

MacVicar, Federico & Lamb, Inc.

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To : Lake Belt Mitigation Committee
From : Tom MacVicar and Jeff Rosenfeld
on behalf of the Miami-Dade Limestone Products Association
Date : October 21, 2011
Subject: L-31N Seepage Barrier Project

At the September 30th Committee meeting, it was suggested that the Monitoring Plan be updated to include additional background monitoring wells and additional coring within the footprint of the proposed 2-mile barrier. Additional monitoring wells near the AVM-3 and AVM-4 locations (3 and 4 miles south of Tamiami Trail) and coring near the north end of the proposed barrier and 2000 feet south of the north end have been added to the attached Monitoring Plan and MDLPA additional costs estimate. This has added \$30,000 to the project cost.

The Design Engineer has developed the attached Scope of Work for the Project, which has been submitted to the SFWMD Engineering & Construction Bureau for review.

The current estimated cost for the proposed 2-mile, 35-foot deep seepage barrier construction:

| | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Geosolutions (Slurry wall construction, mobilization, site preparation/restoration, security) | \$5,405,000 |
| Chapman Pipeline Construction (trenching, mobilization) | \$1,190,000 |
| AMEC-BCI (Specifications/construction plans and field monitoring/inspection/testing services) | \$ 320,000 |
| MDLPA (Coordination, monitoring well and flowmeter stations, hydrologic monitoring, backfill material, transportation, and cone penetrometer testing) | <u>\$ 550,000</u> |
| Subtotal | \$7,465,000 |
| 5% construction contingency | <u>\$ 373,000</u> |
| Total project cost | \$7,838,000 |

In order to complete the construction during the coming dry season, the Miami-Dade Limestone Products Association requests that the Lake Belt Mitigation Committee (LBMC) approve the construction of a 2-mile, 35-foot deep seepage barrier on the west side of the L-31N Canal as Phase 1 in the implementation of the L-31N Seepage Control Project, and authorize 150 WRAP mitigation units.

October 21, 2011

L-31N Seepage Barrier Monitoring Plan

The modeling results indicate that there will be measurable changes in water level and L-31N canal flow with a 2-mile deep barrier. Due to the multiple variables that influence water level and flow, such as local rainfall, evaporation, and operation of the adjacent canal system, actual changes in the field attributed solely to the barrier may be difficult to quantify. This calls for a network of hydrologic data gathering sites to provide the necessary information to evaluate the performance of the barrier. As shown on the attached map, there is already an extensive USGS and SFWMD water level and canal flow monitoring network in the vicinity of the project with years of historical data. The existing network will be supplemented with new flowmeter stations in the L-31N and L-29 canals, 11 new shallow (Miami Limestone) monitoring wells located upgradient and downgradient of the barrier on the L-31N levee, and 3 new shallow (Miami Limestone) monitoring wells located south of the barrier on the L-31N levee for background water level information.

Existing monitoring network

1. L-31N Canal flowmeters - AVM-1, 3, 4, 5, and 7 (1 to 7 miles south of Tamiami Trail)
2. Upgradient monitoring wells in the vicinity of the 2-mile barrier – 3574, 3576, NESRS3, NESS20, and L31NN (4 well cluster)
3. Downgradient monitoring wells in the vicinity of the 2-mile barrier – Krome and 3559
4. Background upgradient monitoring wells – 3575, 3577, 3578, and L31NS (4 well cluster) – (all 2 miles south of project) and NESRS2 (3 miles west of the project)
5. Background downgradient monitoring wells – 3558, 3551, and 3552

Proposed supplemental drilling / monitoring locations

1. Additional geologic information – two 50' deep coreholes will be drilled at the north end and 2000 feet south of the north end of the proposed barrier.
 2. L-31N Canal flowmeters at Tamiami Trail and 2 miles downstream – the Tamiami Trail location will measure the upgradient canal flow at the north end of the barrier and the 2 mile location will measure the downgradient flow at the south end of the barrier.
 3. L-29 Canal flowmeter – will measure the flow in the L-29 Canal between the S334 structure and the L-31N Canal, to be able to determine if there is groundwater seepage into the L-29 Canal downstream of S334 as a result of construction of the barrier.
 4. 11 new shallow (Miami Limestone) monitoring wells located upgradient and downgradient of the barrier – six 11' deep wells will be drilled approximately 25' east of the barrier on the bench adjacent to the L-31N Canal. Five 19' deep wells will be drilled on top of the L-31N Levee approximately 25' west of the barrier. The wells will be drilled 1/3, 2/3, 1, 1 1/3, 1 2/3, and 2 miles south of Tamiami Trail. The L31NN cluster will provide the upgradient water level at the 1-mile location. Dataloggers will be installed in the wells.
 5. 3 new shallow (Miami Limestone) monitoring wells located south of the barrier at the AVM-3 and AVM-4 locations for background water level information – two 11' deep wells will be drilled approximately 25' east of the barrier on the bench adjacent to the L-31N Canal and one 19' deep well will be drilled on top of the L-31N Levee at the AVM-3 location. The L31NS cluster will provide the upgradient water level at the AVM-4 location. Dataloggers will be installed in the wells.
-

September 23, 2011

BCI Engineers & Scientists
1232 W. Indiantown Road
Suite 107
Jupiter, FL 33458
Attn: Les Bromwell

Phone: (561) 741-8838
Fax: (561) 741-8953

P-1147

Proposal
Seepage Barrier Demonstration II
Krome Avenue Site
Southwest Dade County, Florida

Gentlemen;

Geo-Solutions is pleased to present this proposal for the seepage barrier trench project utilizing and air lift. Our pricing is based on our discussions to date and the documents that we have from the previous demonstration project. The major scope items of the project include the following:

- Construction of a cement-bentonite (CB) slurry wall. The slurry wall will have a straight line configuration in plan view and be excavated in the existing CB trench. The wall will be of varying lengths ranging from 5,280 to 10,560 linear feet, extending to depths of 30 or 35 feet. In total, a range approximately 158,400 to 369,600 vertical square feet of cement-bentonite slurry wall will be constructed at a minimum width of 32 in. Prior to CB installation, the CB wall alignment will be trenched to a depth of 30 or 35 feet. The trencher will be under a separate subcontract to the owner. The spoils from the trenching operation will be placed back into the trench. After the trenching operation is completed, CB wall installation will begin. A modified CB mix will be used, having approximately 30% higher Cement and Bentonite to Water ratio than that which was used on the previous demonstration section to account for extra water in the loose backfill. Also, and air lift will be used to keep sediment from building up on the bottom of the trench. Trench spoils will be placed alongside the trenching operation within the reach of the excavator. GSI will load the spoils. Transportation and disposal will be the responsibility of others.
- Site preparation. There is some minor site preparation necessary in order to construct the barrier wall. This work will include stripping our work area to remove weeds, grass and other vegetative materials. Topsoil will be removed and stockpiled. Erosion and sedimentation controls will be installed as shown on the drawings.

- Former Trench Cleanout. The new trench alignment will pass through the old alignment. To avoid sawing through the old CB mix, we will dig that material out and replace it with sand prior to the sawing operation.
- Site Restoration. Site restoration will include loading out the trench spoils from the trench area and transporting them to the designated off-site disposal areas. All disturbed areas associated with our work will be restored to the initial grade and seeded. An 18-inch compacted topsoil cap will be installed above the CB barrier as indicated on the drawings. It is assumed that the volume of topsoil stockpiled from the stripping operation will be sufficient for the site restoration.
- Site Security. Site security will be provided during non-working hours and on weekends and holidays.

Scope of Work

Geo-Solutions will provide all labor, equipment and materials for the CB wall portions of the project.

