TETRA TECH

TECHNICAL MEMO

ISSUED FOR REVIEW

To:	**Mr. Ian Mckenna, P.Eng.** Hatch Corporation	**Date:**	September 16, 2021
		Memo No.:	VGEO03800-01_01 Rev.D
From:	Adriana Luis, EIT / Lothar Chan, P.Eng. John P. Sully, P.Eng.	**File:**	704-ENG.VGEO03800-01
Subject:	**Geotechnical Assessment for Commissioner Street Rail Expansion**		

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1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by Hatch Corporation (Hatch) to provide geotechnical recommendations for the design of the Commissioner Street Rail Expansion project, previously referred to as "CP East L Yard Expansion", between Mile 125.34 and Mile 126.93 in Vancouver, B.C.

The proposed track layout and cross sections provided by Hatch are attached in Appendix B. The scope of services is limited to the geotechnical aspects of the proposed rail development in the area, and is summarized as follows:

- perform a site-specific subsurface exploration and prepare a geotechnical characterization for the site.
- provide foundation assessment and track bed evaluation for the new tracks.
- evaluate the foundation requirements for the retaining wall at New Brighton Road.
- evaluate potential impacts on the Metro Vancouver sewer.
- evaluate potential impacts on the City of Vancouver sewer.
- provide engineering analyses and recommendations for the protection slab at the Metro Vancouver sewer crossing.
- provide a geotechnical assessment for the existing decommissioned pavement structure within the tracked widening footprint.

The purpose of this technical memorandum is to present the results of the site investigation and foundation analyses that have been completed for the proposed development, and to provide relevant geotechnical recommendations for the design and construction of the track expansion.

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2.0 SUBSURFACE EXPLORATION

A subsurface exploration was conducted between April 7th and May 1st, 2020. The scope included a total of twelve (12) testing locations where Dynamic Cone Penetration Tests (DCPT) and solid-stem auger sampling were performed to depths ranging between 3.4 m and 9 m below the existing ground surface. In addition, a Cone Penetration Test with shear wave velocity measurements (SCPT) was performed near the proposed alignment to complement the information obtained from the test holes. The drilling and testing locations were defined by Tetra Tech based on the proposed track alignment (Appendix B). Underhill Geomatics Ltd. provided the UTM coordinates and ground elevations after the locations were selected in the field. The coordinates and elevations for each testing location are provided in the following table, as well as the final depths of the boring/tests.

Test ID	UTM Coordinates (1)		Elevation (m) (2)	Depth (m) (3)
	Northing	Easting		
BH20-01	5459186.901	495305.933	5.18	5.1 / 5.1
BH20-02	5459267.437	495417.221	4.60	4.5 / 4.6
BH20-03	5459362.943	495472.418	4.38	5.3 / 5.0
BH20-04	5459467.058	495523.339	3.95	3.4 / 3.4
BH20-05	5459667.648	495638.240	4.49	4.6 / 4.7
BH20-06	5459785.473	495774.602	4.43	6.1 / 4.7
BH20-07	5459897.134	495979.619	4.14	3.6 / 5.9
BH20-08	5459952.996	496178.003	4.99	5.3 / 5.0
BH20-09	5460005.101	496383.165	5.83	6.1 / 6.2
BH20-10	5459930.089	496692.813	7.05	6.1 / 9.0
BH20-11	5459865.291	496857.791	6.39	4.5 / 5.0
BH20-12	5459766.679	496972.910	9.24	6.1 / 7.7
SCPT20-01	5459921.336	495933.048	4.19	9.0

(1) UTM Coordinates obtained in the field and provided by Underhill Geomatics Ltd.
(2) Ground Elevations provided by Underhill Geomatics Ltd.
(3) Depth of auger hole or CPT Sounding / Depth of DCPT Sounding.

Utility locate request (Ticket No. 20201400061) was submitted to BC One Call by Tetra Tech. Western locates provided the service of utility locating in support to this project. Electromagnetic scanning and GPR was used to locate all nearby utilities, which were marked on the ground prior to drilling. All thirteen (13) testing locations along the proposed rail track alignment were marked and cleared of underground utilities before commencing drilling activities.

The auger drilling and DCPT testing were performed by ConeTec Investigations Ltd. (ConeTec) using a M5T track-mounted rig for part of the drilling program, and a M7 truck-mounted rig for the remaining testing locations. Continuous sampling was performed at the testing locations to a maximum depth of 6.1m using solid-stem augers. After the samples were inspected and logged, representative samples were collected for laboratory testing.

The SCPT was performed by ConeTec using the M7 rig. For the SCPT, tip resistance (qc), sleeve friction (fs), and pore pressure (u2) were recorded at every 2.5cm depth interval. Penetration was suspended at specific horizons to perform pore water pore pressure dissipation tests (PPDT). Penetration was stopped at every 1m interval to allow for shear wave velocity measurements. Due to the presence of gravel and cobbles near the surface, a solid stem auger was used to drill out the coarse materials and allow the sounding to be performed. The CPT report

provided by ConeTec containing CPT profiles, PPD results and shear wave velocity profile is included in Appendix C.

A geotechnical engineer from Tetra Tech was on site during the field investigation to provide full-time supervision, including verifying the test hole locations in the field, completing utility locates, checking and logging the subsurface soil conditions, collecting representative soil samples and recording blow counts from the DCPT soundings. The borehole logs were prepared using the results of field inspection and laboratory testing. Details on DCPT penetration values, sample intervals, soil descriptions and laboratory soil index test results are also presented on the logs. The final borehole logs are presented in Appendix D.

3.0 LABORATORY TESTING

Laboratory tests were performed on disturbed samples collected during the auger drilling. Only disturbed samples were recovered from the auger drilling. Laboratory testing was performed at the Tetra Tech geotechnical laboratory facility located in Richmond, BC. The following soil testing were completed as part of the testing program:

- Soil Description and Classification
- Natural Moisture Content (32)
- Organic Content (2)
- Atterberg Limits (3)
- Particle Size Determination (9)

The numbers in brackets refer to the total number of each test type performed on the soil samples. The laboratory testing was completed by May 14, 2020. The results of the laboratory testing are included in Appendix E.

In addition to the soil classification tests, selected samples were sent to an environmental laboratory for chemical testing to determine pH and sulphate content of the soil. A total of eleven (11) soil samples were tested by CARO Analytical Services (CARO) in Richmond, B.C. Laboratory test results performed by CARO are presented in Appendix F.

The tests completed as part of the laboratory testing program for this subsurface exploration are briefly described in the following sections. The methodology used for each testing generally reflects the procedures outlined by the ASTM standards. The methodologies used by CARO for chemical testing are outlined in the procedures by the Canadian Standards Association (CSA), or otherwise mentioned in the CARO report.

3.1 Soil Description (and Classification)

In the field, immediately upon recovery, the soil samples were classified visually and by texture in accordance with Tetra Tech internal geotechnical soil classification work method by Tetra Tech engineers. Tetra Tech geotechnical soil classification work method has been developed based on the general guidelines provided in the Canadian Foundation Engineering Manual 4th Edition and ASTM Standards. The detailed soil descriptions include the following information:

- Main soil type
- Secondary soil components
- Qualitative assessment of grading (granular soils)

- Structure, texture or other relevant descriptions
- Color

Soils have been classified as granular (coarse-grained) soils or fine-grained soils. Granular soils are described in terms of the relative proportions of the mineral constituents. Fine-grained soils are classified based on plasticity (Atterberg limits) as per ASTM D 2487.

It should be noted that the methodology used to describe grain-size fractions is in accordance with CFEM (4th edition), but the basis of grain size diameter is identified using the classification outlined in ASTM D 2487 and the sieve sizes described in ASTM D 422. In summary, the soil descriptions are based on Tetra Tech geotechnical

soil classification work method and CFEM recommendations, but the particle size boundaries are based on the ASTM definitions (since the lab testing is performed in accordance with ASTM).

On the final drilling logs presented in Appendix C, the field descriptions have been revised to include the results of the laboratory classification tests. The classification for each of the soil layers where specific laboratory test results are available is also included on the borehole logs.

3.2 Natural Water Content

Moisture content determinations were performed on all samples recovered from the auger holes. Water content in the samples selected varies in a range from 3% to 46%, except for the peat encountered at the BH20-03 location. The water content measured in the peat samples were between 195% and 250%. The results of natural water content tests are plotted on the borehole logs (Appendix D) and are included in Appendix E.

Water (or moisture) contents were determined from the difference in measured total and dry weights before and after oven drying of specimens taken from soil samples recovered from the boreholes. Measurements were performed in accordance with the procedures described in ASTM D 2216.

3.3 Organic Content

Two (2) organic content determination were performed for the soils recovered from BH20-02 and BH20-03. Organic contents are determined from the difference in measured dry weights or soil before and after burning the organics in a furnace. Measurements are performed in accordance with the procedures described in ASTM D2974-14. The measured organic content is 3% in a sample containing traces of organics, and 44% in a peat sample recovered from BH20-03.

The results of the organic content testing are included into the soil descriptions on the borehole logs presented in Appendix D and are included in Appendix E.

3.4 Atterberg Limits

Atterberg limit tests were performed using the multipoint test on samples recovered from the boreholes. The liquid and plastic limits are determined for fine grained samples to assist soil classification using the test procedures described in ASTM D4318-17.

The range of results obtained among the three (3) selected samples show that the soils in the explored depth vary from low plastic fines to highly plastic clay along the site.

The results for the Atterberg Limits testing are plotted on the borehole logs in Appendix D and are presented in Appendix E.

3.5 Particle Size Determination

Sieve analyses were performed on a total of nine (9) soil samples. Sieve analyses were performed in accordance with the procedures described in ASTM D 422. The proportion of fines (silt and clay) in a specimen was determined by washing the material through the #200 (75 µm) sieve and computing the percentage passing. Sieves with larger opening were used for the sand and gravel fraction. Results for grain size distribution analyses are presented on a semi-logarithmic plot with grain size (log) versus percentage passing by weight finer than the grain size. The results of the grain size distributions are tabulated and presented graphically in Appendix E. The relative proportions of gravel, sand and fines are also reported on the borehole logs (Appendix D).

4.0 GEOTECHNICAL CONDITIONS

Based on the information provided on the Surficial Geological Map of Vancouver, British Columbia (MAP 1486A), the recent geology at the project site is represented by glacial deposits and colluvium on top of bedrock. Rock surface in this area is typically exposed within 10 m or less from surface. West of the site, the rock can be overlain by glaciomarine and marine deposits (less than 3 m thick), followed by glacial drift materials, including lenses of sand and gravel, and stony silt.

The information obtained from the subsurface exploration indicates the top of the very dense till-like materials are generally present at depths of less than 6 m along the track alignments (i.e. L31 and L30). The deposits overlying the till-like material can be classified into 5 main soil units that vary across the site as shown on Figure 1a to Figure 1c. The characteristics of the main soil units are the following:

Unit 1 – Fill. The granular fill encountered at the project site comprises compact to dense sand and gravel and is generally well graded with angular to sub rounded gravel. Near the west end of the project, from BH20-01 to BH20-03, the thickness of the fill varies from about 3.7 m to 2.7 m. The layer contains some organics and becomes loose at depths below 2 m. Between BH20-04 and BH20-12, the fill layer has thicknesses ranging from 1.5 m to 2.1 m and contains cobbles at various locations.

Unit 2 – Gravelly Sand. Loose to compact gravelly sand to sand and gravel was encountered at most locations below the surficial fill. Field observations indicate that the gravel is subangular to rounded in this layer. The presence of cobbles was observed at different locations, particularly at BH20-07 and BH20-08. Sieve testing on selected samples indicate fines contents are generally less than 8%. The gravelly sand thickness varies from about 3 m to 5 m across the site.

Unit 3 – Silty Sand to Sand and Silt. Loose to compact silty sand to sand and silt was found overlying the till-like layer. The layer thickness varies from about 0.6 m to a maximum of 2.5 m at BH20-10. Observations and testing on representative samples indicate traces of organics at BH20-01 and BH20-02. A pocket of peat (Figure 1a) was found within this unit at BH20-03.

Unit 4 – Low Plasticity Clay. A clay layer was encountered between Unit 3 and the till-like materials at BH20-11. The clay is firm to stiff and is of low plasticity. The thickness of this clay layer was inferred to be 1.7 m to 2.0 m.

Unit 5 – Till-like Materials. The top of the till-like material is generally present at depths of less than 6 m below the existing ground surface along Tracks L30 and L31. Samples recovered from this layer indicated the material consists mainly of silty sand with gravel, except for BH20-06, where the hard layer comprises highly plastic clay. At the location of the Columbia Containers realigned lead connection, SCPT20-01 encountered refusal at about 9 m depth, implying the top of the till-like material may dip towards Burrard Inlet.

The pore water pressure measurements and the results of the PPDT performed at SCPT20-01 indicate the groundwater level is located at a depth of about 4 m, which corresponds to an elevation of about +0.2m. The

groundwater level is expected to vary with the tides in the Burrard Inlet, as well as seasonal changes, precipitation, etc.

5.0 TRACK BED STRUCTURE

For the analyses presented herein, the thickness of the ballast has been taken as 200 mm (8”), as per the Canadian Pacific Engineering Guidelines for Private Siding Design and Construction document. The thickness of the granular bedding was determined in accordance with the procedure outlined in AREMA. The input used in the calculations is summarized in the table below.

Train Load	E90
Train Speed	15 mph
Tie Facing Dimension	9" x 102" (228 mm x 2590 mm)
Tie Spacing	20" (508 mm)

Considering the foundation consists of compact granular soils, the minimum CP track bed structure, consisting of 200 mm (8”) of sub-ballast and 200 mm (8”) of ballast, is expected to provide adequate bearing capacity.

The peat material encountered at BH20-03 is not expected to affect the bearing capacity of the track bed, given the top of the peat layer is located at a depth of about 3 m.

The existing fill contains large particles that are not suitable to be used as sub-ballast and should be removed to provide the full depth of sub-ballast. Alternatively, the existing fill can be removed and processed to meet the sub-ballast requirements.

For the section (between BH20-06 and BH20-09) where the proposed tracks are located within the footprint of existing road, the track bed can be placed on the decommissioned pavement structure once the asphalt layer is removed. The existing road fill has a thickness of about 1.3 m. The gradation of the road fill is shown on Figure 2, indicating the material has a maximum particle size of 50 mm and fines content of generally less than 5%. Based on the results of the gradation analyses presented on Figure 2 and the assumption that the materials were compacted adequately for the construction of the existing road structure, the existing road fill is considered suitable to be used as sub-ballast.

5.1 Foundation Settlement

For estimating the short-term track deflection, a typical range of elastic modulus was assigned to the foundation soils. The elastic modulus of the granular materials is assumed to vary between about 4 MN/m^2 and 28 MN/m^2 for the different granular soils. The elastic foundation settlement corresponding to the E90 loading for the proposed track bed structure is estimated to be less than 25 mm.

The preliminary drawings (Appendix B) indicate the track bed will be placed above the existing grade between Sta. 0+610 and Sta. 1+740. The track bed placement above the existing grade is expected to generate some settlement, especially at the location where peat was encountered (Sta. 1+900 to Sta. 2+000). The settlement resulting from the placement of the fill at the location with peat can cause settlements in the order of 500 mm.

Outside the peat section (Sta. 1+900 to Sta. 2+000), the compressible soils are mostly silts. The long-term settlement is expected to be less than 50 mm.

5.2 Potential Settlement Mitigation for Peat

As discussed above, the placement of a new track in the area where peat was encountered can potentially induce settlements of about 500 mm. The development of settlement was estimated considering fill and sub-ballast will be placed to the bottom of the ballast layer. Ballast is then placed 2 weeks after the initial fill placement and grading. The settlement at each stage is summarized as follows.

- About 150 mm of elastic and consolidation settlements will occur after placing the initial fill and sub-ballast. The settlement will take 1 to 2 weeks to occur.
- Placing the ballast layer will cause additional elastic and consolidation settlements of about 50 mm.
- The remaining 300 mm is caused by the secondary compression within the peat layer and will occur over a period of 25 years. The estimated rate of secondary (long-term) settlement is presented in the table below.

Years after Construction	Estimated Long-term settlement (mm)
0.5 (6 months)	100
1	150
5	200
10	250
25	300

As indicated by the results above, most of the settlement is caused by the secondary compression of the peat. Preloading to include the load from the ballast layer will remove only 50 mm of the total settlement and is not effective in reducing the secondary compression.

To reduce the long-term settlement, the following options can be considered:

Foundation Surcharge – the application of a foundation surcharge will reduce the secondary compression occurring within the peat layer. For example, a 2-m surcharge will reduce the secondary compression or long-term settlement by about 50% (i.e. from 300 mm to about 150 mm). A surcharge duration of 2 to 3 weeks should be considered.

Ground Reduction – Adjust the final grade, such that the grade change is less than 100 mm (based on the assumption that secondary compression is not re-triggered for a stress increase of less than 5% in the peat layer). Ideally, if there is no grade change (i.e. sub-excavating for the placement of sub-ballast and ballast), the on-going secondary compression of the peat is expected to be minimal.

Peat Removal – the peat layer is interpreted to extend to a depth of about 4 m. Temporary support and dewatering will be required for the excavation.

Load Transfer Platform - transferring the load through the peat layer to the underlying firm foundation. This can be achieved by piles, soil mix columns/panels or other form of structural support.

Based on our experience working with other rail projects involving peat, we believe monitoring and re-ballasting is a reasonably cost-effective approach, especially when the post-construction settlement is expected to develop over a long period of time.

For monitoring the settlement during construction (to confirm the rate and magnitude of settlement in the peat zone), we recommend installing a minimum of three (3) settlement gauges. One of the settlement gauges should be placed at the location of borehole BH20-03, where the peat layer was encountered. The other two settlement gauges are recommended to be placed 15 m on either side of BH20-03. Baseline readings (at least 3) should be

obtained prior to any fill placement. The settlement gauges should be read on a daily basis during fill placement. After fill placement, the gauges should be read every 2 days for 2 weeks.

5.3 General Requirements

All organic materials present near the existing ground surface should be removed. Once the excavation is completed to the depth corresponding to the base of the sub-ballast, the granular subgrade should be compacted using a vibratory roller with a minimum number of passes of 4, or until no visible deflection is observed. The subgrade conditions should be inspected prior to fill placement.

For the construction of the new track, the sub-ballast should be 50-mm minus with a fines content less than 5%. A minimum in-situ density of 95% standard Proctor maximum dry density (SPMDD) is required and the fill placement procedure should comply with AREMA (1.3.5.15). The materials and compaction requirements to be used for the ballast and sub-ballast should comply with CP specifications.

6.0 SEISMIC DESIGN CONSIDERATIONS

The rail development has been designed using the seismic design criteria outlined in AREMA. The earthquake return periods shown below are considered typical for the design of track bed structures. For the design of the new tracks, a return period of 975 years was used to carry out the assessment.

Limit State	Return Period (years)
Serviceability	100
Ultimate	475
Survivability	975

The seismic hazard for the project site was obtained from Earthquakes Canada website (Natural Resources Canada) and is presented in Appendix G. The peak ground acceleration (PGA) corresponding to the 975-year return period for a Class C site (360 m/s < Vs < 760 m/s) was determined to be 0.247g.

The project site has been designated to be Class D based on the following:

- The results of the shear wave velocity profile obtained with the SCPT indicate that the shear wave velocity range from 211 m/s to 265 m/s for the soils overlying the till-like materials.
- The soft soils or organics are localized and do not have thickness exceeding 3 m.

As per CHBDC CAN/CSA S6-14 CHBDC, a site coefficient, F(PGA), of 1.05 was used to estimate the PGA at the ground surface for the 975-year earthquake. A PGA value of 0.259g was calculated for the 975-year event and was used to carry out the simplified liquefaction triggering analysis.

6.1 Liquefaction Assessment

The cyclic resistance ratio (CRR) was estimated using the CPT-based approach recommended by Idriss and Boulanger (2014).

To evaluate the liquefaction triggering potential, the calculated cyclic stress ratio (CSR) values were compared with the calculated CRR values. For CRR < CSR (FS<1), the layer is deemed to be susceptible to initial liquefaction. The results of the liquefaction triggering analyses performed for SCPT20-01 are presented on Figure 3.

The results of the analyses indicate the loose to compact sand is susceptible to liquefaction in the vicinity of SCPT20-01. The assessment has not included other locations along the alignment. Upon reviewing the DCPT results, the low penetration values suggest the loose to compact sand across the project site is susceptible to liquefaction under the 975-year earthquake loading. The thickness of potentially liquefied soil could vary from about 0.6 m to 1.2 m along the alignment based on the simple review of the DCPT results.

6.2 Seismic-Induced Ground Deformations

The soils in the profile that liquefy during the EQ ground motions will dissipate the excess pore pressures once the ground movements cease. The post-liquefaction reconsolidation settlements associated with the 975-year earthquake event have been estimated using the approach described by Ishihara and Yoshimi (1992) based on the in situ penetration data. Post-seismic settlement due to the dissipation of excess pore pressure is estimated to be less than 100 mm for the 975-year event.

The potential lateral ground deformation resulting from the 975-year earthquake has been considered as part of the seismic evaluation. The site is reasonably flat, but it is located approximately 30 m or more south of the Burrard Inlet and lateral ground movements may be controlled by the stability of the near shore structures. Considering the relatively small thickness of potentially liquefiable soils, lateral movements are anticipated to attenuate to some degree away from the shoreline and not extend as far as the proposed track development.

Post-seismic limit equilibrium analyses were performed to assess the potential soil movement towards Burrard Inlet. The analyses were performed using the commercially available program SLOPE/W (GeoStudio 2016). The geometry towards the inlet is not known. For the assessment, a slope of 1:1 at the shoreline was assumed. The stability analyses were carried out accounting for the potential loss and reduction of soil strength for the soils susceptible to liquefaction. The results of the analyses are presented on Figure 4 and indicate safety factors of 1.1 for the pseudo-static conditions and 1.5 for the post-seismic conditions for the potential failure surfaces affecting the new tracks. With a calculated factor of safety greater than 1.0, large lateral ground deformations are not anticipated at the L30 and L31 locations.

Based on the very preliminary analysis and reasoning presented above, the potential damage resulting from the 975-year earthquake on tracks L30 and L31 is expected to be repairable.

7.0 UTILITY IMPACT ASSESSMENT

Impact assessments of the proposed train expansion on the nearby Metro Vancouver sewer and City of Vancouver sewer (CoV) were performed. Details of the assessment performed for the Metro Vancouver sewer are presented in a separate document, namely “CP East L Yard Expansion Utility Impact Assessment” (Doc. VGEO03974-01_01 Rev.0, March 2021), and is attached in Appendix H. This document is currently being updated to include a monitoring plan.

To assess the impact from the proposed L30 track loading on the Metro Vancouver and CoV utillities and to account for the three-dimensional effect of the soil response and loading, 3D finite element analyses were conducted using the commercially available program PLAXIS 3D (version 20 update 4). The analysis was performed assuming a 0.4 m thick track bed structure (consisting of 200 mm (8”) of sub-ballast and 200 mm (8”) of ballast) and the loading associated with an E90 train. The assumed load distribution corresponds to that from a single axle across adjacent rail ties, as shown on Figure 5. It should be noted that the analyses in PLAXIS were performed using a sustained train loading. In reality, the live load exerted by the train is a transient load. The rate of drainage of the compressible layer will be slow relative to the duration of the axle loading cycle. Therefore, the estimated settlements presented herein are likely conservative.

This section presents the analyses conducted for the CoV sewer. The location of the CoV sewer is shown in the record drawing provided by the project. The record drawing is attached in Appendix B. Based on the information provided on the record drawing, the existing casing that protects the CoV pipe extends about 2.6 m beyond the centerline of track L30.

Analyses were conducted to evaluate the potential impacts on the section that is not covered by the existing casing. The results of the analyses to estimate the stress increase and settlement affecting the utility are presented on Figures 6a and 6b. A summary of the analyses is provided as follows.

- The soil conditions at the CoV pipe location were inferred from the nearby borehole BH20-09. The soils are generally granular, consisting of 2 m of fill followed by 3 m of gravelly sand and 1 m of silty sand underlain by till-like soils.
- The information provided on the record drawing indicates the top of the existing casing is located at a minimum depth of about 2.2 m. The base of the casing and CoV pipe is located at a minimum depth of about 3.8 m. For the analyses, the top of the CoV pipe is taken to be located at a depth of 3 m, as indicated on the figures.
- The existing casing/protection is considered to extend 2.64 m south from the center line of the L30 track.
- The structural stiffnesses of the casing and the pipe have been accounted for in the analyses and were determined using the concrete sections shown on the record drawing.
- Best-estimate geotechnical parameters were used for the analyses. The analyses indicate the proposed tracks will have a limited effect or impact on the pipe located at a depth of 3 m. Therefore, the estimated stress increase and settlement are not likely sensitive to the potential variations in geotechnical parameters.
- As indicated by the results, the maximum vertical stress increase for the section of the pipe that is not protected is estimated to be less than 15 kPa.
- The settlement impact is estimated to be very small (< 5 mm).

8.0 METRO VANCOUVER SEWER PROTECTION SLAB

The potential use of a protection slab was considered at the location where the proposed Columbia Container lead track crosses the MetroVan HEI sewer. The protection slab will be supported by HP360x132 piles to carry the train loading from the proposed track. The vertical force on each pile was provided by Hatch to be about 500 kN.

8.1 Pile Embedment

The ultimate axial capacity in compression provided by the HP360x132 pile calculated according to the recommendations provided in CAN/CSA S6-19. A factor of safety of 2 was used to determine the allowable capacity, considering the main objective of the protection slab is to limit settlement impact and stress increase on the MV utility. For a vertical load of 500 kN, the required ultimate axial capacity for a single pile is estimated to be 1000 kN using a factor of safety of 2.

To achieve an ultimate axial capacity in compression of 1 MN, the proposed HP360x132 pile will need to be embedded 8.5 m. With the very dense till-like material expected to be encountered at a shallow depth (likely 5 m or less), driving the pile to achieve 8.5 m embedment may be difficult. Additional measures, such as pre-drilling and/or protecting the pile toe, should be considered.

8.2 Protection Slab Limits

Analyses were conducted to provide input to Hatch to define the extents of the required protection. Three cases were analyzed:

- Case 1 – The centerline of the pipe is located 0.5 m from the edge of the rail ties. The pipe is assumed to be located at a depth of about 1.8. This case was evaluated to limit the excavation affecting the existing track.
- Case 2 – The centerline of the pipe is located at the edge of the rail ties. The pipe is assumed to be located at a depth of about 1.8. The results will be used by Hatch to optimize the extents of the protection.
- Case 3 – The pipe is located at the centerline of the proposed track near Sta. 8+058. Based on the information provided by Hatch, top of pipe is located at 2.2m below the base of rail ties that are 10' long. This case provides the worst condition in assessing the settlement impact and stress increase on the MV sewer.

The results of the analyses are presented in Figures 7 to 9. The estimated settlement at the base of the MV pipe and the vertical stresses at the depth of the utility are summarized as follows.

Case	Estimated settlement (mm)	Estimated Vertical Stresses (kPa)		
		Existing Condition	Estimated Stress Increase	Total Stress
1	< 5	35	30	65
2	< 5	35	40	75
3	< 5	40	75	115

9.0 NEW BRIGHTON ROAD RETAINING WALL

The construction of Track L30 next to New Brighton Road, from about Sta. 0+280 to Sta. 0+370, will require excavating part of the existing road embankment and installing a retaining wall.

The input and assumptions used for the wall evaluation are outlined as follows:

- The retaining wall is about 85 m long and has a maximum retained height of 3.2 m. The retaining wall will consist of W610x372 piles installed at 2-m spacing with precast concrete panels placed between the piles.
- The soil conditions along Commissioner Street were defined based on the information obtained from testhole BH20-12 and are summarized in the table below. The groundwater table was interpreted using the available data to be located at a depth of 6 m (from the top of the wall).

Depth from Top of Wall (m)		Soil Type	Soil Strength
From	To		
0	2.4	FILL	ϕ = 34°
2.4	7.8	Loose to compact SAND	ϕ = 32°
> 7.8		Till-like	ϕ = 40°

- A return period of 475 years was used for seismic considerations.
- The road surface behind the wall is assumed to be flat (i.e. no inclination behind the wall).

- For static conditions, the following loads were considered:
  - A traffic surcharge of 16 kPa,
  - An impact load of 100 kN applied perpendicular to the wall at 1 m above the pile top.
  - An impact load of 30 kN applied parallel to the wall at 1 m above the pile top.

Analyses have been conducted using the commercially available program, PYWALL (v2019). Working stress design approach was used for the analyses. The bending moment and shear demands provided herein are unfactored and should be considered by the structural designer for the evaluation of the structural wall elements. The recommendations related to the proposed wall configuration are provided below.

- Active, at rest and passive lateral earth pressure coefficients have been calculated using a friction angle of the 34 degrees for the existing road fill. The lateral earth pressure coefficients are summarized in the table below.

Condition	Coefficient of Lateral Earth Pressure
Active, K_a	0.28
At-rest, K_0	0.44
Passive, K_p	3.54

- For seismic conditions, the magnitude of the earthquake-induced loads is approximated using the Mononobe-Okabe equation. The coefficient of active earth pressure, K_{ae}, was calculated to be 0.34, based on the assumption that the wall is capable of moving 25 mm to 50 mm during the 475-year earthquake.
- The results of the PYWALL analyses are presented on Figure 10. Four cases were evaluated:
  1. Static conditions – active soil loading with a traffic surcharge of 16.8 kPa.
  2. Impact loading – static conditions with the addition of the impact load.
  3. Seismic conditions – application of seismic coefficient corresponding to the 475-year earthquake. Traffic load was not combined in the seismic case.
  4. Post-seismic conditions – residual soil strength was use for the loose to compact sand that will undergo liquefaction. Liquefaction is expected to occur after the strong motion; therefore, not combining seismic load with reduced soil strength
- The deflection at the top of the wall for the worst case is less than 50 mm, which is generally considered acceptable as the deflection in relation to the retained height of 3.2 m is less than 2%. The soldier piles should have a minimum total length of 10 m for a retained height of 3.2 m (i.e., 6.8 m embedment).
- A pile group analysis was conducted to evaluate the effect of the impact load that is applied parallel to the wall. The results of the analysis are shown on Figure 11 and indicate small pile responses.
- Considering the water table is about 2 m to 3 m below the track elevation, and the retained fill and foundation soils being reasonably permeable, water is not likely to accumulate behind the wall and induces hydrostatic pressure on the wall. However, use of swale, or other means of drainage, is recommended to the eliminate the risk.

10.0 LIMITATIONS OF REPORT

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11.0 CLOSURE

We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully Submitted,
Tetra Tech Canada Inc.

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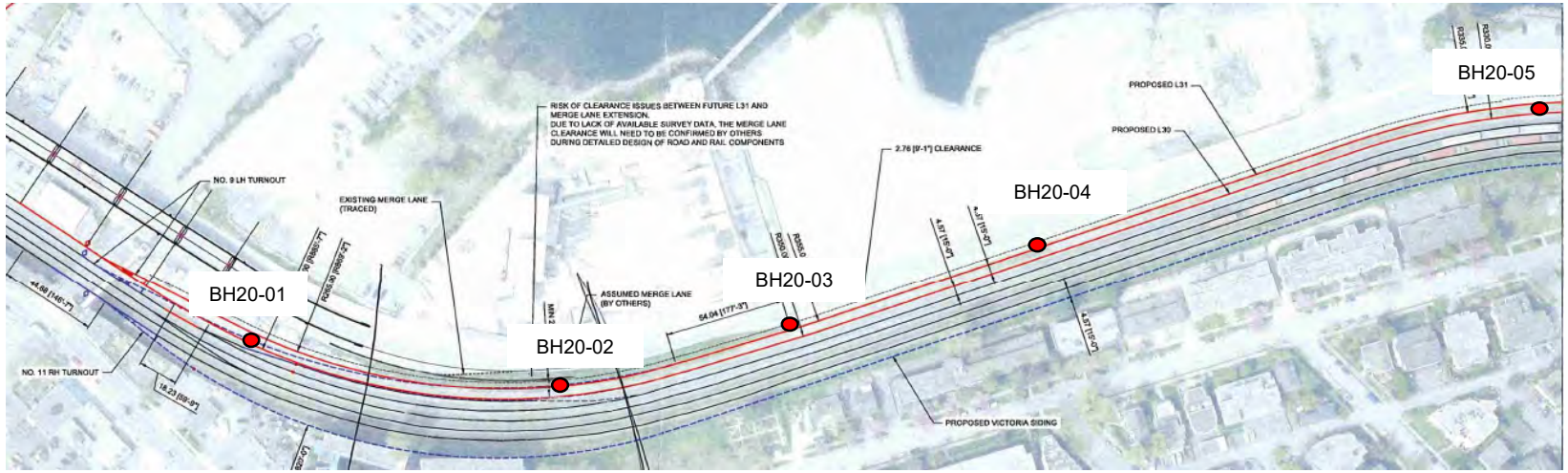
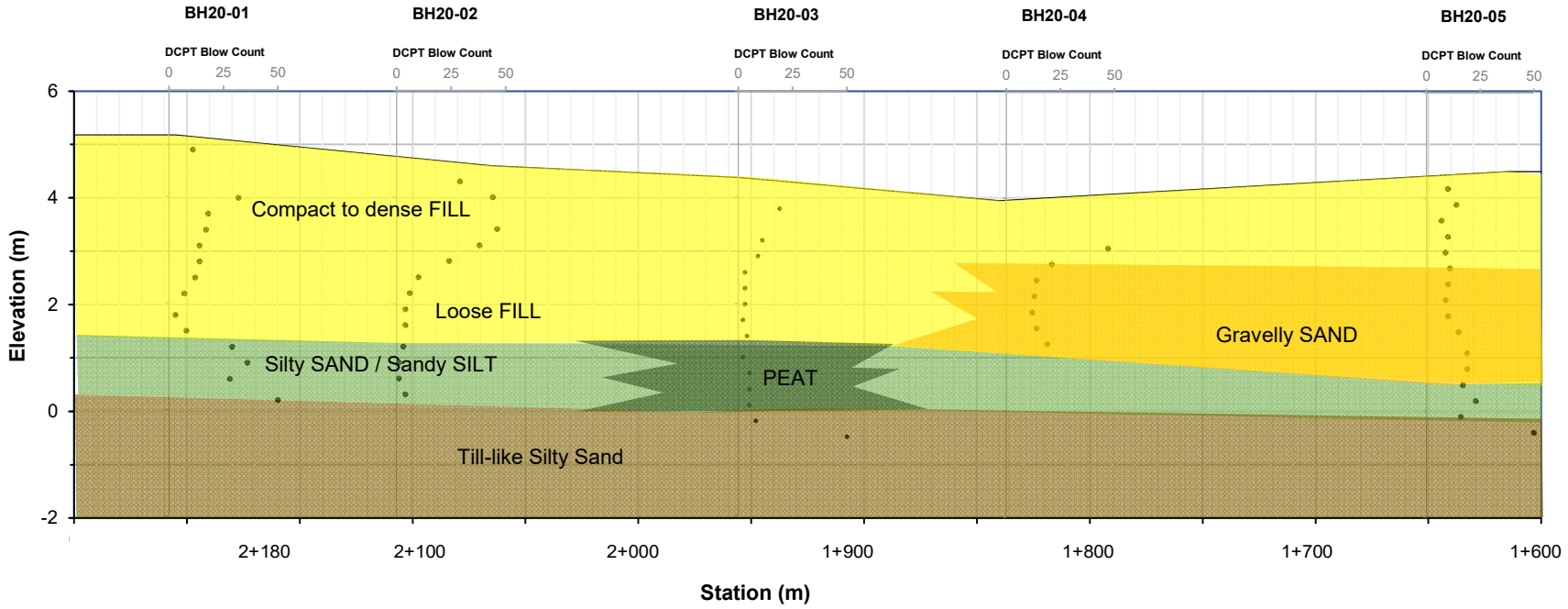
Enclosure: Figures
Appendix A – Limitations on the Use of this Document
Appendix B – Information Provided by Hatch
Appendix C – CPT Report
Appendix D – Borehole Logs
Appendix E – Geotechnical Laboratory Test Results
Appendix F – Chemical Test Results
Appendix G – Seismic Hazard
Appendix H – Impact Assessment for Metro Vancouver Sewer

FIGURES

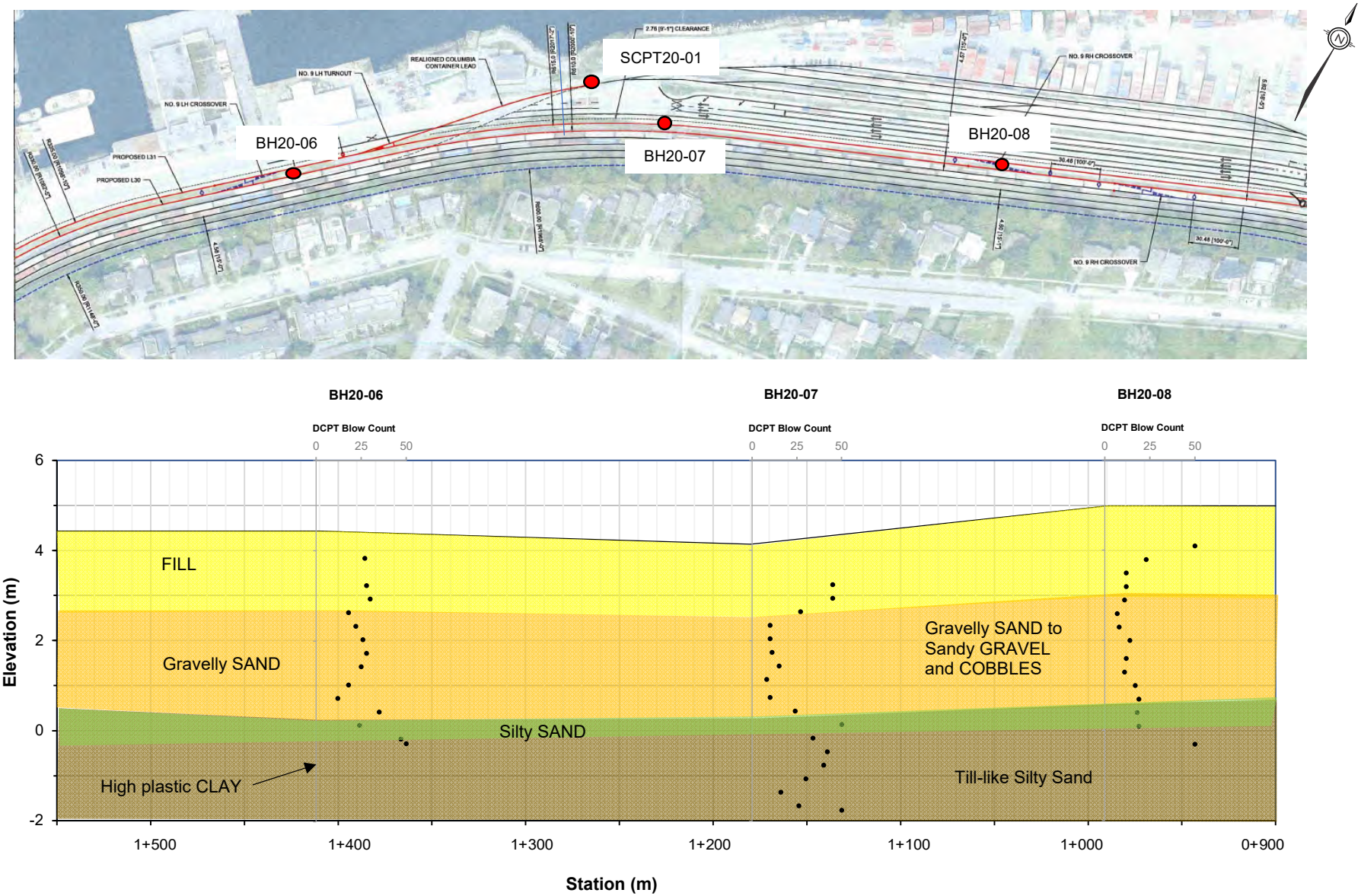




TETRA TECH

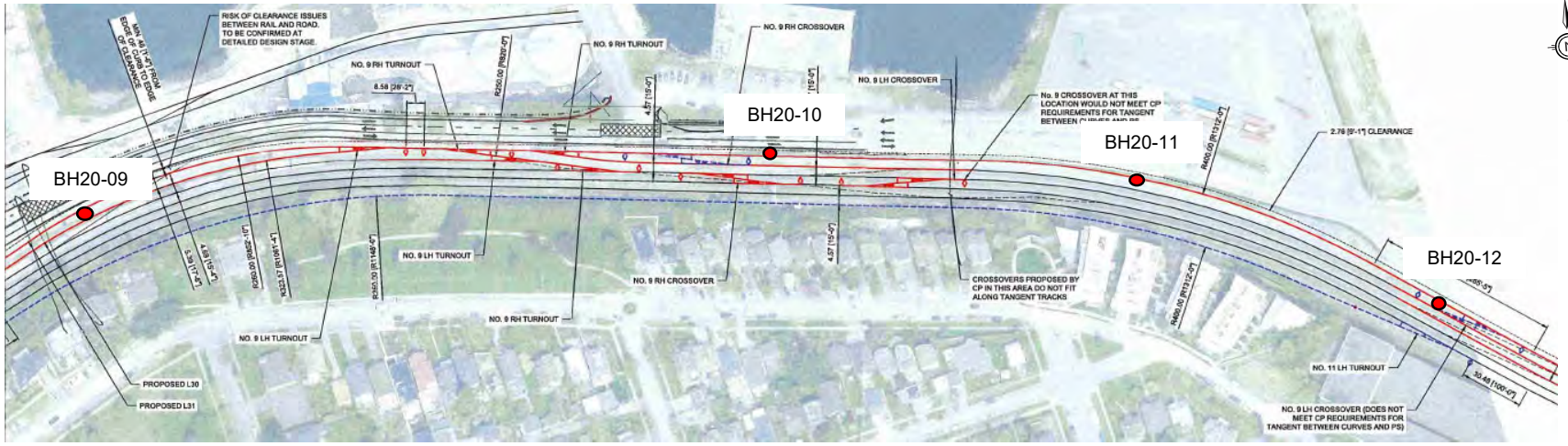
SUBSURFACE EXPLORATION PLAN
Estimated Soil Profile

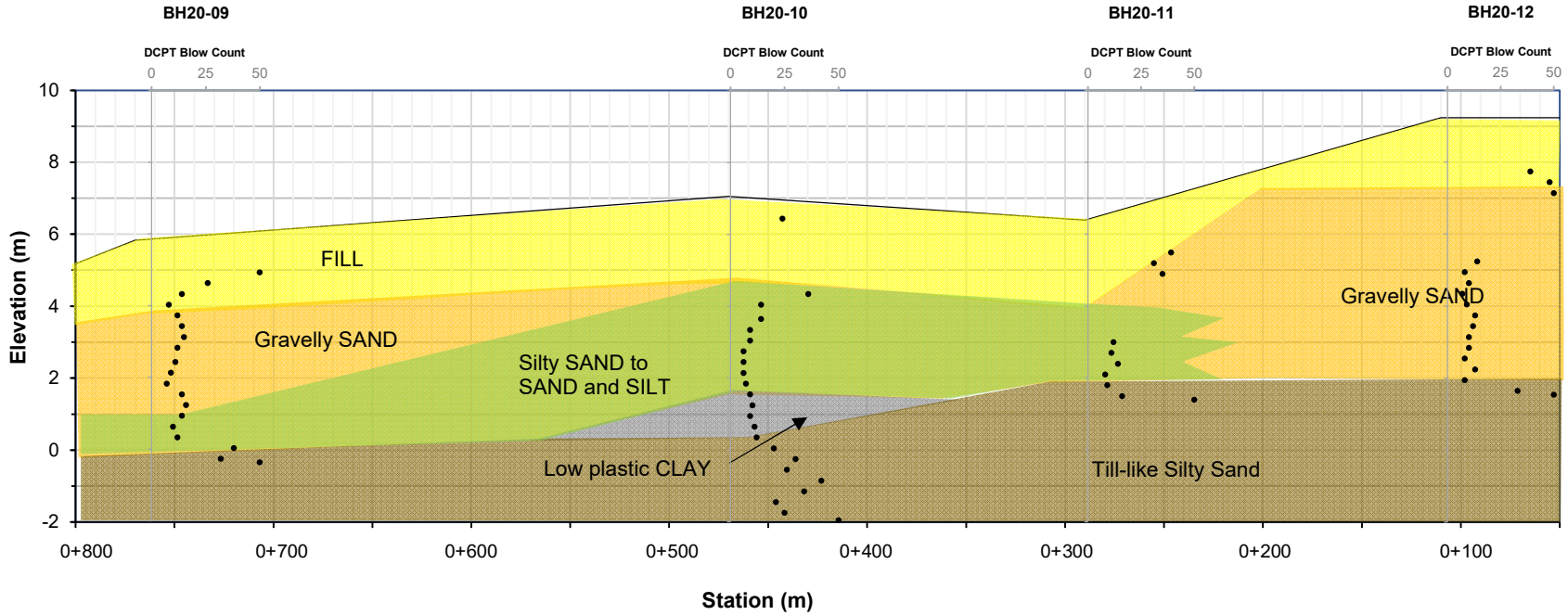
Figure 1a



SUBSURFACE EXPLORATION PLAN
Estimated Soil Profile

Figure 1b

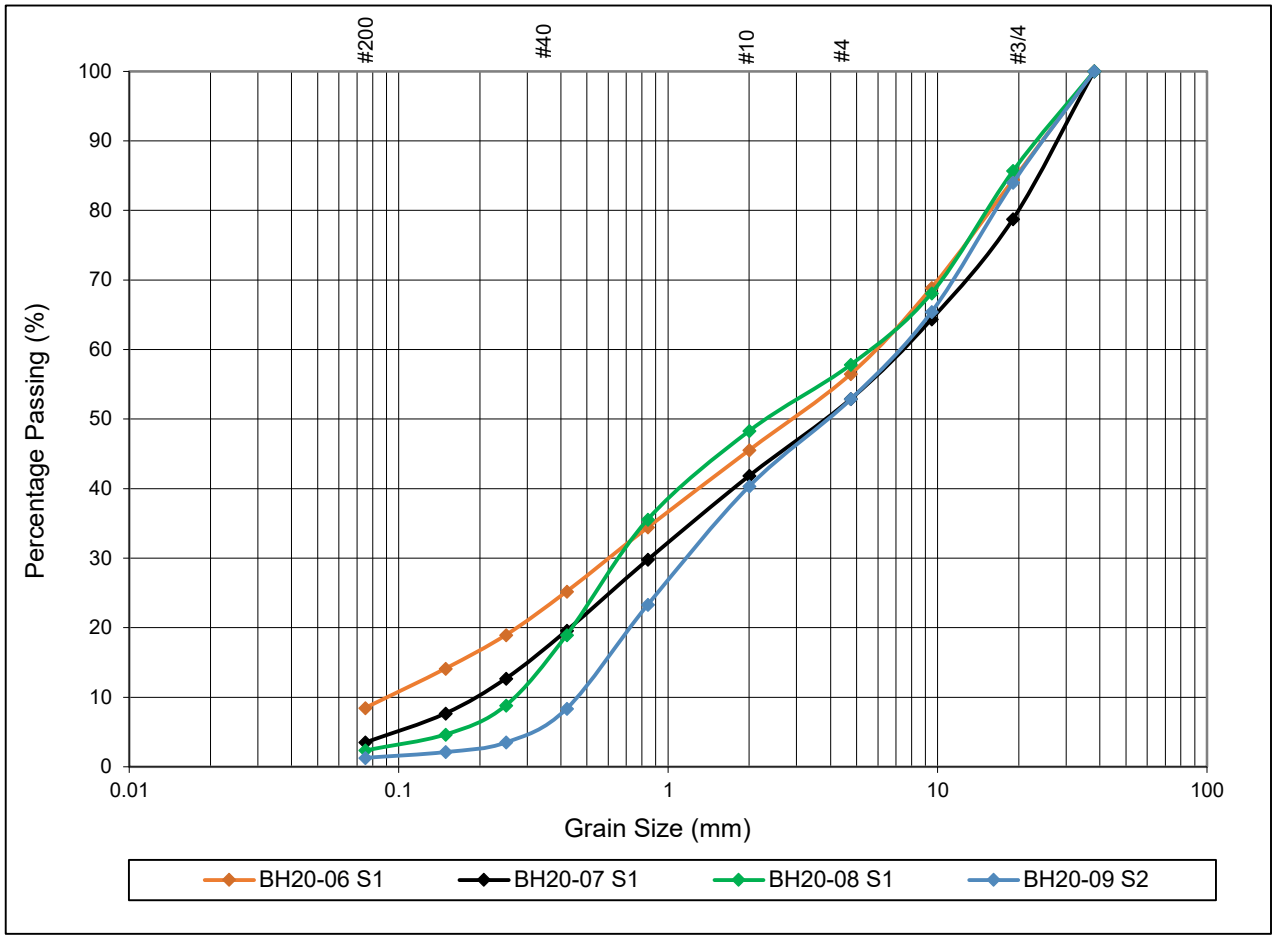




TETRA TECH

SUBSURFACE EXPLORATION PLAN
Estimated Soil Profile

Figure 1c



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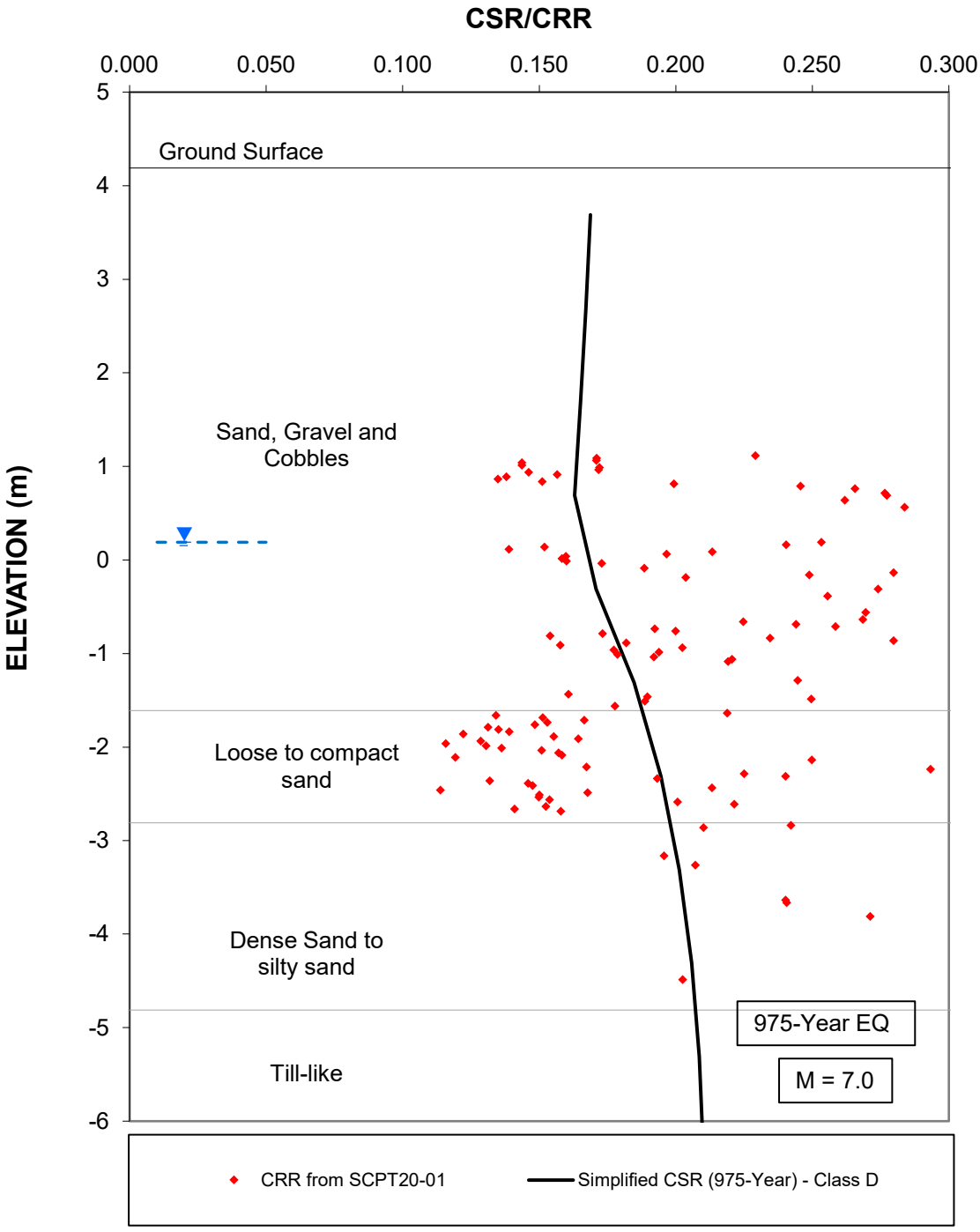
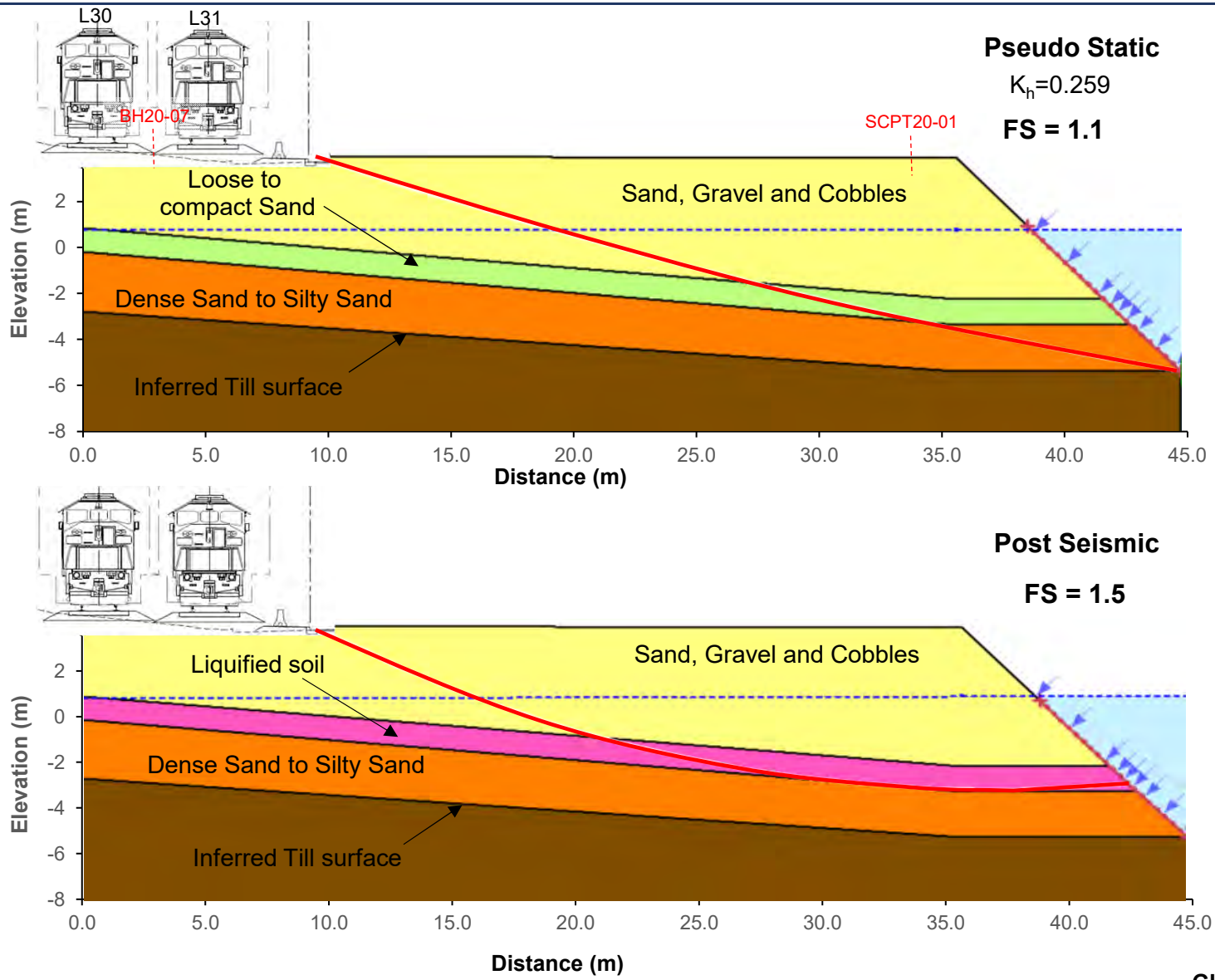
SIEVE ANALYSIS SUMMARY

