GEOTECHNICAL REPORT
GRAND CAMP – PROPOSED COMMERCIAL DEVELOPMENT
TRACT A, BLOCK 4
SHADOW PARK WEST SUBDIVISION
GRAND LAKE, COLORADO

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GRAND LAKE, COLORADO

Prepared for:

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SCOPE

This report presents the results of a geotechnical subsurface exploration for the proposed Grand Camp commercial development to be constructed on Tract A, Block 4, within the Shadow Park West Subdivision in Grand Lake, Colorado. The approximate site location is shown on the Vicinity Map, Fig. 1. The purpose of this report is to evaluate the subsurface conditions at the site and to provide geotechnical recommendations for the proposed commercial development.

This report includes descriptions of subsurface soil and ground water conditions observed in the exploratory test pits, recommended foundation systems, allowable bearing capacity, and recommended design and construction criteria. This report was prepared from data developed during our subsurface exploration and our experience with similar projects and subsurface conditions in the area.

The recommendations presented in this report are based on a commercial structure being constructed within the area shown on the Locations of Exploratory Test Pits, Fig. 2. We should be contacted by the contractor and/or owner to review our recommendations when final plans for the structure have been completed. A summary of our findings and conclusions is presented below.

EXECUTIVE SUMMARY

1. Subsurface conditions observed in the exploratory test pits were generally similar. The subsurface conditions consisted of 0 to 1 foot of topsoil

underlain by either existing fill or natural clay and sand soils to varying depth of 4 to 6 feet. Beneath the existing fill and the natural clay and sand soils, to the maximum depth explored of 13.0 feet, the subsurface conditions observed consisted of a clayey, gravelly, sand with scattered cobbles and boulders. Refer to the SUBSURFACE CONDITIONS section of this report for additional details.

2. Topsoil was observed to a depth of 1 foot in the exploratory test pits. Buried topsoil was also observed within test pit TP-1 from a depth of 2 to 3 feet. However, greater depths of topsoil could be encountered across the site. Any topsoil will need to be removed from all construction areas prior to construction. The topsoil may be used in landscaping areas.

3. Existing fill was observed to varying depths of 2 to 3 feet in test pits TP-1 and TP-3. Greater depths of existing fill could be encountered across the site. Existing fill is characterized by a mottled orange, brown, black, slightly moist to moist, medium stiff, sandy clay with organics. All existing fill should be removed from within the building envelope prior to the start of construction. Refer to the EXISTING FILL section of this report for additional information.

4. At the time of excavating, several stockpile consisting of overexcavated topsoil, timbers, and boulders were observed across the site. These stockpile should be completely removed prior to the start of construction. Refer to the EXCAVATIONS section of this report for additional details.

5. During excavations, ground water was not observed in any of the exploratory test pits to a maximum depth explored of 12 feet in TP-1, of 13 feet in TP-2, and 11 feet in TP-3. Refer to the GROUND WATER section of this report for additional details.

6. We anticipate that the proposed commercial development will be constructed at an elevation of 8413.0. Based on the proposed construction we anticipate excavation cuts up to 11 feet may be necessary, while the placement of fill to a depth of up to 20 feet could be required to bring the site to the pad elevation.

7. We anticipate that the soils at the foundation elevation for the proposed commercial development will consist of either topsoil, clay and sand, clayey, gravelly sand, or new structural fill. It is our opinion that the

natural clay and sand, gravelly sand, or new structural fill will support a spread footing foundation system with a low risk of movement. Refer to the FOUNDATIONS section of this report for more details.

8. We anticipate that the subsurface conditions at the proposed slabs-on-grade elevation will consist of either topsoil, existing fill, the natural clay and sand, clayey, gravelly sand, or new structural fill. It is our opinion that the natural clay and sand, gravelly sand, or new structural fill will support slabs-on-grade with a low risk of movement. Refer to the SLABS-ON-GRADE section of this report for more details.

9. Open cuts and excavations require precautions as outlined in this report in order to maintain the stability of slopes and sides of excavations. Refer to the EXCAVATIONS section of this report for more details.

10. Based on the subsurface conditions observed in the exploratory test pits, it is our opinion that heavy duty construction equipment will be necessary to complete the required excavations. Refer to the EXCAVATIONS section of this report for more details.

11. Drainage around the structure should be designed and constructed to provide for rapid removal of surface runoff and avoid concentration of water adjacent to foundation walls. Refer to the SURFACE DRAINAGE section of this report for details.

12. The potential for radon gas is a concern in the area. Refer to the RADON section of this report for additional details.

13. Mold has become a concern with new construction. Refer to the MOLD section of this report for additional details.

SITE CONDITIONS

The proposed Grand Camp Commercial Development is located on Tract A, Block 4 within the Shadow Park West Subdivision in Grand Lake, Colorado. The subject site is bordered to the east by US Highway 34, to the south and west by Mary Drive, and

to the north by a power line easement. Currently the site is vacant land being used to stockpile overexcavated topsoil, boulders, and timbers. The overall topography of the central portion of the site is generally level. However, on the west edge of the site the topography slopes down to the east at an approximate grade of 25 to 30 percent. The eastern portion of the site slopes down towards US Highway 34 at an approximate grade of 30 percent. US Highway 34 is approximately 10 to 15 feet above the existing site grade. To the north the site has an approximate slope of 15 percent sloping south from the powerline easement. Vegetation on the site consists of natural grasses, bushes, pine trees, and young aspen trees.

PROPOSED CONSTRUCTION

Prior to our subsurface exploration, a site plan was provided by Diamondback Engineering & Surveying, Inc. It is our understand that the proposed project will consist of the construction of the Grand Camp Commercial Development. We anticipate that the proposed commercial development will be constructed on a pad at an elevation of 8413.0. We also anticipate that the commercial development will consist of a 2-story structure with no below grade level, as well as an asphalt parking lot and associated access drive. Based on the proposed construction and the provided topographic map, we anticipate excavation cuts up to 11 feet may be necessary, while the placement of fill to a depth of up to 20 feet could be required to bring the site to the pad elevation. It is our

understanding that up to 13 feet of structural fill could be present beneath the proposed Grand Camp Commercial Development structure. The approximate location of the cut/fill boundary across the site is shown on the Location of Cut and Fill, Fig. 3.

SUBSURFACE EXPLORATION

Subsurface conditions were investigated at this site on July 17, 2008 excavating three exploratory test pits (TP-1 thru TP-3) with a trackhoe at the locations shown on the Locations of Exploratory Test Pits, Fig. 2. An engineer from our office was on site during the field investigation to supervise the excavation of the exploratory test pits and to visually classify and document the subsurface soils and ground water conditions. Graphical logs of the subsurface conditions observed within the exploratory test pits are presented on the Logs of Exploratory Test Pits, Fig. 4; and on Legend of Exploratory Test Pits, Fig. 5.

Soil samples obtained from the exploratory test pits were tested in our laboratory to determine their natural moisture content, natural dry density, gradation properties, and swell-consolidation potential. Results of the laboratory testing are presented on the Logs of Exploratory Test Pits, Fig. 4; on the Gradation Test Results, Fig. 6; on the Swell-Consolidation Test Results, Figs. 7 and 8; and on the Summary of Laboratory Test Results, Table I.

SUBSURFACE CONDITIONS

The subsurface conditions observed in the exploratory test pits were generally similar. The subsurface conditions observed in exploratory test pit TP-1 consisted of existing fill to a depth of 2 feet. The existing fill is characterized a mottled orange, brown, black, slightly moist to moist, medium stiff, sandy clay. A buried topsoil horizon was observed from a depth of 2 to 3 feet. Beneath the buried topsoil horizon, the subsurface conditions consisted of a light brown, slightly moist to moist, medium stiff to stiff, gravelly clay and sand with scattered cobbles to a depth of 5 feet. Underlying the clay and sand, to the maximum depth excavated of 12 feet, the subsurface conditions consisted of a tan, brown, slightly moist to moist, medium dense to very dense, clayey, gravelly, sand with scattered cobbles and boulders. The subsurface conditions observed in TP-2 consisted of 1 foot of topsoil underlain by a light brown, slightly moist to moist, medium stiff to stiff, gravelly clay and sand with scattered cobbles to a depth of 4 feet. Beneath the clay and sand, to the maximum depth excavated of 13 feet, the subsurface conditions consisted of a tan, brown, slightly moist to moist, medium dense to very dense, clayey, gravelly, sand with scattered cobbles and boulders. The subsurface conditions observed in exploratory test pit TP-3 consisted of 1 foot of topsoil underlain by existing fill to a depth of 3 feet. The existing fill is characterized a mottled orange, brown, black, slightly moist to moist, medium stiff, sandy clay. Beneath the existing fill, the subsurface conditions consisted of a light brown, slightly moist to moist, medium stiff to stiff,

gravelly clay and sand with scattered cobbles to a depth of 6 feet. Underlying the clay and sand, to the maximum depth excavated of 11 feet, the subsurface conditions consisted of a tan, brown, slightly moist to moist, medium dense to very dense, clayey, gravelly, sand with scattered cobbles and boulders. Practical trackhoe refusal occurred on a boulder at a depth of 11 feet in test pit TP-3.

