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HIGHWAY 7 & HIGHWAY 11 INTERSECTION IMPROVEMENTS PROJECT

100% GEOTECHNICAL DESIGN REPORT

Client Name: ISL Engineering and Land Services Ltd.
Date: March 11, 2024
MoTI File: 13252
Thurber File: 15723

Suite 2302, 4464 Markham Street, Victoria, British Columbia V8Z 7X8 | Phone: (250) 727-2201

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TABLE OF CONTENTS

APPENDICES

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1. INTRODUCTION

This letter report provides the results of geotechnical investigations carried out by Thurber Engineering Ltd. (Thurber) for the Highway 7 and Highway 11 Intersection Improvements project. It also provides our interpretation of the results and our geotechnical recommendations for design and construction of Phase 2 of the project. Thurber's scope of work is described in our proposal dated September 21, 2023. A previous Thurber report dated April 6, 2017 describes the results of a slope stability assessment and liquefaction analysis. Thurber's work was conducted under "As and When" Contract No. 872CS1768 between ISL Engineering and Land Services Ltd. (ISL Engineering) and the BC Ministry of Transportation and Infrastructure (MoTI).

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2. BACKGROUND

The project involves improvements to improve traffic safety and flow at the intersection of the Lougheed Highway (Highway 7) and the Abbotsford-Mission Highway (Highway 11) in Mission, BC. The north leg of the intersection is referred to as the Cedar Valley Connector.

The area north of Highway 7 is occupied by commercial developments and the area to the south is relatively undeveloped and low-lying. The low area is bisected by the Highway 11 embankment, which is about 5 m to 10 m high with side slopes at approximately 2H:1V (varies). Highway 11 bridges above the CPR tracks approximately 200 m south of the intersection, outside the project grading limits. Southeast of the intersection Windebank Creek runs in a north-south direction parallel to the Highway 11 embankment. Southeast of the intersection a smaller watercourse runs parallel to the west toe of the Highway 11 embankment. A sanitary pipeline crosses below the Highway 11 embankment to the north of the bridge above CPR.

Record drawings (2013, Dwg. R1-736-110) associated with the sidewalk along the east side of Highway 11 indicate that the crest of the embankment slope may be a steepened geogrid reinforced soil slope (GRS) in some areas.

Phase 1 improvements were completed in 2019 and included work in the eastbound left turn lane (West leg of intersection). The Phase 2 improvements include traffic operation improvements to the northbound left turn lanes (South leg) and the eastbound right turn lane (West leg). In addition to traffic pattern changes, the improvements are to include drainage and pavement improvements and new sign structures.

As described in Thurber's 90% design report dated April 6, 2017, a preliminary geotechnical slope stability assessment identified the potential for poor seismic performance of the existing embankments. Further assessment of the seismic performance and the design of potential embankment foundation ground improvements were beyond the scope of the project. The design was modified to avoid geotechnically significant changes to the grade and side-slopes of the embankments.

3. GEOTECHNICAL INVESTIGATION

3.1 Site Reconnaissance

A site reconnaissance was completed by Thurber on November 1, 2016 in the company of representatives from MoTI and ISL Engineering. The purpose of the reconnaissance was to confirm our understanding of the site and to identify drilling access constraints and potential utility conflicts. No signs of recent instability were observed in the embankment slopes and our understanding is there is no documentation of slope instability at the site. Groundwater seepage was observed at the west and east toes of the Highway 11 embankment. ISL Engineering also provided Thurber with photographs and notes regarding areas of pavement distress following a site visit with MoTI on November 17, 2023. A site visit was also conducted by Thurber on February 15, 2024 with ISL to review the location of a proposed sign bridge and potential effects on the embankment slope.

3.2 Drilling Investigation

Previous investigations at the site were limited to two circa 1980 test holes at the CPR bridge to the south (Appendix A).

A drilling investigation was completed in 2016 to characterize the geotechnical conditions at the site and in particular to provide the data required to conduct stability analyses and liquefaction assessments. The existing pavement structure and pavement subgrade materials were also investigated. The investigation was designed to provide adequate information for the design of embankment widening in either the southwest or southeast quadrants. The delineation of the anticipated transition from lowland to upland sediments was a key objective of the investigation.

Subsurface information was obtained at a total of 12 locations including test holes at the crest and toe of both the Highway 7 and Highway 11 embankments. A generalized description of the investigation results is provided in the subsequent sections.

Test hole locations were located using a handheld GPS and offsets from surface features. Surface elevations were estimated based on the provided site elevation contours. The approximate locations of the test holes are shown on the attached Drawing 15723-1.

Test holes were advanced by On Track Drilling Inc. using solid stem augers. Dynamic cone penetration tests (DCPTs) were completed at each location. The depth of investigation at each test hole ranged from about 5 m to 20 m, depending on location and purpose. A standpipe piezometer was installed in TH16-1 to provide a stable piezometric reading. A key to the locked standpipe casing was provided to MoTI care of ISL Engineering.

Additional in situ testing was completed adjacent to TH16-1 at the toe of the Highway 11 embankment in the southeast quadrant. A seismic cone penetration test (SCPT) operated by Schwartz Soil Tech was completed to a depth of 16.8 m, using a 10 ton cone tip. Pore pressure dissipation data was collected at 3 discrete depths. Nilcon vane shear tests were completed at 3 discrete depths within an adjacent hollow stem auger test hole. The raw CPT data was provided in digital format to MoTI care of ISL Engineering for later reuse.

The investigation was supervised by an experienced project geoscientist. The soils were logged in the field and disturbed samples were collected from the recovered soil. All test holes were backfilled with drill cuttings and bentonite chips, in general compliance with the BC Groundwater Protection Regulation.

Test hole logs and in situ testing data are provided in Appendix B.

3.2.1 Discussion of Limitations of Penetration Testing Methods

DCPTs provide a qualitative estimate of in-situ density for granular soil and are useful for identifying stiffness and strength contrasts within and between strata. The DCPT tip is similar in size and shape to the SPT split spoon sampler and is driven using the same hammer. However, the DCPT is not a standardized test and its use to infer the in-situ density of granular soil and assess liquefaction potential is limited.

The blow counts from both DCPTs and SPTs are sensitive to grain size effects, particularly where coarse gravel is present. The tip resistance measured with the CPT is also sensitive to this effect. DCPTs and SPTs are also sensitive to the energy efficiency of the drop hammer used to advance the test. Measurement of the hammer efficiency was beyond the scope of the investigation.

The DCPT is also subject to the effects of increasing rod friction with depth of penetration. This rod friction can result in recorded blow counts which are significantly higher (e.g. double) than those which would be recorded with an SPT. The magnitude of rod friction depends on the subsurface conditions and is therefore site specific. In some cases, the DCPT is restarted following a drill-out to reduce the rod friction effect.

The test hole log descriptions of density and consistency are based on the available DCPT or SPT blow count data. As such, in some cases the field density and strength of the materials may be less than described on the logs due to the combined effects of rod friction and grain size.

3.3 Laboratory Testing

The soil samples were returned to our laboratory for routine visual classification and moisture content testing. Fines content tests and Atterberg limit tests were completed on selected samples to improve the characterization of the soils and to facilitate the liquefaction assessment.

The results of the laboratory testing are provided on the test hole logs in Appendix B.

4. SITE CONDITIONS INTERPRETATION

4.1 Geological Model

The geological conditions encountered in the investigation are complex and heterogenous. The generalized soil conditions are described below. Refer to the test hole logs and testing data in Appendix B for detailed information.

The Geological Survey of Canada has mapped the Mission area at a regional scale. Excerpts of the Surficial Geology Map 1485A (Mission) are provided in Figures 1 and 2. The map indicates that the site is located near the transition between upland glaciofluvial outwash deposits to the north (Sumas Drift Formation,‘Sj’) and the relatively younger and low-lying Fraser River sediments to the south (‘Fh’ on the map). The exact position and nature of the boundary is obscured by the vegetation, highway embankments, and regrading associated with neighbouring developments.

The investigation revealed the presence of relatively young and typically normally consolidated low-land sediments (interpreted as Fraser River deposits) throughout the project area and extending to depths ranging from 15 m to 21 m below current embankment toe grades. This indicates that the near-surface transition from lowland to upland sediments occurs further north than anticipated from the topography and surficial geology mapping.

Below the Fraser River Sediments, coarse grained deposits interpreted as the Sumas Drift Formation were encountered at TH16-1 and TH16-7 and fine grained deposits interpreted as the glaciomarine Fort Langley Formation (‘FLc,d’ on map) were encountered at TH16-3.

Overlying the native sediments, fill embankments in the range of 6 m to 10 m high have been constructed to support the highways.

A summary of the major geological units encountered is presented below in Table 1, listed from youngest to oldest. These geological units are described in further detail in the following sub-sections.

Table 1: Summary of Geological Units within the Study Area

Lithology	Origin / Processes	Common Material Description	Relative Consistency*
Fill	Anthropogenic (Possible Dredge)	Sand with trace gravel and silt	Loose or Dense
Fraser River Sediments	River Channel-Fill, Overbank Floods, Stream Channel Fill	Sequences of Organic Silt, Silt, Sand, and Clay	Loose or Compact / Soft or Firm
Sumas Drift Formation	Glaciofluvial	Gravel and Sand, with silt	Compact or Dense
Fort Langley Formation	Glaciomarine	Clay and Silt, with sand	Stiff

** Provided consistencies are generalized. Refer to penetration test results on logs and above discussion of limitations of penetration testing methods.*

4.2 Fort Langley Formation

The oldest deposits encountered in the investigation are the glaciomarine Fort Langley Formation. The surficial geology map indicates that the Fort Langley Formation may underlie the Sumas Drift Formation. However, where the Fort Langley Formation was encountered (at TH16-3), the Sumas Drift was absent. This formation was only observed at TH16-3 at the toe of the Highway 7 embankment in the southwest quadrant of the intersection. It was encountered at a depth of 17.7 m (approx. EL. -8 m).

The Fort Langley Formation was found to comprise silty clay with sand and had moisture contents between 20% and 30%. DCPT blow counts indicate a consistency of very stiff to hard, however the effects of rod friction on the blow counts must be considered.

4.3 Sumas Drift Formation

South of the intersection along Highway 11, the glaciofluvial Sumas Drift Formation was encountered at TH16-1 and TH16-7 at depths of 15.5 m (approx. EL. -8 m) and 20.7 m (approx. EL. -4 m), respectively. The surficial geology map indicates that the Sumas Drift Formation overlies the Fort Langley Formation and was found to underlie the Fraser River Sediments. North of the investigated area, the surficial geology map indicates that the Sumas Drift is the predominant geologic unit exposed near ground surface. The silty sand encountered underlying the pavement structure at TH16-5 (at the western limit of the investigated area) may be a near-surface observation of the Sumas Formation.

The Sumas Drift Formation was found to comprise sandy gravel to gravelly sand with particles up to 40 mm diameter and trace to some silt. Moisture contents were found to range from 10% to 15% and DCPT blow counts indicate a dense condition. However, qualitatively adjusting for rod friction and particle size effects this material may be in a loose to compact state.

It is also possible that the sand and gravel unit encountered at TH16-1 and TH16-7 is actually a gravelly zone within the Fraser River sediments, and not part of the Sumas Drift Formation.

4.4 Fraser River Sediments

Within the investigated area, relatively young Fraser River sediments were found to underlie the fill embankments and overlie the glacial sediments. These sediments were encountered at all of the test hole locations that extended into native soils (except possibly TH16-5). These sediments were deposited by the Fraser River as channel fill and overbank flood deposits and may also be intermixed with sediments deposited by Windebank Creek. The total thickness of the Fraser River sediments was found to range from 10 m to 18 m (assuming that the sand and gravel unit encountered at depth belongs to the Sumas Drift Formation).

The sequence of stratigraphic layering within the Fraser River Sediments was found to be complex and varied within the investigated area. Generally, organic silts and clays were encountered near the top of the sequence in relatively thin layers, which is consistent with an overbank depositional environment. These were underlain by thick deposits of silt and sand in varying proportions which may be alluvial channel fill deposits.

4.4.1 Organic Silt and Clay

Organic silt was encountered at TH16-1, TH16-2 and TH16-3. It was typically at the base of the fill and ranged in thickness from 0.15 m to 0.6 m. Organic silt was absent in the test holes completed from the crest of the highway embankments, which may indicate it was stripped before embankment construction. At TH16-2 the organic silt was found to have a moisture content of approximately 35% and a liquid limit of 30% and plastic limit of 24%. Moisture contents above the liquid limit may be a result of the organic content and a sensitive soil fabric. DCPT blow counts indicate a very soft to soft consistency.

Clay was observed below the organic silt at TH16-1 and was approximately 1.25 m thick. The moisture content of this layer was approximately 50%, and its Atterberg limits were 48% and 28% for liquid and plastic limits, respectively. Moisture contents above the liquid limit may be a result of organics and a sensitive soil fabric. DCPT blow counts indicate a firm to stiff consistency. The positive CPT pore pressure response within this clay layer indicates a contractive response. A thin layer of clay, 0.05 m thick, was also encountered at TH16-6. These clays are interpreted to be lightly over-consolidated where they are found outside of the existing embankment footprints.

4.4.2 Silt and Sand Mixtures

Most of the Fraser River sediments comprised variable mixtures of silt and sand. These sediments were encountered in test holes that extended into the native soils below the embankments. These sediments were generally finer-grained near the top, and ranged from silt with some sand to sand with some silt with minor fractions of gravel and organics. However, in some cases these conditions were absent or more complex. Passing No. 200 sieve tests on select samples indicate that fines contents range from 79% to 86% in the silt encountered at TH16-1. Fines contents at TH16-2 and TH16-3 indicate a wider range and were from 71% to 81% in the silt and 41% in the sand and silt. Where fines contents were not tested, the descriptions in the test hole logs are based on observational identification.

Moisture contents in the silt were typically between 20% and 30%. However, at TH16-1 moisture contents were in the range of 30% to 50%. Within the deeper sand deposits the moisture contents were in the range of 10 to 20%.

Two Atterberg limits were completed on silt samples that had approximately 80% fines content. At TH16-1 the silt has a liquid limit of 33% and a plasticity index of 11%. At TH16-3 the silt has a liquid limit of 25% and a plasticity index of 4%. The natural moisture contents for both samples were found to exceed the liquid limits, which may be a result of the organic content and a sensitive soil fabric.

DCPT blow counts indicate variable conditions ranging from soft to stiff in the predominantly fine-grained layers, and loose to dense in the sandy layers. Additional in situ testing was completed within this unit at TH16-1, including seismic cone penetration testing (SCPT) and 3 Nilcon vane shear tests. CPT pore pressure responses were generally positive, which indicates a contractive material. The results of vane shear tests completed within the silt indicate a stiff material. Vane shear tests are interpreted assuming an undrained soil behavior response. However, the relatively high permeability of the silt (for a fine-grained soil) likely resulted in partially drained conditions during vane shear testing and penetration testing. This effect may have resulted in unconservative estimates of soil strength.

The investigation results indicate that the silt may be lightly over-consolidated where the sand content is low and where it is beyond the footprint of the existing embankment footprints. Below the embankments, the silt is expected to be normally consolidated.

4.5 Fill

Fill typically was found to overlie native soils at all test hole locations within the investigated area. Test holes drilled through the crest of the highway embankments encountered fill ranging from 6 m to 10 m thick. Test holes drilled adjacent to the toe of the embankments encountered less fill, where it was 0.3 m to 3.4 m thick. Fill may be absent further from the embankment toes and within the Windebank Creek channel.

Generally, the fill was composed of sand with traces of gravel and silt, in some cases it was silty. Passing No. 200 sieve tests on selected samples indicate that fines contents ranged from 7% to 29%. Moisture contents were found to be less than 10% above the groundwater table and from 15% to 30% below it.

DCPT blow counts in the fill indicate very loose to compact conditions near the base and toe of the embankments. DCPT blow counts in the upper portions of the fill embankments were relatively high for compacted sand fill, indicating compact to dense conditions.

Based on the relatively narrow gradation and era of construction, the source of the fill in the Highway 7 and Highway 11 embankments is interpreted to be dredge from the nearby Fraser River. Glass fragments were found within the fill near the base of the embankment at TH16-6. As the fill materials used in this area are very similar to river sediments (dredge), there is some uncertainty in determining fill from native materials near ground surface.

Record drawings for the 2013 concrete sidewalk along the east side of Highway 11 indicate the crest of the embankment slope is a geogrid reinforced soil slope (GRS) in some areas within the site and south of the CPR bridge. We did not observe any geogrid exposed on the slope surface during the site reconnaissance. The potential presence of GRS is inferred in areas where the embankment crest is locally steepened to approximately 1.25H:1V where the sidewalk alignment deviates around luminaire pole bases.

4.5.1 Pavement Structure

The geotechnical investigation was not intended as a comprehensive pavement investigation. As such, there are no test hole locations within the intersection or north of the Highway 7 centreline. Also, several of the test holes were located within the roadway shoulder where pavement is often thinner. Notwithstanding these limitations, the results of the geotechnical investigation indicate that the existing pavement structure includes:

Highway 7 (at 2 locations)	Highway 11 (at 5 locations)
100 mm to 110 mm of asphalt,	75 mm to 100 mm of asphalt,
300 mm to 500 mm of base/sub-base aggregate,	500 mm to 700 mm of base/sub-base aggregate,
5 m to 8 m of sandy embankment fill.	8 m to 10 m of sandy embankment fill.

4.6 Groundwater Conditions

Southwest of the intersection, the groundwater table was generally near-surface at TH16-3 and upward seepage was observed at the toe of the embankment, as noted on Dwg. 15723-1. The groundwater seepage was observed to contribute to flow in the surface water ditch adjacent the west toe of the Highway 11 embankment.

Southeast of the intersection, the groundwater table was generally encountered within 2 m of ground surface at the toe of the embankments and was typically located at or near the base of the fill. The presence of fill below the groundwater table in some areas may indicate the embankment has settled.

Approximately 2 weeks after installation, the groundwater level was recorded within the standpipe piezometer installed at TH16-1 (screened within the silty Fraser River sediments) at 1.9 m below ground surface. This reading was consistent with soil moisture observations during drilling.

The shallow groundwater levels observed in the test holes southeast of the intersection were consistent with the observed surface water elevation in Windebank Creek.

5. GEOTECHNICAL DESIGN CRITERIA

The geotechnical design criteria refers to the pertinent sections of the Canadian Highway Bridge Design Code (S6-19) and the BC MoTI Supplement to CHBDC S6-19 (Ministry Supplement). Technical circulars provide additional design criteria including Geotechnical Design Criteria (T-04/17) and Resilient Instructure Engineering Design – Adaptation to the Impacts of Climate Change and Weather Extremes (T-04/19). Pavement structure design guidelines are provided in technical circular T01-15. In accordance with the Ministry Supplement, MoTI defined the site as a Major-route with Typical Consequence. Thurber completed the design based on a Typical Degree of Understanding.

6. DISCUSSION AND RECOMMENDATIONS

6.1 Seismic Design Input

A preliminary geotechnical slope stability assessment (Thurber report dated April 6, 2017) identified the potential for poor seismic performance of the existing embankments including embankment foundation liquefaction and lateral spreading. This assessment was based on the 2015 NBCC seismic hazard model. The seismic performance of the embankment will not be affected by the project.

Seismic hazard values for the site (Appendix C) were obtained from Natural Resources Canada's on-line seismic hazard calculator, which were generated using the Geological Survey of Canada's (GSC) seismic hazard models developed for the 2015 National Building Code of Canada (NBCC 2015). The seismic hazard calculation provides peak ground acceleration (PGA) and spectral accelerations (Sa) at periods of 0.2, 0.5, 1.0 and 2.0 seconds for various seismic hazard levels including the 10%, 5%, and 2% in 50 years Probability of Exceedance (PoE) levels (equivalent to 1 in 475 yr, 1 in 975 yr, and 1 in 2475 yr return period). Those values are applicable to Site Class C ground conditions, which are defined in CAN/CSA S06-14 as a ground profile with a 30 m average shear wave velocity (Vs) of 450 m/s. The NBC 2020 (6^{th} generation) seismic hazard model generally indicates higher accelerations for this site, however CAN/CSA S06-19 is based on the 2015 NBCC model.

Seismic design considerations are generally not applicable to the re-surfacing works proposed at the intersection of Highway 7 and Highway 11. Refer to Thurber report dated April 6, 2017 for a discussion of Site Class and amplification, which are beyond the current scope of the project.

6.2 Pavement Structure

6.2.1 Traffic Loading

Phase 2 of the project includes resurfacing of pavement along Highway 11 and Highway 7 within the limits of grading. Thurber calculated the 20-year design traffic loading using the modelled average annualized daily traffic (AADT) volumes ISL Engineering provided for each year over the 20-year design life, which included estimates of total truck content. The AADT values for the first and last years of the design life are summarized in Table 2 below. These traffic predictions are approximately 20% greater than indicated by the data available in 2016 and they consider the anticipated increased truck traffic associated with the nearby truck route improvements project at Highway 7/Murray Street.

Table 2: Traffic Data

Year	Highway 11 South Leg		Cedar Valley Connector North Leg		Highway 7 West Leg		Highway 7 East Leg	
	Northbound	Southbound	Southbound	Northbound	Eastbound	Westbound	Westbound	Eastbound
2024	18380	19380	11040	10120	19280	18790	11110	11520
2043	25230	26600	15150	13890	26460	25790	15250	15810
Truck %	11%	5%	6%	8%	6%	7%	2%	7%

The Equivalent Single Axle Loads (ESALs) 20-year design estimates and assumptions are summarized below:

- The representative design case (Design Lane) is the south leg Highway 11 northbound where truck content is greatest and AADT values are among highest.
- Total 20-year traffic for the Design Lane is approximately 160 million.
- Directional Distribution 100% (AADT provided by direction)
- Lane Distribution 100% (per AASHTO method, for 2 lanes per direction)
- 1.0 ESALs per vehicle (truck factor) – general truck factor adopted, detailed truck distribution not available
- 0.007 ESALs per vehicle (non-truck factor)
- ESALs design estimate 17,620,000

6.2.2 New Pavement Structure

Based on the ESAL design estimate, a minimum Type B pavement structure is applicable per Technical Circular 01-15:

150 mm	Hot Mix Asphalt (HMA)
300 mm	25 mm minus Well-Graded Base (WGB)
300 mm	Select Granular Subbase (SGSB)

However, MoTI has indicated that Highway 7 and Highway 11 can be considered High Volume roads. Technical Circular 01-15 requires High Volume roads to be designed for a 90% pavement structure reliability factor, which our calculations indicate will not be met by the above minimum pavement structure. The following pavement structure is recommended for new pavement:

210 mm	Hot Mix Asphalt (HMA)
300 mm	25 mm minus Well-Graded Base (WGB)
300 mm	Select Granular Subbase (SGSB)

The above pavement structure recommendations are based on the assumption of positive drainage of the road surface and a free-draining compacted granular subgrade, such that the base and subbase layers do not become saturated.

6.2.3 Existing Pavement Structure Rehabilitation

Generally, the investigation results suggest that there is an adequate thickness of base and subbase material to protect the subgrade soils. Further, as the highways in this area are constructed at the crest of relatively large embankments, there is a significant separation between traffic loading and the (generally weaker) native subgrade. Penetration blow counts within the fill embankments generally indicate compact to dense conditions.

The asphalt requires strengthening to achieve the recommended pavement structure. A 50 mm mill/fill and 110 mm overlay is recommended. This may not be achievable in all areas of the site within the scope of this rehabilitation project due to site constraints, such as existing concrete curb and gutter and sidewalks.

The grading plan developed by ISL Engineering indicates a mill and 100 mm overlay in the following areas:

- in the intersection,

- Highway 11 (south leg) southbound lanes and
- Highway 11 (south leg) northbound left lane and left turn lanes (dual left).

The grading plan indicates the overlay thickness varies to tie-in with existing sidewalks and the CPR bridge abutment, transitioning from 100 mm overlay to a 50 mm mill/fill inlay in the northbound Highway 11 (south leg) through-lane and right-turn lane and in all lanes at the Highway 11 south limit of grading.

A 50 mm mill and inlay is also indicated on the Cedar Valley Connector (North leg) where no existing pavement structure data is available and on Highway 7 extending approximately 35 m west and 10 m east of the intersection.

The 50 mm mill and inlay continues approximately 140 m east of the intersection in the westbound dual left turn lanes which are to be extended. Full depth new pavement structure is shown where westbound left turn extension is being achieved by widening into the raised median. This localized new pavement should be in accordance with the minimum Type B pavement structure (i.e. 150 mm HMA) or better to match existing asphalt thickness.

6.2.4 Repair of Pavement Distress Areas

Four areas of pavement distress were identified during the November 17, 2023 site visit conducted by ISL and MoTI. The following summarizes Thurber's understanding of the distress and recommendations for repair:

Area 1 'Deep Patch Failure' in westbound right lane (West Leg)

Failure of the asphalt patch appears likely to extend through the full thickness of the asphalt. A localized full depth asphalt replacement is recommended, with appropriate transitions to be specified in the grading design.

Area 2 'Sinkhole' in westbound left lane (West Leg)

This small surface depression appears to be located within the former median where a left-turn light base was removed in Phase 1. Localized settlement of the road surface is likely related to poor quality backfilling when the light base was removed. We recommend a localized excavation extending up to the depth of the former light base foundation to inspect, replace (if needed), and recompact any loose/unsuitable backfill. Appropriate transitions should be specified in the grading design for the asphalt.

Area 3 ‘Heavy Wheel Rutting’ in eastbound left turn lane (West Leg)

We understand that a 50 mm mill and overlay were completed in this lane during Phase 1 of the project, and that rutting was not observed in this area previously. The premature failure of the overlay is interpreted to be related to too much asphalt content in the asphalt mix. We recommend a 50 mm mill and inlay to rehabilitate this area, with quality testing of the new asphalt mix and thickness. Lane closures should be planned to avoid running traffic on this lane too soon after asphalt placement, as this downhill facing left turn lane is subject to heavy braking loads.

Area 4 ‘Crack at bridge slab transition’ on Highway 11 (South Leg)

The specific cause of the cracking has not been investigated but is inferred to be related to differential movement of the fill embankment and pile supported bridge over the CPR ROW. A 50 mm mill and inlay could be considered to smooth out the transition, provided there is sufficient asphalt covering the concrete bridge slab. However, this repair should be considered temporary as it will not address the underlying cause of the differential movement.

6.3 Drainage Improvements on Slopes

A preliminary analysis indicated that the design criteria for slope stability for new and modified embankments were not achievable within the limitations of the project. Under static loading, slope flattening (or other mitigation) would be required to meet the design criteria for new embankments. The project avoids geotechnically significant modifications to the grade and side-slopes of the embankments. However, some drainage improvements are required which result in work on or near the embankment slopes.

Thurber reviewed a draft drainage drawing which indicates that several new and replacement catch basin (CB) leads will be installed on the Highway 11 embankment slopes (South Leg). The enclosed lead pipes are 200 mm to 250 mm in diameter and extend to the toe of the embankment slope with splash pads that consist of erosion matting and live staking at the discharge locations.

The available data indicates that the embankments are mostly composed of sand, which is susceptible to erosion. Clearing and stripping associated with installation of the CB leads should be minimized to mitigate disturbance of the slopes. Where sand fill is exposed on slopes or at the toe, erosion matting and live staking (to match splash pads) should be installed for erosion mitigation. Work on the slopes should be actively managed to limit the extent and duration of soil exposure. Temporary surface drainage measures should be provided to direct runoff away from exposed sand fill areas, which should be covered with poly sheeting when work is not active.

Installation is anticipated to be supported by equipment working at the slope crest or toe. Heavy equipment operating on the embankment slopes should be avoided.

The CB leads should be oriented parallel with the dip of the slope (i.e. aligned to descend the slope directly) to reduce the exposure to slope surface creep loading of the pipe. The lead pipes should be anchored to the slope rather than buried to reduce slope disturbance.

6.4 Concrete Sign Bases

6.4.1 Configuration

We understand that four new overhead sign bases are required:

- New guide sign bridging the northbound lanes on Highway 11 south of the CPR bridge. The bases for the sign bridge are located in-line with the median barrier and in-line with the shoulder barrier near the embankment crest. This is located outside the project grading limits and outside of the geotechnical investigation area. We understand a custom concrete base (pre-cast) is required to accommodate the in-line-with-barrier locations.
- New guide sign on Highway 11 (South Leg) in the median between the intersection and the CPR bridge. We understand this will be a standard pre-cast concrete base per MoTI Standard Specification Section 635.
- New sign for lane designations on Highway 7 (East Leg) in the median. This is located outside the project grading limits and outside of the geotechnical investigation area. We understand this will be a standard pre-cast concrete base per MoTI Standard Specification Section 635.

6.4.2 Concrete Base Bearing Resistance

A factored ULS bearing resistance of 300 kPa is recommended for vertical concentric loading, based on the following assumptions.

