Lewkowich Engineering Associates Ltd.
geotechnical • health, safety & environmental • materials testing

LEES + Associates Landscape Architects
#509 - 318 Homer Street
Vancouver, BC
V6B 2V2

File Number: F3408.01
Date: June 7, 2016

Attention: Mr. David Gibbon

PROJECT: CENTENNIAL PARK UPGRADES, LAKE COWICHAN, BC

SUBJECT: GEOTECHNICAL ASSESSMENT

Dear Mr. Gibbon:

1. INTRODUCTION

As requested, Lewkowich Engineering Associates Ltd. (LEA) has carried out a geotechnical assessment with respect to the above noted development. This report provides a summary of our findings and recommendations.

2. BACKGROUND

LEA understands the proposed upgrades and improvements to the existing Centennial Park include, but are not limited to, reconstruction of the playfield/ball field play area, associated facilities and amenities, including the installation of civil works and services.

3. ASSESSMENT OBJECTIVES

Our assessment, as summarized within this report, is intended to meet the following objectives:

i. Determination of the suitability of subgrade soil conditions, depth to bedrock (if applicable), settlement potential, seismic considerations, depth of the current water table and subsurface drainage considerations, as well as the depth, composition, and consistency of any fill materials, and comments on the suitability of said fill materials for reuse as engineered fill.

ii. Identify any geotechnical deficiencies that may impact the design and reconstruction of the playfield/ball field play area, and the associated facilities, amenities, and civil works

and services.

iii. Prescribe the geotechnical works based on the current conditions of the subsurface soils within the subject development area to ensure suitable ground support for utilities and structures associated with the project.

iv. Relay our findings and recommendation concerning the ground conditions to the Civil Engineer for inclusion in the design parameters.

v. Acknowledge that Approving and/or Building Inspection Officer may rely on this report when making a decision on applications for the development of the land.

4. ASSESSMENT METHODOLOGY

a. The subsurface geotechnical investigation was carried out on May 5, 2015, using a Mobile B-37 track-mounted drill rig provided by Drillwell Enterprises Ltd. A total of ten (10) boreholes (BH 16-01 to BH 16-10) were advanced at locations within the subject development area, as selected by the client, to provide good general coverage of the subsurface conditions of the existing playfield and surrounding area..

b. A site plan showing the location of the boreholes (Figure 1) is attached, following the text of this report.

5. SITE CONDITIONS

5.1. General

a. The proposed development area is located in the southwest region of the Town of Lake Cowichan, BC, north of South Shore Road, south of Point Ideal Drive, and northeast of the Lake Cowichan Centennial Hall and Recreation Center.

b. Currently, the subject area is developed as a baseball playfield, complete with bleachers at the north end, and associated gravel parking to the east. An old asphaltic concrete tennis court is also located at the northwest corner of the site.

c. The subject area is generally level throughout, with the exception of a prominent 1H:1V slope at the south end of the site which declines downward to the north. The parking area for the Lake Cowichan Recreation Center is located to the south and west of the slope.

5.2 Soil Conditions

a. Varying soil strata were encountered during the borehole investigation. Generally, these consisted of miscellaneous fill materials overlying alluvial deposits of sand, gravelly sand, and silt with trace amounts of clay, or minor variations of.

b. The main strata are discussed in general below. Detailed descriptions of the subsurface conditions are provided on the attached borehole logs (BH 16-01 to BH 16-10).

c. Loose to compact, light brown, silty sand with trace gravel and cobbles, and organic matter (topsoil – fill), or minor variations of, was encountered in BH 16-01 to BH 16-06, at depths ranging from 0.0m to 0.5m.

d. Compact to dense, light brown to brown, fine sand and gravel, with some cobbles (import fill), or minor variations of, was encountered in BH 16-07 to BH 16-10, at depths ranging from 0.0m to 1.7m, with the exception of BH 16-09 where a 70mm layer of asphalt was encountered at the surface (tennis courts).

e. Soft to compact, brown to black, silty sand and gravel, with trace cobbles, and some organic silt and debris (wood - fill), or minor variations of, was encountered in in the majority of the boreholes at depths ranging from 0.3m to 1.3m, with the exception of BH 16-02, BH 16-06, & BH 16-10 where compact to dense, medium brown, gravelly sand, with trace silt and trace cobbles (fill), or minor variations of, at depths ranging from 0.3 to 2.8m.

f. Compact to dense, medium brown, fine to medium sand with some silt, trace gravel and trace cobbles (fill) or minor variations of, was encountered in the majority of the boreholes at depths ranging from 1.0m to 3.5m.

g. Stiff, mottled, grey-brown, silt, with trace clay, or minor variations of, was encountered in

the majority of the boreholes at depths ranging from 0.3m to 4.5m.

h. Depths are referenced to the existing ground surface at the time of our field investigation. Soil classification terminology is based on the Modified Unified classification system. The relative proportions of the major and minor soil constituents are indicated by the use of appropriate Group Names as provided in ASTM D2487 Figures 1a, 1b, and 2. Other descriptive terms generally follow conventions of the Canadian Foundation Engineering Manual.

5.3 Groundwater

a. Groundwater seepage was observed in the majority of the boreholes at depths ranging from of 1.3m to 3.2m, with a mean depth of 2.1m.

b. Groundwater levels can be expected to fluctuate seasonally with cycles of precipitation. Groundwater conditions at other times and locations can differ from those observed within the boreholes at the time of our assessment. If groundwater flows or conditions are different than those encountered during the borehole investigation, additional measures may be required during construction. Contact our office immediately if unanticipated conditions are encountered at any point during construction.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 General

From a geotechnical point of view, the land is considered safe and suitable for supporting the proposed reconstruction of the playfield/ball field play area, associated facilities and amenities, civil works and services therein, provided the recommendations in this report are followed.

6.2 Unsuitable Materials and General Excavation/Trenching Recommendations

a. Prior to construction, all unsuitable materials should be removed to provide a suitable base of support in areas where civil works are to be installed, and for structures of the proposed

development requiring foundation support. Unsuitable materials include any non-mineral material such as vegetation, topsoil, peat, fill or other materials containing organic matter, as well as any soft, loose, or disturbed soils.

b. Based on our field investigation we expect unsuitable materials to a mean depth of 1.44m across the site. Fill materials were encountered to a depth of 1.3m throughout the existing play field area; 1.0m to 1.7m within the existing gravel parking area to the east; and to a maximum depth of 2.8m in the vicinity of BH 16-06 & BH 16-10.

c. Ground water ingressing into any excavations or trenches should be controlled with a perimeter ditch located just outside of the construction areas, connected to positive drainage. The Geotechnical Engineer is to confirm the removal of unsuitable materials and approve the exposed competent inorganic subgrade.