Figure 2



Notes: Liquefaction triggering based on method proposed by Idriss & Boulanger (2014)



GLOBAL STABILITY
Pseudo static and Post seismic (975-yr EQ)

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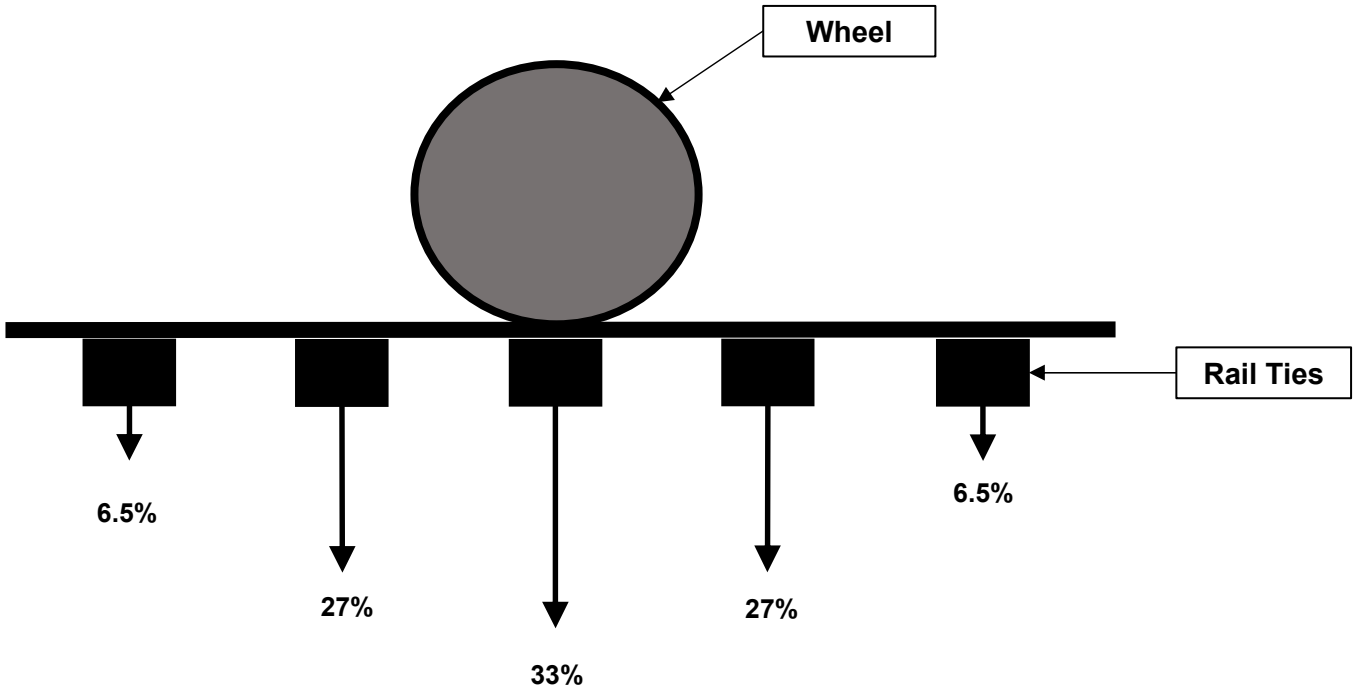
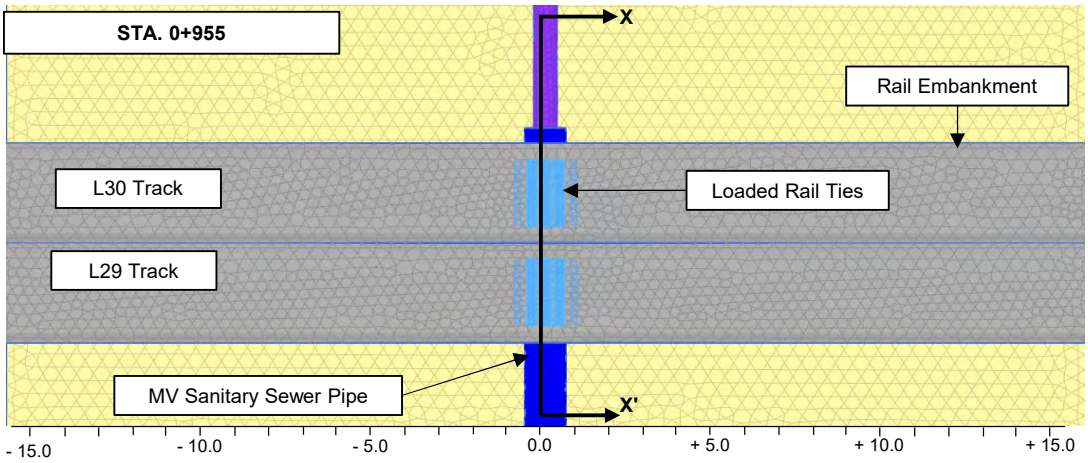
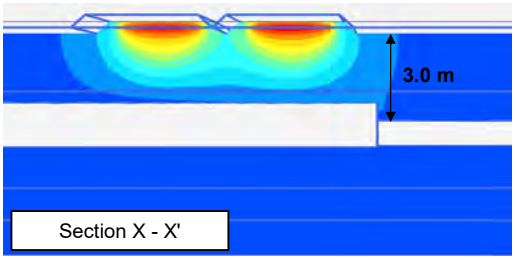
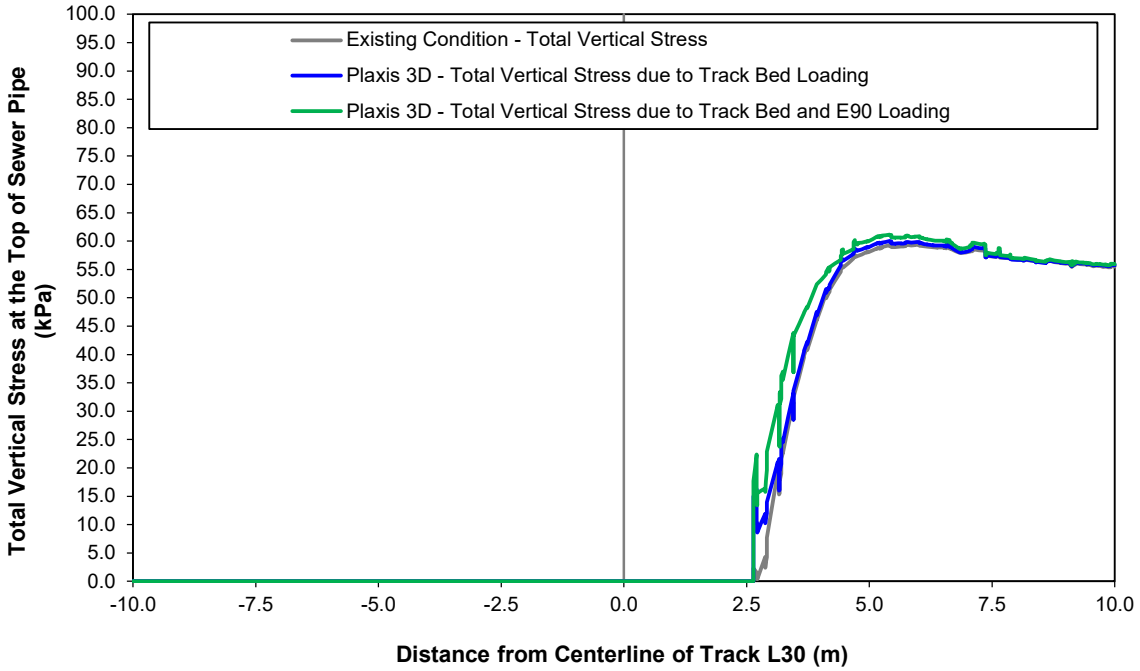
Figure 4



Assumed Wheel Load Distribution







STRESS DISTRIBUTION
CoV Utility - STA. 0+955

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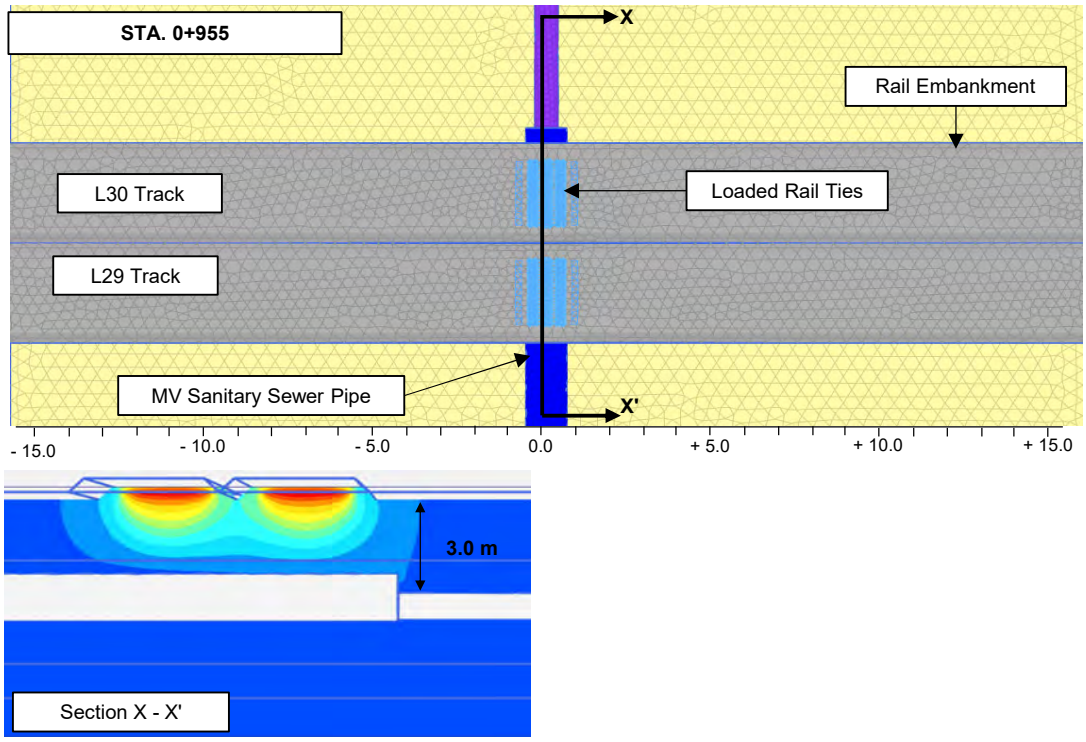
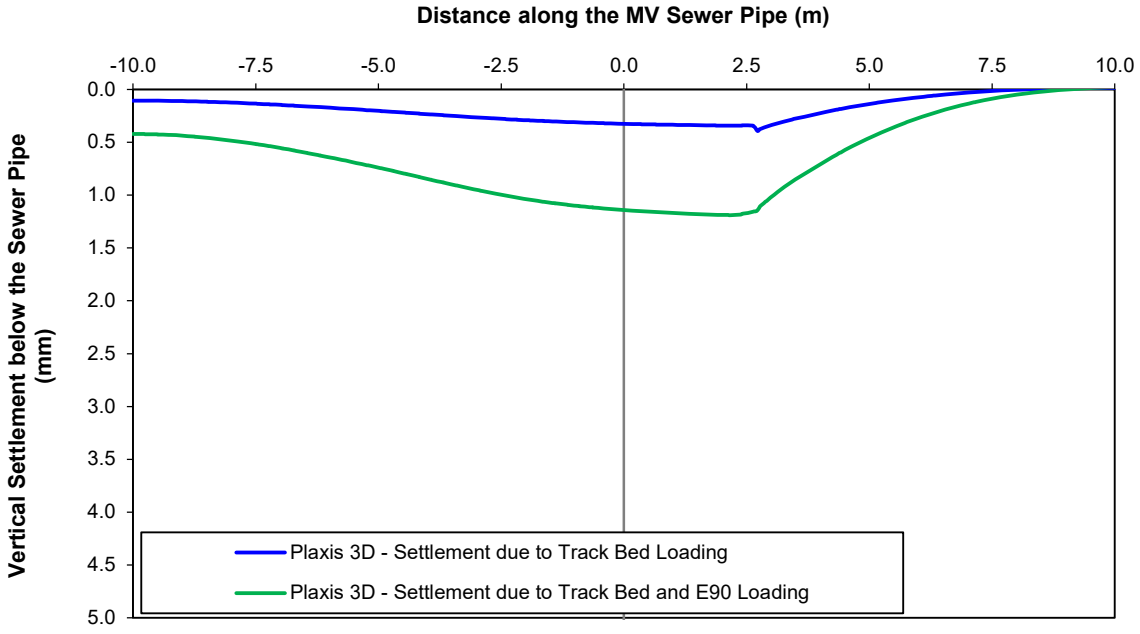
Figure 6a

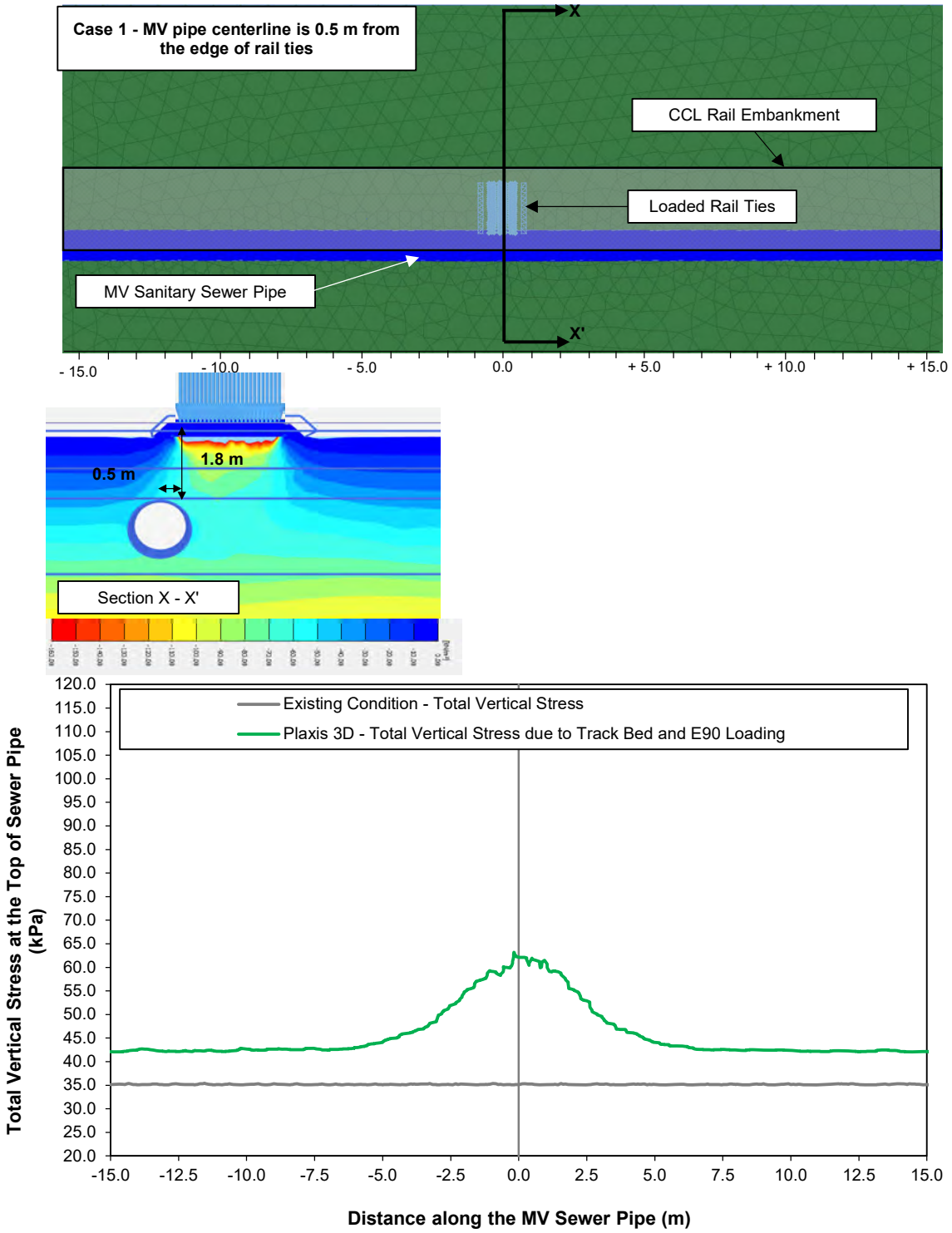




SETTLEMENT DISTRIBUTION
CoV Utility - STA. 0+955

TETRA TECH

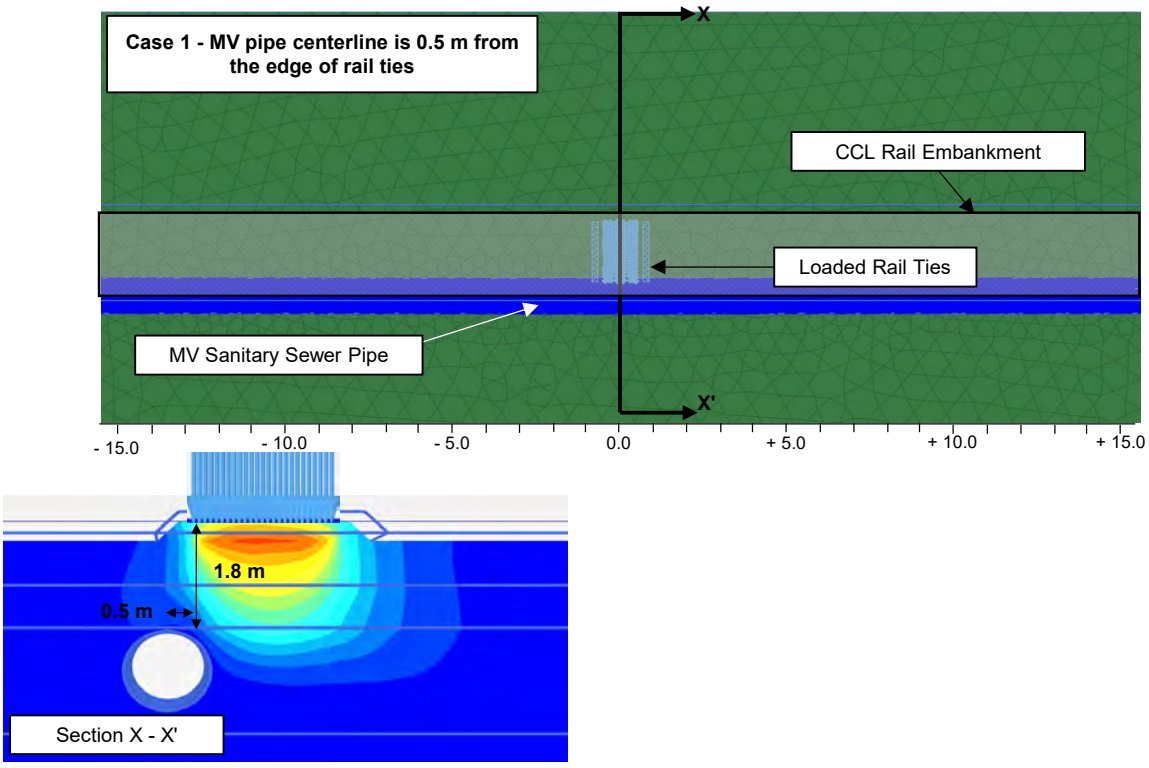
Figure 6b

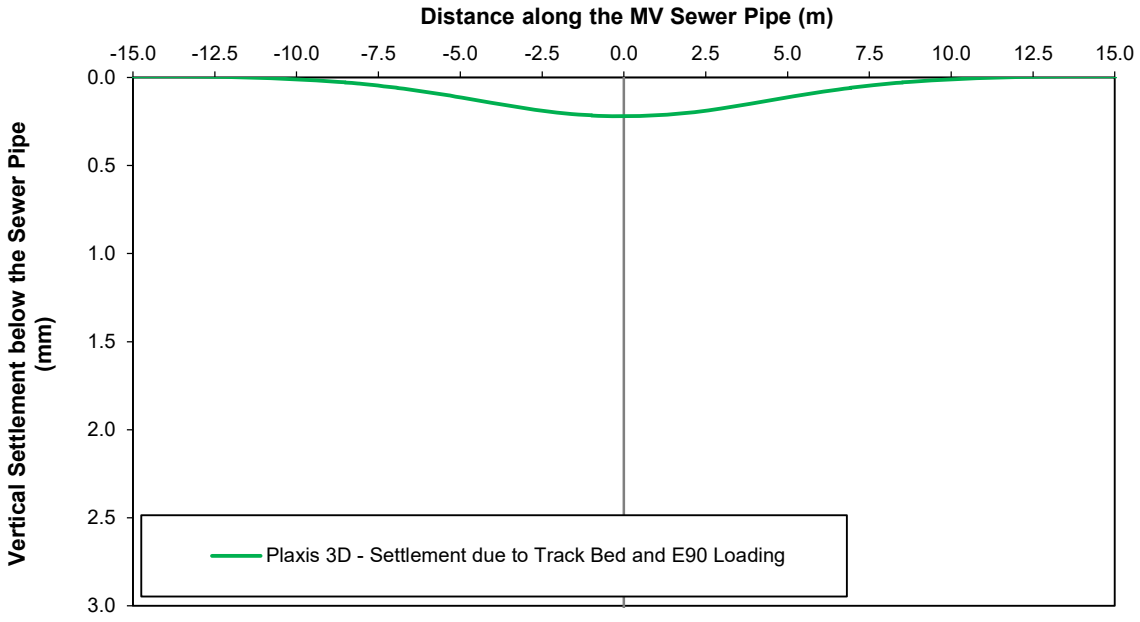


STRESS DISTRIBUTION

Case 1 - MV pipe centerline is 0 m from the edge of rail ties (1.3 m from the rail centerline)

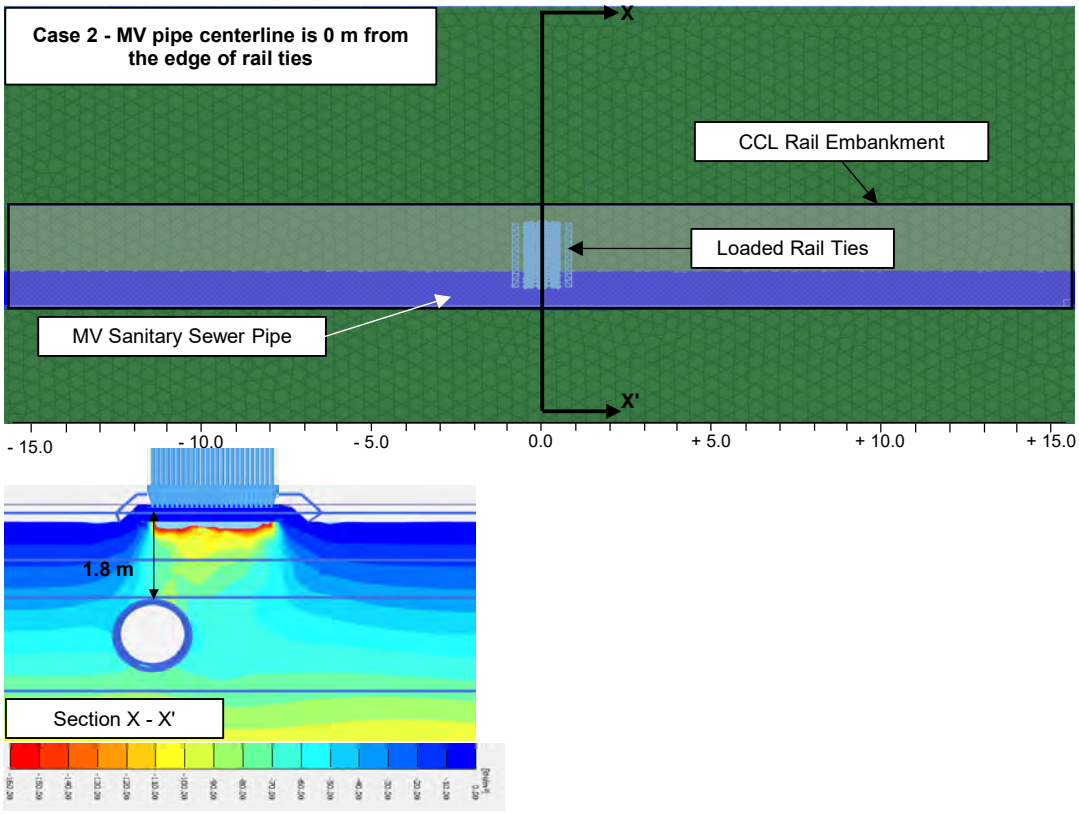
Figure 7a

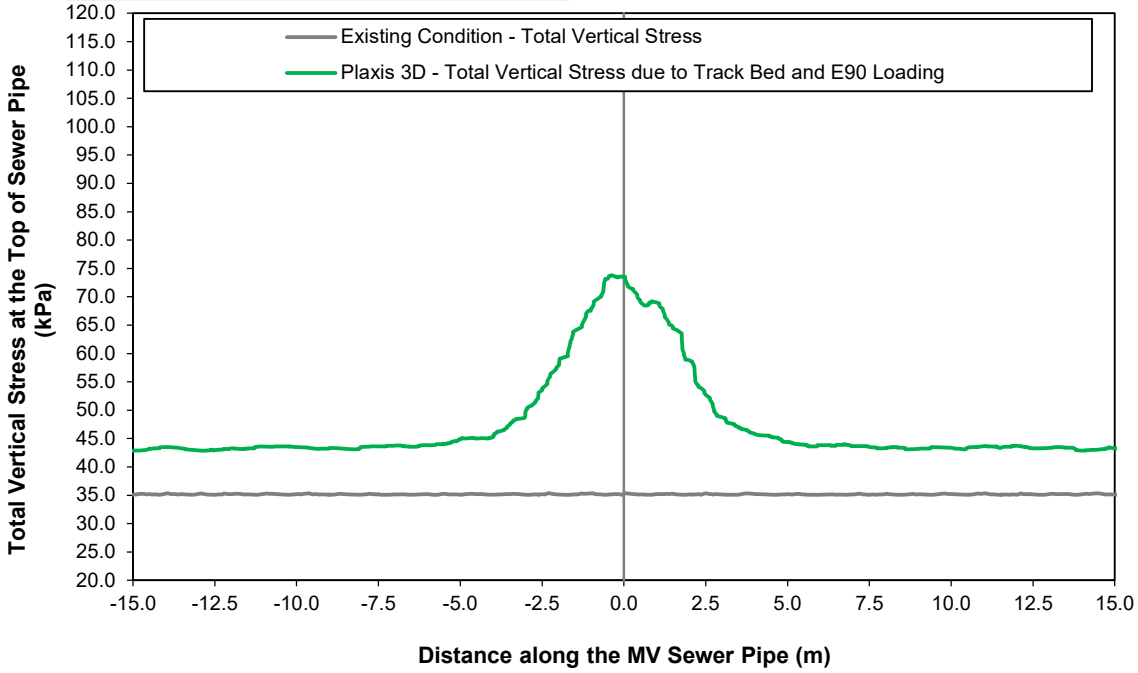




SETTLEMENT DISTRIBUTION

Case 1 - MV pipe centerline is 0.5 m from the edge of rail ties (1.8 m from the rail centerline)

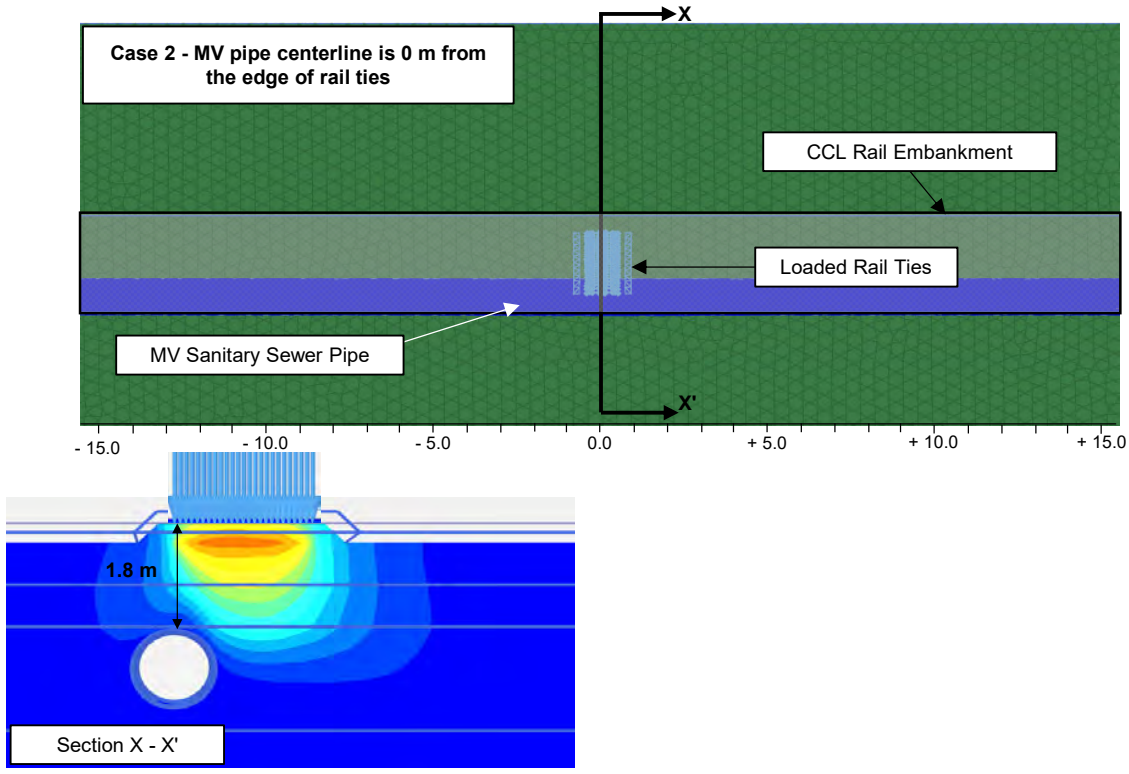


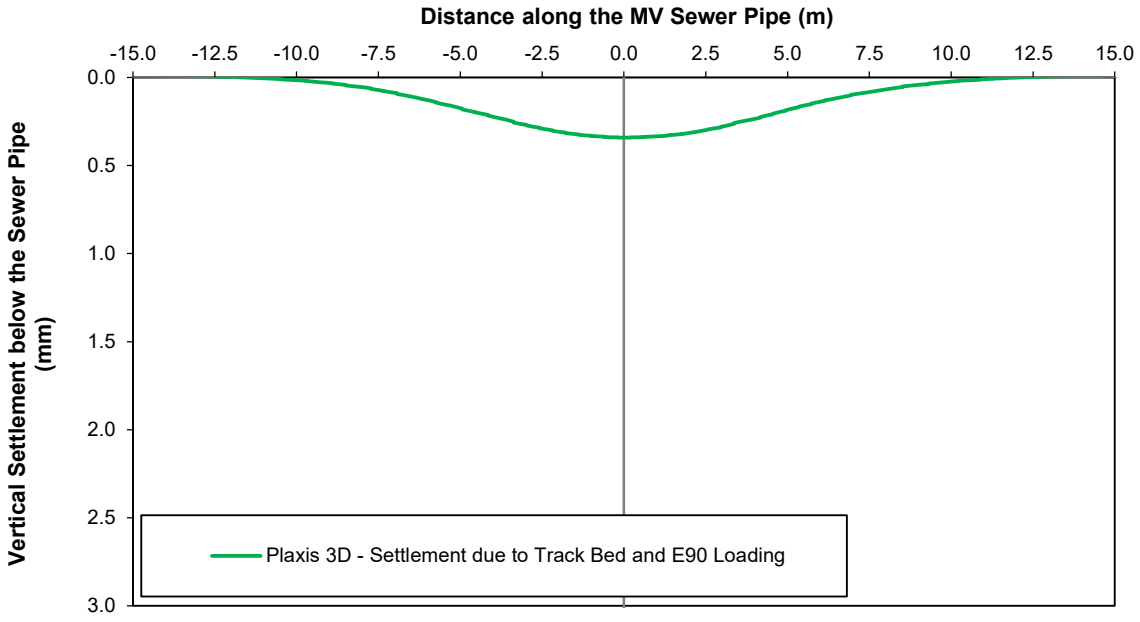


STRESS DISTRIBUTION

Case 2 - MV pipe centerline is 0 m from the edge of rail ties (1.3 m from the rail centerline)

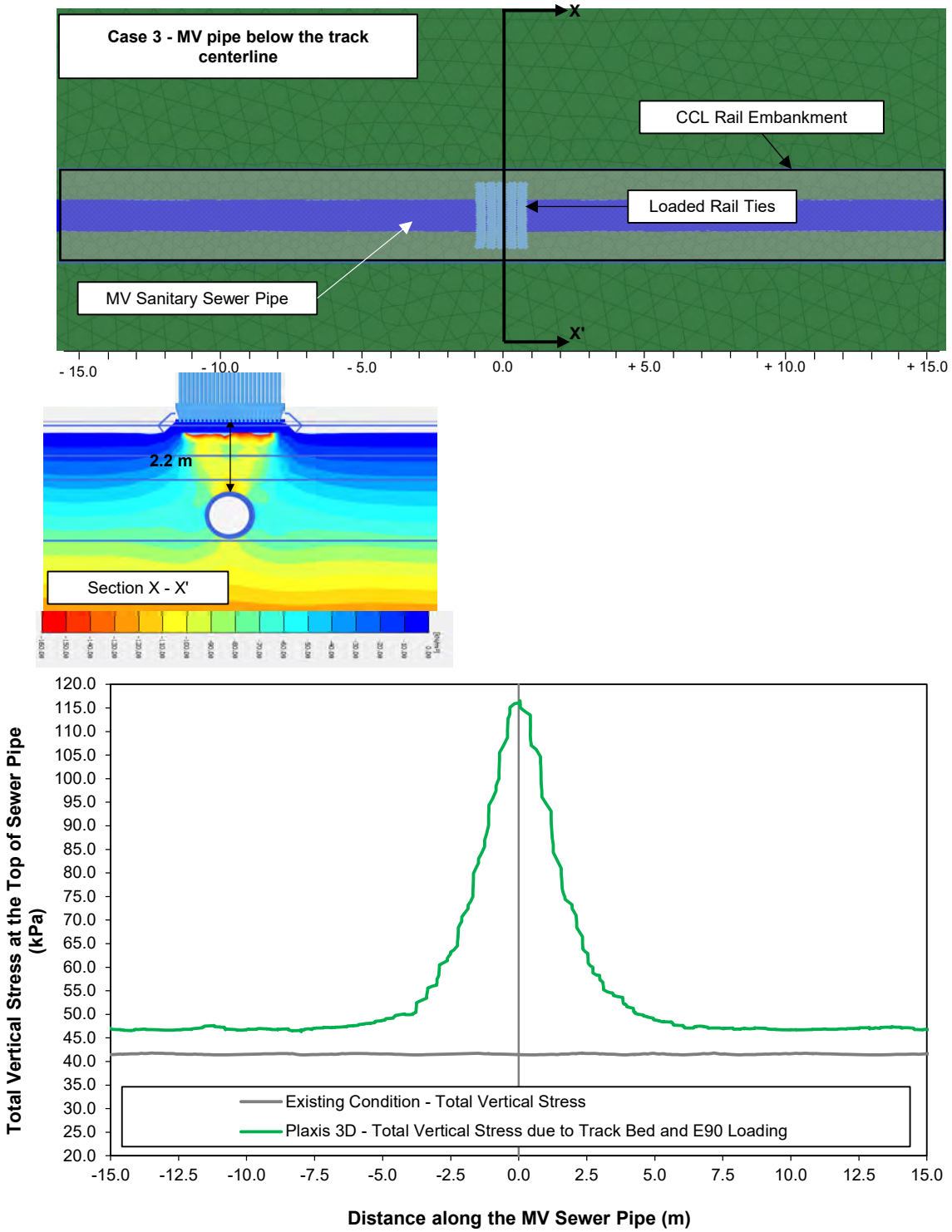
Figure 8a





SETTLEMENT DISTRIBUTION

Case 2 - MV pipe centerline is 0 m from the edge of rail ties (1.3 m from the rail centerline)



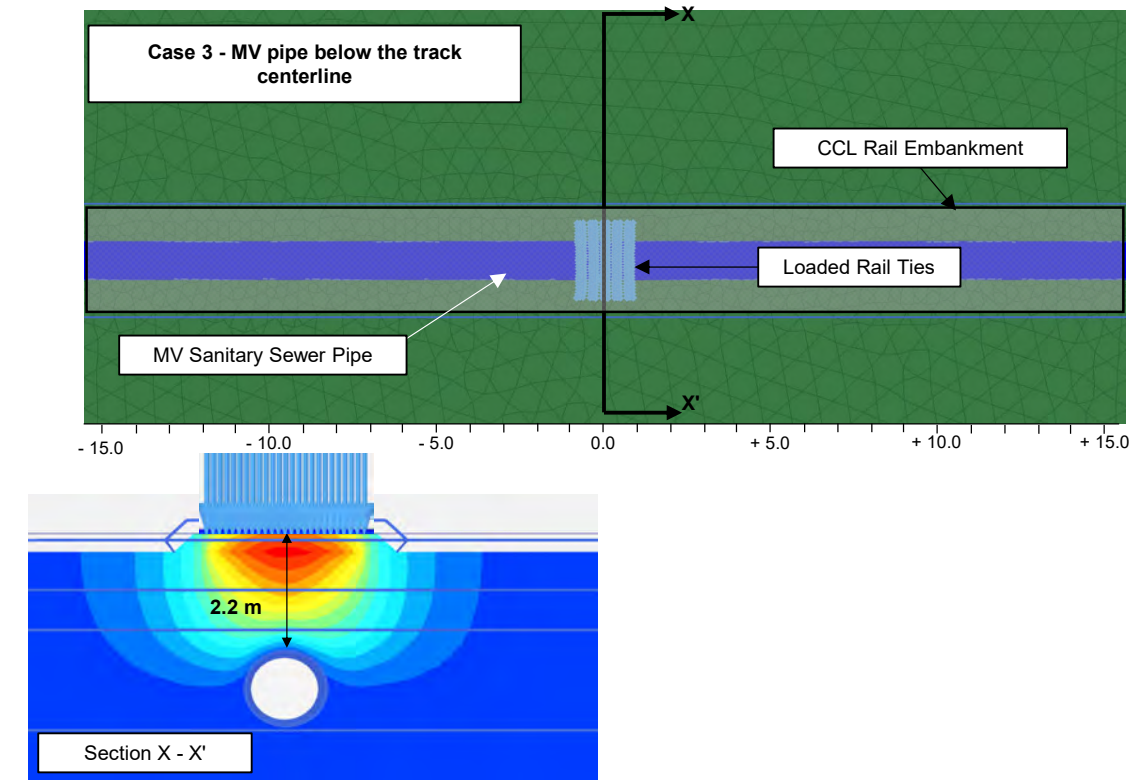
STRESS DISTRIBUTION

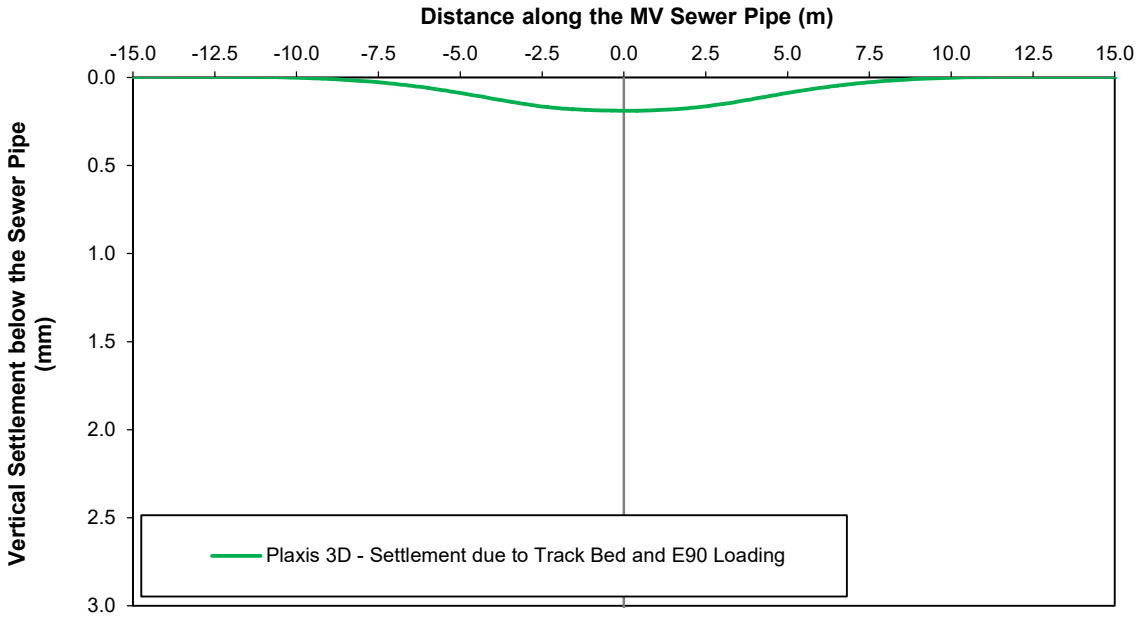
Case 3 - MV pipe below the track centerline (Sta. 8+058)

10 ft. Rail Ties

TETRA TECH

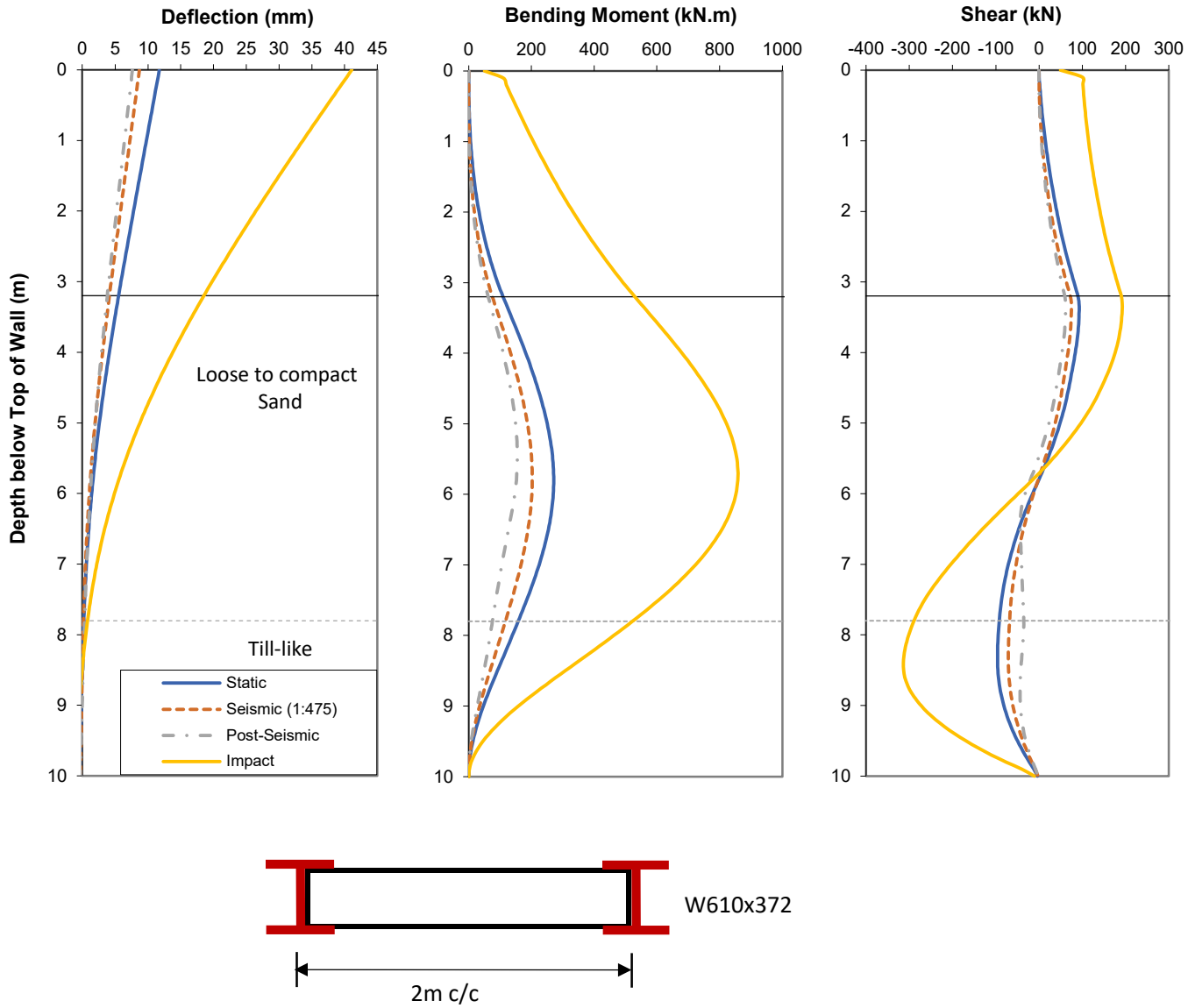
Figure 9a





SETTLEMENT DISTRIBUTION
Case 3 - MV pipe below the track centerline (Sta. 8+058)
10 ft. Rail Ties

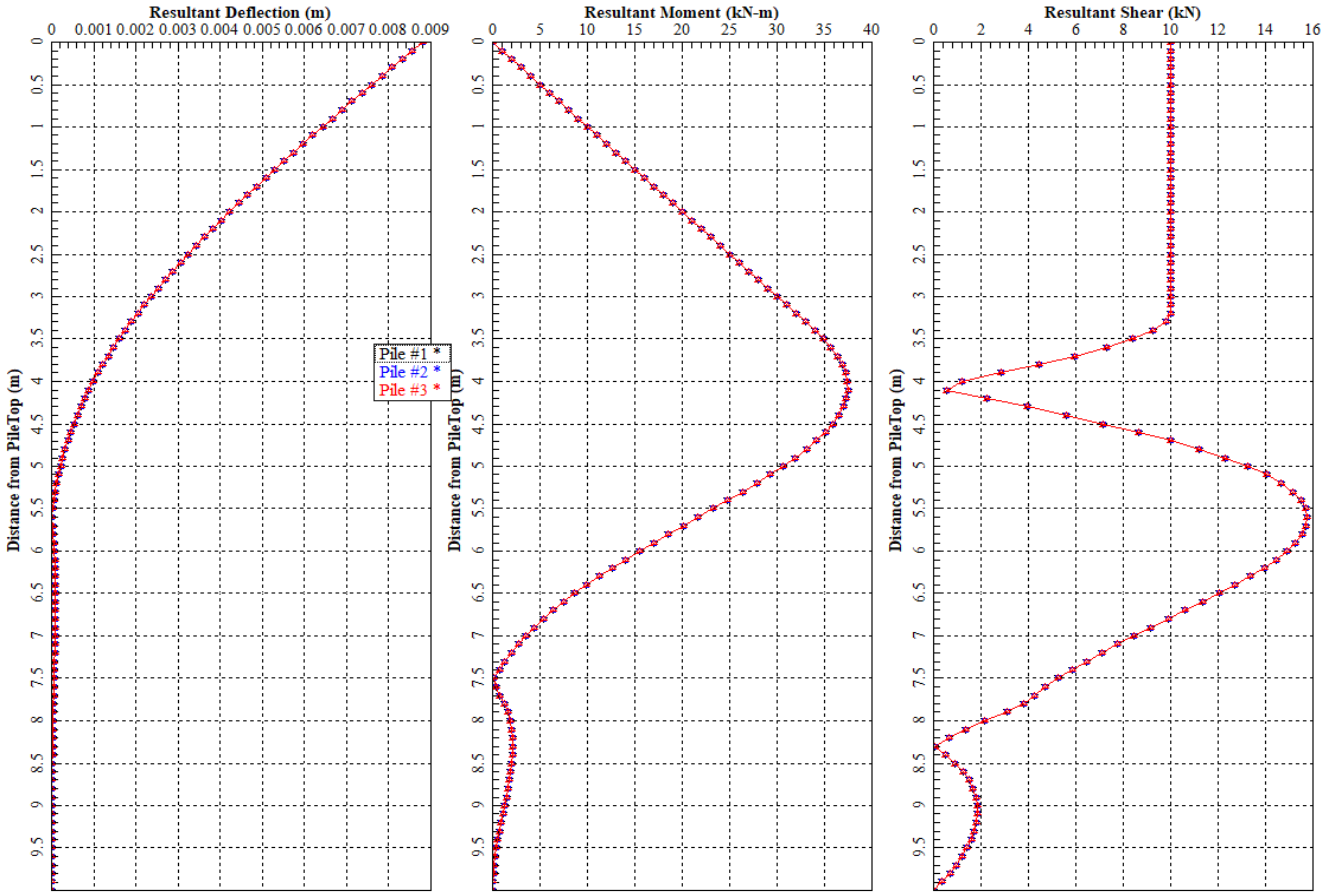
Figure 9b

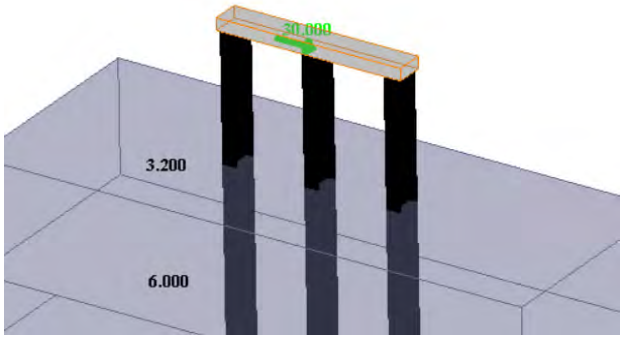


PY WALL ANALYSES

TETRA TECH

Figure 10





PILE GROUP ANALYSIS

Figure 11

APPENDIX A
Limitations

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

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Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

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If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this document, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to explore, address or consider and has not explored, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems, methods and standards employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historical environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional exploration and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques, and construction sequence are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function. Where temporary or permanent drainage systems are installed within or around a structure, these systems must protect the structure from loss of ground due to mechanisms such as internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design details regarding the geotechnical aspects of such systems (e.g. bedding material, surrounding soil, soil cover, geotextile type) should be reviewed by the geotechnical engineer to confirm the performance of the system is consistent with the conditions used in the geotechnical design.

1.16 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.17 SAMPLES

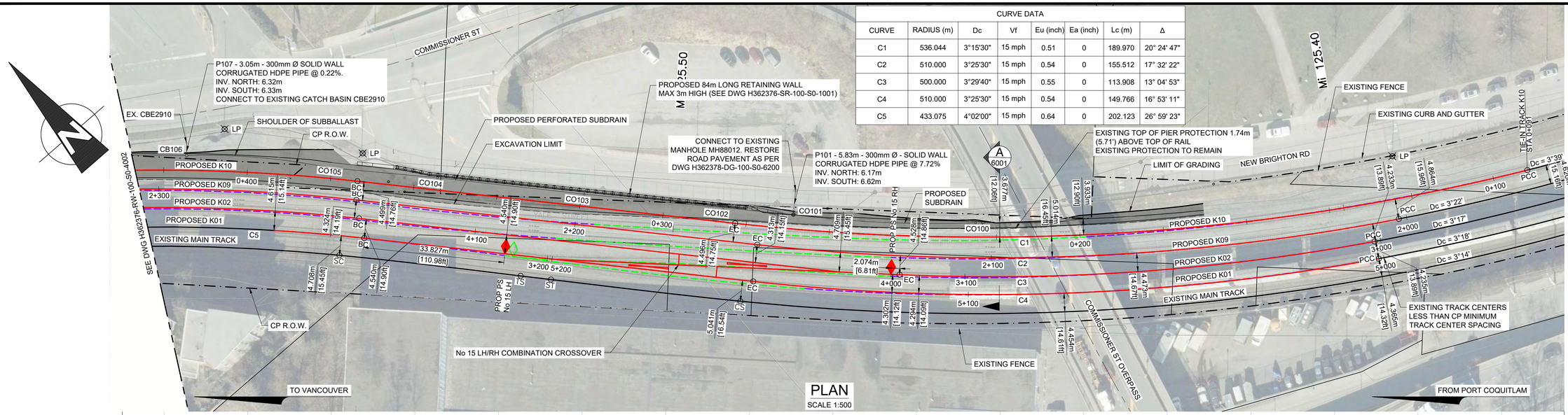
TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

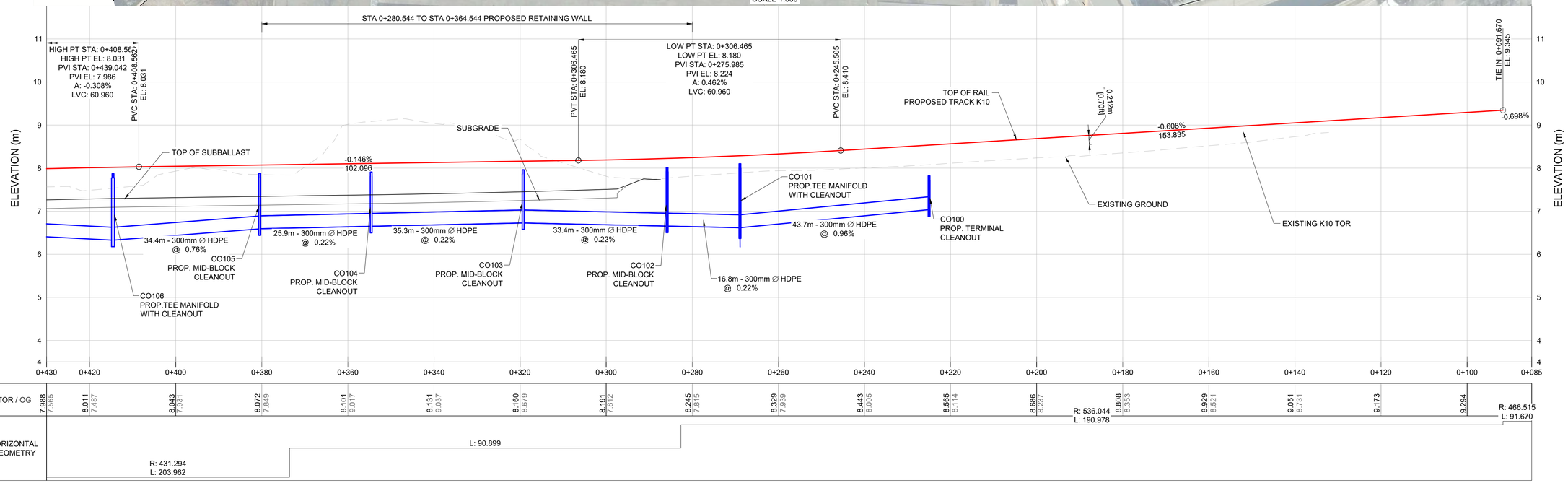
1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

This document has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. TETRA TECH cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.

APPENDIX B
Information Provided by Hatch

CURVE DATA							
CURVE	RADIUS (m)	Dc	Vf	Eu (inch)	Ea (inch)	Lc (m)	Δ
C1	536.044	3°15'30"	15 mph	0.51	0	189.970	20° 24' 47"
C2	510.000	3°25'30"	15 mph	0.54	0	155.512	17° 32' 22"
C3	500.000	3°29'40"	15 mph	0.55	0	113.908	13° 04' 53"
C4	510.000	3°25'30"	15 mph	0.54	0	149.766	16° 53' 11"
C5	433.075	4°02'00"	15 mph	0.64	0	202.123	26° 59' 23"





NOT FOR CONSTRUCTION

PROFILE
SCALE H 1:500
V 1:50

5 m 0 H: 1:500 25 m
0.5 m 0 V: 1:50 2.5 m

HATCH

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED

DESIGNED BY: **F.D.** DATE: 11-09-20	DRAWN BY: **A.S.** DATE: **11-09-20**
CHECKED BY: **V.C.** DATE: **11-09-20**	PROJECT MANAGER: **I.M.** DATE: **11-09-20**
HATCH PROJECT No: **H362376**	DWG SCALE(FULL SIZE): **AS SHOWN**

PROFESSIONAL SEALS

THIS DRAWING WAS PREPARED FOR THE EXCLUSIVE USE OF CANADIAN PACIFIC ("CLIENT") AND IS ISSUED PURSUANT TO THE HATCH-CP ENGINEERING SERVICES AGREEMENT AND RELEVANT PURCHASE ORDER BETWEEN CLIENT AND HATCH CORPORATION ("HATCH"). UNLESS OTHERWISE AGREED IN WRITING WITH CLIENT OR SPECIFIED ON THIS DRAWING, (A) HATCH DOES NOT ACCEPT AND DISCLAIMS ANY AND ALL LIABILITY OR RESPONSIBILITY ARISING FROM ANY USE OF OR RELIANCE ON THIS DRAWING BY ANY THIRD PARTY OR ANY MODIFICATION OR MISUSE OF THIS DRAWING BY CLIENT, AND (B) THIS DRAWING IS CONFIDENTIAL AND ALL INTELLECTUAL PROPERTY RIGHTS EMBODIED OR REFERENCED IN THIS DRAWING REMAIN THE PROPERTY OF HATCH.