During excavations, ground water was not observed in any of the exploratory test pits to a maximum depth explored of 12 feet in TP-1, of 13 feet in TP-2, and 11 feet in TP-3.

RADON

In recent years, radon gas has become a concern. Radon gas is a colorless, odorless gas that is produced by the decay of minerals in soil and rock. The potential for radon gas in the subsurface strata of mountain terrain is likely. Because we anticipate that the proposed structure will not be constructed with a below grade level, the risk for radon gas is low. However, if plans change and a below grade level is added to the structure, we suggest that the structure be designed with ventilation for all below grade levels.

MOLD

Mold has become a concern with new construction. Mold tends to develop in dark or damp areas such as below grade areas, under floor spaces, or bathrooms.

Recommendations for the prevention, remediation, and/or mitigation of mold is outside the scope of this investigation. We recommend that the owner contact a Professional Industrial Hygienist for recommendations for the prevention, remediation, and/or mitigation of mold.

EXISTING FILL

Existing fill was observed within TP-1 and TP-3 at this site to varying depths of 2 to 3 feet. Greater depths of existing fill could be encountered across the site. Existing fill is characterized by a mottled orange, brown, black, slightly moist to moist, medium stiff, sandy clay with organics. A buried topsoil horizon was also observed within test pit TP-1 from a depth of 2 to 3 feet. Stockpiles of overexcavated topsoil, boulders, and timbers were observed within the proposed construction area.

Due to the presence of deleterious material within the existing fill, stockpiles, and the presence of a buried topsoil horizon, we recommend that all existing fill, stockpiles, and topsoil be removed from the area of the proposed commercial structure, associated parking lot, and access drive. Some of the existing fill may be reused as structural fill for this project, provided it satisfies the criteria in the COMPACTED FILL section and any deleterious material is removed prior to its use. Deleterious material includes organic fragments, construction debris, and any cobbles greater than 10 inches. Refer to the COMPACTED FILL section of this report for additional recommendations.

NEW STRUCTURAL FILL

Based on the proposed construction we anticipate that the placement of up to 20 feet of new structural fill could be required to bring the site to the proposed construction elevation. Any fill slopes greater than 10 feet in height should be evaluated on an individual basis. If requested, we can perform the evaluation of these slopes. In general, fill slopes of 2 to 1 (Horizontal to Vertical), up to 10 feet in height should be stable, if properly drained. Natural soil slopes greater than 20 percent in grade should be benched to key the fill into the slope. All fill slopes should be vegetated as soon as possible after construction.

It has been our experience that properly moisture conditioned and compacted structural fill placed in depths greater than 15 feet tends to consolidate over time. Based on the proposed construction, it is our understanding that up to 13 feet of structural fill could be present beneath the proposed Grand Camp Commercial Development structure. However, varying depths of 1 to 20 feet of structural fill could be present beneath the proposed parking lot and associated access drive. All existing fill, topsoil, and stockpiles should be removed to expose the natural soils prior to the placement of compacted structural fill. In addition special care should be taken to remove all organic material and debris in the drainage area adjacent to US Highway 34. Failure to remove this material

will most likely result in consolidation of the overlying structural fill due to the decomposition and consolidation of organic material and the existing fill.

We do not recommend that the proposed structure be constructed on depths of fill greater than 15 feet. It is our opinion that areas of the proposed parking lot and access drive, where structural fill will be placed in depths greater than 15 feet, may experience premature pavement failure due to consolidation of the existing fill. Structural fill for this project may consist of approved on-site materials or non-expansive imported fill. Refer to the COMPACTED FILL section of this report for additional recommendations.

GROUND WATER

During excavations, ground water was not observed in any of the exploratory test pits to a maximum depth explored of 12 feet in TP-1, of 13 feet in TP-2, and 11 feet in TP-3. Based on the conditions observed in test pits TP-1 thru TP-3, we do not anticipate that ground water will adversely influence the construction of the proposed commercial development. However, our investigation was performed during a dry time of the year. It is possible that ground water may be encountered at shallower depths during wetter times of the year. If ground water is encountered within the excavation for the commercial structure, we should be contacted to provide specific recommendations at that time.

EXCAVATIONS

We anticipate that excavations of up to 11 feet will be required for construction of the proposed commercial development. Because cobbles and boulders were observed in the exploratory test pits, it is our opinion that heavy duty construction equipment will be necessary to complete the required excavation.

Care needs to be exercised during construction so that the excavation slopes remain stable. The clay and sand with scattered cobbles and the clayey, gravelly sand with scattered cobbles and boulders classify as Type B soils in accordance with OSHA regulations. OSHA regulations should be followed in all excavations and cuts.

Approximately 1 foot of topsoil was observed in the exploratory test pits. Greater depths of topsoil could be encountered throughout the site. Approximately 2 to 3 feet of existing fill was observed within the test pits. Greater depths of existing fill could also be encountered throughout the site. All topsoil and existing fill beneath the proposed construction should be removed. The topsoil may be used in landscape areas. Approved existing fill free of deleterious material may be reused as structural fill. Backfill should be placed and compacted as recommended in the COMPACTED FILL section of this report.

PERMANENT CUT SLOPE

Any cuts greater than 10 feet at this site should be evaluated on an individual basis. If requested, we can perform the evaluation of these slopes. In general, permanent cut slope constructed at a 2 to 1 (Horizontal to Vertical) slope up to 10 feet in height should be stable, provided that the cut slope remains dry and ground water is not encountered or observed exiting the cut face or surface water is allowed to traverse down the face of the slope. All surface water above the cut slope should be directed away from the top of the cut and not allowed to pond behind the top of the cut slope. If ground water is encountered or observed flowing from the permanent cut slope, we should be contacted to provide specific recommendations to maintain the stability of the slope. All cut slopes should be vegetated as soon as possible after construction.

FOUNDATIONS

We anticipate that the subsurface conditions at the foundation elevation for the proposed Grand Camp Commercial Development will consist of either the clay and sand, the gravelly sand, or the new structural fill. In our opinion, the proposed commercial structure may be supported by a spread footing foundation system bearing on either the clay and sand, the gravelly sand, or the new structural fill with a low risk of movement. Structures constructed on depths of structural fill greater than 15 feet have an increased risk of movement. If the owner is not willing to accept this increased risk of movement,

than the proposed structure should be supported by a deep foundation system. The following sections discuss spread footing foundation systems as well as micro pile foundation systems.

Spread Footing Foundation System

In our opinion, a spread footing foundation system bearing on either the clay and sand, the gravelly sand, or new properly placed and compacted structural fill could support the proposed structure with a low risk of movement. We recommend that spread footings for the proposed commercial structure be designed and constructed to meet the following criteria:

1. Footings may be supported by either the clay and sand, the gravelly sand, or properly moisture conditioned and compacted new structural fill as recommended in Items 6, 8, and 9.

2. Footings bearing on the either the clay and sand, the gravelly sand, or properly moisture conditioned and compacted new structural fill may be designed for a maximum allowable soil bearing pressure of 3,000 psf.

3. Spread footings constructed on the either the clay and sand, the gravelly sand, or up to 15 feet of properly moisture conditioned and compacted new structural fill, may experience up to 1.0 inch of differential movement.

4. Walls should be designed to span a distance of at least 10 feet in order to account for anomalies in the soil.

5. The base of the exterior footings should be established at a minimum depth below the exterior ground surface, in order to reduce the risk of frost heave. In our opinion, the depth for frost protection in the area is 3.5 feet.

6. We anticipate that cobbles and boulders will be encountered at the foundation elevation. Removal of the cobbles and boulders may result in depressions and rough bottoms in the excavation. The resulting

depressions can be backfilled with compacted structural fill or lean concrete. Refer to the COMPACTED FILL section of this report for fill requirements.

7. Column footings should have a minimum dimension of 24 inches square and continuous wall footings should have a minimum width of 16 inches. Footing widths may be greater to accommodate structural design loads.

8. Pockets or layers of loose soil may be encountered in the bottom of the completed footing excavations. These materials should be removed to expose the undisturbed natural clay and sand or the gravelly sand. The foundations should be constructed on the natural soils or properly compacted structural fill. All fill placed for this project should be moisture treated and compacted as recommended in the COMPACTED FILL section of this report.

