Kumar & Associates, Inc.®
Geotechnical and Materials Engineers
and Environmental Scientists

800 Stockton Avenue, #4
Fort Collins, CO 80524
phone: (970) 416-9045
fax: (970) 416-9040
email: kaftcollins@kumarusa.com
www.kumarusa.com

An Employee Owned Company

Office Locations: Denver (HQ), Parker, Colorado Springs, Fort Collins, Glenwood Springs, and Summit County, Colorado

GEOTECHNICAL ENGINEERING STUDY
PROPOSED BENNETT WASTEWATER TREATMENT FACILITY IMPROVEMENTS
NEAR THE INTERSECTION OF 4TH STREET AND KENNEDY AVENUE
BENNETT, COLORADO

Prepared By:

Jacob A. Hanson, P.E.

COLORADO REGISTERED PROFESSIONAL ENGINEER
JACOB ALEXANDER HANSON
54404
6-7-22

Reviewed By:

Joshua L. Barker, P.E.

Prepared For:

Town of Bennett
207 Muegge Way
Bennett, CO 80102

Attn: Ms. Robin Price

Project No. 22-3-146

June 7, 2022

TABLE OF CONTENTS

SUMMARY

1. The subsurface conditions at the site were evaluated by drilling nine (9) exploratory borings to depths of about 30 to 50 feet below the existing ground surface. Borings 1 through 4 encountered gravel surfacing overlying man-placed fill that extended to depths of about 1.5 to 5 feet below the ground surface. The man-placed fill was underlain by layers of naturally deposited (natural) granular and clayey soils that extended to the explored depths of about 30 to 40 feet below the ground surface. Boring 5 encountered man-placed fill at the ground surface that extended to a depth of about 2 feet which was in turn underlain by natural granular soils that extended to the explored depth of about 40 feet. Borings 6 through 8 encountered a thin layer of topsoil overlying nil to about 2 feet of man-placed fill material which was in turn underlain by layers of natural granular and clayey soils that extended to the explored depths of about 30 to 50 feet. Boring 9 encountered natural clayey soils at the ground surface which was underlain by layers of natural granular and clayey soils that extended to a depth of about 47 feet. The natural overburden soils were underlain by claystone bedrock that extended to the explored depth of about 50 feet.

   The man-placed fill material consisted of sandy lean clay to clayey sand to silty sand. The natural clayey soils consisted of sandy lean clay to lean clay with sand. The natural granular soils consisted of poorly graded sand to well to poorly graded sand with silt and clayey sand to silty sand.

   Groundwater was not encountered in the borings at the time of drilling or when subsequently checked 19 to 20 days after drilling.

2. Shallow foundations placed on undisturbed natural soils or properly compacted structural fill extending to natural soils should be designed for an allowable soil bearing pressure of 2,500 psf.

3. Slab-on-grade construction is also feasible at the site. Slab on grade floors should be underlain by a minimum of 2 feet of properly compacted fill material extending to undisturbed natural soils. Additional design considerations and recommendations are presented herein.

PURPOSE AND SCOPE OF WORK

This report presents the results of a geotechnical engineering study for the proposed Bennett Wastewater Treatment Facility Improvements project to be located near the intersection of 4th Street and Kennedy Avenue in Bennett, Colorado. The study was conducted for the purpose of developing building foundation, floor slab and pavement recommendations. This study was performed in general accordance with our Proposal No. P3-22-177 to the Town of Bennett dated April 12, 2022 and revised on April 14, 2022.

A field exploration program consisting of exploratory borings was conducted to obtain information on subsurface conditions. Samples of soils and bedrock obtained during the field exploration were tested in the laboratory to determine their strength, compressibility or swell characteristics, and classification. Results of the field exploration and laboratory testing were analyzed to develop recommendations for the building foundations and floor slabs, exterior flatwork areas, and pavements. The results of the field exploration and laboratory testing are presented herein.

This report has been prepared to summarize the data obtained during this study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to construction of the proposed facility are included in the report.

PROPOSED CONSTRUCTION

Based on the information provided, we understand improvements will be made to the existing pond that will include a new pump station just east of the pond area.

If the proposed construction varies significantly from that described above or depicted in this report, we should be notified to re-evaluate the recommendations presented in this report.

SITE CONDITIONS

At the time of drilling, the site contained an existing operations building, headworks building, process tanks, two existing lagoons, a decommissioned lagoon and a cell tower. The site contained a trash pile east of the decommissioned lagoon. The pile was approximately 5 feet tall and approximately 60 feet wide by 300 feet long. The site was relatively flat with a slight slope down to the north and east and steep slopes into the decommissioned lagoon. The site was bounded to the north by East 38th Avenue, to the east by a vacant field followed Darco Street, to the south by Kennedy Avenue and to the west by a gravel pit.

SUBSURFACE CONDITIONS

The subsurface conditions at the site were evaluated by drilling nine (9) exploratory borings to depths of about 30 to 50 feet below the existing ground surface. Logs of the borings are present on Figs. 2 and 3 and the corresponding legend and notes is presented on Fig. 4. The following subsurface descriptions are of a generalized nature to highlight the major stratification features encountered in the borings. The boring logs should be referenced for more detailed information at the immediate location of the borings.

Borings 1 through 4 encountered gravel surfacing overlying man-placed fill that extended to depths of about 1.5 to 5 feet below the ground surface. The man-placed fill was underlain by layers of naturally deposited (natural) granular and clayey soils that extended to the explored depths of about 30 to 40 feet below the ground surface. Boring 5 encountered man-placed fill at the ground surface that extended to a depth of about 2 feet which was in turn underlain by natural granular soils that extended to the explored depth of about 40 feet. Borings 6 through 8 encountered a thin layer of topsoil overlying nil to about 2 feet of man-placed fill material which was in turn underlain by layers of natural granular and clayey soils that extended to the explored depths of about 30 to 50 feet. Boring 9 encountered natural clayey soils at the ground surface which was underlain by layers of n
atural granular and clayey soils that extended to a depth of about 47 feet. The natural overburden soils were underlain by claystone bedrock that extended to the explored depth of about 50 feet.

The man-placed fill material consisted of sandy lean clay to clayey sand to silty sand. The natural clayey soils consisted of sandy lean clay to lean clay with sand. The natural granular soils consisted of poorly graded sand to well to poorly graded sand with silt and clayey sand to silty sand.

The man-placed fill material contained a fine to coarse grained sand fraction and was dry to slightly moist and brown to dark brown to gray. The natural clayey soils contained a fine to coarse grained sand fraction and were slightly moist to moist and brown to dark brown to gray. The natural granular soils were fine to coarse grained with gravel, slightly moist to moist and light brown to brown to gray. The claystone bedrock was fine to medium grained, moist and gray to brown. Based on sampler penetration resistance, the natural clayey soils were stiff to very stiff, the natural granular soils were loose to dense and the claystone bedrock was medium hard.

Groundwater Conditions: Groundwater was not encountered in the borings at the time of drilling or when subsequently checked 19 to 20 days after drilling. Groundwater levels are expected to fluctuate with time, and may fluctuate upward after wet weather or subsequent to landscape irrigation.

LABORATORY TESTING

Laboratory testing was performed on selected soil samples obtained from the borings to determine in-situ soil moisture content and dry density, Atterberg limits, swell-consolidation characteristics, gradation, and concentration of water soluble sulfates. The results of the laboratory tests are shown to the right of the logs on Figs. 2 and 3 and summarized in Table 1. The results of specific tests are graphically plotted on Figs. 5 through 10. The testing was conducted in general accordance with recognized test procedures, primarily those of ASTM and the Colorado Department of Transportation (CDOT).

Swell-Consolidation: Swell-consolidation testing was conducted on samples of the natural overburden soils and bedrock. The swell-consolidation testing was performed in order to determine the compressibility and swell characteristics of the sample under loading and when submerged in water. The samples were prepared and placed in a confining ring between porous discs, subjected to a surcharge pressure of 1,000-psf, and allowed to consolidate before being submerged. The sample height was monitored until deformation practically ceased under each load increment.

Results of the swell-consolidation testing are plotted as a curve of the final strain at each increment of pressure against the log of the pressure, and are presented on Figs. 4 through 6. Based on the results of swell-consolidation testing, the natural clayey soils exhibited low consolidation potential (1.0%) to low swell potential (0.3%) upon wetting at a surcharge pressure of 1,000-psf. The claystone bedrock exhibited moderate swell potential (2.9%) when wetted at a surcharge pressure of 1,000-psf. Based on our experience with overburden soils in the area, the consolidation of the samples of natural clayey soil was likely due to sample disturbance.

Index Properties: Samples were classified into categories of similar engineering properties in general accordance with the Unified Soil Classification System. This system is based on index properties, including liquid limit and plasticity index and grain size distribution. Values for moisture content, dry density, liquid limit and plasticity index, and the percent of soil passing the U.S. No. 4 and 200 sieves are presented in Table I and adjacent to the corresponding sample on the boring logs.

WATER SOLUBLE SULFATES

The concentration of water-soluble sulfates measured in a sample of the overburden soils obtained from the exploratory borings was 0.00%. This concentration of water soluble sulfates represents a Class S0 severity exposure to sulfate attack on concrete exposed to these materials. These degrees of attack are based on a range of Class S0, Class S1, Class S2, and Class S3 severity exposure as presented in ACI 201.2R-16.

Based on the laboratory test results, we believe special sulfate resistant cement will generally not be required for concrete exposed to the on-site soils.

GEOTECHNICAL CONSIDERATIONS

As previously discussed, site subsurface conditions generally consist of variable depths of fill and natural overburden soils underlain by claystone bedrock. Without documentation of placement conditions including density testing documenting the degree of compaction, the existing fill materials are considered non-engineered and generally not suitable for support of foundations or floor slabs. We have no way to accurately predict the total magnitude of potential settlements if the existing fill is left in place; however, movements exceeding 1-inch are possible.