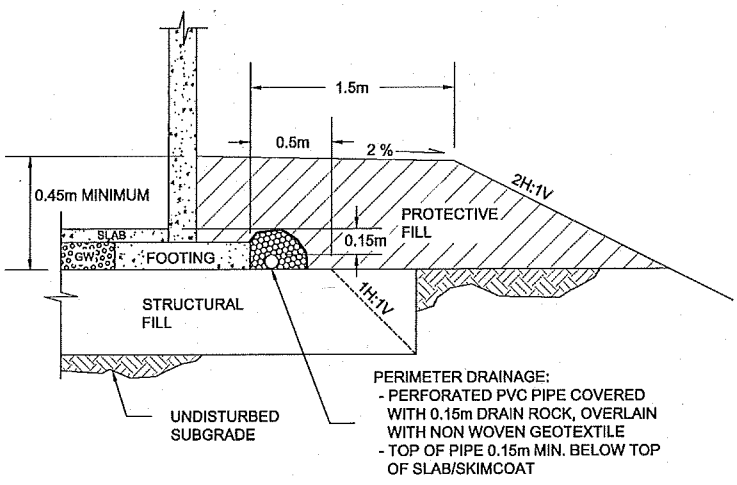
6.1 Placement & Compaction of Structural Fill

a. Where fill is required to raise areas that will support buildings, slabs, or pavements, structural fill should be used. The Geotechnical Engineer should first approve the exposed subgrade in fill areas, to confirm the removal of all unsuitable materials. The thickness of structural fill should be consistent in all areas below the footing elevation to minimize differential settlements.

b. Structural fill should be inorganic sand and gravel. If structural fill placement is to be carried out in the wet season, material with a fines content limited to 5% passing the 75μm sieve should be used, as such a material will not be overly sensitive to moisture, allowing compaction during rainy periods of weather.

c. Structural fill should be compacted to a minimum of 95% of Modified Proctor maximum dry density (ASTM D1557) in foundation and floor slab areas, and a minimum of 95% in paved roadway and parking areas.

d. Structural fills under foundations, roadways, and pavements should include the zone defined by a plane extending down and outward a minimum 0.5m from the outer edge of the foundation at an angle of 45 degrees from horizontal to ensure adequate subjacent support. This support zone is shown in the adjacent figure.



e. Compaction of fill should include moisture conditioning as needed to bring the soils to the optimum moisture content and compacted using vibratory compaction equipment in lift thickness appropriate for the size and type of compaction equipment used.

f. A general guideline for maximum lift thickness is no more than 100mm for light hand equipment such as a 'jumping-jack,' 150mm for a small roller and 300mm for a large roller or heavy (>500 kg) vibratory plate compactor or a backhoe mounted hoe-pac or a large excavator mounted hoe-pac, as measured loose.

g. It should be emphasized that the long-term performance of buildings, slabs, and pavements is highly dependant on the correct placement and compaction of underlying structural fills. Consequently, we recommend that structural fills be observed and approved by the Geotechnical Engineer. This would include approval of the proposed fill materials and performing a suitable program of compaction testing during construction.

6.3 Foundation Design & Construction

a. Prior to construction, the building area should be stripped to remove all unsuitable materials to provide an undisturbed natural soil subgrade for the footing support.

b. Foundation loads should be supported on natural undisturbed soil approved for use as a bearing stratum by our office, or structural fill and may be designed based on an allowable bearing capacity of:

   i. SLS of 100kPa, ULS of 130kPa if founded on the compact to dense upper stratum (grey, gravelly fine sand, trace cobbles),

   ii. SLS of 150kPa, ULS of 200kPa if founded the stiff lower stratum (grey-brown, mottled, silt, trace clay).

   iii. For foundations constructed on the structural fill, as outlined in Section 6.3 of this report, a Service Limit State (SLS) bearing pressure of 150kPa and an Ultimate Limit State (ULS) of 200kPa may be used for design purposes.

c. The above values assume a minimum 0.45m depth of confinement or cover with a total expected excavation depth of approximately 1.3m, to 2.1m (BH 16-10), depending on the location.

d. Exterior footings should be provided with a minimum 0.45m depth of ground cover for frost protection purposes.

e. Settlements should be within the ranges considered "Normal and Tolerable" for typical concrete structure construction under the observed subgrade conditions. Structural design should allow for a total differential settlement up to 25mm.

f. Prior to placement of concrete footings, any bearing soils that have been softened, loosened, or otherwise disturbed during the course of construction should be removed, or else compacted following our recommendations for structural fill. Compaction will only be feasible if the soil has suitable moisture content and if there is access to heavy compaction

equipment. If no structural fill is placed, a smooth-bladed clean up bucket should be used to finish the excavation.

g. The Geotechnical Engineer should evaluate the bearing soils at the time of construction to confirm that footings are based on appropriate and properly prepared founding material.

6.4 Seismic Issues

a. No compressible or liquefiable soils were encountered during the test pitting investigation.

b. Based on the 2012 British Columbia Building Code, Division B, Part 4, Table 4.1.8.4.A, 'Site Classification for Seismic Site Response,' the soils and strata encountered during the test pitting investigation would be 'Site Class D' (Stiff Soil) if founded on the stiff/compact to dense upper stratum, or 'Site Class C' (Very dense soil and soft rock) if founded on engineered fill or the stiff lower stratum (grey-brown, mottled silt, trace clay).

6.5 Permanent Dewatering

a. Conventional requirements of the 2012 British Columbia Building Code pertaining to building drainage are considered suitable at this site. Once final plans and tentative elevations are determined, the Geotechnical Engineer should be consulted to provide further dewatering data.

b. Ground surfaces should be graded to direct surface water away from buildings and structures. Any settlement of backfill around foundations will create undesirable low areas for collection of surface water next to the building, and should be immediately corrected by placement of additional backfill to restore positive surface drainage away from buildings and structures. Settlement of backfill should negligible provided backfill is placed and compacted following our recommendations regarding structural fill.

6.6 Pavement Design – On Site Roadways & Parking Areas

a. Any organic or deleterious material should be removed from beneath the designated roadway, driveway, or parking areas prior to subgrade preparation. If fill is required to bring the subgrade up to the desired elevation, structural fill should be used.

b. The soils found throughout most of the site appeared at or near optimum moisture content. The subgrade should be proof rolled after final compaction and any areas showing visible deflections should be inspected and repaired. The parking lot subgrade and pavement should be sloped to provide adequate drainage.

c. An estimated soaked California bearing ratio of 3.0% and a 20 year design life have been used in the following recommended pavement designs.

i. Areas subject to car and light truck vehicles:

Estimated E.S.A.L. = 2×10^4

Asphaltic Concrete Pavement	= 50 mm
Granular Base Course (19mm crush)	= 100 mm
Standard Subbase Preparation (SGSB)	= 250 mm

ii. Areas subject to delivery trucks

Estimated E.S.A.L. = 1×10^5

Asphaltic Concrete Pavement	= 75 mm
Granular Base Course (19mm crush)	= 150 mm
Standard Subbase Preparation (SGSB)	= 300 mm

d. It is recommended that a reinforced concrete slab be utilized where garbage dumpsters are located. The slab should be large enough to contain the disposal unit and front tires of the garbage truck during disposal operations.

7. GEOTECHNICAL ASSURANCE AND QUALITY ASSURANCE

The 2012 British Columbia Building Code requires that a geotechnical engineer be retained

to provide Geotechnical Assurance services for construction of this nature. Geotechnical Assurance services include review of the geotechnical components of the plans and supporting documents, and responsibility for field reviews of these components during construction.