- The signs are generally in the medians and therefore are not adjacent to sloping ground.
- The subgrade conditions are inferred to be compacted granular fill. Native soils and groundwater are inferred to be greater than 3 m below the underside of the footing.
- The anticipated shallow foundations are precast concrete bases which are trapezoidal in profile with square bases with a minimum 0.6 m wide base and a minimum 0.75 m depth from finished grade to the underside of the base.
- The sign bridge south of the CPR bridge includes a base adjacent to sloping ground. The bearing resistance provided herein is applicable to this sign base, provided the base

is a minimum 2.0 m depth and the centre of the base is setback 2.5 m from the embankment crest.

- Inclined loading should be accounted for by applying a factor (i) to the bearing resistance $i=(1-d_f / 90)^2$, where $d_f = 0$ for vertical loading.
- Eccentric loading should be accounted for by reducing the effective area of the footing (per Section 6.10.2 and Figure 6.2 of CHBDC S6-19).

These bearing resistance recommendations should be reviewed if any of these assumptions do not reflect the final design configuration or encountered conditions.

Three of the proposed sign bases are located outside the limits of the geotechnical investigation. Based on the available information including topography, it is inferred that the concrete bases will be embedded in highway fill embankments. The seismic bearing resistance of the concrete base foundations is dependent on the seismic performance of the underlying fill embankment and the foundation soils below.

6.4.3 Concrete Base Lateral Resistance

Guide signs that overhang traffic typically rely on passive lateral earth pressure from the backfill surrounding the concrete base to resist overturning.

The recommended horizontal earth pressure coefficients are 4.0 for passive resistance (Kp) and 0.25 for active loading (Ka). A unit weight of 20 kN/m^3 can be assumed for compacted backfill. A resistance factor of 0.5 should be applied to the passive resistance based on the assumption that the backfill surrounding the concrete base will be reviewed during construction and follow MoTI Standard Specifications and our recommendations.

For the sign bridge base located in the shoulder at the crest of the embankment slope, full passive resistance may not be mobilized towards the slope. The anticipated configuration is a pre-cast footing approximately 2.25 m wide and 5.0 m long (longitudinal to highway) which is 2.0 m deep and the centre of the base is setback 2.5 m from the crest of the embankment. The passive resistance towards the slope for this footing should be reduced by applying a resistance factor of 0.375 (0.5 for the geotechnical resistance factor x 0.7 for reduced passive soil wedge mobilized towards slope). The overturning demand in this loading direction is anticipated to be low due to the moment couple formed by the sign bridge structure. Resistance to overturning will also be mobilized from the weight of the backfill overlying the footing.

6.4.4 Concrete Base Torsional Resistance

Assuming a square concrete base, the backfill provides passive resistance to torsional loading of the base (e.g. due to wind applied to an overhanging sign). A triangular distribution can be applied to half of each side of the square base, with the factored passive resistance (Kp) applied at the corners, reducing to zero at the neutral centre of each side.

6.4.5 Concrete Base Excavation and Backfill

Excavation and backfill for concrete bases should adhere to MoTI Standard Specifications Section 635. Standard Specification Dwg. SP635-1.4.4 indicates the minimum dimensional requirements for the backfill zone.

The prepared subgrade should be inspected. The geotechnical design assumes that the subgrade is dry, well compacted granular fill, which is free of organics and deleterious material.

Backfill material should conform to the specification for 25 mm Well Graded Base. Backfill shall be placed in layers not exceeding 150 mm compacted thickness (100 mm compacted thickness in the top 300 mm) and should be compacted to a minimum 100% of the standard Proctor maximum dry density. Layer thickness shall be reduced and moisture content of the material adjusted as required to achieve compaction.

It is anticipated that the sign bridge base near the embankment crest may encounter GRS (refer to Section 4.5 for interpretation). The temporary excavation for the sign base may require partial removal and reinstatement of the GRS in this area and should be in accordance with the 2013 record drawing typical detail (Dwg. R1-736-110). The joints between the remaining and reinstated GRS should be oriented towards the slope and parallel to the strengthened axis of the uniaxial geogrid (i.e. no angled joints). The GRS reinstatement should not result in widening or steepening of the embankment crest. GRS removal and reinstatement should be undertaken with geotechnical engineering field review.

6.5 Climate Change Resiliency

Thurber used the Pacific Climate Impacts Consortium Plan2Adapt tool for the Fraser Valley. The Plan2Adapt output summary tables for 2050 and 2080 are provided in Appendix D. The summary indicates that in approximately 50 years climate change is predicted to result in a median increase of 3% in annual precipitation and a 4% median increase in winter precipitation. The median prediction for mean annual temperature is for a rise by 5 degrees Celsius and 92 more frost-free days are anticipated. Furthermore, climate change is generally anticipated to result in an increase in the frequency and intensity of severe precipitation events.

Hotter temperatures in the region may increase the wear and tear on pavement surfaces during the summer months. Conversely warmer winter temperatures could reduce frost related pavement damage. The asphalt is being substantially thickened to resist truck traffic loading, which will also increase the resistance to weather related damage.

It is uncertain how changes in precipitation will translate into changes (if any) in groundwater levels at the site. Pavement structure drainage has not been identified as a pavement performance issue at this site. Highway embankment side-slopes (not modified by this project) may experience erosion or shallow-seated instability in response to extreme precipitation events.

Thurber has completed a MoTI Design Criteria Sheet for Climate Change Resilience for geotechnical design aspects of the project which is provided in Appendix D as per Technical Circular T-04/19.

6.6 Geotechnical Field Reviews

The following field reviews should be completed during construction:

- Sinkhole excavation and backfilling (pavement repair Area 2),
- Pavement base compaction (pavement repair Areas 1 and 2),
- Review of drainage work on slopes,
- Subgrade and backfilling of sign bases, and
- Removal and reinstatement of geogrid reinforced soil slope, if encountered.

The following quality assurance testing is recommended:

- WGB gradation and compaction for new pavement areas (pavement repair Areas 1 and 2) and for sign bases, and
- Asphalt Marshall Mix Analysis (MMA) sampled during placement and asphalt cores after placement, to confirm the mix density and thickness.

THURBER ENGINEERING LTD.

7. CLOSURE

We trust this information meets your requirements. If you have any questions, please contact the undersigned at your convenience.

Caleb Scott, P. Eng.
Geotechnical Engineer

Steven Coulter, M.Sc., P.Eng.
Review Engineer

Thurber Engineering Ltd.
Permit to Practice #1001319

THURBER

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

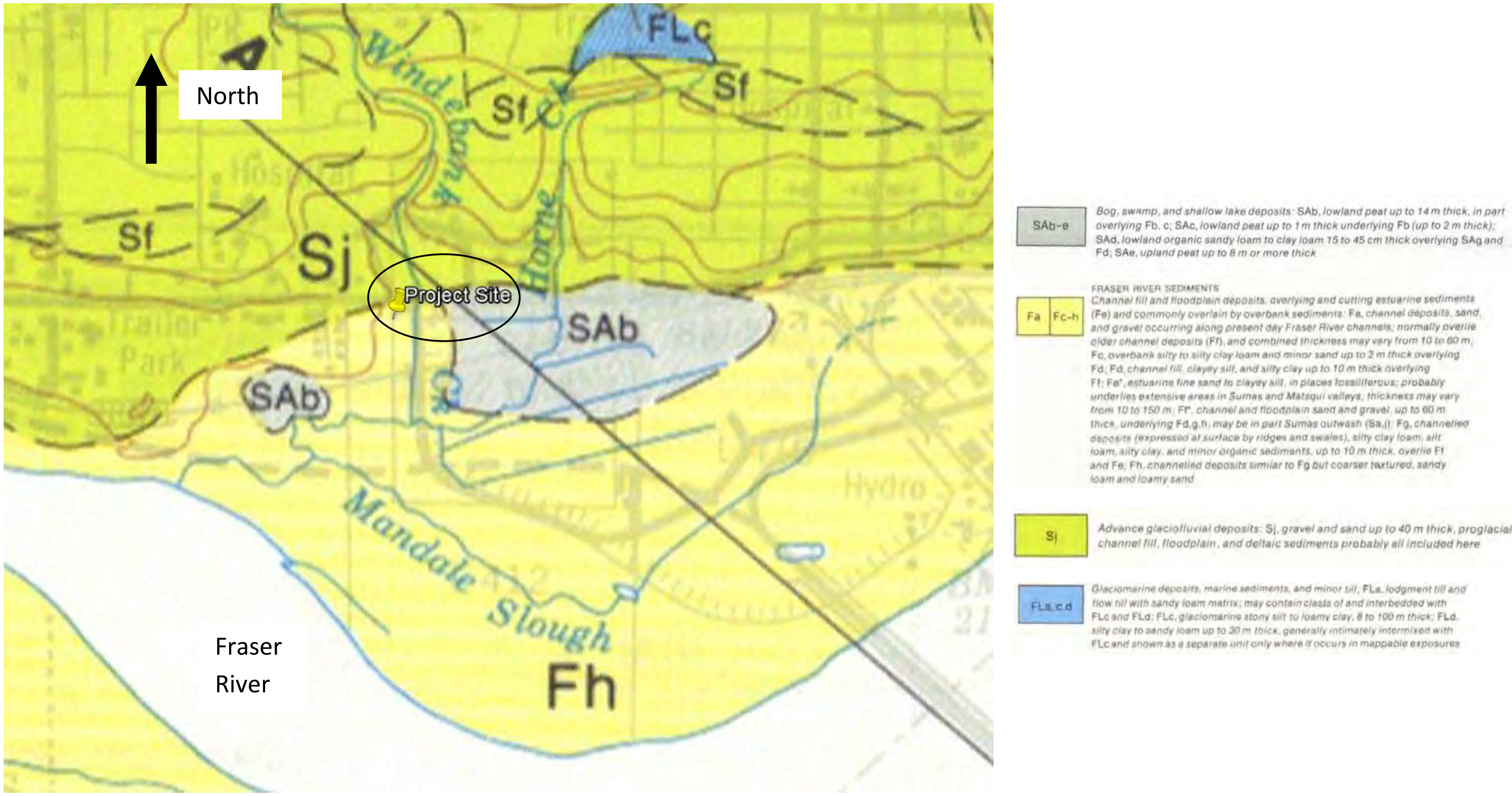
Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

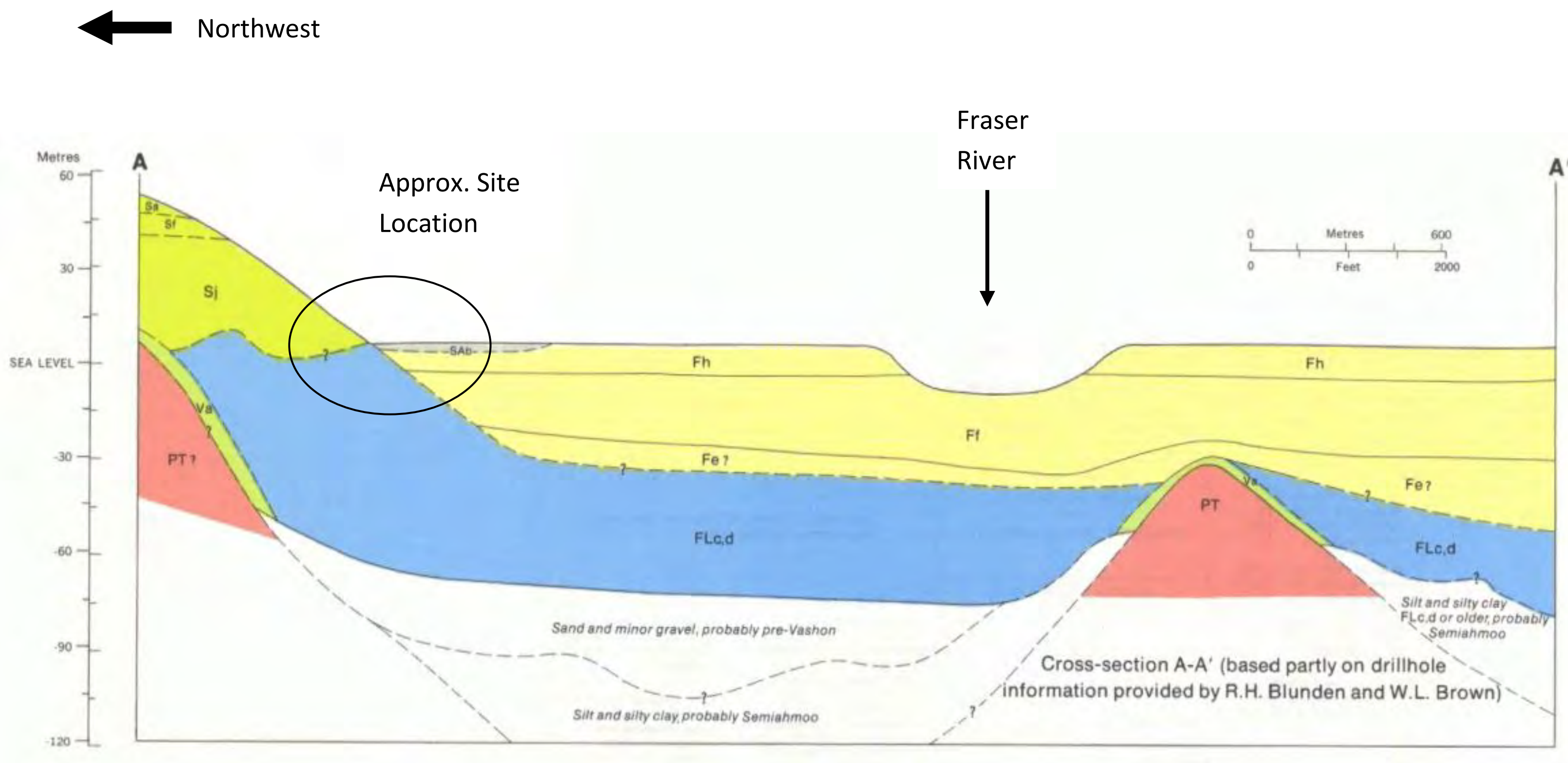
The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

THURBER ENGINEERING LTD.

FIGURES

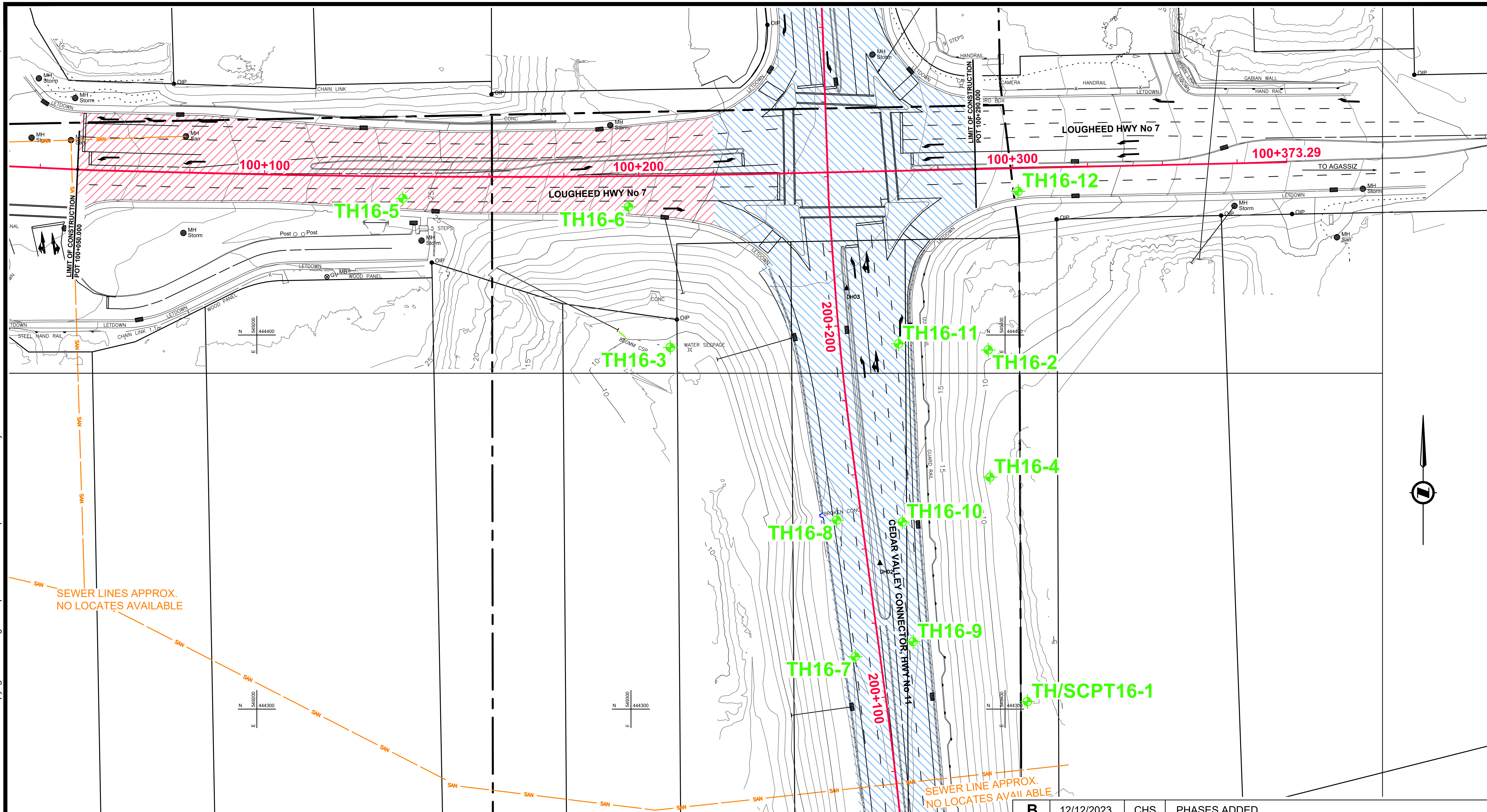


ISL Engineering and Land Services Ltd.		THURBER ENGINEERING LTD.	
Surficial Geology (GSC Map 1485A Excerpt) - Plan	DATE: April 4, 2017	Project No. 15723	
Highway 7 & Highway 11 Intersection Improvements Mission, B.C.		FIGURE: 1	



ISL Engineering and Land Services Ltd.	THURBER ENGINEERING LTD.	
Surficial Geology (GSC Map 1485A Excerpt) - Section	DATE: April 4, 2017	Project No. 15723
Highway 7 & Highway 11 Intersection Improvements — Mission, B.C.		FIGURE: 2

DRAWINGS



B	12/12/2023	CHS	PHASES ADDED
A	24/3/2017	CHS	ALIGNMENT UPDATED
REV.No.	DATE (d/m/y)	BY	DESCRIPTION

NOTES:

1. Test Holes were located using a hand-held GPS unit; locations are approximate only.
2. Digital base plan provided by ISL Engineering & Land Services Ltd.

PHASES:

PHASE 1 PHASE 2

0 10 20 30 40 50 60m
SCALE 1:1000

THURBER ENGINEERING LTD.

ISL ENGINEERING & LAND SERVICES LTD.

TEST HOLE LOCATION PLAN

HIGHWAY 7 AT HIGHWAY 11 INTERSECTION IMPROVEMENTS
GEOTECHNICAL INVESTIGATION

MISSION, B.C.

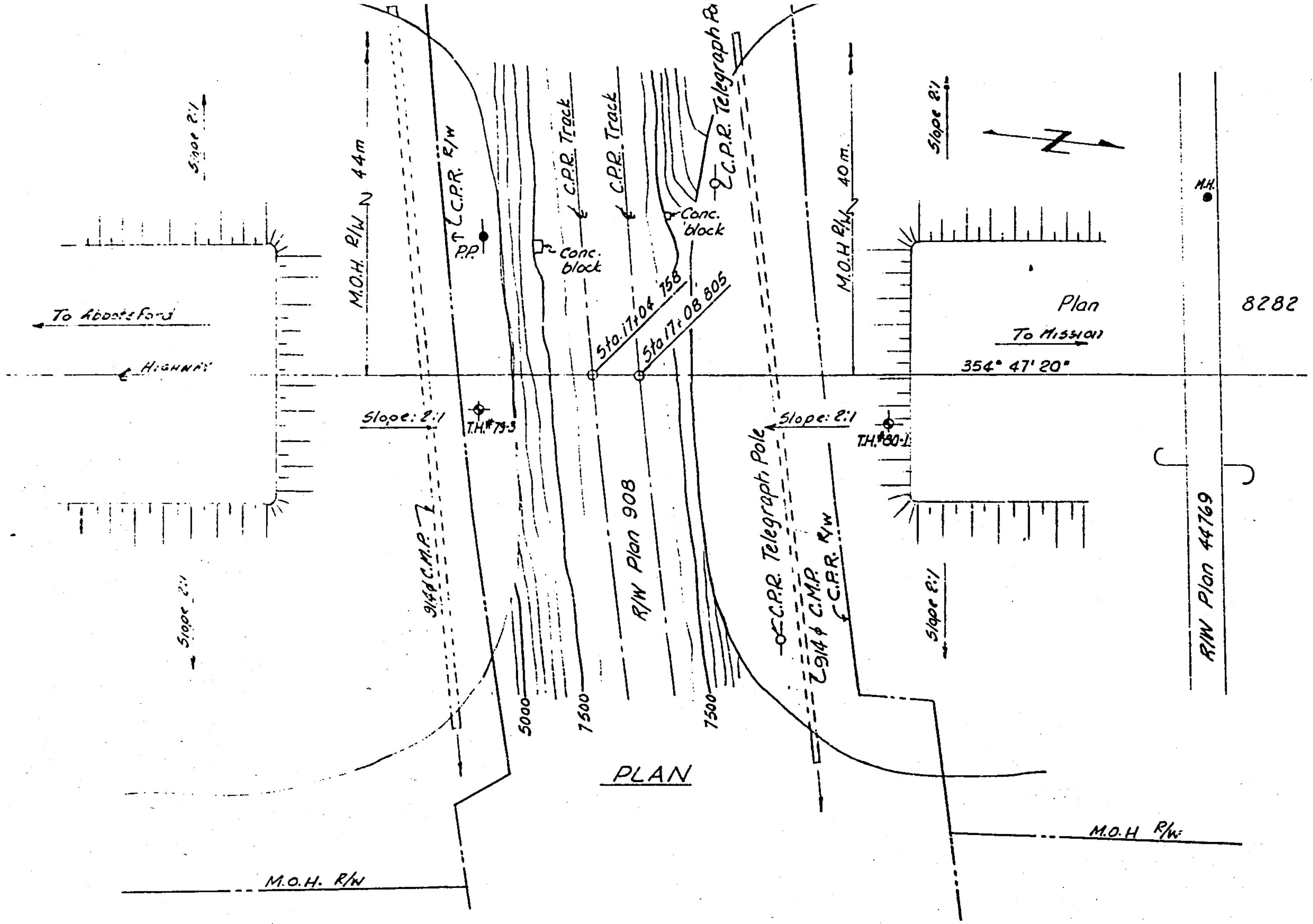
DESIGNED	DRAWN	APPROVED	DATE	SCALE	PROJECT No.	DWG. NO.	REV.
TJS	RRS		MARCH 13, 2017	1:1000	15723	- 1	B

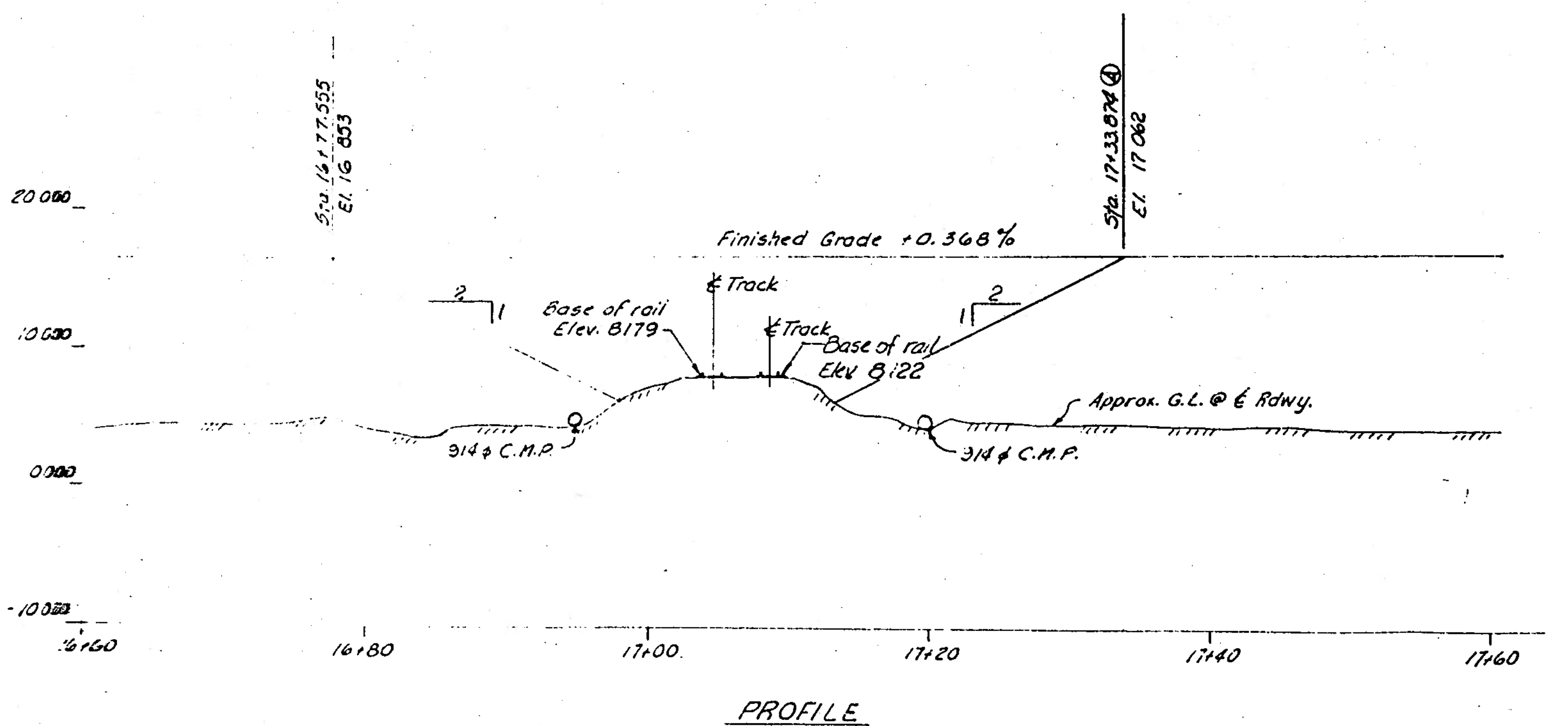
TED04647_REV B.dwg

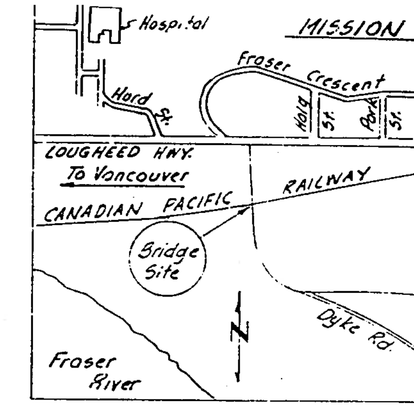
THURBER ENGINEERING LTD.

APPENDIX A

CPR Overhead Bridge 1984 As-built Drawings







KEY MAP
(N.T.S.)

LIST OF DRAWINGS

Dwg Nº	Title
2736-3	Site Plan
" -4	General Arrangement
" -5	Abutments
" -6	Piers
" -7	Stringers
" -8	Deck
" -9	Drain Details
" -10	Bore Hole Drawing
2736-11	Cross Bracing-Sketches
2803-1	Standard Deck Joint
2784-1	Parapet
2784-2	Standard Bridge Parapet Transition
2785-1	Steel Railing

C.P.R. Mile 88.08 - Cascade Subdivision

NOTES:
1. Survey: H.O.&S. May 1979
2. Datum: Geodetic
3. L.B.M.: Galvanized bottom base of power pole approx. 6 300 left of Sta. 17+00.0 C.P.R. Mile 88.08 Cascade subdivision.