Note we have made the following assumptions in pricing this work:

- The work can be done by non-union personnel without interference from organized labor. Prevailing or Davis Bacon wage rates will not apply to our workforce.
- A standard Cement-Bentonite slurry will be used. This will normally achieve a permeability in the range of 10-6 cm/sec. The expected Unconfined Compressive Strength (UCS) will normally be in the range of 10 to 20 psi.
- Our pricing includes 50 hydraulic conductivity and 50 UCS tests performed at a third party offsite testing laboratory.

Items to be Provided by the Owner

As the owner's representative, BCI will be responsible for providing the following work items, supplies, and permanent materials to accomplish the work. For your convenience, we have listed the primary items necessary to complete the work:

- All permits that may be required to accomplish the work.
- Access to the canal water for our mixing operations
- Transportation and disposal of the existing CB backfill and the trench spoils.
- Provision of sand fill as required to fill up the trench after digging up the old CB backfill.

Schedule

The schedule for the work is estimated to be about 11 weeks at 5 to 6 days per week for the 1 mile 30 foot deep CB wall construction, including mobilization, site preparation and site restoration. An efficient workday is usually 10 to 12 hours.

Pricing

GSI is proposing to do the construction at the following prices:

1 Mile @ 30 feet deep

Pricing is as stated below

| Bid Item | Item | Units | Quantity | Unit Price | Total |
|-----------------|-----------------------------|--------------|-----------------|-------------------|-----------------------|
| 1 | CB Slurry Wall Mobilization | LS | 1 | \$105,000.00 | \$ 105,000.00 |
| 2 | Pre-excavate old wall | LS | 1 | \$5,000.00 | \$ 5,000.00 |
| 3 | CB Slurry Wall Installation | SF | 158,400 | \$13.60 | \$ 2,154,240.00 |
| 4 | Site Preparation | LS | 1 | \$50,500.00 | \$ 50,500.00 |
| 5 | Site Restoration | LS | 1 | \$55,000.00 | \$ 55,000.00 |
| 6 | Site Security | WK | 11 | \$2,500.00 | \$ 27,500.00 |
| | | Total | | | \$2,397,240.00 |

1 Mile @ 35 feet deep

Add 26,400 sf @ \$13.60/sf to Base Price

| Bid Item | Item | Units | Quantity | Unit Price | Total |
|-----------------|-----------------------------|--------------|-----------------|-------------------|-----------------|
| 1 | CB Slurry Wall Mobilization | LS | 1 | \$105,000.00 | \$ 105,000.00 |
| 2 | Pre-excavate old wall | LS | 1 | \$5,000.00 | \$ 5,000.00 |
| 3 | CB Slurry Wall Installation | SF | 184,800 | \$13.60 | \$ 2,513,280.00 |
| 4 | Site Preparation | LS | 1 | \$50,500.00 | \$ 50,500.00 |

| | | | | | |
|---|------------------|--------------|----|-------------|------------------------|
| 5 | Site Restoration | LS | 1 | \$55,000.00 | \$ 55,000.00 |
| 6 | Site Security | WK | 13 | \$2,500.00 | \$ 32,500.00 |
| | | Total | | | \$ 2,761,280.00 |

1.5 Miles at 30 feet Add 79,200 sf @ \$13.60/sf and 50% More Site Prep and Restoration

| Bid Item | Item | Units | Quantity | Unit Price | Total |
|-----------------|-----------------------------|--------------|-----------------|-------------------|------------------------|
| 1 | CB Slurry Wall Mobilization | LS | 1 | \$105,000.00 | \$ 105,000.00 |
| 2 | Pre-excavate old wall | LS | 1 | \$5,000.00 | \$ 5,000.00 |
| 3 | CB Slurry Wall Installation | SF | 237,600 | \$13.60 | \$ 3,231,360.00 |
| 4 | Site Preparation | LS | 1 | \$75,750.00 | \$ 75,750.00 |
| 5 | Site Restoration | LS | 1 | \$82,500.00 | \$ 82,500.00 |
| 6 | Site Security | WK | 16 | \$2,500.00 | \$ 40,000.00 |
| | | Total | | | \$ 3,539,610.00 |

1.5 Miles at 35 feet Add 118,800 sf @ \$13.60/sf and 50% More Site Prep and Restoration

| Bid Item | Item | Units | Quantity | Unit Price | Total |
|-----------------|-----------------------------|--------------|-----------------|-------------------|------------------------|
| 1 | CB Slurry Wall Mobilization | LS | 1 | \$105,000.00 | \$ 105,000.00 |
| 2 | Pre-excavate old wall | LS | 1 | \$5,000.00 | \$ 5,000.00 |
| 3 | CB Slurry Wall Installation | SF | 277,200 | \$13.60 | \$ 3,769,920.00 |
| 4 | Site Preparation | LS | 1 | \$75,750.00 | \$ 75,750.00 |
| 5 | Site Restoration | LS | 1 | \$82,500.00 | \$ 82,500.00 |
| 6 | Site Security | WK | 17 | \$2,500.00 | \$ 42,500.00 |
| | | Total | | | \$ 4,080,670.00 |

2 Miles at 30 feet Add 158,400 sf @ \$13.60/sf and 100% More Site Prep and Restoration

| Bid Item | Item | Units | Quantity | Unit Price | Total |
|-----------------|-----------------------------|--------------|-----------------|-------------------|---------------|
| 1 | CB Slurry Wall Mobilization | LS | 1 | \$105,000.00 | \$ 105,000.00 |
| 2 | Pre-excavate old wall | LS | 1 | \$5,000.00 | \$ 5,000.00 |



| | | | | | |
|---|-----------------------------|--------------|---------|--------------|------------------------|
| 3 | CB Slurry Wall Installation | SF | 316,800 | \$13.60 | \$ 4,308,480.00 |
| 4 | Site Preparation | LS | 1 | \$101,000.00 | \$ 101,000.00 |
| 5 | Site Restoration | LS | 1 | \$110,000.00 | \$ 110,000.00 |
| 6 | Site Security | WK | 20 | \$2,500.00 | \$ 50,000.00 |
| | | Total | | | \$ 4,679,480.00 |

2 Miles at 35 feet Add 211,200 sf @ \$13.60/sf and 100% More Site Prep and Restoration

| Bid Item | Item | Units | Quantity | Unit Price | Total |
|-----------------|-----------------------------|--------------|-----------------|-------------------|------------------------|
| 1 | CB Slurry Wall Mobilization | LS | 1 | \$105,000.00 | \$ 105,000.00 |
| 2 | Pre-excavate old wall | LS | 1 | \$5,000.00 | \$ 5,000.00 |
| 3 | CB Slurry Wall Installation | SF | 369,600 | \$13.60 | \$ 5,026,560.00 |
| 4 | Site Preparation | LS | 1 | \$101,000.00 | \$ 101,000.00 |
| 5 | Site Restoration | LS | 1 | \$110,000.00 | \$ 110,000.00 |
| 6 | Site Security | WK | 23 | \$2,500.00 | \$ 57,500.00 |
| | | Total | | | \$ 5,405,060.00 |

Payment will be made for progress on initiation of Mobilization and for work in progress. Invoices will be presented at the end of each monthly billing period and will be due in 30 days. Pricing is valid for 30 days. Should bonding be required, this can be provided at additional cost.

Closing

We look forward to working with you on this project.

Sincerely,

Geo-Solutions Inc.

