

January 20, 2011
Project No. 10040

**Preliminary Subsurface Exploration,
Geologic Hazards, and Geotechnical
Engineering Report
Goodfellow Fingers Short Plat
SR-97
Chelan, Washington**

Introduction

The purpose of this study was to gain subsurface information and perform geologic hazard reconnaissance to be utilized in the preliminary design and development of a 6 lot short plat of the Goodfellow Fingers property in Chelan, Washington. Specific building plans for proposed short plat are not currently available and an addendum to this preliminary report specific to the foundation requirements of the proposed structures may be necessary. This report was prepared for the specific use of Pacific Rim Land, LLC and their clients. It is our understanding that the property will be short platted to 6 building lots. It is likely that minimal grading will be completed for the future buildings with the units being set on or near existing grades. If significant grades changes are proposed as part of future building plan, additional geotechnical engineering recommendations for the grading may be required.. A topographic survey of the property and lot layout was provided by Erlandsen, Inc. for use in preparation of this report.

Site Conditions

The subject property extends to the north of SR-97, just to the west of The Lady of the Lake docks in Chelan, Washington. The property was undeveloped land and it is our understanding that the original grading was completed in the 1960's or early 1970's. The topography of the site consists of three rectangular "fingers" that extend between 250 to 300 feet out into the lake. Each finger was 200 to 230 feet in width and separated by a 20 foot wide channel. All of the fingers were at the approximate same elevation and were level on the surface. The perimeter borders with the lake were armored with large diameter boulders sloping down into the lake at inclination of about 3H:1V to 1.5H:1V (horizontal:vertical). Vegetation on the property consisted of scrub grass and weeds with a few bushes along the highway.

Subsurface Conditions

Subsurface conditions on the property were inferred from visual reconnaissance of the property and a series of 8 subsurface exploration pits excavated across the property. The exploration pits were excavated using a track-mounted backhoe. The exploration pits were logged by a licensed geologist and immediately backfilled. The exploration pits were located in the field based on visual reference. The approximate exploration pit locations are depicted on the Site and Exploration Plan attached to this report.

Exploration pit logs of the completed pits are attached to this report. The subsurface conditions of the three fingers consisted of rock and fill soil. Exposures in cut slopes south of the highway indicate that the large slope south of the property was comprised of glacial drift sediments overlying Cretaceous migmatite igneous rock.

Stratigraphy

The three fingers consisted entirely of fill soil. Based on our exploration close to the north SR-97 highway shoulder, so is at least a portion of the highway road prism. The eight exploration pits ranged in depth from 13 to 16 feet and native sediments underlying the fill were not indentified in any of the exploration pits. The fill soils consisted of horizontal layers of silty fine to medium sand with trace clay and varying amounts of gravel, cobbles, boulders, and fractured (shot) rock. All of the encountered rock was within a soil matrix – i.e. there were no nested boulders with voids between the rocks observed in any of the explorations. The density of the fill soil varied with depth being denser in the upper 4 to 6 feet with a decrease in the density with depth. The upper soils were medium dense to dense and the lower soils were loose to medium dense. Caving and/or sloughing occurred at depth in all of the explorations. The moisture content varied from dry in the upper 3 to 5 feet and increased to wet or saturated conditions below about 10 feet. The fill soils were likely trucked to the site from the cut bench across the road and from other nearby projects. The fill soils were then spread using a dozer and evidenced by the horizontal layering of the brown, grey, light grey and blue grey coloring of the fill soils. It is likely that dozer tracking and truck tire loads were the compactive effort applied to the soil as drum compactors were not in common use at that time although the equipment was around and may have been used during construction of the fill bodies. What is certain about the fill is that since its placement, the fill soils have been subjected to repeated wetting and drying with the yearly raising and lowering of the lake level. The fill soil has also been in place long enough for the upper 6 to 8 inches of the fill to oxidize to a light brown color due to vegetative and weathering influences.

The sediments on the south side of SR-97 as exposed in numerous cuts slope onsite and nearby consisted of dense, dry to damp, light grey, silty fine to medium sand with some gravel and trace clay. This material has been identified as glacial drift sediments that were deposited in association with movement of glacial ice sheet(s) across the project site. The northeast quadrangle geologic map of Washington identifies the age of these sediments as late Wisconsin period of the Cordilleran ice sheet. The glacial drift sediments were deposited in association with the ice that cut the trough that Lake Chelan now occupies.

The rock underlying the glacial drift exposed on nearby cut slopes south of the property was an igneous rock of the Cretaceous period. The geologic map identifies it as migmatite. The rock is good quality with good resistance to weathering .

Ground Water

Ground water was encountered in two of the exploration pits, EP-7 and EP-8. The ground water represents a delayed response from the lake level. As the lake level rises, infiltration into the fill soil begins saturating the fill soils from the outside in towards the center. As the lake levels drop, the process reverses. The amount of ground water and the position of the ground water table will vary with the lake level and season of the year.

Geologic Hazards

The following discussion of potential geologic hazards is based on the visual reconnaissance of the site, the subsurface explorations, and reviews of aerial photographs and regional topographic maps of the area.

