APPENDIX – SUPPLEMENTAL INFORMATION

- Basis of Design Application Form
- 3 Mile Radius Map
- Geotechnical Report
- Engineering Drawings
- Project Specifications
- Arabian Acres Water Supply Study (Jehn Water Consultants, Inc. dated December 18, 2019)

COLORADO
Department of Public Health & Environment

APPENDIX B: BDR Template
Drinking Water Design Submittal
Safe Drinking Water Program Implementation Policy #5

4300 Cherry Creek Drive South, B2
Denver, Colorado 80246-1530
CDPHE.WQEngReview@state.co.us, 303-692-6298

COVER PAGE - BASIC INFO

A. Project and System Information			
System Name	Arabian Acres Metropolitan District		
Project Title	Treatment & Distribution Improvements		
County	Teller County		
PWSID	CO-0160075		
System Owner	Arabian Acres Metropolitan District		
Representative	Edith Coffman, Board President		
Address	c/o Walker Schooler District Managers		
	614 N. Tejon St, Colorado Springs, CO 80903		
Email	edith@aametro.net		
Phone	(719) 505-3823	Fax	

Signatures of System Representatives			
Role	Date	Typed Name	Signature
Board President		Edith Coffman	
The owner is an individual, corporation, partnership, association, state or political subdivision thereof, municipality, or other legal entity.			
Applicant / System Legal Representative			
The system legal representative is the legally responsible agent and decision-making authority for a public water system (e.g. mayor, president of a board, public works director). The Designer or Consulting Engineer is not the legal representative.			

Directions: Prior to submission to the department, the construction application must be signed by the Owner and/or a System Legal Representative. The department expects the public water system to send a duplicate copy to the local county health authority or county commissioner (if no county health authority) in whose jurisdiction(s) the drinking water facility is to be located. Signature is not required from the county.

I was the engineer in responsible charge for (identify portions of work)

Drawings and reports bearing my seal.

during the preparation of the basis of design report for the above-referenced project. To the best of my knowledge, the design is consistent with the most recent published version of the *Design Criteria for Potable Water Systems*, and that all site-specific deviations requests are listed in this report.

Adam Sommers
Typed Name of Professional Engineer

1/14/2020
Date Signed

Signature of Professional Engineer

38,169
License #

P.E. Stamp and Signature

COLORADO
Department of Public Health & Environment

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Phone	(719) 505-3823	Fax	

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Role	Date	Typed Name	Signature
Board President	1/15/20	Edith Coffman	Edith Coffman
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Adam Sommers — Typed Name of Professional Engineer
1/14/2020 — Date Signed
Signature of Professional Engineer
38169 — License #

P.E. Stamp and Signature

Basis of Design Report (BDR) Submittal Checklist

In accordance with Regulation 11 and the Design Criteria for Potable Water Systems, the design review process must include a 'complete design' consisting of a basis of design report (BDR) and corresponding plans and specifications for review and approval by the Department.

Project and System Information				
Project Title	Treatment & Distribution Improvements			
System Name	Arabian Acres Metropolitan District			
PWSID	CO-0160075			
County	Teller County			
Date of Design Submittal	1/17/2020			
Project Eligible for Streamlined Review? (See Appendix A Design Review Matrix)	Yes	☐	No	☒

Section Number and Basis of Design Report Requirements	Applicant to fill out: Included/ Addressed in Submittal? Yes/No/NA	Applicant to fill out: Location in Submittal (BDR, Plans, Other document)
1. Basic Project Information - REQUIRED FOR ALL SUBMITTALS	Yes	BDR
2. Sources of Potential Contamination	NA	
3. Water Quality Data	NA	Will be provided after new wells are installed
4. Process Flow Diagram/ Hydraulic Profile	Yes	Engineering Drawings
5. Capacity Evaluation and Design Calculations	Yes	Engineering Report
6. Monitoring and Sampling Evaluation	NA	
7. Geotechnical Report	Yes	Engineering Report
8. Residuals Handling	NA	
9. Preliminary Plan of Operation	Yes	Engineering Report
10. Impact to Corrosivity	NA	
11. Supplemental or Other Pertinent Information	Yes	Engineering Report
Plans and Specifications		
1. Plans and % complete (60%, 90%)	Yes Treatment Design = 100% Distribution Design = 90%	Engineering Drawings
2. Other schematics	NA	
3. Specifications	Yes - 90%	Project Specifications

Section 1: Application for Construction Approval Form (DCPWS Section 1.2.1)

A. Project and System Information			
Project Title	Treatment & Distribution Improvements		
PWSID (Assigned by Division)	CO-0160075		
Design Company Name	AquaWorks DBO, Inc.		
Design Engineer	Adam Sommers, P.E.	CO License Number	38,169
Address	3252 Williams Street Denver, CO 80205		
Email	adam@aquaworksdbo.com		
Phone	(303) 477-5915	Fax	

B. Public Water System (PWS) Type	Community (CWS)	☒	Non-Transient, Non-Community (NTNC)	☐	Transient, Non-Community (TNC)	☐
C. Current Primary Source Classification	Surface Water/ GWUDI	☐	Ground Water (GW)	☐	Consecutive / Purchased	☐

D. Design Submittal Scope (Check all that apply)

Source		*Treatment Facility*		*Storage Tank*		*Other*	
New ground water (GW) source	☒	New Treatment Facility	☐	New Distribution System Tank	☒	Response to Sanitary Survey	☐
New ground water under the direct influence of surface water (GWUDI) source	☐	Expansion of existing treatment facility	☐	New Tank used for disinfection contact time	☐	Response to Enforcement Order	☐
New surface water (SW) source	☐	Modification to existing treatment	☒	Modifications to existing tank	☐	State Revolving Fund (SRF) Project	☒
Existing source modification	☒					Technical, Managerial, Financial Evaluation	☐
Other (Please describe)							

E. Estimated Project Schedule and Cost Estimate		F. Rated Capacity (Calculations in Section 5)	
Estimated Bid Opening Date	Spring 2020	Minimum Flow	
Estimated Completion Date	Fall 2021	Monthly Average	600,000 Gallons
Estimated Project Cost	$2,500,000	Peak Hour Flow	40 GPM

G. Brief project summary and description of waterworks affected by the project

The Arabian Acres Metropolitan District (District) provides potable water service to Arabian Acres subdivision and Trout Haven Estates Filings 1, 3, 4, and portions of Filing 2. The District currently serves 150 taps with a population of approximately 405 people.

The District has faced considerable challenges over the past few years. These challenges include providing reliable service with the approximately 40 year old, poorly maintained distribution system that leaks considerably. Additionally, the District is in unsatisfactory financial condition due to the high cost to purchase water hauled from offsite to make up for the water loss. The intent of this Construction Application is to permit the following items:

This document recommends implementation of the following improvements:

- Item #1: Replace and replacing the two- existing control (treatment) buildings.
- Item #2: Remove the existing 38,000 gallon water storage tank and replacing it with a 100,000-gallon tank.
- Item #3: Redrill Well #3 and drilling new Well #10
- Item #4: New SCADA System
- Item #5: Removing and replacing portions of the existing distribution system

The improvements will allow the District to provide reliable, long-term potable water service to the users. Until the District can lower water loss to an industry acceptable level, it will continue to spend a considerable percentage of its revenue hauling water and responding to leaks and line breaks.

