THE GALLI GROUP
Geotechnical Consulting

GEOTECHNICAL INVESTIGATION AND DESIGN REPORT PARKS AND PUBLIC WORKS FACILITY CENTRAL POINT, OREGON

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1.0 INTRODUCTION

This report presents results of our geotechnical evaluation of the site for the proposed Parks and Public Works Operations Facilities. The subject property is located on the west of Pacific Highway (Highway 99) in southwest Central Point, Oregon. South Haskell runs along the western edge and Ash Street bounds the northern edge with railroad tracks along the eastern side and a commercial development to the immediate south. Please see Figure 1, Vicinity Map, for a precise site location.

The purpose of this investigation and report was to evaluate the site surface and subsurface conditions with a series of borings and test pits in order to provide geotechnical recommendations for design and construction of the proposed development, including structure foundations, access roads and parking lots.

2.0 SITE AND PROJECT DESCRIPTION

The subject project site is mostly level with 2 distinct elevations present. The upper shelf is located in the northern portion (400') for the full width and along the full east side for about 40' width. This bench is a higher elevation than surrounding development (roughly 2'-7' higher) and gently slopes downward to the west. The lower shelf is located in the south west corner (185'l x 170'w) and is relatively flat with elevations roughly the same as surrounding streets and buildings. The parcel is currently unoccupied and appears to have multiple layers of fill placement for several feet on both the upper and lower benches. This appears to be the result of demolition and removal of an old lumber mill. Much of the fill contains some organic and manmade debris at varied elevations. The lot is mostly covered by scattered light vegetation and short grass.

We understand the project to consist of constructing several equipment maintenance or storage type structures and one office building. We also understand these facility structures are intended to be single-story, wood or light metal framed structures with slab-on-grade floors. An equipment shed may be constructed with posts (and open walls)

supporting a roof. The office building would likely be a wood framed structure with slab-on-grade or wood diaphragm floors. Loads will generally be light to moderate with column loads on the order of 10 to 30 kips and strip footing loads between 1 and 2 kips per lineal foot. Associated entrance roads, access lanes, auto and equipment parking, and landscaped areas will also be included.

3.0 FIELD EXPLORATION

On January 9 and 10, 2019, Staff Professional, Lyn Chand, EIT and support crew members visited the site to accomplish the subsurface borings and test pits. A total of nine (9) exploratory borings were attempted or drilled (several borings had more than one attempt due to early auger refusal, and B-5 was not attempted) throughout the site. These were accomplished using a D-50 drill mounted on an ATV, provided by The Galli Group, at the locations shown on Figure 2, Site Plan.

Borings were located across the entire lot on both the upper and lower benches. Borings across the lower bench resulted in auger refusal at very shallow depths (up to 1 foot) due to the presence of large, angular gravel and cobble fill. Upper bench borings were terminated at depths between 1 foot and 8.5 feet in the manmade fill materials.

Three (3) borings were used to perform Falling Head Permeability testing. Test locations are identified on Figure 2.

It was determined that additional investigation of the site was necessary for proper design of the project. On January 10, 2019 a total of five (5) test pits were accomplished across the site. These were excavated to depths of between 4.5 feet and 10.5 feet with a medium size track mounted excavator, provided by Bill's Backhoe Service. See Figure 2 for the Test Pit locations.

Borings were advanced with sample collection and testing being accomplished at various depths. All holes were refilled after drilling or excavation. Test pits samples were collected at various depths as well and these were refilled with soil spoils and moderate compaction with the backhoe bucket.

In the borings, and at various levels of the test pits, Standard Penetration Testing (SPT) was accomplished. This entails driving a 1½-inch diameter steel split spoon sampler by dropping a 140-pound weight for a 30-inch drop. The total number of blows it takes to drive the sampler the last 12 inches of an 18-inch drive is called the SPT N-value. These can be correlated with soil density and strength parameters from testing on thousands of other projects.

Our representative identified the exploration locations, logged subsurface soils and water conditions and obtained soil samples for transport to our laboratory. Visual classifications of the soils were made in the field and are presented in the Boring Logs in Appendix A and Test Pit Logs in Appendix B, at the end of this report. Please note that

in the logs, soil changes are depicted as distinct layers, while in nature they may be more gradual.

4.0 LABORATORY TESTING

Soil samples were tested for natural moisture content and Expansion Potential. Other tests were not undertaken due to the wide variety of fill materials as well as the inconsistency of soil types across the site (See Section 5.0 for additional subsurface soil descriptions and information).

Expansive Index (EI) testing resulted in EI's from 20 in the silty-sandy Clay soils to 40 in the silty Clay soils. These values indicate low to moderate expansive nature, however, please see the discussion, in Section 7.0 Conclusion, for additional information.

5.0 SUBSURFACE CONDITIONS

5.1 SOIL

The site areas investigated had two (2) distinct benches with a large variety of fill materials across the upper bench and similar soils conditions found on the lower bench. Most Borings on the upper bench terminated with auger refusal into a 4" Minus Crushed rock or other soil with large angular rock occurring 3.0 feet to 4.0 feet below the surface. Boring B-9 was the one exception. In this boring, drilling was advanced to auger refusal near 8.0 feet and terminated within dense silty Sand with gravels. On the lower bench, auger refusal occurred, uniformly, at very shallow depths, between 1.0 feet and 1.5 feet, in a layer of 4" Minus Crushed rock. Test Pits TP-1 and TP-2 were used to advance sample collection in the upper bench to 5.5 feet and 10.5 feet respectively. While TP-1 terminated in a very dense, brown sandy gravel (possibly native soils), TP-2 terminated with organics encountered in medium stiff soils.

Both benches consisted of multiple layers of manmade fill, each contained a varied combination of silt, sand, clay, gravels and cobbles. The variability of distinct layers of soil thickness, color and constituents implies that fill was placed from differing sources in small sections possibly over a long period of time. This is also evidenced by observed surface soils where small sections (not within test pit or boring locations) consisted of notably distinct soil materials, namely a thin section (less than ¾" depth) of pea gravel was observed on the surface of the upper bench near test pit, TP-1, and boring, B-2. A similar situation was encountered on the lower bench near test pit, TP-3 and boring, B-6. In this location a section approximately 20 feet long x 6 feet wide x 6 inches of 1" Minus Crushed Granite (gray and white) was observed. Soils sampled throughout test pits and borings ranged in color from yellow, orange, red and brown and into grays and black with only some soils encountered in different borings appearing to be similar in nature. However, all soils encountered appeared to be manmade with angular to rounded gravels in consistent size and quantity to most layers.

The lower bench level had similar layers encountered within test pits. Test pits TP-3 and TP-4 were capped with a layer of 4" Minus Crushed Rock over a larger "Jaw Run" Shale material which was also encountered in TP-5. Numerous fine organics were observed within the soil matrix surrounding the rock fill in all three test pits. Test Pits TP-4 and TP-5 both had layers of cemented sand soils with fine gravels starting around 4.0 feet deep.

Please see more specific soils information in the Boring Logs in Appendix A and the Test Pit Logs in Appendix B. Please note that the soils are shown as distinct layers in the Boring Logs while in nature they may change more gradually. Soils conditions change somewhat between the locations investigated.

5.2 GROUNDWATER

All soils encountered were damp to moist. Due to the clayey nature of the soils and soil matrices, it is unlikely free water levels could rise to the surface during the wetter months of most years. Perched water was found less than 1 foot in depth through most of the lower bench. No water was encountered in the upper bench. In the lower bench, TP-3 and TP-4 encountered a layer of perched water, while a significant amount of groundwater was discovered in TP-5. Surface waters will likely move from upslope on the upper bench and pond on the lower bench unless the site is regraded for better drainage.

6.0 GEOLOGIC HAZARDS AND SEISMIC DESIGN PARAMETERS

6.1 GEOLOGIC HAZARDS

Slope Stability. There are no significant slopes close to the site. Therefore, there is no possibility of slope failure, rock fall or slide runout damage.

Expansive Soils. The soils tested were found to be low to moderately expansive. However, it is possible that highly expansive soils could be encountered within the manmade fill. Measures to prevent these soils from damaging the project must be incorporated in the design.

Liquefaction. Loose to medium dense, silt or sand soils below the water table were not encountered. Therefore, the risk of damage due to liquefaction is considered low.

Ground Rupture. No Quaternary faults were identified at the project site. Therefore, the risk of damage at the site due to ground rupture is considered very low.

Ground Shaking. The design PGA is 0.237g for Site Class D. See following Seismic Design Table.

Seismic Ground Amplification or Resonance. No hazardous amplification or resonance effects from seismic waves have been associated with the soil subsurface conditions in the project area. The risk of damage at the site from unexpectedly severe shaking due to seismic wave amplification is low.

Tsunami and Seiche. The project site is located over 75 miles inland, and is therefore not subject to inundation from a tsunami. The site is located over 15 miles from lakes. Therefore, the risk of damage to the site is extremely low due to hazard from dam failure, seiche or seismic-induced flooding.

Conclusions. Therefore, based on our site observations and review of geologic literature and mapping, in our opinion, there are no geologic hazards that will potentially cause damage at the site, other than expected seismic shaking and expansive soils. The project must be designed for the potential for moderate ground shaking during the anticipated seismic events and for the expansive clay soils in some areas.

6.2 2014 OSSC AND 2012 IBC DESIGN EARTHQUAKE

The design earthquake for the project area is based upon established values and methodologies in the Oregon Structural Specialty Code (OSSC; 2014), International Building Code (IBC; 2012), and ASCE 07-10.

The Maximum Considered Earthquake (MCE_R) and spectral response accelerations were established as set forth in Section 1613 (IBC, 2012) and Section 11.4 (ASCE 7-10), and were obtained from the online USGS Seismic Design Maps (USGS, 2016).

Seismic parameters are provided for the project- **Table 1 (Site Class D)** is to be used for building sites where most of the thin native soil profile remains in place and possibly structural fill is added upon the soil profile.

Table 1- DESIGN EARTHQUAKE (IBC, 2012; ASCE 7-10; OSSC, 2014)

Parameter	Value
Project Latitude/ Longitude Central Point Parks and Maintenance Facility	Lat. 42.369756 Long -122.918028
Occupancy/Risk Category (Table 1.5-1 ASCE/SEI 7-10)	Risk Category I, II, III
Mapped Spectral Response Acceleration (MCE_R) - Short Period (S_S)	0.619g
Mapped Spectral Response Acceleration (MCE_R) - 1-Second Period (S_1)	0.335g
Site Class - *(Table 20-3-1 ASCE/SEI 7-10*)	**D**
Short Period Site Coefficient based on Site Class - (F_a)	1.305
1-Second Site Coefficient based on Site Class - (Fv)	1.730

MCE_R Spectral Response Acceleration - (S_{MS})	$S_{MS}= F_a * S_S = 0.807g$
MCE_R Spectral Response Acceleration for 1-Second - (S_{M1})	$S_{M1}= Fv * S_1 = 0.580g$
Design Spectral Response Acceleration for Short Periods - (S_{DS})	**S_{DS} = 2/3 S_{MS}= 0.538g**
Design Spectral Response Acceleration for 1-Second - (S_{D1})	**S_{D1} = 2/3 S_{M1} = 0.386g**
PGA= MCE_G (Section 11.8.3.2; and Figures 22-7; ASCE/SEI 7-10)	PGA= 0.293g
F_{PGA} (Table 11.8-1 ASCE/SEI 7-10)	1.214
$PGA_M= F_{pga}$*PGA (EQ 11.8-1; ASCE/SEI 7-10)	= 1.214*0.293=**0.356g**
Design PGA (PGAm*2/3)	PGA_D= 0.356*2/3 **0.237g**
Seismic Design Category (Section 11.6 and Table 11.6-1 and Table 11.6-2; ASCE/SEI 7-10)	D

7.0 CONCLUSIONS

In our professional opinion, based on our field investigation and office review, the soils conditions at the site are marginally suitable for the proposed development, provided the recommendations of our report are incorporated in the design and construction of the project. Variability of soil conditions within undocumented fill across the site make it difficult to determine soil profiles at any specific location. The (potentially) expansive soils must also be mitigated to prevent damage.

CAUTION: Moderately Expansive Soils
CAUTION: Various Types of Undocumented Fill

8.0 GEOTECHNICAL RECOMMENDATIONS

The subject site has poor to moderate soils for support of the structure and asphalt areas. Below the manmade soil zones, the denser native gravels will provide good support. The following sections provide methods for proper site preparation, site grading (including cuts and fills), foundation support and related items.

8.1 SITE PREPARATION AND GRADING

The site has no structures, various layers of manmade fill and low vegetation. Therefore, major debris removal, clearing, grubbing, stripping for organic removal and subgrade soil preparation will apply.

CAUTION

8.1.1 Manmade Fill & Debris Considerations

The site has several manmade Fill layers of varying thickness generally over the entire site. The fill generally consists of various soils, crushed rock, pea gravel, silty clay and silty Sand and Gravels. We observed minor waste materials and some organics within the fill. Therefore, these old fill materials do not need to be wasted off site, but could be used for general fill on the site (but not below structures) for Structural Fill.

All undocumented manmade fill must be removed from beneath structures, and or redensified and prepared as described later in this report.

8.1.2 Clearing, Grubbing and Stripping

All areas proposed for the structure, access roads, parking areas, sidewalks or structural fill and redensification beneath these items shall have all exposed large debris removed and be cleared and grubbed of all trees, stumps, brush and other debris and/or deleterious materials. The site shall then be stripped and cleared of all vegetation, sod and organic topsoil. It appears that *a stripping depth of from 2 to 4 inches* will be required in most areas. The stripped materials and loose waste fill soils removed shall be hauled from the site or stockpiled for use in landscape areas only (such as landscape mounds). This material shall not be used in structural fill or trench backfill or in the redensified surface layer.

Holes or depressions resulting from the removal of underground obstructions that extend below the finish subgrade and will be beneath structures, walkways, parking or roadways (including the test pits) shall be cleared of all loose material and dished to provide access for compaction equipment. These areas shall then be backfilled and compacted to grade with structural fill, as described later in this report.

It is recommended that grubbing and stripping of the site, old fill removal, decision for reuse of old fill and backfill and compaction of depressions below finish subgrade, be observed and/or decided by the geotechnical engineer or his representative from The Galli Group.

When all visible organics, old fill and debris have been removed the exposed subgrade will consist of various materials. The entire surface must be reconditioned to 2% to 3% above optimum moisture and compacted to between 93% and 95% of the maximum dry density. This moisture content being above optimum is important to ensuring that these clayey soils are in a fully swelled condition. **NOTE:** This may be altered in later sections of the report for asphalt areas and building areas.

CAUTION

Any exposed expansive soils subgrades must be kept moist and in a fully swelled condition until covered by concrete or asphalt. This will usually require periodic sprinkling or wetting OR covering with plastic sheeting after wetting. Even rock covered

areas over the expansive clay soils require periodic sprinkling to keep the underlying clays fully swelled.

