ATTACHMENT C–1

INITIAL LIGHT LEVELS

57.3	38.8	34.4	34.5	35.8	40.9	61.3
54.5	39.5	35.4	36.0	36.6	41.6	59.4
42.9	38.0	35.8	36.5	37.1	40.7	49.2
35.3	35.3	36.1	37.3	37.7	38.5	41.7
41.8	37.7	36.5	37.3	37.9	40.9	48.1
54.0	40.6	36.9	37.8	38.3	43.4	59.8
59.9	41.3	37.2	37.5	38.8	44.2	65.4
58.8	41.1	37.7	39.0	39.3	44.3	63.5
60.0	41.2	37.2	37.5	38.8	44.2	65.4
54.0	40.6	36.9	37.8	38.3	43.4	59.8
41.7	37.7	36.5	37.3	37.9	40.9	48.1
35.3	35.2	36.1	37.3	37.6	38.5	41.7
42.8	37.7	35.7	36.4	37.0	40.6	49.2
54.0	39.0	35.2	36.0	36.4	41.5	59.3
56.4	38.3	34.3	34.4	35.6	40.6	61.2

61.8	41.6	36.7	36.2	36.7	42.0	62.8
60.0	42.4	37.7	37.9	37.8	42.8	60.7
49.9	41.6	38.4	38.4	38.3	41.8	50.0
42.4	39.5	39.0	39.3	38.9	39.5	42.4
48.8	42.0	39.4	39.5	39.4	42.1	49.1
60.5	44.5	39.8	40.0	39.9	44.9	61.3
66.1	45.3	40.3	39.7	40.2	45.7	67.6
64.2	45.3	40.6	41.0	40.4	45.6	66.2
66.1	45.3	40.2	39.7	40.2	45.7	67.6
60.5	44.5	39.8	40.0	39.9	44.9	61.3
48.8	41.9	39.4	39.5	39.4	42.1	49.1
42.4	39.4	39.0	39.3	38.9	39.5	42.4
49.8	41.6	38.4	38.4	38.4	41.8	50.0
59.9	42.4	37.7	37.9	37.8	42.8	60.8
61.7	41.5	36.7	36.2	36.7	42.0	62.9

56.6	39.0	35.0	34.2	33.7	38.1	56.1
56.0	39.8	35.7	35.7	34.7	38.7	53.7
47.9	39.5	36.6	36.1	35.3	37.4	42.5
41.0	37.8	37.3	37.1	35.6	34.8	35.1
46.6	40.0	37.5	37.1	36.2	37.6	41.6
56.8	41.8	37.6	37.6	36.6	40.7	54.4
60.5	42.6	38.3	37.3	36.8	41.4	60.4
58.1	42.8	39.1	38.8	37.4	41.3	60.4
60.5	42.6	38.3	37.3	36.8	41.5	60.4
56.8	41.8	37.6	37.6	36.6	40.8	54.4
46.7	40.0	37.6	37.1	36.2	37.6	41.7
41.1	37.8	37.4	37.1	35.7	34.9	35.1
47.9	39.6	36.7	36.2	35.4	37.7	42.6
56.1	39.9	35.8	35.7	34.9	39.2	54.2
56.6	39.1	35.2	34.2	33.9	38.6	57.0

ATTACHMENT C-2

MAINTAINED LIGHT LEVELS

45.9	31.1	27.5	27.6	28.6	32.7	49.0
43.7	31.6	28.3	28.6	29.3	33.3	47.5
34.3	30.4	28.7	29.2	29.7	32.6	39.4
28.2	28.3	28.9	29.8	30.1	30.8	33.4
33.4	30.2	29.2	29.9	30.4	32.8	38.5
43.2	32.5	29.5	30.3	30.7	34.8	47.9
48.0	33.0	29.8	30.0	31.1	35.4	52.3
47.1	32.9	30.2	31.3	31.4	35.5	50.8
48.0	33.0	29.8	30.0	31.1	35.4	52.3
43.3	32.5	29.5	30.3	30.6	34.7	47.9
33.4	30.2	29.2	29.9	30.3	32.7	38.5
28.2	28.2	28.9	29.8	30.1	30.8	33.4
34.3	30.2	28.5	29.2	29.6	32.5	39.4
43.2	31.2	28.2	28.8	29.2	33.2	47.5
45.1	30.7	27.4	27.6	28.5	32.6	49.0

49.5	33.3	29.4	28.9	29.3	33.6	50.3
48.0	34.0	30.2	30.3	30.2	34.3	48.6
39.9	33.3	30.7	30.8	30.7	33.4	40.0
33.9	31.6	31.2	31.5	31.2	31.6	33.9
39.1	33.6	31.6	31.6	31.5	33.7	39.3
48.5	35.8	31.9	32.0	31.9	36.0	49.0
52.9	36.2	32.2	31.8	32.2	36.6	54.1
51.4	36.3	32.5	32.9	32.3	36.5	53.0
52.9	36.2	32.2	31.8	32.2	36.6	54.1
48.5	35.6	31.9	32.0	31.9	36.0	49.0
39.1	33.6	31.5	31.6	31.5	33.7	39.3
33.9	31.6	31.2	31.5	31.2	31.6	33.9
39.9	33.3	30.7	30.8	30.7	33.5	40.0
48.0	33.9	30.2	30.3	30.2	34.3	48.6
49.4	33.3	29.4	28.9	29.4	33.6	50.3

45.3	31.2	28.0	27.4	27.0	30.5	44.9
44.9	31.9	28.6	28.6	27.8	31.0	43.0
38.3	31.7	29.3	28.9	28.2	29.9	34.0
32.9	30.2	29.9	29.7	28.5	27.9	28.1
37.3	32.0	30.0	29.7	29.0	30.1	33.3
45.5	33.5	30.1	30.1	29.3	32.6	43.6
48.4	34.1	30.7	29.8	29.5	33.2	48.4
46.5	34.3	31.3	31.0	29.9	33.1	48.4
48.4	34.1	30.7	29.8	29.5	33.2	48.4
45.5	33.5	30.1	30.1	29.3	32.7	43.5
37.3	32.0	30.1	29.7	29.0	30.1	33.3
32.9	30.3	29.9	29.7	28.6	28.0	28.1
38.4	31.7	29.3	29.0	28.3	30.2	34.1
44.9	31.9	28.7	28.6	28.0	31.4	43.4
45.3	31.3	28.2	27.4	27.1	30.9	45.7