Landslide Hazard Geotechnical Evaluation

The subject property lies across the highway from a large slope up to the south. The slope was comprised of glacial drift sediments smeared onto an igneous rock. The overall inclination of the slope was approximately 1.9H:1V. About 25 feet above the highway, a nearly level bench has previously been cut into the slope. Based on visual review of the slope and on aerial photographs of the slope, there was no evidence of recent slope instability of this slope. Since the slope was comprised of dense sediments and rock and the slope inclination was well below the angle of repose of the material, it is our opinion that the risk of a landslide to affect the planned development is low. Shallow slope movements or rock fall/rock roll would be deposited on the bench on the slope or on the highway with a low potential to impact the short plat properties north of the highway

Erosion Hazard

The onsite soils have a low potential for erosion due to the flat topography of the property. Standard best management practices may be implemented to mitigate the potential for erosion and sediment transport during development.

Seismic Hazard

Generally, there are four types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture; 2) seismically induced landslides; 3) liquefaction; and 4) ground motion. The potential for each of these to impact the site is discussed below.

There was not a known fault zone within the vicinity of the project site. Due to the lack of past active tectonics in the area and the uncertainty of where a possible surface rupture may occur, the potential for surficial ground rupture is considered to be unpredictable and no mitigation is possible or necessary.

Based on the dense, consolidated nature of the glacial drift sediments and igneous rock that are the core of the south slope and their high internal strength characteristics, the risk of a deep seated, rotational landslide is considered to be low to impact the subject property.

Liquefaction is a condition where loose, saturated, fine to medium sands lose their internal shear strength due to rapid pore pressure buildup under the influence of cyclic loading such as occurs during an earthquake. Based on the grain size distribution of the soils and their medium dense condition, it is our opinion that the risk of liquefaction on this site is low.

Seismic hazards that will affect the house will be due to the intensity and duration of the ground shaking. Based on the encountered stratigraphy, structural design of the project should be consistent with 2009 *International Building Code* (IBC) guidelines. In accordance with Table 1613.5.2 of the 2009 IBC, the subject site would be classified as Site Class D.

Geotechnical Engineering Recommendations

From a geotechnical engineering standpoint, the property is considered to be suitable for short platting to 6 building lots. The bearing strata of medium dense fill soil will be suitable for spread footing foundations for typical one or two-story, wood frame structures. Minimal grading is anticipated to be needed for future development. All future development should follow the recommendations contained within this report and in accordance with Chelan City and County development standards as applicable. Any proposed development that varies significantly from the assumption of one or two story, wood frame, single family residences should be reviewed by Battermann Geotechnical Consulting, pllc to provide geotechnical engineering recommendations specific to the planned development.

Site Preparation

Minimal site preparation should be necessary for development of the three fingers. The existing vegetation should be scraped away from all foundation and driveway/parking areas. Any potential organic rich topsoil from the excavations for the driveway cuts should be removed from the site or stored for use in non-structural areas. Topsoil materials are not suitable for use in structural fills and any excess material that will not be part of future landscaping plans should be removed from the site. Topsoil that will be re-used on site should be stockpiled away from structural developments and should be protected from erosion with plastic sheeting.

Erosion control measures applicable to the time of year and appropriate to the type of construction activity should be installed prior to earth disturbing activities. Provisions should be made to route upslope drainage runoff from around the planned work areas either with temporary swales or with permanent cutoff drains.

Temporary cuts to install utility lines using trench box, shoring techniques should remain stable to a depth of about 6 feet to allow the installation of the trench box. The contractor should anticipate some caving and sloughing of trench sides to install trench boxes below a depth of about 6 feet in the three fingers fill bodies depending on ground water levels at the time of construction. Permanent

cut or structural fill slopes should be limited to a maximum inclination of 2H:1V. Fill slopes in non-structural fill areas should be limited to 3H:1V

Structural Fill

Grading plans for the project have not been finalized at the time of this report. There is the potential that a minor amount of structural fill will be necessary for construction of the shared access drives and may be desired to be placed to adjust the elevation of buildings on the lots. Any fill soil to be placed in driveway areas or under structures should be placed and compacted in accordance with the recommendations contained in this section of the report.

All organic soil should be removed from areas to receive structural fill. Loose surface soil disturbed due to the stripping process should be compacted to a firm non-yielding condition prior to placing structural fill. The prepared subgrade should be verified that it ready to receive structural fill by the geotechnical engineer. Non-organic fill soil should be placed in thin lifts, not to exceed 10 inches, on horizontal planes. Filling lifts on non-horizontal planes should be avoided. Each lift of fill should be compacted to a minimum of 95 percent of the modified Proctor maximum dry density per ASTM:D-1557. The structural fill pad should extend a minimum of three feet beyond the edge of a structure or driveway before sloping to match the existing grades.

Placement and compaction of the structural fill should be monitored by a competent field technician. In situ density testing should be performed to verify proper compaction of the fill soil.

Foundations

The medium dense fill soils in the three fingers will be capable of providing suitable foundation support for one or two story, wood frame structures over concrete foundations. Due to the slightly lower density of the fill soils at depth and the yearly high ground water level in the fill soil, we recommend using a reduced bearing pressure for potential structures on the three fingers. An allowable foundation bearing capacity of 1500 pounds per square foot may be used for spread footings set to bear on the three fingers fill soils. A short term increase of one-third may be used for wind, snow, or seismic loads. A 1H:1V load line extending down from the edge of the foundation must not daylight a cut slope. Anticipated settlement of the foundation when properly set to bear on an approved bearing stratum will be less than 1 inch. We recommend that all footing be embedded a minimum of 24 inches below surrounding grades for frost protection.

