FINAL GEOTECHNICAL ENGINEERING REPORT

MIDDLETOWN PUMP STATION

MIDDLETOWN, CONNECTICUT
MGI NO. 14712.01

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I. PURPOSE AND SCOPE

This report presents the determination and analysis of the subsurface soil and rock conditions which would affect the design and construction of the Middletown Pump Station in the City of Middletown, Connecticut. Under this contract a new pump station will be constructed on City owned property located at 34 East Main Street. The new pump station will pump all City sanitary sewer flows to the Mattabassett District Wastewater Treatment Facility in Cromwell, CT for treatment. The City plans to decommission its wastewater treatment facility on River Road. In addition to field subsurface explorations, published geological data and field observations were used in the analysis of the subsurface conditions and in determining the recommendations for this project. The Appendix of this report contains the boring location plan, the generalized soil profiles, and the Engineer's boring logs for the project.

II. FIELD SUBSURFACE INVESTIGATIONS

The completed boring program for the Middletown Pump Station project consisted of six (6) 3-1/4 inch inside diameter hollow stem auger borings (B-1 through B-6). All of the borings were drilled by General Borings, Inc., of Prospect, CT, under contract to Maguire Group Inc. General Borings, Inc. began the boring program on October 26, 2011 and completed operations on October 31, 2011. The borings ranged in depth from 53.0 feet to 55.0 feet in soil and weathered rock. Five foot NQ rock cores were taken in borings B-1

and B-6 to determine the type and condition of the bedrock encountered. Borings B-2, B-3, B-4 and B-5 were drilled to auger refusal, presumably upon bedrock. To classify and determine the density or consistency of the various soil strata encountered, disturbed samples were taken in all borings by driving a split spoon sampler with a 140 pound weight falling 30 inches (standard penetration test). Maguire Group Inc. was responsible for the development, layout, inspection and analysis of the boring program.

III. SUBSURFACE SOIL AND ROCK CONDITIONS

The subsurface soil and rock conditions at the site of the Middletown Pump Station in Middletown, Connecticut will be discussed below. Reference should be made to the series of generalized soil profiles developed from the results of the subsurface explorations which show the basic pattern of soil deposits and rock found within the project limits. These profiles are shown on Figures 2 through 4 in the Appendix of this report. The following proportions are used in all soil descriptions: trace 1% to 10%, little 11% to 20%, some 21% to 35%, and 36% to 50%.

Four (4) major soil strata are present at the project site. The following is a generalized description of the soils encountered from the surface downward.

- A deposit of loose to medium dense, brown fine to medium sand containing some silt and a little gravel 15 to 24 feet thick. A portion of this deposit may be artificial fill.
- A stratum of soft to stiff, gray-brown clayey silt/organic silt with traces of fine sand, peat, wood and roots 12 to 24 feet thick.

- A deposit of medium dense to very dense brown and gray-brown fine to coarse sand containing a little silt and gravel 11 feet to 15 feet thick.
- A stratum of high weathered bedrock up to 5 feet thick.

Bedrock consisting of red-brown, gray and brown siltstone was encountered at depths of 53 feet to 55 feet below the existing ground surface. Groundwater was reported at a depth of approximately 15 feet below the existing ground surface at the time of completion of the borings.

IV. FOUNDATION ANALYSIS AND RECOMMENDATIONS

A foundation analysis and recommendations for design and construction of the Middletown Pump Station in Middletown, Connecticut are presented below. Referring to the following analyses, conclusions and recommendations without referring to the several features previously discussed may result in interpreting certain statements out of context with the desired meaning. Reference to the preceding discussions, knowledge of the field geological conditions, and an interpretative judgment based on the actual appearance and behavior of the subsurface soils and rock comprising the foundation materials are all necessary prior to the most beneficial use of these conclusions and recommendations. With respect to the above presumption the following analyses, conclusions and recommendations are presented for the work within the project limits.

As presently proposed, the pump station will bear within or above the stratum of soft to medium stiff clayey silt/organic silt. These soils are compressible under loading. Any structure founded within or above these soils would be subject to potentially excessive total or differential settlement. Since the equipment within the proposed pump station

will require rigid, horizontal foundations and any differential settlement would be potentially damaging, the clayey silt will be unsuitable for support of the structure. Therefore, it is recommended that the entire structure be founded on piles driven to end bearing on bedrock.

Since the pile lengths on this project will vary widely due to the varying foundation elevations required for the structure and hard driving will be required to penetrate the very dense granular soils and highly weathered bedrock overlying the bedrock surface, steel H piles are recommended for use on this project. Steel H piles are easy to cut and splice, are not susceptible to damage during hard driving and do not displace significant quantities of existing soil, minimizing the possibility of damage to the foundations supporting the adjacent structures.

The following recommendations are provided for use in design of the steel H piles to be utilized on this project.