9. Fill should be placed and compacted as outlined in the COMPACTED FILL section of this report. A representative of our office should observe the site preparation and observe and test the placement and compaction of the structural fill used in foundation construction. It has been our experience that without engineering quality control, inappropriate construction techniques occur which result in unsatisfactory foundation performance.

10. A representative of our office **must** observe the completed foundation excavation. Variations from the conditions described in this report, which were not observed within the exploratory test pits can occur. The representative can observe the excavation to evaluate the exposed subsurface conditions.

Micro-Pile Foundation System

Micro-piles are a type of deep foundation system that is typically used to support foundations in conditions where cobbles and boulders or deep fill could pose a construction problem. For this project the micro-piles will be bearing in gravelly sand with scattered cobbles and boulders. The capacity of the micro-piles

is controlled by the bearing strata, pile diameter, and pile length. We recommend that the micro-pile foundation system be designed and constructed to meet the following criteria:

1. In order to properly design the micro-piles, we recommend that the foundation plans with structural loads be provided to a micro-pile contractor. The micro-pile contractor, in conjunction with the structural engineer, can then determine the size, number, and layout of the micro-piles.

2. Ground water was not observed in any of the exploratory test pits to the maximum depth explored of 13 feet. We do not anticipate that ground water will affect the installation of the micro-piles.

3. We recommend that a representative from our office be on-site while the micro-piles are installed for the proposed commercial structure. Our representative will observe the installation of the micro-piles and record the location, total length of the pile, depth, number and size of micro-pile for each micro–pile observed.

SLABS-ON-GRADE

The subsurface soils at the slab-on-grade elevations could consist of topsoil, the clay and sand, the gravelly sand, existing fill, or properly moisture conditioned and compacted new structural fill. The topsoil and existing fill is not suitable for support of slabs-on-grade. However, it is our opinion that the clay and sand, the gravelly sand, or properly moisture conditioned and compacted new structural fill will support slabs-on-grade with a low risk of movement. We recommend that slabs-on-grade be designed and constructed to meet the following criteria:

1. Slabs may be constructed on the clay and sand, the gravelly sand, or properly moisture conditioned and compacted new structural fill. All topsoil and existing fill beneath slabs-on-grade should be removed prior to construction.

2. Slabs should be separated from exterior walls and interior bearing members. Vertical movement of the slabs should not be restricted.

3. Exterior slabs should be separated from the structure. These slabs should be reinforced to function as independent units. Movement of these slabs should not be transmitted directly to the foundations or walls of the structures.

4. We anticipate that cobbles and boulders will be encountered at the slabs-on-grade elevation. Removal of cobbles and boulders may result in depressions and rough bottoms in the excavation. The resulting depressions can be backfilled with compacted backfill or lean concrete. Refer to the COMPACTED FILL section of this report for backfill requirements.

5. Frequent control joints should be provided in all slabs to reduce problems associated with shrinkage of concrete.

6. Structural fill beneath slabs-on-grades may consist of approved on-site soils or non-expansive, imported fill. Fill should be placed and compacted as recommended in the COMPACTED FILL section of this report. Failure to properly moisture treat and compact the soils will result in excessive settlement and potential cracking of slabs-on-grade. Placement and compaction of fill beneath slabs should be observed and tested by a representative of our office.

FOUNDATION DRAINAGE

Surface water, especially that originating from rain or snowmelt, tends to flow through relatively permeable backfill typically found adjacent to foundations. The water that flows through the fill collects on the surface of relatively impermeable soils

occurring at the foundation elevation. Both this surface water and possible ground water can cause wet or moist below grade conditions after construction.

Since we anticipate the proposed commercial structure will not be constructed with a below grade area, the installation of a foundation drain will not be necessary. However, if plans change and a below grade level is added to the plans, then we recommend the installation of a drain along the below grade foundation walls. The drain should consist of a 4-inch diameter perforated pipe encased in free draining gravel and a manufactured wall drain. The gravel should have a maximum size of 1.5 inches and have a maximum of 3 percent passing the No. 200 sieve. Washed concrete aggregate will be satisfactory for the drainage layer. The drain should be sloped so that water flows to a sump where the water can be removed by pumping or to a positive gravity outlet. Recommended details for a typical foundation wall drain are presented in the Typical Wall Drain Detail, Fig. 9.

LATERAL WALL LOADS

Based on the proposed construction we do not anticipate that walls will be planned which require lateral earth pressures for design. However, if plans change and below grade or partial below grade walls are added to the design of the proposed structure they may be designed as follows. Lateral earth pressures depend on the type of backfill and the height and type of wall. Walls, which are free to rotate sufficiently to mobilize

the strength of the backfill, should be designed to resist the "active" earth pressure condition. Walls, which are restrained, should be designed to resist the "at rest" earth pressure condition. Below grade walls are typically restrained. The following table presents the lateral wall pressures that may be used for design.

Earth Pressure Condition	Equivalent Fluid Pressure[1] (pcf)
Active	35
At-rest	50
Passive	300

Notes:
1. Equivalent fluid pressures are for a horizontal backfill condition with no hydrostatic pressures or live loads.
2. A coefficient of friction of 0.3 may be used at the base of spread footings constructed on the clay and sand or compacted structural fill. A coefficient of friction of 0.4 may be used for footings constructed on the gravelly sand.

Backfill placed behind or adjacent to foundation walls should be placed and compacted as recommended in the COMPACTED FILL section of this report. Placement and compaction of the fill should be observed and tested by a representative of our office.

RETAINING WALLS

Due to the topography of the site, we anticipate that retaining walls may be constructed as part of the development of the site. Foundations for retaining walls may be designed and constructed as outlined in the FOUNDATIONS section of this report. Lateral earth loads for retaining wall designs are presented in the LATERAL WALL LOADS section of this report. In order to reduce the possibility of developing hydrostatic

pressures behind retaining walls, a drain should be constructed adjacent to the wall. The drain may consist of a manufactured drain system and gravel. The gravel should have a maximum size of 1.5 inches and have a maximum of 3 percent passing the No. 200 sieve. Washed concrete aggregate or screened rock will be satisfactory for the drainage layer. The manufactured drain should extend from the bottom of the retaining wall to within 2 feet of subgrade elevation. The water can be drained by a perforated pipe with collection of the water at the bottom of the wall leading to a positive gravity outlet. A typical detail for a retaining wall drain is presented in the Typical Retaining Wall Drain Detail, Fig. 10.

SURFACE DRAINAGE

Reducing the wetting of structural soils and the potential of developing hydrostatic pressure behind below grade walls can be achieved by carefully planned and maintained surface drainage. We recommend the following precautions be observed during construction and maintained at all times after the commercial development is completed.

1. Wetting or drying of the open excavation should be minimized during construction.

2. All surface water should be directed away from the top and sides of the excavation during construction.

3. The ground surface surrounding the exterior of the structure should be sloped to drain away from the building in all directions. We recommend a slope of at least 12 inches in the first 10 feet.

4. Hardscape (concrete and asphalt) should be sloped to drain away from the structure. We recommend a slope of at least 2 percent for all hardscape within 10 feet of the building.

5. Backfill, especially around foundation walls, should be placed and compacted as recommended in the COMPACTED FILL section of this report.

6. Roof drains should discharge at least 10 feet away from foundation walls with drainage directed away from the building.

7. Surface drainage for this site should be designed by a Professional Civil Engineer.

IRRIGATION

Irrigation systems installed next to foundation walls or sidewalks could cause consolidation of backfill below and adjacent to these areas. This can result settling of exterior steps, patios, and/or sidewalks constructed on these soils. We recommend the following precautions be followed:

1. Do not install an irrigation system next to foundation walls. The irrigation system should be at least 10 feet away from the building.

2. Irrigation heads should be pointed away from the structure or in a manner that does not allow the spray to come within 5 feet of the building.

3. The landscape around the irrigation system should be sloped so that no ponding occurs at the irrigation heads.

4. Install landscaping geotextile fabrics to inhibit growth of weeds and to allow normal moisture evaporation. We do not recommend the use of a plastic membrane to inhibit the growth of weeds.

5. Control valve boxes, for automatic irrigation systems, should be located at least 10 feet away from the structure and periodically checked for leaks and flooding.

COMPACTED FILL

Structural fill for this project may consist of approved on-site clay and sand, gravelly sand, existing fill free of deleterious material, or imported granular fill. Cobbles and boulders larger than 10 inches should be removed from the on-site soils before placement as structural fill. The imported fill may consist of non-expansive silty or clayey sands or gravels with up to 30 percent passing the No. 200 sieve and a maximum plasticity index of 10. No cobbles or boulders larger than 10 inches should be placed in fill areas. Fill areas should be stripped of all vegetation and topsoil, scarified, and then compacted. Topsoil may be used in landscape areas. Fill should be placed in thin loose lifts then moisture treated and compacted as shown in the following table. The recommended compaction varies for the given use of the fill.

