Geotechnical Conditions Port Lands, Toronto

Prepared for

Waterfront Toronto

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Contents

Acronyms and Abbreviations

µm	micrometre
ASTM	American Society for Testing and Materials
CH2M	CH2M HILL Canada Limited
CPT	Cone Penetration Test
CSM	Conceptual Site Model
GHD	GHD Limited
m	metre
mbgs	metre below ground surface
mm	millimetre
MVVA	Michael Van Valkenburgh Associates Inc.
PHC	petroleum hydrocarbon
ppm	parts per million
RQD	Rock Quality Designation
TS	Technical Specification
USCS	Unified Social Classification System

Tab D. Geotechnical Conditions

CH2M HILL Canada Limited (CH2M) assessed the geotechnical conditions within the Port Lands area using the available historical investigation information and recent investigation information provided by GHD Limited (GHD) in 2015. Based on geotechnical investigation results and the proposed excavation activities for the proposed River Valley waterway, it is anticipated that the generated materials will vary considerably. As described in Earthwork Methodology (Tab H), the excavated material will be segregated based on its geotechnical properties and the presence of environmental contaminants, when possible. To minimize costs for imported fill and offsite disposal of the excavated material, the reuse of as much of the suitable material for various fill requirements is desired. CH2M determined the desired geotechnical properties of the materials required for the redevelopment efforts based on a review of the Michael Van Valkenburgh Associates Inc. (MVVA) report (MVVA, 2015). These requirements were then compared to the geotechnical properties of the expected excavated soils to determine their suitability. Soil modification methods were also evaluated, where the expected soils generated do not meet these requirements. The following information is provided in this Geotechnical Conditions report:

- Summary of geotechnical conditions encountered within the proposed excavation and filling limits
- Geotechnical properties of materials to be excavated
- Geotechnical properties for materials required for Port Lands redevelopment efforts
- Determination of the suitability of anticipated excavated soils for reuse
- Determination of soil modification methods to facilitate the reuse of unsuitable excavated soils

D.1 Geotechnical Data Compilation and Analysis

Available boring logs and geotechnical data presented in the GHD report (GHD, 2015) and historical data were reviewed to determine geotechnical conditions at the site. GHD-advanced borings were typically drilled to a depth of 7.5 metres below ground surface (mbgs). These borings were extended deeper to fully penetrate soft peat layers if the boring was to be converted to a monitoring well as part of a cluster of wells, or if the boring was intended to investigate the competency of bedrock at that location. As indicated in the Conceptual Site Model (CSM) (Tab A), the general geological conditions at the Site are characterized into five main stratigraphic units:

1. Heterogeneous fill from ground surface up to 10.7 mbgs are composed of unconsolidated gravel, sand, gravelly sand, sandy gravel, clay, silt, silty sand, and clayey silt. The fill typically contains debris, such as brick, glass, concrete, wood chips, charcoal, and cinders.
2. A thick, poorly-graded native sand unit was encountered continuously across the Site extending to bedrock. The native sand unit also contains silty sands, sand and gravel, and localized clay layers.
3. Discontinuous peat and organic layers up to 6.8 metres (m) thick. Peat and organic layers can be interbedded with sandy and silty layers at localized locations.
4. Discontinuous native silt, clayey silt to clay till.
5. Georgian Bay Formation shale bedrock interbedded with limestone was encountered at a depth of approximately 10.8 to 41.3 mbgs. The bedrock consists of light grey, thinly-bedded fissile shale interbedded with occasional limestone layers. The upper 5 m of bedrock is described as highly to slightly weathered with clay infills and typically highly fractured. The bedrock surface elevation is shown in Figure 7. The Rock Quality Designation (RQD) has values ranging from 0% to 93%, indicating a very poor to excellent rock quality. Review of the GHD boring logs and RQD data indicates highly-fractured and severely-weathered bedrock (RQD values ranging from 0 to 50) within

the top 1.5 metres of the bedrock surface. Some borings exhibited highly-fractured, poor-quality bedrock (RQD < 50%) for up to 5 metres within the bedrock surface. Generally, borings exhibited good bedrock quality (RQD ≥75%) at depth of approximately 2.5 metres below the bedrock surface.