A shallow spread footing foundation and slab-on-grade floor system are possible for the structures. Mat slab foundations are also feasible for structures on the site. Depending on the depths of fill encountered during site grading, complete fill removal and replacement could be costly. We have no way to accurately predict the total magnitude of potential settlements if the existing fill is left in place; however, movements exceeding 1-inch is possible. Criteria for shallow spread footing foundations are presented below; however, it is very important to the long-term performance of the structures that all of the existing fill materials be removed from below foundation elements and floor slabs and to a distance beyond the building area as outlined in Item 7 of the “Foundation Recommendations” section below.

FOUNDATION RECOMMENDATIONS

<u>Spread Footing Foundations:</u> The design and construction criteria presented below should be observed for a spread footing foundation system. The construction details should be considered when preparing project documents.

1. Footings placed on undisturbed natural soils or properly compacted structural fill extending to undisturbed natural soils should be designed for a net allowable bearing pressure of

2,500 psf. The fill should meet the material and placement requirements provided in the "Site Grading" section of this report.

2. Based on experience, we estimate total settlement for footings designed and constructed as discussed in this section will be less than 1 inch. Differential settlements between individual foundations are estimated to be approximately ½ to ¾ of the total settlement. Due to the presence of near-surface granular soils, settlements should occur during or shortly after construction.

3. Spread footings should have a minimum footing width of 16 inches for continuous footings and of 24 inches for isolated pads.

4. Exterior footings and footings beneath unheated areas should be provided with adequate soil cover above their bearing elevation for frost protection. Placement of foundations at least 36 inches below the exterior grade is typically used in this area.

5. The lateral resistance of a spread footing supported as recommended herein will be a combination of the sliding resistance of the footing on the foundation materials and passive earth pressure against the side of the footing. Resistance to sliding at the bottoms of the footings can be calculated based on a coefficient of friction of 0.35. Passive pressure against the sides of the footings can be calculated using an equivalent fluid unit weight of 200 pcf. The above values are working values. Structural fill placed against the sides of footings to resist lateral loads should meet the material and placement requirements provided in the "Site Grading" section of this report.

6. Continuous foundation walls should be reinforced top and bottom to span an unsupported length of at least 10 feet.

7. Areas of existing fill, loose and/or soft material, or deleterious substances encountered within footing excavations should be removed and replaced with structural fill. New fill should extend down from the edges of the footings at a 1 horizontal to 1 vertical projection.

8. Care should be taken when excavating the foundations to avoid disturbing the supporting materials.

9. A representative of the geotechnical engineer should observe all footing excavations prior to concrete placement.

Mat Slab Foundations: The design and construction criteria presented below should be observed for a mat foundation system. Construction details should be considered when preparing project documents.

1. A mat foundation placed on undisturbed natural soils or properly compacted structural fill extending to undisturbed natural soils may be designed for an allowable contact pressure of 2,500 psf. This contact pressure may be increased to 3,000 psf for transient loadings.

2. Settlements were computed assuming a rigid mat and symmetrically distributed column loads. Settlement of the subgrade soils were calculated based on elastic theory. These settlements are assumed to occur immediately after the application of loads.

   Based on the above, we estimate settlements beneath a rigid mat will be on the order of 1 inch and differential settlements are estimated to be approximately ½ inch to ¾ inch. Nonuniformity of the subsurface conditions, (stress overlap between adjacent mat foundations) and deviation from the rigid mat assumption will contribute to total and differential settlements.

   Rigidity of the mat is dependent on the mat dimensions, column spacing, rigidity of the superstructure and the modulus of subgrade reaction of the supporting soils. We recommend the foundation be analyzed to determine if the rigidity assumption is valid.

   If the mat cannot be considered rigid, the soil pressure distribution should be computed using a method which models the soil-structure interaction, such as the beam on an elastic foundation procedure. A modulus of vertical subgrade reaction equal to 120 pci may be used for the clayey soils (The modulus value given is for a 1-foot square plate and must be corrected for mat shape and size.)

   When the soil pressure distribution has been determined, we should be contacted to reanalyze the settlement pattern of the foundation. The process of evaluating soil pressure distribution beneath the foundation may require more than one iteration for a foundation which classifies between rigid and flexible.

3. The mat slab should extend down or should be insulated at least 36 inches below exterior grade

4. The mat foundation will create vertical deflection around the building which should be considered. Differential settlements of the street and underground utilities adjacent to the foundation may occur requiring replacement or repair of the affected areas.

5. Areas of loose or soft materials encountered within the foundation excavation should be removed and replaced with structural fill compacted to 98% of the maximum standard Proctor density near optimum moisture content.

6. Care should be taken in excavation of the foundations to avoid disturbing foundation materials.

7. A representative of the geotechnical engineer should observe all mat excavations prior to concrete placement in order to evaluate the supporting capacity of foundation materials.

FLOOR SLABS

We recommend that slabs on grade be placed on a minimum of 2 feet of properly compacted structural fill extending to undisturbed natural soils to mitigate the potential for settlement due to compression of existing fills remaining beneath the floor slabs. The owner should be made aware that there is an increased risk of floor slab movements if existing fills are left in place below floor slabs.

To reduce the effects of some differential movement, floor slabs should be separated from all bearing walls and columns with expansion joints which allow unrestrained vertical movement. Interior non-bearing partitions resting on floor slabs should be provided with slip joints so that, if the slabs move, the movement cannot be transmitted to the upper structure. This detail is also important for wallboards, stairways and door frames. Slip joints which will allow at least 1½ inches of vertical movement are recommended.

Floor slab control joints should be used to reduce damage due to shrinkage cracking. Joint spacing is dependent on slab thickness, concrete aggregate size, and slump, and should be consistent with recognized guidelines such as those of the Portland Cement Association (PCA) and American Concrete Institute (ACI). The joint spacing and slab reinforcement should be established by the designer based on experience and the intended slab use. We suggest joints be provided on the order of about 12 to 15 feet apart in both directions. The requirements for slab reinforcement should be established by the designer based on experience and the intended slab use.

BELOW GRADE STRUCTURES

Retaining structures should be designed for the lateral earth pressure generated by the backfill materials, which is a function of the degree of rigidity of the retaining structure and the type of backfill material used. Retaining structures that are laterally supported and can be expected to undergo only a moderate amount of deflection, such as basement or vault walls, should be designed for a lateral earth pressure based on the following equivalent at-rest fluid pressures:

CDOT Class 1 (<20% passing No. 200 Sieve) .... 55 pcf
Imported, non-expansive, silty or clayey sand .... 65 pcf
On-site or imported, moisture-conditioned granular backfill .... 65 pcf
On-site, moisture-conditioned clay backfill* .... 70 pcf
* Swell potential less than 2%

Cantilevered retaining structures that can be expected to deflect sufficiently to mobilize the full active earth pressure condition should be designed for the following equivalent fluid pressures:

CDOT Class 1 (<20% passing No. 200 Sieve) .... 40 pcf
Imported, non-expansive, silty or clayey sand .... 45 pcf
On-site or imported, moisture-conditioned granular backfill .... 45 pcf
On-site, moisture-conditioned clay backfill* .... 55 pcf
* Swell potential less than 2%

The equivalent fluid pressures recommended above assume drained conditions behind retaining structures and a horizontal backfill surface. The buildup of water behind a retaining structure or an upward sloping backfill surface will increase the lateral pressure imposed on the retaining structure. All retaining structures should also be designed for appropriate surcharge pressures such as traffic, construction materials and equipment.

The zone of backfill placed behind retaining structures to within 2 feet of the ground surface should be sloped upward from the base of the structure at an angle no steeper than 45 degrees measured from horizontal. To reduce surface water infiltration into the backfill, the upper 2 feet of the backfill should consist of a relatively impervious imported soil containing at least 30% passing the No. 200 sieve, or the backfill zone should be covered by a slab or pavement structure.

Backfill should be compacted to at least 95% of the standard Proctor (ASTM D698) maximum dry density at moisture contents within 2 percentage points of optimum for granular materials and between 0 and +4 percentage points of optimum for clay materials. Care should be taken not to over compact the backfill since this could cause excessive lateral pressure on the wall. Hand compaction procedures, if necessary, should be used to prevent lateral pressures from exceeding the design values.

SITE SEISMIC CRITERIA

According to International Building Code (IBC), the natural overburden soils generally classify as IBC Site Class D. Based on the soil profile encountered in our borings and the standard penetration testing from the field exploration indicates that IBC Site Class D should be used in the design. Based on the subsurface profile, site seismicity, and the anticipated ground water conditions, liquefaction is not a design consideration.

SITE GRADING

Material Suitability and Placement: The on-site overburden soils are generally suitable for use as structural fill beneath structures. Structural fill should not contain particles larger than 3 inches. All fill material should be free of any organic matter and other deleterious substances. The geotechnical engineer should evaluate the suitability of the proposed fill materials prior to placement.

Excavation and Dewatering Considerations: Excavations should be constructed in accordance with all OSHA requirements, and other applicable local and state requirements. Based on the OSHA excavation guidelines, we believe that the on-site man-placed fill and natural soils generally classify as an OSHA Type C soil.

We believe that overburden soils similar to those encountered within the explored depths of the exploratory borings, may be excavated with conventional heavy-duty excavation equipment.

Surface water runoff into the excavations can act to erode and potentially destabilize the trench slopes and result in soft ground conditions along the trench bottom, and should not be allowed. Diversion berms and other measures should be used to prevent surface water runoff into the trenches from occurring.

SURFACE DRAINAGE

Proper surface drainage is very important for acceptable performance of the facility during construction and after construction has been completed. Drainage recommendations provided by local, state and national entities should be followed based on the intended use of the facility. The following recommendations should be used as guidelines and changes should be made only after consultation with the geotechnical engineer.

1. Excessive wetting or drying subgrades should be avoided during construction.

2. The ground surface surrounding the exterior of the structures and paved area should be sloped to drain away from those facilities in all directions. We recommend a minimum slope of 6 inches in the first 10 feet in unpaved areas and a minimum slope of 3 inches in the first 10 feet in paved or landscape areas. Site drainage beyond the 10-foot zone should be designed to promote runoff and reduce infiltration. These slopes may be changed as required for handicap access points in accordance with the Americans with Disabilities Act.

3. Exterior backfill should be adjusted to near optimum moisture content (generally ±2% of optimum unless indicated otherwise in the report) and compacted to at least 95% of the standard Proctor (ASTM D 698) maximum dry density.