Lateral loads can be resisted by friction between the foundation and the supporting soils, and/or by passive earth pressure acting on the buried portions of the foundations. The foundations must be backfilled with structural fill compacted to a dense, non-yielding condition to achieve the passive resistance provided below. The structural fill must extend horizontally outward from the embedded portion of the foundation a distance equal to at least three times the embedment depth over which the passive resistance is applied. We recommend the following design parameters.

- Passive equivalent fluid = 250 pcf
- Coefficient of friction = 0.30

The above values are allowable and include a factor of safety of at least 1.5.

Floor Support

Potential structures may utilize either a slab-on-grade floor or a crawlspace type floor. If a crawlspace floor system is used, the interior foundation soils should be covered with a moisture barrier and the crawlspace area should be well ventilated to reduce the potential for moisture damage.

Slab-on-grade concrete floors should be cast atop a prepared subgrade. The subgrade soils should be compacted to a minimum of 90 percent of the modified Proctor maximum dry density or be firm, non-yielding native sediments. The floor slab should be cast atop a capillary break consisting of a minimum of 4 inches of pea gravel or clean crushed rock with less than 5 percent fines (material passing the No.200 sieve). The capillary break will reduce the potential for moisture from wicking through the floor slab. A plastic sheeting vapor barrier should also be placed atop the capillary break material. All concrete placements should follow the guidelines set forth by the American Concrete Institute (ACI).

Drainage Considerations

A perimeter foundation drain should be established to protect the foundation/crawlspace from ground water intrusion. The level of the foundation drain should be set at, or slightly below, the base of the footing elevation. The drain should consist of 4 inch diameter, rigid, perforated, PVC drain pipe and should be set to allow for gravity discharge. The drain pipe should be surrounded by a minimum of 6 inches of pea gravel or washed drain rock.. Roof drains should not tie into the footing drain but should be collected in a separate, tightline drain. Any potential retaining walls planned for the project should have a full height chimney drain established behind the back of the wall to prevent the build-up of hydrostatic pressures.

Conclusion

Based on our site reconnaissance and subsurface explorations the site appears to be suitable for short platting to 6 building lots. We recommend that we be retained to review any proposed development that is significantly different than the aforementioned assumptions to provide additional, development specific, geotechnical engineering recommendations as necessary. Construction monitoring and consultation services should also be provided to verify that subsurface conditions are as expected. Should conditions be revealed during construction that differs from the anticipated subsurface profile, we will evaluate those conditions and provide alternative recommendations where appropriate.

Our findings and recommendations provided in this report were prepared in accordance with generally accepted principles of engineering geology and geotechnical engineering at the time this report was submitted. We make no other warranty, either express or implied.

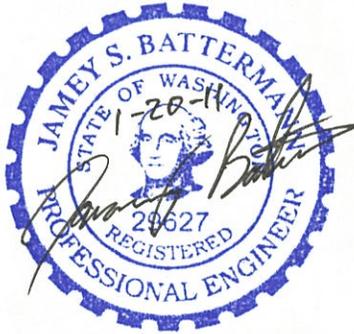
We are available to provide additional geotechnical engineering design and consultation throughout the development of this project. We are also available to provide construction monitoring during development of the project for quality control and to help insure that the recommendations contained

in this report are properly implemented. We have enjoyed working with you on this project. If there are any questions, please contact us at 425 273-5062.