No.	DATE	REVISION	BY
C	03-08-21	ISSUED FOR 90% DESIGN	F.D.
B	31-05-21	REISSUED FOR 30% DESIGN	F.D.
A	11-09-20	ISSUED FOR 30% DESIGN	L.C.

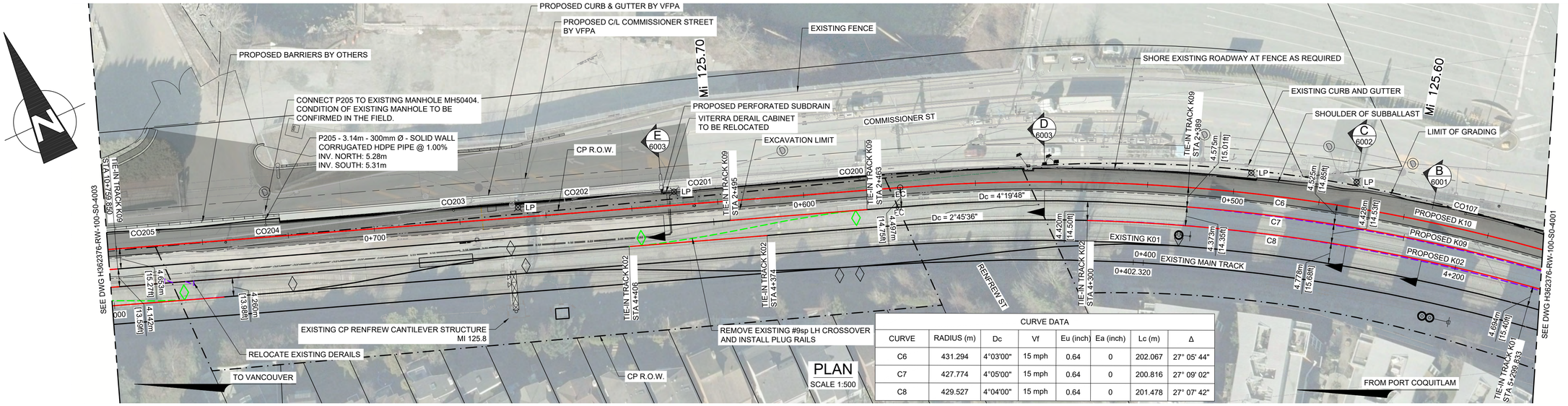
ENGINEERING PROJECTS - WEST

VANCOUVER DIVISION MILE 125.37 TO 127.00 CASCADE SUBDIVISION

EAST L YARD EXPANSION
RAIL - PLAN & PROFILE
TRACK K10 - STA 0+085 TO 0+430

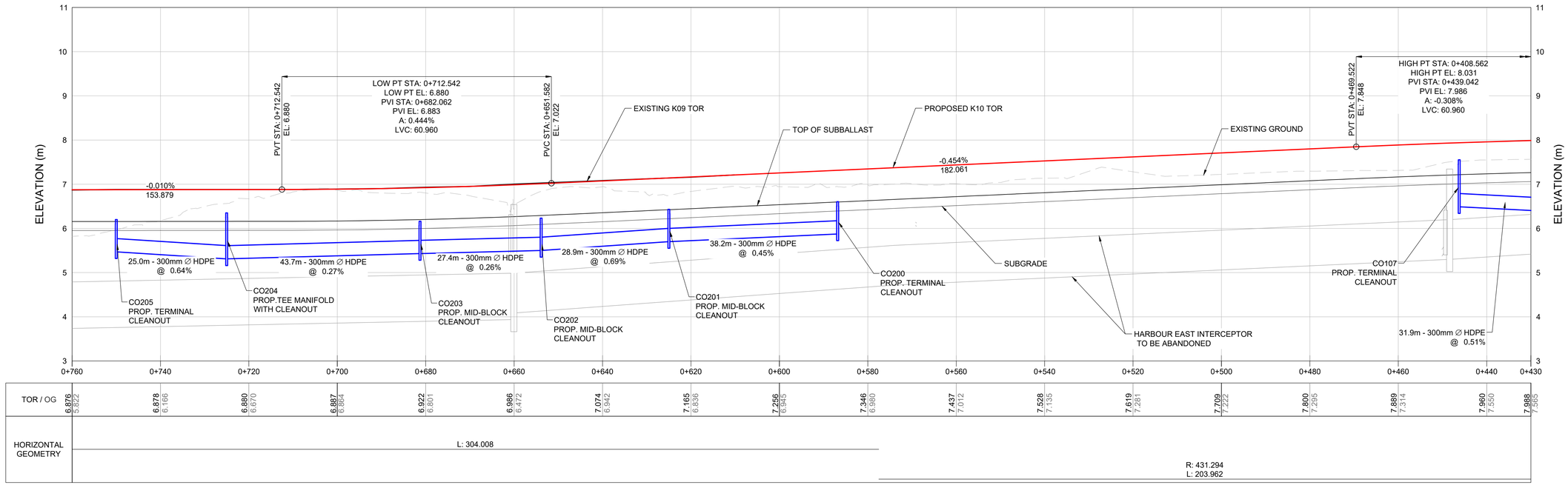
DWG. BY: CHK BY:	OFFICE FILE:
	SCALE:
MANAGER - DESIGN:	DATE:
M.FAVREAU DIR. PROJECT SERVICES WEST	PLAN No. H362376-RW-100-S0-4001 Rev. C

Aug 03 , 2021 , 4:59pm Login name: shob11128
Drawing Name: C:\pwworking\hi\pasha.shoberi@hatch.com\d0694048\H362376-RW-100-S0-4001 to 4008.dwg



CURVE DATA							
CURVE	RADIUS (m)	Dc	Vf	Eu (inch)	Ea (inch)	Lc (m)	Δ
C6	431.294	4°03'00"	15 mph	0.64	0	202.067	27° 05' 44"
C7	427.774	4°05'00"	15 mph	0.64	0	200.816	27° 09' 02"
C8	429.527	4°04'00"	15 mph	0.64	0	201.478	27° 07' 42"

PLAN
SCALE 1:500



0+760	0+740	0+720	0+700	0+680	0+660	0+640	0+620	0+600	0+580	0+560	0+540	0+520	0+500	0+480	0+460	0+440	0+430
TOR	6.876	6.878	6.880	6.887	6.922	6.986	7.074	7.165	7.256	7.346	7.437	7.528	7.619	7.709	7.800	7.889	7.960	7.988
OG	5.922	6.166	6.670	6.864	6.901	6.472	6.942	6.836	6.945	6.980	7.012	7.135	7.281	7.222	7.295	7.314	7.350	7.565

NOT FOR CONSTRUCTION

PROFILE
SCALE H 1:500
V 1:50

5 m 0 H: 1:500 25 m
0.5 m 0 V: 1:50 2.5 m

HATCH

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED

DESIGNED BY:	DRAWN BY:
F.D. DATE: **11-09-20**	**A.S.** DATE: **11-09-20**
CHECKED BY: **V.C.** DATE: **11-09-20**	PROJECT MANAGER: **I.M.** DATE: **11-09-20**
HATCH PROJECT No: **H362376**	DWG SCALE(FULL SIZE): **AS SHOWN**

PROFESSIONAL SEALS

THIS DRAWING WAS PREPARED FOR THE EXCLUSIVE USE OF CANADIAN PACIFIC ("CLIENT") AND IS ISSUED PURSUANT TO THE HATCH-CP ENGINEERING SERVICES AGREEMENT AND RELEVANT PURCHASE ORDER BETWEEN CLIENT AND HATCH CORPORATION ("HATCH"). UNLESS OTHERWISE AGREED IN WRITING WITH CLIENT OR SPECIFIED ON THIS DRAWING, (A) HATCH DOES NOT ACCEPT AND DISCLAIMS ANY AND ALL LIABILITY OR RESPONSIBILITY ARISING FROM ANY USE OF OR RELIANCE ON THIS DRAWING BY ANY THIRD PARTY OR ANY MODIFICATION OR MISUSE OF THIS DRAWING BY CLIENT, AND (B) THIS DRAWING IS CONFIDENTIAL AND ALL INTELLECTUAL PROPERTY RIGHTS EMBODIED OR REFERENCED IN THIS DRAWING REMAIN THE PROPERTY OF HATCH.

No.	DATE	REVISION	BY
C	03-08-21	ISSUED FOR 90% DESIGN	F.D.
B	31-05-21	REISSUED FOR 30% DESIGN	F.D.
A	11-09-20	ISSUED FOR 30% DESIGN	L.C.

ENGINEERING PROJECTS - WEST

VANCOUVER DIVISION MILE 125.37 TO 127.00 CASCADE SUBDIVISION

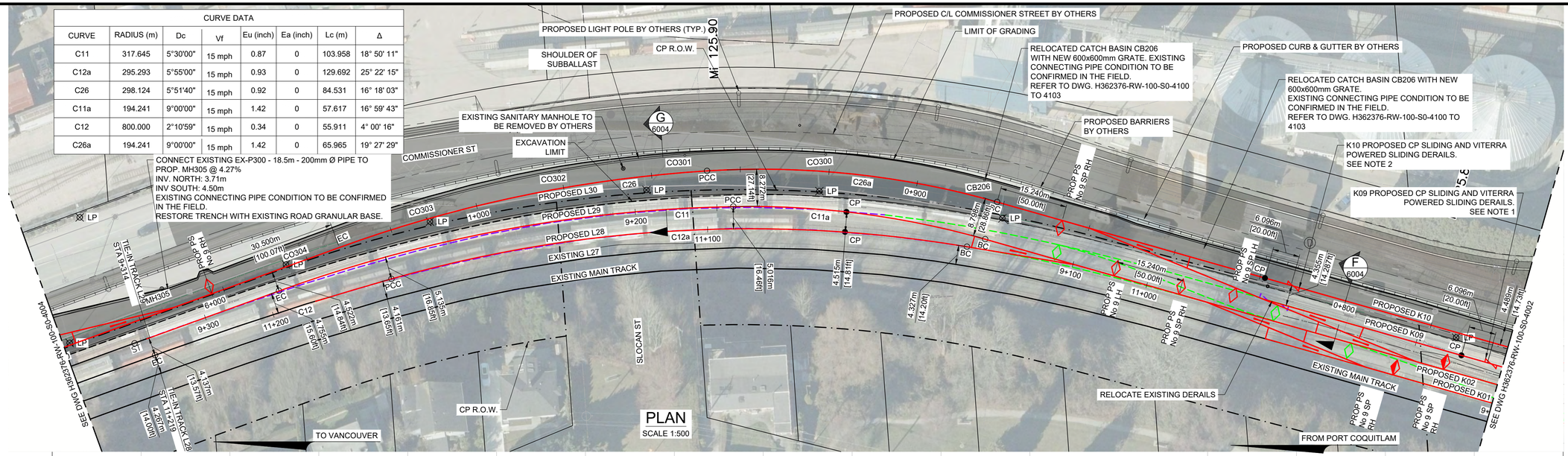
EAST L YARD EXPANSION
RAIL - PLAN & PROFILE
TRACK K10 - STA 0+430 TO 0+760

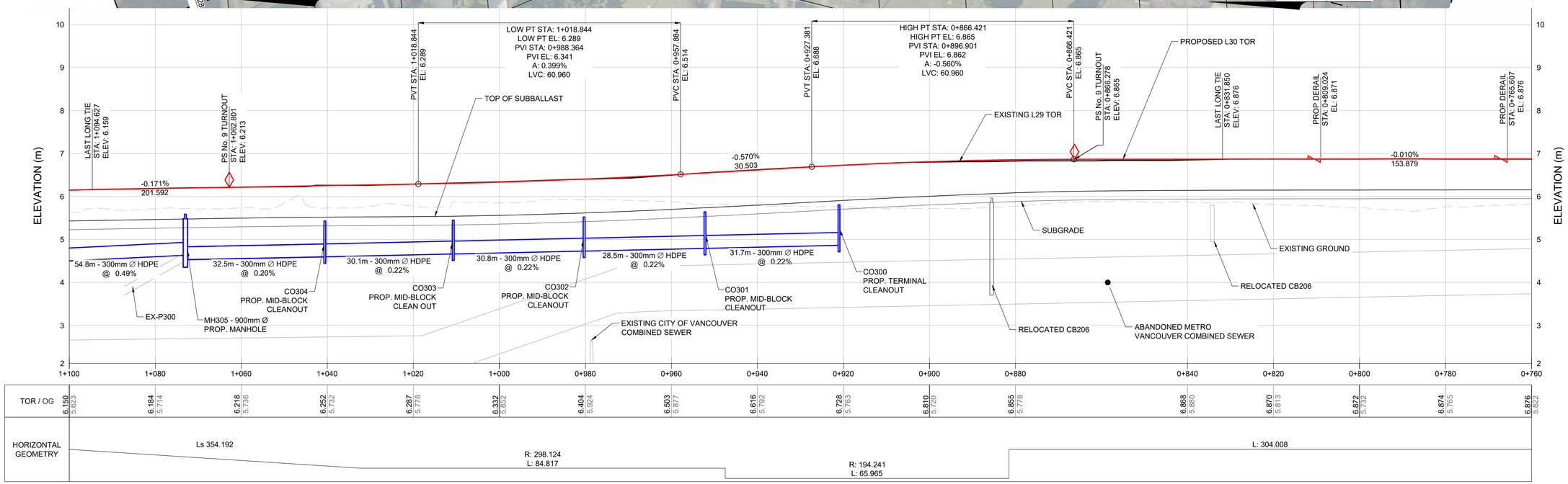
DWG. BY:	CHK BY:	OFFICE FILE:	
MANAGER - DESIGN:		SCALE:	
M.FAVREAU DIR. PROJECT SERVICES WEST		DATE:	
		PLAN No.	Rev.
		H362376-RW-100-S0-4002	C

Aug 03 , 2021 , 6:54pm Login name: mcke92314
Drawing Name: C:\pwworking\hl\mcke92314\d0694048\H362376-RW-100-S0-4001 to 4008.dwg

CURVE DATA							
CURVE	RADIUS (m)	Dc	Vf	Eu (inch)	Ea (inch)	Lc (m)	Δ
C11	317.645	5°30'00"	15 mph	0.87	0	103.958	18° 50' 11"
C12a	295.293	5°55'00"	15 mph	0.93	0	129.692	25° 22' 15"
C26	298.124	5°51'40"	15 mph	0.92	0	84.531	16° 18' 03"
C11a	194.241	9°00'00"	15 mph	1.42	0	57.617	16° 59' 43"
C12	800.000	2°10'59"	15 mph	0.34	0	55.911	4° 00' 16"
C26a	194.241	9°00'00"	15 mph	1.42	0	65.965	19° 27' 29"

CONNECT EXISTING EX-P300 - 18.5m - 200mm Ø PIPE TO PROP. MH305 @ 4.27%
INV. NORTH: 3.71m
INV SOUTH: 4.50m
EXISTING CONNECTING PIPE CONDITION TO BE CONFIRMED IN THE FIELD.
RESTORE TRENCH WITH EXISTING ROAD GRANULAR BASE.





NOT FOR CONSTRUCTION

PROFILE
SCALE H 1:500
V 1:50

5 m 0 H: 1:500 25 m
0.5 m 0 V: 1:50 2.5 m

NOTES:
1. K09 - CP SLIDING DERAIL LOCATED AT STA 10+765.237, 20' EAST OF CLEARANCE POINT
   VITERRA POWERED SLIDING DERAIL LOCATED AT STA 10+763.713, 25' EAST OF CLEARANCE POINT
2. K10 - CP SLIDING DERAIL LOCATED AT STA 0+812.610, 20' EAST OF CLEARANCE POINT
   VITERRA POWERED SLIDING DERAIL LOCATED AT STA 0+811.500, 25' EAST OF CLEARANCE POINT

HATCH

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED

DESIGNED BY:	DRAWN BY:
F.D. DATE: 11-09-20	**A.S.** DATE: **11-09-20**
CHECKED BY: **V.C.** DATE: **11-09-20**	PROJECT MANAGER: **I.M.** DATE: **11-09-20**
HATCH PROJECT No: **H362376**	DWG SCALE(FULL SIZE): **AS SHOWN**

PROFESSIONAL SEALS

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No.	DATE	REVISION	BY
C	03-08-21	ISSUED FOR 90% DESIGN	F.D.
B	31-05-21	REISSUED FOR 30% DESIGN	F.D.
A	11-09-20	ISSUED FOR 30% DESIGN	L.C.

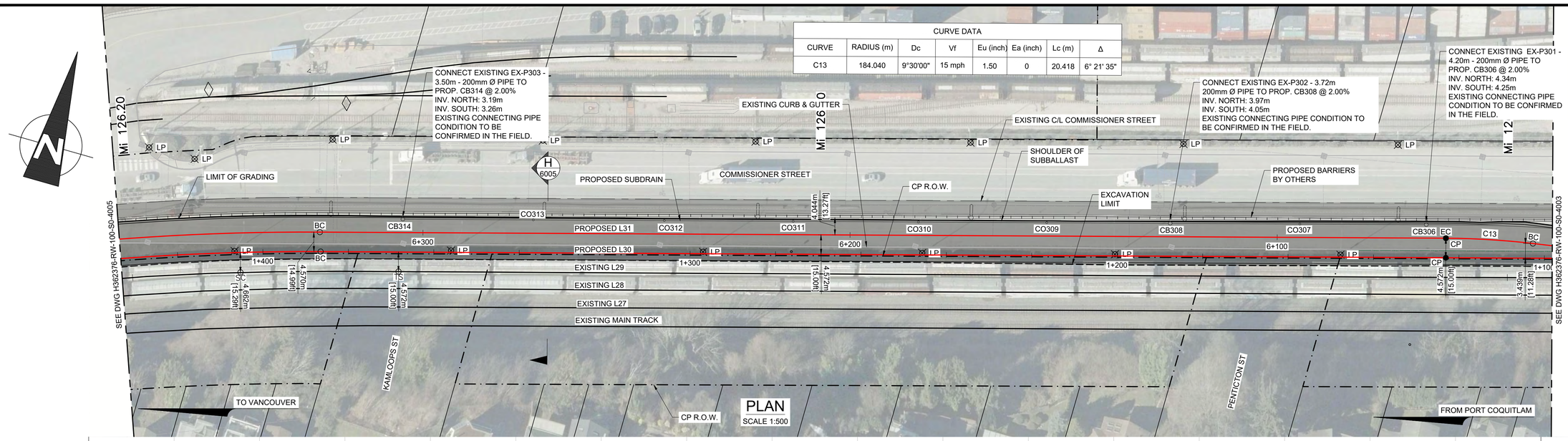
CP
ENGINEERING PROJECTS - WEST

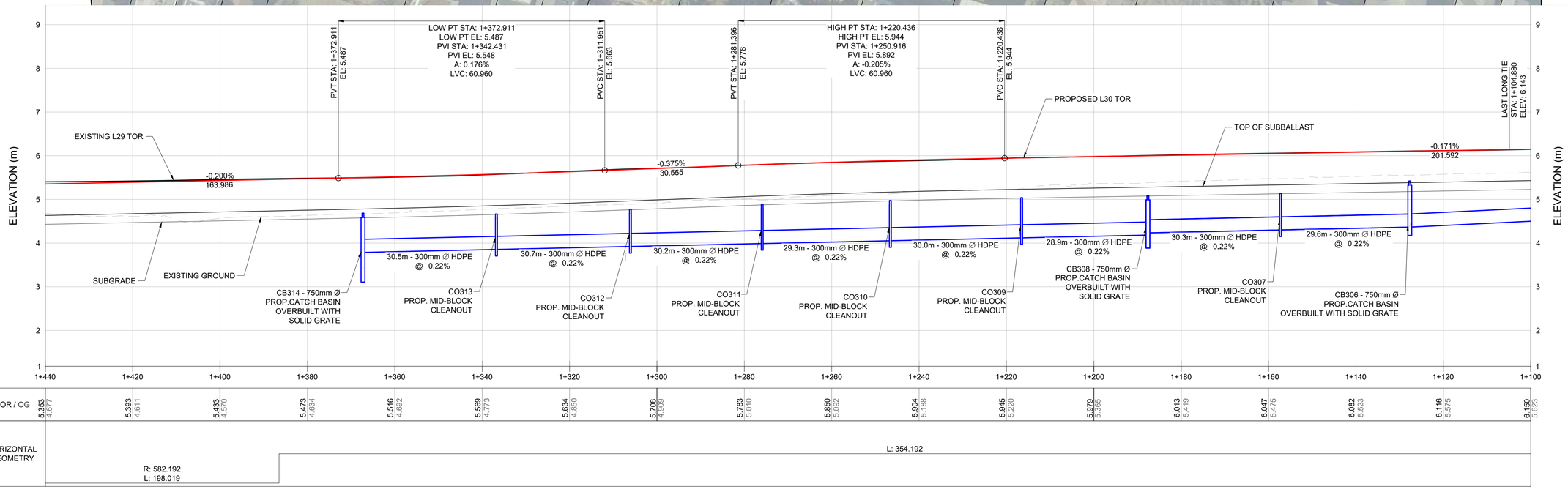
VANCOUVER DIVISION MILE 125.37 TO 127.00 CASCADE SUBDIVISION

EAST L YARD EXPANSION
RAIL - PLAN & PROFILE
TRACK L30 - STA 0+760 TO 1+100

DWG. BY:	CHK BY:	OFFICE FILE:	
		SCALE:	
MANAGER - DESIGN:		DATE:	
M.FAVREAU DIR. PROJECT SERVICES WEST		PLAN No. H362376-RW-100-S0-4003	Rev. C

Aug 03 , 2021 - 6:51pm Login name: mcke92314
Drawing Name: C:\pwworking\hi\mcke92314\d0694048\H362376-RW-100-S0-4001 to 4008.dwg





NOT FOR CONSTRUCTION

PROFILE
SCALE H 1:500
V 1:50

5 m 0 H: 1:500 25 m
0.5 m 0 V: 1:50 2.5 m

HATCH

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED

DESIGNED BY:	DRAWN BY:
F.D. DATE: 11-09-20	A.S. DATE: 11-09-20
CHECKED BY: V.C. DATE: 11-09-20	PROJECT MANAGER: I.M. DATE: 11-09-20
HATCH PROJECT No: H362376	DWG SCALE(FULL SIZE): AS SHOWN

PROFESSIONAL SEALS

THIS DRAWING WAS PREPARED FOR THE EXCLUSIVE USE OF CANADIAN PACIFIC ("CLIENT") AND IS ISSUED PURSUANT TO THE HATCH-CP ENGINEERING SERVICES AGREEMENT AND RELEVANT PURCHASE ORDER BETWEEN CLIENT AND HATCH CORPORATION ("HATCH"). UNLESS OTHERWISE AGREED IN WRITING WITH CLIENT OR SPECIFIED ON THIS DRAWING, (A) HATCH DOES NOT ACCEPT AND DISCLAIMS ANY AND ALL LIABILITY OR RESPONSIBILITY ARISING FROM ANY USE OF OR RELIANCE ON THIS DRAWING BY ANY THIRD PARTY OR ANY MODIFICATION OR MISUSE OF THIS DRAWING BY CLIENT, AND (B) THIS DRAWING IS CONFIDENTIAL AND ALL INTELLECTUAL PROPERTY RIGHTS EMBODIED OR REFERENCED IN THIS DRAWING REMAIN THE PROPERTY OF HATCH.

No.	DATE	REVISION	BY
C	03-08-21	ISSUED FOR 90% DESIGN	F.D.
B	31-05-21	REISSUED FOR 30% DESIGN	F.D.
A	11-09-20	ISSUED FOR 30% DESIGN	L.C.

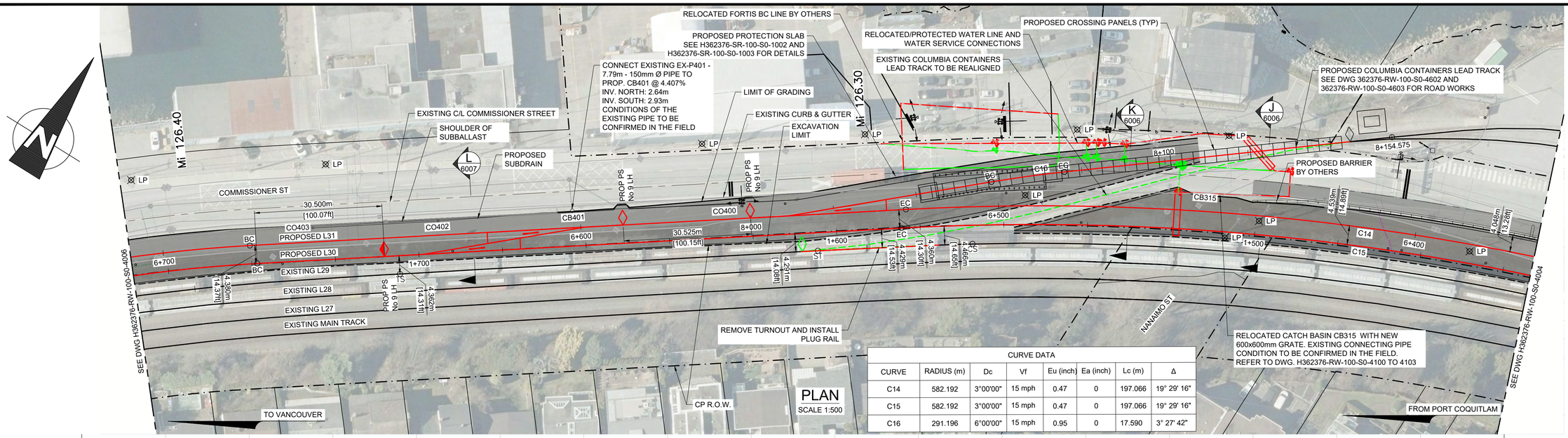
CP
ENGINEERING PROJECTS - WEST

VANCOUVER DIVISION MILE 125.37 TO 127.00 CASCADE SUBDIVISION

EAST L YARD EXPANSION
RAIL - PLAN & PROFILE
TRACK L30 - STA 1+100 TO 1+440

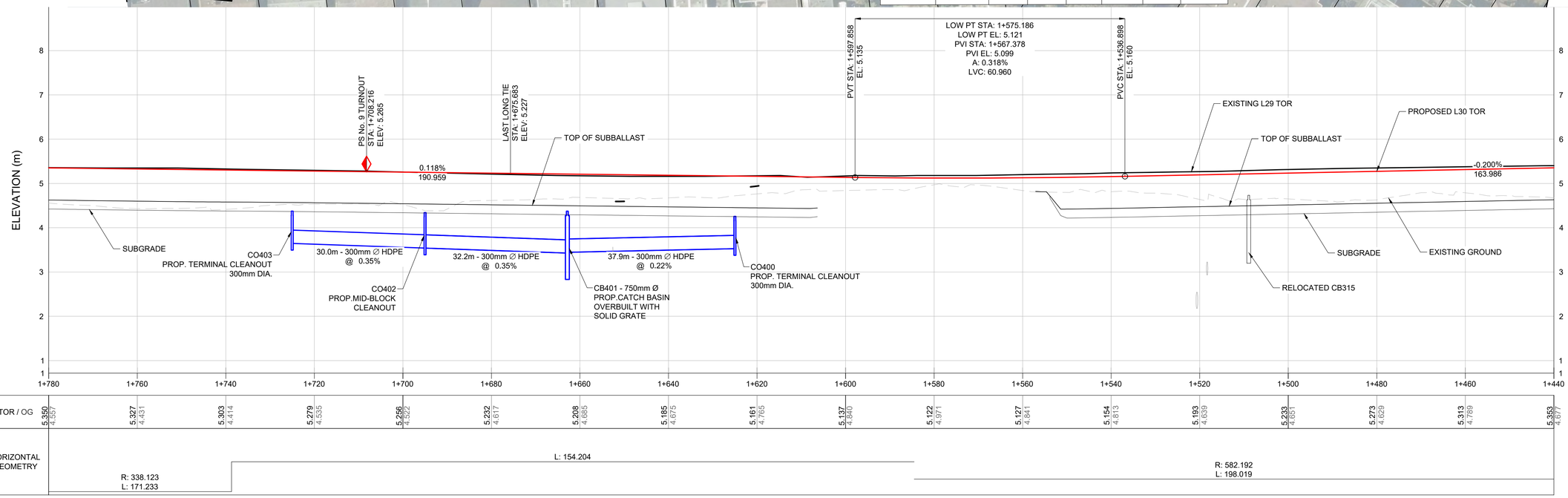
DWG. BY:	CHK BY:	OFFICE FILE:	
		SCALE:	
MANAGER - DESIGN:		DATE:	
M.FAVREAU DIR. PROJECT SERVICES WEST		PLAN No. H362376-RW-100-S0-4004	Rev. C

Aug 03 , 2021 , 5:01pm Login name: shob11128
Drawing Name: C:\pwworking\h\\pasha.shobeiri@hatch.com\d0694048\H362376-RW-100-S0-4001 to 4008.dwg



PLAN
SCALE 1:500

CURVE DATA							
CURVE	RADIUS (m)	Dc	Vf	Eu (inch)	Ea (inch)	Lc (m)	Δ
C14	582.192	3°00'00"	15 mph	0.47	0	197.066	19° 29' 16"
C15	582.192	3°00'00"	15 mph	0.47	0	197.066	19° 29' 16"
C16	291.196	6°00'00"	15 mph	0.95	0	17.590	3° 27' 42"



PROFILE
SCALE H 1:500
V 1:50

5 m 0 H: 1:500 25 m
0.5 m 0 V: 1:50 2.5 m

NOT FOR CONSTRUCTION

HATCH

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES
UNLESS OTHERWISE NOTED

DESIGNED BY: **F.D.** DATE: 11-09-20	DRAWN BY: **A.S.** DATE: **11-09-20**
CHECKED BY: **V.C.** DATE: **11-09-20**	PROJECT MANAGER: **I.M.** DATE: **11-09-20**
HATCH PROJECT No: **H362376**	DWG SCALE(FULL SIZE): **AS SHOWN**

PROFESSIONAL SEALS

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C	03-08-21	ISSUED FOR 90% DESIGN	F.D.
B	31-05-21	REISSUED FOR 30% DESIGN	F.D.
A	11-09-20	ISSUED FOR 30% DESIGN	L.C.

ENGINEERING PROJECTS - WEST

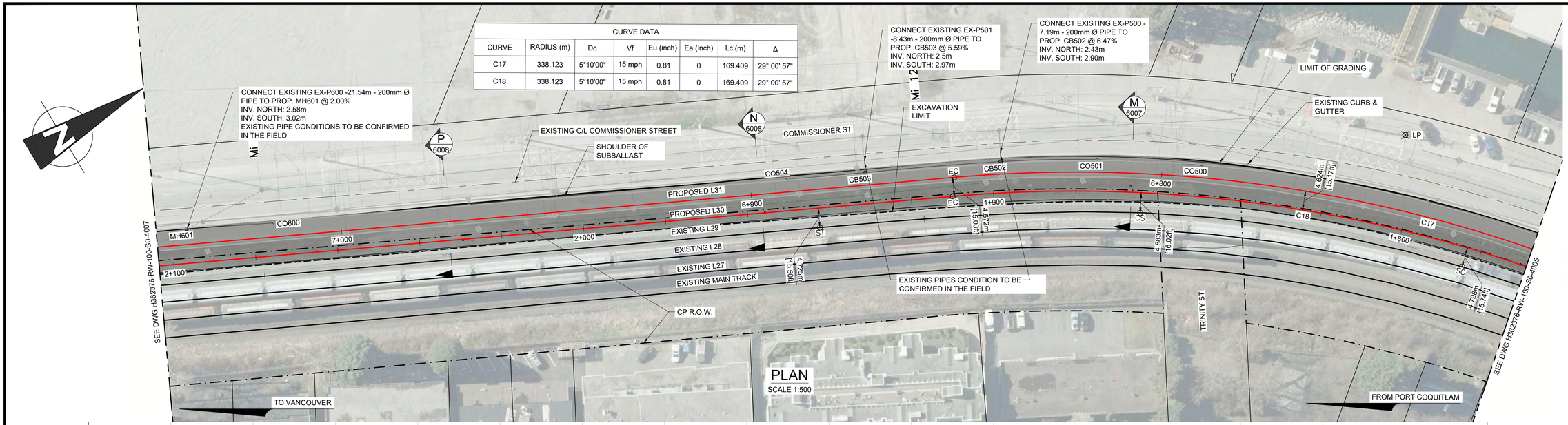
VANCOUVER DIVISION MILE 125.37 TO 127.00 CASCADE SUBDIVISION

EAST L YARD EXPANSION
RAIL - PLAN & PROFILE
TRACK L30 - STA 1+440 TO 1+780

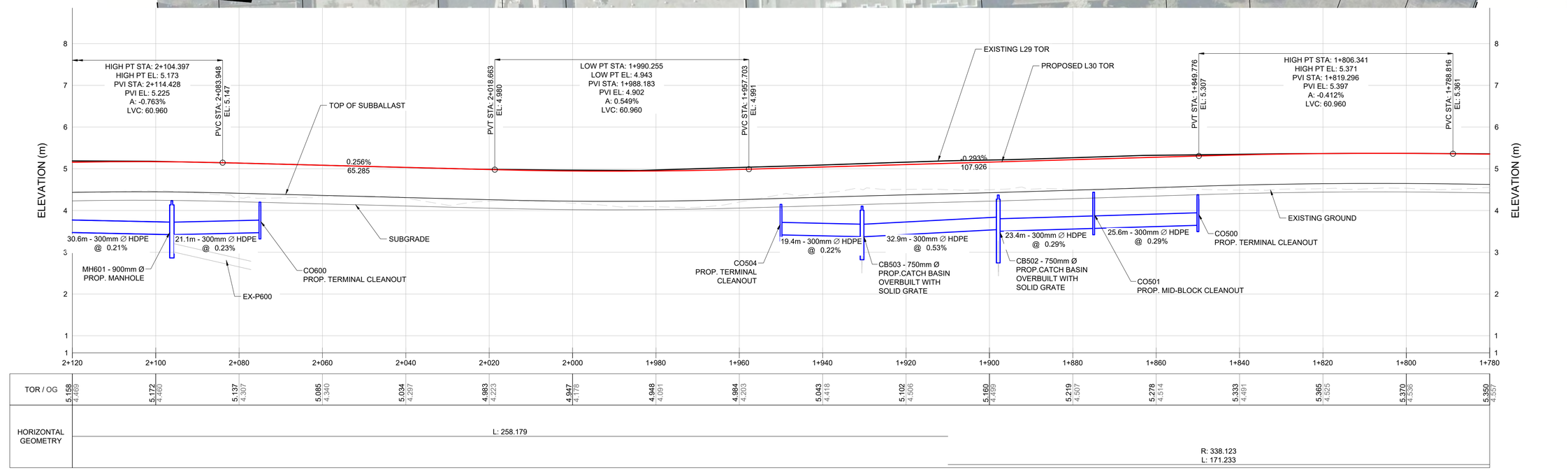
DWG. BY:	CHK BY:	OFFICE FILE:	
MANAGER - DESIGN:		SCALE:	
M.FAVREAU DIR. PROJECT SERVICES WEST		DATE:	
		PLAN No. H362376-RW-100-S0-4005	Rev. C

Aug 03 , 2021 - 6:56pm Login name: mcke92314
Drawing Name: C:\pwworking\hl\mcke92314\d0694048\l362376-RW-100-S0-4001 to 4008.dwg

CURVE DATA							
CURVE	RADIUS (m)	Dc	Vf	Eu (inch)	Ea (inch)	Lc (m)	Δ
C17	338.123	5°10'00"	15 mph	0.81	0	169.409	29° 00' 57"
C18	338.123	5°10'00"	15 mph	0.81	0	169.409	29° 00' 57"



PLAN
SCALE 1:500



PROFILE
SCALE H 1:500
V 1:50

5 m 0 H: 1:500 25 m
0.5 m 0 V: 1:50 2.5 m

NOT FOR CONSTRUCTION

HATCH

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED

DESIGNED BY:	DRAWN BY:
F.D. DATE: 11-09-20	**A.S.** DATE: **11-09-20**
CHECKED BY: **V.C.** DATE: **11-09-20**	PROJECT MANAGER: **I.M.** DATE: **11-09-20**
HATCH PROJECT No: **H362376**	DWG SCALE(FULL SIZE): **AS SHOWN**

PROFESSIONAL SEALS

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C	03-08-21	ISSUED FOR 90% DESIGN	F.D.
B	31-05-21	REISSUED FOR 30% DESIGN	F.D.
A	11-09-20	ISSUED FOR 30% DESIGN	L.C.

ENGINEERING PROJECTS - WEST

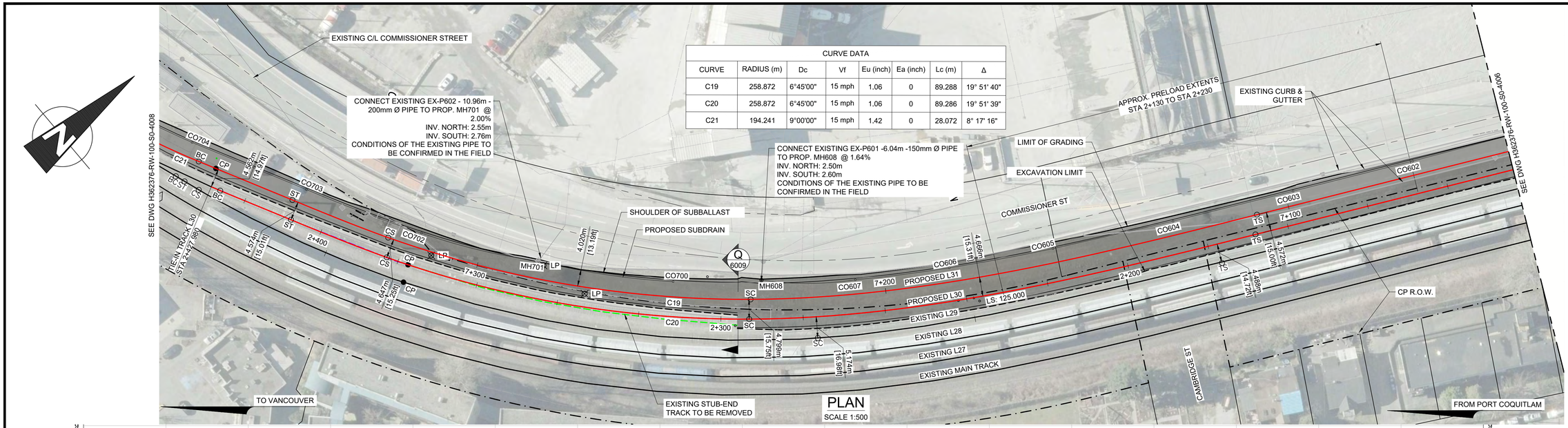
VANCOUVER DIVISION MILE 125.37 TO 127.00 CASCADE SUBDIVISION

EAST L YARD EXPANSION
RAIL - PLAN & PROFILE
TRACK L30 - STA 1+780 TO 2+120

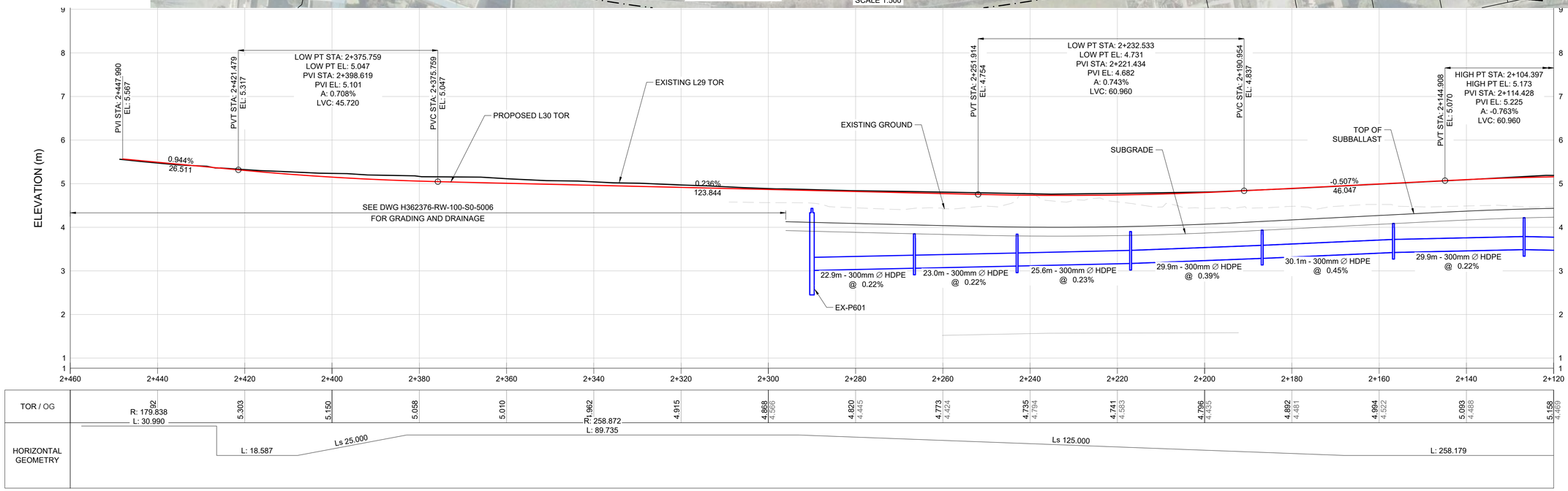
DWG. BY:	CHK BY:	OFFICE FILE:	
		SCALE:	
MANAGER - DESIGN:		DATE:	
M.FAVREAU DIR. PROJECT SERVICES WEST		PLAN No. H362376-RW-100-S0-4006	Rev. C

Aug 03 , 2021 , 5:02pm Login name: shob11128
Drawing Name: C:\pwworking\h\\posha.shobeiri@hatch.com\d0694048\H362376-RW-100-S0-4001 to 4008.dwg

CURVE DATA							
CURVE	RADIUS (m)	Dc	Vf	Eu (inch)	Ea (inch)	Lc (m)	Δ
C19	258.872	6°45'00"	15 mph	1.06	0	89.288	19° 51' 40"
C20	258.872	6°45'00"	15 mph	1.06	0	89.286	19° 51' 39"
C21	194.241	9°00'00"	15 mph	1.42	0	28.072	8° 17' 16"



PLAN
SCALE 1:500



PROFILE
SCALE H 1:500
V 1:50

5 m 0 H: 1:500 25 m
0.5 m 0 V: 1:50 2.5 m

NOT FOR CONSTRUCTION

HATCH

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED

DESIGNED BY: **F.D.** DATE: 11-09-20	DRAWN BY: **A.S.** DATE: **11-09-20**
CHECKED BY: **V.C.** DATE: **11-09-20**	PROJECT MANAGER: **I.M.** DATE: **11-09-20**
HATCH PROJECT No: **H362376**	DWG SCALE(FULL SIZE): **AS SHOWN**

PROFESSIONAL SEALS

THIS DRAWING WAS PREPARED FOR THE EXCLUSIVE USE OF CANADIAN PACIFIC ("CLIENT") AND IS ISSUED PURSUANT TO THE HATCH-CP ENGINEERING SERVICES AGREEMENT AND RELEVANT PURCHASE ORDER BETWEEN CLIENT AND HATCH CORPORATION ("HATCH"). UNLESS OTHERWISE AGREED IN WRITING WITH CLIENT OR SPECIFIED ON THIS DRAWING, (A) HATCH DOES NOT ACCEPT AND DISCLAIMS ANY AND ALL LIABILITY OR RESPONSIBILITY ARISING FROM ANY USE OF OR RELIANCE ON THIS DRAWING BY ANY THIRD PARTY OR ANY MODIFICATION OR MISUSE OF THIS DRAWING BY CLIENT, AND (B) THIS DRAWING IS CONFIDENTIAL AND ALL INTELLECTUAL PROPERTY RIGHTS EMBODIED OR REFERENCED IN THIS DRAWING REMAIN THE PROPERTY OF HATCH.

No.	DATE	REVISION	BY
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B	31-05-21	REISSUED FOR 30% DESIGN	F.D.
A	11-09-20	ISSUED FOR 30% DESIGN	L.C.

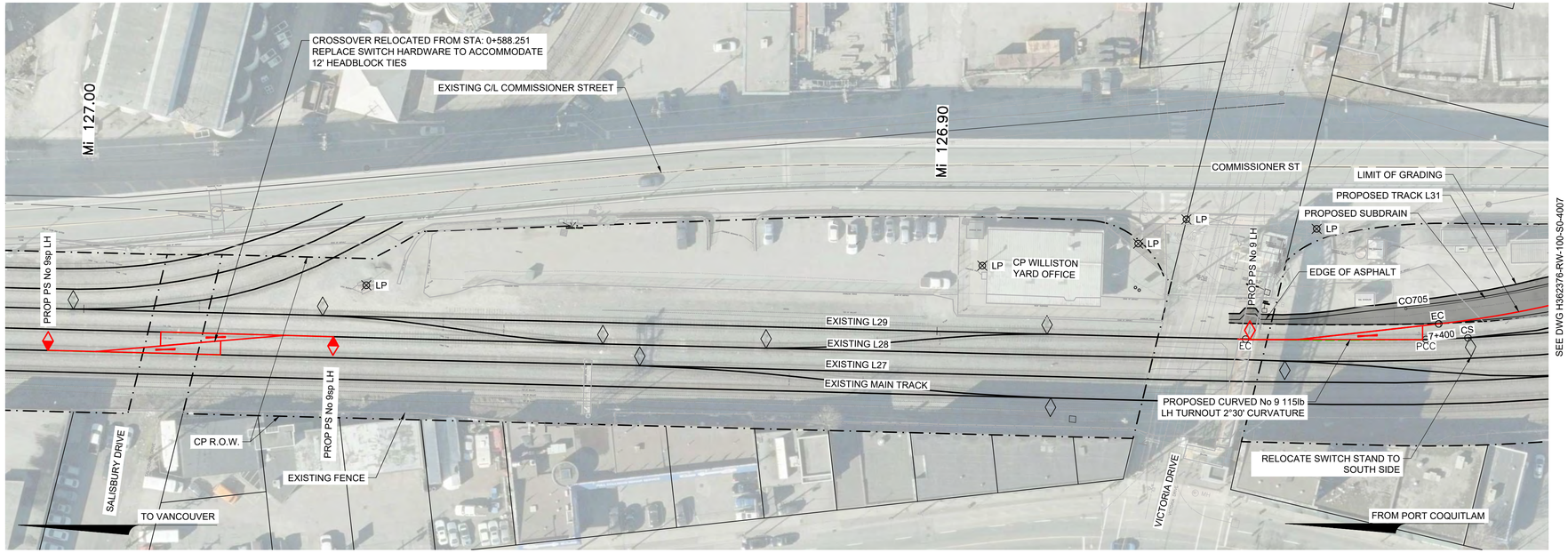
CP
ENGINEERING PROJECTS - WEST

VANCOUVER DIVISION MILE 125.37 TO 127.00 CASCADE SUBDIVISION

EAST L YARD EXPANSION
RAIL - PLAN & PROFILE
TRACK L30 - STA 2+120 TO 2+460

DWG. BY: CHK BY:	OFFICE FILE:
	SCALE:
MANAGER - DESIGN:	DATE:
M.FAVREAU DIR. PROJECT SERVICES WEST	PLAN No. H362376-RW-100-S0-4007 Rev. C

Aug 03 , 2021 - 5:03pm Login name: shob11128
Drawing Name: C:\pwworking\rh\posha.shober@hatch.com\d0694048\H362376-RW-100-S0-4001 to 4008.dwg



SEE DWG H362376-RW-100-S0-4007

SEE DWG H362376-RW-100-S0-5006 FOR L31 PROFILE AND DRAINAGE

PLAN

SCALE 1:500

5 m 0 1:500 25 m

NOT FOR CONSTRUCTION

HATCH

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES
UNLESS OTHERWISE NOTED

DESIGNED BY: **F.D.** DATE: 11-09-20	DRAWN BY: **A.S.** DATE: **11-09-20**
CHECKED BY: **V.C.** DATE: **11-09-20**	PROJECT MANAGER: **I.M.** DATE: **11-09-20**
HATCH PROJECT No: **H362376**	DWG SCALE(FULL SIZE): **1:500**

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A	11-09-20	ISSUED FOR 30% DESIGN	L.C.

CP

ENGINEERING PROJECTS - WEST

VANCOUVER DIVISION MILE 125.37 TO 127.00 CASCADE SUBDIVISION

EAST L YARD EXPANSION
RAIL - PLAN & PROFILE
L31 CONNECTION AND SALISBURY DRIVE CROSSOVER

DWG. BY: CHK BY:	OFFICE FILE:
MANAGER - DESIGN:	SCALE: DATE:
M.FAVREAU DIR. PROJECT SERVICES WEST	PLAN No. H362376-RW-100-S0-4008 Rev. C

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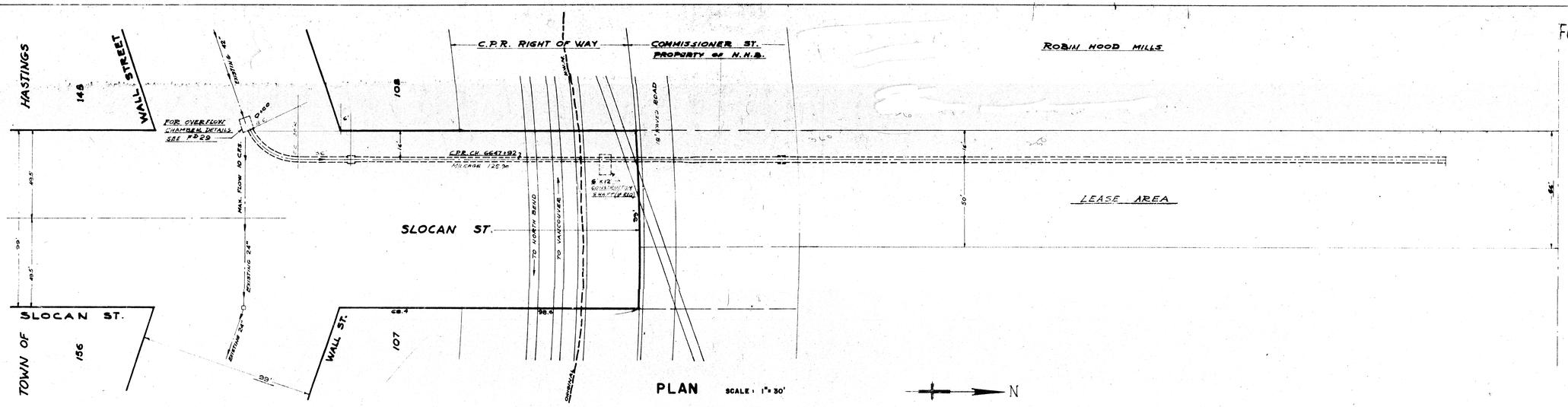
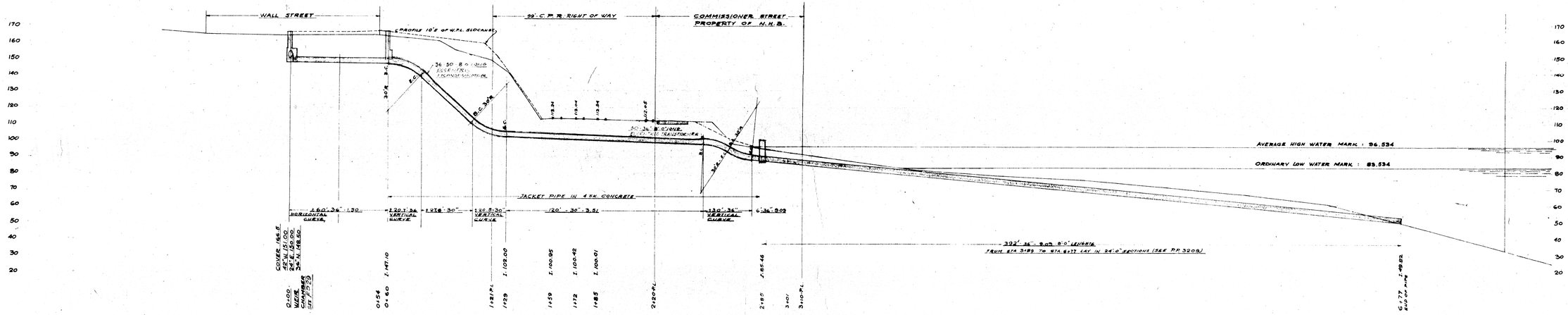
LB 152

Foreshore Plan 976





PROFILE SCALE: H. & V.: 1"=30'

NOTE
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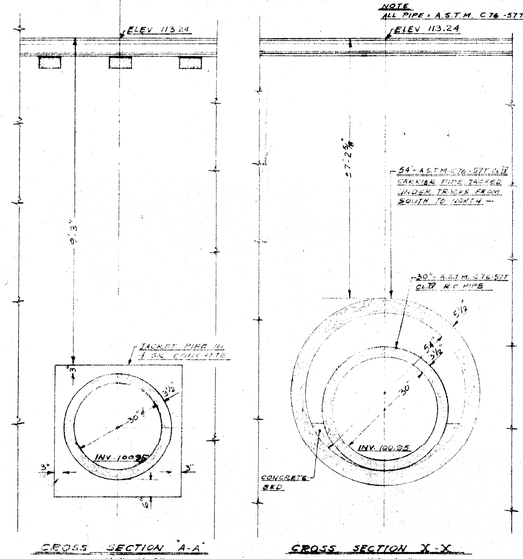
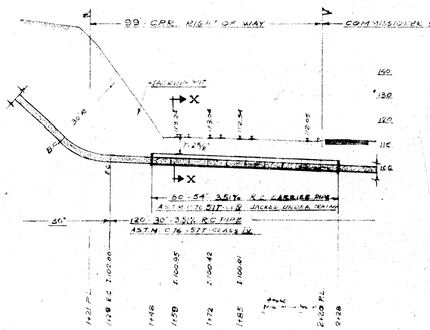


CROSS SECTION "A-A"
SCALE 1/8"=1'-0"

CROSS SECTION X-X
SCALE 1/8"=1'-0"



ALTERNATIVE C.P.R. RIGHT OF WAY CROSSING

PLAN TO ACCOMPANY APPLICATION UNDER THE NAVIGABLE WATERS PROTECTION ACT

FEB. 24, 1960

Deposited Pursuant to Navigable Waters Protection Act in Land Registry Office, Vancouver, British Columbia
this 25th day of MARCH 1960
ALBERT SMITH
REGISTRAR

CERTIFIED TO BE A TRUE COPY OF PLAN 976.
Albert Smith
CLERK

REFERENCE: PP 3209, FD 29

CITY OF VANCOUVER ENGINEERING DEPT. SEWER & WATERWORKS DIVISION			
REVISIONS		PROPOSED SEWER OVERFLOW AT SLOCAN STREET VANCOUVER, B.C.	
ISSUE	DATE	BY	
1	JAN 20 1959	R.A.B.	
2	JUN 4 1959	R.A.B.	
3	AUG 6 1959	R.A.B.	
4	FEB 2 1960	R.A.B.	
5	FEB 24 1960	R.A.B.	
SCALE H&V: 1"=30'		DR. TR. CK.	No. LB 152

5-B-33-255

APPENDIX C
CPT Report (ConeTec)

PRESENTATION OF SITE INVESTIGATION RESULTS

CP East Yard Track L30

Prepared for:

Tetra Tech Canada Inc.