The conceptual engineer's opinion of probable costs for this project is $1,000,000. This opinion of cost includes replacing and upgrading 10% of the distribution system for Item #1 and Item #2 to Item #5 from the list of improvements. This balances financial limitations with the most cost effective alternatives. Improvements can be completed approximately 12 months from the time funding is available.

H. Scaled Map

See Engineering Drawings

I. Implementation Plan and Schedule

See Engineering Report

J. Requested Deviations

No.	DCPWS Requirement (e.g., Section 4.3 Redundant filters)	Site Specific Deviation Request (additional information can be included in the supplemental information section see 1.2.10 of the DCPWS)	Location in Submittal (page)
1			
2			
3			
4			
5			
6			
7			

Section 2: Sources of Potential Contamination (DCPWS Section 1.2.2)

Project Title: Arabian Acres Treatment & Distribution Improvements

100 Year Flood Plain

All water facilities must have the potential 100-year flood threat evaluated based on all available floodplain data from one or more of the following sources: the Colorado Water Conservation Board, U.S. Army Corps of Engineers, Housing and Urban Development, County Government, local flood districts, etc. A copy of any background information used in the 100-year flood threat determination process must be included along with a comparison of the site vertical elevation datum and floodplain reference elevation datum.

The 100-year flood threat was evaluated for:

_____

(e.g. Well, Water Treatment Facility, Tank)

100-year flood threat determination was based on the information enclosed from:

_____

(e.g. FEMA floodplain map, U.S. Army Corp, elevation)

For Non-Community Public Water Systems, an authorized representative of the system responsible for operation and compliance must sign the Floodplain Certification.

I hereby certify that a judgment has been made after evaluating all available floodplain data and in my opinion, these waterworks, as located and designed, are not subject to flood damage by a 100-year event.

_____ _____

Typed Name of Authorized System Representative Date Signed

_____

Signature of Authorized System Representative

For Community Systems, a Professional Engineer licensed in Colorado must stamp and sign the Floodplain Certification.

I hereby certify that a Professional Engineering judgment has been made after evaluating all available floodplain data and in my professional opinion, these waterworks, as located and designed, are not subject to flood damage by a 100-year event.

_____ _____

Typed Name of Professional Engineer Date Signed

_____ _____

Signature of Professional Engineer License #

Contamination Sources

The project does not affect the contamination potential.

Mitigation Strategy

Not Applicable.

Section 3: Water Quality Data (DCPWS Section 1.2.3)

Project Title: Arabian Acres Treatment & Distribution Improvements
Source Data
Water quality data for two consecutive quarters for the redrill of Well #3 and Well #10 will be provided after the wells are installed.
Process Selection Data
See Engineering Report
Other Pertinent WQ or Operational Data
See Engineering Report

Section 4: Process Flow Diagram/ Hydraulic Profile (DCPWS Section 1.2.4)

Project Title: Arabian Acres Treatment & Distribution Improvements

Process Flow Diagram

See Engineering Drawings

Hydraulic Profile

See Engineering Drawings.

Section 5: Capacity Evaluation and Design Calculations (DCPWS Section 1.2.5)

Project Title: Arabian Acres Treatment & Distribution Improvements

Discussion of calculations included

See Engineering Report

Unit Processes (e.g. flocculation, hypochlorite addition)	Unit Process Description at Rated Capacity

Disinfection

	Item	Number	Unit
1	Peak Instantaneous Flow (at each control building)	40	GPM
2	Temperature	5	C
3	BF—Baffling Factor	1	
4	pH	8	s.u.
5	Minimum Pipe Volume	320	Gallons
6	TDT—Theoretical Detention Time (Volume/Flow)	8	Minutes
7	Actual Detention Time (TDT x BF)	8	Minutes
8	Chlorine Residual Concentration (minimum)	1	mg/L
9	Virus Log Inactivation	4	log

Plug Flow

Item	Number	Unit/Notes
HDPE DR11 (10")		
Pressure Rating	200	psi
Inside Pipe Diameter	8.68	in
Pipe Volume per Foot	710	in^3
Pipe Volume per Foot	3.052	gallons
Pipe Loop Length	120	feet
Volume Provided	366	gallons
Length/Diameter Ratio	165.89	Exceeds Minimum Ratio of 160
Min. Individual Segments	28.93	Pipe Segments of 60' Exceeds Minimum Length

Section 6: Monitoring and Sampling Evaluation (DCPWS Section 1.2.6)

Project Title:
Sampling locations and parameters to be monitored
See Engineering Drawings
Discussion of control strategy
See SCADA Plan

Section 7: Geotechnical Report (DCPWS Section 1.2.7)

Project Title:
Geotechnical report
See Engineering Report

Section 8: Residuals Handling (DCPWS Section 1.2.8)

Project Title:
Residuals handling plan - Chapter 9 of the DCPWS
Not applicable. Project does not generate residuals.

Section 9: Preliminary Plan of Operation (DCPWS Section 1.2.9)

Project Title:
Staffing and Operator Certification
See Engineering Report
Operating Considerations
See Engineering Report

Section 10: Impact to Corrosivity (DCPWS Section 1.2.10)

Project Title:
Project Category (Category 1 - 4: see Appendix A, Table A.2 for Category descriptions. (Add justification for category changes here)
No changes are proposed to corrosion control measures.
Impacts to Corrosivity (Category 2 and 3. Category 4 submit Appendix K) -
Category 2: Confirm materials evaluation and proper sampling pool (Regulation 11.26(2)) Category 3: Submit evaluation of project's impact to corrosivity Category 4: New OCCT or changes to existing OCCT - submit Appendix K of the DCPWS)

Section 11: Supplemental/Other Information (DCPWS Section 1.2.11)

Project Title:

Supplemental Information

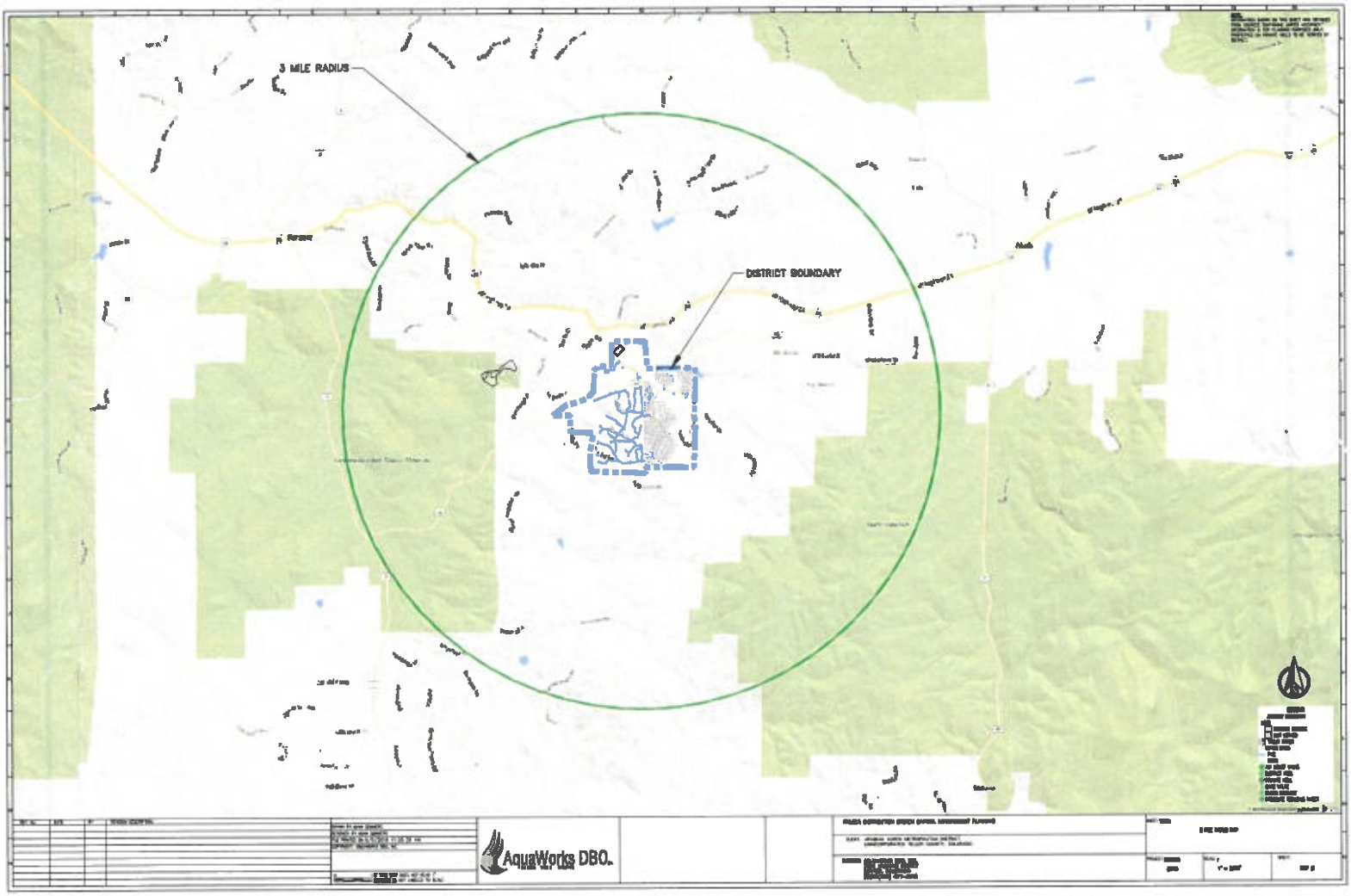
See Engineering Report

Additional Deviation Request Information

Not Applicable. Deviations not requested.

PLANS AND SPECIFICATIONS (DCPWS Section 1.5)

Project Title:
Plans Description and key sheets
See Engineering Drawings
Pertinent Specifications for Design
See Project Specifications
ATTACH PLANS AND INCLUDE SPECS.


3 MILE RADIUS
DISTRICT BOUNDARY
AquaWorks DBO.

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

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An Employee Owned Company

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

GEOTECHNICAL ENGINEERING STUDY
ARABIAN ACRES METROPOLITAN DISTRICT
PROPOSED WATER SYSTEM IMPROVEMENTS
TELLER COUNTY, COLORADO

Prepared By:
Jake D. Cochran, P.E.

Reviewed By:
Arben F. Kalaveshi, P.E.

Prepared for:

Arabian Acres Metropolitan District
PO Box 147
Colorado Springs, Colorado 80901

Attn: Ms. Jennifer Waller, President

Project No. 19-2-139

May 10, 2019

TABLE OF CONTENTS

SUMMARY

1. The borings generally encountered granular overburden soils consisting of well graded sand with clay and gravel to clayey sand with gravel extending to approximately 2 to 9.5 feet below the existing grade. The overburden soils were underlain by sandstone bedrock in Boring 1 and weathered granite bedrock in Borings 2 through 4. The bedrock extended to the maximum depths explored of 18 to 20 feet below grade. Practical Auger Refusal was encountered in Boring 4 at 18 feet.

2. Groundwater was encountered in Borings 1 and 2 at depths of 7.4 and 4.9 feet at the time of drilling. Groundwater was not encountered in the remaining borings. We anticipate that the depth to groundwater will fluctuate over time.

3. It is our opinion a shallow foundation bearing on a minimum of 1 foot of properly compacted structural fill will perform adequately for the proposed precast fiberglass buildings. Footings bearing on the granular overburden soils should be designed for a maximum allowable bearing pressure of 2,000 psf, and with the other design and construction considerations presented in this report.

4. We understand that the proposed water tank will be constructed on a concrete ring foundation. The ring foundation should bear on the undisturbed weathered granite bedrock. Footings bearing on undisturbed bedrock should be designed for a maximum allowable bearing pressure of 5,000 psf, and with the other design and construction considerations presented in this report.

PURPOSE AND SCOPE OF WORK

This report presents the results of a geotechnical engineering study for the proposed Arabian Acres Metropolitan District's proposed water distribution system improvements within the Arabian Acres Subdivision in Teller County, Colorado. The project site is shown on Fig. 1. This study was conducted in accordance with the scope of work in our Proposal No. C19-140 dated March 7, 2019, to develop recommendations for the proposed construction.

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 the proposed construction are included in the report.

PROPOSED CONSTRUCTION

We understand the proposed construction will consist of two, 10-foot by 18-foot prefabricated fiberglass basin buildings and a new above-ground 35-foot diameter by 18-foot tall steel water storage tank constructed on a concrete ring foundation. Foundation loads for the buildings are anticipated to be light, and the foundation loads for the proposed water tank are anticipated to be moderate, typical of the proposed construction types. Site grading is anticipated to be negligible with cut and fill depths of less than about 2 to 3 feet. If the proposed construction varies significantly from that described above or depicted in this report, we should be notified to reevaluate the recommendations contained herein.

SITE CONDITIONS

The proposed building areas are located within the Arabian Acres subdivision, as shown on Fig. 1, and were generally surrounded by residential construction and neighborhood roadways. An existing tank water storage tank was located adjacent to the proposed tank location and will be demolished prior to construction. Regional topography includes mountainous terrain and rolling hills. The areas of proposed construction were generally level, and were sparsely vegetated with natural grasses and deciduous and evergreen trees. Exposed granite bedrock outcroppings were observed in the areas of Borings 2 through 4. A small pond was located approximately 75 feet south of Boring 2.

FIELD EXPLORATION

The field exploration of subsurface conditions consisted of drilling four borings at the approximate locations shown on Figs. 1 through 1C. The borings were drilled on April 17, 2018. The boring log and the corresponding legend and notes are included on Figs. 2 and 3.

The boring was drilled with 4-inch diameter continuous flight augers and was logged by a representative of Kumar & Associates, Inc. Samples of the overburden soils and bedrock were taken with a 2-inch I.D. California sampler. The sampler was driven into the various strata with blows from a 140-pound hammer falling 30 inches. Penetration resistance values, when properly evaluated, provide an indication of the relative density or consistency of the soils. Depths at which the samples were taken and the penetration resistance values are shown on the boring logs, Fig. 2.

The water levels in the borings were checked at the time of drilling. The borings were then backfilled with the on-site soils.