Sincerely

Battermann Geotechnical Consulting, PLLC

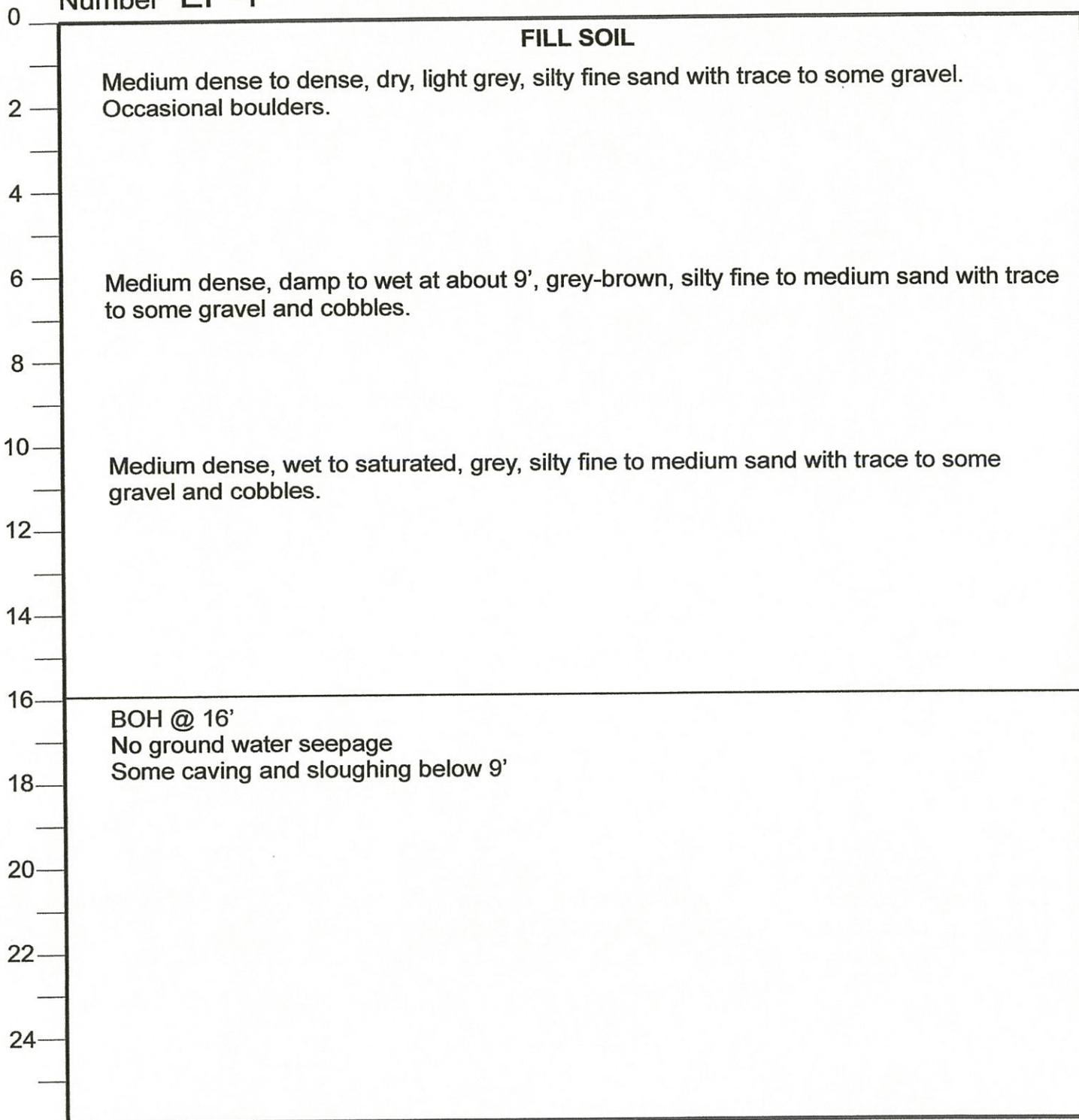
Jamey S. Battermann, PE, LG



Attachments: Site and Exploration Plan
Exploration Pit Logs

EXPLORATION PIT LOG

Number EP-1



Subsurface conditions depicted represent our observation at the time and location of this exploratory hole, modified by geologic interpretation, engineering analysis and judgment. We will not accept responsibility for the use or interpretation by others of information presented on this log.



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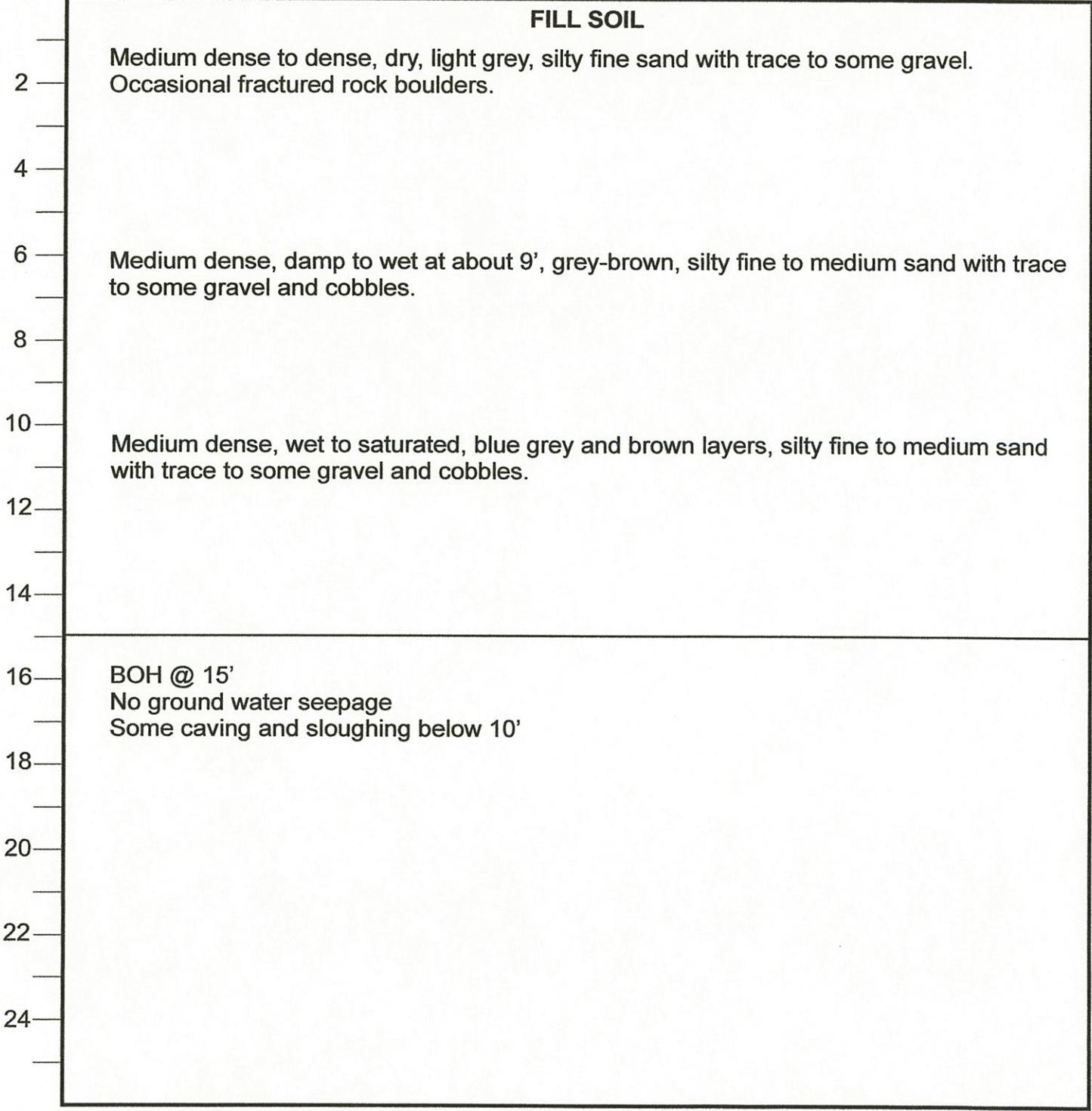
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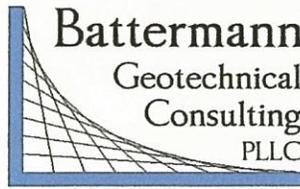
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NOVEMBER 12, 2010
PROJECT No. 10040

