRACTOR shall capture and store all recovered liquids in an appropriate container ~~for subsequent characterization and transport the container to the designated on-site storage location disposal.~~
- C. Releases to the subsurface or surrounding work area of liquids recovered from the piping will be immediately remediated by the CONTRACTOR. Excessive release will be remediated by the CONTRACTOR with no additional cost to the OWNER'S AGENT.
- D. Pipe tapping and dismantlement will be performed with non-sparking methods and equipment to prevent explosion and fire. Pipe tapping, drainage, and dismantlement will be performed in accordance with protocols prepared by the CONTRACTOR and approved by the ENGINEER.
- E. Dismantling and removal of piping shall be conducted in a manner as to prevent the migration of dust, fluids, contaminants, and debris outside of the work area.

02110
SITE CLEARING

- F. The utilities shall be abandoned in a manner that prohibits slurry and soil-bentonite backfill from entering the conduits during groundwater barrier wall installation.

3.06 WELL ABANDONMENT

- A. The CONTRACTOR shall abandon groundwater monitoring wells in accordance with OAR Section 690 Division 240. The groundwater monitoring wells to be abandoned are designated on the Construction Drawings.
- B. CONTRACTOR shall inspect the entire length of the well and remove all equipment such as pumps, pressure lines, etc. that may obstruct the placement and performance of the sealing agent.
- C. Wells ~~constructed with an impermeable annular seal~~ shall be abandoned by completely redrilling/cutting off the borehole to casing a minimum of the original diameter. All casing, annular sealing material, drill cuttings, debris, and filter pack material 4 feet below land surface. The remaining casing shall be removed prior to sealing. Grout slurries completely filled with a neat cement grout or bentonite cement grout. The remaining hole volume shall be placed backfilled with natural material, with the following exception: where backfilling with natural material would result in a grout plug less than 4 feet long, the hole shall be filled to approximately one foot from the bottom upground surface with the neat cement grout or bentonite cement grout.
- ~~D. Wells not known to be constructed with an impermeable annular seal shall be abandoned by a tremie pipe completely removing the well casing and sealing with neat cement or bentonite cement grout to avoid segregation or dilution of the sealant. The discharge end approximately one foot from the ground surface. If the casing cannot be removed during the abandonment of a well, the casing shall be thoroughly ripped or perforated from top to bottom, except that perforations will not be required over intervals of the tremie pipe shall be submerged in the grout to avoid breaking the seal while filling well that are sealed with cement. The screened portion of the well and the annular space between the casing and the borehole wall shall be effectively and completely filled with cement or bentonite cement grout applied under pressure.~~
- DE. The CONTRACTOR shall record the specifics of the abandonment, such as location and procedure, and submit the abandonment report to the ENGINEER and to other appropriate agencies.

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SITE CLEARING

E. Well sealant shall be PureGold®, or approved equivalent, consisting of a smooth grout slurry mixed from granular sodium bentonite.

3.06 DISPOSAL OF MATERIALS

- A. General refuse and construction debris that accumulates during the course of construction shall be disposed in separate containers supplied by the CONTRACTOR. Refuse shall be accumulated and disposed periodically.
- B. All trees, brush, limbs, and other yard waste materials shall be chipped directly into designated containers provided by the CONTRACTOR for disposal on-site. No chipping equipment shall discharge directly to the ground. Chipping equipment shall be supplied by the CONTRACTOR.

END OF SECTION

02200 – Earthwork

02200
EARTHWORK

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Work covered by this Section consists of furnishing all materials, labor, tools, equipment and transportation necessary for all construction as it pertains to the excavating, handling, stockpiling, backfilling, compacting and grading of earthwork. The Work includes all hauling, stockpiling, covering, wetting or drying, dewatering, conditioning, compacting and other operations pertaining thereto for constructing and preparing the earthwork complete in accordance with these Specifications and Drawings, or as directed by the ENGINEER or OWNER'S AGENT.
- B. The Work shall include, but not be limited to, the following activities:
1. Construction of earthen berms, ditches and/or swales, and other measures for management of surface water flow;
 2. Hauling, conditioning, stockpiling, and management of soils removed for installation of the clearance trench and groundwater barrier wall;
 3. Excavations and backfilling of soils or trench spoils associated with any portion of the Work required herein, including the clearance trench;
 4. Furnishing, preparing, hauling, testing, placing, and compacting common structural fill;
 5. Furnishing, preparing, hauling, testing, placing, and compacting clay;
 6. Site grading;
 7. Stockpiling and managing materials throughout Work;
 8. Dust control; and,
 9. Dewatering, transportation, and on-off-site management, storage, disposal or treatment and discharge of any accumulated stormwater runoff and groundwater within excavations.
- C. No soils, debris, or liquids shall be removed from the Site unless otherwise instructed or approved by the ENGINEER or OWNER'S AGENT. The CONTRACTOR shall store, characterize, decontaminate, transport, dispose of, and otherwise manage all materials in accordance with these Specifications and the Contaminated Material Management Plan, (CMMP), included as Attachment 1.
- D. All soil types shall consist of materials approved by the ENGINEER or OWNER'S AGENT from off-site sources or from the clearance trench excavation, as approved for reuse. During construction, the construction area shall be well drained. No materials shall be backfilled when either the material or the surfaces on which it is to be placed are frozen, subject

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to standing water, or excessively wet or soft, unless otherwise specified by the ENGINEER or OWNER'S AGENT. When the Work is interrupted by heavy precipitation or freezing temperatures, fill operations shall not be

resumed until the ENGINEER or OWNER'S AGENT determines that the moisture content, density and integrity of the previously-placed soils are as specified.

- E. All soils shall be removed to the limits and depths as specified on the Drawings and Specifications.

1.02 DEFINITIONS

- A. “Common Structural Fill” includes all soils utilized as supplemental fill to backfill excavations or construct earthen berms or other engineered structures, as required.
- B. “Clay” includes those clean soils required for the low permeability layer of the soil cap to be installed above the groundwater barrier wall. The soil shall exhibit a laboratory-tested permeability of less than or equal to 1×10^{-5} centimeters per second (cm/sec).
- C. “Trench Spoils” includes all excavated materials generated from the excavation of the clearance trench.
- D. “Impacted Spoils” includes those soils existing within the extent of the clearance trench, groundwater barrier wall, or elsewhere that are observed to be contaminated, as determined by the ENGINEER or OWNER'S AGENT.
- E. “Obstructive Debris” includes those materials encountered during the Work that would interfere or obstruct the installation of the groundwater barrier wall.
- F. “Subbase” includes the existing soil or materials which have been prepared as a foundation for common fill, aggregate, or other fill material.

1.03 REFERENCES

- A. ASTM D-422 Particle-Size Analysis of Soils
- B. ASTM D-698 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5 Pound Rammer and 12-inch Drop
- C. ASTM D-2216 Standard Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures

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- D. ASTM D-2487 Classification of Soils for Engineering Purposes
- E. ASTM D-~~6938~~ [Standard Test Method for In-Place~~2922~~ Density and Water Content](#) of Soil and Soil-Aggregate ~~in Place~~ by Nuclear Methods (Shallow Depth)
- F. ASTM D-4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- G. ASTM D-2974 Organic Content of Soils
- H. ASTM D-1556 Test Method for Density of Soil In Place by Sand-Cone Method
- I. ASTM D-1557 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 Pound Rammer and 18-Inch Drop
- ~~J. ASTM D-3017 Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)~~
- ~~K. ASTM D-5084 Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter~~
- ~~KL. EPA 9095-A Paint Filter Liquids Test~~

1.04 QUALITY ASSURANCE

- A. All materials, procedures, operations, and methods shall be in strict conformance with the Drawings and Specifications, and shall be subject to strict quality control monitoring as detailed herein and in the Construction Quality Assurance/Quality Control (CQA/QC) Plan. The backfilled soils shall conform exactly to the Drawings and Specifications, except as otherwise authorized in writing by the ENGINEER or OWNER'S AGENT.
- B. The CONTRACTOR shall comprehend and anticipate construction quality assurance activities by the ENGINEER or OWNER'S AGENT, or others, and account for these activities in the installation schedule.

1.05 SUBMITTALS

- A. The CONTRACTOR shall submit to the ENGINEER or OWNER'S AGENT for review a Work Plan proposing methods of excavation, separation of materials (i.e., obstructive debris from trench spoils), backfilling and compaction in the clearance trench, proper staging, conditioning, dewatering, and sequencing for the various portions of the Work. Review shall be for method only. The CONTRACTOR shall

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remain fully responsible for the adequacy and safety of the methods proposed.

- B. The CONTRACTOR shall submit to the ENGINEER or OWNER'S AGENT a stockpiling and staging plan for all Work, including soils, trench spoils, obstructive debris, and other materials prior to the commencement of earthwork activities. The plan shall indicate the location and contents of each stockpile. Generalized locations for soil stockpiles are as designated on the Drawings; the final stockpiling plan is subject to the approval of the ENGINEER or OWNER'S AGENT.
- C. The CONTRACTOR shall submit a 50-pound sample from each of the off-site borrow sources proposed to furnish the required quantity of fill materials. The samples shall be submitted to the ENGINEER or OWNER'S AGENT no less than two (2) weeks prior to the anticipated placement of any soil materials.
- D. The CONTRACTOR shall submit the location of all off-site borrow sources and the results of the tests listed below to the ENGINEER or OWNER'S AGENT no less than two (2) weeks prior to the anticipated placement of any soil materials.
- E. The CONTRACTOR shall submit the results of the ASTM tests listed below for each borrow pit location and designated fill classification to verify that the soil materials meet the technical requirements of this Section.

PARAMETER	ASTM TEST METHOD	FREQUENCY FOR CQC TESTING	FILL CLASSIFICATION
Moisture Content	D-2216	One per 2,000 cy or each change in Material Type	Common Structural Fill and Clay
Soil Classification	D-2487	One per 2,000 cy or each change in Material Type	Common Structural Fill and Clay
Particle-Size Analysis with Hydrometer	D-422	One per 2,000 cy or each change in Material Type	Common Structural Fill and Clay
Atterberg Limits	D-4318	One per 2,000 cy or each change in Material Type	Common Structural Fill and Clay
Modified Proctor	D-1557	One per 2,000 cy or each change in Material Type	Common Structural Fill and Clay
Standard Proctor	D-698	One per 2,000 cy or each change in Material Type	Trench Spoils
Hydraulic Conductivity	D-5084	One per 2,000 cy or each change in Material Type	Clay

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The test results shall be submitted to the ENGINEER or OWNER'S AGENT no less than one week prior to the anticipated placement of any general fill materials furnished from off-site.

1.06 SOIL TESTING

- A. Prior to the general placement of the fill, and during such placement, the ENGINEER or OWNER'S AGENT shall select areas within the limits of the fill for testing the degree of compaction obtained. The CONTRACTOR shall be responsible for the cost of all quality control testing. The CONTRACTOR shall cooperate fully to allow the ENGINEER or OWNER'S AGENT to perform supplemental quality assurance testing.
- B. Payment for any in-place quality assurance testing verification will be made by the OWNER or OWNER'S AGENT. If the results are unsatisfactory, all costs involved in correcting deficiencies in compacted materials to the satisfaction of the ENGINEER or OWNER'S AGENT and any additional costs for retesting will be borne by the CONTRACTOR.
- C. The testing frequency required in Paragraph 1.05 of this Section may be increased at the discretion of the ENGINEER or OWNER'S AGENT when visual observation or construction performance indicates a potential problem.

PART 2 – MATERIALS

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2.01 COMMONSTRUCTURAL FILL SOILS

CommonStructural fill soils shall consist of mineral soil substantially free from organic materials, loam, wood, trash, and other objectionable materials which may be compressible or which cannot be properly compacted. CommonStructural fill soils shall not contain stones larger than two (2) inches in largest diameter and shall be classified according to the Unified Soil Classification System (USCS) as SM, SC, SC-SM, ML-CL, ML, or CL. CommonStructural fill soils shall have a maximum plasticity index of 40. CommonStructural fill soils shall not contain granite blocks, broken concrete, masonry, rubble, or other similar materials. It shall have physical properties such that it can readily spread and be compacted during filling. Snow, ice, and frozen soil shall not be permitted.

CommonStructural fill soils shall be used as backfill for excavated areas.
Common fill soils shall be procured from a commercial soil borrow site.

2.02 CLAY

Clay soils shall consist of mineral soil substantially free from organic materials, loam, wood, trash, and other objectionable materials which may be compressible or which cannot be properly compacted. The material shall be classified according to the Unified Soil Classification System (USCS) as SM, SC, ML, CL, ML-CL, MH, or CH. The material shall have a minimum plasticity index of 10; 100 percent of the particles having a dimension less than two (2) inches; a maximum of 10 percent of the particles, by weight, greater than 0.75 inches in greatest dimension; and, a minimum of 25 percent of the particles, by weight, having a maximum dimension less than 0.002 millimeters. ~~The soils shall not contain material larger than three (3) inches prior to compaction in any lift.~~ Clay soil shall not contain granite blocks, broken concrete, masonry rubble, sound rock, or other similar materials. Snow, ice, and frozen soil shall not be permitted. The clay soil shall have a maximum laboratory-tested hydraulic conductivity of 1×10^{-5} cm/sec. Clay shall be procured from a commercial soil borrow site.

PART 3 – EXECUTION

3.01 GENERAL

- A. Prior to earthwork activities, the Site shall be prepared in accordance with Section 02110 – SITE CLEARING.
- B. Wet, soft, frozen or otherwise unsuitable subgrade, shall be allowed to dry, prior to any grading or backfilling activities, and as approved by the ENGINEER or OWNER'S AGENT. If a firm subgrade foundation is not achieved, the subbase soils shall be excavated and backfilled with commonstructural fill soils so that fill materials will ultimately be placed on a firm foundation.

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- C. All excavations shall be cut accurately within the lines and limits shown on the Drawings or otherwise as directed by the ENGINEER or OWNER'S AGENT. All roots, stumps, rock and foreign matter in the sides and bottom of excavations shall be removed. Excavations and filling shall conform to the slope, grade, and shape of the section shown. Care shall be taken not to excavate below the grades indicated, unless otherwise approved by the ENGINEER or OWNER'S AGENT. Excessive excavation shall be backfilled to grade with suitable fill material as directed by the ENGINEER or OWNER'S AGENT with no additional cost to the OWNER/OWNER'S AGENT. Any required shoring activities shall be conducted in accordance with local, state and federal codes, and as approved by the ENGINEER or OWNER'S AGENT. All trenches ditches, and structures excavated under this Section shall be maintained until final acceptance of the Work.
- D. Neighboring on-site and off-site structures, utilities, roadways, sidewalks, the Willamette River, and other facilities shall be protected from damage caused by settlement, lateral movement, undermining, wash-out and other hazards created by the earthwork operations or delivery of fill materials.

The CONTRACTOR shall be responsible for retaining engineering services required to perform the scope of work established in the Contract Documents, including, but not limited to, design and/or verification of groundwater barrier wall alternatives; engineered shoring, bracing, and support; or, other such matters that require engineering expertise. Associated drawings and calculations shall be prepared and sealed by an Oregon Professional Engineer retained by the CONTRACTOR (herein referred to as CONTRACTOR's Engineer).

- E. Pumping and Drainage
1. At all times during construction, and up to the point of actual turnover to OWNER'S AGENT, the CONTRACTOR shall provide and maintain proper equipment and facilities to prevent all surface-water from entering excavations, and keep such excavations dry so as to obtain a satisfactory undisturbed subgrade foundation condition until the fill soils to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural levels. Where required, design of an appropriate dewatering system will be the responsibility of the CONTRACTOR, submitted to the ENGINEER or OWNER'S AGENT for review prior to commencing Work.

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2. Dewatering shall be conducted in such a manner as to remove all water associated with the naturally occurring groundwater table and surface water runoff that has entered the depressed areas.
3. Water entering the limits of the work area from surface runoff shall be re-directed, via berms or ditches, around the perimeter of the excavation, and discharged to stable ground such that no erosion occurs at the point of discharge.
4. Groundwater, or surface water that enters an excavation, shall not be discharged, or permitted to flow, off-site. These fluids that are collected during dewatering operations shall be contained. If the fluids are not re-used in the GWBW trench, they shall be tested and disposed in accordance with these Specifications, or as approved by the ENGINEER or OWNER'S AGENT.
5. Removal of dewatering equipment shall be accomplished after the system is no longer required; the material and equipment constituting the system shall be removed by the CONTRACTOR.
6. All precautions necessary to preclude the accidental discharge of fuel, oil, etc., shall be taken in order to prevent adverse effects on surface water or groundwater quality.
7. Prior to backfilling stockpiled or off-site common borrow, the areas to be backfilled shall be fully excavated as required and rough graded in accordance with the Contract Documents. Wherever directed by the ENGINEER or OWNER'S AGENT, any soft boggy, organic, or otherwise unsuitable material shall be excavated so that backfill material will be placed on a firm foundation. The use of explosives shall not be permitted in the performance of site excavation.
8. The CONTRACTOR shall be responsible for maintaining a dry excavation at all times and shall be responsible for providing the necessary equipment to maintain dry excavations. The CONTRACTOR is advised that any water removed from excavations shall be managed as contaminated water, unless otherwise approved by the ENGINEER or OWNER'S AGENT.
9. Groundwater, or surface water that enters an excavation, shall not be discharged, or permitted to flow, off-site. These fluids that are collected during dewatering operations shall be contained. If the fluids are not re-used in the GWBW trench, they shall be transported to the designated on-site storage location. ~~tested and disposed off-site at an approved facility.~~

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- F. If the moisture content of any fill material is outside the accepted range to be returned to the excavation, the soil shall be wetted or dried, as appropriate.
1. Fill material that is too wet to permit compaction shall be removed and stockpiled, or spread and allowed to dry. Drying may be assessed by disking, harrowing, or pulverizing until moisture content is reduced to a satisfactory level.
 2. Fill material that is too dry shall be wetted uniformly so as to prevent free water appearing on the surface during or subsequent to compaction operations.
- G. Any delays in progress due to the necessary wetting or drying of soil are the responsibility of the CONTRACTOR.
- H. Soils placed in fill areas shall be graded to smooth true lines, strictly conforming to grades indicated on the Drawings, or otherwise approved by the ENGINEER or OWNER'S AGENT.
- I. The CONTRACTOR shall subcontract a Professional Land Surveyor registered in the State of Oregon to certify that all soil material has been placed to the lines, grades, and elevations presented on the Drawings. The CONTRACTOR may use in-house personnel for the certifications, provided the certification is performed by a surveyor registered in the State of Oregon.
- J. Fill materials shall be placed in such a manner as to facilitate drainage at all times. Ponding of surface-water runoff shall not be permitted.
- K. If compaction or other tests indicate that any portion of the Work does not meet the specified requirements, then the CONTRACTOR shall remove that section, replace and recompact at no additional cost to the OWNER or OWNER'S AGENT. Determinations of the extent of removal and the acceptability of the in-place fill materials shall be made by the ENGINEER or OWNER'S AGENT.
- L. If significant precipitation causes wet conditions, placement and compaction activities shall be terminated until the conditions have dried sufficiently to continue according to the ENGINEER or OWNER'S AGENT.
- M. Equipment or vehicles shall not be allowed to travel in a single track or form ruts. Any ruts or irregularities formed shall be scarified and re-

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compacted by the CONTRACTOR at its expense as required and directed by the ENGINEER or OWNER'S AGENT.

- N. Prior to backfilling fill materials, the areas shall be prepared in accordance with the Specifications. The existing soils shall be proof-rolled to achieve a compact, uniform grade, and the surface shall be free of stones, roots, or other debris.
- O. Inspection
1. Prior to implementing any of the Work in this Section, the CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the Work of this Section may properly commence without adverse impact.
 2. If the CONTRACTOR has any concerns regarding the installed Work of other Sections, CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT in writing. Failure to notify the ENGINEER or OWNER'S AGENT prior to conducting Work within this or other Sections will be construed as CONTRACTOR'S acceptance of the related Work of all other applied Sections.
- P. The CONTRACTOR shall protect on-going and completed work from precipitation, excessive heat, freezing, and other elements to avoid compromising the integrity of prior Work. Prior Work affected by such conditions shall be repaired by the CONTRACTOR at no additional cost to the OWNER or OWNER'S AGENT.
- Q. The CONTRACTOR shall provide erosion-control measures to prevent erosion or displacement of soils, or other Work materials, and discharge of sediment-laden runoff or airborne dust to adjacent properties or water bodies.

3.02 TRENCH SPOILS DEWATERING AND CONDITIONING

- A. Conditioning of excess spoils generated during groundwater barrier wall installation shall be performed, as necessary, to meet the ~~disposal facility's~~ moisture requirements for on-site disposal of non-liquid waste; i.e., pass the Paint Filter Liquids Test, and/or achieve non-hazardous characterization, at the direction of the ENGINEER or OWNER'S AGENT, in accordance with the CMMP. Conditioning may include air drying, blending with clean soils, blending with reagents; e.g. lime or cement kiln dust (CKD), or other conditioning methods approved by the ENGINEER or OWNER'S AGENT. The CONTRACTOR shall submit the methods for conditioning to the ENGINEER or OWNER'S AGENT

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for review prior to commencement of Work. All conditioning shall be performed in the area of the spoils to be conditioned or on a designated area lined with a minimum 30-mil PVC geomembrane. No conditioning shall be performed in an area where impacted spoils could intermingle with clean or other materials.

- B. The CONTRACTOR shall condition the excavated materials, as necessary, using the methods described in Part 3.02 A, to enable proper management; i.e., handling, hauling, and disposal of the materials and to ensure that the materials to be disposed are solids rather than liquids. The CONTRACTOR shall perform a Paint Filter Liquids Test in accordance with the USEPA's test method, Method 9095A, ~~as required by the selected facility~~. In accordance with this method, if any portion of the test materials collect in the cylinder during the 5-minute test period, the material is deemed to contain free liquids, and therefore, the CONTRACTOR shall further condition the materials and re-test.
- C. The CONTRACTOR shall include in the Work Plan, as required in Part 1.05 A, the procedure for conditioning of the waste materials for review and approval by the ENGINEER or OWNER'S AGENT. Acceptable methods for conditioning include, but are not limited to, air drying, mixing with soil, mixing with lime, and mixing with other agents, as approved by the ENGINEER or OWNER'S AGENT.

3.03 EXCAVATION

- A. A clearance trench shall be excavated in the location depicted on the Drawings to facilitate installation of the groundwater barrier wall. The clearance trench shall have a minimum bottom width of three feet.
- B. Excavation shall be made to the depths shown on the Drawings. Care shall be exercised when removing soil as to prevent over-excavation.
- C. All excavation activities shall be conducted in compliance with all applicable OSHA regulations. All excavations shall be conducted in a safe and stable manner. The slopes of the excavation shall be stable at all times. The CONTRACTOR is responsible for the design and installation of temporary shoring, if required.
- D. If unsuitable subgrade materials are uncovered during excavation or otherwise, it shall be removed, stockpiled for conditioning, disposal, replaced, compacted, and graded with ~~common~~ structural fill, as required and approved by the ENGINEER or OWNER'S AGENT.
- E. -Unsuitable subgrade materials shall be removed and managed as directed in Paragraph 3.06 of this Section.

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- F. Excavation of materials shall be accomplished using properly sized hydraulic excavators or equivalent. The equipment will operate so as to eliminate the potential for spreading contamination onto uncontaminated areas or surfaces.
- G. Obstructive debris encountered during clearance trench excavation and groundwater barrier wall construction shall be segregated and stockpiled ~~on for subsequent off-site, in accordance with the CMMP disposal.~~ Obstructive debris includes those materials that, in the opinion of the ENGINEER or OWNER'S AGENT, may impact or obstruct the construction of the groundwater barrier wall (e.g. objects with a dimension greater than the thickness of the groundwater barrier wall).
- H. Impacted spoils encountered during clearance trench excavation and groundwater barrier wall construction shall be segregated and stockpiled ~~on for subsequent off-site, in accordance with the CMMP disposal.~~ Impacted spoils ~~include~~ ~~included~~ those materials that exhibit visual gross contamination, as determined by the ENGINEER or OWNER'S AGENT. The CONTRACTOR shall stage impacted spoils on minimum 30-mil PVC geomembrane.