8. ACKNOWLEDGEMENTS

Lewkowich Engineering Associates Ltd. acknowledges that this report may be requested by the building inspector (or equivalent) of the Town of Lake Cowichan as well as other governmental entities, as a precondition to the issuance of a building or development permit. It is acknowledged that the Approving Officers and Building Officials may rely on this report when making a decision on application for development of the land. We acknowledge that this report has been prepared solely for, and at the expense of LEES + Associates Landscape Architects. We have not acted for or as an agent of the Town of Lake Cowichan in the preparation of this report.

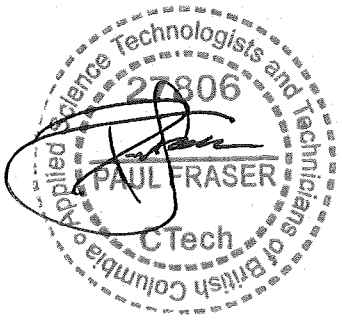
9. LIMITATIONS

The conclusions and recommendations submitted in this report are based upon the data obtained from a limited number of widely spaced subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction or further investigation. The recommendations given are based on the subsurface soil conditions encountered during the borehole investigation, current construction techniques, and generally accepted engineering practices. No other warrantee, expressed or implied, is made. Due to the geological randomness of many soil formations, no interpolation of soil conditions between or away from the boreholes has been made or implied. Soil conditions are known only at the borehole locations. If other soils are encountered, unanticipated conditions become known during construction or other information pertinent to the structures become available, the recommendations may be altered or modified in writing by the undersigned.

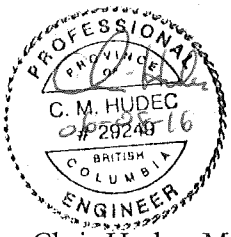
10. CLOSURE

Lewkowich Engineering Associates Ltd. appreciates the opportunity to be of service on this project. If you have any comments, or additional requirements at this time, please contact us at your convenience.

Respectfully Submitted,
Lewkowich Engineering Associates Ltd.



Paul Fraser, B.A., CTech
Technician



Chris Hudec, M.A.Sc., P.Eng.
Senior Project Engineer

Attachments: Site Plan (FIGURE 1), Borehole Logs (BH 16-01 to BH 16-10)

REV No.	DATE	BY	P.Eng.	REVISION DESCRIPTION

DRAWING TITLE
BOREHOLE SITE PLAN

PROJECT NAME
TOWN OF LAKE COWICHAN CENTENNIAL PARK
LAKE COWICHAN, BC

LEGAL DESCRIPTION

ENGINEER'S SEAL

PLOT DATE	DRAWN BY
06/06/2016	SBS
REVIEWED BY	SCALE
CH	NTS
PROJECT No.	DRAWING No.
F3408	F3408.01

LEA
Lewkowich Engineering Associates Ltd.

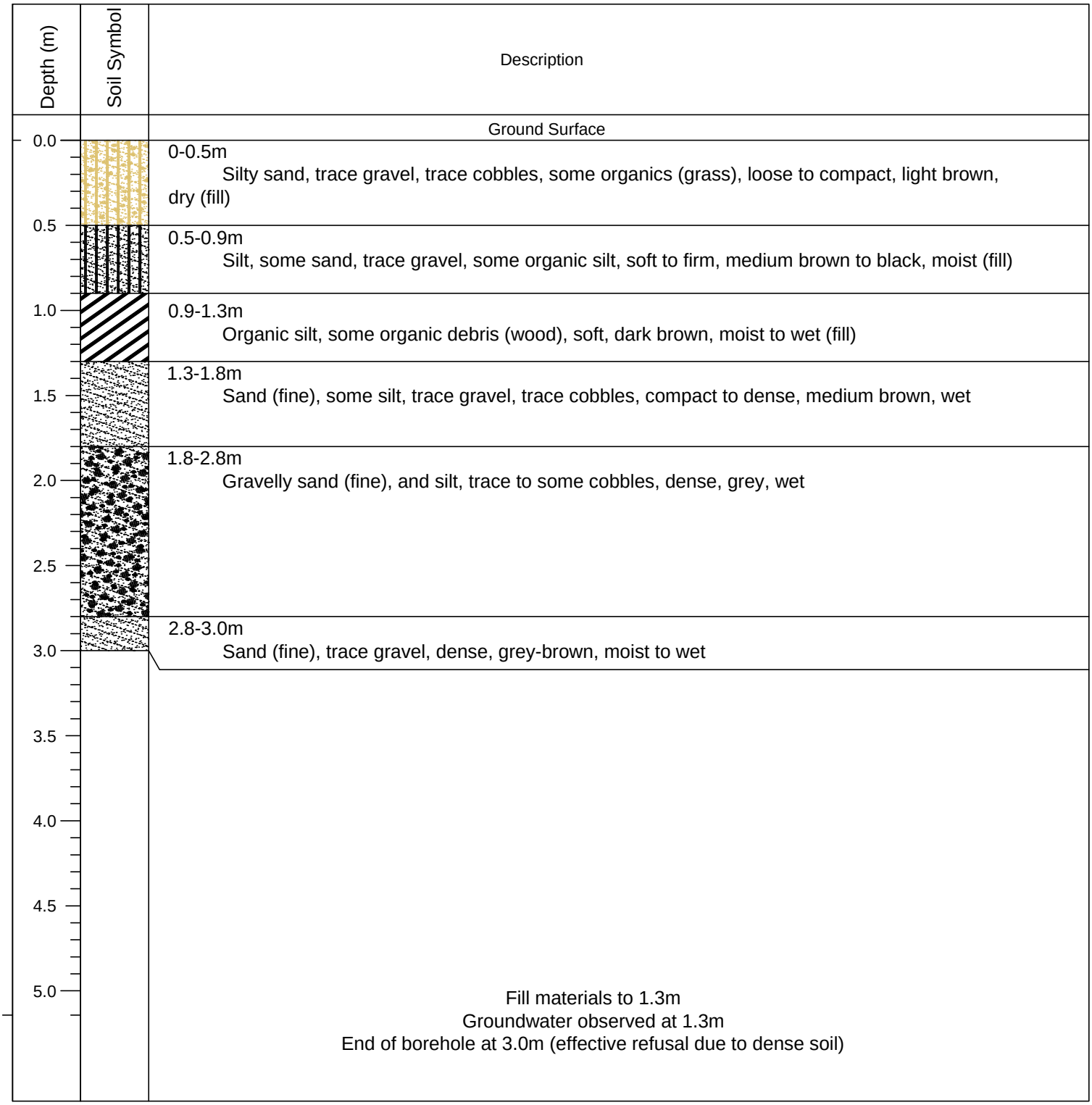
BOREHOLE LOG

Lewkowich Engineering Associates Ltd.