EXPLORATION PIT LOG

Number EP-2



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EXPLORATION PIT LOG

0 Number EP-3

FILL SOIL

2 Medium dense to dense, dry, light grey, silty fine sand with gravel to cobble sized fractured rock.

4
6 Medium dense, damp to moist, brown, silty fine to medium sand with trace to some gravel.

8
10 Loose to medium dense, wet, grey blue grey and brown layers, silty fine to medium sand with some gravel and occasional boulders.

12
14
16 BOH @ 15'
No ground water seepage
Some caving and sloughing below 6'

18

20

22

24

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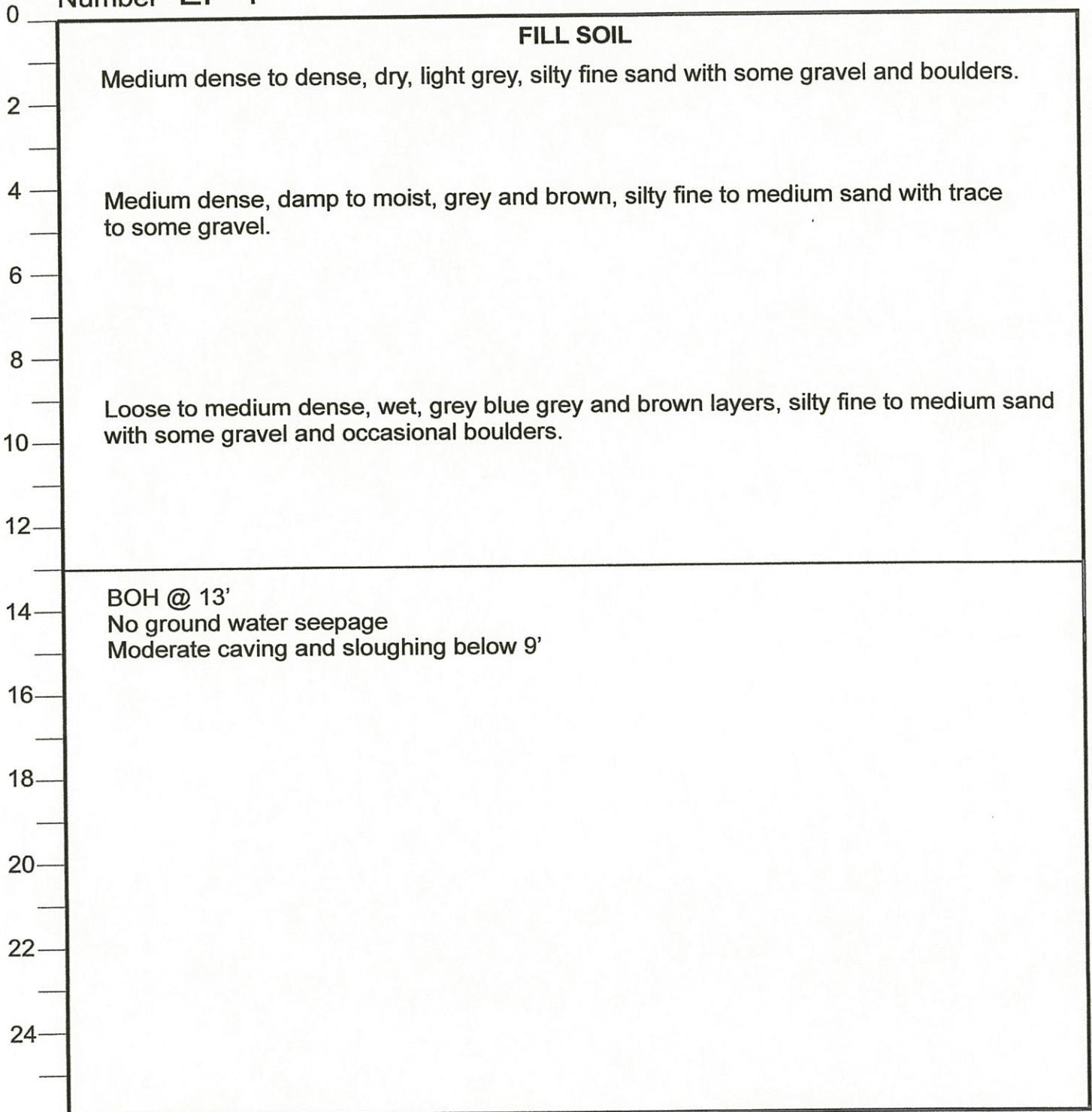
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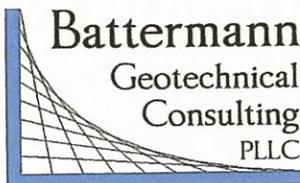
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EXPLORATION PIT LOG