- Pile type – steel H pile
- Pile section – as needed based on final design loads
- Pile driving criteria – drive to practical refusal on bedrock (minimum 20 blows per inch for last 2 inches of penetration)
- Maximum allowable axial pile capacity – 100 tons per pile in compression
- Minimum pile spacing – 3 feet center to center
- Estimated pile length – varies 15 feet to 55 feet
- Minimum embedment in pile cap – 6 inches (12 inches preferred)
- Lateral load capacity of vertical piles – 3 kips

- If possible, all lateral loads should be taken in axial load on battered piles
- Maximum pile batter – 1 horizontal to 3 vertical
- Uplift capacity – weight of pile
- Splices
  - fully welded if pile will ever be tension
  - mechanical if pile will always be in compression
  - maximum one splice per pile
  - no splices in the top 10 feet of any pile
- Minimum hammer energy – 19,500 foot pounds per blow
- Vibratory hammers should <u>not</u> be allowed
- Pile tip reinforcement is required
- Epoxy coating of piles to inhibit corrosion or a 1/16" reduction in pile cross section to allow for corrosion is recommended
- Two (2) test piles should be provided to confirm anticipated driving length
- Pile dynamic analyzer (PDA) tests are recommended on each test pile to confirm anticipated pile capacity
- For all pile groups, piles must be driven in such a sequence that the interior piles of the group are driven prior to the exterior piles
- Pile design must be consider imposed bending resulting from freestanding piles in fluid soil
- Piles in fluid soils must be designed as unsupported columns
- System must be tied together to resist lateral spreading of soils
- Bottom of liquefaction susceptible soils (fluid soils) E1.-20.0

No bedrock will be encountered in the excavation for the pump station. However, it is recommended that a nominal quantity of rock excavation be estimated to account for any boulders which may be present within the soil mass.

Due to the depth of the required excavation, the relatively high ground water table and the proximity of several existing structures, the use of an open excavation for construction of the pump station would be impractical. Therefore, temporary support of the excavation will be required. It is recommended that internally braced steel sheeting be utilized for this purpose. The sheeting may be left in place or removed after the completion of construction.

Extensive dewatering of the excavation will be required during construction. It is anticipated that a system of wellpoints or deep dewatering wells may be required to lower the water table in the project area and reduce the lateral loads on the sheeting. All structural concrete must be placed in the dry. Under no circumstances should any structural concrete be placed under wet conditions.

It is recommended that the Contractor be responsible for the design of both the excavation support and dewatering systems since the method and sequence of construction will have significant bearing on the design of these installations. A factor of safety of 1.5 should be provided in the design of the excavation support systems.

Groundwater levels observed in borings drilled at the site were generally about 15 feet below ground surface (elevation +5.0). Ground water levels higher than those observed

will likely be encountered after construction of the proposed facilities during periods of prolonged heavy precipitation. According to the Flood Insurance Rate Map (FIRM) for the project area, the potential flood elevation at the project site is elevation 25.0. It is possible that, during periods of sustained, heavy precipitation, the ground water level at the project site could rise to that level. It is recommended that the design water level for this project be established at elevation 25.0 feet.

Since the design water table is considerably above the finished floor grade of the proposed structures, all structures must be designed to resist both lateral and vertical water and soil pressures. It is recommended that an equivalent fluid pressure of 82.0 pounds per square foot per foot be utilized in the design of all below grade walls. In addition, the structures should be designed to resist all buoyancy forces by gravity. All backfill placed outside the structures must consist of clean, granular material containing less than 10 percent by weight passing the number 100 sieve. For design purposes, it may be assumed that all backfill material outside the structure walls will have a dry unit weight of 120.0 pounds per cubic foot and a saturated unit weight of 57.6 pounds per cubic foot. A minimum factor of safety of 1.15 is recommended for use in all floatation calculations. When calculating the floatation safety factor, the vertical resistance mobilized by friction along the exterior face of the structure shall be neglected. Also, weight of any soil outside of the exterior walls shall be neglected.

The soil gradations and the results of the standard penetration tests performed in the borings were evaluated with regard to liquefaction potential. The liquefaction potential

for the clayey silt stratum is moderate to high. The liquefaction potential for all other soils present at the site is low. The recommended "S" factor for design is 1.2.

Foundations for all proposed gravity sewers, force mains and yard piping will be addressed in a future geotechnical engineering report.

Most existing near surface soils at the site are suitable for reuse as fill under structures (storage, maintenance, tool room) and pavements. Virtually all of the near surface soils are suitable for use as fill under landscaped areas. The volume change of these materials is estimated to be negligible. All fills placed under proposed structures and pavements should be compacted to at least 95 percent of maximum dry density. All ice, snow and frozen materials must be removed prior to placing any structure or pavement fills. Any topsoil removed during construction may be stockpiled for reuse on site.

The following pavement structure is recommended for all access drives and parking areas on the site: 3 inches of bituminous concrete placed in 2 courses on 6 inches of processed aggregate base and 10 inches of subbase.

If the existing structures on the site are designated to remain during construction operations, the Contractor will be required to protect and maintain the structural integrity of those structures.