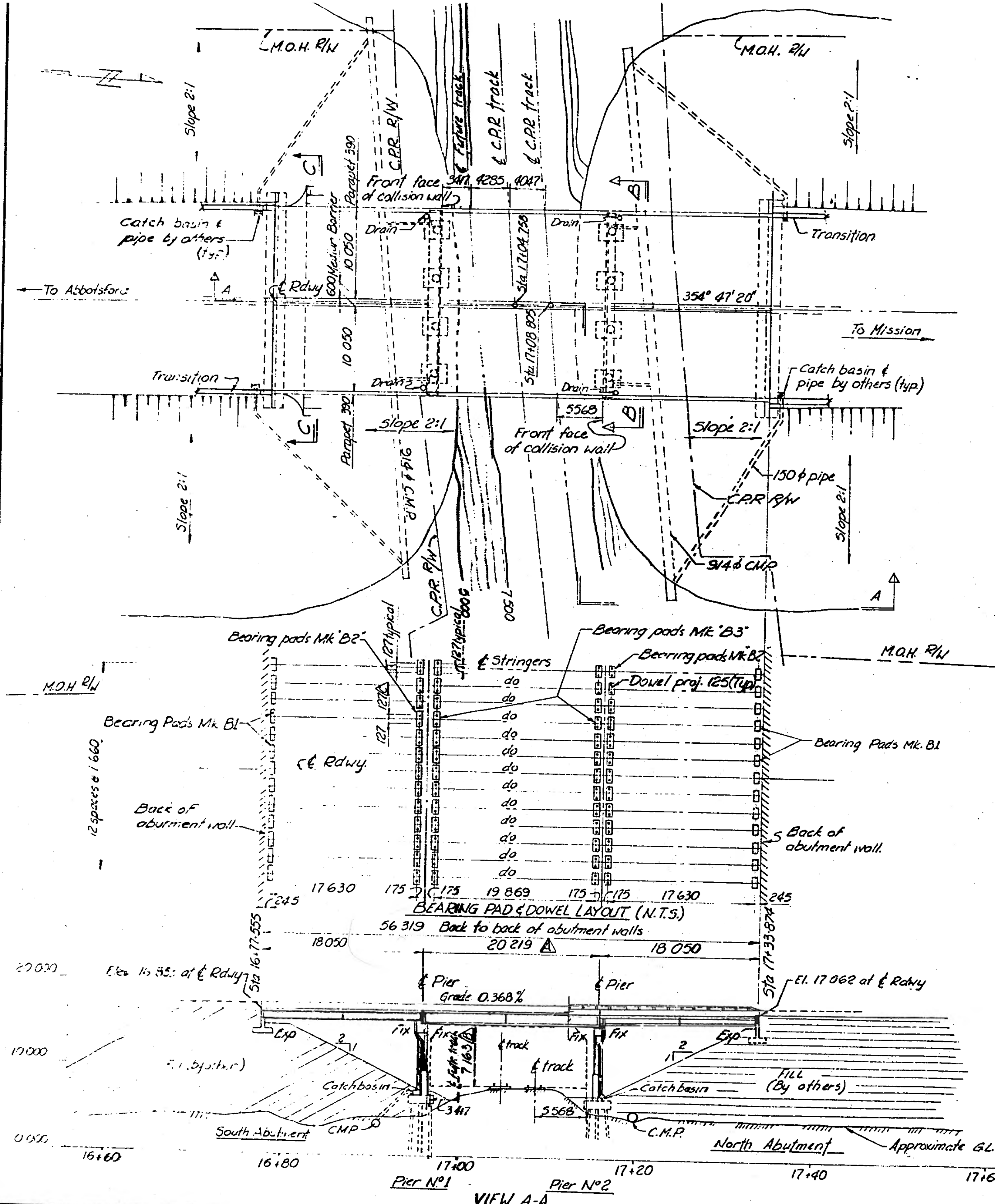
GOVERNMENT OF BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND HIGHWAYS
BRIDGE ENGINEERING BRANCH

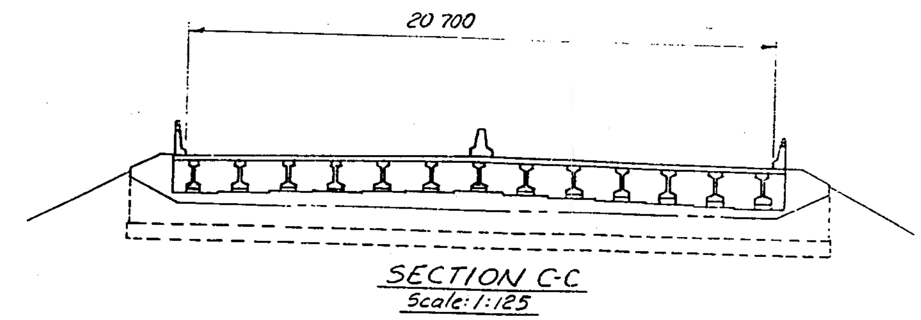
CHILLIWACK DISTRICT
ABBOTSFORD - MISSION HIGHWAY Nº 11
MISSION OVERHEAD
SITE PLAN

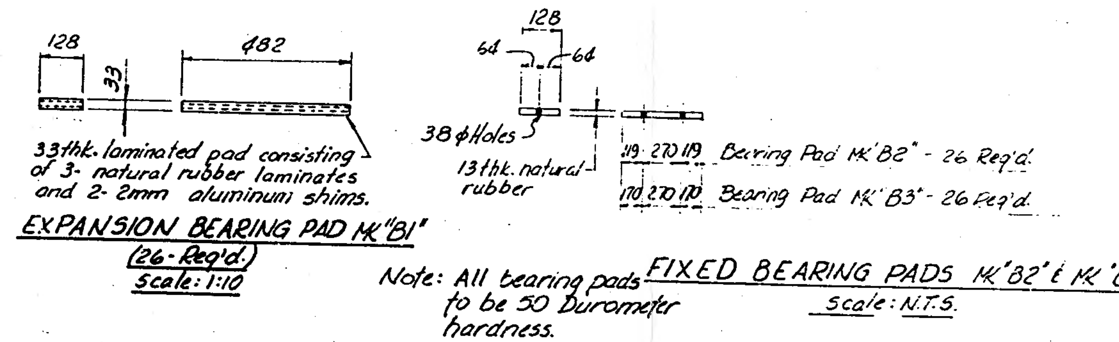
	REVISIONS		
D			
C			
B	As Built	J.E.S.	Dec/84
A	Finished Grade-Elev. Sta.	J.E.H.	Jan/83

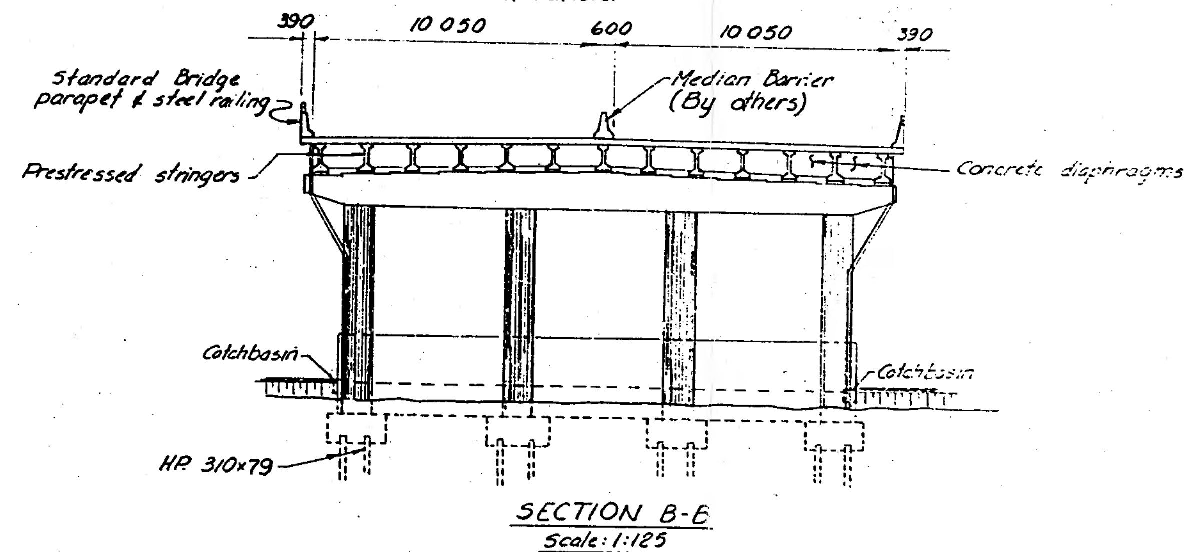
PREPARED UNDER THE DIRECTION OF: T.V.E. Vickers, Senior Bridge Design Engineer	DATE: 82/10/12	SCALE: 250 & As Noted	NEG No: 274393
		DRAWN: J.E.S. Aug/82	CHECKED: P.B. Sep'82
APPROVED FOR USE IN CONSTRUCTION: Engineer of Bridge Engineering	DATE: 82-10-27	EXAMINED AND ACCEPTED: Executive Director of Engineering	DRAWING No. 2736-3 (B)

CANCEL PRINTS BEARING EARLIER LETTER









C.P.R. Mile 83.08 - Cascade Subdivision

NOTES:
1. Design Specification - Can 3-S6-M78
2. Live Load: MS 225-77

GOVERNMENT OF BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND HIGHWAYS
BRIDGE ENGINEERING BRANCH

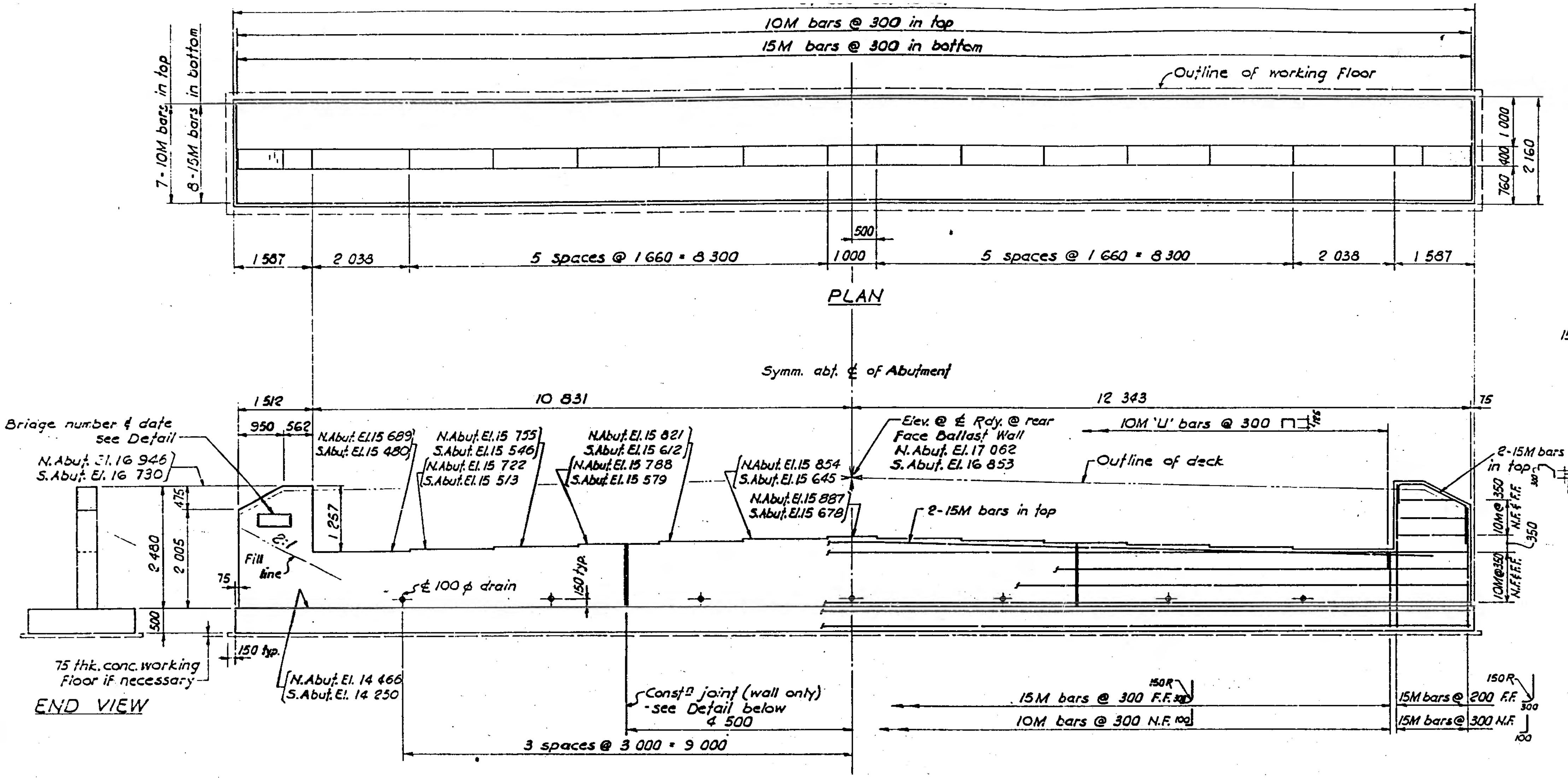
CHILLIWACK DISTRICT
ABBOTSFORD - MISSION HIGHWAY Nº 11

MISSION OVERHEAD
GENERAL ARRANGEMENT

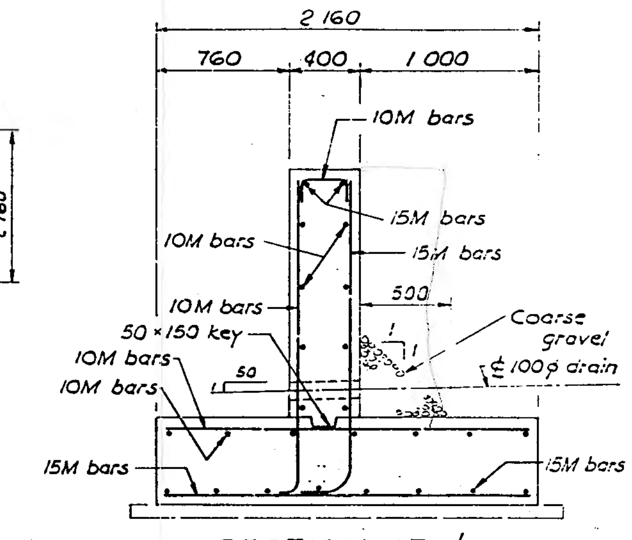
Revision	Description	By	Date
	As Built	J.E.S.	Dec/84
	Dowel Spacing	I.R.M.	Jun/83
	Vertical Clearance	I.R.M.	May/83
	Main Span	I.R.M.	Jan/83
REVISIONS			

PREPARED UNDER THE DIRECTION OF: T.V.E. Vickers, Senior Bridge Design Engineer	DATE	SCALE: 1:250 & as noted	NEG No 274399
		DRAWN I.R.M. Dec/82	CHECKED G.E.D. Jan/83
APPROVED FOR USE IN CONSTRUCTION: Director of Bridge Engineering	DATE	EXAMINED AND ACCEPTED: Executive Director of Engineering	DRAWING No. 2736-4

CANCEL PRINTS BEARING EARLIER LETTER



ELEVATION - NORTH ABUTMENT (looking north)
ELEVATION - SOUTH ABUTMENT (looking south)

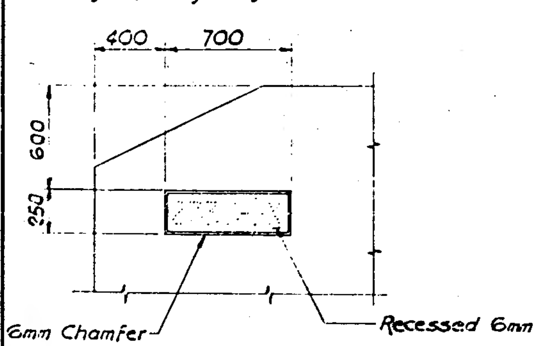


SECTION AT ℄
Scale 1:20

Notes:

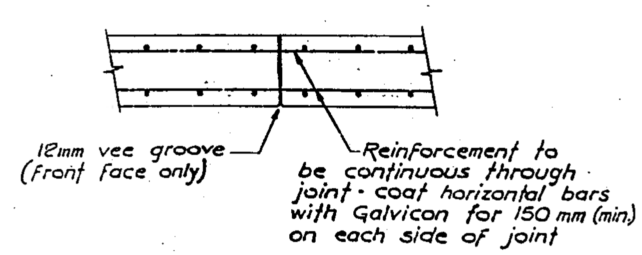
1. All concrete to be Class 'A'
2. A continuous horizontal drainage course of coarse gravel to be placed at drainage holes as shown
3. Footings to be carried down to elevations shown or to such lower elevations as may be ordered by the Engineer
4. Reinf. steel to be C.S.A. specification G30.12M grade 400
5. Reinf. steel to have 50 mm minimum cover unless noted otherwise
6. Lap of bars for splices to be 40 × d. Splices to be staggered
7. Exposed edges of concrete to be chamfered 25 mm

Bridge number & year of construction cast in 125 mm numerals as shown. Numeral forms loaned by the Ministry of Highways



DETAIL OF BRIDGE NUMBER

Scale 1:20



DETAIL OF VERTICAL CONSTRUCTION JOINT

ESTIMATED QUANTITIES

	Concrete	Formwork	Reinf. steel
North Abut.	46 m³	110 m²	1650 kg.
South Abut.	46 m³	110 m²	1650 kg.
Total	92 m³	220 m²	3300 kg.

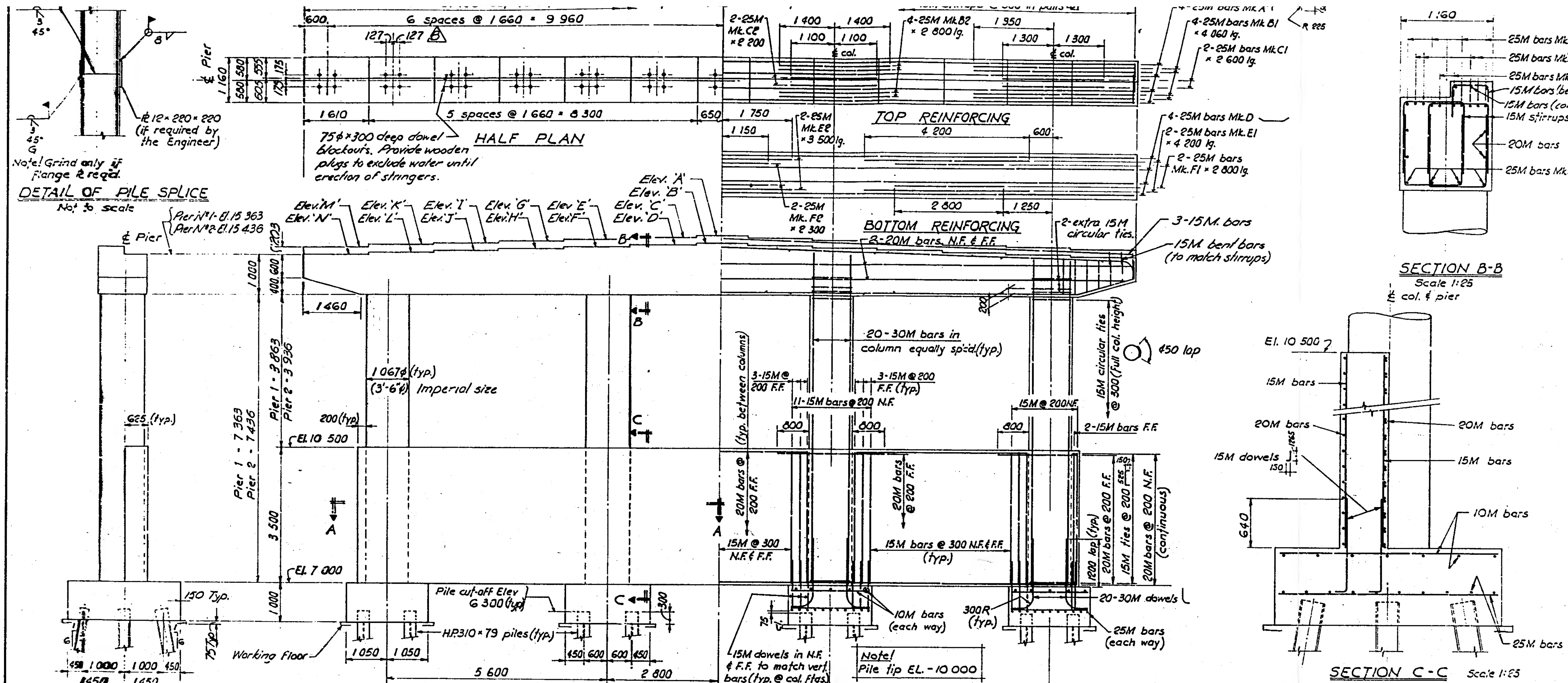
	REVISIONS		
D			
C			
B	As Built	J.E.S.	Dec/83
A	Main span revised - Elevations	P.B.	[illegible]

GOVERNMENT OF BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND HIGHWAYS
BRIDGE ENGINEERING BRANCH

CHILLIWACK DISTRICT
ABBOTSFORD - MISSION HIGHWAY Nº II
MISSION OVERHEAD
ABUTMENTS

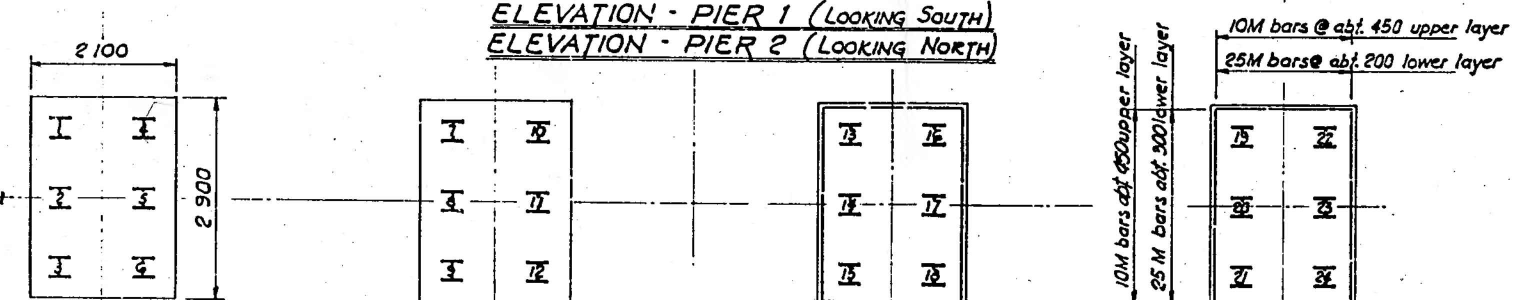
PREPARED UNDER THE DIRECTION OF: T.V.E. Vickers, Senior Bridge Design Engineer — DATE: [illegible]
SCALE: 1:50 & as noted — REG No [illegible]
DRAWN: D.C. Aug.82 — CHECKED: P.B. Sept.82
APPROVED FOR USE IN CONSTRUCTION: Director of Bridge Engineering — DATE: [illegible]
EXAMINED AND ACCEPTED: Executive Director of Engineering — DATE: [illegible]
DRAWING No. 2736-5 — 5

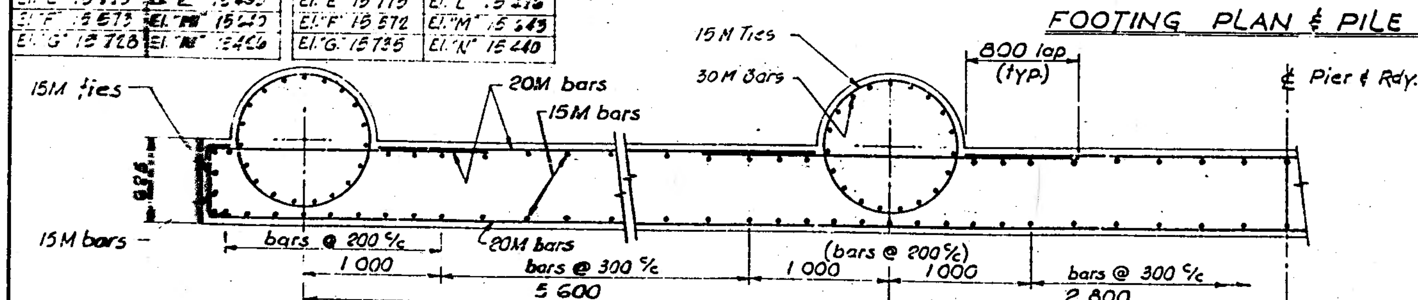
CANCEL PRINTS BEARING EARLIER LETTER



ELEVATION - PIER 1 (LOOKING SOUTH)
ELEVATION - PIER 2 (LOOKING NORTH)

PIER No 1 (Left of ℄)		PIER No 1 (Right of ℄)	
El. "A" 15 704	El. "H" 15 453	El. "A" 15 704	El. "H" 15 451
El. "B" 15 556	El. "I" 15 632	El. "B" 15 556	El. "I" 15 626
El. "C" 15 730	El. "J" 15 429	El. "C" 15 732	El. "J" 15 431
El. "D" 15 535	El. "K" 15 500	El. "D" 15 533	El. "K" 15 595
El. "E" 15 534	El. "L" 15 335	El. "E" 15 693	El. "L" 15 396
El. "F" 15 435	El. "M" 15 558	El. "F" 15 496	El. "M" 15 568
El. "G" 15 540	El. "N" [illegible]	El. "G" 15 659	El. "N" 15 559
PIER No 2 (Left of ℄)		**PIER No 2 (Right of ℄)**	
El. "A" 15 822	El. "H" 15 530	El. "A" 15 822	El. "H" 15 530
El. "B" 15 625	El. "I" 15 697	El. "B" 15 625	El. "I" 15 703
El. "C" 15 737	El. "J" 15 498	El. "C" 15 802	El. "J" 15 506
El. "D" 15 603	El. "K" 15 670	El. "D" 15 599	El. "K" 15 673
El. "E" 15 710	El. "L" 15 463	El. "E" 15 775	El. "L" 15 476
El. "F" 15 573	El. "M" 15 640	El. "F" 15 572	El. "M" 15 643
El. "G" 15 728	El. "N" 15 466	El. "G" 15 735	El. "N" 15 440





SECTION A-A
Scale 1:25

NOTES:

1. All concrete to be Class "A"
2. Chamfer all exposed edges 25 mm
3. Reinforcing steel to conform to C.S.A. specification G30.12M grade 400
4. Lap of bars for splices to be 40 × 'd'. Splices to be staggered
5. Reinforcing steel to have 50 mm cover unless noted otherwise
6. For location of deck drain downpipe anchor bolts see Dwg. No. 2736-9.

ESTIMATED QUANTITIES				
	Concrete	Formwork	Reinf. steel	H.P. 310 × 79
Pier 1	116 m^3	315 m^2	16 150 kg.	24 @ 16.3 m
Pier 2	116 m^3	315 m^2	16 150 kg.	24 @ 16.3 m
Total	232 m^3	630 m^2	32,300 kg.	48 @ 16.3 = 782.4 m

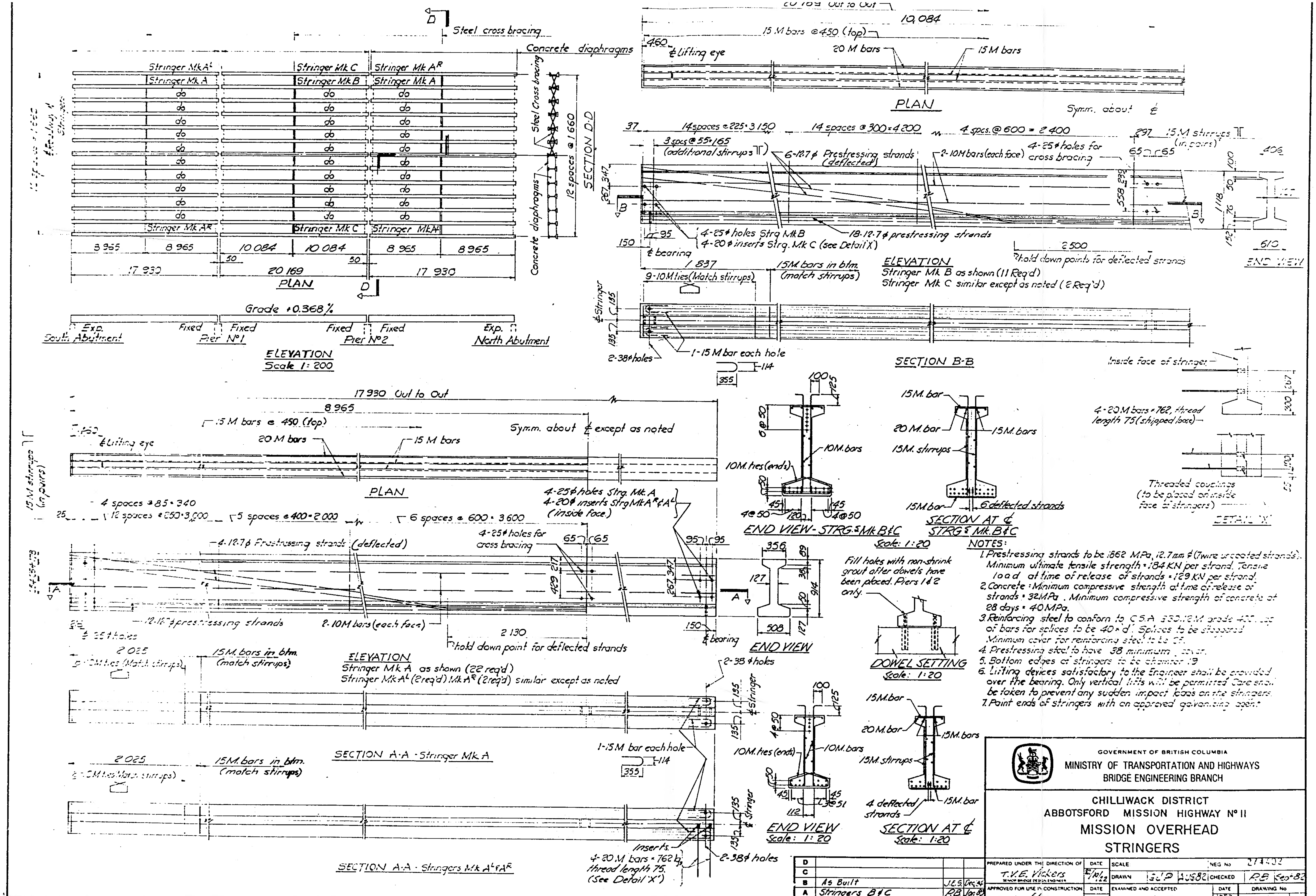
	REVISIONS		
D			
C	As Built	JES	Dec/84
B	Dowel Spacing	IRM	June/83
A	Cap & elevs. - Main span revised	PB	Dec/82

GOVERNMENT OF BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND HIGHWAYS
BRIDGE ENGINEERING BRANCH

CHILLIWACK DISTRICT
ABBOTSFORD - MISSION HIGHWAY No II
MISSION OVERHEAD
PIERS

PREPARED UNDER THE DIRECTION OF: T.V.E. Vickers, Senior Bridge Design Engineer	DATE: 82/10/22	SCALE: 1:50 & as noted	NEG No 2?4401
		DRAWN: D.C. Aug.'82	CHECKED: P.B. Sep.'82
APPROVED FOR USE IN CONSTRUCTION: Director of Bridge Engineering	DATE	EXAMINED AND ACCEPTED: Executive Director of Engineering	DRAWING No. 2736-6 C

CANCEL PRINTS BEARING EARLIER LETTER



NOTES:
1. Prestressing strands to be 1862 MPa, 12.7 mm ∅ (7 wire uncoated strands). Minimum ultimate tensile strength = 184 KN per strand. Tensile load at time of release of strands = 129 KN per strand.
2. Concrete: Minimum compressive strength at time of release of strands = 32 MPa. Minimum compressive strength of concrete at 28 days = 40 MPa.
3. Reinforcing steel to conform to CSA G30.12M grade 400. Lap of bars for splices to be 40×d. Splices to be staggered. Minimum cover for reinforcing steel to be 25.
4. Prestressing steel to have 38 minimum cover.
5. Bottom edges of stringers to be chamfer 19.
6. Lifting devices satisfactory to the Engineer shall be provided over the bearing. Only vertical lifts will be permitted. Care shall be taken to prevent any sudden impact loads on the stringers.
7. Paint ends of stringers with an approved galvanizing agent.

