NTH Consultants, Ltd.
Infrastructure Engineering
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Mayor Dennis Morley
City of Eastlake
Mayor's Office
35150 Lakeshore Boulevard
Eastlake, Ohio 44060

June 16, 2016
NTH Project No. 86-160105-200

RE: Geotechnical Engineering Services
Galalina Storm Sewer Pump Station
And Storm Sewer Improvements
Eastlake, Ohio

Dear Mr. Morley:

We are pleased to submit this geotechnical exploration report performed for the proposed Galalina storm sewer pump station and storm sewer improvements. The purpose of this report is to present the results of our exploration for the project, including subsurface soil and groundwater conditions as well as construction considerations and recommendations for project design aspects. We provided our engineering services in general accordance with the agreed-upon scope of work outlined in our Proposal No. 86-160105, dated March 1, 2016.

We appreciate this opportunity to have been of service to you and trust the information provided in this report satisfies your present needs. If you have any questions, or if we may be of further assistance, please contact us.

Very truly yours,

NTH Consultants, Ltd.

Anthoni M. Fazio
Senior Staff Engineer

Heather Audet, P.E.
Senior Project Engineer

cc: Brien Croff- CT Consultants, Inc.

1.0 PROJECT BACKGROUND

We understand that the City of Eastlake is planning to improve the Galalina storm sewer collection system. The planned improvements include a new pump station located at the intersection of Galalina Boulevard and Wacocka Drive as well as new storm sewers on Galalina Boulevard, Wacocka Drive, River Drive, Forest Drive, Matoma Boulevard, Wanaka Drive, Hillside and Hiawatha Boulevard. The depths of the storm sewers are expected to range from 6 to 10 feet, and the pump station is proposed to extend to a depth of approximately 15 feet below the existing ground surface.

2.0 GEOTECHNICAL EXPLORATION

For design of the new sewers and pump station, a geotechnical investigation program was performed over the period from May 2 through May 5, 2016. NTH and our drilling subcontractor, Ohio TestBor, Inc., mobilized to the project site, where we performed 11 test borings and installed three monitoring wells.

Prior to performing the test borings, clearances for underground utilities were obtained from the Ohio Utility Protection Service (OUPS) and the Oil and Gas Producers Underground Protection Service (OGPUPS) by NTH Consultants, Ltd. Test boring locations were staked in the field by NTH personnel. The test boring locations are shown on the Test Boring Location Plan, Figure No. 1 in the Appendix.

2.1 FIELD EXPLORATION

The test borings were drilled using a track-mounted drilling rig under the direct supervision of an NTH field engineer. Borings TB-1 through TB-11 were drilled at the location of the proposed pump station as well as along the alignments of the new sewers.

The test borings were advanced using 2¼ -inch inside diameter hollow stem augers. Soil samples were obtained at 2.5-foot intervals to a depth of 10 feet and then at 5.0-foot intervals thereafter until termination depths of 15 feet were reached for TB-1 through TB-10 and 25 feet for TB-11.

Overburden soil samples were obtained using a standard split spoon sampler and the Standard Penetration Test (SPT) method. The SPT method (ASTM D-1586) consists of driving a 2½-inch inside diameter split-barrel sampler into the soil with a 140-pound weight falling freely through a distance of 30 inches. The sampler is generally driven three successive 6-inch increments, with the number of blows for each increment being recorded. The number of blows required to advance the sampler the last 12 inches is termed the Standard Penetration Resistance (N) and is presented on the individual logs of the test borings. As added information, the blow counts for each 6-inch increment are presented on the test boring logs. The automatic hammer on the rig was calibrated and reported to have an efficiency rating of 96 percent

Soil samples recovered from the split-barrel sampler are designated as "S" on the test boring logs. The soil samples obtained with the split-barrel sampler were sealed in jars and transported to our laboratory for further classification and testing. Samples obtained using the SPT method are generally considered disturbed.

In the field, an NTH engineer supervised the drilling procedures and performed the following specific duties: classified each sample recovered and preserved all recovered soil samples in airtight glass jar; prepared a log of each boring; made seepage and groundwater observations; and provided liaison between Ohio TestBor, Inc. and our Project Engineer so the exploration program could be modified in the event of unanticipated conditions.

General Notes defining the nomenclature used on the logs and elsewhere in this report are presented on Figure No.2. Individual Logs of Test Borings are presented on Figure Nos. 3 to 13. In addition to subsoil stratification, the test boring logs present Standard Penetration Test results, drilling and sampling information, and other pertinent data. The test boring logs included with this report have been prepared based on field and laboratory classification and testing.

Within TB-6, 9 and 11, temporary groundwater monitoring wells were installed at the completion of drilling to evaluate static groundwater levels and conduct in-situ testing of the hydraulic properties of the granular soils located below the groundwater table. The wells were screened between the depths of 10 to 15 feet along the sewer alignment and 20 to 25 feet at the pump station. Logs of Monitoring Wells are presented in Figure Nos. 24 to 26. Slug testing was performed to determine the hydraulic conductivity of the native soils below the groundwater table to aid in evaluating ground water control measures during construction. The results can be seen in Section 4.3.

2.2 LABORATORY TESTING

Representative soil samples were subjected to laboratory testing to determine pertinent engineering characteristics of the subsurface soils. Testing included the determination of natural moisture content, Atterberg Limits, grain-size distribution using mechanical as well as hydrometer testing methods, dry density, unconfined compressive strength and loss on ignition to evaluate the content of organic matter. The results of the soil laboratory tests are presented on the Tabulation of Soil Test Data (Figure No. 14) and in the Logs of Test Boring. The results of grain-size distribution and hydrometer analyses (Figure Nos. 15 through 20).

3.0 SUBSURFACE CONDITIONS

Although the subsurface conditions encountered at the test boring locations varied somewhat, the general subsurface conditions encountered consist of asphalt pavement and base material underlain by native cohesive soils that are in turn underlain by native granular materials that extend to the explored depths.

The surficial materials at most of the explored locations consist of a 2 to 12-inch thick layer of asphalt underlain by 7 to 24 inches of gravel and sand base material. At the proposed pump station location, TB-11 was located outside of the pavement area and at this location the surficial materials consist of 5 inches of topsoil.

Fill materials were encountered in TB-7 and TB-11 and extended to depths of approximately 3 feet at both locations. The fill materials encountered within TB-7 consisted of loose sand and gravel while the fill materials encountered at TB-11 consisted of medium compact clayey silt.

Beneath the surficial pavement and fill materials, the native soils are generally cohesive in nature and consist of soft to hard gray silty clay and clayey silt. At the boring locations, the cohesive soils extended to depths ranging from 3 feet to 8 feet below ground surface (bgs) with the exception of TB-10 where they extended to the explored depth of 15 feet.

The granular soils encountered below the cohesive soils consist of very loose to medium compact sand, sandy silt, clayey sand, silty sand, and sand and gravel. These soils generally extend to the termination of the borings. At the location of TB-11, a thin layer of silty clay was encountered directly below the granular materials, extending from a depth of 24½ feet to the termination depth of 25 feet.

Ground water was encountered at most of the test boring locations during drilling. In general, groundwater was encountered within the test borings at depths ranging between 4 to 10 feet which corresponds to elevations ranging from 571 to 566. Due to the granular nature of the subsurface materials the boreholes filled up with water quickly once the initial water table was reached. Borings TB-1, TB-2, TB-4, TB-5, TB-7, and TB-11 encountered artesian ground water conditions, with water rising to 2 to 3.5 feet bgs. Upon completion of drilling, the recorded groundwater levels correspond to elevations ranging from approximately 572.8 to 571.6. Specific water levels are available on the individual Log of Test Boring sheets attached to this report.

4.0 RECOMMENDATIONS AND CONCLUSIONS

We understand that open-cut construction methods are the preferred option for this project. Conclusions and recommendations pertaining to the design and construction of the proposed storm sewer pump station and storm sewer improvements are presented in the following paragraphs.

4.1 EARTHWORK CONSIDERATIONS

During earthwork operations, the contractor should be prepared to remove portions of the existing pavement that includes asphalt and gravel base. See individual Log of Test Boring sheets to determine asphalt thickness as it varies for each location. In areas where the proposed storm sewer improvements are located within the tree and lawn areas, the contractor should expect topsoil to be present at the ground surface.

Underneath the asphalt and gravel base the contractor should expect to encounter cohesive deposits of silty clay that range in consistency from medium to hard. The clayey soils are expected to extend to depths ranging from approximately 3.0 to 8.0 feet. Where excavations extend through the clayey soils, the underlying materials are expected to consist of granular deposits of sand, gravel or silt. Excavations that penetrate the overlying cohesive soils and extend into the granular materials should expect to encounter groundwater. At many of the test boring locations, the groundwater was noted to be artesian due to the confining nature of the clayey soils near the ground surface. As such any excavations that extend below Elevations on the order of 572.8 to 571.6, including those in clayey ground, should expect to encounter groundwater that will require a positive means of control before extending excavations below these depths.

4.2 STABILITY OF EXCAVATIONS

Based on the subsurface conditions encountered at the boring locations, we anticipate the majority of excavations will be performed through cohesive and wet granular soils. Based on our field exploration and laboratory test results, open cut construction methods appear feasible provided that appropriate positive means of groundwater control are utilized for any excavations that extend below the expected groundwater elevation in granular soils.

Excavations must be properly sloped or protected in accordance with OSHA requirements. In trenches and other excavations where there is inadequate space to allow for proper side slopes due to the presence of adjacent structures or utilities, temporary earth support should be provided using steel sheet piling. Appropriate trench box type excavation support systems can also be considered for shallow excavations.

Bracing systems for utility trenches may include portable trench boxes or sliding trench shields, provided groundwater control is undertaken. Otherwise, a watertight system will be required. In all cases, OSHA requirements must be followed and adequate protection provided for workers. Construction traffic and excavated material stockpiles should be kept away from excavations a minimum distance equal to the full depth of the excavation, unless the resulting surcharge loads are accounted for in the design of the lateral bracing system.

Based on the soil and groundwater conditions encountered, bottom instability and potential quick or heaving conditions are anticipated if the ground water is not controlled during excavation.

Extreme care must be exercised when making excavations close to surface and subsurface structures and utilities to prevent undermining or damage to the supported facilities. If excavations extend into the zone of influence of footings for any other structures, it will be necessary to provide temporary support to the existing footings during the time when excavations are open. Such temporary support measures could include temporary support systems, or underpinning of the existing footings adjacent to open excavations. The zone of influence of a footing may be considered to extend from the edge of the footing bottom in a downward direction at a slope of 1 unit horizontal to 1 unit vertical (1H:1V) away from the footing. Similarly, it will be necessary to provide temporary support to existing pavements if foundation or other excavations are made adjacent to or closely approach existing roadway pavements that are to remain.

4.3 GROUNDWATER CONTROL IN CONSTRUCTION EXCAVATIONS

On June 1, 2016 permeability testing was done for all monitoring wells within the granular soils. Table 1 below outlines the permeability coefficient (K) estimated using data from the slug tests. Figures 21 through 23 also present the graphical representation of slug testing data.

