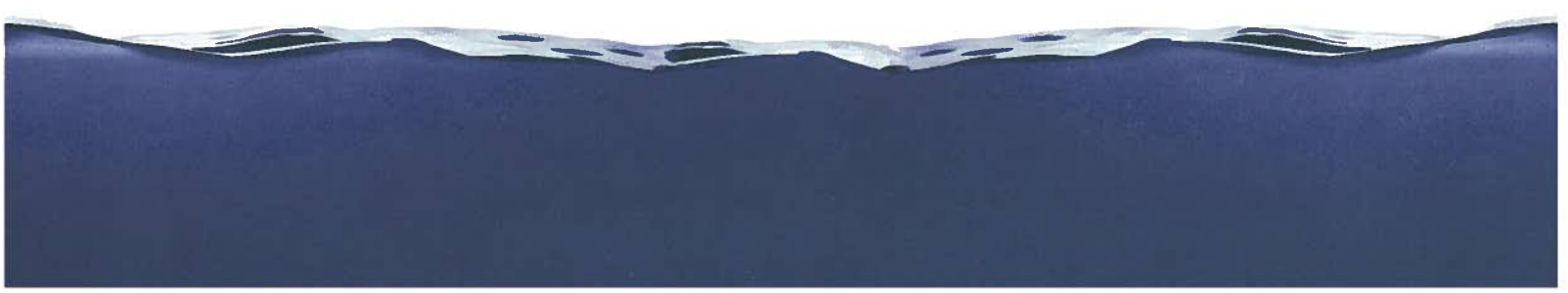
APPENDIX H

Site Soil Conditions



GEOTECHNICAL ENGINEERING REPORT

10,000 SEWAGE LAGOON
BOXELDER SEWAGE TREATMENT PLANT
1075 SW FRONTAGE ROAD
FORT COLLINS, COLORADO

ELI PROJECT NO. 20945282
February 2, 1995

Prepared for:

BOXELDER SANITATION DISTRICT
P. O. BOX 1518
FORT COLLINS, COLORADO 80522
ATTN: MR. DEAN SMITH

Prepared by:

Empire Laboratories, Inc.
A Division of The Terracon Companies, Inc.
301 North Howes
Fort Collins, Colorado 80521

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Chester C. Smith, P.E.
Larry G. O'Dell, P.E.
Neil R. Sherrod, C.P.G.

February 2, 1995

Boxelder Sanitation District
P. O. Box 1518
Fort Collins, Colorado 80522

Attn: Mr. Dean Smith

Re: **Geotechnical Engineering Report, 10,000 Gallon Sewage Lagoon**
Boxelder Sewage Treatment Plant, 1075 SW Frontage Road
Fort Collins, Colorado
ELI Project No. 20945282

Empire Laboratories, Inc. (ELI) has completed a geotechnical engineering exploration for the proposed lagoon to be located at the Boxelder Sewage Treatment Plant located southeast of Fort Collins, Colorado. This study was performed in general accordance with our proposal number D2094397 dated November 10, 1994.

The results of our engineering study, including the boring location diagram, laboratory test results, test boring records, and the geotechnical recommendations needed to aid in the design and construction of other earth connected phases of this project are attached.

The subsurface soils consisted of lean clay and sandy lean clay underlain by silty and clayey sands and well-graded gravel with cobbles. The upper subsoils are underlain by claystone-siltstone bedrock. Groundwater was encountered at relatively shallow depths of 3 to 5 feet below existing grade over the majority of the site. The information obtained by the results of field exploration and laboratory testing completed for this study indicates the clay soils are relatively impervious and are suitable for use to line the proposed sewage lagoon. The granular soils are suitable for use to construct the embankment forming the lagoon. Due to the shallow depth to groundwater, temporary dewatering will be required during construction of the proposed lagoon. Minimum water levels will need to be maintained in the lagoon to prevent damage to the liner due to hydrostatic uplift.

Other design and construction details, based upon geotechnical conditions, are presented in the report.

We appreciated being of service during the geotechnical engineering phase of this project, and are prepared to assist during the construction phases as well. If you have any questions concerning this report or any of our testing, inspection, design and consulting services, please do not hesitate to contact us.

Sincerely,
EMPIRE LABORATORIES, INC.
A Division of **The Terracon Companies, Inc.**

Neil R. Sherrod
Senior Engineering Geologist

Reviewed by:

Larry G. O'Dell, P.E.
Office Manager

NRS\LGO\clc

Copies to: Addressee (3)
The Engineering Company - Mr. Warren Mesloh (1)

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GEOTECHNICAL ENGINEERING REPORT

Terracon

10,000 SEWAGE LAGOON
BOXELDER SEWAGE TREATMENT PLANT
1075 SW FRONTAGE ROAD
FORT COLLINS, COLORADO

ELI Project No. 20945282
February 2, 1995

INTRODUCTION

This report contains the results of our geotechnical engineering exploration for the proposed sewage lagoon at the Boxelder Sewage Treatment Plant at 1075 SW Frontage Road, Fort Collins, Colorado. The site is located in the Northeast 1/4 of Section 28, Township 7 North, Range 68 West of the 6th Principal Meridian.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil and bedrock conditions
- groundwater conditions
- earthwork
- drainage

The conclusions and recommendations contained in this report are based upon the results of field and laboratory testing, engineering analysis, and experience with similar soil conditions, structures and our understanding of the proposed project.

PROPOSED CONSTRUCTION

The project as we understand it is to construct a 10,000 gallon sewage lagoon. The bottom of the pond will be placed at approximate elevation 4863. Due to the shallow depth to groundwater, the bottom elevation of the pond may need to be raised 1 to 2 feet and the surface area of the pond increased. The pond will be constructed with 3:1 (horizontal:vertical) slopes and will be lined with the on-site clay materials.

SITE EXPLORATION

The scope of the services performed for this project included site reconnaissance by an engineering geologist, a subsurface exploration program, laboratory testing and engineering analysis.

Field Exploration: A total of eight test borings were drilled on January 4, 1995 to depths of 5 to 15 feet at the locations shown on the Site Plan, Figure 1. Six borings were drilled within the footprint of the proposed sewage lagoon and two borings were drilled in the area of proposed borrow and/or future roadway areas. All borings were advanced with a truck-mounted drilling rig, utilizing 4- and 6-inch diameter solid stem auger.

The borings were located in the field by pacing from existing sewage lagoons and/or existing site features. Elevations were taken at each boring location by measurements with an engineer's level from a bench mark (BM) shown on the Site Plan. The accuracy of boring locations and elevations should only be assumed to the level implied by the methods used.

Continuous lithologic logs of each boring were recorded by the engineering geologist during the drilling operations. At selected intervals, samples of the subsurface materials were taken by pushing thin-walled Shelby tubes, or by driving split-spoon samplers. Representative bulk samples of subsurface materials were obtained from representative borings.

Penetration resistance measurements were obtained by driving the split-spoon into the subsurface materials with a 140-pound hammer falling 30 inches. The penetration resistance value is a useful index to the consistency, relative density or hardness of the materials encountered.

Groundwater measurements were made in each boring at the time of site exploration, and two days after drilling.

Laboratory Testing: All samples retrieved during the field exploration were returned to the laboratory for observation by the project geotechnical engineer, and were classified in accordance with the Unified Soil Classification System described in Appendix C. Samples of bedrock were classified in accordance with the general notes for Bedrock Classification. At that time, the field descriptions were confirmed or modified as necessary, an applicable laboratory testing program was formulated to determine engineering properties of the subsurface materials. Boring logs were prepared and are presented in Appendix A.