Robert M. Schindler

Robert M. Schindler
Vice President

September 30, 2011

Construction of a 2-mile 35-foot deep L-31N barrier project

AMEC-BCI cost estimate

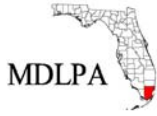
| | |
|----------------------------------|-----------------|
| 1. Engineering Design | \$ 23,000 |
| 2. Construction Services | \$ 284,000 |
| 3. As-built Report | \$ 7,000 |
| 3. Project Review and Evaluation | <u>\$ 6,000</u> |
| TOTAL | \$ 320,000 |

October 21, 2011

Construction of a 2-mile 35-foot deep L-31N barrier project

MDLPA - additional costs estimate

| | | |
|-------------------------------------------------------------------------|-----------|------------------|
| 1. Coordination, right-of-way permitting and evaluation (labor/mileage) | | \$ 51,000 |
| 2. Monitoring | | \$ 305,000 |
| Coring/Monitoring well abandonment/construction/dataloggers | \$101,000 | |
| Flowmeter stations/stream gauging | \$150,000 | |
| Data collection/surveying | \$ 54,000 | |
| 2. Backfill material (2500 cubic yards) | | \$ 42,000 |
| 3. Transportation (32,000 cubic yards) | | \$ 112,000 |
| 4. Cone penetrometer testing (four events) | | <u>\$ 40,000</u> |
| | TOTAL | \$ 550,000 |



SCOPE OF WORK

Construction of Phase 1 Cement-Bentonite Seepage Barrier L-31N Canal, Miami-Dade County Florida

Prepared on behalf of the Miami-Dade Limestone Products Association by
MacVicar, Federico & Lamb, Inc./AMEC-BCI Engineers & Scientists, Inc.

Background

A seepage barrier, consisting of a cement-bentonite (CB) slurry wall 2-miles long will be constructed in a 32-inch wide trench excavated to a depth of 35 feet below ground surface using a large chain-type trenching machine. After the trench is excavated, it will be backfilled with excavated sand and rock fragments (-4 inches maximum dimension). Using a track hoe, the trench will be re-excavated in panels and simultaneously backfilled with CB slurry prepared in a mixing plant and pumped to the trench location.

In order to ensure that the barrier is homogeneous and consistent throughout the full depth, an air lift pump will be utilized behind the track hoe to clean the bottom of the trench of any sediment. In addition, the CB mix will utilize approximately 35% more bentonite and cement than a conventional mix for similar geologic conditions. Further, the Quality Control/Quality Assurance program will be considerably more extensive than normally employed, involving closely-spaced probing of slurry depth, and frequent testing and sampling of the slurry to confirm that project specifications are met throughout the entire depth of the barrier wall.

The Project will be constructed and completed in accordance with the plans and specifications prepared by AMEC/BCI Engineers and Scientists, Inc. (Geotechnical Engineer), which are attached to this Scope of Work as **Appendices A and B**, respectively. The Owner of the Project is the Miami Dade Limestone Products Association, Inc. (MDLPA) and the Engineer of Record is MacVicar Federico & Lamb, Inc.

Compliance with SFWMD Right-Of-Way Permit

The project will be constructed adjacent to the L-31N levee, south of Tamiami Trail, on property owned by the South Florida Water Management District (SFWMD). A right-of-way permit will be obtained from SFWMD for access to the site to construct the Project. The permit is part of the plans and specifications for the Project, and the Contractor shall comply with all provisions of the permit.

General Test Description

Recent investigations by the U.S. Geological Survey documented the distinct layering within the Biscayne Aquifer, with highly conductive horizontal flow zones separated by much denser limestone strata. One of the high flow layers is the Miami Limestone, which makes up the top 10 to 15 feet of the aquifer. Other high flow zones exist in the underlying Fort Thompson formation. The upper layers of porous rock appear to transmit much of the water from the wetlands within the adjacent Everglades National Park (ENP) to the L-31N Canal.

The goal of the Phase 1 seepage barrier is to document, in the field, the performance of a partially penetrating flow barrier in reducing groundwater interception by the canal. The test will consist of constructing a flow barrier in a narrow trench excavated through the Miami Limestone and Upper Ft. Thompson formations of the aquifer just west of the L-31N Canal. The test barrier will start just south of Tamiami Trail (US Highway 41) and proceed south for two miles, as shown on the project plans.

Scope of Work

The rock formations will be excavated using an Austin Trencher Model AT-750 double chain trenching machine (or equivalent), modified to excavate up to 40 feet below ground surface. Specifications for the AT-750 are shown in **Appendix C**. As the 32-inch wide trench is excavated to a bottom depth of 35 feet, the sand and rock fragments will be discharged onto the work platform adjacent to the machine. A bulldozer following the trencher will backfill the trench with the excavated material.

The trench will be excavated by H.L. Chapman Pipeline Construction, Inc. of Leander, Texas. It will take approximately 3 months to excavate the 2-mile long trench along the center line of the wall alignment shown on the project plans.

The Trenching Contractor's Scope of Work includes the following items:

1. Coordinate with SFWMD regarding the General and Special Conditions of the Right-of-Way Permit.
2. Excavate Phase 1 trench 32 inches in width, 35 feet in depth, and 2 miles in length along the alignment staked by others.
3. Place excavated material on work platform adjacent to trench for utilization by CB Wall Contractor.
4. Perform all work in accordance with Project Plans and Specifications.

Construction of the CB slurry wall will follow closely behind the trenching operation, and will be completed in approximately 5 months; that is, 2 months after the trenching is complete. The CB wall contractor is Geo Solutions, Inc. of New Kensington, Pennsylvania.

The CB wall construction will utilize a track hoe to re-excavate the trench in progressive panels, which will be simultaneously backfilled with CB slurry prepared in a mixing plant

and pumped to the trench location. The CB slurry consists of a viscous mixture of Wyoming bentonite and Portland cement in water.

The CB wall construction will include several special procedures in order to ensure that the barrier is homogeneous and consistent throughout the full depth. It will include an air lift pump system on a trolley that will follow the track hoe and clean the bottom of the trench of any sediment. In addition, the CB mix will contain 117 lbs. bentonite and 364 lbs. cement per cubic yard of mix, which is approximately 35% more bentonite and cement than a conventional mix for similar geologic conditions.

Further, the Quality Control/Quality Assurance program will be considerably more extensive than normally employed, involving closely-spaced repeated probing of slurry depth, and frequent sampling and testing of the slurry to confirm that project specifications are met throughout the entire depth of the barrier wall. A description of the QA/QC Plan is in **Appendix D**.

A list of the major equipment items to be furnished by the CB wall contractor is provided in **Appendix E**.

The CB Wall Contractor's Scope of Work includes the following items:

1. Coordinate with SFWMD and Owner's Representative regarding the General and Special Conditions of the Right-of-Way Permit.
2. Implement safety and access controls.
3. Implement site security and fencing as needed.
4. Provide office space if needed by Contractors.
5. Install silt fences adjacent to the L-31N canal extending beyond the boundaries of the work area.
6. Grade and stabilize work platform and construct a runoff control berm adjacent to the silt fences.
7. Layout trench alignment and install survey controls.
8. Construct CB slurry wall in accordance with plans and specifications.
9. Implement and maintain the required Quality Control Program throughout construction.
10. Load haul trucks for disposal of excess soils, slurry materials, empty bags, and other wastes.
11. Cleanup and restore all work areas.
12. Grade and re-vegetate site in accordance with plans and specifications.
13. Complete an as-built survey of the slurry wall alignment, including major project features.

Scope of Work
Construction of Phase 1 Cement-Bentonite Seepage Barrier
L-31N

The Owner will provide the following items to facilitate the work:

1. Permits required to access and utilize the site
2. Access to water from adjacent canal
3. Portland cement for CB slurry, delivered and blown into Contractor's silo.
4. Engineering Representative and Full-time Technician to implement and maintain Quality Assurance Program and to conduct additional sampling and testing.