Table 1 Permeability Coefficients

Location	Screen Elevation (ft)	Soil	Permeability (ft./sec)
MW-6	551-546	Silty Sand	$2.7x10^{-5}$
MW-9	551-546	Sandy Gravel and Silty Sand	$7.6x10^{-2}$
MW-11	535-525	Sand and Gravelly Sand	$4.3x10^{-2}$

Based on the high permeability rate of the granular soils encountered at the boring locations, we anticipate significant groundwater inflow from the silt and sand layers into open cut excavations that extend below the groundwater table. Based on the relatively high permeability of the granular soils at the site as well as the relatively high groundwater table, we recommend that excavations extending below the groundwater table utilize a positive means of groundwater control such as well points to maintain the stability of trench bottoms and sides and prevent the migration of soil materials into excavations for the proposed sewers and pump station. The pump station excavation must be dewatered to prevent bottom instability and the use of a water-tight earth retention system is recommended to maintain a stable excavation.

4.4 TRENCH BEDDING AND BACKFILL

We anticipate the proposed storm sewer will be constructed using open cut methods. Trench bedding below and above the storm sewer should conform to the City of Eastlake requirements or the Ohio Department of Transportation 2013 Construction and Material Specifications (CMS) Section 603, entitled Pipe Culverts, Sewers, and Drains. The ODOT specification details the thickness and type of bedding and other information pertinent to the proposed construction. Due to the generally very loose to loose nature of the granular soils at the anticipated sewer invert level, the pipe installation trench should be excavated a minimum of 12 inches below the invert level of the pipe, loose native soils removed, and pipe bedding placed along the full width of the trench bottom. The pipe bedding should be ODOT Type 1 or Type 2 structural backfill and meet the requirements set forth in the ODOT standards and specifications for gradation and

compaction. The bedding materials should be clean and free of organics and other deleterious material and be properly compacted prior to placement of the pipe within the trench bottom.

If not addressed by the project or City specifications, we recommend compaction procedures and equipment for the pipe bedding is chosen based on ODOT Item of the 2013 CMS.

Based on the ODOT specifications for Item 603, we expect that the cohesive soils excavated for pipe construction will not meet the requirements for Type 1 and Type 2 structural fill and therefore will not be suitable for reuse as the bedding or backfill. The sand and gravel and sandy gravel layers meet the requirements of Type 1 and 2 backfill, however, we expect that these materials will be available in limited quantities. Due to their presence below the groundwater table, these materials may also require drying and conditioning so that they are at the optimum moisture content before being used as backfill.

4.5 LATERAL EARTH PRESSURES

As indicated earlier in this report, based on the prevailing site conditions and the anticipated depth of excavation on the order of 20 feet at the pump station, the use of internally braced soldier pile and lagging system with groundwater control or driven steel sheet piles for the earth retention system appears to be feasible for ground support. Such a system is considered to be flexible and will allow for some lateral movement. The amount of movement will depend on the spacing and stiffness of the structural members used and on the presence and spacing of the bracing levels.

Temporary earth support systems that are braced or cantilevered, should be designed by a licensed professional engineer that is experienced in evaluating temporary loading conditions associated with the soil and groundwater conditions at the pump station location. The system selected by the contractor should also consider an appropriate surcharge loading associated with equipment and materials that will be located near the excavation. For the permanent pump station, we expect that the walls of the structure will be generally fixed against lateral movement due to external soil and hydrostatic loading. As such, we recommend that the walls for the structure be designed on the basis of "at rest" earth pressure conditions. Accordingly, an equivalent fluid pressure of 60 psf/ft

may be used for the portion of the walls above the design groundwater level. Below the groundwater level, an equivalent fluid pressure of 90 psf/ft should be used for design of the walls. As indicated earlier in this report, we recommend the groundwater level should be treated as being at the ground surface for purposes of permanent wall design. If long terms surcharge loads are expected due to adjacent activities, these should also be evaluated and included in the permanent lateral load for the structure.

4.6 PUMP STATION FOUNDATION CONSIDERATIONS

Based on an overall evaluation of the subsurface data developed during the course of this investigation as well as the available data regarding the proposed construction, the pump station invert will be located near the interface of the loose gray sand and the underlying medium compact gravelly sand. Due to the loose nature of the soils to a depth of 17 feet, we recommend that the pump station be founded on the medium compact gravelly materials located below Elevation 559. The proposed pump station may be supported on a structural slab or mat foundation bearing on the gravelly sand or upon properly compacted engineered fill that extends from the recommended bearing material. A net allowable bearing pressure of 3000 pounds per square foot (psf) may be used for the design of the foundation for the support of the proposed structure.. The applied gross bearing pressure for a pump station should be calculated based on the weight of the structure including the slab or mat foundation, the contents of the structure, and backfill over the structure, plus any external live loads that may act on the structure.

The granular soils encountered at the proposed pump station invert level during our field exploration could lose stability when overworked by construction equipment and foot traffic or if ground water control is not continued during construction. Therefore, we recommend that once the required bearing materials has been achieved and any required engineered fill placed, that the bottom of the excavation be covered with a layer of coarse aggregate to minimize disturbance of the bearing soils and provide a stable base during the floor construction. Alternatively, a thin mud mat can be constructed to serve as a working platform and also to help stabilize the bottom of the excavation.

In addition to bearing capacity considerations, the foundation design process should also consider whether the total weight of the structure is adequate to withstand the uplift forces resulting from hydrostatic pressures from the accumulation of groundwater within the backfill. We recommend the factor of safety against buoyancy be a value of 1.1 or greater. If the weight of the empty structure is not adequate to resist the hydrostatic uplift forces with an adequate factor of safety, consideration may be given to increasing the plan dimensions of the floor slab / mat foundation so that the foundation projects beyond the walls of the structure. The purpose of such a projection would be to engage the soil (backfill) surrounding the structure so that the weight of the soil would contribute to resisting the uplift forces. Another approach to providing an adequate factor of safety against buoyancy is to increase the floor slab and/or top slab thickness to increase the dead weight of the structure sufficiently. This approach may be used in combination with enlarging the floor slab / mat foundation to project beyond the walls of the structure.

The determination of the required depth of excavation at the foundation location should be performed by a qualified representative of the geotechnical engineer. The foundation excavation should be carefully observed and tested to verify that adequate in-situ soil bearing pressures compatible with the design value are achieved.

If the recommendations outlined in this report are followed, total settlement of the structure is expected to be less than one inch, and differential settlement is expected to be on the order of one-half of the total settlement, provided that the foundation is adequately reinforced and constructed to be sufficiently rigid. In general, increasing the reinforcement and rigidity of the foundation will decrease the differential settlement.

Based on our review of the conditions encountered in the test borings, as well as our knowledge of regional geology in the area, the site may be classified as Site Class E in accordance with the 2013 Ohio Building Code.

5.0 DATA REVIEW AND FIELD MONITORING

The evaluations and recommendations presented in this report relative to site preparation and structure support have been formulated on the basis of the information provided and/or the assumptions stated herein relating to the proposed project. Any significant changes in this information should be brought to our attention for review with respect to the prevailing subsurface conditions.

Our experience indicates that the actual subsoil conditions at a site may vary from those generalized on the basis of test borings made at specific locations. Therefore, we recommend that an experienced geotechnical engineer be retained to provide soil engineering services during the site preparation, excavation, and foundation installation. This is to observe compliance with the design concepts, specifications, and recommendations. Also, field monitoring allows design changes to be made in a timely manner in the event that subsurface conditions differ from those anticipated prior to the start of construction.

After the foundation designs have been completed, the geotechnical engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At this time, it may be necessary to submit supplementary recommendations. If NTH is not retained to perform these functions, NTH will not be responsible for the impact of those conditions on the project. This report has been prepared for the exclusive use CT Consultants, Inc. and the City of Eastlake for the specific application to the proposed Galalina pump station and storm sewer improvements.

6.0 REPORT LIMITATIONS

This report is specifically intended for the design of the proposed Galalina pump station and storm sewer improvements in Eastlake, Ohio. The work was performed in accordance with the prevailing standard of practice in this area at the time the work was performed. No other warranty, express or implied, is provided or intended.

Soil samples obtained during this exploration will be held at our Valley View, Ohio office for 90 days. At that time, CT Consultants, Inc. will have the option to take possession of the samples for continued storage, or we will make arrangement for sample disposal.

The scope of services for this exploration was limited to an evaluation of subsurface conditions for the determination of foundation design for the pump station and storm sewer improvements. The recommendations presented in this report are based on the findings at the 11 soil borings located within the proposed project location. It must be understood that variations between borings can occur. Should significantly different subsurface conditions be encountered during construction, NTH should be contacted immediately to assess the impact of these changes on our recommendations. No environmental surveys, hydrological studies or chemical testing or analyses were performed as part of this geotechnical exploration.

LEGEND

APPROXIMATE LOCATION OF TEST BORINGS DRILLED BY OHIO TESTBOR, INC. UNDER THE SUPERVISION OF NTH CONSULTANTS, LTD. MAY 2 THROUGH MAY 5, 2016

NTH Consultants, Ltd.
Infrastructure Engineering and Environmental Services

CAD FILE NAME: 86-160105	NTH PROJECT No.: 86-160105
INCEP DATE: MAY 2016	DESIGNED BY: AF
DRAWING SCALE: AS SHOWN	DRAWN BY: TG
PLOT DATE: MAY 2016	CHECKED BY: HA

TEST BORING LOCATION PLAN
STORM SEWER IMPROVEMENTS

GALALINA PUMP STATION
EASTLAKE, OHIO

FIGURE No.
1

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NTH Consultants, Ltd.

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GENERAL NOTES

TERMINOLOGY

Unless otherwise noted, all terms utilized herein refer to the Standard Definitions presented in ASTM D 653.

PARTICLE SIZES

Boulders	-	Greater than 12 inches (305mm)
Cobbles	-	3 inches (76.2mm) to 12 inches (305mm)
Gravel - Coarse	-	3/4 inches (19.05 mm) to 3 inches (76.2mm)
Fine	-	No. 4 - 3/16 inches (4.75mm) to 3/4 inches (19.05 mm)
Sand - Coarse	-	No. 10 (2.00mm) to No. 4 (4.75mm)
Medium	-	No. 40 (0.425mm) to No. 10 (2.00mm)
Fine	-	No. 200 (0.074mm) to No. 40 (0.425mm)
Silt	-	0.005mm to 0.074mm
Clay	-	Less than 0.005mm

CLASSIFICATION

The major soil constituent is the principal noun, i.e., clay, silt, sand, gravel. The second major soil constituent and other minor constituents are reported as follows:

Second Major Constituent (percent by weight)	Minor Constituents (percent by weight)
Trace - 1 to 12%	Trace - 1 to 12%
Adjective - 12 to 35% (clayey, silty, etc.)	Little - 12 to 23%
And - Over 35%	Some - 23 to 33%

COHESIVE SOILS

If clay content is sufficient so that clay dominates soil properties, clay becomes the principal noun with the other major soil constituent as modified; i.e., silty clay. Other minor soil constituents may be included in accordance with the classification breakdown for cohesionless soils; i.e., silty clay, trace of sand, little gravel.

