



# **CPR Geotechnical protocol for pipeline and utility installations within Railway Right of Way**

Last updated 2009 07 30

## **1. Introduction**

The purpose of this document is to assure the safety of rail operation during the process of third party pipe crossing of the Canadian Pacific Railway right-of-way. It is intended to guide the Proponent of the pipe crossing, CPR Real Estate and the CPR geotechnical engineering group in screening and approving applications for pipe/track crossings. The goal of the protocol is to:

- 1.1 Provide safe track conditions during and after installation.
- 1.2 Set out specifications and procedures to reduce problems during installation and operation of pipe/track crossing.
- 1.3 Specify minimum engineering standards.
- 1.4 Assure adequate geotechnical investigation and engineering review has been completed to achieve the above goals.
- 1.5 Allow timely processing of crossing approvals.

Limitations - The following protocol is independent of the requirements for assessing the structural components of the pipeline crossing. The structural requirements for all pipe crossings are included in CPR – SP-TS-2.39 Pipeline and Cable Installations within Railway Right of Way. A separate approval from CPR's Structures group or Real Estates (pipe and wire crossings) Group is also required. Proposals for pipelines and utilities parallel to the track are not covered by this protocol.

Geotechnical approval of a proposed crossing by CPR in no way warrants the applicability of the construction method to the expected ground conditions nor does it warrant the suitability of the ground conditions for the use proposed by the proponent of the crossing. CPR does not take any responsibility for the suitability of the construction method or warrantee the ground conditions. CPR geotechnical approval of a specific design indicates that based on available information the proposed construction and design addresses the railways needs. With all third party work on our right-of-way CPR will not attract any liability because of its approval of a specific design. As a result, CPR does not provide recommendations, direction or minimum standards to the proponent or their contractor. CPR insists that the proponent provide adequate documentation identifying the geotechnical engineer of record and the components of the project for which they are responsible.



## **2. Emergencies**

In the event of any occurrence that does or could pose a hazard immediately contact Canadian Pacific Railway at **1 800 716 9132**.

## **3. General terminology**

3.1 Base of rail (BOR) is the bottom surface of the rail and is frequently used as a local datum from which vertical measurements are referenced. If an external datum is utilized the elevation of the BOR will be identified.

3.2 The “zone of potential track loading” (zptl) is considered the area under the track and within a 1V to 1.5H zone extending down from a point at the level of the BOR and 2 m (6.6 ft) from the centreline of track as shown in Figure 3.

## **4. Process**

To provide the appropriate level of engineering review of a specific proposal and allow timely processing of applications, the geotechnical review has been divided into three processes. Table 1 identifies the three levels, Minimum, Intermediate and Detailed, of geotechnical investigation and engineering dependent on the size, proximity and construction methodology of the proposed crossing. The proponent should consult Table 1 to assess what effort and detail of submission is required to meet the CPR requirements.

**Table 4.1 – Process identification**

		Process		
		1. Minimum <sup>1</sup>	2. Intermediate	3. Detailed
<b>Condition</b>	Outside pipe diameter	Less than 750 mm (29.5")	750 mm (29.5") to 1500 mm (59")	Greater than 1500 mm (59")
	Cover between BOR and top of pipe	Greater than 1.5 m (5 ft) or three pipe diameters which ever is greater	Greater than 1.5 m (5 ft) or two (2) pipe diameters which ever is greater	Less than 1.5 m (5 ft) or two (2) pipe diameters
	Adjacent structures, switches and signals	Greater than 10 m (32.8 ft)	Within 2.5 times cover between BOR and top of pipe	



		Process		
		1. Minimum <sup>1</sup>	2. Intermediate	3. Detailed
	Depth of pipes outside zptl	Refer to SP-TS 2.39 All pipes will be at least 0.91 m (3 ft) below ground where pipes are not below the zptl	Less than 0.91 m (3 ft) burial within the zone of potential track loading	
<b>Conditions</b>	Excavation near the track	Jacking/access pits shall be more than 10 m (30 ft) from the closest track centreline and not encroach on the zptl.	Excavations or jacking/access pits within 10 m (30 ft) of the closest track centreline	
	Crossing angle	Less than 45 degrees off perpendicular to the track	More than 45 degrees off perpendicular to the track	
<b>Construction method</b>	Non-tunneling method <sup>2</sup>		All methods considered	
	Pipe bursting will only be considered where the predicted heave is less than 10% of the movement that would result in a change of the FRA or TC track class.			
<b>Approval process</b>	Real Estate Group to approve with no geotechnical submission	CPR Geotechnical to review	Proponent to pay the cost for CPR to retain an independent geotechnical engineer to review the proponents engineers design, construction method and work	

<sup>1</sup> Move to next class if one or more criteria are not met.