CTL | THOMPSON
INCORPORATED

GEOTECHNICAL INVESTIGATION
LIGHT STANDARDS AT
CITY PARK TENNIS COURTS
FORT COLLINS, COLORADO

Prepared For:

CITY OF FORT COLLINS
PARKS DIVISION
413 South Bryan Avenue
Fort Collins, Colorado 80521

Attention: Ms. Eileen Scholl

Project No. FC03321

October 1, 2004

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SCOPE

This report presents the results of our geotechnical investigation for the light standards at the City Park tennis courts. The City Park tennis courts are located southwest of the intersection of Roosevelt Street and Oak Street in Fort Collins, Colorado. The existing tennis court facility is lighted by six light standards located at the east and west ends and middle of the courts (Fig. 1). The City of Fort Collins Park Division is planning to remove the existing light standards and replace them with new light standards to improve the lighting at the facility.

We investigated the subsurface conditions in the vicinity of the tennis courts to provide geotechnical design criteria and construction recommendations for the new light standards. This report presents the results of our field and laboratory studies and our conclusions, opinions and recommendations regarding the proposed improvements. Our conclusions are summarized below.

SUMMARY OF CONCLUSIONS

1. The soils we encountered generally consisted of medium stiff to stiff sandy clay fill over soft to stiff natural sandy clay and medium dense silty sand.

2. Ground water was measured in our borings at depths of approximately 7 feet to 17 feet below the existing ground surface.

3. Based on past performance of existing light standard foundations and the subsurface conditions encountered, we believe the new light standards may be founded on footings or pads bearing on well-compacted fill or natural soil. Geotechnical design criteria for footing foundations are presented in the report.

4. Excavations deeper than 5 feet will likely encounter soft or saturated soil and/or ground water. Where ground water is encountered in excavations, dewatering may be necessary. Methods for dewatering excavations are presented in the report.

SITE CONDITIONS

The City Park tennis courts are located southwest of the intersection of Roosevelt Street and Oak Street in Fort Collins, Colorado (Fig. 1). The existing tennis courts are located on the north portion of City Park. A trolley rail line is adjacent to the east of the tennis courts. A 3-feet high concrete retaining wall is located adjacent south and west of the tennis court fence. The ground surface slopes down to the north toward Oak Street. A residential neighborhood bounds the site to the north. City Park property bounds the site to the east, west and south.

The existing tennis courts consist of a slab-on-grade court and chain-link fence that encompasses three playing courts. A narrow strip of asphalt paving (1 to 2 feet wide) surrounds the outside of the fence. Existing light standards are located along the east and west fence lines (inside the fence) and between each of the three courts (Fig. 1). The existing light standards appear to be founded on a footing or shallow pier. The City of Fort Collins Parks Department was not able to provide us with specific information regarding the existing light standard foundations. The existing light standards appear to have performed well since their construction.

PROPOSED CONSTRUCTION

We understand the City intends to remove the existing light standards and their foundations without entirely removing the existing slab-on-grade and concrete retaining walls. New light standards will then be constructed to provide better lighting for the tennis courts. At the time or our investigation, the City had not determined the exact locations of the new light standards.

SUBSURFACE CONDITIONS

We drilled one boring at each of the four corners of the tennis court facility for a total of four (4) borings. The borings were drilled outside of the fence in the irrigated lawn that surrounds the facility. The approximate boring locations are shown on Fig. 1. Our borings were drilled with a 4-inch diameter, continuous flight auger and a truck-mounted drill rig. The drilling operations were observed by our field engineer who logged the soils and obtained samples for laboratory testing. Graphic logs of the soils found in our borings including results of field penetration resistance tests are shown on Figure 2. Results of our laboratory tests are presented on Figs. 3 through 5 and are summarized in Table I.

Our borings penetrated 2 to 6 feet of medium stiff to stiff, moist sandy clay fill over soft to medium stiff natural sandy clay and medium dense silty sand (TH-1 and TH-3) to the maximum depth drilled of 20 feet. Ground water was encountered at depths ranging from 7 to 17 feet in each of the borings during drilling. When the borings were checked several days after drilling, ground water was measured in two borings (TH-1 and TH-3) at depths of 13 and 14 feet. Ground water will likely affect construction of the light standards if foundations extend to elevation 97 or deeper. Further discussion is presented below.

The clay fill and natural sandy clays tested for swell/consolidation exhibited slight compression to low swell (-0.1 to 0.0 percent). The clay fill and sandy clays exhibited low plasticity and had 59 to 95 percent clay and silt size particles (passing the –200 sieve). One sample of silty sand tested had 12 percent silt sized particles. The silty sands are considered to be non-swelling.

LIGHT STANDARD FOUNDATIONS

Ground conditions and characteristics in the area of planned improvements consist of medium stiff to stiff sandy clay fill and soft to stiff natural sandy clay in the near surface deposits. We do not know the depth of the existing light standard foundations. We did not see evidence of movement or distress to the existing structures. It appears that the existing foundations have performed well over the life of the structures.

We considered foundation alternatives for the light standards that included conventional footing foundations; shallow, drilled footings; and drilled friction piers. A deep foundation system will encounter soft soils and ground water that will make construction of piers difficult or impractical. Design criteria and construction recommendations for conventional footings and drilled footings are presented below.

Footings. Based on the subsurface conditions encountered, we believe the planned light standards can be founded with footings or footing pads bearing on the natural near surface soils. Footings or footing pads bearing on the near surface clays and sands can be designed for a maximum soil bearing pressure of 1,500 psf.