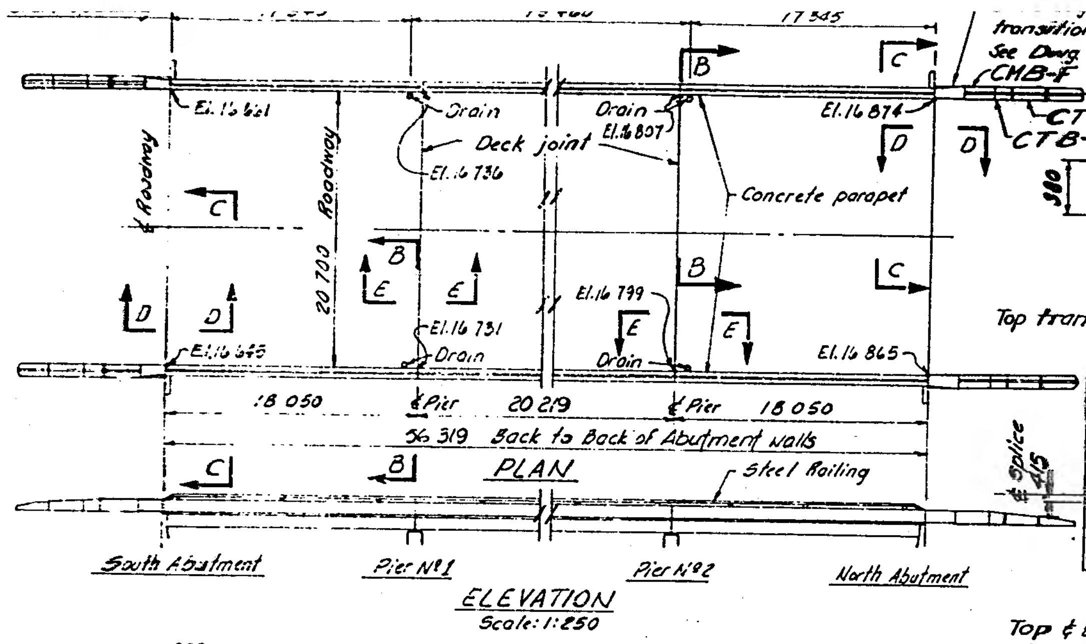
GOVERNMENT OF BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND HIGHWAYS
BRIDGE ENGINEERING BRANCH

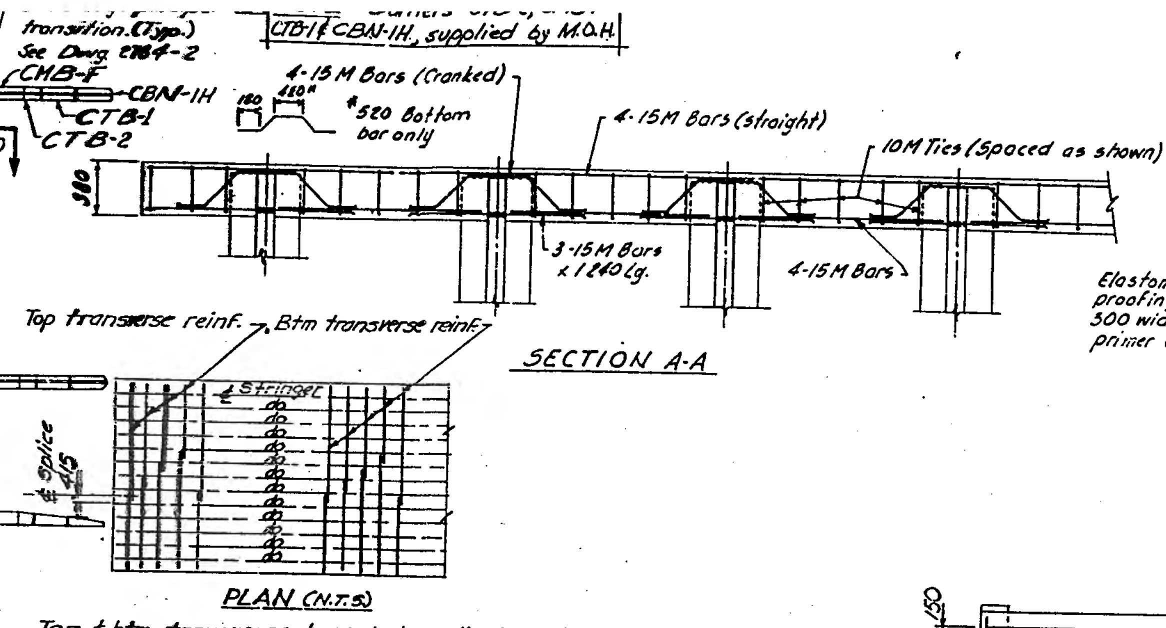
CHILLIWACK DISTRICT
ABBOTSFORD MISSION HIGHWAY No II
MISSION OVERHEAD
STRINGERS

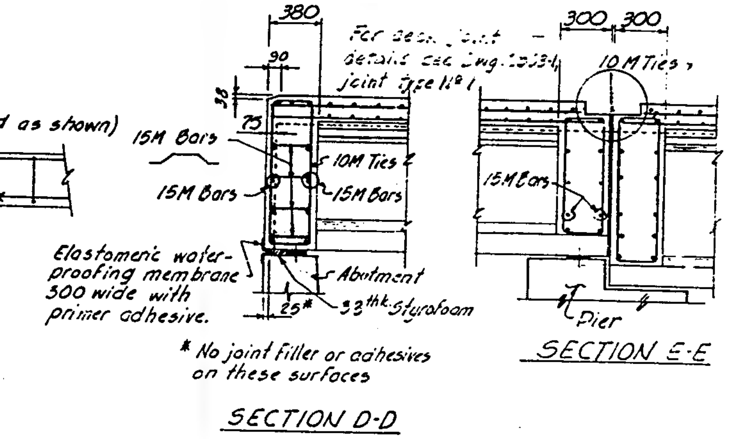
D			
C			
B	As Built	J.C.S.	
A	Stringers B & C	R.B.	Jan 83
	REVISIONS		

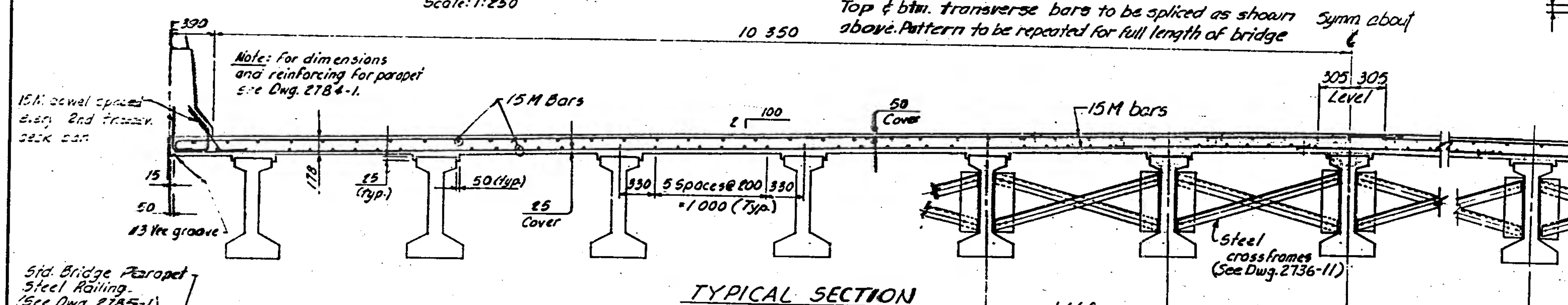
PREPARED UNDER THE DIRECTION OF: T.V.E. Vickers — DATE — SCALE — NEG No 274402
DRAWN: G.J.P. Aug 82 — CHECKED: R.B. Sept 82
APPROVED FOR USE IN CONSTRUCTION — DATE — EXAMINED AND ACCEPTED — DATE — DRAWING No 2736-7

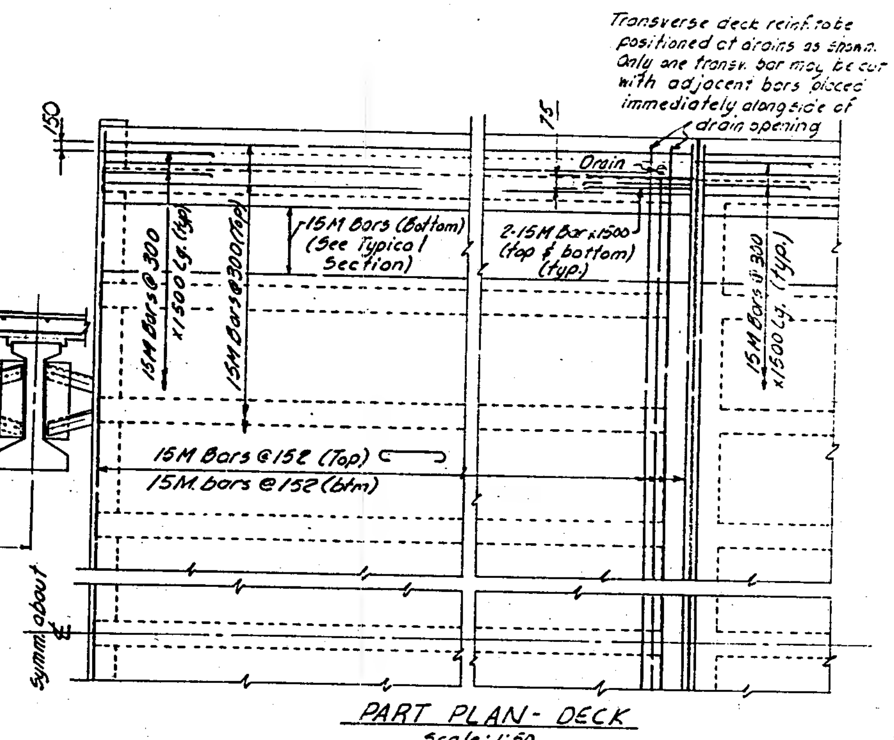
CANCEL PRINTS BEARING EARLIER LETTER

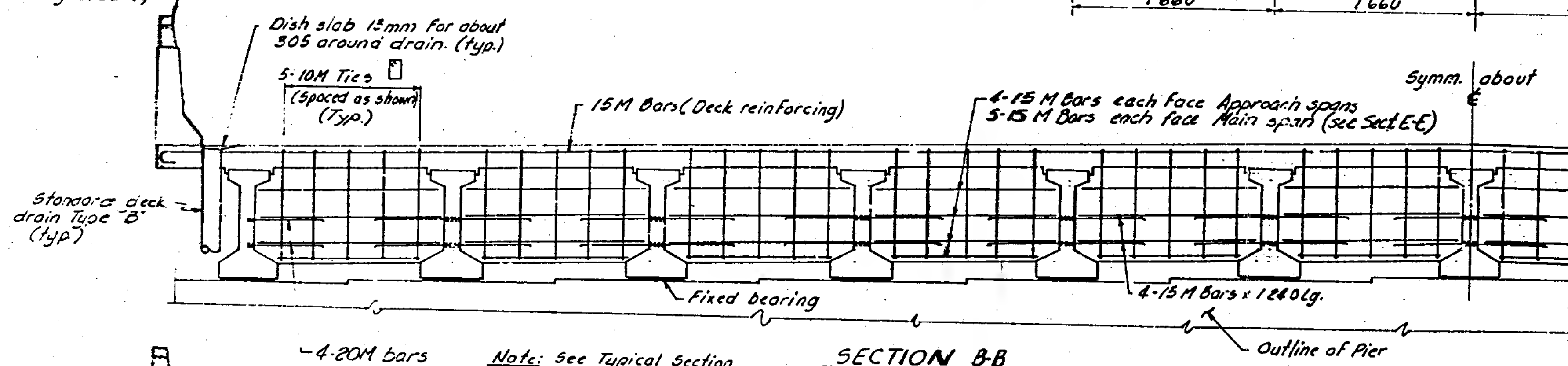


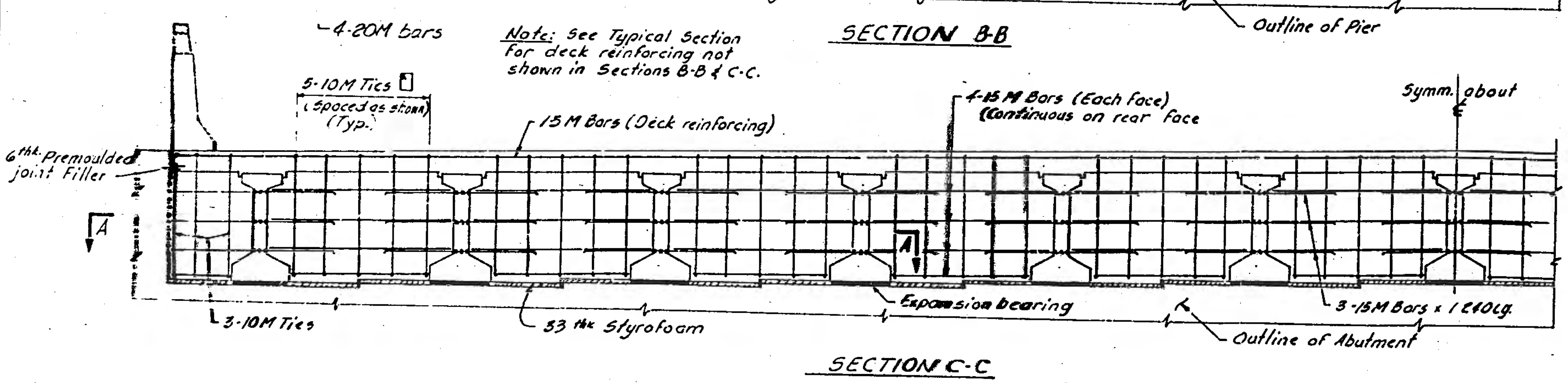












Notes:

1. All concrete to be Class "A". Exposed edges to have 13mm chamfer except as noted.
2. All reinforcing steel to conform to C.S.A. Specification G30.12M grade 400.
3. Reinforcing steel to have 50 mm cover except as noted.
4. Splicing of transverse bars to be as shown in 'Plan'. Lap of bars to be 40 x d.
5. Deflection and difference in camber will be accommodated by a modified vertical alignment which will be supplied by the Ministry. Haunches may vary to suit. Slab thicknesses between stringers to remain constant.
6. Bolts connecting crossframes to stringer webs shall be tightened by the following method: Bolts shall be brought to a snug tight condition as may be produced by a few blows of an impact wrench or an ordinary spud wrench. Bolts shall then be further tightened by rotating the nut a half turn from the snug tight condition. Washers to be placed over slotted holes.

ESTIMATED QUANTITIES

Concrete	Formwork	Reinf. Steel
290 m³	1405 m²	46,250 Kg.

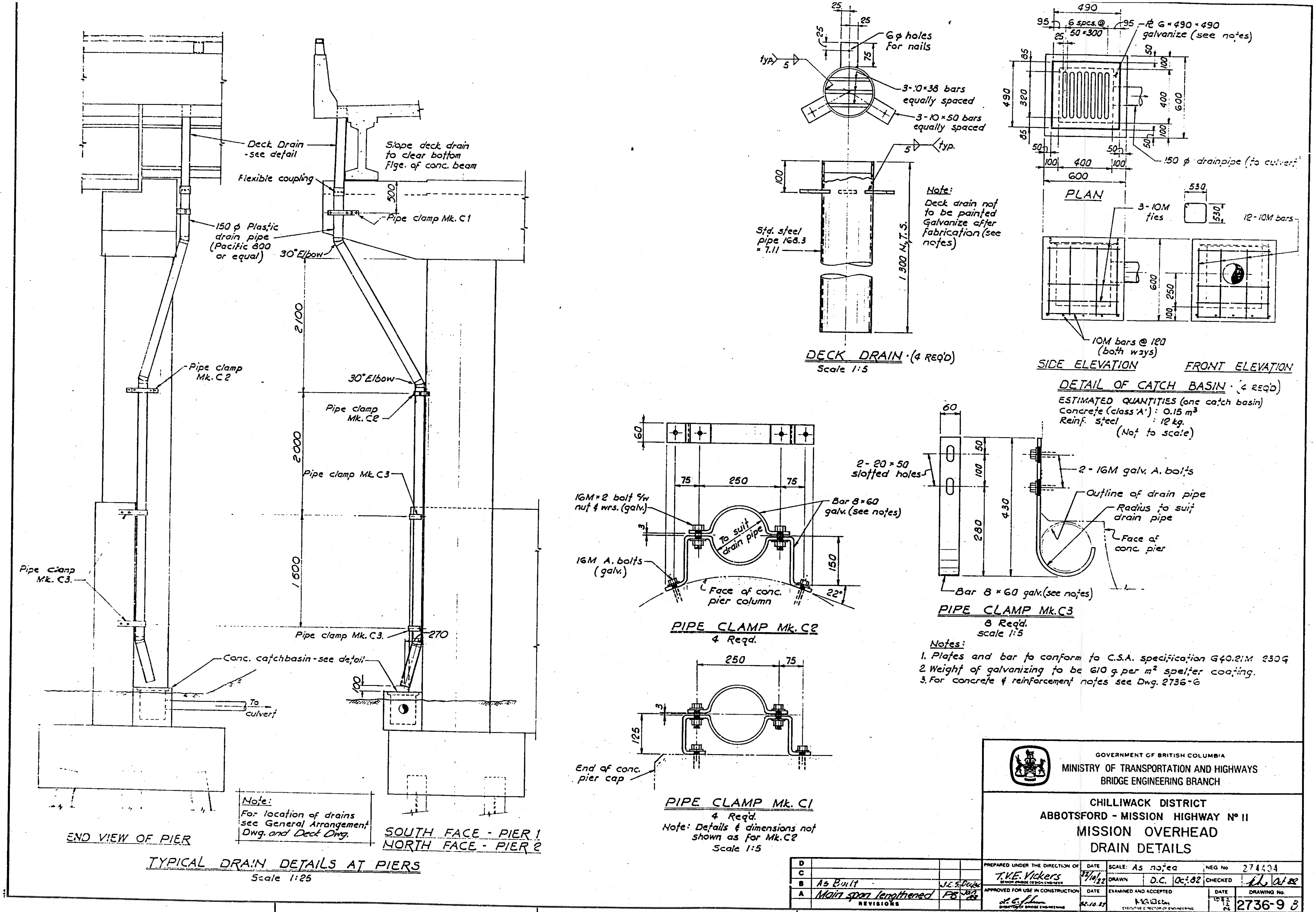
	REVISIONS		
D			
C	As Built	J.E.S	Dec/86
B	Barrier End Unit	J.P.M.	Sept/83
A	Main span lengthened	P.B	Jan/83

GOVERNMENT OF BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND HIGHWAYS
BRIDGE ENGINEERING BRANCH

CHILLIWACK DISTRICT
ABBOTSFORD - MISSION HIGHWAY Nº 11
MISSION OVERHEAD
DECK

PREPARED UNDER THE DIRECTION OF: T.V.E. Vickers, SENIOR BRIDGE DESIGN ENGINEER — DATE 15/11/82
SCALE: 1:25 And as noted — NEG. No. 2?403
DRAWN: J.E.S. Aug/82 — CHECKED
APPROVED FOR USE IN CONSTRUCTION: DIRECTOR OF BRIDGE ENGINEERING
EXAMINED AND ACCEPTED: EXECUTIVE DIRECTOR OF ENGINEERING
DRAWING No. 2736-8 C

CANCEL PRINTS BEARING EARLIER LETTER


Deck Drain - see detail
Flexible coupling
150 φ Plastic drain pipe (Pacific 800 or equal)
30° Elbow
Pipe clamp Mk. C2
Pipe clamp Mk. C3.
Conc. catchbasin - see detail
To culvert
Slope deck drain to clear bottom flge. of conc. beam
Pipe clamp Mk. C1
2100
2000
1600
270
Note: For location of drains see General Arrangement Dwg. and Deck Dwg.
END VIEW OF PIER
SOUTH FACE - PIER 1
NORTH FACE - PIER 2
TYPICAL DRAIN DETAILS AT PIERS
Scale 1:25
6 φ holes for nails
3-10×38 bars equally spaced
3-10×50 bars equally spaced
Std. steel pipe 168.3 × 7.11
1 300 H.T.S.
Note: Deck drain not to be painted. Galvanize after fabrication (see notes)
DECK DRAIN · (4 REQ'D)
Scale 1:5
490
6 spcs. @ 50 = 300
PL G × 490 × 490 galvanize (see notes)
150 φ drainpipe (to culvert)
PLAN
3-10M ties
12-10M bars
10M bars @ 120 (both ways)
SIDE ELEVATION
FRONT ELEVATION
DETAIL OF CATCH BASIN · (4 REQ'D)
ESTIMATED QUANTITIES (one catch basin)
Concrete (class 'A'): 0.15 m³
Reinf. steel : 12 kg.
(Not to scale)
16M × 2 bolt c/w nut & wrs. (galv.)
16M A. bolts (galv.)
To suit drain pipe
Bar 8 × 60 galv. (see notes)
Face of conc. pier column
PIPE CLAMP Mk. C2
4 Reqd.
End of conc. pier cap
PIPE CLAMP Mk. C1
4 Reqd.
Note: Details & dimensions not shown as for Mk. C2
Scale 1:5
2-20 × 50 slotted holes
2-16M galv. A. bolts
Outline of drain pipe
Radius to suit drain pipe
Face of conc. pier
Bar 8 × 60 galv. (see notes)
PIPE CLAMP Mk. C3
8 Reqd.
Scale 1:5
Notes:
1. Plates and bar to conform to C.S.A. specification G40.21M 230G
2. Weight of galvanizing to be 610 g. per m² spelter coating.
3. For concrete & reinforcement notes see Dwg. 2736-6
GOVERNMENT OF BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND HIGHWAYS
BRIDGE ENGINEERING BRANCH
CHILLIWACK DISTRICT
ABBOTSFORD - MISSION HIGHWAY Nº 11
MISSION OVERHEAD
DRAIN DETAILS
REVISIONS
B As Built
A Main span lengthened
PREPARED UNDER THE DIRECTION OF T.V.E. Vickers
SCALE: As noted
NEG No 274404
DRAWN D.C. Oct. 82
DRAWING No. 2736-9 B
CANCEL PRINTS BEARING EARLIER LETTER

BOREHOLE Nº 80-1

Location Sta. 17+30m, 4.25m Rt. Elevation 5.5m (Approx)
Driller E. BUDZKO Method DIAMOND DRILL Dates 80-3-11/17

EL +5.5

Drilling Details	Depth (m.)	Sample Type	Blowcount	Recovery mm.	Shear Strength	Fines	Sand	Gravel	W_L	W_P	W	Classification	Description	Other Tests
													low plastic organic SILT	
		S	2	406		90	5		44	29	38	OL	5% ORGANIC	
	3.1								56 / 45	33 / 28	49 / 43	ML	3.1m SILT, ϕ 32° C' 144 psf. 4.3m	
		S	5			95			40	30	42	OL	5% ORGANIC	
									51	34	57	OH	highly plastic organic SILT ϕ = 31° c = 0	
		S	5			55	5		55	48	68	OH	40% ORGANIC	
													5.8m	
		S				5	55	40				SP		
		S	55			10	90					SP SM	compact SAND with some silt layers	
		S	55			5	55	40				SP		
			34	229		5	55	40				SP		
	15.2	S	56			5	60	35				SP		
													17.4m	
	18.3	S	37			45	55					SM	silty SAND	
													18.9m	
		S				5	95					SP	compact SAND	
													23.5m	
	24.4	S	35	610		80	20					CL	stiff sandy CLAY	

EL -4.3

-11.5
~Pile Tip Elev

-18

BOREHOLE Nº 80-1 CONT'D

Location ______ Elevation ______
Driller ______ Method ______ Dates ______

Drilling Details	Depth (m.)	Sample Type	Blowcount	Recovery mm.	Shear Strength	Fines	Sand	Gravel	W_L	W_P	W	Classification	Description	Other Tests
	27.4	S	40	406		95	5		52	25	38	CH		
													28.6m	
	30.5	S	7 / 100	152		5	15	80				GC	very dense clayey sandy GRAVEL	
													31.1m END OF HOLE	

BOREHOLE Nº 79-3

Location Sta. 16+95m 3m Rt. Elevation 4.6m (Approx)
Driller D. BUYDENS Method AUGER RIG Dates 79-9-18/25

Drilling Details	Depth (m.)	Sample Type	Blowcount	Recovery mm.	Shear Strength	Fines	Sand	Gravel	W_L	W_P	W	Classification	Description	Other Tests
Aug		A				95	5		55	25	39	ML		
		A				85			55	36	49	OH	15% ORGANIC	
79-9-25		T		356		95	5		51	29	46	OH	Soft to Firm ORGANIC SILT with traces of fine sand and clay	
H casing	3.1	T		610		90	10		39 / 41	26 / 26	34 / 55	OL	C_c = .32, e_o = 1.23	C
		T		356		100			57	35	73	OH	+ organic, near liquid limit	
	6.1	T		610		95	5		47	31	48	OL	C_c = .37, e_o = 1.40 ϕ' = 33.5° C' = 144 psf.	
		T		610		95	5		49	31	60	OL		
	9.1	T		0										
													9.75m	
		S	5	152		15	85					SM	← loose layer	
	12.2	S	65	610		10	90					SP SM	dense silty SAND	
		S	45	610		5	85	10				SP	← minor gravel	
	15.2	S	48	356		5	95					SP		
H RODS		S	25	610		10	90					SP SM		
	18.3	S	8	610		20	80					SM	loose layer silty & clayey layers	
		S	46	610		20	80					SC		
	21.3	S	30	610		20	80					SM		
		S	86	254		5	95					SP		
	24.4	S	95	610		20	80					SM		
													25m END OF HOLE	

EL -5.1

BOREHOLE Nº

Location ______ Elevation ______
Driller ______ Method ______ Dates ______

Drilling Details	Depth (m.)	Sample Type	Blowcount	Recovery	Shear Strength	Fines	Sand	Gravel	W_L	W_P	W	Classification	Description	Other Tests

BOREHOLE Nº

Location ______ Elevation ______
Driller ______ Method ______ Dates ______

Drilling Details	Depth (m.)	Sample Type	Blowcount	Recovery	Shear Strength	Fines	Sand	Gravel	W_L	W_P	W	Classification	Description	Other Tests

BOREHOLE Nº

Location ______ Elevation ______
Driller ______ Method ______ Dates ______

Drilling Details	Depth (m.)	Sample Type	Blowcount	Recovery	Shear Strength	Fines	Sand	Gravel	W_L	W_P	W	Classification	Description	Other Tests

SOIL CLASSIFICATION

MAJOR DIVISIONS			SYMBOL	SOIL TYPE
COARSE GRAINED SOILS	GRAVEL & GRAVELLY SOILS		GW	WELL-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GM*	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC*	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND & SANDY SOILS		SW	WELL-GRADED SANDS OR GRAVELLY SANDS LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS OR GRAVELLY SANDS LITTLE OR NO FINES
			SM*	SILTY SANDS SAND-SILT MIXTURES
			SC*	CLAYEY SANDS SAND-CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS L.L.<50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILT-CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS L.L.>50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS
TOPSOIL			TS	TOPSOIL WITH ROOTS, ETC
COBBLES			SB	ROCK FRAGMENTS AND COBBLES, PARTICLE SIZE 3 in. TO 12 in. IN DIAMETER (75 - 300 mm)
BOULDERS			LB	BOULDERS, PARTICLE SIZE OVER 12 in. (300 mm) IN DIAMETER

* GM_1, GC_1, SM_1, SC_1 ... 12 - 20%
GM_2, GC_2, SM_2, SC_2 ... 20 - 30%
GM_3, GC_3, SM_3, SC_3 ... 30 - 40%
GM_4, GC_4, SM_4, SC_4 ... 40 - 50%
passing No. 200 sieve

H-241 (AMENDED SEPT. 1973)

SAMPLE TYPE	SHEAR STRENGTH	TESTS
A - Auger	U - Unconfined Compression	M - Mechanical Analysis
C - Core	L_V - Lab Vane	Q$\bar{R}$S - Triaxial Compression
D - Denison	F_V - Field Vane	C - Consolidation
S - Split Spoon	R - Remoulded	DS - Direct Shear
T - Shelby Tube		$W_L W_P$ - Liquid Plastic Limits
W - Wash		W - Moisture Content

Blowcount - Standard Penetration Test (ASTM 1586)

PREPARED BY:
GEOTECHNICAL & MATERIALS BRANCH

DRAWING NO.
INDEX | NEG. NO. | SHT. NO. ___ OF ___

GOVERNMENT OF BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND HIGHWAYS
BRIDGE ENGINEERING BRANCH

CHILLIWACK DISTRICT
ABBOTSFORD - MISSION HIGHWAY Nº 11
MISSION OVERHEAD
TEST HOLES

	REVISIONS	
D		
C		
B		
A	As Built	J.E.S. Dec/84

PREPARED UNDER THE DIRECTION OF [illegible] DATE [illegible]
SUPERVISING GEOTECHNICAL ENGINEER
APPROVED FOR USE IN CONSTRUCTION DATE [illegible]
DIRECTOR OF BRIDGE ENGINEERING
SCALE NEG. No. 274405
DRAWN AUG '80 CHECKED [illegible]
EXAMINED AND ACCEPTED DATE
DRAWING No. 2736-10 A

CANCEL PRINTS BEARING EARLIER LETTER

THURBER ENGINEERING LTD.