Selected soil and bedrock samples were tested for the following engineering properties:

- Water content
- Dry density
- Plasticity Index
- Permeability
- Water soluble sulfate content

The significance and purpose of each laboratory test is described in Appendix C. Laboratory test results are presented in Appendix B, and were used for the geotechnical engineering analyses, and the development of earthwork recommendations. All laboratory tests were performed in general accordance with the applicable ASTM, local or other accepted standards.

SITE CONDITIONS

The site consists of an area north of three existing sewage lagoons at the Boxelder Sewage Treatment Facility adjacent to the Cache La Poudre River, southeast of Fort Collins, Colorado. The area is relatively flat and has minor to poor drainage to the southeast toward the river. The property is bordered on the west and south by the Cache La Poudre River, and on the east by Boxelder Creek, which enters the Poudre River at the southeast corner of the property. Several buildings are located to the east of the existing lagoons. Trees line the river banks adjacent to the west and south sides of the property. The northern portion of the proposed lagoon is located in a fenced area vegetated with native grasses. The southern portion of the lagoon area has been partially stripped, and a stockpile of strippings and asphalt is located along the west edge of the proposed lagoon site.

SUBSURFACE CONDITIONS

Geology: The proposed area is located within the Colorado Piedmont section of the Great Plains physiographic province. The Colorado Piedmont, formed during Late Tertiary and Early Quaternary time (approximately 2,000,000 years ago), is a broad, erosional trench which separates the Southern Rocky Mountains from the High Plains. Structurally, the site lies along the western flank of the Denver Basin. During the Late Mesozoic and Early Cenozoic Periods (approximately 70,000,000 years ago), intense tectonic activity occurred, causing the uplifting of the Front Range and associated downwarping of the Denver Basin to the east. Relatively flat uplands and broad valleys characterize the present-day topography of the Colorado Piedmont in this region. The site is underlain by the Cretaceous Pierre Formation. The Pierre shale underlies the site at approximate depths of 14½ to 20 feet below the surface. The bedrock is overlain by alluvial gravels, sands and clays of Pleistocene and/or Recent Age.

Mapping completed by the Colorado Geological Survey ([1]Hart, 1972), indicates the site in an area of "Low Swell Potential". Potentially expansive materials mapped in this area include bedrock, weathered bedrock and colluvium (surficial units).

Soil and Bedrock Conditions: As presented on the Logs of Boring, the subsurface soils are presented as follows:

- Silty Topsoil and Fill Material: The majority of the site is overlain by a 6-inch layer of silty topsoil. The topsoil has been penetrated by root growth and organic matter. A 1-foot layer of fill material was encountered at the surface of Boring 6. The fill consists of sandy lean clay with gravel and is moist and stiff.

- Sandy Lean Clay: A layer of lean clay and/or sandy lean clay underlies the topsoil in Borings 1, 2, and 7 and extends to depths of 1 to 4½ feet below the surface. The lean clay and sandy lean clay is moist, plastic, and relatively impervious when properly compacted.

- Silty and/or Clayey Sand: This stratum was encountered in Borings 4, 5, and 8 at depths of ½ foot and extends to the granular stratum below. The silty and/or clayey sand is nonplastic to slightly plastic, dry to wet and medium dense to dense.

- Well-Graded Gravel with Sand and Cobbles: The granular stratum was encountered in all borings at depths of ½ to 8 feet and extends to the depths explored and/or the bedrock below. The well-graded gravel contains varying amounts of silt and cobbles ranging in size up to approximately 12 inches in diameter. The gravel is medium dense to dense and moist to wet in situ.

- Siltstone-Claystone Bedrock: The bedrock was encountered in Borings 1 and 6 at depths of 14½ feet and extends to greater depths. The bedrock encountered is weathered and moderately hard.

Field and Laboratory Test Results: Field test results indicate the clay soils are moderately plastic and are relatively impervious when properly compacted. The granular soils exhibit non to low plasticity and are anticipated to be highly pervious.

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[1]Hart, Stephen S., 1972, ***Potentially Swelling Soil and Rock in the Front Range Urban Corridor, Colorado,*** Colorado Geological Survey, Environmental Geology No. 7.

Groundwater Conditions: Groundwater was encountered in Borings 1, 2, and 6 at approximate depths of 3 to 5 feet in the test borings at the time of field exploration. Borings 3, 4 and 5 were caved at approximate depths of 4 to 5 feet, and Borings 7 and 8 were dry at the time of drilling. When checked 48 hours after drilling, groundwater was measured at approximate depths of 3 to 4½ feet in Borings 1, 5 and 6. Borings 2, 3 and 4 were caved at approximate depths of 2 feet, and Borings 7 and 8 were dry. These observations represent only current groundwater conditions, and may not be indicative of other times, or at other locations. Groundwater levels can be expected to fluctuate with varying seasonal and weather conditions and the volume of flow in the Cache La Poudre River and Boxelder Creek.

Based upon review of U.S. Geological Survey maps ([2]Hillier, et al, 1983), regional groundwater is expected to be encountered in unconsolidated alluvial deposits on the site, at depths ranging from 5 to 10 feet below the existing ground surface at the project site.

Fluctuations in groundwater levels can best be determined by implementation of a groundwater monitoring plan. Such a plan would include installation of groundwater monitoring wells, and periodic measurement of groundwater levels over a sufficient period of time.

The possibility of groundwater fluctuations should be considered when developing design and construction plans for the project.

CONCLUSIONS AND RECOMMENDATIONS

Geotechnical Considerations: In view of the subsoils encountered at the site, it is our opinion the proposed sewage lagoon construction is feasible. Due to the shallow depth to groundwater, it is suggested the bottom of the lagoon elevation be raised above the existing groundwater if possible. If this is not possible, temporary dewatering will be required during construction, and a minimum water level will be required in the lagoon to minimize damage to the liner due to hydrostatic uplift. Based on the subsoil conditions encountered, it is recommended the berms for the proposed lagoon be constructed with the on-site granular soils and that the lagoon be lined with the on-site clay soils encountered in the areas of Borings 1, 2 and 7. The bottom and wetted perimeter of the ponds should be lined with

[2]Hillier, Donald E.; Schneider, Paul A., Jr.; and Hutchinson, E. Carter, 1983, ***Depth to Water Table (1979) in the Boulder-Fort Collins-Greeley Area, Front Range Urban Corridor, Colorado,*** United States Geological Survey, Map I-855-I.

a minimum of 18 inches of the on-site clay material. If sufficient quantities of suitable on-site clay are not available on site, imported impervious clay or a mixture of soil and bentonite should be used as liner material.

Earthwork:

- Site Clearing:

  1. Strip and remove existing vegetation, debris, and other deleterious materials from proposed lagoon bottom an embankment area. All exposed surfaces should be free of mounds and depressions which could prevent uniform compaction.

  2. If unexpected fills or underground facilities are encountered during site clearing, such features should be removed and the excavation thoroughly cleaned prior to backfill placement and/or construction. All excavations should be observed by the geotechnical engineer prior to backfill placement.

  3. Stripped materials consisting of vegetation and organic materials should be stockpiled and used to revegetate exposed slopes after completion of grading operations.

  4. All exposed areas which will receive fill, once properly cleared and benched where necessary, should be scarified to a minimum depth of < >ten, twelve inches, conditioned to near optimum moisture content, and compacted.

- Excavation:

  1. It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment.

  2. Some additional effort may be necessary to extract cobble-sized materials, particularly in deep narrow excavations such as utility trenches.

  3. Based on the proposed bottom pond elevation of 4863, groundwater will be encountered in excavation on the site. Pumping from sumps may be utilized

to control water within excavations. Well points may be required for significant groundwater flow, or where excavations penetrate groundwater to a significant depth.