LABORATORY TESTING

Samples obtained from the exploratory borings were visually classified in the laboratory by the project engineer and samples were selected for laboratory testing. Laboratory testing included index property tests such as in-situ moisture content and dry unit weight, grain size analysis, and Atterberg limits. Additional testing performed included concentration of water soluble sulfates. The testing was conducted in general accordance with recognized test procedures, primarily those of the American Society for Testing of Materials (ASTM). Results of the laboratory testing program are shown on Figs. 2 and 4 through 6, and are summarized on Table I.

SUBSURFACE CONDITIONS

The borings generally encountered granular overburden soils consisting of well graded sand with clay and gravel to clayey sand with gravel extending to approximately 2 to 9.5 feet below the existing grade. The overburden soils in Borings 2 through 4 were generally decomposed granite materials. Based on the sampler penetration blow counts recorded the overburden soils were very loose to dense.

The overburden soils were underlain by sandstone bedrock in Boring 1, and weathered granite in Borings 2 through 4. The bedrock extended to the maximum depths explored of 18 to 20 feet below grade. Practical Auger Refusal was encountered in Boring 4 at 18 feet. Based on

sampler penetration resistance blow counts, the sandstone and weathered granite bedrock were generally medium hard to very hard.

Groundwater was encountered in Borings 1 and 2 at depths of 7.4 and 4.9 feet at the time of drilling. Groundwater was not encountered in the remaining borings. We anticipate that the depth to groundwater will fluctuate over time.

FOUNDATION RECOMMENDATIONS

Considering the subsurface conditions encountered in the exploratory borings and the nature of the proposed construction, a shallow foundation bearing on a minimum of 1 foot of properly compacted structural fill should perform adequately for the proposed prefabricated basin buildings. Ring foundations bearing on the undisturbed bedrock should perform adequately for the desired application.

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 a minimum of 1 foot of scarified and compacted native soils should be designed for an allowable soil bearing pressure of 2,000 psf. Foundations placed on the undisturbed bedrock should be designed for an allowable soil bearing pressure of 5,000 psf.

2. Based on experience, we estimate total settlement for footings designed and constructed as discussed in this section will be 1 inch or less.

3. Due to the fractured nature of the weathered granite bedrock a smooth surface for foundations and the tank bottom may be difficult to achieve. To provide a uniform bearing surface a properly compacted 6-inch thick layer of Class 1 material can be used. The overburden soils and processed bedrock will likely meet the requirements for Class 1 materials. The bedrock should be processed to a minus 2-inch material. Based on the highly fractured nature of the bedrock processing should be possible with minimal effort.

4. Spread footings should have a minimum footing width of 16 inches for continuous footings, and 20 inches for isolated pads.

5. 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 30 inches below the exterior grade is typically used in this area.

6. The lateral resistance of a spread footings, or ring foundations will be a combination of the sliding resistance of the foundation on the bearing materials and passive earth pressure against the side of the foundation. Resistance to sliding at the bottom of the foundation may be calculated based on an allowable coefficient of friction of 0.35. Passive pressure against the sides of the foundations may be calculated using an allowable equivalent fluid unit weight of 180 pcf. Compacted fill placed against the sides of the footings to resist lateral loads should be a minus 2-inch granular material compacted to at least 95% of the maximum modified proctor density (ASTM D1557) at a moisture content within 2 percent of optimum. Additional lateral resistance may also be achieved by socketing the footing into an excavation in the undisturbed bedrock.

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

8. Structural fill placed inside of the ring foundation should consist of moisture-conditioned on-site fill or CDOT Class 1 structural fill. The structural fill should be compacted to at least 95% of the maximum Modified Proctor density (ASTM D1557) at a moisture content within 2 percentage points of optimum.

9. Areas of loose material or any deleterious materials encountered within the foundation excavation should be removed and replaced with granular structural fill compacted to 95% of the maximum Modified Proctor density (ASTM D1557) within 2 percentage points of optimum. Structural fill should extend down from the edges of the footings at a 1 horizontal to 1 vertical projection.

10. Based on the measured water table depths, the proposed foundation elevations appear to be within about 2 to 5 feet of the groundwater level at Borings 1 and 2. Groundwater levels can fluctuate and could rise above the measured levels. Therefore, it may be necessary to dewater some footing excavations during construction. Dewatering should be conducted by using sumps, drains, and/or other dewatering methods to maintain water levels at least 1 to 2 feet below the subgrade elevation to mitigate against loss of soil support.

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

PIPE BACKFILL

The use and requirements for bedding material should be in accordance with the pipe manufacturer's recommendations, local building authority, or utility district requirements. In the absence of such guidance, we recommend the pipe bottom consist of imported granular bedding material intended for bedding and pipe embedment zone fill. Bedding and embedment zone material may consist of a rounded granular gravel or sand with a maximum size of ¾ inch, less than 25% passing the No. 50 sieve, and less than 5% passing the No. 200 sieve. The bedding layer should be of adequate thickness to fully support the pipes when seated on top of the bedding. Bedding placed within 6 inches beneath the pipe invert should not be compacted to allow the pipe to seat in the bedding material during installation. Prior to placing the bedding, the subgrade should be excavated, and any loose material should be removed to provide firm subgrade support. If loose soil conditions exist in the trench bottom, it may be necessary to sub-excavate to a greater depth and replace such soils with a deeper bedding section to provide proper pipe support. Bedding material placed below the 6-inch depth for additional support, if required should be compacted using a vibratory plate or other approved densification methods.

The pipe-zone material placed above the bedding and surrounding the pipe should consist of granular material similar to that described above for pipe bedding, and should be compacted to at least 75% relative density (ASTM D 4253 and ASTM D 4254), and in accordance with requirements of the pipe manufacturer, to provide the required support around the pipe and to help mitigate potential bedding settlement zones. The pipe-zone material should also be placed and compacted in accordance with the requirements of the pipe manufacturer. Portions of the pipeline bedding not below current or proposed roadways should be compacted to at least 70% relative density. Special care should be taken to provide adequate compaction below the haunches of the pipe using a concrete vibrator, vibratory plates or other light compaction equipment as needed. In confined areas of the pipeline where compaction is difficult, placement of a cementitious flow fill around the pipe should be considered.

Backfill placed above the pipe-zone materials to the surface may consist of suitable on-site soil obtained from the pipeline excavation. Suitable soils should have a maximum particle size of 3 inches and should be free of organics, wood, or other deleterious material that could decay over time. Most of the soils encountered in the exploratory borings satisfy the material requirements based on laboratory testing of selected samples. Bedrock used in pipe backfill should be

processed to include particles no larger than 3 inches and should have even moisture distribution throughout the material, which may be difficult to achieve in trench conditions. The use of bedrock material that does not break down into a soil-like material may be considered as trench backfill above the embedment material in areas where some amount of settlement can be tolerated. The amount of settlement will be related to the depth of the pipe/thickness of the backfill which may be as much as 2 percent of the backfill thickness. The backfill should be compacted to at least 90% of the modified Proctor (ASTM D 1557) maximum dry density at a moisture content within 2 percent of optimum for granular soils. Materials with excessive moisture, for example those excavated near or below the ground water level, may not be suitable for reuse unless they are allowed to dry prior to placement.