Footing bearing elevation should be a minimum of 30 inches below lowest adjacent grade for frost protection. Footings or pads should have a minimum size of 16 inches by 16 inches. These are minimum dimensions and larger footings may be required to support foundation and wind loads. Alternatively, the light standards could be founded using drilled footings or short piers that are at least 18 inches in diameter and 30 inches deep. Concrete could be poured "neat" into the drilled excavations. Drilled footings would require less removal of the existing slab-on-grade than conventional "form and pour" techniques. The project structural engineer should design steel reinforcement for footings.

Soft, unstable soils and ground water may be encountered during construction if excavations are made deeper than 5 feet below the ground surface. Our recommendations for mitigating these conditions are included below in the Ground Water section.

Prior to the placement of reinforcing steel or concrete, the base and sides of the excavation should be clear of debris, trash, and loose soil. Loose soil should be removed to expose firm natural soil or compacted in place to a minimum 95 percent of the maximum dry density as determined in accordance with ASTM D 698. Excavations should not remain open for more than 2 days. Soil within the excavation should remain in a moist condition. Moisture conditioning may be required prior to the placement of concrete.

A representative of CTL | Thompson should observe the completed foundation excavations prior to placing the forms to verify subsurface conditions are as anticipated from our borings.

Lateral loads applied to footings or pads can be resisted by friction between the concrete at the base of the footing or pad and the ground and by the passive pressure of densely compacted backfill and/or undisturbed ground against the sides of a footing or pad provided that soil will not be removed over the life of the structure. A friction coefficient of 0.35 can be used between the foundation concrete and the natural soil or backfill. The passive earth pressure against a footing or mat can be calculated using an equivalent fluid density of 270 pcf for undisturbed soil or engineered fill.

Slab-on-Grade Construction. We understand removal of the existing light standards may require partial removal of the existing slabs-on-grade and construction of new concrete slabs in some areas. Where new slabs are constructed, some differential movement between existing slabs and new slabs should be anticipated.

The designer may wish to consider dowelled connections of the new slab and existing slab interface. The potential for differential movement can also be reduced by extending the slab removal area a distance (typically on the order of two feet) beyond the excavation edges so that expected and normal settlement of backfill is partially bridged by undisturbed material. Backfill settlement can be reduced by compaction to 98 percent of standard Proctor maximum dry density (ASTM D 698) at a moisture content within 2 percent of optimum. We do not recommend rigid connections between foundation elements and slabs-on-grade. For new slabs-on-grade we recommend the following additional precautions be observed. These precautions will not eliminate slab-on-grade movement but will reduce the potential for damage due to movement of slabs:

1. Slabs should be isolated from retaining walls, columns or other slab penetrations.

2. New slabs-on-grade should generally be constructed in a manner similar to the existing construction. For example, if a 6-inch gravel section underlies the existing slab, a similar section with the new slabs will reduce the potential for differential movement between the two slabs. A gravel layer is typically recommended where ground water is within about 3 to 5 feet below the slab.

3. Frequent control joints should be provided in conventional slabs-on-grade to reduce problems associated with shrinkage cracking and curling. Panels that are approximately square generally perform better than rectangular areas. We advocate an additional joint about 3 feet away from and parallel to the retaining walls.

Ground Water. Our borings encountered water at depths as shallow as 7 feet. If excavations are to be deeper than 5 feet below grade, we recommend the contractor anticipate soft soils and wet conditions that will result from water seeping into excavations for the foundations. Soft soils or unstable excavations caused by localized seepage can be stabilized by crowding coarse aggregate (such as CDOT No. 4 or No. 57) into the excavation using conventional construction equipment. For excavations that will penetrate the ground water surface, dewatering prior to excavation is recommended. Dewatering is discussed in more detail below in the Excavations section.

ADDITIONAL CONSTRUCTION CONSIDERATIONS

Fill. We anticipated that minor amounts of fill might be necessary in areas where existing grades have been disturbed by removal of the existing light standards. The area to receive fill should be scarified, moisture-conditioned to within two percent of optimum moisture content and compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698). The near surface, on-site soils can be used as engineered fill providing they are free from organics, trash, or other deleterious materials. If imported fill is needed, the soils should be low swelling, sandy clays similar to the on-site soils, or granular soils. Highly plastic and swelling clays and claystone are not desirable as imported fill because they may cause problems associated with expansive soils. A sample of soils proposed for import for fill should be submitted to our office for classification and approval prior to hauling them to the site. We believe imported clay fill should be placed at high moisture content to reduce the swell potential. Imported clay fills should be moisture-treated to between optimum and 3 percent above optimum moisture content, and sand fill or on-site soils within ±2 percent of optimum moisture content. Fills should be compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698). The placement and compaction of engineered fill should be observed and tested by our representative.

Excavations. Footing excavations in the near surface soils can be performed with conventional trenchers or backhoes. Shallow ground water was encountered below the site. We anticipate ground water will impact the proposed construction if excavations are 5 feet or more below the current ground surface.

Medium stiff to stiff clay fill and soft to medium stiff sandy clays will likely be the predominant soils encountered during construction. According to the Occupational Safety and Health Administration (OSHA) criteria, the fill and sandy clay we encountered will classify as Type B soil, allowing excavation slopes of 1:1 (horizontal to vertical). The contractor's "Competent Person" on site should identify the soils encountered in excavations and refer to OSHA standards to determine appropriate slopes.

Spoils piles should not be placed immediately adjacent to the excavations. We recommend a distance back from the edge of the trench at least as great as the depth of the trench.

Ground water was measured at depths of 7 to 17 feet below the existing ground surface. Any excavations deeper than 5 feet will likely encounter soft or saturated soil and/or ground water. Where ground water is encountered in excavations, dewatering may be possible by sloping excavations to one or more sumps where water can be removed by pumping. The sumps should be several feet below the bottom of the excavations to pump water down through the soil rather than up through the bottom of the excavation. Pumping water up through the base of the excavation will likely result in destabilization of the base of the excavation. The ground surface surrounding the excavation should be sloped to direct runoff away from the excavation.