- **Fill Materials**:

1. Clean on-site soils or approved imported materials may be used as fill material for the following:

   - general site grading
   - embankment
   - pond liner

2. On-site sands and gravels are suitable for use as embankment material.

3. On-site or imported clay is suitable for use as liner material.

4. Frozen soils should not be used as fill or backfill.

5. Imported soils for liner material (if required) should conform to the following:

Gradation	Percent fines by weight (ASTM C136)
No. 4 Sieve	50-100
No. 200 Sieve	70 (max)
• Liquid Limit	30 (max)
• Plasticity Index	15 (max)
• Permeability	1×10^{-6} cm/sec (min)

6. On-site silty and/or clayey sand soils mixed with bentonite may also be used to line the pond. Laboratory permeability tests should be performed on all imported clay and soil and clay mixtures to ensure specified permeability rates can be obtained.

- Placement and Compaction:

  1. Place and compact fill in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift.

  2. No fill should be placed over frozen ground.

  3. Materials should be compacted to the following:

Material	Minimum Percent (ASTM D698)
Subgrade soils beneath fill and liner areas	95
On-site soils and Imported fill:	
Embankment material	95
Liner material	95
Miscellaneous backfill	90

  4. If a well defined maximum density curve cannot be generated by impact compaction in the laboratory for any fill type, engineered fill should be compacted to a minimum of 80 percent relative density by determined by ASTM D4253 D4254.

  5. On-site clay, sand and gravel soils should be compacted within a moisture content range of 2 percent below, to 2 percent above optimum. Imported soils should be compacted within a moisture range of 2 percent below to 2 percent above optimum.

- Shrinkage: For balancing grading plans, estimated shrink or swell of soils and bedrock when used as compacted fill following recommendations in this report are as follows:

Material	Estimated Shrink(-) Swell (+) Based on ASTM D698
On-site soils:	
Clays	-15 to -20%
Sands and gravels	-10 to -15%

- Slopes:

1. Permanent slopes in compacted fill areas of 3:1 or flatter are recommended. If steeper slopes are required for site development, stability analyses should be completed to design the grading plan.

2. The face of all slopes should be compacted to the minimum specification for fill embankments. Alternately, fill slopes can be over-built and trimmed to compacted material.

- Compliance: Recommendations for slabs-on-grade, foundations and pavement elements supported on compacted fills or prepared subgrade depend upon compliance with "Earthwork" recommendations. To assess compliance, observation and testing should be performed under the direction of the geotechnical engineer.

- Excavation and Trench Construction: Excavations into the on-site soils will encounter a variety of conditions. Excavations into the clays and bedrock can be expected to stand on relatively steep temporary slopes during construction. However, the granular soils may cave and groundwater will also be encountered. The individual contractor(s) should be made responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottom. All excavations should be sloped or shored in the interest of safety following local, and federal regulations, including current OSHA excavation and trench safety standards.

The soils to be penetrated by the proposed excavations may vary significantly across the site. The preliminary soil classifications are based solely on the materials encountered in widely spaced exploratory test borings. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, the actual

conditions should be evaluated to determine any excavation modifications necessary to maintain safe conditions.

As a safety measure, it is recommended that all vehicles and soil piles be kept to a minimum lateral distance from the crest of the slope equal to no less than the slope height. The exposed slope face should be protected against the elements.

Drainage:

- Surface Drainage:

  Positive drainage should be provided during construction and maintained throughout the life of the proposed lagoon. Infiltration of water into utility excavations must be prevented during construction.

Additional Design and Construction Considerations:

- Underground Utility Systems: All piping should be adequately bedded for proper load distribution. It is suggested that clean, graded gravel compacted to 80 percent of Relative Density ASTM D4253 be used as bedding below the pipe. Where utilities are excavated below groundwater, temporary dewatering will be required during excavation, pipe placement and backfilling operations for proper construction. Utility trenches should be excavated on safe and stable slopes in accordance with OSHA regulations as discussed above. Backfill should consist of the on-site soils. The pipe backfill should be compacted to a minimum of 95 percent of Standard Proctor Density ASTM D698.

- Corrosion Protection: Results of soluble sulfate testing indicate that ASTM Type I-II Portland cement is suitable for all concrete on and below grade. Foundation concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

GENERAL COMMENTS

It is recommended that the Geotechnical Engineer be retained to provide a general review of final design plans and specifications in order to confirm that grading recommendations have been interpreted and implemented. In the event that any changes of the proposed project are planned, the conclusions and recommendations contained in this report should be reviewed and the report modified or supplemented as necessary.

The Geotechnical Engineer should also be retained to provide services during excavation, grading, foundation and construction phases of the work. Construction testing, including field and laboratory evaluation of liner fill, backfill materials, and concrete should be performed to determine whether applicable project requirements have been met. It would be logical for Empire Laboratories, Inc. to provide these additional services for continuing from design through construction and to determine the consistency of field conditions with those data used in our analyses.

The analyses and recommendations in this report are based in part upon data obtained from the field exploration. The nature and extent of variations beyond the location of test borings may not become evident until construction. If variations then appear evident, it may be necessary to re-evaluate the recommendations of this report.

Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in this or similar localities. No warranty, express or implied, is made. We prepared the report as an aid in design of the proposed project. This report is not a bidding document. Any contractor reviewing this report must draw his own conclusions regarding site conditions and specific construction techniques to be used on this project.

This report is for the exclusive purpose of providing geotechnical engineering and/or testing information and recommendations. The scope of services for this project does not include, either specifically or by implication, 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.