ConeTec Job No: 20-02-20725

Project Start Date: 30-Apr-2020
Project End Date: 30-Apr-2020
Report Date: 04-May-2020

Prepared by:

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Richmond, BC V6V1J8

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CONETEC

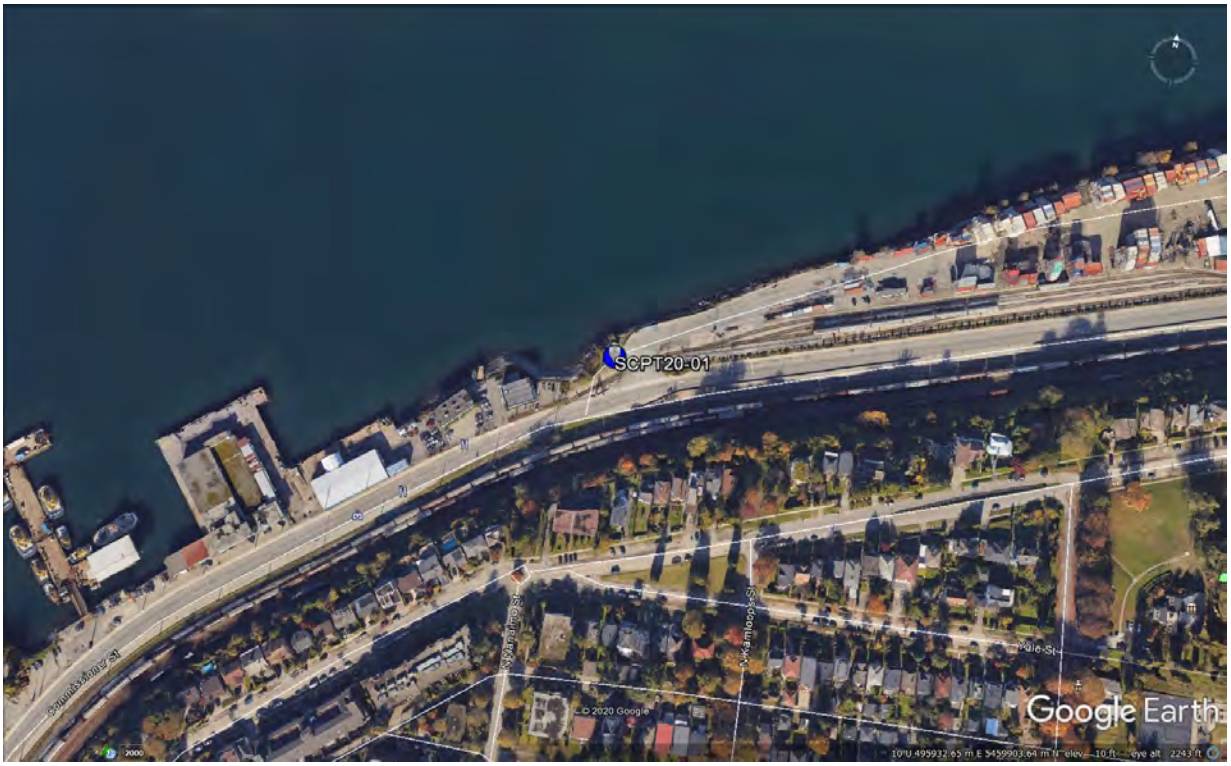
Introduction

The enclosed report presents the results of the site investigation program conducted by ConeTec Investigations Ltd. for Tetra Tech Canada Inc. near Commissioner Street, Vancouver, BC. The program consisted of one seismic cone penetration test (SCPTu).

Project Information

Project	
Client	Tetra Tech Canada Inc.
Project	CP East Yard Track L30
ConeTec project number	20-02-20725

An aerial overview from Google Earth including the SCPTu test locations is presented below.



Rig Description	Deployment System	Test Type
CPT truck rig (M7)	14 ton rig cylinder	SCPTu

Coordinates		
Test Type	Collection Method	EPSG Number
SCPTu	Consumer grade GPS	32610

Cone Penetrometers Used for this Project						
Cone Description	Cone Number	Cross Sectional Area (cm^2)	Sleeve Area (cm^2)	Tip Capacity (bar)	Sleeve Capacity (bar)	Pore Pressure Capacity (psi)
648:T1500F15U500	648	15	225	1500	15	500
Cone 648 was used for all SCPTu soundings.						

Cone Penetration Test (CPTu)	
Depth reference	Depths are referenced to the existing surface at the time of each test.
Tip and sleeve data offset	0.1 meter This has been accounted for in the CPT data files.
Additional plots	• Advanced plots with Ic, Qtn,cs, Phi, and N1(60) • Seismic velocity plots • Soil Behaviour Type (SBT) scatter plots

Calculated Geotechnical Parameter Tables	
Additional information	The Normalized Soil Behaviour Type Chart based on Q_{tn} (SBT Q_{tn}) (Robertson, 2009) was used to classify the soil for this project. A detailed set of calculated CPTu parameters have been generated and are provided in Excel format files in the release folder. The CPTu parameter calculations are based on values of corrected tip resistance (q_t) sleeve friction (f_s) and pore pressure (u_2). Effective stresses are calculated based on unit weights that have been assigned to the individual soil behaviour type zones and the assumed equilibrium pore pressure profile. Soils were classified as either drained or undrained based on the Q_{tn} Normalized Soil Behaviour Type Chart (Robertson, 2009). Calculations for both drained and undrained parameters were included for materials that classified as silt mixtures (zone 4).

Limitations

This report has been prepared for the exclusive use of Tetra Tech Canada Inc. (Client) for the project titled "CP East Yard Track L30". The report's contents may not be relied upon by any other party without the express written permission of ConeTec Investigations Ltd. (ConeTec). ConeTec has provided site investigation services, prepared the factual data reporting and provided geotechnical parameter calculations consistent with current best practices. No other warranty, expressed or implied, is made.

The information presented in the report document and the accompanying data set pertain to the specific project, site conditions and objectives described to ConeTec by the Client. In order to properly understand the factual data, assumptions and calculations, reference must be made to the documents provided and their accompanying data sets, in their entirety.

Cone penetration tests (CPTu) are conducted using an integrated electronic piezocone penetrometer and data acquisition system manufactured by Adara Systems Ltd., a subsidiary of ConeTec.

ConeTec's piezocone penetrometers are compression type designs in which the tip and friction sleeve load cells are independent and have separate load capacities. The piezocones use strain gauged load cells for tip and sleeve friction and a strain gauged diaphragm type transducer for recording pore pressure. The piezocones also have a platinum resistive temperature device (RTD) for monitoring the temperature of the sensors, an accelerometer type dual axis inclinometer and a geophone sensor for recording seismic signals. All signals are amplified down hole within the cone body and the analog signals are sent to the surface through a shielded cable.

ConeTec penetrometers are manufactured with various tip, friction and pore pressure capacities in 5 cm^2, 10 cm^2 and 15 cm^2 tip base area configurations in order to maximize signal resolution for various soil conditions. The specific piezocone used for each test is described in the CPT summary table presented in the first appendix. The 15 cm^2 penetrometers do not require friction reducers as they have a diameter larger than the deployment rods. The 10 cm^2 piezocones use a friction reducer consisting of a rod adapter extension behind the main cone body with an enlarged cross-sectional area (typically forty-four millimeter diameter over a length of thirty-two millimeter with tapered leading and trailing edges) located at a distance of 585 millimeters above the cone tip.

The penetrometers are designed with equal end area friction sleeves, a net end area ratio of 0.8 and cone tips with a sixty-degree apex angle.

All ConeTec piezocones can record pore pressure at various locations. Unless otherwise noted, the pore pressure filter is located directly behind the cone tip in the "u_2" position (ASTM Type 2). The filter is six millimeters thick, made of porous plastic (polyethylene) having an average pore size of 125 microns (90-160 microns). The function of the filter is to allow rapid movements of extremely small volumes of water needed to activate the pressure transducer while preventing soil ingress or blockage.

The piezocone penetrometers are manufactured with dimensions, tolerances and sensor characteristics that are in general accordance with the current ASTM D5778 standard. ConeTec's calibration criteria also meets or exceeds those of the current ASTM D5778 standard. An illustration of the piezocone penetrometer is presented in Figure CPTu.

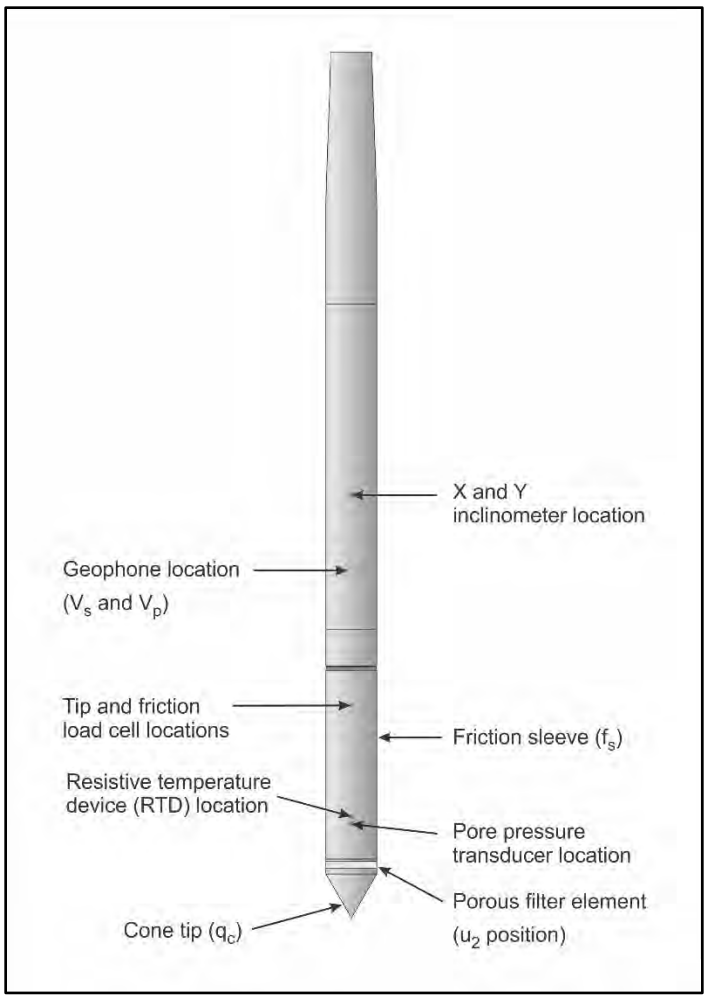


Figure CPTu. Piezocone Penetrometer (15 cm^2)

The ConeTec data acquisition systems consist of a Windows based computer and a signal conditioner and power supply interface box with a sixteen bit (or greater) analog to digital (A/D) converter. The data is recorded at fixed depth increments using a depth wheel attached to the push cylinders or by using a spring loaded rubber depth wheel that is held against the cone rods. The typical recording interval is 2.5 centimeters; custom recording intervals are possible. The system displays the CPTu data in real time and records the following parameters to a storage media during penetration:

- Depth
- Uncorrected tip resistance (q_c)
- Sleeve friction (f_s)
- Dynamic pore pressure (u)
- Additional sensors such as resistivity, passive gamma, ultra violet induced fluorescence, if applicable

All testing is performed in accordance to ConeTec's CPT operating procedures which are in general accordance with the current ASTM D5778 standard.

Prior to the start of a CPTu sounding a suitable cone is selected, the cone and data acquisition system are powered on, the pore pressure system is saturated with silicone oil and the baseline readings are recorded with the cone hanging freely in a vertical position.

The CPTu is conducted at a steady rate of two centimeters per second, within acceptable tolerances. Typically, one-meter length rods with an outer diameter of 38.1 millimeters are added to advance the cone to the sounding termination depth. After cone retraction final baselines are recorded.

Additional information pertaining to ConeTec's cone penetration testing procedures:

- Each filter is saturated in silicone oil under vacuum pressure prior to use
- Recorded baselines are checked with an independent multi-meter
- Baseline readings are compared to previous readings
- Soundings are terminated at the client's target depth or at a depth where an obstruction is encountered, excessive rod flex occurs, excessive inclination occurs, equipment damage is likely to take place, or a dangerous working environment arises
- Differences between initial and final baselines are calculated to ensure zero load offsets have not occurred and to ensure compliance with ASTM standards

The interpretation of piezocone data for this report is based on the corrected tip resistance (q_t), sleeve friction (f_s) and pore water pressure (u). The interpretation of soil type is based on the correlations developed by Robertson et al. (1986) and Robertson (1990, 2009). It should be noted that it is not always possible to accurately identify a soil behaviour type based on these parameters. In these situations, experience, judgment and an assessment of other parameters may be used to infer soil behaviour type.

The recorded tip resistance (q_c) is the total force acting on the piezocone tip divided by its base area. The tip resistance is corrected for pore pressure effects and termed corrected tip resistance (q_t) according to the following expression presented in Robertson et al. (1986):

$$q_t = q_c + (1\text{-}a) \bullet u_2$$

where: q_t is the corrected tip resistance
q_c is the recorded tip resistance
u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)
a is the Net Area Ratio for the piezocone (0.8 for ConeTec probes)

The sleeve friction (f_s) is the frictional force on the sleeve divided by its surface area. As all ConeTec piezocones have equal end area friction sleeves, pore pressure corrections to the sleeve data are not required.

The dynamic pore pressure (u) is a measure of the pore pressures generated during cone penetration. To record equilibrium pore pressure, the penetration must be stopped to allow the dynamic pore pressures to stabilize. The rate at which this occurs is predominantly a function of the permeability of the soil and the diameter of the cone.

The friction ratio (Rf) is a calculated parameter. It is defined as the ratio of sleeve friction to the tip resistance expressed as a percentage. Generally, saturated cohesive soils have low tip resistance, high friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

A summary of the CPTu soundings along with test details and individual plots are provided in the appendices. A set of files with calculated geotechnical parameters were generated for each sounding based on published correlations and are provided in Excel format in the data release folder. Information regarding the methods used is also included in the data release folder.

For additional information on CPTu interpretations and calculated geotechnical parameters, refer to Robertson et al. (1986), Lunne et al. (1997), Robertson (2009), Mayne (2013, 2014) and Mayne and Peuchen (2012).

References

ASTM D5778-12, 2012, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils", ASTM International, West Conshohocken, PA. DOI: 10.1520/D5778-12.

Lunne, T., Robertson, P.K. and Powell, J. J. M., 1997, “Cone Penetration Testing in Geotechnical Practice”, Blackie Academic and Professional.

Mayne, P.W., 2013, “Evaluating yield stress of soils from laboratory consolidation and in-situ cone penetration tests”, Sound Geotechnical Research to Practice (Holtz Volume) GSP 230, ASCE, Reston/VA: 406-420. DOI: 10.1061/9780784412770.027.

Mayne, P.W. and Peuchen, J., 2012, “Unit weight trends with cone resistance in soft to firm clays”, Geotechnical and Geophysical Site Characterization *4,* Vol. 1 (Proc. ISC-4, Pernambuco), CRC Press, London: 903-910.

Mayne, P.W., 2014, “Interpretation of geotechnical parameters from seismic piezocone tests”, CPT’14 Keynote Address, Las Vegas, NV, May 2014.

Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J., 1986, “Use of Piezometer Cone Data”, Proceedings of InSitu 86, ASCE Specialty Conference, Blacksburg, Virginia.

Robertson, P.K., 1990, “Soil Classification Using the Cone Penetration Test”, Canadian Geotechnical Journal, Volume 27: 151-158. DOI: 10.1139/T90-014.

Robertson, P.K., 2009, “Interpretation of cone penetration tests – a unified approach”, Canadian Geotechnical Journal, Volume 46: 1337-1355. DOI: 10.1139/T09-065.

Shear wave velocity (Vs) testing is performed in conjunction with the piezocone penetration test (SCPTu) in order to collect interval velocities. For some projects seismic compression wave velocity (Vp) testing is also performed.

ConeTec's piezocone penetrometers are manufactured with a horizontally active geophone (28 hertz) that is rigidly mounted in the body of the cone penetrometer, 0.2 meters behind the cone tip.

Shear waves are typically generated by using an impact hammer horizontally striking a beam that is held in place by a normal load. In some instances, an auger source or an imbedded impulsive source may be used for both shear waves and compression waves. The hammer and beam act as a contact trigger that initiates the recording of the seismic wave traces. For impulsive devices an accelerometer trigger may be used. The traces are recorded using an uphole integrated digital oscilloscope which is part of the SCPTu data acquisition system. An illustration of the shear wave testing configuration is presented in Figure SCPTu-1.

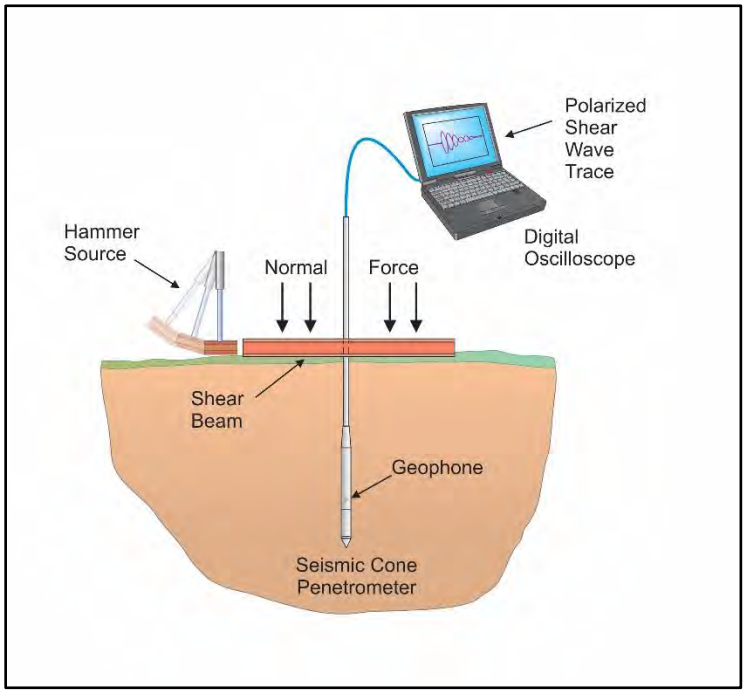


Figure SCPTu-1. Illustration of the SCPTu system

All testing is performed in accordance to ConeTec's SCPTu operating procedures which are in general accordance with the current ASTM D5778 and ASTM D7400 standards.

Prior to the start of a SCPTu sounding, the procedures described in the Cone Penetration Test section are followed. In addition, the active axis of the geophone is aligned parallel to the beam (or source) and the horizontal offset between the cone and the source is measured and recorded.

Prior to recording seismic waves at each test depth, cone penetration is stopped and the rods are decoupled from the rig to avoid transmission of rig energy down the rods. Typically, five wave traces for each orientation are recorded for quality control and uncertainty analysis purposes. After reviewing wave traces for consistency the cone is pushed to the next test depth (typically one meter intervals or as requested by the client). Figure SCPTu-2 presents an illustration of a SCPTu test.

For additional information on seismic cone penetration testing refer to Robertson et al. (1986).

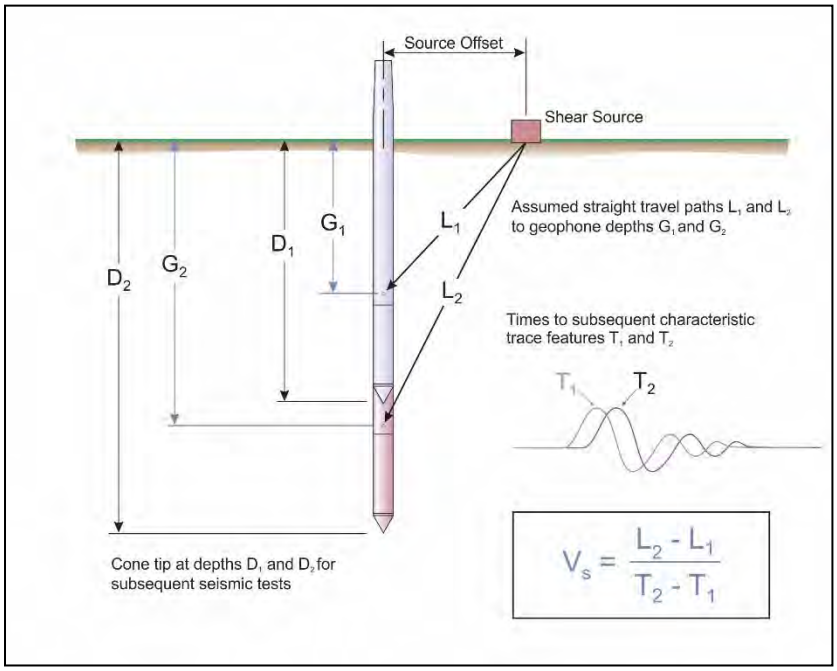


Figure SCPTu-2. Illustration of a seismic cone penetration test

Calculation of the interval velocities are performed by visually picking a common feature (e.g. the first characteristic peak, trough, or crossover) on all of the recorded wave sets and taking the difference in ray path divided by the time difference between subsequent features. Ray path is defined as the straight line distance from the seismic source to the geophone, accounting for beam offset, source depth and geophone offset from the cone tip.

The average shear wave velocity to a depth of thirty meters (V_{s30}) has been calculated and provided for all applicable soundings using an equation presented in Crow et al. (2012).

$$V_{s30} = \frac{\text{total thickness of all layers (30m)}}{\sum(\text{layer traveltimes})}$$

The layer travel times refers to the travel times propagating in the vertical direction, not the measured travel times from an offset source.

Tabular results and SCPTu plots are presented in the relevant appendix.

References

ASTM D5778-12, 2012, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils", ASTM International, West Conshohocken, PA. DOI: 10.1520/D5778-12.

ASTM D7400/D7400M-19, 2019, "Standard Test Methods for Downhole Seismic Testing", ASTM International, West Conshohocken, PA. DOI: 10.1520/D7400_D7400M-19.

Crow, H.L., Hunter, J.A., Bobrowsky, P.T., 2012, “National shear wave measurement guidelines for Canadian seismic site assessment”, GeoManitoba 2012, Sept 30 to Oct 2, Winnipeg, Manitoba.

Robertson, P.K., Campanella, R.G., Gillespie D and Rice, A., 1986, “Seismic CPT to Measure In-Situ Shear Wave Velocity”, Journal of Geotechnical Engineering ASCE, Vol. 112, No. 8: 791-803. DOI: 10.1061/(ASCE)0733-9410(1986)112:8(791).

The cone penetration test is halted at specific depths to carry out pore pressure dissipation (PPD) tests, shown in Figure PPD-1. For each dissipation test the cone and rods are decoupled from the rig and the data acquisition system measures and records the variation of the pore pressure (u) with time (t).

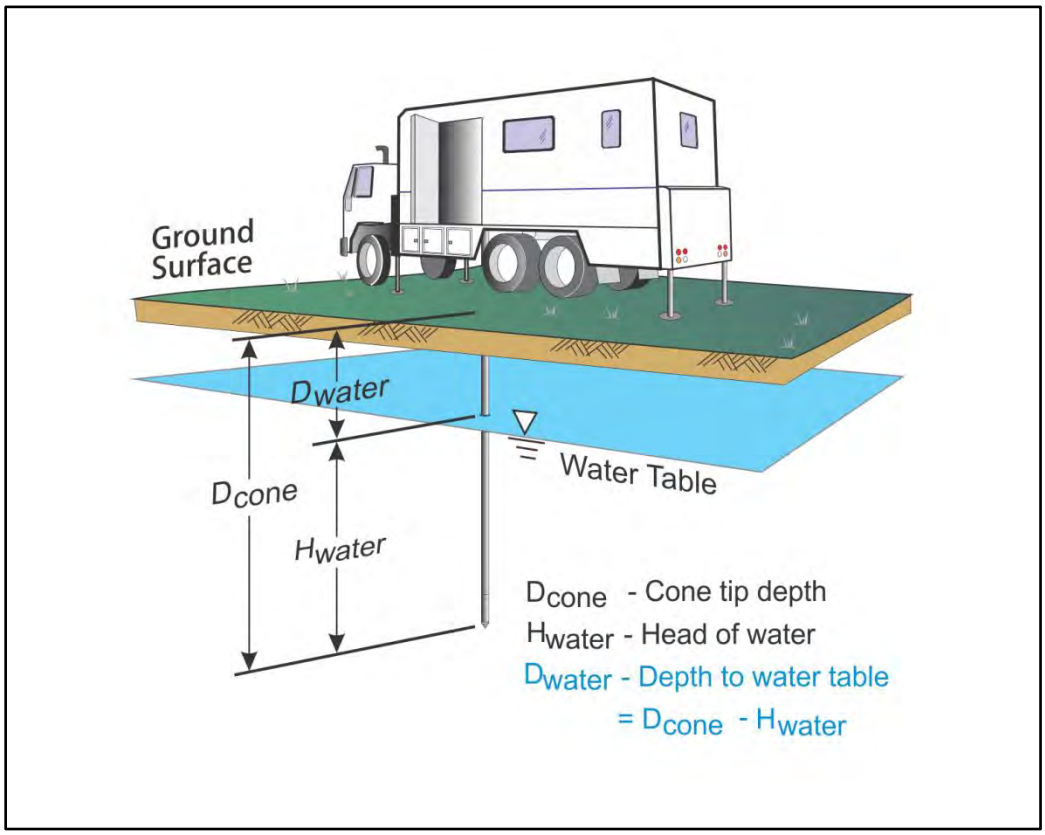


Figure PPD-1. Pore pressure dissipation test setup

Pore pressure dissipation data can be interpreted to provide estimates of ground water conditions, permeability, consolidation characteristics and soil behaviour.

The typical shapes of dissipation curves shown in Figure PPD-2 are very useful in assessing soil type, drainage, in situ pore pressure and soil properties. A flat curve that stabilizes quickly is typical of a freely draining sand. Undrained soils such as clays will typically show positive excess pore pressure and have long dissipation times. Dilative soils will often exhibit dynamic pore pressures below equilibrium that then rise over time. Overconsolidated fine-grained soils will often exhibit an initial dilatory response where there is an initial rise in pore pressure before reaching a peak and dissipating.

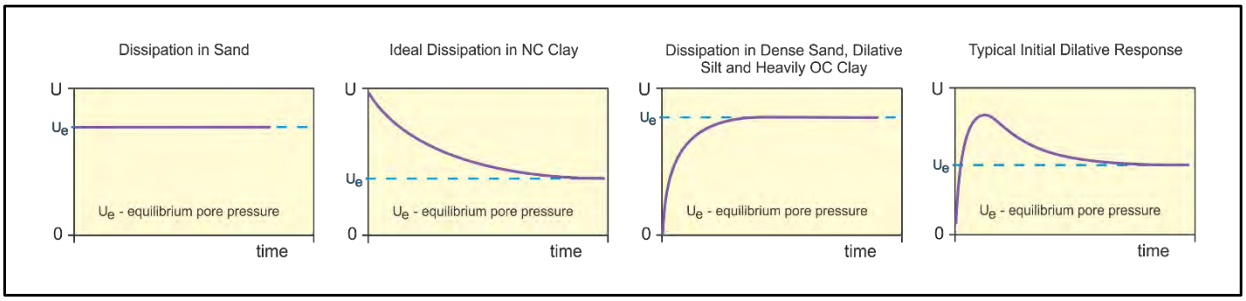


Figure PPD-2. Pore pressure dissipation curve examples

In order to interpret the equilibrium pore pressure (u_{eq}) and the apparent phreatic surface, the pore pressure should be monitored until such time as there is no variation in pore pressure with time as shown for each curve in Figure PPD-2.

In fine grained deposits the point at which 100% of the excess pore pressure has dissipated is known as t_{100}. In some cases this can take an excessive amount of time and it may be impractical to take the dissipation to t_{100}. A theoretical analysis of pore pressure dissipations by Teh and Houlsby (1991) showed that a single curve relating degree of dissipation versus theoretical time factor (T*) may be used to calculate the coefficient of consolidation (c_h) at various degrees of dissipation resulting in the expression for c_h shown below.

$$c_h = \frac{T^* \cdot a^2 \cdot \sqrt{I_r}}{t}$$

Where:

T* is the dimensionless time factor (Table Time Factor)
a is the radius of the cone
I_r is the rigidity index
t is the time at the degree of consolidation

Table Time Factor. T* versus degree of dissipation (Teh and Houlsby (1991))

Degree of Dissipation (%)	20	30	40	50	60	70	80
T* (u_2)	0.038	0.078	0.142	0.245	0.439	0.804	1.60

The coefficient of consolidation is typically analyzed using the time (t_{50}) corresponding to a degree of dissipation of 50% (u_{50}). In order to determine t_{50}, dissipation tests must be taken to a pressure less than u_{50}. The u_{50} value is half way between the initial maximum pore pressure and the equilibrium pore pressure value, known as u_{100}. To estimate u_{50}, both the initial maximum pore pressure and u_{100} must be known or estimated. Other degrees of dissipations may be considered, particularly for extremely long dissipations.

At any specific degree of dissipation the equilibrium pore pressure (u at t_{100}) must be estimated at the depth of interest. The equilibrium value may be determined from one or more sources such as measuring the value directly (u_{100}), estimating it from other dissipations in the same profile, estimating the phreatic surface and assuming hydrostatic conditions, from nearby soundings, from client provided information, from site observations and/or past experience, or from other site instrumentation.

For calculations of c_h (Teh and Houlsby (1991)), t_{50} values are estimated from the corresponding pore pressure dissipation curve and a rigidity index (I_r) is assumed. For curves having an initial dilatory response in which an initial rise in pore pressure occurs before reaching a peak, the relative time from the peak value is used in determining t_{50}. In cases where the time to peak is excessive, t_{50} values are not calculated.

Due to possible inherent uncertainties in estimating I_r, the equilibrium pore pressure and the effect of an initial dilatory response on calculating t_{50}, other methods should be applied to confirm the results for c_h.

Additional published methods for estimating the coefficient of consolidation from a piezocone test are described in Burns and Mayne (1998, 2002), Jones and Van Zyl (1981), Robertson et al. (1992) and Sully et al. (1999).

A summary of the pore pressure dissipation tests and dissipation plots are presented in the relevant appendix.

References

Burns, S.E. and Mayne, P.W., 1998, "Monotonic and dilatory pore pressure decay during piezocone tests", Canadian Geotechnical Journal 26 (4): 1063-1073. DOI: 1063-1073/T98-062.

Burns, S.E. and Mayne, P.W., 2002, "Analytical cavity expansion-critical state model cone dissipation in fine-grained soils", Soils & Foundations, Vol. 42(2): 131-137.

Jones, G.A. and Van Zyl, D.J.A., 1981, "The piezometer probe: a useful investigation tool", Proceedings, 10th International Conference on Soil Mechanics and Foundation Engineering, Vol. 3, Stockholm: 489-495.

Robertson, P.K., Sully, J.P., Woeller, D.J., Lunne, T., Powell, J.J.M. and Gillespie, D.G., 1992, "Estimating coefficient of consolidation from piezocone tests", Canadian Geotechnical Journal, 29(4): 539-550. DOI: 10.1139/T92-061.

Sully, J.P., Robertson, P.K., Campanella, R.G. and Woeller, D.J., 1999, "An approach to evaluation of field CPTU dissipation data in overconsolidated fine-grained soils", Canadian Geotechnical Journal, 36(2): 369-381. DOI: 10.1139/T98-105.

Teh, C.I., and Houlsby, G.T., 1991, "An analytical study of the cone penetration test in clay", Geotechnique, 41(1): 17-34. DOI: 10.1680/geot.1991.41.1.17.

The appendices listed below are included in the report:

- Cone Penetration Test Summary and Standard Cone Penetration Test Plots
- Advanced Cone Penetration Test Plots
- Seismic Cone Penetration Test Plots
- Seismic Cone Penetration Test Tabular Results
- Seismic Cone Penetration Test Wave Traces
- Soil Behaviour Type (SBT) Scatter Plots
- Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots

Cone Penetration Test Summary and Standard Cone Penetration Test Plots

CONETEC

Job No:	20-02-20725
Client:	Tetra Tech Canada Inc.
Project:	CP East Yard Track L30
Start Date:	30-Apr-2020
End Date:	30-Apr-2020

CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Assumed Phreatic Surface[1] (m)	Final Depth (m)	Northing[2] (m)	Easting[2] (m)	Refer to Notation Number
SCPT20-01	20-02-20725_SP01	30-Apr-2020	638:T1500F15U500	4.0	9.000	5459920	495930	

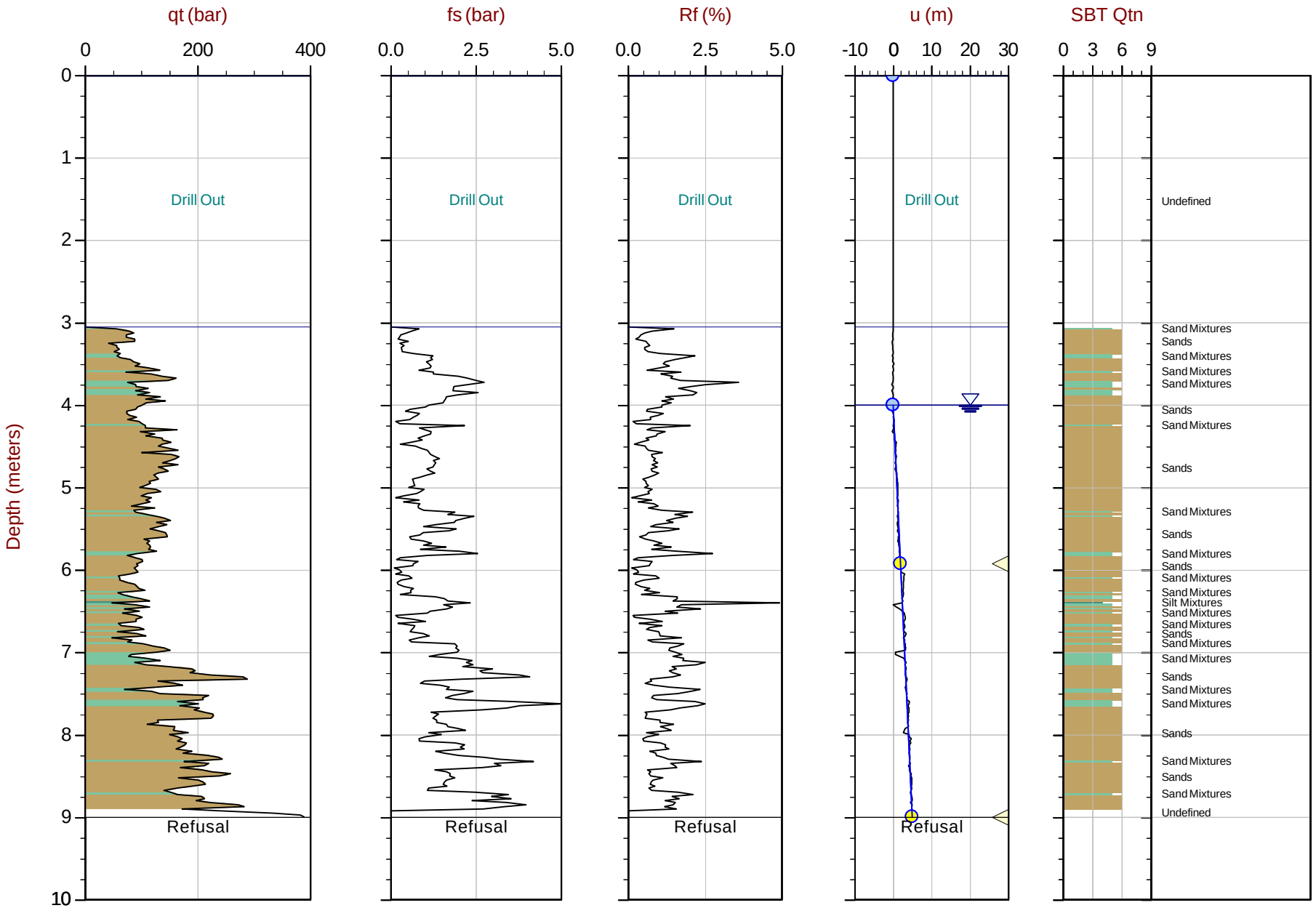
1. The assumed phreatic surface was based on pore pressure dissipation tests. Hydrostatic conditions were assumed for the calculated parameters.
2. Coordinates were collected with a consumer grade GPS device with datum WGS84/UTM Zone 10 North.

CONETEC

Tetra Tech

Job No: 20-02-20725
Date: 2020-04-30 08:40
Site: Commissioner St

Sounding: SCPT20-01
Cone: 648:T1500F15U500



Max Depth: 9.000 m / 29.53 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-02-20725_SP01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 10N N: 5459920m E: 495930m
Sheet No: 1 of 1

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

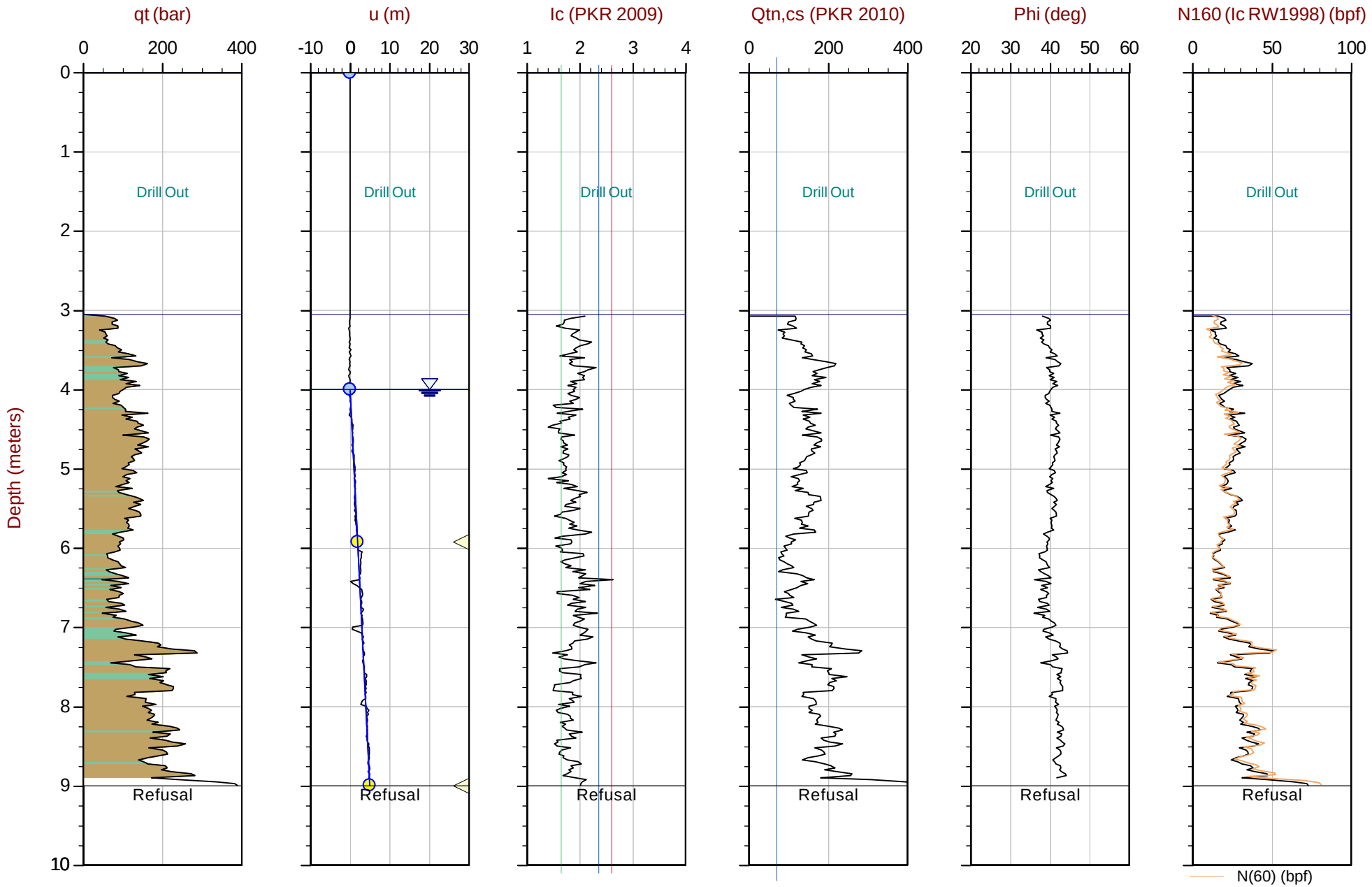
Advanced Cone Penetration Test Plots

CONETEC

Tetra Tech

Job No: 20-02-20725
Date: 2020-04-30 08:40
Site: Commissioner St

Sounding: SCPT20-01
Cone: 648:T1500F15U500



Max Depth: 9.000 m / 29.53 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-02-20725_SP01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 10N N: 5459920m E: 495930m
Sheet No: 1 of 1

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

Seismic Cone Penetration Test Plots

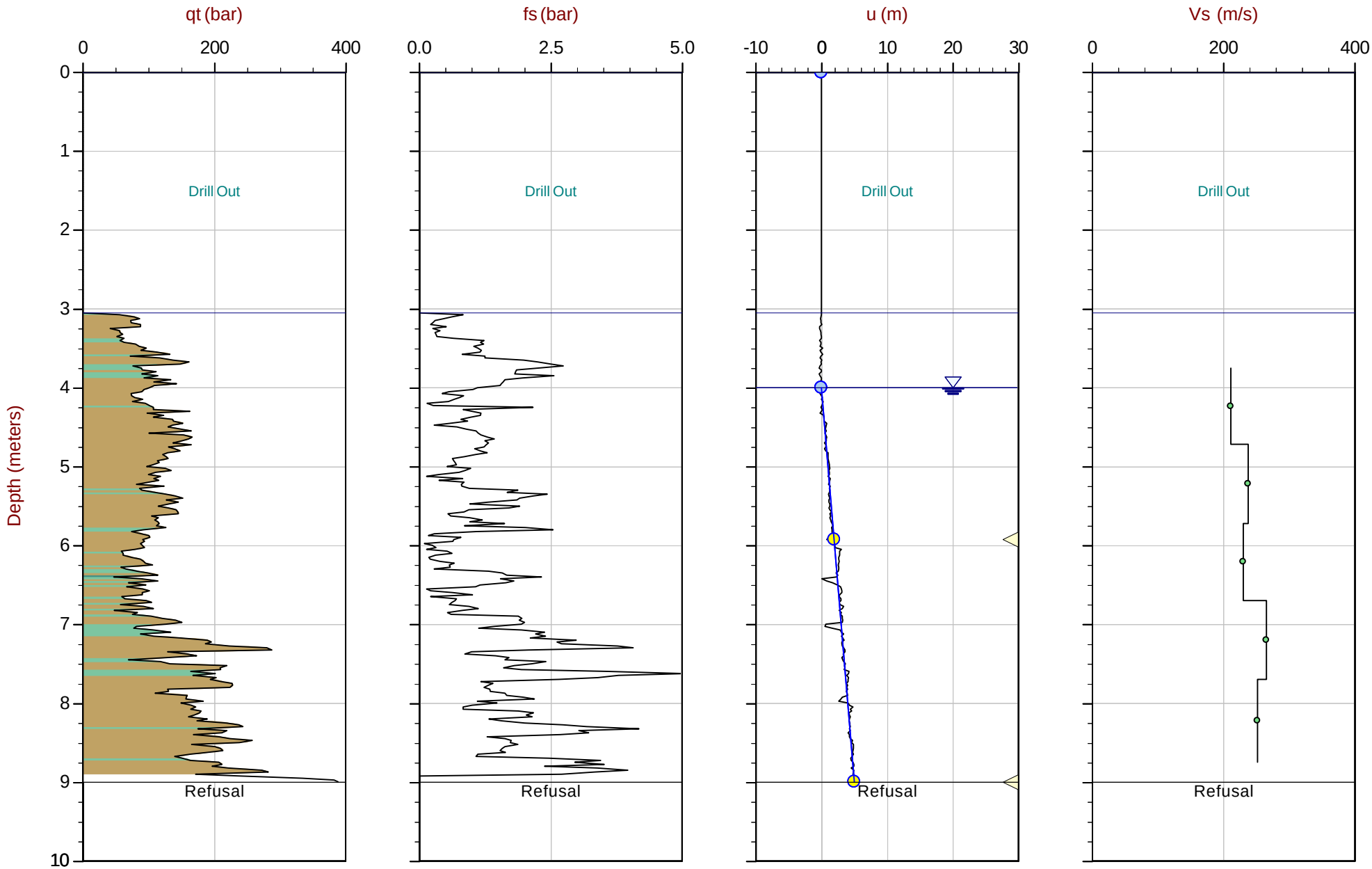
CONETEC

CONETEC

Tetra Tech

Job No: 20-02-20725
Date: 2020-04-30 08:40
Site: Commissioner St

Sounding: SCPT20-01
Cone: 648:T1500F15U500



Max Depth: 9.000 m / 29.53 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 20-02-20725_SP01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 10N N: 5459920m E: 495930m
Sheet No: 1 of 1

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

Seismic Cone Penetration Test Tabular Results

CONETEC

Job No:	20-02-20725
Client:	Tetra Tech Canada Inc.
Project:	CP East Yard Track L30
Sounding ID:	SCPT20-01
Date:	30-Apr-2020
Seismic Source:	Beam
Seismic Offset (m):	0.92
Source Depth (m):	0.00
Geophone Offset (m):	0.20

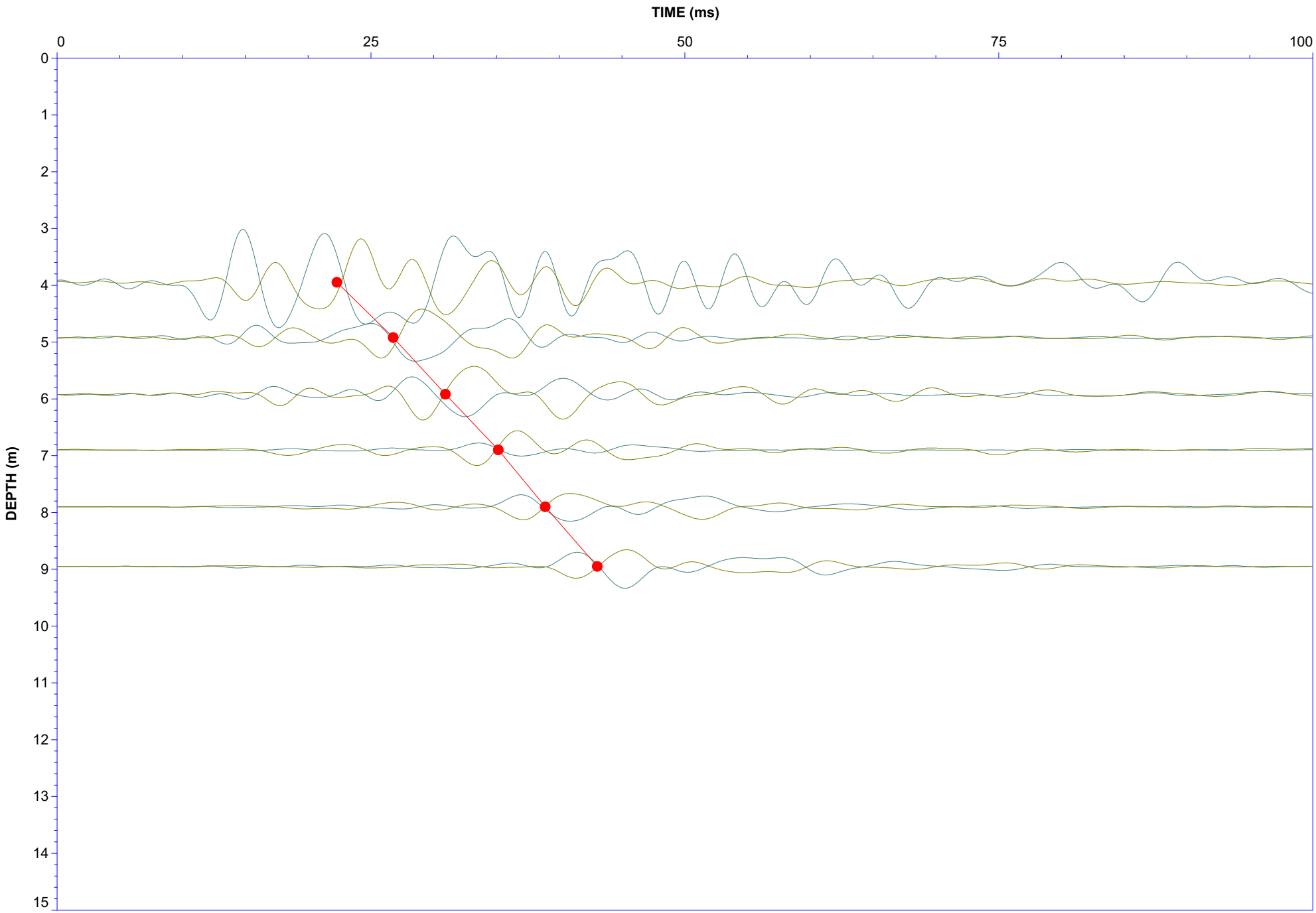
SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (m)	Geophone Depth (m)	Ray Path (m)	Ray Path Difference (m)	Travel Time Interval (ms)	Interval Velocity (m/s)
3.95	3.75	3.86			
4.92	4.72	4.81	0.95	4.49	211
5.92	5.72	5.79	0.99	4.15	238
6.90	6.70	6.76	0.97	4.21	230
7.90	7.70	7.76	0.99	3.74	265
8.95	8.75	8.80	1.04	4.14	252

Seismic Cone Penetration Test Wave Traces

CONETEC

Job No: 20-02-20725 Client: Tetra Tech Canada Inc. Project: CP East Yard Track L30 Filter: 0-300Hz Sounding: SCPT20-01
Date: 30-Apr-2020



Soil Behaviour Type (SBT) Scatter Plots

CONETEC

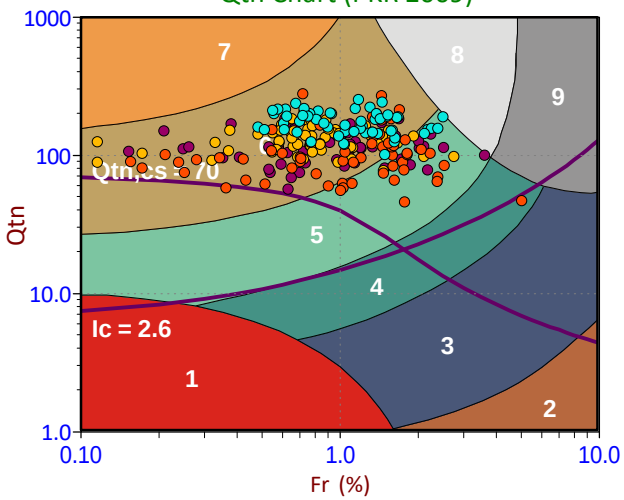
CONETEC

Tetra Tech

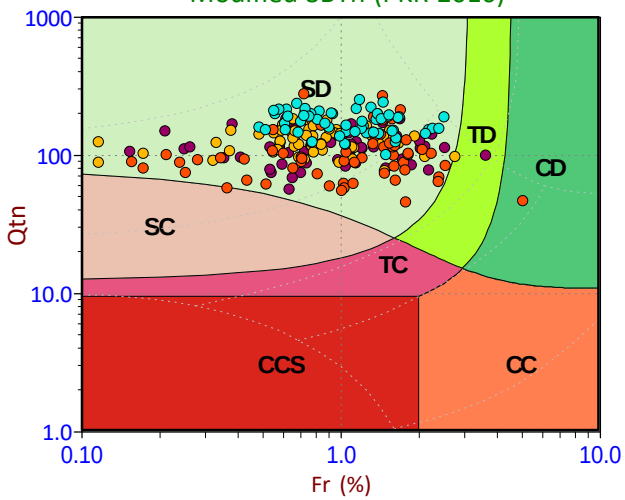
Job No: 20-02-20725
Date: 2020-04-30 08:40
Site: Commissioner St

Sounding: SCPT20-01
Cone: 648:T1500F15U500

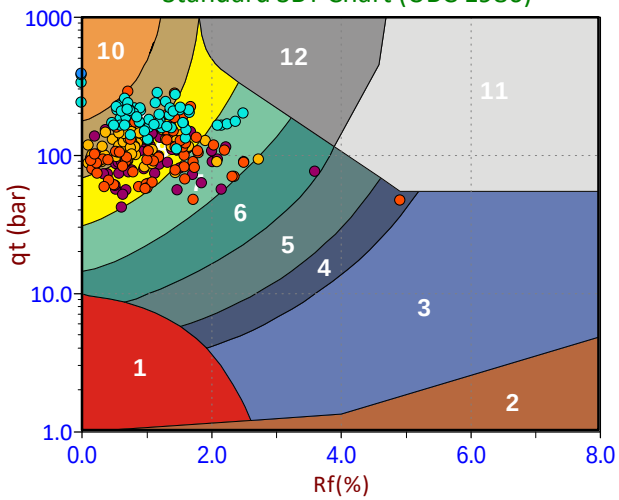
Qtn Chart (PKR 2009)



Modified SBTn (PKR 2016)



Standard SBT Chart (UBC 1986)



Depth Ranges

- >0.0 to 1.5 m
- >1.5 to 3.0 m
- >3.0 to 4.5 m
- >4.5 to 6.0 m
- >6.0 to 7.5 m
- >7.5 to 9.0 m
- >9.0 to 10.5 m
- >10.5 to 12.0 m
- >12.0 to 13.5 m
- >13.5 to 15.0 m
- >15.0 m

Legend

- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots

Job No:	20-02-20725
Client:	Tetra Tech Canada Inc.
Project:	CP East Yard Track L30
Start Date:	30-Apr-2020
End Date:	30-Apr-2020

CPTu PORE PRESSURE DISSIPATION SUMMARY

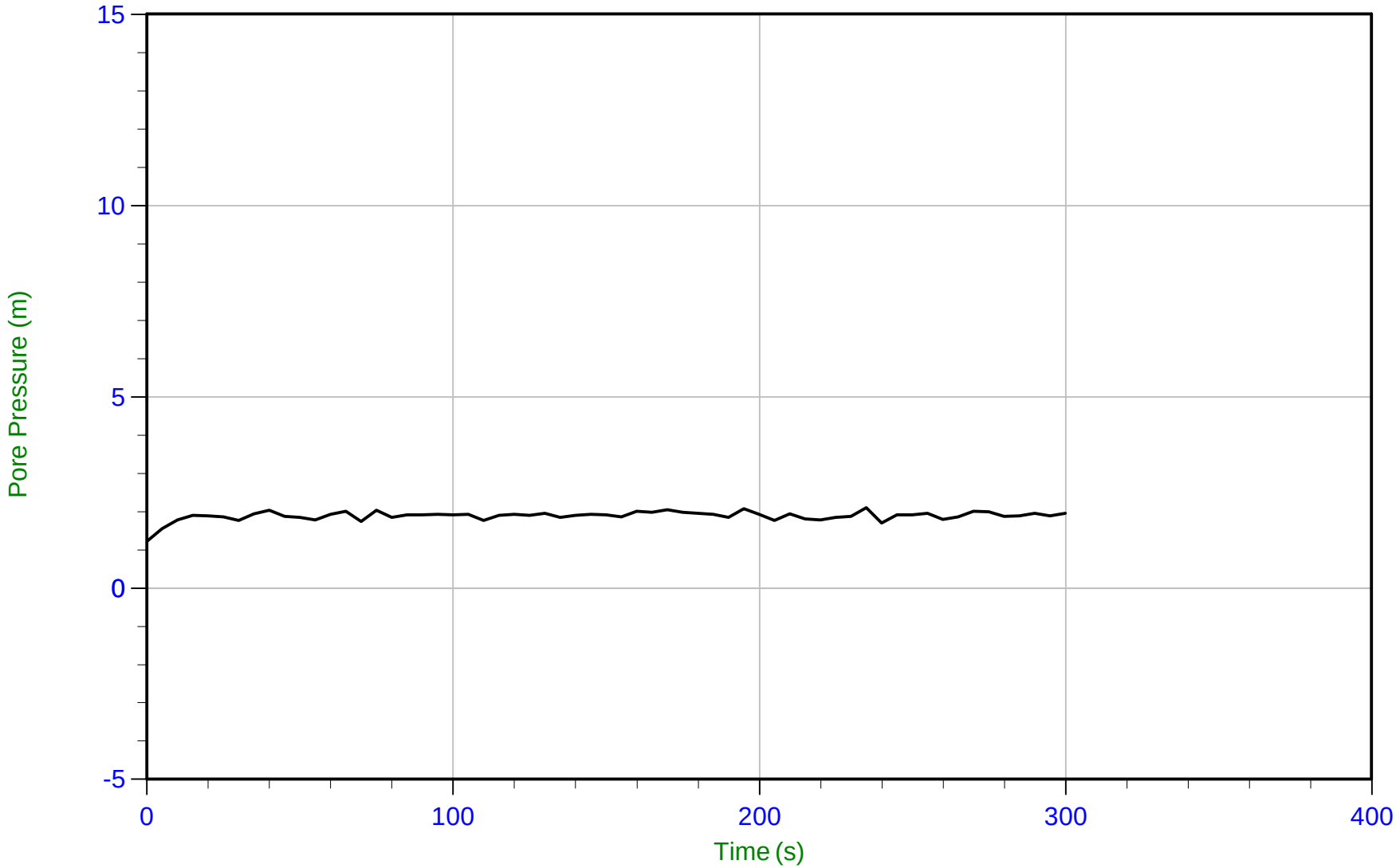
Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (m)	Estimated Equilibrium Pore Pressure U_{eq} (m)	Calculated Phreatic Surface (m)
SCPT20-01	20-02-20725_SP01	15	300	5.925	2.0	4.0
SCPT20-01	20-02-20725_SP01	15	300	9.000	5.0	4.0