Use of Fill	Recommended Compaction	
	Percentage of the Standard Proctor Maximum Dry Density (ASTM D-698)	Percentage of the Modified Proctor Maximum Dry Density (ASTM D-1557)
Below Foundations	98	95
Below Slabs-On-Grade	98	90
Utility Trench Backfill	95	90
Backfill (Non-Structural)	90	90
Notes: 1. For granular soils or non-expansive clay soils the moisture content should be –2 to +2 percent of the optimum moisture content.		

We recommend that a representative from our office observe and test the placement and compaction of each lift placed for structural fill. Fill placed beneath foundations and slabs-on-grade is considered structural. It has been our experience that without engineering quality control, inappropriate construction techniques can occur which results in unsatisfactory foundation and slab performance.

LIMITATIONS

Although the exploratory test pits were located to obtain a reasonably accurate determination of subsurface conditions, variations in the subsurface conditions are always possible. Any variations that exist beneath the site generally become evident during excavation for the proposed commercial development. Therefore, we should be contacted by the contractor and/or owner so that a representative of our office can observe the

completed excavation to confirm that the soils are as indicated by the exploratory test pits and to verify our foundation and slab-on-grade recommendations.

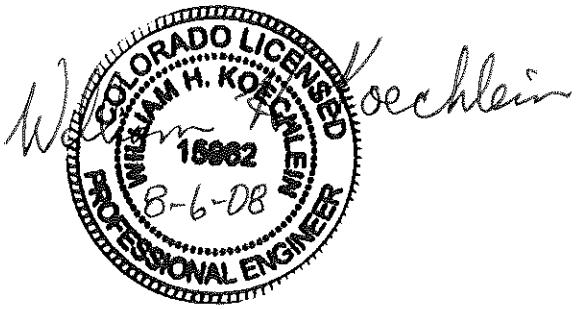
The placement and compaction of fill, as well as installation of foundations, should also be observed and tested. The design criteria and subsurface data presented in this report are valid for 3 years provided that a representative from our office observes the site at that time and confirms that the site conditions are similar to the conditions presented in the SITE CONDITIONS section of this report and that the recommendations presented in this report are still applicable. We recommend that final plans and specifications for proposed construction be submitted to our office for study, prior to beginning construction, to determine compliance with the recommendations presented in this report and that the recommendations presented in this report are still applicable.

We appreciate the opportunity to provide this service. If we can be of further assistance in discussing the contents of this report or in analyses of the proposed structure from a geotechnical viewpoint, please contact our office.

KOECHLEIN CONSULTING ENGINEERS, INC.

Jessica E. Street, E.I.
Staff Engineer

Reviewed by:



William H. Koechlein, P.E.
President

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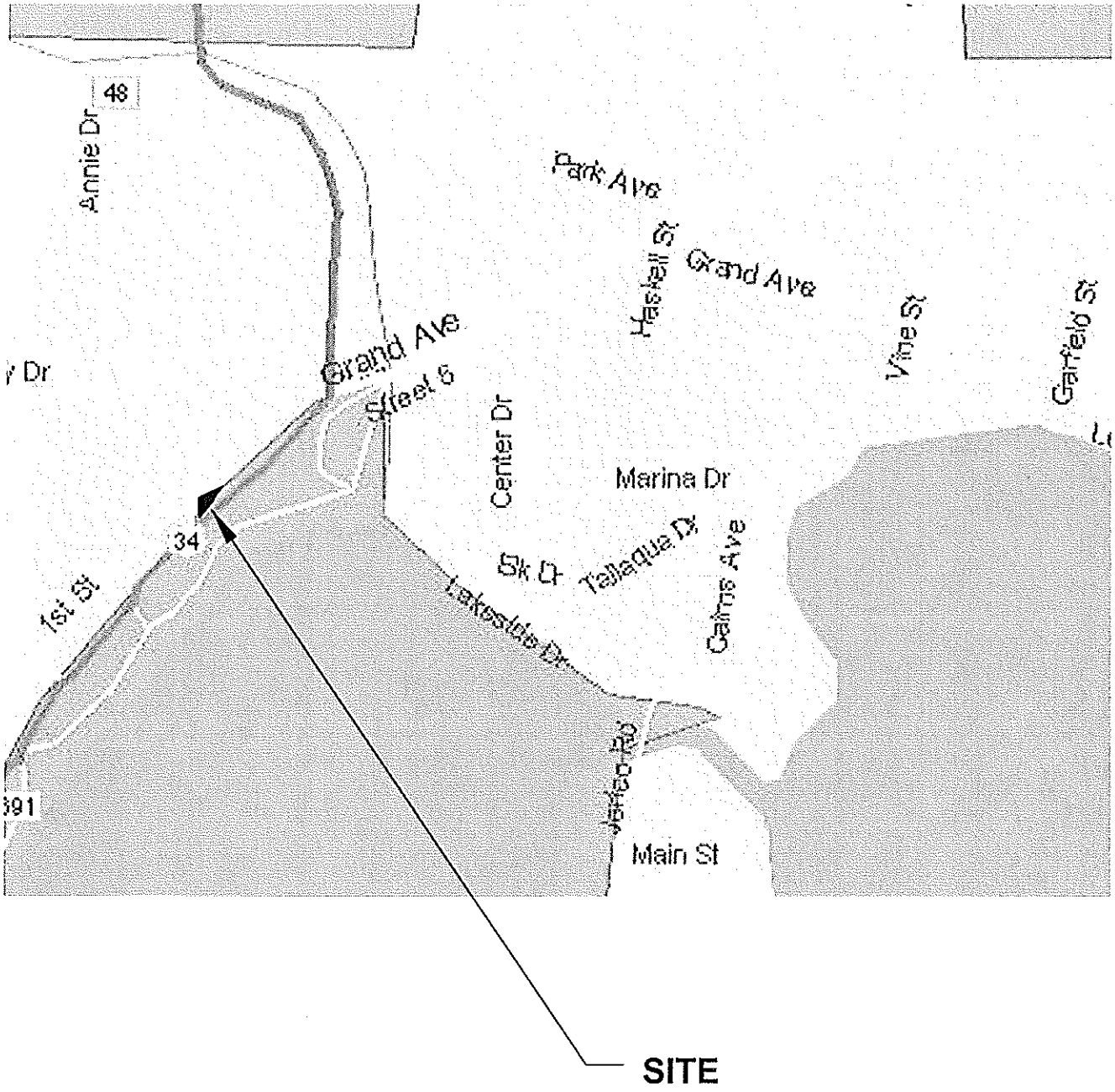
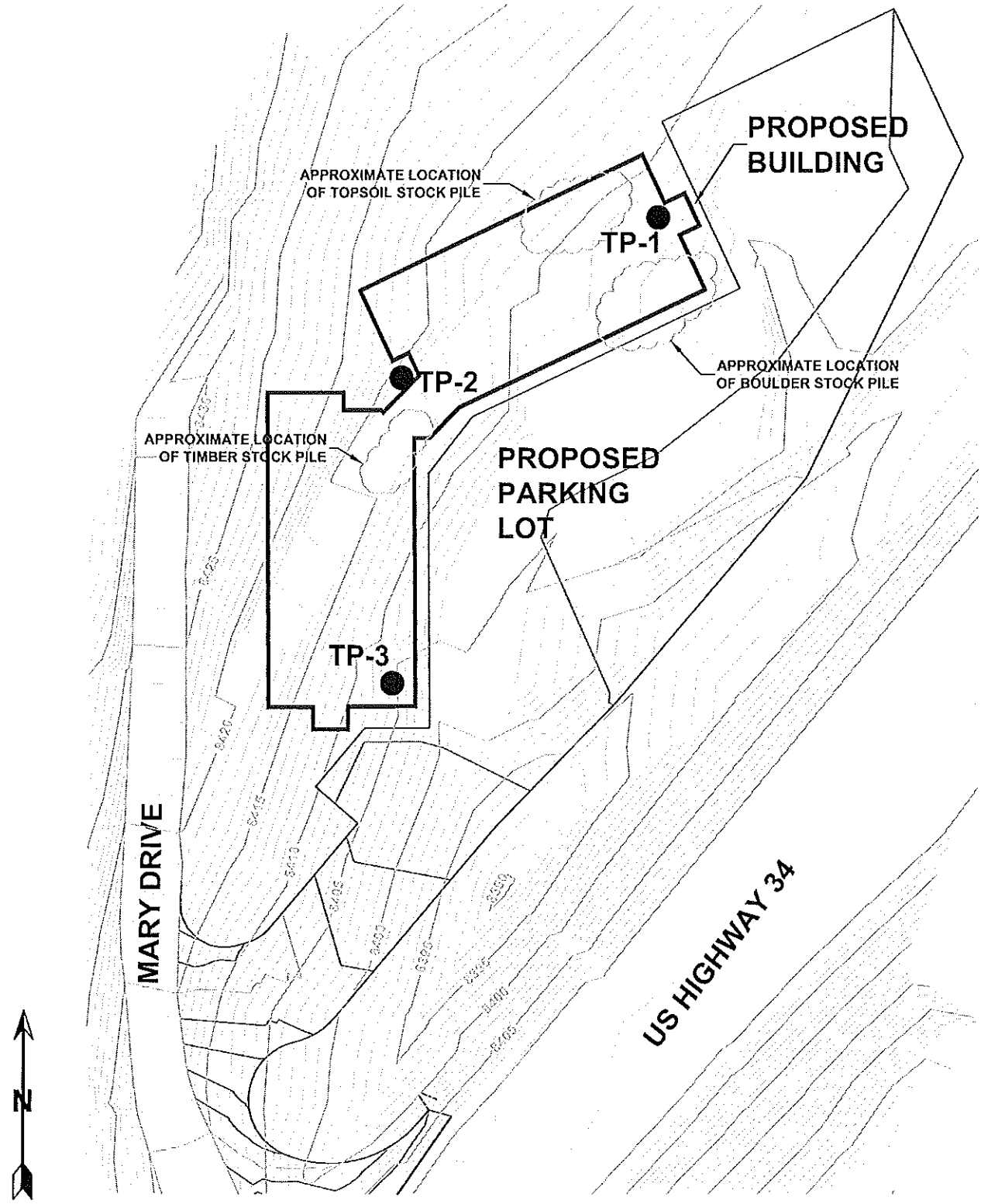