At the western portion of the Port Lands area (west of the restricted Pan American Games area), the depth to groundwater is approximately 1 to 2 mbgs, which corresponds to stations 0+000 to 0+500 on cross-section E-E' and also, stations 0+000 to 0+500 on cross-section A-A' (Figure 9A). The depth to groundwater within the restricted Pan American Games area is approximately 1 to 3 mbgs, which corresponds to stations 0+500 to 0+900 on cross-section E-E’ and stations 0+500 to 0+900 on cross-section A-A' (Figure 9A). The depth to groundwater on the eastern portion of the Port Lands area (east of the restricted Pan American Games area) is approximately 2 to 5 mbgs, which corresponds to stations 0+900 to 1+500 on cross-section E-E' and stations 0+900 to 1+850 on cross-section A-A' (Figure 9A). The geotechnical conditions at the site have been summarized based on these approximate areas.

In areas to the west of the restricted Pan American Games area (station 0+000 to 0+500 on cross-section A-A' on Figure 9A), typical soil conditions include fill with thicknesses of up to approximately 5 m. In some locations, fill material traces were observed in native soil layers at greater depths. The soil matrix of the fill was generally classified as a medium dense to very dense well-graded sand or well-graded gravel. The presence of brick, glass, wood, coal, and other construction debris were observed within the fill layer. Underlying the fill layer within this portion of the Port Lands area is a fine- to medium-grained, very loose to medium dense poorly-graded sand; but was typically very loose to loose. During the GHD investigation, heaving conditions were observed within the poorly-graded sand layer, at depths of approximately 2 to 3 mbgs. These conditions necessitated the use of clean water or mud to balance the uplift pressure within the borehole. In some locations, generally at depths below the poorly-graded sand layer and just above bedrock, thin-interbedded layers of low-plasticity silts and clays with medium stiffness and thin-interbedded layers of loose to medium dense well-graded sands and gravels were encountered. Within this portion of the Port Lands area, bedrock was encountered at depths of approximately 15 to 17 mbgs.

Borings and test pits installed during the Stage 2 investigation provided additional information regarding the subsurface conditions within the restricted Pan American Games area (station 0+500 to 0+900 on cross-section A-A’ of Figure 9A). Typical soil conditions include fill with thicknesses up to 7 m; in some locations, traces of fill material were observed in native soil layers at greater depths. The soil matrix of the fill was generally classified as a poorly-graded sand (very loose to medium dense) or a medium dense to very dense well-graded sand or well-graded gravel. The presence of brick, glass, wood, coal, and other construction debris were observed within the fill layer. The presence of petroleum hydrocarbons (PHC) was observed in the test pits, which extended to a maximum depth of 2.9 mbgs, as evidenced by sheens, black/gray staining, and strong odours. PHC impact were also observed at deeper depths of the fill and underlying native soils within the borings. Underlying the fill layer within this portion of the Port Lands area is a medium- to coarse-grained, loose to medium dense gravelly-sand and/or a fine- to medium-grained, very loose to medium dense poorly-graded sand; the majority of poorly-graded sands material was classified as very loose to loose. During the GHD investigation, heaving conditions were observed within the poorly-graded sand layer, at depths of approximately 2 to 6 mbgs. These conditions necessitated the use of clean water or mud to balance the uplift pressure within the borehole. Some boring locations within the restricted Pan American Games area encountered a very soft peat layer above and below the native sands; the thickness of the peat layer ranged from 0.5 m to 2.75 m. In some locations, generally at depths below the poorly-graded sand layer and just above bedrock, thin-interbedded layers of low-plasticity silts and clays with medium stiffness and thin-interbedded layers of loose to medium dense well-graded sands and gravels were encountered. Two borings (MW33A-15 and MW28A-15) within the restricted Pan American Games area were extended in depth to evaluate the quality of bedrock. The depth to bedrock within MW33A-15 was determined to be 16 mbgs, which is consistent with depth to bedrock in other portions of the Port Lands area. The depth to bedrock within MW28A-15 was determined to be 41.31 mbgs, which is anomalous from depth to bedrock measurements in other portions of the Port Lands area. Cores of bedrock obtained from these borings indicated extensive fracturing and poor quality.