8.1.3 Subgrade Proofrolling

The exposed subgrade throughout the site, and each successive lift of structural fill, shall be proofrolled under the observation of a representative from The Galli Group. The proofrolling may be accomplished with an empty to loaded dump truck, loaded water truck or large heavy roller with no vibration (to be determined by our representative). Proofrolling shall be discontinued if it appears the operation is pumping moisture up to the surface or otherwise disturbing the in-place soils. *When proofrolling, the tires of a loaded truck shall not deflect the soil subgrade more than ⅜ inch. Rock fill should deflect no more than ¼ inch.* **NOTE:** Proofrolling will take place on the exposed subgrade and on successive lifts of Structural Fill.

Where subgrade soils are disturbed or do not demonstrate a firm, unyielding condition when proofrolled, the soil shall be removed, aerated and replaced, or replaced with imported granular fill. The imported fill material shall be compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM Test Method D-698 (Standard Proctor). All soft and/or unstable areas shall be over-excavated and backfilled with granular structural fill.

We recommend our representative observe proofrolling of the excavated subgrade after excavations are complete and prior to placement of structural fill. *After completion of overexcavation and then proofrolling, the contractor must take care to protect the subgrade from disturbance due to construction equipment, especially during very wet weather, and also from it drying out.*

8.2 SITE EXCAVATIONS

During the construction of the project, we anticipate excavations will be required for construction of utility lines, foundations and roadway grades within the project. The utility excavations will encounter the expansive clay soils and possibly the weathered Siltstone.

CAUTION

Excavations. Excavators of moderate size and larger should have no difficulty in excavating trenches to 4 to 5 feet depth, if required. The various mix of soils will likely ravel and experience side wall collapse in trenches. Deep trenches will require some form of shoring or may widen due to potential large-scale sloughing of the walls. *Do not pile trench spoils close to the trenches. This will likely cause added wall collapse.*

Temporary Cut Slopes. During dry weather, temporary cut slopes in the soils may be cut at 1H:1V or flatter for cuts up to 6 feet. During wet weather, the contractor must be prepared to flatten temporary cut slopes in the soils to 1¼H :1V or flatter. We would not expect any cut slopes greater than 6 feet tall on this project.

Permanent Cut Slopes. Some areas may require a permanent cut slope for overall grade development. These will have to be flatter than the temporary cut slopes in order to remain stable under long-term weather conditions. The following are recommended cut slope inclinations for the various soil types.

Expansive Clay Soils	3H:1V
Mixed Fill	2H:1V
Angular Shale	1½H:1V

Please note, that while we have commented on the anticipated stability of the soil in trenches and cuts, we are not responsible for job site safety. The contractor is at all times responsible for job site safety, including excavation safety. We recommend all local, state and federal safety regulations be adhered to.

8.3 STRUCTURAL FILL PLACEMENT AND COMPACTION

8.3.1 Beneath Structures and Roadways

Structural fill is defined as any fill placed and compacted to specified densities and used in areas that will be under roadways, structures, driveways, sidewalks and other load-bearing areas or that will create fill slopes. It appears that the roadways, building pads, parking areas, exterior slabs and sidewalks could have structural fill below them. The subgrade needs to be prepared properly and the fill must be placed and compacted correctly for proper long-term performance.

Structural Fill Materials. Ideally, and particularly for wet weather construction, structural fill should consist of a free-draining granular material (non-expansive) with a maximum particle size of six inches. The material shall be reasonably well-graded with less than 5 percent fines (silt and clay size passing the No. 200 mesh sieve). During dry weather, any organic-free, non-expansive, compactable granular material, meeting the maximum size criteria, is typically acceptable for this purpose. Locally available crushed rock and clean, jaw-run crushed "shale" (low-grade rock) have performed adequately for most applications of structural fill. See Section 8.11 for various Structural Fill Specifications. The on-site old fill with small amounts of clay soils may be used as structural fill beneath asphalt and exterior concrete areas (not beneath structures). The on-site expansive clay is not recommended beneath structures, but acceptable under asphalt areas.

Imported Structural Fill for beneath structures shall meet the requirements of Aggregate Base Rock (AB) or Aggregate Subbase Rock (ASB) as specified in section 8.11. During dry weather only, it may consist of Embankment Fill which is any angular rock, sand and silt combination with specifications as listed in Section 8.11.

Note: Section 8.11 provides various options for Structural Fill. Some will be difficult to nearly impossible to compact during wet weather. *The contractor must select the type of structural fill that will be able to be placed and compacted during the weather conditions that can take place during the construction schedule.*

Structural Fill Placement. All structural fill shall be placed in horizontal lifts not exceeding 8 inches loose thickness (less, if necessary to obtain proper compaction) for heavy compaction equipment and four inches for light and hand-operated equipment. Each lift shall be compacted to a minimum of 98 percent of the maximum dry density, as determined by ASTM Test Method D-698 (Standard Proctor).

Beneath Footings. Structural fill placed beneath footings or other structural elements must extend beyond all sides of such elements a distance equal to at least one half of the total depth of the structural fill beneath the structural element in question for vertical support (i.e. for 2 feet of structural fill beneath footings, extend the fill at least 1 foot past all edges of the footing). This is for imported angular crushed rock fill. It must extend one (1) times the depth of fill beyond all edges when consisting of rounded gravels or silty sandy, cobbly soil.

To facilitate the earthwork and compaction process, the earthwork contractor shall place and compact fill materials at or slightly above their optimum moisture content. If fill soils are too high on the wet side of optimum, they can be dried by continuous windrowing and aeration or by intermixing lime or Portland Cement to absorb excess moisture and improve soil properties. If soils become dry during the summer months, a water truck should be available to help keep the moisture content at or near optimum during compaction operations.

Fill Placement Observation and Testing Methods. The required construction monitoring of the structural fill utilizing standard nuclear density gauge testing and standard laboratory compaction curves (ASTM D-698 specified) is applicable to materials 2-inch size and smaller. Larger (2½" or above) jaw-run "shale", crushed rock and the native cobbles and gravels do not yield consistent results with this type of testing. The high percentage of rock particles greater than ¾'s of an inch in these materials causes laboratory and field density test results to be erratic and does not provide an adequate representation of the density achieved. Therefore, construction specifications for this type of material typically specify method of placement and compaction coupled with visual observation during the placement and compaction operations and proofrolling of lifts, instead of nuclear density testing.

Observation of Fill Placement. For these larger rock materials (including the onsite soils), we recommend the 8-inch lifts (after being "worked in" with a dozer) be compacted by a minimum of 3 passes with a heavy vibratory roller. One "pass" is defined as the roller moving across an area once in both directions. The placement and compaction should be observed by our representative. After compaction, as specified above, is completed the entire area shall be proofrolled with a loaded dump truck to verify density has been achieved. *All areas which exhibit movement or compression of the rock material more than 1/4 inch, under proofrolling, shall be reworked or removed and replaced as specified above (3/8 inch for the native materials).*

Nuclear Density Testing of Fill. Field density testing by nuclear density gage would be adequate for verifying compaction of 2-inch to ¾-inch minus crushed base rock or shale. Therefore, typical % compaction specifications would suffice. Testing shall be accomplished in a systematic manner on all lifts as they are placed. Testing only the upper lifts is not adequate.

8.3.2 Non-Structural Fill

Any waste soil, organic strippings or other deleterious soil would be considered non-structural fill. These materials may make reasonable landscape soils and lawn topsoil material. This material may be placed in landscape areas and waste soil areas such as berms with slopes at 3.5H:1.0V or flatter. It shall not be placed under structures, sidewalks, roadways, parking areas or as part of a structural fill slope. It is recommended that when these soils are used, they be given a moderate level of compaction (90 to 92 percent) to help seal them from surface water.

8.4 UTILITY LINE RECOMMENDATIONS

Below we have provided general recommendations for utility construction for the project. Recommendations are based upon observations from our field investigation and experience on other projects with similar subsurface conditions.

CAUTION

Trench Excavation. Trenches will be required across the site for utility installation of various kinds. As discussed earlier, all soils encountered should be able to be excavated with moderate size excavators. Trench excavation should be moderately easy in all areas of the site. *Sideslopes of trenches will likely have sloughing and rock fall.* Therefore, trench boxes or wide trenches could be required.

Trench Backfill and Compaction. The new utility lines will require trench backfill and compaction along the entire alignment. The pipes need to be adequately supported and the trenches need to be backfilled and compacted properly to prevent subsidence of the surface or damage to utility lines or the potential overlying pavement section.

In our experience, utility trench backfill has been the source of the majority of post-construction fill settlement problems in paved areas. They are also areas which cause early pavement failure due to inadequate subgrade support.

Pipe Bedding. The bottom of the trench must be shaped out of acceptable bedding materials (refer to manufacturer's recommendations) to fit the pipe base prior to placement of the pipe. It is critical to the long-term performance of the pipe that the bottom and haunches be fully supported by a dense bedding which decreases pipe distortion from load. Finer crushed rock materials (such as ¾-inch minus crushed rock) usually provide the best bedding material.

Pipe bedding should be compacted to 95% of ASTM D-698 (Standard Proctor) or to that which is specified by the pipeline designer. Cement-treated pea-gravel or sand/cement slurry (with at least 200 pounds of cement per cubic yard) will solidify and would typically not require compaction after placement and also makes good bedding material. Care must be taken to make sure the pipe does not "float" up in the fluid mix prior to it "setting".

Pipe Zone Material. All of the lines shall be backfilled around and to approximately 12-inches (more, if required by manufacturer) above the pipe with an acceptable "pipe zone" material. This may consist of finer crushed rock, cement-treated pea gravel, sand/cement slurry, coarse sand with fine gravel, or other material acceptable to the client and pipeline designers. The pipe zone material shall be well compacted on each side of the pipe, and to at least 12 inches above the pipe. Mechanical means will typically be required to densify these materials to the required densities (unless a cement-treated material is used).

Density requirements for "pipe zone" backfill shall be per the manufacturer's specifications for the type of pipe being used (we recommend using 95% to 97% of ASTM D-698). Care must be taken when compacting close to and immediately above the pipe so as to not damage the pipe.

General Trench Backfill. Above the "pipe zone" the backfill materials would typically consist of any compactable material that does not have excessive voids (such as gap-graded large gravels and cobbles), organics, expansive clay, debris or other deleterious material. Crushed rock, clean jaw-run shale and sand and gravel works well for general trench backfill.

Where laterals of any kind, or valuing, extend upward from the lines, we recommend the trench areas adjacent to these items be backfilled with the "pipe zone" backfill materials. This will prevent the larger pieces of other backfill materials from damaging the valves and/or other equipment.

We strongly recommend that all general trench backfill be placed and compacted in the same manner as for general structural fill. Trench backfill beneath asphalt pavements but not under structures should be compacted to at least 98 percent of the maximum dry density, as determined by ASTM Test Method D-698 (Standard Proctor) for the upper 36 inches. Below 36 inches the trench backfill should be compacted to between 95 and 98 percent of the maximum dry density. Trench backfill in landscape areas, that are not part of a cut or fill slope, may be compacted to at least 93 percent of the maximum dry density.

CAUTION

8.5 SITE DEVELOPMENT

Due to the various layers of fill that tend to be 3 to 6 feet or deeper across the site, it is not practical to remove and replace all undocumented fill beneath all developed areas of

the site. Therefore, it appears that recompaction of various depths of old fill should be adequate for support of site development except for structures.

Various areas of the site development shall be supported as listed below.

Asphaltic Concrete Access and Parking.
These areas shall have 3 feet of old fill materials removed and reused as redensified fill. The exposed subgrade must be redensified to at least 94% to 95% of ASTM D 698. Then replace the removed materials as compacted fill in 8-inch lifts compacted to 95% of ASTM D 698. This overexcavation and replacement shall extend 3 feet beyond the edges of all AC areas.

Exterior Concrete Patios and Walkways.
For items that will be rigid and have reinforcing, the redensified fill shall be 2 feet deep. As above, redensify the exposed subgrade and replace the removed material in 8-inch lifts as redensified fill to 95% of ASTM D 698. Extend at least 18 inches past the edges of the concrete.

General Landscape Areas.
For these areas remove and replace as structural fill at least 12 inches of the existing fill, after redensifying the exposed subgrade.

With the old fill materials redensified as described above, it will provide reasonable long-term support for the various described site improvements, when constructed as described later in this report.

8.6 BUILDING SUPPORT RECOMMENDATIONS

The following sections provide additional information for both footing and floor slab support. The structure footings, retaining wall footings and slab-on-grade floor areas must be supported on a stable subgrade. This will be created by construction of building pads and footing support as described below.

8.6.1 Building Pad Construction

The entire building area, including the slab and footings, to at least 4 feet outside edges of all footings, must have the building pad area excavated down to the bottom of the manmade fill or to 5 feet below the surface, whichever is shallower.

The exposed subgrade must be redensified to at least 94% to 95% of ASTM D 698. Cover the redensified subgrade with a woven support fabric (ACF 180 or equivalent). Then the overexcavated area shall be backfilled with approved structural fill, in 8-inch lifts compacted to at least 95% of ASTM D 698 (first 2 lifts) and then 98% of ASTM D 698 to the top of the fill. **Note:** the structural fill used beneath structures as described above may use some of the on-site old fill, that has been approved by our representative.

This would be the material with a high percent of crushed rock and gravels and minimum clay and organics.

NOTE: For structures such as equipment storage sheds where some settlements will not create structural or cosmetic issues, the soil removal and redensification may be accomplished the same as for Asphaltic Concrete areas described above (3 feet deep).

8.6.2 Foundation Recommendations

Footings over Crushed Rock

Foundations shall have a minimum of 24 inches of crushed rock structural fill placed over the redensified exposed subgrade within the areas where 5 feet of material has been redensified (or fill was removed down to undisturbed native soil). Design and construct foundations as described below.

1. Excavate into building pad to subgrade for 24 inches of structural fill.
2. Redensify the exposed subgrade.
3. If fabric beneath building pad is damaged, cover base of redensified area with woven support fabric (ACF 180 or equivalent).
4. Place and compact crushed rock or clean jaw run shale in 8” to 10” lifts to at least 98% of ASTM D 698 maximum dry density.
5. Footings placed on subgrades prepared as described above may be designed for a bearing pressure of 2,000 psf.
6. Design may include a 1/3 increase in bearing pressure for infrequent transitory live loads.
7. The base of all footings shall be at least 16 inches below the finish grade for lateral resistance and frost protection.
8. Minimum widths of footings are 18 inches for strip footings and 30 inches for isolated spread footings.

Settlement. We anticipate total and differential settlement for footings designed and constructed as described above to be up to 1 inch and 3/4 inch, respectfully. If these settlements are unacceptable, the structure shall be supported on small diameter steel pipe piles as described below.

Pile Supported Structure

For structures that must not undergo moderate total and differential settlement (i.e., office structure) support on pile foundations is recommended. These may consist of driven, small diameter (3” and 4”) steel pipe piles. These have been found to provide very good support over sites with variable fill depths at reasonable cost. These shall be designed and constructed as listed below.

Pipe Pile Design

- Driven 3" or 4” diameter galvanized steel pipe piles.
- Standard wall thickness (Sch 40; 0.237" wall thickness).
- Drive closed ended; anticipated depth is 15 to 20 feet.