MIAMI-DADE LIMESTONE PRODUCTS ASSOCIATION
13292 N.W. 118th Avenue
Miami, FL 33178

October 2011

APPENDIX A
PROJECT CONSTRUCTION PLANS
(sent under separate cover)

Scope of Work
Construction of Phase 1 Cement-Bentonite Seepage Barrier
L-31N

APPENDIX B

PROJECT SPECIFICATIONS

**TECHNICAL SPECIFICATIONS
L-31N SEEPAGE CONTROL PROJECT PHASE 1
CEMENT-BENTONITE SLURRY WALL**

1.0 GENERAL

This Specification describes requirements for the construction of a Cement-Bentonite (CB) Slurry Trench Seepage Barrier (also termed CB wall) and related work, as indicated on the plans and project drawings and as hereinafter specified. The work consists of furnishing all labor, equipment, materials, and means of performing all operations, as required, for installing a CB wall. All references to the "Contractor" or "he" in this document refer to the company that will perform the operations for installing the CB wall.

The CB wall will have a minimum width of 32 inches and a minimum depth of 35 feet below ground surface as indicated on the plans and project drawings. The completed CB wall is intended to provide a partial barrier to groundwater and will have a permeability in the 10^{-6} cm/sec range and a minimum 28-day unconfined compressive strength (UCS) of 10 psi.

The CB wall will be constructed within a trench previously excavated in rock to the specified depth by others using an Austin Trencher Model AT 750 or equivalent mechanical drive chain trencher. The excavated trench will be backfilled to approximately ground surface using material excavated by the Trencher. The CB wall construction will involve re-excavation of the backfilled trench with simultaneous placement of CB slurry, as shown in the plans and project drawings and described in this specification.

Due to unique site conditions, and the importance of achieving satisfactory performance of the seepage barrier, Quality Control and Quality Assurance monitoring and testing will be exceptionally extensive and thorough.

The site is adjacent to Everglades National Park, which is a national treasure and extremely environmentally sensitive. Precautions must be taken to avoid any on-site or off-site contamination. All areas disturbed by construction activities must be restored to pre-construction conditions.

1.1. Qualifications

The person responsible for the supervision and quality control of the CB slurry wall construction is designated as the CB Specialist. The CB Specialist shall be knowledgeable in all phases of CB wall construction including testing, inspection, quality control, and recordkeeping, and shall possess a minimum of five years experience including a minimum of five projects of similar size and scope, or larger. In particular, the CB Specialist shall be familiar with the means and methods to perform the following: controlling composition, mixing, placing, cleaning, and maintaining slurry; supervising alignment and depth of slurry trenches; controlling mixing and placement of CB backfill, including backhoe operation and use of air lift pump. The CB Specialist shall be on the Site at all times during slurry trenching/backfill operations.

1.2. Characterization of Overburden Materials and Buried Utilities

A description of the typical strata through which the CB slurry wall is to be excavated is indicated by boring logs included in the plans and project drawings. In general, the slurry wall shall extend through the overburden and rock to a depth of 35 feet, which will penetrate lower permeability strata underlying the shallow Miami Oolite formation, as indicated in the plans and project drawings.

The CB wall is not expected to encounter buried utilities. Any known buried utilities will be identified by others prior to initial trenching by the Trenching operation, and any conflicts resolved prior to the start of CB work.

1.3. Reference Standards

Following is a list of standards, which will be referenced in this specification. Such referenced standards shall be considered part of this specification as if fully presented herein.

| <u>REFERENCE</u> | <u>TITLE OR DESCRIPTION</u> |
|------------------|-------------------------------------------------------------------------------------------------------|
| API Spec 13A | Specification for Drilling-Fluid Materials |
| API RP 13B-1 | Recommended Practice Standard Procedure for Field Testing Water-Based Drilling Fluids |
| ASTM C 150 | Standard Specification for Portland Cement |
| ASTM D 1633 | Compressive Strength of Molded Soil-Cement Cylinders |
| ASTM D 4380 | Density of Bentonite Slurries |
| ASTM D 4832 | Preparation and Testing of Controlled Low Strength Material Test Cylinders |
| ASTM D 5084 | Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter |

1.4. Submittals

- A. Qualifications – The Contractor shall submit evidence that he is experienced and competent to construct a cement-bentonite slurry trench. The specialty slurry wall contractor shall have at least five years of prior experience in successful CB wall projects of similar size or larger.

The submittal shall include the qualifications of the CB Specialist who will supervise the construction, slurry preparation, and quality control, documenting at least five years of experience and at least five successful CB wall projects of similar size or larger during the past fifteen years.

The company name, key contact, and qualifications of the Contractor's Laboratory shall also be submitted. The laboratory shall have previous experience with CB slurry

- wall materials, experienced laboratory technicians, and permeability testing equipment meeting ASTM Standard D 5084.
- B. CB Design Mix – At least two weeks prior to construction, the Contractor shall submit proportions and properties of the proposed CB design mix including cement, bentonite, additives, and water proportions; viscosity, density, Unconfined Compressive Strength, and permeability to the Owner’s Representative for review and approval. A new project-specific laboratory design mix program is required. The Contractor shall also perform a laboratory-scale test to verify that the mix will meet the strength and permeability requirements of this Specification following dilution by a flowable sand/gravel slurry having a volume equal to 20% of the CB volume.
 - C. Record Documents – Within thirty days after completing all field activities, Contractor shall submit a final report detailing mix proportions, testing data, daily logs, and all quality control records as specified herein.

The results of at least five laboratory tests shall be submitted demonstrating that the installed CB wall provides an Unconfined Compressive Strength within the range of 10 to 50 psi and a maximum permeability of 5×10^{-6} cm/sec.

- D. Record Drawing – The Owner’s Representative will make necessary surveys and measurements for “as-built” record drawings showing the actual depths and location of barrier wall together with any supplementary details at direction changes and other information as may be required to fully describe the installed Works.

2.0 CEMENT BENTONITE SLURRY

2.1 Materials

- A. All materials used in the CB slurry wall will be subject to prior approval by the Owner’s Representative. Owner, at his option, may provide suitable equipment and materials for Contractor’s use.
- B. Bentonite – Pulverized natural Wyoming sodium montmorillonite clay complying with American Petroleum Institute Specification API 13A, Section 9, 2004 edition.
- C. Cement – ASTM C 150 Portland Type I or Type I-II and/or ASTM C 989 Ground Granular Blast Furnace Slag Grade 120 or a mixture of both.
- D. Water – Water shall be clean, fresh, and free from excessive oil, acid, organic matter, or other deleterious substances. At the Contractor’s option, water may be obtained from the adjacent L-31N canal, provided water quality requirements are met.

E. Additives –

- Additives of any kind must be approved by the Owner’s Representative.
- Common water treatment additives may be used to correct water quality or enhance bentonite hydration and mixing. These additives may include soda ash, lime, or alum.
- Admixtures of softening agents, dispersants, retarders, or plugging or bridging agents may be added to the water or the slurry to permit efficient use of bentonite and proper workability of the cement-bentonite slurry.
- Retarders, thinners, and accelerators may be used to correct specific problems.
- Peptizing or bulking agents will not be permitted for mixing with slurry.

2.2 Delivery, Storage and Handling of Materials

- A. Contractor shall make all arrangements for transportation, delivery, and handling of materials required for execution and completion of the CB wall. Owner, at his option, may provide equipment and materials for Contractor’s use.
- B. Materials shall be protected from moisture, spillage, and deterioration during transit to and storage at the Site.
- C. For each shipment of materials, Contractor shall provide written certification of compliance from the manufacturer verifying that the materials meet the requirements of this Specification. Supplier’s certified weight of each delivery of materials shall also be provided.
- D. Any materials not meeting this Specification shall be promptly removed from the Site, and replaced with materials conforming to these requirements.

2.3 Mixtures

The proportions of the CB slurry shall be supervised by the Specialist. The Specialist may alter the proportions of the ingredients for workability or to provide greater strength where needed. The CB slurry shall harden to a material with the specified strength and permeability.