3.04 APPROVAL OF SUBGRADE

- A. CONTRACTOR shall notify ENGINEER or OWNER'S AGENT when excavations have reached required subgrade, or when the waste materials have been removed, to the extent practical, from a specific location.
- B. If ENGINEER or OWNER'S AGENT determines that unsatisfactory soil materials are present, the CONTRACTOR shall continue excavation and replace with acceptable backfill material, as directed.
- C. Where accessibility permits; i.e., all locations except on side slopes equivalent to three (3) horizontal to one (1) vertical or steeper, proof-roll subgrade, including all waste materials, with heavy loaded tandem to identify soft pockets and areas of excess yielding, otherwise, compact subgrade by other methods approved by ENGINEER or OWNER'S AGENT. Clearance trench spoils shall be backfilled and compacted in accordance with the procedures presented in Paragraph 3.05 of this Section.
- D. CONTRACTOR shall reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the ENGINEER or OWNER'S AGENT.

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3.05 BACKFILLING

- A. With the exception of large debris and impacted soils, as determined by the ENGINEER or OWNER'S AGENT, trench spoils removed during clearance trench excavation shall be placed back in the excavation and compacted as specified in Part 3.05 F of this Section. It is the CONTRACTOR's responsibility to compact the trench spoils to the extent necessary, but at a minimum compliant with Part 3.05 F, to ensure that sloughing, sliding, or buckling will not occur during subsequent groundwater barrier wall installation through the backfill.
- B. Final grade shall be backfilled to the contours and elevations indicated on the Drawings, or as directed by the ENGINEER or OWNER'S AGENT. Grading and placement of the various materials shall be in conformity with the tolerances specified in this Specification.
- C. CommonStructural Fill
1. CommonStructural fill material shall meet the requirements of Part 2.01 of this Section.
 2. CommonStructural fill material used as supplemental fill to backfill the clearance trench shall be placed and compacted as specified in Part 3.05 F of this Section; otherwise, commonstructural fill shall be placed and compacted as specified below.
 3. CommonStructural fill shall be placed in a maximum loose lift of approximately nine (9) inches resulting in a maximum compacted lift of approximately six (6) inches. Compaction shall be accomplished by designated compaction equipment with a minimum weight of 40,000 lbs. Compaction equipment weighing less than 40,000 lbs may be used if the CONTRACTOR can demonstrate that the equipment can achieve the required compaction results and the equipment is, or as otherwise approved by the ENGINEER or OWNER'S AGENT.
 4. CommonStructural fill shall be compacted to 90 percent of maximum dry density obtainable, as determined by ASTM D-1557. The fill shall be compacted within a range of 1 percent below to 3 percent above the optimum moisture content, as determined by ASTM D-1557.
 5. A maximum 5 percent of all field moisture content test results are permitted outside the specified range. The outliers are, however, not permitted to be concentrated in one lift or one area, and no

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moisture content shall be less than 2 percent or more than 4 percent of the optimum moisture content. The areal extent is at the discretion of the ENGINEER or OWNER'S AGENT.

6. A maximum 5 percent of all field dry density test results are permitted outside the specified range. The outliers are, however, not permitted to be concentrated in one lift or one area, and no dry density less than 87 percent as determined by ASTM D-1557 is permitted. The areal extent is at the discretion of the ENGINEER or OWNER'S AGENT.
7. If the criteria set forth in (4) and (5) of this part have been exceeded, the CONTRACTOR shall remove the failing ~~common~~ structural fill and replace, compact and grade new, acceptable fill at no cost to the OWNER'S AGENT.

E. Clay

1. Clay material shall meet the requirements of Part 2.02 of this Section.
2. The maximum final compacted thickness of each lift of clay material shall be six (6) inches. Compaction shall be accomplished with a sheepsfoot roller or similar equipment approved by the ENGINEER or OWNER'S AGENT. The final grade of all clay material shall be uniform.
3. Clay shall be compacted to 90 percent of maximum dry density obtainable, as determined by ASTM D-1557. The fill shall be compacted within a range of 1 percent below to 3 percent above the optimum moisture content, as determined by ASTM D-1557.
4. A maximum 5 percent of all field moisture content test results are permitted outside the specified range. The outliers are, however, not permitted to be concentrated in one lift or one area, and no moisture content shall be less than 2 percent or more than 4 percent of the optimum moisture content. The areal extent is at the discretion of the ENGINEER or OWNER'S AGENT.
5. A maximum 5 percent of all field dry density test results are permitted outside the specified range. The outliers are, however, not permitted to be concentrated in one lift or one area, and no dry density less than 87 percent as determined by ASTM D-1557 is permitted. The areal extent is at the discretion of the ENGINEER or OWNER'S AGENT.

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6. If the criteria set forth in (4) and (5) of this part have been exceeded, the CONTRACTOR shall remove the failing clay and replace, compact and grade new, acceptable clay at no cost to the OWNER or OWNER'S AGENT.

F. Trench Spoils

1. Prior to excavation and backfill of the clearance trench, the CONTRACTOR shall select an area, with the approval of the ENGINEER or OWNER'S AGENT, to construct a minimum 15-foot long by 15-foot wide by 12-inch thick compaction test pad. The purpose of the test pad is to evaluate the compactive effort required when placing the trench spoils in the clearance trench. A test pad shall be constructed for each source or change in materials.
2. The CONTRACTOR shall test the in-place density and moisture content of the test pad by nuclear methods in accordance with ASTM D-~~6938, 2922~~ and ASTM D-~~3017~~, respectively. The CONTRACTOR shall conduct a minimum of one density and moisture content test.
3. If the test results meet or exceed the criteria set forth herein, backfilling of the clearance trench may commence. If the test results fail, the test pad shall be removed and reconstructed by modified construction techniques, as approved by the ENGINEER or OWNER'S AGENT. The reconstructed test pad shall be retested in accordance with this Section.
4. The trench spoils shall be placed in a maximum loose lift of approximately 12 inches. Compaction shall be accomplished using a tamping plate attachment on an excavator or backhoe bucket, or as otherwise approved by the ENGINEER or OWNER'S AGENT.
5. The trench spoils shall be compacted to a minimum of 90 percent of the maximum dry density obtainable, as determined by ASTM D-698.
6. Upon meeting or exceeding the criteria set forth herein, the trench spoils shall be placed and compacted using the same equipment and methodology as that required in construction of the test pad.

3.06 EXCESS MATERIALS

- A. All general waste or debris ([i.e. material not designated for on-site disposal in the CMMP](#)) shall be containerized on-site and periodically disposed off-site in accordance with these Specifications.

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- B. Suitable materials, as determined by tests discussed in these Specifications, shall be classified and stockpiled in approved areas for immediate or future use.
- C. Stockpiles shall be graded to drain; no surface-water ponding is permitted on stockpiles. Stockpiles shall be covered with plastic sheeting or other material to preserve the soil integrity. Proper erosion controls; i.e., silt fence, shall be installed at the perimeter of the stockpile.
- D. Stockpiles that are not used for more than 14 days shall be covered as discussed in Paragraph 3.06 C, or be temporarily vegetated in accordance with these Specifications.
- E. Obstructive debris, excess or impacted spoils, and other unsuitable ~~materials~~material that are not replaced as backfill into the clearance trench shall be stockpiled on a minimum 30-mil geomembrane that is continuously seamed. The material shall also be covered to provide a protective envelope to prevent contact with any precipitation or surface water runoff. Obstructive debris and excess or impacted spoils ~~These materials~~ shall be disposed onoff-site, as approved by the ENGINEER or at an OWNER/OWNER'S AGENT, approved disposal facility. All activities shall comply with the Contaminated Material Management Plan.

3.07 GRADING

- A. Uneven areas and low spots which may develop in the backfilling operations shall be eliminated via minor excavations or placement of appropriate fill materials. Levels, profiles and contours of the final site configuration shall be maintained as established on the Drawings.
- B. The areas to be backfilled shall be uniformly graded to within the limits of grading under this Section. A smooth finished surface shall result within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades to the satisfaction of the ENGINEER or OWNER'S AGENT.
- C. Constructed slopes shall be blended into existing undisturbed areas gradually in order to provide neat, clean transition zones. Feathering of constructed slopes into existing grades shall be accomplished to promote natural drainage and to eliminate possible surface-water ponding.
- D. The right is reserved by the ENGINEER or OWNER'S AGENT to make minor adjustments or revisions in lines or grades if found necessary as the

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Work progresses, due to discrepancies on the Drawings or in order to obtain satisfactory construction. Any suspected discrepancies shall be reported to the ENGINEER or OWNER'S AGENT as soon as detected.

3.08 CRITERIA AND TOLERANCES

- A. Compaction and moisture criteria and tolerances are discussed in Part 3.05 of this Section.
- B. Final soil grades shall be within two tenths of one (0.2) foot below to five tenths of one (0.5) foot above (-0.2 to +0.5) the grades and contours indicated on Drawings, or as indicated by changed field conditions, and approval by the ENGINEER or OWNER'S AGENT. Regardless of the final grade tolerance, the thickness of each specified layer shall meet the minimum thickness.
- C. In recognition of the moisture-density relationship of soils, the ENGINEER or OWNER'S AGENT may direct that the compaction and moisture content tolerances be modified if required by variabilities in the soils. This decision, if required, will be based on the ENGINEER or OWNER'S AGENT interpretation of the laboratory analysis for each soil.
- D. No additional payment shall be made for quantities of soils placed in excess of that amount required to achieve the minimum specified thickness.

3.09 FIELD QUALITY CONTROL

- A. The CONTRACTOR shall test the in-place density and moisture content of the ~~common~~structural fill soils by nuclear methods in accordance with ASTM D-~~69382922~~ and ASTM D-3017, respectively, and these Specifications. The testing shall be conducted at a frequency not less than three tests per lift per area of interest. Every 25th nuclear density test shall be verified in accordance with ASTM D-1556 and ASTM D-2216. All test locations shall be recorded and provided on the "As-Built" Drawings.
- B. The CONTRACTOR shall test the in-place density and moisture content of the clay plug material by nuclear methods in accordance with ASTM D-~~69382922~~ and ASTM D-3017, respectively, and these Specifications. Tests must be conducted every 50 lineal feet on each lift. The density and moisture content results shall be verified in accordance with ASTM D-1556 and ASTM D-2216, respectively. A minimum of three verification tests shall be conducted for each soil material type as determined by the ENGINEER or OWNER'S AGENT. Failing tests shall be repeated. Continued test failure will require re-working of the material prior to re-

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testing and acceptance. All test locations shall be recorded and provided on the "As-Built" Drawings.

- C. The CONTRACTOR shall provide field control; i.e., grade stakes, to determine layer thickness. The ENGINEER OR OWNER'S AGENT shall perform verifying thickness measurements in the field in accordance with quality assurance activities.
- D. The CONTRACTOR shall provide a minimum of 24 hours notice to the ENGINEER or OWNER'S AGENT when each compacted lift is ready for testing.
- E. The CONTRACTOR shall provide access and repair any damage to subgrade caused by correctly performed tests, and cooperate in other ways necessary to permit the ENGINEER or OWNER'S AGENT to conduct testing when and where he/she desires and as expeditiously as possible.
- F. Fill material shall not be placed over a lift which has not been tested and accepted by the ENGINEER or OWNER'S AGENT.
- G. All placement operations shall comply with all requirements of these Specifications.

END OF SECTION

02232 – *Granular Materials*

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GRANULAR MATERIALS

PART 1 - GENERAL

1.01 DESCRIPTION

Work covered by this Section consists of furnishing all labor, materials, tools, equipment and incidentals necessary for obtaining and placing the granular components as indicated on the Drawings and specified herein.

1.02 DEFINITIONS

“Dense-Graded Aggregate (DGA)” includes all aggregate utilized for stabilization of disturbed areas and construction of access roads, if necessary.

1.03 REFERENCES

- A. AASHTO T 27 Sieve Analysis of Fine and Coarse Aggregates
- B. [ASTM D-1556 Test Method for Density of Soil In Place by Sand-Cone Method](#)——~~2005 Oregon Department of Environmental Quality Erosion and Sediment Control Manual~~
- C. [ASTM D-1557 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 Pound Rammer and 18-Inch Drop](#)
- D. [ASTM D-6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods \(Shallow Depth\)](#)
- E. [2005 Oregon Department of Environmental Quality Erosion and Sediment Control Manual](#)
- F. 2008 Oregon Standard Specifications for Construction, Volume 2

1.04 QUALITY ASSURANCE

All materials, procedures, operations, and methods shall be in strict conformance with the Drawings and these Specifications, and shall be subject to strict quality control monitoring as detailed herein and in the Construction Quality Assurance/Quality Control (CQA/QC) Plan. The placed granular materials shall conform exactly to the Drawings and these Specifications, except as otherwise authorized in writing by the ENGINEER or OWNER’S AGENT.

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1.05 SUBMITTALS

- A. The CONTRACTOR shall submit the location of all borrow pits to the ENGINEER or OWNER'S AGENT no less than two weeks prior to the anticipated placement of any granular materials.
- B. The CONTRACTOR shall submit a 50-pound sample from each of the suppliers proposed to furnish the required quantity of granular materials. The samples shall be submitted to the ENGINEER or OWNER'S AGENT no less than two weeks prior to the anticipated placement of any granular materials.
- C. Dense-Graded Aggregate
1. The CONTRACTOR shall submit the results of the particle-size analysis for dense-graded aggregate conducted in accordance with AASHTO T 27 for every ~~2,500,000~~ cubic yards of materials imported to the Site, with a minimum of three (3) tests required.
 2. The CONTRACTOR shall submit the results of a Modified Proctor for dense-graded aggregate conducted in accordance with ASTM D-1557 for every 5,000 cubic yards of materials imported to the Site, with a minimum of two (2) tests required.
 32. The test results shall verify that the material meets the technical requirements of these Specifications. The test results shall be submitted to the ENGINEER or OWNER'S AGENT no less than one week prior to the anticipated placement of granular materials.

1.06 DELIVERY

The CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT one (1) week in advance of delivery of all granular materials. The CONTRACTOR shall stockpile granular materials only at a location approved by the OWNER and/or ENGINEER or OWNER'S AGENT.

PART 2- MATERIALS

2.01 GRANULAR MATERIALS

- A. Dense-Graded Aggregate
1. Aggregate shall consist of hard, strong, durable particles that are free of any materials, roots, trees, stumps, concrete, construction debris, other organic matter, and deleterious materials. Aggregate shall be procured from a commercial borrow site.

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GRANULAR MATERIALS

2. The aggregate shall meet the gradation requirements set forth by the Oregon Standard Specifications for Construction for ¾-inch dense-graded aggregate as given below and as determined by AASHTO T 27.

~~Percent Passing (by weight)~~ Dense Graded Aggregate ¾ inch to 0

Sieve Size	1 1/2" <u>0</u> <u>Percent</u> <u>Passing (by</u> <u>weight)</u>
1"	100
¾"	90-100
½"	-
3/8"	55-75
¼"	40-60
No. 10	*

* Of the fraction passing the ¼-inch sieve, 40% to 60% shall pass the No. 10 sieve

PART 3 - EXECUTION

3.01 INSPECTION

- A. The CONTRACTOR shall verify that finished grades, slopes, and elevations are level with the existing grades and conform to the specified requirements. Misgraded Work shall be corrected at no additional cost to the OWNER or OWNER'S AGENT. CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT immediately if a specified grade, slope or elevation appears inconsistent with the others specified.
- B. At the beginning of each day's Work, the ENGINEER or OWNER'S AGENT will inspect the previously placed granular materials and institute whatever corrective action, if any, that the ENGINEER or OWNER'S AGENT deems appropriate, at no extra cost to the OWNER or OWNER'S AGENT, unless the action requested is clearly beyond the scope of this Contract. This may include, but is not limited to the removal of unsuitable granular materials.

3.02 PLACEMENT OF GRANULAR MATERIALS

- A. Dense-graded aggregate shall be used to stabilize access and on-site roadways, as necessary. Any additional roadways required to ensure

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access to all areas of the Work shall be constructed as deemed necessary by the CONTRACTOR.

- B. Granular materials shall be placed, not dumped, to the limits and grades shown on the Drawings.
- C. Material shall be placed in a maximum loose lift of 9-inches resulting in a maximum compacted lift of 6 inches. Compaction shall be accomplished with a minimum of 4 passes with the designated compaction equipment. The type and weight of compaction equipment shall be submitted by the CONTRACTOR in writing and accepted by the ENGINEER or OWNER'S AGENT.
- D. Dense-graded aggregate shall be compacted to 95 percent of maximum dry density obtainable, as determined by ASTM D-1557. The fill shall be compacted within a range of 0 percent below to 4 percent above the optimum moisture content as determined by ASTM D-1557.
- E. A maximum 5 percent of all field moisture content test results are permitted outside the specified range. The outliers are, however, not permitted to be concentrated in one lift or one area, and no moisture content shall be less than 2 percent or more than 4 percent of the optimum moisture content. The areal extent is at the discretion of the ENGINEER or OWNER'S AGENT.
- F. A maximum 5 percent of all field dry density test results are permitted outside the specified range. The outliers are, however, not permitted to be concentrated in one lift or one area, and no dry density less than 87 percent as determined by ASTM D-1557 is permitted. The areal extent is at the discretion of the ENGINEER or OWNER'S AGENT.
- E. The subbase materials shall be compacted and proof-rolled or otherwise, to observe any soil pumping or insufficient compaction as determine by the ENGINEER or OWNER'S AGENT.
- C. ~~Material shall be spread and graded in one lift to the thickness shown on the Drawings and compacted with a steel roller.~~

3.03 CRITERIA AND TOLERANCES

- A. Final grades shall be within two tenths of one (0.2) foot below to five tenths of one (0.5) foot above (-0.2 to +0.5) the grades and contours indicated on the Drawings, or as dictated by changed field conditions, and approval by the ENGINEER or OWNER'S AGENT. Regardless of the final grade tolerances, the thickness of the granular materials shall meet the minimum thickness as stated in each application.

02242 - *Groundwater Barrier
Wall*

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GROUNDWATER BARRIER WALL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Work covered by this Section consists of furnishing all labor, materials, tools, and equipment necessary for constructing the soil-reagent groundwater barrier wall (GWBW) that meets or exceeds the requirements specified herein and presented on the Drawings.
- B. The GWBW construction shall occur in three distinct phases, as follows:
 - 1. Laboratory Phase: the CONTRACTOR shall perform a bench-scale study with the proposed reagent-soil mixes to refine the final mix.
 - 2. Field Phase: prior to full-scale implementation of the GWBW, the CONTRACTOR shall construct and evaluate a test section of the GWBW to verify performance and in-place characteristics.
 - 3. Full-Scale Phase: complete construction of the GWBW in accordance with these Specifications and Drawings.

1.02 REFERENCES

- A. ASTM C143: Standard Test Method for Slump of Hydraulic Cement Concrete
- B. ASTM C150-95: Standard Specifications for Portland Cement
- C. ASTM D421: Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants
- D. ASTM D422: Standard Test Method for Particle-Size Analysis of Soils
- E. ASTM D698: Test Method for Laboratory Compaction Characteristics of Soil Using Standard Proctor Effort
- F. ASTM D1556 : Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
- G. ASTM D1633 : Standard Test Method for Compressive Strength of Molded Soil-Cement Cylinders
- H. ASTM D2216 : Standard Test Method for Laboratory Determination of Moisture Content of Soil and Rock

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- ~~I.~~ ~~ASTM D2922 : Standard Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)~~
- ~~J.~~ ~~ASTM D3017 : Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)~~
- ~~K.~~ ~~ASTM D3083 : Chemical Compatibility of HDPE and Coal Tar, Soil Burial Test (Geomembrane)~~
- ~~L.~~ ASTM D4016: Standard Test Method for Viscosity of Chemical Grouts by Brookfield Viscometer
- ~~JM.~~ ASTM D4318 : Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils
- ~~KN.~~ ASTM D4380 : Standard Test Method for Density of Bentonite Slurries
- ~~LO.~~ ASTM D5084 : Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
- ~~M.~~ ~~ASTM D6938 : Standard Test Method for In-Place Density and Water Content of Soil and Soil Aggregate by Nuclear Methods (Shallow Depth)~~
- ~~NP~~ ASTM D7100: Standard Test Method for Hydraulic Conductivity Compatibility Testing of Soils with Aqueous Solutions
- ~~OQ.~~ EPA 160.1: Test Method for Total Dissolved Solids
- ~~PR.~~ EPA 200.7: Test Method for Dissolved Metals
- ~~QS.~~ EPA 215.1: Test Method for Calcium Concentration
- ~~RF.~~ EPA 242.1: Test Method for Magnesium Concentration
- ~~SU.~~ EPA 273.1: Test Method for Sodium Concentration
- ~~TV.~~ EPA 418.1: Test Method for Total Recoverable Hydrocarbons
- ~~UW.~~ EPA 8240: Test Method for VOC's
- ~~VX.~~ EPA 9040: Test Method for pH
- ~~WY.~~ EPA 9090: Test Method for Chemical Compatibility

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- | [XZ](#). SW-846 9045A: pH Test for Slurry
- | [YAA](#). USP NF X VII: Free Swell Test
- | [ZAB](#). API Specification 13A: Drilling Fluid Materials
- | [AAAC](#). API RP 13B-1: Recommended Practice for Field Testing Water-Based Drilling Fluids

1.03 DEFINITIONS

The terms used in this Section are defined as follows:

- A. The “Groundwater Barrier Wall” is a low permeability hydraulic barrier installed through the existing ground or prepared working surface using one of several methods, including the slurry method of excavation, deep soil mixing, or jet grouting.
- B. The “Slurry Method of Excavation” consists of excavating a vertical walled trench (soil-bentonite slurry trench) and at the same time keeping the trench filled with a bentonite slurry mixture. The purpose of the slurry is to support the walls of the trench and prevent movement of groundwater.
- C. “Deep Soil Mixing” consists of constructing overlapping wall panels by inserting and withdrawing a multi-shaft mixing apparatus at consecutive locations.
- D. “Jet Grouting” consists of constructing overlapping wall panes by injecting low permeability grout at consecutive locations.
- E. “Bentonite” is an ultrafine natural clay whose principal mineral constituent is sodium cation montmorillonite.
- F. “Bentonite Slurry” is a colloidal mixture of bentonite and water.
- G. “Soil-Bentonite (S-B) Backfill” is a homogeneous mixture of material produced by mixing soil with bentonite slurry and additional dry bentonite, as necessary, which is placed into the excavated trench to complete the soil-bentonite slurry trench.
- H. The “Ground Water Level” is the piezometric level of the ground water as determined from piezometers and wells.

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- I. The “Working Surface” is the top of the stripped and/or prepared natural ground from which the groundwater barrier wall shall be constructed.
- J. The “Confining Stratum” is the soil stratum or rock unit to which the bottom of the groundwater barrier wall is excavated.
- K. The “Groundwater Barrier Wall Cap” is the section of fill that is placed above the groundwater barrier wall and extends the wall to final grade. The geometry of the groundwater barrier wall cap is depicted on the Drawings and shall be constructed in accordance with Section 02200 – EARTHWORK.