Consistency	Unconfined Compressive Strength (psf)	Approximate Range of (N)
Very Soft	Below 500	0 - 2
Soft	500 - 1000	3 - 4
Medium	1000 - 2000	5 - 8
Stiff	2000 - 4000	9 - 15
Very Stiff	4000 - 8000	16 - 30
Hard	8000 - 16000	31 - 50
Very Hard	Over 16000	Over 50

Consistency of cohesive soils is based upon an evaluation of the observed resistance to deformation under load and not upon the Standard Penetration Resistance (N).

COHESIONLESS SOILS

Density Classification	Relative Density %	Approximate Range of (N)
Very Loose	0 - 15	0 - 4
Loose	16 - 35	5 - 10
Medium Compact	36 - 65	11 - 30
Compact	66 - 85	31 - 50
Very Compact	86 - 100	Over 50

Relative density of cohesionless soils is based upon the evaluation of the Standard Penetration Resistance (N), modified as required for depth effects, sampling effects, etc.

SAMPLE DESIGNATIONS

AS - Auger Sample - directly from auger flight
BS - Miscellaneous Sample - bottle or bag
S - Split Spoon Sample - ASTM D 1586
LS - Split Spoon Sample S with Liner Insert 3 inches in length
ST - Shelby Tube Sample - 3 inch diameter unless otherwise noted
PS - Piston Sample - 3 inch diameter unless otherwise noted
RC - Rock Core - NX core unless otherwise noted
CS - Continuous Sample - from rock core barrel or continuous sampling device
VS - Vane Shear

STANDARD PENETRATION TEST (ASTM D 1586) - A 2.0" outside-diameter, 1-3/8" inside-diameter, split barrel sampler is driven into undisturbed soil by means of a 140-pound weight falling freely through a vertical distance of 30 inches. The sampler is normally driven three successive 6-inch increments. The total number of blows required for the final 12 inches of penetration is the Standard Penetration Resistance (N).

LOG OF TEST BORING NO: TB-1

Project Name: Galalina Pump Station
Project Location: Eastlake, Ohio

NTH Consultants, Ltd.
NTH Proj. No.: 86-160105-200
Checked By: MA

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 575.0	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
575		574.8	ASPHALT	0.2									
			GRAVEL Base										
		573.0		2.0			10 4 3						
		572.0	Very Stiff Gray SILTY CLAY	3.0		S-1		7	16				*5000
570					5	S-2	1 2 3	5	9				
			Loose to Very Loose Gray SILTY SAND			S-3	2 1 3	4	8				
565					10	S-4	1 2 1	3	7				
		563.5		11.5									
			Medium Compact Gray SAND										
560		560.0		15.0	15	S-5	5 8 7	15	12				
			END OF BORING AT 15.0 FEET.										
555													
550													
545													
540													

Total Depth: *15 FT*
Drilling Start Date: *5/4/16*
Drilling End Date: *5/4/16*
Inspector: *A. Fazio*
Contractor: *Ohio TestBor, Inc.*
Driller: *D. Hepner*
Drilling Method:
2 1/4" HSA Mobile B-57 track-mounted rig

Plugging Procedure:
Backfilled with bentonite grout, and pavement repaired using cold patch.

Water Level Observation:
Groundwater encountered at 5' during drilling, and encountered at 2'2" upon completion.

Notes:
** = pocket penetrometer value*

Approximate GPS Coordinates:

Figure No. 3

LOG OF TEST BORING 86-160105-200.GPJ NTH CORPORATE.GDT 5/31/16

LOG OF TEST BORING NO: TB-2

Project Name: Galalina Pump Station
Project Location: Eastlake, Ohio

NTH Consultants, Ltd.
NTH Proj. No.: 86-160105-200
Checked By: MA

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 575.0	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
575		574.5	ASPHALT	0.5									
		572.5	GRAVEL Base	2.5		S-1	10 7 4	11	6				
570		570.0	Stiff Dark Gray CLAYEY SILT, Trace Sand, Intermittent Sand Layers	5.0	5	S-2	3 4 5	9	16				*3000
		567.0	Soft Gray SILTY CLAY, Trace Organics	8.0		S-3	1 1 2	3	15				*3000
565					10	S-4	1 2 1	3	8				*3000
560		560.0	Very Loose to Loose Gray SILTY SAND Blowing Sand at 12'	15.0	15	S-5	2 3 5	8	10				*3000
555			END OF BORING AT 15.0 FEET.										
550													
545													
540													

Total Depth: *15 FT*
Drilling Start Date: *5/6/16*
Drilling End Date: *5/6/16*
Inspector: *A. Fazio*
Contractor: *Ohio TestBor, Inc.*
Driller: *D. Hepner*
Drilling Method:
2 1/4" HSA Mobile B-57 track-mounted rig

Plugging Procedure:
Backfilled with bentonite grout, and pavement repaired using cold patch.

Water Level Observation:
Groundwater encountered at 4' during drilling, and encountered at 3'5" upon completion.

Notes:
** = pocket penetrometer value*

Approximate GPS Coordinates:

Figure No. 4

LOG OF TEST BORING 86-160105-200.GPJ NTH CORPORATE.GDT 5/31/16

LOG OF TEST BORING NO: TB-3

Project Name: Galalina Pump Station
Project Location: Eastlake, Ohio

NTH Consultants, Ltd.
NTH Proj. No.: 86-160105-200
Checked By: JA

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 576.0	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
575		575.7	ASPHALT	0.3									
			GRAVEL Base										
		573.7		2.3		S-1	7 3 3	6	18				*3000
						S-2	1 1 2	3	18				*3000
			Stiff Gray SILTY CLAY		5								
570						S-3	1 1 2	3	18				*4500
		568.0		8.0									
						S-4	1 1 1	2	18				
			Very Loose Gray SANDY SILT, Trace Clay		10								
565		564.0		12.0									
			Very Loose Gray SAND, Trace Clay										
		561.0		15.0	15	S-5	3 2 2	4	12				
560			END OF BORING AT 15.0 FEET.										
555													
550													
545													

Total Depth: *15 FT*
Drilling Start Date: *5/6/16*
Drilling End Date: *5/6/16*
Inspector: *A. Fazio*
Contractor: *Ohio TestBor, Inc.*
Driller: *D. Hepner*
Drilling Method:
2 1/4" HSA Mobile B-57 track-mounted rig

Plugging Procedure:
Backfilled with bentonite grout, and pavement repaired using cold patch.

Water Level Observation:
Groundwater encountered at 8' during drilling. No groundwater reading upon completion.

Notes:
** = pocket penetrometer value*

Approximate GPS Coordinates:

Figure No. 5

LOG OF TEST BORING 86-160105-200.GPJ NTH CORPORATE.GDT 6/9/16

LOG OF TEST BORING NO: TB-4

NTH Consultants, Ltd.

Project Name: Galalina Pump Station
Project Location: Eastlake, Ohio

NTH Proj. No.: 86-160105-200
Checked By: MM

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 575.0	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
575		574.4	ASPHALT	0.6									
		573.5	GRAVEL Base	1.5									
		572.0	Stiff Brown SILTY CLAY, Little Sand, Trace Organics	3.0		S-1	3 2 2	4	18				*2500
570			Very Loose Brown SANDY SILT, Little Clay		5	S-2	1 1 1	2	18				
		569.0		6.0		S-3	1 2 1	3	18				
565			Very Loose Coarse SILTY SAND And GRAVEL		10	S-4	1 1 2	3	10				
560		560.0		15.0	15	S-5	1 1 1	2	12				
			END OF BORING AT 15.0 FEET.										
555													
550													
545													
540													

Total Depth: *15 FT*
Drilling Start Date: *5/3/16*
Drilling End Date: *5/3/16*
Inspector: *C. Fellows*
Contractor: *Ohio TestBor, Inc.*
Driller: *D. Hepner*
Drilling Method:
2 1/4" HSA Mobile B-57 track-mounted rig

Plugging Procedure:
Backfilled with bentonite grout, and pavement repaired using cold patch.

Water Level Observation:
Groundwater encountered at 6' during drilling, and encountered at 2'6" upon completion.

Notes:
** = pocket penetrometer value*

Approximate GPS Coordinates:

Figure No. 6

LOG OF TEST BORING NO: TB-5

Project Name: Galalina Pump Station
Project Location: Eastlake, Ohio

NTH Consultants, Ltd.
NTH Proj. No.: 86-160105-200
Checked By: MJB

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 575.0	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
575		574.6	ASPHALT	0.4									
		574.0	GRAVEL Base And Slag	1.0									
			Medium Gray SANDY CLAY, Some Silt			S-1	4 2 2	4	18				*2000
		572.0		3.0									
570					5	S-2	1 1 1	2	13				
			Very Loose Gray SILTY SAND, Trace Clay, Trace Gravel			S-3	1 1 1	2	18		27.4		
565					10	S-4	2 2 2	4	10				
		564.0		11.0									
			Very Loose SILTY SAND, Little Gravel, Trace Clay										
560		560.0		15.0	15	S-5	2 1 2	3	18		19.1		
			END OF BORING AT 15.0 FEET.										
555													
550													
545													
540													

Total Depth: *15 FT*
Drilling Start Date: *5/4/16*
Drilling End Date: *5/4/16*
Inspector: *A. Fazio*
Contractor: *Ohio TestBor, Inc.*
Driller: *D. Hepner*
Drilling Method:
2 1/4" HSA Mobile B-57 track-mounted rig

Plugging Procedure:
Backfilled using cement grout, and pavement repaired using cold patch

Water Level Observation:
Groundwater encountered at 5' during drilling, and encountered at 2'4" upon completion.

Notes:
** = pocket penetrometer value*

Approximate GPS Coordinates:

Figure No. 7

LOG OF TEST BORING 86-160105-200.GPJ NTH CORPORATE.GDT 6/9/16

LOG OF TEST BORING NO: TB-6

NTH Consultants, Ltd.

Project Name: Galalina Pump Station
Project Location: Eastlake, Ohio
NTH Proj. No.: 86-160105-200
Checked By: MAO

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 576.0	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
575		575.6	ASPHALT	0.4									
			Very Stiff Gray SILTY CLAY			S-1	4 2 3	5	17				*5000
		573.0		3.0									
			Medium Gray SILTY CLAY		5	S-2	1 2 2	4	16		26.4	101.1	*1660
570		569.5		6.5		S-3	1 2 1	3	17				
					10	S-4	1 1 1	2	16		23.9		
565			Very Loose Gray SILTY SAND, Trace Clay and Gravel										
		561.0		15.0	15	S-5	1 1 2	3	5				
560			END OF BORING AT 15.0 FEET.										
555													
550													
545													

Total Depth: *15 FT*
Drilling Start Date: *5/5/16*
Drilling End Date: *5/5/16*
Inspector: *A. Fazio*
Contractor: *Ohio TestBor, Inc.*
Driller: *D. Hepner*
Drilling Method:
2 1/4" HSA Mobile B-57 track-mounted rig

Plugging Procedure:
Monitoring well installed.