4. To promote runoff, the upper 1 to 2 feet of the backfill should be a relatively impervious on-site soil or be covered by flatwork or a pavement structure.

5. Ponding of water should not be allowed in backfill material or in a zone within 10 feet of the structures, whichever is greater.

SITE GRADING

Site Preparation: Based on our understanding of the proposed construction and observed site topography, site grading over most of the site is expected to consist of minor permanent cuts and fills. Material types encountered during site grading will generally consist of natural granular soils and existing fill materials. These materials can be excavated during site grading operations with heavy duty earth moving equipment.

Existing fills, if encountered, are considered non-engineered and unsuitable in their current condition for support of structures unless properly prepared. Proper preparation should include complete removal and replacement of existing fill from beneath foundations, and floor slabs.

The existing on-site natural soils and fill materials should be suitable for use as general site fill and as structural fill beneath structures, provided they do not contain organic material or other deleterious material.

Excavations extending below the groundwater level should be properly dewatered during and possibly prior to the excavation process to help maintain the stability of excavation side slopes and provide stable subgrade conditions for fill placement and foundation construction. The construction dewatering systems should be capable of intercepting groundwater before it can reach the face of excavation side slopes or to maintain a groundwater level at least 2 feet below the bottom of the excavation. Dewatering should continue until construction and associated backfilling extends above the ground water table.

Cut and Fill Slopes: Permanent unretained cuts in the overburden soils and fill slopes up to 10 feet high should be constructed at a 2H:1V (horizontal to vertical) or flatter inclination for stability purposes and at a 3H:1V or flatter inclination for limiting the potential for erosion. If groundwater seepage is encountered during or prior to cut slope excavation, a stability evaluation should be conducted to determine if the seepage would adversely affect the cut.

Material Specifications: Unless specifically modified in the preceding sections of this report, the following recommended material and compaction requirements are presented for compacted fills on the project site. A geotechnical engineer should evaluate the suitability of all proposed fill materials for the project prior to placement.

1. *Structural Fill beneath Structures and Settlement-Sensitive Exterior Flatwork*: Structural fill should consist of on-site soils or, if needed, imported non-expansive soils with a maximum of 50% passing the No. 200 sieve, a maximum Liquid Limit of 30, and a maximum Plasticity Index of 10. Fill source materials, including on-site soils, not meeting these criteria may be acceptable if they meet the swell criteria presented in Item 5 below.

2. *Beneath Movement-Tolerant Exterior Flatwork*: Compacted fill should consist of moisture-conditioned on-site materials or non-expansive imported soil materials.

3. *Pipe Bedding Material*: Pipe bedding material should be a free draining, coarse-grained sand and/or fine gravel.

4. *Utility Trench Backfill*: Materials excavated from the utility trenches may be used for trench backfill above the pipe zone fill provided they do not contain unsuitable material or particles larger than 4 inches and can be placed and compacted as recommended herein.

5. *Material Suitability*: Unless otherwise defined herein, all fill material should be a non-expansive soil free of vegetation, brush, sod, trash and debris, and other deleterious substances, and should not contain rocks or lumps having a diameter of more than 4 inches. A fill material should be considered non-expansive if the swell potential of the material, when remolded to 95% of the standard Proctor (ASTM D 698) maximum dry density at optimum moisture content, does not exceed 0.5% when wetted under a 200 psf surcharge pressure. If grading is performed during times of freezing weather, the fill should not contain frozen materials, and if the subgrade is allowed to freeze, all frozen material should be removed prior to additional fill placement for footing or slab construction.

   Based on the data from the borings and results of the laboratory testing, the on-site soils should be suitable for reuse as compacted site grading fill and as structural fill.

   Evaluation of potential structural fill sources, particularly those not meeting the above liquid limit and plasticity index criteria for imported fill materials, should include determination of laboratory moisture-density relationships and swell-consolidation tests on remolded samples prior to acceptance.

<u>Compaction Requirements</u>: We recommend the following compaction criteria be used on the project:

1. *Moisture Content*: Fill materials should be compacted at moisture contents within 2 percentage points of the optimum moisture content for predominantly granular materials and between 0 and +4 percentage points of optimum for predominantly cohesive materials, if used. The contractor should be aware that the clay materials, including on-site and imported materials, may become somewhat unstable and deform under wheel loads if placed near the upper end of the moisture range.

2. *Placement and Degree of Compaction*: Unless otherwise defined herein, compacted fill should be placed in maximum 8-inch-thick loose lifts. The following compaction criteria should be followed during construction:

Fill Location	Percentage of Maximum Standard Proctor Density (ASTM D-698)
Below Foundations	98%
Beneath Floor Slabs and Settlement-Sensitive Flatwork Areas	
Fill less than 8 Feet below the final ground surface	95%
Fill more than 8 Feet below the final ground surface	98%
Utility Trenches	
Exterior Less Than 8 Feet below the final ground surface	95%
Exterior More Than 8 Feet below the final ground surface	98%
Landscape and Other Areas	90%

[1] Aggregate base course should be compacted to a minimum of 95 percent of the modified Proctor (ASTM D 1557) maximum dry density at moisture contents within 2 percentage points of optimum.

3. *Subgrade Preparation*: Areas receiving new fill should be prepared as recommended in specific sections of this report to provide a uniform base for fill placement. All other areas to receive new fill not specifically addressed herein should be scarified to a depth of at least 8 inches and recompacted to at least 95% of the standard Proctor (ASTM D 698) maximum dry density at moisture contents recommended above.

   Subgrade preparation should include proofrolling with a heavily loaded pneumatic-tired vehicle or a heavy, smooth-drum vibratory roller compactor. Areas that deform excessively during proofrolling should be removed and replaced to achieve a reasonably stable subgrade prior to placement of compacted fill or slabs, or flatwork.

UNDERDRAIN SYSTEM

We encourage the use of an underdrain system to limit the development of perched water near foundations. Given the clayey subgrade soils encountered at the site, there is a risk of post-construction movement due to development of a perched water condition. If an underdrain is not installed, there is still a risk of subsurface water becoming perched near foundations and the owner should be aware and accept the associated risk.

We recommend that the foundations be protected by a perimeter drain system. Although groundwater was not encountered in our explorations at depths near the proposed foundation/

slab elevations, it has been our experience that local perched groundwater may develop during times of heavy precipitation, snow melt, or seasonal irrigation.

The drain system should consist of rigid drainpipe placed in the bottom of a trench or the exterior side of the foundation and surrounded above the invert level with free-draining granular material. Free-draining granular material used in the drain system should contain less than 5% passing the No. 200 sieve, less than 35% passing the No. 4 sieve and have a maximum size of 2 inches. The perimeter drain should be at least 4 inches in diameter. The drain lines should be placed at the bottom of the structural fill layer beneath the foundation and graded to sumps at a minimum slope of 1/2%. The granular underdrain system should be sloped to a sump or multiple sumps where water can be removed by pumping or gravity drainage.

Standby pump capacity should be provided in the event of pump failure. We also believe an overdesigned pump capacity is desirable in the event groundwater conditions change.

DESIGN AND CONSTRUCTION SUPPORT SERVICES

Kumar & Associates, Inc. should be retained to review the project plans and specifications for conformance with the recommendations provided in this report. We are also available to assist the design team in preparing specifications for geotechnical aspects of the project and, if necessary, perform additional studies to accommodate any changes in the proposed construction.

We recommend that Kumar & Associates, Inc. be retained to provide construction observation and testing services to document that the intent of this report and the requirements of the plans and specifications are being followed during construction. This will allow us to identify possible variations in subsurface conditions from those encountered during this study and to allow us to re-evaluate our recommendations, if needed. We will not be responsible for implementation of the recommendations presented in this report by others, if we are not retained to provide construction observation and testing services.