1.04 WORK BY CONTRACTOR

- A. A groundwater barrier wall (GWBW) shall be constructed along the alignment specified on the Construction Drawings to form a continuous hydraulic barrier along the riverbank, as specified on the Construction Drawings. The GBWW shall be constructed with a soil-bentonite, or other approved reagent mix, utilizing an appropriate construction methodology to meet, or exceed, the specified requirements herein. Construction methods may include slurry wall, jet grouting, deep soil mixing, continuous trenching, or other appropriate technique to achieve the minimum GBWW dimensions and a maximum in-place coefficient of permeability for the completed wall of 1×10^{-6} cm/sec. The GBWW shall have the depth and minimum width specified in Part 3.04 of this Section. The wall shall extend to the top of the basaltic bedrock, as depicted in the Construction Drawings.
- B. The CONTRACTOR shall furnish the necessary plant, labor, materials, tools, equipment, services, utilities, and the water required to construct the GBWW in accordance with these Specifications.
- C. The CONTRACTOR shall furnish and install all supplementary or miscellaneous items, appurtenances, and devices (including, but not limited to, chisel, bore, excavate, or key-in the wall) that are not specifically indicated but which are necessary to complete the installation of the GBWW. The CONTRACTOR shall take all necessary steps to install a barrier wall with a maximum, in-place permeability of the completed wall of 1×10^{-6} cm/sec. Specific concerns or omissions are the responsibility of the CONTRACTOR to identify during the bidding process and acknowledge with the bids.
- D. The CONTRACTOR shall be responsible for controlling all storm-water runoff and providing run-on controls during the GBWW construction to

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assure compliance with the existing storm-water runoff system and the requirements of the ODEQ. This work includes, but shall not be limited to, all trenching, excavations, drilling, mixing, and product storage.

- E. Subsurface utilities that intersect the GWBW shall be cut, capped, and/or grouted, as indicated on the Drawings. The overhead power line shall be ~~disconnected and removed to facilitate~~ temporarily rerouted during construction of the GWBW. The CONTRACTOR shall verify and protect all other buried and above-ground utilities during construction of the GWBW. In the event that a utility line not identified for abandonment is damaged during construction, the CONTRACTOR shall immediately notify the ENGINEER or OWNER'S AGENT and the affected utility so that damaged items can be repaired at the CONTRACTOR's expense.
- F. The CONTRACTOR shall remove objectionable material from the area of the GWBW operations on an as-needed basis in accordance with Paragraph 3.02(A)(1) of this Section. This includes unforeseen buried debris encountered along the alignment of the GWBW. Disposal of an unforeseen material shall be the responsibility of the CONTRACTOR. The CONTRACTOR is responsible for handling materials and placing it in the appropriate containers to be provided by the CONTRACTOR on the Site. The CONTRACTOR is responsible for disposal of debris generated by the CONTRACTOR in order to perform the work, and shall dispose of the materials appropriately.
- GGH. The CONTRACTOR shall be responsible for connecting to the OWNER'S AGENT's ~~OWNER-Agent's~~ service water supply for GWBW construction activities. Such connections shall assure that water is available in the volumes deemed adequate, but not excessive by the OWNER'S AGENT. The OWNER's service water supply is located on-site. The CONTRACTOR is responsible for transporting the water to the necessary GWBW construction area as well as providing the means for filling any water-carrying vehicles. Chemical analyses on the service water supply are presented in the Supplemental Information section of the Contract Documents for CONTRACTOR's reference. The CONTRACTOR is responsible for assuring chemical compatibility of the water supply with the hydraulic isolation wall products and construction activities.
- H. The CONTRACTOR shall take precautions to assure that all groundwater extracted from the trench and used for construction activities, including run-off, is prohibited from leaving the Site. Run-off of the groundwater from the Site shall not be permitted.

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- I. The CONTRACTOR is solely responsible for the security of the CONTRACTOR's equipment, materials, and the constructed products at the Site at all times throughout the construction period.

1.05 QUALITY CONTROL AND ASSURANCE

- A. All materials, procedures, operations, quality control and methods of construction are the responsibility of the CONTRACTOR, and shall be in strict conformance with the Drawings and Specifications. The Work shall be subjected to strict quality assurance (QA) and quality control (QC) monitoring by the OWNER or OWNER'S AGENT and the CONTRACTOR, respectively, as provided in Section 01400 – QUALITY CONTROL of the Specifications and in the Construction Quality Assurance/Quality Control (CQA/QC) Plan. The installed GWBW shall conform to the Drawings and Specifications, except where changes are authorized in writing by the ENGINEER or OWNER'S AGENT.
- B. ENGINEER or OWNER'S AGENT Responsibilities:
1. Review product data and samples.
 2. On delivery, inspect products jointly with CONTRACTOR.
 3. Conduct QA testing, as deemed necessary. The QA testing shall in no way relieve the CONTRACTOR of the responsibility of performing tests necessary to meet the QC requirements.
- C. CONTRACTOR's Responsibilities:
1. Arrange for and deliver information for "Record Drawings", product data, samples, and all testing results and certifications to the OWNER'S AGENT or their Representative in a timely manner. All QC samples and testing shall be referenced to the GWBW alignment station and depth at which the sample was obtained or test was conducted.
 2. Receive and unload products at site; inspect for completeness or damage, jointly with the OWNER'S AGENT and repair or replace items damaged after receipt.
 3. Install and test the test wall section to document construction methods and demonstrate that material mixes are acceptable and that

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the proposed technology shall meet the minimum hydraulic isolation wall specifications.

4. Conduct QC testing in accordance with Section 01400, the CQA/QC Plan, and Part 4.0 of this Section as necessary to control the hydraulic isolation wall installation quality.
5. The CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT whenever the trench excavation or GWBW installation is near the design depth to allow for inspections. The ENGINEER or OWNER'S AGENT shall observe any cuttings from the bottom of the GWBW for continuity.
6. The CONTRACTOR shall cooperate with the ENGINEER or OWNER'S AGENT during any inspections or QA testing. The CONTRACTOR shall provide, at no additional cost, labor and materials to 1) measure the lines and grades associated with the Work and 2) collect samples for QA testing.
7. The CONTRACTOR shall submit to the ENGINEER or OWNER'S AGENT on a regular schedule (as noted) the following items:
 - a. Soundings and As-built Profile (daily): a record of the soundings taken during construction, including depth of trench/GWBW, backfill slope (for slurry wall construction), and other construction-related information obtained at the beginning and end of each day. The CONTRACTOR shall use the soundings to generate the as-built profile.
 - b. Reagent Slurry Mix (daily): quantities, proportions, properties and admixtures shall be submitted. The report shall include the mix from the plant and the mix in the trench.
 - c. Construction Methodologies and Techniques: Any modifications to the approach presented in the Work Plan shall be submitted to the ENGINEER or OWNER'S AGENT.

1.06 CONTRACTOR QUALIFICATIONS

The CONTRACTOR shall maintain full-time supervisory personnel, competent in the hydraulic isolation wall technology, on-site during construction to control the Work. The site superintendent and key personnel shall have not less than five (5) years experience in the technology, shall have participated in the construction of not less than five (5) projects of similar scope and magnitude, including two (2) with a

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similar or greater depth, and shall have successfully installed a minimum area of 1,000,000 square feet. Qualifications for these individuals shall be provided at the time of bidding (see Part 1.08 for submittal requirements), and shall be subject to the approval of the OWNER or OWNER'S AGENT.

1.07 HEALTH AND SAFETY

- A. The CONTRACTOR shall develop and implement the CONTRACTOR's site-specific Health and Safety Plan (HASP) for all GWBW activities to protect on-site personnel. Hazardous waste materials may be disturbed during the Work and contact with waste, waste liquids, and/or waste gases is expected.
- B. The CONTRACTOR shall provide adequate health and safety personal protective equipment (PPE) for employees, the OWNER or OWNER'S AGENT, representatives of the ODEQ or other regulatory agencies, and others who might be affected by the on-site activities.
- C. Work procedures shall conform with all applicable EPA, OSHA, ODEQ, State of Oregon, local government, and other federal and state and county regulations (latest editions).

1.08 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. All materials shall be delivered in undamaged, unopened containers bearing the manufacturer's original label and shall be handled to prevent contamination, segregation, or damage.
- B. The storage location of all materials shall not interfere with construction activities or OWNER's daily plant operations and shall be approved by the ENGINEER or OWNER'S AGENT.
- C. Bentonite, hydrophilic sealing material and similar materials shall be stored in weathertight enclosures to protect against dampness and contamination.

1.09 SUBMITTALS

- A. The CONTRACTOR shall submit qualifications of key project personnel, including superintendent and primary equipment operator(s), with their bid. The following information shall be submitted to the ENGINEER or OWNER'S AGENT for the superintendent, primary equipment operator(s), and other key personnel:
 - 1. Name, address, and telephone number of customer and point of contact for projects forming the experience record;

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2. Contract number, contract amount, date of award, and date of completion of the projects forming the experience;
 3. GBW length and depth; and,
 4. Description of the method of construction and equipment used.
- B. The CONTRACTOR shall submit qualifications, company name, and key contact of the CONTRACTOR's QC Laboratory with their bid. The laboratory shall have previous experience with slurry wall materials, experienced laboratory technicians, and modern permeability testing equipment.
- C. The CONTRACTOR shall submit a detailed work plan describing the proposed GBW construction methodology, procedures, equipment, and schedules. The work plan shall include, but not be limited to:
1. Construction, maintenance, and removal of working platforms, mixing pads, and haul roads;
 2. Equipment set-up and site use layout, including storage areas, haul roads, mixing pads, and work platform locations and dimensions;
 3. Equipment specifications, including maximum depth capability of excavator, number and type of backfill mixing equipment, and specifications of slurry mixing equipment;
 4. Procedure for water-bentonite slurry mixing, transportation, and re-circulation;
 5. Procedure for trench excavation and backfilling;
 6. Material properties, sources, and (manufacturer's) certificates of quality;
 7. Control of drainage, spills, wastes, etc.; and,
 8. Clean-up, spoils disposal, and slurry disposal.
- D. Quality Control Plan

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The CONTRACTOR shall submit a quality control plan with details of the personnel, responsibilities, inspections, and organization for ensuring the quality of construction required by these Specifications. The plan shall provide a table listing testing methods, frequencies, and minimum acceptable values. The plan shall explain the methods and locations for obtaining samples for testing and reporting schedules. Copies of quality control forms shall be submitted for review and approval.

- E. The CONTRACTOR shall submit the results of the Laboratory Phase and the proposed mix design to the ENGINEER or OWNER'S AGENT within 48 hours of receipt of the report from the laboratory.
- F. The CONTRACTOR shall submit the results of the Field Phase to the ENGINEER or OWNER'S AGENT within 48 hours of completion.
- G. The results of all QC testing required by these Specifications shall be furnished to the ENGINEER or OWNER'S AGENT. The CONTRACTOR shall furnish records of all observations, measurements, and tests performed, identified with the location, date, and time of testing. These records shall be furnished no later than 24 hours after the observation, measurement, or test is performed.
- H. A record of the soundings taken during construction, including the depth of the GWBW and backfill slope (if applicable), shall be submitted to the ENGINEER or OWNER'S AGENT by noon of the day following the date of the measurement.
- I. The CONTRACTOR shall submit a 50-pound sample from each of the off-site borrow sources proposed to furnish the required quantity of fill materials. The samples shall be submitted to the ENGINEER or OWNER'S AGENT no less than two (2) weeks prior to the anticipated placement of any soil materials.

1.10 SUBSURFACE CONDITIONS

- A. Subsurface investigations have been conducted during prior work activities. Boring location maps and corresponding boring logs are provided in the Supplemental Information section of the Technical Specifications. Neither the OWNER, OWNER'S AGENT, nor ENGINEER assumes responsibility for interpretation or deductions made from the borings or logs. Local variations may exist in the subsurface materials between boring locations. Soils classifications presented on the logs are the result of field observations. Geotechnical tests were conducted on selected boring locations and are presented in the Supplemental Information section.

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- B. Geologic cross sections are presented in the Supplemental Information section to provide a general description of the existing conditions observed from prior subsurface investigations. Fill materials comprise the upper zone along the alignment of the GWBW. Debris, i.e., concrete and rubble, has been observed within the fill materials. The geologic cross section presents the elevations of the fill materials, native materials, water table and basalt rock.
- C. Analytical test results of the groundwater and subsurface materials (fill and native soils) are provided in the Supplemental Information section. The CONTRACTOR shall consider this information to assess any potential affect of the constituents on the GWBW.
- D. Test excavations were conducted in specific locations to observe and remove any large debris located within the fill materials. An additional clearance trench is required under this contract to remove any remaining debris. The locations of the test excavations are presented on Drawing No. 2 and a summary of the observations and findings from the subsurface debris investigation are presented as Attachment [32](#). The clearance trench requirements specified under this contract are described herein and on the Drawings.
- E. Groundwater contour maps for the hydrogeologic units that will be encountered during GWBW installation are presented in the Supplemental Information section.

1.11 MIX DESIGN TESTING

- A. Slurry materials testing was conducted during preparation of the Focused Feasibility Study. For reference purposes, the Slurry Materials Testing Report is presented as Attachment [24](#). The report and associated results are presented for informational purposes only and shall not be construed as a recommendation of the appropriate mix design. The CONTRACTOR is responsible for providing a GWBW mix design that meets the performance-based design requirements of this Section.
- B. The CONTRACTOR shall perform bench-scale testing during the Laboratory Phase to determine the appropriate reagent(s) and mix. This study may refine the mixes evaluated in the Slurry Materials Testing Report, or consider alternative reagents and/or mix percentages. It is the CONTRACTOR's responsibility to ensure that the final mix meets the performance requirements defined herein.

PART 2 – PRODUCTS

2.01 MIX REAGENT

- A. The GWBW shall be constructed using a reagent mix that was evaluated in the Laboratory Phase and demonstrates compliance with the requirements specified herein. Typical reagents include bentonite and/or other alternative reagents.
- B. Alternative reagents may be proposed by the CONTRACTOR but are subject to approval by the ENGINEER, OWNER'S AGENT, or OWNER. CONTRACTOR is responsible for demonstrating performance to the satisfaction of the ENGINEER, OWNER'S AGENT, or OWNER. Approval of the alternate reagents in the Laboratory Phase will not constitute approval for subsequent phases.

2.02 BENTONITE - Slurry Wall, Jet Grouting, and Deep Soil Mixing Applications

- A. Bentonite shall be a premium grade, high-swelling, sodium-cation montmorillonite bentonite that meets or exceeds the standards of the American Petroleum Institute (API) as contained in API Specifications 13-A (Spec 13-A), Section 5 (not chemically treated) and Table 02242-1. Bentonite that does not meet the specifications shall be promptly removed from the Site at no additional cost to the OWNER or OWNER'S AGENT.
- B. Bentonite shall be protected from moisture during transportation and storage.
- C. The material shall have been manufactured to function in the presence of water soluble contaminants without losing its filtrate control properties.

2.03 WATER - Slurry Wall, Jet Grouting, and Deep Soil Mixing Applications

- A. The OWNER/OWNER'S AGENT will provide the water supply for the CONTRACTOR's use to manufacture all slurries and/or grout. CONTRACTOR shall be responsible for all water connections and transport to the Work site.
- B. It shall be the responsibility of the CONTRACTOR to assure that the resulting slurry and/or grout meet the standards and requirements of this Specification. The CONTRACTOR shall verify chemical analysis for pH, hardness, and salt content for the OWNER/OWNER'S AGENT-provided water supply. If the CONTRACTOR elects to use an alternative water source, it is the CONTRACTOR'S responsibility to obtain chemical analysis for pH, hardness, and salt content for both the OWNER/OWNER'S AGENT-provided service water supply and the alternative water supply to

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verify the chemical compatibility of the alternative water supply with the GWBW products. The water supply is expected to be substantially clean, fresh, and free from oil, acid, alkali, or other deleterious substances; the water shall comply with Table 02242-1. If the water supply is deemed inappropriate, an alternate source shall be investigated by the CONTRACTOR to verify chemical compatibility. The test results shall indicate that the bentonite, when mixed with the water, will yield the required parameters. It shall be the responsibility of the CONTRACTOR to add bentonite as necessary to meet the slurry viscosity and to have stable excavation.

2.04 SLURRY - Soil-Bentonite Slurry Wall Application

- A. Base Product: the slurry supporting the sides of the trench and for wetting the backfill material shall consist of a stable colloidal suspension of bentonite in water.
- B. The bentonite utilized in the slurry shall conform to the requirements outlined in Part 2.02 of this Section.
- C. The water utilized in the slurry shall conform to the requirements outlined in Part 2.03 of this Section.
- D. Initial Slurry Mixture:
 - 1. At the time of introducing slurry into the trench, the slurry mixture shall consist of a minimum of five (5) percent bentonite per unit weight of water. The initial slurry mixture shall comply with the requirements specified in Table 02242-1.
 - 2. The CONTRACTOR shall add additional bentonite to make the slurry denser or more viscous than the limits specified herein, if deemed necessary by the ENGINEER or OWNER'S AGENT.
 - 3. Admixtures to alter the characteristics of the slurry in the trenches, including but not limited to softening agents, dispersants, retarders or plugging/bridging agents, shall not be permitted, unless otherwise approved by the ENGINEER or OWNER'S AGENT.
 - 4. A record of mixed bentonite slurry quantities and proportions shall be maintained. Adjustments to the slurry mixture shall be noted.
- E. Slurry Mixture in Trench:

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1. The bentonite slurry in the trench shall comply with the requirements specified in Table 02242-1. A record of in-trench bentonite slurry properties shall be maintained. Adjustments to the slurry shall be recorded.
2. The bentonite must be fully hydrated and the slurry must be homogeneous. Slurry with balls of partially wetted clay will be rejected by the ENGINEER or OWNER'S AGENT at the trench.

2.05. SOIL-REAGENT BACKFILL

- A. The CONTRACTOR shall design the soil-reagent backfill mixture to achieve a maximum, in-place permeability of 1×10^{-6} cm/sec, as determined by ASTM D-5084.
- B. The material for trench backfilling shall be composed of fresh slurry, trench slurry, reagents (including bentonite and/or approved alternatives), and trench spoils and/or selected soils obtained from a designated off-site borrow source. Trench spoils or borrow soil shall be friable and free from roots, organic matter, refuse, rubble, debris, concrete, boulders, frozen materials, or other deleterious materials.
- C. The soil-reagent mixture shall be thoroughly mixed and [is required to](#) have the following minimum percent passing gradation limits:

<u>U.S. Standard Sieve</u>	<u>Percent Passing</u>
3 inch	100
No. 200	1520

These requirements shall be evaluated by the CONTRACTOR for consistency with the criteria required to obtain the minimum coefficient of permeability specified in Paragraph 2.05 A of this Section. [If the soil-reagent mixture does not meet the required gradation limits, the CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT immediately and present a rationale for use of the gradation or propose any necessary changes to the soil-reagent mix design to ensure that the minimum coefficient of permeability is obtained. Any change to the soil reagent mix design, or any use of soil-reagent backfill not meeting the required gradation limits, must be approved by the ENGINEER or OWNER'S AGENT](#)~~06 A of this Section and, if found inadequate, shall notify the ENGINEER or OWNER'S AGENT immediately.~~

- D. Soil excavated from the trench (trench spoils) may be used as backfill provided it is mixed to be homogeneous and meets the Specifications. If

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excavated soil does not meet the Specifications, borrow material from other sources shall be added to the excavated soils, thoroughly mixed with the excavated soils to a homogeneous mixture and used as backfill. Soil removed from the trench which may not be suitable for mixing and returning to the trench for any reason shall be disposed of as provided in Section 02250 – TRANSPORTATION AND DISPOSAL OF MATERIALS of the Specifications. Any contaminated items excavated must be loaded into appropriate containers supplied by CONTRACTOR for recycling or disposal.

- E. Borrow material to be used as part of the backfill shall come from an accepted source. The CONTRACTOR shall not change the borrow source for the duration of the Work without prior written acceptance from the ENGINEER or OWNER'S AGENT.
- F. The soil-reagent backfill may be mixed in-situ or ex-situ, permitted the performance criteria of the GWBW are met. Trench spoils removed from the trench may be mixed with the reagent(s) along side the trench on the landward side of the excavation. Alternatively, trench spoils may be transported to a central staging or mixing area. Precautions shall be taken to ensure that excess water and fluids from the excavated material, or any stormwater or fluid runoff from the mixing area, will be directed back to the trench, or managed accordingly to prevent the water or fluids from leaving the Site. Collecting, pumping, or transporting this fluid is the CONTRACTOR's responsibility. The trench spoils must be screened and/or mixed, if necessary, to meet the screen specifications outlined above.
- G. The CONTRACTOR shall increase the reagent content and mixing operations, as needed, and account for any variations in the in-situ soil properties to achieve the specified performance criteria.
- H. For determining compliance with the permeability specification, after 28 days of curing, no value of the in-situ backfill coefficient of permeability shall exceed 1×10^{-6} cm/sec for the length of the GWBW. The CONTRACTOR shall obtain two (2) ~~one~~ undisturbed ~~sample~~sample of the soil-reagent backfill from for each 200 lineal feet of four (4) locations wall at 25 vertical foot intervals for permeability testing. From each location one (1) sample must be taken from the ground surface to mid-depth and one (1) sample must be taken from mid-depth to the bottom of the GWBW. Of the four locations, one (1) must be with in the Chlorate Area and one (1) must be within the Acid Plant Area. All locations for permeability sampling shall be approved by the ENGINEER or OWNER'S AGENT. If QA tests by the ENGINEER or OWNER'S AGENT or QC tests by the CONTRACTOR indicate that non-compliance exists, all work shall cease until the source of the problem is determined. The CONTRACTOR shall not be paid extra to

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replace any portions of the soil-reagent wall that do not meet these Specifications. Any in-place portions of the GWBW that do not meet these Specifications shall be replaced at no additional cost.

- I. Admixtures: Admixtures shall not be used except as approved in writing by the ENGINEER or OWNER'S AGENT and shall be submitted with the bid if anticipated before the start of work.
- J. The CONTRACTOR shall conduct quality control testing on the soil-reagent backfill, including particle size analysis, permeability, slump, and density. The soil-reagent backfill mixture shall comply with the requirements specified in Table 02242-1.

PART 3 – EXECUTION

3.01 LABORATORY PHASE

- A. Prior to construction of the GWBW, the CONTRACTOR shall perform a bench scale study to select the specific mix reagents and percentages required to meet the Specifications. The bench scale study shall also include an evaluation of the long-term compatibility of the selected GWBW mix.
- B. The CONTRACTOR shall provide all personnel, equipment, and materials to perform the Laboratory Phase. The CONTRACTOR shall notify the ENGINEER or OWNER'S AGENT ten (10) days prior to commencing the Laboratory Phase and shall provide interim updates and data throughout the process.
- C. The OWNER'S AGENT will provide the CONTRACTOR with representative samples of site soil, groundwater, and potable water (i.e. mix water) for use in the Laboratory Phase.
- D. The Laboratory Phase shall consist of the following:
 - 1. Testing of site soil and mix water as indicated in Table 02242-2.
 - 2. Selection of a minimum of two (2) proven and commercially available reagents for use in creating slurry and/or soil-reagent mixes; at least one of the reagents shall be bentonite. Compatibility testing of reagents shall be performed as indicated in Table 02242-2.
 - 3. Compatibility testing of water-reagent slurries shall be performed as indicated in Table 02242-2. The ultimate water-reagent slurry mix selected shall meet the requirements in Table 02242-1 and be deemed compatible by the ENGINEER or OWNER'S AGENT.

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4. Soil-reagent backfill mixes at varying reagent concentrations shall be prepared by combining site soil with water-reagent slurries. Compatibility testing of backfill mixes shall be performed as indicated in Table 02242-2. A minimum of five (5) different soil-reagent backfill mixes shall be evaluated.
 5. The ultimate soil-reagent backfill mix selected shall exhibit a maximum long-term permeability of 5×10^{-7} cm/sec.
- E. The CONTRACTOR shall provide the results to the ENGINEER or OWNER'S AGENT for review and approval prior to Field Phase implementation. If the mixes do not meet the required specifications, the CONTRACTOR shall review the procedures with the ENGINEER or OWNER'S AGENT and perform another Laboratory Phase. Any supplemental Laboratory Phase shall be performed at no additional cost to the OWNER or OWNER'S AGENT.
- F. An initial mix design study was previously performed to determine the potential range of reagents applicable to the Site. The results of this study are presented as Attachment [2+](#) for CONTRACTOR consideration.
- G. The CONTRACTOR shall provide the source (i.e. supplier) and product data for all reagents proposed for use in the Laboratory Phase.