SEISMIC DESIGN CRITERIA

The generalized subsurface profile was assumed to consist of relatively shallow sedimentary and granitic bedrock. The weighted average of the estimated shear wave velocities for this subsurface profile to a depth of 100 feet indicates an IBC design Site Class C. Based on the subsurface profile and site seismicity, liquefaction is not a design consideration.

WATER SOLUBLE SULFATES

The concentrations of water soluble sulfates measured in samples obtained from the exploratory borings ranged from less than 0.01% to 0.05%. These concentrations of water soluble sulfates represent a Class 0 severity of exposure to sulfate attack on concrete exposed to these materials. The degree of attack is based on a range of Class 0 to Class 3 severity of exposure as presented in ACI 201. Based on this information and our experience with the soil types encountered, we believe special sulfate resistant cement will not be required for concrete exposed to the on-site soils.

SURFACE DRAINAGE

Proper surface drainage is very important for acceptable performance of the structures during construction and after the construction has been completed. Drainage recommendations provided by local, state and national entities should be followed based on the intended use of the structures. 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 of the foundation subgrades should be avoided during construction.

2. Any backfill away from the proposed construction should be adjusted to a moisture content ±2% of optimum and compacted to at least 90% of the maximum Modified Proctor density (ASTM D1557).

3. Care should be taken when compacting around the foundation walls to avoid damage to the structure.

4. The ground surface surrounding the exterior of the building should be sloped to drain away from the foundation in all directions. We recommend a minimum slope of 6 inches in the first 10 feet in unpaved areas. Site drainage beyond the 10-foot zone should be designed to promote runoff and reduce infiltration.

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

6. Roof downspouts and drains should discharge well beyond the limits of all backfill.

EXCAVATION CONSIDERATIONS

In our opinion, the overburden soils should be excavatable with conventional excavation equipment. Excavations in the weathered bedrock will likely require heavy excavation equipment. Rippers may be required if localized harder zones are encountered.

All excavations should be in accordance with OSHA, state and local requirements. In accordance with OSHA guidelines, the native granular soils classify as a Type C material. The bedrock will likely classify as a Type B material due to its surficial weathered nature. Temporary unretained excavations in Type B and C materials should have slopes no steeper than 1:1 and 1.5:1 (H:V), respectively. A properly braced excavation or the use of a trench box should be used where the indicated unretained slopes cannot be accommodated. The contractor should take appropriate precautions during construction. Flatter slopes will be required where groundwater is encountered. Surface draining should be diverted away from all temporary cut slopes in order to reduce the potential for slope erosion and instability. OSHA regulations require that excavations greater than 20 feet in depth be designed by a professional engineer.

If groundwater is encountered in excavations, we believe the dewatering can be accomplished by pumping from sumps installed within the excavation. The pits should be constructed well below the base of the excavation to avoid loss of supporting capacity of the soils. The

dewatering system should be properly designed, installed and maintained. The bottom and sides of the excavation may become unstable if the groundwater level is not maintained at a sufficient depth below the bottom of the excavation.

OSHA regulations require that excavations greater than 20 feet in depth be designed by a professional engineer. If soils different from those indicated in this report are encountered, the OSHA soil type may vary and the required cut slopes may need to be adjusted. The contractor's on-site "competent person" should confirm that all necessary slope and shoring design are performed.

DESIGN AND SUPPORT SERVICES

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

We recommend that Kumar & Associates, Inc. be retained to provide 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, and to identify possible variations in subsurface conditions from those encountered in this study so that we can re-evaluate our recommendations, if needed.

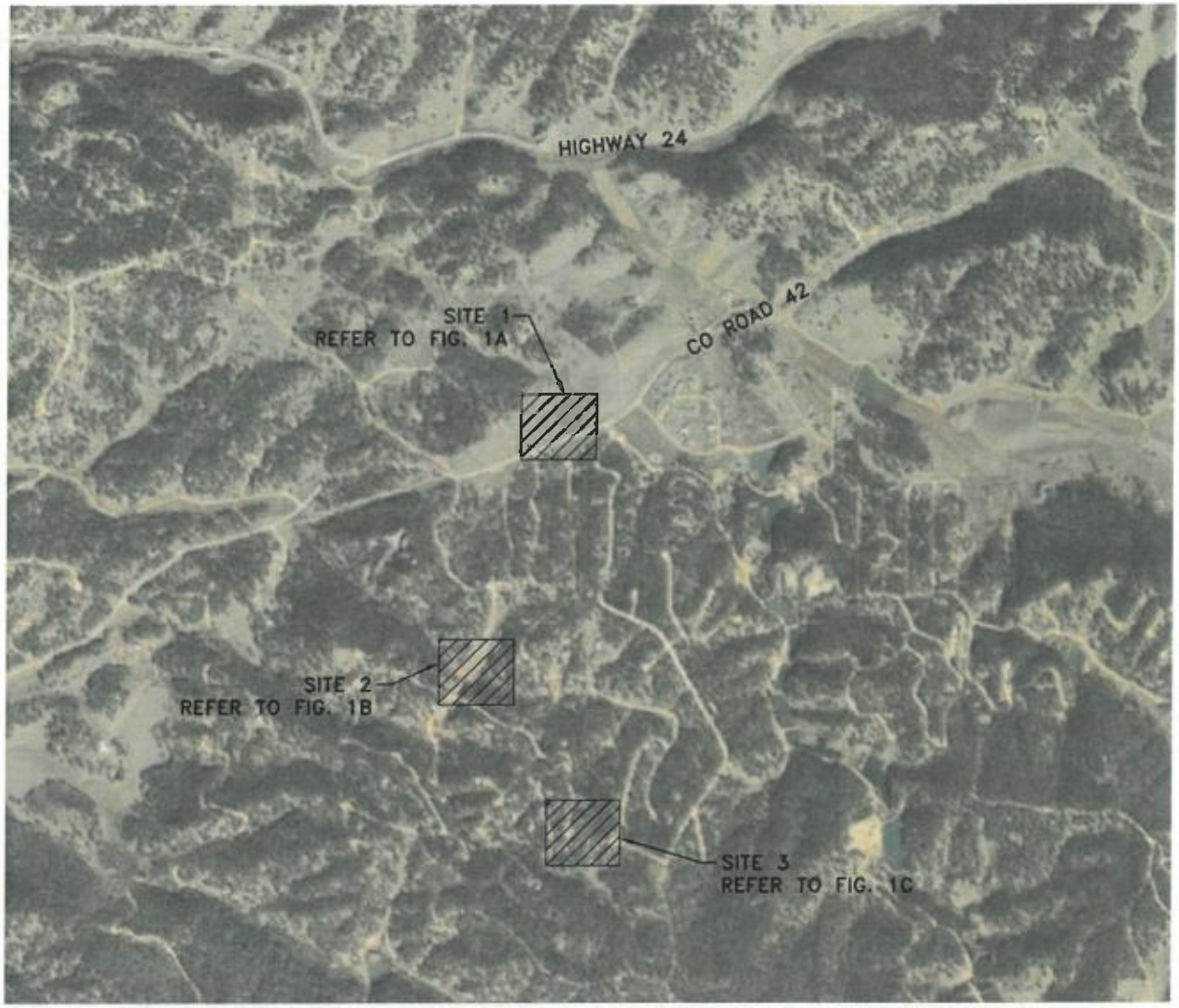
LIMITATIONS

This study has been conducted in accordance with generally accepted geotechnical engineering practices in this area for exclusive use by the client for design purposes. The conclusions and recommendations submitted in this report are based upon data obtained from the exploratory borings at the approximate locations indicated on Figs. 1 through 1C, and the proposed construction. This report may not reflect subsurface variations that occur, 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.