<sup>2</sup> Non – tunneling methods include all forms of pipe augering, pipe jacking, directional drilling or the use of tunnel boring machines (TBM's) but excludes any type of mining techniques where any stand up time is required before the tunnel support is placed.

## **5. General requirements**

5.1 All proposals for crossing approvals will be under the signature of a locally registered professional engineer. The objective here is to ensure a registered professional / firm or



organization is given the responsibility to assess the site and take responsibility to ensure the proposal is appropriate for the site conditions. This may be in addition to the requirement for the proposal to be signed by a geotechnical and or structural engineer.

5.2 Applications to meet current regulatory and industry criteria for structural capacity, etc.

5.3 The application will include a construction plan that specifies the terms and conditions for execution of the work, including assignment of responsibility. The proponent of the crossing is responsible to the railway and must ensure the work is executed in accordance with the terms of the agreement.

All pipe/track crossing will be accompanied by at least the following three drawings showing the features indicated in true scale.

5.3.1. Plan of the proposed pipe crossing under the track (Figure 1) – This drawing will show the following features:

5.3.1.1 The location of the crossing referencing identifiable landmarks including the mileage and subdivision of the proposed crossing as per the CPR subdivision naming and mileage convention. The proponent can obtain the mileage and subdivision information from the CPR Real Estates (pipe & wire crossing) Group.

5.3.1.2 The pipe centerline, size and limits;

5.3.1.3 Any adjacent structures, signals, switches;

5.3.1.4 The location of the ditch line and any breaks in slope;

5.3.1.5 The location of any boreholes or test pits; and

5.3.1.6 The location of all tracks.

5.3.2 Profile of the track and proposed pipe crossing along the centreline of the track (Figure 2). This drawing will show the following features:

5.3.2.1 The location of the crossing referencing identifiable landmarks including the mileage and subdivision of the proposed crossing;

5.3.2.2 The pipe centerline, size and limits;

5.3.2.3 Any adjacent structures, signals, switches or buried services including Fibre Optics Transmission Systems (FOTS);

5.3.2.4 The elevation of the surface water in ditches, the elevation of the ground water table at all bore holes locations and the date they were measured;

5.3.2.5 The test pit and borehole location and stratigraphic logs as determined by the geotechnical investigation;

5.3.2.6 The depth of the top of pipe to the base of rail; and

5.3.2.7 The profile of the track.

5.3.3 Section of the track along the centreline of the proposed pipe crossing (Figure 3). This drawing will show the following features:

5.3.3.1 The location of the crossing referencing identifiable landmarks including the mileage and subdivision of the proposed crossing;



- 5.3.3.2 The pipe centerline, size and limits;
  - 5.3.3.3 Any adjacent structures, signals, switches and buried services including FOTS;
  - 5.3.3.4 The elevation of the surface water in ditches, the elevation of the ground water table at all bore holes locations and the date they were measured;
  - 5.3.3.5 The test pit and borehole location and stratigraphic logs as determined by the geotechnical investigation;
  - 5.3.3.6 The location of jacking or access pits and proposed cut slope angles;
  - 5.3.3.7 The location of the centerline of all tracks;
  - 5.3.3.8 The depth of the top of pipe to the base of rail; and
  - 5.3.3.9 Any excavations that encroach on the zptl;
- 5.4 Proposals for open cut will only be considered at sites where conditions make other installation techniques impractical or where rail traffic is low.
- 5.5 Installations using water jet methods will not be considered.
- 5.6 The cost of re-mediating any settlement or heave induced by the crossing installation will be borne by the crossing proponent.
- 5.7 All pipes installed below the highest ground water level predicted will be sealed during construction.
- 5.8 All pipes that will or could carry water shall be:
- 5.8.1 Installed with even bearing throughout its length to limit local settlement, and
  - 5.8.2 Slope to one end and prevent standing water. Special exemptions will be considered for inverted siphons or other applications requiring level pipes.
- 5.9 CPR head office is located in Calgary. As a result submissions received in English will generally be reviewed and processed more rapidly than those in French.

## **6. Process 1 – Minimum**

### **6.1 Conditions**

The general requirements included in Section 5 and the following requirements must be met to obtain approval for a pipe crossing that qualifies as a Process 1 crossing.

- 6.1.1 The pipe diameter is less than 750 mm (29.5 inches).
- 6.1.2 The cover between the BOR and the pipe obvert exceeds the greater of 1.5 m (5 ft) or three times the pipe diameter.
- 6.1.3 There are no structures, signals or track switches within 10 m horizontal of the pipe.