- Utilize vibratory driver sized for 3" or 4" pipe (1100-pound class).
- Final set criteria; drive until less than 1 inch of advancement in 10 seconds or more of continuous driving.
- Pile Top; new construction cap of ½"x6"x6" steel plate for each pile (or per Structural Engineer).
- Use sleeved friction couplers; piles are for vertical compression load only (no Uplift Load Capacity).
- Pile capacity is 12 kips (3" pile) and 20 kips (4" pile) with Factor of Safety of 2.0; pile load tests (3) shall be accomplished at time of production driving; this is strongly recommended.
- Typical Spacing; 5 to 6 feet along strip footings; depending upon the loads above.
- Multiple piles beneath larger spread footings depending upon the load and stability needed.
- Advantage of rapid installation; 30+ per day.
- Low installation costs ($25/foot of pile).

Embed top of pile with 6" x 6" reaction plate at distance up into footing or grade beam as recommended by project structural engineer (usually 6" to 8" depending upon footing/grade beam thickness).

Note: Number and location of these small diameter piles will be determined by the structural engineer based on loads and design pile capacity. We should review the final pile layout prior to construction bidding.

CAUTION
Note: If piles are used to support the footings then fill soils that raise site grades above the existing ground surface must be placed over redensified soils. Such added fill (above existing) grades beneath or adjacent to the structure will likely cause consolidation of the underlying soils that have not been redensified. This will result in settlement of the slabs, while the foundations will not settle, resulting in differential settlement between footings and slabs. Recommendations for floor support will be provided in a later section of the report.

Foundation Drains. We recommend all footings be installed with a footing drain to intercept groundwater seepage. Footing drains consisting of a rigid, smooth-wall perforated pipe surrounded by drain rock (one side and above), all wrapped in a non-woven geotextile fabric and should be placed adjacent to the footings. This is addressed more fully later in this report (Section 8.9). These drains may be placed over the top of the spread footings as long as this at least is 24 inches below finish floor (slab-on-grade).

8.6.3 Column Support of Equipment Shed

It appears this site development could include a post supported roof over an equipment storage/parking area with Asphaltic Concrete surfacing. These types of structures are not enclosed on the sides. They are supported only on large posts. Such posts may be supported on spread footings as discussed in an earlier section. They also may be

supported on posts embedded in concrete drilled piers. For posts embedded into drilled piers, the design recommendations are as follows.

1. Drill the piers into dense native soil and to minimum depth of 8 feet.
2. Pier diameters of 18" and 24" (or larger) are recommended.
3. Vertical bearing load capacity of the piers is as follows (includes FS=3.0).

Pier Diameter (Inches)	Capacity (Kips)
18	8
24	15
30	24

Overturning and lateral resistance may be computed using the passive equivalent fluid pressures given in Section 8.8 of this report. A soil arching multiplier of 1.35 may be used. Ignore function capacity due to presence of Manmade Fill.

8.7 INTERIOR FLOOR SLABS

Floor Support will require a minimum of 12 inches of compacted crushed rock below the floor drainage layer.

Slab Support Section. The following recommendations are provided for slabs constructed on at least 12 inches of compacted rock structural fill.

1. Prepare building pad as specified in section 8.6.1 above.
2. Cover the exposed subgrade with at least 12" of ¾" minus crushed rock Structural Fill (this may be part of the Building Pad Structural Fill).
3. Place a 4" to 6" layer of clean ¼" to ¾" crushed drainage rock over the rock in 2 above. This must be thickened to 10 inches in basement levels or embedded areas of the structures (where this drainage layer will be below exterior grades).
4. Install floor subdrains as shown on Figure 6.
5. Place a tough impermeable membrane, such as Stego Industries 15-mil Stego vapor barrier (or an equivalent product) over the crushed rock drainage layer to further retard upward migration of moisture vapor into and through the concrete slab. Seal all seams well with manufacturers recommended method.

The subgrade preparation beneath interior slabs shall be accomplished as described earlier in this report to create the structural fill Building Pad (section 8.6.1).

Note: The slab drainage layer and subdrains can be reviewed (may be removed) by the Geotechnical Engineer once finish floor elevation and site elevations are known.

8.8 LATERAL LOAD RESISTANCE

Lateral loads exerted upon these structures can be resisted by passive pressure acting on buried portions of the foundations, retaining walls and other buried structures and by friction between the bottom of structural elements of the wall and slabs and the underlying soil.

We recommend the use of passive equivalent fluid pressures of the following values for portions of the structure and foundations embedded into the native soils.

- Native Soil; silty Clay (ignore upper 18") 250 pcf; FS=1.0
- Native Soil; Silty Sandy Gravels 350 pcf; FS=1.0
- Old Fill 250 pcf; FS=1.0
- Dense Compacted Crushed Rock (5' wide minimum) 450 pcf; FS=1.0

A coefficient of friction of 0.55 can be used for elements poured neat against crushed rock structural fill. These shall be reduced to 0.20 for areas over a vapor barrier, 0.40 over native silty, sandy gravelly soils and 0.30 over clayey soils.

8.9 FOUNDATION, FLOOR AND WALL DRAINS

All exterior foundations and embedded structures should have proper drainage.

Footing Drains. Foundation drainage shall consist of a rigid smooth wall perforated pipe surrounded by at least 8 inches of drain rock on top and one side, all wrapped in a non-woven geotextile designed as a filter fabric (such as Mirafi 140N or equivalent). We recommend the fabric be covered with a two to three-inch layer of sand to protect it against damage during backfilling operations and potential long-term plugging from soil fines. The perforated pipe shall be located on the footing next to the stem wall (or beside the footing), provided this is at least 12 inches below underslab drain rock. Please see Figures 3 and 4. See Section 8.12 for drain rock, pipe and filter fabric specifications.

Floor Drains. Where the drain rock layer below slabs will be lower than the adjacent exterior grades, water will tend to accumulate in this low area. To drain this, include a series of subdrains at the bottom of the drain rock layer beneath the slab. The subdrain lines typically consist of 3-inch diameter, smooth interior, solid wall, perforated pipe at spacing of 10 feet (or less) across the structure (and around the interior perimeter). The perforated pipe is placed in a deepened zone of the drain layer as shown on Figure 5 with perforations down. The pipes are sloped to drain and collected by a tightline which leads to the stormwater disposal system. We recommend we be allowed to review the subdrain system design prior to final plan submittal or construction bidding.

Wall Drains. Wall drains shall also have a minimum 12-inch wide drainage zone of drain rock wrapped in non-woven filter fabric immediately behind the wall extending up from the drainage section to within 12 inches of the surface. A preformed, fabric-wrapped, polymer sheet drain, such as Amerdrain, Linq Drain, Enkamat or other must be placed against the wall. Exterior wall drains, which will not be sealed on top by asphalt

or concrete, should have the upper 12 inches backfilled with compacted onsite silt soils to minimize intrusion of surface waters into the wall drain system. Please see Figure 6.

Walls that should not pass water vapor must be fully sealed (with a bitumen-based sealer that will not harden or crack) before the sheet drain is attached. Wall seal such as MasterBlend HLM5000 or equivalent, should be used and applied per the manufacturer's recommendations. Multiple coats are recommended for best results.

All drains should be tightlined and positively sloped to an approved stormwater disposal location in the public storm drain system. **Note:** In no case shall water be collected and/or directed or discharged close to the foundations. Such improper water discharge can cause added water related problems.

We strongly recommend against connecting roof drains or surface area drains to foundation floor or wall drains. Foundation drains should consist of rigid smooth-wall perforated pipe (see section 8.12). The rigid smooth-wall pipe can be cleaned out by means of a "roto-rooter" type system should it become plugged with sediment or fine roots. We recommend cleanouts be placed periodically by the designer to facilitate cleaning and maintenance of the drains.

8.10 EXTERIOR CONCRETE FLATWORK DESIGN

Light duty reinforced concrete will likely be utilized for walkways, patios, access ramps, HVAC pads and Dumpster Pad. Heavy duty concrete slab areas could be Entrance Drive Lanes. These are NOT intended for heavy truck traffic. The subgrade shall be prepared as listed in section 8.5 of this report.

Heavy Duty Concrete.
6" Portland Cement Concrete (3,500 psi mix)
10" Aggregated Base (3/4" or 1" Minus Crushed Rock)
Redensified Subgrade Per Section 8.5.

Standard Duty Concrete.
4" Portland Cement Concrete (3,500 psi mix)
6" Aggregate Base (3/4" or 1" minus Crushed Rock)
Redensified Subgrade Per Section 8.1 and 8.5.

Note: These concrete section designs assume the subgrade is properly prepared as per section 8.5.

Note: Where expansive clays will make up the subgrade at least 12 inches of compacted ¾" minus crushed rock or sandy decomposed granite should be used to help buffer the clay impacts. Rebar should also be continuous across all joints and dissimilar pours to help prevent vertical offsets due to the expansive clay.

The following items are suggested as part of the concrete design and construction.

Aggregate Base: Extend beyond edges of concrete at least 12 inches.

Reinforcing: No. 4's @ 16" O.C. each way (No. 3's for 4" slab); Include continuous edge bars at 3" to 4" from all edges. Reinforcing to be continuous across all different pours or joints. Overlap all bars at least 18 inches. At all corners use hooks 24" each way (minimum 18" overlap). **NOTE:** Due to the presence of moderately expansive soils and multiple types of manmade fill, we recommend the deformed reinforcing bars be continuous across all construction joints and across joints between dissimilar pours. To better concentrate drying shrinkage cracks in the joints or saw cuts, 50% of the rebar may be cut at the joints.

Concrete: 3,500 psi 28-day strength mix; 6% ± 2% entrained air; water/cement ratio below 0.5 and do not add extra water at site; place at 4" slump or use admixtures to keep same water/cement ratio for higher slump. Do not use steel trowel on surface until all bleed water has surfaced. This can trap bleed moisture below the finish and lead to freeze-thaw damage. Should have moderately rough broom finish for skid resistance.

Surface Jointing: Surface jointing at 8 to 10 feet on center each way will help decrease cracking in the "field". If saw cutting is used it must be done as soon as the surface will support the work to make sure cracks do not develop within the concrete mass prior to the surface cutting. *This must be done the same day as the concrete pour.*

Note: *All details for concrete work shall be reviewed by the project structural engineer.*

8.11 ASPHALTIC PAVEMENTS

It is our understanding that the access entrance auto parking and heavy equipment parking will likely consist of Hot Mix Asphaltic Concrete (HMAC) paved surface. The following sections provide recommendations for asphaltic concrete section design and construction.

8.11.1 Pavement Subgrade & Traffic Loading

The subject site is underlain by various types of fill and some expansive clay soils. The subgrade must be prepared as described in Section 8.5. This will result in at least 36" of redensified fill for the subgrade. These materials will provide moderate support for the asphaltic concrete paving.

Standard design methods where expansive clays make up the subgrade dictate that an R-Value = 3 be used in design of the AC section. For this site, given the mixture of fill material, we have used an R-Value of 10 for design.

The following asphalt sections were designed utilizing a Crushed Rock Equivalent (CRE) method. Sufficient thickness of asphaltic concrete and rock materials are used to provide

the computed crushed rock equivalent needed to protect the subgrade soils and successive rock layers from anticipated traffic loads.

We anticipate the traffic loading to consist of autos, pick-ups, heavy delivery trucks, occasional trash trucks and repeated heavy maintenance equipment. Only medium heavy (3 axle or 4 axle) truck traffic is anticipated for these accessways on the site. In our professional opinion, based on traffic data for similar projects, the following portions of the project should use the Traffic Indice (TI) as listed. The TI values are based on the anticipated traffic numbers, axle loads from trucks and for a 15 to 20-year life.

Project Area		**Traffic Index (TI)**
Heavy Duty	Entrance Road Access Roads & Equipment Parking	7.3
Standard Duty	Auto Only Lanes	5.5
Light Duty	Auto Parking Stalls	4.5

The successful performance of pavement structures is a function of subgrade material properties, traffic conditions, drainage conditions, the pavement material properties and design, careful construction, and ongoing maintenance.

8.11.2 Asphaltic Concrete Pavement Design

We have designed the pavement sections using the Traffic Indices (TI) listed above. Based on these TI's and R-values of 10, 50 and 80, (subgrade soil, 4" minus or low-grade crushed rock subbase and ¾" or 1" minus crushed rock must all meet Specifications in Section 8.12). We have computed asphalt design sections (utilizing the Crushed Rock Equivalent Method) with the following results.

Heavy Duty Pavement (TI = 7.3)

4" AC
6" AB (3/4" or 1" minus Crushed Rock)
14" ASB (3" or 4" minus Crushed Rock)
Woven Geotextile Support Fabric (ACF 180 or Equivalent)
Subgrade Per Section 8.5.

Standard Duty Pavements (TI = 5.5)

3" AC
4" AB (3/4" or 1" minus Crushed Rock)
12" ASB (3" or 4" minus Crushed Rock)
Woven Geotextile Support Fabric (ACF 180 or Equivalent)
Subgrade Per Section 8.5.

Light Duty Pavements (TI = 4.5)

3" AC
4" AB (3/4" or 1" minus Crushed Rock)
8" ASB (3" or 4" minus Crushed Rock)
Woven Geotextile Support Fabric (ACF 180 or Equivalent)
Subgrade Per Section 8.5.

8.11.3 General Recommendations

Subgrade Preparation. This shall be accomplished in accordance with the specifics of section 8.5.

CAUTION

Note: As discussed earlier, where the expansive clay soils will remain as portions of the subgrade, care must be taken to ensure they remain in a *moist and fully swelled condition*. This is critical to all areas of the site. *Covering over dried out expansive clay soils will likely result in swell/heave issues when these re-swell during the wet winter months.*

Soft or loose materials disturbed during the site preparation process, incapable of achieving the compaction criteria shall be removed to appropriate bearing materials prior to replacing with structural fill. Where loose or softened subgrade areas are identified, the area shall be over-excavated and replaced with imported granular fill with less than 7 percent (5% during wet weather) passing the number 200 sieve. See section 8.12 for specifications.

It should be noted that in no case shall construction trucks be allowed to "run" directly on top of the subgrade soils until they are covered with rock. This could result in the disturbance of the subgrade soils due to the heavily loaded vehicles (which would result in additional over-excavation to remove softened soils). We recommend covering the subgrade soils with at least 12 inches of crushed rock or "shale" ASB over the woven fabric prior to light construction truck traffic traversing the area. Therefore, construction traffic must be carefully coordinated in order to minimize disturbance to the underlying fine-grained soils.

Note: *The contractor must provide the total depth of ASB required to support the construction traffic in order to protect the subgrade during the construction process during all manner of weather during the building construction.*

Wet Weather Construction. We recommend that for construction during wet weather, in all construction roads and drive lanes, the subgrade shall be covered with a woven geotextile support fabric (ACF 200 or equivalent) and a minimum of 16 inches of imported granular 4-inch minus crushed rock (ASB). Compaction of the fill shall not begin until a minimum of 12 inches of rock is placed above the fabric. Compact carefully so as not to disturb the subgrade. This should provide an adequate working surface and help protect the subgrade from damage from construction traffic.