3.02 FIELD PHASE

- A. A Test Wall Section is required to demonstrate that the materials, mixture methods, and installation methods are adequate to meet the Specifications. Materials and procedures for the test section shall be the same as intended for the installation of the permanent GWBW. The Field Phase shall not be conducted when during inclement weather conditions are unsuitable for proper performance of the work, as determined by the ENGINEER or OWNER'S AGENT.
- B. The Test Wall Section shall be located along the alignment of the permanent GWBW at a location approved by the ENGINEER or OWNER'S AGENT. The location of the test wall will be recommended by the ENGINEER or OWNER'S AGENT at the Pre-Bid meeting. The length of the Test Wall Section varies depending on the technology adopted, but in no instance shall be shorter than 25 feet, and shall be constructed to the full depth as specified on the Drawings.
- C. The Test Wall Section shall meet the requirements and shall be subjected to verification testing as specified in Table 02242-1. The Test Wall Section

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shall exhibit a maximum, in-place permeability of 1×10^{-6} cm/sec, as determined by ASTM D-5084.

- D. The CONTRACTOR shall provide the results to the ENGINEER or OWNER'S [AGENT](#) for review and approval prior to Full-Scale implementation. If the Test Wall Section does not meet the required specifications, the CONTRACTOR shall review the procedures with the ENGINEER or OWNER'S AGENT and perform another Field Phase that complies with all the requirements of Part 3.02. The additional Field Phase shall be performed at no additional cost to the OWNER or OWNER'S AGENT.
- E. The CONTRACTOR shall provide all personnel, equipment, and materials to perform the Field Phase. The CONTRACTOR shall document the methods, materials, and equipment used during the Field Phase. The ENGINEER or OWNER'S AGENT shall be present to observe the Field Phase process.

3.03 GROUNDWATER BARRIER WALL CONSTRUCTION

- A. A GWBW shall be constructed to the lines, grades, depth, and cross-section indicated on the Drawings. The GWBW shall have vertical walls, have a minimum width of 36 inches, have a maximum in-place permeability of 1×10^{-6} cm/sec. and extend to the top of the basalt bedrock.
- B. Site Preparation: Prior to GWBW construction, the area on both sides of the wall alignment shall be prepared as shown on the Construction Drawings and as specified herein.
1. A clearance trench shall be constructed in the locations and to the depth indicated on the Drawings to remove debris prior to GWBW construction. Debris and other obstructions shall be segregated and stockpiled for subsequent [on-off](#)-site disposal by the CONTRACTOR. Reference Section 02200 – EARTHWORK for excavation and backfilling requirements associated with the clearance trench.
 2. The GWBW location shall be accurately staked by the CONTRACTOR prior to construction. The GWBW shall be located along the alignment presented on the Drawings. [With the exception of the segment of GWBW between stations 0+00 and 1+60, the](#)The constructed GWBW alignment shall vary no more than five (5) feet laterally from the alignment presented on the Drawings. If the CONTRACTOR prefers an alternative layout that varies more than five (5) feet horizontally from the alignment presented on the Drawings, the CONTRACTOR shall submit both the base layout and the alternative layout with their bid. [The segment of GWBW](#)

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between stations 0+00 and 1+60 shall follow exactly the alignment presented on the Drawings.

3. The CONTRACTOR shall prepare the working surface from which to construct the GWBW, including but not limited to clearing, removal of existing structures, utility abandonment and re-routing, well abandonment and disposal of unsuitable materials, in accordance with Section 02110 – SITE CLEARING.

 4. Grade:
 - a. The longitudinal grade of the working surface shall not exceed one (1) percent, unless otherwise approved by the ENGINEER or OWNER'S AGENT.
 - b. In the event that the static ground water table is encountered at a depth of three (3) feet, or less, below the designated working surface, the CONTRACTOR shall raise the working surface with approved fill material to maintain a three-foot separation between the working grade and the water table.
 - c. The working surface shall be graded to ensure that the GWBW excavation/installation equipment produces a vertical trench.
 - d. The CONTRACTOR shall provide and maintain gravity drainage control along the working surface. Controls shall prohibit surface water flow into the excavated trench.

 5. The CONTRACTOR shall maintain the working surface free of excessive amounts of debris and slurry.

 6. The CONTRACTOR shall prepare and maintain a temporary work/staging area at a remote location from the GWBW to support installation of the GWBW, including mixing operations, material storage, equipment storage, and other ancillary activities.
- C. Equipment: The CONTRACTOR shall furnish the necessary plant, tools and equipment for efficient construction of the hydraulic isolation wall.
1. Excavation and Drilling Equipment: The equipment used for construction of the GWBW shall be capable of performing excavation and/or drilling operations to the required depth of the GWBW and shall be approved by the ENGINEER, OWNER'S AGENT and/or OWNER. Excavating equipment shall be capable of

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excavating the minimum trench width in a single pass while minimizing raveling of the trench sides during use.

2. Preparation and Placement Equipment: The slurry or grout plant shall include the necessary equipment such as a mixer, a mechanically agitated sump, pumps, valves, hoses, supply lines, and small tools; all as may be required to adequately mix and supply slurry or grout to the GWBW location in a continuous manner. A backup system shall be designed to supply sufficient slurry or grout in case substantial slurry or grout loss occurs. Storage ponds or containers shall be constructed above grade (no excavation). All slurry held in storage shall be agitated or recirculated to maintain a homogenous mix. Mixing of slurry or grout shall continue until all particles are thoroughly mixed and the resulting mixture is homogenous. The location of the slurry or grout plant and storage areas shall be approved by the ENGINEER or OWNER'S AGENT.
 3. Backfill Mixing and Placing: Equipment for mixing and placing backfill may consist of suitable earthmoving or grading equipment, such as bulldozers, blade graders, backhoes, or blenders such as a pug mill, that are capable of thoroughly mixing the backfill materials into a homogeneous blend meeting the required properties. Clods shall be broken to a four-inch maximum size by the backfill preparation equipment and methods employed. Deleterious materials, debris, and oversized particles shall be removed from the backfill before approval for placement.
 4. Decontamination Area:
 - a. All equipment utilized in GWBW construction shall pass through the decontamination area for cleaning prior to leaving the Site in accordance with applicable regulations.
 - b. All water from the decontamination area shall be containerized and stored on-site ~~disposed off-site~~ in accordance with Section 02250 – TRANSPORTATION AND DISPOSAL OF MATERIALS.
- D. Personnel: The CONTRACTOR shall provide all workers' PPE in accordance with 29 CFR and OSHA, and with the level of knowledge necessary to implement health and safety procedures. The CONTRACTOR shall designate a health and safety officer for the project who is responsible for maintaining worker's compliance with established health and safety procedures.
- E. Construction:

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1. The CONTRACTOR shall have equipment capable of excavating or drilling to the required depths. The CONTRACTOR shall measure and record the distances to the bedrock with the ENGINEER or OWNER'S AGENT every 20 feet along the wall alignment. The CONTRACTOR shall remove all loose material from the bedrock surface so that a clean surface exists. The GWBW shall extend to the basaltic bedrock interface. Achievement of the design depth shall be determined in the field by the ENGINEER or OWNER'S AGENT based on refusal of the excavating equipment and visual exam of the excavated material.
2. In areas where materials unsuitable for incorporation into the GWBW are removed, as determined by the ENGINEER, the material shall be placed in containers by the CONTRACTOR for disposal.
3. At the intersection of two (2) straight line segments, the GWBW shall extend a minimum of five (5) feet beyond the outside of the intersection through all depths. If the GWBW overlaps into a previously completed segment, the GWBW shall extend a minimum of 10 feet into the previously placed segment through all depths. There will be no additional payments for excavation of installed GWBW to make tie-ins.
4. Upon completion of the GWBW and prior to placement of the cap over the wall, no vehicular traffic should cross the GWBW without prior acceptance by the ENGINEER or OWNER'S AGENT. If access is needed before the wall has "set up" properly, the CONTRACTOR shall provide a temporary bridge for crossing a completed GWBW section so as not to disturb the completed GWBW. If a temporary crossing bridge is required, the CONTRACTOR shall install a minimum 1-inch thick steel plate, overlapped sufficiently so that no gaps and/or cracks are apparent and to permit traffic to proceed normally across it.
5. No blasting is permitted for construction of the GWBW.
6. Stability:
 - a. The CONTRACTOR is responsible for ensuring and maintaining the stability of the Work area at all times during all operations, including excavations, drilling, backfilling, injections, and the results of such activities to the adjacent areas, such as the riverbank.

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- b. The CONTRACTOR shall control all surcharges from all excavation, drilling, injection, grading, backfilling, mixing and other equipment, waste, berm construction, stockpiles, and any other loading situations that may affect GWBW construction stability.

F. Capping:

1. The surface of the backfill shall not be allowed to desiccate prior to placing the final cap. A temporary cover shall be used to protect the backfill prior to placing the final cap. The temporary cover shall consist of at least one (1) foot of uncompacted backfill placed within one (1) day after the backfill is placed. After a minimum of one (1) week, the temporary cover shall be removed. Any depressions or settlement shall be repaired by placing additional backfill or the permanent cap.
2. Upon removal of the temporary cover and before desiccation of the backfill surface can occur, the GWBW shall be covered with a clay cap meeting the requirements of Section 02200 – EARTHWORK and in accordance with the details depicted on the Drawings.

G. Post-Construction of GWBW:

1. Upon completion of backfilling and grading operations, all remaining excavated material, residual slurry or grout, and mixed backfill shall be removed and disposed by the CONTRACTOR in accordance with Section 02250 – TRANSPORTATION AND DISPOSAL OF MATERIALS and the appropriate ODEQ regulations.
2. All disturbed areas shall be cleaned, leveled, and returned to the original condition as directed by the ENGINEER or OWNER'S AGENT.

3.04 SOIL-REAGENT SLURRY WALL CONSTRUCTION

- A. Equipment: The CONTRACTOR shall furnish the necessary plant, tools and equipment for efficient excavation of the trench, mixing and placing of slurry, and transporting, mixing, and placing backfill material. Equipment shall be capable of excavating the minimum 36-inch wide trench in one pass and to a minimum depth of 90 feet.
- B. Slurry Placement:

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1. The CONTRACTOR shall maintain the stability of the excavated trench at all times. The excavated trench above the slurry level shall be maintained to prevent cave-in. The CONTRACTOR is responsible for maintaining slurry densities and levels to ensure stable conditions within any excavations.
2. The CONTRACTOR shall provide all personnel, equipment and material to maintain the slurry level at all times during the trench construction, after hours, weekends, and holidays included.
3. It is the CONTRACTOR's sole responsibility to ensure that the mixing of any reagents/backfill/slurries do not affect the stability of any open excavations. In the event of sloughing, sliding or other failure of a trench wall prior to completion of backfilling, the CONTRACTOR shall re-excavate the trench, remove all material displaced into the trench, and take corrective action to prevent further deterioration, at the CONTRACTOR's expense.
4. The CONTRACTOR is responsible for testing and maintaining the initial slurry mix and the slurry in the trench, at the frequencies specified in Table 02242-1, to meet the requirements specified herein.
5. The CONTRACTOR shall ensure that the slurry sand content is not excessive and dropping out of the slurry to the bottom of the trench affecting the overall performance of the trench.
6. Slurry shall be introduced into the trench at the time excavation begins. The level of the slurry in the open trench shall be maintained at least three (3) feet above the water table and no more than two (2) feet below the working surface until the placement of the reagent mix backfill is complete, unless otherwise approved by the ENGINEER or OWNER'S AGENT.
7. Slurry shall not be diluted by surface water.
8. The level of the slurry in the trench shall be routinely monitored throughout the day; the level of slurry shall be monitored and recorded each morning and evening. Any noticeable difference in the elevation of the slurry may indicate a loss of slurry through the formation or cave-ins. Corrective action shall be taken to address any noticeable change in the elevation of the slurry.

C. Trench Excavation:

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1. The width of the hydraulic isolation wall shall be equal to or greater than 36 inches.
2. The CONTRACTOR shall ensure that no loose material, cuttings, or debris are left in the bottom of the trench before slurry backfilling commences and employ appropriate equipment to verify cleaning of the trench bottom. The CONTRACTOR shall remove from the trench any slurry which contains excessive suspended solids as indicated by a slurry unit weight exceeding 85 pcf or within 15 pcf of the unit weight of the backfill mixture. The removal of this slurry or materials from the bottom of the trench shall be done with suitable equipment. Upon these removal activities, the trench shall be sounded immediately before placing backfill, and the soundings shall be compared to the trench excavation soundings to verify the bottom.
3. At a minimum, soundings shall be taken each morning and each evening and compared to monitor for cave-ins or excessive settlement. Corrective action, including trench bottom cleaning, shall be taken to address soundings that indicate these conditions. The trench bottom shall be cleaned by using an excavator bucket, air lift pump, or other approved equipment to ensure removal of sand, gravel, sediment, and other material left in the trench or settled out of the slurry. Cleaning shall not remove material from the walls of the trench.
4. The CONTRACTOR shall conduct Work to avoid damage to utilities and other structures. Excavation equipment shall remain a safe distance (at least 20 feet or as determined in the HASP) from the overhead utilities.
5. The excavation shall begin at the working surface and shall provide a vertical (within two (2) percent) continuous 36-inch minimum width trench to the required depth along the centerline of the excavation. The toe of the slope of the trench excavation shall not precede the toe of the reagent backfill slope by less than 30 feet or more than 100 feet.
6. A lead-in trench is required at the start of the GWBW and at the intersection of two segments. The lead-in trench shall commence far enough away from the GWBW and ramp down to the full depth of the GWBW at a slope which avoids segregation of backfill particles.
7. Trench spoils that are suitable for backfill mixture may be stockpiled adjacent to, or remote from, the trench for processing. Care shall be taken to ensure that unprocessed spoils do not re-enter the trench.

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Any spoils or excavated materials that are not used in the backfill process shall be disposed onoff-site at an approved locationsfacility.

D. Backfill requirements:

1. Bentonite, or other reagents, shall be added and mixed uniformly and homogeneously with soil backfill such that the soil-reagent backfill mixture meets the criteria presented in Table 02242-1.
2. The soil-reagent backfill shall be thoroughly mixed, via disking, harrowing, bulldozing, blading, or other approved methods, into a homogeneous mass, free from large lumps or clods of soil or pockets of fines, sand or gravel. Occasional lumps/clods of up to three (3) inches in their largest dimension will be permitted.
3. All particles shall be coated with slurry. Sluicing with water is not permitted.
4. If mixing occurs along the trench, heavy equipment, i.e., bulldozers, shall not operate in a back and forth fashion parallel to the open trench. Unmixed materials shall not be permitted to flow into the trench. Excess slurry shall not flow beyond the limits of Work.

E. Backfill Placement:

1. At the beginning of the excavation, the initial layer of backfill shall be placed from one location only. If a lead-in trench is not excavated, the initial backfill shall be placed by lowering the material to the bottom of the trench by means of a clamshell bucket, tremie methods, or other approved equipment until the backfill emerges from below the slurry surface and achieves its natural angle of repose. A lead-in trench shall start at a point outside the limits of the GWBW to allow the soil-reagent backfill face to form prior to reaching the full depth of the required GWBW. The slope of the lead-in trench shall be excavated to prohibit sliding, sloughing, buckling, or other failures which could trap pockets of material or otherwise affect the performance of the wall. Free dropping of soil-reagent backfill through the slurry is not permitted at anytime throughout construction.
2. The point of trench backfilling shall progress towards the areas of active excavation. Backfilling operations shall proceed in such a manner that the slope of the initial backfill will be maintained. The new backfill material shall be allowed to slide down the slope of the previously placed backfill and shall be placed in such a manner that

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the pockets of slurry shall not be trapped during subsequent backfilling.

3. Care shall be exercised during mixing and backfilling to ensure that the backfill flows and displaces the slurry in the trench and to ensure that a uniform and homogenous trench is constructed.
4. The CONTRACTOR shall backfill continuously in the direction of the excavation from the beginning of the trench to the end of the trench, unless approved otherwise by the ENGINEER or OWNER'S AGENT.
5. Backfilling shall occur so that no pockets of slurry are present in the completed GWBW. The backfill shall not be deposited in any manner that will cause segregation.
6. No payments will be made for the portion of trenches which lie outside of the limits of work.
7. No mixing or placing of soil-reagent backfill shall occur when the air temperature is below 30 degrees Fahrenheit.

3.05 JET GROUTING CONSTRUCTION

- A. Any jet grout hole lost or damaged as the result of mechanical failure of equipment, inadequacy of grout supplies, or improper drilling or injection procedures shall be backfilled with cement grout and replaced by another hole, drilled and injected by the CONTRACTOR at no additional cost to the OWNER'S AGENT. The replacement hole shall be in a location that maintains the integrity of the wall.
- B. Jet grout injection and jet monitor rotation and extraction rates shall be sufficient to produce grout columns/panels meeting the minimum diameter, depth, overlap, and material property requirements specified herein, and to assure that the completed wall achieves the minimum permeability specifications. The CONTRACTOR shall determine and provide with the bid recommended row numbers, diameters, spacing, overlaps, pressures, construction and verification methods, and other necessary information to the ENGINEER or OWNER'S AGENT to demonstrate compliance in order to meet the performance standards.
- C. Jet grout mix shall be proportioned and injected so that the grout column produced meets the following requirements:
 1. Coefficient of permeability not to exceed 1×10^{-6} cm/sec; and,

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2. Additional tests specified in Table 02242-1.

- D. Equipment for mixing, holding, and pumping grout shall be in a secure location and shall be operated to minimize spillage of material. No material will be allowed to enter storm drains or other drainage courses.
- E. The CONTRACTOR shall use the same equipment, materials, and procedures as determined satisfactory in the Test Wall Section to perform jet grouting of the remaining wall alignment.
- F. The wall shall consist of, at a minimum, a single row of overlapping jet grout columns/panels with a minimum diameter of 36 inches. The minimum overlap shall be the greater of 1/8 of the column diameter/panel width or six inches. Multiple rows may, at the discretion of the CONTRACTOR, be employed to assure meeting the minimum performance standards.
- G. Upon completion of backfilling and grading operations, all remaining excavated material, residual slurry or grout, and mixed backfill shall be removed and disposed by the CONTRACTOR in accordance with Section 02250 – TRANSPORTATION AND DISPOSAL OF MATERIALS and the appropriate ODEQ regulations.

3.06 DEEP SOIL MIXING (DSM) CONSTRUCTION

- A. Equipment: The DSM rig shall consist of a series of overlapping mixing shafts capable of creating a wall with a minimum thickness of 36 inches.
- B. Alignment:
 - 1. The auger flights and mixing blades between the shafts of the DSM rig shall be overlapped to achieve continuity in the stabilized soil column.
 - 2. The placement of strokes shall be controlled by the use of a template or other approved means to gauge the distance between strokes.
 - 3. The vertical alignment of the auger stroke shall be controlled by the DSM equipment operator.
- C. Shaft speed: The mixing shaft speed shall be adjusted to accommodate a constant rate of mixing shaft penetration based on the degree of drilling difficulty.

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- D. Penetration Rate: The penetration rate of the mixing shafts shall be maintained in the range of 1 to 8 vertical ft/minute during both penetration and withdrawal, unless otherwise demonstrated during the Test Wall Section.
- E. Grout: The grout injection rate per vertical foot of column shall be adjusted to the requirements of the design mix, as proposed by the CONTRACTOR.
- F. The resulting soil column wall shall not exceed an in-place coefficient of permeability of 1×10^{-6} cm/sec and shall comply with Table 02242-1. The materials, equipment, mix design, construction method, and verification methods shall be submitted to the ENGINEER or OWNER'S AGENT with the bid to demonstrate assurance for meeting the performance standards.
- G. The CONTRACTOR shall determine the overlap of successive auger locations to ensure a continuous GWBW that meets the required specifications. The ENGINEER or OWNER'S AGENT shall evaluate the data provided by the CONTRACTOR to confirm that the appropriate overlap is being implemented; a minimum overlap of 30 percent is required between successive auger locations. If insufficient overlap is observed or the GWBW does not meet the performance requirements, the CONTRACTOR shall reprocess the area at no additional cost to the OWNER or OWNER'S AGENT.
- H. Upon completion of backfilling and grading operations, all remaining excavated material, residual slurry or grout, and mixed backfill shall be removed and disposed by the CONTRACTOR in accordance with Section 02250 – TRANSPORTATION AND DISPOSAL OF MATERIALS and the appropriate ODEQ regulations.

PART 4 - QUALITY CONTROL AND QUALITY ASSURANCE

4.01 DEFINITIONS

- A. The CONTRACTOR shall be responsible to construct a GWBW which meets these Specifications, and conduct all QC tests as necessary to demonstrate that the construction of the GWBW meets the Specifications. The CONTRACTOR shall provide quality control inspectors, as needed, to ensure proper quality control of the project and to obtain quality control samples as required herein and on Table 02242-1.
- B. The ENGINEER or OWNER'S AGENT will be responsible for QA testing.

4.02 QUALITY CONTROL OF DELIVERED PRODUCTS

- A. Bentonite:

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1. The CONTRACTOR shall supply to the ENGINEER or OWNER'S AGENT, for each designated load of bentonite, the bentonite manufacturer's certifications and laboratory test results that demonstrate that the bentonite meets the Specifications.
2. The CONTRACTOR shall supply to the ENGINEER or OWNER'S AGENT samples of bentonite as required by the Specifications or as requested by the ENGINEER or OWNER'S AGENT.
3. The CONTRACTOR shall keep a log of bentonite deliveries that includes: date, source, time of delivery, weight and laboratory quality control test results supplied by the Manufacturer.
4. It shall be the responsibility of the CONTRACTOR to verify that the bentonite delivered meets the Specifications.

B. Other Reagents:

1. The CONTRACTOR shall supply to the ENGINEER or OWNER'S AGENT, for each designated load of reagent, the reagent manufacturer's certifications and laboratory test results that demonstrate that the reagent meets the Specifications.
2. The CONTRACTOR shall supply to the ENGINEER or OWNER'S AGENT samples of reagent as required by the Specifications or as requested by the ENGINEER or OWNER'S AGENT.
3. The CONTRACTOR shall keep a log of reagent deliveries that includes: date, source, time of delivery, weight and laboratory quality control test results supplied by the Manufacturer.
4. It shall be the responsibility of the CONTRACTOR to verify that the reagent delivered meets the Specifications.

4.03 QUALITY CONTROL OF SOIL-REAGENT SLURRY TRENCH

- A. The submittals and tests for reagent and water shall meet the requirements outlined in Table 02242-1.
- B. Soil-Reagent Backfill Material:
 1. The CONTRACTOR shall obtain samples of the soil-bentonite backfill as required by these Specifications and as deemed necessary to achieve the performance requirements specified in Table 02242-1.

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The test results shall be supplied to the ENGINEER or OWNER'S AGENT as soon as possible.