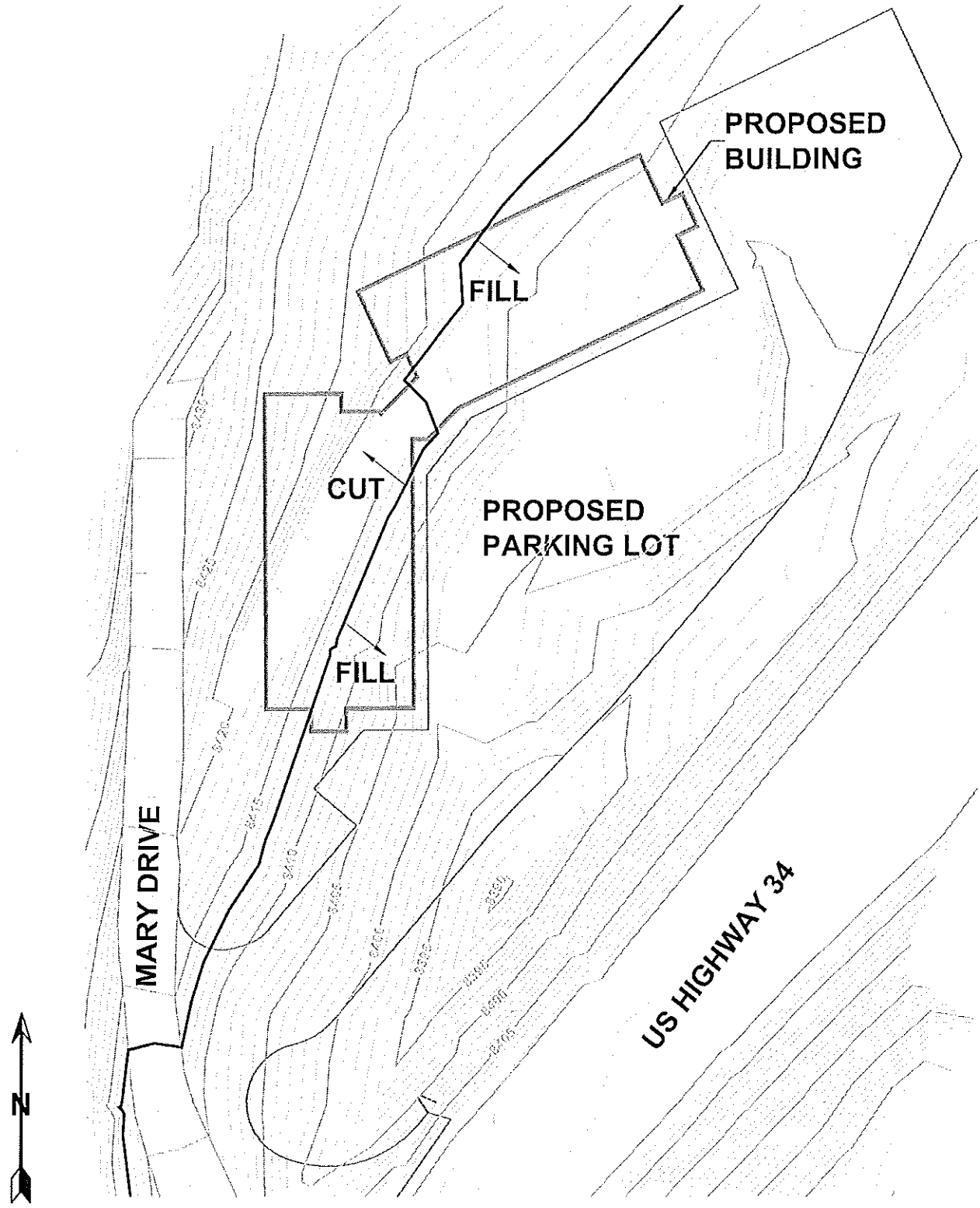
NOT TO SCALE

VICINITY MAP



SCALE: 1" = 50'

LOCATIONS OF EXPLORATORY TEST PITS

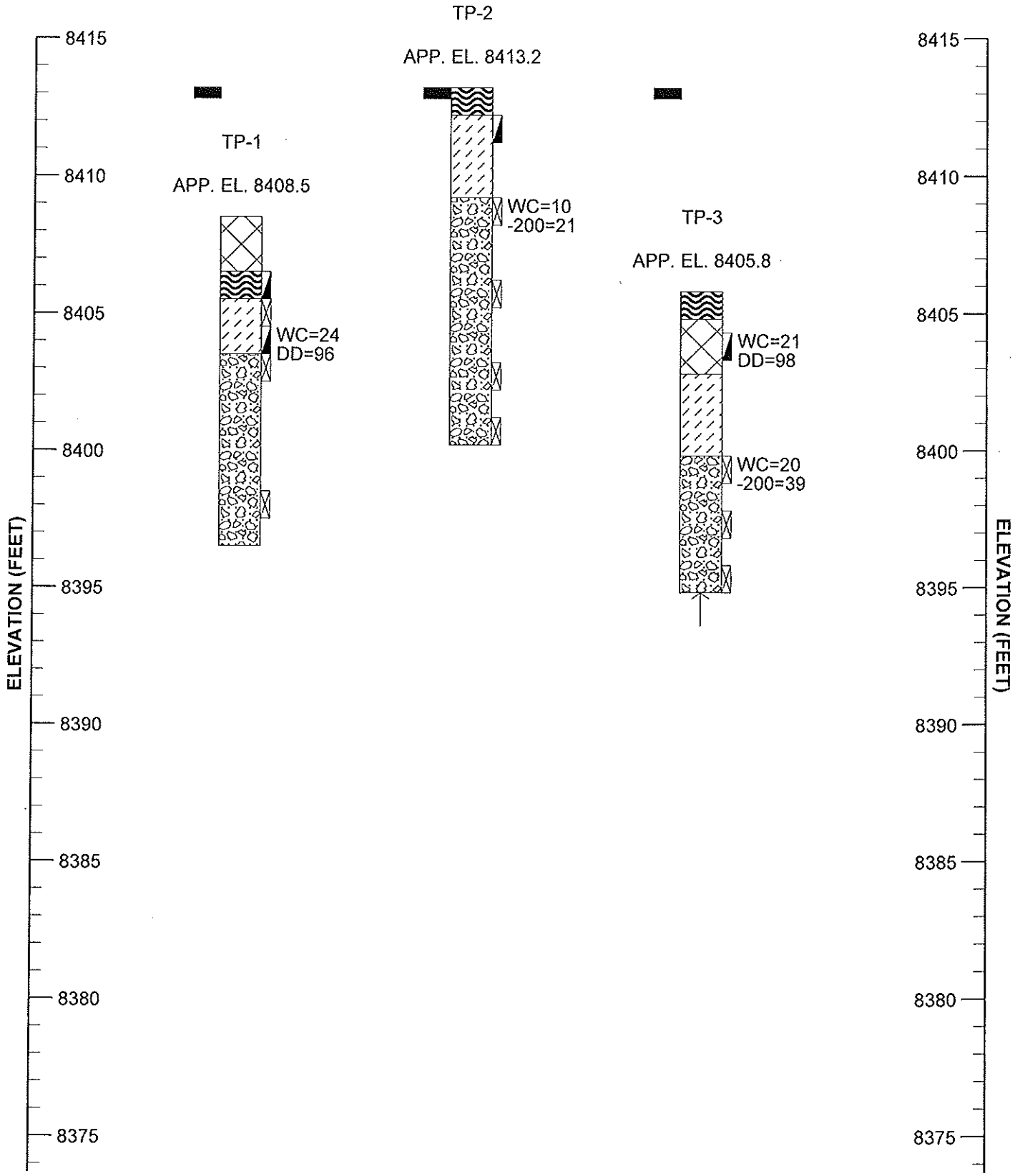


SCALE: 1" = 50'

LOCATION OF CUT AND FILL

JOB NO. 08-060

FIG. 3



LOGS OF EXPLORATORY TEST PITS

JOB NO. 08-060

FIG. 4

LEGEND:


FILL, Clay, Sandy, Organics, Slightly moist, Medium stiff, Mottled, Orange, Brown, Black.