In portions of the Port Lands area east of the restricted Pan American Games area (station 0+900 to 1+850 on cross-section A-A' on Figure 9A), typical soil conditions include fill with similar consistency and thickness as described herein. In some locations, traces of fill material were observed in native soil layers at deeper depths. Underlying the fill layer is a fine- to medium-grained, very loose to medium dense poorly-graded sand layer followed by a very soft peat layer. In some locations, the peat layer exists on top of the poorly-graded sand layer or is interbedded within the poorly-graded sand. Although no consolidation testing data for the peat is available, the material appears to be highly compressible based on the low blow counts and high moisture content. Some thin layers of low-plasticity clays, low-plasticity silts, and high-plasticity organic clays also exist within this portion of the Port Lands area. The high-plasticity materials contain a high moisture content and are generally soft to very soft. Depth to bedrock within this portion of the Port Lands area is at depths of approximately 8 to 17 mbgs.

D.1.1 Implications for Excavation of New River Valley

The proposed excavation depth for the new River Valley ranges from 5 to 8 mbgs. Based on the soil conditions within the vertical and horizontal limits of the proposed River Valley, the final grade of the waterway is to be excavated within the poorly-graded sand and peat layers that exists below the Site. Because of the loose and soft nature of these materials, it is unlikely the native materials can sustain slopes greater than 5H:1V if excavated in still water. The document titled *ICE Design and Practice Guides: Dredging* (Yell and Riddell, 1995, recommends for active waters, mudline slopes will be no steeper than 10H:1V for fine sands and silts. The preliminary channel design includes slopes of 2H:1V; therefore, over-excavation and replacement of native sands with fill that can achieve the desired slopes is required. It is recommended that the invert and side slopes be over excavated by 1 to 2 m to facilitate backfill with a material that will support construction of the preliminary channel design.

Final configuration of the new River Valley banks will have to be designed from both a coastal and geotechnical standpoint. Coastal engineering design will include the development of the required slopes, and revetments or slope protection that addresses the hydraulics of the new river, while geotechnical engineering design will be necessary to assure the adequacy of the proposed configuration from a slope stability standpoint.

D.1.2 Implications for Redevelopment of Upland Areas

It is anticipated that the new River Valley will be excavated and dredged through the Site, and grades will be increased in areas around the new River Valley (upland areas) by 1.5 to 2.m. Excavated and dredged soils deemed to be acceptable fill materials, either in their excavated condition or after amendment, are expected to be reused for redevelopment. For areas at the western end of the Site, close to the Lake Ontario waterfront, tolerable settlements can be expected in response to raising the grades, since these areas are mostly underlain by fill material and natural granular soils. However, subsurface conditions vary significantly at the eastern end of the Site, where excessive settlement can be expected because of the proposed regrading in the area. The entire area east of the north-south alignment of the new River Valley, or more specifically east of Don Roadway, was found to contain peat and cohesive soils; this was especially prevalent at the northeast corner of the Site (the area of Don Roadway and Commissioners Street). For this eastern portion of the Site, preloading (that is, excess soil material placed above regraded materials) will be necessary to expedite settlement, and reduce post-construction settlement to acceptable values. Conceptually, preload would consist of additional fill material placed over the critical areas before final grading or construction activities in the area. If necessary, to meet schedule constraints, preloading can be accelerated using wick drains to dissipate pore water pressure and remove excess pore water. Wick drains are vertical drains installed in the area to be preloaded to facilitate the drainage process and expedite the completion of the expected consolidation settlements.