We recommend excavation backfill be placed in thin, loose lifts, moisture conditioned to within 2 percent of optimum moisture content and compacted to at least 98 percent of standard Proctor maximum dry density (ASTM D 698) in areas below the slab. In unpaved, undeveloped areas excavation backfill should be compacted to at least 90 percent of standard Proctor maximum dry density (ASTM D 698). The placement and compaction of fill and backfill should be observed and tested by a representative of our firm during construction.

CONCRETE

Concrete that comes into contact with soils can be subject to sulfate attack. We measured water-soluble sulfate concentrations in one sample from this site. The concentration measured was 0.023 percent. Sulfate concentrations less than 0.1 percent indicate Class 0 exposure to sulfate attack for concrete that comes into contact with the subsoils, according to the American Concrete Institute (ACI). For this level of sulfate concentration, ACI indicates any type of cement can be used for concrete that comes into contact with the subsoils. In our experience, superficial damage may occur to the exposed surfaces of highly permeable concrete, even though sulfate levels are relatively low. To control this risk and to resist freeze-thaw deterioration, the water-to-cementitious material ratio should not exceed 0.50 for concrete in contact with soils that are likely to stay moist due to surface drainage or high water tables. Concrete should be air entrained.

LIMITATIONS

We based the discussions in this report on our understanding of the proposed construction and planned structures; conditions disclosed by exploratory drilling; review of maps, plans, and aerial photographs; site observation; results of our laboratory tests; engineering analysis of field and laboratory data; and our experience.

Our borings were located to provide us the needed picture of the underground based on plans known at the time of our investigation. Variations between the borings will occur.

A representative of our firm should be present during construction to observe and test fill and backfill placement and foundation excavations. We believe this investigation was conducted in a manner consistent with that level of care and skill ordinarily used by geotechnical engineers practicing in this area at this time. No warranty, express or implied, is made. If we can be of further service in discussing the contents of this report or analyses of the influence of subsurface conditions on the design of the proposed development, utilities, structures and streets, please call.

CTL | THOMPSON, INC

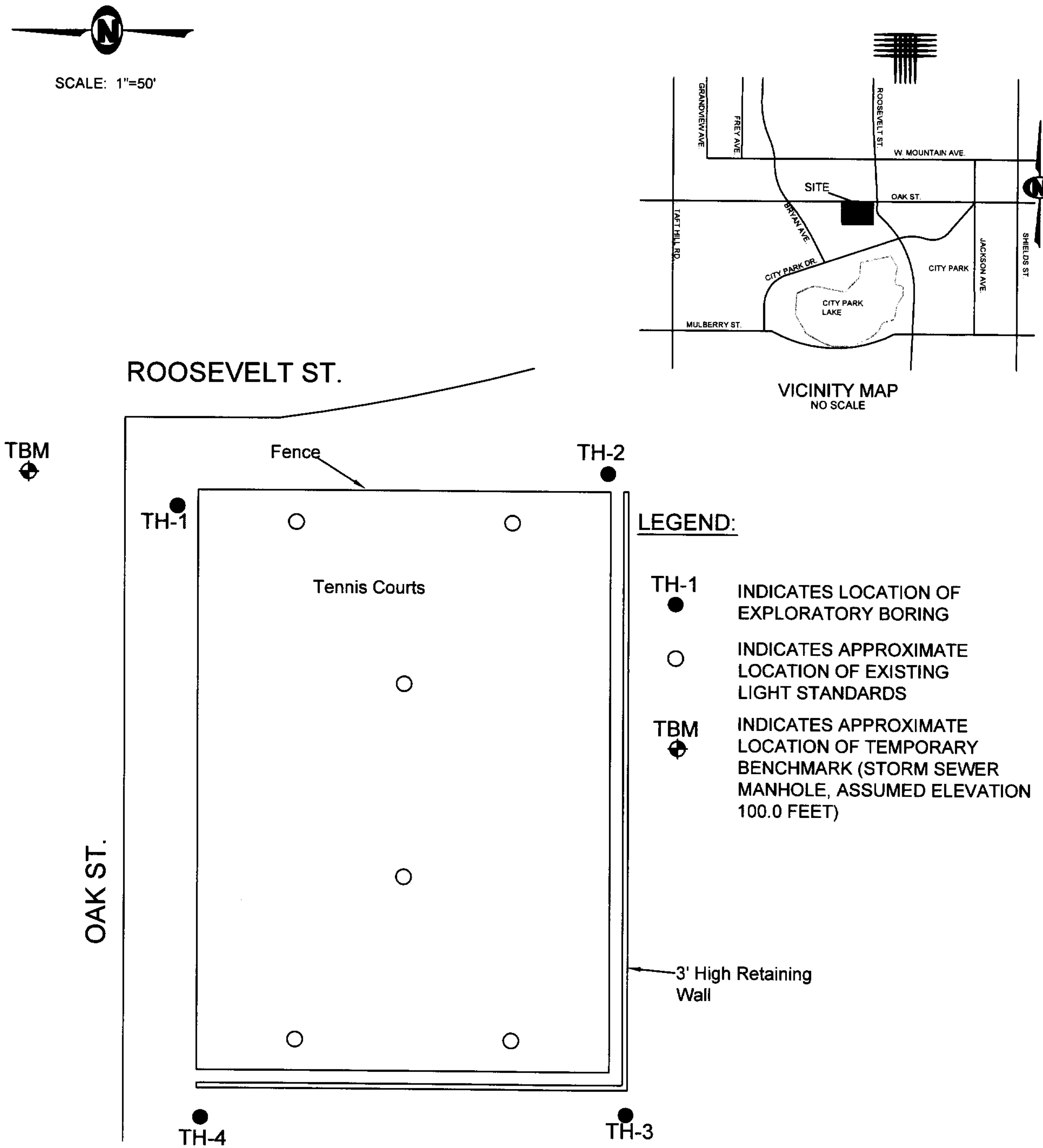
Gary Diewald
Staff Engineer

Reviewed by:

COLORADO REGISTERED PROFESSIONAL ENGINEER
THOMAS A. CHAPEL
33848
10/1/04

Thomas A. Chapel, CPG, PE
Associate/Division Manager

GD:TAC/bly
(6 copies sent)

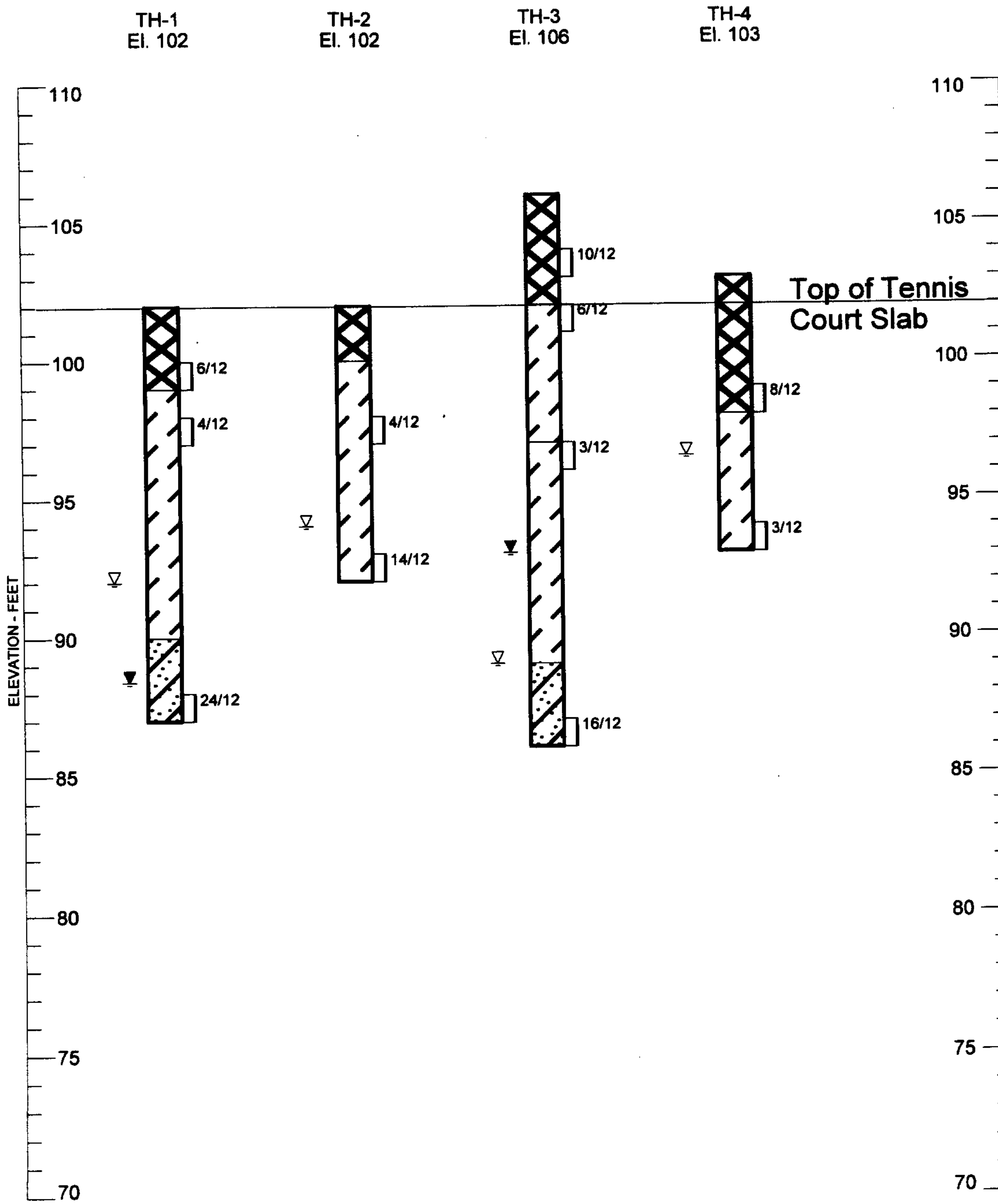


FC03321 LNH 09/21/04

City of Fort Collins
Light Standards at City
Park Tennis Courts
PROJECT NO. FC03321

Locations of Exploratory Borings

FIGURE 1



SUMMARY LOGS OF EXPLORATORY BORINGS

CITY PARK TENNIS COURTS
JOB NO. FC03321

LEGEND:

FILL, CLAY, SANDY, MEDIUM STIFF TO STIFF, MOIST, BROWN (FILL).

CLAY, SANDY, SOFT TO MEDIUM STIFF, MOIST, BROWN (CL).

SAND, SILTY WITH GRAVEL, MEDIUM DENSE, WET, BROWN (SM).

DRIVE SAMPLE.THE SYMBOL 6/12 INDICATES THAT 6 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 12 INCHES.