File Number: F3408 BH 16-01

Project: Town of Lake Cowichan Centennial Park

Location: Lake Cowichan, BC



Logged By: PF

Reviewed By: CH

Digging Method: Drillwell - Mobile Drill Rig

Date: June 6, 2016

Sheet: 1 of 10

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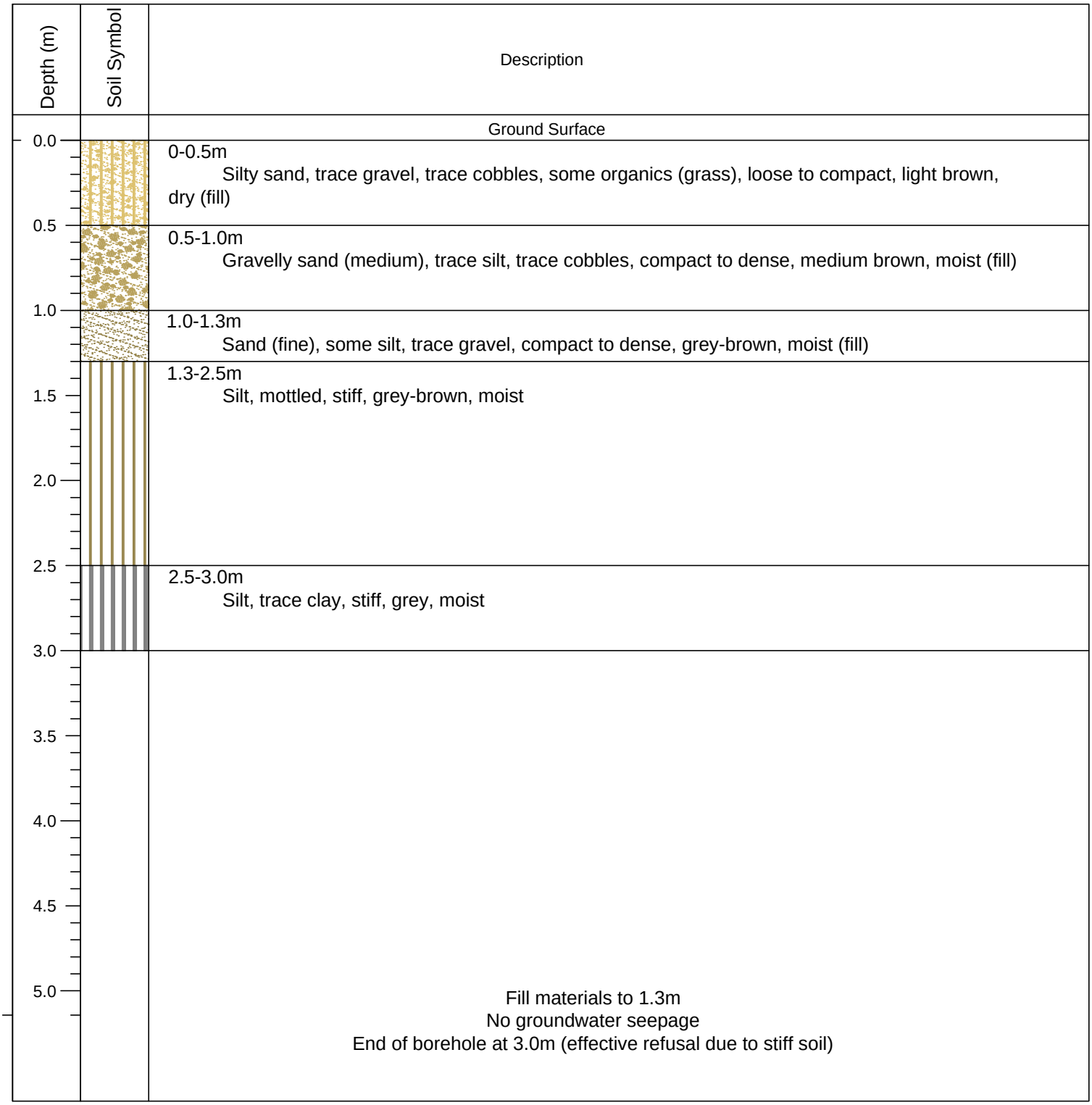
Lewkowich Engineering Associates Ltd.

BOREHOLE LOG

File Number: F3408 BH 16-02

Project: Town of Lake Cowichan Centennial Park

Location: Lake Cowichan, BC



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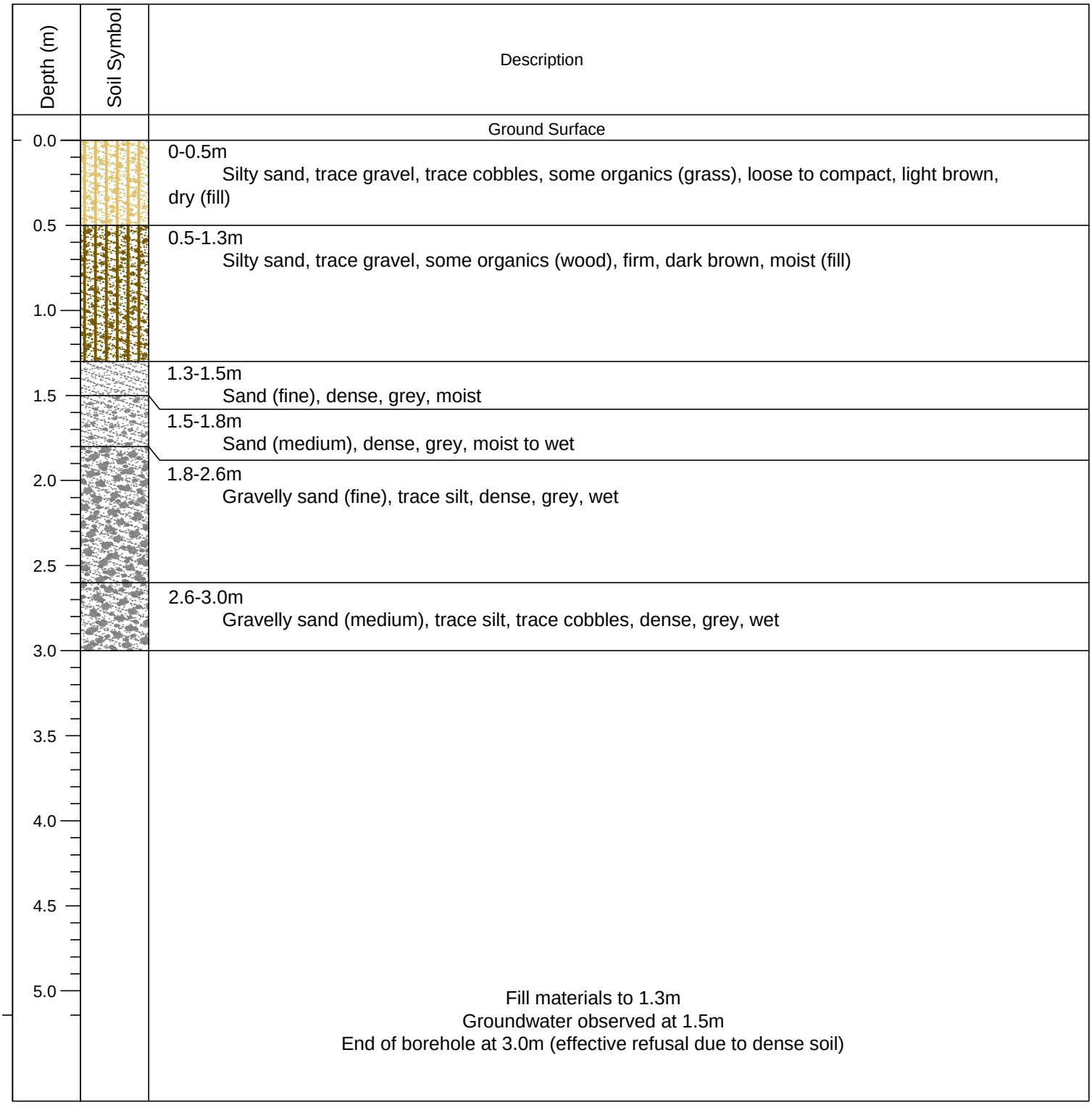
Lewkowich Engineering Associates Ltd.