D.1.3 Implications for Proposed Land Reclamation

As part of the Port Lands project, lakefilling (land reclamation) will be required at the Essroc Quay area at the northwest corner of the Site. The design of the materials and methods for lakefill at Essroc Quay is being completed by Riggs Engineering, the marine engineering consultant. The provided assessment and proposed construction methodology are for consideration. Typically, before reclamation, the area to be filled will need to be protected from the environment and wave action. Therefore, shoreline protection bunding will be necessary. The bunding will consist of rock core material covered with a rock filter layer and armour protection rock at the Lake Ontario waterfront. After the reclaimed area is protected, reclamation operations may proceed. It is recommended that reclamation work take place using structural fill consisting of well-graded granular materials with minimal fines content (finer than the No. 200 sieve), preferably no more than 15 percent fines.

The reclamation material placement will result in settlement because of the expected compressible materials that are most likely present at the Keating Channel mudline. Also, the reclamation material will be required to be densified. These two issues will need to be addressed to assure adequate performance of the reclamation material.

Once the materials are deposited below the water level, it will be densified so the material can support future loads imposed on them at ground surface. For the densification of the granular soils, especially below the water level, ground improvement techniques will be necessary. CH2M considers vibro-compaction to be the ideal and most economic ground improvement option for the densification of the granular reclamation soil. Vibro-compaction is a ground improvement technique that uses specially designed probe-type, depth vibrators for in situ densification of loose sands and gravels. As the probe penetrates the ground and densifies the in situ granular soils, additional soils are added as part of the densification process.

It is recommend that the vibro-compaction operation take place after the settlement of compressible materials is addressed. The CH2M compaction methodology for Essroc Quay is provided for consideration. The detailed fill placement methodology will be determined by Riggs Engineering.

Very limited to no geotechnical data have been collected in the area to be reclaimed and it is recommended that this data be collected in future investigations as identified in the data gap summary in the CSM (Tab A). However, it is anticipated that subsurface conditions beneath the mudline in the areas to be reclaimed consist of soft silts and river mud. These materials will consolidate and result in settlement because of the filling operations.

Depending on the thickness and compressibility of the soft soils beneath the mudline, the reclaimed area might have to be left for a period of time so that the soft soils consolidate and settle. Alternatively, grades may be increased in the area to be reclaimed (that is, preloading) to expedite the consolidation process. Based on future additional subsurface investigation, including performing borings on water in the area to be reclaimed, and consolidation testing performed on the collected undisturbed samples, finalization of the filling operation can be performed. With the additional required geotechnical information, it would be assessed whether preloading (that is, additional filling) is necessary and the required time for consolidation would be determined. If the compressible soils at mudline are found to be organic, it is most likely that preloading, and also, the use of wick drains (prefabricated vertical drains) might be necessary in order to expedite the consolidation and settlement process. If wick drains are found to be necessary, typical arrangements are usually a square or triangular grid pattern, with spacing ranging from 1.5 m to 4 m. These details can be finalized in future phases of the project, after the collection of additional subsurface geotechnical data from the area to be reclaimed.

The preloading work is expected to be performed before the recommended vibro-compaction ground improvement necessary for the reclamation fill.

Once additional investigation and analysis have been completed, a performance-type specification will be developed for this ground improvement, where the objective is to limit post-construction settlement. Ideally, trial areas are conducted initially to investigate the ideal vibro-compaction grid pattern. It is recommended that initial 3-m, 3.5-m, and 4-m triangular grids be considered. Pre- and post-improvement boreholes or Cone Penetration Tests (CPTs) will be necessary to assess the improvement, which will result in choosing the ideal vibro-compaction pattern. Additionally, zone load tests, consisting of footings or an embankment, would be constructed and loaded to assess the performance of the reclaimed material.