TOPSOIL


CLAY and Sand, Gravelly, Scattered cobbles, Slightly moist to very moist, Medium stiff to stiff, Light brown.


SAND, Gravelly, Clayey, Scattered cobbles and boulders, Slightly moist to moist, Medium dense to very dense, Tan, brown.

CONSTRUCTION PAD. Indicates approximate elevation of proposed pad.


REFUSAL. Indicates practical trackhoe refusal.


HAND DRIVE SAMPLE. Indicates 2.0 inch diameter brass liner driven into the soil by a hammer.


BULK SAMPLE. Obtained from the bucket of the trackhoe.

Notes:

1. Exploratory test pits were excavated on July 17, 2008 using a trackhoe.

2. No free ground water was encountered at the time of excavating in any of the test pits to the maximum depth explored of 13.0 feet.

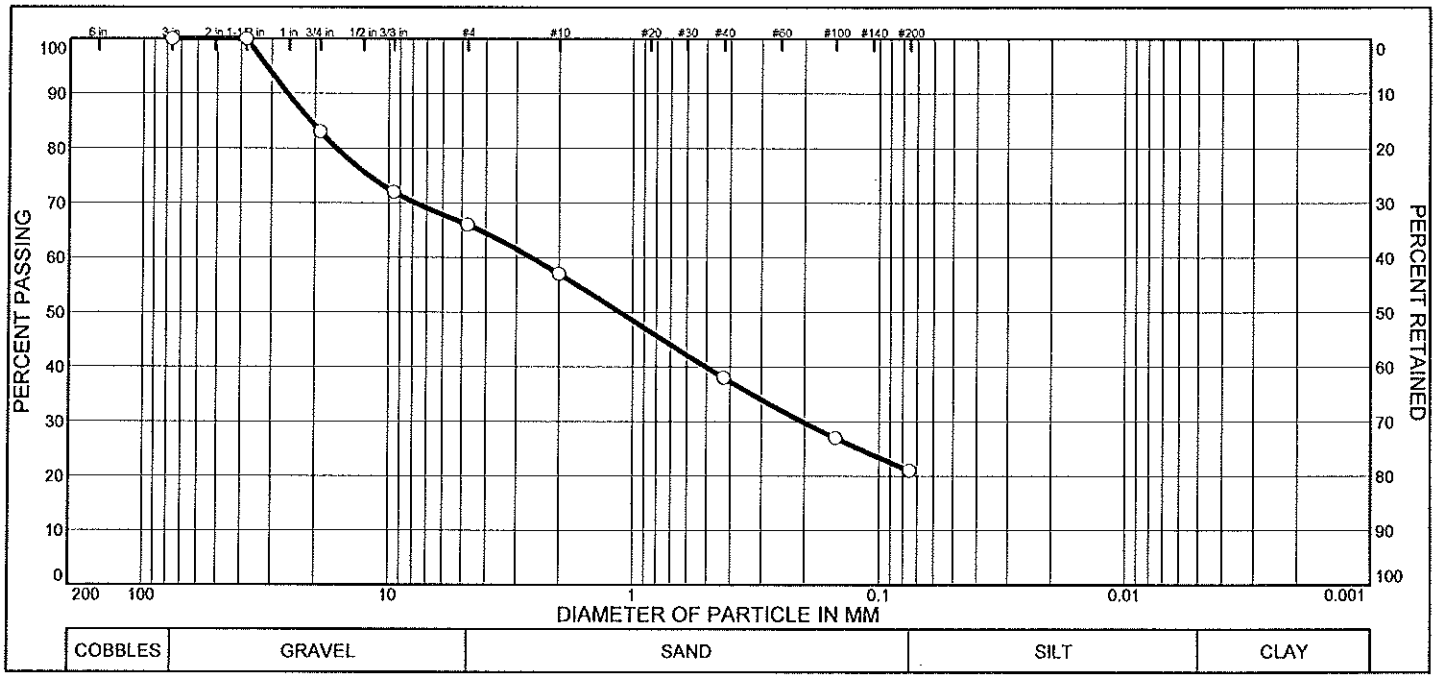
3. The Test Pit Logs are subject to the explanations, limitations, and conclusions as contained in this report.

4. Laboratory Test Results:
   - WC - Indicates natural moisture content (%)
   - DD - Indicates natural dry density (pcf)
   - -200 - Indicates percent passing the No. 200 sieve (%)

5. Approximate elevations are based on placing test pit locations on the topographic map provided by Diamondback Engineeirng and Surveying Inc. and verifying the elevational changes with the readings taken using a Stanley Compulevel Elevation Measurement System.

LEGEND OF EXPLORATORY TEST PITS

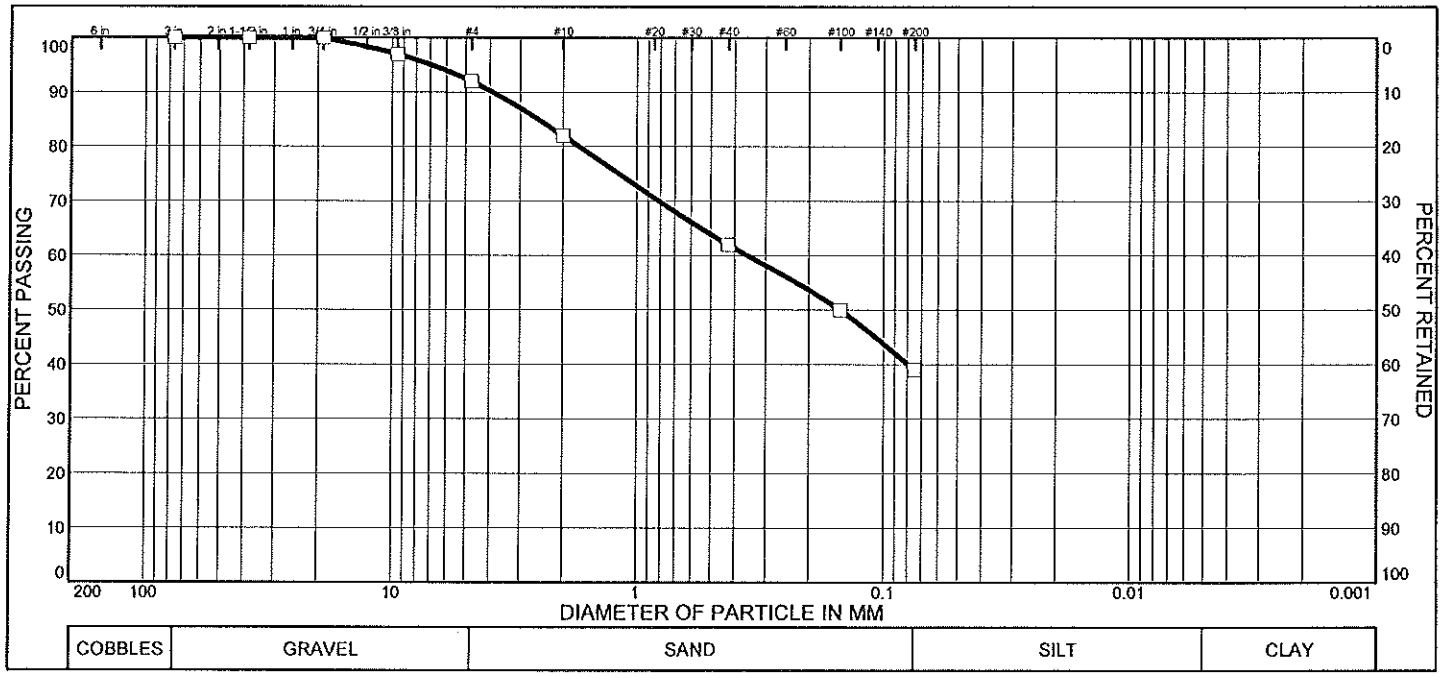
KOECHLEIN CONSULTING ENGINEERS



Sample of SAND, Gravelly, Clayey **GRAVEL** 34 % **SAND** 45 %

Source TP-2 **Sample No.** _____ **Elev./Depth** 4.0 feet **SILT & CLAY** 21 % **LIQUID LIMIT** _____ %