2.4 Panel Construction

CB wall construction is completed in discrete sections of backfilled trench known as panels. A portion of the CB slurry that hardens in the trench creates a vertical panel and the joined panels create the completed barrier wall. In general, each day’s work, or separate portions of the day’s work, may be considered a panel. Successful panel construction relies upon the proper placement of the CB slurry. The proper placement of CB slurry in panel construction includes the following:

- A. Panel Construction – The slurry trench may be extended by alternating panels, by continuous excavation, or by a combination thereof provided the overlap requirements are met.
- B. Overlaps – Panels are joined by excavating new panels into previously constructed panels, which is termed an overlap. Overlaps are generally limited to a distance of 2 feet as measured along the bottom of the slurry trench. Newly constructed panels shall not be disturbed, except for the jointing, topping-off, or capping, until the panel has hardened for a minimum of three days and demonstrates cement hydration. Untimely disturbing of a new panel may cause the panel to fail to harden properly.
- C. Topping Off – It is normal for the surface of the CB panel to shrink, settle, bleed, and crack as it hardens. Shrinkage and bleed shall not be greater than 10%, and cracking shall not extend to a depth exceeding 1 foot. After the CB has hardened, the panel shall be completed by filling with fresh CB. After final filling, the CB shall be covered and capped as shown in the project drawings in order to prevent desiccation and damage.
- D. Overbreak – The CB slurry will fill voids in the trench walls, grout soil pores, and fill the trench. In addition, CB slurry will be wasted in creating overlaps and by normal spillage. The volume of CB used, compared to the neat volume of the trench, shall be calculated daily. The excess volume, known as the overbreak, shall be monitored by the CB Specialist to ensure quality control, minimize waste, and avoid environmental impact.

3.0 EXECUTION

3.1 Equipment Requirements

- A. The CB wall will be constructed by continuous excavation to the extent practical. If alternating panels are constructed, they shall be tied together by overlap into adjacent previously constructed panels to provide a continuous watertight barrier.
- B. Trench Excavation Equipment – A hydraulic excavator or backhoe shall be used for excavation. The design of the bucket shall maintain the specified width of the trench and minimize raveling of the trench sides during use. Equipment shall be capable of excavating the minimum required width in a single pass.
- C. Slurry Mixing and Placing Equipment.
 - Colloidal Mixer – A high-speed/high-shear colloidal mixer or high-velocity/high-pressure venturi jet mixer shall be used in conjunction with a high speed/high-shear centrifugal pump. The pump may be dedicated to mixing and/or can be used to mix and deliver CB slurry to the trench.
 - Colloidal Mix Tank – The mix tank shall be equipped with a mechanically or hydraulically agitated sump including vanes, valves, hoses, and other equipment as required to prepare slurry mixtures.

- Slurry shall not be prepared or mixed in the trench.
 - CB slurry that has been in the mixer for more than three hours shall be wasted and not used for trench fill.
- D. Field Laboratory Equipment – The following equipment shall be provided:
- Marsh funnel and cup.
 - Mud balance (direct reading of density).
 - Slurry sampler (backhoe bucket may be used).
 - Cylinders to mold laboratory samples (2 inches diameter x 12 inches long).
 - Water test kit including hardness, pH and alkalinity.
- E. Trench Bottom Preparation Equipment – After the final pass of the excavator bucket at each location, the trench bottom will be cleaned using an appropriate air lift pump. If loose sediments are detected after passage of the air lift pump, additional excavating and pumping will be conducted until the trench bottom is clean of sediment.

3.2 Working Platform

The slurry trench shall be installed from a prepared, level, and stable surface. The purpose of the working platform is to support the excavation and to ensure access for proper measuring and quality control of the work. The working platform shall be maintained in a condition that minimizes the potential for loose soils or debris falling into the completed trench.

The cement-bentonite wall will be installed from the working platform, which will be adjacent to the centerline of the trench excavated by others on the lines and grades shown on the project drawings.

3.3 Slurry Trench Excavation

- A. Excavate the backfilled trench a continuous 32-inch minimum width trench to a minimum depth of 35 feet at all points along the centerline of the excavation. Excavate the slurry trench from the working platform by the slurry method.
- B. Maintain trench full of slurry for trench support. Do not excavate below the groundwater table without slurry.
- C. Excavation shall proceed in panels. CB slurry shall be introduced into the trench during trenching and slurry shall be maintained in the trench during excavation.
- D. Maintain the stability of the excavated trench at all times for the full depth.
- E. Slurry shall always be at least 2 feet above groundwater level and not more than 3 feet below the top of trench during excavation.

- F. Once the CB mix is introduced into the trench, excavation shall be continuous. If excavation is delayed for more than two hours, agitate the panel by other means or incorporate additives to prevent the slurry from setting. If slurry in the trench begins to set or becomes unworkable before excavation is completed, terminate the panel. Do not add water to the slurry in the trench. CB slurry that does not set shall be removed and replaced.
- G. When a trench segment is extended, and the slurry in the previously excavated trench has taken an initial set, the excavation shall extend into the previously excavated trench to provide a minimum overlap distance of 2 feet at the bottom of the trench.
- H. Take precautionary measures necessary to minimize damage to the work from groundwater and surface runoff water.
- I. Maintain the cement-bentonite slurry at all times in a condition that meets the requirements of this Specification. Provide constant circulation for any slurry that is not pumped directly to the trench.

3.4 Trench Bottom Treatment

- A. After the final pass of the excavator bucket at each location, the trench bottom will be cleaned using an appropriate air lift pump. The air lift pump shall follow as close as practical behind the excavator bucket. The air lift pump shall discharge at the top of the slurry, at a location and depth readily accessible for observation and sampling.
- B. The volume displaced by the air lift pump shall be sufficient to maintain the bottom of the trench free from sand and gravel sediment.
- C. The Contractor shall sound the trench at 10-foot intervals behind the air lift pump using a weighted tape to determine the depth of the slurry. If the sounding indicates inadequate excavation or sedimentation of sand/gravel, additional excavation and air lift pumping shall be conducted until the sounding indicates full depth of CB slurry.
- D. If sand/gravel sediment is detected at the bottom of the trench after passage of the air lift pump, the viscosity and density of the CB slurry will be measured at the discharge of the air lift pump and increased as necessary using additional cement and bentonite.
- E. At any location where sand/gravel sediment is detected, excavation shall not proceed until uniform slurry with entrained sand/gravel is determined to exist from top to bottom of the trench.
- F. As the excavation proceeds, soundings at 10-foot spacing shall be repeated at every 50-foot interval, starting at the beginning of the 50-foot interval. All depth soundings shall be recorded and compared with subsequent soundings.

- G. If any of the repeat soundings indicate sedimentation of sand/gravel greater than 3 inches, a sample will be taken at the bottom of the trench using an appropriate thief or piston sediment sampler. Based on the appearance and viscosity of the sample, the Owner's Representative will determine if the sample exhibits satisfactory slurry behavior or whether additional excavation or air pump operation is required. All such samples taken shall be photographed and placed in a 2-inch diameter sample mold for laboratory testing.
- H. The final depth of the CB wall shall be measured and checked by the Contractor and approved by the Owner's Representative following excavation. Unless otherwise directed, the bottom of the slurry trench will be the minimum depth of excavation by the trenching machine.

3.5 Trench Top Treatment

After initial hardening of the CB grout, the top of the completed trench shall be checked for free water or surface depressions. Any free water and cracked CB material shall be removed and the trench filled with fresh CB slurry to the elevation specified in the project drawings. Following initial set of this additional CB grout, the top of the trench shall be protected to prevent drying of the slurry with a cap of hand-compacted soil placed in 6-inch maximum loose lifts to original ground level and compacted to a minimum 90% of standard Proctor density.

3.6 Cleanup

- A. Material excavated from the trench shall be disposed of in designated off-site disposal areas by others. The Contractor shall be responsible for loading the excess material onto haul trucks in a suitable condition for over-the-road transport. After completion of the CB wall, the work areas shall be cleared of excess slurry and excavated materials, and graded to restore the original topography.
- B. Prior to demobilizing, all wastes and excess materials and equipment shall be removed and all disturbed surface areas restored to original condition. Disturbed areas shall be grassed as shown on the project drawings.