Number EP-4



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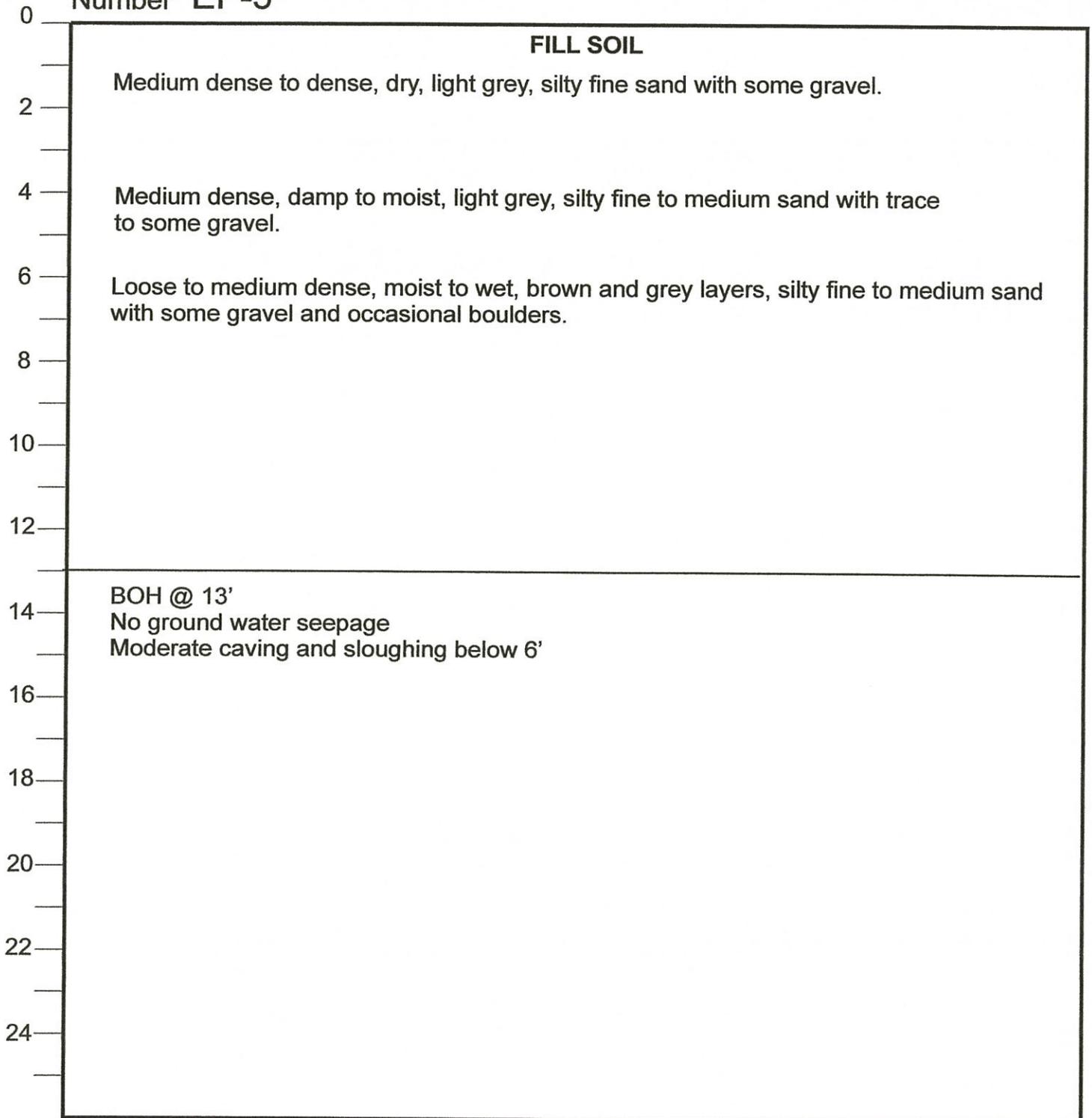