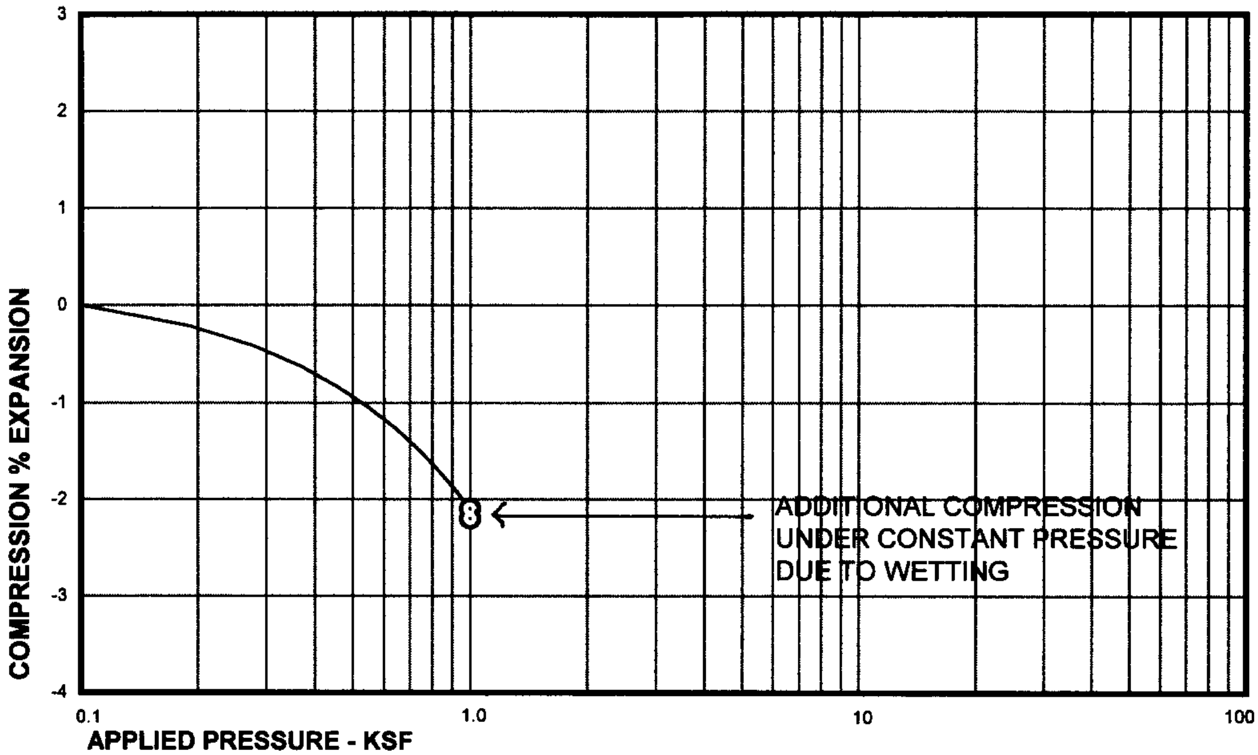
▽ WATER LEVEL MEASURED AT TIME OF DRILLING.

▼ WATER LEVEL MEASURED SEVERAL DAYS AFTER DRILLING.

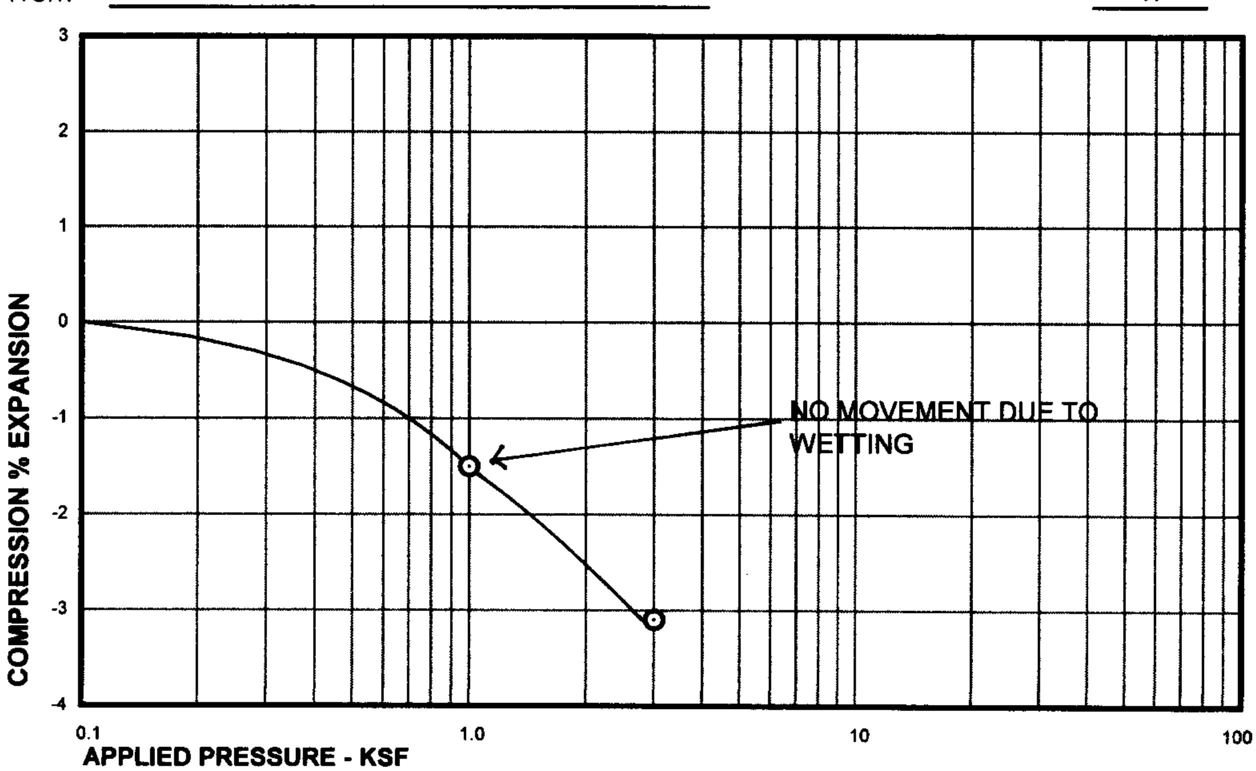
NOTES:

1. THE BORINGS WERE DRILLED ON AUGUST 30TH 2004, USING 4-INCH DIAMETER CONTINUOUS-FLIGHT AUGER AND A TRUCK-MOUNTED DRILL RIG.
2. BORING LOCATIONS AND ELEVATIONS WERE SURVEYED BY A REPRESENTATIVE OF OUR FIRM REFERENCING THE TEMPORARY BENCHMARK SHOWN ON FIGURE 1.
3. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS AND CONCLUSIONS IN THIS REPORT.