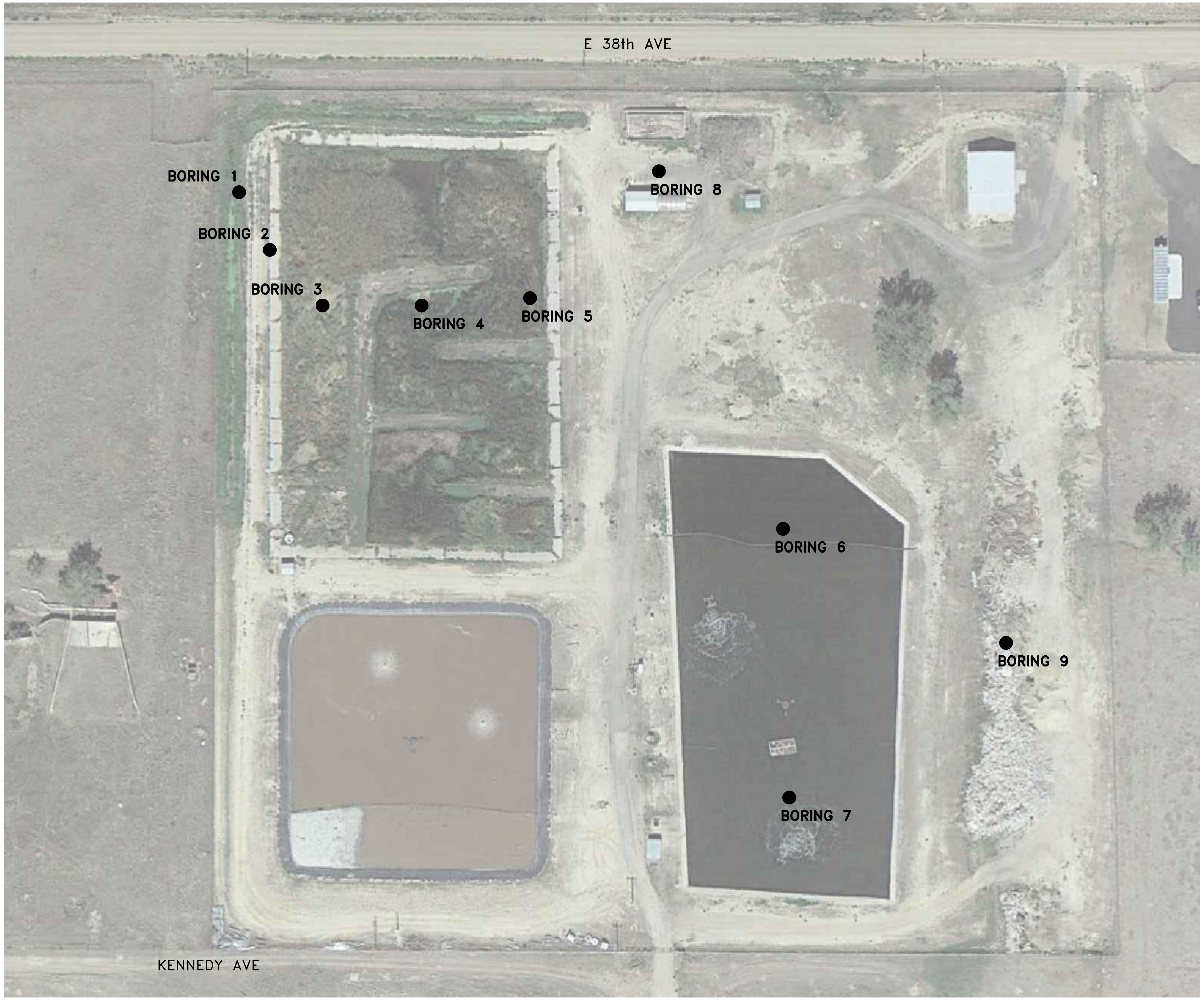
LIMITATIONS

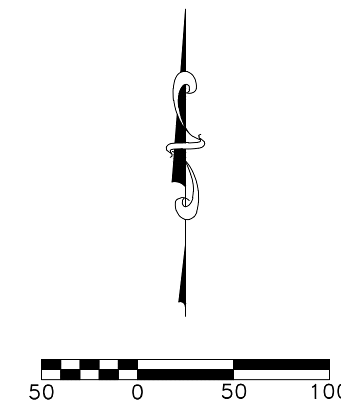
This study has been conducted for exclusive use by the client for geotechnical related design and construction criteria for the project. The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory borings at the locations indicated on Fig. 1 or as described in the report, and the proposed type of construction. This report may not reflect subsurface variations that occur between the exploratory borings, and the nature and extent of variations across the site may not become evident until site grading and excavations are performed. If during construction, fill, soil, rock or water conditions appear to be different from those described herein, Kumar & Associates, Inc. should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. Kumar & Associates, Inc. is not responsible for liability associated with interpretation of subsurface data by others.

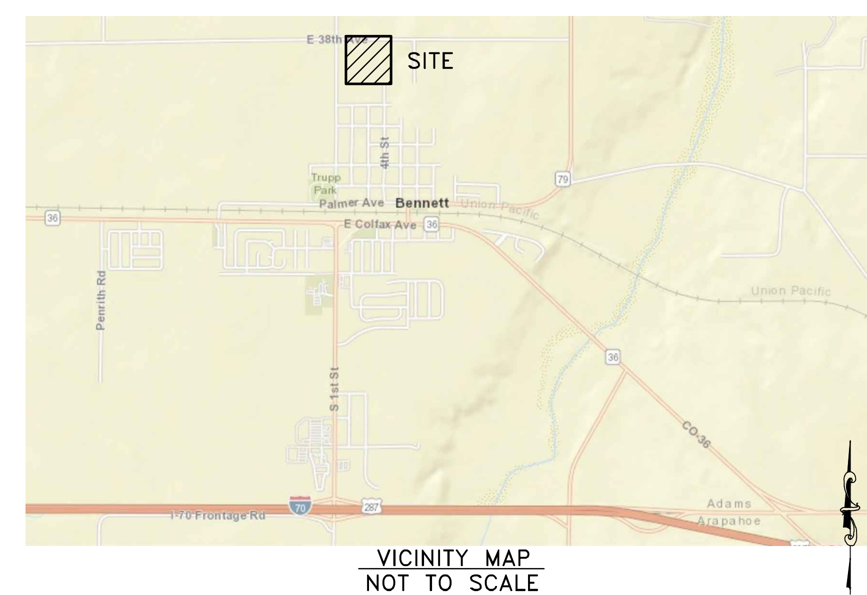
Swelling soils occur on this site. Such soils are stable at their natural moisture content but can undergo high volume changes with changes in moisture content. The extent and amount of perched water beneath the building site as a result of area irrigation and inadequate surface drainage is difficult, if not impossible, to foresee.

The recommendations presented in this report are based on current theories and experience of our engineers on the behavior of swelling soil in this area. The owner should be aware that there is risk of movement and possible damage to foundations, interior slab-on-grade floors, and exterior slabs and pavements on sites where expansive soils and/or bedrock occur. Following the recommendations given by a geotechnical engineer, careful construction practice and prudent maintenance by the owner can, however, decrease this risk.