D.2 Geotechnical Requirements of Redevelopment Materials

The Port Lands project, a portion of Toronto's Waterfront Renewal initiative, will involve extensive earthwork necessary to create the River Valley, construct infrastructure (such as, roadways and flood control structures) that will facilitate future construction, and create reclaimed land. Early phases of the project will include excavation of the existing fill around the Site at the identified future river alignment. This section provides an overview of the excavated material and possible uses of the excavated material as fill around the Site. However, this section first outlines the required material types for various construction activities and required properties.

Various fill materials will be required to facilitate the implementation of the project, including structural fill, controlled fill, clay, road-base material, topsoil, and armour rock protection for shoreline embankments exposed to wave action. The anticipated geotechnical requirements for each of these materials is described further herein. When possible, the requirements for these materials were adapted from City of Toronto Standard Specifications for Road Works (2015), City of Toronto Technical Specifications, or *Ontario Provincial Standards for Roads and Public Works* (Ontario Ministry of Transportation, 2015). Before reusing material generated from site excavations, sampling and testing will also be verified to confirm contaminant concentrations do not exceed applicable standards for the desired use and to verify no unacceptable exposure will be posed to the human or ecological receptors.

D.2.1 Structural Fill

CH2M anticipates structural fill will be required during construction of the following infrastructure components for Toronto's Waterfront Renewal initiative:

- Major regrading work
- Flood protection landforming
- Embankments
- Lake fill
- Aggregate base for shallow foundations

Specific components of construction referenced within the MVVA report (2015) that would require the use of structural fill include in-water fill and above-water fill for the Essroc Quay infill, and for filling in structural upland areas. Structural fill used as in-water fill as part of the Essroc Quay Infill can have up to 15 percent fines content, while structural fill used as above-water fill for the Essroc Quay Infill may contain up to 20 percent fines content. Structural fill will also be used for regrading work onsite, in areas that will be developed in the future (that is, buildings, roadways, and nonlandscaped areas). Structural fill can be produced from the natural sand soils on-site, or possibly the fill after removal of the deleterious material from it. Structural fill will consist of well-graded soil and/or aggregate material composed of natural, hard, strong, durable particles that are free of roots, trees, stumps, construction debris, other organic matter, and deleterious materials that could inhibit adequate compaction.

Structural fill will have less than 0.5 percent organic content; will have a maximum grain size of 76 millimetres (mm); and will have a maximum fines content (passing the 74-micrometre [µm] sieve) of 15 percent. Structural fill is recommended to be placed in lifts not exceeding 200 mm thick and compacted to at least 95 percent of maximum dry density as determined by Modified Proctor testing (American Society for Testing and Materials [ASTM] D1557).

D.2.2 Controlled Fill

Controlled-fill material is soil material that will be used as general fill to modify grades of existing land in nonstructural areas, to facilitate the proposed redevelopment activities. CH2M anticipates controlled fill will be obtainable for some excavated material and suitable for use to construct berms (confinement structures), as referenced in the MVVA report (2015). The majority of quantities of materials for other components of berms (confinement structures), such as core material, filter stone, and riprap, need to be imported. Controlled fill will consist of approved materials substantially free from organic materials, loam, wood debris, trash, roots, brush, gravel, and other objectionable materials, which may be compressible; and its material will have less than 0.5 percent organic content. Controlled fill soil will not contain pieces of granite blocks, broken concrete, masonry rubble, or other similar materials that will inhibit compaction. It will have a maximum grain size of 150 mm and will have a maximum fines content (passing the 74-µm sieve) of 20 percent. Controlled fill will be classified according to Unified Soil Classification System (USCS) (ASTM D2487) as SW, SM, SC-SM, or SC. Controlled-fill material is recommended to be placed in lifts not exceeding 300 mm and compacted to at least 90 percent of maximum dry density as determined by modified proctor testing (ASTM D-1557).