Water Level Observation:
Groundwater encountered at 6'. No groundwater reading upon completion.

Notes:
** = pocket penetrometer value*

Approximate GPS Coordinates:

Figure No. 8

LOG OF TEST BORING 86-160105-200.GPJ NTH CORPORATE.GDT 5/31/16

LOG OF TEST BORING NO: TB-7

Project Name: Galalina Pump Station
Project Location: Eastlake, Ohio

NTH Consultants, Ltd.
NTH Proj. No.: 86-160105-200
Checked By: TDA

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 575.0	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
575		574.6	ASPHALT	0.4									
		573.5	GRAVEL Base	1.5									
		572.0	Fill: Loose Brown Coarse SAND And GRAVEL, Some Clay	3.0		S-1	7 5 4	9	18				
570		569.5	Very Soft Brown SANDY SILT, Some Clay	5.5	5	S-2	1 1 1	2	18				*500
		568.5	Very Loose Coarse Brown SAND and GRAVEL	6.5		S-3	1/18" - -		18				< *500
		567.5	Very Soft Gray SANDY SILT	7.5									
565					10	S-4	1 2 2	4	16				
			Loose Gray Coarse SILTY SAND And GRAVEL										
560		560.0		15.0	15	S-5	2 3 2	5	18				
			END OF BORING AT 15.0 FEET.										
555													
550													
545													
540													

Total Depth: *15 FT*
Drilling Start Date: *5/3/16*
Drilling End Date: *5/3/16*
Inspector: *C. Fellows*
Contractor: *Ohio TestBor, Inc.*
Driller: *D. Hepner*
Drilling Method:
2 1/4" HSA Mobile B-57 track-mounted rig

Plugging Procedure:
Backfilled with cuttings and pavement repaired with cold patch.

Water Level Observation:
Groundwater encountered at 5' during drilling, and encountered at 2'10" upon completion.

Notes:
** = pocket penetrometer value*

Approximate GPS Coordinates:

Figure No. 9

LOG OF TEST BORING 86-160105-200.GPJ NTH CORPORATE.GDT 5/31/16

LOG OF TEST BORING NO: TB-8

Project Name: Galalina Pump Station
Project Location: Eastlake, Ohio

NTH Consultants, Ltd.
NTH Proj. No.: 86-160105-200
Checked By: RA

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 575.0	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
575		574.6	ASPHALT	0.4									
		574.0	SAND Base	1.0									
		572.5	Very Stiff Gray SANDY CLAY	2.5		S-1	5 4 2	6	18				*5500
570			Very Soft Gray SILTY CLAY		5	S-2	1 1 1	2	18				*500
		569.0		6.0									
		567.0	Very Soft Gray SANDY SILT, Some Clay	8.0		S-3	WOH 1 1	2	18				< *500
565					10	S-4	1 2 3	5	14				
			Very Loose to Loose Gray SILTY SAND and GRAVEL										
560		560.0		15.0	15	S-5	2 3 1	4	18				
			END OF BORING AT 15.0 FEET.										
555													
550													
545													
540													

Total Depth: *15 FT*
Drilling Start Date: *5/3/16*
Drilling End Date: *5/3/16*
Inspector: *C. Fellows*
Contractor: *Ohio TestBor, Inc.*
Driller: *D. Hepner*
Drilling Method:
2 1/4" HSA Mobile B-57 track-mounted rig

Plugging Procedure:
Backfilled with cuttings and pavement repaired with cold patch.

Water Level Observation:
Groundwater encountered at 6.5' during drilling. No groundwater encountered upon completion.

Notes:
** = pocket penetrometer value*

Approximate GPS Coordinates:

Figure No. 10

LOG OF TEST BORING 86-160105-200.GPJ NTH CORPORATE.GDT 5/31/16

LOG OF TEST BORING NO: TB-9

Project Name: Galalina Pump Station
Project Location: Eastlake, Ohio

NTH Consultants, Ltd.
NTH Proj. No.: 86-160105-200
Checked By: HA

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 576.0	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
575		575.0	ASPHALT	1.0									
		573.0	Medium Gray SILTY CLAY	3.0		S-1	8 5 2	7	17				*1500
			Very Soft Gray CLAYEY SILT, Trace Sand, Trace Organics		5	S-2	WOH WOH 1	0	17		66		< *500
570		568.5		7.5		S-3	W O H	0	18				< *500
			Loose Dark Gray SANDY GRAVEL, Trace Clay		10	S-4	2 2 2	4	15		14.5		
565		564.0		12.0									
		561.0	Loose Dark Gray SILTY SAND	15.0	15	S-5	WOH 1 3	4	11				
560			END OF BORING AT 15.0 FEET.										
555													
550													
545													

Total Depth: *15 FT*
Drilling Start Date: *5/5/16*
Drilling End Date: *5/5/16*
Inspector: *A. Fazio*
Contractor: *Ohio TestBor, Inc.*
Driller: *D. Hepner*
Drilling Method:
2 1/4" HSA Mobile B-57 track-mounted rig

Plugging Procedure:
Set Monitoring Well to 15'.

Water Level Observation:
Groundwater encountered at 10' during drilling. No groundwater encountered upon completion.

Notes:
** = pocket penetrometer value*

Approximate GPS Coordinates:

Figure No. 11

LOG OF TEST BORING NO: TB-10

Project Name: Galalina Pump Station
Project Location: Eastlake, Ohio

NTH Consultants, Ltd.
NTH Proj. No.: 86-160105-200
Checked By: KA

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 575.0	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
575													
		574.0	ASPHALT	1.0									
		573.5	SAND Base	1.5		S-1	5 4 4	8	18		16.6		>*9000
570					5	S-2	4 6 7	13	18				>*9000
			Hard Brown SILTY CLAY, Little Sand And Fine Gravel			S-3	4 5 6	11	18		15.3	116.9	>*8280
565					10	S-4	4 6 7	13	18				>*9000
560		560.0		15.0	15	S-5	3 5 7	12	18				>*9000
			END OF BORING AT 15.0 FEET.										
555													
550													
545													
540													

Total Depth: *15 FT*
Drilling Start Date: *5/3/16*
Drilling End Date: *5/3/16*
Inspector: *C. Fellows*
Contractor: *Ohio TestBor, Inc.*
Driller: *D. Hepner*
Drilling Method:
2" OD SS, Standard

Plugging Procedure:
Monitoring well installed.

Water Level Observation:
No groundwater encountered upon completion.

Notes:
** = pocket penetrometer value*

Approximate GPS Coordinates:

Figure No. 12

LOG OF TEST BORING 86-160105-200.GPJ NTH CORPORATE.GDT 6/16/16

LOG OF TEST BORING NO: TB-11

Project Name: Galalina Pump Station
Project Location: Eastlake, Ohio

NTH Consultants, Ltd.
NTH Proj. No.: 86-160105-200
Checked By:

SUBSURFACE PROFILE						SOIL SAMPLE DATA							
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 576.0	DEPTH	DEPTH (FT)	SAMPLE TYPE/NO.	BLOWS/ 6-INCHES	STD. PEN RESIST. (N)	REC (in)	FIELD TEST (ppm)	MOIST. CONTENT (%)	DRY DENSITY (PCF)	UNCONF. COMP ST (PSF)
575		575.5	Topsoil CLAYEY SILT	0.5									
			FILL: Medium Compact Brown CLAYEY SILT, Trace Sand			S-1	5 6 6	12	15				
		573.0		3.0									
			Medium Gray SILTY CLAY, Trace Sand		5	S-2	1 1 1	2	17				*2000
		570.5		5.5									
570						S-3	WOH 1 1	2	18		32.2	88.8	*800
			Very Soft Gray SANDY SILT, Little Clay		10	S-4	WOH 1 1	2	17		41.5		
565		564.0		12.0									
			Loose Gray SAND, Trace GRAVEL		15	S-5	3 3 4	7	5				
560		559.0		17.0									
			Medium Compact Gray GRAVELLY SAND, Trace Clay and Silt		20	S-6	4 6 6	12	12		12.8		
555		551.5		24.5									
		551.0	Gray SILTY CLAY	25.0	25	S-7	5 6 6	12	15				
550			END OF BORING AT 25.0 FEET.										
545													

Total Depth: *25 FT*
Drilling Start Date: *5/4/16*
Drilling End Date: *5/4/16*
Inspector: *A. Fazio*
Contractor: *Ohio TestBor, Inc.*
Driller: *D. Hepner*
Drilling Method:
2 1/4" HSA Mobile B-57 track-mounted rig

Plugging Procedure:
Set monitoring well

Water Level Observation:
Groundwater encountered at 5' during drilling and encountered at 2' upon completion.

Notes:
** = pocket penetrometer value*

Approximate GPS Coordinates:

Figure No. 13

PROJECT NO. 86-160105-200 NTH CONSULTANTS, LTD. SHEET 1 OF 1

TABULATION OF LABORATORY SOIL TEST DATA

BORING / TEST PIT / PROBE DESIGNATION	SAMPLE NUMBER	DEPTH OF SAMPLE TIP (FT)	ELEVATION OF SAMPLE TIP (FT)	UNCONFINED COMPRESSIVE STRENGTH (PSF)	FAILURE STRAIN (%)	NATURAL WATER CONTENT (% OF DRY WEIGHT)	IN-PLACE DRY DENSITY (LBS/CU.FT)	PERMEABILITY (CM/SEC)	PARTICLE SIZE DISTRIBUTION (%)						ATTERBERG LIMITS (%)			APPARENT SPECIFIC GRAVITY	LOSS ON IGNITION (%)	UNIFIED SOIL CLASSIFICATION
									CLAY	SILT	FINE SAND	MEDIUM SAND	COARSE SAND	GRAVEL	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX			
B-5	S-3	7.5	567.5	-	-	27.4	-		-	-	-	-	-	-	-	-	-	-	-	-
B-5	S-4	10	565	-	-	19.1	-		5.8	16.2	22	30	11	15	-	-	-	-	-	-
B-6	S-2	5	571	1660	15	26.4	101.1		-	-	-	-		-	-	-	-	-	-	-
B-6	S-4	10	566	-	-	23.9	-		6.8	14.2	45	16	13	5	-	-	-	-	-	-
B-9	S-3	7.5	568.5	-	-	66.0	-		23.4	73.6	2	1	0	-	-	-	-	-	6.2	-
B-9	S-4	10	566	-	-	14.5	-		←	8	7	19	19	47	-	-	-	-	-	-
B-10	S-1	3	572	-	-	16.6	-		-	-	-	-	-	-	-	-	-	-	-	-
B-10	S-3	10	565	8280	8.9	15.3	116.9		-	-	-	-	-	-	-	-	-	-	-	-
B-11	S-3	7.5	568.5	800	15	32.2	88.8		-	-	-	-	-	-	27	20	7	-	-	-
B-11	S-4	10	566	-	-	41.5	-		15.9	55.1	26	3	0	0	-	-	-	-	-	-
B-11	S-6	20	556	-	-	12.8	-		←	11	9	23	22	35	-	-	-	-	-	-