3.7 Environmental Requirements

- A. Erosion and sedimentation controls shall be placed as shown on the project drawings. If additional controls are needed to prevent damage or runoff to surrounding areas, they shall be provided by the Contractor.
- B. Dust and particulate emissions during construction shall be controlled in accordance with local and Federal laws.
- C. Any spills or releases, whether on-site or off-site, shall be immediately reported to the Owner's Representative. Any emergency actions required to minimize potential damage or impacts shall be immediately initiated by the Contractor.

- D. Until project completion and demobilization, the installed barrier wall shall be protected from damage caused by equipment, vehicles, and other possible damaging influences.

4.0 QUALITY CONTROL

Quality control shall be the primary responsibility of the CB Specialist. The Specialist shall perform or supervise all operations, measurements, and tests. The Specialist shall prepare and maintain detailed records of the mixes, materials, tests, and excavation soundings. A summary of the required tests is shown in **Table 1**. The primary aspects of Quality Control include the following:

- A. Maintain project quality control and quality control records. Perform quality control observations, measurements, and tests described in this Specification. Make quality control records, routine testing procedures, inspections, observations, and measurements. Quality Control testing methods and frequencies are shown in **Table 1**.
- B. Obtain Certificate of Compliance from the material manufacturer for bentonite and cement.
- C. Measure the viscosity, pH, and density of the bentonite slurry each day, and each time the configuration of the plant is modified.
- D. Measure the density of the cement-bentonite slurry at least four times per shift and any time sedimented sand/gravel is detected.
- E. Measure the pH and the temperature of the cement-bentonite slurry at least once per shift.
- F. Make molded samples of the fluid cement-bentonite slurry from the trench, two for each 100 lf of trench. The samples shall be properly cured and stored. One set of samples shall be delivered to the Owner's Representative. Any samples not destructively tested by the Contractor shall be retained for a minimum of ninety days. Additional samples that may be requested by the Owner's Representative shall be provided by the Contractor.
- G. Excavation soundings shall be taken and recorded along the trench centerline at frequencies no greater than 10 feet apart, using a weighted tape, cable, or other suitable measuring device. Contractor shall place and maintain stakes, or other suitable reference points, at 20-foot intervals adjacent to trench, clearly indicating station and reference elevation on the stakes.

H. Records – Contractor shall maintain records for testing, measurements, and inspections performed to ascertain that the CB barrier wall construction meets the requirements of the Plans and Specifications. Contractor shall furnish reports, records, and documentation to Owner’s Representative on a weekly basis during construction. Contractor shall maintain the following records:

- As-built profile of the trench bottom, including descriptions of typical materials encountered in the excavation, as determined from soundings.
- Results of construction control testing required by this Specification, including water tests, slurry tests, strength, and permeability tests. Records of observations, measurements, and tests shall be identified by Station No.
- Bentonite slurry and cement-bentonite grout mix quantities, and proportions of additives utilized, if any. Report any adjustments made to slurry mixes.
- Construction log of daily activities including delays encountered during construction, causes of delays, locations of affected areas, and extent of delays. Record unusual conditions or problems encountered and the dispositions made.

Table 1: Cement - Bentonite Slurry Trench Quality Control Testing Plan

| Property | Requirement | Minimum Test Frequency | Test Method | Comment |
|---------------------------------|-------------------------------|------------------------|--------------------------|----------------------------------------------|
| Bentonite Powder | | | | |
| a. Certification | By Manufacturer | 1 per shipment | API 13A | Wyoming type (90 bbl/ton) |
| Cement Powder | | | | |
| a. Certification | By Manufacturer | 1 per shipment | ASTM C 150 ASTM C 989 | Portland Type I or I-II GG BFS Grade 120I |
| Water for Slurry Mixing | | | | |
| a. pH | 6 to 9 | 1 per source | Hach Kit | Site Source |
| b. Hardness | < 250 ppm | 1 per source | Hach Kit | |
| c. Alkalinity | < 250 ppm | 1 per source | Hach Kit | |
| d. Total Dissolved Solids | < 1500 ppm | 1 per source | Hach Kit | |
| Initial Bentonite Slurry | | | | |
| a. Viscosity | > 30 sec. | 1 per shift | API RP 13B-1 | Each AM prior to Production |
| b. Density | > 1.025 gm/cc | 1 per shift | API RP 13B-1 | |
| c. pH of Slurry | > 7.5 | 1 per shift | Hach Kit | |
| d. Bentonite content | B/W > 4% | 1 per batch | Record | Batch records |
| Cement-Bentonite Slurry | | | | |
| a. Density | > 1.12 gm/cc | 4 per shift | API RP 13B-1 | |
| b. Viscosity | Record | 2 per shift | API RP 13B-1 | |
| c. pH of Grout | > 10 | 1 per shift | Hach Kit | |
| d. Temperature of Grout | Record | 1 per shift | Thermometer | |
| e. Cement content | C/W > 15% | 1 per batch | Record | Batch records |
| Hardened CB Grout | | | | |
| a. Samples | Archive 90 days | 1 per 100 ft | ASTM D4832 | Backup |
| b. Bleed | < 10% | 1 per shift | ASTM C292 | Before top off |
| c. Permeability | < 9 x 10 ⁻⁶ cm/sec | 1 per 100 lf | ASTM D5084 | |
| d. UCS | Min. 10 psi | 1 per 100 lf | ASTM D1633 | |

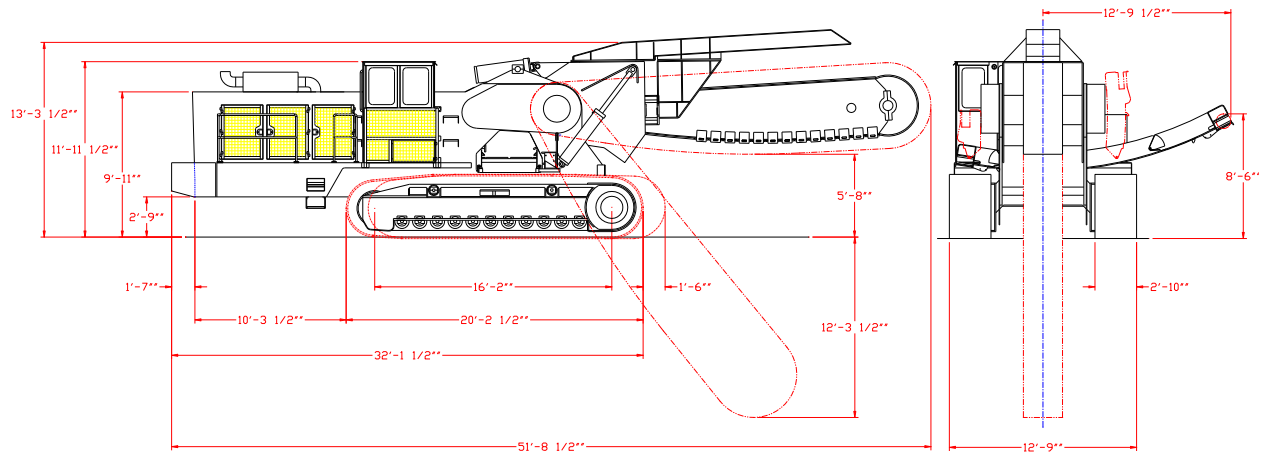
END OF SPECIFICATION

Scope of Work
Construction of Phase 1 Cement-Bentonite Seepage Barrier
L-31N

APPENDIX C
AT-750 TRENCHING MACHINE SPECIFICATIONS

AUSTIN TRENCHER INCORPORATED

9250 F.M. 2243 LEANDER, TX. 78641 PH.(512) 259-7662 FAX (512) 259-7870



AUSTIN TRENCHER MODEL AT-750 SPECIFICATIONS

APPROXIMATE WEIGHT: 260,000 - 280,000 lbs.