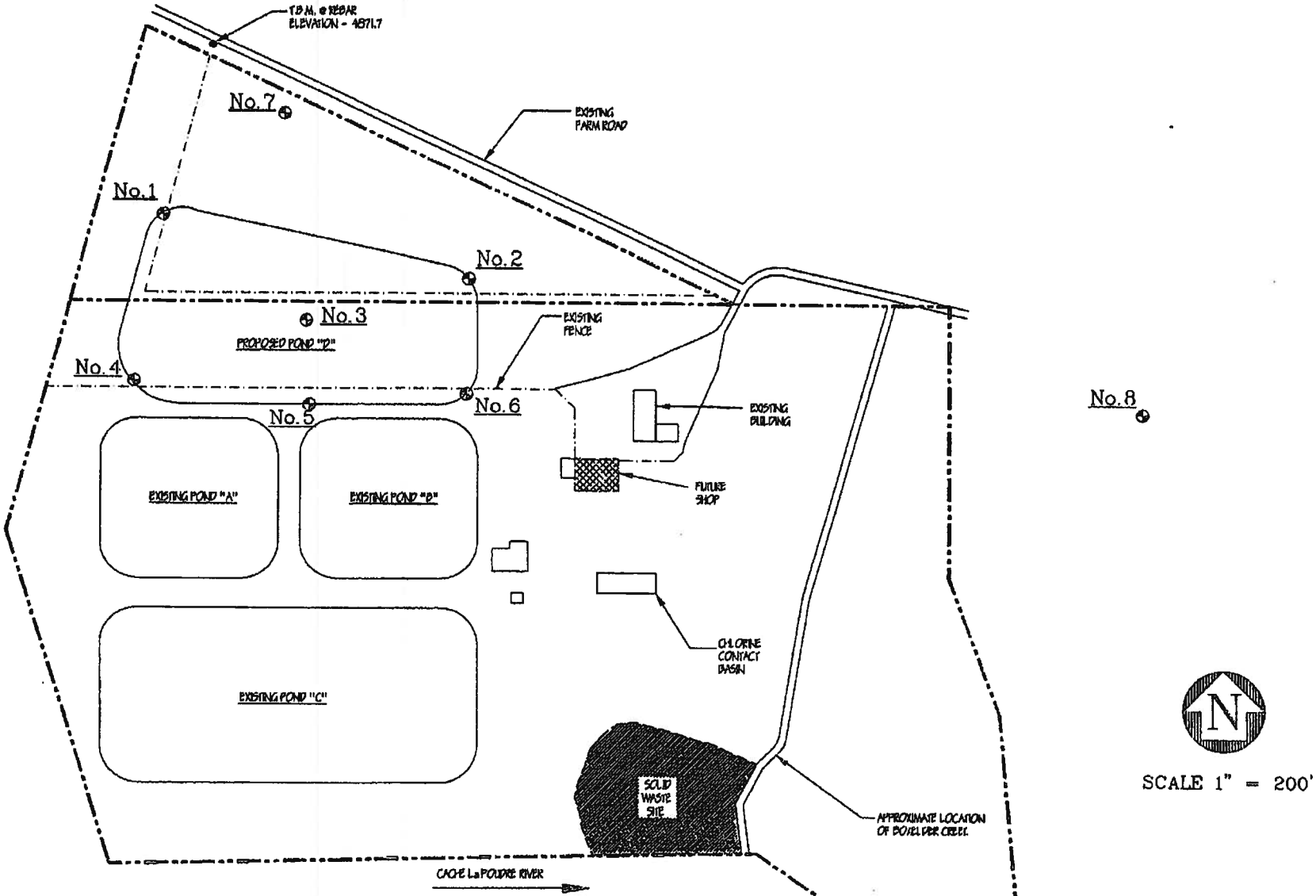


FIGURE 1: SITE PLAN

BOXELDER SEWAGE TREATMENT PLANT
FORT COLLINS, COLORADO
ELI PROJECT No. 20945282

Empire Laboratories, Inc.
A Division of The Terracon Companies, Inc.

LOG OF BORING No. 1

CLIENT: Boxelder Sanitation District

ARCHITECT/ENGINEER: The Engineering Co.

SITE: Boxelder Sewage Treatment Plant, Fort Collins, Colorado

PROJECT: 10,000 Gallon sewage Lagoon

Approx. Surface Elev.: 4868.9 ft.

GRAPHIC LOG	DESCRIPTION	DEPTH (FT.)	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY	SAMPLES SPT - N BLOWS / FT.	TESTS MOISTURE, %	TESTS DRY DENSITY PCF	TESTS UNCONFINED STRENGTH PSF
	0.5 6" TOPSOIL — 4868.4									
	SANDY LEAN CLAY WITH GRAVEL, Brown, moist, stiff		CL	1	SS	12"	11	15		
	3.0 — 4865.9									
				2	ST	12"		2		
			GW	3	SS	12"	21	5		
	WELL GRADED GRAVEL WITH SAND & COBBLES, Tan, moist to wet, medium dense (Cobbles 12" maximum)	5								
				4	SS	12"	24	13		
		10								
				5	SS	12"	27	24		
	14.5 — 4854.4									
	15.0 WEATHERED CLAYSTONE — 4853.9	15								
	Black, moist, moderately hard									
	BOTTOM OF BORING									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS				
WL	▽ 5.1'	W.D.	▽ 4.8'	A.B.
WL				
WL	Water checked 2 days A.B.			

Empire Laboratories Incorporated
Division of Terracon

BORING STARTED	1-4-95		
BORING COMPLETED	1-4-95		
RIG	CME-55	FOREMAN	DML
APPROVED	NRS	JOB #	20945282

LOG OF BORING No. 2

CLIENT: Boxelder Sanitation District

ARCHITECT/ENGINEER: The Engineering Co.

SITE: Boxelder Sewage Treatment Plant, Fort Collins, Colorado

PROJECT: 10,000 Gallon sewage Lagoon

Approx. Surface Elev.: 4867.3 ft.

GRAPHIC LOG	DESCRIPTION	DEPTH (FT.)	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY	SPT - N / BLOWS / FT.	TESTS MOISTURE, %	TESTS DRY DENSITY PCF	TESTS UNCONFINED STRENGTH PSF	TESTS ATTERBERG LIMITS LL/PL/PI
	0.5 6" TOPSOIL — 4866.8										
	SANDY LEAN CLAY Brown, moist, stiff Composite sample @ 0.5 to 4 ft.		CL	1	SS	12"	11	25			
				2	BS						27/18/9
				3	ST	12"		15	109		
	4.5 ▽4862.8			4	SS	12"	8	30			
	WELL GRADED GRAVEL WITH SAND & COBBLES Brown/tan, wet, medium dense (Cobbles 12" maximum)	5	GW								
				5	SS	12"	29	23			
		10									
	14.0 — 4853.3										
	BOTTOM OF BORING										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS			
WL	▽ 4.2'	W.D.	▽
WL		2.2'	D.C.I.
WL	Water checked 2 days A.B.		

Empire Laboratories Incorporated
Division of Terracon

BORING STARTED	1-4-95		
BORING COMPLETED	1-4-95		
RIG	CME-55	FOREMAN	DML
APPROVED	NRS	JOB #	20945282

LOG OF BORING No. 3

CLIENT: Boxelder Sanitation District	ARCHITECT/ENGINEER: The Engineering Co.
SITE: Boxelder Sewage Treatment Plant, Fort Collins, Colorado	PROJECT: 10,000 Gallon sewage Lagoon

Approx. Surface Elev.: 4867.3 ft.

GRAPHIC LOG	DESCRIPTION	DEPTH (FT.)	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY	SAMPLES SPT - N BLOWS / FT.	TESTS MOISTURE, %	TESTS DRY DENSITY PCF	TESTS UNCONFINED STRENGTH PSF
	0.5 6" TOPSOIL 4866.8									
				1	SS	12"	23	2		
			GW	2	SS	12"	30	7		
	WELL GRADED GRAVEL WITH SAND & COBBLES Brown, dry to wet Medium dense to dense (Cobbles 12" maximum)	5								
				3	SS	12"	23	13		
		10								
				4	SS	12"	39	22		
	15.0 4852.3 BOTTOM OF BORING	15								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS				
WL	▽		▼	
WL	3.8'	W.C.I.	1.8'	D.C.I.
WL	Water checked 2 days A.B.			

Empire Laboratories Incorporated
Division of Terracon

BORING STARTED	1-4-95		
BORING COMPLETED	1-4-95		
RIG	CME-55	FOREMAN	DML
APPROVED	NRS	JOB #	20945282

LOG OF BORING No. 4

CLIENT: Boxelder Sanitation District

ARCHITECT/ENGINEER: The Engineering Co.

SITE: Boxelder Sewage Treatment Plant, Fort Collins, Colorado

PROJECT: 10,000 Gallon sewage Lagoon

Approx. Surface Elev.: 4868.9 ft.

GRAPHIC LOG	DESCRIPTION	DEPTH (FT.)	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY	SAMPLES SPT - N BLOWS / FT.	TESTS MOISTURE, %	TESTS DRY DENSITY PCF	TESTS UNCONFINED STRENGTH PSF	TESTS ATTERBERG LIMITS LL/PL/PI
	0.5 6" TOPSOIL — 4868.4										
	CLAYEY SAND Brown, moist, medium dense Composite sample @ 0.5 to 3 ft.		SC	1	SS	12"	27	8			
				2	BS						23/16/7
				3	SS	12"	29	2			
	5.5 — 4863.4	5									
	WELL GRADED GRAVEL WITH SAND & COBBLES Brown, wet, medium dense (Cobbles 12" maximum)		GW	4	SS	12"	23	15			
	14.0 — 4854.9	10									
	BOTTOM OF BORING										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS				
WL	▽		▼	
WL	5.2'	W.C.I.	2.0'	D.C.I.
WL	Water checked 2 days A.B.			