FIGURE NO. 14

NTH Consultants, Ltd.
Infrastructure Engineering
and Environmental Services

NTH Consultants, Ltd.
Southeast Michigan Laboratory

Telephone: 248.553.6300
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Aggregate/Soil Test Report

Report No: MAT:86-160105-200-S011
Issue No: 1

Client: City of Eastlake

Project: Galalina PS and Sewer Improvements
Geotechnical Investigation

Job No: 86-160105-200

This laboratory is accredited by the American Association of State Highway and Transportation Officials (AASHTO). The tests reported have been completed in accordance with the terms of the

AASHTO R18

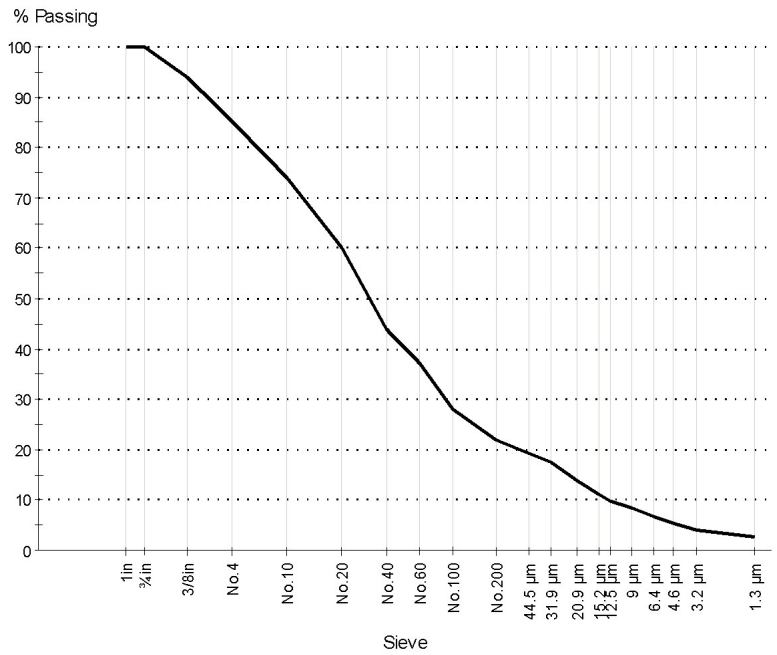
Date of Issue: 5/19/2016
Approved Signatory: Zeerak Paydawy

Sample Details

Boring No:	TB-5
Field Sample No:	S-4
Sample Depth:	10.0
Date Sampled:	5/2/2016
Sampled By:	
LWO No:	001174
Sample Location:	Galalina Pump Station & Storm Sewer

Sample Description:

Particle Size Distribution



COBBLES	GRAVEL		SAND			FINES	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
(0.0%)	(0.0%)	(15.0%)	(11.0%)	(30.0%)	(22.0%)	(16.2%)	(5.8%)

Grading: Particle Size Analysis of Soils - Sieve & Hydrometer [ASTM D 422 - 07]

Drying by:
Date Tested: 5/16/2016

Sieve Size	% Passing	Limits
1in	100	
¾in	100	
3/8in	94	
No.4	85	
No.10	74	
No.20	60	
No.40	44	
No.60	37	
No.100	28	
No.200	22	
44.5 µm	19.4	
31.9 µm	17.5	
20.9 µm	13.9	
15.2 µm	11.3	
12.5 µm	9.9	
9.0 µm	8.4	
6.4 µm	6.9	
4.6 µm	5.5	
3.2 µm	4.0	
1.3 µm	2.6	

NTH Consultants, Ltd.
Infrastructure Engineering
and Environmental Services

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Southeast Michigan Laboratory

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Aggregate/Soil Test Report

Report No: MAT:86-160105-200-S011
Issue No: 1

Client: City of Eastlake

Project: Galalina PS and Sewer Improvements
Geotechnical Investigation

Job No: 86-160105-200

This laboratory is accredited by the American Association of State Highway and Transportation Officials (AASHTO). The tests reported have been completed in accordance with the terms of the

Date of Issue: 5/19/2016
Approved Signatory: Zeerak Paydawy

Sample Details

Boring No: TB-5
Field Sample No: S-4
Sample Depth: 10.0
Date Sampled: 5/2/2016
Sampled By:
LWO No: 001174
Sample Location: Galalina Pump Station & Storm Sewer

Other Test Results

Description	Method	Result	Limits
Particle Size Analysis of Soils - Sieve & Hydrometer [ASTM D 422 - 07]			
Dispersion device		SOIL MIXER	
Dispersion time (min)		1 MINUTE	
Shape			
Hardness			
Date Tested		5/16/2016	
Moisture Content and Dry Density [ASTM D 2216 - 05]			
Moisture Content (%)		19.1	
Wet Density (lb/ft³)			
Dry Density (lb/ft³)			
Date Tested		5/12/2016	

Comments

N/A

NTH Consultants, Ltd.
Infrastructure Engineering
and Environmental Services

NTH Consultants, Ltd.
Southeast Michigan Laboratory

Telephone: 248.553.6300
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Aggregate/Soil Test Report

Report No: MAT:86-160105-200-S009
Issue No: 1

Client: City of Eastlake

Project: Galalina PS and Sewer Improvements
Geotechnical Investigation

Job No: 86-160105-200

This laboratory is accredited by the American Association of State Highway and Transportation Officials (AASHTO). The tests reported have been completed in accordance with the terms of the

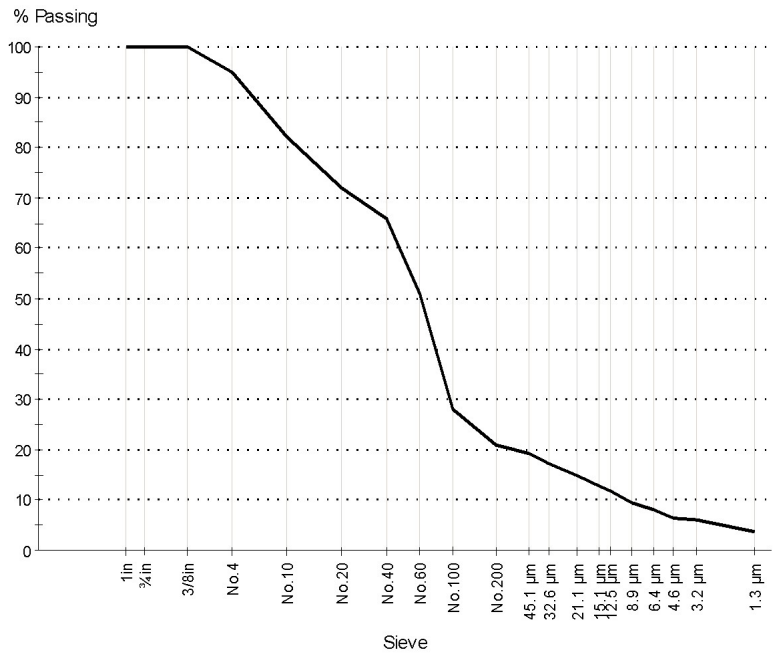
Date of Issue: 5/19/2016
Approved Signatory: Zeerak Paydawy

Sample Details

Boring No:	TB-6
Field Sample No:	S-4
Sample Depth:	10.0
Date Sampled:	5/2/2016
Sampled By:	
LWO No:	001174
Sample Location:	Galalina Pump Station & Storm Sewer

Sample Description:

Particle Size Distribution



COBBLES	GRAVEL		SAND			FINES	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
(0.0%)	(0.0%)	(5.0%)	(13.0%)	(16.0%)	(45.0%)	(14.2%)	(6.8%)

Grading: Particle Size Analysis of Soils - Sieve & Hydrometer [ASTM D 422 - 07]

Drying by:
Date Tested: 5/16/2016

Sieve Size	% Passing	Limits
1in	100	
¾in	100	
3/8in	100	
No.4	95	
No.10	82	
No.20	72	
No.40	66	
No.60	51	
No.100	28	
No.200	21	
45.1 µm	19.3	
32.6 µm	17.3	
21.1 µm	14.9	
15.1 µm	12.9	
12.5 µm	11.7	
8.9 µm	9.6	
6.4 µm	8.0	
4.6 µm	6.4	
3.2 µm	6.0	
1.3 µm	3.6	

NTH Consultants, Ltd.
Infrastructure Engineering
and Environmental Services

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Telephone: 248.553.6300
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Aggregate/Soil Test Report

Report No: MAT:86-160105-200-S009
Issue No: 1

Client: City of Eastlake

Project: Galalina PS and Sewer Improvements
Geotechnical Investigation

Job No: 86-160105-200

This laboratory is accredited by the American Association of State Highway and Transportation Officials (AASHTO). The tests reported have been completed in accordance with the terms of the

Date of Issue: 5/19/2016
Approved Signatory: Zeerak Paydawy

Sample Details

Boring No:	TB-6
Field Sample No:	S-4
Sample Depth:	10.0
Date Sampled:	5/2/2016
Sampled By:	
LWO No:	001174
Sample Location:	Galalina Pump Station & Storm Sewer

Other Test Results

Description	Method	Result	Limits
Particle Size Analysis of Soils - Sieve & Hydrometer [ASTM D 422 - 07]			
Dispersion device		SOIL MIXER	
Dispersion time (min)		1 MINUTE	
Shape			
Hardness			
Date Tested		5/16/2016	
Moisture Content and Dry Density [ASTM D 2216 - 05]			
Moisture Content (%)		23.9	
Wet Density (lb/ft³)			
Dry Density (lb/ft³)			
Date Tested		5/12/2016	

Comments

N/A

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Telephone: 248.553.6300
Fax: 734.524.0927

Aggregate/Soil Test Report

Report No: MAT:86-160105-200-S006
Issue No: 1

Client: City of Eastlake

Project: Galalina PS and Sewer Improvements
Geotechnical Investigation

Job No: 86-160105-200

This laboratory is accredited by the American Association of State Highway and Transportation Officials (AASHTO). The tests reported have been completed in accordance with the terms of the