Construction traffic must not be allowed to traverse the area until the minimum of 16 inches of compacted material has been placed and compacted over the support fabric. **Note:** It may be necessary, in order to protect the subgrade soils, for construction "haul roads" to be established to the ends of each parking lot area. This would consist of the woven fabric covered with at least 20 inches of subbase or base rock. When the rock placement moves across the site the extra thickness of the haul road rock may be graded out to help fill the areas adjacent to the haul road. In this way the subgrade is protected and no additional crushed rock is required.

Note: *It is the contractor's responsibility to protect the subgrade from the truck traffic during all weather until the project has been completed.*

Geotextile Fabric Placement. When the subgrade soils have been properly prepared, many areas must be covered with the woven geotextile support fabric. We recommend a fabric such as ACF 180 or equivalent. The fabric shall be laid longitudinally with the drive lanes. All ends and edges shall be overlapped a minimum of 5 and 2 feet, respectively. Fabric layout shall be such that it "runs" aligned with the lane traffic directions. **Note:** If construction will be accomplished in the winter months, this fabric must be upgraded to one with a weight of at least 5 oz./yd.^{2}. See Section 8.12 for Geotextile Fabric recommendations.

Care must be taken to not damage the fabric. In no case shall track vehicles be allowed on the fabric. At least 8 inches of rock (12 inches during wet weather) shall be over the fabric prior to allowing truck traffic in the area. Then the traffic must be light to protect the subgrade. Be careful not to disturb the subgrade when compacting the rock.

Materials. All materials used and construction techniques applied at the site must result in conditions as assumed for design of the pavement sections. We recommend materials used in the pavement support sections be as listed in section 8.12.

We recommend avoiding the use of soft rock or subrounded and/or sandy gravel materials for the aggregate base, since they typically do not perform well in supporting asphaltic pavement sections (i.e., usually do not meet CBR requirements or project specification provided in section 8.12).

Installation of utilities and other site work, which may compromise the integrity of the support fabric, completed base rock section or redensified subgrade should be avoided when possible. Therefore, utilities which must cross through these areas should be placed and backfilled before fabric and base rock are placed. If these have trenches excavated through completed sections then they must be repaired with the fabric overlap and compaction of fill in lifts.

We recommend that the finished subgrade and subbase be viewed and proofrolled and that base rock be tested for density and stability by a representative of The Galli Group prior to placement of asphalt at the site.

Drainage. This site will likely have areas adjacent to it that will direct surface flow beneath asphalt areas. Adequate provision should be made to direct surface water away from the pavement section and subgrade where possible. Ponded water adjacent to the asphalt areas can saturate the subgrade resulting in loss of support. Therefore, we recommend the areas along the edge of the asphalt be well drained. All paved areas should be sloped and drainage gradients maintained to carry surface water to catch basins or ditches for transmission off the roadways and parking areas. Excessive landscape watering can also saturate the subgrade and decrease pavement life. Deep curbs, drip irrigation and/or use of dry-land plants will mitigate these affects. **Note:** Water entering into the base and subbase upslope on the project can likely emerge through AC to concrete seams lower on the project. Subdrains along the upslope edges could be used to reduce potential water intrusion.

Maintenance. Pavement life can be extended by providing proper maintenance and overlays as needed. Cracks in the pavement should be filled to prevent intrusion of surface water into the subbase. Asphalt pavements typically require seal coats or overlays after 10 to 12 years to maintain structural performance and aesthetic appearance.

8.12 MATERIALS SPECIFICATIONS

The following materials specifications shall apply to the materials used on this project.

Note: All such materials to be used on the project must be submitted for compliance testing or review, at least two weeks prior to use at the site.

Aggregate Base Rock (Acceptable for Structural Fill)

- Angular Crushed Rock (¾ or 1" Minus); R=85 or greater; Well Graded (No Gaps and at least 60% retained on the No. 4 sieve).
- Exceeds the fracture, durability and sand equivalent requirements outlined in Section 00641 of the Oregon Standard Specifications for Construction.
- Maximum passing the No. 200 sieve ≤ 5% Total; ≤ 2% Clay Size.
- Compacted to 98% of the maximum dry density as determined by ASTM D698 or AASHTO T-99.

Aggregate Subbase Rock (Acceptable for Structural Fill)

- Angular Clean Crushed (jaw run) hard "Shale" (4" Minus Jaw-Run) or Crushed Rock (2" to 4" Minus); R=50 or greater; Angular and Reasonably Well Graded.
- At Least 60% retained on the No. 4 Sieve.
- Exceeds the fracture, durability and sand equivalent requirements outlined in Section 00641 of the Oregon Standard Specifications for Construction.
- Maximum passing the No. 200 sieve ≤ 10% Total; ≤ 3% Clay Size.
- During wet weather; passing No. 200 sieve ≤ 5%; 3% Clay Size.

- Compacted to 95% of the maximum dry density as determined by ASTM D698 or AASHTO T-99; initial lift may not attain 95% due to soft subgrade; Engineer to decide in the field.
- Care must be taken to avoid very silty subbase that will not support construction loads, especially when wet (will not meet specifications).

Embankment Fill (Acceptable for Structural Fill During Dry Weather)

- Reasonably well graded (not open work); Soil Rock Mixture
- Has at least 60% retained on the No. 4 sieve.
- Has no more than 20% passing No. 200 sieve.
- Passing No. 200 sieve must have less than 10% clay size.

On-Site Soil Fill (Acceptable Only as Specified in Report)

- Gravelly Silt.
- Crushed Rock Fill.
- Silty sandy Decomposed Granite Fill.
- Expansive Clay Soils.
- Place when weather allows proper compaction (some will not compact in wet weather).

Note: Some fill materials will be difficult to nearly impossible to compact during wet weather and others provide poor support. *The contractor must select the type of structural fill that will be able to be placed and compacted to specified conditions during the weather conditions that may take place during the construction schedule.*

Sand

- Clean washed sand or sand and gravel, less than 1% passing No. 200.
- Gravel to be rounded or subrounded (no fracture faces), 1" or less.
- Must have less than 30% gravel by weight.

Drain Rock (For drainage sections)

- Clean washed rounded or angular openwork drain rock.
- Gradation to be 1/4" and greater, sized to not move into and through perforations in the pipe.
- 1/4" to 3/4" clean crushed, 3/4" to 1" clean rounded rock and 1" to 2" clean angular rock are all acceptable.
- Clean means washed rock with NO coating of silt, clay or sand.

Note: All types may be used in all applications of drain rock that are not beneath Asphaltic Concrete paved areas. In all AC areas angular clean drain rock must be used for AC support.

Note: Drainage layer drain rock that is beneath the floor slab must be the angular clean crushed drain rock.

Geotextile Filter Fabric

- Non-woven geotextile filter fabric for wrapping drainage sections and separation of openwork rock from sands or soils fines.
- Meet specifications as per Mirafi 140N or equivalent.
- Overlap all edges at least 24 inches (12" for drainage section envelope).
- Secure in place such that overlaps will not move during covering operation.

Geotextile Support Fabric

- Woven geotextile support fabric designed for separation of crushed rock and subgrade soil and for rock section support.
- Meet specifications as per ACF180 woven support fabric.
- Must be at least 5oz/sq. yd. during wet weather.
- Overlap edges at least 2 feet and ends at least 5 feet.
- Align roll lengthwise with direction of traffic in all drive lanes.
- Pull tight full length and keep tight during placement of crushed rock above fabric.
- Do not drive on the fabric until it is covered with rock.

Perforated Pipe

- 3", 4" or 6" rigid wall, smooth interior perforated pipe.
- Secure all joints with solvent weld glue. DO NOT use only compression push together fittings.
- Slope to drain per specifications in report or on plan sheets.
- Align perforations in the downward direction.
- Must always be placed within filter fabric wrap unless specifically specified otherwise.
- Protect from construction traffic until buried at least 2 times pipe diameter (minimum 8 inches) of angular rock fill.

Wall Sheet Drain

- Polymer sheet drain with filter fabric attached 1 or 2 sides, designed for drainage of vertical embedded foundation or retaining walls.
- For walls up to 10 feet tall. Must meet specifications as for American Wick Drain's AMERDRAIN 200 or 220.
- Install and splice and patch per manufacturer's recommendations.
- Install with fabric side towards the backfill.
- Attach to wall per manufacturer's recommendations.
- Extend down wall all the way to bottom of drainage section around perforated pipe.
- Protect from damage when backfilling with crushed rock larger than 2-inch minus.
- Repair all damaged areas prior to final backfill.

Asphaltic Concrete

- Type 2 Dense Graded HMAC
- PG 64-22
- Compacted to between 91% and 95% of "Maximum Specific Gravity" for first courses; between 92% and 95% for wearing course.
- Must have densification completed while temperature is above 185 degrees F.
- Do not over densify as this will significantly decrease frost heave protection of internal air voids.
- The contractor must provide a HMAC design mix for review and approval.
- All aspects of the asphaltic paving shall be accomplished in accordance with applicable ODOT standards and recommendations.

Asphaltic Concrete Installation. Section 00745 of the 2008 edition (or newer) of the Oregon Standard Specifications for Construction shall be specified for all HMAC provided for this project. We recommend all aspects of the asphaltic paving be accomplished in accordance with applicable ODOT standards and recommendations. Alternately, the standard roadway asphaltic concrete mix used by the City of Medford and/or Jackson County should be acceptable.

These materials shall be used on this project as specified in this report and on project plans or specifications.

NOTE: DEVIATIONS FROM SPECIFIED MATERIALS MUST BE APPROVED IN WRITING BY THE GEOTECHNICAL ENGINEER, OWNER AND OWNER'S OTHER CONSULTANTS/DESIGN ENGINEERS PRIOR TO USE AT THE SITE.

CAUTION

8.13 SITE DRAINAGE

Some areas of the site are low and tend to collect runoff. These must be adequately drained.

The site shall be graded during construction such that surface water does not pond within building footprints or beneath pavement areas. Surface runoff shall be controlled during construction and with final site grading. All areas adjacent to the structures must be designed to have a permanent slope away from the foundations at an inclination of at least 6 inches in eight (8) feet. All surface water shall be channeled into landscape area drains or catch basins, or shall be conveyed around the structures and to detention ponds or storm drains. Where items such as landscape areas and walkways block the flow of surface water, small area drains should be installed to collect the surface runoff. Good site design accommodates all site runoff and conveys it away from the structures and off the site to an acceptable disposal location or to a detention pond, without undue erosion problems. This would include drainage of surface water along the upslope side of the project.

All roof downspouts must be connected to a sealed tightline system, which discharges to an acceptable disposal location. In no case shall these be connected to footing drains or subdrains beneath floors.

9.0 ON-SITE PERMEABILITY TESTING

During our site exploration, three (3) of the shallow borings were used to complete on-site falling head permeability tests. These were accomplished with the results as described below.

At all three locations the following procedure was followed:

1. Drilled each hole to approximately 2.75 and 3.75 feet deep. Cleaned up the holes to a uniform diameter and removed loose material out of the bottom.
2. Presoaked the holes by filling with water and allowing it to seep into the ground. Added water as needed to assure saturation.
3. Refill holes at start of test.
4. Measurements from the top of the hole down to the water surface were taken and recorded along with the time of each reading. Measurements were obtained at time intervals as the water level receded due to soil absorption.
5. The water level drop, elapsed time between readings, full depth of hole and hole diameter were utilized in a formula for falling head permeability tests. The average of multiple test intervals was used to compute the hydraulic conductivity (permeability) of the soil at each hole location.

Soil Conditions and Test Results. The soils encountered in the three borings were somewhat different due to the various fill types encountered. The soils generally consisted of gravelly, silty Clay soils.

Computed Hydraulic Conductivity results for the three test holes were as follows:

Hole No.	Diameter (in.)	Depth (ft.)	Depth to Free Water Prior to Test (ft.)	Hydraulic Conductivity in./sec.	Hydraulic Conductivity in./hr.
PH-1	8.0	3.75	N/A	2.82×10^{-6}	1.0×10^{-2}
PH-2	8.0	2.75	N/A	3.64×10^{-6}	1.3×10^{-2}
PH-3	8.0	3.68	N/A	9.52×10^{-5}	3.4×10^{-2}

In reviewing the data, we found the results to be somewhat consistent between the holes. The hydraulic conductivity was generally very low. Clayey and silty soils typically have low permeability and the soils on this site are no exception.

Saturation of the ground and particularly the upper soil zones can take place during very wet months, especially when snow melt is combined with heavy rainfall. This can limit the amount of water that will move into the soil. Because our testing was accomplished

during this wet season, the hydraulic conductivity values likely reflect reasonably wet site conditions. However, permeability can still be expected to be low, even in the summer season.

Design Values. Based on the hydraulic conductivity values calculated from the three locations, we would recommend using a value at the lower end of the range provided. This should help take into account anomalies in the soil and reduce the likelihood of the permeable paver drainage system from being overwhelmed. For design, we would recommend using a value of between 2.0×10^{-2} in./hr. and 2.5×10^{-2} in./hr. Appropriate factors of safety should also be applied.

10.0 EROSION CONTROL

The site soils are only moderately susceptible to erosion. The site grades are moderate, especially in the area which will be disturbed by construction. Therefore, site erosion should be low to moderate.

Construction Erosion Control. All disturbed areas shall have the low side surrounded by a silt fence with the bottom edge embedded in the soil at least two (2) inches. At select locations settling ponds of hay-bale backed silt fence must be established to decrease silt content of water flowing off site. Hay bales or wattles shall be used to protect street catch basins or cross culverts within 300 feet of the site (if water flows from the site can reach them).

The site will also require crushed rock (or shale) entrances to prevent "tracking" of mud by construction vehicles on the City streets. These are typically required to be at least 50 feet long and be constructed of 10" to 18" of crushed rock over a woven fabric (more if needed to protect the subgrade soils). These entrances will have to be cleaned periodically.

Permanent Erosion Control. Permanent project landscaping and paving as required by the City of Central Point or Jackson County will normally meet most needs of long-term erosion control. All disturbed areas on the site but outside the developed area of the project must be reseeded with local native grasses for erosion prevention. These areas shall be graded reasonably smooth and the surface scarified to ½ inch deep. The area should then be hydroseeded with a combination of erosion control grass seed, fertilizer and mulch OR should be covered with a thin layer of crushed rock.

11.0 ADDITIONAL SERVICES AND LIMITATIONS

11.1 ADDITIONAL SERVICES

We should review construction plans and specifications for this project as they are being developed. In addition, The Galli Group should be retained to review all geotechnical-related

portions of the plans and specifications to evaluate whether they are in conformance with the recommendations provided in our report. Additionally, to observe compliance with the intent of our recommendations, design concepts, and the plans and specifications, all construction operations dealing with earthwork, foundations and rock placement and compaction should be observed by a representative from The Galli Group.