The scope of services for this project does not include any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken.

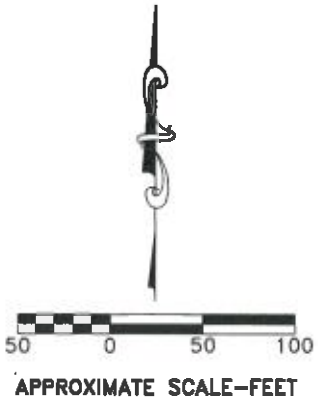
JDC:bj

cc: Mike Groselle, P.E., Aqua Works DBO



NOT TO SCALE

19-2-139	Kumar & Associates	VICINITY MAP	Fig. 1

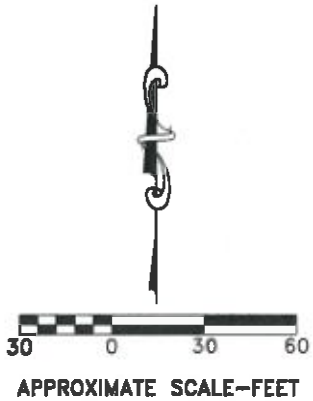


19–2–139	Kumar & Associates	LOCATION OF EXPLORATORY BORING	Fig. 1A

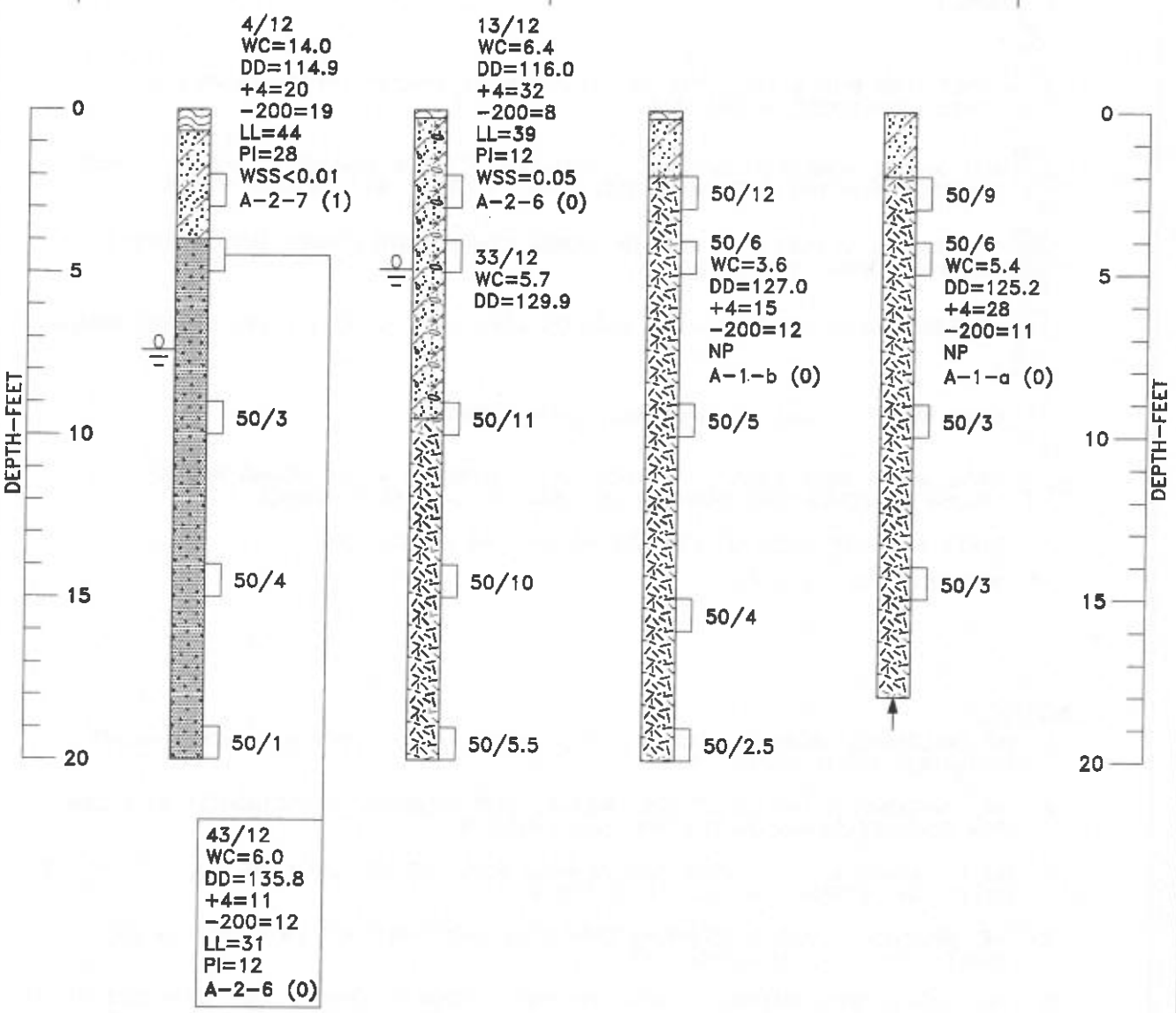
50 0 50 100

APPROXIMATE SCALE–FEET

19–2–139	Kumar & Associates	LOCATION OF EXPLORATORY BORING	Fig. 1B



19-2-139	Kumar & Associates	LOCATION OF EXPLORATORY BORINGS	Fig. 1C



19-2-139	Kumar & Associates	LOGS OF EXPLORATORY BORINGS	Fig. 2

LEGEND


TOPSOIL.


CLAYEY SAND WITH GRAVEL (SC), MEDIUM PLASTICITY, FINE TO COURSE GRAINED WITH GRAVEL, VERY LOOSE, MOIST, GRAY.


WELL GRADED SAND WITH CLAY AND GRAVEL (SW-SC), LOW PLASTICITY, FINE TO COURSE GRAINED WITH GRAVEL, MEDIUM TO VERY DENSE, MOIST TO WET, REDDISH BROWN.


SANDSTONE, LOW PLASTICITY, FINE TO COURSE GRAINED WITH GRAVEL, MEDIUM HARD TO VERY HARD, MOIST, REDDISH BROWN.


WEATHERED GRANITE, NON PLASTIC, HARD TO VERY HARD, SLIGHTLY MOIST, REDDISH BROWN.