AASHTO R18

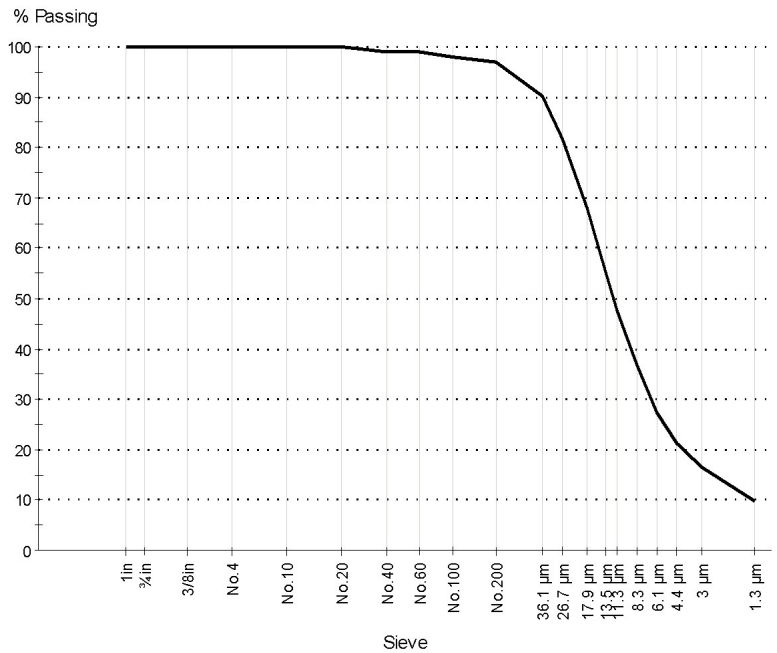
Date of Issue: 5/19/2016
Approved Signatory: Zeerak Paydawy

Sample Details

Boring No:	TB-9
Field Sample No:	S-3
Sample Depth:	7.5
Date Sampled:	5/2/2016
Sampled By:	
LWO No:	001174
Sample Location:	Galalina Pump Station & Storm Sewer

Sample Description:

Particle Size Distribution



Grading: Particle Size Analysis of Soils - Sieve & Hydrometer [ASTM D 422 - 07]

Drying by:
Date Tested: 5/16/2016

Sieve Size	% Passing	Limits
1in	100	
¾in	100	
3/8in	100	
No.4	100	
No.10	100	
No.20	100	
No.40	99	
No.60	99	
No.100	98	
No.200	97	
36.1 µm	90.3	
26.7 µm	81.6	
17.9 µm	68.0	
13.5 µm	55.4	
11.3 µm	47.6	
8.3 µm	36.9	
6.1 µm	27.2	
4.4 µm	21.4	
3.0 µm	16.5	
1.3 µm	9.7	

COBBLES	GRAVEL		SAND			FINES	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
(0.0%)	(0.0%)	(0.0%)	(0.0%)	(1.0%)	(2.0%)	(73.6%)	(23.4%)

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Southeast Michigan Laboratory

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Aggregate/Soil Test Report

Report No: MAT:86-160105-200-S006
Issue No: 1

Client: City of Eastlake

Project: Galalina PS and Sewer Improvements
Geotechnical Investigation

Job No: 86-160105-200

This laboratory is accredited by the American Association of State Highway and Transportation Officials (AASHTO). The tests reported have been completed in accordance with the terms of the

Date of Issue: 5/19/2016
Approved Signatory: Zeerak Paydawy

Sample Details

Boring No:	TB-9
Field Sample No:	S-3
Sample Depth:	7.5
Date Sampled:	5/2/2016
Sampled By:	
LWO No:	001174
Sample Location:	Galalina Pump Station & Storm Sewer

Other Test Results

Description	Method	Result	Limits
Particle Size Analysis of Soils - Sieve & Hydrometer [ASTM D 422 - 07]			
Dispersion device		SOIL MIXER	
Dispersion time (min)		1 MINUTE	
Shape			
Hardness			
Date Tested		5/16/2016	
Moisture, Ash and Organic Content [ASTM D 2974 - 07]*			
Ash Content (%)		93.8	
Organic Content (%)		6.2	
Furnace Temperature (°C)		440	
Moisture Content (%)		66.0	
Moisture contents are proportioned by		oven-dried mass	
Moisture Content Method (A or B)		A	
Ash Content Method (C or D)		C	
Date Tested		5/16/2016	
Moisture Content and Dry Density [ASTM D 2216 - 05]			
Moisture Content (%)		66.0	
Wet Density (lb/ft³)			
Dry Density (lb/ft³)			
Date Tested		5/12/2016	

Comments

* Unaccredited test method

Figure 17

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Aggregate/Soil Test Report

Report No: MAT:86-160105-200-S007
Issue No: 1

Client: City of Eastlake

Project: Galalina PS and Sewer Improvements
Geotechnical Investigation

Job No: 86-160105-200

This laboratory is accredited by the American Association of State Highway and Transportation Officials (AASHTO). The tests reported have been completed in accordance with the terms of the

AASHTO R18

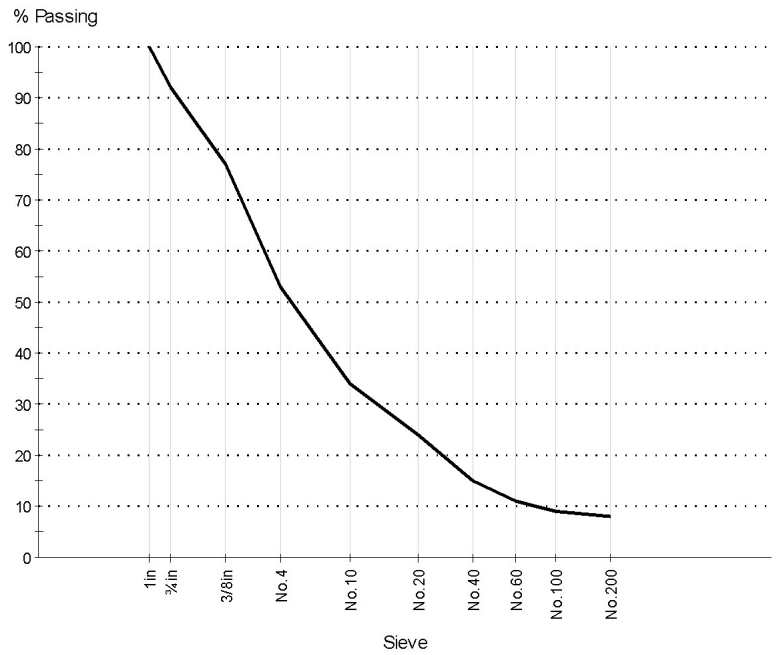
Date of Issue: 5/19/2016
Approved Signatory: Zeerak Paydawy

Sample Details

Boring No:	TB-9
Field Sample No:	S-4
Sample Depth:	10.0
Date Sampled:	5/2/2016
Sampled By:	
LWO No:	001174
Sample Location:	Galalina Pump Station & Storm Sewer

Sample Description:

Particle Size Distribution



COBBLES	GRAVEL		SAND			FINES (8.0%)	
(0.0%)	Coarse (8.0%)	Fine (39.0%)	Coarse (19.0%)	Medium (19.0%)	Fine (7.0%)	Silt	Clay

Grading: Particle Size Analysis of Soils - Sieve & Wash#200 [ASTM D 422 - 07]

Drying by:
Date Tested: 5/16/2016

Sieve Size	% Passing	Limits
1in	100	
¾in	92	
3/8in	77	
No.4	53	
No.10	34	
No.20	24	
No.40	15	
No.60	11	
No.100	9	
No.200	8	
Finer No.200 (75µm)	8	

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Aggregate/Soil Test Report

Report No: MAT:86-160105-200-S007
Issue No: 1

Client: City of Eastlake

Project: Galalina PS and Sewer Improvements
Geotechnical Investigation

Job No: 86-160105-200

This laboratory is accredited by the American Association of State Highway and Transportation Officials (AASHTO). The tests reported have been completed in accordance with the terms of the AASHTO R18

Date of Issue: 5/19/2016
Approved Signatory: Zeerak Paydawy

Sample Details

Boring No:	TB-9
Field Sample No:	S-4
Sample Depth:	10.0
Date Sampled:	5/2/2016
Sampled By:	
LWO No:	001174
Sample Location:	Galalina Pump Station & Storm Sewer

Other Test Results

Description	Method	Result	Limits
Particle Size Analysis of Soils - Sieve & Wash#200 [ASTM D 422 - 07]			
Dispersion device			
Dispersion time (min)			
Shape			
Hardness			
Date Tested		5/16/2016	
Moisture Content and Dry Density [ASTM D 2216 - 05]			
Moisture Content (%)		14.5	
Wet Density (lb/ft³)			
Dry Density (lb/ft³)			
Date Tested		5/12/2016	

Comments

N/A

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Aggregate/Soil Test Report

Report No: MAT:86-160105-200-S002
Issue No: 1

Client: City of Eastlake

Project: Galalina PS and Sewer Improvements
Geotechnical Investigation

Job No: 86-160105-200

This laboratory is accredited by the American Association of State Highway and Transportation Officials (AASHTO). The tests reported have been completed in accordance with the terms of the

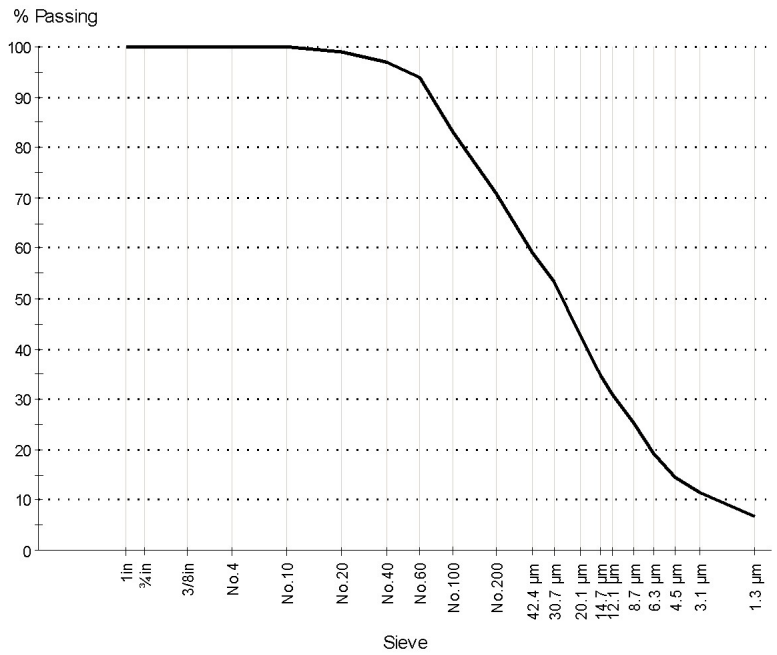
Date of Issue: 5/19/2016
Approved Signatory: Zeerak Paydawy

Sample Details

Boring No:	TB-11
Field Sample No:	S-4
Sample Depth:	10.0
Date Sampled:	5/2/2016
Sampled By:	
LWO No:	001174
Sample Location:	Galalina Pump Station & Storm Sewer

Sample Description:

Particle Size Distribution



COBBLES	GRAVEL		SAND			FINES	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
(0.0%)	(0.0%)	(0.0%)	(0.0%)	(3.0%)	(26.0%)	(55.1%)	(15.9%)

Grading: Particle Size Analysis of Soils - Sieve & Hydrometer [ASTM D 422 - 07]