2. Permeability:
 - a. The CONTRACTOR shall collect bulk and undisturbed samples of the soil-bentonite backfill at the frequencies specified in Table 02242-1 for laboratory permeability testing by a third-party laboratory to be procured by the CONTRACTOR. The tests shall be constant-head type permeability tests performed under a back pressure of 25 psi. During the saturation phase of the flexible wall permeability test, the difference between the chamber pressure and the back pressure shall not exceed 5 psi. The back pressure must be applied in small increments, with adequate time between increments to allow equalization of pore water pressure throughout the specimen. Typically, chamber pressure is about 7 psi and a chamber pressure and back pressure shall be in increment maintaining the back pressure at about 5 psi less than the chamber pressure. The imposed hydraulic gradient shall be less than 12 to minimize consolidation of the sample during testing. No additional consolidation stresses shall be applied to the test specimen other than that resulting from the imposed hydraulic gradient. Maximum turnaround times for quality control testing shall be required to be within one (1) week. The test results shall be provided to the ENGINEER or OWNER'S AGENT as soon as possible.
 - b. The in-place coefficient of permeability of the soil-bentonite backfill shall be as specified in Table 02242-1.
 3. The CONTRACTOR shall run additional tests as necessary to construct a GWBW that meets the Specifications. The CONTRACTOR shall split samples with the ENGINEER or OWNER'S AGENT, at the ENGINEER or OWNER'S AGENT request, to verify test results.
- C. Bentonite Slurry: The submittals and tests for initial slurry and in-trench slurry shall meet the requirements specified in Table 02242-1.
- D. The Test Wall Section shall be 100 feet in length.

4.04 QUALITY CONTROL OF JET GROUTING

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- A. Submittals and tests for reagents shall meet the requirements outlined in Table 02242-1.
- B. Prior to construction, ten (10) pre-production test columns, or a minimum of 25 feet in wall length, shall be constructed in site soils to evaluate the CONTRACTOR's proposed methods and the grout mix's ability to produce grout columns meeting the required depth and diameter. After evaluation of the test columns, modifications in the jet grout production procedures may be required to assure achieving the minimum performance requirements for the wall. Significant modifications will require a re-installation of the Test Wall Section, and subsequent re-testing.
- C. The CONTRACTOR shall conduct quality control tests on the jet grouting technology as specified in Table 02242-1

4.05 QUALITY CONTROL OF DEEP SOIL MIXING

- A. Submittals and tests for reagents shall meet the requirements outlined in Table 02242-1.
- B. The Test Wall Section shall be a minimum of 25 feet in length.
- C. The CONTRACTOR shall conduct quality control tests on the Deep Soil Mixing technology as specified in Table 02242-1

4.06 QUALITY CONTROL OF CLAY CAP

The CONTRACTOR shall test the in-place density and moisture content of the clay cap material in accordance with Section 02200 – EARTHWORK.

4.07 SOUNDINGS

- A. Soundings shall be taken every 20 feet along the GWBW centerline using a weighted tape, cable, or other device. Soundings shall be recorded to the nearest 0.5 feet. Soundings shall record the following:
 - 1. Bottom of Excavation: The bottom elevation of the GWBW shall be determined subject to approval by the ENGINEER or OWNER'S AGENT.
 - 2. Bottom of Excavation Prior to Backfilling: Soundings shall be used to monitor for sidewall collapse and accumulation of sediments.

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3. Profile of Backfill Slope: The backfill slope and trench bottom, if applicable, shall be sounded at the beginning and end of each shift and converted to an as-built drawing. This drawing shall be reviewed daily as an indication of trench collapse, excessive settlement or sloughing.

4.08 AS-BUILT PROFILE

An as-built profile of the trench bottom, backfill slopes, including descriptions of materials encountered in the trench, and bottom of trench shall be continuously maintained by the CONTRACTOR. This profile shall indicate the extent of excavation and the backfill profile at the beginning and end of each work day or shift, as determined from the soundings. The daily profile drawing shall be in AutoCAD 2010. Materials encountered in the GWBW and bottom of the GWBW shall be described at a maximum interval of 20 lineal feet. The CONTRACTOR shall furnish profile drawings and records of all observations, measurements, and tests performed, identified with the location, date, and time of testing. These records shall be furnished to the ENGINEER or OWNER'S AGENT no later than 24 hours after the tests, measurements, and/or observations are made.

4.09 CONFIRM CONFINING LAYER

The ENGINEER or OWNER'S AGENT will determine when the top of bedrock has been reached. One method the ENGINEER or OWNER'S AGENT may consider for determining when the target depth has been achieved is the inability of the CONTRACTOR's equipment to advance more than six (6) inches in depth over a length of 20 lineal feet in a 30 minute period.

4.10 REJECTED GROUNDWATER BARRIER WALL SECTION

If the required quality control parameters are not achieved for a given sample, the corresponding section of GWBW will be rejected. The deficient section limits will be determined by the ENGINEER or OWNER'S AGENT. If tests fail to meet the specified requirements, the ENGINEER or OWNER'S AGENT reserves the right to require additional sampling and testing at the CONTRACTOR's expense. For failed/rejected sections, the CONTRACTOR shall remove and replace the GWBW within the limits specified by the ENGINEER or OWNER'S AGENT at no additional cost to the OWNER or OWNER'S AGENT.

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TABLE 02242-1 QUALITY CONTROL TESTING

Technology	Construction Phase	Component	Parameter	Test Method	Frequency	Acceptance Criteria
Soil-Bentonite Slurry Wall	Pre-Construction	Bentonite	Free Swell Test	USP NF XVII	Once per borrow source	16 cm ³ minimum
			YP/PV Ratio	API 13A	Once each truck or railcar shipment	3 minimum
			Plastic Viscosity	API 13A	Once per borrow source	10 minimum
			Filtrate Loss	API 13A	Once each truck or railcar shipment	15 cm ³ maximum
			Moisture Content	ASTM D2216	Once each truck or railcar shipment	10% maximum
			Viscometer	API 13A	Once per borrow source	30 minimum @ 600 rpm
		Residue > 75 um	API 13A	Once per borrow source	4% maximum	
		Mix Water	pH	API RP 13B-1	Once per source	6 to 8
			Total Dissolved Solids	EPA 600	Once per source	500 mg/L maximum
		Soil Backfill (Imported Soil Backfill Only)	Hardness	API RP 13B-1	Once per source	50 mg/L maximum
	Particle Size Analysis		ASTM D422	Once every 500 cy	100% passing 3 in, minimum 15% passing No. 200	
	Construction	Soil Backfill (Imported Soil Backfill Only)	Moisture Content	ASTM D2216	Once every 500 cy	For record
			Atterberg Limits	ASTM D4318	Once every 500 cy	LL > 30, PI > 10
		Initial Slurry	Viscosity	API RP 13B-1	Twice per 8-hour shift	40 marsh seconds minimum
			Density	ASTM D4380	Twice per 8-hour shift	64 pcf minimum and > 15 pcf less than the backfill
			Filtrate Loss	API RP 13B-1	Twice per 8-hour shift	<25 cm ³ in 30 minutes @ 100 psi
		In-Trench Slurry	pH	API RP 13B-1	Twice per 8-hour shift	6 to 9
			Viscosity	API RP 13B-1	Twice per 8-hour shift	40 marsh seconds minimum
			Density	ASTM D4380	Twice per 8-hour shift	64 to 85 pcf and > 15 pcf less than the backfill
		Soil-Bentonite Backfill	Particle Size Analysis	ASTM D422	One per day or one every 200 lineal feet at alternating 25 vertical foot intervals	100% passing 3 in, minimum 15% passing No. 200
			Atterberg Limits	ASTM D4318	One per day or one every 200 lineal feet at alternating 25 vertical foot intervals	LL > 30, PI > 10
Permeability	ASTM D5084		One per day or one every 200 lineal feet at alternating 25 vertical foot intervals	1 x 10 ⁻⁶ cm/sec maximum		
Slump	ASTM C143		Twice per 8-hour shift	4 to 6 inches		
Post-Construction	Soil-Bentonite Backfill	Density	ASTM D4380	Twice per 8-hour shift	At least 15 pcf greater than the in-trench slurry	
		Permeability	ASTM D5084	One undisturbed sample from the ground surface to mid-depth and one from mid-depth to the bottom in the Chlorate Area and in the Acid Plant Area	1 x 10 ⁻⁶ cm/sec maximum	
Deep Soil Mixing	Pre-Construction	Bentonite	Free Swell Test	USP NF XVII	Once per borrow source	16 cm ³ minimum
			YP/PV Ratio	API 13A	Once each truck or railcar shipment	3 minimum
			Plastic Viscosity	API 13A	Once per borrow source	10 minimum
			Filtrate Loss	API 13A	Once each truck or railcar shipment	15 cm ³ maximum
			Moisture Content	ASTM D2216	Once each truck or railcar shipment	10% maximum
			Viscometer	API 13A	Once per borrow source	30 minimum @ 600 rpm
		Residue > 75 um	API 13A	Once per borrow source	4% maximum	
	Mix Water	pH	API RP 13B-1	Once per source	6 to 8	
		Total Dissolved Solids	EPA 600	Once per source	500 mg/L maximum	
	Construction	Column Mold	Hardness	API RP 13B-1	Once per source	50 mg/L maximum
Permeability			ASTM D5084	One per day or one every 200 lineal feet at alternating 25 vertical foot intervals	1 x 10 ⁻⁶ cm/sec maximum	
Post-Construction	Cured Core	Permeability	ASTM D5084	One undisturbed sample from the ground surface to mid-depth and one from mid-depth to the bottom in the Chlorate Area and in the Acid Plant Area	1 x 10 ⁻⁶ cm/sec maximum	
		Permeability	ASTM D5084	One undisturbed sample from the ground surface to mid-depth and one from mid-depth to the bottom in the Chlorate Area and in the Acid Plant Area	1 x 10 ⁻⁶ cm/sec maximum	
Jet Grouting	Pre-Construction	Bentonite	Free Swell Test	USP NF XVII	Once per borrow source	16 cm ³ minimum
			YP/PV Ratio	API 13A	Once each truck or railcar shipment	3 minimum
			Plastic Viscosity	API 13A	Once per borrow source	10 minimum
			Filtrate Loss	API 13A	Once each truck or railcar shipment	15 cm ³ maximum
			Moisture Content	ASTM D2216	Once each truck or railcar shipment	10% maximum
			Viscometer	API 13A	Once per borrow source	30 minimum @ 600 rpm
		Residue > 75 um	API 13A	Once per borrow source	4% maximum	
	Mix Water	pH	API RP 13B-1	Once per source	6 to 8	
		Total Dissolved Solids	EPA 600	Once per source	500 mg/L maximum	
	Construction	Column Mold	Hardness	API RP 13B-1	Once per source	50 mg/L maximum
Permeability			ASTM D5084	One per day or one every 200 lineal feet at alternating 25 vertical foot intervals	1 x 10 ⁻⁶ cm/sec maximum	
Post-Construction	Cured Core	Permeability	ASTM D5084	One undisturbed sample from the ground surface to mid-depth and one from mid-depth to the bottom in the Chlorate Area and in the Acid Plant Area	1 x 10 ⁻⁶ cm/sec maximum	
		Permeability	ASTM D5084	One undisturbed sample from the ground surface to mid-depth and one from mid-depth to the bottom in the Chlorate Area and in the Acid Plant Area	1 x 10 ⁻⁶ cm/sec maximum	

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Technology	Construction Phase	Component	Parameter	Test Method	Frequency	Acceptance Criteria
Soil-Bentonite Slurry Wall	Pre-Construction	Bentonite	Free Swell Test	USP NF XVII	Once per borrow source	16 cm ³ minimum
			YP/PV Ratio	API 13A	Once each truck or railcar shipment	3 minimum
			Plastic Viscosity	API 13A	Once per borrow source	10 minimum
			Filtrate Loss	API 13A	Once each truck or railcar shipment	15 cm ³ maximum
			Moisture Content	ASTM D2216	Once each truck or railcar shipment	10% maximum
			Viscometer	API 13A	Once per borrow source	30 minimum @ 600 rpm
		Residue > 75 um	API 13A	Once per borrow source	4% maximum	
		Mix Water	pH	API RP 13B-1	Once per source	6 to 8
			Total Dissolved Solids	EPA 600	Once per source	500 mg/L maximum
		Soil Backfill	Hardness	API RP 13B-1	Once per source	50 mg/L maximum
	Particle Size Analysis		ASTM D422	Once every 500 cy	100% passing 3 in, minimum 20% passing No. 200	
	Construction	Initial Slurry	Moisture Content	ASTM D2216	Once every 500 cy	For record
			Atterberg Limits	ASTM D4318	Once every 500 cy	LL > 30, PI > 10
			Viscosity	API RP 13B-1	Twice per 8-hour shift	40 marsh seconds minimum
			Density	ASTM D4380	Twice per 8-hour shift	64 pcf minimum and > 15 pcf less than the backfill
		In-Trench Slurry	Filtrate Loss	API RP-13B-1	Twice per 8-hour shift	<25 cm ³ in 30 minutes @ 100 psi
			pH	API RP 13B-1	Twice per 8-hour shift	6 to 9
			Viscosity	API RP 13B-1	Twice per 8-hour shift	40 marsh seconds minimum
			Density	ASTM D4380	Twice per 8-hour shift	64 to 85 pcf and > 15 pcf less than the backfill
	Soil-Bentonite Backfill	Particle Size Analysis	ASTM D422	One per day or one every 200 lineal feet at alternating 25 vertical foot intervals	100% passing 3 in, minimum 20% passing No. 200	
Atterberg Limits		ASTM D4318	One per day or one every 200 lineal feet at alternating 25 vertical foot intervals	LL > 30, PI > 10		
Permeability		ASTM D5084	One per day or one every 200 lineal feet at alternating 25 vertical foot intervals	1 x 10 ⁻⁶ cm/sec maximum		
Slump		ASTM C143	Twice per 8-hour shift	4 to 6 inches		
Density		ASTM D4380	Twice per 8-hour shift	At least 15 pcf greater than the in-trench slurry		
Permeability		ASTM D5084	One undisturbed sample from the ground surface to mid-depth and one from mid-depth to the bottom in the Chlorate Area and in the Acid Plant Area	1 x 10 ⁻⁶ cm/sec maximum		
Deep Soil Mixing	Pre-Construction	Bentonite	Free Swell Test	USP NF XVII	Once per borrow source	16 cm ³ minimum
			YP/PV Ratio	API 13A	Once each truck or railcar shipment	3 minimum
			Plastic Viscosity	API 13A	Once per borrow source	10 minimum
			Filtrate Loss	API 13A	Once each truck or railcar shipment	15 cm ³ maximum
			Moisture Content	ASTM D2216	Once each truck or railcar shipment	10% maximum
			Viscometer	API 13A	Once per borrow source	30 minimum @ 600 rpm
	Residue > 75 um	API 13A	Once per borrow source	4% maximum		
	Mix Water	pH	API RP 13B-1	Once per source	6 to 8	
		Total Dissolved Solids	EPA 600	Once per source	500 mg/L maximum	
	Hardness	API RP 13B-1	Once per source	50 mg/L maximum		
Construction	Column Mold	Permeability	ASTM D5084	One per day or one every 200 lineal feet at alternating 25 vertical foot intervals	1 x 10 ⁻⁶ cm/sec maximum	
Post-Construction	Cured Core	Permeability	ASTM D5084	One undisturbed sample from the ground surface to mid-depth and one from mid-depth to the bottom in the Chlorate Area and in the Acid Plant Area	1 x 10 ⁻⁶ cm/sec maximum	
Jet Grouting	Pre-Construction	Bentonite	Free Swell Test	USP NF XVII	Once per borrow source	16 cm ³ minimum
			YP/PV Ratio	API 13A	Once each truck or railcar shipment	3 minimum
			Plastic Viscosity	API 13A	Once per borrow source	10 minimum
			Filtrate Loss	API 13A	Once each truck or railcar shipment	15 cm ³ maximum
			Moisture Content	ASTM D2216	Once each truck or railcar shipment	10% maximum
			Viscometer	API 13A	Once per borrow source	30 minimum @ 600 rpm
	Residue > 75 um	API 13A	Once per borrow source	4% maximum		
	Mix Water	pH	API RP 13B-1	Once per source	6 to 8	
		Total Dissolved Solids	EPA 600	Once per source	500 mg/L maximum	
	Hardness	API RP 13B-1	Once per source	50 mg/L maximum		
Construction	Column Mold	Permeability	ASTM D5084	One per day or one every 200 lineal feet at alternating 25 vertical foot intervals	1 x 10 ⁻⁶ cm/sec maximum	
Post-Construction	Cured Core	Permeability	ASTM D5084	One undisturbed sample from the ground surface to mid-depth and one from mid-depth to the bottom in the Chlorate Area and in the Acid Plant Area	1 x 10 ⁻⁶ cm/sec maximum	

*02250 – Transportation and
Disposal of Materials*

TRANSPORTATION AND DISPOSAL OF MATERIALS

PART 1 - GENERAL

1.01 DESCRIPTION

The CONTRACTOR shall furnish all labor, materials, tools, and equipment, required to transport all concrete/asphalt debris, piping, spoils, liquids, and other waste materials for ~~on-site recycling or~~ disposal as specified in these Contract Documents. All concrete/asphalt debris, piping, spoils, liquids, and other waste materials, other than general refuse and sanitary wastes, shall be contained and/or disposed on-site, in accordance with these Specifications and the Contaminated Material Management Plan (Attachment 1).

1.02 REGULATORY REQUIREMENTS

- A. All concrete/asphalt and other general construction debris, piping, and spoils shall be disposed at approved on-site locations. All liquids generated during performance of the Work shall be containerized and stored at approved on-site locations. All disposal and storage shall be in accordance with the Contaminated Material Management Plan (Attachment 1) and all federal, state, and local regulations.
- B. All concrete/asphalt debris, piping, and other general construction debris shall be cleaned and properly decontaminated prior to disposal on-site.

1.03 TRANSPORTATION

- A. The CONTRACTOR shall be responsible for transporting concrete/asphalt debris, piping, spoils, liquids, and other waste materials to the appropriate on-site location for disposal.
- B. The CONTRACTOR shall be responsible for all sampling and testing required by the ENGINEER or OWNER'S AGENT.
- C. ~~The CONTRACTOR shall provide all necessary traffic controls at the ingress and egress location along Northwest Front Avenue, such as flagmen, during trucking operations, or as otherwise directed by the ENGINEER or OWNER'S AGENT.~~
- D. ~~No queuing of trucks shall be permitted on Northwest Front Avenue. Any queuing of trucks that occurs on-site shall not interfere with daily traffic.~~

~~1.04 SUBMITTALS~~

- ~~A. In accordance with Section 01300 SUBMITTALS and the Construction Quality Assurance/Quality Control (CQA/QC) Plan.~~

TRANSPORTATION AND DISPOSAL OF MATERIALS

- B. The CONTRACTOR shall be responsible for performing any tests (e.g. Paint Filter Liquids Test EPA Method 9095A) required to ensure the materials are suitable for disposal on-site. The CONTRACTOR shall submit copies of results of any tests performed.
- C. The CONTRACTOR shall not commence with the disposal of concrete/asphalt debris, piping, spoils, liquids, and other waste materials until the ENGINEER or OWNER'S AGENT has approved the submitted information.
- D. For each waste material stream disposed, the CONTRACTOR shall submit documentation to the ENGINEER or OWNER'S AGENT identifying, at a minimum, the origin of the material, the quantity of the material (tons, cubic yards, units, etc.), and the date and location of where the material was disposed.

~~1.05~~ OFF-SITE TRANSPORTATION AND DISPOSAL

- ~~A.~~ It is not anticipated that any concrete/asphalt debris, piping, spoils, or liquids will be disposed off-site as part of the Work. However, if the ENGINEER or OWNER'S AGENT determines that off-site disposal of waste materials is desirable, the following minimum requirements shall apply.
1. The concrete/asphalt debris, piping, spoils, liquids, and other waste materials removed ~~during the Work~~ shall be cleaned and properly decontaminated (or contained in the case of contaminated soils and liquids) sufficient for transportation in accordance with these Specifications and all federal, state, and local regulations.
 - ~~2.B.~~ All concrete/asphalt debris, piping, spoils, liquids, and other waste materials shall be disposed at an approved waste disposal facility in accordance with all federal, state, and local regulations.
 - ~~C.~~ The CONTRACTOR shall comply with all applicable regulatory requirements and all federal, state, or local laws, codes, and ordinances which govern the transportation ~~of equipment~~ and disposal of material to be removed from the Site. Materials transported off-site shall meet the ODEQ off-site disposal policy and comply with all applicable regulations.
 - ~~3.D.~~ The CONTRACTOR shall obtain any and all permits required for transport and disposal and comply with all applicable

TRANSPORTATION AND DISPOSAL OF MATERIALS

requirements.

~~4.1.03 TRANSPORTATION~~

- ~~A. The CONTRACTOR shall be responsible for transporting concrete/asphalt debris, piping, spoils, liquids, and other waste materials to the appropriate off-site facility for disposal.~~
- ~~B. The CONTRACTOR shall be responsible for all sampling and testing required by the off-site disposal facility.~~
- E. The CONTRACTOR shall provide all necessary traffic controls at the ingress and egress location along Northwest Front Avenue, such as flagmen, during trucking operations, or as otherwise directed by the ENGINEER or OWNER'S AGENT.
- F. No queuing of trucks shall be permitted on Northwest Front Avenue. Any queuing of trucks that occurs on-site shall not interfere with daily traffic.

1.04 SUBMITTALS

- A. In accordance with Section 01300 – SUBMITTALS and the Construction Quality Assurance/Quality Control (CQA/QC) Plan.
- ~~B. Unless directed by the OWNER'S AGENT to dispose material at a particular facility, the CONTRACTOR shall be responsible for locating disposal facilities; e.g., solid waste disposal facility, hazardous waste disposal facility, etc., which shall accept all materials removed from the Site to be disposed, including materials generated from site clearing and grubbing or other activities performed within the areas of Work, as applicable.~~
5. The CONTRACTOR shall submit written documentation certifying that the disposal facility is in compliance with all regulations and permits, and is willing to accept the material. A copy of the most recent inspection report shall be submitted to the ENGINEER or OWNER'S AGENT verifying that the facilities have no violations or other environmental conditions that affect the satisfactory operation of the facility.
- 6C. The CONTRACTOR shall submit ~~copies of~~ results of any tests performed at the disposal facility by the disposal facility prior to waste acceptance. The CONTRACTOR shall be responsible for performing any ~~testtests~~ required by the receiving facility prior for

TRANSPORTATION AND DISPOSAL OF MATERIALS

the disposal of materials.

5. The disposal facility shall be approved by the ENGINEER or OWNER'S AGENT. The disposal facility shall be in compliance with all current federal and state regulations governing construction and operation of an appropriate waste disposal facility.
6. In the event that the identified and approved facilities cease to accept the stated materials or the facility ceases operations or the OWNER'S AGENT rejects the facility, it is the CONTRACTOR's responsibility to locate an alternate approved and permitted facility for accepting materials. The CONTRACTOR is responsible for making the necessary arrangements to utilize the facility and the alternate facility must be approved in writing by the OWNER'S AGENT in the same manner and with the same requirements as the original facility before the concrete/asphalt debris, spoils, waste materials, impacted water, or other materials, are removed from the Site.
- ~~7.D.~~ The CONTRACTOR shall prepare and submit to the ENGINEER or OWNER'S AGENT information regarding transporting materials from the Site, including type of trucks and/or trailers, method of transportation, the transport route to the facility, the anticipated number of trips, and the proposed types and locations of necessary traffic control devices to be used by the CONTRACTOR. The CONTRACTOR shall also list all federal, state, and local regulations that must be complied with and all permits that must be obtained.
- ~~8E.~~ The CONTRACTOR shall not commence with the removal of concrete/asphalt debris, piping, spoils, liquids, and other waste materials from the Site until the ENGINEER or OWNER'S AGENT has approved the submitted information.
- F. The CONTRACTOR shall submit copies of weigh tickets or other receipts provided by the disposal facility to the ENGINEER or OWNER'S AGENT as evidence of the arrival and disposal of the material at the disposal site, including any salvaging, recycling, or recovery. The documentation submitted to the ENGINEER or OWNER'S AGENT shall, at a minimum, identify the origin of the material, the quantity of the material (tons, cubic yards, units, etc.), the identification of the transport vehicle, ~~the~~ type of material, and the date the material was disposed at the facility.

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TRANSPORTATION AND DISPOSAL OF MATERIALS

1.05 ~~DISPOSAL FACILITIES~~

A.