CONETEC

Tetra Tech

Job No: 20-02-20725
Date: 04/30/2020 08:40
Site: Commissioner St

Sounding: SCPT20-01
Cone: 648:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-02-20725_SP01.PPF
Depth: 5.925 m / 19.439 ft
Duration: 300.0 s

u Min: 1.2 m
u Max: 2.1 m
u Final: 1.9 m

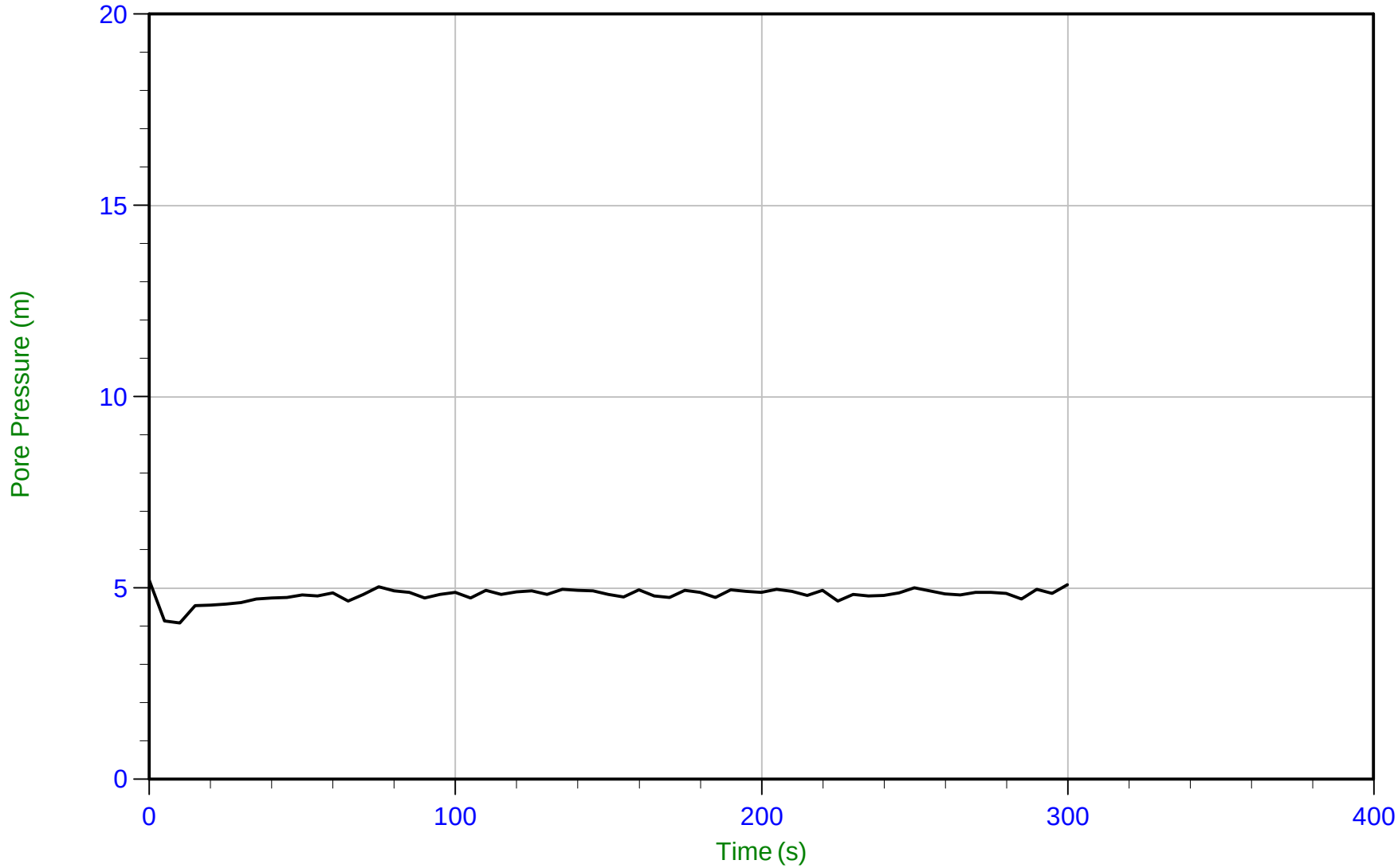
WT: 3.978 m / 13.051 ft
Ueq: 1.9 m

CONETEC

Tetra Tech

Job No: 20-02-20725
Date: 04/30/2020 08:40
Site: Commissioner St

Sounding: SCPT20-01
Cone: 648:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 20-02-20725_SP01.PPF
Depth: 9.000 m / 29.527 ft
Duration: 300.0 s

u Min: 4.1 m
u Max: 5.2 m
u Final: 5.1 m

WT: 4.000 m / 13.123 ft
Ueq: 5.0 m

APPENDIX D
Borehole Logs

Borehole No: **BH20-01**

Project: CP East L Yard Expansion - Track L30	Project No: 704-ENG.VGEO03800-01
Location: Commissioner St.	Ground Elev: 5.18 m
Vancouver, B.C.	UTM: 495305.933 E; 5459186.901 N; Z 10

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Fines: Silt (%)	Fines: Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa)	Elevation (m)
0			ASPHALT (38mm)										5
1	Solid stem auger / DCPT		SAND and GRAVEL (Fill), well graded, dry to moist, compact to very dense, brown and grey; fine to coarse sand; fine to coarse gravel, subangular to subrounded			S1	44	51	5				4
2			SAND and GRAVEL (Fill), trace organics, ocassional wood pieces, moist to wet, loose to compact, dark brown; fine to coarse sand; fine to coarse gravel, subangular to subrounded			S2							3
3													2
4			SAND, silty, trace organics, moist to wet, compact to dense, grey, ocassional coarse rounded gravel (max size 100mm)			S3							1
5			SAND, silty, poorly graded, moist, dense to very dense, grey; fine to medium sand			S4							0
6			End of Auger Hole at 5.1m. End of Sounding at 5.1m upon refusal. - Upon completion of drilling, the auger hole was backfilled with drilling cuttings and bentonite pellets. Pavement surface was restored with cold asphalt. - Soil descriptions and estimates of soil consistency were interpreted from drilling effort, in-situ data, and visual classification of recovered samples. These descriptions are based on engineering judgement.										-1
7													-2
8													-3
9													-4
10													

Field Blowcount (blows/300 mm): ○ DCPT; 10 20 30 40; 65 60 90

Field Vane (kPa): Post-Peak ◇ Peak; 10 20 30 40

Plastic Limit | Moisture Content | Liquid Limit; 20 40 60 80

Contractor: Conetec Investigations Ltd.	Completion Depth: 5.1 m
Drilling Rig Type: M5T	Start Date: April 7, 2020
Logged By: AL	Completion Date: April 7, 2020
Reviewed By: LC	Page 1 of 1

Borehole No: **BH20-02**

Project: CP East L Yard Expansion - Track L30	Project No: 704-ENG.VGEO03800-01
Location: Commissioner St.	Ground Elev: 4.6 m
Vancouver, B.C.	UTM: 495417.221 E; 5459267.437 N; Z 10

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Fines: Silt (%)	Fines: Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa) / Plastic Limit, Moisture Content, Liquid Limit	Elevation (m)
0	Solid stem auger / DCPT		SAND and GRAVEL (Fill), well graded, dry to moist, dense to very dense, brown and grey; fine to coarse sand; fine to coarse gravel (max size 100mm), subangular to subrounded			S1					DCPT: 60		4
1													3
2													2
3			SAND, some gravel, trace organics, moist, loose, reddish brown; fine to medium sand; coarse gravel, subrounded to rounded - organic content of 3.3% at 2.85m			S2 S3							1
			SILT, sandy, saturated, soft, low plastic, grey			S4							
4			SAND and GRAVEL, moist, loose to very dense, brown and grey; poor recovery in auger								DCPT: 100		0
5			End of Auger Hole at 4.5m. End of Sounding at 4.6m upon refusal. - Upon completion of drilling, the auger hole was backfilled with drilling cuttings and bentonite pellets. - Soil descriptions and estimates of soil consistency were interpreted from drilling effort, in-situ data, and visual classification of recovered samples. These descriptions are based on engineering judgement.										-1
6													-2
7													-3
8													-4
9													-5
10													

Field Vane (kPa): Post-Peak ◇ — Peak ◆; 10 20 30 40

Plastic Limit — Moisture Content — Liquid Limit; 20 40 60 80

Contractor: Conetec Investigations Ltd.	Completion Depth: 4.5 m
Drilling Rig Type: M5T	Start Date: April 7, 2020
Logged By: AL	Completion Date: April 7, 2020
Reviewed By: LC	Page 1 of 1

Borehole No: **BH20-03**

Project: CP East L Yard Expansion - Track L30	Project No: 704-ENG.VGEO03800-01
Location: Commissioner St.	Ground Elev: 4.38 m
Vancouver, B.C.	UTM: 495472.418 E; 5459362.943 N; Z 10

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Fines: Silt (%)	Fines: Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa) / Plastic Limit, Moisture Content, Liquid Limit	Elevation (m)
0	Solid stem auger / DCPT		ASPHALT (150mm)								DCPT: 10 20 30 40	Post-Peak / Peak: 10 20 30 40; Plastic Limit / Moisture Content / Liquid Limit: 20 40 60 80	4
			SAND and GRAVEL (Fill), occasional presence of rootlets, dry, compact to dense, brown; medium to coarse sand; fine to coarse gravel (maximum size 3"), subangular to rounded			S1							
1			SAND (Fill), some gravel, occasional cobbles, occasional wood bark pieces, well graded, moist, very loose to loose, brown; medium to coarse sand; subrounded to rounded gravel and cobbles; poor recovery on augers								68		3
2													2
						S2							
3			PEAT, amorphous, some sand, wet, dark brown; transitions to fibrous peat below 4.1m										1
4			- organic content of 44% at 3.8m			S3						195	
						S4						250	0
			SAND (Till-like), silty, trace gravel, moist, loose to very dense, grey; fine to coarse sand.										
5						S5							-1
			End of Auger Hole at 5.3m. End of Sounding at 5.0m upon refusal.										
6			- Upon completion of drilling, the auger hole was backfilled with drilling cuttings and bentonite pellets. Pavement surface was restored with cold asphalt.										-2
7			- Soil descriptions and estimates of soil consistency were interpreted from drilling effort, in-situ data, and visual classification of recovered samples. These descriptions are based on engineering judgement.										-3
8													-4
9													-5
10													

Contractor: Conetec Investigations Ltd.	Completion Depth: 5.3 m
Drilling Rig Type: M7	Start Date: April 29, 2020
Logged By: AL	Completion Date: April 29, 2020
Reviewed By: LC	Page 1 of 1

Borehole No: **BH20-04**

Project: CP East L Yard Expansion - Track L30	Project No: 704-ENG.VGEO03800-01
Location: Commissioner St.	Ground Elev: 3.95 m
Vancouver, B.C.	UTM: 495523.339 E; 5459467.058 N; Z 10

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Fines: Silt (%)	Fines: Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa) / Plastic Limit, Moisture Content, Liquid Limit	Elevation (m)
0			ASPHALT (125mm)										
	Solid stem auger / DCPT		SAND and GRAVEL (Fill), some cobbles, dry, compact to very dense, brown an grey; fine to medium sand; coarse gravel, angular to subrounded			S1							
1			- becomes moist below 1.5m - gravel becomes subangular to rounded										3
2													2
3						S2							1
			End of Auger Hole at 3.4m. End of Sounding at 3.4m upon refusal. - Upon completion of drilling, the auger hole was backfilled with drilling cuttings and bentonite pellets. Pavement surface was restored with cold asphalt. - Soil descriptions and estimates of soil consistency were interpreted from drilling effort, in-situ data, and visual classification of recovered samples. These descriptions are based on engineering judgement.										
4													0
5													-1
6													-2
7													-3
8													-4
9													-5
10													-6

Field Blowcount (blows/300 mm): ○ DCPT; 10 20 30 40; 100 100

Field Vane (kPa): Post-Peak ◇ Peak; 10 20 30 40

Plastic Limit Moisture Content Liquid Limit; 20 40 60 80

Contractor: Conetec Investigations Ltd.	Completion Depth: 3.4 m
Drilling Rig Type: M7	Start Date: May 1, 2020
Logged By: AL	Completion Date: May 1, 2020
Reviewed By: LC	Page 1 of 1

Borehole No: **BH20-05**

Project: CP East L Yard Expansion - Track L30	Project No: 704-ENG.VGEO03800-01
Location: Commissioner St.	Ground Elev: 4.49 m
Vancouver, B.C.	UTM: 495638.24 E; 5459667.648 N; Z 10

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Fines: Silt (%)	Fines: Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa) / Plastic Limit, Moisture Content, Liquid Limit	Elevation (m)
0	Solid stem auger / DCPT		SAND and GRAVEL (Fill), well graded, dry to moist, loose to compact, brown and grey; fine to coarse sand; fine to coarse gravel (max size 100mm), angular to subrounded			S1							4
1													3
2			SAND, gravelly, poorly graded, moist, loose to compact, brown; medium to coarse sand										2
3						S2	21	74	5				1
4			SAND, silty, trace gravel, moist, compact to very dense, brown and grey; medium to coarse sand			S3							0
5			End of Auger Hole at 4.6m. End of Sounding at 4.7m upon refusal. - Upon completion of drilling, the auger hole was backfilled with drilling cuttings and bentonite pellets. - Soil descriptions and estimates of soil consistency were interpreted from drilling effort, in-situ data, and visual classification of recovered samples. These descriptions are based on engineering judgement.										-1
6													-2
7													-3
8													-4
9													-5
10													

Field Blowcount (blows/300 mm): ○ DCPT; 10 20 30 40

Field Vane (kPa): Post-Peak ◇ Peak; 10 20 30 40

Plastic Limit / Moisture Content / Liquid Limit: 20 40 60 80

Contractor: Conetec Investigations Ltd.	Completion Depth: 4.6 m
Drilling Rig Type: M5T	Start Date: April 7, 2020
Logged By: AL	Completion Date: April 7, 2020
Reviewed By: LC	Page 1 of 1

Borehole No: **BH20-06**

Project: CP East L Yard Expansion - Track L30	Project No: 704-ENG.VGEO03800-01
Location: Commissioner St.	Ground Elev: 4.43 m
Vancouver, B.C.	UTM: 495774.602 E; 5459785.473 N; Z 10

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Fines: Silt (%)	Fines: Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa)	Elevation (m)
0	Solid stem auger / DCPT		ASPHALT (150mm)								○ DCPT	Post-Peak ◇ Peak	4
			SAND and GRAVEL (Fill), well graded, dry to moist, compact to very dense, brown; fine to medium sand; fine to coarse gravel (maximum size 100mm), subangular to subrounded			S1	44	48	8			54	
1													3
2			SAND, gravelly, occasional cobbles, well graded, moist, compact, brown; fine to medium sand; subangular to rounded gravel										2
3						S2							
4													1
			SAND, silty; some gravel, moist, dense, grey; fine to medium sand			S3							0
5			CLAY, moist, hard, highly plastic, grey and brown										
						S4							-1
6			- trace sand and gravel below 5.4m										
			End of Auger Hole at 6.1m. End of Sounding at 4.7m upon refusal.										-2
7			- Upon completion of drilling, the auger hole was backfilled with drilling cuttings and bentonite pellets. Pavement surface was restored with cold asphalt.										-3
8			- Soil descriptions and estimates of soil consistency were interpreted from drilling effort, in-situ data, and visual classification of recovered samples. These descriptions are based on engineering judgement.										-4
9													
10													-5

Field Blowcount (blows/300 mm): ○ DCPT — 10 20 30 40

Field Vane (kPa): Post-Peak ◇ Peak — 10 20 30 40

Plastic Limit / Moisture Content / Liquid Limit — 20 40 60 80

Contractor: Conetec Investigations Ltd.	Completion Depth: 6.1 m
Drilling Rig Type: M7	Start Date: April 29, 2020
Logged By: AL	Completion Date: April 29, 2020
Reviewed By: LC	Page 1 of 1

TETRA TECH

Borehole No: **BH20-07**

Project: CP East L Yard Expansion - Track L30	Project No: 704-ENG.VGEO03800-01
Location: Commissioner St.	Ground Elev: 4.14 m
Vancouver, B.C.	UTM: 495979.619 E; 5459897.134 N; Z 10

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Fines: Silt (%)	Fines: Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa) / Plastic Limit / Moisture Content / Liquid Limit	Elevation (m)
0	Solid stem auger / DCPT		ASPHALT (250mm)								DCPT: 10 20 30 40	Post-Peak / Peak: 10 20 30 40; Plastic Limit / Moisture Content / Liquid Limit: 20 40 60 80	4
1			SAND and GRAVEL (Fill), occasional cobbles, well graded, dry, very dense, grey; fine to medium sand; coarse angular to subangular gravel			S1	47	49	4				3
2			GRAVEL and COBBLES, coarse, subangular to rounded; no recovery on augers										2
3			SAND, gravelly, well graded, moist, compact, brown; fine to coarse sand; coarse gravel rounded to subrounded; poor recovery on augers			S2							1
4			End of Auger Hole at 3.6m. End of Sounding at 5.9m upon refusal. - Upon completion of drilling, the auger hole was backfilled with drilling cuttings and bentonite pellets. Pavement surface was restored with cold asphalt. - Soil descriptions and estimates of soil consistency were interpreted from drilling effort, in-situ data, and visual classification of recovered samples. These descriptions are based on engineering judgement.										0
5													-1
6													-2
7													-3
8													-4
9													-5
10													

Contractor: Conetec Investigations Ltd.	Completion Depth: 3.6 m
Drilling Rig Type: M7	Start Date: April 29, 2020
Logged By: AL	Completion Date: April 29, 2020
Reviewed By: LC	Page 1 of 1

Borehole No: **BH20-08**

Project: CP East L Yard Expansion - Track L30	Project No: 704-ENG.VGEO03800-01
Location: Commissioner St.	Ground Elev: 4.99 m
Vancouver, B.C.	UTM: 496178.003 E; 5459952.996 N; Z 10

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Fines: Silt (%)	Fines: Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa) / Plastic Limit / Moisture Content / Liquid Limit	Elevation (m)
0			ASPHALT (100mm)										
			SAND and GRAVEL (Fill), poorly graded, dry to moist, dense, brown; fine to coarse sand; fine to coarse gravel, angular to subrounded (maximum size 50mm); poor recovery on augers			S1	42	56	2				
1													4
	Solid stem auger / DCPT		GRAVEL and COBBLES, coarse, subangular to rounded; no recovery on augers										
2													3
3													2
			SAND, some gravel to gravelly, well graded, moist, compact, brown; medium to coarse sand; fine to coarse gravel, rounded to subrounded			S2							
4			SAND (Till-like), silty, moist, compact to dense, grey; fine to medium sand; poor recovery on augers			S3							1
5													0
			End of Auger Hole at 5.3m. End of Sounding at 5.0m upon refusal.										
6			- Upon completion of drilling, the auger hole was backfilled with drilling cuttings and bentonite pellets. Pavement surface was restored with cold asphalt.										-1
7			- Soil descriptions and estimates of soil consistency were interpreted from drilling effort, in-situ data, and visual classification of recovered samples. These descriptions are based on engineering judgement.										-2
8													-3
9													-4
10													-5

Field Blowcount (blows/300 mm): ○ DCPT; 10 20 30 40

Field Vane (kPa): Post-Peak ◇ Peak; 10 20 30 40

Plastic Limit / Moisture Content / Liquid Limit: 20 40 60 80

Contractor: Conetec Investigations Ltd.	Completion Depth: 5.3 m
Drilling Rig Type: M7	Start Date: April 29, 2020
Logged By: AL	Completion Date: April 29, 2020
Reviewed By: LC	Page 1 of 1

TETRA TECH

Borehole No: **BH20-09**

Project: CP East L Yard Expansion - Track L30	Project No: 704-ENG.VGEO03800-01
Location: Commissioner St.	Ground Elev: 5.83 m
Vancouver, B.C.	UTM: 496383.165 E; 5460005.101 N; Z 10

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Fines: Silt (%)	Fines: Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa) / Plastic Limit, Moisture Content, Liquid Limit	Elevation (m)
0	Solid stem auger / DCPT		ASPHALT (140mm)								DCPT: 10 20 30 40	Post-Peak / Peak: 10 20 30 40; Plastic Limit / Moisture Content / Liquid Limit: 20 40 60 80	5
1			SAND and GRAVEL (Road Fill), well graded, dry, compact to very dense, brown and grey; fine to coarse sand; fine to coarse gravel, angular to subrounded; poor recovery on augers			S1					72, 105		4
2			SAND and GRAVEL, poorly graded, moist, loose to compact, brown; medium to coarse sand; coarse gravel, rounded										3
3						S2	47	52	1				2
4						S3							1
5			SAND, silty, some gravel, moist, compact to very dense, brown to grey; fine to medium sand; coarse gravel, rounded			S4							0
6			End of Auger Hole at 6.1m. End of Sounding at 6.2m upon refusal. - Upon completion of drilling, the auger hole was backfilled with drilling cuttings and bentonite pellets. Pavement surface was restored with cold asphalt. - Soil descriptions and estimates of soil consistency were interpreted from drilling effort, in-situ data, and visual classification of recovered samples. These descriptions are based on engineering judgement.										-1
7													-2
8													-3
9													-4
10													

Contractor: Conetec Investigations Ltd.	Completion Depth: 6.1 m
Drilling Rig Type: M5T	Start Date: April 7, 2020
Logged By: AL	Completion Date: April 7, 2020
Reviewed By: LC	Page 1 of 1

Borehole No: **BH20-10**

Project: CP East L Yard Expansion - Track L30	Project No: 704-ENG.VGEO03800-01
Location: Commissioner St.	Ground Elev: 7.05 m
Vancouver, B.C.	UTM: 496692.813 E; 5459930.089 N; Z 10

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Fines: Silt (%)	Fines: Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa) / Plastic Limit, Moisture Content, Liquid Limit	Elevation (m)
0	Solid stem auger / DCPT		ASPHALT (230mm)								DCPT: 10 20 30 40	Post-Peak / Peak: 10 20 30 40; Plastic Limit / Moisture Content / Liquid Limit: 20 40 60 80	7
1			SAND (Fill), some gravel to gravelly, dry, very dense, brown; fine to medium sand; fine to coarse gravel (maximum size 50mm), angular to subrounded			S1					100		6
2			SAND, silty, some gravel, moist, loose to compact, grey; fine to medium sand; fine to coarse subangular to rounded gravel								66 60 100		5
3						S2							4
4						S3	13	51	36				3
5			CLAY, some sand to sandy, trace gravel, moist, firm to stiff, low plastic, grey; fine sand			S4							2
6													1
7			End of Auger Hole at 6.1m. End of Sounding at 9.0m upon refusal. - Upon completion of drilling, the auger hole was backfilled with drilling cuttings and bentonite pellets. Pavement surface was restored with cold asphalt. - Soil descriptions and estimates of soil consistency were interpreted from drilling effort, in-situ data, and visual classification of recovered samples. These descriptions are based on engineering judgement.										0
8													-1
9													-2
10													

Contractor: Conetec Investigations Ltd.	Completion Depth: 6.1 m
Drilling Rig Type: M7	Start Date: April 30, 2020
Logged By: AL	Completion Date: April 30, 2020
Reviewed By: LC	Page 1 of 1

Borehole No: **BH20-11**

Project: CP East L Yard Expansion - Track L30	Project No: 704-ENG.VGEO03800-01
Location: Commissioner St.	Ground Elev: 6.39 m
Vancouver, B.C.	UTM: 496857.791 E; 5459865.291 N; Z 10

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Fines: Silt (%)	Fines: Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa) / Plastic Limit, Moisture Content, Liquid Limit	Elevation (m)
0			ASPHALT (230mm)										6
	Solid stem auger / DCPT		SAND and GRAVEL (Road Fill), dry, dense, grey; fine to medium sand; coarse angular gravel			S1							
1			SAND (Fill), gravelly to some gravel, moist, dense, grey, medium to coarse sand; fine gravel										5
2			SAND, silty, trace gravel, moist, grey; fine to coarse sand			S2							4
3			SAND and SILT, trace gravel, moist, compact, brown and grey; fine to medium sand; occasional lenses of grey silt			S3	8	56	36				3
4			SAND, some gravel, moist, loose to compact, dark grey; fine to medium sand; coarse gravel			S4							2
4.5			End of Auger Hole at 4.5m. End of Sounding at 5.0m upon refusal.										1.5
5			- Upon completion of drilling, the auger hole was backfilled with drilling cuttings and bentonite pellets. Pavement surface was restored with cold asphalt.										1
6			- Soil descriptions and estimates of soil consistency were interpreted from drilling effort, in-situ data, and visual classification of recovered samples. These descriptions are based on engineering judgement.										0
7													-1
8													-2
9													-3
10													

Field Blowcount (blows/300 mm): ○ DCPT; 10 20 30 40

Field Vane (kPa): Post-Peak ◇ Peak; 10 20 30 40

Plastic Limit Moisture Content Liquid Limit: 20 40 60 80

Contractor: Conetec Investigations Ltd.	Completion Depth: 4.5 m
Drilling Rig Type: M7	Start Date: April 30, 2020
Logged By: AL	Completion Date: April 30, 2020
Reviewed By: LC	Page 1 of 1

Borehole No: **BH20-12**

Project: CP East L Yard Expansion - Track L30	Project No: 704-ENG.VGEO03800-01
Location: Commissioner St.	Ground Elev: 9.24 m
Vancouver, B.C.	UTM: 496972.91 E; 5459766.679 N; Z 10

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Fines: Silt (%)	Fines: Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa) / Plastic Limit, Moisture Content, Liquid Limit	Elevation (m)
0	Solid stem auger / DCPT		ASPHALT (230mm)								DCPT: 10 20 30 40	Post-Peak / Peak: 10 20 30 40; Plastic Limit / Moisture Content / Liquid Limit: 20 40 60 80	9
			SAND, silty, some gravel (Fill), dry, very dense, brown; fine to medium sand; fine to coarse gravel; angular to subrounded gravel			S1	12	66	22				
1											70		8
											66		
2			SAND, some gravel to gravelly, trace silt, moist, loose to compact, brown and grey; fine to medium sand; fine to coarse gravel; subrounded to rounded; occasional wood fibres										7
											100		
3						S2							6
4						S3							5
5						S4							4
6													3
			End of Auger Hole at 6.1m. End of Sounding at 7.7m upon refusal.										
7			- Upon completion of drilling, the auger hole was backfilled with drilling cuttings and bentonite pellets. Pavement surface was restored with cold asphalt.										2
8			- Soil descriptions and estimates of soil consistency were interpreted from drilling effort, in-situ data, and visual classification of recovered samples. These descriptions are based on engineering judgement.										1
9													0
10													

Contractor: Conetec Investigations Ltd.	Completion Depth: 6.1 m
Drilling Rig Type: M7	Start Date: April 30, 2020
Logged By: AL	Completion Date: April 30, 2020
Reviewed By: LC	Page 1 of 1

APPENDIX E
Geotechnical Laboratory Test Results

TETRA TECH CANADA INC.

Form Nº TT121

Project:	Hatch - CP East Yard Track L30	Project No.:	704-ENG.VGEO03800-01
Location:	Vancouver, BC	Date:	May 14, 2020
Borehole:	Various	Page:	1 of 2

Water Content and Organic Content (ASTM D2974)

Sample N°	Depth (m)	Tin N°	Wt. of tare (TW) (g)	TW+ Wet weight (g)	TW+ Dry weight (g)	Water Content (%)	Crucible N°	Wt. of Crucible (g)	Wt. of Crucible + Dry Sample (g)	Weight of Crucible + Ash (g)	Ash Content (%)	Organic Matter Content (%)
BH20-01												
S1	1.08	C20	196.89	1507.00	1441.92	5.23						
S2	2.53	77	33.82	207.49	152.36	46.51						
S3	3.88	84	34.49	188.64	163.02	19.93						
S4	5.03	75	32.10	181.39	158.33	18.27						
BH20-02												
S2	2.93	82	25.11	207.98	165.52	30.24	100	32.44	82.76	81.12	96.74	3.26
S3	3.18	81	24.05	152.24	122.45	30.27						
S4	3.73	89A	32.51	210.18	171.30	28.01						
BH20-03												
S3	3.90	D11	210.25	451.92	292.09	195.30	12	33.01	58.58	47.33	56.00	44.00
S4	4.30	86	25.77	115.09	51.26	250.41						
S5	5.10	44	33.25	175.14	149.76	21.78						
BH20-05												
S2	2.63	1	149.45	1413.92	1281.32	11.72						
S3	3.73	80	23.63	213.63	187.04	16.27						
BH20-06												
S1	0.70	C32	143.27	2022.29	1972.92	2.70						
S3	4.40	C33	148.70	760.71	709.83	9.07						
S4	5.30	91	33.38	129.30	105.16	33.63						
BH20-07												
S1	0.40	H1	196.18	1998.37	1942.13	3.22						
S2	3.30	22	24.48	149.11	145.19	3.25						

Performed By:	PC	Checked By:	PS	Approved By:	PS
Date:	May 14, 2020	Date:	May 14, 2020	Date:	May 14, 2020

TETRA TECH CANADA INC.

Form Nº TT121

Project:	Hatch - CP East Yard Track L30	Project No.:	704-ENG.VGEO03800-01
Location:	Vancouver, BC	Date:	May 14, 2020
Borehole:	Various	Page:	2 of 2

Water Content and Organic Content (ASTM D2974)

Sample N°	Depth (m)	Tin N°	Wt. of tare (TW) (g)	TW+ Wet weight (g)	TW+ Dry weight (g)	Water Content (%)	Crucible N°	Wt. of Crucible (g)	Wt. of Crucible + Dry Sample (g)	Weight of Crucible + Ash (g)	Ash Content (%)	Organic Matter Content (%)
BH20-08												
S1	1.10	D4	206.39	2698.19	2608.69	3.73						
S2	3.90	14A	24.89	185.64	175.95	6.41						
S3	4.30	8	23.68	150.91	131.57	17.93						
BH20-09												
S2	2.93	C31	195.64	1948.20	1894.50	3.16						
S3	4.13	63	34.20	214.46	208.24	3.57						
S4	5.08	49	24.88	216.79	185.37	19.58						
BH20-10												
S2	2.90	12	34.74	163.68	146.08	15.81						
S3	4.10	111	33.11	140.58	124.47	17.63						
S4	5.30	11	32.90	149.73	132.60	17.18						
BH20-11												
S2	2.30	48	23.36	142.12	128.69	12.75						
S3	3.70	C03	143.70	2033.10	1807.40	13.57						
S4	4.30	98	33.88	135.92	122.38	15.30						
BH20-12												
S1	0.50	B5	136.35	1582.15	1503.00	5.79						
S2	2.90	10	34.25	178.31	162.81	12.06						
S4	5.30	62	24.97	256.74	230.87	12.56						

Performed By:	PC	Checked By:	PS	Approved By:	PS
Date:	May 14, 2020	Date:	May 14, 2020	Date:	May 14, 2020

TETRA TECH CANADA INC.

Form Nº TT104

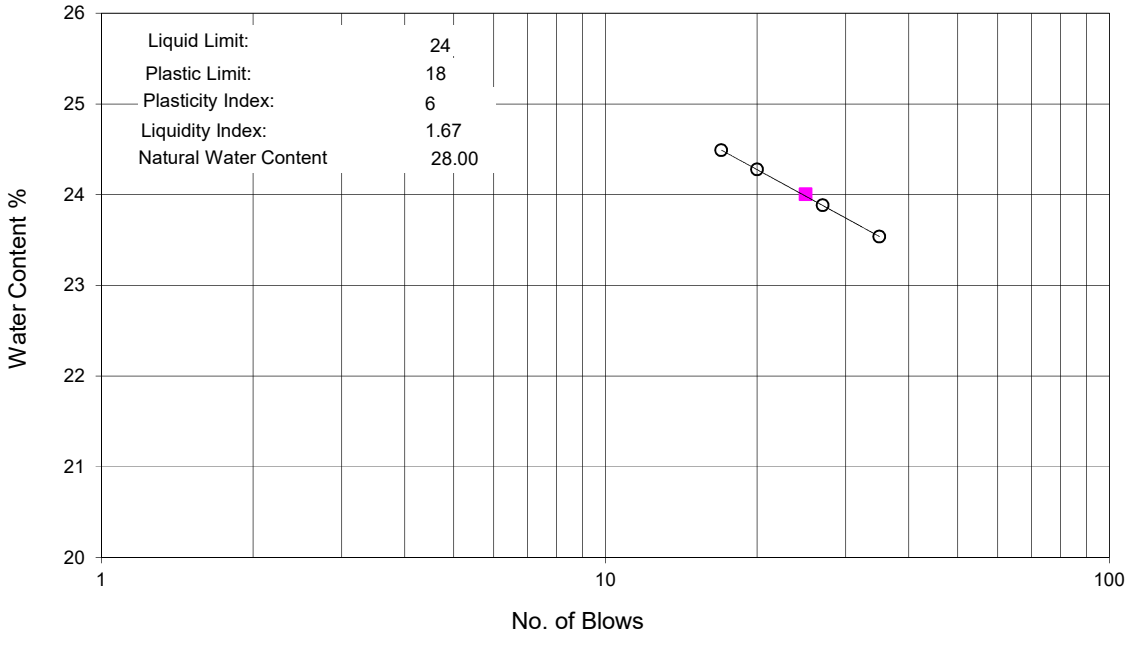
Project:	Hatch - CP East Yard Track L30			Project No.:	704-ENG.VGEO03800-01
Location:	Vancouver, BC			Date:	May 14, 2020
Borehole:	BH20-02	Sample No.:	S4	Depth (m):	3.73

Liquid Limit, Plastic Limit and Plasticity Index of Soils (ASTM D4318)

LIQUID LIMIT								PLASTIC LIMIT						
TIN No.	Tare + Weight of Wet Soil (g)	Tare + Weight of Dry Soil (g)	Weight of Tin (g)	Weight of Water (g)	Weight of Dry Soil (g)	Water Content (%)	No. of Blows	TIN No.	Tare + Weight of Wet Soil (g)	Tare + Weight of Dry Soil (g)	Weight of Tin (g)	Weight of Water (g)	Weight of Dry Soil (g)	Water Content (%)
69	33.31	31.46	23.84	1.85	7.62	24.3	20	9	31.29	30.30	24.84	0.99	5.46	18.1
24A	44.39	42.52	34.69	1.87	7.83	23.9	27	57	30.06	29.11	23.97	0.95	5.14	18.5
94	44.07	41.86	32.47	2.21	9.39	23.5	35							
35	43.06	41.51	35.18	1.55	6.33	24.5	17							

Classification of the material : CL-ML

100 % with respect to the total of the material smaller than sieve No. 40



Observations: _____

Prepared by:	PC	Checked by:	PS	Approved by:	PS
Date:	May 14, 2020	Date:	May 14, 2020	Date:	May 14, 2020

TETRA TECH CANADA INC.

Form Nº TT104

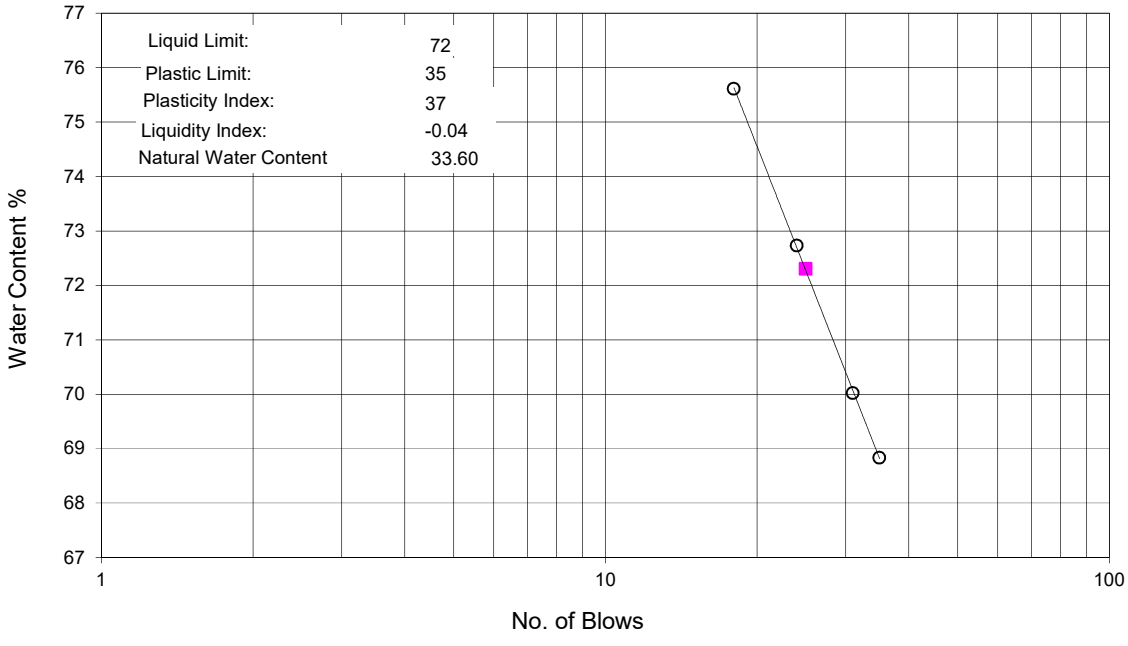
Project:	Hatch - CP East Yard Track L30			Project No.:	704-ENG.VGEO03800-01
Location:	Vancouver, BC			Date:	May 14, 2020
Borehole:	BH20-06	Sample No.:	S4	Depth (m):	5.30

Liquid Limit, Plastic Limit and Plasticity Index of Soils (ASTM D4318)

LIQUID LIMIT								PLASTIC LIMIT						
TIN No.	Tare + Weight of Wet Soil (g)	Tare + Weight of Dry Soil (g)	Weight of Tin (g)	Weight of Water (g)	Weight of Dry Soil (g)	Water Content (%)	No. of Blows	TIN No.	Tare + Weight of Wet Soil (g)	Tare + Weight of Dry Soil (g)	Weight of Tin (g)	Weight of Water (g)	Weight of Dry Soil (g)	Water Content (%)
51	40.56	37.27	32.49	3.29	4.78	68.8	35	54	30.83	28.94	23.47	1.89	5.47	34.6
7	42.32	38.63	33.36	3.69	5.27	70.0	31	26	30.58	28.85	23.89	1.73	4.96	34.9
65A	33.65	29.65	24.15	4.00	5.50	72.7	24							
85	41.25	37.84	33.33	3.41	4.51	75.6	18							

Classification of the material : MH

100 % with respect to the total of the material smaller than sieve No. 40



Observations: _____

Prepared by:	PC	Checked by:	PS	Approved by:	PS
Date:	May 14, 2020	Date:	May 14, 2020	Date:	May 14, 2020

TETRA TECH CANADA INC.

Form Nº TT104

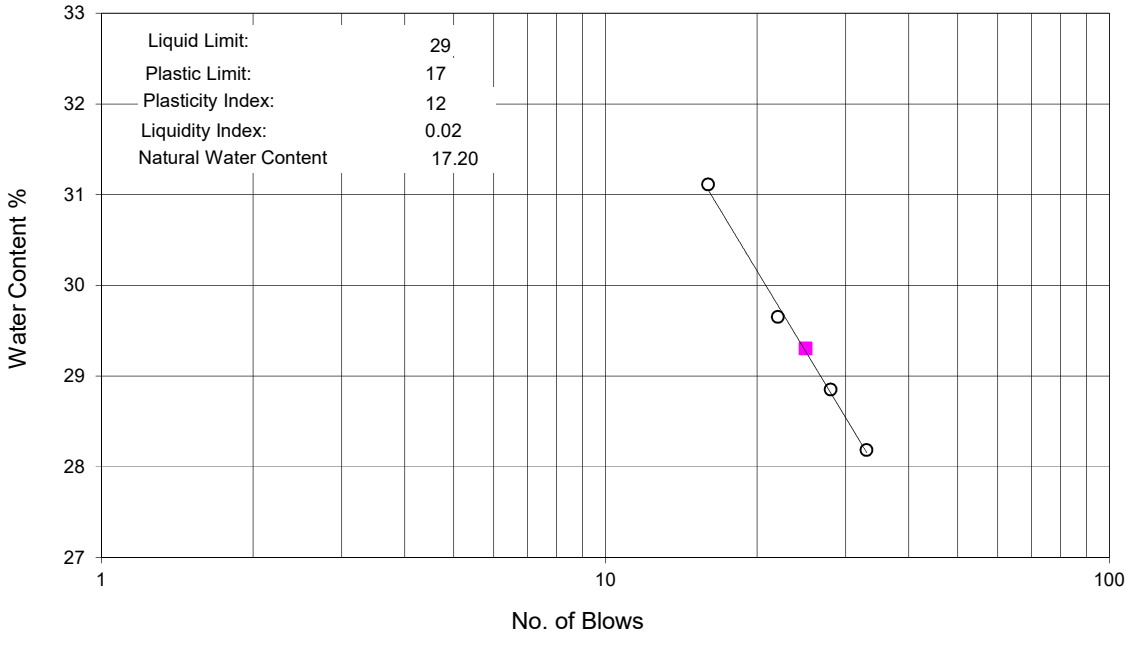
Project:	Hatch - CP East Yard Track L30			Project No.:	704-ENG.VGEO03800-01
Location:	Vancouver, BC			Date:	May 14, 2020
Borehole:	BH20-10	Sample No.:	S4	Depth (m):	5.30

Liquid Limit, Plastic Limit and Plasticity Index of Soils (ASTM D4318)

LIQUID LIMIT								PLASTIC LIMIT						
TIN No.	Tare + Weight of Wet Soil (g)	Tare + Weight of Dry Soil (g)	Weight of Tin (g)	Weight of Water (g)	Weight of Dry Soil (g)	Water Content (%)	No. of Blows	TIN No.	Tare + Weight of Wet Soil (g)	Tare + Weight of Dry Soil (g)	Weight of Tin (g)	Weight of Water (g)	Weight of Dry Soil (g)	Water Content (%)
92	40.39	38.73	32.84	1.66	5.89	28.2	33	64	40.19	39.21	33.35	0.98	5.86	16.7
32a	40.78	38.85	32.16	1.93	6.69	28.8	28	86	32.66	31.67	25.75	0.99	5.92	16.7
48	32.29	30.25	23.37	2.04	6.88	29.7	22							
44	42.09	39.99	33.24	2.10	6.75	31.1	16							

Classification of the material : CL

100 % with respect to the total of the material smaller than sieve No. 40



Observations: _____

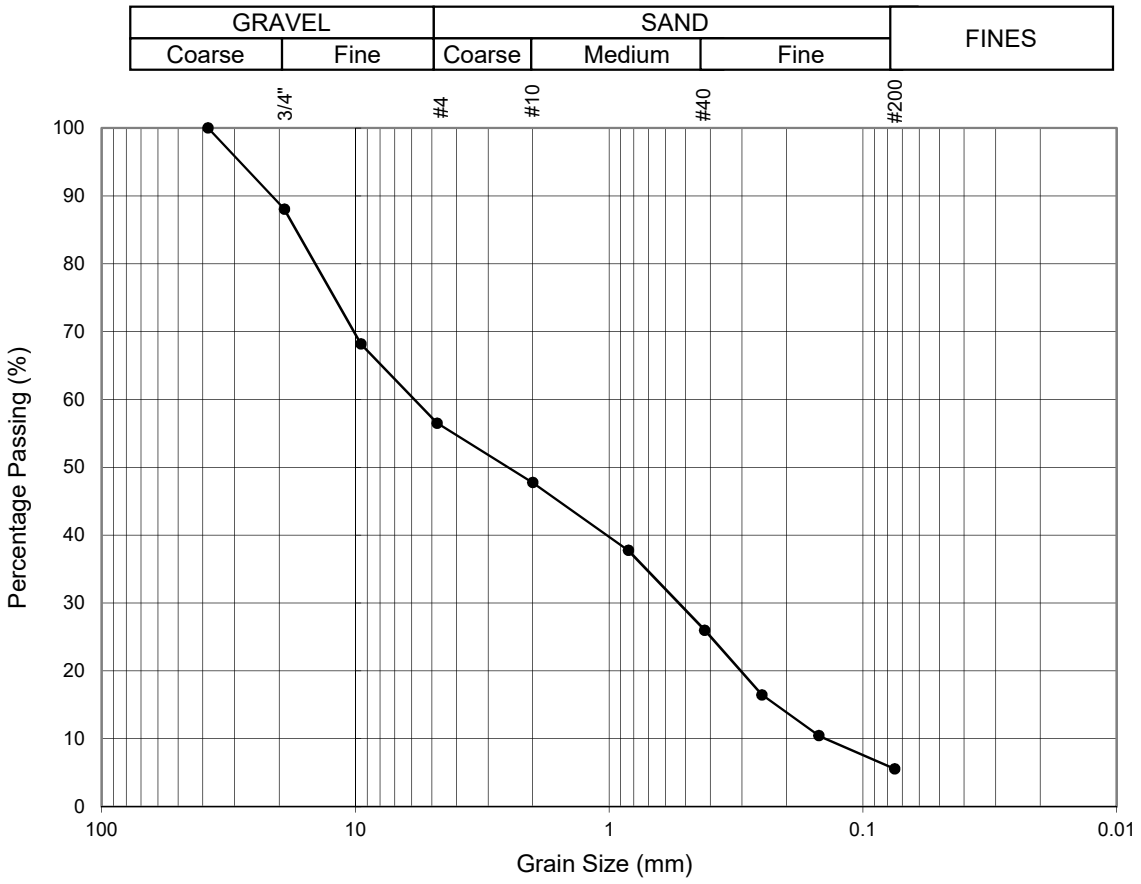
Prepared by:	PC	Checked by:	PS	Approved by:	PS
Date:	May 14, 2020	Date:	May 14, 2020	Date:	May 14, 2020

TETRA TECH CANADA INC.

Form Nº TT106a

Project:	Hatch - CP East Yard Track L30			Project No.:	704-ENG.VGEO03800-01
Location:	Vancouver, BC			Date:	May 14, 2020
Borehole:	BH20-01	Sample No.:	S1	Depth (m):	1.08

Particle Size Distribution (ASTM D422)



Sample No.	Depth (m)	Percentage of Material by Weight (%)					
		Gravel		Sand			Fines
		Coarse	Fine	Coarse	Medium	Fine	
S1	1.08	12	32	9	22	20	6

Comments: ASTM requires a minimum of 3000g of Material. All of the sample collected was used for the sieve gradation (approx. 1245g)

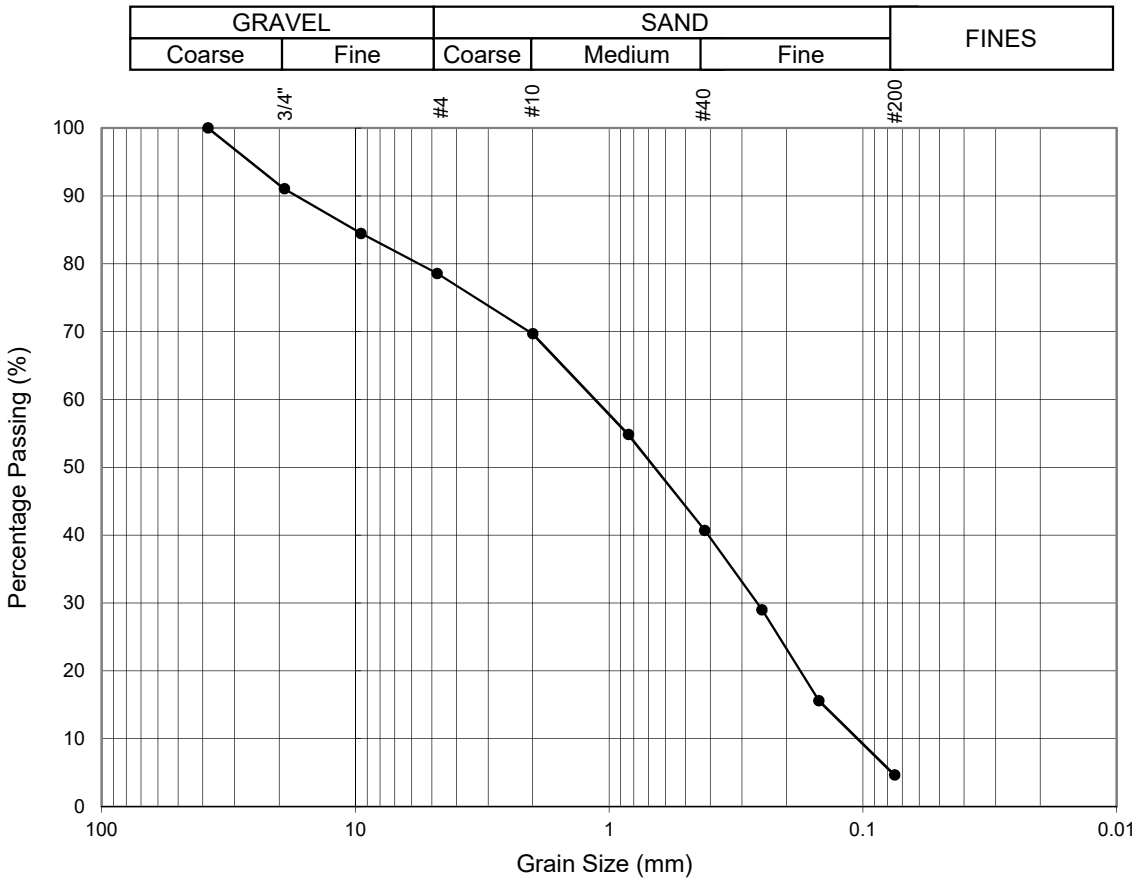
Prepared by:	PC	Checked by:	PS	Approved by:	PS
Date:	May 14, 2020	Date:	May 14, 2020	Date:	May 14, 2020

TETRA TECH CANADA INC.

Form Nº TT106a

Project:	Hatch - CP East Yard Track L30			Project No.:	704-ENG.VGEO03800-01
Location:	Vancouver, BC			Date:	May 14, 2020
Borehole:	BH20-05	Sample No.:	S2	Depth (m):	2.63

Particle Size Distribution (ASTM D422)



Sample No.	Depth (m)	Percentage of Material by Weight (%)					
		Gravel		Sand			Fines
		Coarse	Fine	Coarse	Medium	Fine	
S2	2.63	9	12	9	29	36	5

Comments: ASTM requires a minimum of 3000g of Material. All of the sample collected was used for the sieve gradation (approx. 1132g)

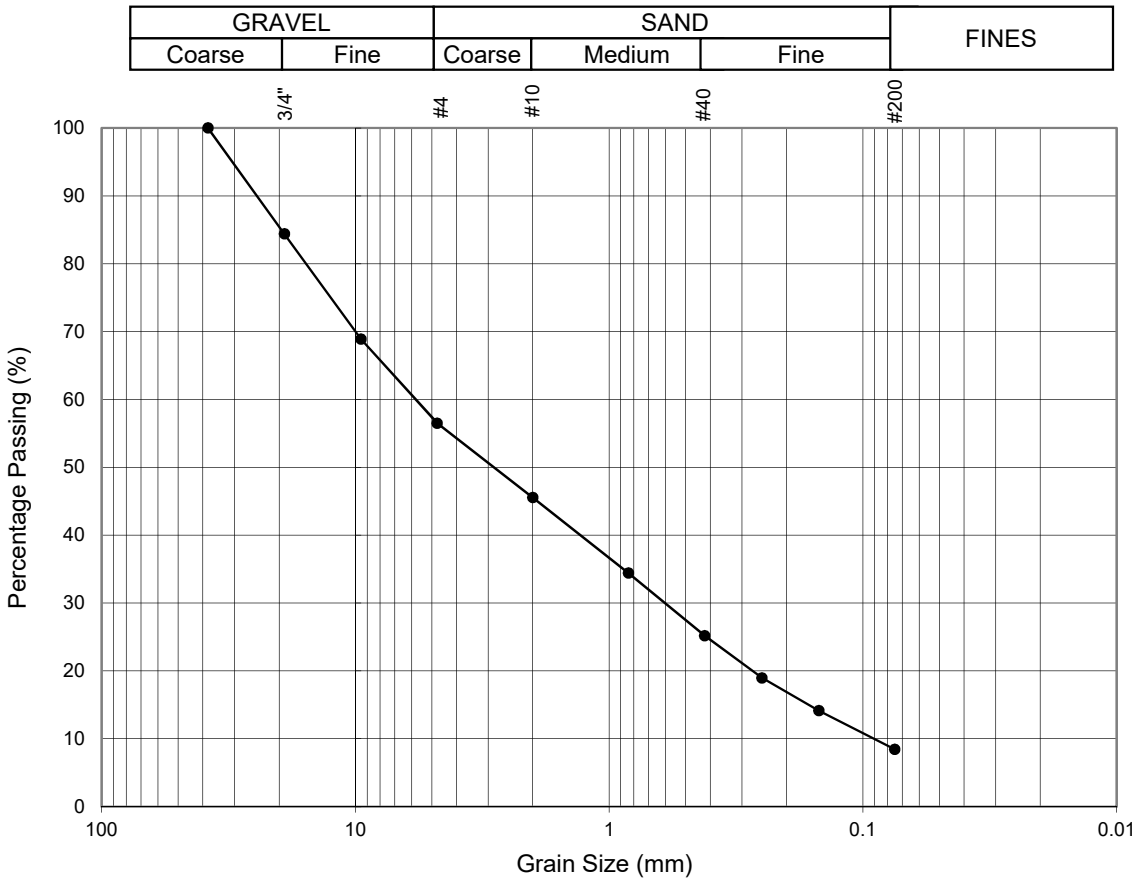
Prepared by:	PC	Checked by:	PS	Approved by:	PS
Date:	May 14, 2020	Date:	May 14, 2020	Date:	May 14, 2020

TETRA TECH CANADA INC.

Form Nº TT106a

Project:	Hatch - CP East Yard Track L30			Project No.:	704-ENG.VGEO03800-01
Location:	Vancouver, BC			Date:	May 14, 2020
Borehole:	BH20-06	Sample No.:	S1	Depth (m):	0.7

Particle Size Distribution (ASTM D422)



Sample No.	Depth (m)	Percentage of Material by Weight (%)					
		Gravel		Sand			Fines
		Coarse	Fine	Coarse	Medium	Fine	
S1	0.7	16	28	11	20	17	8

Comments: ASTM requires a minimum of 3000g of Material. All of the sample collected was used for the sieve gradation (approx. 1830g)

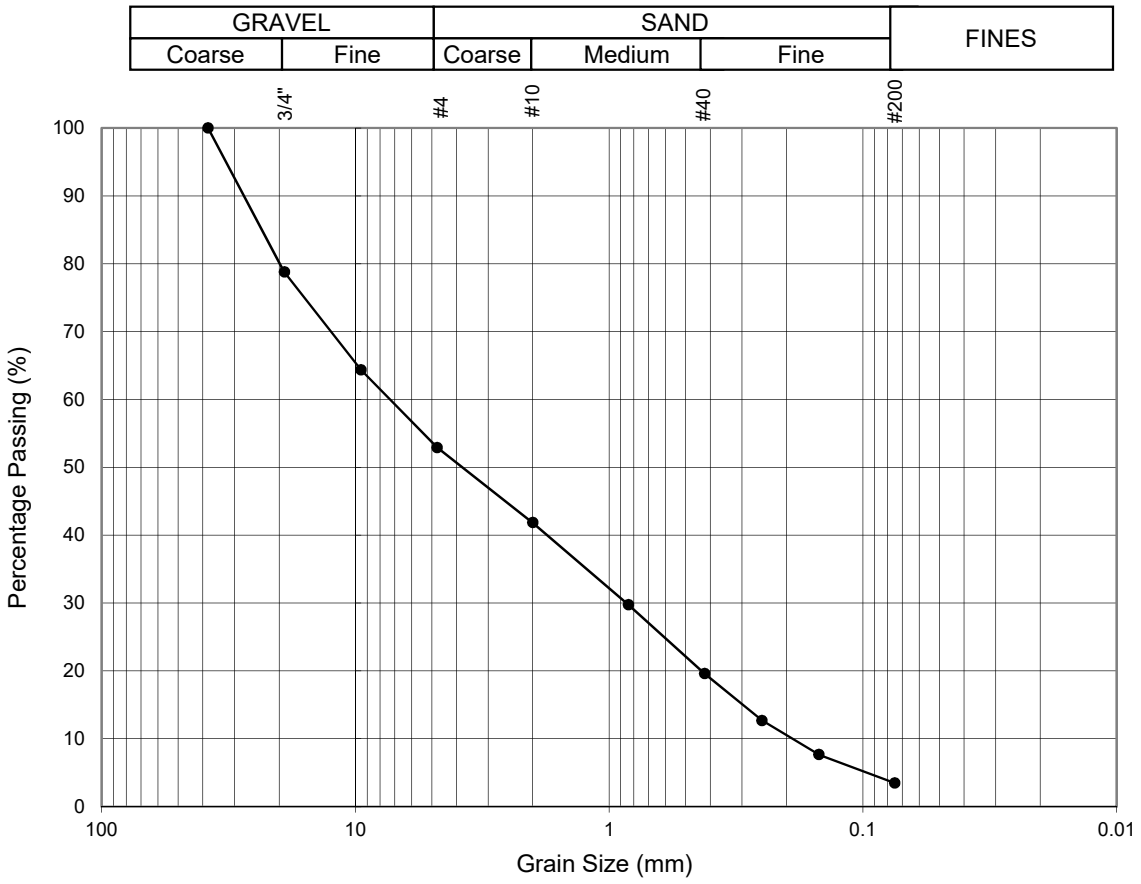
Prepared by:	PC	Checked by:	PS	Approved by:	PS
Date:	May 14, 2020	Date:	May 14, 2020	Date:	May 14, 2020

TETRA TECH CANADA INC.

