SECTION 02248

COMPACTED CLAY LINER

PART 1 GENERAL

1.1 SECTION INCLUDES

A. The processing and placement of compacted clay liner within the leachate collection sump. Clay liner material obtained from an off-site borrow source.

1.2 RELATED SECTIONS

A. Section 02221 – Excavation and Stockpiling.

B. Section 02222 – Engineered Fill and Protective Soil Cover, Soil Cushion and Anchor Trench Backfill.

C. Section 02223 – Geosynthetic Subgrade Preparation.

1.3 REFERENCES

A. Construction Quality Assurance Plan.

B. Latest version of American Society for Testing and Materials standards:

1. ASTM D-422 – Standard Method for Particle-Size Analysis of Soils.

2. ASTM D-698 – Test Method for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using a 5.5-lb Rammer and 12-inch Drop.

3. ASTM D-1140 – Standard Test Method for Amount of Material in Soils Finer than the No. 200 Sieve.

4. ASTM D-1556 – Standard Test Method for determining soil density, Sand Cone Method.

5. ASTM D-1587 – Standard Practice for Thin-Walled Tube Sampling of Soils.

6. ASTM D-2216 – Standard Test Method for determining water content of soil aggregate mixtures.

7. ASTM D-2434 – Standard Test Method for Permeability of Granular Soils (Constant Head).

8. ASTM D-2487 – Classification of soils for engineering purposes (Unified Soil Classification System).

9. ASTM D-2488 – Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

10. ASTM D-2922 – Standard Test Method for Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth).

11. ASTM D-2937 – Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.

12. ASTM D-3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

13. ASTM D-4220 – Standard Practices for Preserving and Transporting Soil Samples.

14. ASTM D-4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

15. ASTM D-5080 – Standard Test Method for Rapid Determination of Percent Compaction.

16. ASTM D-5084 – Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

C. Daniel, D.E. and R.M. Koerner, (1993), Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities, EPA/600/R-93/182.

1.4 SUBMITTALS

A. The CONTRACTOR shall submit a written workplan for excavation, processing (particle size reduction), moisture conditioning, mixing, placement, and compaction of clay liner to the OWNER's representative for review and approval prior to low permeability soil placement. The plan shall include as a minimum the following:

1. Method and personnel responsible for identifying and selecting lay liner materials and sequencing of placement.

2. Method of processing the clay liner material. Low Permeability material will be obtained from an off-site clay borrow source, located 13 miles south west of the landfill. Previous cells have been constructed by processing and moisture conditioning the clay material with a pugmill. Alternative methods such as a rototiller (asphalt reclaimer) can be proposed.

3. Equipment (number, type, method of operation, and duration) for:

    a. Excavating

    b. Processing (particle size reduction)

    c. Moisture conditioning

    d. Mixing

    e. Placement

    f. Compaction

    g. Trimming

    h. Surface maintenance

    i. Surveying

B. The CONTRACTOR shall notify the OWNER in writing a minimum of 7 days prior to starting construction of the compacted low permeability soil layer. The notice shall state the material to be used, the equipment to be used, the date and time that placement operations will start, and the name of the person in the field who will be in charge of the construction of the compacter clay liner.

C. If work is interrupted for reasons other than inclement weather, the CONTRACTOR shall notify the OWNER's representative a minimum of 24 hours prior to the resumption of work.

1.5 CONSTRUCTION QUALITY ASSURANCE

A. Construction of the compacted clay shall be monitored as outlined in the CQA Plan.

B. The CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these activities in the construction schedule.

1. The proposed minimum testing frequencies for CQA are presented in the CQA Plan. Actual test frequencies may vary, CQA testing, or lack thereof, does not relieve the CONTRACTOR from its responsibility to complete the Work in accordance with the Specifications.

2. Sampling locations shall be selected by the OWNER's representative. If necessary, the location of routine in-place moisture content and dry unit weight tests shall be determined using a non-biased sampling plan.

3. Undisturbed compacted clay material samples for laboratory permeability testing shall be taken in accordance with ASTM D-1587 with

the assistance of the CONTRACTOR such that the sample tube is inserted vertically into the compacted clay with a continuous smooth stroke. This may require use of the CONTRACTOR's equipment as reaction frames for pushing sampling tubes.

4. Additional testing may be performed at the OWNER's representative's discretion.

C. If a defective area is discovered in the compacted clay, the OWNER's representative shall determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the OWNER's representative shall determine the extent of the defective area by additional tests, observations, a review of records, or other means that the OWNER's representative deems appropriate.