APPENDIX B

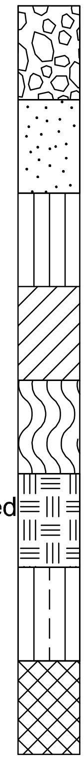
Test Hole Logs and Testing Results

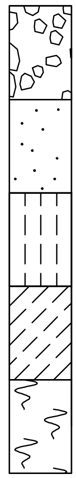
SYMBOLS AND TERMS

FOR SOIL DESCRIPTION AND TEST HOLE LOGS

BASIC SOIL SYMBOLS

Predominant Material	Secondary Material
GRAVEL	gravelly to some gravel
SAND	sandy to some sand
SILT	silty to some silt
CLAY	clayey to some clay
PEAT / ORGANICS	some organics
Undifferentiated BEDROCK	
ORGANIC SILT	
FILL / DEBRIS	



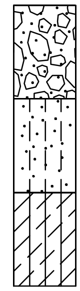


SYMBOL VARIATIONS - EXAMPLES [1]

SAND and GRAVEL

SAND, silty

SILT with some clay



DENSITY OF GRANULAR SOILS	
Description	SPT N [5] [6]
Very Loose	0 - 4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very Dense	> 50

PROPORTION OF MINOR COMPONENTS BY WEIGHT [2]	
and	35 - 50%
y / ey	20 - 35%
some	10 - 20%
trace	0 - 10%

CONSISTENCY OF COHESIVE SOILS	
Description	Undrained Shear Strength (kPa) [6]
Very Soft	< 12
Soft	12 - 25
Firm	25 - 50
Stiff	50 - 100
Very Stiff	100 - 200
Hard	> 200

PENETRATION TESTS

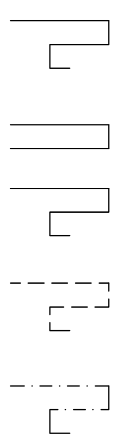
Dynamic Cone Penetration

Standard Penetration

Becker Closed Casing

Becker Open Casing

Bounce Chamber Pressure



CLASSIFICATION BY PARTICLE SIZE				
		Size Range [6]		
			U.S. Standard Sieve Size	
Name		(mm) [3]	Retained	Passing
Boulders		> 200	8 inch	-
Cobbles		75 - 200	3 inch	8 inch
Gravel:	coarse	19 - 75	0.75 inch	3 inch
	fine	5 - 19	No. 4	0.75 inch
Sand:	coarse	2 - 5	No. 10	No. 4
	medium	0.4 - 2	No. 40	No. 10
	fine	0.075 - 0.4	No. 200	No. 40
Fines (Silt or Clay) [4]		< 0.075	-	No. 200

(1) Only selected examples of the possible variations or combinations of the basic symbols are illustrated.
(2) Example: SAND, silty, trace of gravel = sand with 20 to 35% silt and up to 10% gravel, by dry weight. Percentages of secondary materials are estimates based on visual and tactile assessment of samples.
(3) Approximate metric conversion.
(4) Fines are classified as silt or clay on the basis of Atterberg limits.
(5) SPT N values on test hole logs are uncorrected field values.
(6) Reference Canadian Foundation Engineering Manual 4th Edition, 2006.

THURBER

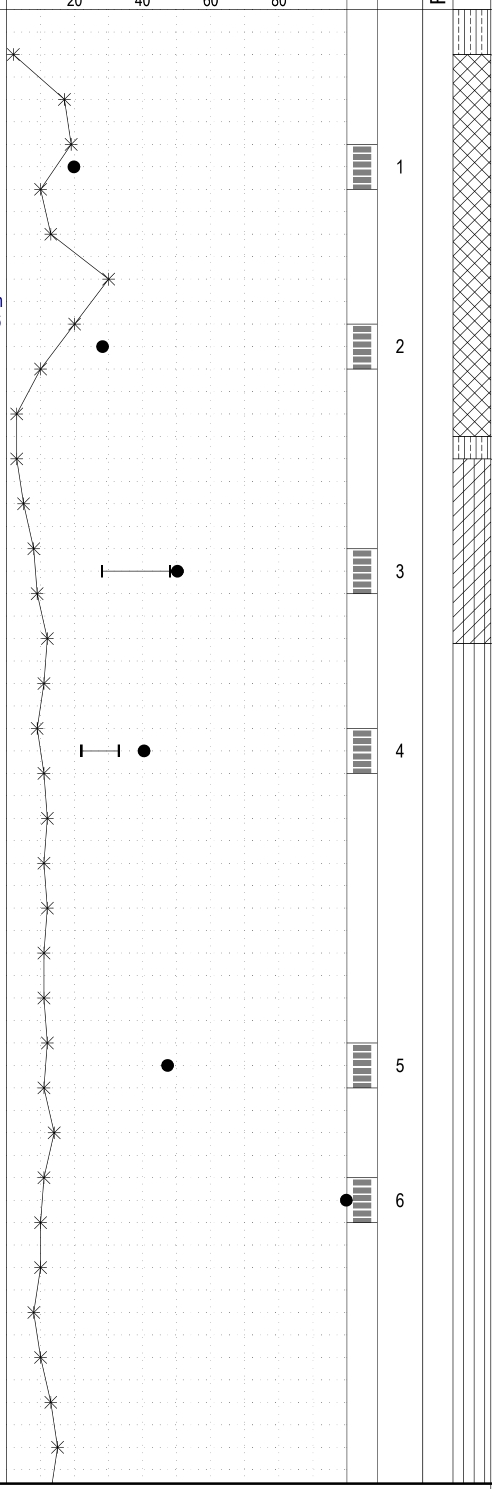
SUMMARY LOG

Drill Hole #: TH/SCPT16-1

British Columbia — Ministry of Transportation and Infrastructure

Project: **Highway 7 at Highway 11 Intersection Improvements**	Date(s) Drilled: November 5, 2016
Location: Mission, B.C.	Drilling Company: On Track Drilling Inc.
Prepared by: Thurber Engineering Ltd. 15723	Driller: Andrew Rice
Datum: Local Ground — Alignment: L200	Drill Make/Model: Yanmar 60
Northing/Easting: 444302 , 549406 — Station/Offset: 200+52; 34 m R	Drilling Method: DCPT / Solid Stem Auger
Logged by: TJS — Reviewed by: CHS — Elevation: 8 m (Approx.) — *Coordinates taken with GPS*	

Column headings: DEPTH (m) | DRILLING DETAILS | Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; DYNAMIC CONE (BLOWS/300 mm); Natural Vane (KPa) / Remold Vane (KPa); SPT "N" (BLOWS/300 mm); W_P% W% W_L% 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | SOIL SYMBOL | SOIL DESCRIPTION | CLASSIFICATION | COMMENTS TESTING Drillers Estimate {G % S % F %} | SLOTTED PIEZOMETER | DEPTH (m)



Depth (m)	Drilling Details	Sample No	Soil Description	Classification	Comments / Testing
0 – 0.3m			Loose, wet, brown SAND (TOPSOIL); contains organics	TS	Piezometer Stickup (0.6 m)
0.3m – 2.9m	Drop hammer temporarily mis-firing at 1.8 m depth. Water-1.9m 23/11/2016	1, 2	Compact, moist, brown SAND (FILL); trace silt - loose, wet, grey below 1.8 m depth	SP	**Sieve** (Sa#2) G:% S:93% F:7%
2.9m – 3.05m			Soft, wet, brown, organic SILT	OL	
3.05m – 4.3m		3	Firm to stiff, moist, orange-brown, silty CLAY; trace gravel; trace organics	ML/CL	**Atterberg** (Sa#3): PL:28% LL:48%
4.3m –		4, 5, 6	Firm, wet, grey SILT; some sand; trace gravel; trace clay; trace to some organics	ML	**Atterberg** (Sa#4): PL:22% LL:33% **Sieve** (Sa#4) G:% S:20% F:80% **Sieve** (Sa#5) G:% S:17% F:83% **Sieve** (Sa#6) G:% S:14% F:86%

Legend Sample Type: A-Auger; C-Core; G-Grab; V-Vane; L#-Lab Sample; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube

Legend Installation: Sand; Grout; Cement; Bentonite; Drill Cuttings; Slotted; Slough; Piezometer

Final Depth of Hole: 18.3 m
Depth to Top of Rock:

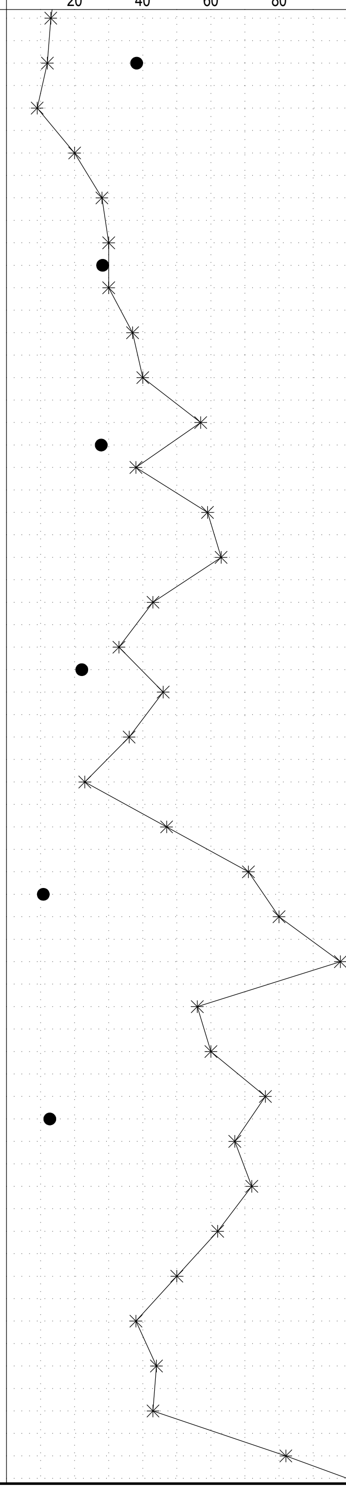
BRITISH COLUMBIA Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: TH/SCPT16-1

Prepared by: Thurber Engineering Ltd. 15723	Project: **Highway 7 at Highway 11 Intersection Improvements**	Date(s) Drilled: November 5, 2016
	Location: Mission, B.C.	Drilling Company: On Track Drilling Inc.
	Datum: Local Ground / Alignment: L200	Driller: Andrew Rice
	Northing/Easting: 444302 , 549406 / Station/Offset: 200+52; 34 m R	Drill Make/Model: Yanmar 60
Logged by: TJS / Reviewed by: CHS	Elevation: 8 m (Approx.) / *Coordinates taken with GPS*	Drilling Method: DCPT / Solid Stem Auger

Column headings: DEPTH (m) | DRILLING DETAILS | × Pocket Penetrometer ✕ Shear Strength (kPa) 100 200 300 400; ✳ DYNAMIC CONE (BLOWS/300 mm) ✳; + Natural Vane (KPa) ⊕ Remold Vane (KPa); ▲ SPT "N" (BLOWS/300 mm) ▲; W_P% W% W_L% 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | SOIL SYMBOL | SOIL DESCRIPTION | CLASSIFICATION | COMMENTS TESTING Drillers Estimate *{G % S % F %}* | SLOTTED PIEZOMETER | DEPTH (m)



Depth	Sample No	Soil Description	Classification	Comments / Testing
10.0m	7	Firm, wet, grey SILT; some sand; trace gravel; trace clay; trace to some organics	ML	**Sieve** (Sa#7) G:9% S:10% F:81%
11.3m	8, 9, 10	Stiff, wet, brown, sandy SILT; trace gravel; trace clay; trace organics - becomes grey at 13.1 m depth	ML	**Sieve** (Sa#8) G:% S:21% F:79%
15.5m	11, 12	Compact, wet, grey, gravelly SAND; rounded to sub-angular gravel to 30 mm diameter; trace silt	SP	
18.3m		End of Test Hole at 18.3 m depth. Hole collapsed to 2.1 m depth. Test Hole completion: 25 mm diameter piezometer installed. Test Hole located approximately 3 m west of SCPT.		

Depth scale: 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

Legend Sample Type: A-Auger, C-Core, G-Grab, V-Vane, L#-Lab Sample, S-Split Spoon, O-Odex (air rotary), W-Wash (mud return), T-Shelby Tube

Legend Installation: Sand, Grout, Cement, Bentonite, Drill Cuttings, Slotted, Slough, Piezometer

Final Depth of Hole: 18.3 m
Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: TH/SCPT16-1

Ministry of Transportation and Infrastructure — British Columbia

Prepared by: Thurber Engineering Ltd. 15723	Project: **Highway 7 at Highway 11 Intersection Improvements**
Logged by: TJS Reviewed by: CHS	Location: Mission, B.C.
	Datum: Local Ground — Alignment: L200
	Northing/Easting: 444302 , 549406 — Station/Offset: 200+52; 34 m R
	Elevation: 8 m (Approx.) — *Coordinates taken with GPS*

Date(s) Drilled: November 5, 2016
Drilling Company: On Track Drilling Inc.
Driller: Andrew Rice
Drill Make/Model: Yanmar 60
Drilling Method: DCPT / Solid Stem Auger

DEPTH (m)	DRILLING DETAILS	× Pocket Penetrometer ✕ Shear Strength (kPa) 100 200 300 400 / ✳ DYNAMIC CONE (BLOWS/300 mm) ✳ / + Natural Vane (KPa) ⊕ Remold Vane (KPa) / ▲ SPT "N" (BLOWS/300 mm) ▲ / W_P% W% W_L% 20 40 60 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate *{G % S % F %}*	SLOTTED PIEZOMETER	DEPTH (m)
20	DCPT Refusal at 20.2 m depth.	>>✳ >>✳									
21											21
22											22
23											23
24											24
25											25
26											26
27											27
28											28
29											29
30											

Legend Sample Type: A-Auger, C-Core, G-Grab, V-Vane, L#-Lab Sample, S-Split Spoon, O-Odex (air rotary), W-Wash (mud return), T-Shelby Tube

Legend Installation: Sand, Grout, Cement, Bentonite, Drill Cuttings, Slotted, Slough, Piezometer

Final Depth of Hole: 18.3 m
Depth to Top of Rock:

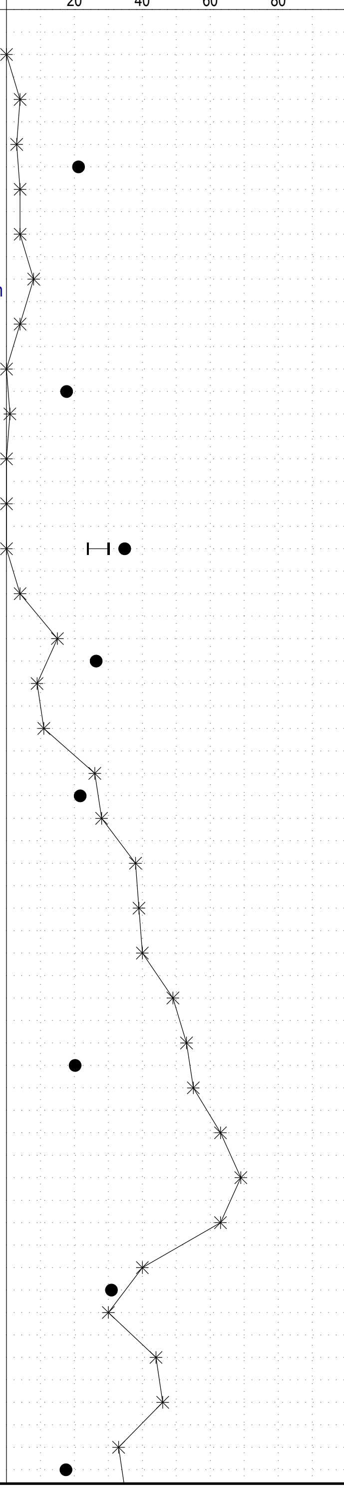
SUMMARY LOG

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

Drill Hole #: TH16-2

Prepared by: Thurber Engineering Ltd. 15723	Project: **Highway 7 at Highway 11 Intersection Improvements**	Date(s) Drilled: November 5/6, 2016
	Location: Mission, B.C.	Drilling Company: On Track Drilling Inc.
	Datum: Local Ground — Alignment: L200	Driller: Andrew Rice
	Northing/Easting: 444396 , 549396 — Station/Offset: 201+47; 33 m R	Drill Make/Model: Yanmar 60
Logged by: TJS — Reviewed by: CHS	Elevation: 10.5 m (Approx.) — *Coordinates taken with GPS*	Drilling Method: DCPT / Solid Stem Auger

Column headings: DEPTH (m) | DRILLING DETAILS | Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; DYNAMIC CONE (BLOWS/300 mm); Natural Vane (KPa) / Remold Vane (KPa); SPT "N" (BLOWS/300 mm); W_P% W% W_L% 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | SOIL SYMBOL | SOIL DESCRIPTION | CLASSIFICATION | COMMENTS TESTING Drillers Estimate *{G % S % F %}* | DEPTH (m)



Depth (m)	Drilling Details	Sample No	Soil Description	Classification	Comments / Testing
0 – 0.3m			Loose, wet, brown SAND (TOPSOIL); contains organics	SM	
0.3m – 3.4m	Water-1.8m 5/11/2016	1, 2	Loose, moist, brown, silty SAND (possible FILL); trace gravel - very loose, wet, grey below 1.8 m depth	SM	**Sieve** (Sa#2) G:% S:71% F:29%
3.4m – 4.0m		3	Very soft, wet, dark brown, organic SILT; trace sand; fibrous organics; contains wood fragments	OL/ML	**Atterberg** (Sa#3): PL:24% LL:30%
4.0m – 9.8m		4, 5, 6, 7	Soft to firm, wet, grey, sandy SILT; trace gravel; trace clay; trace organics - becomes stiff at 5.8 m depth	ML	**Sieve** (Sa#4) G:3% S:26% F:71%
9.8m		8			

Legend
Sample Type: A-Auger; C-Core; G-Grab; V-Vane; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube; L#-Lab Sample

Final Depth of Hole: 15.2 m
Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: **TH16-2**

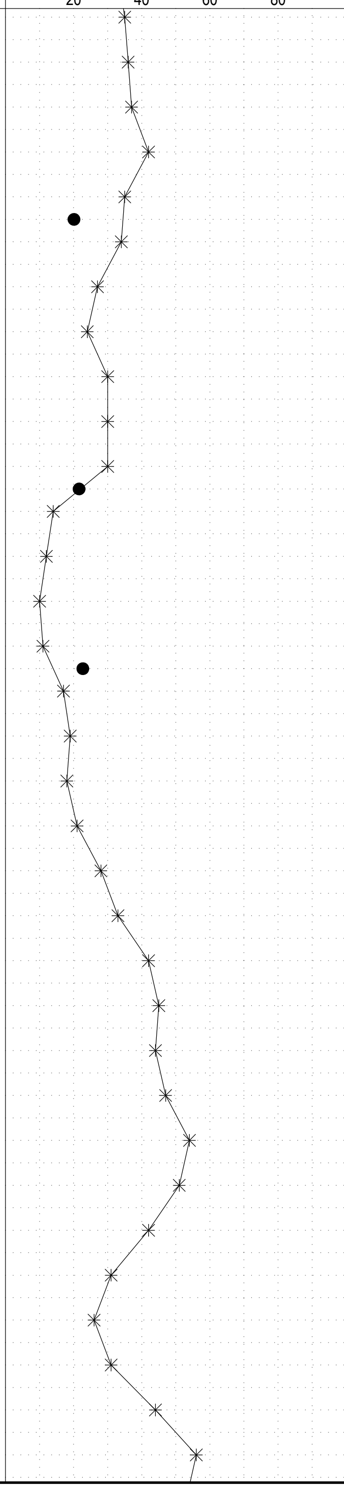
Ministry of Transportation and Infrastructure — BRITISH COLUMBIA

Project: **Highway 7 at Highway 11 Intersection Improvements**	Date(s) Drilled: November 5/6, 2016
Location: Mission, B.C.	Drilling Company: On Track Drilling Inc.
Datum: Local Ground; Alignment: L200	Driller: Andrew Rice
Northing/Easting: 444396 , 549396; Station/Offset: 201+47; 33 m R	Drill Make/Model: Yanmar 60
Elevation: 10.5 m (Approx.); *Coordinates taken with GPS*	Drilling Method: DCPT / Solid Stem Auger

Prepared by: Thurber Engineering Ltd. 15723

Logged by: TJS Reviewed by: CHS

Column headings: DEPTH (m) | DRILLING DETAILS | Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; DYNAMIC CONE (BLOWS/300 mm); Natural Vane (KPa) / Remold Vane (KPa); SPT "N" (BLOWS/300 mm); W_P% W% W_L% 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | SOIL SYMBOL | SOIL DESCRIPTION | CLASSIFICATION | COMMENTS TESTING Drillers Estimate *{G % S % F %}* | DEPTH (m)



Depth (m)	Sample No	Soil Description	Classification
10.0 – 13.1	9 (at ~11.4 m)	Compact, wet, brown SAND and SILT *(continued)*	SM/ML
13.1 – 18.3	10 (at ~13.3 m), 11 (at ~14.5 m)	Firm, wet, grey SILT; some sand; trace clay - becomes stiff at 15.8 m depth	ML
18.3		End of Test Hole at 18.3 m depth. Hole collapsed to 2.6 m depth.	

Depth scale: 10 11 12 13 14 15 16 17 18 19 20

Legend
Sample Type: A-Auger; C-Core; G-Grab; V-Vane; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube; L#-Lab Sample

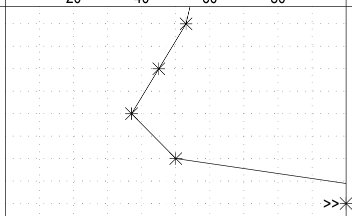
Final Depth of Hole: 15.2 m
Depth to Top of Rock:

SUMMARY LOG

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

Drill Hole #: **TH16-2**

Prepared by: 15723 Thurber Engineering Ltd.	Project: **Highway 7 at Highway 11 Intersection Improvements**	Date(s) Drilled: November 5/6, 2016
	Location: Mission, B.C.	Drilling Company: On Track Drilling Inc.
	Datum: Local Ground — Alignment: L200	Driller: Andrew Rice
	Northing/Easting: 444396 , 549396 — Station/Offset: 201+47; 33 m R	Drill Make/Model: Yanmar 60
Logged by: TJS — Reviewed by: CHS	Elevation: 10.5 m (Approx.) — *Coordinates taken with GPS*	Drilling Method: DCPT / Solid Stem Auger

DEPTH (m)	DRILLING DETAILS	× Pocket Penetrometer × Shear Strength (kPa) 100 200 300 400; ✳ DYNAMIC CONE (BLOWS/300 mm) ✳; + Natural Vane (KPa) ⊕ Remold Vane (KPa); ▲ SPT "N" (BLOWS/300 mm) ▲; W_P% W% W_L% 20 40 60 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate *{G % S % F %}*	DEPTH (m)
20										
21	DCPT Refusal at 21.3 m depth.	>>								21
22										22
23										23
24										24
25										25
26										26
27										27
28										28
29										29
30										

Legend
Sample Type: A-Auger; C-Core; G-Grab; V-Vane; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube; L#-Lab Sample

Final Depth of Hole: 15.2 m
Depth to Top of Rock:

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: TH16-3

Project: **Highway 7 at Highway 11 Intersection Improvements**
Location: Mission, B.C.

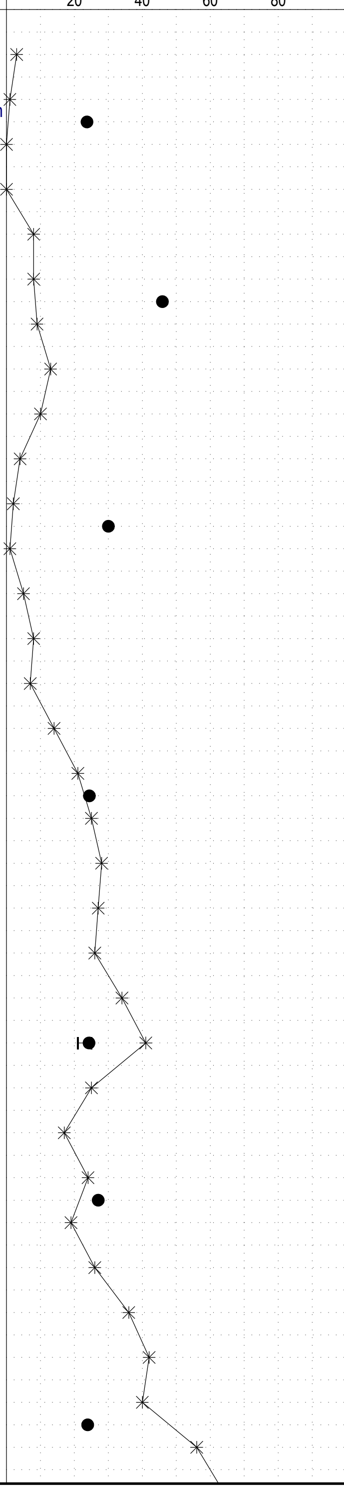
Prepared by: 15723
Thurber Engineering Ltd.

Logged by: TJS Reviewed by: CHS

Datum: Local Ground Alignment: L200
Northing/Easting: 444397 , 549311 Station/Offset: 201+55; 52 m L
Elevation: 10 m (Approx.) *Coordinates taken with GPS*

Date(s) Drilled: November 6, 2016
Drilling Company: On Track Drilling Inc.
Driller: Andrew Rice
Drill Make/Model: Yanmar 60
Drilling Method: DCPT / Solid Stem Auger

DEPTH (m)	DRILLING DETAILS	SAMPLE TYPE	SAMPLE NO	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING (Drillers Estimate *{G % S % F %}*)	DEPTH (m)
0				SAND and GRAVEL (FILL)	GP/SP		
0.3m	Water-0.6m 5/11/2016		1	Very loose to loose, wet, grey SAND; some silt; trace gravel; contains wood fragments; slight organic odour	SM		1
2			2			**Sieve** (Sa#2) G:1% S:79% F:20%	2
2.7m				Soft, moist, brown, organic SILT; strong organic odour	OL		
3.0m			3	Loose, wet, brown SAND and SILT; trace clay; trace organics	SM	**Sieve** (Sa#3) G:% S:59% F:41%	3, 4
4.6m			4, 5, 6, 7	Firm to stiff, wet, grey SILT; some sand; trace organics	ML	**Atterberg** (Sa#5): PL:21% LL:25% **Sieve** (Sa#5) G:0% S:19% F:81%	5, 6, 7, 8, 9
10							



Legend
Sample Type: A-Auger; C-Core; G-Grab; V-Vane; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube
L#-Lab Sample

Final Depth of Hole: 19.8 m
Depth to Top of Rock:

SUMMARY LOG

Ministry of Transportation and Infrastructure — British Columbia

Drill Hole #: TH16-3

Project: **Highway 7 at Highway 11 Intersection Improvements**
Location: Mission, B.C.