JAH/mr
Rev. by: JLB
cc: file



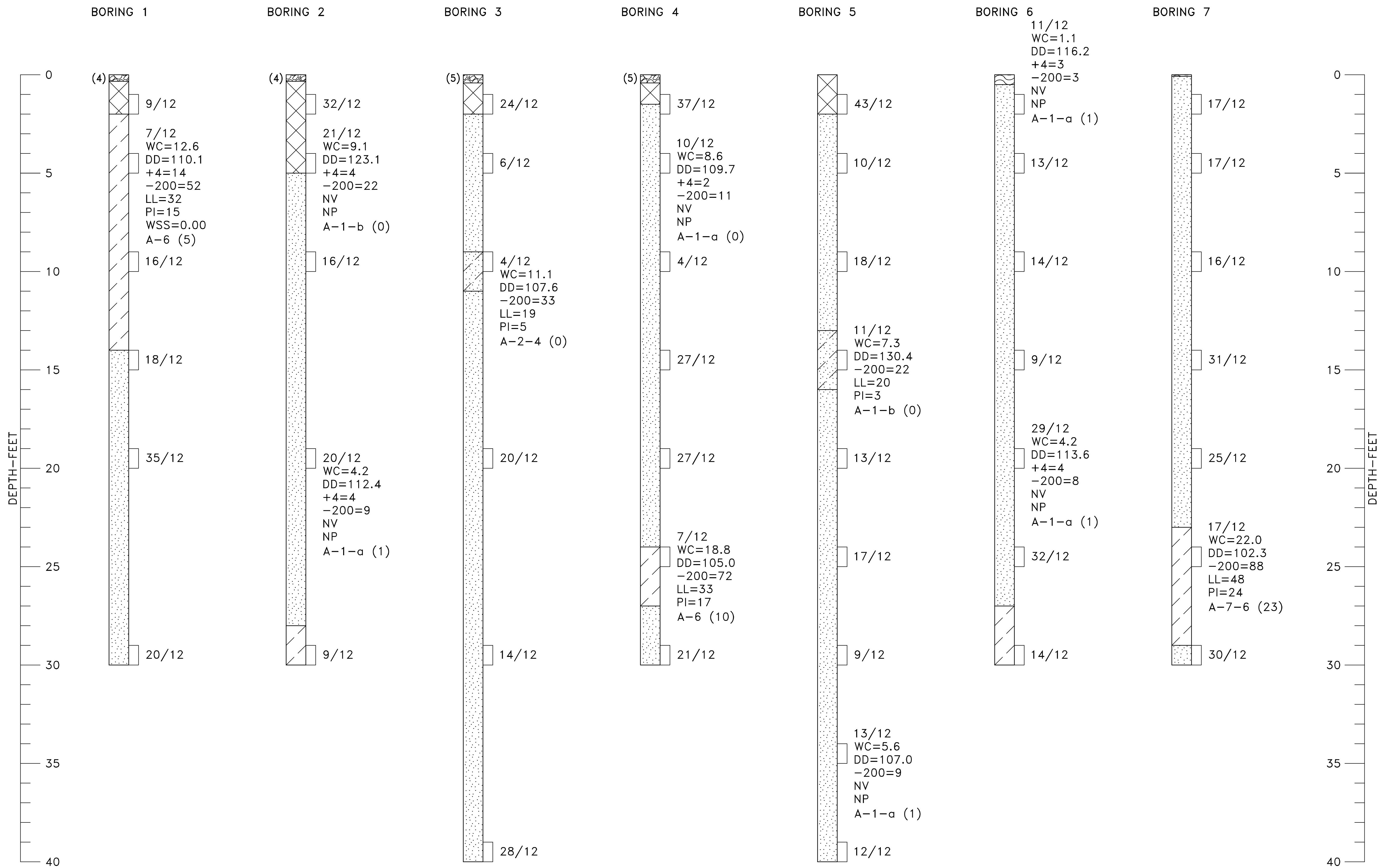




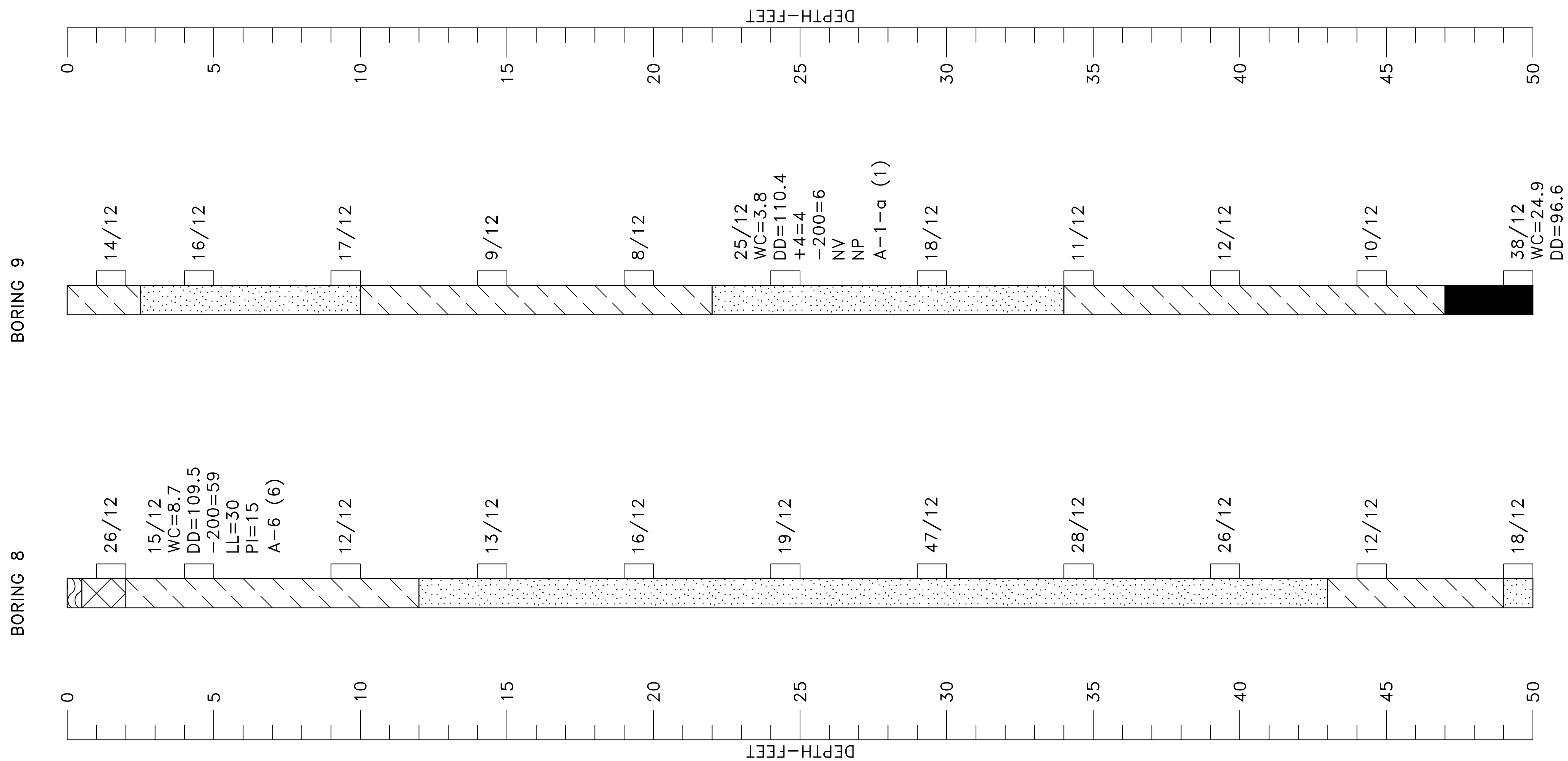
VICINITY MAP
NOT TO SCALE

22–3–146	Kumar & Associates	BENNETT WASTEWATER TREATMENT PLANT IMPROVEMENTS	LOCATION OF EXPLORATORY BORINGS	Fig. 1

June 03, 2022 – 06:34am
V:\Projects\2022\22-3-146 Bennett Wastewater Treatment Facility Improvments\Drafting\223146-01.dwg



22−3−146	Kumar & Associates	BENNETT WASTEWATER TREATMENT PLANT IMPROVEMENTS	LOGS OF EXPLORATORY BORINGS	Fig. 2



22-3-146	Kumar & Associates	BENNETT WASTEWATER TREATMENT PLANT IMPROVEMENTS	LOGS OF EXPLORATORY BORINGS	Fig. 3

LEGEND

(4) GRAVEL SURFACING, THICKNESS IN INCHES SHOWN IN PARENTHESES TO LEFT OF THE LOG.

TOPSOIL.

FILL: SANDY LEAN CLAY (CL) TO CLAYEY SAND (SC) TO SILTY SAND (SM), FINE TO COARSE GRAINED SAND FRACTION, DRY TO SLIGHTLY MOIST, BROWN TO DARK BROWN TO GRAY.

POORLY GRADED SAND (SP) TO WELL TO POORLY GRADED SAND WITH SILT (SW–SM TO SP–SM), FINE TO COARSE GRAINED WITH GRAVEL, LOOSE TO DENSE, MOIST, LIGHT BROWN TO BROWN.

SANDY LEAN CLAY (CL) TO LEAN CLAY WITH SAND (CL), FINE TO COARSE GRAINED SAND FRACTION, STIFF TO VERY STIFF, SLIGHTLY MOIST TO MOIST, BROWN TO DARK BROWN TO GRAY.

CLAYEY SAND (SC) TO SILTY SAND (SM), FINE TO COARSE GRAINED, LOOSE TO MEDIUM DENSE, SLIGHTLY MOIST TO MOIST, LOOSE TO MEDIUM DENSE, GRAY TO BROWN.

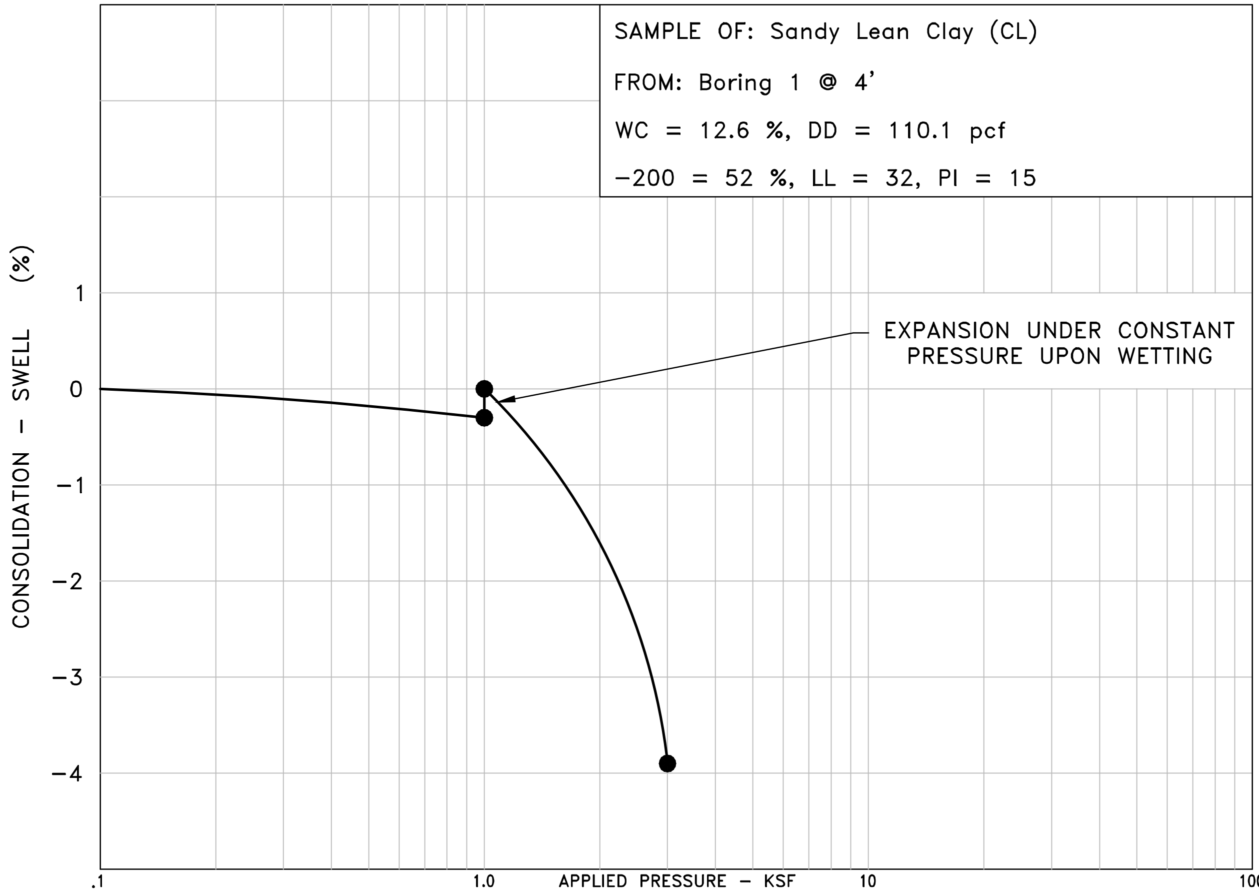
CLAYSTONE BEDROCK, FINE TO MEDIUM GRAINED, MEDIUM HARD, MOIST, BROWN TO GRAY.

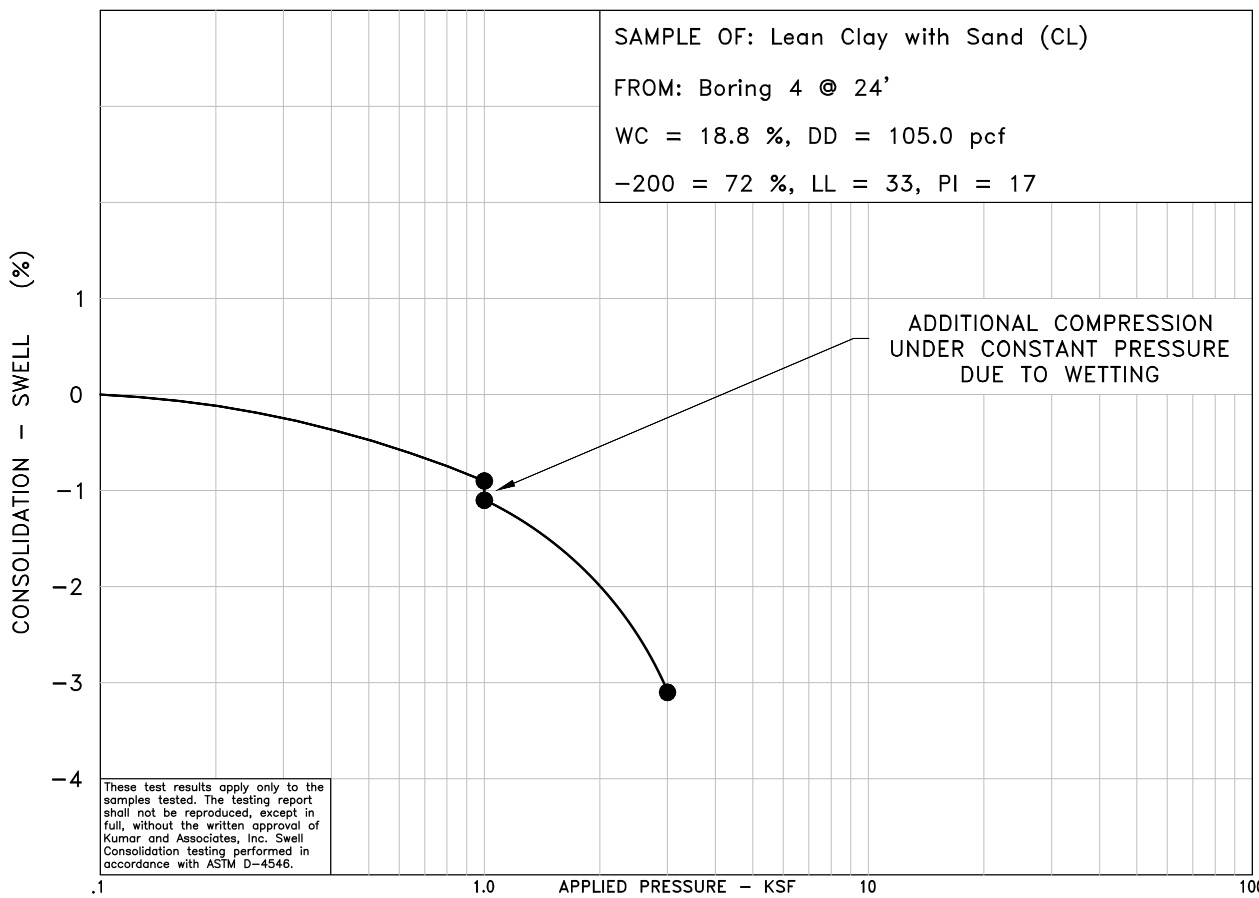
DRIVE SAMPLE, 2–INCH I.D. CALIFORNIA LINER SAMPLE.