- 6.1.4 Installation is by a "non-tunneling method" (including boring, jacking, combined jack and bore, directional drilling, etc.).
- 6.1.5 All pipes will be at least 0.91 m (3 ft) below ground where pipes are not below the zone of potential track loading.
- 6.1.6 Jacking or access pits shall not be within 10 m (30 ft) from the centreline of track and not encroach on the zone of potential track loading.

## **6.2 Requirements**

- 6.2.1 The proponent will provide drawings containing the information identified in Figures 1, 2 and 3.
- 6.2.2 Generally a geotechnical investigation is not required. However, in areas or conditions where problems have arisen with similar pipe crossings CPR reserves the right to require a geotechnical investigation be completed and submitted with the application.
- 6.2.3 Even if not required by CPR a geotechnical investigation may be completed at the discretion of the proponent.

## **6.3 Process**

- 6.3.1 Proponent submits engineering documents to CPR Real Estate.
- 6.3.2 Real Estate reviews documents to assure appropriate engineering documents have been provided.
- 6.3.3 Real Estate group to provide approval.

## **7. Processes 2 and 3**

The intermediate and detailed processes pertain to those proposed pipe/track crossings that exceed the minimum criteria. The applicant will be required to submit information for review and approval by CPR geotechnical engineers or their designated consultants.

CPR requires that all designs, analysis and notification protocol be reviewed by a qualified geotechnical engineer.

## **8. Process 2 – Intermediate**

The intermediate process pertains to those proposed pipe/track crossings that exceed the minimum criteria but do not exceed the maximum criteria. The applicant will be required to submit information for review and approval of our engineers but may not be subjected to additional engineering, monitoring and construction requirements.

### **8.1 Conditions**

- 8.1.1 The general requirements identified in Section 5 must be met.
- 8.1.2 The pipe diameter is 1500 mm (59") or less.
- 8.1.3 The cover between the BOR and the pipe obvert is the greater of 1.5 m (5 ft) or more than twice times the pipe diameter.
- 8.1.4 There are no structures, signals or track switches horizontally within 2.5 times the distance from the BOR to the invert of the pipe.



- 8.1.5 Installation is by a "non-tunneling method" (including boring, jacking, combined jack and bore, or directional drilling).
- 8.1.6 Pipe bursting methods will only be considered where the predicted heave is less than 10 percent of the movement that would result in a change of the FRA or TC track class as per Transport Canada - Track Safety Rules accessible at <http://www.tc.gc.ca/eng/railsafety/rules-tce31-100.htm>.
- 8.1.7 Excavations or jacking/access pits are within 10 m (30 ft) of the closest track centreline or encroach on the zone of potential track loading.

## **8.2 Requirements**

- 8.2.1 Identification of the geotechnical engineer of record.
- 8.2.2 Description of the subsurface soil and ground water conditions within and adjacent to CPR embankment along the proposed pipe/track crossing alignment and to a depth no less than 1.5 times the invert depth below the BOR. This will consider the impact of silt, fine sand or sand soil, and their relation to the water table and pipe depth.
- 8.2.3 An estimate of the expected extent and magnitude of ground movement over time based on the proposed pipe installation method will be provided.
- 8.2.4 A program of ground surface and subsurface (settlement plates) movement monitoring will be implemented. The program must be capable of detecting movement of no less than 50 percent of the movement that would result in a change of the track FRA or TC class as per the Transport Canada - Track Safety Rules accessible at <http://www.tc.gc.ca/eng/railsafety/rules-tce31-100.htm>.
- 8.2.5 A procedure for notification of the appropriate CPR personnel in the event that excessive or unexpected settlement occurs. A complete CPR contact list, including local personnel and NMC will be compiled.
- 8.2.6 A recovery plan will be provided outlining the steps to be implemented in the event of failure (excessive ground loss or settlement / collapse, heaving etc).
- 8.2.7 Design of de-watering control measures where applicable for the proposed construction method.
- 8.2.8 Temporary track support system will be required if any of the excavation is closer than 6 m (19.7 feet) from the centre of track and encroaches on the zone of potential track loading. The length of the excavation and an estimated stand-up time of the proposed cut within these limits must be provided and demonstrated to be safe.
- 8.2.9 A complete description of the proposed construction method.
- 8.2.10 Confirmation that the proposed construction/installation technique is suited to the site conditions and performance criteria. An assessment of the influence of construction on the track structure including estimated settlement/heave and assessment of risk associated with uncontrolled loss of ground or heaving.
- 8.2.11 Upon review of the conditions, the geotechnical group may elevate a proposed crossing to Process 3 if complexities arise through the review of the project.