~~The OWNER and OWNER'S AGENT reserve the right to direct the CONTRACTOR to dispose material at a facility identified by the OWNER'S AGENT.~~

~~B. Unless directed by the OWNER'S AGENT to dispose material at a particular facility, the CONTRACTOR shall be responsible for locating disposal facilities; e.g., solid waste disposal facility, hazardous waste disposal facility, etc., which shall accept all materials removed from the Site to be disposed, including materials generated from site clearing and grubbing or other activities performed within the areas of Work, as applicable.~~

~~C. The disposal facilities shall be approved by the ENGINEER or OWNER'S AGENT. The disposal facility shall be in compliance with all current federal and state regulations governing construction and operation of an appropriate waste disposal facility.~~

1.06 ~~ALTERNATE DISPOSAL FACILITY~~

~~A. In the event that the identified and approved facilities cease to accept the stated materials or the facility ceases operations or the OWNER'S AGENT rejects the facility, it is the CONTRACTOR's responsibility to locate an alternate approved and permitted facility for accepting materials. The CONTRACTOR is responsible for making the necessary arrangements to utilize the facility and the alternate facility must be approved in writing by the OWNER'S AGENT in the same manner and with the same requirements as the original facility before the concrete/asphalt debris, spoils, waste materials, impacted water, or other materials, are removed from the Site.~~

PART 2 - PRODUCTS

(not used)

PART 3 - EXECUTION

3.01 GENERAL

A. No vehicle shall leave the Site unless it is in a clean condition, free of loose dirt or loose material on tailgates, axles, wheels, etc.

TRANSPORTATION AND DISPOSAL OF MATERIALS

- B. No vehicle shall leave the Site ~~with concrete/asphalt debris, piping, spoils, liquids, or other waste materials,~~ unless the materials being transported are secure and tightly covered/tarped or contained so that no material, dust, or water is able to drop off, blow off, or leak out. Trucks shall be lined at the discretion of the ENGINEER or OWNER'S AGENT.
- C. Loading and transportation of concrete/asphalt debris, piping, spoils, liquids, and other waste materials shall be conducted in a manner as to eliminate all dust.
- D. All personnel, equipment, and trucks shall enter and exit the Site from Northwest Front Avenue. Prior to exiting the Site all decontamination requirements of these Specifications and the Site Health and Safety Plan shall be met.
- E. In the event that the materials being transported are dropped or spilled from the truck during transportation, the CONTRACTOR shall take the following steps.
1. If contents are spilled on-site, the CONTRACTOR shall immediately notify the ENGINEER or OWNER'S AGENT. The CONTRACTOR is responsible for immediate removal of the waste materials and cleaning the area to the satisfaction of the ENGINEER or OWNER'S AGENT.
 2. If contents are spilled off-site, the CONTRACTOR shall immediately notify the ENGINEER, OWNER'S AGENT, OWNER, and the appropriate authorities; i.e., local fire and police departments. The appropriate clean up activities shall be coordinated without delay with these authorities.
 3. If contents are spilled, the truck shall return and go through the decontamination station again before proceeding off-site.
 4. If contents are spilled, no additional loads shall leave the site until the decontamination procedures are reviewed and necessary changes implemented to ensure that dropping or tracking of material and debris beyond the decontamination station does not occur.
 53. The CONTRACTOR shall bear full responsibility for any required clean up of all spilled material. All clean up and remediation activities associated with spilled materials shall be performed at no extra cost to the OWNER or OWNER'S AGENT.

*02290 – Soil Erosion and
Sediment Control*

02290
SOIL EROSION AND SEDIMENT CONTROL

PART 1- GENERAL

1.01 DESCRIPTION

- A. The Work covered by this Section consists of furnishing all materials, equipment, tools and labor to construct, maintain, and remove soil erosion and sediment control systems.
- B. The Work to be performed includes, but is not limited to the installation or construction of silt fence, ~~storm drain inlet protection~~, permanent seeding, and any other controls necessary as specified herein, ~~shown on the Drawings~~, or required to eliminate the potential for sediment-laden surface water to flow beyond the limits of disturbance.

1.02 REFERENCES

- A. 2005 Oregon Department of Environmental Quality Erosion and Sediment Control Manual
- B. 2008 Portland Erosion and Sediment Control Manual

1.03 QUALITY ASSURANCE

- A. All materials, procedures, operations, and methods shall be in strict conformance with the Drawings and these Specifications, and shall be subject to strict quality control monitoring as detailed herein. The installed erosion and sediment controls shall conform exactly to the Drawings and these Specifications, except as otherwise authorized in writing by the ENGINEER or OWNER'S AGENT.
- B. The CONTRACTOR shall comprehend and anticipate quality assurance activities and account for these activities in the installation schedule.
- C. The CONTRACTOR shall periodically inspect and maintain proper erosion and sediment control measures throughout the duration of the project, including weekends and holidays. All erosion and sediment controls shall be maintained as necessary for rainfalls one-half inch (1/2") or greater.

1.04 SUBMITTALS

Product data shall be submitted as indicated in these Contract Documents.

SOIL EROSION AND SEDIMENT CONTROL

PART 2 - PRODUCTS

2.01 SOIL EROSION AND SEDIMENT CONTROL MATERIALS

Silt Fence: The CONTRACTOR shall supply silt fence to control surface-water runoff and sediment in locations indicated on the Drawings. As specified in the Portland Erosion and Sediment Control Manual, silt fence material shall be heavy-duty fabric and shall retain 85 percent of the soil by weight. The fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0 to 120 degrees Fahrenheit.

The CONTRACTOR shall submit the manufacturer's product data to the ENGINEER or OWNER'S AGENT for approval.

PART 3 - EXECUTION

3.01 TRANSPORTATION, HANDLING AND STORAGE

Materials shall be handled in such a manner as to prevent damage to the material. Materials shall not be dropped or dragged over the ground. Any materials damaged shall be replaced at no expense to the OWNER or OWNER'S AGENT.

3.02 EROSION AND SEDIMENT CONTROL STRUCTURES

Silt Fence: The CONTRACTOR shall install silt fence in accordance with the Specifications and installation instructions provided by the manufacturer, as shown on the Drawings, or as directed by the ENGINEER or OWNER'S AGENT. Presiding authority shall be as follows, in descending order: ENGINEER or OWNER'S AGENT direction, Drawings, Specifications, manufacturer's installation instructions. The CONTRACTOR shall maintain the silt fence until permanent cover is established, and the entire Site is stabilized, as approved by the ENGINEER or OWNER'S AGENT.

END OF SECTION

02711 - Geotextile

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the manufacture, storage, delivery, installation, and testing of the geotextile portions of this project, including installation as herein specified and as shown on the Drawings.
- B. The CONTRACTOR shall perform the installation of the geotextiles in conjunction with all necessary construction, as depicted on the Drawings.

1.02 REFERENCES

- A. ASTM D-5261 Measuring Mass Per Unit Area of Geotextiles
- B. ASTM D-3776 Mass Per Unit Area (Weight) of Fabric
- C. ASTM D-4491 Water Permeability of Geotextiles by the Permittivity Method.
- D. ASTM D-4533 Trapezoid Tearing Strength of Geotextiles.
- E. ASTM D-~~4632~~ [Standard Test Method for Grab ~~6496~~](#)
———Breaking Load and Elongation of Geotextiles (~~Grab Method~~).
- F. ASTM D-4751 Determining Apparent Opening Size of a Geotextile.
- G. ASTM D-~~6241~~ [Standard Test Method for the Static~~4833~~——Index Puncture ~~StrengthResistance~~ of Geotextiles and Geotextile- Related Products Using a 50-mm ProbeGeomembranes](#)

1.03 QUALITY ASSURANCE

All materials, procedures, operations, and methods shall be in strict conformance with the Drawings and Specifications and shall be subject to strict quality control monitoring as detailed herein. The installed geotextiles shall conform exactly to the Drawings and Specifications, except as otherwise authorized in writing by the ENGINEER or OWNER'S AGENT.

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GEOTEXTILE

1.04 SUBMITTALS

- A. Prior to shipment of any geotextile materials, the CONTRACTOR shall submit the necessary information on the geotextile to document compliance with these Specifications.
- B. The geotextile manufacturer shall replace any material that is rejected because it does not comply with these Specifications.
- C. Upon delivery to the site, the CONTRACTOR and the ENGINEER or OWNER'S AGENT shall inspect the physical condition of the material. If the protective wrapping is damaged, or if damage is suspected, the material shall be replaced.

PART 2-PRODUCTS

2.01 GEOTEXTILE MATERIAL

- A. General Requirements
 - 1. Unless otherwise noted on the Drawings, geotextile suppliers shall furnish materials whose "Minimum Average Roll Values", as defined by the Federal Highway Administration (FHWA), meet or exceed the criteria specified in Table 02711-1. The geotextiles provided by the supplier shall meet or exceed the property value specified and shall be stock products; i.e., unless authorized, the supplier shall not furnish products specially, manufactured to meet the specifications of this project.
 - 2. The supplier shall furnish test results for the design criteria, as well as written certification that the materials meet the specifications in accordance with these Contract Documents.
 - 3. The geotextile material shall also perform the following:
 - a. Retain its structure during handling, placement and long-term service;
 - b. The material shall be capable of withstanding direct exposure to sunlight for 30 days with no measurable deterioration; and,
 - c. The material shall be chemically compatible with the materials that will be in contact with it.

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B. Labeling

1. The geotextile shall be supplied wrapped in relatively impermeable and opaque protective covers.
2. The geotextile shall be marked or tagged with the following information:
 - a. Manufacturer's name;
 - b. Product identification;
 - c. Lot number;
 - d. Roll number; and,
 - e. Roll dimensions.
3. Additionally, if any special placement is required, it shall be so marked on the textile material; e.g., "This Side Up", or "This Side Against Soil to be Retained".

2.02 TRANSPORTATION, HANDLING, AND STORAGE

- A. Transportation of the CONTRACTOR-supplied geotextile materials is the responsibility of the CONTRACTOR.
- B. Handling, storage, and care of the CONTRACTOR-supplied geotextile materials prior to and following installation at the site is the responsibility of the CONTRACTOR. The CONTRACTOR shall provide adequate storage space at the site.
- C. During shipment and storage, geotextiles shall be protected from ultraviolet light exposure, precipitation, or other inundation, mud, dirt, dust, punctures, cutting or any other damaging or deleterious conditions. Any additional storage procedures required by the geotextile manufacturer shall be the CONTRACTOR's responsibility.

PART 3-EXECUTION

3.01 HANDLING AND PLACEMENT

- A. The CONTRACTOR shall handle all geotextiles in such a manner as to ensure that they are not damaged in any way.
- B. In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

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GEOTEXTILE

C. Inspection:

Prior to implementing any of the Work in this Section, the installed Work of all other Sections shall be complete to the point where the Work of this Section may properly commence without adverse impact.

- D. During placement, care shall be taken not to entrap in the geotextile stones, excessive dust, or moisture that could cause damage.
- E. An examination of the geotextile over the entire surface, after installation, will be conducted by the ENGINEER or OWNER'S AGENT to ensure that no potentially harmful foreign objects, such as needles, are present. Any foreign objects so encountered shall be removed or the geotextile shall be replaced.
- F. The geotextile shall only be cut using a geotextile cutter or other methods approved by the ENGINEER or OWNER'S AGENT.
- G. After unwrapping the geotextile from its opaque wrapping, the geotextile shall not be left exposed for longer than 14 days, unless approved by the ENGINEER or OWNER'S AGENT.

3.02 SEAMS AND OVERLAPS

- A. If seams are required, all geotextiles shall be overlapped 6 inches.
- B. The CONTRACTOR shall pay particular attention at seams to ensure that no foreign material is inadvertently inserted beneath a geotextile.

3.03 REPAIR

- A. Any holes or tears in the geotextile shall be repaired by one of the following methods:
1. Liestering a patch made from the same geotextile over the affected area, with a minimum of 1 foot overlap in all directions.
 2. Sewing a patch made from the same geotextile over the affected area with a minimum of 6 inch overlap in all directions.

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3.04 PLACEMENT OF OVERLYING MATERIALS

- A. The CONTRACTOR shall place all overlying materials located on top of the geotextile in such a manner as to ensure:
1. No damage of the geotextile or underlying layers;
 2. Minimal slippage between the geotextile and the underlying layers; and,
 3. No excess tensile stresses in the geotextile.
- B. Equipment shall not be driven directly on the geotextile.

Table 02711-1

REQUIRED PROPERTY VALUES FOR NON-WOVEN GEOTEXTILES

PROPERTIES	QUALIFIER	SPECIFIED VALUE	TEST METHOD
Polymer Composition	Minimum	95% weight polypropylene or polyester	----
Fabric Weight	Minimum	10 oz/sq yd	ASTM D-5261
Puncture Strength	Minimum	700 lbs	ASTM D-6241
Grab Tensile Strength	Minimum	250 lbs	ASTM D-4632
Grab Tensile Elongation	Minimum	50 %	ASTM D-4632
Trapezoidal Tear Strength	Minimum	100 lbs	ASTM D-4533
Flow Rate	Minimum	75 gpm/sq ft	ASTM D-4491
Permittivity	Minimum	0.8 sec ⁻¹	ASTM D-4491
Apparent Opening Size (A.O.S.)	Maximum	Sieve Size: 100	ASTM D-4751

END OF SECTION

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GEOTEXTILE

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02715 - Geogrid

PART 1 – GENERAL

1.01 DESCRIPTION

The CONTRACTOR shall furnish all materials, equipment, and labor necessary for installing geogrid reinforcement to the lines and grades designated on the Drawings.

1.02 REFERENCES

- A. ASTM D-4355 Standard Test Method~~1248 Specification~~ for Deterioration of Geotextiles by Exposure to Light, Moisture~~Polyethylene Plastics Molding~~ and Heat in a Xenon Arc Type Apparatus~~Extrusion Materials~~
- B. ASTM D-4759 Standard Practice for Determining the Specification Conformance of Geosynthetics ~~1388 Test Methods for Stiffness of Fabrics~~
- C. ASTM D-1777 Method for Measuring Thickness of Textile Materials
- ~~D. 5732 Standard~~ ASTM D-4218 Test Method for Stiffness of Nonwoven Fabrics Using the Cantilever Test~~Carbon Black Content in Polyethylene Compounds by the Muffle Furnace Technique~~
- D. ASTM D-5818 Standard Practice for Exposure and Retrieval of Samples To Evaluate Installation Damage of Geosynthetics
- E. ASTM D-6637 Standard Test~~COE Method~~ CW-02215 Civil Works Construction Guide ~~November 1977~~
- ~~F. for Determining GRI-GG1 Geogrid Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method~~Strength
- F. EPA 9090 Test Method for Determining the Chemical Waste Compatibility of Synthetic Liners
- G. GRI-GG2 Geogrid Junction Strength
- ~~H. GRI-GG3 Creep Behavior and Long-Term Design Load of Geogrids~~

1.03 DELIVERY, STORAGE, AND HANDLING

- A. CONTRACTOR shall inspect the geogrid upon delivery to ensure that the proper material has been received.
- B. Geogrid shall be stored above -20°F (-29°C) and shall be shielded from direct exposure to sunlight.

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- C. CONTRACTOR shall prevent excessive mud, wet cement, epoxy, and like materials, which may affix themselves to the geogrid, from contacting the geogrid material.
- D. Rolled geogrid material may be laid flat or stood on end for storage.

1.04 QUALITY ASSURANCE

- A. All materials, procedures, operations, and methods shall be in strict conformance with these Specifications, and shall be subject to strict quality control monitoring as detailed herein. The installed geogrid shall conform exactly to the Specifications, except as otherwise authorized in writing by the ENGINEER or OWNER'S AGENT.
- B. The CONTRACTOR shall comprehend and anticipate CQA activities and account for these activities in the installation schedule.

1.05 SUBMITTALS

- A. In accordance with these Contract Documents.
- B. The Manufacturer and the Fabricator shall provide, two weeks prior to delivery, samples and Certificates of Compliance that the material is in accordance with these Specifications and is suitable for use.
- C. The Manufacturer of the geogrid shall provide recommendations for overlapping, cable-tying, and general installation recommendations.
- D. The CONTRACTOR shall provide, two weeks prior to installation, Shop Drawings showing anchoring details and other details pertinent to the installation of the geogrid under this contract.
- E. The CONTRACTOR shall list all equipment, tools, materials, protective clothing, and labor to be provided prior to the start of installation to ensure the timely completion of all installations.
- F. The manufacturer shall submit to the ENGINEER or OWNER'S AGENT, two weeks prior to delivery, data on the physical and chemical properties of the materials with reference to appropriate ASTM testing methods utilized in obtaining the data and the following information on the raw materials:
 - 1. Origin and production date of the resin;
 - 2. A copy of the quality control certificates issued by the resin supplier;

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3. Reports of tests conducted by the Manufacturer to verify that the material is in conformance with all requirements identified in this Section; and,
 4. Certification that no reclaimed polymer is added to the resin.
- G. The CONTRACTOR shall transport, handle, and store the geogrid as necessary to maintain the integrity of the geogrid prior to its installation.

PART 2 – PRODUCTS

2.01 DEFINITIONS

- A. Geogrid: A high density polyethylene (HDPE) grid structure manufactured for use as a subbase reinforcement layer for roadways installed over soft soils or other unstable materials.
- B. Biaxial Geogrid: A geogrid which has been manufactured with high junction strength and high tensile strength and modules in two directions, along the roll length and across the roll width.
- C. Direction of Geogrid: Refers to the orientation in which the geogrid is used for a particular project, which is along the machine direction (roll direction) for biaxial geogrid.
- D. MD: Machine direction.
- E. CMD: Cross-machine direction.
- F. All slack shall be mechanically removed from the placed geogrids before any material (e.g., aggregate base course) is placed on top of it.
- G. All information pertaining to placement of aggregate on top of the geogrid is included in Section 02232 – GRANULAR MATERIALS.

2.02 ACCEPTABLE MANUFACTURERS

- A. The Tensar Corporation, Morrow, Georgia.
- B. A manufacturer of equivalent products, pre-approved by the ENGINEER or OWNER'S AGENT.

2.03 MATERIALS

- A. The geogrid shall:

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1. Be model BX1500 manufactured by Tensar Corporation, or an approved equivalent.
2. Be a biaxially-oriented grid structure.
3. Be composed of high density polyethylene (HDPE).
4. Have aperture geometry and rib and junction cross-sections sufficient to permit mechanical interlock with the material being supported.
5. Have high continuity of tensile strength through all ribs and junctions of the grid structure.
6. Maintain its reinforcement and interlock capabilities under repeated dynamic loads while in service.
7. Be resistant to ultraviolet degradation, to damage under normal construction practices, and to all forms of biological or chemical degradation typically encountered at similar sites.

B. Labeling

1. Geogrid shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers.
2. Geogrid and rolls shall be marked or tagged with the following information:
 - a) Manufacturer's name;
 - b) Product identification;
 - c) Lot number;
 - d) Roll number; and,
 - e) Roll dimensions.
3. Additionally, if any special placement is required, it shall be so marked on the geogrid material, e.g., "This Side Up", or "This Side Against Soil to be Retained".

- C. The geogrid shall conform in all respects to the property requirements listed in Table 02715-1.

PART 3 - EXECUTION

3.01 EXAMINATION

The CONTRACTOR shall check the geogrid upon delivery to verify that the proper material has been received. The geogrid shall be inspected by the Contractor to be free of flaws or damage occurring during manufacturing, shipping, or handling.

3.02 PREPARATION

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The subgrade soil shall be prepared as indicated on the Construction Drawings or as directed by the ENGINEER or OWNER'S AGENT.

3.03 INSTALLATION

- A. The geogrid shall be laid at the proper alignment as shown on the Construction Drawings.
- B. The geogrid shall be installed in accordance with the installation guidelines provided by the Manufacturer or as directed by the ENGINEER or OWNER'S AGENT.
- C. The geogrid may be temporarily secured in place with ties, staples, pins, sand bags or backfill as required by fill properties, fill placement procedures or weather conditions or as directed by the ENGINEER or OWNER'S AGENT.

3.04 GRANULAR FILL PLACEMENT OVER GEOGRID

- A. Granular fill material shall be placed in lifts and compacted as directed under Section 02232 – GRANULAR MATERIALS. Granular fill material shall be placed, spread, and compacted in such a manner that minimizes the development of wrinkles in the geogrid and/or movement of the geogrid.
- B. A minimum loose fill thickness of 12 inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid. When underlying substrate is trafficable with minimal rutting, rubber-tired equipment may pass over the geogrid reinforcement at slow speeds (less than 10 mph) when integrally-formed geogrids are used. When woven, multi-layer or welded-strip geogrids are used, rubber-tired equipment shall not be allowed to pass directly on the geogrid. Sudden braking and sharp turning movements shall be avoided.

3.05 INSPECTION

- A. The OWNER, ENGINEER or OWNER'S REPRESENTATIVE may randomly inspect geogrid before, during and after (using test pits) installation.
- B. Any damaged or defective geogrid (i.e. frayed coating, separated junctions, separated layers, tears, etc.) will be repaired/replaced in accordance with Part 3.06 of this Section.

3.06 REPAIR

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- A. Any roll of geogrid damaged before, during and after installation shall be replaced by the CONTRACTOR at no additional cost to the OWNER or OWNER'S AGENT.
- B. Proper replacement shall consist of replacing the affected area adding three (3) feet of geogrid to either side of the affected area.

3.07 PROTECTION

Follow the Manufacturer's recommendations regarding protection from exposure to sunlight.

**Table 02715-1
Geogrid Properties**

Property	Test Method	Units	Value¹
<i>Index Properties</i>			
Aperture Dimensions ²	ASTM D-4759		
MD		in	1.0 (nom)
XMD		in	1.2 (nom)
Rib Thickness ²	ASTM D-4759		
MD		in	0.07 (nom)
XMD		in	0.07 (nom)
Tensile Strength @ 2% Strain ³	ASTM D-6637		
MD		lb/ft	580
XMD		lb/ft	690
Tensile Strength @ 5% Strain ³	ASTM D-6637		
MD		lb/ft	1,200
XCMD		lb/ft	1,370
Ultimate Tensile Strength ³	ASTM D-6637		
MD		lb/ft	1,850
XMD		lb/ft	2,050
<i>Structural Integrity</i>			
Junction Efficiency ⁴	GRI-GG2-87	%	93
Flexural Stiffness ⁵	ASTM D-5732-95	mg-cm	2,000,000
Aperture Stability ⁶		m-N/deg	0.75
<i>Durability</i>			
Resistance to Installation	ASTM D-	%SC/%SW/%GP	95/93/90

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Damage ⁷	5818		
	ASTM D-6637		
Resistance to Long-Term Degradation ⁸	EPA 9090	%	100
Resistance to UV Degradation ⁹	ASTM D-4355	%	100

Notes:

1. Unless indicated otherwise, values shown are minimum average roll values (MARV) determined in accordance with ASTM D-4759. The row labeled MD represents results from testing the product in the machine direction. The row labeled XMD represents results from testing the product in the cross-machine (transverse) direction.

2. Nominal dimensions.

3. True resistance to elongation when initially subjected to a load determined in accordance with ASTM D-6637 without deforming test materials under load before measuring such resistance or employing “secant” or “offset” methods of tangent measurement so as to overstate tensile properties.

4. Load transfer capability determined in accordance with GRI-GG2-87 and expressed as a percentage of ultimate tensile strength.

5. Resistance to bending force determined in accordance with ASTM D-5732-95, using specimens of width two ribs wide, with transverse ribs cut flush with exterior edges of longitudinal ribs (as a “ladder”), and of length sufficiently long to enable measurement of the overhang dimension. The overall flexural stiffness is calculated as the square root of the product of MD and XMD flexural stiffness values.

6. Resistance to in-plane rotational movement measured by applying a 20 kg-cm (2 m2m-N) moment to the central junction of a 9 inch x 9 inch specimen restrained at its perimeter in accordance with U.S. Army Corps of Engineers Methodology for measurements for torsional rigidity.