D.2.3 Clay

Clay material is to be used to construct the cores of the First Gulf Flood Protection Landform and potentially for Valley Wall low-permeability cores. Clay will consist of approved materials substantially free from organic materials, loam, wood debris, trash, roots, brush, gravel, and other objectionable materials, which may be compressible; and will have less than 0.5 percent organic content. Clay will not contain pieces of granite blocks, broken concrete, masonry rubble, or other similar materials that will inhibit compaction; and will be classified according to USCS (ASTM D2487) as CL-ML or CL. Clay material is recommended to be placed in lifts not exceeding 200 mm and compacted to at least 95 percent of maximum dry density as determined by Standard Proctor testing (ASTM D-698). Clay material is recommended to achieve a maximum hydraulic conductivity of 1×10^{-6} centimetres per second, as determined by flexible wall permeameter testing (ASTM D-5084, Method A), when compacted to 95 percent of maximum dry density as determined by Standard Proctor testing (ASTM D-698).

D.2.4 Road-base Material

Road-base material will be necessary to establish an adequate foundation for asphalt or concrete pavements. Road-base material will consist of aggregate and will be classified as Granular A material, as defined by the City of Toronto Standard Specifications for Road Works (2015) and the Ontario Provincial Standard Specifications (2015). Surface course and base course for existing roadways may be reclaimed for use as future road-base material. Granular A material may be composed of reclaimed asphalt pavement and/or reclaimed concrete material. Gypsum, gypsum plaster, and wall board mix will not be allowed for use within Granular A material. Granular A material will have a minimum of 50 percent crushed particles and will be classified as nonplastic material. Specific gradation and other requirements for Granular A material are presented in the City of Toronto Standard Specifications for Road Works (2015), Technical Specification (TS) 3.40.05.03 and the Amendment to the Ontario Provincial Standard Specification's OPSS.MUNI 1010 (April 2013) – Material Specification for Aggregates – Base, Subbase, Select Subgrade, and Backfill Material.

D.2.5 Topsoil

Topsoil will be needed to re-establish vegetation on disturbed lands. Before excavating the River Valley or disturbing lands for redevelopment, existing topsoil material may be able to be stripped and stockpiled for reuse, provided the material does not contain unacceptable concentrations of chemical contaminants. CH2M anticipates that either recycled or manufactured topsoil can be used as the top layer for banks and floodplains, as referenced in the MVVA report (2015). The majority of quantities of other materials for channel construction, such as middle layer for the channel bed and subgrade/grade control base material, will be imported. CH2M also anticipates that recycled or manufactured topsoil can be used as tree planting soil; shrub, ground cover, and wetland planting soil; and lawn planting soil for Parkland and Naturalized Landscapes, as referenced within the MVVA report (2015). Topsoil will be naturally occurring soil, harvested from the O or A horizon of the soil profile, suitable for the germination of seeds and the support of vegetative growth. Topsoil will have an organic content of no less than 2.5 percent by dry weight and a pH between 5.5 and 7.8. Topsoil will have phosphorus, potassium, calcium, and magnesium contents ranging from 10 to 60 parts per million (ppm), 80 to 250 ppm, less than 5,000 ppm, and 100 to 300 ppm, respectively.

Peds are defined as the clumps of soil naturally aggregated during the soil building process, by clays and soils biology. Topsoil will retain a significant portion of the soils' ped structure when stockpiled. At least 25 percent of the soil volume will be soil peds larger than 25 mm in diameter.

Topsoil will not contain materials and contaminants at levels that would be harmful to plant growth, including the following:

- Refuse, roots, construction debris, wood or sticks larger than 25 mm in diameter, brush, clumps of root mats of plants and toxic materials
- Lumps of clay or subsoil larger than 50 mm
- Stones larger than 75 mm
- Deleterious substances, plant or soil pests, undesirable grasses including crabgrass or couch grass, noxious or weeds or weed seeds

Topsoil is recommended to comply with Toronto Municipal Code Chapter 489, Grass and Weeds. It will not be a soil mix including any combination of sand, fertilizer, or organic matter or compost added to mineral soil to meet the texture, chemical, or organic requirements for topsoil. The organic matter content of the soil will be residue of long term, natural soil building processes and not from added organic matter or compost. Additional requirements for Topsoil are as indicated by City of Toronto TS 5.10 (April 2014), Construction Specification for Growing Medium, and horticultural requirements as may be required for a planting media.