FIG. 2



Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	111	PCF
From	TH-2 AT 9 FEET	MOISTURE CONTENT=	17	%

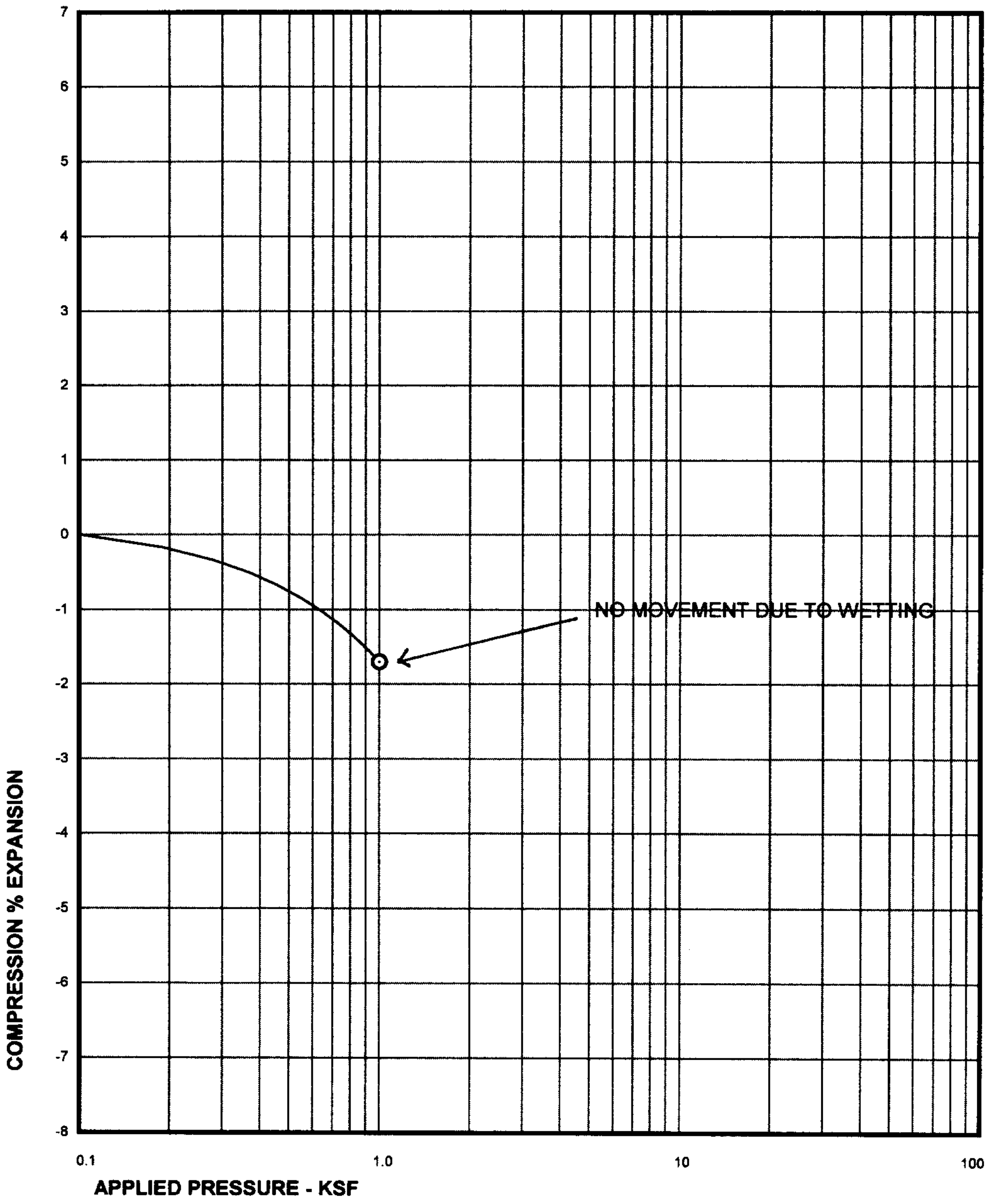


Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	111	PCF
From	TH-3 AT 4 FEET	MOISTURE CONTENT=	16	%