Form Nº TT106a

Project:	Hatch - CP East Yard Track L30			Project No.:	704-ENG.VGEO03800-01
Location:	Vancouver, BC			Date:	May 14, 2020
Borehole:	BH20-07	Sample No.:	S1	Depth (m):	0.4

Particle Size Distribution (ASTM D422)



Sample No.	Depth (m)	Percentage of Material by Weight (%)					
		Gravel		Sand			Fines
		Coarse	Fine	Coarse	Medium	Fine	
S1	0.4	21	26	11	22	16	4

Comments: ASTM requires a minimum of 3000g of Material. All of the sample collected was used for the sieve gradation (approx. 1746g)

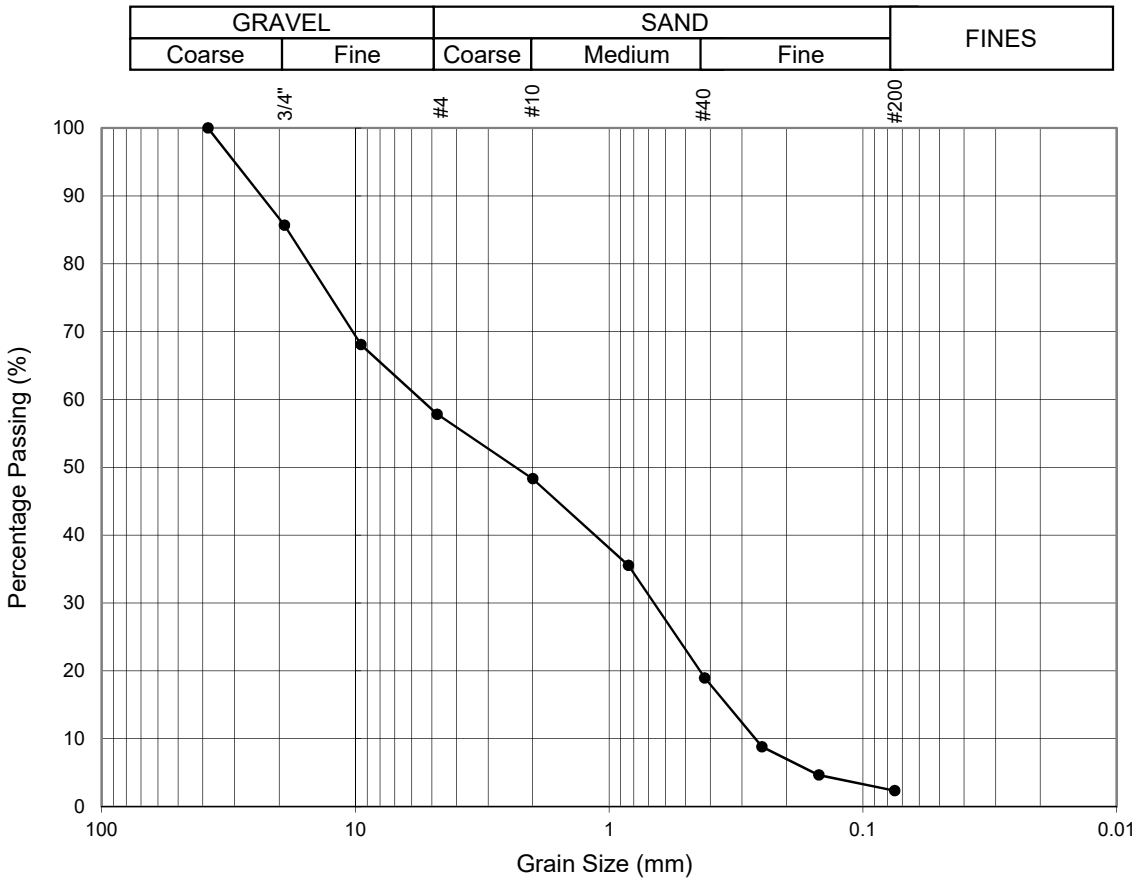
Prepared by:	PC	Checked by:	PS	Approved by:	PS
Date:	May 14, 2020	Date:	May 14, 2020	Date:	May 14, 2020

TETRA TECH CANADA INC.

Form Nº TT106a

Project:	Hatch - CP East Yard Track L30			Project No.:	704-ENG.VGEO03800-01
Location:	Vancouver, BC			Date:	May 14, 2020
Borehole:	BH20-08	Sample No.:	S1	Depth (m):	1.1

Particle Size Distribution (ASTM D422)



Sample No.	Depth (m)	Percentage of Material by Weight (%)					
		Gravel		Sand			Fines
		Coarse	Fine	Coarse	Medium	Fine	
S1	1.1	14	28	10	29	17	2

Comments: ASTM requires a minimum of 3000g of Material. All of the sample collected was used for the sieve gradation (approx. 2402g)

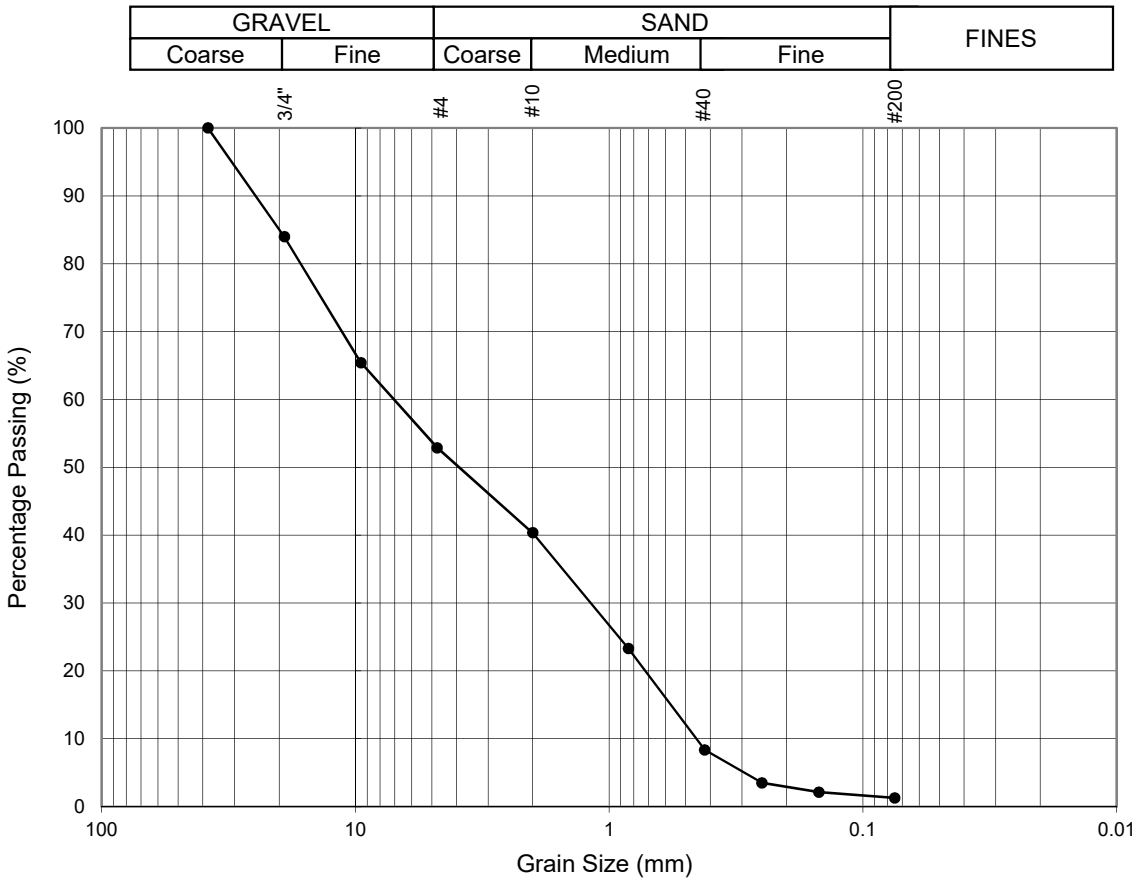
Prepared by:	PC	Checked by:	PS	Approved by:	PS
Date:	May 14, 2020	Date:	May 14, 2020	Date:	May 14, 2020

TETRA TECH CANADA INC.

Form Nº TT106a

Project:	Hatch - CP East Yard Track L30			Project No.:	704-ENG.VGEO03800-01
Location:	Vancouver, BC			Date:	May 14, 2020
Borehole:	BH20-09	Sample No.:	S2	Depth (m):	2.93

Particle Size Distribution (ASTM D422)



Sample No.	Depth (m)	Percentage of Material by Weight (%)					
		Gravel		Sand			Fines
		Coarse	Fine	Coarse	Medium	Fine	
S2	2.93	16	31	13	32	7	1

Comments: ASTM requires a minimum of 3000g of Material. All of the sample collected was used for the sieve gradation (approx. 1699g)

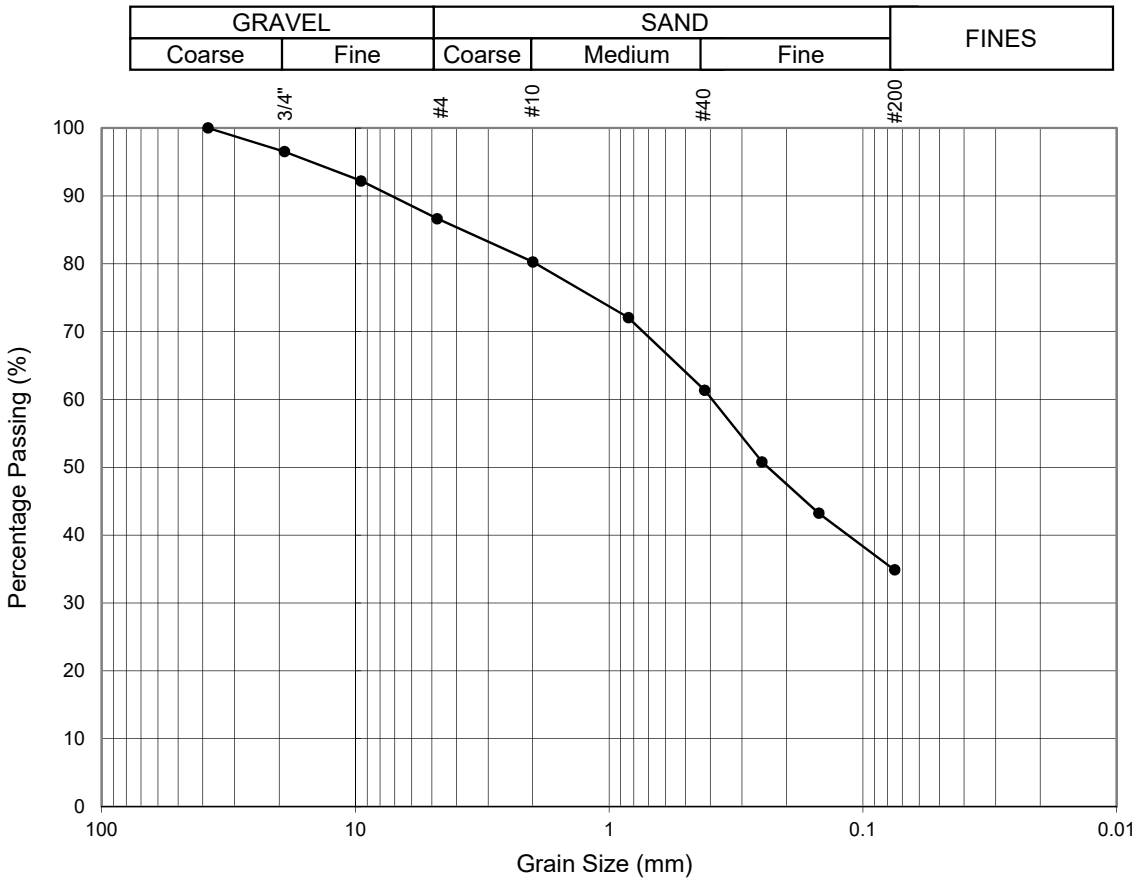
Prepared by:	PC	Checked by:	PS	Approved by:	PS
Date:	May 14, 2020	Date:	May 14, 2020	Date:	May 14, 2020

TETRA TECH CANADA INC.

Form Nº TT106a

Project:	Hatch - CP East Yard Track L30			Project No.:	704-ENG.VGEO03800-01
Location:	Vancouver, BC			Date:	May 14, 2020
Borehole:	BH20-10	Sample No.:	S3	Depth (m):	4.1

Particle Size Distribution (ASTM D422)



Sample No.	Depth (m)	Percentage of Material by Weight (%)					
		Gravel		Sand			Fines
		Coarse	Fine	Coarse	Medium	Fine	
S3	4.1	3	10	6	19	26	35

Comments: ASTM requires a minimum of 3000g of Material. All of the sample collected was used for the sieve gradation (approx. 1398g)

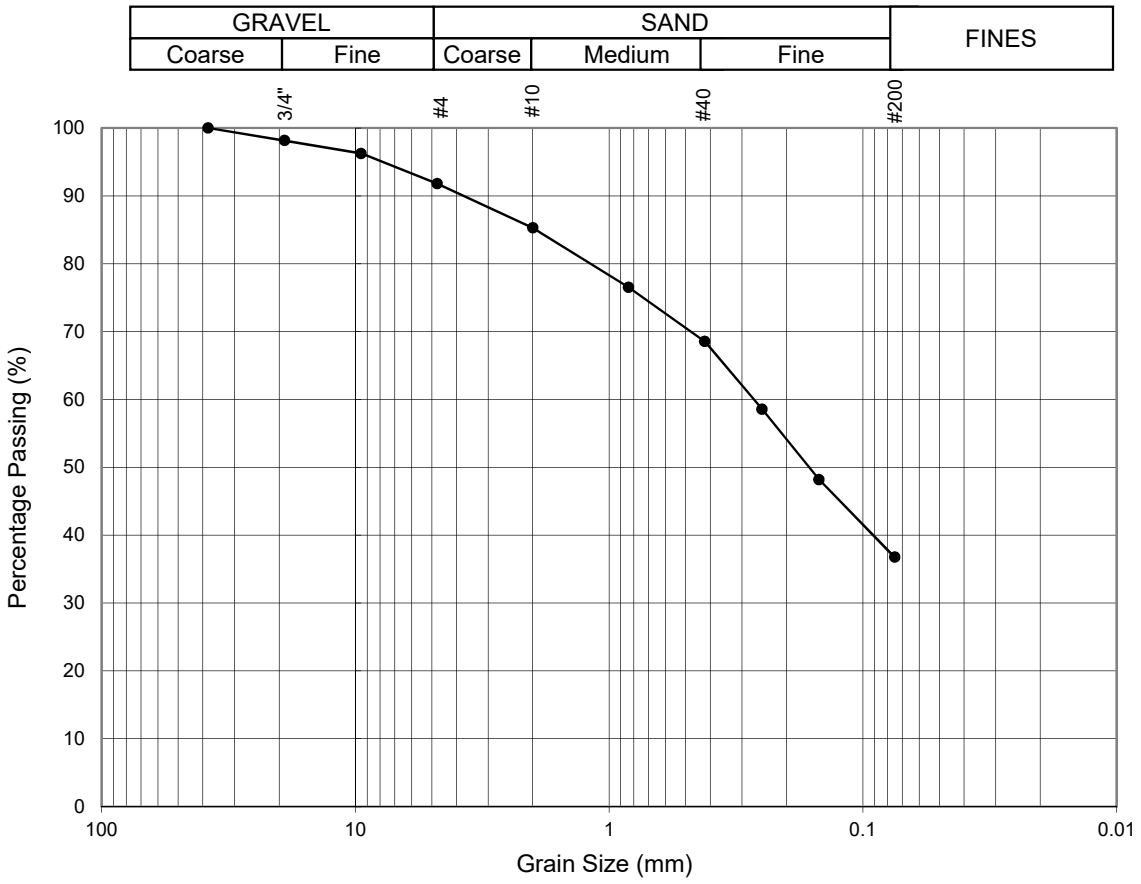
Prepared by:	PC	Checked by:	PS	Approved by:	PS
Date:	May 14, 2020	Date:	May 14, 2020	Date:	May 14, 2020

TETRA TECH CANADA INC.

Form Nº TT106a

Project:	Hatch - CP East Yard Track L30			Project No.:	704-ENG.VGEO03800-01
Location:	Vancouver, BC			Date:	May 14, 2020
Borehole:	BH20-11	Sample No.:	S3	Depth (m):	3.7

Particle Size Distribution (ASTM D422)



Sample No.	Depth (m)	Percentage of Material by Weight (%)					
		Gravel		Sand			Fines
		Coarse	Fine	Coarse	Medium	Fine	
S3	3.7	2	6	7	17	32	37

Comments: ASTM requires a minimum of 3000g of Material. All of the sample collected was used for the sieve gradation (approx. 1663g)

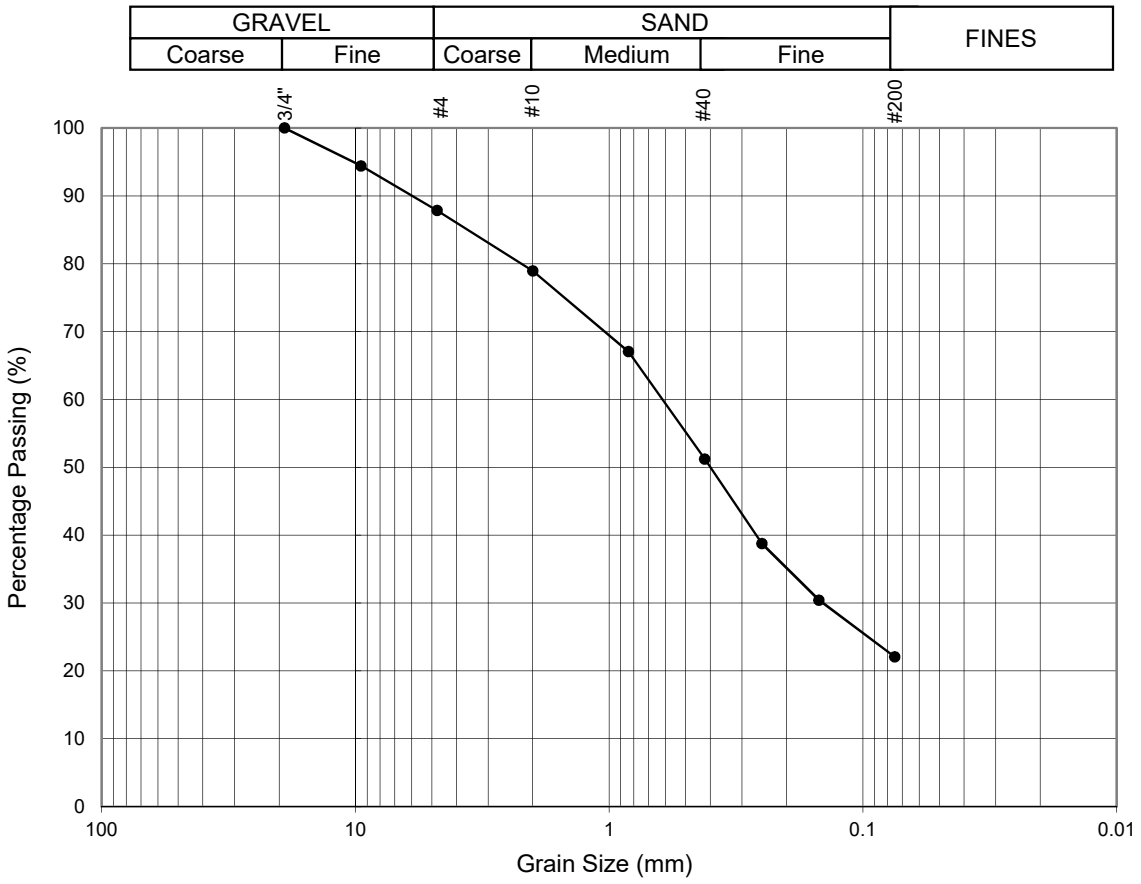
Prepared by:	PC	Checked by:	PS	Approved by:	PS
Date:	May 14, 2020	Date:	May 14, 2020	Date:	May 14, 2020

TETRA TECH CANADA INC.

Form Nº TT106a

Project:	Hatch - CP East Yard Track L30			Project No.:	704-ENG.VGEO03800-01
Location:	Vancouver, BC			Date:	May 14, 2020
Borehole:	BH20-12	Sample No.:	S1	Depth (m):	0.5

Particle Size Distribution (ASTM D422)



Sample No.	Depth (m)	Percentage of Material by Weight (%)					
		Gravel		Sand			Fines
		Coarse	Fine	Coarse	Medium	Fine	
S1	0.5	0	12	9	28	29	22

Comments: _____

Prepared by:	PC	Checked by:	PS	Approved by:	PS
Date:	May 14, 2020	Date:	May 14, 2020	Date:	May 14, 2020

APPENDIX F
Chemical Test Results (CARO)

CERTIFICATE OF ANALYSIS

REPORTED TO	Tetra Tech EBA Inc. (Vancouver) 1000 - 885 Dunsmuir Street Vancouver, BC V6C 1N5		
ATTENTION	Adriana Luis	**WORK ORDER**	0050988
PO NUMBER	704-ENG.VGEO03800-01	**RECEIVED / TEMP**	2020-05-12 14:04 / 19°C
PROJECT	704-ENG.VGEO03800-01	**REPORTED**	2020-05-20 13:46
PROJECT INFO			

Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO 17025:2005 for specific tests listed in the scope of accreditation approved by CALA.

Big Picture Sidekicks

You know that the sample you collected after snowshoeing to site, digging 5 meters, and racing to get it on a plane so you can submit it to the lab for time sensitive results needed to make important and expensive decisions (whew) is VERY important. We know that too.

We've Got Chemistry

It's simple. We figure the more you enjoy working with our fun and engaged team members; the more likely you are to give us continued opportunities to support you.

Ahead of the Curve

Through research, regulation knowledge, and instrumentation, we are your analytical centre for the technical knowledge you need, BEFORE you need it, so you can stay up to date and in the know.

If you have any questions or concerns, please contact me at nyipp@caro.ca

Authorized By:

Nicole Yipp
Team Lead, Client Service

TEST RESULTS

REPORTED TO	Tetra Tech EBA Inc. (Vancouver)	**WORK ORDER**	0050988
PROJECT	704-ENG.VGEO03800-01	**REPORTED**	2020-05-20 13:46

Analyte	Result	RL	Units	Analyzed	Qualifier
BH20-01 S2 (0050988-01) | Matrix: Soil | Sampled: 2020-04-07					
General Parameters					
Sulfate, Water-Soluble	< 0.050	0.050	%	2020-05-20	
pH (1:2 H2O Solution)	**5.51**	0.10	pH units	2020-05-15	
BH20-02 S3 (0050988-02) | Matrix: Soil | Sampled: 2020-04-07					
General Parameters					
Sulfate, Water-Soluble	< 0.050	0.050	%	2020-05-20	
pH (1:2 H2O Solution)	**6.83**	0.10	pH units	2020-05-19	
BH20-05 S1 (0050988-03) | Matrix: Soil | Sampled: 2020-04-07					
General Parameters					
Sulfate, Water-Soluble	< 0.050	0.050	%	2020-05-20	
pH (1:2 H2O Solution)	**5.89**	0.10	pH units	2020-05-15	
BH20-09 S3 (0050988-04) | Matrix: Soil | Sampled: 2020-04-07					
General Parameters					
Sulfate, Water-Soluble	< 0.050	0.050	%	2020-05-20	
pH (1:2 H2O Solution)	**8.13**	0.10	pH units	2020-05-19	
BH20-03 S3 (0050988-05) | Matrix: Soil | Sampled: 2020-04-29					
General Parameters					
Sulfate, Water-Soluble	**0.186**	0.050	%	2020-05-20	
pH (1:2 H2O Solution)	**5.94**	0.10	pH units	2020-05-19	
BH20-06 S2 (0050988-06) | Matrix: Soil | Sampled: 2020-04-29					
General Parameters					
Sulfate, Water-Soluble	< 0.050	0.050	%	2020-05-20	
pH (1:2 H2O Solution)	**8.29**	0.10	pH units	2020-05-15	
BH20-07 S2 (0050988-07) | Matrix: Soil | Sampled: 2020-04-29					
General Parameters					
Sulfate, Water-Soluble	< 0.050	0.050	%	2020-05-20	
pH (1:2 H2O Solution)	**8.03**	0.10	pH units	2020-05-19	
BH20-10 S2 (0050988-08) | Matrix: Soil | Sampled: 2020-04-30					

TEST RESULTS

REPORTED TO	Tetra Tech EBA Inc. (Vancouver)	**WORK ORDER**	0050988
PROJECT	704-ENG.VGEO03800-01	**REPORTED**	2020-05-20 13:46

Analyte	Result	RL	Units	Analyzed	Qualifier
BH20-10 S2 (0050988-08) | Matrix: Soil | Sampled: 2020-04-30, Continued					
General Parameters					
Sulfate, Water-Soluble	< 0.050	0.050	%	2020-05-20	
pH (1:2 H2O Solution)	**8.06**	0.10	pH units	2020-05-15	
BH20-11 S2 (0050988-09) | Matrix: Soil | Sampled: 2020-04-30					
General Parameters					
Sulfate, Water-Soluble	< 0.050	0.050	%	2020-05-20	
pH (1:2 H2O Solution)	**8.02**	0.10	pH units	2020-05-15	
BH20-12 S2 (0050988-10) | Matrix: Soil | Sampled: 2020-04-30					
General Parameters					
Sulfate, Water-Soluble	< 0.050	0.050	%	2020-05-20	
pH (1:2 H2O Solution)	**7.45**	0.10	pH units	2020-05-15	
BH20-12 S3 (0050988-11) | Matrix: Soil | Sampled: 2020-04-30					
General Parameters					
Sulfate, Water-Soluble	< 0.050	0.050	%	2020-05-20	
pH (1:2 H2O Solution)	**8.39**	0.10	pH units	2020-05-15	

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	Tetra Tech EBA Inc. (Vancouver)	**WORK ORDER**	0050988
PROJECT	704-ENG.VGEO03800-01	**REPORTED**	2020-05-20 13:46

Analysis Description	Method Ref.	Technique	Location
pH in Soil	Carter 16.2 / SM 4500-H+ B (2017)	1:2 Soil/Water Slurry / Electrometry	Richmond
Sulfate, Water-Soluble in Soil	CSA A23.2-3B / CSA A23.2-2B	Extraction (HCl) / Gravimetry (Barium Sulfate Precipitation)	Richmond

Glossary of Terms:

RL	Reporting Limit (default)
%	Percent
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
pH units	pH < 7 = acidic, ph > 7 = basic
CSA	Canadian Standards Association Chemical Test Methods
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

General Comments:

The results in this report apply to the samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Results in **Bold** indicate values that are above CARO's method reporting limits. Any results that are above regulatory limits are highlighted **red**. Please note that results will only be highlighted red if the regulatory limits are included on the CARO report. Any Bold and/or highlighted results do not take into account method uncertainty. If you would like method uncertainty or regulatory limits to be included on your report, please contact your Account Manager:nyipp@caro.ca

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Tetra Tech EBA Inc. (Vancouver)	**WORK ORDER**	0050988
PROJECT	704-ENG.VGEO03800-01	**REPORTED**	2020-05-20 13:46

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in “batches” and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup)**: An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- **Blank Spike (BS)**: A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- **Matrix Spike (MS)**: A second aliquot of sample is fortified with with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM)**: A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B0E1220										
Blank (B0E1220-BLK1)				Prepared: 2020-05-15, Analyzed: 2020-05-20						
Sulfate, Water-Soluble	< 0.050	0.050	%							
Duplicate (B0E1220-DUP1)			**Source: 0050988-01**	Prepared: 2020-05-15, Analyzed: 2020-05-20						
Sulfate, Water-Soluble	< 0.050	0.050	%		< 0.050				19	
Matrix Spike (B0E1220-MS1)			**Source: 0050988-02**	Prepared: 2020-05-15, Analyzed: 2020-05-20						
Sulfate, Water-Soluble	0.641	0.050	%	0.671	< 0.050	88	63-117			

APPENDIX G
Seismic Hazard

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

Site: 49.285N 123.065W **User File Reference:** CP East L Yard 2020-05-05 22:08 UT

Requested by: Tetra Tech Canada

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.430	0.297	0.213	0.094
Sa (0.1)	0.653	0.453	0.326	0.144
Sa (0.2)	0.809	0.568	0.412	0.183
Sa (0.3)	0.811	0.574	0.417	0.183
Sa (0.5)	0.716	0.502	0.361	0.151
Sa (1.0)	0.406	0.279	0.195	0.077
Sa (2.0)	0.247	0.165	0.112	0.042
Sa (5.0)	0.079	0.046	0.028	0.009
Sa (10.0)	0.028	0.016	0.010	0.003
PGA (g)	0.351	0.247	0.179	0.078
PGV (m/s)	0.527	0.359	0.249	0.093

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" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. 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.**

References

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

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
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

APPENDIX H
Impact Assessment for Metro Vancouver Sewer

TETRA TECH

TECHNICAL MEMO

ISSUED FOR USE

To:	Mr. Ian McKenna Hatch Corporation	**Date:**	March 26, 2021
		Memo No.:	VGEO03974-01_01 Rev.0
From:	Shahrooz Rashidi / Lothar Chan John P. Sully	**File:**	704-ENG.VGEO03974-01

Subject: **CP East L Yard Expansion Utility Impact Assessment**

Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix A and Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by Hatch Corporation (Hatch) to perform an impact assessment of the proposed Canadian Pacific (CP) East L Yard Expansion on the nearby Metro Vancouver sewer utility. The proposed development is located along Commissioner Street in Vancouver, B.C. between CP Mile 125.34 and Mile 126.93 in Vancouver, B.C. The work consists of construction of L30, L31 and Columbia Container Lead (CCL) tracks near existing Metro Vancouver Harbour East Interceptor Combined Gravity Sewer (MV-HEI Sewer).

The proposed track layout and cross-sections provided by Hatch (Utility Conflict Plans, H362376-UT-100-S0-4410 to -4416 Rev.A) are attached in Appendix B. Based on the information provided by Hatch, west of Sta. 0+980 the proposed L30 and L31 tracks are to be constructed south of MV- HEI Sewer at varying distances from the pipe centerline. It is understood that east of Sta. 0+960, where the existing MV-HEI crosses below the proposed L30 track (and is to be realigned, by others), the pipe will be grouted and abandoned in place.

The Columbia Container Lead (CCL) track is to be constructed north of the MV-HEI Sewer and crosses the sewer to connect to the L31 track at about Sta. 6+400. It is understood a protection slab will be used at the crossing to protect the MV-HEI Sewer.

Tetra Tech scope of services is limited to geotechnical aspects of the proposed rail development and is summarized as follows:

- review available geotechnical information and assess the ground conditions in the area near the proposed tracks;
- assess the potential impact on the MV-HEI Sewer.

The purpose of this technical memorandum is to provide the results of the impact assessment study relevant to the design and construction of the CP L Yard expansion on the MV-HEI Sewer.

2.0 SITE CONDITION / SITE LOGISTICS / SITE LAYOUT

Based on the information provided by Hatch, the proposed CP L Yard expansion will consist of the following components:

Tetra Tech Canada Inc.
Suite 1000 – 10th Floor, 885 Dunsmuir Street
Vancouver, BC V6C 1N5 CANADA
Tel 604.685.0275 Fax 604.684.6241

- Construction of L30 and L31 tracks to the south of Commissioner Street between Commissioner Street overpass (East) and Victoria Drive (West);
- Construction and realignment of the Columbia Container Lead (CCL) track north of Commissioner Street. The CCL track is proposed to exit the Columbia Container Yard near Nanaimo Street crossing Commissioner Street to connect to L31 track.

The information provided by Hatch (Appendix B) provides five typical sections (Sections A through E) and detailed sections showing the locations of the proposed tracks in relation to the existing MV-HEI Sewer pipe. Seven sections were selected to carry out the impact assessment. A summary of the seven sections including the station, proposed grade elevation, pipe invert elevation, horizontal and vertical offset distance from the pipe centerline is provided in Table 1. It should be noted that the station numbers referenced in this report correspond to the chainage along L30 track.

Additional details about the typical sections relevant to the impact assessment study are as follows:

Section A: represents the proposed development layout to the east of Sta. 0+980. It is our understanding that the existing MV utility to the east of approximate Sta.0+980 is to be capped, grouted and abandoned. Hence, an impact assessment is not required for this section.

Section B: corresponds to the proposed development layout between about Sta. 0+980 and Sta.1+600. Along the noted chainage, the existing MV-HEI Sewer is considered to be located outside of the proposed L30 and L31 track zone of influence. Hence, no additional stresses or settlements along the sewer pipe due to construction of the proposed rail expansion is anticipated.

Sections C, D, E, 2+175 and 2+225: these represent the condition to the west of about Sta. 1+600 where the MV-HEI Sewer is considered to be within the zone of influence of the proposed CP L Yard Expansion tracks. Analyses to examine the potential impact on the MV-HEI Sewer were performed, and the details are discussed in the following sections of this report.

At the time of preparation of this report, the proposed CCL track at the Commissioner Street crossing was under review by Hatch and was not included as part of this study.

3.0 GEOTECHNICAL CONDITIONS

The project site is located on the south shore of Burrard Inlet. The Surficial Geology Map No. 1486A, prepared by the Geological Survey of Canada identifies the subsurface soil conditions at this site to consist of landfill over bedrock. The landfill is understood to include sand, gravel, and (reworked) till. Bedrock is anticipated to be located within 10 m from the ground surface.

The geotechnical information relevant to the evaluation is presented in the geotechnical report referenced below:

- Tetra Tech Canada Inc. (June 2020) Geotechnical Assessment for CP East L Yard Expansion – L30 Track (File No. 704-ENG.VGEO03800-01)

The general soil conditions in the area consist of 2 m of compact to dense sand and gravel, followed by about 2 m to 3 m of loose to compact sand and silt. The sand and silt layer is underlain by till-like material which is generally present at depths of less than 5 m below the existing ground surface. Based on the available data, a pocket of peat within the sand and silt unit was found in test hole BH20-03, indicating the potential presence of soft compressible material between Sta. 2+100 and Sta. 2+300. The interpreted soil conditions relevant to each of the three sections

analyzed are summarized in Table 2. Soil profile drawings illustrating the subsurface soil conditions and variations along the proposed development were presented in the referenced report. The reference soil profile drawings are included in Appendix C for completeness. For the engineering analyses, the ground water level is considered to be located at a depth of about 3 m below ground surface.

4.0 IMPACT ON METRO VANCOUVER HARBOUR EAST SANITARY SEWER INTERCEPTOR

The settlement criteria for the concrete segmental sewer pipe were provided by MV Proximal Works, indicating a differential settlement tolerance along the pipe of 1 in 1500, and a total vertical pipe settlement not exceeding 10 mm.

The base of the 1511 mm MV sewer interceptor is located at elevations varying from El. 0.93 m near section C to El. 0.19 m near section E, translating to depths of about 4 m to 4.5 m below the proposed tracks. The horizontal offset distance between the track and the centerline of the sewer varies from about 2.5 m to 4.1 m west of section C.

To assess the impact from the proposed L30 and L31 track loading on the MV sewer interceptor and to account for the three-dimensional effect of the soil response and loading, 3D finite element analyses were conducted using the commercially available program PLAXIS 3D (version 20 update 4). The analyses were conducted using the best-estimate soil parameters. To account for the effect of the stiffness of the utility impacting the change in the stress distribution in the surrounding soils, the MV sewer pipe was also incorporated in the model. Pipe stiffness properties were provided by Hatch and are included in Appendix D. The following assumptions and limitations should be noted:

- Soil conditions are assumed to be homogeneous. The actual settlement will be sensitive to any changes in the soil conditions (e.g. difference in compaction of the surrounding backfill).
- The precision of the settlement prediction required to evaluate the Proximal Works Requirements falls outside the accuracy of the soil model due to the inherent assumptions.

The analysis was performed assuming a 0.4 m thick track bed structure (consisting of 200 mm (8”) of sub-ballast and 200 mm (8”) of ballast) and the loading associated with an E90 train. To estimate the differential settlement, the maximum of which is expected to occur outside the loaded area, assumptions were made to estimate the load distribution from a single axle across adjacent rail ties. The assumed load distribution is shown on Figure 1. The settlement calculations in PLAXIS were performed using a sustained train loading. In reality, the live load exerted by the train is a transient load. The rate of drainage of the compressible layer will be slow relative to the duration of the axle loading cycle. Therefore, the estimated settlements presented herein are likely conservative.

The general layout of the analyses including the settlement and stress contours for Section E, which is considered to be the most critical section analyzed, are presented on Figure 2a and Figure 2b. Additional details about the impact assessment study completed for each of the typical sections analyzed are presented below:

Section C: represents the condition between approximately Sta. 1+600 and Sta. 1+700. Along this section the pipe is located within the L31 track zone of influence. The maximum vertical stress increase on top of the MV-HEI sewer pipe, due to track bed and E90 train wheel loading is estimated to be less than about 5 kPa. No soft soils are inferred at this location and the maximum settlement associated with the placement of the track bed and train loading is estimated to be negligible. The analysis results in terms of total vertical stress on top of pipe and settlement below the base of the pipe are presented on Figure 3a and Figure 3b, respectively. Settlements below the sewer pipe are considered to be negligible since soft soils are not anticipated to be present along this section.

Section D: corresponds to the proposed development layout between about Sta. 1+700 and Sta. 2+100. Along the noted chainage the pipe is located within the L31 track zone of influence. In this area, the foundation soils are inferred to be granular. The maximum vertical stress increase on top of the pipe is estimated to be about 5 kPa. The maximum settlement associated with the placement of the track bed and train loading is estimated to be negligible. The analysis results in terms of total vertical stress on top of pipe and settlement below the base of the pipe are presented on Figure 4a and Figure 4b, respectively.

Section E: corresponds to the CP L Yard expansion between approximately Sta. 2+100 and Sta. 2+310. Along the noted chainage the pipe is located within the L31 track zone of influence. In this area, the foundation soils are inferred to consist of soft compressible peat. Based on the analysis results, the maximum vertical stress increase on top of pipe is estimated to be about 25 kPa. The maximum settlement associated with the placement of the track bed and train loading is estimated to be less than 10 mm. The analysis results in terms of total vertical stress on top of pipe and settlement below the base of the pipe are presented on Figure 5a and Figure 5b, respectively. Sections 2+175 and 2+225 were selected to carry out additional evaluation, assuming the peat extends laterally to these locations. The results of the analyses are presented on Figures 6a through 7b, and indicate a lower settlement and stress increase compared to Section E.

The results indicate that the ground settlement is not expected to exceed the MetroVan limit of 10 mm. With regards to the 10 mm settlement exceedance, the following should be taken into consideration:

- The precision of the settlement prediction required to evaluate the Proximal Works Requirements falls outside the accuracy of the soil model due to the inherent assumptions.
- If the finished grade for the rail embankment is to be at or lower than the existing ground surface elevation, net foundation loading will be close to zero. Therefore, the long-term settlement along the sewer is anticipated to be caused solely by E90 train loading.
- Considering the close proximity of the MV-HEI pipe base elevation to the till-like material, the soft compressible material below the base of the pipe may have been excavated and replaced by pipe bedding material. It is recommended that Metro Vancouver be consulted and/or as-built drawings be reviewed to confirm the extent of pipe bedding material. In the case where soft compressible material has been excavated and replaced by granular pipe bedding, total settlements due to track bed construction and E90 loading can be expected to be less than 5 mm.

The vertical differential settlement along the length of the utility is estimated to be less than 1 in 1500 mm for all sections analyzed. The Metro Vancouver “Proximal Work Requirements” document does not provide any information about loading stress tolerances for MV Utilities. Allowable loading stress tolerances should be evaluated and verified by a utility engineer.

5.0 LIMITATIONS OF REPORT

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6.0 CLOSURE

We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully Submitted,
Tetra Tech Canada Inc.

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Mar. 26, 2021

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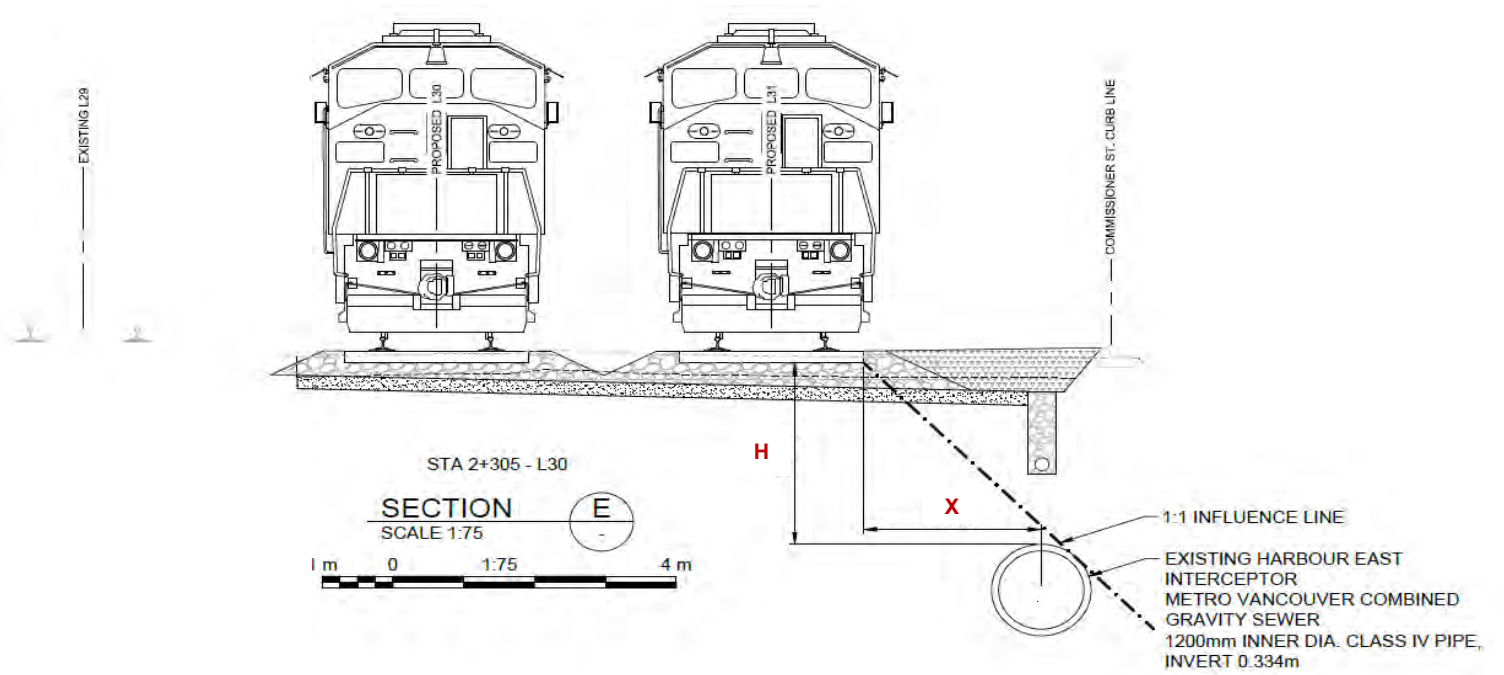
TABLES AND FIGURES

Section	Station No.	Invert El. (m)	Pipe Outside Diameter (m)	Pipe Wall Thickness (m)	Top of Pipe El. (m)	Vertical Distance to Edge of Rail Tie, H (m)	Horizontal Distance from Edge of Tie to Pipe Center, X (m)	Base of Pipe El. (m)	Base of Rail Tie El. (m)	Approximate Ground Surface El. (m)
* Section A	0+956	3.178	To be Capped, Grouted and Abandoned after CSRR							
** Section B	1+332	1.71	1.442	0.1875	2.96	2.27	5.02	1.52	5.24	4.50
Section C	1+643	1.075	1.511	0.146	2.44	2.31	3.55	0.93	4.75	4.70
Section D	1+808	0.906	1.511	0.146	2.27	2.56	3.65	0.76	4.83	4.40
-	2+175	0.40	1.511	0.146	1.76	2.72	4.12	0.25	4.48	4.40
-	2+225	0.30	1.511	0.146	1.66	2.58	2.76	0.15	4.24	4.24
Section E	2+305	0.334	1.511	0.146	1.70	2.80	2.51	0.19	4.50	4.50

* Considering the pipe is to be capped and abondoned, it was not included as part of Tetra Tech's analyses

** The pipe is considered to be outside of the tracks L30 and L31 influence zone



Section C - Station 1+643 (BH20-06 & BH20-07)

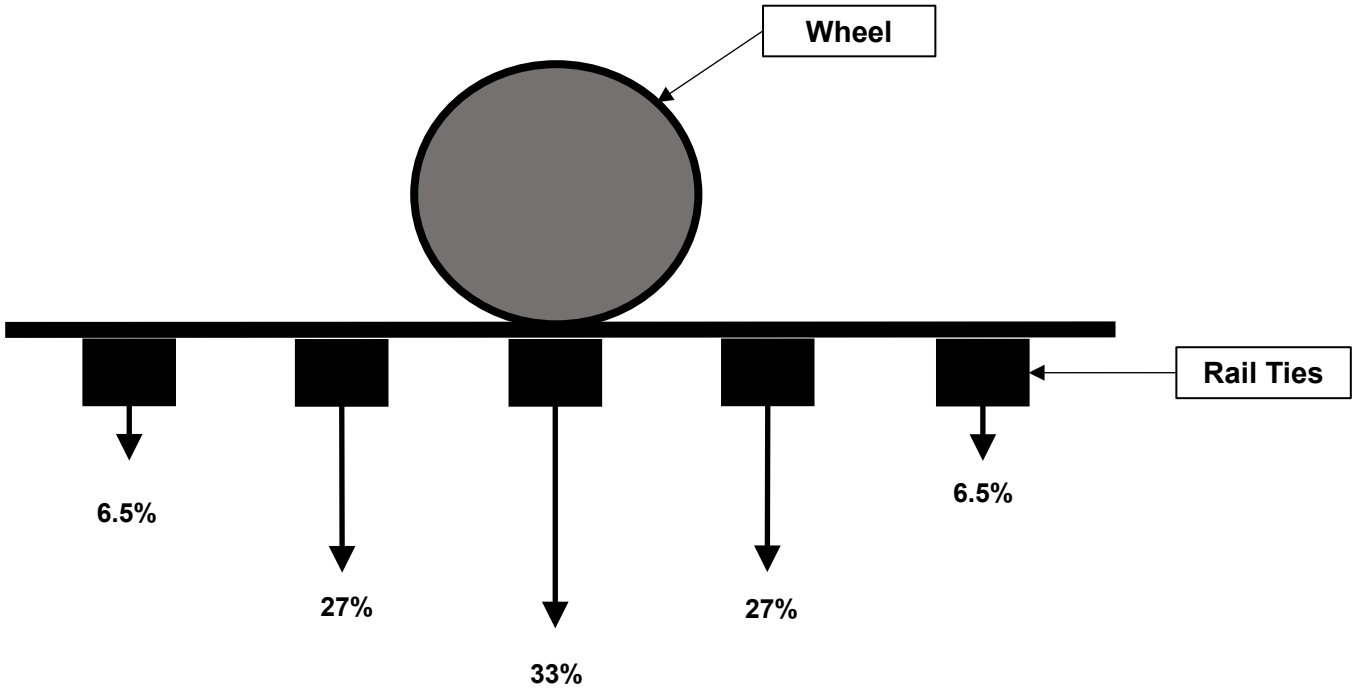
Depth (m)		Elevation (m)		Material	γ (kN/m^3)	DCPT Blows	ϕ (deg)	S_u (kPa)	Plaxis Analyses Soil Parameters							
From	To	From	To						C_c	C_r	e_0	ν	E^{ref}_{50} (KPa)	E^{ref}_{oed} (KPa)	E^{ref}_{ur} (KPa)	m
0.0	1.0	4.1	3.1	Dense gravelly SAND (FILL)	19.0	30 - 60	38	-	-	-	-	0.2	38,400	38,400	115,200	0.50
1.0	1.8	3.1	2.3	Compact gravelly SAND (FILL)	19.0	10 - 25	34	-	-	-	-	0.2	28,800	28,800	86,400	0.50
1.8	3.8	2.3	0.3	Loose silty SAND to SAND & SILT	18.0	3 - 10	28	-	-	-	-	0.25	13,000	13,000	39,000	0.50
> 3.8		< 0.3		TILL-LIKE	20.0	-	40	-	-				-	-	-	-

Section D - Station 1+808 (BH20-04 & BH20-05)

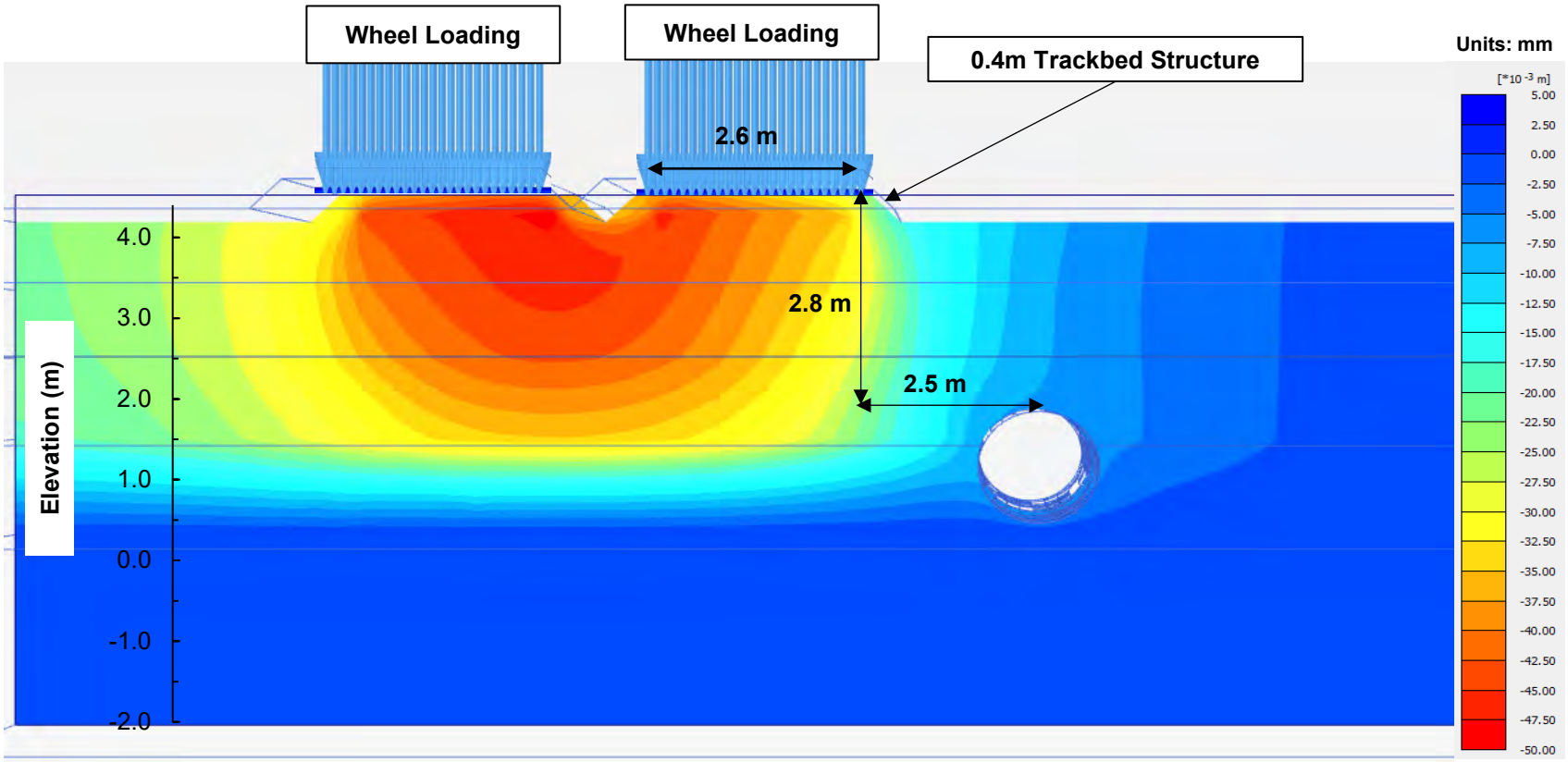
Depth (m)		Elevation (m)		Material	γ (kN/m^3)	DCPT Blows	ϕ (deg)	S_u (kPa)	Plaxis Analyses Soil Parameters							
From	To	From	To						C_c	C_r	e_0	ν	E^{ref}_{50} (KPa)	E^{ref}_{oed} (KPa)	E^{ref}_{ur} (KPa)	m
0.0	1.0	4.4	3.4	Dense gravelly SAND (FILL)	19.0	30 - 60	38	-	-	-	-	0.2	38,400	38,400	115,200	0.50
1.0	2.0	3.4	2.4	Compact gravelly SAND (FILL)	19.0	10 - 25	34	-	-	-	-	0.2	28,800	28,800	86,400	0.50
2.0	4.4	2.4	0.0	Loose silty SAND to SAND & SILT	18.0	8- 15	28	-	-	-	-	0.25	13,000	13,000	39,000	0.50
> 4.4		< 0.0		TILL-LIKE	20.0	-	40	-	-				-	-	-	-

Section E - Station 2+305 (BH20-02 & BH20-03)

Depth (m)		Elevation (m)		Material	γ (kN/m^3)	DCPT Blows	ϕ (deg)	S_u (kPa)	Plaxis Analyses Soil Parameters							
From	To	From	To						C_c	C_r	e_0	ν	E^{ref}_{50} (KPa)	E^{ref}_{oed} (KPa)	E^{ref}_{ur} (KPa)	m
0.0	1.0	4.4	3.4	Dense gravelly SAND (FILL)	19.0	30 - 60	38	-	-	-	-	0.2	38,400	38,400	115,200	0.50
1.0	2.0	3.4	2.4	Compact gravelly SAND (FILL)	19.0	10 - 25	34	-	-	-	-	0.2	28,800	28,800	86,400	0.50
2.0	3.2	2.4	1.2	Loose silty SAND to SAND & SILT	18.0	3 - 10	28	-	-	-	-	0.25	13,000	13,000	39,000	0.50
3.2	4.6	1.2	-0.2	PEAT	15.0	1 - 5	-	15	2.6	0.5	2.65	0.3	-	-	-	-
> 4.8		< -0.2		TILL-LIKE	20.0	-	40	-	-				-	-	-	-