For this project, we anticipate additional services could include the following:

- Review of final construction plans and specifications for compliance with geotechnical recommendations.
- Possible project team meetings to clarify issues and proceed smoothly into and through the construction process. Must include preconstruction meeting where contractor clearly understands what is expected from a geotechnical perspective.
- Observation of subgrade preparation, including old fill removal, subgrade redensification, structural fill placement and compaction and proofrolling of each lift.
- Observation and/or testing of over-excavated areas, recompacted native soils, subgrade preparation, building pad preparation, structural fill placement, subdrains, subgrade proofrolling, pavement subgrade preparation, footing subgrade and overexcavation, structural fill placement, aggregate base placement and compaction, site grading, surface drainage, wall and floor drainage.
- Periodic construction field reports, as requested by the client and required by the building department.

We would provide these additional services on a time-and-expense basis in accordance with our current Standard Fee Schedule and General Conditions at the time of construction. If we are not retained to provide these services, we cannot be held responsible for the decisions by others or geotechnical related issues in the constructed product.

11.2 LIMITATIONS

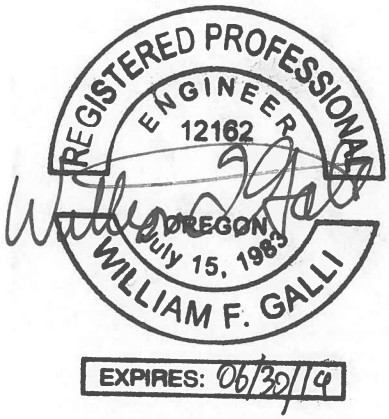
The analyses, conclusions and recommendations contained in this report are based on site conditions and assumed development plans as they existed at the time of the study, and assume soils, rock and groundwater conditions exposed and observed in the borings and test pits during our investigation are representative of soils and groundwater conditions throughout the site. If during construction, subsurface conditions or assumed design information is found to be different, we should be advised at once so that we can review this report and reconsider our recommendations in light of the changed conditions. If there is a significant lapse of time between submission of this report and the start of work at the site, if the project is changed, or if conditions have changed due to acts of God or construction at or adjacent to the site, it is recommended that this report be reviewed in light of the changed conditions and/or time lapse.

This report was prepared for the use of the City and their design and construction team for the design and construction of the project. It should be made available to contractors for information and factual data only. This report should not be used for contractual purposes as a warranty of site subsurface conditions. It should also not be used at other sites or for projects other than the one intended.

We have performed these services in accordance with generally accepted geotechnical engineering practices in southern Oregon, at the time the study was accomplished. No other warranties, either expressed or implied, are provided.

THE GALLI GROUP
GEOTECHNICAL CONSULTING

William F. Galli, P.E., G.E.
Principal Engineer

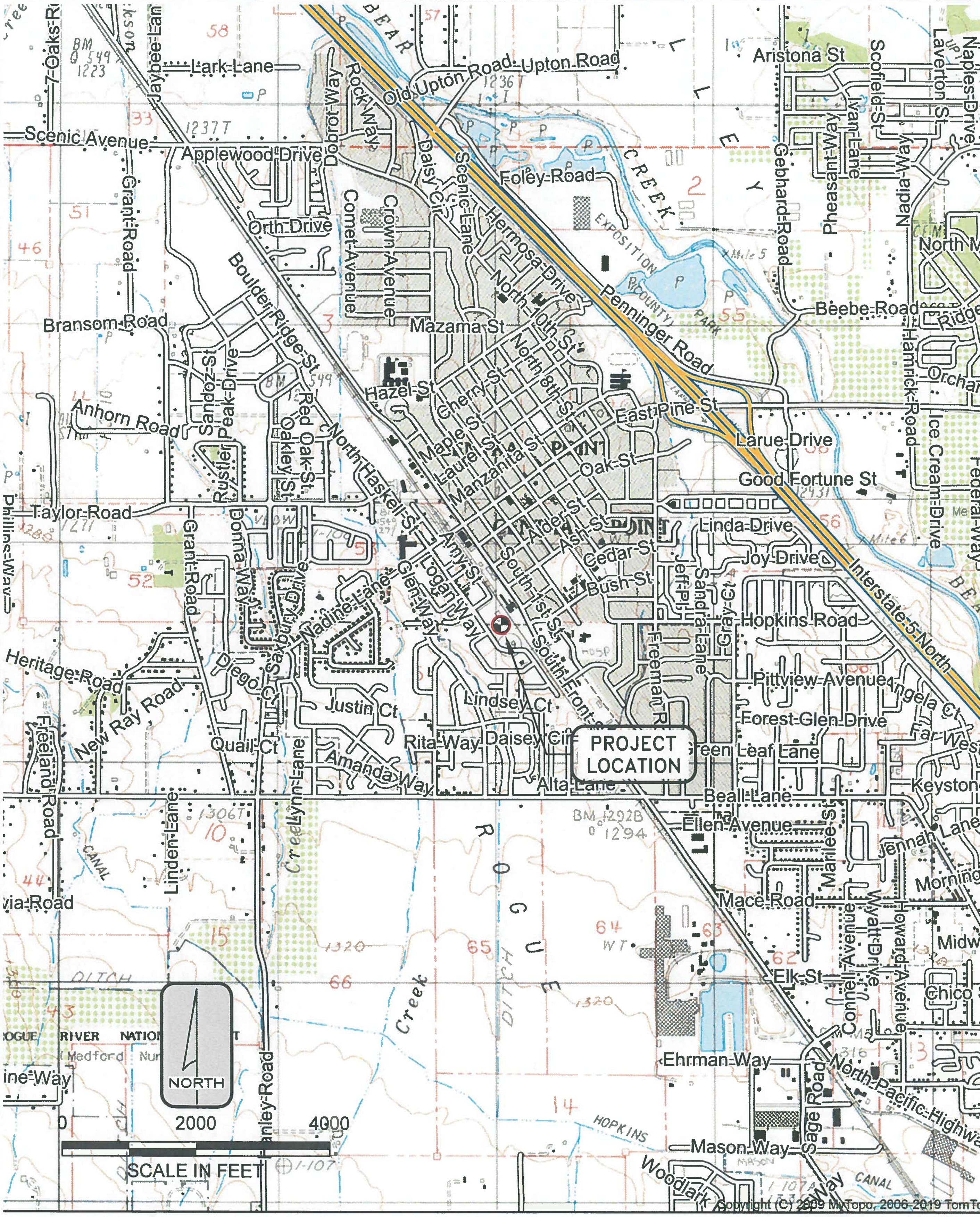


References

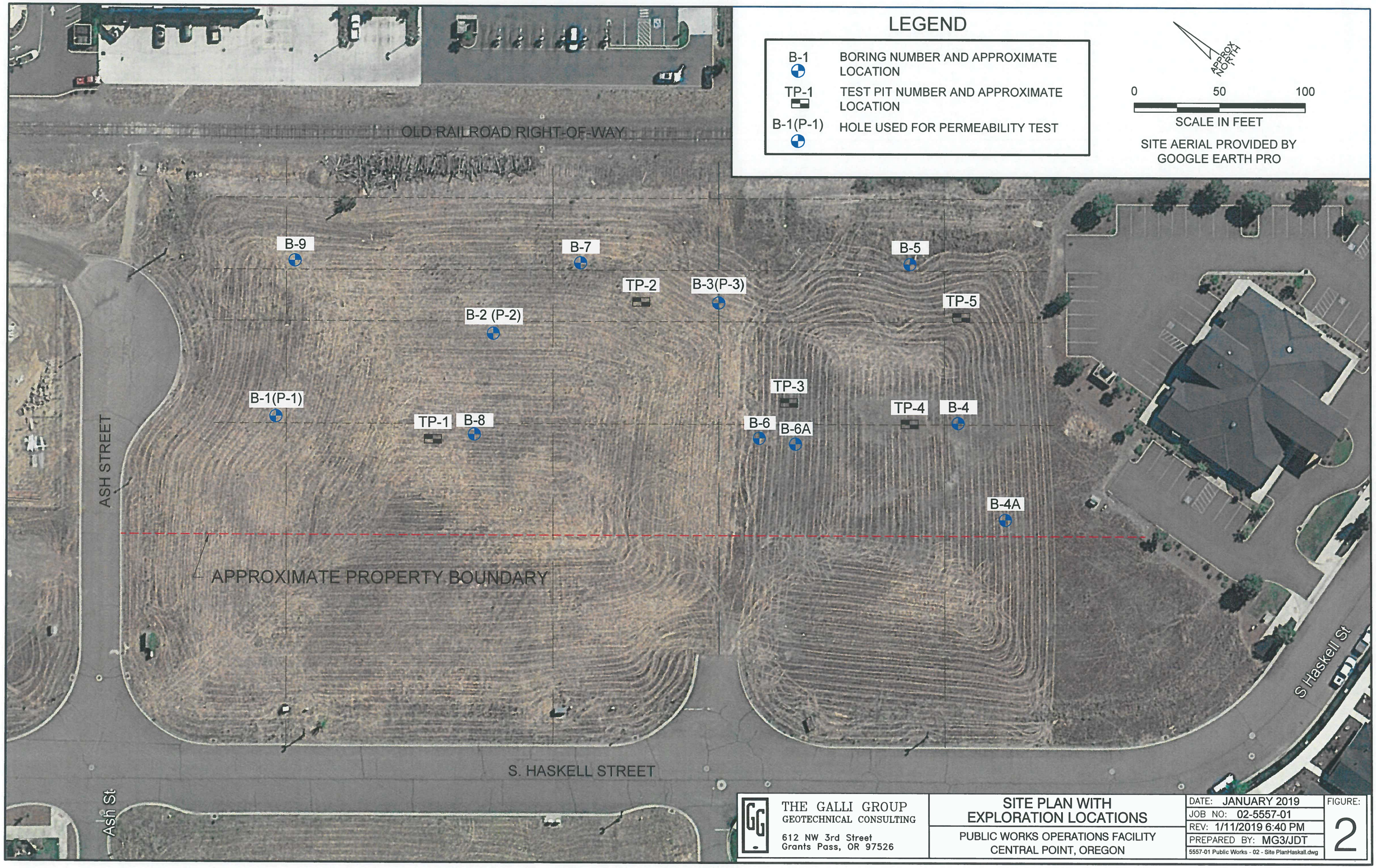
ASCE 7-10; 2010; American Society of Civil Engineers; ASCE 7-10 Minimum Design Loads for Buildings and Other Structures

OSSC; 2014; Oregon Structural Specialty Code; International Code Council, Inc.

USGS; 2016; United States Geological Survey; Seismic Design Maps; online at: http://earthquake.usgs.gov/designmaps/us/application.php



THE GALLI GROUP GEOTECHNICAL CONSULTING 612 NW 3rd Street Grants Pass, OR 97526	VICINITY MAP PUBLIC WORKS OPERATIONS FACILITY CENTRAL POINT, OREGON	DATE: JANUARY 2019 JOB NO: 02-5557-01 REV: 01/09/2019 PREPARED BY: MG3/JDT 5557-01 Public Works - 01 - Vicinity.dwg	FIGURE: 1



THE GALLI GROUP
GEOTECHNICAL CONSULTING

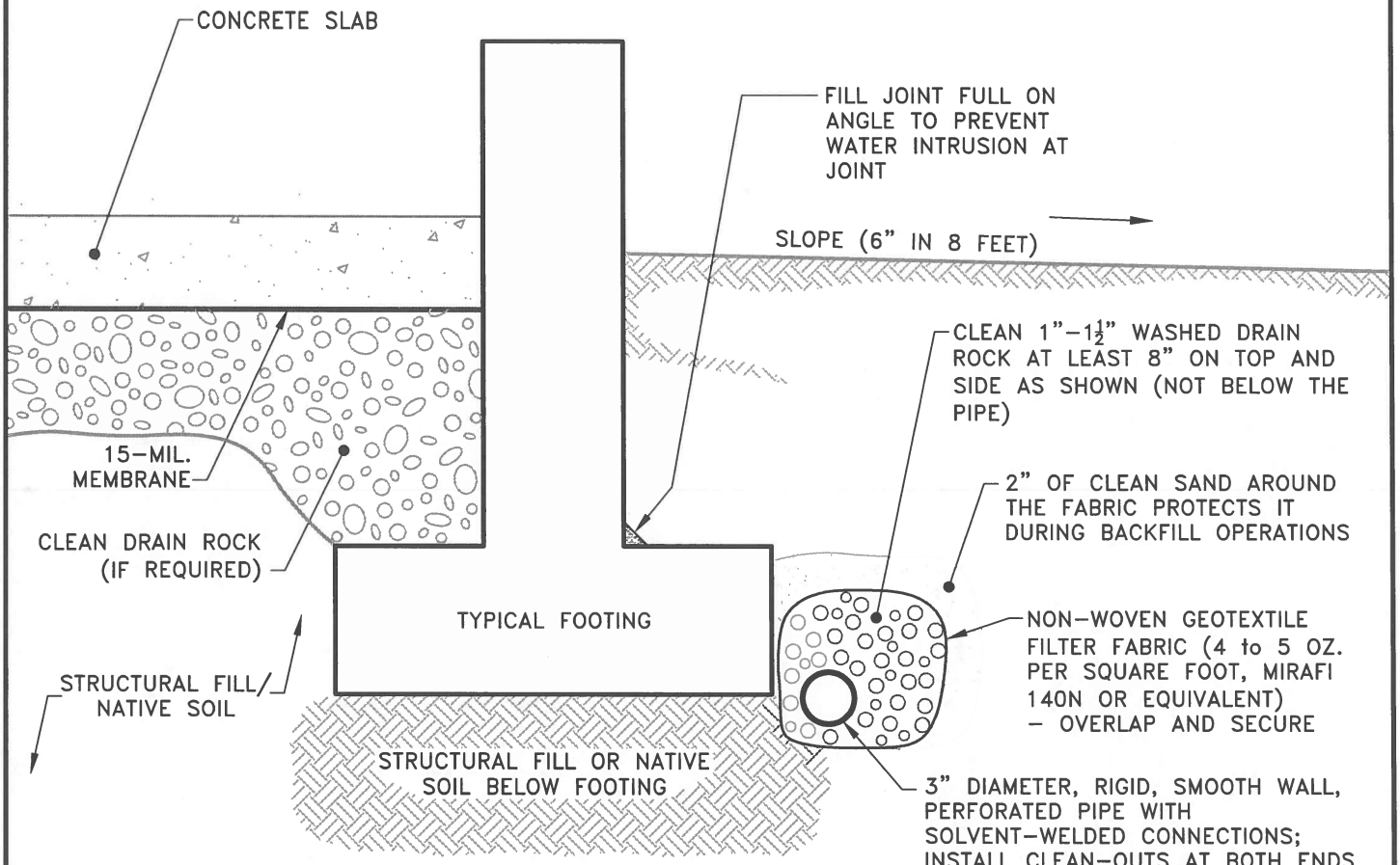
612 NW 3rd Street
Grants Pass, OR 97526

SITE PLAN WITH EXPLORATION LOCATIONS

PUBLIC WORKS OPERATIONS FACILITY
CENTRAL POINT, OREGON

DATE:	JANUARY 2019
JOB NO:	02-5557-01
REV:	1/11/2019 6:40 PM
PREPARED BY:	MG3/JDT
	5557-01 Public Works - 02 - Site PlanHaskall.dwg

FIGURE: 2



NOTES:

(1) VAPOR BARRIER TO BE STEGO INDUSTRIES 15mil STEGO WRAP OR EQUIVALENT. OWNER MAY CHOOSE TO USE 6mil VISQUENE, UNDERSTANDING IT WILL NOT WORK AS WELL.