DIGGING CAPACITIES: Widths of 16" - 24" with a single chain; 26" - 46" with double chains; and 48" - 62" with triple chains. Depths can be up to 30 ft. depending on digging width and conditions.

ENGINE: Caterpillar 3412 direct injected, turbocharged and aftercooled diesel, rated at 800 horsepower at 2100 rpm. Fuel consumption is approximately 25 to 30 gallons per hour during normal operation. Exhaust is equipped with muffler and rain cap. Engine and transmission module is attached to the mainframe at three points, on rubber mounts for vibration and torsion resistance.

AIR CLEANERS: Two, high capacity air cleaner units are used, containing both primary and safety elements. Elements are easily accessible through the engine compartment side doors for service. Turbo II pre-cleaners are also provided to extend filter element life. All air intake tubing joints are double clamped for extra protection from dust.

ENGINE COOLING SYSTEM: High capacity radiator with 54" engine driven, blower fan. The cooling system is adequate up to approximately

125 degree ambient temperature. Radiator core tubes are individually mounted for easy field repair. Front grille is hinged for easy access to radiator for cleaning or repair.

FUEL TANKS: Two fuel tanks are provided with a total capacity of 725 gallons.

CRAWLER TRACKS: Caterpillar components are used and mounted to fabricated steel frames. Adjusters are grease cylinder type with high capacity springs to reduce sprocket jumping. Track frames are detachable for transport or repair, and have two mounting positions for better machine balance when using various types of digging booms.

TRACK DRIVE: Tracks are independent hydrostatically driven through rotating housing type planetary gearboxes. Hydraulically shifted, two speed hydraulic motors are used to provide a high speed of 1.2 mph for tramping and low speeds from 0 to 40 feet per minute for digging. Gearboxes contain automatically applied brakes for parking or emergency use. No roller chains are used.

OPERATORS CAB: Cab is fully enclosed, climate controlled, and contains all controls necessary for machine operation. Windows behind and to the

side of the operator swing open for ventilation if required. Cab elevates hydraulically up to 42", and is fully insulated for noise reduction. The high backed operators seat has folding arm rests, is adjustable up and down, forward and backward, and swivels for operator comfort and increased visibility.

COUNTERWEIGHT: Extendible counterweight is attached to the front of the machine to maintain stability when the boom is in the raised position. The weight is approximately 13,000 lbs. and hydraulically extends out 48".

HYDRAULIC SYSTEM: Closed loop hydrostatic transmissions operate the tracks and conveyor, open loop gear type systems operate all other functions. The hydraulic oil reservoir is mounted to the side of the machine and has a capacity of 220 gallons. A side mounted oil cooler with a hydraulically driven fan provides adequate cooling.

CONVEYOR: A 42" width, belt conveyor with an arched frame is used to discharge the spoil. The conveyor frame is shiftable from side to side and the belt is reversible. Solid, low friction slide material is used to support the belt. No bearings are used except on the end rollers. The frame consists of a center section with folding extensions on each end. Both long and short extensions are available for various spoil placement or overall width requirements. The conveyor shifting mechanism automatically locks when the desired position is reached.

BOOM HOIST: The boom is elevated by three, 12" diameter cylinders mounted on top of the mainframe and two, 7 1/2" diameter cylinders mounted to the sides of the mainframe. Two hoist

speeds are provided, SLOW: for making small grade corrections and, FAST: for positioning the boom into or out of the ditch quickly.

DIGGING ASSEMBLY DRIVE: The digging chain is driven mechanically through a large power shift transmission mounted directly to the engine. The transmission contains a torque converter which multiplies the engine torque when the digging chain attempts to stall. The transmission and torque converter is cooled by two oil coolers mounted to the side of the machine along with a separate, hydraulically driven fan. A differential gearbox is used for extra reduction and to divide the power to each side of the machine. The headshaft is driven through multiple strand roller chains with eccentric idlers for adjustment. Digging chain speeds are approximately 189, 347, 476, and 614 feet per minute.

DIGGING ASSEMBLY: Caterpillar type chains are used with high strength plates bolted across them. Tooth holders for carbide tipped teeth are welded to these plates. These plates also contain drag bars to help carry the excavated material out of the trench. The digging chain is adjusted with large grease type hydraulic cylinders mounted to each side of the boom. The adjustment is maintained with shims and bolts which keep the boom from sliding in or out. The boom is fabricated of heavy steel plate with extra weight added to increase diggability. Replaceable, abrasive resistant wear plates are provided on the surfaces where the digging chain contacts the boom. The tailwheels are 48" diameter and mounted in large spherical roller bearings. Double seals are provided for dirt and moisture exclusion. Extra weight can also be added to the tailwheels if necessary.

Scope of Work
Construction of Phase 1 Cement-Bentonite Seepage Barrier
L-31N

APPENDIX D
QUALITY CONTROL/QUALITY ASSURANCE PLAN

AMEC-BCI

CONSTRUCTION QUALITY CONTROL/QUALITY ASSURANCE PLAN

The slurry wall specialty Contractor will perform the field quality control (QC) testing, and the Geotechnical Engineer will provide full time monitoring inspection during construction, and will also provide quality assurance (QA) testing services. The scope of services for the QA/QC work, described below, has been developed following recommendations published by the Portland Cement Association and the USACE.

Additional testing and monitoring items, beyond what are required on typical slurry wall projects, have been included based on a comprehensive review and evaluation of the demonstration wall constructed at the site in August 2009. In particular, the Plan requires intensive probing, sampling, and testing during the initial phase of the project—defined as the first 1000 feet of wall construction. The purpose of the increased QC/QA activities is to confirm that the as-built wall has suitable composition and properties meeting the project specifications, and extends from top to bottom of trench with limited entrainment of sand and gravel particles.

Contractor’s Quality Control Requirements

The slurry wall Contractor will provide QC testing during design, construction, and post-construction as described in the following paragraphs. Industry standard test procedures apply to this project, and will be part of the Contractor’s QC program:

| <u>REFERENCE</u> | <u>TITLE OR DESCRIPTION</u> |
|------------------|-------------------------------------------------------------------------------------------------------|
| API Spec 13A | Specification for Drilling-Fluid Materials |
| API RP 13B-1 | Recommended Practice Standard Procedure for Field Testing Water-Based Drilling Fluids |
| ASTM C 150 | Standard Specification for Portland Cement |
| ASTM D 1633 | Compressive Strength of Molded Soil-Cement Cylinders |
| ASTM D 4380 | Density of Bentonite Slurries |
| ASTM D 4832 | Preparation and Testing of Controlled Low Strength Material Test Cylinders |
| ASTM D 5084 | Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter |

Initial Testing

The Contractor shall perform mix design testing to document that the selected mix design meets the project specifications. The tests will include a bench scale demonstration that documents satisfactory performance of the slurry in an environment that replicates conditions at the L-31N site after trenching and before slurry placement (specifications for test include demonstration tank of appropriate size with flowing sand + water placed in bottom 25% of volume, mixing/blending instrument, and design mix).

At least two weeks prior to construction, Contractor shall submit proportions and properties of the proposed CB design mix, including cement, bentonite, additives, and water proportions; viscosity, density, unconfined compressive strength, and permeability values. Design mix and properties will be submitted to the Owner's Representative for review and approval.

Equipment

The Contractor shall mobilize slurry mixing, storage, and delivery equipment of suitable capacity and manufacture to accomplish the mixing, blending, and delivery of cement bentonite slurry to the trench excavation at the rate required for construction, and with the properties required to meet the material specifications.