9/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 9 BLOWS OF A 140–POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

NOTES

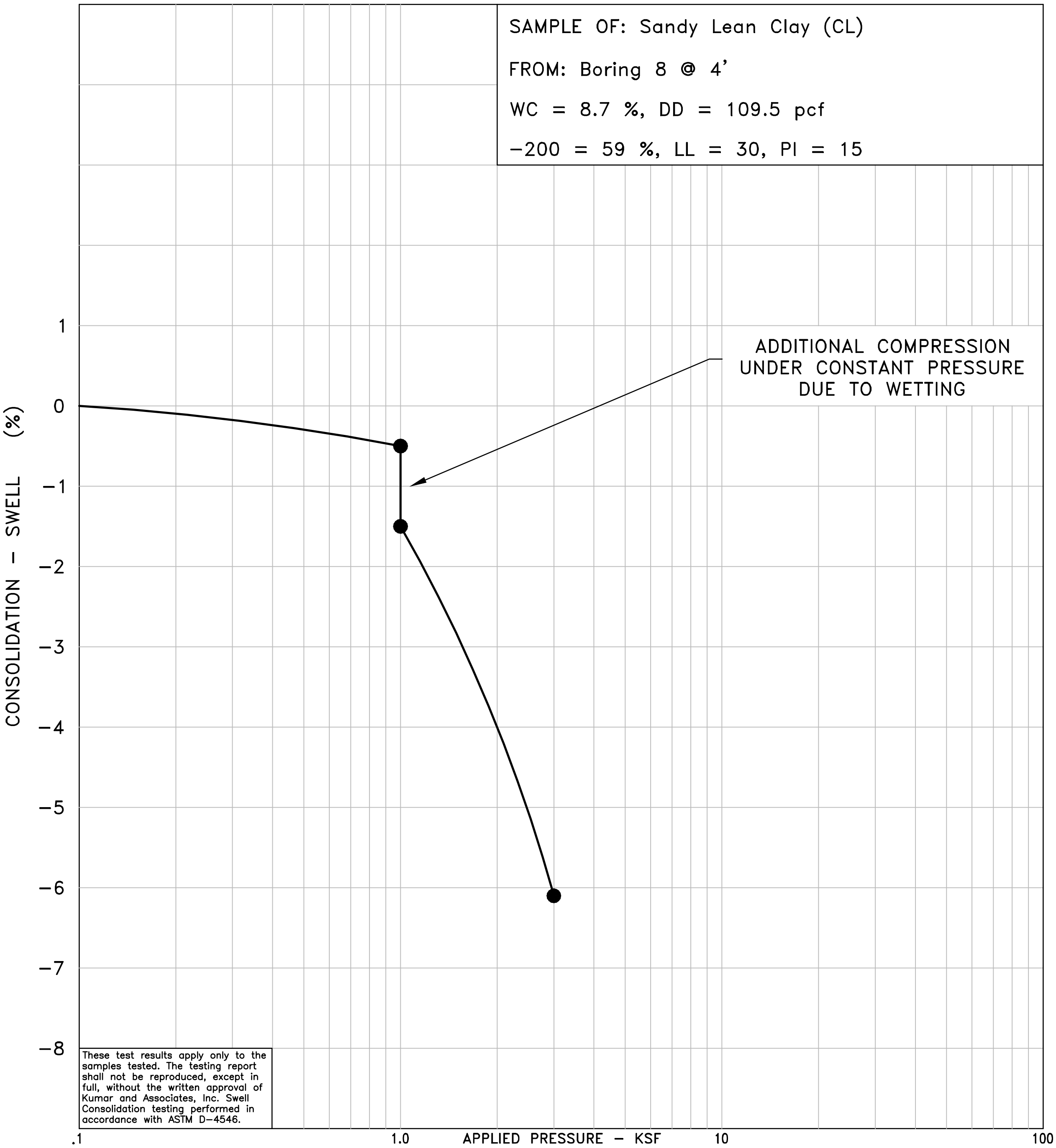
1. THE EXPLORATORY BORINGS WERE DRILLED ON MAY 3 AND 4, 2022 WITH A 4–INCH–DIAMETER CONTINUOUS–FLIGHT POWER AUGER.
2. THE EXPLORATORY BORINGS WERE MEASURED APPROXIMATELY BY HANDHELD GPS DEVICE.
3. THE ELEVATIONS OF THE EXPLORATORY BORINGS WERE NOT MEASURED AND THE LOGS OF THE EXPLORATORY BORINGS ARE PLOTTED TO DEPTH.
4. THE EXPLORATORY BORING LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
5. THE LINES BETWEEN MATERIALS SHOWN ON THE EXPLORATORY BORING LOGS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.
6. GROUNDWATER WAS NOT ENCOUNTERED IN THE BORINGS AT THE TIME OF DRILLING OR WHEN CHECKED 19 TO 20 DAYS LATER.
7. LABORATORY TEST RESULTS:
   WC = WATER CONTENT (%) (ASTM D2216);
   DD = DRY DENSITY (pcf) (ASTM D2216);
   +4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D6913);
   –200= PERCENTAGE PASSING NO. 200 SIEVE (ASTM D1140);
   LL = LIQUID LIMIT (ASTM D4318);
   PI = PLASTICITY INDEX (ASTM D4318);
   NV = NO LIQUID LIMIT VALUE (ASTM D4318);
   NP = NON–PLASTIC (ASTM D 4318);
   WSS = WATER SOLUBLE SULFATES (%) (CP–L 2103);
   A-2-6 (0) = AASHTO CLASSIFICATION (GROUP INDEX) (AASHTO M145).





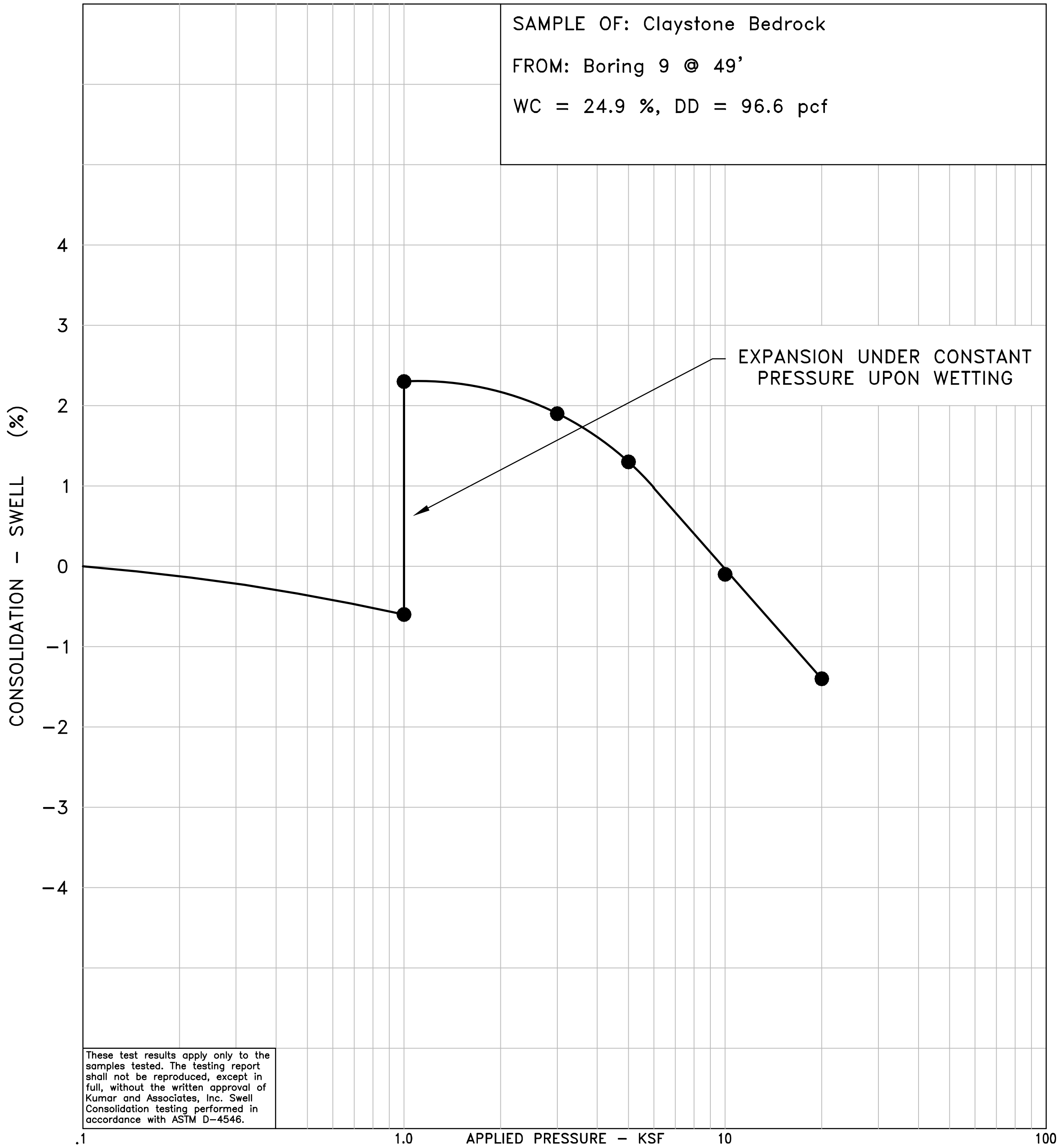
22-3-146	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 5