(2) CAPILLARY BREAK ROCK BELOW VAPOR BARRIER TO BE 1/4" TO 3/4" CLEAN CRUSHED ROCK OR EQUIVALENT.

FOR ILLUSTRATION PURPOSES ONLY – NOT FOR CONSTRUCTION
NOT TO SCALE

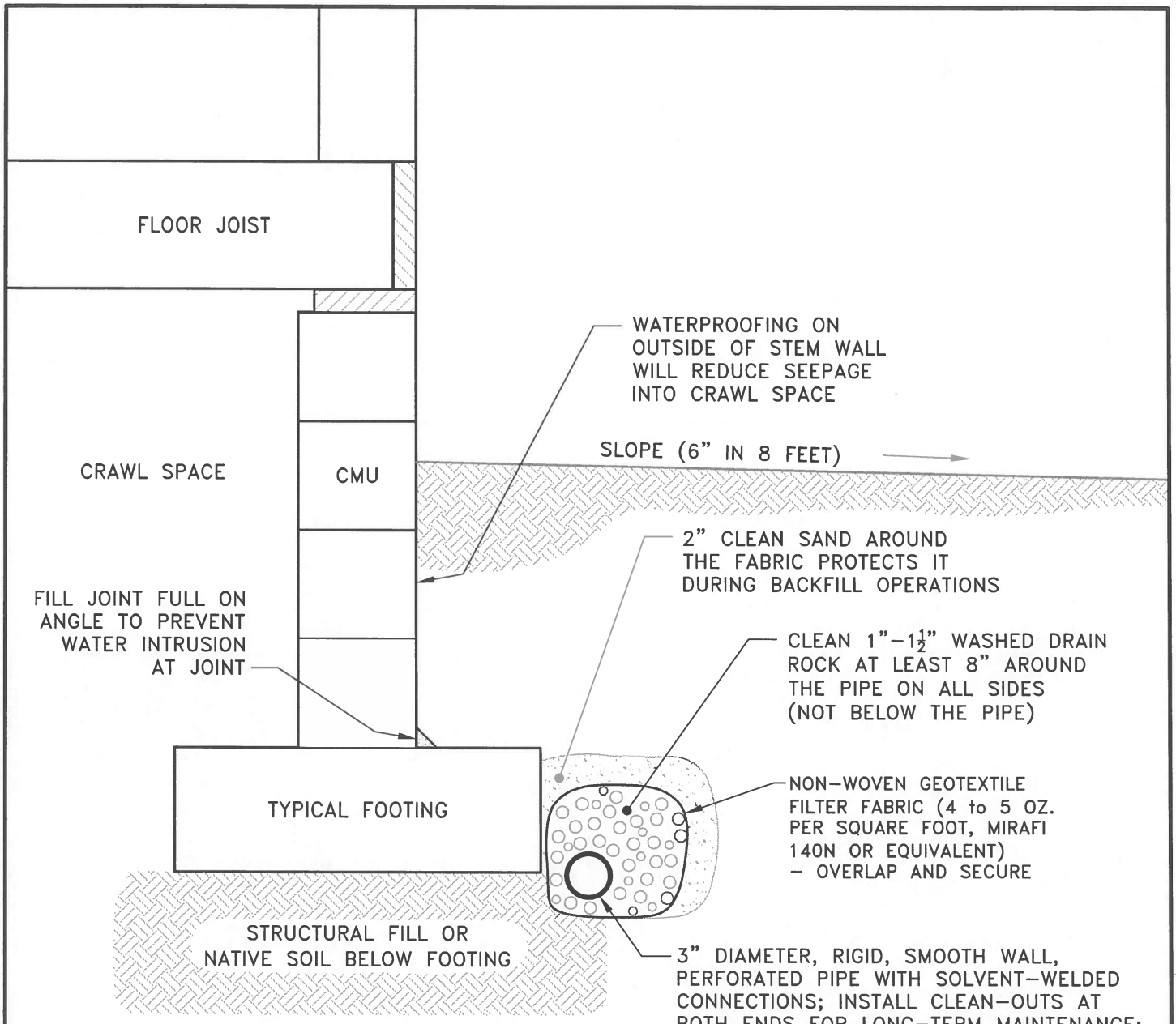
THE GALLI GROUP
GEOTECHNICAL CONSULTING
612 NW 3rd Street
Grants Pass, OR 97526

TYPICAL FOUNDATION DRAIN SLAB ON GRADE FLOOR

PUBLIC WORKS OPERATIONS FACILITY
CENTRAL POINT, OREGON

DATE:	JANUARY 2019
JOB NO:	02-5557-01
REV:	1/9/2019 9:49 PM
PREPARED BY:	MG3/JDT
	5557-01 Public Works - 03 - found drain-slab-2.dwg

FIGURE: 3



NOTES:

(1) VAPOR BARRIER TO BE STEGO INDUSTRIES 15mil STEGO WRAP OR EQUIVALENT. OWNER MY CHOOSE TO USE 6mil VISQUENE, UNDERSTANDING IT WILL NOT WORK AS WELL.

(2) CAPILLARY BREAK ROCK BELOW VAPOR BARRIER TO BE 1/4" TO 3/4" CLEAN CRUSHED ROCK OR EQUIVALENT.

FOR ILLUSTRATION PURPOSES ONLY – NOT FOR CONSTRUCTION
NOT TO SCALE

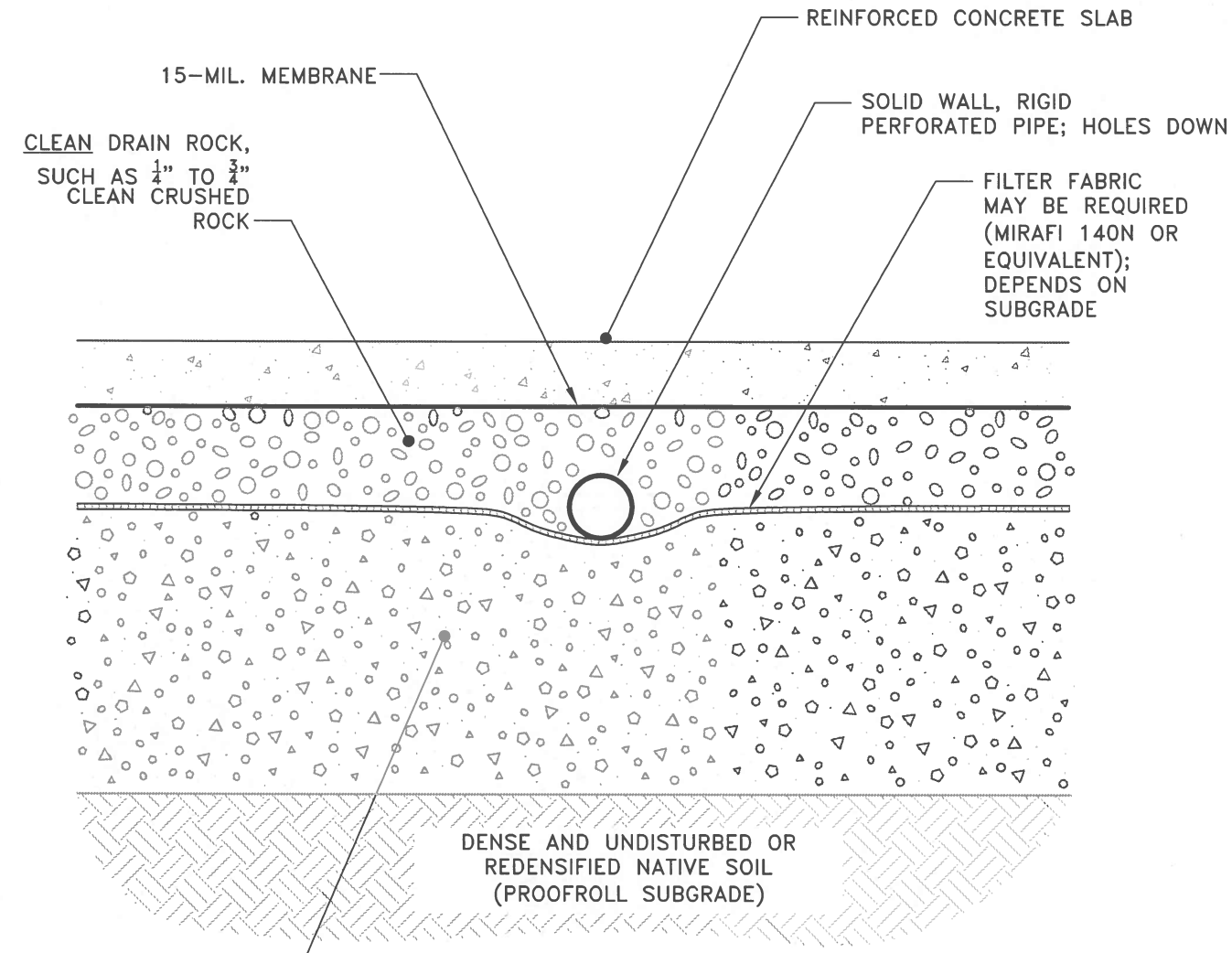
THE GALLI GROUP
GEOTECHNICAL CONSULTING
612 NW 3rd Street
Grants Pass, OR 97526

TYPICAL FOUNDATION DRAIN WITH CRAWL SPACE

PUBLIC WORKS OPERATIONS FACILITY
CENTRAL POINT, OREGON

DATE:	JANUARY 2019
JOB NO:	02-5557-01
REV:	1/9/2019 6:03 PM
PREPARED BY:	MG3/JDT
	5557-01 Public Works - 04 - found drain-crawl 03.dwg

FIGURE: 4



NOTES:

(1) MAXIMUM SPACING IS 10 TO 15 FEET.

(2) ORIENT PIPE PERFORATIONS TO BOTTOM.

(3) ASSEMBLE PIPE USING SOLVENT-WELDED CONNECTIONS.

(4) DO NOT DRIVE OVER DRAIN LINES.

(5) DRAIN ROCK AND STRUCTURAL FILL TO MEET SPECS. IN REPORT BODY – SLOPE PIPE TO DRAIN.

(6) MAY REQUIRE FILTER FABRIC ON NATIVE SUBGRADE OR IF STRUCTURAL FILL IS VERY SILTY OR SANDY.

(7) BEST VAPOR BARRIER IS STEGO INDUSTRIES 15mil STEGO WRAP (OR EQUIVALENT). OWNER MAY CHOOSE TO USE 6mil VISQUENE WITH THE UNDERSTANDING IT DOES NOT PERFORM NEARLY AS WELL.

FOR ILLUSTRATION PURPOSES ONLY
NOT TO SCALE

THE GALLI GROUP
GEOTECHNICAL CONSULTING
612 NW 3rd Street
Grants Pass, OR 97526

FLOOR SUBDRAIN DETAIL

PUBLIC WORKS OPERATIONS FACILITY
CENTRAL POINT, OREGON

DATE:	JANUARY 2019
JOB NO:	02-5557-01
REV:	1/9/2019 9:45 PM
PREPARED BY:	MG3/JDT
	5557-01 Public Works - 05 - subdrain sog-10.2015.dwg

FIGURE: 5

TYPICAL RETAINING WALL CROSS-SECTION

NOTE: TWO COATS (OR ONE THICK COAT) OF A HIGH QUALITY WALL SEALER. FLEXIBLE BITUMEN-BASED, SPRAYED, ROLLED OR TROWELED-ON MATERIALS SHALL BE USED. WE RECOMMEND MASTERBLEND HLM5000, OR EQUIVALENT. BENTONITE PANELS AND STICKY-BACKED MEMBRANES ALSO WORK WELL. THIS IS CRITICAL FOR WALLS WHICH HAVE DRY LIVING SPACE INSIDE

NOTES: DRAINAGE OF THE RETAINING WALL IS A CRITICAL ITEM IN ITS PROPER LONG-TERM PERFORMANCE. ANY COMPROMISE IN MATERIALS OR CONSTRUCTION QUALITY CAN HAVE VERY SIGNIFICANT (DISASTROUS) ADVERSE AFFECTS.

THESE WALL SECTIONS ASSUME FULLY DRAINED CONDITIONS FOR THE LIFE OF THE STRUCTURE.

IN NO CASE SHOULD WEEP HOLES BE SUBSTITUTED FOR THIS DRAINAGE SECTION.

CLAYEY SOIL SEAL OR PLASTIC SHEETING ON TOP OF DRAIN ROCK

BACKSLOPE EXTERIOR SURFACES AT LEAST 2% TO 5% FOR A MINIMUM OF 6 FEET

STANDARD WALL DRAIN CONSISTING OF 12" WIDE (AT LEAST) WASHED DRAIN ROCK WRAPPED IN A NON-WOVEN GEOTEXTILE FABRIC (4 to 5 OZ. PER SQUARE FOOT; Mirafi 140N OR EQUIVALENT). TO WITHIN 6" OF SURFACE AND MUST EXTEND DOWN TO FABRIC WRAPPED BASE DRAINAGE SECTION. BACKFILL MAY BE ANY APPROVED GRANULAR MATERIAL CAPABLE OF NECESSARY COMPACTION. NOTE: THIS STANDARD WALL DRAIN MAY BE OMITTED IF THE WALL SEAL AND MAT/SHEET DRAIN ARE IN PLACE AND BACKFILL IS FULLY FREE DRAINING. SEE BELOW.

ALTERNATIVE TO STANDARD WALL DRAIN: RETAINING WALL BACKFILL SHALL CONSIST OF COMPACTED GRANULAR BACKFILL WHICH MUST BE FULLY FREE-DRAINING MATERIAL AND MUST EXTEND DOWN TO THE BASE DRAINAGE SECTION; THIS ALTERNATIVE ALSO MUST INCLUDE THE WALL MAT/SHEET DRAIN AND WALL SEAL, DESCRIBED ON THIS SHEET.

BEVELED MORTAR TO SHED WATER

FABRIC COVERED POLYMER COMPOSITE MAT/SHEET DRAIN – SUCH AS AMERICAN WICK DRAIN'S AMERDRAIN 200, OR EQUIVALENT. ATTACH WITH THE PERMEABLE FABRIC SIDE AWAY FROM THE RETAINING WALL. INSTALL PER MANUFACTURER'S RECOMMENDATIONS.

12" SOIL COVER OVER FOOTING

ALTERNATE FOOTING/BASE DRAIN LOCATION ACCEPTABLE FOR EXTERIOR WALLS.

NOTE: 2" CLEAN SAND OVER THE FABRIC PROTECTS IT DURING BACKFILL OPERATIONS.

12" MIN.

CLEAN 1"-1½" WASHED DRAIN ROCK AT LEAST 8" AROUND THE PIPE ON ALL SIDES (NOT BELOW PIPE).

NON-WOVEN GEOTEXTILE FILTER FABRIC (4 to 5 OZ. PER SQUARE FOOT). OVERLAP AND SECURE.