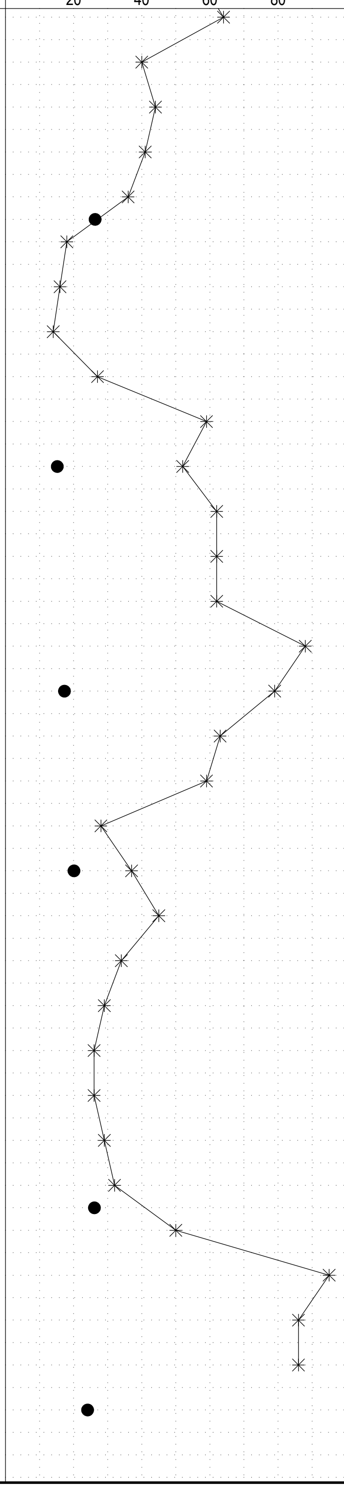
Prepared by: 15723
Thurber Engineering Ltd.

Logged by: TJS Reviewed by: CHS

Datum: Local Ground Alignment: L200
Northing/Easting: 444397 , 549311 Station/Offset: 201+55; 52 m L
Elevation: 10 m (Approx.) *Coordinates taken with GPS*

Date(s) Drilled: November 6, 2016
Drilling Company: On Track Drilling Inc.
Driller: Andrew Rice
Drill Make/Model: Yanmar 60
Drilling Method: DCPT / Solid Stem Auger

Chart key: × Pocket Penetrometer, ✕ Shear Strength (kPa), scale 100, 200, 300, 400; ✳ DYNAMIC CONE (BLOWS/300 mm) ✳; + Natural Vane (KPa), ⊕ Remold Vane (KPa); ▲ SPT "N" (BLOWS/300 mm) ▲; W_P% ● W% W_L%, scale 20, 40, 60, 80



DEPTH (m)	DRILLING DETAILS	SAMPLE NO	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate *{G % S % F %}*
10.0m – 12.5m		8	Firm to stiff, wet, grey SILT; some sand; trace organics	ML	
12.5m – 17.7m		9, 10, 11	Compact to dense, wet, grey SAND; trace to some silt	SM	
17.7m – 19.8m	End DCPT at 19.2 m depth.	12, 13	Very stiff, moist, grey, silty CLAY; trace to some sand	CL	

End of Test Hole at 19.8 m depth.
Hole collapsed to 1.5 m depth.
Free water encountered at 0.6 m depth while drilling.

Legend
Sample Type: A-Auger, C-Core, G-Grab, V-Vane, S-Split Spoon, O-Odex (air rotary), W-Wash (mud return), T-Shelby Tube
L#-Lab Sample

Final Depth of Hole: 19.8 m
Depth to Top of Rock:

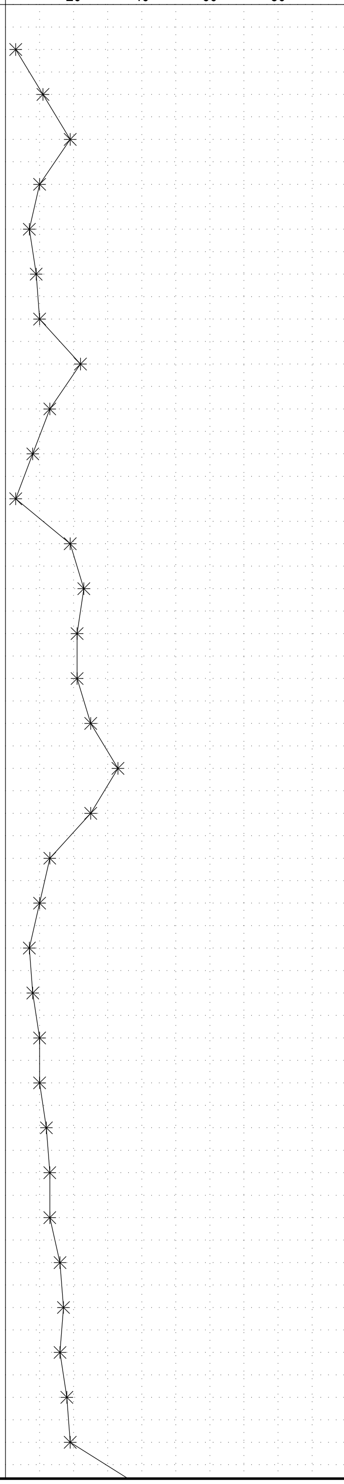
SUMMARY LOG

Drill Hole #: TH16-4

Ministry of Transportation and Infrastructure — British Columbia

Prepared by: Thurber Engineering Ltd. 15723	Project: **Highway 7 at Highway 11 Intersection Improvements**	Date(s) Drilled: November 6, 2016
	Location: Mission, B.C.	Drilling Company: On Track Drilling Inc.
	Datum: Local Ground — Alignment: L200	Driller: Andrew Rice
	Northing/Easting: 444362 , 549396 — Station/Offset: 201+13; 30 m R	Drill Make/Model: Yanmar 60
Logged by: TJS — Reviewed by: CHS	Elevation: 8.5 m (Approx.) — *Coordinates taken with GPS*	Drilling Method: DCPT

DEPTH (m)	DRILLING DETAILS	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; DYNAMIC CONE (BLOWS/300 mm); Natural Vane (KPa) / Remold Vane (KPa); SPT "N" (BLOWS/300 mm); W_P% W% W_L% 20 40 60 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING — Drillers Estimate *{G % S % F %}*	DEPTH (m)
0									DCPT only.	
1										1
2										2
3										3
4										4
5										5
6										6
7										7
8										8
9										9
10										



Legend
Sample Type: A-Auger, C-Core, G-Grab, V-Vane, S-Split Spoon, O-Odex (air rotary), W-Wash (mud return), T-Shelby Tube, L#-Lab Sample

Final Depth of Hole: 17.1 m
Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: TH16-4

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

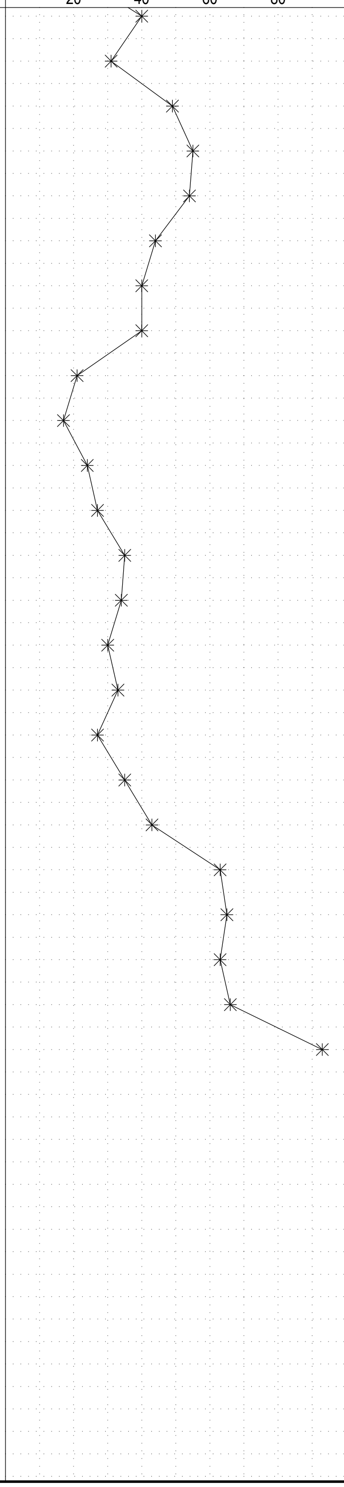
Prepared by: Thurber Engineering Ltd. 15723

Logged by: TJS Reviewed by: CHS

Project: **Highway 7 at Highway 11 Intersection Improvements**
Location: Mission, B.C.
Datum: Local Ground
Alignment: L200
Northing/Easting: 444362 , 549396
Station/Offset: 201+13; 30 m R
Elevation: 8.5 m (Approx.)
Coordinates taken with GPS

Date(s) Drilled: November 6, 2016
Drilling Company: On Track Drilling Inc.
Driller: Andrew Rice
Drill Make/Model: Yanmar 60
Drilling Method: DCPT

DEPTH (m)	DRILLING DETAILS	× Pocket Penetrometer ⊠ Shear Strength (kPa) 100 200 300 400 / ✳ DYNAMIC CONE (BLOWS/300 mm) ✳ / + Natural Vane (KPa) ⊕ Remold Vane (KPa) / ▲ SPT "N" (BLOWS/300 mm) ▲ / W_P% W% W_L% 20 40 60 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING / Drillers Estimate *{G % S % F %}*	DEPTH (m)
10									DCPT only.	
11										11
12										12
13										13
14										14
15										15
16										16
17	End DCPT at 17.1 m depth.									17
18										18
19										19
20										



Legend
Sample Type:
A-Auger
C-Core
G-Grab
V-Vane
S-Split Spoon
O-Odex (air rotary)
W-Wash (mud return)
T-Shelby Tube
L#-Lab Sample

Final Depth of Hole: 17.1 m
Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: TH16-5

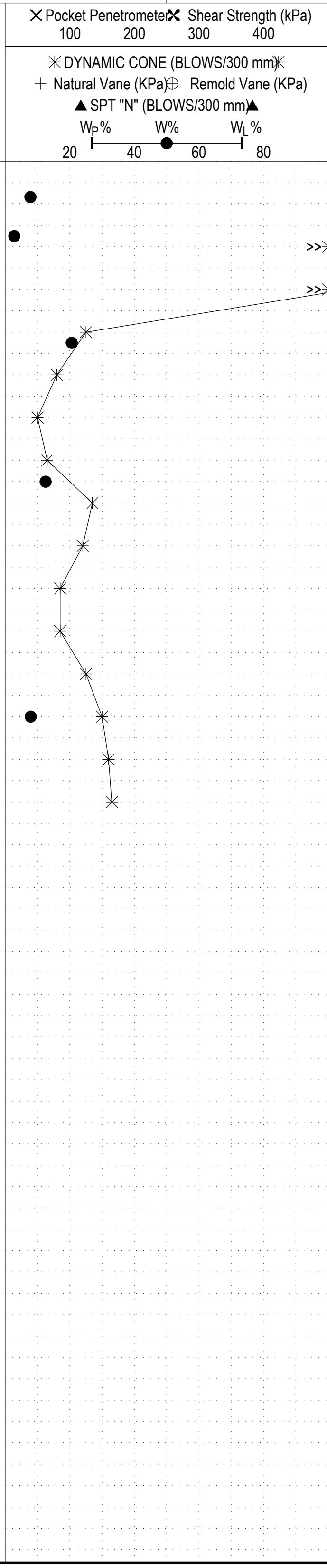
British Columbia — Ministry of Transportation and Infrastructure

Prepared by: Thurber Engineering Ltd. 15723

Logged by: TJS Reviewed by: CHS

Project: **Highway 7 at Highway 11 Intersection Improvements**
Location: Mission, B.C.
Datum: Local Ground
Alignment: L100
Northing/Easting: 444437 , 549239
Station/Offset: 101+37; 8 m R
Elevation: 25.5 m (Approx.)
Coordinates taken with GPS

Date(s) Drilled: November 7, 2016
Drilling Company: On Track Drilling Inc.
Driller: Andrew Rice
Drill Make/Model: Yanmar 60
Drilling Method: DCPT / Solid Stem Auger



DEPTH (m)	DRILLING DETAILS	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate *{G % S % F %}*	DEPTH (m)
0	Start DCPT at 0.3 m depth.					ASPHALT (approximately 200 mm thick) — 0.2m	AS		
		G	1			Dense, moist, brown, sandy GRAVEL (Road base FILL) — 0.8m	GP/SP		
		G	2						
1		G	3			Compact, moist, brown, silty SAND (possible FILL)	SM		1
2		G	4						2
3									3
4		G	5						4
	End DCPT at 4.6 m depth.					— 4.6m			
5						End of Test Hole at 4.6 m depth. Hole collapsed to 2.4 m depth.			5
6									6
7									7
8									8
9									9
10									

Legend
Sample Type: A-Auger, C-Core, G-Grab, V-Vane, S-Split Spoon, O-Odex (air rotary), W-Wash (mud return), T-Shelby Tube, L#-Lab Sample

Final Depth of Hole: 4.6 m
Depth to Top of Rock:

BRITISH COLUMBIA | Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: TH16-6

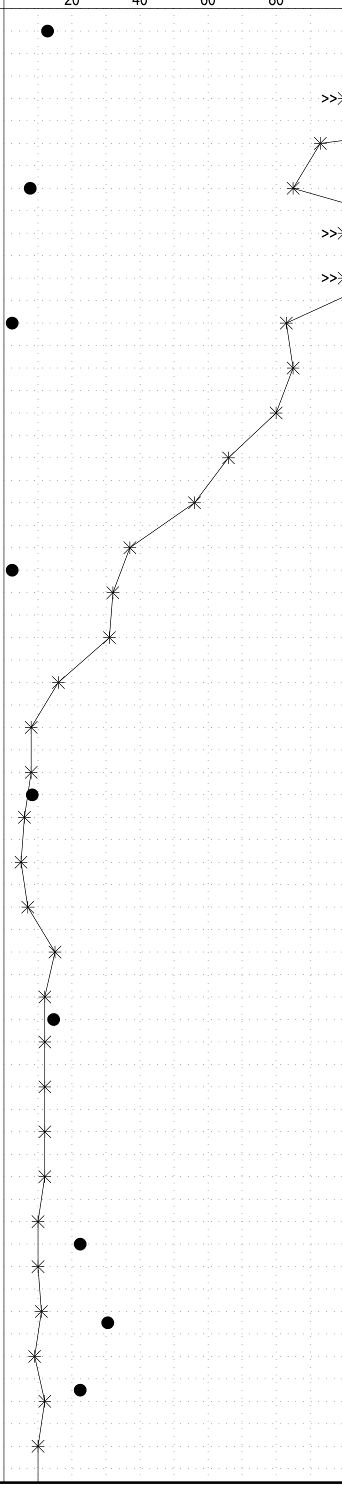
Project: **Highway 7 at Highway 11 Intersection Improvements**
Location: Mission, B.C.

Prepared by: Thurber Engineering Ltd. 15723
Logged by: TJS Reviewed by: CHS

Datum: Local Ground
Northing/Easting: 444434 , 549299
Elevation: 21.5 m (Approx.)
Alignment: L100
Station/Offset: 101+97; 10 m R
Coordinates taken with GPS

Date(s) Drilled: November 7, 2016
Drilling Company: On Track Drilling Inc.
Driller: Andrew Rice
Drill Make/Model: Yanmar 60
Drilling Method: DCPT / Solid Stem Auger

Column headings: DEPTH (m) | DRILLING DETAILS | Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; DYNAMIC CONE (BLOWS/300 mm); Natural Vane (KPa) / Remold Vane (KPa); SPT "N" (BLOWS/300 mm); W_P% W% W_L% 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | SOIL SYMBOL | SOIL DESCRIPTION | CLASSIFICATION | COMMENTS TESTING Drillers Estimate *{G % S % F %}* | DEPTH (m)



Depth	Drilling Details	Sample No	Soil Description	Classification
0 – 0.1m	Start DCPT at 0.3 m depth.	1	ASPHALT (approximately 110 mm thick)	AS
0.1m – 0.6m			Dense, moist, brown, sandy GRAVEL (Road base FILL); gravel to 30 mm diameter; trace silt	GP/SP
0.6m – 6.1m		2, 3, 4, 5	Dense, moist, brown SAND (FILL); trace gravel to 10 mm diamter; trace silt - gravelly, some silt at 3.7 m depth - loose, contains glass fragments at 5.2 m depth	SP-SM
6.1m – 8.85m		6, 7	Firm, moist, brown, sandy SILT; some gravel; trace organics	ML
8.85m – 9.0m	Water-9.0m 7/11/2016	8	Firm, moist, grey-brown, silty CLAY; trace organics; slight organic odour	CL
9.0m – 9.3m			Loose, wet, grey SAND; trace silt; slight organic odour	SP
9.3m – 9.45m		9	Firm, wet, dark brown, clayey SILT; some sand; strong organic odour	ML/OL

Depth scale: 0 1 2 3 4 5 6 7 8 9 10

Legend
Sample Type: A-Auger; C-Core; G-Grab; V-Vane; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube
L#-Lab Sample

Final Depth of Hole: 13.7 m
Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: **TH16-6**

Ministry of Transportation and Infrastructure, British Columbia

Project: **Highway 7 at Highway 11 Intersection Improvements**
Location: Mission, B.C.

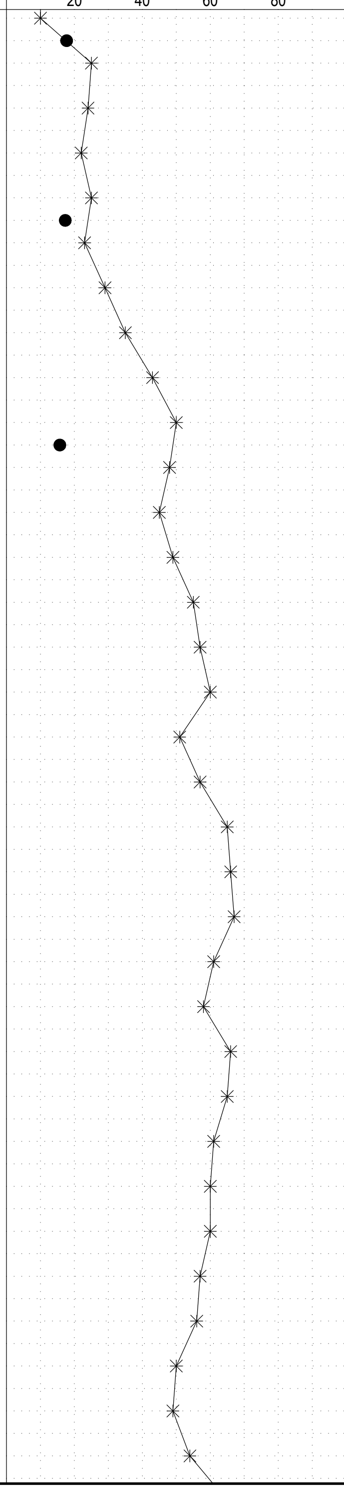
Date(s) Drilled: November 7, 2016
Drilling Company: On Track Drilling Inc.

Prepared by: 15723
Thurber Engineering Ltd.

Logged by: TJS Reviewed by: CHS

Datum: Local Ground Alignment: L100
Northing/Easting: 444434 , 549299 Station/Offset: 101+97; 10 m R
Elevation: 21.5 m (Approx.) *Coordinates taken with GPS*

Driller: Andrew Rice
Drill Make/Model: Yanmar 60
Drilling Method: DCPT / Solid Stem Auger

DEPTH (m)	DRILLING DETAILS	× Pocket Penetrometer ✕ Shear Strength (kPa) 100 200 300 400; ✳ DYNAMIC CONE (BLOWS/300 mm) ✳; + Natural Vane (KPa) ⊕ Remold Vane (KPa); ▲ SPT "N" (BLOWS/300 mm) ▲; W_P% W% W_L% 20 40 60 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate *{G % S % F %}*	DEPTH (m)
10				10			Compact becoming dense, wet, brown, silty SAND *(continued)*			
11				11				SM		11
12										12
13				12						13
							13.7m			
14							End of Test Hole at 13.7 m depth. Hole collapsed to 9.3 m depth.			14
15										15
16										16
17										17
18										18
19										19
20										

Legend
Sample Type: A-Auger; C-Core; G-Grab; V-Vane; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube
L#-Lab Sample

Final Depth of Hole: 13.7 m
Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: **TH16-6**

Ministry of Transportation and Infrastructure, British Columbia

Prepared by: 15723 Thurber Engineering Ltd.

Logged by: TJS Reviewed by: CHS

Project: **Highway 7 at Highway 11 Intersection Improvements**

Location: Mission, B.C.

Datum: Local Ground Alignment: L100

Northing/Easting: 444434 , 549299 Station/Offset: 101+97; 10 m R

Elevation: 21.5 m (Approx.) *Coordinates taken with GPS*

Date(s) Drilled: November 7, 2016

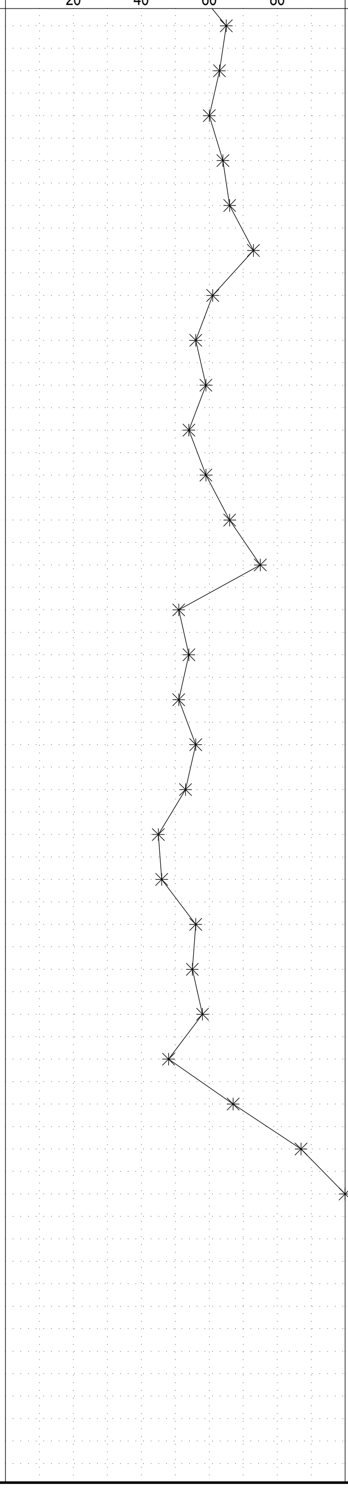
Drilling Company: On Track Drilling Inc.

Driller: Andrew Rice

Drill Make/Model: Yanmar 60

Drilling Method: DCPT / Solid Stem Auger

DEPTH (m)	DRILLING DETAILS	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; DYNAMIC CONE (BLOWS/300 mm); Natural Vane (KPa) / Remold Vane (KPa); SPT "N" (BLOWS/300 mm); W_P% W% W_L% 20 40 60 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate *{G % S % F %}*	DEPTH (m)
20										
21										21
22										22
23										23
24										24
25										25
26										26
27										27
28	DCPT Refusal at 28.0 m depth.									28
29										29
30										



Legend
Sample Type: A-Auger, C-Core, G-Grab, V-Vane, S-Split Spoon, O-Odex (air rotary), W-Wash (mud return), T-Shelby Tube, L#-Lab Sample

Final Depth of Hole: 13.7 m
Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: **TH16-7**

British Columbia — Ministry of Transportation and Infrastructure

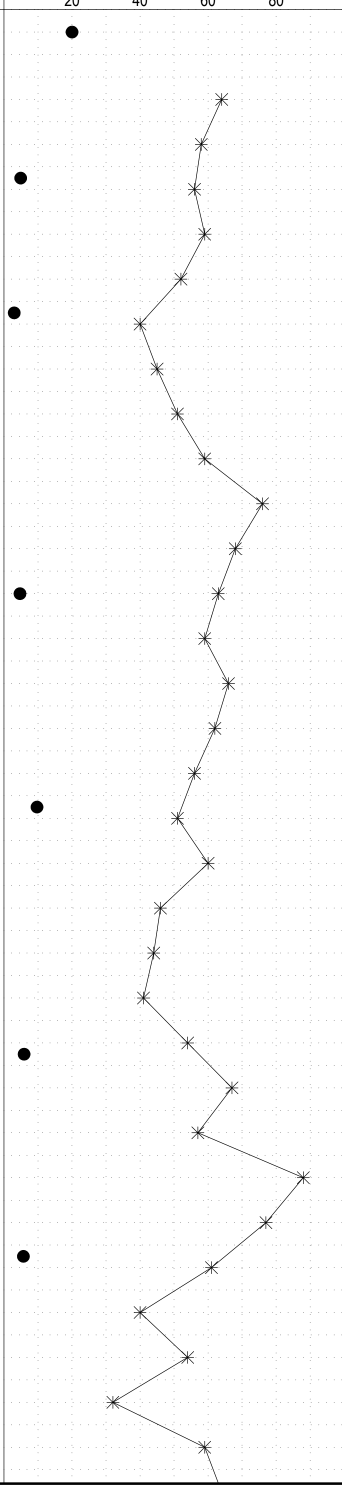
Project: **Highway 7 at Highway 11 Intersection Improvements**
Location: Mission, B.C.

Prepared by: Thurber Engineering Ltd. 15723
Logged by: TJS Reviewed by: CHS

Datum: Local Ground
Northing/Easting: 444314 , 549360
Elevation: 17 m (Approx.)
Alignment: L200
Station/Offset: 200+68; 10 m L
Coordinates taken with GPS

Date(s) Drilled: November 7, 2016
Drilling Company: On Track Drilling Inc.
Driller: Andrew Rice
Drill Make/Model: Yanmar 60
Drilling Method: DCPT / Solid Stem Auger

Chart legend: × Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; ✳ DYNAMIC CONE (BLOWS/300 mm); + Natural Vane (KPa) ⊕ Remold Vane (KPa); ▲ SPT "N" (BLOWS/300 mm); W_P% W% W_L% 20 40 60 80



DEPTH (m)	DRILLING DETAILS	SAMPLE NO	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}
0	Start DCPT at 0.3 m depth.	1	ASPHALT (approximately 100 mm thick) — 0.1m	AS	
			Dense, moist, grey, gravelly SAND (Road base FILL); trace silt — 0.6m	SP	
1		2	Dense, moist, grey SAND (FILL); trace gravel; trace silt		
2		3			
4		4			
5		5		SP	
7		6			
8		7			
10					

Legend
Sample Type: A-Auger; C-Core; G-Grab; V-Vane; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube; L#-Lab Sample

Final Depth of Hole: 21.3 m
Depth to Top of Rock:

British Columbia — Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: TH16-7

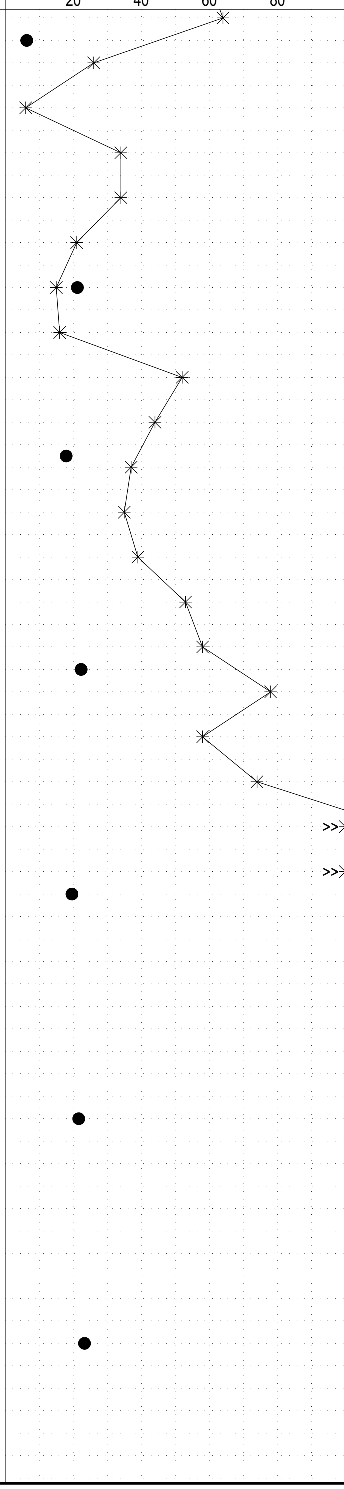
Project: **Highway 7 at Highway 11 Intersection Improvements**
Location: Mission, B.C.