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

4/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 4 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

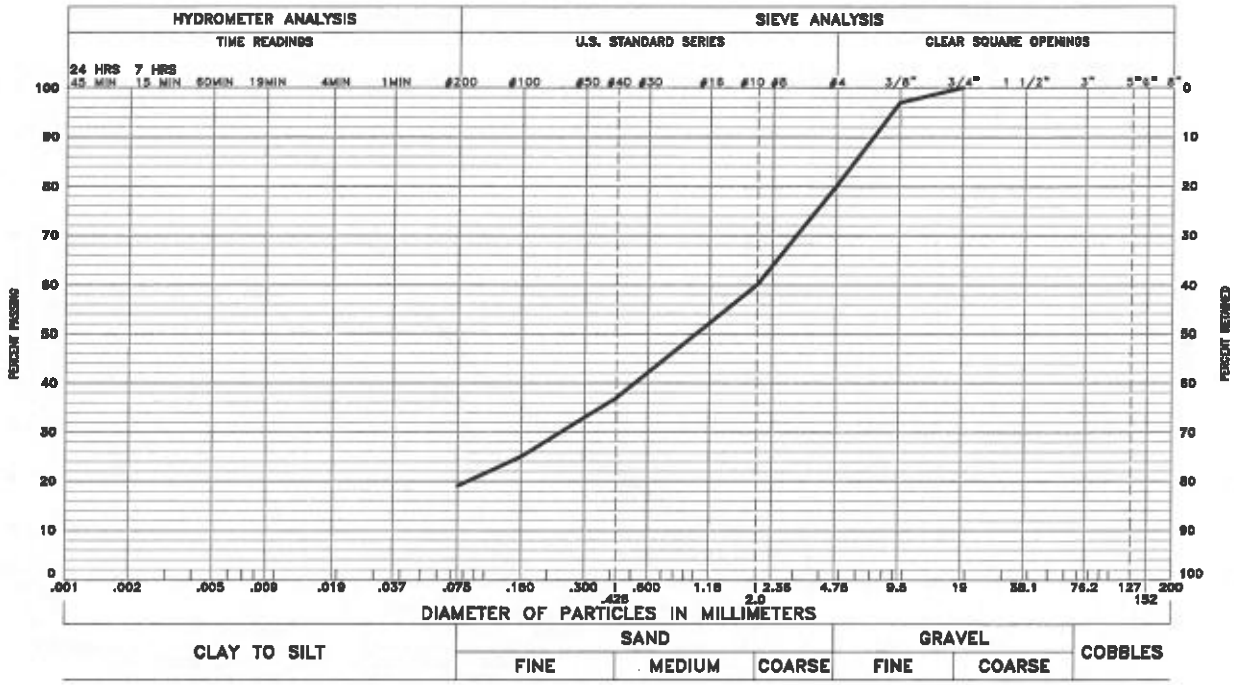

DEPTH TO WATER LEVEL ENCOUNTERED AT THE TIME OF DRILLING.


PRACTICAL AUGER REFUSAL.

NOTES

1. THE EXPLORATORY BORINGS WERE DRILLED ON APRIL 17, 2019 WITH A 4-INCH-DIAMETER CONTINUOUS-FLIGHT POWER AUGER.
2. THE LOCATIONS OF THE EXPLORATORY BORINGS WERE MEASURED APPROXIMATELY BY PACING FROM FEATURES SHOWN ON THE SITE PLAN PROVIDED.
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 LEVELS SHOWN ON THE LOGS WERE MEASURED AT THE TIME AND UNDER CONDITIONS INDICATED. FLUCTUATIONS IN THE WATER LEVEL MAY OCCUR WITH TIME.
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);
   WSS = WATER SOLUBLE SULFATES (%) (CP-L 2103);
   A-2-7 (1) = AASHTO CLASSIFICATION (GROUP INDEX) (AASHTO M 145).

19-2-139	Kumar & Associates	LEGEND AND NOTES	Fig. 3



GRAVEL 20 % SAND 61 % SILT AND CLAY 19 %

LIQUID LIMIT 44 PLASTICITY INDEX 25

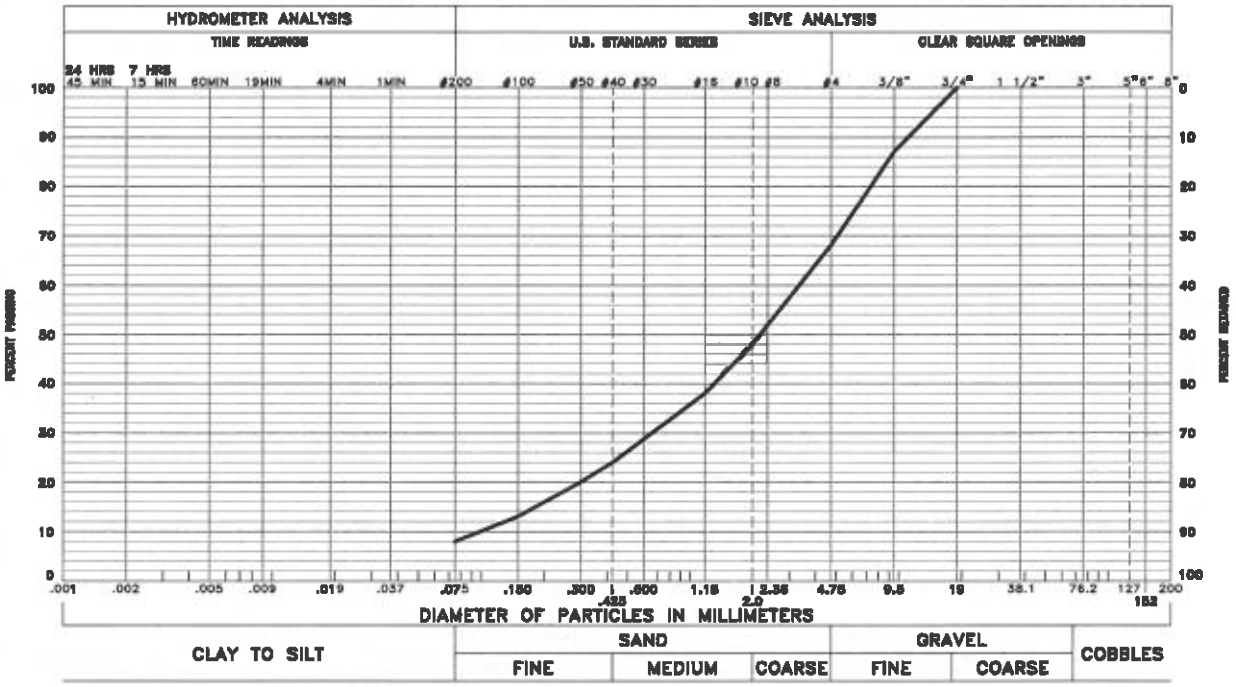
SAMPLE OF: Clayey Sand with Gravel (SC) FROM: Boring 1 @ 2'

GRAVEL 11 % SAND 77 % SILT AND CLAY 12 %

LIQUID LIMIT 31 PLASTICITY INDEX 12

SAMPLE OF: Sandstone FROM: Boring 1 @ 4'