Empire Laboratories Incorporated
Division of Terracon

BORING STARTED	1-4-95		
BORING COMPLETED	1-4-95		
RIG	CME-55	FOREMAN	DML
APPROVED	NRS	JOB #	20945282

LOG OF BORING No. 5

CLIENT	ARCHITECT/ENGINEER
Boxelder Sanitation District	The Engineering Co.
SITE Boxelder Sewage Treatment Plant, Fort Collins, Colorado	**PROJECT** 10,000 Gallon sewage Lagoon

GRAPHIC LOG	DESCRIPTION	DEPTH (FT.)	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY	SAMPLES SPT - N BLOWS / FT.	TESTS MOISTURE, %	TESTS DRY DENSITY PCF	TESTS UNCONFINED STRENGTH PSF
	Approx. Surface Elev.: 4867.5 ft.									
	0.5 6" TOPSOIL — 4867.0									
	SILTY SAND Brown, moist to wet Medium dense to dense ▼		SM	1	SS	12"	33	8		
	4.0 — 4863.5									
	WELL GRADED GRAVEL WITH SAND & COBBLES Brown, wet, medium dense (Cobbles 12" maximum)		GW	2	SS	12"	17	2		
		5								
				3	SS	12"	23	13		
		10								
	14.0 — 4853.5									
	BOTTOM OF BORING									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS			
WL	▽	▼ 3.0'	A.B.
WL	4.3' W.C.I.		
WL	Water checked 2 days A.B.		

Empire Laboratories Incorporated
Division of Terracon

BORING STARTED	1-4-95		
BORING COMPLETED	1-4-95		
RIG	CME-55	FOREMAN	DML
APPROVED	NRS	JOB #	20945282

LOG OF BORING No. 6

CLIENT	ARCHITECT/ENGINEER
Boxelder Sanitation District	The Engineering Co.
SITE Boxelder Sewage Treatment Plant, Fort Collins, Colorado	**PROJECT** 10,000 Gallon sewage Lagoon

Approx. Surface Elev.: 4867.4 ft.

DEPTH (FT.)	GRAPHIC LOG	DESCRIPTION	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY	SAMPLES SPT - N BLOWS / FT.	TESTS MOISTURE, %	TESTS DRY DENSITY PCF	TESTS UNCONFINED STRENGTH PSF
0		FILL-Sandy lean clay with gravel Brown, moist, stiff	CL	1	SS	12"	22	9		
1.0		4866.4								
		WELL GRADED GRAVEL WITH SAND & COBBLES Brown, moist to wet Medium dense (Cobbles 12" maximum)	GW	2	SS	12"	24	9		
5				3	SS	12"	18	22		
10				4	SS	12"	45	6		
14.5		4852.9								
15.0		WEATHERED CLAYSTONE/ SILTSTONE Blue/black, moist, moderately hard								
15		4852.4								
		BOTTOM OF BORING								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS			
WL	▽ 3.0' W.D.	▽ 3.0' A.B.	
WL			
WL	Water checked 2 days A.B.		

Empire Laboratories Incorporated
Division of Terracon

BORING STARTED	1-4-95		
BORING COMPLETED	1-4-95		
RIG	CME-55	FOREMAN	DML
APPROVED	NRS	JOB #	20945282

LOG OF BORING No. 7

CLIENT	ARCHITECT/ENGINEER
Boxelder Sanitation District	The Engineering Co.
SITE Boxelder Sewage Treatment Plant, Fort Collins, Colorado	**PROJECT** 10,000 Gallon sewage Lagoon

GRAPHIC LOG	DESCRIPTION	DEPTH (FT.)	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY	SAMPLES SPT - N BLOWS / FT.	TESTS MOISTURE, %	TESTS DRY DENSITY PCF	TESTS UNCONFINED STRENGTH PSF	TESTS ATTERBERG LIMITS LL/PL/PI
	Approx. Surface Elev.: 4869.5 ft.										
	0.5 6" TOPSOIL 4869.0										
	Composite sample @ 0.5 to 3 ft.		CL	1	BS						26/16/10
	LEAN CLAY Tan/brown, moist, stiff										
	3.0 4866.5										
	WELL GRADED GRAVEL WITH SAND & COBBLES Tan, moist, medium dense		GW								
	5.0 4864.5	5									
	BOTTOM OF BORING										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS				
WL	▽ None	W.D.	▽ None	A.B.
WL				
WL	Water checked 2 days A.B.			

Empire Laboratories Incorporated
Division of Terracon

BORING STARTED	1-4-95		
BORING COMPLETED	1-4-95		
RIG	CME-55	FOREMAN	DML
APPROVED	NRS	JOB #	20945282

LOG OF BORING No. 8

CLIENT	ARCHITECT/ENGINEER
Boxelder Sanitation District	The Engineering Co.
SITE Boxelder Sewage Treatment Plant, Fort Collins, Colorado	**PROJECT** 10,000 Gallon sewage Lagoon

GRAPHIC LOG	DESCRIPTION	DEPTH (FT.)	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY	SAMPLES: SPT - N BLOWS / FT.	TESTS: MOISTURE, %	TESTS: DRY DENSITY PCF	TESTS: UNCONFINED STRENGTH PSF	TESTS: ATTERBERG LIMITS LL/PL/PI
	Approx. Surface Elev.: 4881.3 ft.										
	0.5 6" TOPSOIL 4880.8										
	Composite sample @ 0.5 to 5 ft.		SM	1	BS						18/NP/NP
	SILTY SAND Tan/brown, dry to moist Medium dense	5									
	8.0 4873.3										
	WELL GRADED GRAVEL WITH SAND & COBBLES Tan, moist, medium dense		GW								
	10.0 4871.3	10									
	BOTTOM OF BORING										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS				
WL	▽ None	W.D.	▼ None	A.B.
WL				
WL	Water checked 2 days A.B.			

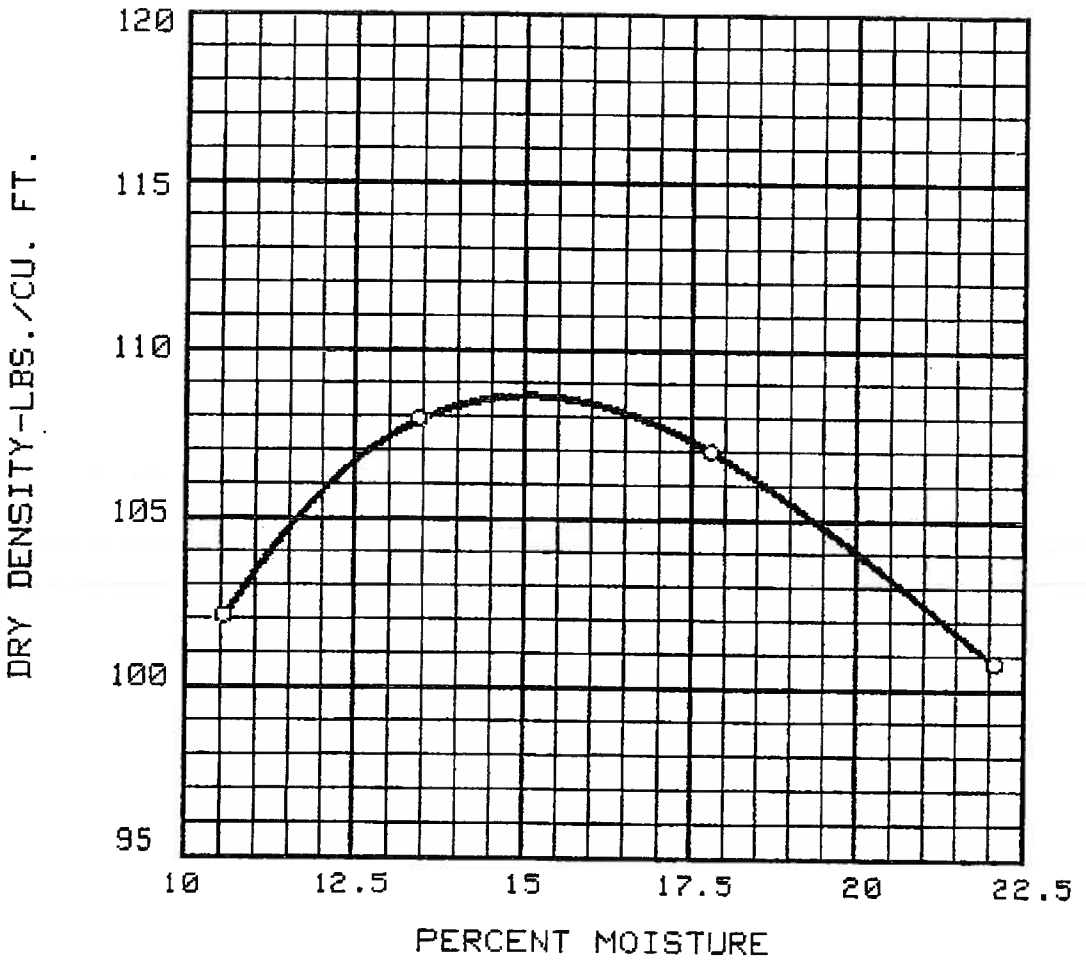
Empire Laboratories Incorporated
Division of Terracon