BOREHOLE LOG

File Number: F3408 BH 16-03

Project: Town of Lake Cowichan Centennial Park

Location: Lake Cowichan, BC



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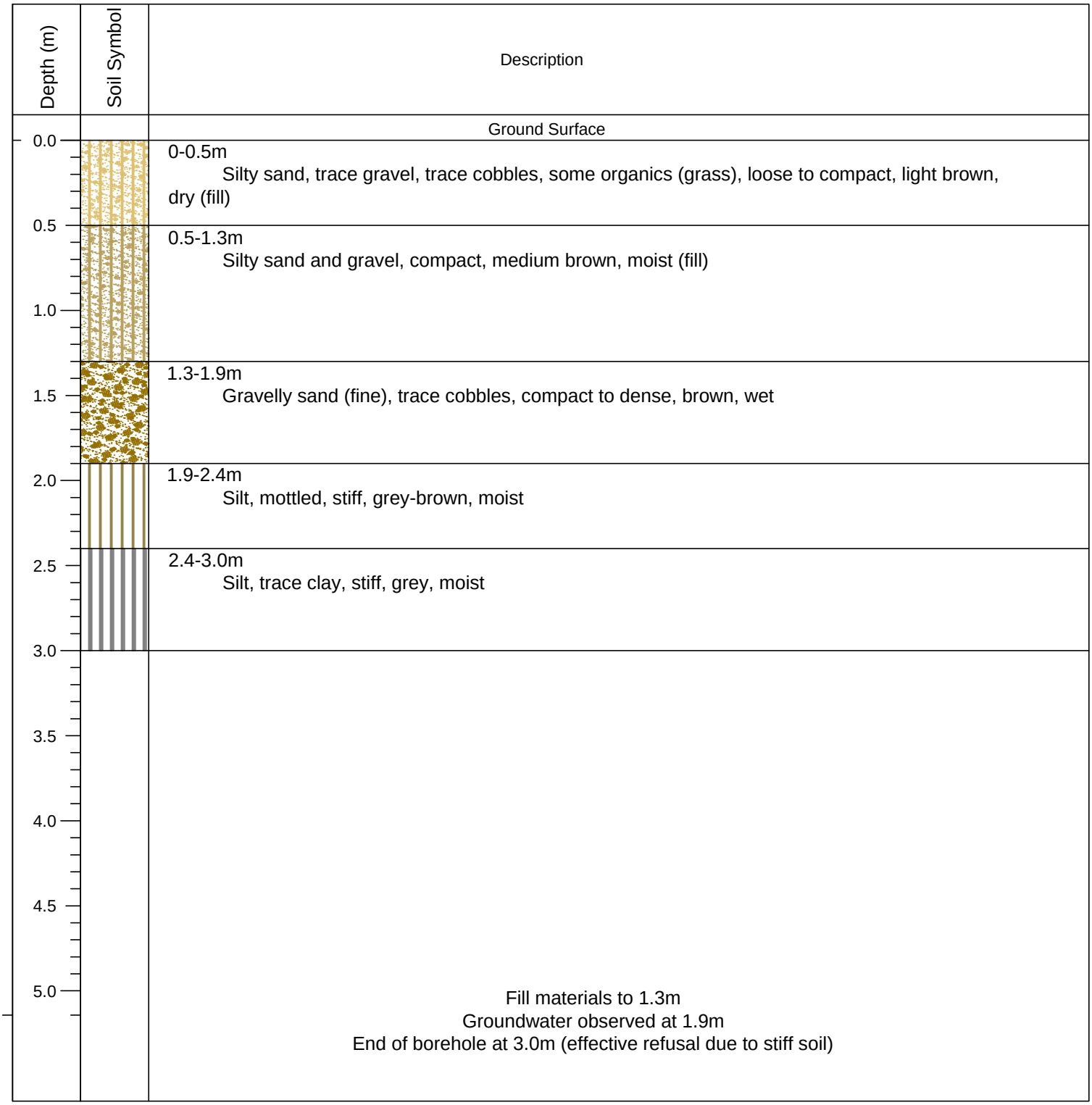
BOREHOLE LOG

Lewkowich Engineering Associates Ltd.

File Number: F3408 BH 16-04

Project: Town of Lake Cowichan Centennial Park

Location: Lake Cowichan, BC



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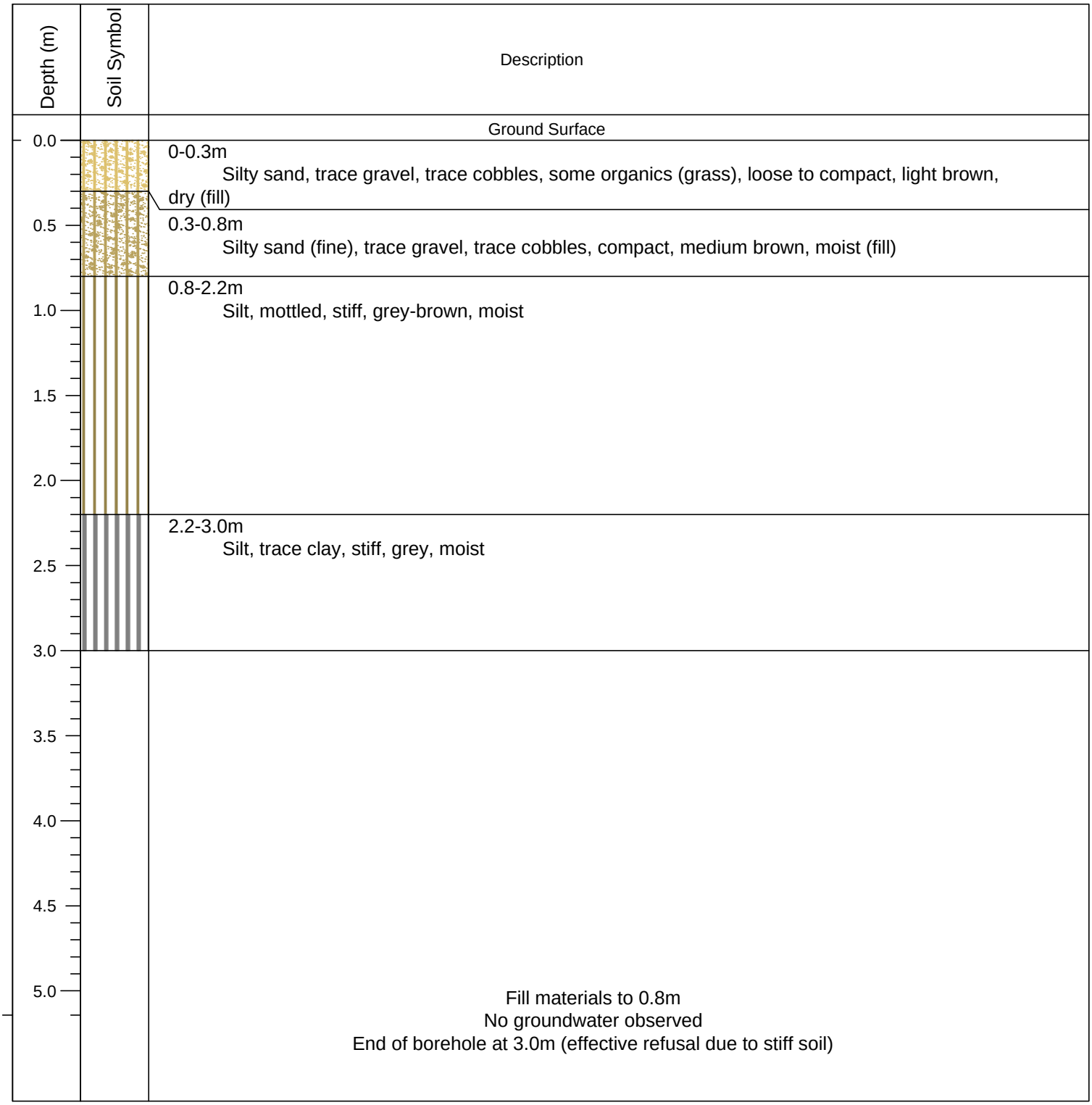
BOREHOLE LOG