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EXPLORATION PIT LOG

Number EP-5



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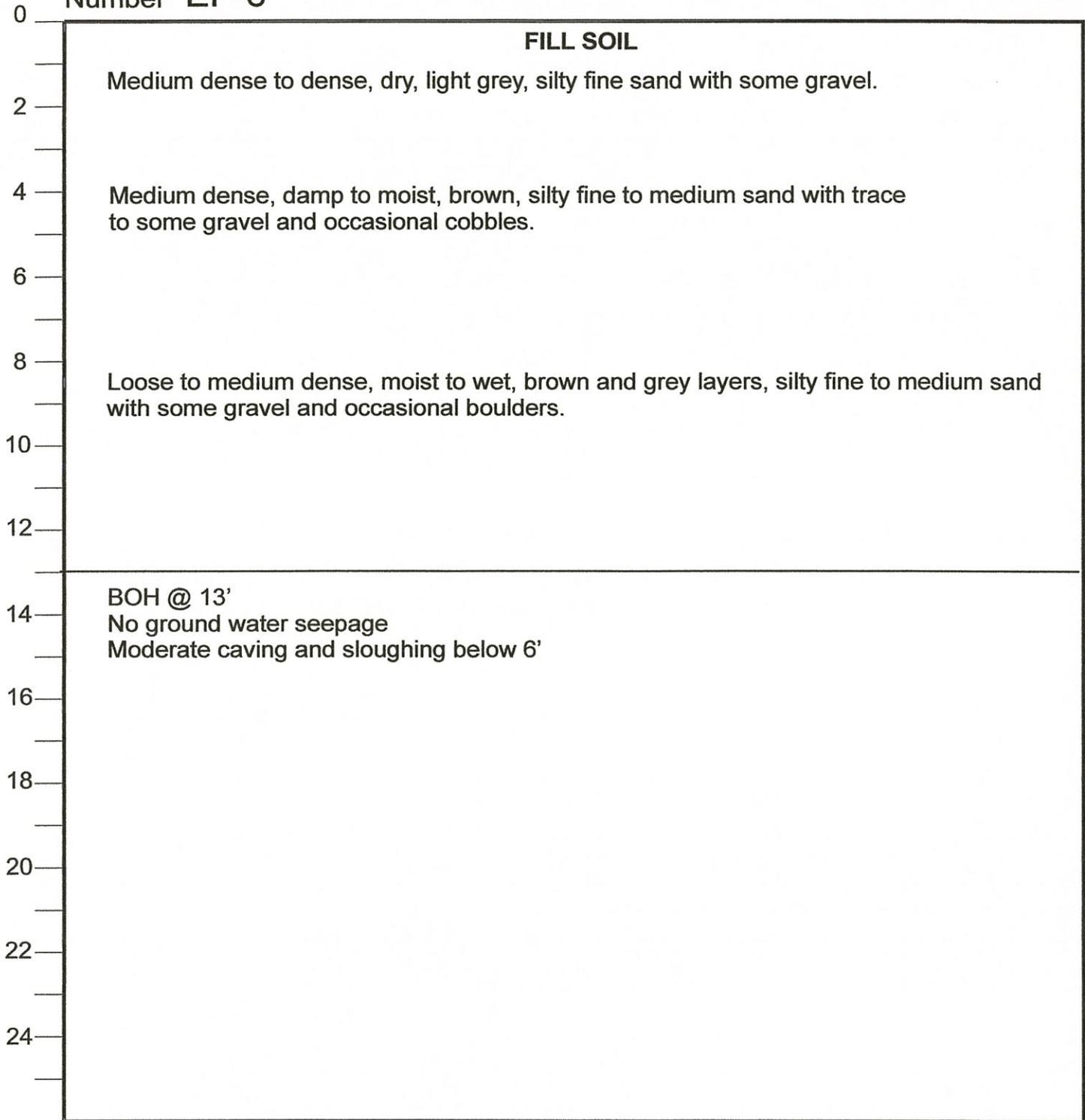


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EXPLORATION PIT LOG

Number EP-6



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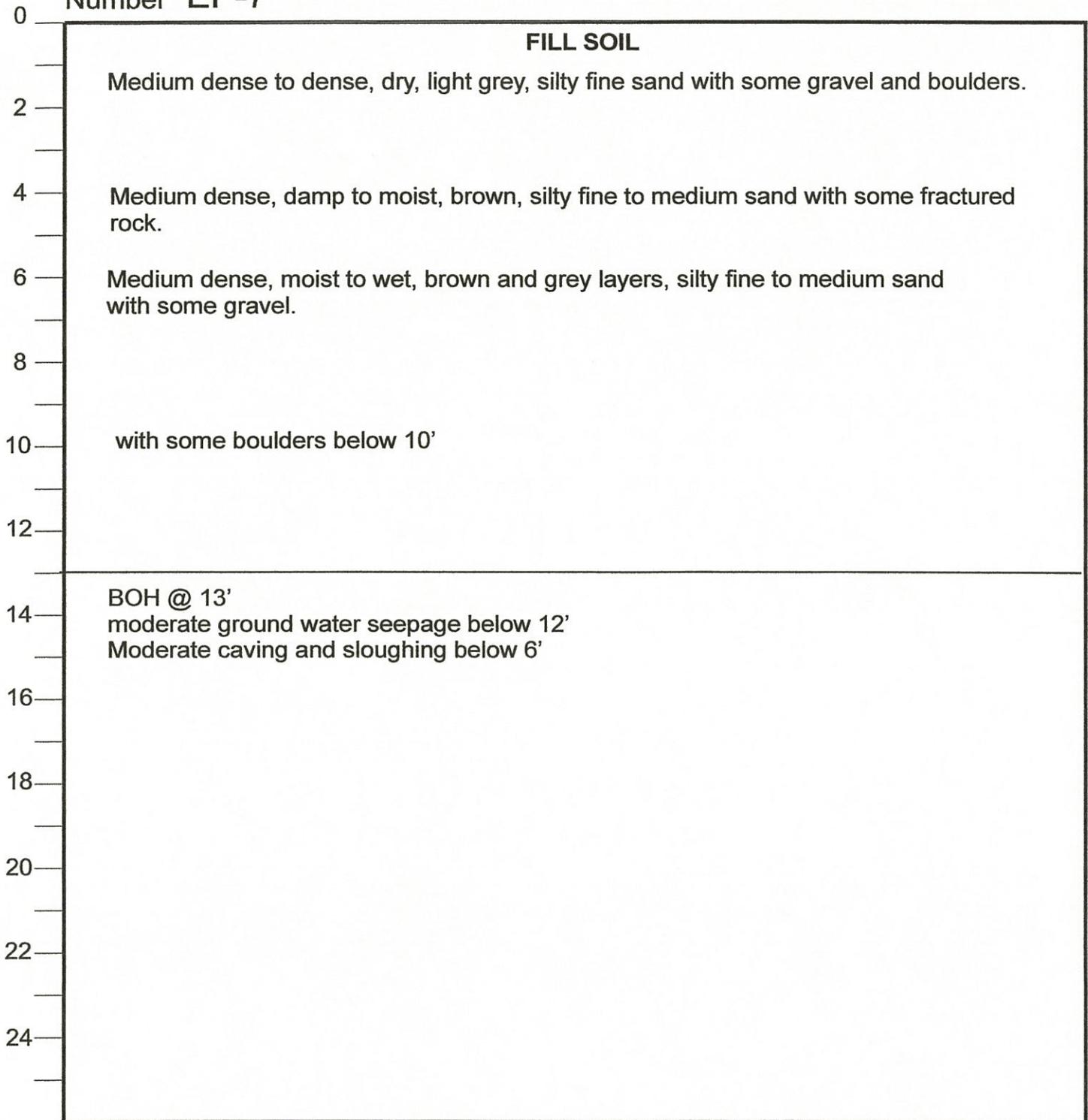