Swell Consolidation Test Results

FIG. 3

PROJECT NO. FC03321



Sample of FILL, CLAY, SANDY

From TH-4 AT 4 FEET

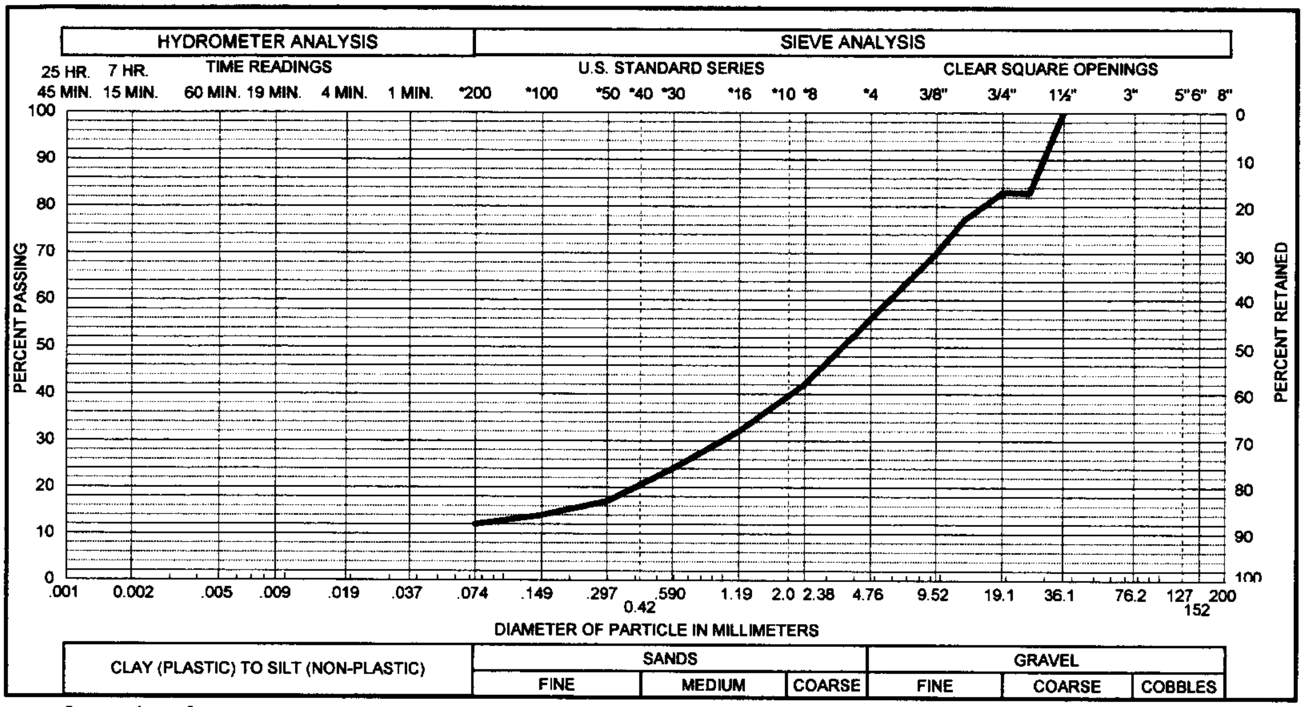
DRY UNIT WEIGHT= 102 PCF

MOISTURE CONTENT= 22 %

Swell Consolidation Test Results

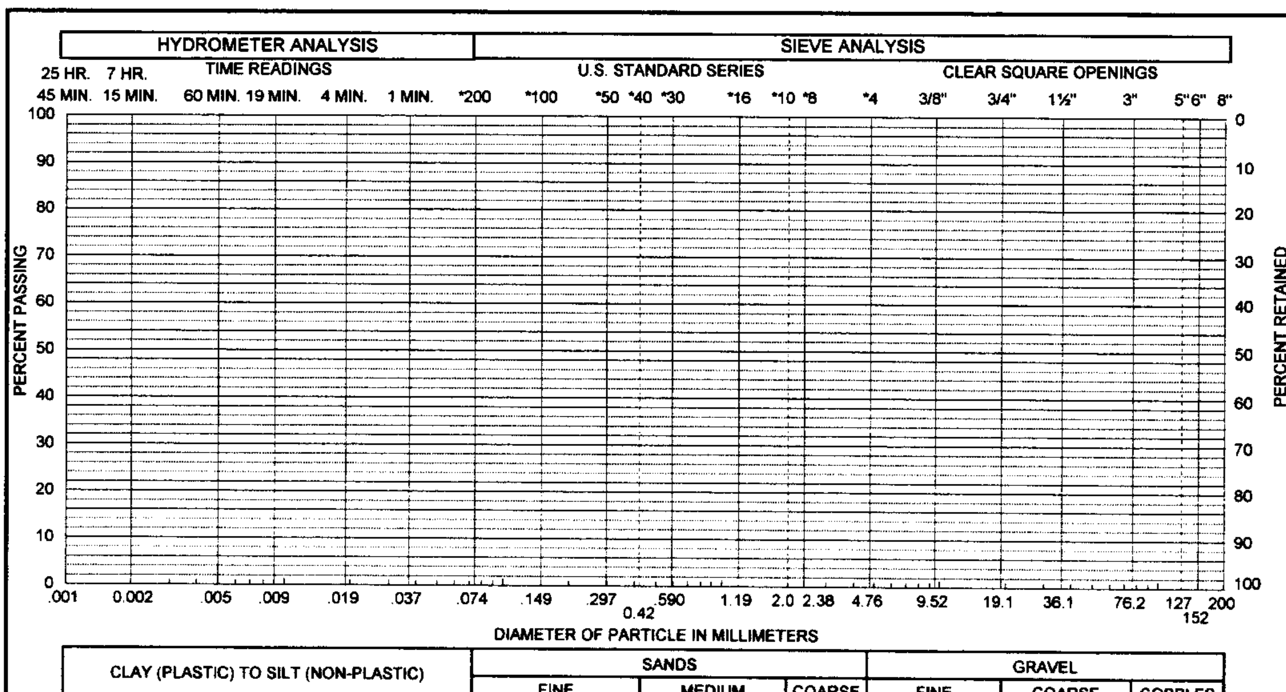
FIG. 4

PROJECT NO. FC03321



Sample of SAND, SILTY (SM)
From TH-1 AT 14 FEET

GRAVEL 44 % SAND 44 %
SILT & CLAY 12 % LIQUID LIMIT - %
PLASTICITY INDEX - %



Sample of
From

GRAVEL % SAND %
SILT & CLAY % LIQUID LIMIT %
PLASTICITY INDEX %

Gradation Test Results

PROJECT NO. FC03321

FIG. 5

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

BORING	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	SWELL TEST DATA			PASSING NO. 200 SIEVE (%)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	WATER SOLUBLE SULFATES (%)	SOIL TYPE
				SWELL (%)	APPLIED PRESSURE (PSF)	SWELL PRESSURE (PSF)		LIQUID LIMIT (%)	PLASTICITY INDEX (%)			
TH-1	4	26.8	93				95	37	21			CLAY, SANDY (CL)
TH-1	14	9.5	124				12					SAND, SILTY (SM)
TH-2	4	24.9	97							1,360		CLAY, SANDY (CL)
TH-2	9	16.9	111	-0.1	1,000							CLAY, SANDY (CL)
TH-3	2	18.5	105				83	41	25	3,540		FILL, CLAY, SANDY
TH-3	4	15.9	111	0.0	1,000							CLAY, SANDY (CL)
TH-3	9	22.9	104				59					CLAY, SANDY (CL)
TH-4	4	22.2	102	0.0	1,000						0.023	FILL, CLAY, SANDY
TH-4	9	28.9					63					CLAY, SANDY (CL)