June 03, 2022 - 06:34am
V:\Projects\2022\22-3-146 Bennett Wastewater Treatment Facility Improvments\Drafting\223146-05 to 07.dwg



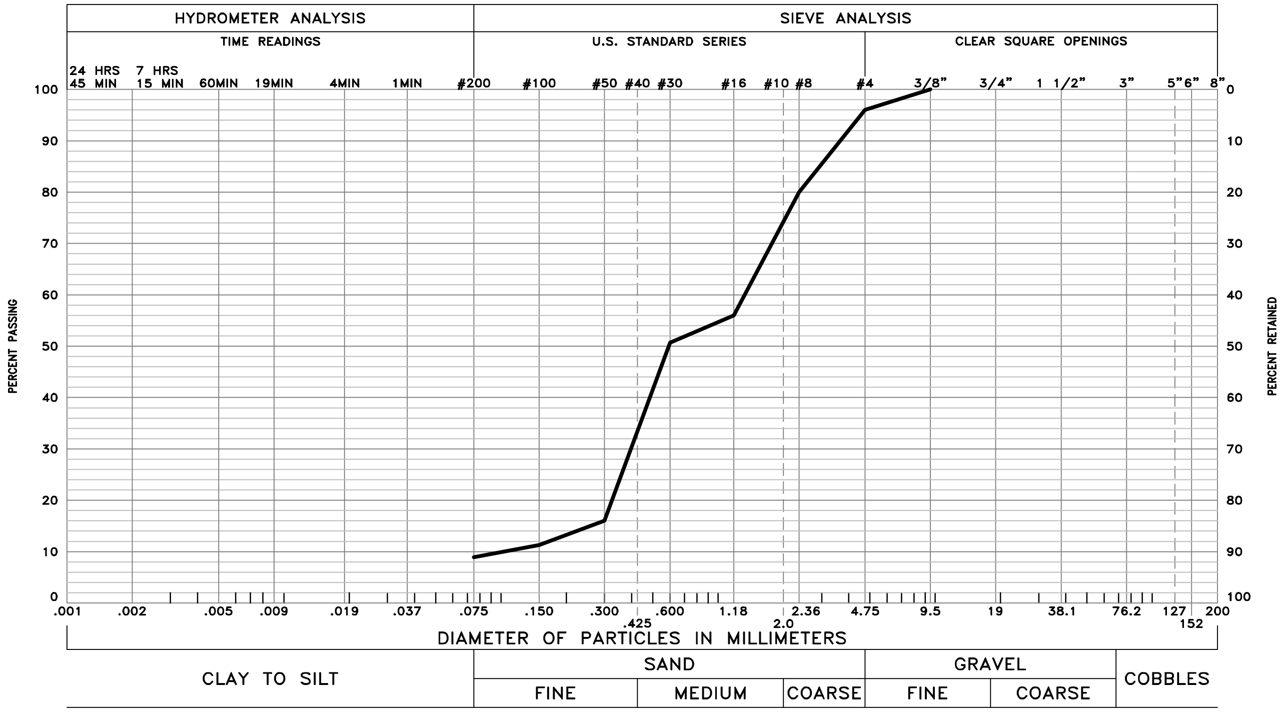
22-3-146	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 6

June 03, 2022 - 06:34am
V:\Projects\2022\22-3-146 Bennett Wastewater Treatment Facility Improvments\Drafting\223146-05 to 07.dwg



June 03, 2022 - 06:34am
V:\Projects\2022\22-3-146 Bennett Wastewater Treatment Facility Improvments\Drafting\223146-05 to 07.dwg

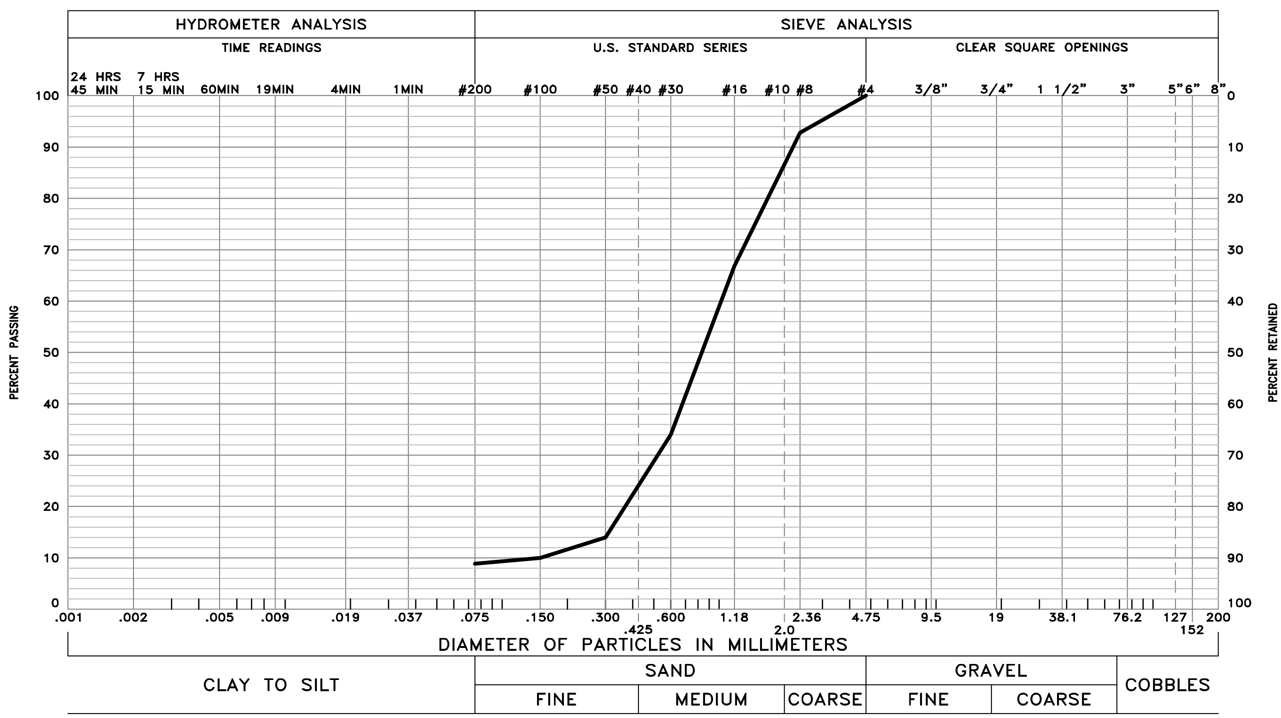
22-3-146	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 7



GRAVEL 4 % SAND 87 % SILT AND CLAY 9 %

LIQUID LIMIT NV PLASTICITY INDEX NP

SAMPLE OF: Well Graded Sand with Silt (SW-SM) FROM: Boring 2 @ 19'

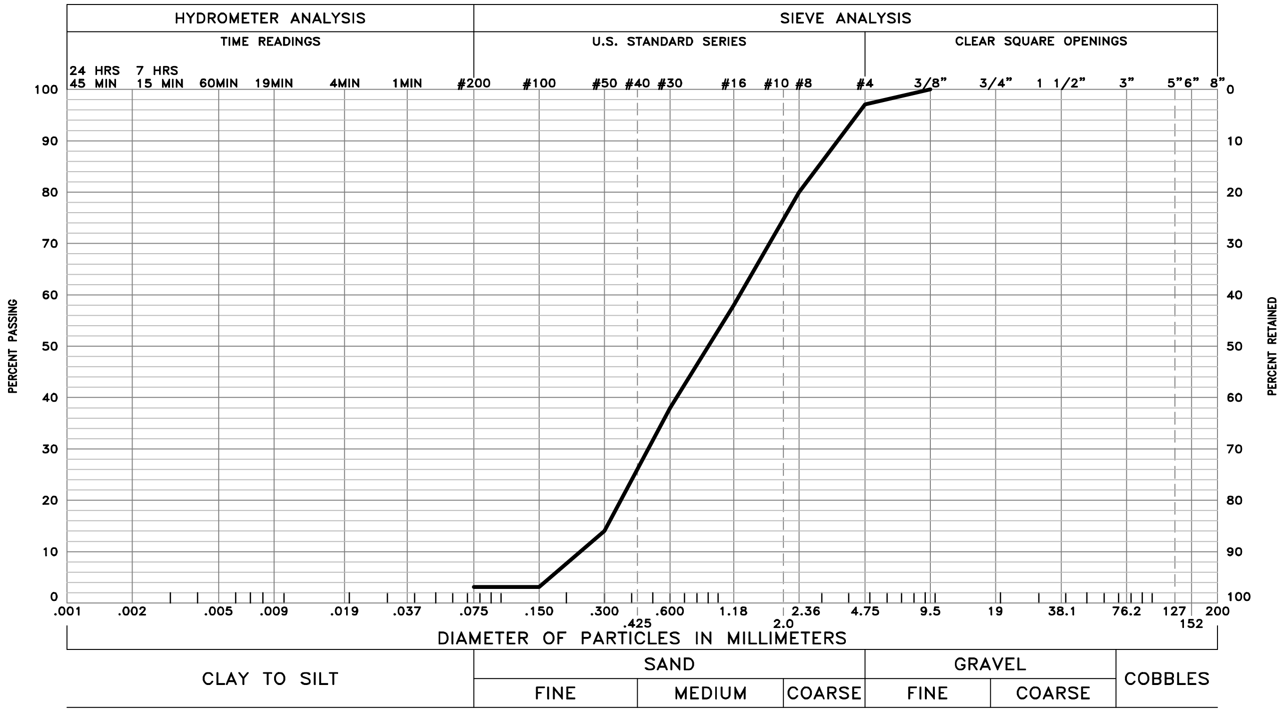


GRAVEL 0 % SAND 91 % SILT AND CLAY 9 %

LIQUID LIMIT NV PLASTICITY INDEX NP

SAMPLE OF: Well Graded Sand with Silt (SW-SM) FROM: Boring 5 @ 34'