BORING STARTED	1-4-95		
BORING COMPLETED	1-4-95		
RIG	CME-55	FOREMAN	DML
APPROVED	NRS	JOB #	20945282

MOISTURE DENSITY CURVE

PROJECT: BOXELDER SANITATION DISTRICT
LOCATION OF SAMPLE: SEWAGE LAGOON
TEST BORING #7 @ 0.5' - 3.0'
SAMPLE DESCRIPTION: TAN-BROWN SANDY LEAN CLAY

TEST PROCEDURE: ASTM D 698-91 Method A
MAXIMUM DRY DENSITY: 108.6 PCF
OPTIMUM MOISTURE: 15.1 %



EMPIRE LABORATORIES INC.

PERMEABILITY

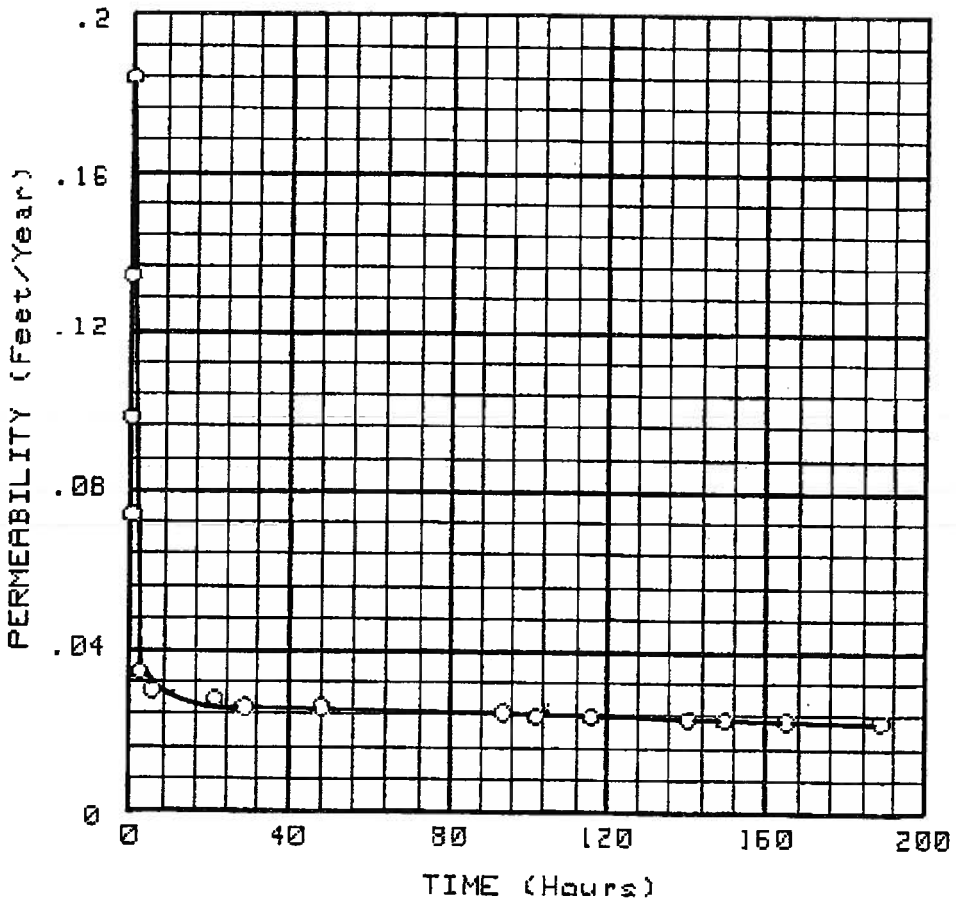
PROJECT: BOXELDER SANITATION DISTRICT
BOXELDER SEWAGE TREATMENT PLANT

SAMPLE NUMBER: COMPOSITE SAMPLE TB # 7 @ 0.5'-3.0'

TEST PROCEDURE: FALLING HEAD METHOD

DENSITY: 103.5 PCF @ 95.3% STANDARD PROCTOR

PERMEABILITY: .022 FT/YR = .022 X 10^{-6} CM/SEC



EMPIRE LABORATORIES INC.

SUMMARY OF TEST RESULTS

PROJECT NO. 20945282

Boring No.	Depth Ft.	Moisture %	Dry Density (PCF)	Compressive Strength (PSF)	Swell Pressure (PSF)	Soluble Sulfates %	pH	Liquid Limit %	Plasticity Index %	Group Index	Classification AASHTO USCS	Resistivity (OHM-CM)	Penetration Blow/In.
1	.5-1.5	15											11/12
	3-4	2											
	4-5	5											21/12
	9-10	13											24/12
	14-15	24											27/12
2	.5-1.5	25											11/12
	3-4	15	109										
	4-5	30				.0585							8/12
	9-10	23											29/12
Comp. Samp.	.5-4.0							27	9	3	A-4(3); CL		
3	.5-1.5	2											23/12
	4-5	7											30/12
	9-10	13											23/12
	14-15	22											39/12
4	.5-1.5	8											27/12
	4-5	2											29/12
	9-10	15				.0033							23/12
Comp. Samp.	.5-3.0							23	7	0	A-4(0); SC		
5	.5-1.5	8											33/12
	4-5	2											17/12

SUMMARY OF TEST RESULTS

PROJECT NO. 20945282

Boring No.	Depth Ft.	Moisture %	Dry Density (PCF)	Compressive Strength (PSF)	Swell Pressure (PSF)	Soluble Sulfates %	pH	Liquid Limit %	Plasticity Index %	Group Index	Classification AASHTO USCS	Resistivity (OHM-CM)	Penetration Blow/In.
5	9-10	13											23/12
6	.5-1.5	9											22/12
	4-5	9											24/12
	9-10	22											18/12
	14-15	6											45/12
7	.5-3.0							26	10	6	A-4(6); CL		
8	.5-5.0							19	NP	0	A-4(0); SM		

GEOTECHNICAL ENGINEERING REPORT

PROPOSED MAINTENANCE BUILDING
BOXELDER SANITATION COMPLEX
NE ¼ OF SECTION 28, TOWNSHIP 7 NORTH, RANGE 68 WEST
FORT COLLINS, COLORADO

TERRACON PROJECT NO. 20015058

APRIL 12, 2001

Prepared for:

BOXELDER SANITATION DISTRICT
P.O. BOX 1518
FORT COLLINS, COLORADO 80522

ATTN: MR. DEAN SMITH

Prepared by:

Terracon
301 North Howes Street
Fort Collins, Colorado 80521

Terracon

April 12, 2001

Terracon
301 N. Howes • P.O. Box 503
Fort Collins, Colorado 80521-0503
(970) 484-0359 Fax. (970) 484-0454

Boxelder Sanitation District
P.O. Box 1518
Fort Collins, Colorado 80522

Attn: Mr. Dean Smith

Re: **Geotechnical Engineering Report**
Proposed Maintenance Building
Boxelder Sanitation Complex
Fort Collins, Colorado
Terracon Project No. 20015058

Terracon has completed a geotechnical engineering exploration for the proposed single story, slab on grade maintenance facility building to be constructed at the Boxelder Sanitation Complex in Fort Collins, Colorado. This study was performed in general accordance with our Proposal No. D2001114 dated March 13, 2001.