Prepared by: Thurber Engineering Ltd. 15723
Logged by: TJS Reviewed by: CHS

Datum: Local Ground
Northing/Easting: 444314 , 549360
Elevation: 17 m (Approx.)
Alignment: L200
Station/Offset: 200+68; 10 m L
Coordinates taken with GPS

Date(s) Drilled: November 7, 2016
Drilling Company: On Track Drilling Inc.
Driller: Andrew Rice
Drill Make/Model: Yanmar 60
Drilling Method: DCPT / Solid Stem Auger

Columns: DEPTH (m) | DRILLING DETAILS | Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; DYNAMIC CONE (BLOWS/300 mm); Natural Vane (KPa) / Remold Vane (KPa); SPT "N" (BLOWS/300 mm); W_P% W% W_L% 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | SOIL SYMBOL | SOIL DESCRIPTION | CLASSIFICATION | COMMENTS TESTING Drillers Estimate *{G % S % F %}* | DEPTH (m)



Depth (m)	Drilling Details	Sample No	Soil Description	Classification
10.1		8	Loose to compact, wet, brown SAND; trace to some silt	SM
11.6		9, 10, 11, 12, 13, 14	Compact / firm becoming dense / stiff, wet grey-brown SAND and SILT; trace clay; trace organics	SM/ML
15.8	DCPT Refusal at 15.8 m depth.			

Depth scale: 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

Legend
Sample Type: A-Auger; C-Core; G-Grab; V-Vane; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube; L#-Lab Sample

Final Depth of Hole: 21.3 m
Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: **TH16-7**

Ministry of Transportation and Infrastructure, British Columbia

Prepared by: Thurber Engineering Ltd. 15723	Project: **Highway 7 at Highway 11 Intersection Improvements**	Date(s) Drilled: November 7, 2016
	Location: Mission, B.C.	Drilling Company: On Track Drilling Inc.
	Datum: Local Ground; Alignment: L200	Driller: Andrew Rice
	Northing/Easting: 444314 , 549360; Station/Offset: 200+68; 10 m L	Drill Make/Model: Yanmar 60
Logged by: TJS Reviewed by: CHS	Elevation: 17 m (Approx.) *Coordinates taken with GPS*	Drilling Method: DCPT / Solid Stem Auger

Column headings: DEPTH (m) | DRILLING DETAILS | × Pocket Penetrometer ✕ Shear Strength (kPa) 100 200 300 400; ✳ DYNAMIC CONE (BLOWS/300 mm) ✳; + Natural Vane (KPa) ⊕ Remold Vane (KPa); ▲ SPT "N" (BLOWS/300 mm) ▲; W_P% W% W_L% 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | SOIL SYMBOL | SOIL DESCRIPTION | CLASSIFICATION | COMMENTS TESTING Drillers Estimate *{G % S % F %}* | DEPTH (m)

Depth (m)	Sample Type	Sample No	Soil Description	Classification
20 – 20.7	G-Grab	15	Compact / firm becoming dense / stiff, wet grey-brown SAND and SILT; trace clay; trace organics *(continued)*	
20.7m – 21.3m	G-Grab	16	Wet, grey, sandy GRAVEL; some silt; sub-rounded to rounded gravel to 40 mm diameter	GM
21.3m			End of Test Hole at 21.3 m depth. Hole collapsed to 10.1 m depth.	

Depth scale: 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

Legend
Sample Type: A-Auger; C-Core; G-Grab; V-Vane; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube; L#-Lab Sample

Final Depth of Hole: 21.3 m
Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: TH16-8

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

Prepared by: Thurber Engineering Ltd. 15723

Logged by: TJS Reviewed by: CHS

Project: **Highway 7 at Highway 11 Intersection Improvements**

Location: Mission, B.C.

Datum: Local Ground Alignment: L200

Northing/Easting: 444351 , 549355 Station/Offset: 201+05; 12 m L

Elevation: 17 m (Approx.) *Coordinates taken with GPS*

Date(s) Drilled: November 8, 2016

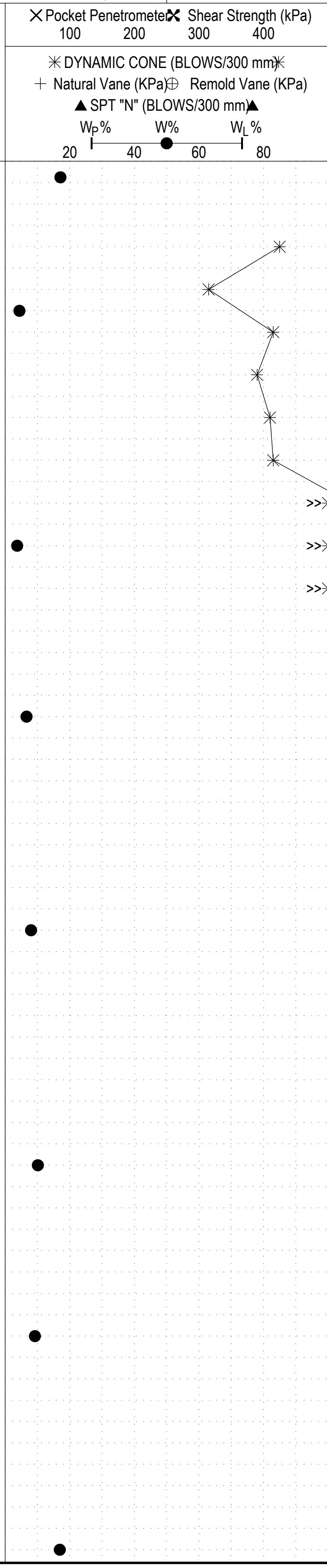
Drilling Company: On Track Drilling Inc.

Driller: Andrew Rice

Drill Make/Model: Yanmar 60

Drilling Method: DCPT / Solid Stem Auger

DEPTH (m)	DRILLING DETAILS	SAMPLE NO	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate *{G % S % F %}*	DEPTH (m)
0	Start DCPT at 0.3 m depth.	1	ASPHALT (approximately 75 mm thick) 0.1m	AS		
			Dense, moist, sandy GRAVEL (Road base FILL); gravel to 25 mm diameter; trace silt 0.6m	GP		
1		2	Dense, moist, brown SAND (FILL); trace sub-rounded gravel to 20 mm diameter; trace silt	SP		1
2						2
3	DCPT Refusal at 3.0 m depth.	3				3
4		4				4
5		5				5
6						6
7		6				7
8		7				8
9			9.1m			9
10		8	Wet, brown SAND; some silt; trace gravel to 25 mm diameter; trace organics			



SAMPLE TYPE | RECOVERY (%) | SOIL SYMBOL

Legend
Sample Type: A-Auger C-Core G-Grab V-Vane S-Split Spoon O-Odex (air rotary) W-Wash (mud return) T-Shelby Tube L#-Lab Sample

Final Depth of Hole: 12.2 m

Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: **TH16-8**

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

Project: **Highway 7 at Highway 11 Intersection Improvements**	Date(s) Drilled: November 8, 2016
Location: Mission, B.C.	Drilling Company: On Track Drilling Inc.
Prepared by: Thurber Engineering Ltd. 15723	Datum: Local Ground — Alignment: L200 — Driller: Andrew Rice
Northing/Easting: 444351 , 549355 — Station/Offset: 201+05; 12 m L	Drill Make/Model: Yanmar 60
Logged by: TJS — Reviewed by: CHS — Elevation: 17 m (Approx.) — *Coordinates taken with GPS*	Drilling Method: DCPT / Solid Stem Auger

Column headings: DEPTH (m) | DRILLING DETAILS | Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; DYNAMIC CONE (BLOWS/300 mm); Natural Vane (KPa) / Remold Vane (KPa); SPT "N" (BLOWS/300 mm); W_P% W% W_L% 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | SOIL SYMBOL | SOIL DESCRIPTION | CLASSIFICATION | COMMENTS TESTING — Drillers Estimate *{G % S % F %}* | DEPTH (m)

Depth (m)	Sample No	Soil Description	Classification	Comments
10 – 12.2	9 (at ~11.7 m, W ≈ 20%)	Wet, brown SAND; some silt; trace gravel to 25 mm diameter; trace organics *(continued)*	SM	
12.2m		End of Test Hole at 12.2 m depth. Hole collapsed to 9.4 m depth.		

Depth scale: 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

Legend
Sample Type: A-Auger; C-Core; G-Grab; V-Vane; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube; L#-Lab Sample

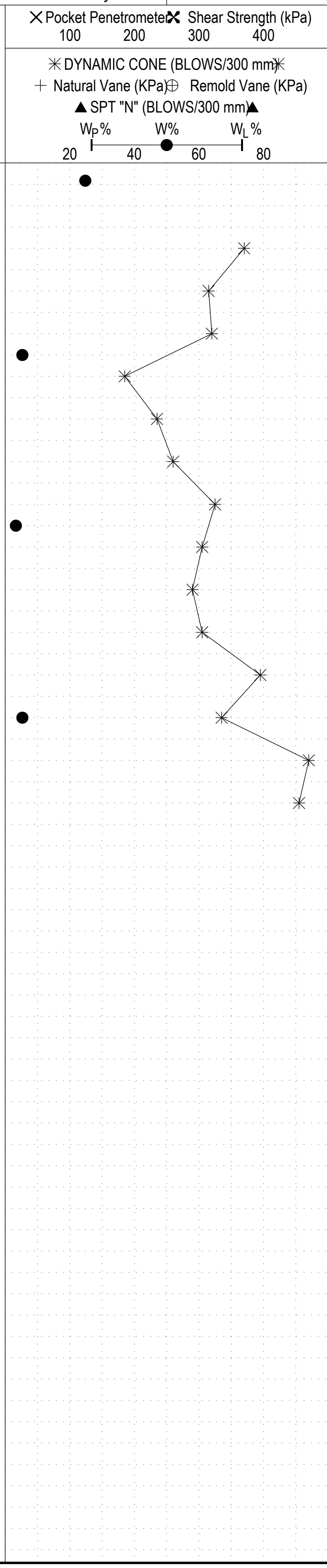
Final Depth of Hole: 12.2 m
Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: TH16-9

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

Prepared by: 15723 Thurber Engineering Ltd.	Project: **Highway 7 at Highway 11 Intersection Improvements**	Date(s) Drilled: November 8, 2016
	Location: Mission, B.C.	Drilling Company: On Track Drilling Inc.
	Datum: Local Ground — Alignment: L200	Driller: Andrew Rice
	Northing/Easting: 444318 , 549375 — Station/Offset: 200+71; 6 m R	Drill Make/Model: Yanmar 60
Logged by: TJS Reviewed by: CHS	Elevation: 17 m (Approx.) — *Coordinates taken with GPS*	Drilling Method: DCPT / Solid Stem Auger



DEPTH (m)	DRILLING DETAILS	SAMPLE NO	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate *{G % S % F %}*
0	Start DCPT at 0.3 m depth.	1	ASPHALT (approximately 90 mm thick) — 0.1m	AS	
			Dense, moist, brown, sandy GRAVEL (Road base FILL); angular to sub-rounded gravel to 25 mm diameter; trace silt — 0.8m	GP/SP	
1		2	Dense, moist, brown SAND (FILL); trace gravel to 20 mm diameter; trace silt	SP	
2		3			
3					
4	End DCPT at 4.6 m depth.	4	— 4.6m		
5			End of Test Hole at 4.6 m depth. Hole collapsed to 4.6 m depth.		
6					
7					
8					
9					
10					

Legend
Sample Type: A-Auger; C-Core; G-Grab; V-Vane; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube; L#-Lab Sample

Final Depth of Hole: 4.6 m
Depth to Top of Rock:

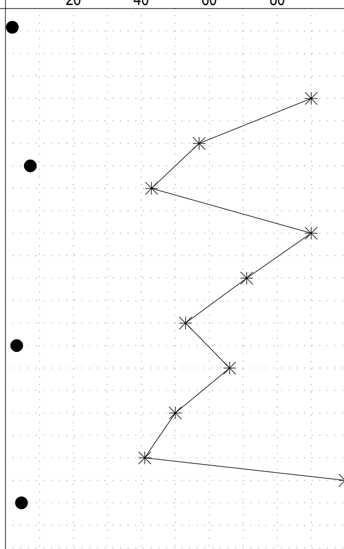
SUMMARY LOG

Drill Hole #: TH16-10

Ministry of Transportation and Infrastructure, British Columbia

Prepared by: Thurber Engineering Ltd. 15723	Project: **Highway 7 at Highway 11 Intersection Improvements**	Date(s) Drilled: November 8, 2016
	Location: Mission, B.C.	Drilling Company: On Track Drilling Inc.
	Datum: Local Ground — Alignment: L200	Driller: Andrew Rice
	Northing/Easting: 444350 , 549373 — Station/Offset: 201+03; 6 m R	Drill Make/Model: Yanmar 60
Logged by: TJS Reviewed by: CHS	Elevation: 17 m (Approx.) — *Coordinates taken with GPS*	Drilling Method: DCPT / Solid Stem Auger

Column headings: DEPTH (m) | DRILLING DETAILS | Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; DYNAMIC CONE (BLOWS/300 mm); Natural Vane (KPa) / Remold Vane (KPa); SPT "N" (BLOWS/300 mm); W_P% W% W_L% 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | SOIL SYMBOL | SOIL DESCRIPTION | CLASSIFICATION | COMMENTS TESTING Drillers Estimate *{G % S % F %}* | DEPTH (m)



Depth (m)	Drilling Details	Sample No	Soil Description	Classification
0–0.1	Start DCPT at 0.3 m depth.	1	ASPHALT (approximately 90 mm thick)	AS
0.1–0.6			Dense, moist, brown, sandy GRAVEL (Road base FILL); angular to sub-rounded gravel to 20 mm diameter; trace silt	GP
0.6–4.6	DCPT Refusal at 3.2 m depth.	2, 3, 4	Dense, moist, brown SAND (FILL); trace gravel to 10 mm diameter; trace silt	SP
4.6			End of Test Hole at 4.6 m depth. Hole collapsed to 4.6 m depth.	

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Legend
Sample Type: A-Auger; C-Core; G-Grab; V-Vane; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube; L#-Lab Sample

Final Depth of Hole: 4.6 m
Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: TH16-11

British Columbia — Ministry of Transportation and Infrastructure

Prepared by: Thurber Engineering Ltd. 15723

Logged by: TJS Reviewed by: CHS

Project: **Highway 7 at Highway 11 Intersection Improvements**

Location: Mission, B.C.

Datum: Local Ground | Alignment: L200

Northing/Easting: 444398 , 549372 | Station/Offset: 201+50; 9 m R

Elevation: 17.5 m (Approx.) | *Coordinates taken with GPS*

Date(s) Drilled: November 8, 2016

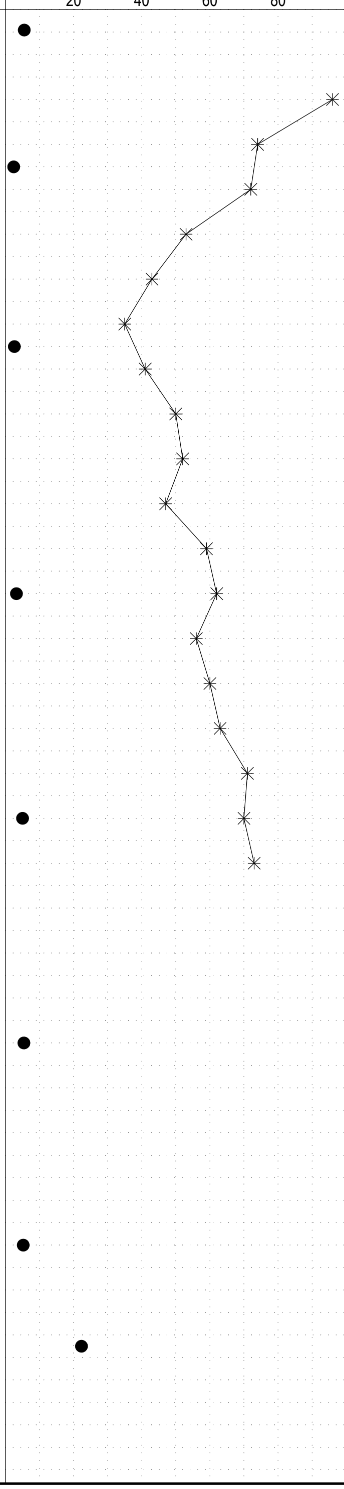
Drilling Company: On Track Drilling Inc.

Driller: Andrew Rice

Drill Make/Model: Yanmar 60

Drilling Method: DCPT / Solid Stem Auger

Column headings: DEPTH (m) | DRILLING DETAILS | Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; DYNAMIC CONE (BLOWS/300 mm); Natural Vane (KPa) / Remold Vane (KPa); SPT "N" (BLOWS/300 mm); W_P% W% W_L% 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | SOIL SYMBOL | SOIL DESCRIPTION | CLASSIFICATION | COMMENTS TESTING Drillers Estimate *{G % S % F %}* | DEPTH (m)



Depth (m)	Drilling Details	Sample No	Soil Description	Classification
0	Start DCPT at 0.3 m depth.	1	ASPHALT (approximately 90 mm thick) — 0.1m	AS
			Dense, moist, brown, sandy GRAVEL (Road base FILL); angular to sub-rounded gravel to 25 mm diameter; trace silt — 0.6m	GP
1		2	Dense, moist, brown SAND (FILL); trace gravel to 20 mm diameter; trace silt	SP
2		3		
3				
4		4		
5	End DCPT at 5.7 m depth.	5		
6				
7		6		
8		7		
9		8	9.0m Moist, grey, sandy SILT; trace gravel; trace organic silt in seams; strong organic odour — 9.2m	ML
			Wet, brown SAND; some silt to silty	SM
10				

Legend

Sample Type: A-Auger | C-Core | G-Grab | V-Vane | S-Split Spoon | O-Odex (air rotary) | W-Wash (mud return) | T-Shelby Tube | L#-Lab Sample

Final Depth of Hole: 12.2 m

Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: **TH16-11**

Ministry of Transportation and Infrastructure — British Columbia

Prepared by: 15723 Thurber Engineering Ltd.	Project: **Highway 7 at Highway 11 Intersection Improvements**	Date(s) Drilled: November 8, 2016
	Location: Mission, B.C.	Drilling Company: On Track Drilling Inc.
	Datum: Local Ground / Alignment: L200	Driller: Andrew Rice
	Northing/Easting: 444398 , 549372 / Station/Offset: 201+50; 9 m R	Drill Make/Model: Yanmar 60
Logged by: TJS Reviewed by: CHS	Elevation: 17.5 m (Approx.) *Coordinates taken with GPS*	Drilling Method: DCPT / Solid Stem Auger

Column headings: DEPTH (m) | DRILLING DETAILS | Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; DYNAMIC CONE (BLOWS/300 mm); Natural Vane (KPa) / Remold Vane (KPa); SPT "N" (BLOWS/300 mm); W_P% W% W_L% 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | SOIL SYMBOL | SOIL DESCRIPTION | CLASSIFICATION | COMMENTS TESTING Drillers Estimate *{G % S % F %}* | DEPTH (m)

Depth (m)	Sample No	Soil Description	Classification
10.0–10.5		Wet, brown SAND; some silt to silty *(continued)*	
10.5–11.3	9	Wet, brown, sandy GRAVEL; gravel to 35 mm diameter; some; trace organics; strong organic odour	GM
11.3–12.2	10	Wet, brown, sandy SILT; slight organic odour	ML
12.2		End of Auger Hole at 12.2 m depth. Hole collapsed to 10.7 m depth.	

Depth scale: 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

Legend
Sample Type: A-Auger; C-Core; G-Grab; V-Vane; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube; L#-Lab Sample

Final Depth of Hole: 12.2 m
Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: TH16-12

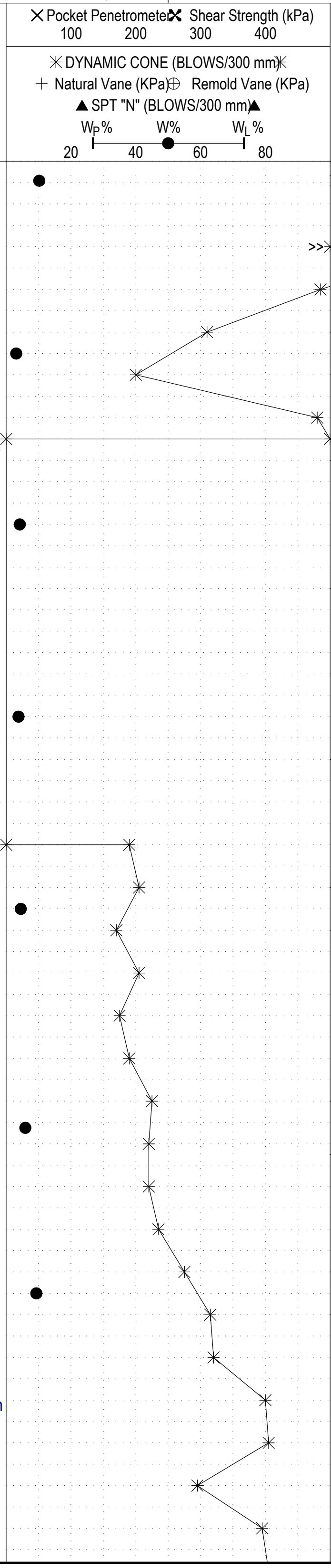
British Columbia — Ministry of Transportation and Infrastructure

Prepared by: Thurber Engineering Ltd. 15723

Logged by: TJS Reviewed by: CHS

Project: **Highway 7 at Highway 11 Intersection Improvements**
Location: Mission, B.C.
Datum: Local Ground
Alignment: L100
Northing/Easting: 444438 , 549404
Station/Offset: 103+01; 9 m R
Elevation: 16.5 m (Approx.)
Coordinates taken with GPS

Date(s) Drilled: November 9, 2016
Drilling Company: On Track Drilling Inc.
Driller: Andrew Rice
Drill Make/Model: Yanmar 50
Drilling Method: DCPT / Solid Stem Auger



DEPTH (m)	DRILLING DETAILS	SAMPLE NO	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	DEPTH (m)
0	Start DCPT at 0.3 m depth.	1	ASPHALT (approximately 100 mm thick) 0.1m	AS		
			Dense, moist, brown, sandy GRAVEL (Road base FILL); angular to sub-rounded gravel to 20 mm diameter; trace silt 0.5m	GP		
1		2	Dense, moist, brown SAND (FILL); some gravel; some silt			1
2	DCPT Refusal at 2.0 m depth.					2
3	Drill out 2.0 to 4.6 m depth to re-try DCPT.	3				3
4		4				4
5	Restart DCPT at 4.6 m depth.	5		SM		5
6						6
7		6				7
8		7				8
9	Water-8.8m 9/11/2016		8.8m Dense, wet, brown SAND and SILT; trace gravel; trace clay			9
10						

Legend
Sample Type: A-Auger, C-Core, G-Grab, V-Vane, S-Split Spoon, O-Odex (air rotary), W-Wash (mud return), T-Shelby Tube, L#-Lab Sample

Final Depth of Hole: 17.7 m
Depth to Top of Rock:

SUMMARY LOG

Ministry of Transportation and Infrastructure — British Columbia

Drill Hole #: TH16-12

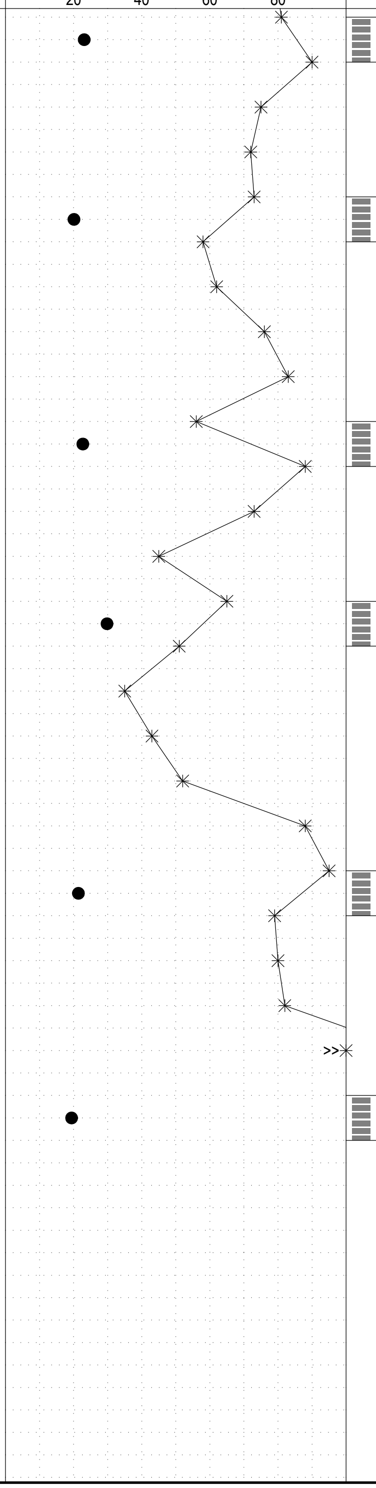
Project: **Highway 7 at Highway 11 Intersection Improvements**
Location: Mission, B.C.

Prepared by: 15723
Thurber Engineering Ltd.

Logged by: TJS Reviewed by: CHS

Datum: Local Ground	Alignment: L100	Date(s) Drilled: November 9, 2016
Northing/Easting: 444438 , 549404	Station/Offset: 103+01; 9 m R	Drilling Company: On Track Drilling Inc.
Elevation: 16.5 m (Approx.)	*Coordinates taken with GPS*	Driller: Andrew Rice
		Drill Make/Model: Yanmar 50
		Drilling Method: DCPT / Solid Stem Auger

Column headings: DEPTH (m) | DRILLING DETAILS | × Pocket Penetrometer ✕ Shear Strength (kPa) 100 200 300 400; ✳ DYNAMIC CONE (BLOWS/300 mm) ✳; + Natural Vane (KPa) ⊕ Remold Vane (KPa); ▲ SPT "N" (BLOWS/300 mm) ▲; W_P% W% W_L% 20 40 60 80 | SAMPLE TYPE | SAMPLE NO | RECOVERY (%) | SOIL SYMBOL | SOIL DESCRIPTION | CLASSIFICATION | COMMENTS TESTING Drillers Estimate *{G % S % F %}* | DEPTH (m)



Depth (m)	Drilling Details	Sample No	Soil Description	Classification
10		8	Dense, wet, brown SAND and SILT; trace gravel; trace clay *(continued)*	SM/ML
11		9		
13		10		
14		11		
16		12	- becomes grey at 15.8 m depth	
17	DCPT Refusal at 17.1 m depth.	13		
18.3m			End of Auger Hole at 18.3 m depth. Hole collapsed to 9.1 m depth.	

Depth scale: 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

Legend
Sample Type: A-Auger, C-Core, G-Grab, V-Vane, S-Split Spoon, O-Odex (air rotary), W-Wash (mud return), T-Shelby Tube, L#-Lab Sample

Final Depth of Hole: 17.7 m
Depth to Top of Rock:

Schwartz SOIL TECH

NILCON SHEAR VANE DATA TABLE

Testing date: November 5, 2016
Client: Thurber Engineering
Location: Adjacent to SCPT16-01 (Hwy 7 & Hwy 11 Intersection, Mission)
Vane size: Small and Medium
Vane diameter: 5.0 and 6.5 cm
Vane factor: 0.2 and 0.1

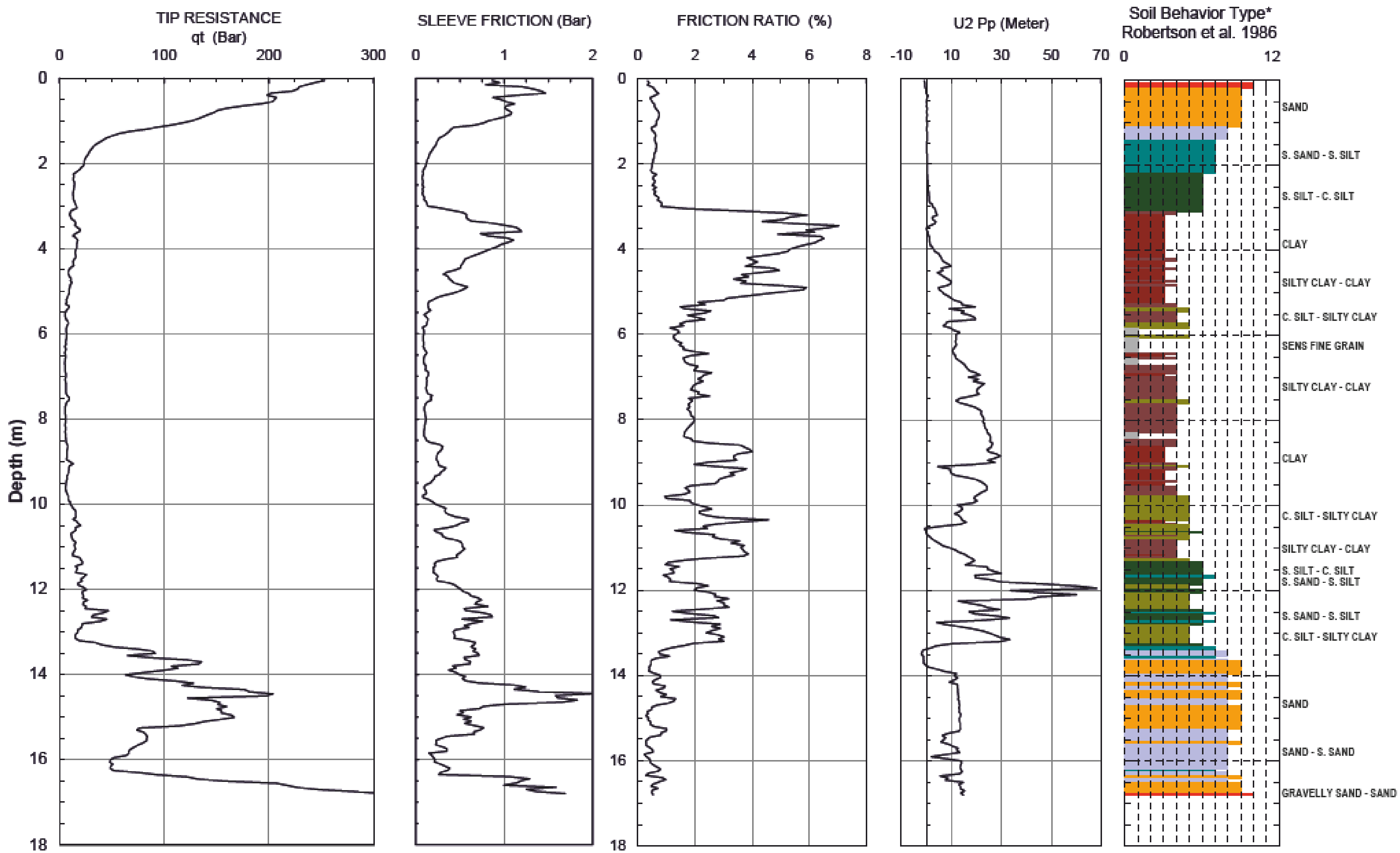
Torque mechanism = Nilcon #79.212
Torque mechansim calibration = 1.1748
Conversion = 98.1

Testing notes: Hollow stem augers were installed to a depth of 9 feet before vane tests were conducted.