Drying by:
Date Tested: 5/16/2016

Sieve Size	% Passing	Limits
1in	100	
¾in	100	
3/8in	100	
No.4	100	
No.10	100	
No.20	99	
No.40	97	
No.60	94	
No.100	83	
No.200	71	
42.4 µm	59.1	
30.7 µm	53.3	
20.1 µm	42.7	
14.7 µm	34.9	
12.1 µm	31.0	
8.7 µm	25.2	
6.3 µm	19.4	
4.5 µm	14.5	
3.1 µm	11.6	
1.3 µm	6.8	

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Aggregate/Soil Test Report

Report No: MAT:86-160105-200-S002
Issue No: 1

Client: City of Eastlake

Project: Galalina PS and Sewer Improvements
Geotechnical Investigation

Job No: 86-160105-200

This laboratory is accredited by the American Association of State Highway and Transportation Officials (AASHTO). The tests reported have been completed in accordance with the terms of the

Date of Issue: 5/19/2016
Approved Signatory: Zeerak Paydawy

Sample Details

Boring No:	TB-11
Field Sample No:	S-4
Sample Depth:	10.0
Date Sampled:	5/2/2016
Sampled By:	
LWO No:	001174
Sample Location:	Galalina Pump Station & Storm Sewer

Other Test Results

Description	Method	Result	Limits
Particle Size Analysis of Soils - Sieve & Hydrometer [ASTM D 422 - 07]			
Dispersion device		SOIL MIXER	
Dispersion time (min)		1 MINUTE	
Shape			
Hardness			
Date Tested		5/16/2016	
Moisture Content and Dry Density [ASTM D 2216 - 05]			
Moisture Content (%)		41.5	
Wet Density (lb/ft³)			
Dry Density (lb/ft³)			
Date Tested		5/12/2016	
Moisture, Ash and Organic Content [ASTM D 2974 - 07]*			
Ash Content (%)		95.6	
Organic Content (%)		4.4	
Furnace Temperature (°C)		440	
Moisture Content (%)		42.0	
Moisture contents are proportioned by		oven-dried mass	
Moisture Content Method (A or B)		A	
Ash Content Method (C or D)		C	
Date Tested		5/16/2016	

Comments

* Unaccredited test method

Figure 19

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Aggregate/Soil Test Report

Report No: MAT:86-160105-200-S003
Issue No: 1

Client: City of Eastlake

Project: Galalina PS and Sewer Improvements
Geotechnical Investigation

Job No: 86-160105-200

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AASHTO R18

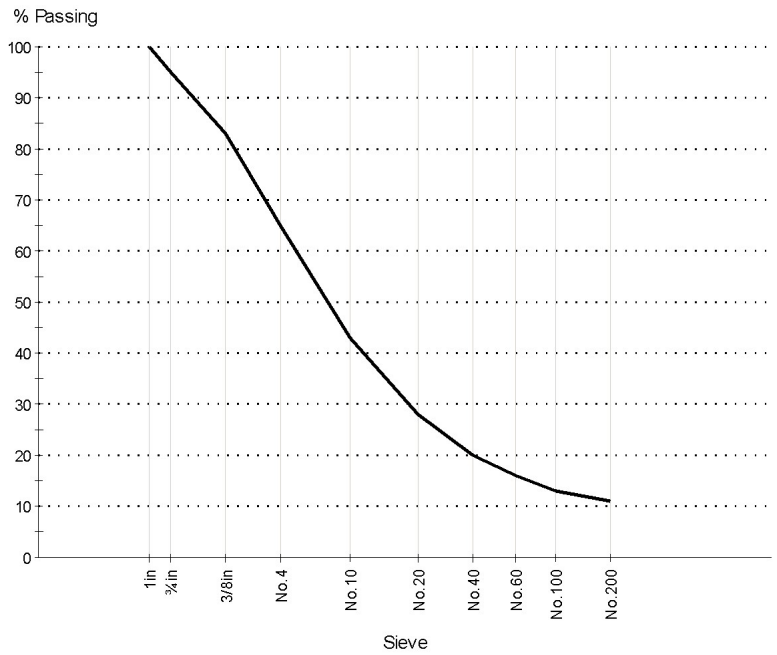
Date of Issue: 5/19/2016
Approved Signatory: Zeerak Paydawy

Sample Details

Boring No:	TB-11
Field Sample No:	S-6
Sample Depth:	20.0
Date Sampled:	5/2/2016
Sampled By:	
LWO No:	001174
Sample Location:	Galalina Pump Station & Storm Sewer

Sample Description:

Particle Size Distribution



COBBLES	GRAVEL		SAND			FINES (11.0%)	
(0.0%)	Coarse (5.0%)	Fine (30.0%)	Coarse (22.0%)	Medium (23.0%)	Fine (9.0%)	Silt	Clay

Grading: Particle Size Analysis of Soils - Sieve & Wash#200 [ASTM D 422 - 07]

Drying by:
Date Tested: 5/16/2016

Sieve Size	% Passing	Limits
1in	100	
¾in	95	
3/8in	83	
No.4	65	
No.10	43	
No.20	28	
No.40	20	
No.60	16	
No.100	13	
No.200	11	
Finer No.200 (75µm)	10	

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Aggregate/Soil Test Report

Report No: MAT:86-160105-200-S003
Issue No: 1

Client: City of Eastlake

Project: Galalina PS and Sewer Improvements
Geotechnical Investigation

Job No: 86-160105-200

This laboratory is accredited by the American Association of State Highway and Transportation Officials (AASHTO). The tests reported have been completed in accordance with the terms of the AASHTO R18

Date of Issue: 5/19/2016
Approved Signatory: Zeerak Paydawy

Sample Details

Boring No:	TB-11
Field Sample No:	S-6
Sample Depth:	20.0
Date Sampled:	5/2/2016
Sampled By:	
LWO No:	001174
Sample Location:	Galalina Pump Station & Storm Sewer

Other Test Results

Description	Method	Result	Limits
Moisture Content and Dry Density [ASTM D 2216 - 05]			
Moisture Content (%)		12.8	
Wet Density (lb/ft³)			
Dry Density (lb/ft³)			
Date Tested		5/12/2016	
Particle Size Analysis of Soils - Sieve & Wash#200 [ASTM D 422 - 07]			
Dispersion device			
Dispersion time (min)			
Shape			
Hardness			
Date Tested		5/16/2016	