D. After determining the extent and nature of the defect, the OWNER's representative shall notify the CONTRACTOR and schedule retests when the defective area has been corrected.

PART 2 PRODUCTS

2.1 CLAY LINER MATERIAL

A. Clay liner soil shall consist of relatively homogeneous material, obtained from an OWNER provided offsite location.

B. Clay liner soil shall be free of gypsum, ferrous, calcareous concretions, roots debris, foreign objects, excess silt, and organics.

C. Clay liner soil shall be classified according to the Unified Soil Classification System as ML, MH, CL or CH having a maximum particle size of 1-inch, with a minimum percent passing the No. 200 sieve of 50 percent by weight.

D. Clay liner soil shall not be gap-graded or susceptible to piping.

E. Clay liner soil shall have an *in situ* permeability equal to or less than 1×10^{-7} cm/sec as measured in the laboratory by ASTM D-5084 when compacted to a minimum 95 percent relative compaction and at least 3 percent above optimum moisture content as determined by ASTM D-698.

F. Substandard soils shall be segregated at the source and will not be permitted at the work area. Any substandard materials shall be removed from the work area by the CONTRACTOR at no additional cost to the OWNER.

PART 3 EXECUTION

3.1 FAMILIARIZATION

A. Prior to implementing any work of this section, the CONTRACTOR shall become thoroughly familiar with the site, the site conditions, and all portions of the work falling within this section and the CQA Plan. Placement of clay liner shall not commence until all material test data have been certified or approved by the CQA firm and approved by the OWNER's representative.

B. Prior to implementing work of this section, the CONTRACTOR shall carefully inspect the installed work of all other sections and verify that all such work is completed to the point where the installation of this section may properly commence without adverse impact.

C. If the CONTRACTOR has concerns regarding the installed work of other sections of the site, the CONTRACTOR shall notify the CQA ENGINEER and the OWNER in writing within 48 hours of the site visit. Failure to notify the OWNER or CQA ENGINEER prior to installation of the compacted clay liner will be construed as CONTRACTOR's acceptance of the related work of all other sections.

D. The CONTRACTOR shall verify that the as-built subgrade has been surveyed to sufficient accuracy and approved by the ENGINEER prior to placement of any compacted clay liner material.

3.2 CLAY LINER SOIL PLACEMENT

A. The construction of the compacted clay shall be monitored as outlined in the CQA Plan.

B. CONTRACTOR shall not place clay liner until after completion of any pre-requisite testing by a third party CQA laboratory retained by OWNER, when such test is required.

C. The CONTRACTOR shall construct the compacted clay liner to the grades, slopes and elevations shown on the construction drawings and as specified in this section.

D. The CONTRACTOR shall construct the compacted clay on a firm, compacted subgrade. Clay liner shall not be placed prior to approval and acceptance by CQA Monitor of the underlying subgrade.

E. The compacted clay material shall be spread and compacted in lifts not to exceed a compacted thickness of 6 inches. Hauling and spreading equipment shall not be considered compaction equipment. CONTRACTOR shall place layers of clay liner materials to form a continuous monolithic liner. If a lift of compacted clay liner material dries out during placement operations, the CONTRACTOR shall scarify,

moisture condition the dry soil and recompact and retest the lift prior to placement of additional lifts. If a lift of compacted clay liner material becomes overly wet due to precipitation or over watering, the CONTRACTOR shall allow the wet soil to dry or remove the materials before placement of additional lifts.

F. Prior to compaction, the CONTRACTOR shall process the compacted clay by disc-harrowing or an approved equivalent method to a homogeneous consistency without clods which are not easily broken by the compaction process.

G. Lifts shall be compacted with an appropriate penetrating-foot compactor subject to approval from the CQA inspection personnel.

H. Equipment or truck traffic will not be permitted on the surface during the period between scarifying and placement of the following lift.

I. Unless otherwise modified by the ENGINEER, the clay liner will be compacted to a minimum value of 95 percent relative compaction at a moisture content a least 3 percent over optimum as determined by ASTM D-698. The moisture content of the material shall be uniform and homogeneous throughout the clay layer being tested. If dry zones are encountered within the clay liner materials, they shall be moisture conditioned and mixed with the surrounding materials.

J. Prior to placement of a lift of fill, the previous compacted lift shall be thoroughly scarified to provide good bonding between lifts. Scarification shall be accomplished by raking with a grader, disking, or an alternate method approved by the ENGINEER.