File Number: F3408 BH 16-05

Project: Town of Lake Cowichan Centennial Park

Location: Lake Cowichan, BC



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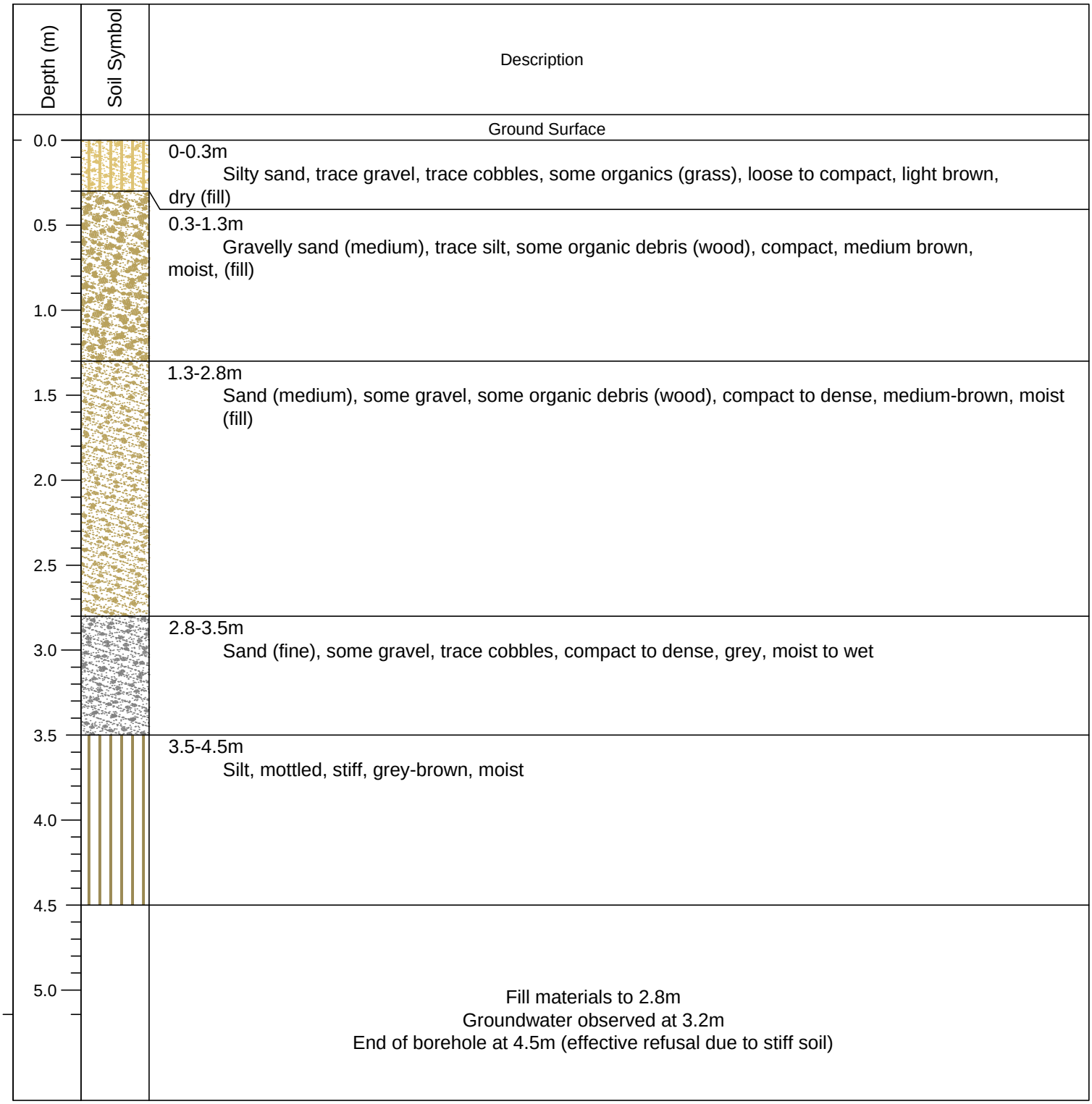
BOREHOLE LOG

Lewkowich Engineering Associates Ltd.