Comments

N/A

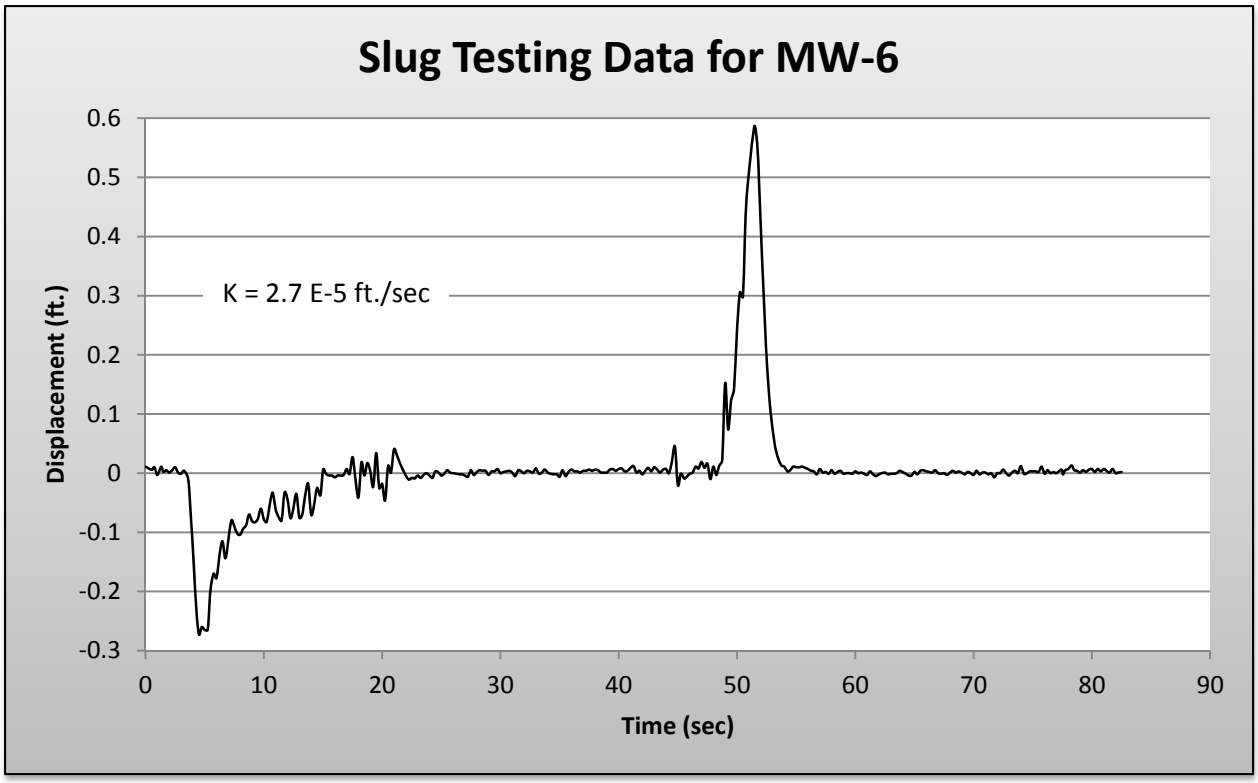


Figure No. 21

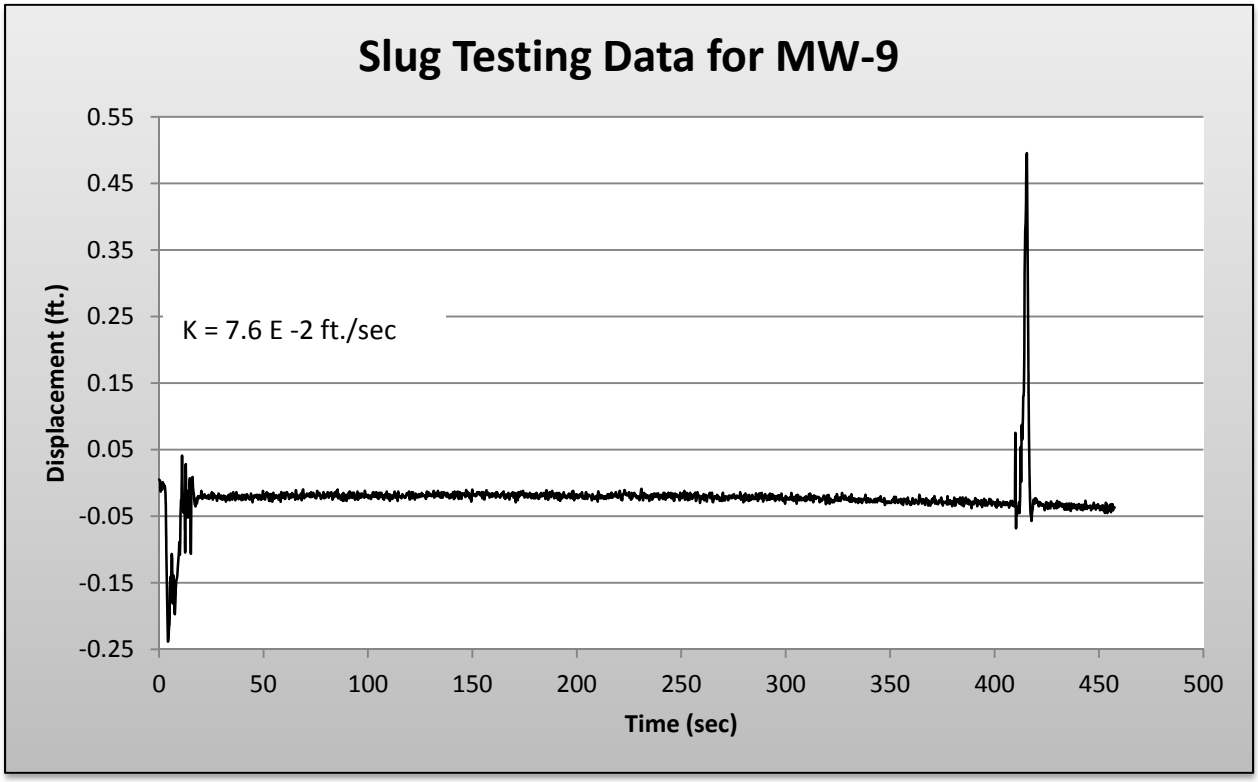


Figure No. 22

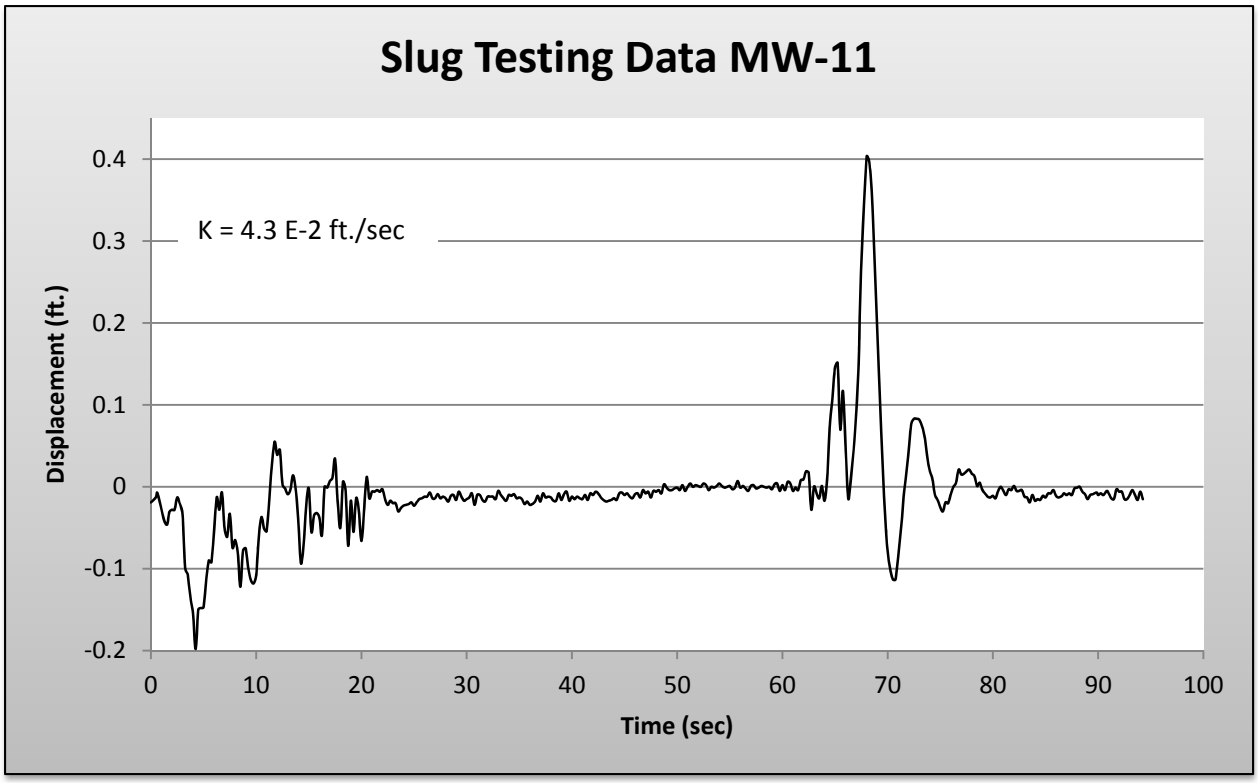

Slug Testing Data MW-11
K = 4.3 E-2 ft./sec
Displacement (ft.)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
0
10
20
30
40
50
60
70
80
90
100
Time (sec)

Figure No. 23

MONITORING WELL: MW-6

Project Name: Galalina PS Sewer
Project Location: Eastlake, OH

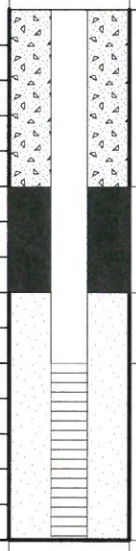
NTH Consultants, Ltd.
NTH Proj. No.: 86-160105
Checked By:

LOG OF MONITORING WELL

SUBSURFACE PROFILE

ELEV. (FT)	ELEV	GROUND SURFACE ELEVATION: 576.0	DEPTH
			0.0
575	575.6	ASPHALT	0.4
		Very Stiff Gray SILTY CLAY	
	573.0		3.0
		Medium Gray SILTY CLAY	
570	569.5		6.5
		Very Loose Gray SILTY SAND, Trace Clay and Gravel	
565	561.0		15.0
560		END OF BORING AT 15.0 FEET.	
555			
550			
545			

INSTALLATION SCHEMATIC



TOP OF WELL CASING ELEVATION: 575.8 ft

0.0	
Cement Grout	
5.0	
Bentonite Slurry	
8.0	
Sand	
10.0	
Sand	
15.0	

WATER LEVEL DATA

DATE	ELEV (FT)	Depth
5/18/2016	572.4	3.4 feet
5/27/2016	572.6	3.2 feet
5/18/2016	571.4	4.4 feet

Total Depth: *15.0 FT*
Installation Date: *5/5/2016*
Inspector: *A. Fazio*
Contractor: *Ohio TestBor, Inc.*
Driller: *D. Hepner*
Equipment: *2 1/4" HSA Mobile track-mounted rig*

Notes:

Casing Diameter: *2"*
Casing Length: *5'*
Casing Type: *PVC*
Tip Elevation:
GPS Coordinates:

Screen Diameter: *2"*
Screen Length: *10'*
Screen Mesh: *SLOTTED"*
Screen Type: *PVC*

Well Type: *MONITORING WELL*

Figure No. 24

MONITORING WELL LOG MW 86-160105.GPJ NTH CORPORATE.GDT 6/16/16

MONITORING WELL: MW-9

Project Name: Galalina PS Sewer
Project Location: Eastlake, OH

NTH Consultants, Ltd.
NTH Proj. No.: 86-160105
Checked By: [illegible]

LOG OF MONITORING WELL

SUBSURFACE PROFILE						INSTALLATION SCHEMATIC		DEPTH DATA		
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 576.0	DEPTH	DEPTH (FT)	Well Detail	TOP OF WELL CASING ELEVATION: 575.8 ft	DATE	ELEV (FT)	Depth
				0.0			0.0	5/18/2016	573.7	2.1 feet
575		575.0	ASPHALT	1.0				5/27/2016	573.95	1.85 feet
		573.0	Medium Gray SILTY CLAY	3.0			Cement Grout	5/18/2016	573.6	2.2 feet
			Very Soft Gray CLAYEY SILT, Trace Sand, Trace Organics		5		5.0			
570		568.5		7.5			Bentonite Slurry 8.0			
			Loose Dark Gray SANDY GRAVEL, Trace Clay		10		Filter Sand 10.0			
565		564.0		12.0			Filter Sand			
			Loose Dark Gray SILTY SAND							
		561.0		15.0	15		15.0			
560			END OF BORING AT 15.0 FEET.							
555										
550										
545										

Total Depth: *15.0 FT*
Installation Date: *5/5/2016*
Inspector: *A. Fazio*
Contractor: *Ohio TestBor, Inc.*
Driller: *D. Hepner*
Equipment: *2 1/4" HSA Mobile track-mounted rig*

Notes:

Casing Diameter: *2"*
Casing Length: *5'*
Casing Type: *PVC*
Tip Elevation:
GPS Coordinates:

Screen Diameter: *2"*
Screen Length: *10'*
Screen Mesh: *SLOTTED"*
Screen Type: *PVC*

Well Type: *MONITORING WELL*

Figure No. 25

MONITORING WELL LOG MW 86-160105.GPJ NTH CORPORATE.GDT 6/15/16

MONITORING WELL: MW-11

Project Name: Galalina PS Sewer
Project Location: Eastlake, OH

NTH Consultants, Ltd.
NTH Proj. No.: 86-160105
Checked By:

LOG OF MONITORING WELL

SUBSURFACE PROFILE						INSTALLATION SCHEMATIC		WATER LEVEL DATA		
ELEV. (FT)	PRO-FILE	ELEV	GROUND SURFACE ELEVATION: 576.0	DEPTH	DEPTH (FT)	Well Detail	TOP OF WELL CASING ELEVATION: 575.8 ft	DATE	ELEV (FT)	Depth
				0.0			0.0	5/18/2016	573.8	2 feet
575		575.5	Topsoil CLAYEY SILT	0.5				5/27/2016	574.2	1.6 feet
			FILL: Medium Compact Brown CLAYEY SILT, Trace Sand					5/18/2016	573.6	2.2 feet
		573.0		3.0						
			Medium Gray SILTY CLAY, Trace Sand		5					
570		570.5		5.5			Cement Grout			
			Very Soft Gray SANDY SILT, Little Clay		10					
565							11.0			
		564.0		12.0			Bentonite Slurry			
							14.0			
			Loose Gray SAND, Trace GRAVEL		15		Sand 15.0			
560		559.0		17.0						
			Medium Compact Gray GRAVELLY SAND, Trace Clay and Silt		20		Sand			
555										
		551.5		24.5						
		551.0	Gray SILTY CLAY	25.0	25		25.0			
550			END OF BORING AT 25.0 FEET.							
545										

Total Depth: *25.0 FT*
Installation Date: *5/5/2016*
Inspector: *A. Fazio*
Contractor: *Ohio TestBor, Inc.*
Driller: *D. Hepner*
Equipment: *2 1/4" HSA Mobile track-mounted rig*

Notes:

Casing Diameter: *2"*
Casing Length: *15'*
Casing Type: *PVC*
Tip Elevation:
GPS Coordinates:

Screen Diameter: *2"*
Screen Length: *10'*
Screen Mesh: *SLOTTED"*
Screen Type: *PVC*

Well Type: *MONITORING WELL*

Figure No. 26

MONITORING WELL LOG MW 86-160105.GPJ NTH CORPORATE.GDT 6/16/16