The results of our engineering study, including the boring location diagram, laboratory test results, test boring records, and the geotechnical engineering recommendations needed to aid in the design and construction of foundations, pavements and other earth connected phases of this project are attached.

The subsoils at the site consisted of relatively uniform granular sand and/or gravel layers extending to depths explored and/or bedrock below. Claystone bedrock was encountered in Test Boring No. 2 at approximately 14 feet below existing site grades. Groundwater was encountered at approximate depths of 6 to 9 feet below existing surface elevations.

Based on the geotechnical engineering analyses, subsurface exploration and laboratory test results, we recommend that the proposed structure be supported by a spread footing foundation system bearing on the on-site soils encountered during this exploration and/or on compacted imported engineered fill material. Slab-on-grade construction is feasible provided the recommendations set forth in this report are followed. Further details are provided in this report.

Geotechnical Engineering Exploration
Boxelder Sanitation District
Proposed Maintenance Building
Terracon Project No. 20015058

We appreciate the opportunity to be of service to you on this phase of your project. If you have any questions concerning this report, or if we may be of further service to you, please do not hesitate to contact us.

Sincerely,
TERRACON

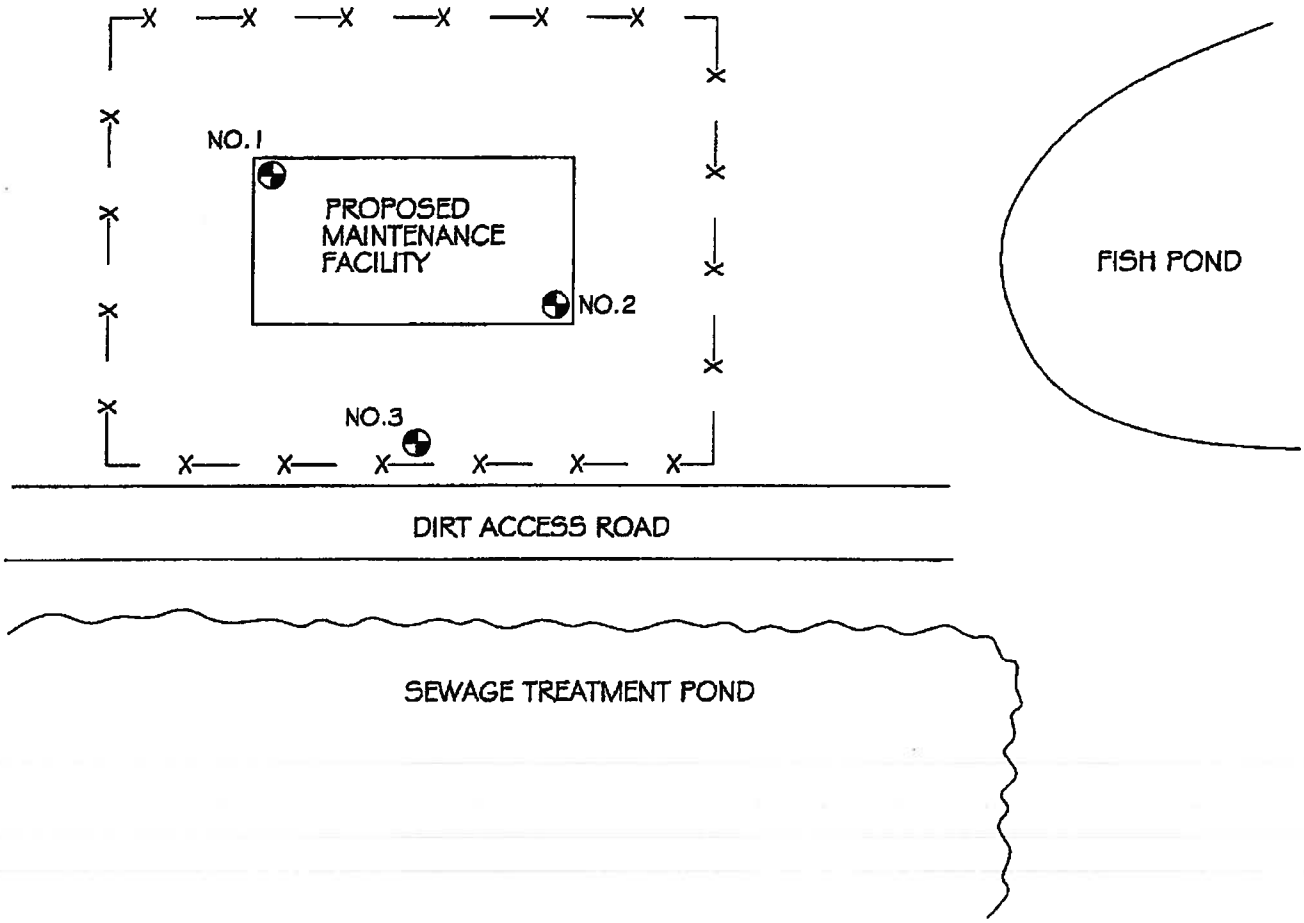
Prepared by:

Daniel Lambert, E.I.T
Geotechnical Engineer

Reviewed by:

David A. Richer P.E.
Geotechnical Engineer/Department Manager

Copies to: (3) Addressee



LEGEND

TEST BORING LOCATIONS

DIAGRAM IS FOR GENERAL LOCATION ONLY,
AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

N

FIGURE 1: SITE PLAN
PROPOSED MAINTENANCE FACILITY
BOX ELDER SANITATION COMPLEX
FORT COLLINS, COLORADO

Project Mngr: DAR	Terracon	Project No.	20015058
Designed By: DAR		Scale:	NTS
Checked By: DAR	301 N. Howes Street	Date:	4/13/01
Approved By: DAR	Fort Collins, Colorado 80521	Drawn By:	WTT
File Name: 5058FIG1		Figure No.	1

LOG OF BORING NO. 1

CLIENT: Boxelder Sanitation District

ARCHITECT / ENGINEER:

SITE: Boxelder Sanitation Complex, Fort Collins, Colorado

PROJECT: New Maintenance Building and Parking Area

GRAPHIC LOG	DESCRIPTION	DEPTH (FT.)	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY	SAMPLES SPT - N BLOWS/FT.	TESTS MOISTURE, %	TESTS DRY DENSITY PCF	TESTS UNCONFINED STRENGTH PSF	TESTS LIQUID LIMIT PLAST. INDEX % (-) #200
	Approx. Surface Elev.: 4871.0 ft.										
	SILTY GRAVEL with SAND Brown, red, tan, moist to wet, medium dense		GM	1	SS	12"	14	5			NV/NP/15
				2	SS	12"	23	5			
	7.0 ▽4864.0	5									
	POORLY GRADED SAND with SILT Red, brown, tan, wet, medium dense		SP	3	SS	12"	25	10			NV/NP/8
		10									
				4	SS	12"	20	12			
	15.0 4856.0	15									
	BOTTOM OF BORING										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS			
WL	▽ 7.0'	WD	▽
WL			
WL	Initial Water Level Reading		