7. Resistance to loss of load capacity or structural integrity when subjected to mechanical installation stress in clayey sand (SC), well graded sand (SW), and crushed stone classified as poorly graded gravel (GP). The geogrid shall be sampled in accordance with ASTM D-5818 and load capacity shall be determined in accordance with ASTM D-6637.

8. Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments in accordance with EPA 9090 immersion testing.

9. Resistance to loss of load capacity or structural integrity when subjected to 500 hours of ultraviolet light and aggressive weathering in accordance with ASTM D-4355.

END OF SECTION

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GEOGRID

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*02831 – Chain Link Fences and
Gates*

02831
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Work covered by this Section consists of installing a permanent, 6-foot high chain link security fence with three strands of barbed wire as required to replace the sections of fence that were removed to enable performance of the Work, as shown on the Drawings. Temporary, 6-foot high chain link security fence with three strands of barbed wire shall be provided, as necessary, to ensure a continuous, secure perimeter exists around the entire Site at all times.
- B. Portions of the existing fence will remain in place; some existing fence may need to be replaced due to the loss of integrity and functionality.
- C. The Work includes, but is not limited to, installing new fence posts, and appurtenances within the locations where the segment of fence is required to be removed. The new fence shall be connected to the existing fence to provide a continuous perimeter security fence following construction of the groundwater barrier wall. Additionally, signs containing the words “NO TRESPASSING” shall be installed on the new and existing fence at maximum 100 foot intervals.
- D. During Work, the perimeter of the entire Site shall be secure with existing fence and/or temporary fence at all times; barricades, building walls, and other temporary measures may be considered.

1.02 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.):
 - RR-F-191K/GEN Fencing, Wire and Post Metal (and Gates, Chain Link Fence Fabric, and Accessories) (General Specification)
 - RR-F-19 1/1d Fencing, Wire and Post, Metal (Chain-Link Fence Fabric) (Detail Specification)
 - BR-F- 19 1/2d Fencing, Wire and Post, Metal (Chain-Link Fence Gates) (Detail Specification)
 - RR-F-19 1/3d Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces) (Detail Specification)
 - RR-F- 19 1/4d Fencing, Wire and Post, Metal (Chain-Link Fence Accessories) (Detail Specification)

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CHAIN LINK FENCES AND GATES

C. American Society for Testing and Materials (ASTM) Publications:

ASTM A 123	Zinc (Hot Galvanized) Coatings of Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strips.
ASTM F 567	Installation of Chain-Link Fence.
ASTM A 120	Pipe, Steel, Black and Hot-dipped Zinc-coated (Galvanized) welded and Seamless, for Ordinary Uses.
ASTM C 94	Ready-mixed Concrete.
ASTM B 429	Framework.
ASTM A 569	Steel Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial Quality.
ASTM A 570	Steel, Sheet & Strip, Carbon, Hot-Rolled Structural Quality.

D. Underwriters Laboratories (UL) Inc. Publication:

UL 467	Grounding and Bonding Equipment
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1.03 QUALITY CONTROL

- A. In accordance with Section 01400 – QUALITY CONTROL.
- B. Installation of the chain link fence shall be accomplished by an installation contractor, approved by the manufacturer, having a minimum of three (3) years experience in the satisfactory performance of similar work.

1.04 SUBMITTALS

- A. In accordance with Section 01300 – SUBMITTALS.
- B. Specific work history of the chain link fence installer shall be provided.
- C. The CONTRACTOR'S submittals shall include a plan layout; spacing of components; and a schedule of components.

CHAIN LINK FENCES AND GATES

- D. The CONTRACTOR shall submit manufacturer's installation instructions to the ENGINEER or OWNER'S AGENT a minimum of two (2) weeks prior to fence installation.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All new materials shall conform to Fed. Spec. RR-F-191 and detailed specifications forming the various parts thereto. Chain link security fence shall be constructed at the locations and alignment shown on the Drawings. All chain link security fence materials shall be the standard product of one manufacturer who is regularly engaged in the manufacture of chain link security fencing. Products which differ only in nonessential details from those specified herein will be acceptable. Drawings shall be submitted for any deviations to the ENGINEER or OWNER'S AGENT or its authorized representative.
- B. Delivery, Storage and Protection: Materials shall be delivered to the Site in an undamaged condition. Materials shall be carefully stored off the ground to provide proper protection against oxidation caused by ground contact.
- C. Storage and Protection of Existing Fence Materials: Materials obtained through the removal of existing chain link fence(s) to be reused shall be stored and protected as stated in paragraph B above. All materials stored for reuse shall be cleaned and recoated as necessary in accordance with the following specifications at the discretion of the ENGINEER or OWNER'S AGENT prior to storage.
- D. Temporary Fence: The temporary fence shall be 6-foot high, chain link fence that provides continuous security when abutted to the existing fence or other structures. The post shall be secured, i.e., in concrete or other means approved by the ENGINEER or OWNER'S AGENT.

2.02 POSTS, RAILS, AND BRACES

- A. Fed. Spec. RR-F- 191/3 galvanized steel, 1.8 ounce per square foot, except as modified herein.
- B. Post Braces and Truss Rods: For each gate, corner, pull or end post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment. Truss rods shall be 3/8 inch diameter.

CHAIN LINK FENCES AND GATES

- C. Intermediate Posts: C-section line posts of the same dimension as H-post, 0.120 inch wall thickness, and fabricated from steel conforming to ASTM A570, Grade 33 may be furnished in lieu of H- or round posts.
- D. Posts, Braces, Rails, and Gate Frames: Steel pipe manufactured from steel conforming to ASTM A 569, cold-rolled. Steel pipe shall be of the same external dimension and minimum wall thickness as Class 1 - steel pipe as listed in Fed. Spec. RR-F-191/3. Post, brace, nail and gate frame sizes shall be as indicated on the Drawings.
- E. Barbed Wire Support Arms: All posts shall be provided with pressed copper-bearing galvanized steel extension arms. All end posts shall be provided with heavy malleable iron extension arms. All extension arms shall be heavily coated with zinc by the hot-dip process. Each extension arm shall be sized to carry three strands of 12-1/2 GA, 4 PT, Class III barbed wire at an angle of 45 degrees, the upper strand 12 inches out from the fence line and 12 inches above the top of the fabric. Arms shall be the type that allow top rail to pass through their bases to form a continuous brace. Barbed wire arms shall be of sufficient strength to withstand a weight of 250 pounds applied at the outer or the top strand of barbed wire.
- F. Barbed Wire: Barbed wire shall be of the four-point pattern, composed of three strands of No. 12-1/2 gauge copper-bearing steel wire, Class III with large hard temper barbs spaced a maximum of 5 inches apart, and shall be heavily galvanized by the hot-dip process.

2.03 CHAIN-LINK FABRIC

- A. Fed. Spec. RR-F-191/1; Type I, 1.2 ounces per square foot coating, or Type II, 0.40 ounce per square foot coating, and shall be 9-gauge wire woven in a 2-inch mesh. Fabric width shall be as indicated.
- B. Attach fabric by method standard with the manufacturer, except that welding will not be permitted.

2.05 CONCRETE

- A. ASTM C 94, using 3/4 inch maximum-size aggregate, and having minimum compressive strength of 3,000 psi at 28 days.

2.06 COMPONENTS

- A. Top, bottom, and upright gate frame members shall be minimum 1 5/8-inch O.D. steel pipe.

CHAIN LINK FENCES AND GATES

- B. Fence fabric shall be 1.75-inch diamond mesh, galvanized steel wire, interwoven 9-gauge thick with top selvage twisted tight and bottom selvage knuckle and closed.
 - C. Caps shall be galvanized steel sized to post dimension.
 - D. All sleeves, bands, clips, rail bends, tensions, bars, fasteners and fittings shall be galvanized steel.
 - E. Tension Wire shall have a minimum tensile strength of 75,000 psi, zinc-coated for use with zinc-coated fabric and aluminum coated for use with aluminum-coated fabric. Minimum weight of aluminum coating shall be 0.40 ounce of aluminum per square foot of wire.
 - F. Tie Wire shall be nine gauge galvanized steel wire for attaching fabric to rails, braces, and intermediate posts.
 - G. Hog Rings shall be nine gauge (minimum) galvanized steel wire for attaching fabric to bottom reinforcing wires.
 - H. Padlocks shall be Fed. Spec. FF-P-101, type EPB, 1-3/4-inch size, with chain. All padlocks shall be keyed alike.
- 2.07 FINISHES

- A. Frame components shall be galvanized at a rate of 1.8 ounces per square foot in accordance with ASTM A 123.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. CONTRACTOR shall install framework, fabric, gates, and accessories in accordance with ASTM F 567 and as shown on the Drawings.
- B. The fence shall be installed on previously prepared surfaces to line and grade indicated. Fence installation shall be as specified and in accordance with the fence manufacturer's written installation instructions.
- C. Excavation for concrete-embedded items shall be of the dimensions indicated. Post holes shall be cleared of loose materials. Spoil material shall be spread where directed by the ENGINEER or OWNER'S AGENT. The ground surface irregularities, along the fence line and in areas not being altered by area grading, shall be eliminated to the extent necessary to maintain a 2-inch clearance between the bottom of the fabric and finish

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grade.

- D. CONTRACTOR shall provide 6-foot nominal height fence with line posts not exceeding 10 feet, center-to-center.

CHAIN LINK FENCES AND GATES

- E. All posts shall be set plumb and in alignment in concrete floorings with top of footing a minimum of two inches above finished grade. Posts shall be set in concrete a minimum of 40 inches and top of concrete shall be sloped for water runoff. Concrete shall be thoroughly compacted as to be free of voids and finished in a dome. Concrete shall cure 3 days prior to installation of fabric. Straight runs between braced posts shall not exceed 500 feet.
- F. Each gate and corner post shall be braced back to adjacent line post with horizontal brace and rail and diagonal truss rods.
- G. Contractor shall furnish center and bottom brace rails on corner posts and gate leaves.
- H. Tension wire shall be used to secure the top of the fence except at gate locations, end posts, and corners.
- I. Bottom tension wire shall be installed before installing chain-link fabric and shall be pulled taut.
- J. Post caps shall be of the design as required to accommodate the top rail. Post caps shall be installed as recommended by the manufacturer.
- K. Supporting arms shall be of the design as required to accommodate the top rail. Supporting arms shall be installed as recommended by the manufacturer.
- L. Top rail shall be installed at all gate locations, end posts, and corners only before installing chain-link fabric and shall pass through intermediate post caps. Expansion coupling shall be provided and spaced a maximum of 100 feet on center.
- M. Fabric shall be placed two inches above finished grade and mechanically pulled taut and secured to the top rail or tension wire and bottom wire close to both sides of each post and at intervals of not more than 24 inches on center. Fabric shall be secured to line posts using ties at the top and bottom at intervals of not more than 15 inches. Fabric shall be secured to end, corner, pull, and gate posts for the full length by integrally weaving to fastening loops or by using stretcher bars and bands. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.
- N. Padlocks shall be furnished for gate openings and shall have chains that are securely attached to the gate or gate posts. Padlocks shall be keyed alike and five keys shall be provided by the CONTRACTOR to the ENGINEER or OWNER'S AGENT.

CHAIN LINK FENCES AND GATES

- O. Barbed Wire: Each extension arm shall carry three strands of barbed wire at an angle of 45 degrees, the upper strand 12 inches out from the fence line and 12 inches above the top of the fabric. Install three strands on the extension arms at the top of the fence and over gates. The extension arms shall be installed so that they are pointing to the exterior of the perimeter created by the fence.

3.02 TEMPORARY CHAIN LINK SECURITY FENCE

- A. Temporary, 6-foot high chain link security fence shall be provided, as necessary, to ensure a continuous, secure perimeter exists around the entire Site at all times.
- B. The temporary fence shall be securely connected to the existing fence so that the existing and temporary fences form a continuous barrier.

3.03 RELOCATION OF EXISTING CHAIN LINK SECURITY FENCE AND GATES

- A. The removal of existing fence designated for relocation or temporary removal shall be in accordance with the requirements hereinbefore specified for removal thereof. All fence materials to be reinstalled in the Work shall be jointly inspected by the CONTRACTOR and the ENGINEER or OWNER'S AGENT prior to dismantling or removal by the CONTRACTOR. An agreement briefly setting forth the current condition of the fence and gates to be reinstalled shall be prepared by the CONTRACTOR and signed by the CONTRACTOR and the ENGINEER or OWNER'S AGENT after the pre-construction walk-through.
- B. Reinstallation shall be as specified under paragraph 3.01 of this Section. The CONTRACTOR shall supply such new parts conforming to the requirements of this Section as are necessary to complete the installation of the relocated fences and gates.

3.04 GROUNDING

- A. Fence fabric shall be grounded at each site of every gate, at points 150 feet each side of overhead power-transmission lines, at intervals of every 1,000 to 1,500 feet of length when fences are located in isolated places, and every 500 to 750 feet when in close proximity (100 feet or less) to public roads, highways, and buildings. Fence shall be grounded at locations where the fence alignment changes more than 15 degrees.

*02901 – Miscellaneous Work and
Site Cleanup*

02901
MISCELLANEOUS WORK AND SITE CLEANUP

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. CONTRACTOR shall furnish all labor, materials, equipment, and incidentals required to perform miscellaneous Work not specified in other Sections, but necessary for the proper completion of the Work as shown on the Drawings.
- B. When applicable, the CONTRACTOR shall perform the Work in accordance with other Sections of these Specifications. When no applicable specification exists, the CONTRACTOR shall perform the Work in accordance with established industry practice ~~and~~ or as directed by the ENGINEER or OWNER'S AGENT.
- C. The Work of this Section includes, but is not limited to, the following:
1. Cleanup.
 2. Incidental work.
 3. Restoration of disturbed areas.
 4. Restoring easement and right-of-ways.
 5. Temporary facilities.
 6. Protection of existing equipment, underground and aboveground utilities, including significant gas supply lines, monitoring wells, materials and structures that are designated to remain.
 - ~~7. Restoration of electrical lines temporarily removed for work.~~

PART 2 - PRODUCTS

2.01 MATERIALS

Materials required for this section shall be the same quality of materials that are to be restored. Where possible, the CONTRACTOR may use existing materials that are removed subject to the approval of the ENGINEER or OWNER'S AGENT.

PART 3 - EXECUTION

3.01 CLEANUP

- A. The CONTRACTOR shall remove all construction material, waste, buildings, equipment and other debris remaining on the project, except as otherwise specified, as a result of construction operations and shall restore the site of the Work to a neat and orderly condition.
- B. During the course of the Work, the CONTRACTOR shall keep the site of operations in as clean and neat a condition as is possible. CONTRACTOR shall dispose of all residuals resulting from the Work that are not otherwise re-used or replaced.
- C. At the completion of the Work, the CONTRACTOR shall:
1. Remove waste materials, rubbish, tools, equipment, machinery, and surplus materials.
 2. Remove grease, dust, stains, labels, and other deleterious or foreign materials from the Site.
 3. Repair, patch, and touch up marred or otherwise damaged surfaces.
 4. Prior to transferring the completed project, conduct an inspection of surfaces, and all Work areas, to verify that the areas affected by the Work have been restored toentire Site is in an OSHA-compliantorderly condition.
- D. In order to prevent environmental pollution arising from the construction activities related to the performance of this project, the CONTRACTOR and Subcontractors shall comply with all applicable federal, state and local laws and regulations concerning waste material disposal, as well as the specific requirements stated in this Section and elsewhere in these Specifications.
- E. The CONTRACTOR is advised that the disposal of excess excavated material in wetlands, stream corridors, and floodplains is strictly prohibited. Any violation of this restriction by the CONTRACTOR, or any Subcontractor or employee, will be brought to the immediate attention of the responsible regulatory agencies, with a request that appropriate action be taken against the offending parties. TheTherefore, the CONTRACTOR shallwill be required to remove the fill and restore the area impacted without additional cost to the OWNER/OWNER'S AGENT.

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MISCELLANEOUS WORK AND SITE CLEANUP

3.02 INCIDENTAL WORK

CONTRACTOR shall perform all incidental work not otherwise specified, but necessary ~~for~~ the proper completion of the Work as specified and as shown on the Drawings.

3.03 RESTORATION OF DISTURBED AREAS

The CONTRACTOR shall be responsible for restoring and stabilizing all disturbed areas prior to demobilizing from the site. Stabilization and restoration shall be conducted in accordance with the Drawings and Technical Specifications and shall ensure that sediment laden surface water will not enter drainageways, streams, rivers or other water conveyance systems.

3.04 RESTORING EASEMENTS AND RIGHT-OF-WAYS

Existing vegetated surfaces damaged by construction shall be replaced. The CONTRACTOR shall restore the areas with an equivalent depth and quality of loam, seed and fertilizer as necessary to produce a stand of grass at least equal to that existing prior to construction. These areas shall be maintained and re-seeded, if necessary, until the Work has been completed and accepted. Any additional Work required to restore property to the original condition shall be performed by the CONTRACTOR.

3.05 PROTECTION OF EXISTING UNDERGROUND AND ABOVEGROUND UTILITIES AND OTHER INFRASTRUCTURE

- A. Utilities (telephone, sewer, culverts, etc.) and other infrastructure may exist within, or adjacent to, the project area. These items shall be maintained and protected at all times. Locations of these items may or may not be shown on the Drawings. Prior to starting work the CONTRACTOR shall be responsible for identifying these items and providing proper protection; ~~barricades~~, such that the integrity is not compromised nor the daily operations of the facilities affected. Any damage to such facilities as a direct result of CONTRACTOR operations will be the sole responsibility of the CONTRACTOR to repair and/or replace at no cost to the OWNER/ OWNER'S AGENT.
- B. The CONTRACTOR shall cooperate with the OWNER/ OWNER'S AGENT, and other organizations; i.e., utility companies, and shall not allow plant or utility service to be disrupted or relocated without the permission of the ENGINEER or OWNER'S AGENT and the written permission of the utility owner.

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MISCELLANEOUS WORK AND SITE CLEANUP

- C. In the event that an existing structure or utility not already identified for relocation must be relocated in order to avoid a conflict with the Work, the CONTRACTOR shall notify the ENGINEER, OWNER'S AGENT and the OWNER promptly.

END OF SECTION

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CHAIN LINK FENCES AND GATES

grade.

- D. CONTRACTOR shall provide 6-foot nominal height fence with line posts not exceeding 10 feet, center-to-center.

CHAIN LINK FENCES AND GATES

- E. All posts shall be set plumb and in alignment in concrete floorings with top of footing a minimum of two inches above finished grade. Posts shall be set in concrete a minimum of 40 inches and top of concrete shall be sloped for water runoff. Concrete shall be thoroughly compacted as to be free of voids and finished in a dome. Concrete shall cure 3 days prior to installation of fabric. Straight runs between braced posts shall not exceed 500 feet.
- F. Each gate and corner post shall be braced back to adjacent line post with horizontal brace and rail and diagonal truss rods.
- G. Contractor shall furnish center and bottom brace rails on corner posts and gate leaves.
- H. Tension wire shall be used to secure the top of the fence except at gate locations, end posts, and corners.
- I. Bottom tension wire shall be installed before installing chain-link fabric and shall be pulled taut.
- J. Post caps shall be of the design as required to accommodate the top rail. Post caps shall be installed as recommended by the manufacturer.
- K. Supporting arms shall be of the design as required to accommodate the top rail. Supporting arms shall be installed as recommended by the manufacturer.
- L. Top rail shall be installed at all gate locations, end posts, and corners only before installing chain-link fabric and shall pass through intermediate post caps. Expansion coupling shall be provided and spaced a maximum of 100 feet on center.
- M. Fabric shall be placed two inches above finished grade and mechanically pulled taut and secured to the top rail or tension wire and bottom wire close to both sides of each post and at intervals of not more than 24 inches on center. Fabric shall be secured to line posts using ties at the top and bottom at intervals of not more than 15 inches. Fabric shall be secured to end, corner, pull, and gate posts for the full length by integrally weaving to fastening loops or by using stretcher bars and bands. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.
- N. Padlocks shall be furnished for gate openings and shall have chains that are securely attached to the gate or gate posts. Padlocks shall be keyed alike and five keys shall be provided by the CONTRACTOR to the ENGINEER or OWNER'S AGENT.

Notes:

1. Unless indicated otherwise, values shown are minimum average roll values (MARV) determined in accordance with ASTM D-4759. The row labeled MD represents results from testing the product in the machine direction. The row labeled XMD represents results from testing the product in the cross-machine (transverse) direction.
2. Nominal dimensions.
3. True resistance to elongation when initially subjected to a load determined in accordance with ASTM D-6637 without deforming test materials under load before measuring such resistance or employing “secant” or “offset” methods of tangent measurement so as to overstate tensile properties.
4. Load transfer capability determined in accordance with GRI-GG2-87 and expressed as a percentage of ultimate tensile strength.
5. Resistance to bending force determined in accordance with ASTM D-5732-95, using specimens of width two ribs wide, with transverse ribs cut flush with exterior edges of longitudinal ribs (as a “ladder”), and of length sufficiently long to enable measurement of the overhang dimension. The overall flexural stiffness is calculated as the square root of the product of MD and XMD flexural stiffness values.
6. Resistance to in-plane rotational movement measured by applying a 20 kg-cm (2m-N) moment to the central junction of a 9 inch x 9 inch specimen restrained at its perimeter in accordance with U.S. Army Corps of Engineers Methodology for measurements for torsional rigidity.
7. Resistance to loss of load capacity or structural integrity when subjected to mechanical installation stress in clayey sand (SC), well graded sand (SW), and crushed stone classified as poorly graded gravel (GP). The geogrid shall be sampled in accordance with ASTM D-5818 and load capacity shall be determined in accordance with ASTM D-6637.
8. Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments in accordance with EPA 9090 immersion testing.
9. Resistance to loss of load capacity or structural integrity when subjected to 500 hours of ultraviolet light and aggressive weathering in accordance with ASTM D-4355.

END OF SECTION

CHAIN LINK FENCES AND GATES

- O. Barbed Wire: Each extension arm shall carry three strands of barbed wire at an angle of 45 degrees, the upper strand 12 inches out from the fence line and 12 inches above the top of the fabric. Install three strands on the extension arms at the top of the fence and over gates. The extension arms shall be installed so that they are pointing to the exterior of the perimeter created by the fence.

3.02 TEMPORARY CHAIN LINK SECURITY FENCE

- A. Temporary, 6-foot high chain link security fence shall be provided, as necessary, to ensure a continuous, secure perimeter exists around the entire Site at all times.
- B. The temporary fence shall be securely connected to the existing fence so that the existing and temporary fences form a continuous barrier.

3.03 RELOCATION OF EXISTING CHAIN LINK SECURITY FENCE AND GATES

- A. The removal of existing fence designated for relocation or temporary removal shall be in accordance with the requirements hereinbefore specified for removal thereof. All fence materials to be reinstalled in the Work shall be jointly inspected by the CONTRACTOR and the ENGINEER or OWNER'S AGENT prior to dismantling or removal by the CONTRACTOR. An agreement briefly setting forth the current condition of the fence and gates to be reinstalled shall be prepared by the CONTRACTOR and signed by the CONTRACTOR and the ENGINEER or OWNER'S AGENT after the pre-construction walk-through.
- B. Reinstallation shall be as specified under paragraph 3.01 of this Section. The CONTRACTOR shall supply such new parts conforming to the requirements of this Section as are necessary to complete the installation of the relocated fences and gates.

3.04 GROUNDING

- A. Fence fabric shall be grounded at each site of every gate, at points 150 feet each side of overhead power-transmission lines, at intervals of every 1,000 to 1,500 feet of length when fences are located in isolated places, and every 500 to 750 feet when in close proximity (100 feet or less) to public roads, highways, and buildings. Fence shall be grounded at locations where the fence alignment changes more than 15 degrees.