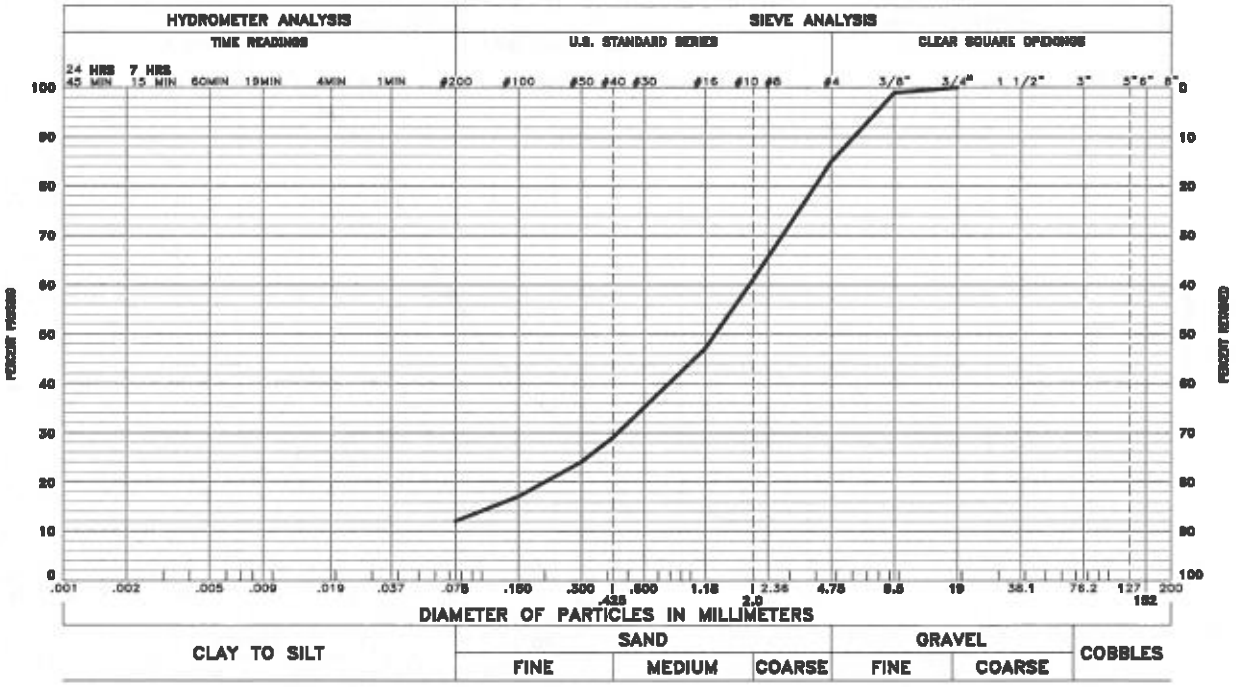
19-2-139	Kumar & Associates	GRADATION TEST RESULTS	Fig. 4



GRAVEL 32 % SAND 60 % SILT AND CLAY 8 %

LIQUID LIMIT 39 PLASTICITY INDEX 12

SAMPLE OF: Well Graded Sand with Clay and Gravel (SW-SM) FROM: Boring 2 @ 2'

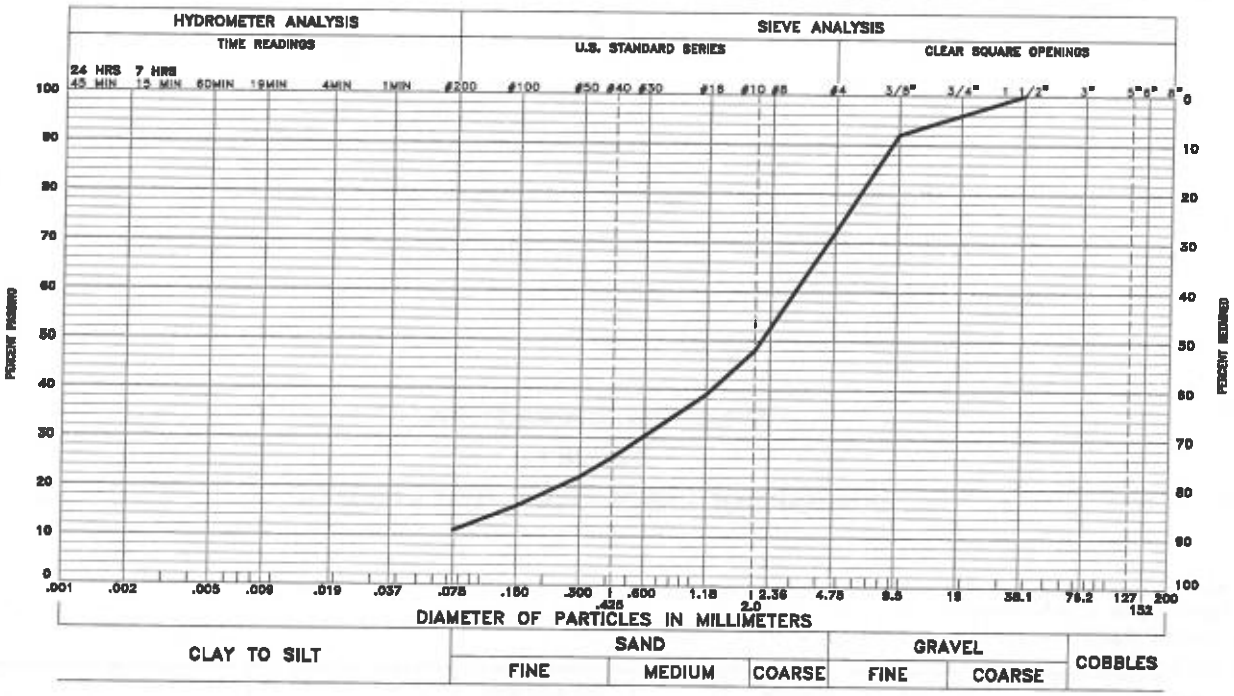


GRAVEL 15 % SAND 73 % SILT AND CLAY 12 %

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Granite FROM: Boring 3 @ 4'

19-2-139	Kumar & Associates	GRADATION TEST RESULTS	Fig. 5



GRAVEL 28 % SAND 61 % SILT AND CLAY 11 %

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Weathered Granite FROM: Boring 4 @ 4'

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.

19-2-139	Kumar & Associates	GRADATION TEST RESULTS	Fig. 6

Kumar and Associates, Inc.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 19-2-139
Project Name : Arabian Acres Metro District
Date Sampled: 4/17/2019
Date Received: 4/18/2019

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE SULFATES (%)	AASHTO CLASSIFICATION (Group Index)	SOIL OR BEDROCK TYPE (Unified Soil Classification)
BORING	DEPTH (ft)				GRAVEL (%)	SAND (%)		LIQUID LIMIT	PLASTICITY INDEX			
1	2	4/22/19	14.0	114.9	20	61	19	44	28	<0.01	A-2-7 (1)	Clayey Sand with Gravel (SC)
1	4	4/22/19	6.0	135.8	11	77	12	31	12		A-2-6 (0)	Sandstone
2	2	4/22/19	6.4	116.0	32	60	8	39	12	0.05	A-2-6 (0)	Well Graded Sand with Clay and Gravel (SW-SC)
2	4	4/22/19	5.7	129.9								Well Graded Sand with Clay and Gravel (SW-SC)
3	4	4/22/19	3.6	127.0	15	73	12		NP		A-1-b (0)	Granite
4	4	4/22/19	5.4	125.2	28	61	11		NP		A-1-a (0)	Granite