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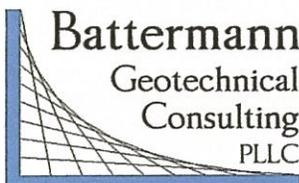
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EXPLORATION PIT LOG

Number EP-7



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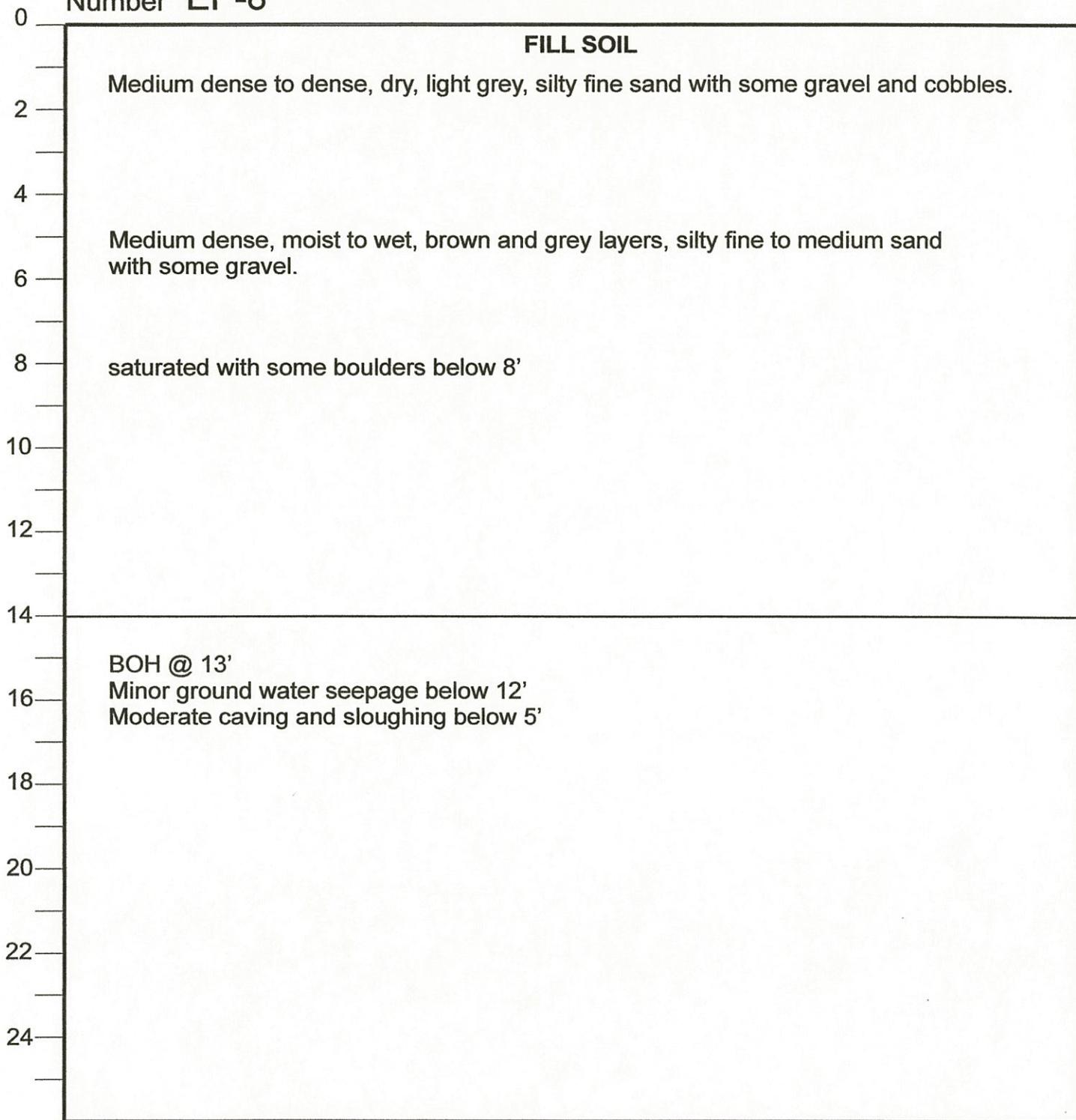
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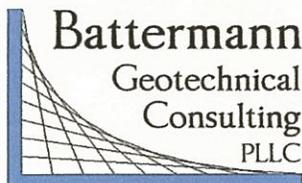
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EXPLORATION PIT LOG

Number EP-8



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