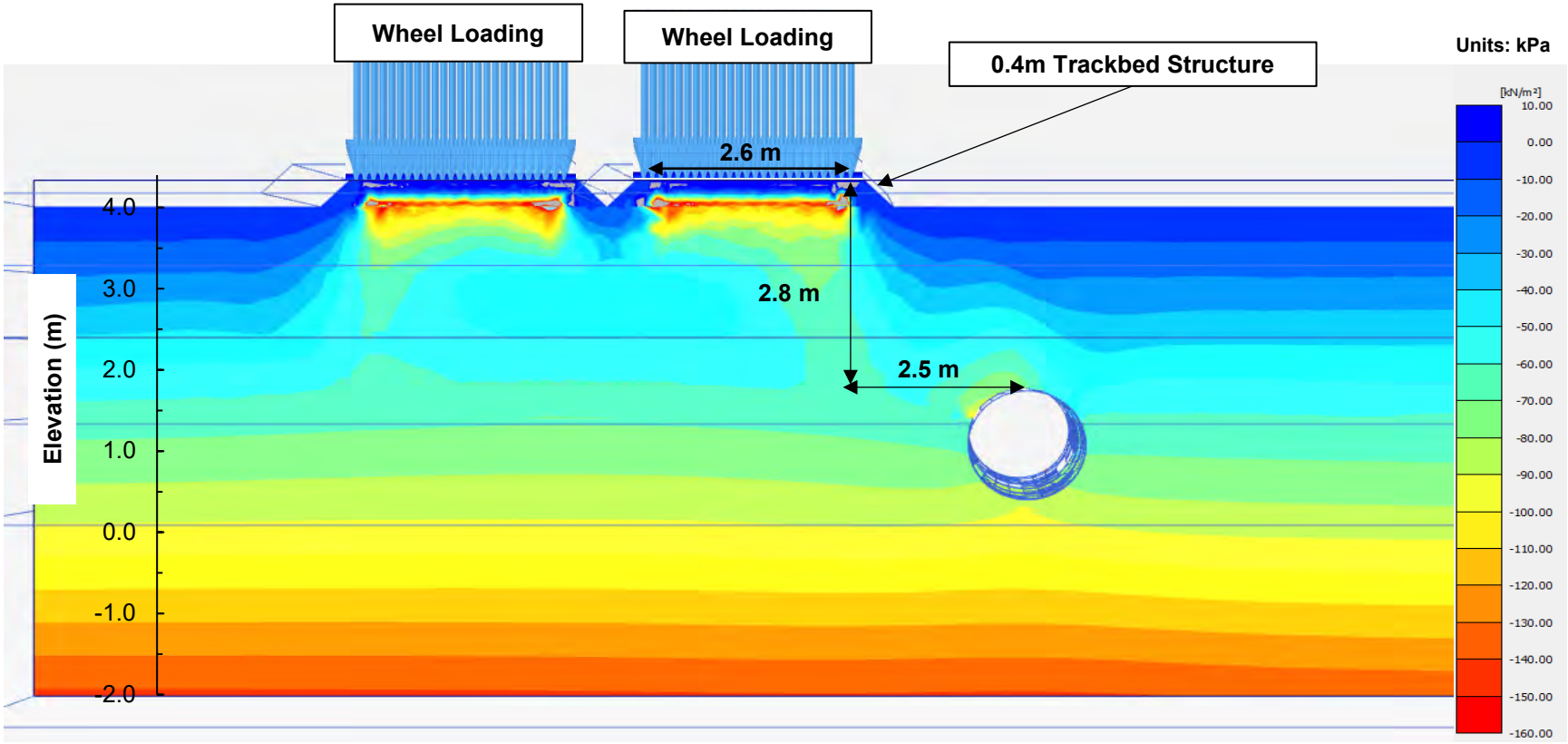


Assumed Wheel Load Distribution



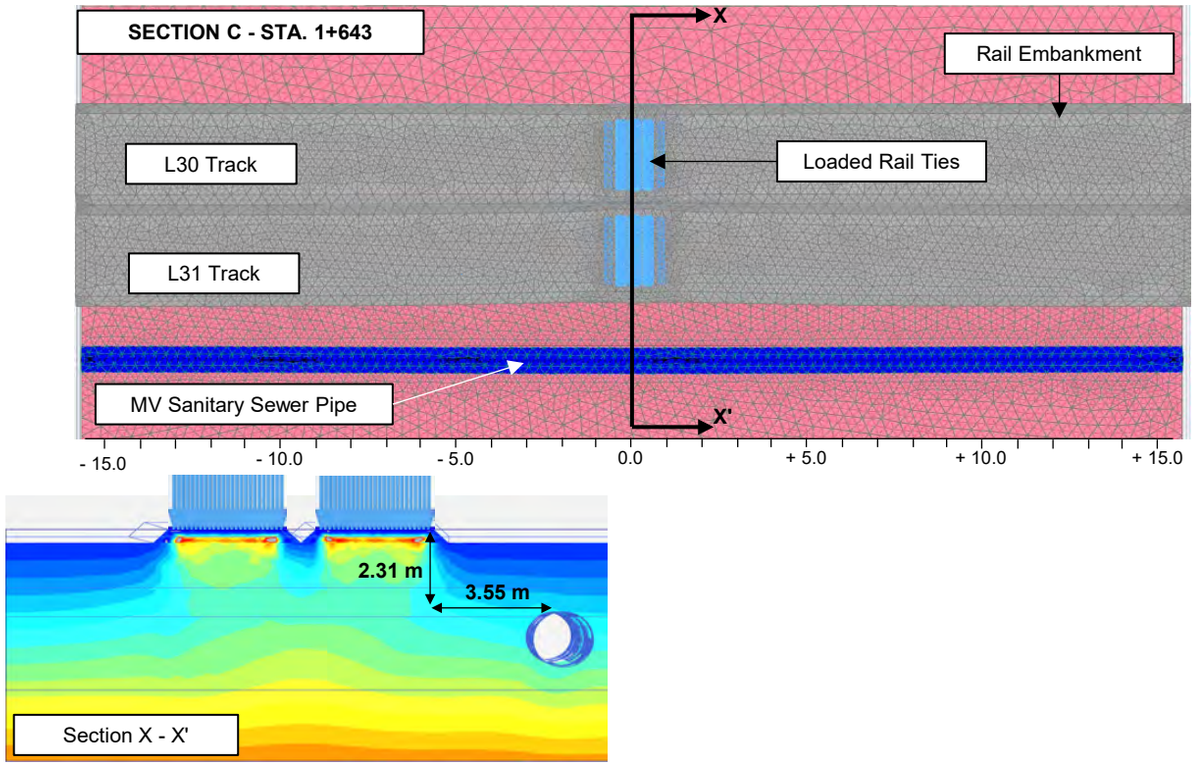
PLAXIS 3D ANALYSES
SECTION E - STA. 2+305
Vertical Settlement Contours

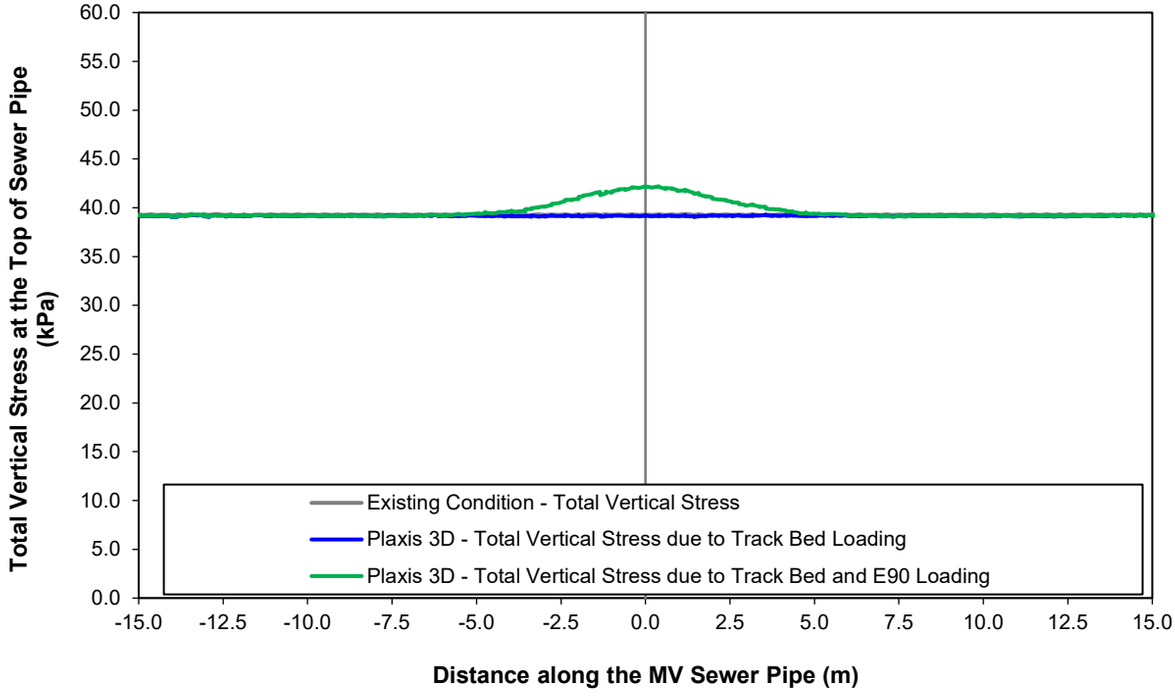
Figure 2a



PLAXIS 3D ANALYSES
SECTION E - STA. 2+305
Vertical Total Stress Contours

Figure 2b

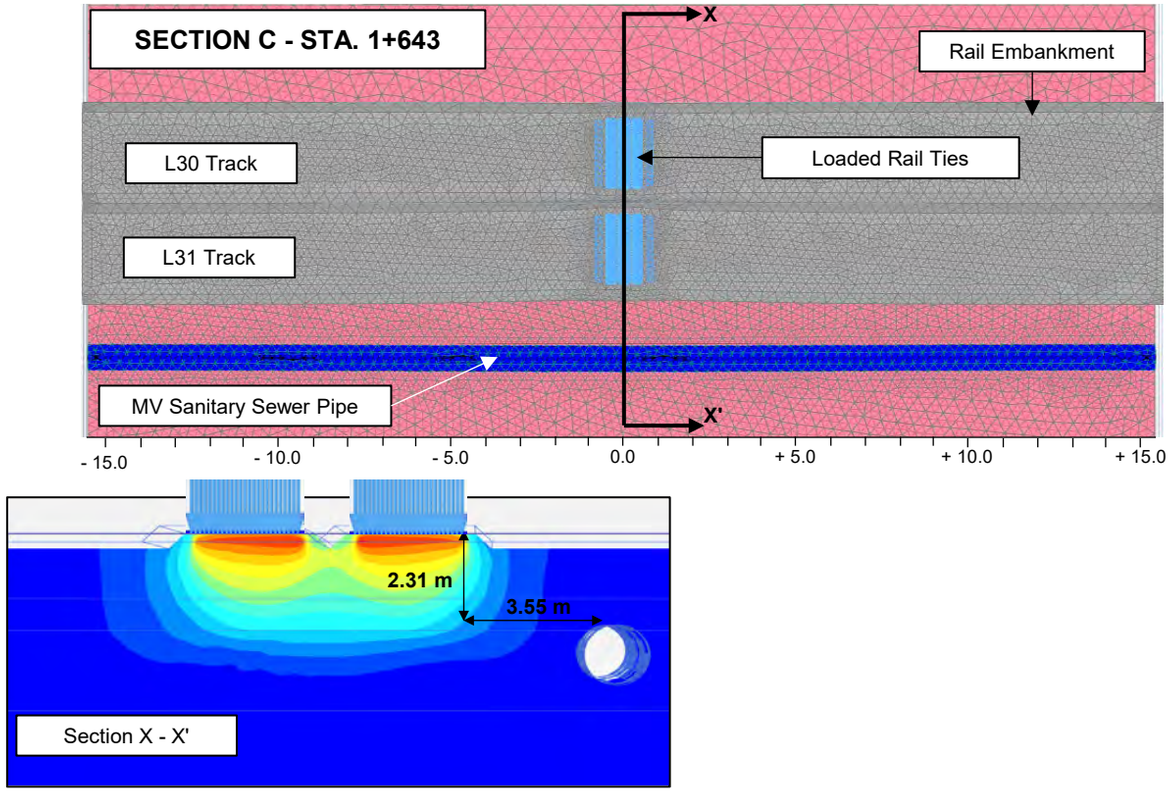


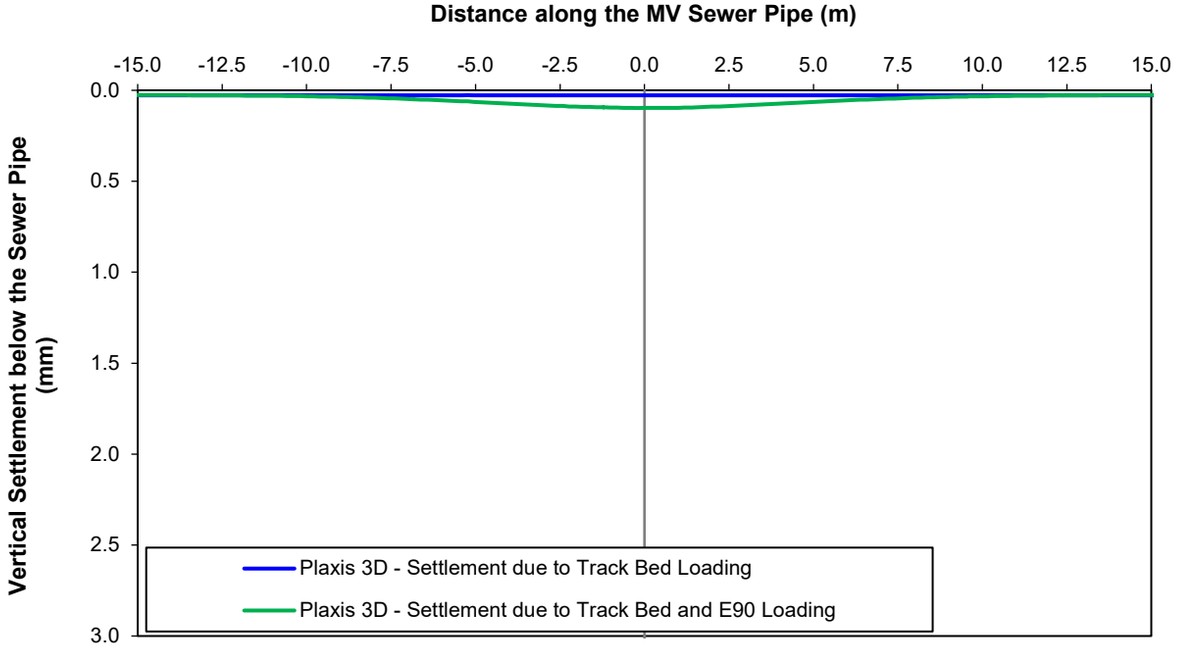


STRESS DISTRIBUTION
SECTION C - STA. 1+643

TETRA TECH

Figure 3a

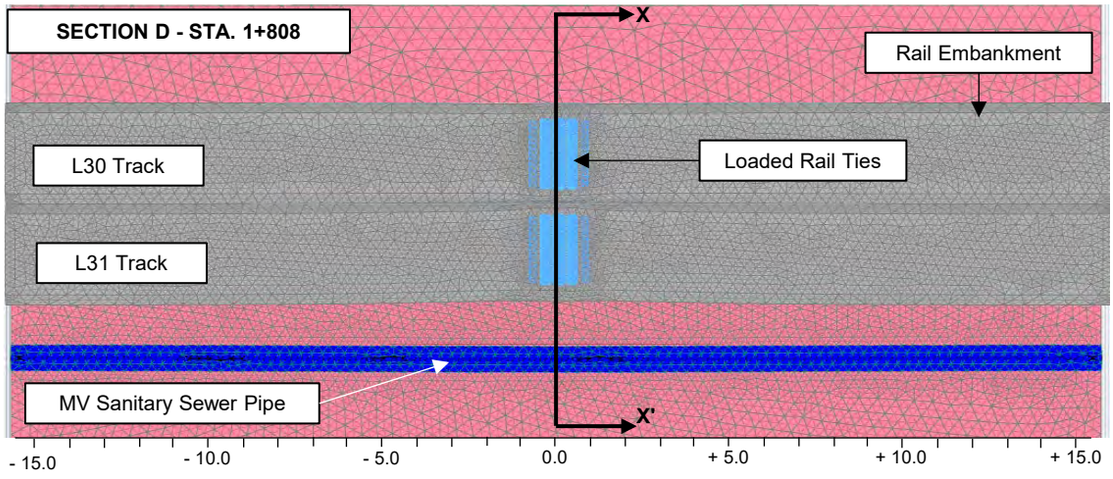


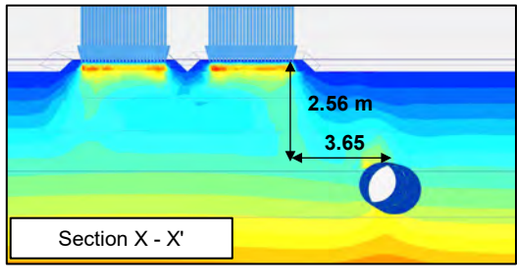


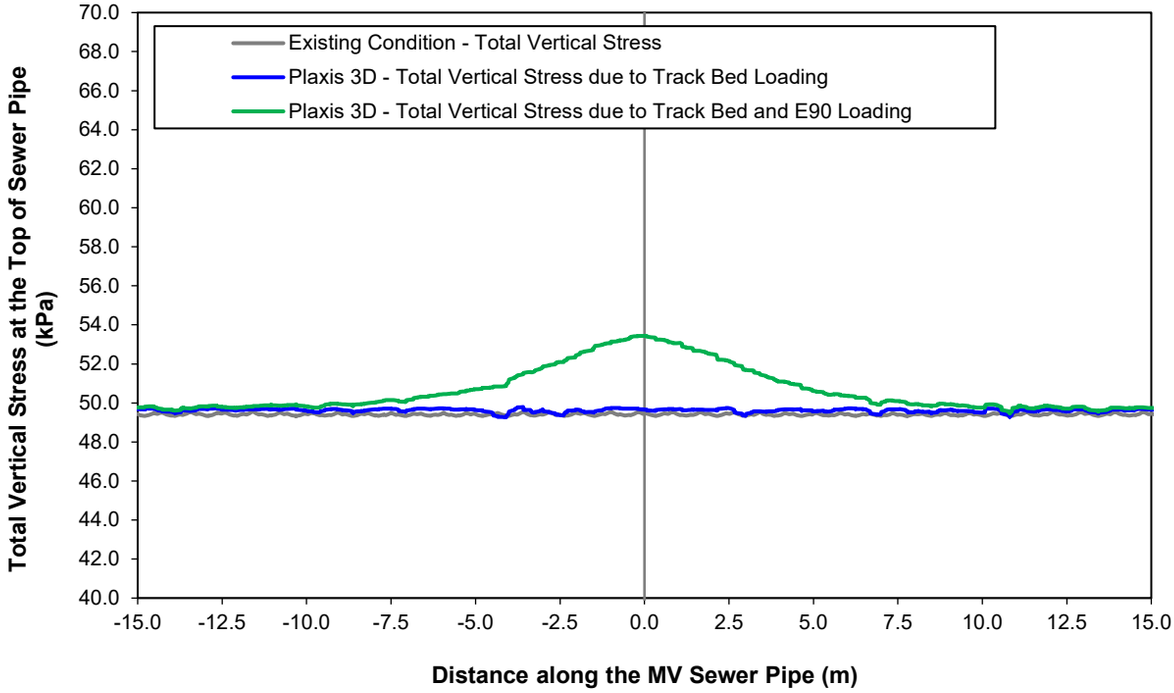
SETTLEMENT DISTRIBUTION
SECTION C - STA. 1+643

TETRA TECH

Figure 3b



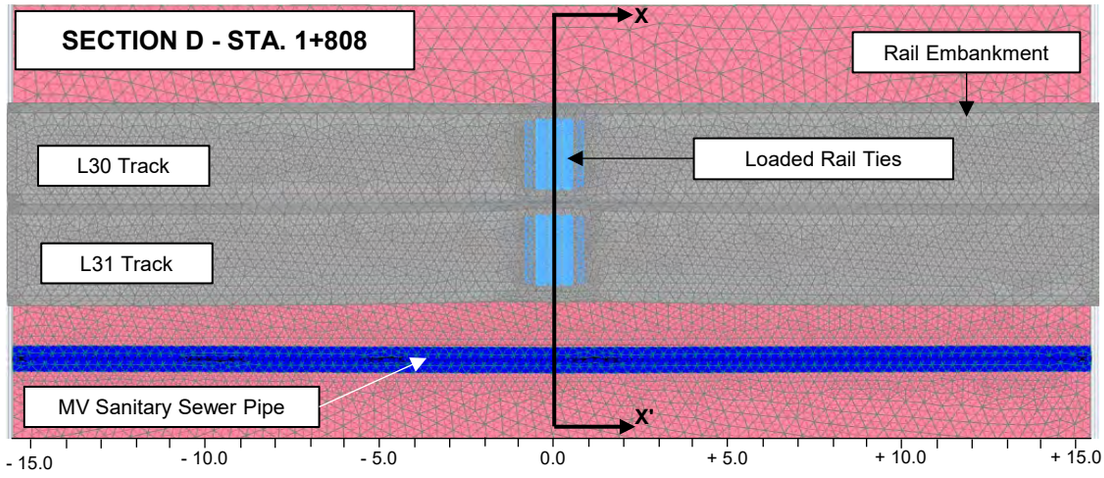


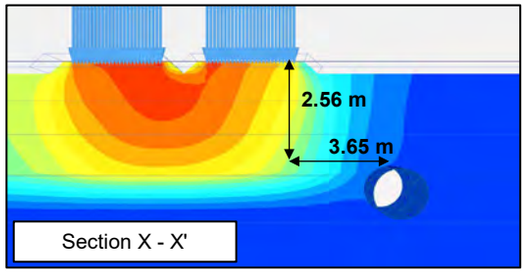


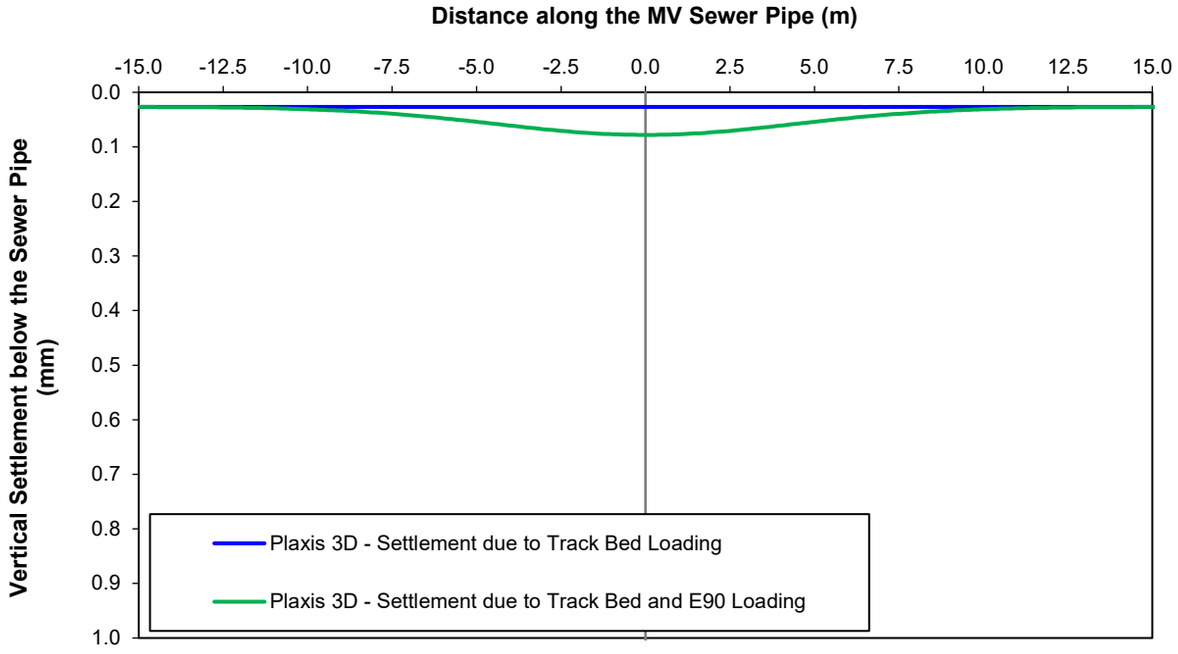
STRESS DISTRIBUTION
SECTION D - STA. 1+808

TETRA TECH

Figure 4a



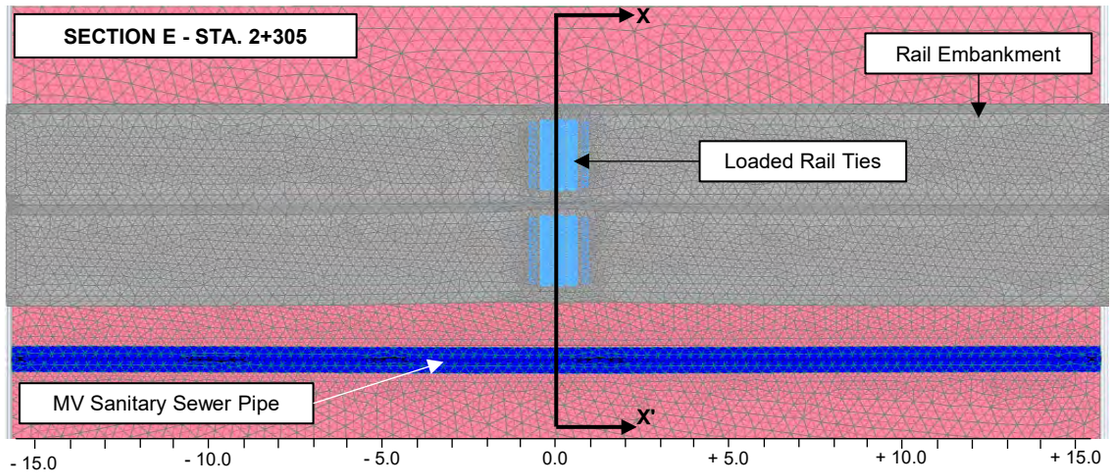


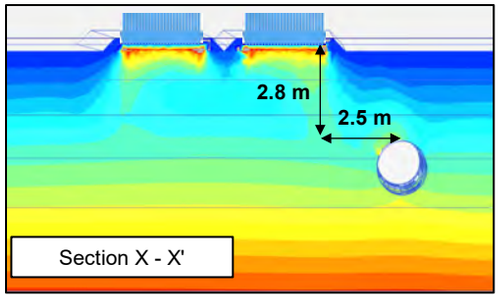


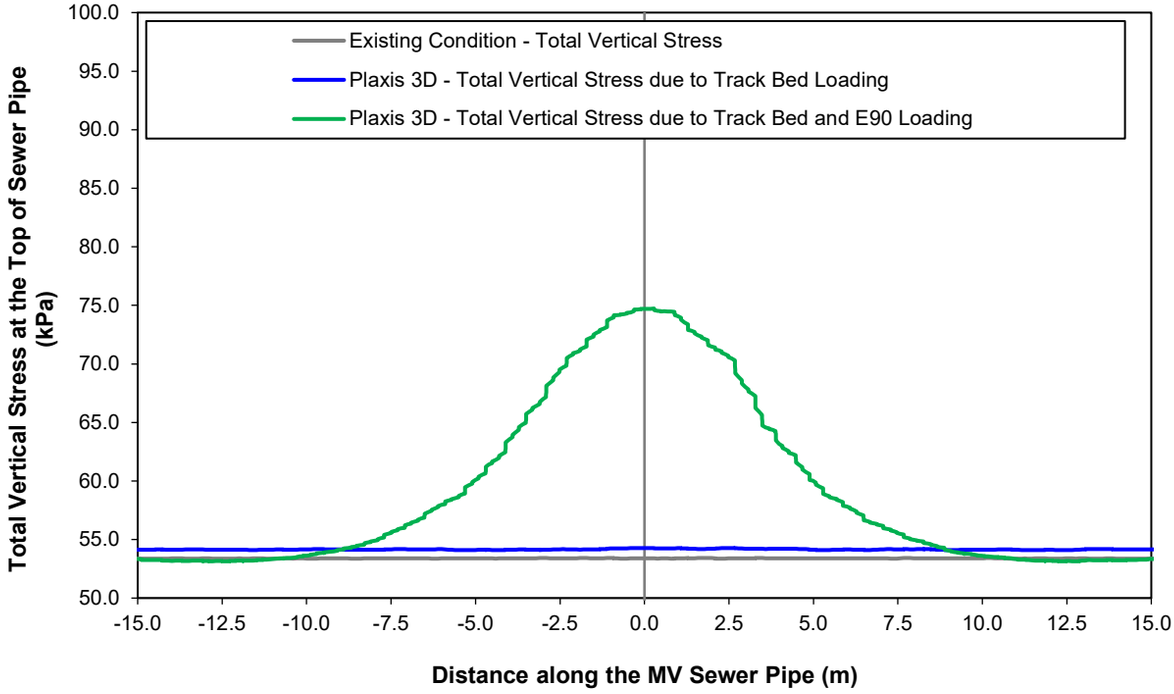
SETTLEMENT DISTRIBUTION
SECTION D - STA. 1+808

TETRA TECH

Figure 4b



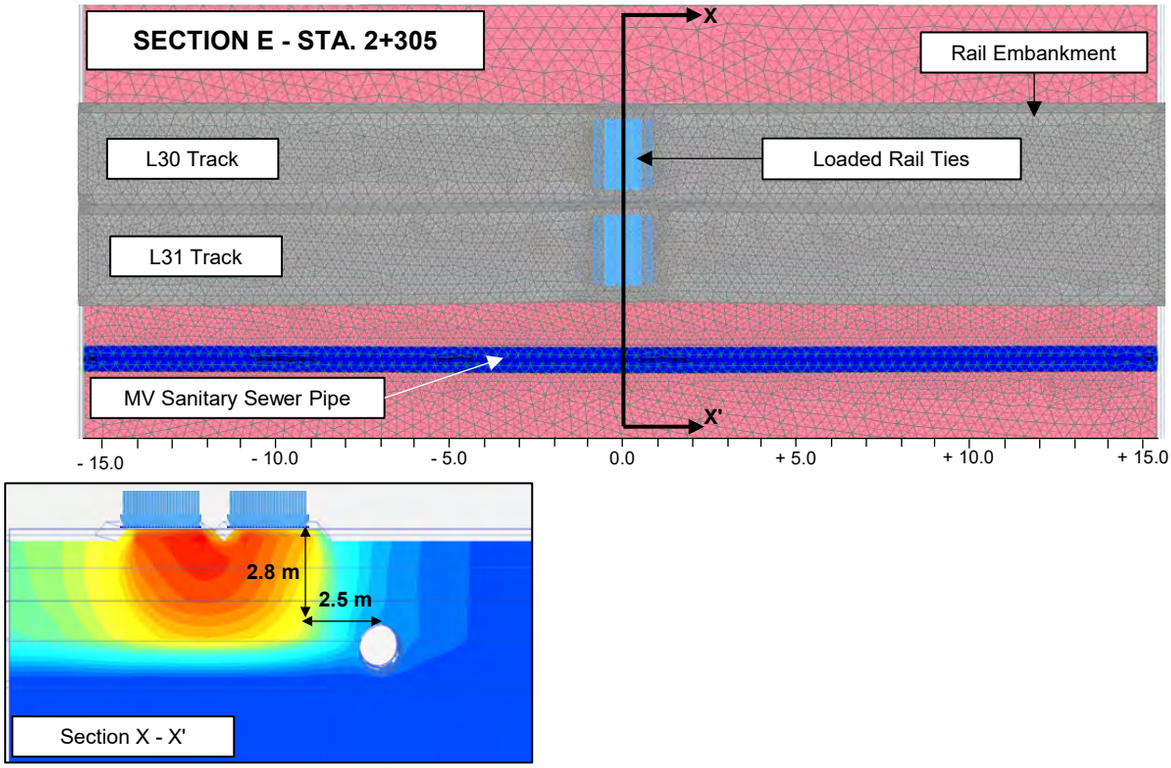


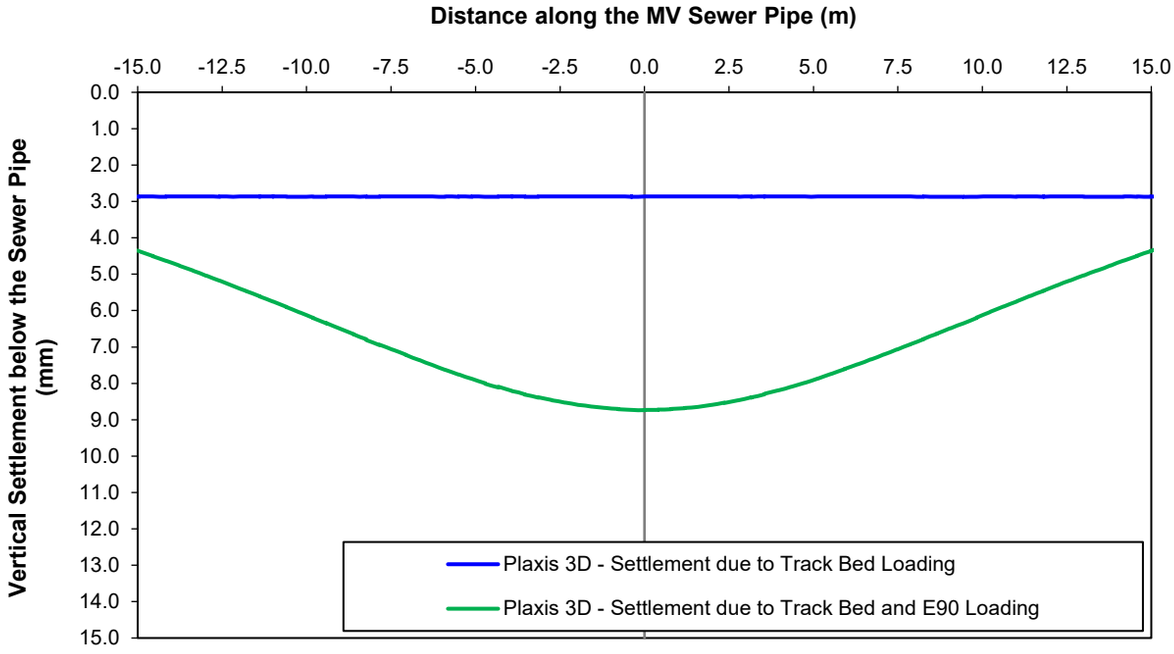


STRESS DISTRIBUTION
SECTION E - STA. 2+305

TETRA TECH

Figure 5a

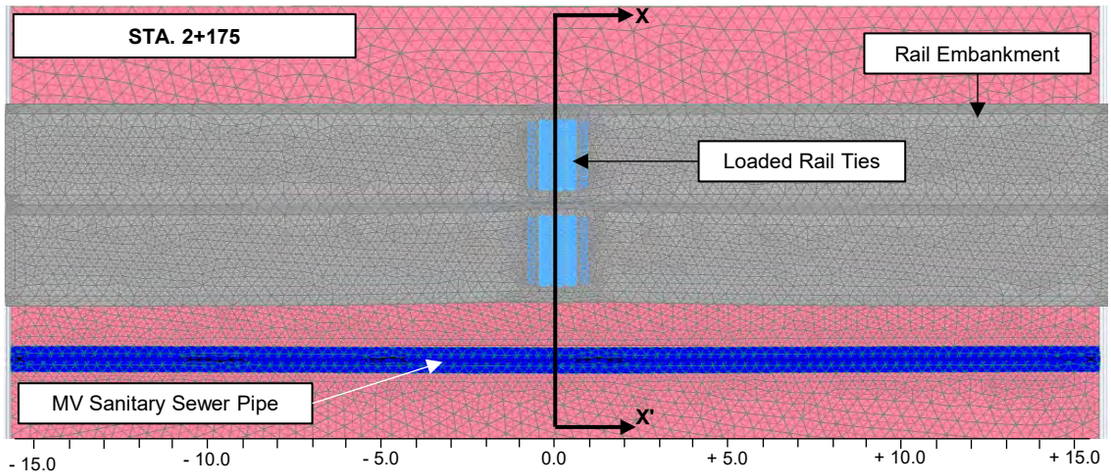


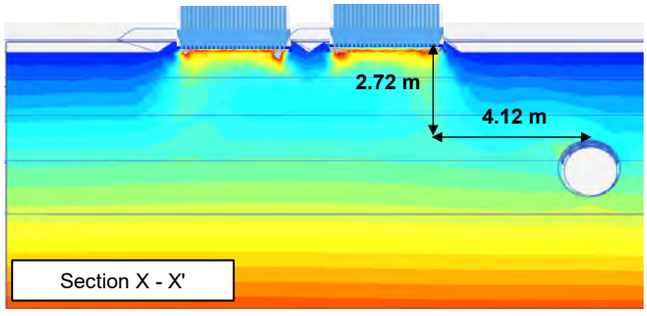


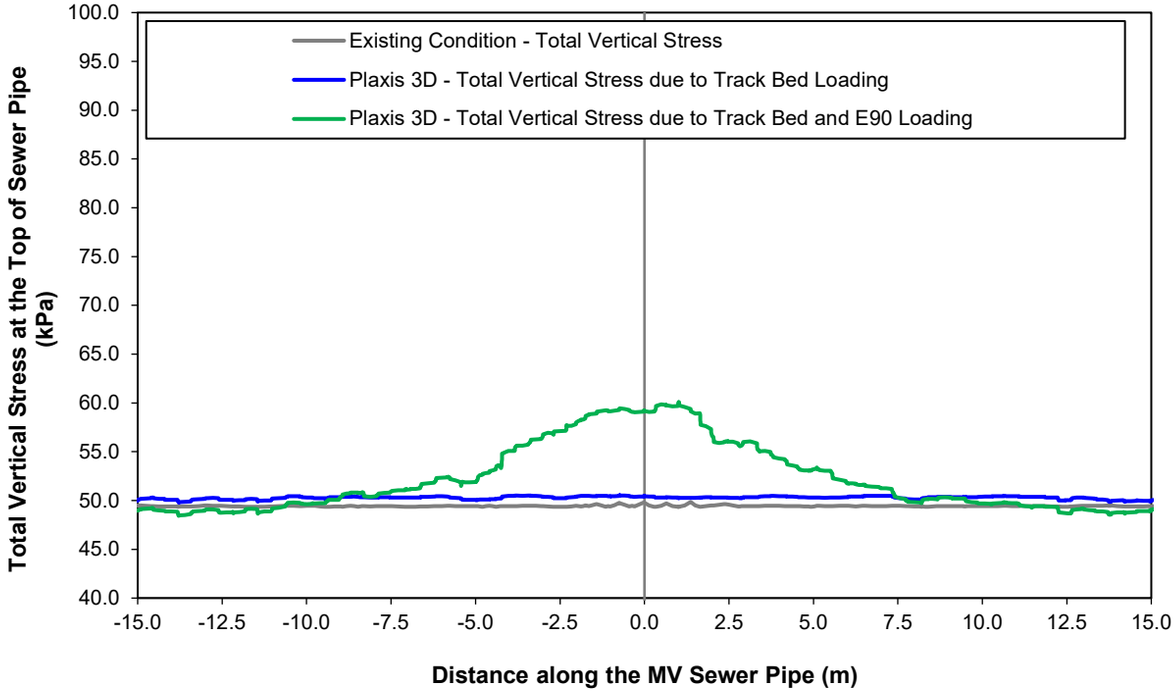
SETTLEMENT DISTRIBUTION
SECTION E - STA. 2+305

TETRA TECH

Figure 5b



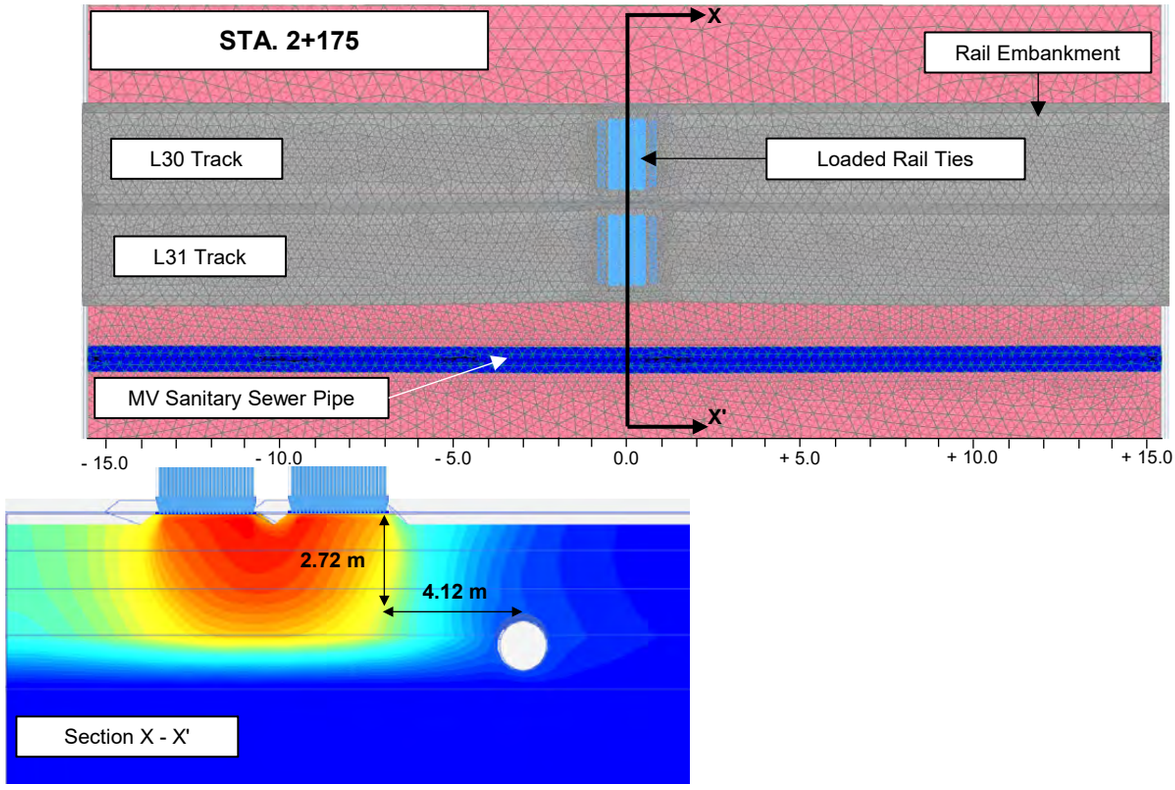


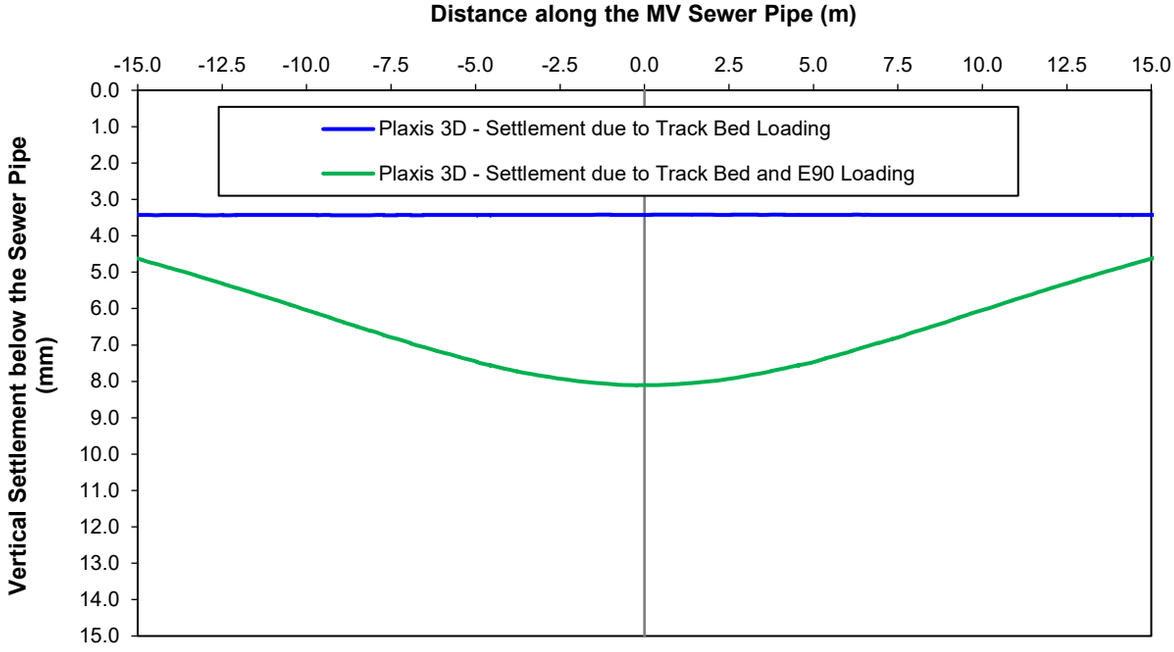


STRESS DISTRIBUTION
SECTION E - STA. 2+175

TETRA TECH

Figure 6a

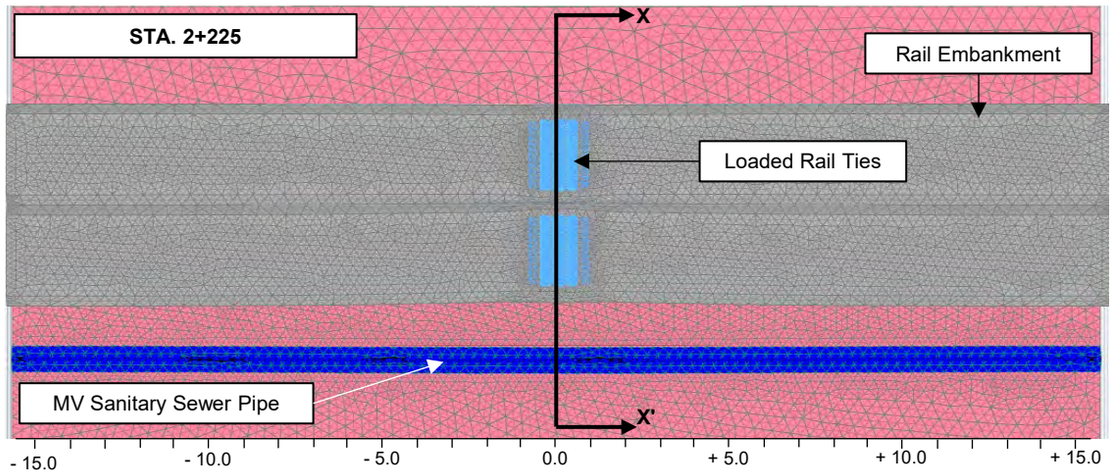


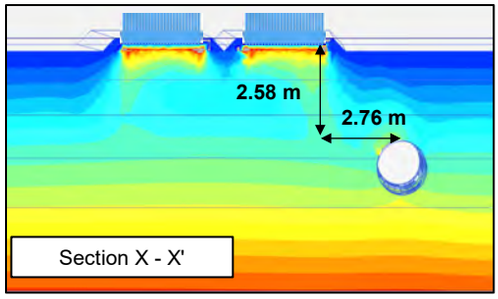


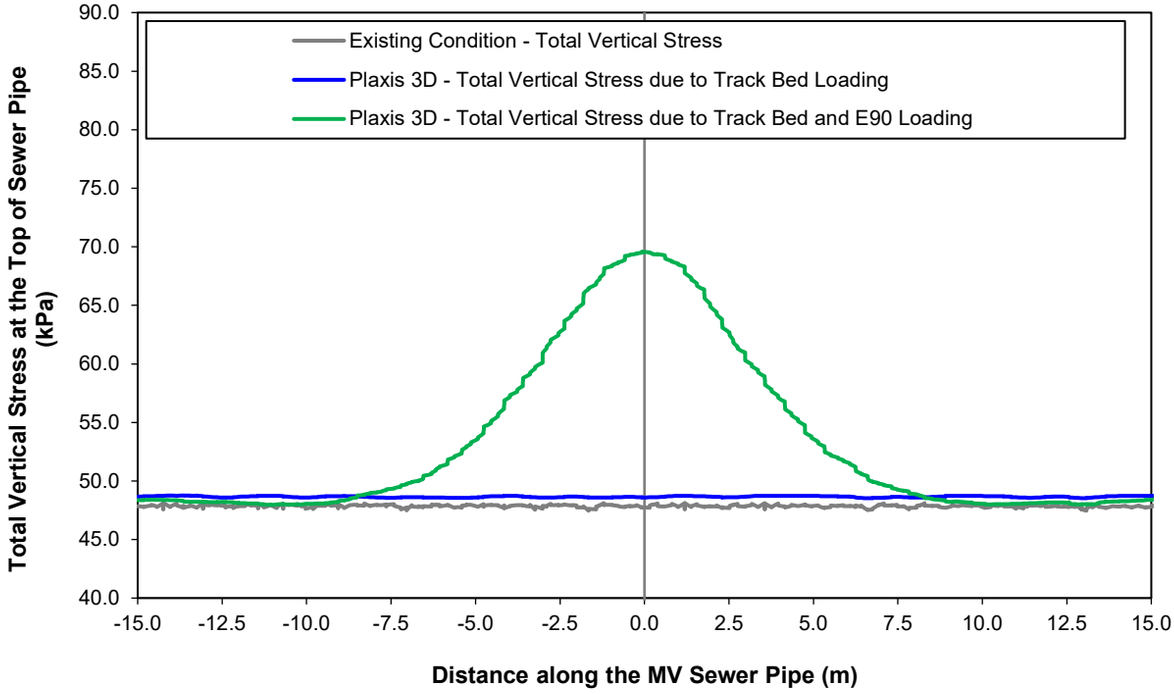
SETTLEMENT DISTRIBUTION
SECTION E - STA. 2+175

TETRA TECH

Figure 6b



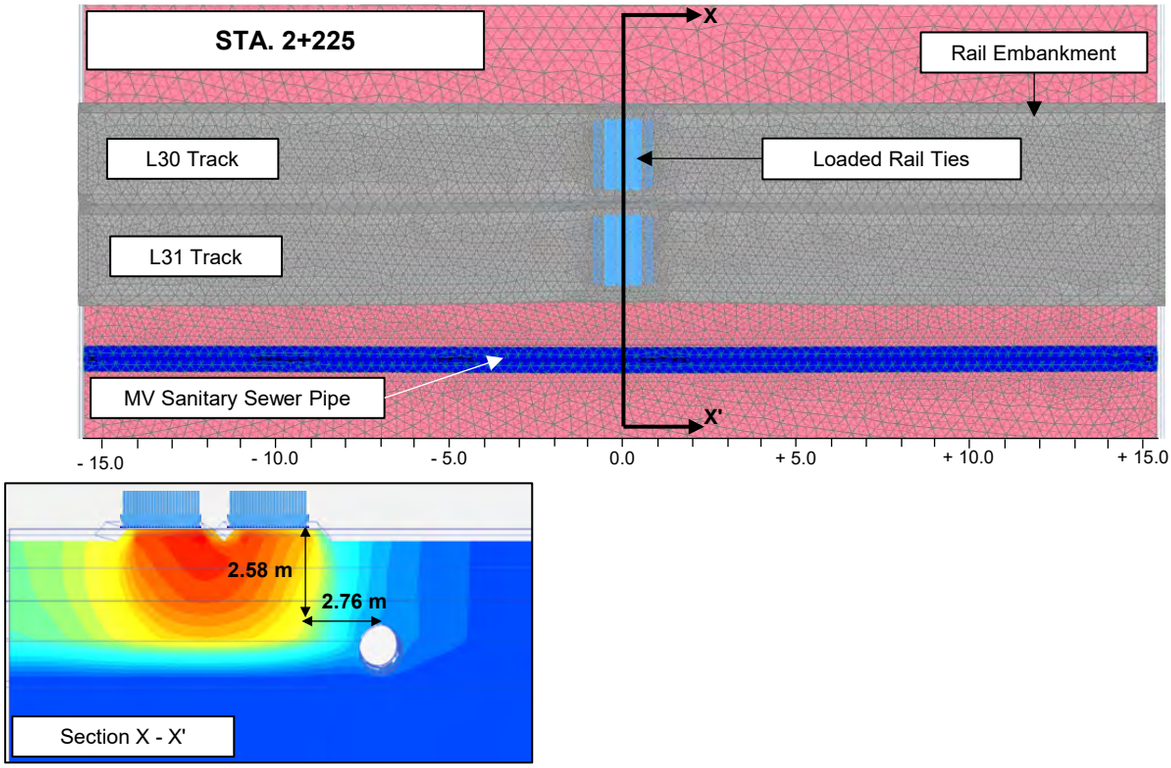


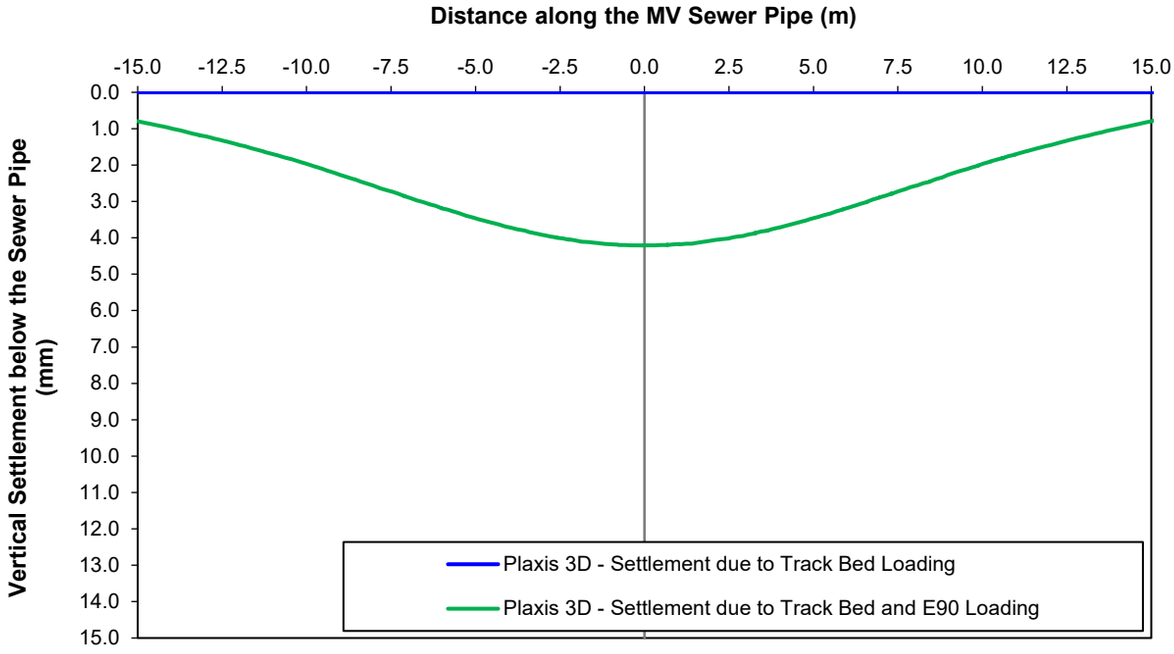


STRESS DISTRIBUTION
SECTION E - STA. 2+225

TETRA TECH

Figure 7a





SETTLEMENT DISTRIBUTION
SECTION E - STA. 2+225

TETRA TECH

Figure 7b

APPENDIX A
LIMITATIONS ON USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

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Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

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If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this document, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to explore, address or consider and has not explored, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems, methods and standards employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historical environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional exploration and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques, and construction sequence are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function. Where temporary or permanent drainage systems are installed within or around a structure, these systems must protect the structure from loss of ground due to mechanisms such as internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design details regarding the geotechnical aspects of such systems (e.g. bedding material, surrounding soil, soil cover, geotextile type) should be reviewed by the geotechnical engineer to confirm the performance of the system is consistent with the conditions used in the geotechnical design.

1.16 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

This document has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. TETRA TECH cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.