File Number: F3408 BH 16-06

Project: Town of Lake Cowichan Centennial Park

Location: Lake Cowichan, BC



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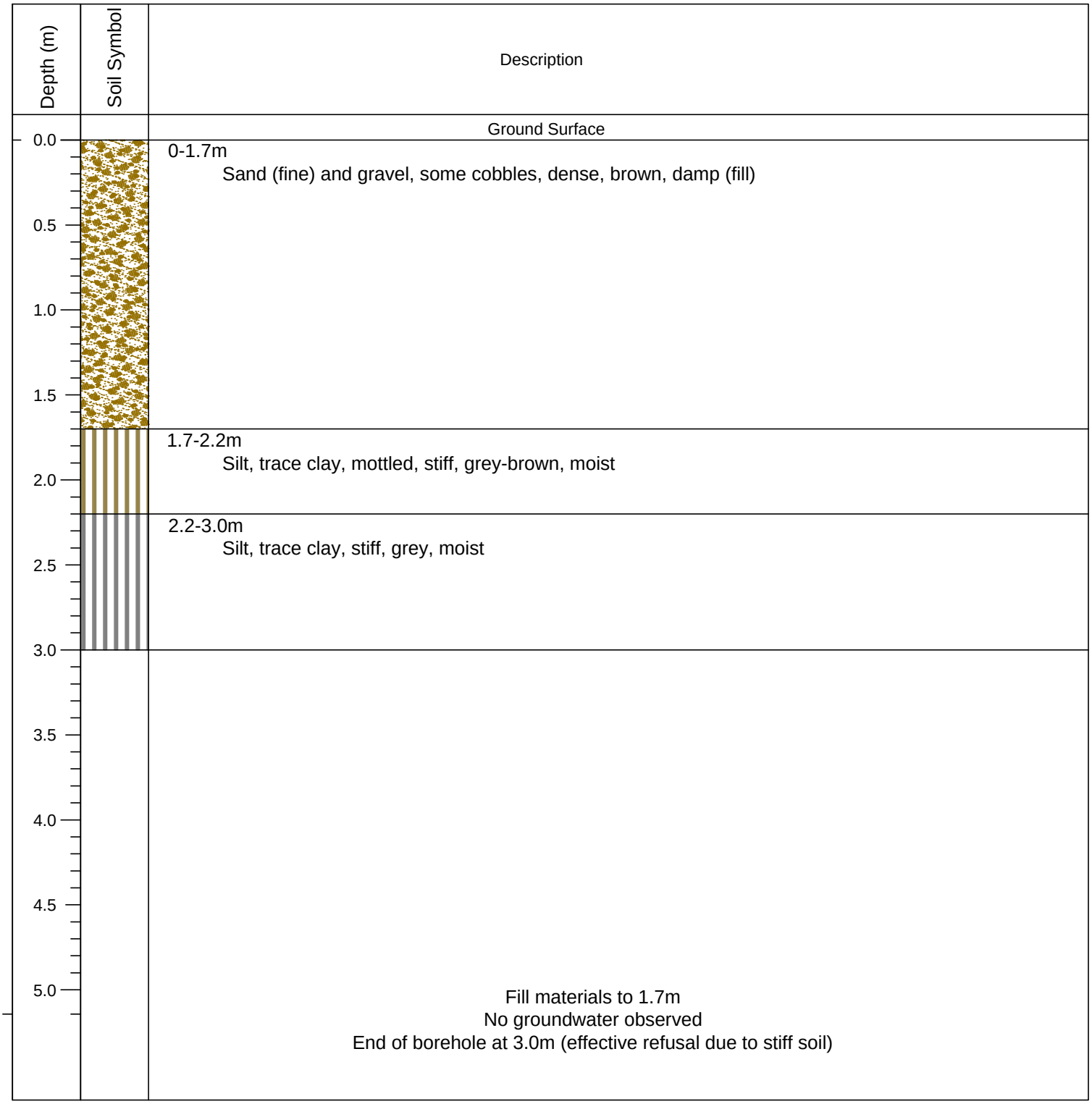
BOREHOLE LOG

File Number: F3408 BH 16-07

Project: Town of Lake Cowichan Centennial Park

Location: Lake Cowichan, BC



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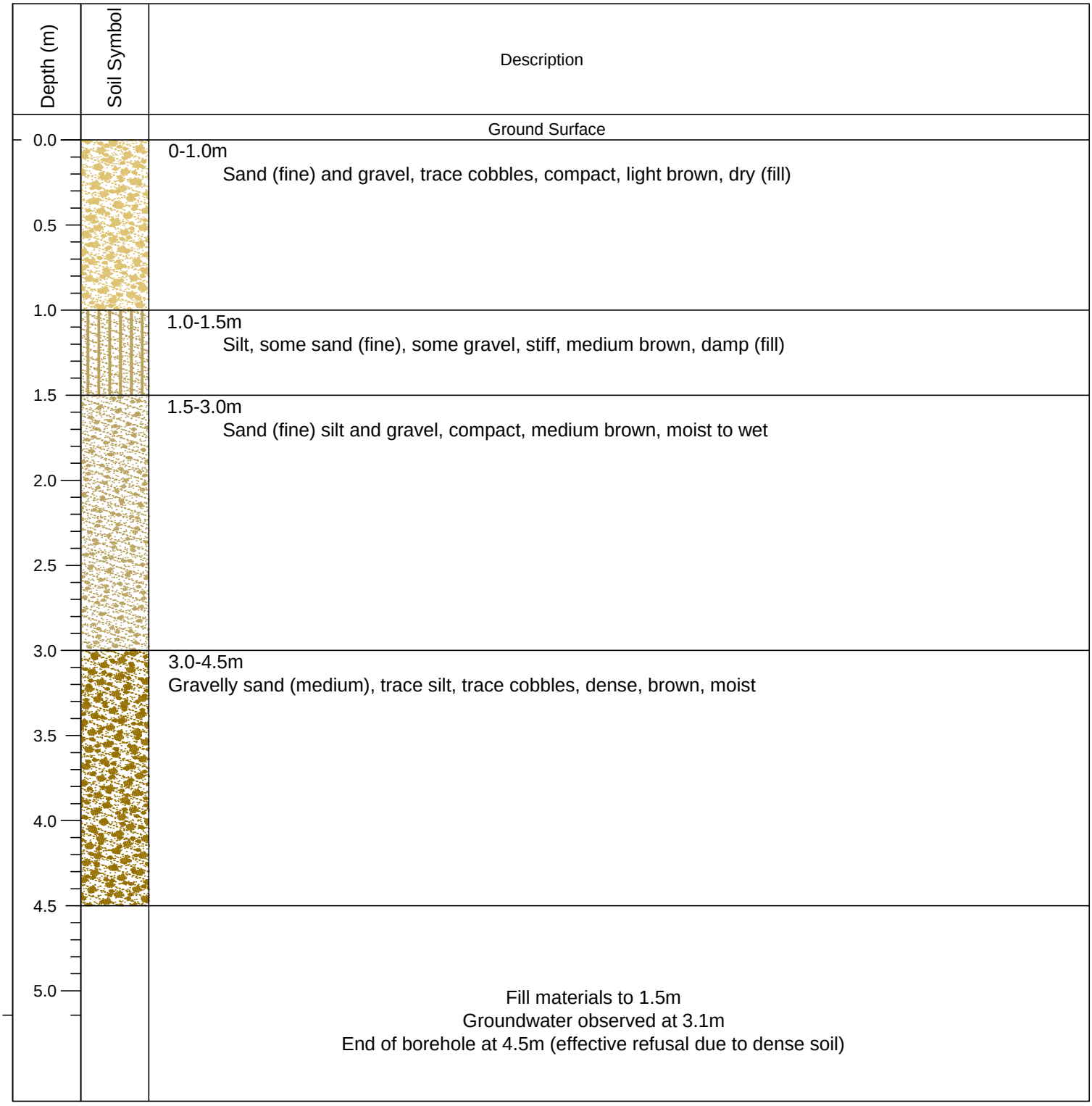
BOREHOLE LOG

Lewkowich Engineering Associates Ltd.