D.3 Suitability of Excess Soils for Reuse and Treatment Options

Based on the excavation and material processing methods described in the Soil Management Plan (Tab F) and the various strata within the limits of soil excavation, CH2M anticipates most excavated soil types can be segregated based on geotechnical properties. The following types of materials will be generated:

- Fill material
- Poorly graded sand
- Silt
- Brown lean clay
- Peat

The following section describes the properties of each of these materials that is based on available existing data. A discussion is also provided within each subsection regarding possible treatment methods for improving properties of unsuitable materials to allow them to be reused in redevelopment.

D.3.1 Fill Material

The fill material will be a heterogeneous mixture of soil types with construction debris distributed throughout the soil matrix. Based on the boring logs, the soil matrix within the fill unit has been classified as poorly-graded sand, well-graded sand, or well-graded gravel. The fines content of this material is generally less than 15 percent. Following excavation, the removal of large debris, and the decanting of water from the fill material, the remaining soil material could be used as controlled fill or blended with dried peat or chipped trees to create topsoil. If additional cohesion is needed for this material, Portland cement or other pozzolanic reagents could be blended with the soil at a rate of approximately 2 to 5 percent Portland cement based on dry weight of the soil, for soil materials that will be placed above the water level. No additives or reagents should be added to soil materials to be placed below water level. To assure adequate compaction can be achieved for use as controlled fill, the moisture content of the end material will typically range from 8 to 15 percent. The optimum moisture content of the material will periodically be checked via Standard Proctor (ASTM D698) or Modified Proctor (ASTM D1557) testing.

D.3.2 Poorly-graded Sand

In conjunction with the fill material, the poorly-graded sand is the most material that will be generated from the proposed River Valley excavation. Fines content of this material is generally less than 15 percent. Following excavation, removal of large debris, and decanting of water from the fill material, the remaining soil material could be used as controlled fill or structural fill. If not used directly and additional cohesion is needed for this material, Portland cement or other pozzolanic reagents could be blended with the soil at a rate of approximately 2 to 5 percent Portland cement, based on dry weight of the soil. To assure adequate compaction can be achieved as structural fill or controlled fill, the moisture content of the end material will range from 8 to 15 percent. The optimum moisture content of the material will periodically be checked via Standard Proctor (ASTM D698) or Modified Proctor (ASTM D1557) testing. The poorly-graded sand could also be blended with dried peat or chipped trees to create topsoil.

D.3.3 Silt

Low-plasticity silt that can be excavated and segregated could be used as controlled fill but the fines content might be excessive or more than the maximum preferable amount because of the fine-grained nature of the soil. This soil may be suitable to support construction of wetland soil profile without amendment. If it is necessary to reduce the plasticity of the silt material, hydrated lime or a similar reagent could be blended with the soil at a rate of approximately 2 to 5 percent hydrated lime, based on dry weight of the soil. To assure adequate compaction can be achieved, the moisture content of the end material will typically range from 12 to 24 percent. The optimum moisture content of the material will periodically be checked via Standard Proctor (ASTM D698) or Modified Proctor (ASTM D1557) testing.

D.3.4 Lean Clay

Low-plasticity clay that can be excavated and segregated can be used as the clay core for the flood protection landform. To assure adequate compaction can be achieved, the moisture content of the end material will typically range from 12 to 24 percent. The optimum moisture content of the material will periodically be checked via Standard Proctor (ASTM D698) testing.

D.3.5 Peat

The peat underlying the site has been determined to be highly compressible and contain a high moisture content. If this material contains adequate carbon content and does not contain unacceptable levels of contaminants, the peat could be dried and blended with onsite poorly-graded sand or fill to create topsoil.

D.4 References

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