UNDISTURBED OR REDENSIFIED NATIVE SOIL SUBGRADE OR SPECIFIED STRUCTURAL ROCK FILL

4" DIAMETER (3" ON SMALLER WALLS), RIGID, SMOOTH WALL, PERFORATED PIPE (HOLES DOWN) WITH SOLVENT-WELDED CONNECTIONS; INSTALL CLEAN-OUTS AT BOTH ENDS FOR LONG-TERM MAINTENANCE; SLOPE FOR POSITIVE DRAINAGE AND ORIENT THE PERFORATIONS FACING DOWN

IMPERMEABLE MEMBRANE

BEVELED MORTAR TO SHED WATER

FOR ILLUSTRATION PURPOSES ONLY
NOT TO SCALE

THE GALLI GROUP
GEOTECHNICAL CONSULTING
612 NW 3rd Street
Grants Pass, OR 97526

EXTERIOR RETAINING WALL DRAINAGE CROSS-SECTION

PUBLIC WORKS OPERATIONS FACILITY
CENTRAL POINT, OREGON

DATE: JANUARY 2019
JOB NO: 02-5557-01
REV: 01/09/2019
PREPARED BY: MG3/JDT
5557-01 Public Works - 06 - retwall drain-ext-03.dwg

FIGURE: 6

APPENDIX A

BORING LOGS

THE GALLI GROUP
GEOTECHNICAL CONSULTANTS

BORING LOG
B-1

Project: Public Works Operation Facility
Client: Central Point Public Works
Location: Central Point, Oregon
Driller: The Galli Group
Drill Rig: ATV Mounted
Depth To Water> Initial ▽ :

Project No.: 5557
Date: 01/09/2019
Elevation:
Logged By: Lyn Chand
At Completion ▼ :

Graphic Log	USCS	Description	Depth	Sample No. and Type	NMC	Standard Penetration Test N	Standard Penetration Test CURVE (10 30 50)
	OH/OL	Root Zone - Orangic Topsoil 0.25	0				
	CL/CH	Medium stiff, orange brown and red brown, sandy CLAY; moist (Manmade Fill). (inorganic debris at 6" depth)		S-1			
	CL/CH	Medium stiff, orange brown, sandy CLAY; trace rounded gravels, moist (Manmade Fill).	1.5	S-2			
				S-3		7	
	CL/CH	Stiff, orange brown, sandy CLAY; moist (Manmade Fill).					
	CL/CH	Very stiff, dark orange brown, sandy CLAY; with fine rounded to subangular gravels (up to 1/2" dia.), orange and gray mottles, moist (Manmade Fill). 4.0	3	S-4		24	
		Bottom of Boring	4.5				
			6				
			7.5				
			9				
			10.5				

Legend of Samplers: ☐ Grab sample ◪ SPT sample ⌶ Shelby tube sample

This information pertains only to this boring and should not be interpreted as being indicative of the site.

THE GALLI GROUP
GEOTECHNICAL CONSULTANTS

BORING LOG
B-2

Project: Public Works Operation Facility
Client: Central Point Public Works
Location: Central Point, Oregon
Driller: The Galli Group
Drill Rig: ATV Mounted
Depth To Water> Initial ▽ :

Project No.: 5557
Date: 01/09/2019
Elevation:
Logged By: Lyn Chand
At Completion ▼ :

Graphic Log	USCS	Description	Depth	Sample No. and Type	NMC	Standard Penetration Test N	Standard Penetration Test CURVE (10 30 50)
	OH/OL	Root Zone - Orangic Topsoil 0.25	0				
	CL/CH	Medium stiff, brown, sandy CLAY; moist (Fill).		S-1			
	CL/CH	Stiff, orange and orange brown, sandy CLAY; (3) 1" thick bands of coarse sand and fine sub angular gravels with silt matrix, moist (Manmade Fill).	1.5	S-2 S-3		13	
		2.5					
	GP/SP	Dense, Crushed GRAVEL; angular (up to 4" dia.), some brown clay in tip, moist (Manmade Fill).	3	S-4		29	
		4.0					
		Bottom of Boring	4.5				
			6				
			7.5				
			9				
			10.5				

Legend of Samplers: ☐ Grab sample ◪ SPT sample ▯ Shelby tube sample

This information pertains only to this boring and should not be interpreted as being indicative of the site.

THE GALLI GROUP
GEOTECHNICAL CONSULTANTS

BORING LOG
B-3

Project: Public Works Operation Facility
Client: Central Point Public Works
Location: Central Point, Oregon
Driller: The Galli Group
Drill Rig: ATV Mounted
Depth To Water> Initial ▽ :

Project No.: 5557
Date: 01/09/2019
Elevation:
Logged By: Lyn Chand
At Completion ▼ :

Graphic Log	USCS	Description	Depth	Sample No. and Type	NMC	Standard Penetration Test N	Standard Penetration Test CURVE (10 30 50)
	OH/OL	Root Zone - Orangic Topsoil 0.25	0				
	CL/CH	Medium stiff, brown, sandy CLAY; moist (Fill).		S-1			
	CL/CH	Stiff, orange brown, sandy CLAY; trace angular gravel (up to 1/2' dia.), moist (Manmade Fill).	1.5	S-2			
				S-3		15	
	CL/CH	Hard, orange brown, sandy CLAY; increasing sand content and angular gravel (up to 1" dia.), moist (Manmade Fill).	3				
				S-4		36	
		4.0 Bottom of Boring	4.5				
			6				
			7.5				
			9				
			10.5				

Legend of Samplers: ☐ Grab sample ◪ SPT sample ▯ Shelby tube sample

This information pertains only to this boring and should not be interpreted as being indicative of the site.

THE GALLI GROUP
GEOTECHNICAL CONSULTANTS

BORING LOG
B-4

Project: Public Works Operation Facility
Client: Central Point Public Works
Location: Central Point, Oregon
Driller: The Galli Group
Drill Rig: ATV Mounted
Depth To Water> Initial ▽ :

Project No.: 5557
Date: 01/09/2019
Elevation:
Logged By: Lyn Chand
At Completion ▽ :

Graphic Log	USCS	Description	Depth	Sample No. and Type	NMC	Standard Penetration Test N	Standard Penetration Test CURVE 10 30 50
	OH/OL	Root Zone - Orangic Topsoil 0.25	0				
	GW-GC	Medium stiff, 4" Minus Crushed Rock in brown clay matrix; moist (Manmade Fill).		S-1			
				S-2			
		1.5	1.5				
		Auger refusal at 1.5 feet. Bottom of Boring					
			3				
			4.5				
			6				
			7.5				
			9				
			10.5				

Legend of Samplers: ☐ Grab sample ◪ SPT sample ▯ Shelby tube sample

This information pertains only to this boring and should not be interpreted as being indicative of the site.

THE GALLI GROUP
GEOTECHNICAL CONSULTANTS

BORING LOG
B-4A

Project: Public Works Operation Facility
Client: Central Point Public Works
Location: Central Point, Oregon
Driller: The Galli Group
Drill Rig: ATV Mounted
Depth To Water> Initial ▽ : 1.0

Project No.: 5557
Date: 01/09/2019
Elevation:
Logged By: Lyn Chand
At Completion ▼ : 0.75

Graphic Log	USCS	Description	Depth	Sample No. and Type	NMC	Standard Penetration Test N	Standard Penetration Test CURVE (10 30 50)
	OH/OL	Root Zone - Orangic Topsoil 0.25	0				
	GW-GC	Medium stiff, 4" Minus Crushed Rock in brown clay matrix; wet (Manmade Fill). 1					
		Auger refusal at 1.0 feet Bottom of Boring	1.5				
			3				
			4.5				
			6				
			7.5				
			9				
			10.5				

Legend of Samplers: ☐ Grab sample ◪ SPT sample ▯ Shelby tube sample

This information pertains only to this boring and should not be interpreted as being indicative of the site.

THE GALLI GROUP
GEOTECHNICAL CONSULTANTS

BORING LOG
B-5

Project: Public Works Operation Facility
Client: Central Point Public Works
Location: Central Point, Oregon
Driller: The Galli Group
Drill Rig: ATV Mounted
Depth To Water> Initial ⏚ :

Project No.: 5557
Date: 01/09/2019
Elevation:
Logged By: Lyn Chand
At Completion ⏚ :

Graphic Log	USCS	Description	Depth	Sample No. and Type	NMC	Standard Penetration Test N	Standard Penetration Test CURVE 10 30 50
	GW	Medium Dense, 4" Minus Crushed Rock, with silt and sand, moist (Manmade Fill).	0				
		BORING NOT ATTEMPTED	1.5				
			3				
			4.5				
			6				
			7.5				
			9				

Legend of Samplers: ☐ Grab sample ◪ SPT sample ⌶ Shelby tube sample

This information pertains only to this boring and should not be interpreted as being indicative of the site.

THE GALLI GROUP
GEOTECHNICAL CONSULTANTS

BORING LOG
B-6

Project: Public Works Operation Facility
Client: Central Point Public Works
Location: Central Point, Oregon
Driller: The Galli Group
Drill Rig: ATV Mounted
Depth To Water> Initial ▽ :

Project No.: 5557
Date: 01/09/2019
Elevation:
Logged By: Lyn Chand
At Completion ▽ :

Graphic Log	USCS	Description	Depth	Sample No. and Type	NMC	Standard Penetration Test N	Standard Penetration Test CURVE 10 30 50
	OH/OL	Root Zone - Orangic Topsoil 0.25	0				
	GW-GC	Medium stiff, 4" Minus Crushed Rock in brown clay matrix; fine bark in matrix, moist (Manmade Fill). 1					
		Auger refusal at 1.0 feet. Bottom of Boring	1.5				
			3				
			4.5				
			6				
			7.5				
			9				
			10.5				

Legend of Samplers: ☐ Grab sample ◪ SPT sample 𝙸 Shelby tube sample

This information pertains only to this boring and should not be interpreted as being indicative of the site.

THE GALLI GROUP
GEOTECHNICAL CONSULTANTS

BORING LOG
B-6A

Project: Public Works Operation Facility
Client: Central Point Public Works
Location: Central Point, Oregon
Driller: The Galli Group
Drill Rig: ATV Mounted
Depth To Water> Initial ▽ :

Project No.: 5557
Date: 01/09/2019
Elevation:
Logged By: Lyn Chand
At Completion ▼ :

Graphic Log	USCS	Description	Depth	Sample No. and Type	NMC	Standard Penetration Test N	Standard Penetration Test CURVE 10 30 50
	OH/OL	Root Zone - Orangic Topsoil 0.25	0				
	GW-GC	Medium stiff, 4" Minus Crushed Rock in brown clay matrix; fine bark in matrix, moist (Manmade Fill). 1					
		Auger refusal at 1.0 feet. Bottom of Boring	1.5				
			3				
			4.5				
			6				
			7.5				
			9				
			10.5				

Legend of Samplers: ☐ Grab sample ◪ SPT sample ▯ Shelby tube sample

This information pertains only to this boring and should not be interpreted as being indicative of the site.

THE GALLI GROUP
GEOTECHNICAL CONSULTANTS

BORING LOG
B-7

Project: Public Works Operation Facility
Client: Central Point Public Works
Location: Central Point, Oregon
Driller: The Galli Group
Drill Rig: ATV Mounted
Depth To Water> Initial ▽ :

Project No.: 5557
Date: 01/09/2019
Elevation:
Logged By: Lyn Chand
At Completion ▽ :

Graphic Log	USCS	Description	Depth	Sample No. and Type	NMC	Standard Penetration Test N	Standard Penetration Test CURVE (10 30 50)
	OH/OL	Root Zone - Orangic Topsoil	0.25				
	CL/CH	Medium stiff, brown, silty CLAY; trace rounded gravels (up to 1/2"), moist (Manmade Fill).					
	CL/CH	Very stiff, dark brown, silty, sandy CLAY; some rounded gravels (up to 1/2"), moist (Manmade Fill).	3.0	S-1		32	
	GC/SC	Hard, medium brown, clayey SAND & GRAVEL; damp (Manmade Fill).	4.0				
		Auger refusal at 3.4 feet. Bottom of Boring					

0 1.5 3 4.5 6 7.5 9 10.5

Legend of Samplers: ☐ Grab sample ◪ SPT sample ⌶ Shelby tube sample

This information pertains only to this boring and should not be interpreted as being indicative of the site.

THE GALLI GROUP
GEOTECHNICAL CONSULTANTS

BORING LOG
B-7A

Project: Public Works Operation Facility
Client: Central Point Public Works
Location: Central Point, Oregon
Driller: The Galli Group
Drill Rig: ATV Mounted
Depth To Water> Initial ▽ :

Project No.: 5557
Date: 01/09/2019
Elevation:
Logged By: Lyn Chand
At Completion ▼ :

Graphic Log	USCS	Description	Depth	Sample No. and Type	NMC	Standard Penetration Test N	Standard Penetration Test CURVE (10 30 50)
	OH/OL	Root Zone - Orangic Topsoil	0.25				
	CL/CH	Medium stiff, brown, silty CLAY; trace rounded gravels (up to 1/2"), moist (Manmade Fill).					
	CL/CH	Very stiff, dark brown, silty, sandy CLAY; some rounded to subangular gravels (up to 1/2"), moist (Manmade Fill).	3.25				
	GM/SM	Medium dense, orange brown, silty SAND & GRAVEL; damp (Manmade Fill).	3.75				
	VC	Very stiff, gray and brown, silty, sandy CLAY; moist (Manmade Fill). (Crushed Rock in tip of full sample)	4.75	S-1		27	
		Auger refusal at 4.75 feet. Bottom of Boring					

0 1.5 3 4.5 6 7.5 9 10.5

Legend of Samplers: ☐ Grab sample ◪ SPT sample ⌶ Shelby tube sample

This information pertains only to this boring and should not be interpreted as being indicative of the site.

THE GALLI GROUP
GEOTECHNICAL CONSULTANTS

BORING LOG
B-8

Project: Public Works Operation Facility
Client: Central Point Public Works
Location: Central Point, Oregon
Driller: The Galli Group
Drill Rig: ATV Mounted
Depth To Water> Initial ▽ :

Project No.: 5557
Date: 01/09/2019
Elevation:
Logged By: Lyn Chand
At Completion ▼ :

Graphic Log	USCS	Description	Depth	Sample No. and Type	NMC	Standard Penetration Test N	Standard Penetration Test CURVE 10 30 50
	OH/OL	Root Zone - Top Soil .25	0				
	CL/CH	Medium stiff, brown CLAY; with sand, moist (Manmade Fill).	1.5				
	SM/GM	Very dense, brown and gray silty SAND; with bands of coarse sand and subangular gravels (up to 1" dia.), moist to damp (Crushed Rock Fill). 2.5	3	S_1		60	
		4.0 Auger refusal at 3.0 feet. Bottom of Boring	4.5				
			6				
			7.5				
			9				
			10.5				

Legend of Samplers: ▯ Grab sample ◪ SPT sample 𝙸 Shelby tube sample

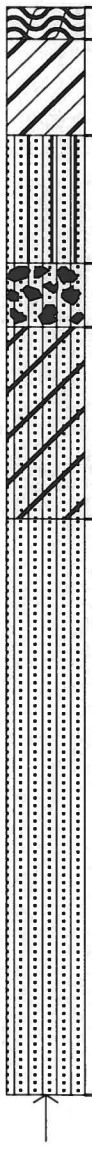
This information pertains only to this boring and should not be interpreted as being indicative of the site.