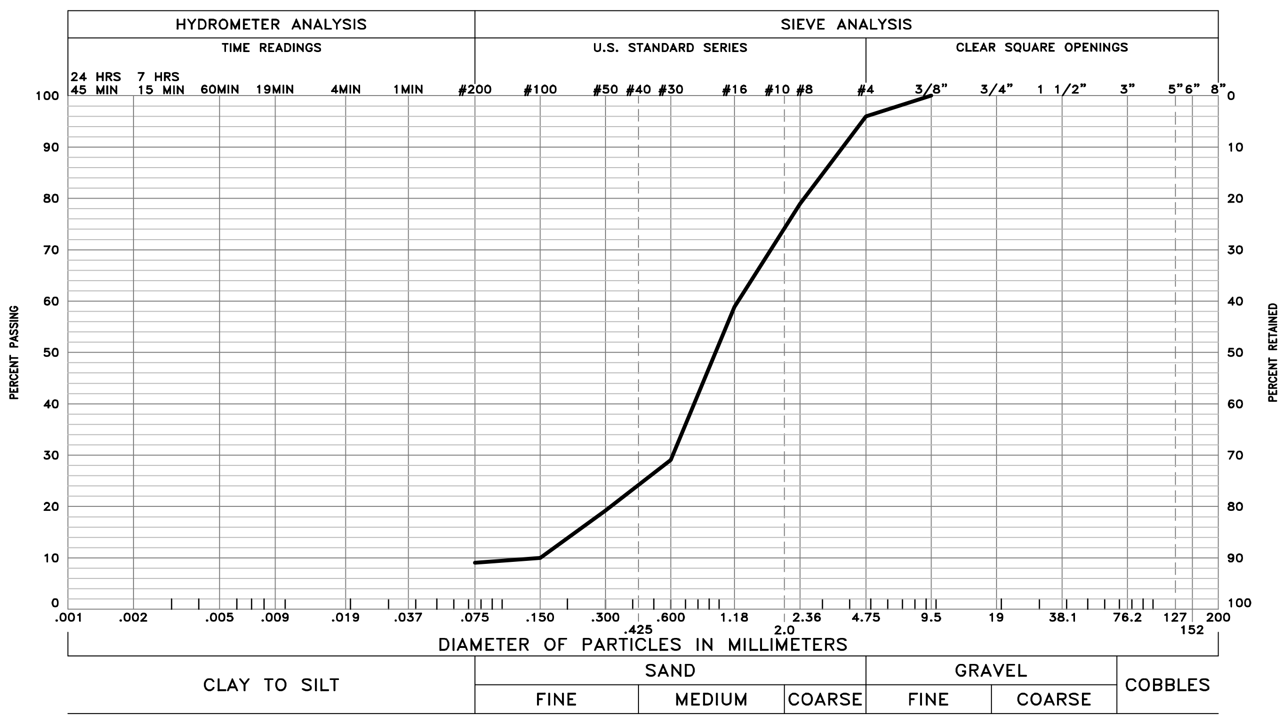
Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.



GRAVEL 3 % SAND 94 % SILT AND CLAY 3 %

LIQUID LIMIT NV PLASTICITY INDEX NP

SAMPLE OF: Poorly Graded Sand (SP) FROM: Boring 6 @ 1'

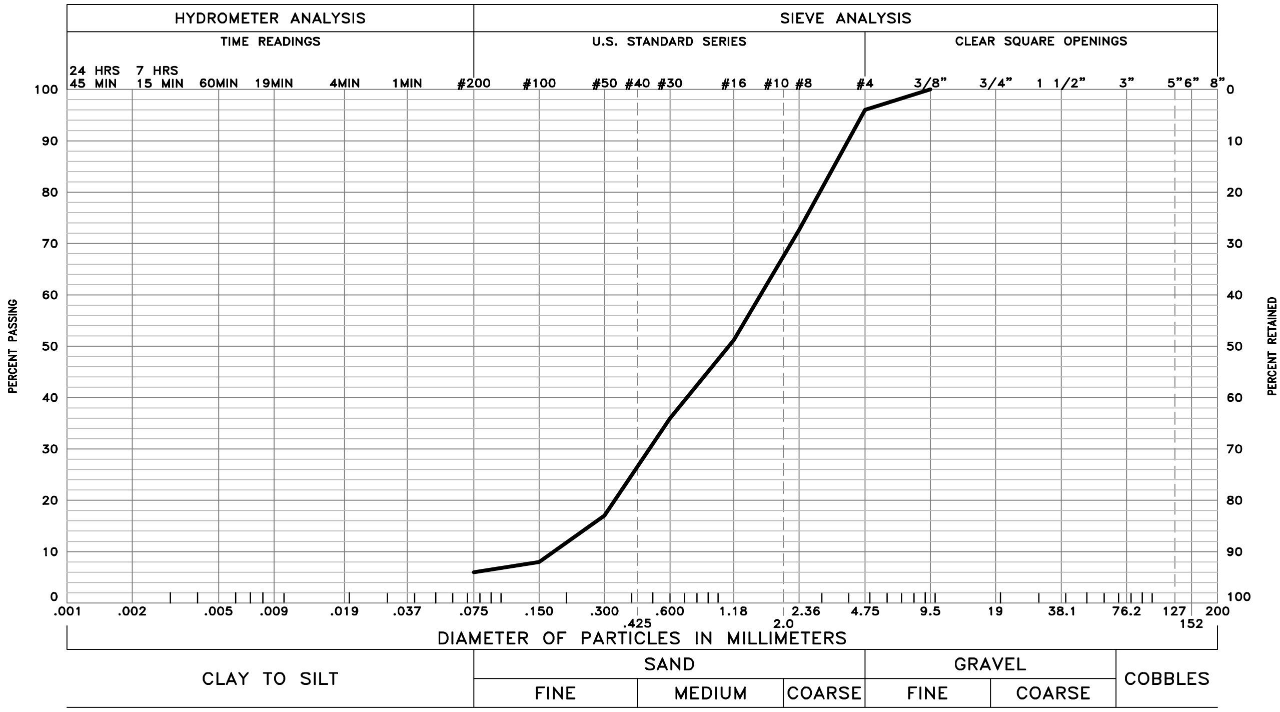


GRAVEL 4 % SAND 88 % SILT AND CLAY 8 %

LIQUID LIMIT NV PLASTICITY INDEX NP

SAMPLE OF: Well Graded Sand with Silt (SW-SM) FROM: Boring 6 @ 19'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.



GRAVEL 4 % SAND 90 % SILT AND CLAY 6 %

LIQUID LIMIT NV PLASTICITY INDEX NP

SAMPLE OF: Poorly Graded Sand with Silt (SP-SM) FROM: Boring 9 @ 24'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.

22-3-146	Kumar & Associates	GRADATION TEST RESULTS	Fig. 10

June 03, 2022 - 06:34am V:\Projects\2022\22-3-146 Bennett Wastewater Treatment Facility Improvements\Drafting\223146-08 to 10.dwg

Table I
Summary of Laboratory Test Results

Project No.: 22-3-146
Project Name: Bennett Wastewater Treatment Plant Improvements
Date Sampled: May 3 and 4, 2022
Date Received: May 4, 2022

Sample Location					Gradation			Atterberg Limits				
Boring	Depth (Feet)	Date Tested	Natural Moisture Content (%)	Natural Dry Density (pcf)	Gravel (%)	Sand (%)	Percent Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Limit (%)	Water Soluble Sulfates (%)	AASHTO Classification (Group Index)	Soil or Bedrock Type
1	4	5/11/22	12.6	110.1	14	34	52	32	15	0.00	A-6 (5)	Sandy Lean Clay (CL)
2	4	5/11/22	9.1	123.1	4	74	22	NV	NP		A-1-b (0)	Fill: Silty Sand (SM)
2	19	5/11/22	4.2	112.4	4	87	9	NV	NP		A-1-a (1)	Well Graded Sand with Silt (SW-SM)
3	9	5/11/22	11.1	107.6			33	19	5		A-2-4 (0)	Silty, Clayey Sand (SC-SM)
4	4	5/11/22	8.6	109.7	2	87	11	NV	NP		A-1-a (0)	Well Graded Sand with Silt (SW-SM)
4	24	5/11/22	18.8	105.0			72	33	17		A-6 (10)	Lean Clay with Sand (CL)
5	14	5/11/22	7.3	130.4			22	20	3		A-1-b (0)	Silty Sand (SM)
5	34	5/11/22	5.6	107.0		91	9	NV	NP		A-1-a (1)	Well Graded Sand with Silt (SW-SM)
6	1	5/11/22	1.1	116.2	3	94	3	NV	NP		A-1-a (1)	Poorly Graded Sand (SP)
6	19	5/11/22	4.2	113.6	4	88	8	NV	NP		A-1-a (1)	Well Graded Sand with Silt (SW-SM)
7	24	5/11/22	22.0	102.3			88	48	24		A-7-6 (23)	Lean Clay (CL)
8	4	5/11/22	8.7	109.5			59	30	15		A-6 (6)	Sandy Lean Clay (CL)
9	24	5/11/22	3.8	110.4	4	90	6	NV	NP		A-1-a (1)	Poorly Graded Sand with Silt (SP-SM)
9	49	5/11/22	24.9	96.6								Claystone Bedrock