PLASTICITY INDEX _____ %



Sample of SAND, Clayey, Some gravel **GRAVEL** 8 % **SAND** 53 %

Source TP-3 **Sample No.** _____ **Elev./Depth** 6.0 feet **SILT & CLAY** 39 % **LIQUID LIMIT** _____ %

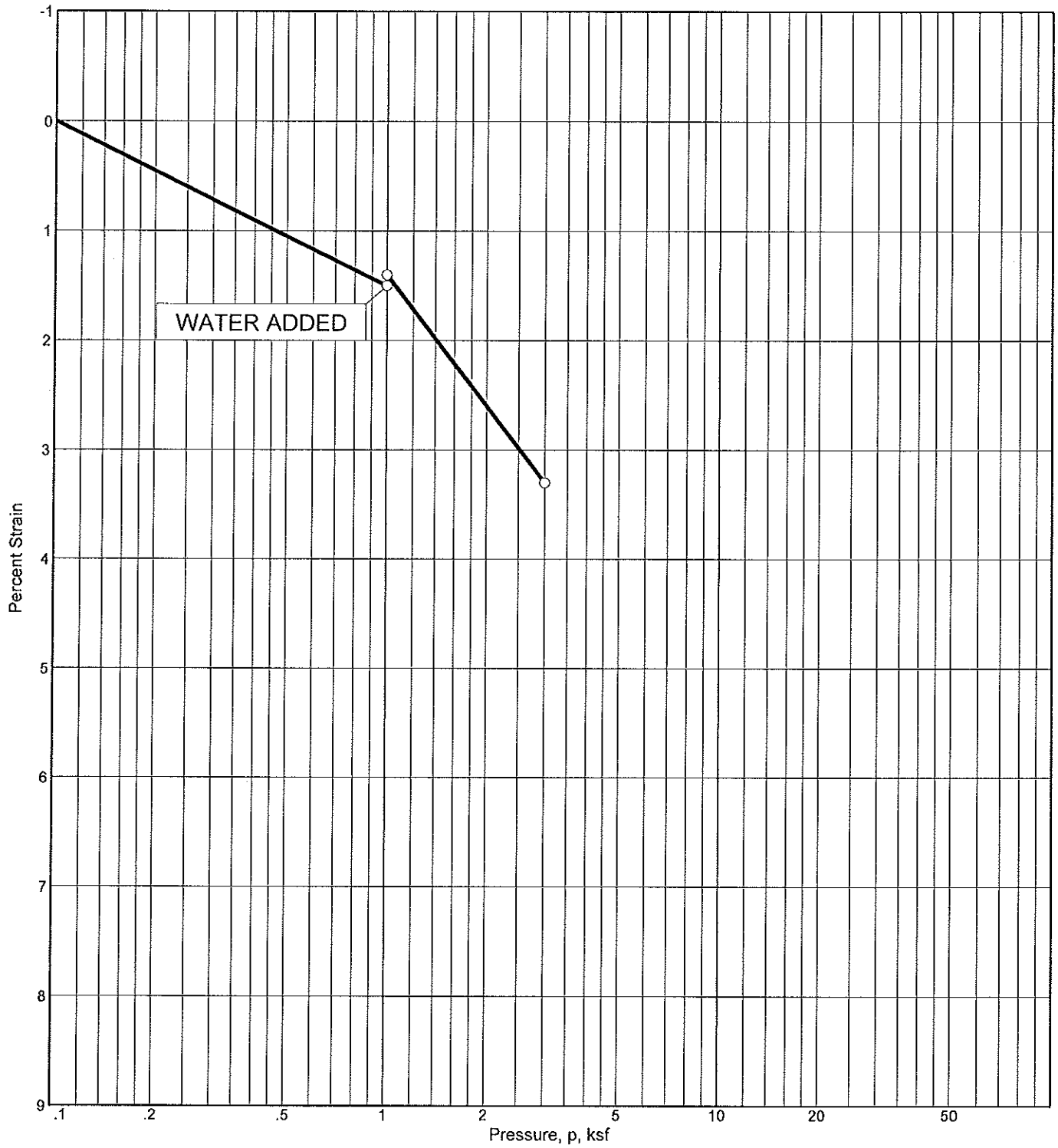
PLASTICITY INDEX _____ %

GRADATION TEST RESULTS

Job No. 08-060

FIG. 6

KOECHLEIN CONSULTING ENGINEERS



Sample of CLAY, Sandy

Source TP-1 Sample No. _____ Elev./Depth 4.0 feet

Natural Dry Unit Weight= 95.8 (pcf)