APPENDIX B

SITE PLAN AND TYPICAL SECTION PROVIDED BY HATCH

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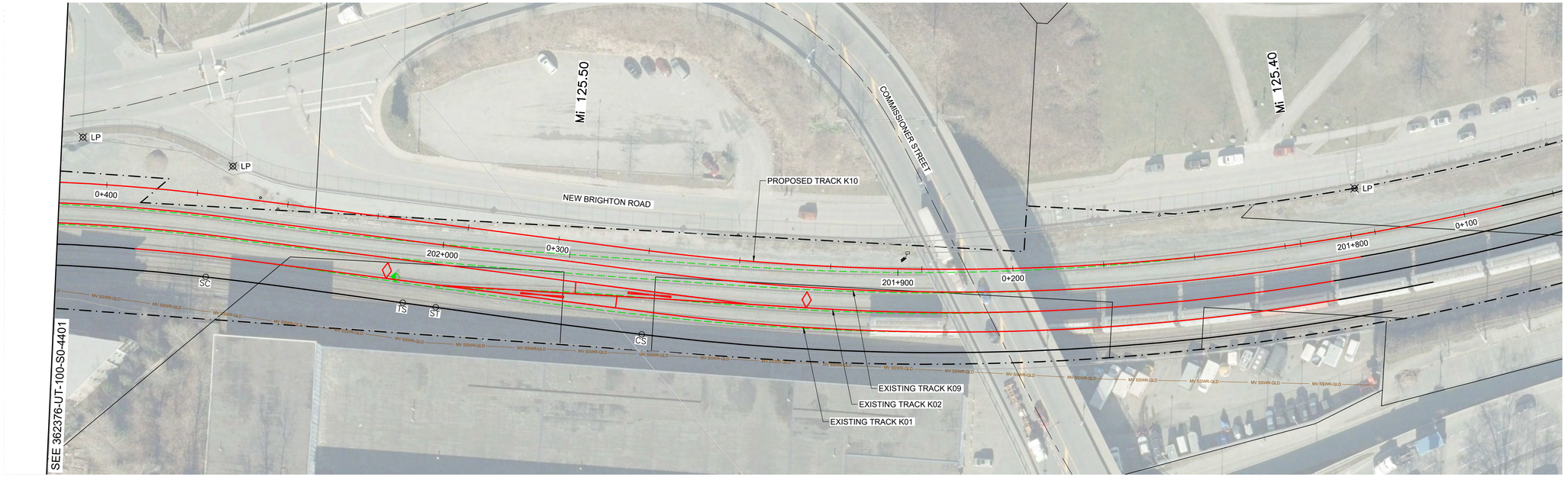

PLAN
SCALE 1:500
5 m 0 1:500 25 m

CONFLICTS WITH PROPOSED TRACKS

		Stations				Utility Info	
Conflict No.	Track	Project Stations of L30 (m), From/To		Mainline Mileage, From/To		Abandoned	Quality Level
H1	L30	0+445	0+450	125.590	125.593	*No - Concrete encased*	D
H2	L30	0+450	0+965	125.593	125.913	*Yes - CSRR Project*	D
H3	L31	1+485	1+620	126.233	126.320	No	B
H4	L31	1+620	1+650	126.320	126.339	No	D
H5	L31	1+775	1+825	126.416	126.447	No	D
H6	L31	2+000	2+325	126.556	126.758	No	D

NOTES:

1. ZONE OF POTENTIAL TRACKING (ZPTL) DEFINED AS 1:1 SLOPE OFF END OF TIE
2. SEWER ELEVATION DATA FROM METRO VANCOUVER RECORD DRAWINGS
3. TRACK ALIGNMENT SHOWN FOR ILLUSTRATIVE PURPOSES ONLY AND SUBJECT TO CHANGE

UTILITIES LEGEND:

CATCH BASIN	CB
STORM / SEWER MANHOLE	MH
POWER POLE	PP
LAMP STANDARD	LS
EQUIPMENT BOX	EB
HYDRANT	FH
WATERMAIN VALVE	
GAS MAIN VALVE	

HEI SEWER - EXISTING FROM SURVEY FEB. 2021 — MV SSWR-QLB
HEI SEWER - EXISTING FROM VFPA / CoV GIS — MV SSWR-QLD
HEI SEWER - PROPOSED BY AECOM CSRR PROJECT — SAN
HEI SEWER - REMOVALS BY CSRR PROJECT

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A	11-09-20	ISSUED FOR 30% DESIGN	R.N.F.

ENGINEERING PROJECTS - WEST

VANCOUVER DIVISION MILE 125.37 TO 127.00 CASCADE SUBDIVISION

EAST L YARD EXPANSION
UTILITY CONFLICT PLANS
HARBOUR EAST INTERCEPT - SHEET 1 OF 7

DWG. BY: CHK BY:	OFFICE FILE:
MANAGER - DESIGN:	SCALE: **AS SHOWN**
M. FAVREAU DIR. PROJECT SERVICES WEST	DATE:
	PLAN No. H362376-UT-100-S0-4410
	Rev. A

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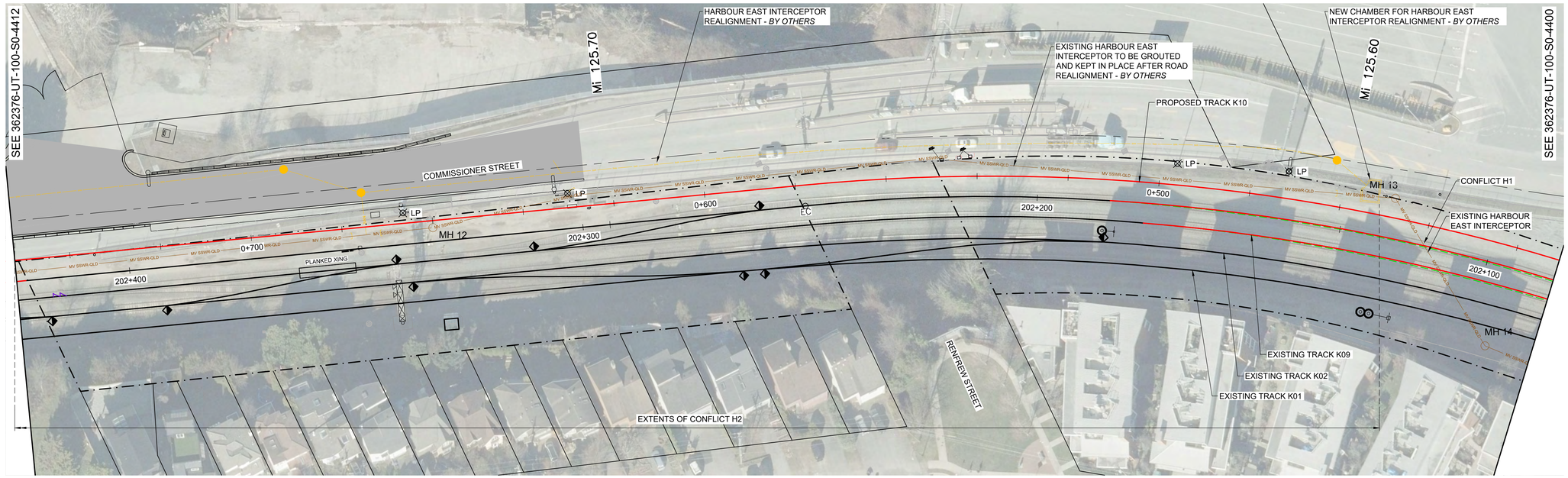

TO VANCOUVER

FROM PORT COQUITLAM

PLAN

SCALE 1:500

5 m 0 1:500 25 m

CONFLICTS WITH PROPOSED TRACKS

		Stations				Utility Info	
Conflict No.	Track	Project Stations of L30 (m), From/To		Mainline Mileage, From/To		Abandoned	Quality Level
H1	L30	0+445	0+450	125.590	125.593	*No - Concrete encased*	D
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H3	L31	1+485	1+620	126.233	126.320	No	B
H4	L31	1+620	1+650	126.320	126.339	No	D
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H6	L31	2+000	2+325	126.556	126.758	No	D

NOTES:

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CATCH BASIN	CB
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LAMP STANDARD	LS
EQUIPMENT BOX	EB
HYDRANT	FH
WATERMAIN VALVE	
GAS MAIN VALVE	

HEI SEWER - EXISTING FROM SURVEY FEB. 2021	MV SSWR-QLB
HEI SEWER - EXISTING FROM VFPA / CoV GIS	MV SSWR-QLD
HEI SEWER - PROPOSED BY AECOM CSRR PROJECT	SAN
HEI SEWER - REMOVALS BY CSRR PROJECT	SAN

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A	11-09-20	ISSUED FOR 30% DESIGN	R.N.F.

ENGINEERING PROJECTS - WEST

VANCOUVER DIVISION MILE 125.37 TO 127.00 CASCADE SUBDIVISION

EAST L YARD EXPANSION
UTILITY CONFLICT PLANS
HARBOUR EAST INTERCEPT - SHEET 2 OF 7

DWG. BY: CHK BY:	OFFICE FILE:
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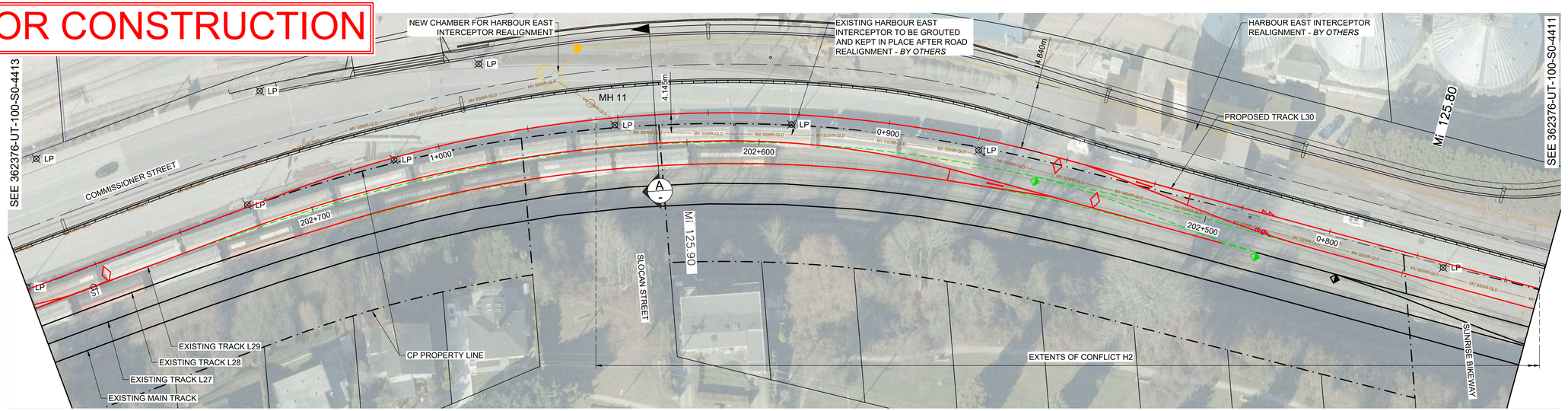

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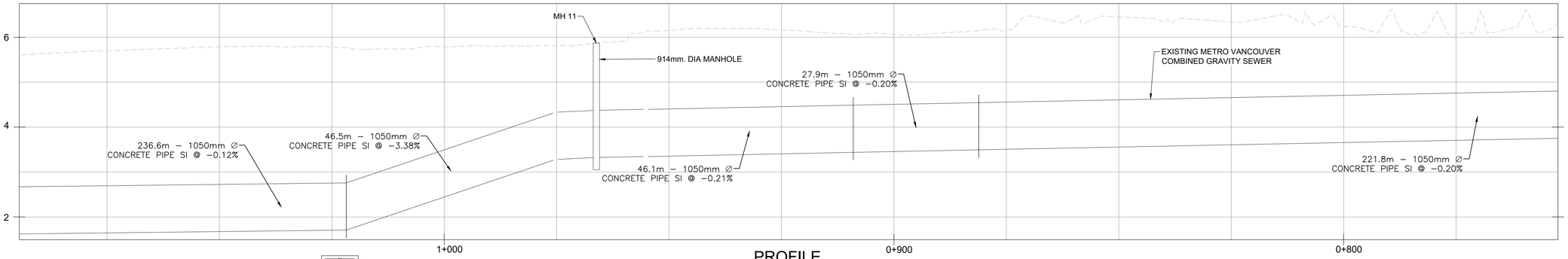

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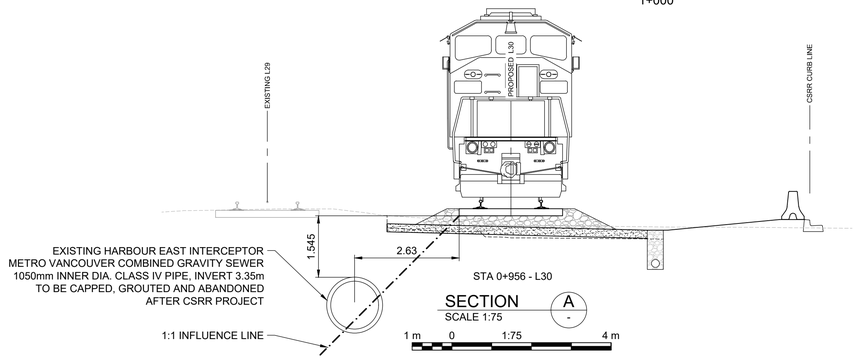

SECTION A-A

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CONFLICTS WITH PROPOSED TRACKS

		Stations				Utility Info	
Conflict No.	Track	Project Stations of L30 (m), From/To		Mainline Mileage, From/To		Abandoned	Quality Level
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UTILITIES LEGEND:

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CHECKED BY: **B.N.** DATE: **11-09-20**	PROJECT MANAGER: **I.M.** DATE: **11-09-20**
HATCH PROJECT No: **362376**	DWG SCALE(FULL SIZE): **AS SHOWN**

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B	03-03-21	UPDATE - ISSUED FOR REVIEW	C.A.R.
A	11-09-20	ISSUED FOR 30% DESIGN	R.N.F.

CP

ENGINEERING PROJECTS - WEST

VANCOUVER DIVISION MILE 125.37 TO 127.00 CASCADE SUBDIVISION

EAST L YARD EXPANSION
UTILITY CONFLICT PLANS
HARBOUR EAST INTERCEPT - SHEET 3 OF 7

DWG. BY: CHK BY:	OFFICE FILE:
MANAGER - DESIGN:	SCALE: **AS SHOWN** DATE:
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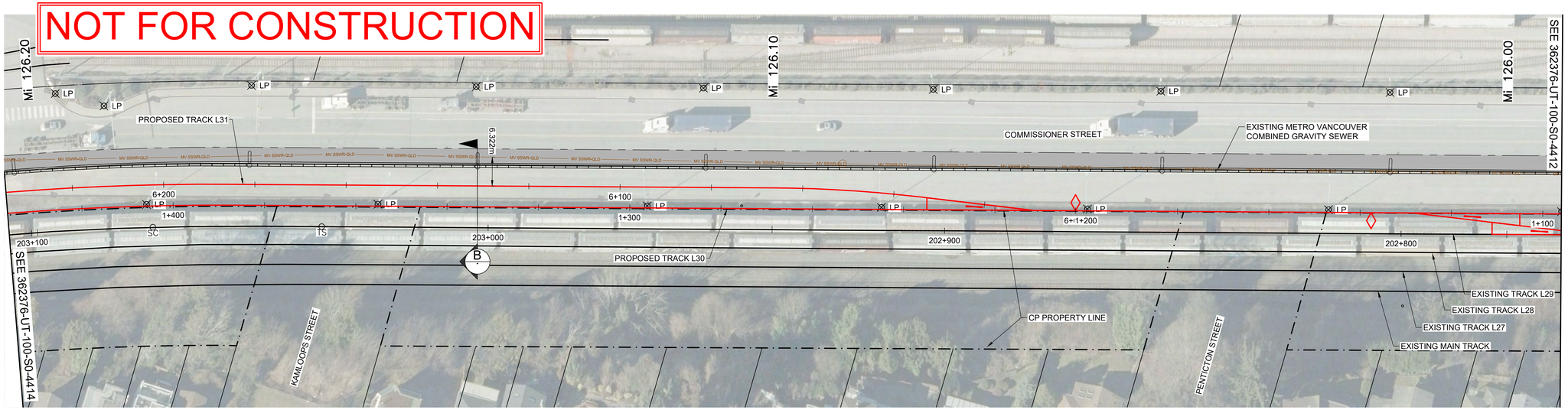

TO VANCOUVER

FROM PORT COQUITLAM

PLAN

SCALE 1:500

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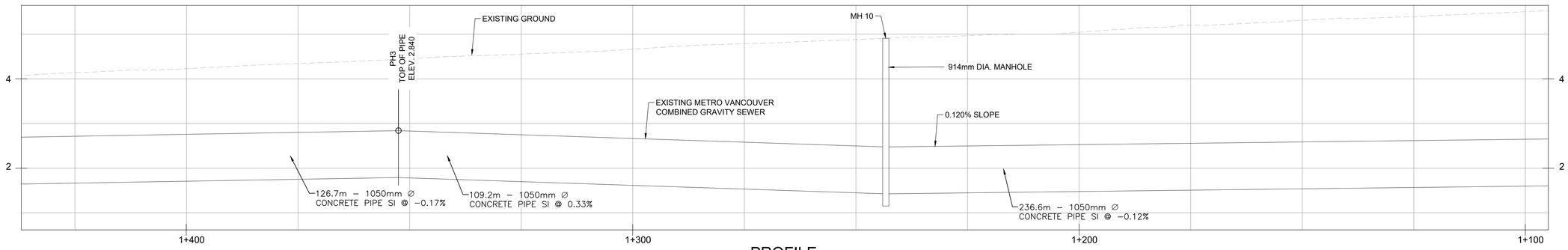

PROFILE

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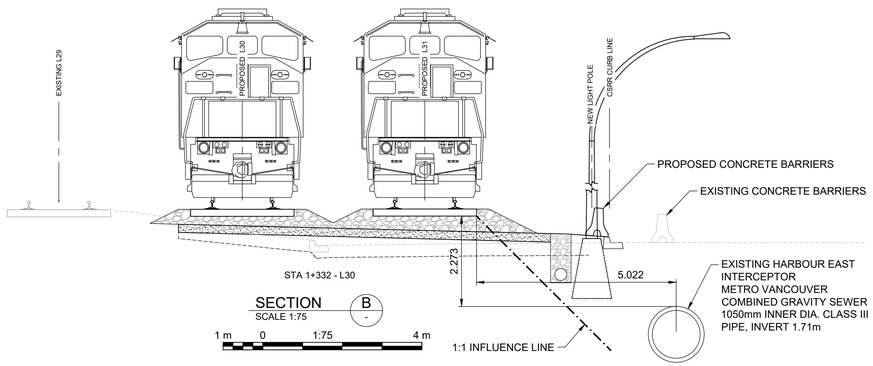

SECTION B

SCALE 1:75

1 m 0 1:75 4 m

CONFLICTS WITH PROPOSED TRACKS

		Stations				Utility Info	
Conflict No.	Track	Project Stations of L30 (m), From/To		Mainline Mileage, From/To		Abandoned	Quality Level
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HATCH PROJECT No: **362376**	DWG SCALE(FULL SIZE): **AS SHOWN**

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A	11-09-20	ISSUED FOR 30% DESIGN	R.N.F.

CP

ENGINEERING PROJECTS - WEST

VANCOUVER DIVISION MILE 125.37 TO 127.00 CASCADE SUBDIVISION

EAST L YARD EXPANSION
UTILITY CONFLICT PLANS
HARBOUR EAST INTERCEPT - SHEET 4 OF 7

DWG. BY:	CHK BY:	OFFICE FILE:	
MANAGER - DESIGN:		SCALE: **AS SHOWN**	
		DATE:	
M. FAVREAU DIR. PROJECT SERVICES WEST		PLAN No. H362376-UT-100-S0-4413	Rev. A

Mar 05 , 2021 , 2:44pm Login name: FARA90237
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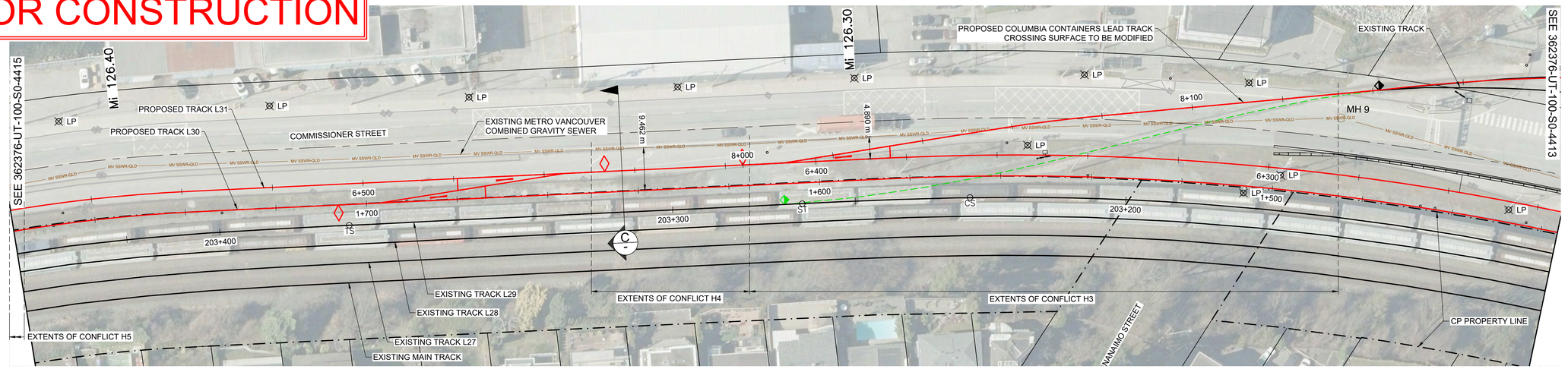
NOT FOR CONSTRUCTION



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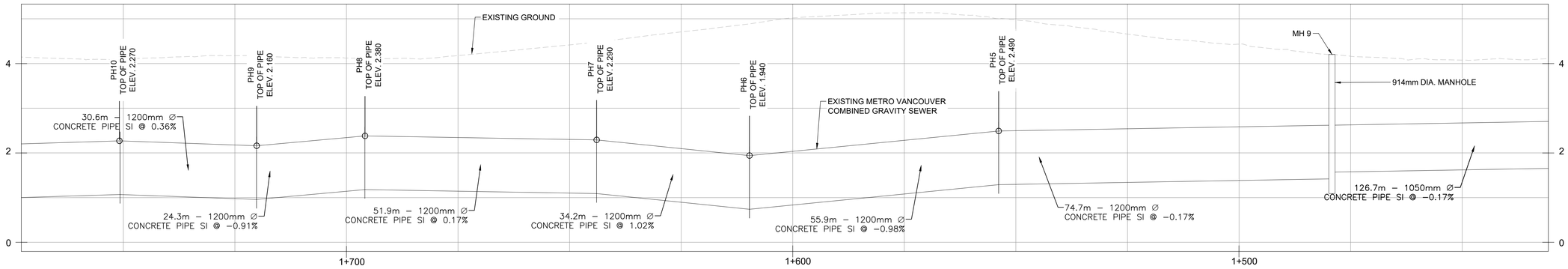

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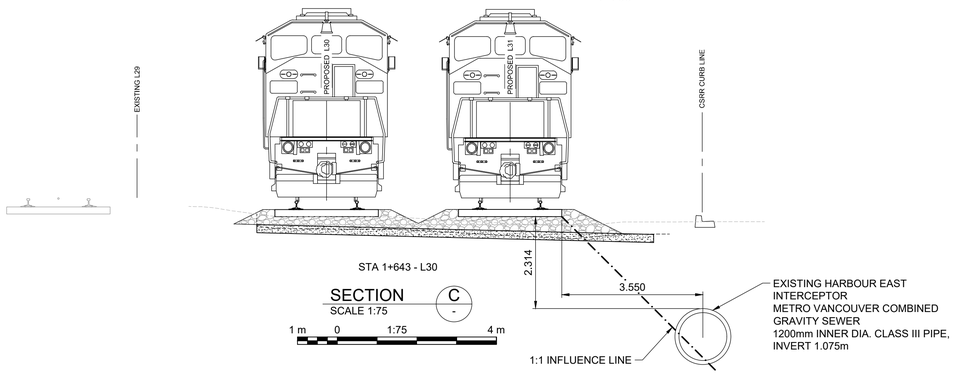

SECTION C

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CONFLICTS WITH PROPOSED TRACKS

		Stations				Utility Info	
Conflict No.	Track	Project Stations of L30 (m), From/To		Mainline Mileage, From/To		Abandoned	Quality Level
H1	L30	0+445	0+450	125.590	125.593	*No - Concrete encased*	D
H2	L30	0+450	0+965	125.593	125.913	Yes - *CSRR Project*	D
H3	L31	1+485	1+620	126.233	126.320	No	B
H4	L31	1+620	1+650	126.320	126.339	No	D
H5	L31	1+775	1+825	126.416	126.447	No	D
H6	L31	2+000	2+325	126.556	126.758	No	D

NOTES:

1. ZONE OF POTENTIAL TRACKING (ZPTL) DEFINED AS 1:1 SLOPE OFF END OF TIE
2. SEWER ELEVATION DATA FROM SURVEY
3. TRACK ALIGNMENT SHOWN FOR ILLUSTRATIVE PURPOSES ONLY AND SUBJECT TO CHANGE

UTILITIES LEGEND:

CATCH BASIN	CB
STORM / SEWER MANHOLE	MH
POWER POLE	PP
LAMP STANDARD	LS
EQUIPMENT BOX	EB
HYDRANT	FH
WATERMAIN VALVE	
GAS MAIN VALVE	

HEI SEWER - EXISTING FROM SURVEY FEB. 2021 — MV SSWR-QLD
HEI SEWER - EXISTING FROM VFPA / CoV GIS — MV SSWR-QLD
HEI SEWER - PROPOSED BY AECOM CSRR PROJECT — SAN
HEI SEWER - REMOVALS BY CSRR PROJECT — SAN

HATCH

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE NOTED

DESIGNED BY: **R.N.F.** DATE: **11-09-20**	DRAWN BY: **R.N.F.** DATE: **11-09-20**
CHECKED BY: **B.N.** DATE: **11-09-20**	PROJECT MANAGER: **I.M.** DATE: **11-09-20**
HATCH PROJECT No: **362376**	DWG SCALE(FULL SIZE): **AS SHOWN**

PROFESSIONAL SEALS

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B	03-03-21	UPDATE - ISSUED FOR REVIEW	C.A.R.
A	11-09-20	ISSUED FOR 30% DESIGN	R.N.F.

ENGINEERING PROJECTS - WEST

VANCOUVER DIVISION MILE 125.37 TO 127.00 CASCADE SUBDIVISION

EAST L YARD EXPANSION
UTILITY CONFLICT PLANS
HARBOUR EAST INTERCEPT - SHEET 5 OF 7

DWG. BY: CHK BY:	OFFICE FILE:
MANAGER - DESIGN:	SCALE: **AS SHOWN**
M. FAVREAU DIR. PROJECT SERVICES WEST	DATE:
	PLAN No. H362376-UT-100-S0-4414 Rev. A

Mar 05 , 2021 , 2:44pm Login name: FARA90237
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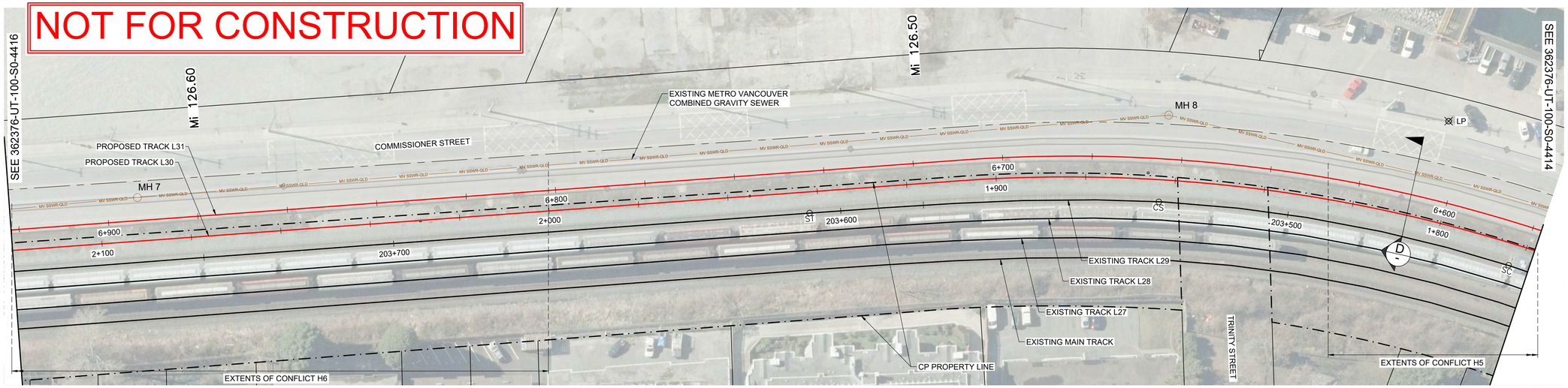
NOT FOR CONSTRUCTION



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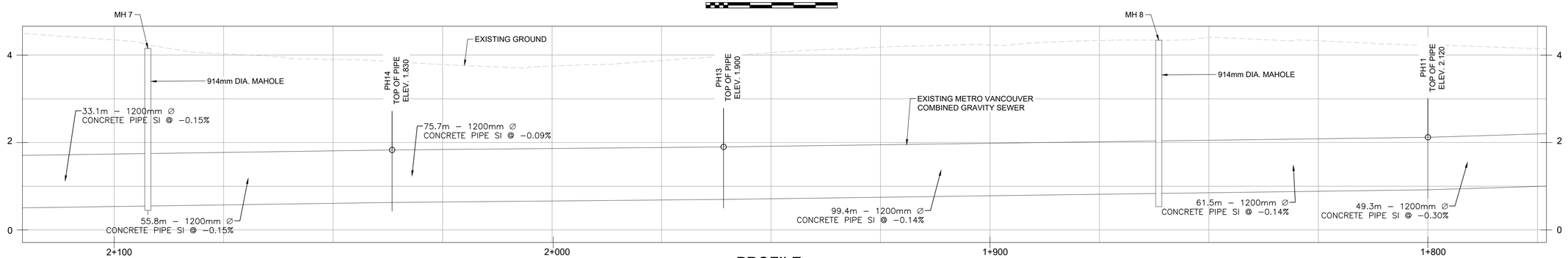

PROFILE

SCALE
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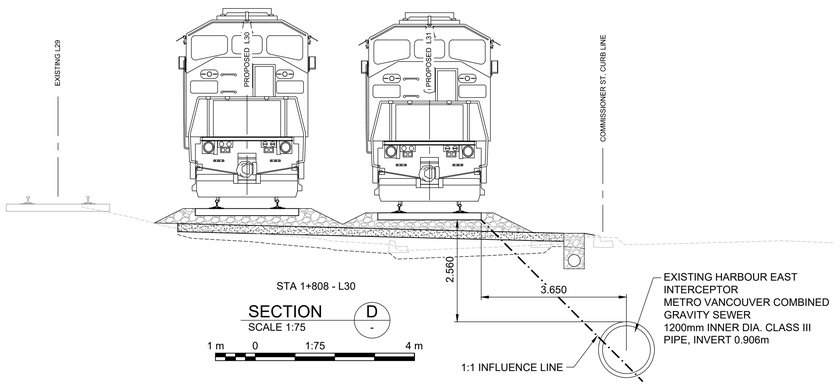
V 1:50



SECTION D

SCALE 1:75

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CONFLICTS WITH PROPOSED TRACKS

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Conflict No.	Track	Project Stations of L30 (m), From/To		Mainline Mileage, From/To		Abandoned	Quality Level
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H4	L31	1+620	1+650	126.320	126.339	No	D
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WATERMAIN VALVE	
GAS MAIN VALVE	
HEI SEWER - EXISTING FROM SURVEY FEB. 2021	MV SSWR-QLB
HEI SEWER - EXISTING FROM VFPA / CoV GIS	MV SSWR-QLD
HEI SEWER - PROPOSED BY AECOM CSRR PROJECT	SAN
HEI SEWER - REMOVALS BY CSRR PROJECT	SAN

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HATCH PROJECT No: **362376**	DWG SCALE(FULL SIZE): **AS SHOWN**

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A	11-09-20	ISSUED FOR 30% DESIGN	R.N.F.

CP

ENGINEERING PROJECTS - WEST

VANCOUVER DIVISION MILE 125.37 TO 127.00 CASCADE SUBDIVISION

EAST L YARD EXPANSION
UTILITY CONFLICT PLANS
HARBOUR EAST INTERCEPT - SHEET 6 OF 7

DWG. BY: . CHK BY: .	OFFICE FILE:
MANAGER - DESIGN: .	SCALE: **AS SHOWN**
M. FAVREAU DIR. PROJECT SERVICES WEST	DATE: .
	PLAN No. H362376-UT-100-S0-4415 Rev. A

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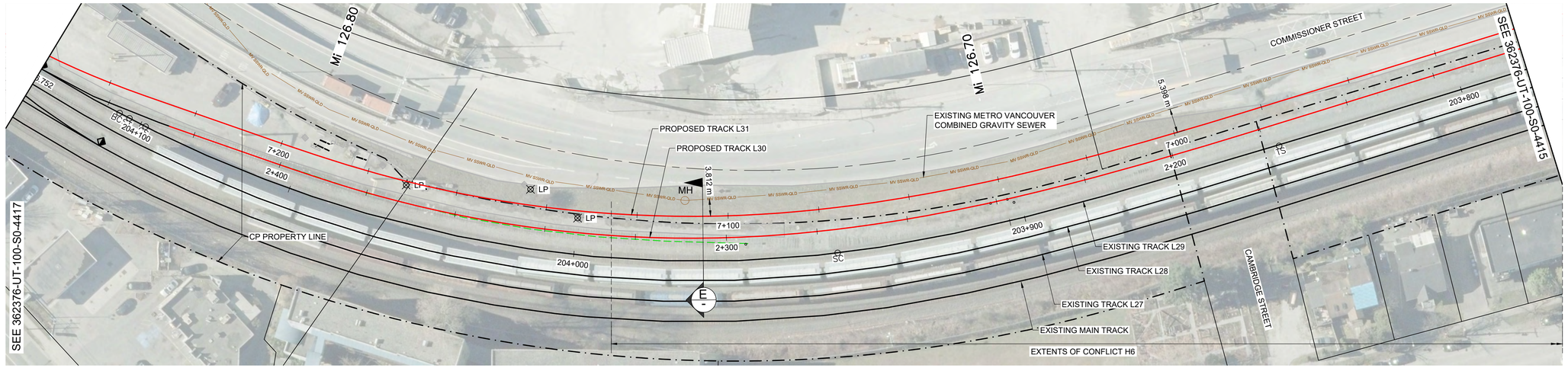

PLAN

SCALE 1:500

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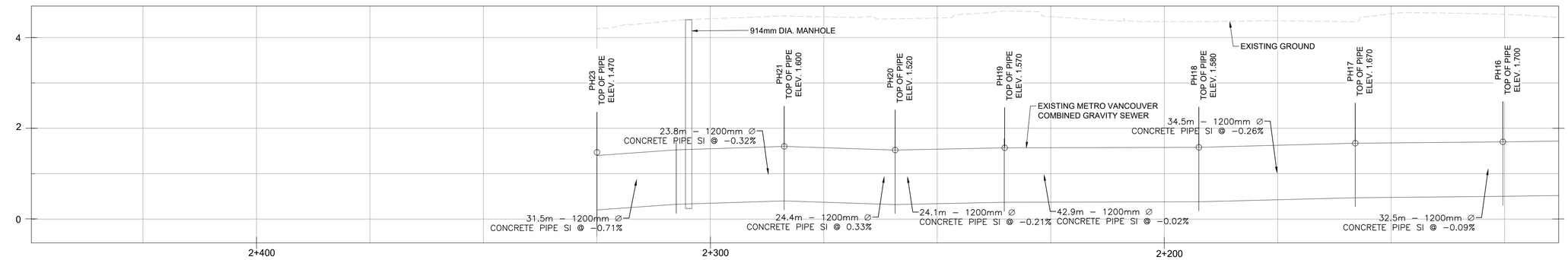

PROFILE

SCALE
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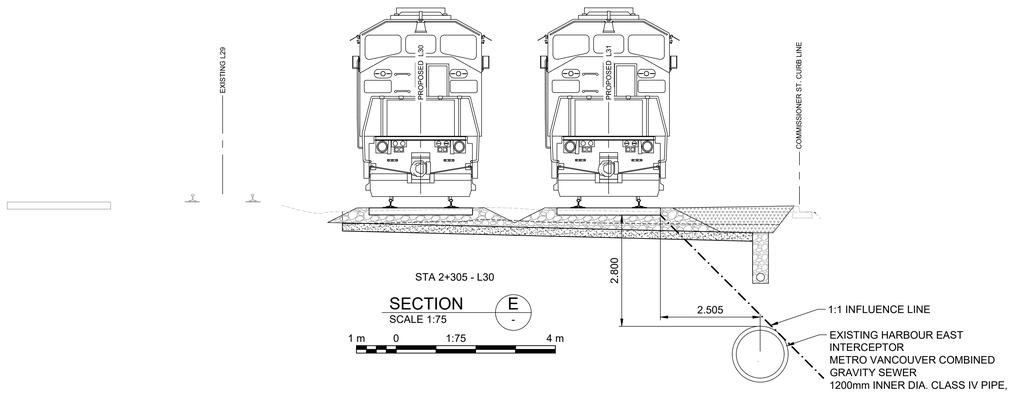
V 1:50



SECTION E

SCALE 1:75

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NOT FOR CONSTRUCTION

CONFLICTS WITH PROPOSED TRACKS

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LAMP STANDARD	LS
EQUIPMENT BOX	EB
HYDRANT	FH
WATERMAIN VALVE	
GAS MAIN VALVE	

HEI SEWER - EXISTING FROM SURVEY FEB. 2021	MV SSWR-QLB
HEI SEWER - EXISTING FROM VFPA / CoV GIS	MV SSWR-QLD
HEI SEWER - PROPOSED BY AECOM CSRR PROJECT	SAN
HEI SEWER - REMOVALS BY CSRR PROJECT	SAN

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HATCH PROJECT No: **362376**	DWG SCALE(FULL SIZE): **AS SHOWN**

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A	11-09-20	ISSUED FOR 30% DESIGN	R.N.F.

ENGINEERING PROJECTS - WEST

VANCOUVER DIVISION MILE 125.37 TO 127.00 CASCADE SUBDIVISION

EAST L YARD EXPANSION
UTILITY CONFLICT PLANS
HARBOUR EAST INTERCEPT - SHEET 7 OF 7

DWG. BY:	CHK BY:	OFFICE FILE:	
MANAGER - DESIGN:		SCALE: **AS SHOWN** DATE:	
M. FAVREAU DIR. PROJECT SERVICES WEST		PLAN No. H362376-UT-100-S0-4416	Rev. A

Mar 05 , 2021 - 2:45pm Login name: FAR090237
Drawing Name: C:\pwworking\hi\fara90237\d0694034\H362376-UT-100-S0-441X.dwg

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SECTION - STA: 0+025

SECTION - STA: 0+050

SECTION - STA: 0+075

SECTION - STA: 0+100

SECTION - STA: 0+125

SECTION - STA: 0+150

SECTION - STA: 0+175

SECTION - STA: 0+200

SECTION - STA: 0+225

SECTION - STA: 0+250

SECTION - STA: 0+275

SECTION - STA: 0+300

SECTION - STA: 0+325

SECTION - STA: 0+350

SECTION - STA: 0+375

SECTION - STA: 0+400

SECTION - STA: 0+425

SECTION - STA: 0+450

SECTION - STA: 0+475

SECTION - STA: 0+500

SECTION - STA: 0+500

SECTION - STA: 0+525

SECTION - STA: 0+525

SECTION - STA: 0+550

SECTION - STA: 0+550

SECTION - STA: 0+575

SECTION - STA: 0+575

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SECTION - STA: 0+725

SECTION - STA: 0+750

SECTION - STA: 0+775

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SECTION - STA: 0+900

SECTION - STA: 0+925

SECTION - STA: 0+950

SECTION - STA: 0+975

SECTION - STA: 1+000

SECTION - STA: 1+025

SECTION - STA: 1+050

SECTION - STA: 1+075

SECTION - STA: 1+100

SECTION - STA: 1+125

SECTION - STA: 1+150

SECTION - STA: 1+175

SECTION - STA: 1+200

SECTION - STA: 1+225

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SECTION - STA: 1+700

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SECTION - STA: 1+750

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SECTION - STA: 1+875

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SECTION - STA: 1+925

SECTION - STA: 1+950

SECTION - STA: 1+975

SECTION - STA: 2+000

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SECTION - STA: 2+050

SECTION - STA: 2+075

SECTION - STA: 2+100

SECTION - STA: 2+125

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SECTION - STA: 2+250

SECTION - STA: 2+275

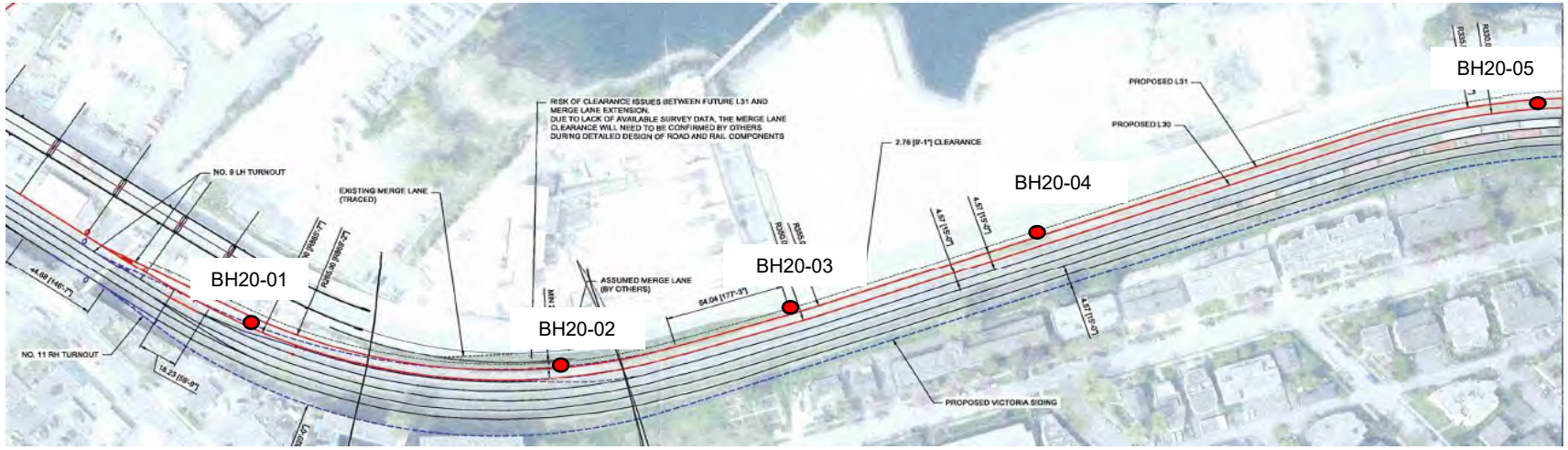
SECTION - STA: 2+300

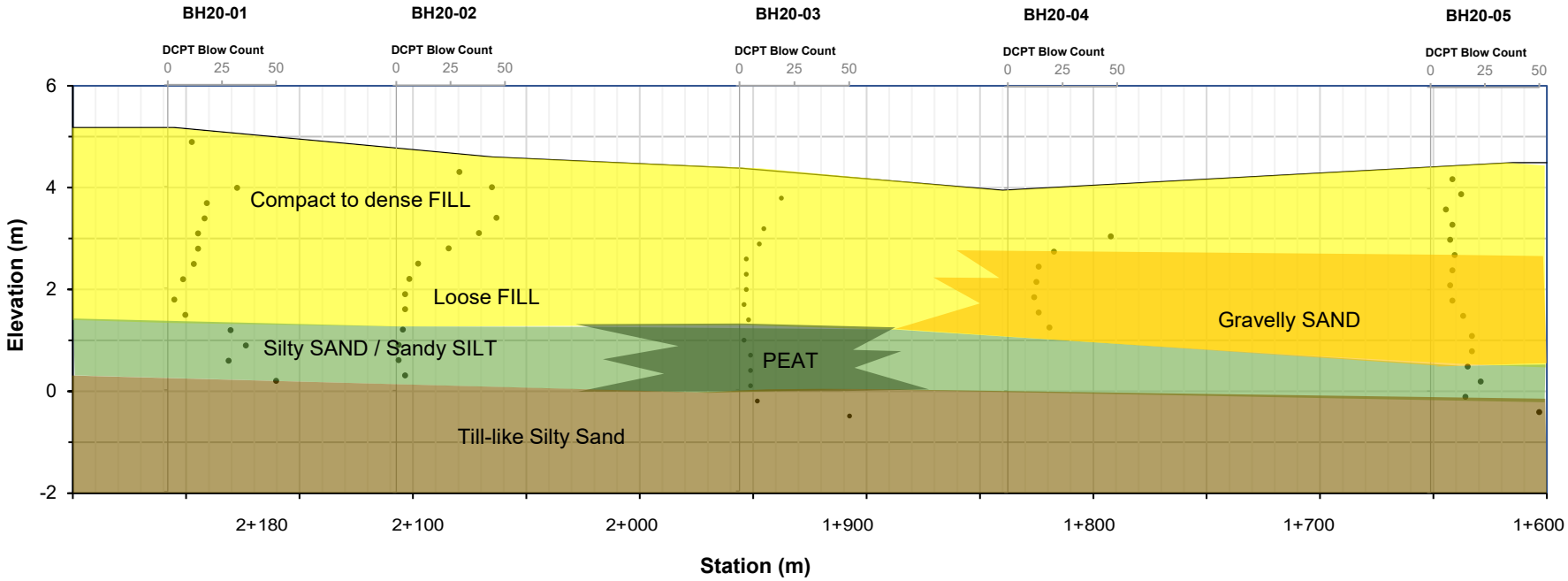
SECTION - STA: 2+325

SECTION - STA: 2+327.965

APPENDIX C

SOIL PROFILE DRAWINGS FROM TETRA TECH GEOTECHNICAL ASSESSMENT REPORT FOR CP EAST L YARD EXPANSION (JUNE 202)

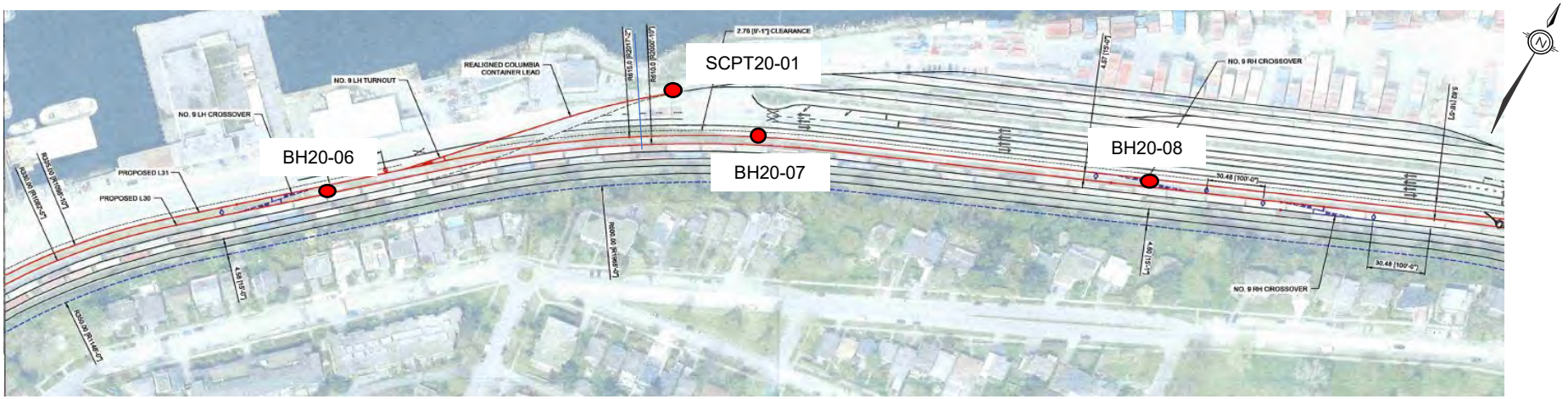


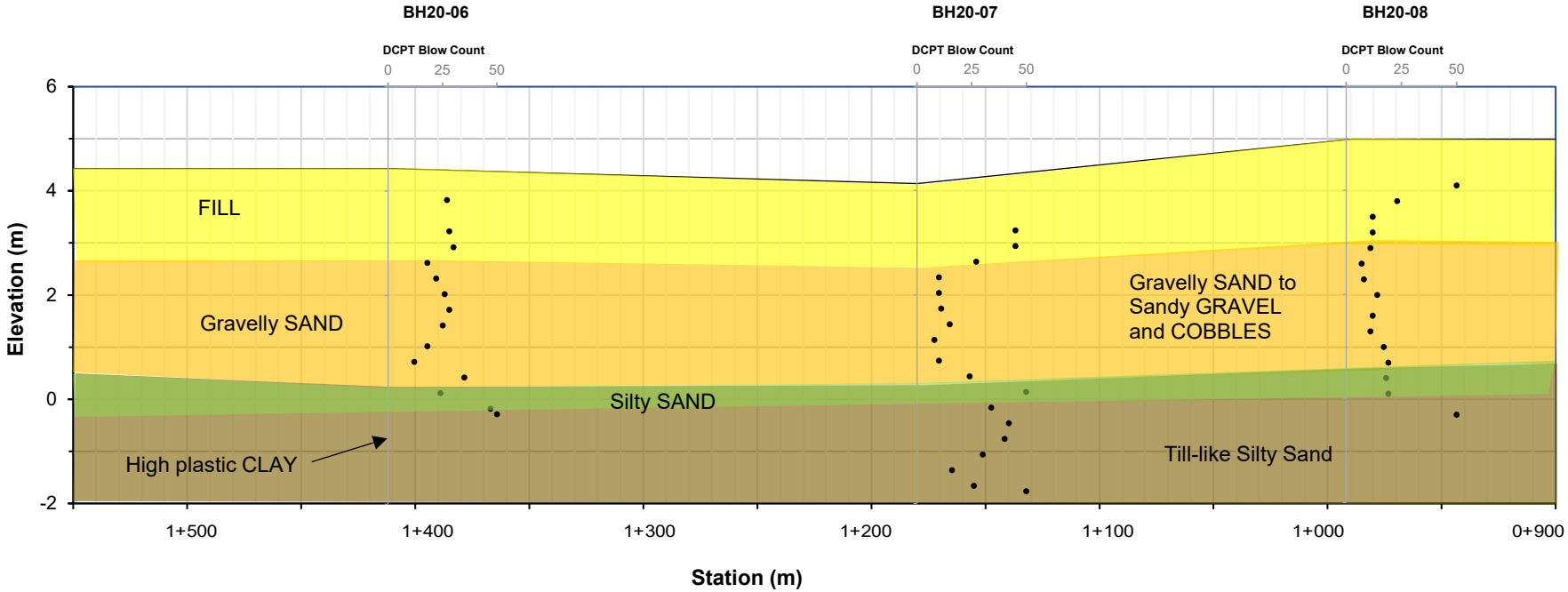


TETRA TECH

SUBSURFACE EXPLORATION PLAN
Estimated Soil Profile

Figure 1a

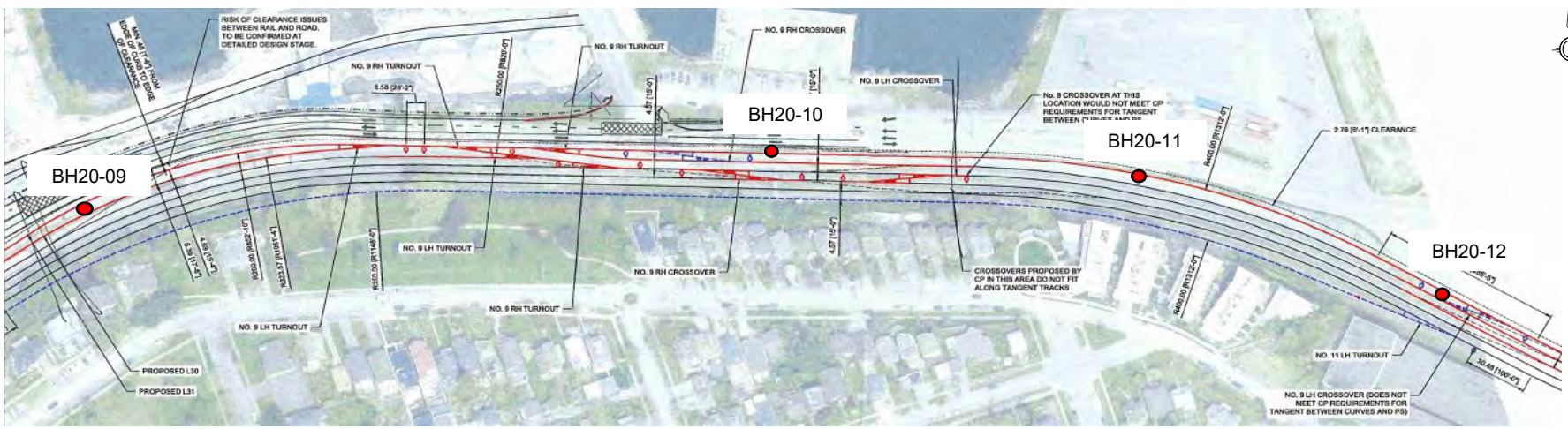


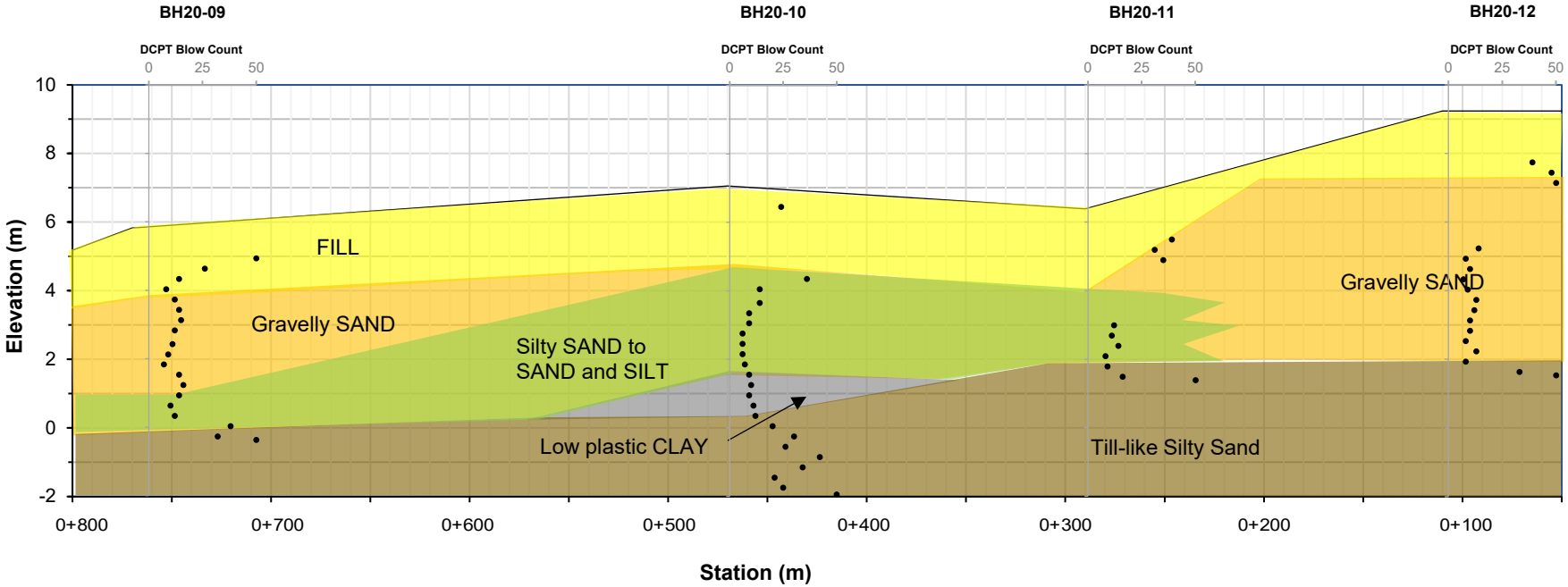


TETRA TECH

SUBSURFACE EXPLORATION PLAN
Estimated Soil Profile

Figure 1b





TETRA TECH

SUBSURFACE EXPLORATION PLAN
Estimated Soil Profile

Figure 1c

APPENDIX D

MV SEWER PIPE INFORMATION PROVIDED BY HATCH

Properties for Geotechnical Evaluation

Stationing	Track #	Pipe Standard	Pipe Class	Nominal Pipe ID (mm)	Wall Designation	Pipe ID (mm)	Pipe OD (mm)	Igrosswall (mm4/m)	Igrosspipe (mm4)	28day f'c (MPa) a.	v (possions ratio) b.	Unit weight (kg/m3) c.	Ecpipe (MPa) d.	G (MPa) e.
1+332	L30	ASTM C76	IV	1050	C	1067	1442	549316406	148541499467	35	0.2	2440	28872	12030
1+531	L30	ASTM C76	IV	1200	C	1219	1511	259344667	147411294037	35	0.2	2440	28872	12030
1+808	L30	ASTM C76	III	1200	C	1219	1511	259344667	147411294037	35	0.2	2440	28872	12030
2+250	L30	ASTM C76	IV	1200	C	1219	1511	259344667	147411294037	35	0.2	2440	28872	12030

NOTES:

a. Miminum value taken for precast elements from the CPCI Precast and Prestressed Concrete Design Manual. C1 Exposure Class CSA A23.1.
b. Poisson's ratio generally has a range between 0.11 to 0.27 but generally assumed to be 0.2 for pre-cast elements.
c. CSA A23.3 recommends 24 kN/m3 for normal density concrete.
d. Young's modulus determined using the equation 8-1 in CL 8.6.2.2 given in CSA A23.3 and is usually adequate for design.
e. Shear modulus determined from G=Ec/(2*(1+v)) in the elastic region.