File Number: F3408 BH 16-08

Project: Town of Lake Cowichan Centennial Park

Location: Lake Cowichan, BC



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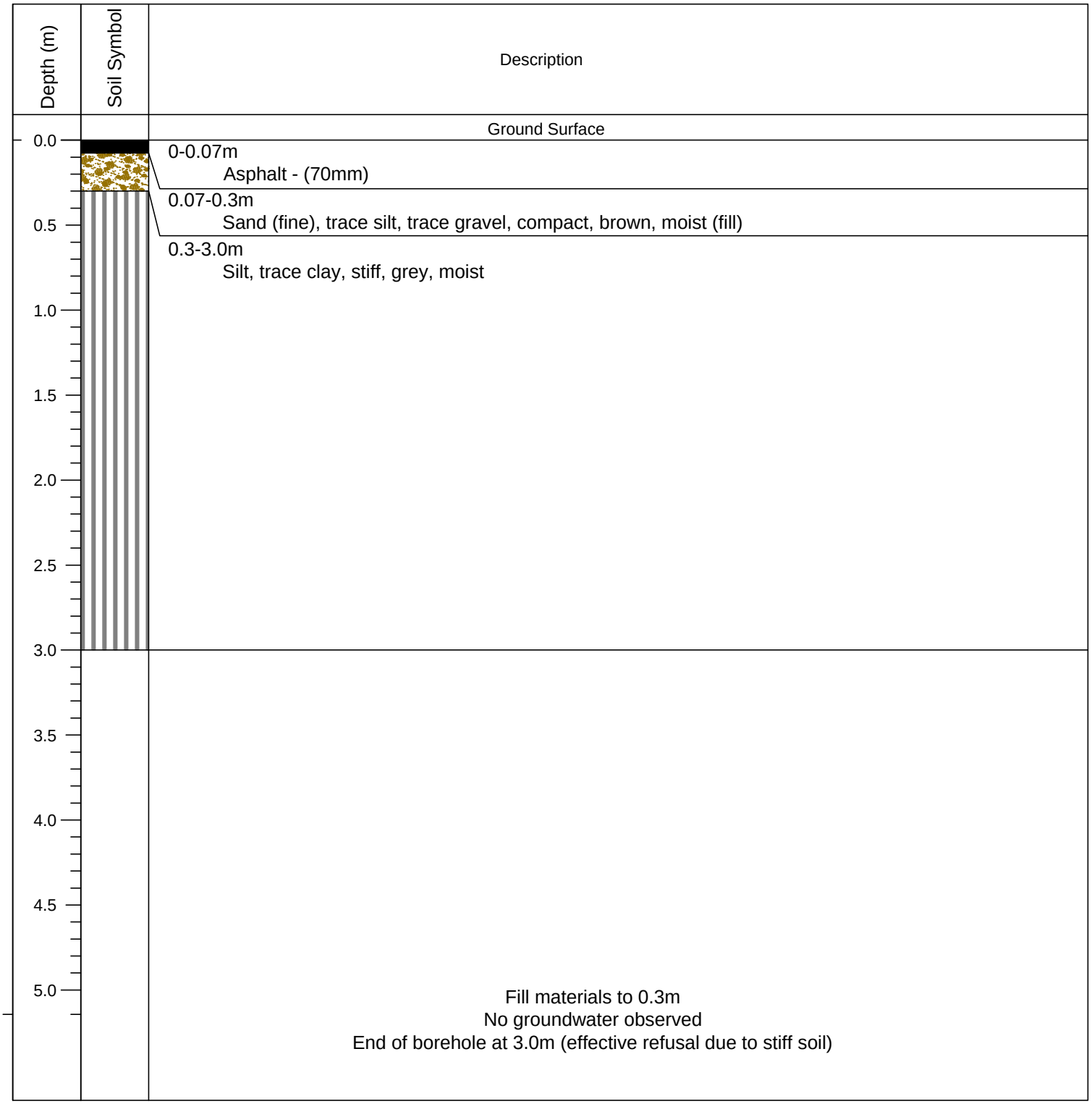
BOREHOLE LOG

File Number: F3408 BH 16-09

Project: Town of Lake Cowichan Centennial Park

Location: Lake Cowichan, BC



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BOREHOLE LOG

File Number: F3408 BH 16-10

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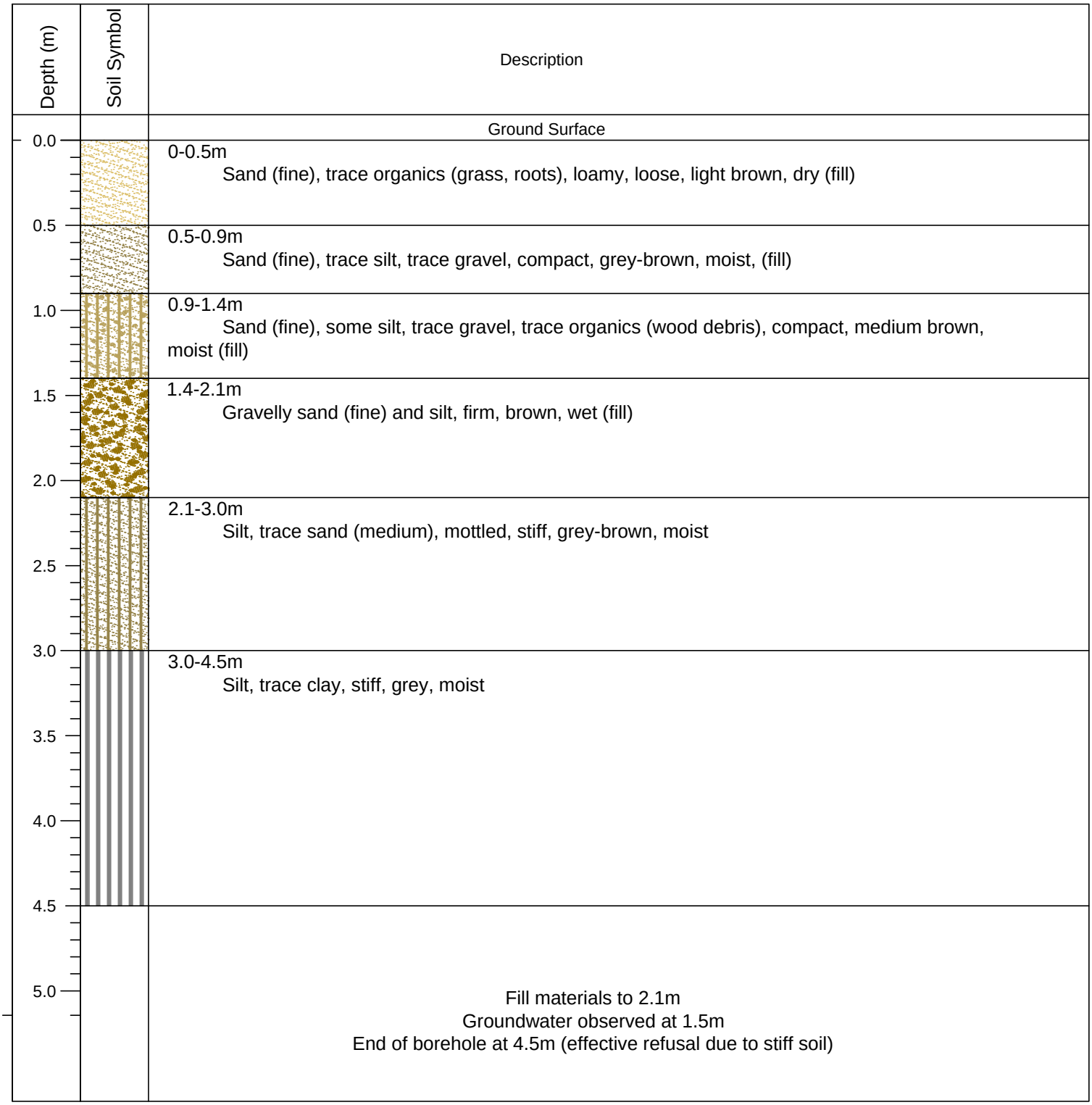
Location: Lake Cowichan, BC



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