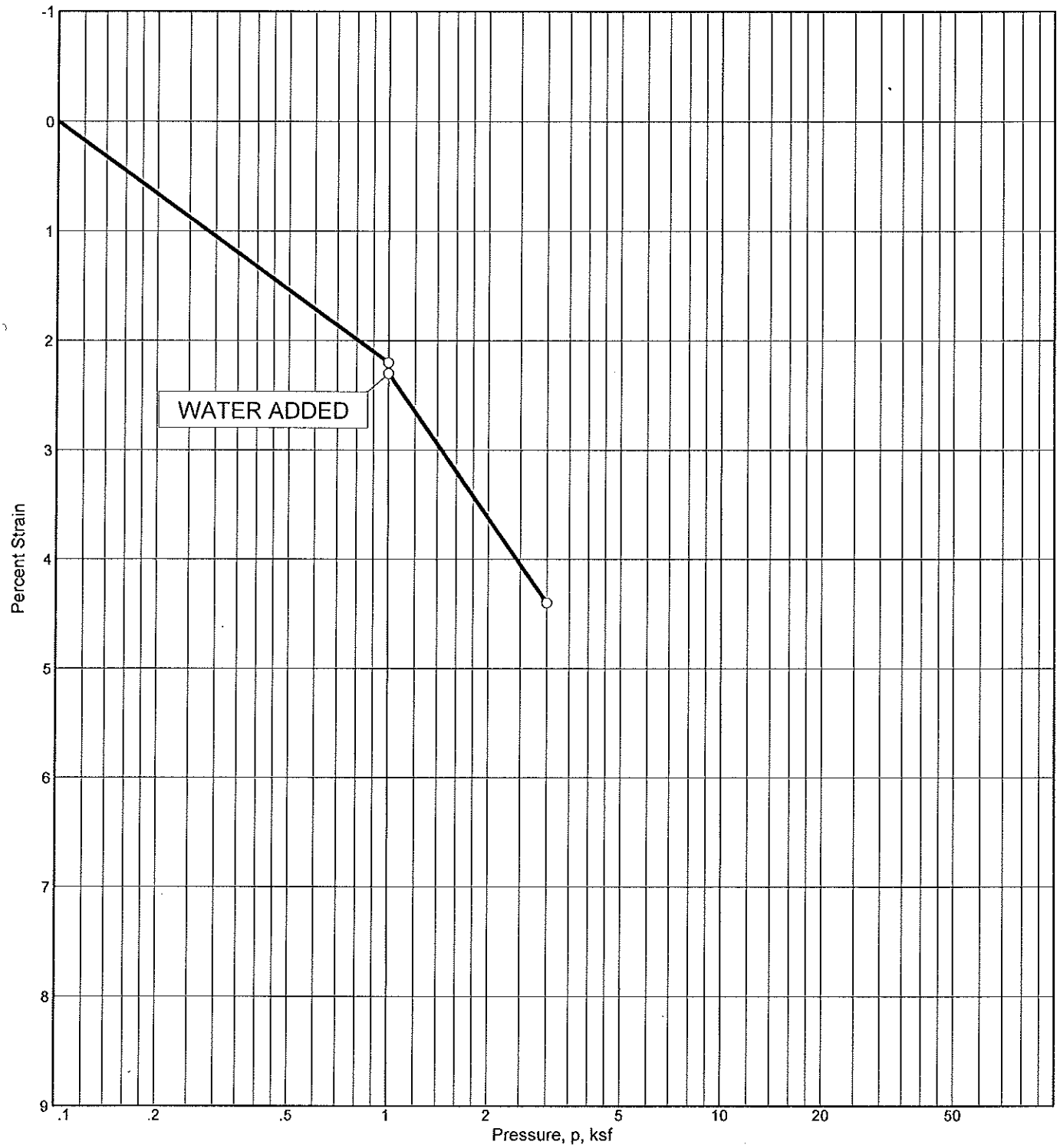
Natural Moisture Content= 24 %

SWELL-CONSOLIDATION TEST RESULTS

Job No. 08-060

FIG. 7

KOECHLEIN CONSULTING ENGINEERS



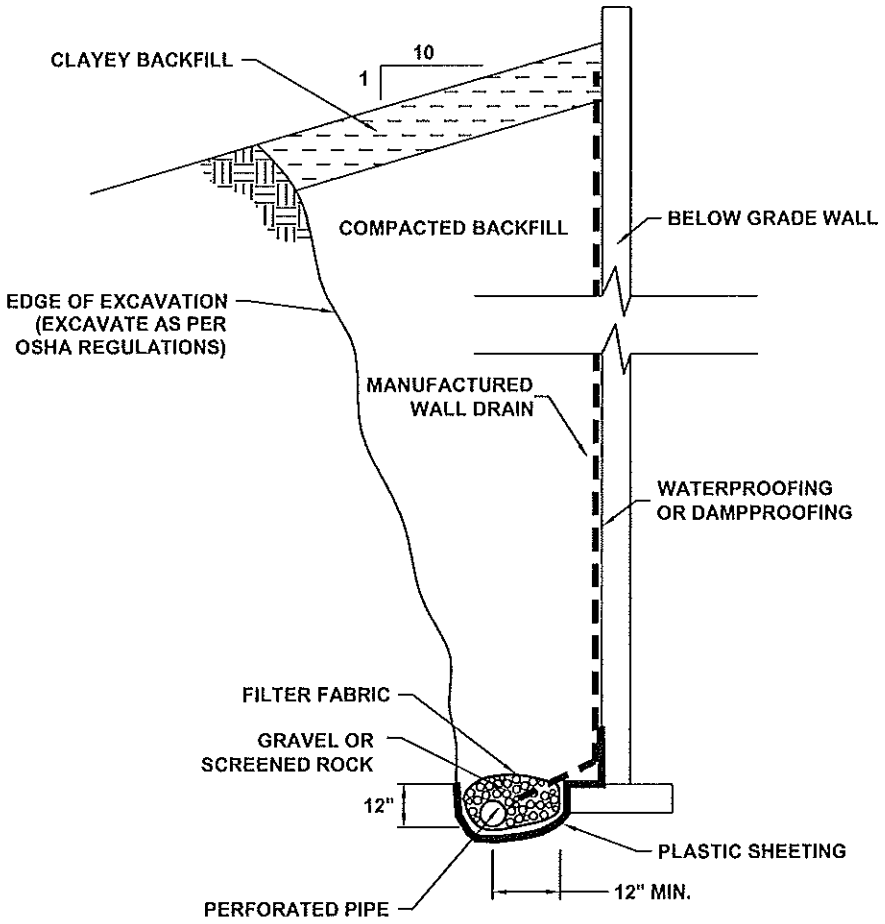
Sample of FILL, Clay, Sandy — Natural Dry Unit Weight= 97.5 (pcf)

Source TP-3 Sample No. — Elev./Depth 1.5 feet — Natural Moisture Content= 21 %

SWELL-CONSOLIDATION TEST RESULTS

Job No. 08-060

FIG. 8



NOTES:

1. DRAIN SHOULD BE AT LEAST 12 INCHES BELOW TOP OF FOOTING AT THE HIGHEST POINT AND SLOPE DOWNWARD TO A POSITIVE GRAVITY OUTLET OR TO A SUMP WHERE WATER CAN BE REMOVED BY PUMPING.

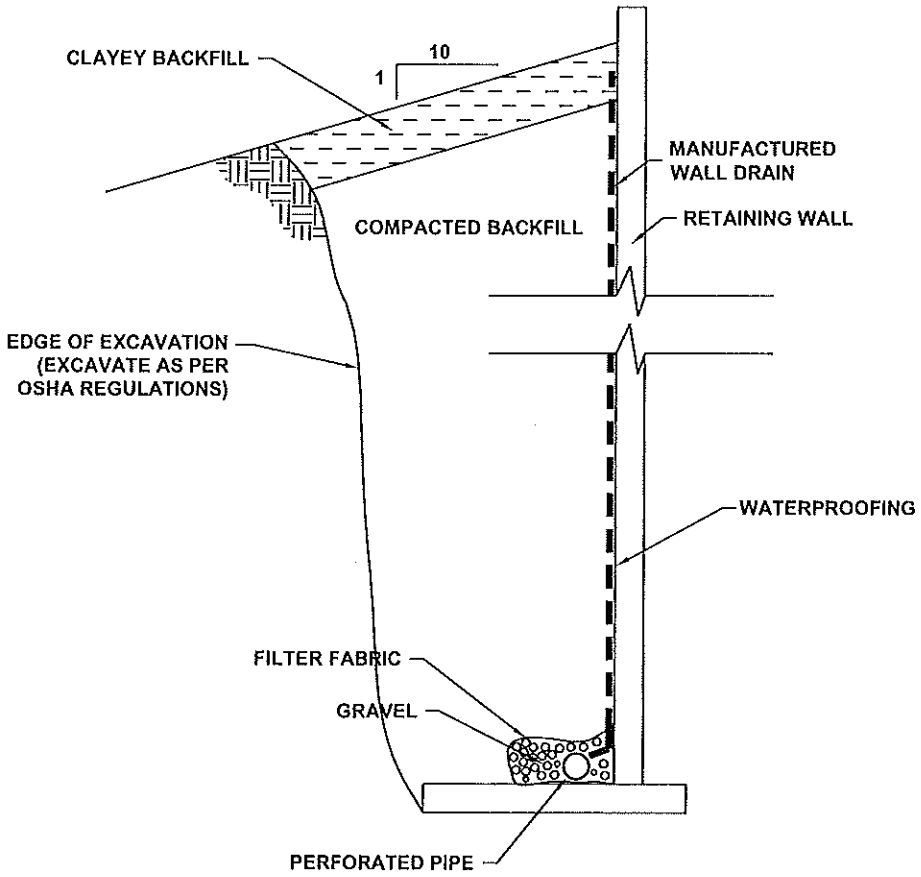
2. EXCAVATIONS ADJACENT TO FOOTINGS SHOULD BE CUT AT A 1 TO 1 (HORIZONTAL TO VERTICAL) OR FLATTER SLOPE FROM THE BOTTOM OF THE FOOTINGS. EXCAVATIONS ADJACENT TO FOOTINGS SHOULD NOT BE CUT VERTICALLY.

3. THE DRAIN SHOULD BE LAID ON A SLOPE RANGING BETWEEN 1/8 INCH AND 1/4 INCH DROP PER FOOT OF DRAIN.

4. GRAVEL SPECIFICATIONS: 1.5 INCH TO NO. 4 GRAVEL WITH LESS THAN 3 % PASSING THE NO. 200 SIEVE.

5. THE BELOW GRADE CONCRETE FOUNDATION WALLS SHOULD BE PROTECTED FROM MOISTURE INFILTRATION BY APPLYING A SPRAYED ON MASTIC WATERPROOFING, DAMPPROOFING, OR AN EQUIVALENT PROTECTION METHOD.

TYPICAL WALL DRAIN DETAIL



NOTES:

1. DRAIN SHOULD BE SLOPED DOWNWARD TO A POSITIVE GRAVITY OUTLET OR TO A SUMP WHERE WATER CAN BE REMOVED BY PUMPING.

2. THE DRAIN SHOULD BE LAID ON A SLOPE RANGING BETWEEN 1/8 INCH AND 1/4 INCH DROP PER FOOT OF DRAIN.

3. GRAVEL SPECIFICATIONS: WASHED 1.5 INCH TO NO. 4 GRAVEL WITH LESS THAN 3% PASSING THE NO. 200 SIEVE.

4. THE BELOW GRADE CONCRETE RETAINING WALLS SHOULD BE PROTECTED FROM MOISTURE INFILTRATION BY APPLYING A SPRAYED ON MASTIC WATERPROOFING OR AN EQUIVALENT PROTECTION METHOD.

TYPICAL RETAINING WALL DRAIN DETAIL

SUMMARY OF LABORATORY TEST RESULTS

TABLE I

HOLE	SAMPLE DEPTH (ft)	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	ATTERBERG LIMITS		PASSING NO. 200 SIEVE (%)	PERCENT SWELL AT 1,000 PSF (%)	SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)			
TP-1	4.0	24	96				+0.01	CLAY, Sandy
TP-2	4.0	10				21		SAND, Gravelly, Clayey
TP-3	1.5	21	98				-0.1	FILL, Clay, Sandy
TP-3	6.0	20				39		SAND, Clayey, Some gravel