Terracon

BORING STARTED	3-30-01		
BORING COMPLETED	3-30-01		
RIG	CME-55	FOREMAN	AS
APPROVED	DAR	JOB #	20015058

LOG OF BORING NO. 2

CLIENT: Boxelder Sanitation District

ARCHITECT / ENGINEER:

SITE: Boxelder Sanitation Complex, Fort Collins, Colorado

PROJECT: New Maintenance Building and Parking Area

GRAPHIC LOG	DESCRIPTION	DEPTH (FT.)	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY	SAMPLES SPT - N BLOWS/FT.	TESTS MOISTURE, %	TESTS DRY DENSITY PCF	TESTS UNCONFINED STRENGTH PSF	TESTS LIQUID LIMIT PLAST. INDEX % (-) #200
	Approx. Surface Elev.: 4870.0 ft.										
	POORLY GRADED SAND with GRAVEL Brown, red, tan, moist to wet, medium dense		SP	1	SS	12"	16	15			
				2	SS	12"	13	3			NV/NP/4
		5									
				3	SS	12"	22	18			
		10									
	14.0 4856.0										
	15.0 CLAYSTONE 4855.0 Gray, rust, moist, moderatley hard to hard			4	SS	12"	50	15			
		15									
	BOTTOM OF BORING										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS			
WL	▽ 6.0'	WD	▽
WL			
WL	Initial Water Level Reading		

Terracon

BORING STARTED	3-30-01		
BORING COMPLETED	3-30-01		
RIG	CME-55	FOREMAN	AS
APPROVED	DAR	JOB #	20015058

LOG OF BORING NO. 3

CLIENT: Boxelder Sanitation District

ARCHITECT / ENGINEER:

SITE: Boxelder Sanitation Complex, Fort Collins, Colorado

PROJECT: New Maintenance Building and Parking Area

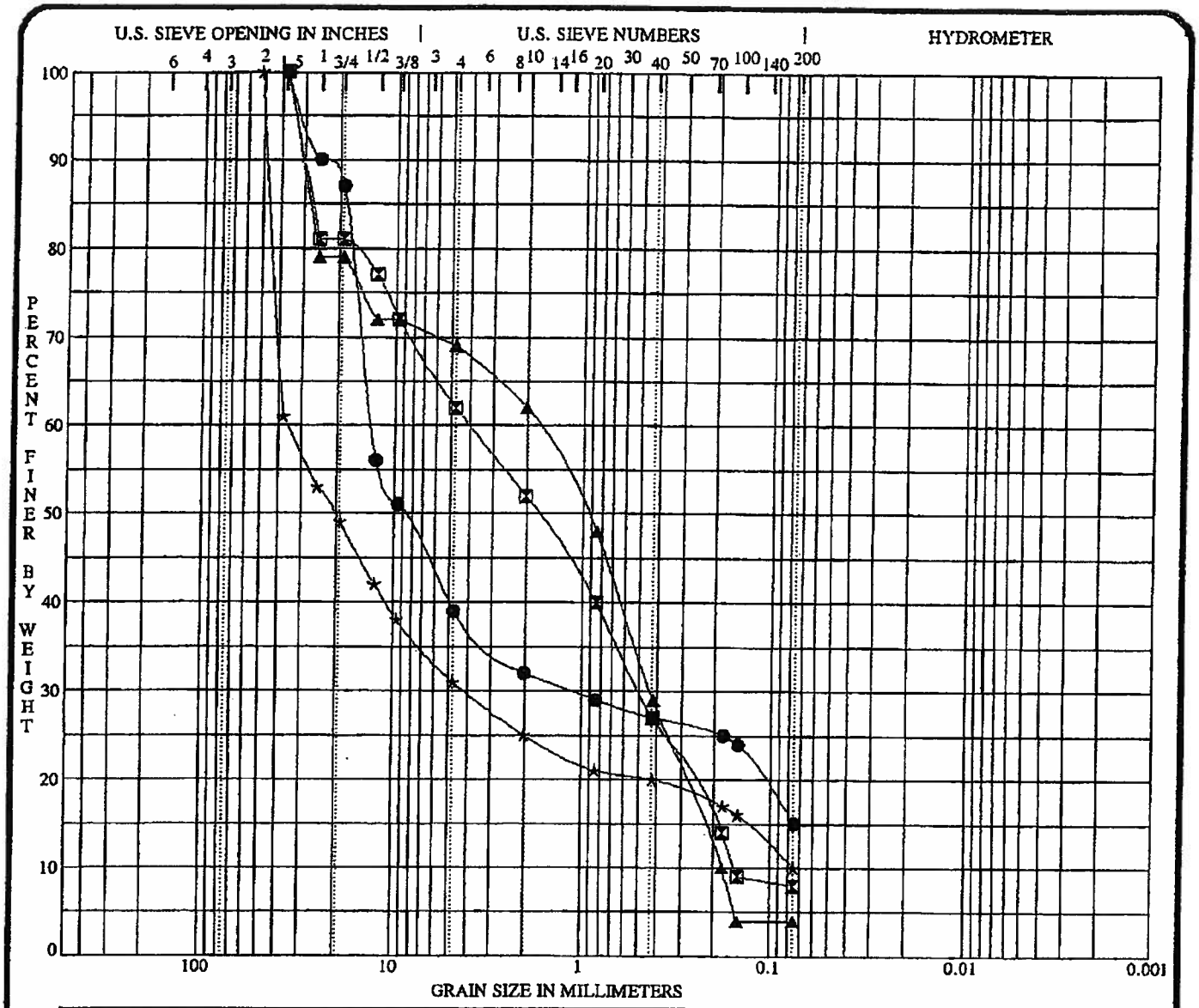
GRAPHIC LOG	DESCRIPTION	DEPTH (FT.)	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY	SAMPLES SPT - N BLOWS/FT.	TESTS MOISTURE, %	TESTS DRY DENSITY PCF	TESTS UNCONFINED STRENGTH PSF	TESTS LIQUID LIMIT PLAST. INDEX % (-) #200
	Approx. Surface Elev.: 4872.0 ft.										
	POORLY GRADED GRAVEL with SILT and SAND Brown, red, tan, moist to wet, medium dense		GP	1	SS	12"	11				SO4 = .0010%
				2	SS	12"	20	6			NV/NP/10
		5									
				3	SS	12"	18	7			
		10									
				4	SS	12"	21	9			
	15.0 4857.0 BOTTOM OF BORING	15									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS			
WL	▽ 9.0'	WD	▽
WL			
WL	Initial Water Level Reading		

Terracon

BORING STARTED	3-30-01		
BORING COMPLETED	3-30-01		
RIG	CME-55	FOREMAN	AS
APPROVED	DAR	JOB #	20015058



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	1	0.5	SILTY GRAVEL with SAND GM	5	NP	NP	NP		
⊠	1		POORLY GRADED SAND with SILT and GRAVEL SP-SM	10	NP	NP	NP	0.40	25.7
▲	2	4.0	POORLY GRADED SAND with GRAVEL SP	3	NP	NP	NP	0.61	9.8
★	3		POORLY GRADED GRAVEL with SILT and SAND GP-GM	6	NP	NP	NP	6.33	475.3

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	1	0.5	37.50	13.19	1.131		61.0	24.0	15.0	
⊠	1	9.0	37.50	4.00	0.499	0.1556	38.0	54.0	8.0	
▲	2	4.0	37.50	1.77	0.441	0.1800	31.0	65.0	4.0	
★	3	4.0	50.80	35.65	4.112	0.0750	69.0	21.0	10.0	

PROJECT New Maintenance Building and Parking Area - Boxelder Sanitation Complex

JOB NO. 20015058

DATE 4/12/01

GRADATION CURVES
TERRACON