The Contractor shall employ trench bottom preparation equipment, including desanding equipment, air-lift pump, or other suitable approved equipment to ensure removal of loose particles or debris on the trench bottom, and full penetration of the cement bentonite slurry.

The Contractor shall provide field sampling and testing equipment as required to meet the Quality Control specifications. As a minimum, the equipment shall include the following: Standard Marsh funnel viscometer, Mud Balance Scale for direct reading of density, Slurry Sampler (piston or thief sampler), Sounding Tape for measuring depth to bottom of excavation, API Filter Press for filtrate loss, Standard Test Cylinders for laboratory test samples, 200 mesh Sieve for sand/gravel determination, and Water Test Kit (pH, hardness, alkalinity, temperature).

Slurry Placement and Blending

Slurry placement will begin with excavation of the backfilled trench down to the design depth of 35 feet below land surface (or to the depth that trench was cut with trenching machine, whichever is greater), using appropriate mechanical excavation equipment. As the backfill is excavated, CB slurry will be introduced into the excavation at a rate sufficient to maintain the slurry at least 2 feet above the groundwater level and no lower than 2 feet below ground surface.

An air lift pump will follow as close as practical behind the excavator. The air lift pump will be placed with its suction intake as close as practical to the bottom of the excavation. The discharge will be at the top of the slurry, at a location and depth readily accessible for observation and sampling.

The volume displaced by the air lift pump will be adequate to maintain the bottom of the trench free from sand and gravel sediment. CB slurry shall be maintained at all times in a condition that meets the Specifications with regard to composition, viscosity, and density.

If sand/gravel sediment is measured or sampled at the bottom of the trench after passage of the air lift pump, the viscosity and density of the CB slurry will be measured and

increased as necessary using additional cement and bentonite. Excavation shall cease until uniform slurry with minimum sand/gravel sediment is determined to exist from top to bottom of the trench.

Quality Control Testing and Sampling Program

Quality control shall be the responsibility of the Contractor. The quality control testing and monitoring program is designed to ensure that the CB slurry placed in the trench excavation has (a) suitable composition and properties meeting the project specifications, (b) consistent placement from top to bottom of trench, and (c) limited entrainment of sand and gravel particles.

During the installation process, slurry density, viscosity, pH and filtrate properties shall be monitored to check that the slurry meets all specified properties. These properties are designed to ensure the slurry will have the characteristics required to maintain a stable excavation and avoid dilution by sedimented backfill or groundwater. All of these slurry properties are checked using field testing equipment according to American Petroleum Institute (API) methods listed above.

As the excavation proceeds, the depth of the trench shall be sounded at 10 foot intervals behind the air lift pump, using the weighted tape. At every 50 foot interval, soundings shall be repeated, starting at the beginning of the 50 foot interval. All depth soundings shall be recorded and compared with subsequent soundings.

If any soundings indicate sedimentation of sand/gravel greater than 3 inches, a sample will be taken at the bottom of the trench using an appropriate thief or piston sampler. Based on the sample appearance and viscosity, the Owner's Representative will determine if the sample exhibits satisfactory slurry behavior.

If any samples do not exhibit satisfactory slurry behavior, the Contractor will utilize the air lift pump and the excavator to remix and blend the slurry until satisfactory slurry behavior is observed. Additional cement and bentonite may be added to the slurry to assist in achieving satisfactory behavior. At the Contractor's option, air-lifted sediment may be removed from the trench to assist in achieving satisfactory behavior.

To determine the final backfill properties during the initial phase of slurry wall construction, both samples and test cylinders of trench slurry will be taken. Provided all soundings and samples taken during the excavation process described above indicate satisfactory slurry penetration and properties, test samples shall be taken every 100 feet of completed slurry wall.

The test samples will be taken at three locations: the air lift pump discharge, mid-depth of the wall (15 feet below ground surface), and bottom of wall (35 feet below ground surface). Samples will be placed in test cylinders, cured and tested at an off-site laboratory for strength and permeability values, as described in the Specifications. Additional jar samples will be taken for classification testing at the site.

Following the initial phase of wall construction, if the test results indicate satisfactory slurry installation in terms of consistency and depth, the sample interval will be extended to 500 feet. At any time, in the judgment of the Owner's Representative, additional probing and sampling may be required.

QUALITY ASSURANCE TESTING AND MONITORING

The project Geotechnical Engineer will be responsible for the Quality Assurance (QA) testing program. The scope and schedule of testing and oversight are described in the following sections.

Hand Cone Penetrometer Testing

During the initial phase of slurry wall construction, hand cone penetrometer testing will be done every 100 feet along the wall. Approximately 72 hours after placement of the slurry, a penetration test will be performed using an instrumented cone penetrometer advanced by hand pushing. The penetrometer will be mounted in a centering rig spanning the width of the trench. The resistance to penetration will be measured every 1 foot below top of wall, down to refusal. Data will be recorded and the total depth of penetration compared to the depth soundings taken during installation.

If the data indicate significant variations in the consistency of the wall, or in the total depth, an evaluation will be made by the project technical team as to whether or not project specifications have been met. A truck-mounted Cone Penetration Test rig may be used to assist the evaluation. Standard Penetration Borings may also be made to secure samples of the wall material.

An unsatisfactory evaluation, indicating failure to meet project specifications and a likely failure to perform as intended, will require reconstruction of the wall in the failed area.

Provided the wall construction during the initial phase is satisfactory, the hand cone testing during subsequent construction will be conducted at 500-foot intervals along the wall.

Truck-mounted Cone Penetration Tests (CPT)

Following construction of each 2500 lineal feet of wall, cone penetration tests using a truck-mounted rig will be made each 500 feet to determine the final as-built properties of the wall. These tests will be scheduled at least 30 days after installation of the wall at each test section.

Based on the results of the CPT tests, additional sampling using SPT borings plus undisturbed Shelby tube sampling will be completed at selected locations, based on variations in wall construction identified by the CPT tests.

Additional QA Testing

During construction, an experienced geotechnical technician will be on site full-time to observe and record the progress of the work for the Owner. The technician will record depth soundings and make additional soundings as needed to confirm the data. The geotechnical technician will observe and note trench location and depth during the operation of the trenching machine, and will record the daily progress of both the trenching contractor and the slurry wall contractor.

The technician will also take additional samples of representative slurry materials for independent testing to confirm physical properties such as strength, permeability, and sand/gravel content.

The geotechnical technician will also perform the hand cone penetrometer tests and other probing and sampling following construction needed to confirm that Specifications are being met.

The geotechnical technician will also note any environmental or safety issues that are observed, and bring them immediately to the attention of the Contractor and Owner.

APPENDIX E

GEO SOLUTIONS EQUIPMENT LIST FOR 2-MILE CB SEEPAGE BARRIER CONSTRUCTION

- Cat D6 LGP dozer
- Cat 325 Excavator
- JCB 508 Extendable Forklift
- Plastic 4-6 inch pipe fusion welder and small 5 kva generator.
- Cat 250 kw diesel powered generator (portable)
- Komatsu PC 400 Excavator
- Geo-Solutions custom stick for extended reach
- Geo-Solutions custom buckets (2) for specified width
- Bentonite Superbag silo and feeder with weigh scale
- Cement 30 ton silo with weigh scale and remote controlled feed system
- Geo-Solutions custom continuous-mix plant for high capacity CB slurry production, complete with electronic monitoring of principal mixing and pumping parameters and key quality control data
- Geo-Solutions high capacity bentonite slurry shear mixer with adjustable vacuum feed system
- 25000 gal capacity frac tank with internal mixing system (for bentonite slurry storage)
- Two six inch electric water/trash pumps with 50 HP motors
- Moyno 14 CB slurry pump with 450 gpm capacity and 75 HP electric motor
- 175 cfm compressor—mobile
- Geo-Solutions custom-fabricated airlift system and trolley
- 25 ton mobile hydraulic crane