Calculation procedure:
Peak Su length = plot length in cm - rod friction length in cm
Peak Su = (Peak Su length in cm) x (Vane factor) x (1.1726) x (98.1)

VANE TEST NO	Adjacent to SCPT16-01	VANE TIP DEPTH (m)	PEAK		RESIDUAL	REMOLDED	SENSITIVITY	NOTES
			Time to failure (secs)	Su (kPa)	Su (kPa)	Su (kPa)	Peak / Remolded	
1	SCPT16-01	4.50	233	95.0	48.4	31.0	3.1	Medium Vane
2	SCPT16-01	6.00	80	69.1	46.1	21.4	3.2	Small Vane
3	SCPT16-01	7.50	85	55.8	39.2	28.1	2.0	Small Vane

THURBER Thurber Engineering	Operator: Schwartz Soil Technic□□ Sounding: □CPT16 - □1 Cone ID: D□□1236	Date: □o□e□□er 5, 2016 Site: Hwy 7 & Hwy 11 Intersection, Mission Thurber project no: 15723	Schwartz SOIL TECH



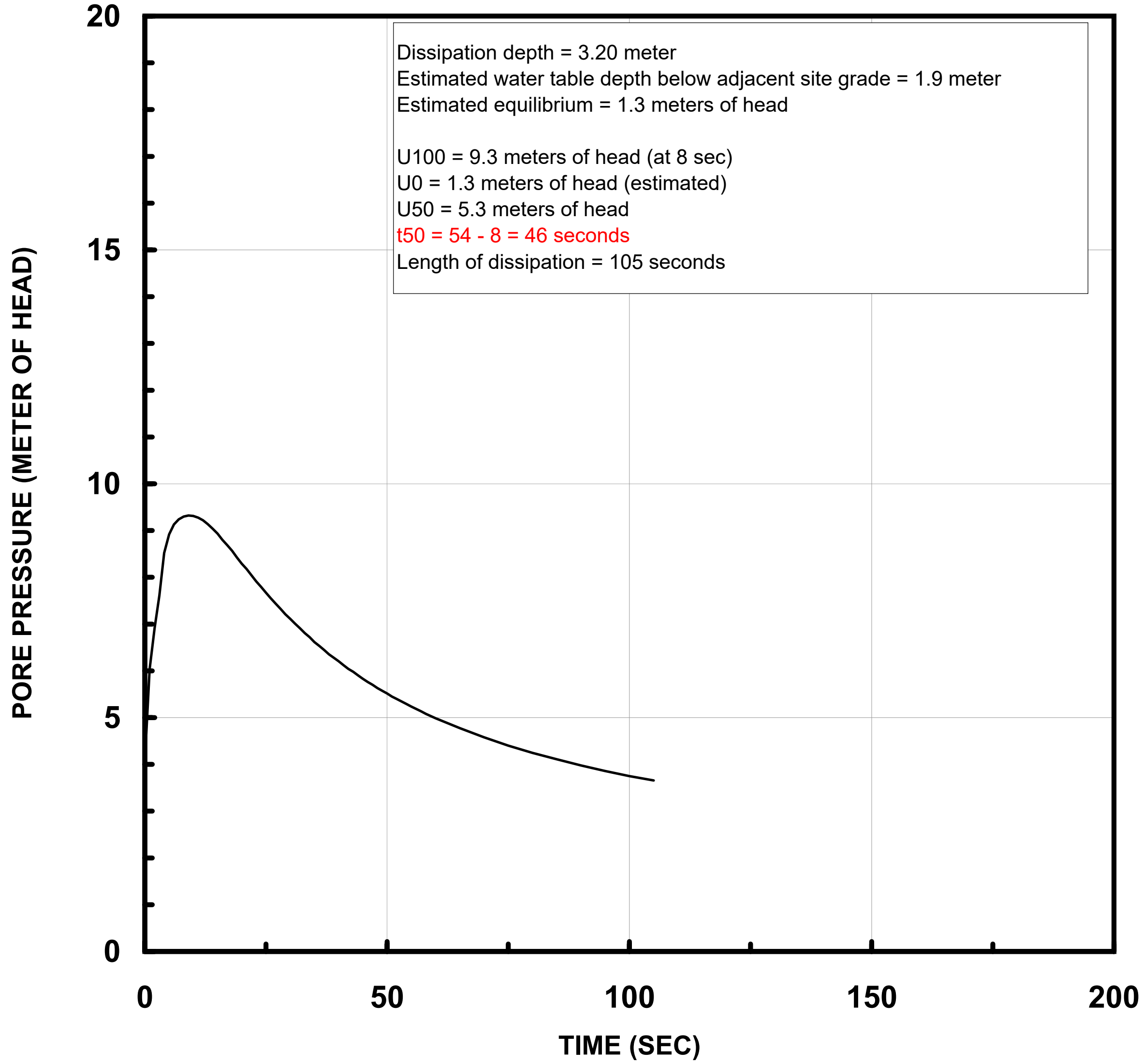
Maximum Depth = 16□3□ meters

Depth Increment = 0.05 meters

1 sensitive fine grained	4 silty clay to clay	7 silty sand to sandy silt	10 gravelly sand to sand
2 organic material	5 clayey silt to silty clay	8 sand to silty sand	11 very stiff fine grained (*)
3 clay	6 sandy silt to clayey silt	9 sand	12 sand to clayey sand (*)

THURBER ENGINEERING

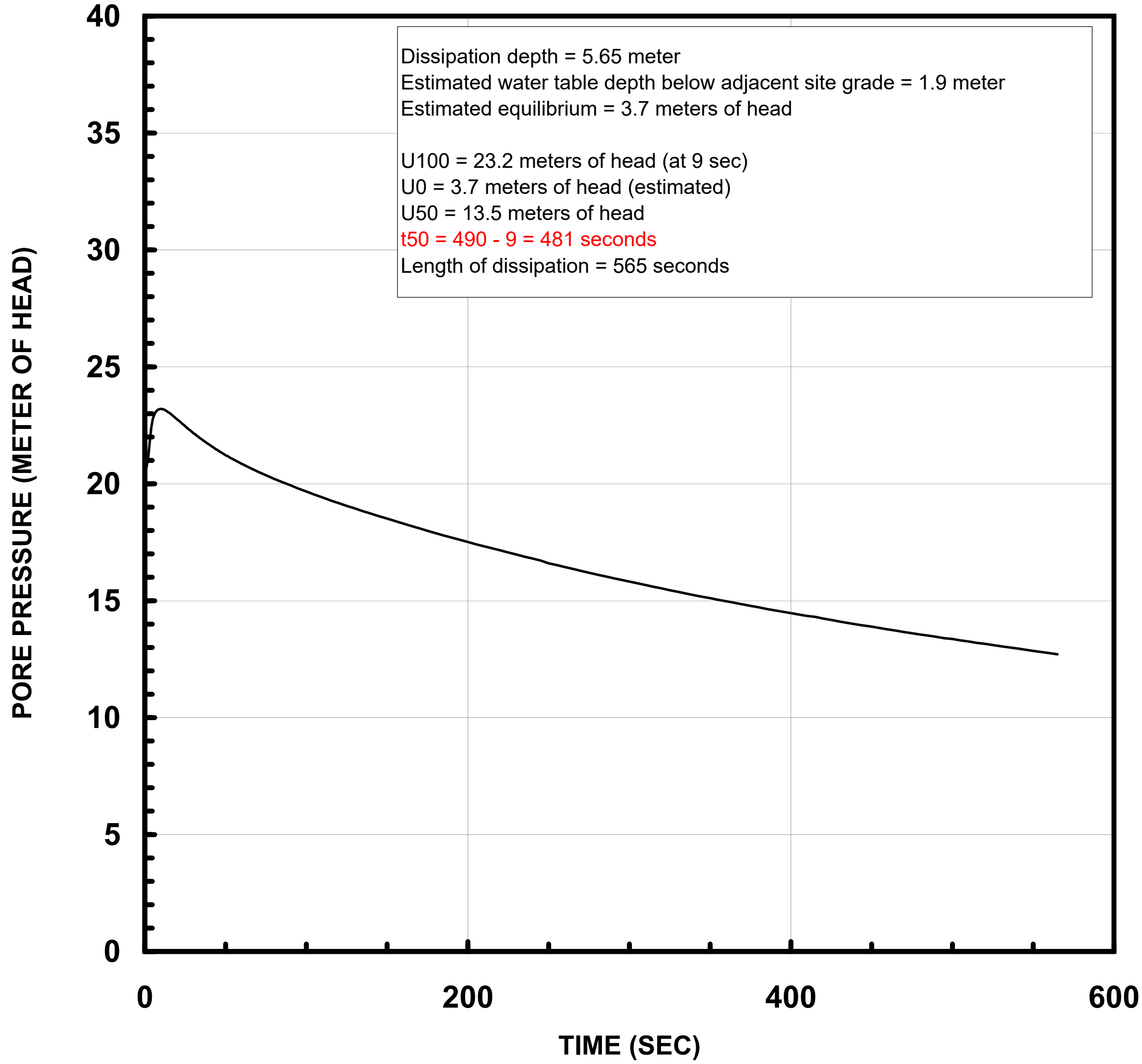
U2 PORE PRESSURE DISSIPATION
HWY 7 & HWY 11 INTERSECTION, MISSION
SCPT16 - 01   3.20 METER DEPTH
NOVEMBER 5, 2016



Schwartz SOIL TECH

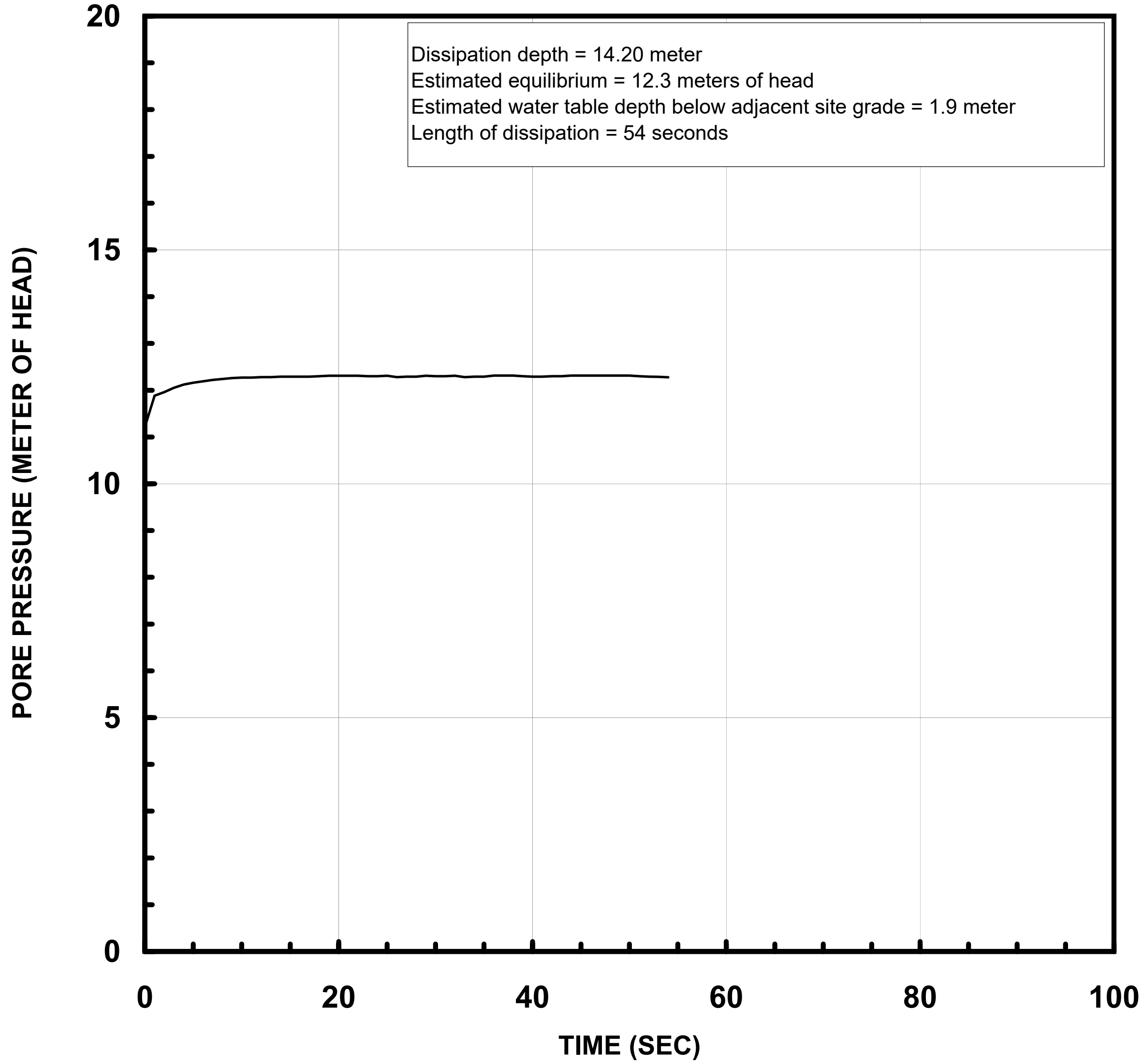
THURBER ENGINEERING

U2 PORE PRESSURE DISSIPATION
HWY 7 & HWY 11 INTERSECTION, MISSION
SCPT16 - 01 5.65 METER DEPTH
NOVEMBER 5, 2016



THURBER ENGINEERING

U2 PORE PRESSURE DISSIPATION
HWY 7 & HWY 11 INTERSECTION, MISSION
SCPT16 - 01 14.20 METER DEPTH
NOVEMBER 5, 2016



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SHEAR WAVE VELOCITY DATA

Client:	Thurber Engineering Ltd.	Date:	Nov 5, 2016
Test:	SCPT16 - 01	Cone ID:	DPG1236
Site:	Hwy 7 & Hwy 11 Intersection	Source offset:	0.45 m
	Mission, B.C.	Source:	Beam

CONE TIP DEPTH (m)	GEOPHONE DEPTH (m)	INTERVAL VELOCITY (m/sec)
1.20	0.95	
		N/A
2.20	1.95	
		108
3.20	2.95	
		124
4.20	3.95	
		153
5.20	4.95	
		133
6.20	5.95	
		120
7.20	6.95	
		116
8.20	7.95	
		111
9.20	8.95	
		118
10.20	9.95	
		178
11.20	10.95	
		213
12.20	11.95	
		227
13.20	12.95	
		232
14.20	13.95	
		217
15.20	14.95	
		227
16.20	15.95	
		261
16.80	16.55	

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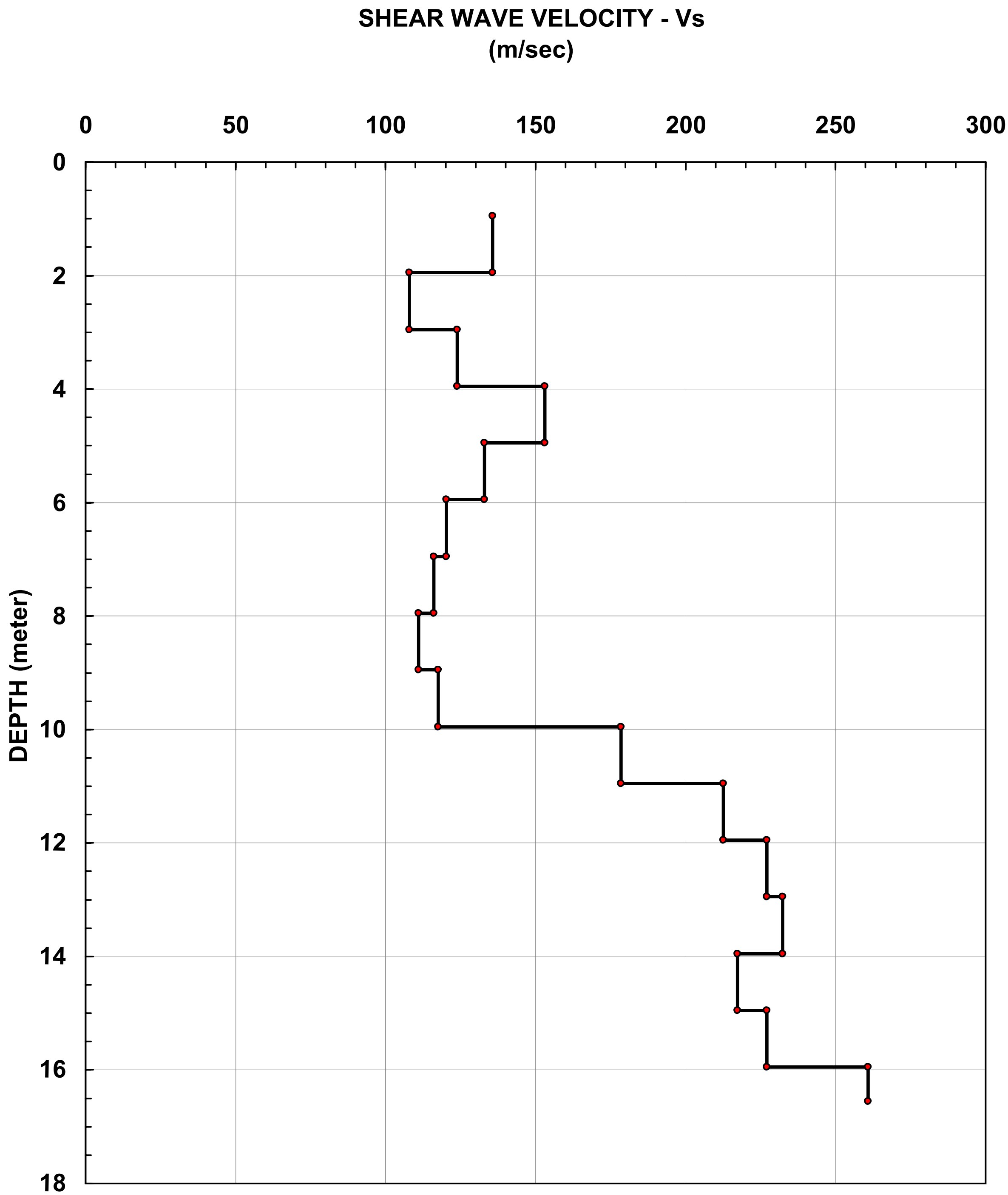
SHEAR WAVE VELOCITY PROFILE

Client:	Thurber Engineering Ltd.	Date:	Nov 5, 2016
Test:	SCPT16 - 01	Cone ID:	DPG1236
Site:	Hwy 7 & Hwy 11 Intersection	Source offset:	0.45 m
	Mission, B.C.	Source:	Beam



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APPENDIX C

NRCAN 2015 Seismic Hazard Calculator Output

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

November 19, 2016

Site: 49.1321 N, 122.326 W User File Reference: Highway 7 and Highway 11 Intersection, Mission BC

Requested by: ,

National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.05)	Sa(0.1)	**Sa(0.2)**	Sa(0.3)	**Sa(0.5)**	**Sa(1.0)**	**Sa(2.0)**	**Sa(5.0)**	**Sa(10.0)**	**PGA (g)**	**PGV (m/s)**
0.343	0.519	**0.649**	0.636	**0.554**	**0.329**	**0.204**	**0.069**	**0.024**	**0.285**	**0.421**

Notes. Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. ***These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.***

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.05)	0.076	0.169	0.235
Sa(0.1)	0.116	0.259	0.357
Sa(0.2)	0.151	0.331	0.455
Sa(0.3)	0.150	0.329	0.450
Sa(0.5)	0.124	0.283	0.390
Sa(1.0)	0.065	0.158	0.225
Sa(2.0)	0.036	0.093	0.136
Sa(5.0)	0.0082	0.024	0.041
Sa(10.0)	0.0031	0.0087	0.014
PGA	0.064	0.144	0.198
PGV	0.076	0.195	0.283

References

National Building Code of Canada 2015 NRCC no. 56190;
Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

Aussi disponible en français

Natural Resources Canada Ressources naturelles Canada

Canada

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APPENDIX D

Design Criteria Sheet for Climate Change Resilience

PCIC Plan2Adapt Climate Change Tool Outputs Fraser Valley in 2050, 2080

Design Criteria Sheet for Climate Change Resilience

Highway Infrastructure Engineering Design and Climate Change Adaptation
BC Ministry of Transportation and Infrastructure
(Separate Criteria Sheet per Discipline)
(Submit all sheets to the Chief Engineers Office at: BCMoTI-ChiefEngineersOffice@gov.bc.ca)

Project:	Highway 7 / 11 Intersection Improvement – MoTI Project No. 13252-0001 [Thurber Project No. 15723]
Type of work:	Intersection Improvements
Location:	Highway 11, LKI Segment 2776, km 9.31 to km 9.92 (NB) Highway 7, LKI Segment 2737, km 2.96 to km 3.13 (WB) Mission, BC
Discipline:	Geotechnical

Design Component	Design Life or Return Period	Design Criteria + (Units)	Design Value Without Climate Change	Change in Design Value from Future Climate	Design Value Including Climate Change	Adaptation Cost Estimate ($)	Comments / Notes / Deviations / Variances
Geotechnical Design	N/A	N/A	N/A	N/A	N/A	See Discussion Below	-

Project Scope:

This project is for intersection improvements at Highway 7 and Highway 11 located in Mission, BC. The project primary objective is to add a second dedicated NB left turn on Highway 11 to improve the capacity of the left turn movement westbound onto Highway 7. The work includes lane reconfiguration within the existing paved carriageway; removal of existing median and replace with CMB barrier along Highway 11; resurfacing; relocation of existing catch basins; replacement of 3 traffic raised islands in the NE, SE and SW quadrants and Highway 7 westbound dual left turn extension. A smart channel right turn without mountable truck apron is provided in the SW quadrant because right turning traffic on Highway 7 eastbound are on downhill grade must yield to traffic immediately downstream of the intersection to Highway 11 southbound. The geotechnical scope is limited to pavement structure improvements, geotechnical aspects of signage foundations, and review of grading and drainage improvements to mitigate potential effects on slope stability.

Explanatory Notes / Discussion:

The PCIC Plan2Adapt tool predicts +3.1C Annual for the Fraser Valley in 2050. A 20 to 25 year horizon is appropriate to pavement design. Hotter temperatures in the region may increase the wear and tear on pavement surfaces during the summer months. Conversely warmer winter temperatures could reduce frost related pavement damage. The asphalt is being substantially thickened as an outcome of this project to resist truck traffic loading, which will also increase the resistance to weather related damage.

The Plan2Adapt tool predicts the following changes for the Fraser Valley in total precipitation.
2050: -1.9% Annual, -2.4% Winter
2080: +3.1% Annual, +3.8% Winter
It is uncertain how changes in precipitation will translate into changes (if any) in groundwater levels at the site. Pavement structure drainage has not been identified as a pavement performance issue at this site. Highway embankment side-slopes (not modified by this project) may experience erosion or shallow-seated instability in response to extreme precipitation events.

Recommended by: Engineer of Record (Geotechnical): Caleb Scott, P.Eng.

PROFESSIONAL PROVINCE OF BRITISH COLUMBIA ENGINEER
C. H. SCOTT
48539
2024-03-12

Engineering Firm: Thurber Engineering Ltd.

Thurber Engineering Ltd.
Permit to Practice #1001319

Accepted by BCMoTI Consultant Liaison: ____________________
(For External Design)

Deviations and Variances Approved by the Chief Engineer: ____________________
Program Contact: Chief Engineer BCMoTI

I am interested in information about projected climate change in British Columbia ...

within the region of

Fraser Valley

during the

2050s (2040–2069)

Summary Impacts Maps Graphs Notes References About

The table below shows projected changes in average (mean) temperature, precipitation and several derived climate variables from the baseline historical period (1961-1990) to the 2050s (2040-2069) for the Fraser Valley region. The ensemble median is a mid-point value, chosen from a PCIC standard set of Global Climate Model (GCM) projections (see the 'Notes' tab for more information). The range values represent the lowest and highest results within the set.

Climate Variable	**Season**	**Projected Change from 1961-1990 Baseline**	
		Ensemble Median	**Range (10th to 90th percentile)**
Temperature (°C)	Annual	+3.1 °C	+2.2 °C to +4.3 °C
Precipitation (%)	Annual	-1.9%	-5.6% to +1.9%
	Summer	-12%	-38% to -1.0%
	Winter	-2.4%	-6.1% to +3.9%
Precipitation as Snow* (%) *CAUTION: This variable may have a low baseline. See note 2 below.*	Annual	-50%	-55% to -43%
	Winter	-46%	-48% to -36%
	Spring	-61%	-68% to -51%
Growing Degree-Days* (degree-days)	Annual	+647 degree-days	+409 to +942 degree-days
Frost-Free Days* (days)	Annual	+54 days	+43 to +72 days
Heating Degree-Days* (degree-days)	Annual	-1050 degree-days	-1410 to -743 degree-days
Cooling Degree-Days* (degree-days)	Annual	+106 degree-days	+43.9 to +202 degree-days

Notes:

1. Climate variables marked with * are derived from temperature and/or precipitation values, and are not direct outputs of the climate models.
2. CAUTION: Percent changes from a low baseline value can result in deceptively large percent change values. A small baseline can occur when the season and/or region together naturally make for zero or near-zero values. For example, snowfall in summer in low-lying southern areas.

I am interested in information about projected climate change in British Columbia ...

within the region of

Fraser Valley

during the

2080s (2070–2099)

Summary Impacts Maps Graphs Notes References About

The table below shows projected changes in average (mean) temperature, precipitation and several derived climate variables from the baseline historical period (1961-1990) to the 2080s (2070-2099) for the Fraser Valley region. The ensemble median is a mid-point value, chosen from a PCIC standard set of Global Climate Model (GCM) projections (see the 'Notes' tab for more information). The range values represent the lowest and highest results within the set.

Climate Variable	Season	Projected Change from 1961-1990 Baseline	
		Ensemble Median	**Range (10th to 90th percentile)**
Temperature (°C)	Annual	+5.1 °C	+3.7 °C to +6.8 °C
Precipitation (%)	Annual	+3.1%	-5.5% to +9.0%
	Summer	-22%	-60% to -2.0%
	Winter	+3.8%	-4.5% to +14%
Precipitation as Snow* (%) *CAUTION: This variable may have a low baseline. See note 2 below.*	Annual	-69%	-75% to -55%
	Winter	-64%	-70% to -51%
	Spring	-82%	-89% to -64%
Growing Degree-Days* (degree-days)	Annual	+1110 degree-days	+749 to +1600 degree-days
Frost-Free Days* (days)	Annual	+92 days	+71 to +110 days
Heating Degree-Days* (degree-days)	Annual	-1640 degree-days	-2050 to -1240 degree-days
Cooling Degree-Days* (degree-days)	Annual	+233 degree-days	+111 to +440 degree-days

Notes:

1. Climate variables marked with * are derived from temperature and/or precipitation values, and are not direct outputs of the climate models.
2. CAUTION: Percent changes from a low baseline value can result in deceptively large percent change values. A small baseline can occur when the season and/or region together naturally make for zero or near-zero values. For example, snowfall in summer in low-lying southern areas.