K. At the beginning of each day's work, the previously placed compacted clay shall be observed by the CQA ENGINEER. The CQA ENGINEER may specify scarification of the top surface of soil and/or recompaction as necessary in the judgment of the CQA ENGINEER to obtain the compaction criteria and provide a suitable surface for the next lift. This work will be performed at no cost to the OWNER.

L. The compacted clay material shall have appropriate moisture content during the time the compactor is working the soil. The CONTRACTOR shall spray the soil with a sufficient quantity of clean water and mix the water into the soil to bring the soil to a uniform, proper moisture content.

M. If the clay cannot be conditioned to meet specifications, it shall be removed and replaced by Contractor at no cost to the OWNER. If the test pad should prove unsatisfactory, adjustments to the construction and/or compaction procedure shall be made and agreed upon by the ENGINEER, the CQA MONITOR, and the CONTRACTOR. Additional test fills shall be constructed using the adjusted construction procedures and evaluated for conformance with the specification requirements.

N. No compacted clay shall be placed over a lift which has not been tested and approved by the CQA ENGINEER. Should the field test indicate that the density and moisture of any layer of compacted clay, or portion thereof, is below the required dry unit weight and moisture, the particular layer, or portion thereof, shall be reworked or removed at no extra cost to the OWNER.

O. The daily work area will extend a distance no greater than necessary to maintain moist soil conditions and continuous operations. Desiccation sand crusting of the lift surface shall be avoided as much as possible.

P. If desiccation and crusting of the lift surface occurs before placement of the next lift, this area will be sprinkled with water and then scarified and recompacted and tested for water content to ensure uniform moisture before placement of a subsequent lift.

Q. Transition from full depth liner to beginning of adjacent new section will be accomplished by sloping (cutting back) the end of a full depth section at 3H:1V or flatter for tying in a new lift as shown on the construction drawings.

R. No frozen or thawing compacted clay material shall be placed, spread or compacted.

S. No compacted clay liner material shall be placed, spread or compacted while the subgrade is frozen or thawing, during unfavorable weather conditions, or during periods of precipitation.

T. Hand compaction at the proper moisture content shall be used in all locations around penetrations, corners, appurtenances, etc., in order to achieve the specified dry unit weight and moisture content. Care shall be taken to protect piping.

U. The same material and compaction methods as outlined in this section shall be used to replace unacceptable zones detected by the CQA ENGINEER.

V. The compacted clay surface shall be made smooth and free from ruts or indentations at the end of every working day when precipitation is forecast and/or at the completion of compaction operations in that area.

W. The CONTRACTOR shall finish each day's work with a smooth roller to create a smooth surface which will promote surface water run-off and minimize moisture penetration.

X. After completion of a segment of compacted clay liner, but before installation of the overlying material, the top of the clay will be surveyed to ensure that the specified thickness of the compacted clay liner has been achieved, the top of the clay liner slopes across the cell at the grades specified, and the top of the clay liner

in the leachate collection sump area is at the grades and elevations specified on the drawings.

Y. Any holes in the compacted clay liner shall be backfilled with similar clay materials or with granulated or powered bentonite. The backfill materials shall be compacted in loose lift thicknesses no greater than 8 inches.

Z. All grade stakes shall be removed upon the achievement of final grade. Holes remaining after removal of grade stakes shall be backfilled with bentonite powder or granules.

AA. The laboratory permeability test results shall be less than 1 x 10-7 cm/sec prior to acceptance of the compacted clay liner.

3.3 PRODUCT PROTECTION AND REPAIRS

A. The CONTRACTOR shall use all means necessary to protect all prior work, including all material and completed work of other sections from damage including but not limited to desiccation from drying, saturation from ponding of water, erosion from runoff, and general construction damage from equipment.

B. The CQA ENGINEER shall identify all areas requiring repair by the CONTRACTOR.

C. In the event of damage, the CONTRACTOR shall immediately make all repairs and replacements necessary to the approval of the CQA ENGINEER and at no cost to the OWNER.

D. A repair on the clay liner shall be performed in accordance with the requirements of this section.

3.4 ACCEPTANCE

A. CONTRACTOR retains all ownership and responsibility for the clay liner until acceptance by the OWNER.

B. OWNER will accept the clay liner when the work is complete, all final as-built surveys have been performed, all required field and laboratory testing is complete, and all other necessary documentation from the CQA ENGINEER demonstrates compliance with these specifications.

END OF SECTION