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CHAIN LINK FENCES AND GATES

- B. Each fence post to be grounded shall be connected to a ground electrode consisting of a 3/4-inch diameter copper-dad steel ground rod 10 feet long, driven not less than 11 feet into the ground with rod located at the fence line or as near the fence line as is practical. Ground rods shall conform to UL 467. Connection of fence post to ground electrode shall be made below grade with not less than No. 4 AWG stranded-copper wire with TW insulation by approved clamp-type fitting of copper on fence post and electrode. Each gate panel shall be bonded with a flexible bond strap to its gate post.

END OF SECTION

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MISCELLANEOUS WORK AND SITE CLEANUP

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. CONTRACTOR shall furnish all labor, materials, equipment, and incidentals required to perform miscellaneous Work not specified in other Sections, but necessary for the proper completion of the Work as shown on the Drawings.
- B. When applicable, the CONTRACTOR shall perform the Work in accordance with other Sections of these Specifications. When no applicable specification exists, the CONTRACTOR shall perform the Work in accordance with established industry practice ~~and~~ or as directed by the ENGINEER or OWNER'S AGENT.
- C. The Work of this Section includes, but is not limited to, the following:
1. Cleanup.
 2. Incidental work.
 3. Restoration of disturbed areas.
 4. Restoring easement and right-of-ways.
 5. Temporary facilities.
 6. Protection of existing equipment, underground and aboveground utilities, including significant gas supply lines, monitoring wells, materials and structures that are designated to remain.
 - ~~7. Restoration of electrical lines temporarily removed for work.~~

PART 2 - PRODUCTS

2.01 MATERIALS

Materials required for this section shall be the same quality of materials that are to be restored. Where possible, the CONTRACTOR may use existing materials that are removed subject to the approval of the ENGINEER or OWNER'S AGENT.

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MISCELLANEOUS WORK AND SITE CLEANUP

PART 3 - EXECUTION

3.01 CLEANUP

- A. The CONTRACTOR shall remove all construction material, waste, buildings, equipment and other debris remaining on the project, except as otherwise specified, as a result of construction operations and shall restore the site of the Work to a neat and orderly condition.
- B. During the course of the Work, the CONTRACTOR shall keep the site of operations in as clean and neat a condition as is possible. CONTRACTOR shall dispose of all residuals resulting from the Work that are not otherwise re-used or replaced.
- C. At the completion of the Work, the CONTRACTOR shall:
1. Remove waste materials, rubbish, tools, equipment, machinery, and surplus materials.
 2. Remove grease, dust, stains, labels, and other deleterious or foreign materials from the Site.
 3. Repair, patch, and touch up marred or otherwise damaged surfaces.
 4. Prior to transferring the completed project, conduct an inspection of surfaces, and all Work areas, to verify that the [areas affected by the Work have been restored toentire Site is in an OSHA-compliantorderly](#) condition.
- D. In order to prevent environmental pollution arising from the construction activities related to the performance of this project, the CONTRACTOR and Subcontractors shall comply with all applicable federal, state and local laws and regulations concerning waste material disposal, as well as the specific requirements stated in this Section and elsewhere in these Specifications.
- E. The CONTRACTOR is advised that the disposal of excess excavated material in wetlands, stream corridors, and floodplains is strictly prohibited. Any violation of this restriction by the CONTRACTOR, or any Subcontractor or employee, will be brought to the immediate attention of the responsible regulatory agencies, with a request that appropriate action be taken against the offending parties. ~~The~~Therefore, the CONTRACTOR ~~shall~~~~will be required to~~ remove the fill and restore the area impacted without additional cost to the OWNER/OWNER'S AGENT.

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MISCELLANEOUS WORK AND SITE CLEANUP

3.02 INCIDENTAL WORK

CONTRACTOR shall perform all incidental work not otherwise specified, but necessary ~~for~~ the proper completion of the Work as specified and as shown on the Drawings.

3.03 RESTORATION OF DISTURBED AREAS

The CONTRACTOR shall be responsible for restoring and stabilizing all disturbed areas prior to demobilizing from the site. Stabilization and restoration shall be conducted in accordance with the Drawings and Technical Specifications and shall ensure that sediment laden surface water will not enter drainageways, streams, rivers or other water conveyance systems.

3.04 RESTORING EASEMENTS AND RIGHT-OF-WAYS

Existing vegetated surfaces damaged by construction shall be replaced. The CONTRACTOR shall restore the areas with an equivalent depth and quality of loam, seed and fertilizer as necessary to produce a stand of grass at least equal to that existing prior to construction. These areas shall be maintained and re-seeded, if necessary, until the Work has been completed and accepted. Any additional Work required to restore property to the original condition shall be performed by the CONTRACTOR.

3.05 PROTECTION OF EXISTING UNDERGROUND AND ABOVEGROUND UTILITIES AND OTHER INFRASTRUCTURE

- A. Utilities (telephone, sewer, culverts, etc.) and other infrastructure may exist within, or adjacent to, the project area. These items shall be maintained and protected at all times. Locations of these items may or may not be shown on the Drawings. Prior to starting work the CONTRACTOR shall be responsible for identifying these items and providing proper protection; ~~barricades~~, such that the integrity is not compromised nor the daily operations of the facilities affected. Any damage to such facilities as a direct result of CONTRACTOR operations will be the sole responsibility of the CONTRACTOR to repair and/or replace at no cost to the OWNER/ OWNER'S AGENT.
- B. The CONTRACTOR shall cooperate with the OWNER/ OWNER'S AGENT, and other organizations; i.e., utility companies, and shall not allow plant or utility service to be disrupted or relocated without the permission of the ENGINEER or OWNER'S AGENT and the written permission of the utility owner.

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MISCELLANEOUS WORK AND SITE CLEANUP

- C. In the event that an existing structure or utility not already identified for relocation must be relocated in order to avoid a conflict with the Work, the CONTRACTOR shall notify the ENGINEER, OWNER'S AGENT and the OWNER promptly.

END OF SECTION

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*02831 – Chain Link Fences and
Gates*

02831
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Work covered by this Section consists of installing a permanent, 6-foot high chain link security fence with three strands of barbed wire as required to replace the sections of fence that were removed to enable performance of the Work, as shown on the Drawings. Temporary, 6-foot high chain link security fence with three strands of barbed wire shall be provided, as necessary, to ensure a continuous, secure perimeter exists around the entire Site at all times.
- B. Portions of the existing fence will remain in place; some existing fence may need to be replaced due to the loss of integrity and functionality.
- C. The Work includes, but is not limited to, installing new fence posts, and appurtenances within the locations where the segment of fence is required to be removed. The new fence shall be connected to the existing fence to provide a continuous perimeter security fence following construction of the groundwater barrier wall. Additionally, signs containing the words “NO TRESPASSING” shall be installed on the new and existing fence at maximum 100 foot intervals.
- D. During Work, the perimeter of the entire Site shall be secure with existing fence and/or temporary fence at all times; barricades, building walls, and other temporary measures may be considered.

1.02 REFERENCES

- A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.):
 - RR-F-191K/GEN Fencing, Wire and Post Metal (and Gates, Chain Link Fence Fabric, and Accessories) (General Specification)
 - RR-F-19 1/1d Fencing, Wire and Post, Metal (Chain-Link Fence Fabric) (Detail Specification)
 - BR-F- 19 1/2d Fencing, Wire and Post, Metal (Chain-Link Fence Gates) (Detail Specification)
 - RR-F-19 1/3d Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces) (Detail Specification)
 - RR-F- 19 1/4d Fencing, Wire and Post, Metal (Chain-Link Fence Accessories) (Detail Specification)

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CHAIN LINK FENCES AND GATES

C. American Society for Testing and Materials (ASTM) Publications:

ASTM A 123	Zinc (Hot Galvanized) Coatings of Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strips.
ASTM F 567	Installation of Chain-Link Fence.
ASTM A 120	Pipe, Steel, Black and Hot-dipped Zinc-coated (Galvanized) welded and Seamless, for Ordinary Uses.
ASTM C 94	Ready-mixed Concrete.
ASTM B 429	Framework.
ASTM A 569	Steel Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial Quality.
ASTM A 570	Steel, Sheet & Strip, Carbon, Hot-Rolled Structural Quality.

D. Underwriters Laboratories (UL) Inc. Publication:

UL 467	Grounding and Bonding Equipment
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1.03 QUALITY CONTROL

- A. In accordance with Section 01400 – QUALITY CONTROL.
- B. Installation of the chain link fence shall be accomplished by an installation contractor, approved by the manufacturer, having a minimum of three (3) years experience in the satisfactory performance of similar work.

1.04 SUBMITTALS

- A. In accordance with Section 01300 – SUBMITTALS.
- B. Specific work history of the chain link fence installer shall be provided.
- C. The CONTRACTOR'S submittals shall include a plan layout; spacing of components; and a schedule of components.
- D. The CONTRACTOR shall submit manufacturer's installation instructions to the ENGINEER or OWNER'S AGENT a minimum of two (2) weeks prior to fence installation.

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CHAIN LINK FENCES AND GATES

PART 2 - PRODUCTS

2.01 GENERAL

- A. All new materials shall conform to Fed. Spec. RR-F-191 and detailed specifications forming the various parts thereto. Chain link security fence shall be constructed at the locations and alignment shown on the Drawings. All chain link security fence materials shall be the standard product of one manufacturer who is regularly engaged in the manufacture of chain link security fencing. Products which differ only in nonessential details from those specified herein will be acceptable. Drawings shall be submitted for any deviations to the ENGINEER or OWNER'S AGENT or its authorized representative.
- B. Delivery, Storage and Protection: Materials shall be delivered to the Site in an undamaged condition. Materials shall be carefully stored off the ground to provide proper protection against oxidation caused by ground contact.
- C. Storage and Protection of Existing Fence Materials: Materials obtained through the removal of existing chain link fence(s) to be reused shall be stored and protected as stated in paragraph B above. All materials stored for reuse shall be cleaned and recoated as necessary in accordance with the following specifications at the discretion of the ENGINEER or OWNER'S AGENT prior to storage.
- D. Temporary Fence: The temporary fence shall be 6-foot high, chain link fence that provides continuous security when abutted to the existing fence or other structures. The post shall be secured, i.e., in concrete or other means approved by the ENGINEER or OWNER'S AGENT.

2.02 POSTS, RAILS, AND BRACES

- A. Fed. Spec. RR-F- 191/3 galvanized steel, 1.8 ounce per square foot, except as modified herein.
- B. Post Braces and Truss Rods: For each gate, corner, pull or end post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment. Truss rods shall be 3/8 inch diameter.
- C. Intermediate Posts: C-section line posts of the same dimension as H-post, 0.120 inch wall thickness, and fabricated from steel conforming to ASTM A570, Grade 33 may be furnished in lieu of H- or round posts.

CHAIN LINK FENCES AND GATES

- D. Posts, Braces, Rails, and Gate Frames: Steel pipe manufactured from steel conforming to ASTM A 569, cold-rolled. Steel pipe shall be of the same external dimension and minimum wall thickness as Class 1 - steel pipe as listed in Fed. Spec. RR-F-191/3. Post, brace, nail and gate frame sizes shall be as indicated on the Drawings.
- E. Barbed Wire Support Arms: All posts shall be provided with pressed copper-bearing galvanized steel extension arms. All end posts shall be provided with heavy malleable iron extension arms. All extension arms shall be heavily coated with zinc by the hot-dip process. Each extension arm shall be sized to carry three strands of 12-1/2 GA, 4 PT, Class III barbed wire at an angle of 45 degrees, the upper strand 12 inches out from the fence line and 12 inches above the top of the fabric. Arms shall be the type that allow top rail to pass through their bases to form a continuous brace. Barbed wire arms shall be of sufficient strength to withstand a weight of 250 pounds applied at the outer or the top strand of barbed wire.
- F. Barbed Wire: Barbed wire shall be of the four-point pattern, composed of three strands of No. 12-1/2 gauge copper-bearing steel wire, Class III with large hard temper barbs spaced a maximum of 5 inches apart, and shall be heavily galvanized by the hot-dip process.

2.03 CHAIN-LINK FABRIC

- A. Fed. Spec. RR-F-191/1; Type I, 1.2 ounces per square foot coating, or Type II, 0.40 ounce per square foot coating, and shall be 9-gauge wire woven in a 2-inch mesh. Fabric width shall be as indicated.
- B. Attach fabric by method standard with the manufacturer, except that welding will not be permitted.

2.05 CONCRETE

- A. ASTM C 94, using 3/4 inch maximum-size aggregate, and having minimum compressive strength of 3,000 psi at 28 days.

2.06 COMPONENTS

- A. Top, bottom, and upright gate frame members shall be minimum 1 5/8-inch O.D. steel pipe.
- B. Fence fabric shall be 1.75-inch diamond mesh, galvanized steel wire, interwoven 9-gauge thick with top selvage twisted tight and bottom selvage knuckle and closed.

CHAIN LINK FENCES AND GATES

- C. Caps shall be galvanized steel sized to post dimension.
 - D. All sleeves, bands, clips, rail bends, tensions, bars, fasteners and fittings shall be galvanized steel.
 - E. Tension Wire shall have a minimum tensile strength of 75,000 psi, zinc-coated for use with zinc-coated fabric and aluminum coated for use with aluminum-coated fabric. Minimum weight of aluminum coating shall be 0.40 ounce of aluminum per square foot of wire.
 - F. Tie Wire shall be nine gauge galvanized steel wire for attaching fabric to rails, braces, and intermediate posts.
 - G. Hog Rings shall be nine gauge (minimum) galvanized steel wire for attaching fabric to bottom reinforcing wires.
 - H. Padlocks shall be Fed. Spec. FF-P-101, type EPB, 1-3/4-inch size, with chain. All padlocks shall be keyed alike.
- 2.07 FINISHES

- A. Frame components shall be galvanized at a rate of 1.8 ounces per square foot in accordance with ASTM A 123.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. CONTRACTOR shall install framework, fabric, gates, and accessories in accordance with ASTM F 567 and as shown on the Drawings.
- B. The fence shall be installed on previously prepared surfaces to line and grade indicated. Fence installation shall be as specified and in accordance with the fence manufacturer's written installation instructions.
- C. Excavation for concrete-embedded items shall be of the dimensions indicated. Post holes shall be cleared of loose materials. Spoil material shall be spread where directed by the ENGINEER or OWNER'S AGENT. The ground surface irregularities, along the fence line and in areas not being altered by area grading, shall be eliminated to the extent necessary to maintain a 2-inch clearance between the bottom of the fabric and finish grade.
- D. CONTRACTOR shall provide 6-foot nominal height fence with line posts not exceeding 10 feet, center-to-center.

CHAIN LINK FENCES AND GATES

- E. All posts shall be set plumb and in alignment in concrete floorings with top of footing a minimum of two inches above finished grade. Posts shall be set in concrete a minimum of 40 inches and top of concrete shall be sloped for water runoff. Concrete shall be thoroughly compacted as to be free of voids and finished in a dome. Concrete shall cure 3 days prior to installation of fabric. Straight runs between braced posts shall not exceed 500 feet.
- F. Each gate and corner post shall be braced back to adjacent line post with horizontal brace and rail and diagonal truss rods.
- G. Contractor shall furnish center and bottom brace rails on corner posts and gate leaves.
- H. Tension wire shall be used to secure the top of the fence except at gate locations, end posts, and corners.
- I. Bottom tension wire shall be installed before installing chain-link fabric and shall be pulled taut.
- J. Post caps shall be of the design as required to accommodate the top rail. Post caps shall be installed as recommended by the manufacturer.
- K. Supporting arms shall be of the design as required to accommodate the top rail. Supporting arms shall be installed as recommended by the manufacturer.
- L. Top rail shall be installed at all gate locations, end posts, and corners only before installing chain-link fabric and shall pass through intermediate post caps. Expansion coupling shall be provided and spaced a maximum of 100 feet on center.
- M. Fabric shall be placed two inches above finished grade and mechanically pulled taut and secured to the top rail or tension wire and bottom wire close to both sides of each post and at intervals of not more than 24 inches on center. Fabric shall be secured to line posts using ties at the top and bottom at intervals of not more than 15 inches. Fabric shall be secured to end, corner, pull, and gate posts for the full length by integrally weaving to fastening loops or by using stretcher bars and bands. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.
- N. Padlocks shall be furnished for gate openings and shall have chains that are securely attached to the gate or gate posts. Padlocks shall be keyed alike and five keys shall be provided by the CONTRACTOR to the ENGINEER or OWNER'S AGENT.

CHAIN LINK FENCES AND GATES

- O. Barbed Wire: Each extension arm shall carry three strands of barbed wire at an angle of 45 degrees, the upper strand 12 inches out from the fence line and 12 inches above the top of the fabric. Install three strands on the extension arms at the top of the fence and over gates. The extension arms shall be installed so that they are pointing to the exterior of the perimeter created by the fence.

3.02 TEMPORARY CHAIN LINK SECURITY FENCE

- A. Temporary, 6-foot high chain link security fence shall be provided, as necessary, to ensure a continuous, secure perimeter exists around the entire Site at all times.
- B. The temporary fence shall be securely connected to the existing fence so that the existing and temporary fences form a continuous barrier.

3.03 RELOCATION OF EXISTING CHAIN LINK SECURITY FENCE AND GATES

- A. The removal of existing fence designated for relocation or temporary removal shall be in accordance with the requirements hereinbefore specified for removal thereof. All fence materials to be reinstalled in the Work shall be jointly inspected by the CONTRACTOR and the ENGINEER or OWNER'S AGENT prior to dismantling or removal by the CONTRACTOR. An agreement briefly setting forth the current condition of the fence and gates to be reinstalled shall be prepared by the CONTRACTOR and signed by the CONTRACTOR and the ENGINEER or OWNER'S AGENT after the pre-construction walk-through.
- B. Reinstallation shall be as specified under paragraph 3.01 of this Section. The CONTRACTOR shall supply such new parts conforming to the requirements of this Section as are necessary to complete the installation of the relocated fences and gates.

3.04 GROUNDING

- A. Fence fabric shall be grounded at each site of every gate, at points 150 feet each side of overhead power-transmission lines, at intervals of every 1,000 to 1,500 feet of length when fences are located in isolated places, and every 500 to 750 feet when in close proximity (100 feet or less) to public roads, highways, and buildings. Fence shall be grounded at locations where the fence alignment changes more than 15 degrees.

CHAIN LINK FENCES AND GATES

- B. Each fence post to be grounded shall be connected to a ground electrode consisting of a 3/4-inch diameter copper-dad steel ground rod 10 feet long, driven not less than 11 feet into the ground with rod located at the fence line or as near the fence line as is practical. Ground rods shall conform to UL 467. Connection of fence post to ground electrode shall be made below grade with not less than No. 4 AWG stranded-copper wire with TW insulation by approved clamp-type fitting of copper on fence post and electrode. Each gate panel shall be bonded with a flexible bond strap to its gate post.

END OF SECTION

*02901 – Miscellaneous Work and
Site Cleanup*

02901
MISCELLANEOUS WORK AND SITE CLEANUP

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. CONTRACTOR shall furnish all labor, materials, equipment, and incidentals required to perform miscellaneous Work not specified in other Sections, but necessary for the proper completion of the Work as shown on the Drawings.
- B. When applicable, the CONTRACTOR shall perform the Work in accordance with other Sections of these Specifications. When no applicable specification exists, the CONTRACTOR shall perform the Work in accordance with established industry practice and/or as directed by the ENGINEER or OWNER'S AGENT.
- C. The Work of this Section includes, but is not limited to, the following:
 - 1. Cleanup.
 - 2. Incidental work.
 - 3. Restoration of disturbed areas.
 - 4. Restoring easement and right-of-ways.
 - 5. Temporary facilities.
 - 6. Protection of existing equipment, underground and aboveground utilities, including significant gas supply lines, monitoring wells, materials and structures that are designated to remain.
 - 7. Restoration of electrical lines temporarily removed for work.

PART 2 - PRODUCTS

2.01 MATERIALS

Materials required for this section shall be the same quality of materials that are to be restored. Where possible, the CONTRACTOR may use existing materials that are removed subject to the approval of the ENGINEER or OWNER'S AGENT.

PART 3 - EXECUTION

3.01 CLEANUP

- A. The CONTRACTOR shall remove all construction material, waste, buildings, equipment and other debris remaining on the project, except as otherwise specified, as a result of construction operations and shall restore the site of the Work to a neat and orderly condition.
- B. During the course of the Work, the CONTRACTOR shall keep the site of operations in as clean and neat a condition as is possible. CONTRACTOR shall dispose of all residuals resulting from the Work that are not otherwise re-used or replaced.
- C. At the completion of the Work, the CONTRACTOR shall:
 - 1. Remove waste materials, rubbish, tools, equipment, machinery, and surplus materials.
 - 2. Remove grease, dust, stains, labels, and other deleterious or foreign materials from the Site.
 - 3. Repair, patch, and touch up marred or otherwise damaged surfaces.
 - 4. Prior to transferring the completed project, conduct an inspection of surfaces, and all Work areas, to verify that the entire Site is in an orderly condition.
- D. In order to prevent environmental pollution arising from the construction activities related to the performance of this project, the CONTRACTOR and Subcontractors shall comply with all applicable federal, state and local laws and regulations concerning waste material disposal, as well as the specific requirements stated in this Section and elsewhere in these Specifications.
- E. The CONTRACTOR is advised that the disposal of excess excavated material in wetlands, stream corridors, and floodplains is strictly prohibited. Any violation of this restriction by the CONTRACTOR, or any Subcontractor or employee, will be brought to the immediate attention of the responsible regulatory agencies, with a request that appropriate action be taken against the offending parties. Therefore, the CONTRACTOR will be required to remove the fill and restore the area impacted without additional cost to the OWNER/OWNER'S AGENT.

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MISCELLANEOUS WORK AND SITE CLEANUP

3.02 INCIDENTAL WORK

CONTRACTOR shall perform all incidental work not otherwise specified, but necessary to the proper completion of the Work as specified and as shown on the Drawings.

3.03 RESTORATION OF DISTURBED AREAS

The CONTRACTOR shall be responsible for restoring and stabilizing all disturbed areas prior to demobilizing from the site. Stabilization and restoration shall be conducted in accordance with the Drawings and Technical Specifications and shall ensure that sediment laden surface water will not enter drainageways, streams, rivers or other conveyance systems.

3.04 RESTORING EASEMENTS AND RIGHT-OF-WAYS

Existing vegetated surfaces damaged by construction shall be replaced. The CONTRACTOR shall restore the areas with an equivalent depth and quality of loam, seed and fertilizer as necessary to produce a stand of grass at least equal to that existing prior to construction. These areas shall be maintained and re-seeded, if necessary, until the Work has been completed and accepted. Any additional Work required to restore property to the original condition shall be performed by the CONTRACTOR.

3.05 PROTECTION OF EXISTING UNDERGROUND AND ABOVEGROUND UTILITIES AND OTHER INFRASTRUCTURE

- A. Utilities (telephone, sewer, culverts, etc.) and other infrastructure may exist within, or adjacent to, the project area. These items shall be maintained and protected at all times. Locations of these items may or may not be shown on the Drawings. Prior to starting work the CONTRACTOR shall be responsible for identifying these items and providing proper protection; barricades, such that the integrity is not compromised nor the daily operations of the facilities affected. Any damage to such facilities as a direct result of CONTRACTOR operations will be the sole responsibility of the CONTRACTOR to repair and/or replace at no cost to the OWNER/ OWNER'S AGENT.

- B. The CONTRACTOR shall cooperate with the OWNER/ OWNER'S AGENT, and other organizations; i.e., utility companies, and shall not allow plant or utility service to be disrupted or relocated without the permission of the ENGINEER or OWNER'S AGENT and the written permission of the utility owner.

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MISCELLANEOUS WORK AND SITE CLEANUP

- C. In the event that an existing structure or utility not already identified for relocation must be relocated in order to avoid a conflict with the Work, the CONTRACTOR shall notify the ENGINEER, OWNER'S AGENT and the OWNER promptly.

END OF SECTION