THE GALLI GROUP
GEOTECHNICAL CONSULTANTS

BORING LOG
B-9

Project: Public Works Operation Facility
Client: Central Point Public Works
Location: Central Point, Oregon
Driller: The Galli Group
Drill Rig: ATV Mounted
Depth To Water> Initial ▽ :

Project No.: 5557
Date: 01/09/2019
Elevation:
Logged By: Lyn Chand
At Completion ▽ :



USCS	Description	Depth	Sample No. and Type	NMC	Standard Penetration Test N
OH/OL	Root Zone - Top Soil	0			
	.25				
CL/CH	Medium stiff, brown, sandy CLAY; moist (Fill).				
	1.0				
MH/SM	Medium dense, medium brown, silty SAND; with clay, moist (Fill).	1.5			
	2.0				
SM/GM	Medium dense, coarse SAND and fine GRAVEL (up to 1/4" dia.); moist (Manmade Fill).				
	2.5				
VC	Stiff, red brown, silty CLAY; with sand, moist (Fill).	3	S-1		17
	4.0				
SM	Very dense, orange brown, silty SAND; some clay, moist to damp (Fill).	4.5			
		6	S-2		60
SM	Dense, orange brown, silty SAND; numerous fine subangular to rounded gravels (increasing in occurance and size with depth, up to 3/4" dia.), with some clay, moist. (Manmade Fill)	7.5	S-3		30
	8.5				
	Auger refusal at 8.0 feet. Bottom of Boring	9			
		10.5			

Standard Penetration Test CURVE: 10 30 50

Legend of Samplers: ▯ Grab sample ◪ SPT sample ▮ Shelby tube sample

This information pertains only to this boring and should not be interpreted as being indicative of the site.

APPENDIX B

TEST PIT LOGS

TEST PIT LOGS

Please note that the soil descriptions given below are representative of how the field representative observed and classified them at the time of excavation. However, these should not be used as a guarantee of subsurface conditions across the site. Any interpretation or estimates made by others based on these logs, is done at their sole risk.

TP-1

0.0 – 0.25	Topsoil/Rootzone
0.25 – 0.75	Medium stiff, dark brown, silty Clay; fine gravels; moist.
0.75 – 1.0	Medium Dense, red brown, silty Sand; moist, fine and poorly graded. MC = 19.8%
1.0 – 1.25	Medium stiff, dark brown, silty Clay; moist, gravels to 1 1/2 inch.
1.25 – 2.25	Medium dense, yellow brown, slightly clayey, silty, coarse Sand; moist. MC = 16.9%
2.25 – 3.5	Dense, Gravels & Cobbles in brown silty Sand matrix; moist. (Manmade Fill).
3.5 – 4.5	Dense, orange, silty, clayey Sand; moist.
4.5 – 5.5	Very dense, brown, clayey Sand; moist, scattered fine gravels. SPT 4.0' to 5.5'; 9/20/40; N=60 MC = 18.4%

No Free Groundwater or Seepage Observed
Bottom of Test Pit at 5.5 feet

TP -2

0.0 – 0.25	Topsoil/Rootzone
0.25 – 1.0	Medium stiff, brown, silty Clay; moist, scattered gravels.
1.0 – 1.75	Medium dense, orange brown, silty, clayey, coarse Sand; moist. MC = 13.1%
1.75 – 6.0	Dense, light brown, silty Sand; moist, cobbles, gravels and debris. (Manmade Fill).
6.0 – 9.8	Medium dense, gray to black, silty, clayey Sand; moist, cobbles and/or gravels, some 4-inch minus crushed rock. (Manmade Fill). SPT 6.0' to 7.5'; 13/10/13; N=23 MC = 10.6% SPT 7.5' to 9.0'; 5/9/5; N=14 SPT 9.0' to 10.5'; 4/7/10; N=17
9.8 – 10.5	Medium stiff, black, organic sandy Silt; moist to wet, abundant organics and piece of wood.

No Free Groundwater or Seepage Observed
Bottom of Test Pit at 10.5 feet

TP -3

0.0 – 0.25	Topsoil/Rootzone
0.25 – 0.75	Medium dense, orange, 4-inch minus Crushed Rock; woven fabric at 10 inches depth. (Manmade Fill). MC = 19.6%
0.75 – 3.0	Dense, brown, silty Shale; wet to saturated, 8 inch minus, jaw-run shale. (Manmade Fill).
3.0 – 4.5	Very dense, orange brown, clayey Sand; wet, scattered gravels. SPT 3.0' to 4.5'; 15/19/33; N=52 MC = 17.7%

Perched Water Observed at 10 inches
Bottom of Test Pit at 4.5 feet

TP -4

0.0 – 0.25	Topsoil/Rootzone
0.25 – 0.75	Medium dense to dense, orange, 4 inch minus, jaw-run Shale; moist, woven fabric at the base of the Shale. (Manmade Fill).
0.75 – 2.0	Dense, dark brown to black, 4" and 8" minus, jaw-run Shale in organic Silt matrix; wet to saturated. (Manmade Fill).
2.0 – 3.9	Very dense, brown, cemented, clayey Silt and Sand; scattered gravels.
3.9 – 4.9	Very dense, dark brown, clayey Sand; moist, scattered gravels. SPT 3.9' to 4.9'; 11/50 for 6"; N=100

Perched Water Observed at 10 inches
Bottom of Test Pit at 4.9 feet

TP -5

0.0 – 0.25	Topsoil/Rootzone
0.25 – 1.5	Medium dense, brown, angular, 4-inch minus, jaw-run Shale; moist to saturated, abundant organic debris, woven fabric at bottom of Shale. (Manmade Fill).
1.5 – 6.0	Loose to medium dense, gray, clayey Sand: moist to wet, with gravels, cemented 4.2 to 6.0 feet. SPT 5.0' to 6.0'; 10/6/17; N=23
6.0 – 8.0	Medium dense to dense, gray brown, Sand and clayey Sand; moist, scattered fine gravels. SPT 6.5' to 8.0'; 8/22/25; N=47

Seepage Observed at 10 inches.
Perched Water Observed at 4.2 feet.
Seepage Observed at 5.0 feet.
Bottom of Test Pit at 8.0 feet

APPENDIX C

LABORATORY TEST RESULTS

THE GALLI GROUP
Geotechnical Consulting

Expansion Index Worksheet (ASTM D-4829)

Client:	Central Point Public Works
Project	Public Works Operations Facility
Job No:	02-5557-01
Test Date:	1/11/2019
Sample Location:	B-1, S-1
Sample Date:	1/10/2019
Description of Soil:	Dark brown silty Clay

Expansion Index measured (EIm):

$EI_m = \Delta H / H_{orig} * 1000$

begin dial :	0.0119
end dial:	0.0333
EI_m:	**21**

Weight of ring (g):	365.3
Wt. Wet sample in ring(g):	741.0
Sample Wet Weight (g):	375.76
Sample Length (in.):	1
Sample Diameter (in.):	4.01
Volume of sample (ft^3):	0.007309
Sample Unit Wt. (PCF):	**113.2**
Sample Dry Unit Wt. (PCF):	**101.8**

Saturation (S):

$S=(SG)(w)\gamma d)/(SG)*62.4)-\gamma d$

SG:	2.7
γd:	101.8
$\%w$:	11.3
S=	**46**

As prepared for testing:

can no.	D-2
wet weight of soil + can (g)	402.67
dry weight of soil + can (g)	374.89
weight of can (g)	128.03
weight of dry soil (g)	246.86
weight of water (g)	27.78
moisture content (% of dry weight)	11.3

EI_{50} Calculation:

$EI_{50=EIm - (50-Sm)*[(65+EIm)/(220-Sm)]}$

EI_M	21
S	46
EI_{50} =	**20**

After testing:

can no.	G8
wet weight of soil + can (g)	555.39
dry weight of soil + can (g)	475.63
weight of can (g)	127.80
weight of dry soil (g)	347.83
weight of water (g)	79.76
moisture content (% of dry weight)	22.9

#4 + (dry wt.)	736.7
#4 - (dry wt.)	1243.4

% Passing #4 Sieve = 62.8

Tested By: Dennis Duru

THE GALLI GROUP
Geotechnical Consulting

Expansion Index Worksheet (ASTM D-4829)

Client:	Central Point Public Works
Project	Public Works Operations Facility
Job No:	02-5557-01
Test Date:	1/22/2019
Sample Location:	B-3, S-2
Sample Date:	1/10/2019
Description of Soil:	Dark brown and gray, silty Clay with gravels

Expansion Index measured (EIm):

$EI_m = \Delta H / H_{orig} * 1000$

begin dial :	0.0304
end dial:	0.0722
EI_m:	**42**

Weight of ring (g):	191.6
Wt. Wet sample in ring(g):	572.9
Sample Wet Weight (g):	381.33
Sample Length (in.):	1
Sample Diameter (in.):	4.01
Volume of sample (ft^3):	0.007309
Sample Unit Wt. (PCF):	**114.9**
Sample Dry Unit Wt. (PCF):	**103.5**

Saturation (S):

$S=(SG)(w)\gamma d)/(SG)*62.4)-\gamma d$

SG:	2.7
γd:	103.5
%w :	11.0
S=	**47**

As prepared for testing:

can no.	A-6
wet weight of soil + can (g)	622.51
dry weight of soil + can (g)	576.19
weight of can (g)	155.05
weight of dry soil (g)	421.14
weight of water (g)	46.32
moisture content (% of dry weight)	11.0

EI_{50} Calculation:

$EI_{50=EIm - (50-Sm)*[(65+EIm)/(220-Sm)]}$

EI_M	42
S	47
EI_{50} =	**40**

After testing:

can no.	G-7
wet weight of soil + can (g)	608.30
dry weight of soil + can (g)	528.79
weight of can (g)	191.48
weight of dry soil (g)	337.31
weight of water (g)	79.51
moisture content (% of dry weight)	23.6

#4 + (dry wt.)	544.38
#4 - (dry wt.)	1042.23

% Passing #4 Sieve = 65.7

Tested By: Aaron Reeser

APPENDIX D

PERMEABILITY TEST RESULTS

FALLING HEAD PERMEABILITY TESTING

THE GALLI GROUP
Geotechnical Consulting

Client: City of Central Point
Project: Public Works Operations Facility
Job No.: 02-5557-02
Test Date: January 9 & 10, 2019

Test Hole No.: P-1
Depth of Hole (FT): 3.75
Diameter (IN): 8.0

Actual Time	Lapsed Time (s)	Water Depth (ft)	(1) Dh (in)	(2) Dt (s)	(3) V (in^3)	(4) Q (in^3/s)	(5) L (in)	(6) Hc (in)
9:51:00		0.21	0.0	0	0.0	0.000	0.0	0.0
10:33:00	2520	0.50	3.5	2520	176.0	0.070	43.2	21.6
11:52:00	4740	0.71	2.5	4740	125.4	0.026	43.8	21.9
13:25:00	5580	0.81	1.2	5580	62.7	0.011	44.4	22.2
23:25:00	36000	1.00	2.3	36000	113.3	0.003	43.9	21.9

Actual Time	(7) mL/D	(8) (1+(mL/D)^2)^0.5	(9) ln (7)+(8)	(10) 2pLHc	(11) (4)/(10)	(12) k (in/s)	k (in/hr)
10:33:00	5.41	5.50	2.39	5876.0	1.19E-05	2.840E-05	0.102
11:52:00	5.47	5.56	2.40	6013.8	4.40E-06	1.056E-05	0.038
13:25:00	5.55	5.64	2.41	6186.5	1.82E-06	4.385E-06	0.016
23:25:00	5.48	5.57	2.40	6046.8	5.21E-07	1.251E-06	0.005

Average Permeability Coefficient (k): 2.82E-06 in/sec

Average Permeability Coefficient (k): 0.01 in/hr

FALLING HEAD PERMEABILITY TESTING

THE GALLI GROUP
Geotechnical Consulting

Client: City of Central Point
Project: Public Works Operations Facility
Job No.: 02-5557-02
Test Date: January 9 & 10, 2019

Test Hole No.: P-2
Depth of Hole (FT): 2.75
Diameter (IN): 8.0

Actual Time	Lapsed Time (s)	Water Depth (ft)	(1) Dh (in)	(2) Dt (s)	(3) V (in^3)	(4) Q (in^3/s)	(5) L (in)	(6) Hc (in)
10:28:00		0.13	0.0	0	0.0	0.000	0.0	0.0
11:50:00	4920	0.50	4.5	4920	226.1	0.046	30.8	15.4
13:24:00	5640	0.58	1.0	5640	48.2	0.009	32.5	16.3
23:24:00	36000	0.75	2.0	36000	102.5	0.003	32.0	16.0

Actual Time	(7) mL/D	(8) (1+(mL/D)^2)^0.5	(9) ln (7)+(8)	(10) 2pLHc	(11) (4)/(10)	(12) k (in/s)	k (in/hr)
11:50:00	3.84	3.97	2.06	2970.6	1.55E-05	3.181E-05	0.114
13:24:00	4.07	4.19	2.11	3322.4	2.57E-06	5.432E-06	0.020
23:24:00	4.00	4.12	2.09	3213.0	8.86E-07	1.856E-06	0.007

Average Permeability Coefficient (k): 3.64E-06 in/sec

Average Permeability Coefficient (k): 0.01 in/hr

FALLING HEAD PERMEABILITY TESTING

THE GALLI GROUP
Geotechnical Consulting

Client: City of Central Point
Project: Public Works Operations Facility
Job No.: 02-5557-02
Test Date: January 9 & 10, 2019

Test Hole No.: P-3
Depth of Hole (FT): 3.68
Diameter (IN): 8.0

Actual Time	Lapsed Time (s)	Water Depth (ft)	(1) Dh (in)	(2) Dt (s)	(3) V (in^3)	(4) Q (in^3/s)	(5) L (in)	(6) Hc (in)
8:52:00		0.35	0.0	0	0.0	0.000	0.0	0.0
9:55:00	3780	0.95	7.2	3780	361.7	0.096	40.6	20.3
11:54:00	7140	1.16	2.5	7140	126.6	0.018	42.9	21.5
13:23:00	5340	1.41	3.0	5340	150.7	0.028	42.7	21.3

Actual Time	(7) mL/D	(8) (1+(mL/D)^2)^0.5	(9) ln (7)+(8)	(10) 2pLHc	(11) (4)/(10)	(12) k (in/s)	k (in/hr)
9:55:00	5.07	5.17	2.33	5168.3	1.85E-05	4.307E-05	0.155
11:54:00	5.36	5.45	2.38	5781.8	3.07E-06	7.303E-06	0.026
13:23:00	5.33	5.43	2.38	5717.3	4.94E-06	1.173E-05	0.042

Average Permeability Coefficient (k): 9.52E-06 in/sec

Average Permeability Coefficient (k): 0.03 in/hr