A qualified independent engineer is required to provide periodic or continuous (at the discretion of CPR) on-site supervision and document conditions during construction.

### **8.3 Process**

- 8.3.1 Proponent submits engineering documents to CPR Real Estate.
- 8.3.2 Real Estate reviews documents to assure appropriate engineering documents have been provided.
- 8.3.3 Geotechnical Group to review and provide geotechnical approval.
- 8.3.4 Structural Engineering Group may have to provide structural approval.
- 8.3.5 Real Estate group to provide final approval.

## **9. *Process 3 – Detailed***

The third process will be followed for those crossing designs that do not meet the conditions of Process 2. In these instances, expert engineering submissions are required, along with preliminary work such as dewatering as well as, monitoring by on site engineering consultants during construction.

### **9.1 Conditions**

- 9.1.1 Provided the above general requirements are met, and
- 9.1.2 Ground conditions, complex installation method, and/or the complexity of the project warrant that specialist-engineering personnel review the design and or construction of the pipe/track crossing.

### **9.2 Requirements**

- 9.2.1 The proponent will meet the requirement outlined in Process 2 - Section 8.2.
- 9.2.2 The proponent will provide resources for CPR to retain qualified geotechnical engineers or experts to analyses and advise CPR on the impact of the proponent's proposal to the right-of-way.

### **9.3 Process**

- 9.3.1 Proponent submits engineering documents to CPR Real Estate.
- 9.3.2 Real Estate reviews documents to assure appropriate engineering documents have been provided.
- 9.3.3 Review by independent geotechnical or tunneling specialist (at the proponents cost).
- 9.3.4 Upon acceptable review by independent geotechnical consultant or tunneling specialist the CPR Geotechnical Group to provide approval.
- 9.3.5 Structural Engineering Group to provide structural approval.
- 9.3.6 Real Estate group to provide final approval.

## **10. *Geotechnical Engineering check-list***

The following is a check list of steps that will be completed to assure that the appropriate level of care has been taken for Process 2 and 3 pipe crossings below the track.





**Table 2 – Check List**

No.	Step	Group
10.1	Submission of crossing proposal by proponent including details of the crossing specification and potential construction method(s) to CPR Real Estate.	Proponent
10.2	Review of the proposal with respect to this protocol to determine what level of geotechnical engineering and review is required.	Real Estate
10.3	Designation of review (CPR Real Estate, CPR Geotechnical Engineering or Independent geotechnical engineer) required.	Real Estate
10.4	Identification of the geotechnical engineer of record.	Geotechnical Engineering
10.5	Assessment of the adequacy of the geotechnical investigation.	Geotechnical Engineering
10.6	Proponent's geotechnical engineer determines that the proposed construction/installation method will not cause settlement of the CPR track or structures.	Geotechnical Engineering
10.7	If there is a possibility of track settlement, a monitoring program will be developed by the proponent's geotechnical engineer, and reviewed and approved by CPR.	Geotechnical Engineering
10.8	Once a contractor has been selected, the geotechnical engineer of record will review the shop drawings submitted by the contractor or the sub-contractor(s) to determine if the tunnel and dewatering (if required) method proposed could cause track settlement.	Geotechnical Engineering
10.9	The proponent will provide CPR with written documentation of who will be completing the onsite review of the contractor's construction practice and the specifics of the assignment.	Geotechnical Engineering
10.10	The proponent will enlist the services of a geotechnical engineer with the responsibility for inspection of the tunnel contractor's work. They will also assure that adequate measures are in place to minimize the potential for track settlement. The intention is not make the geotechnical engineer responsible for the settlement of the track but to empower an appropriate group with the task of assuring that actions undertaken by the contractor do not endanger the track structure as a result of ground loss during tunneling.	Geotechnical Engineering
10.11	An emergency response will be developed and posted on site and will reside with key personnel.	Geotechnical Engineering
10.12	A contingency plan will be identified that can be completed within hours if settlement is experienced.	Geotechnical Engineering



### ***11. Abandoned pipe/track crossing***

In the event that an existing installation is abandoned or a proposed crossing is abandoned during construction, all potential hazards to CPR property must be removed or abated. This may be achieved by removal of any buried pipes and the backfill and compaction of any excavations. Alternately, upon approval of the CPR Geotechnical group any voids within ground may be backfilled with non-shrinkable fill, or pressured grout sufficient to prevent future sloughing or track settlement. Any buried material (wood or metal) that could increase or decrease volume over time due to chemical reaction (oxidation) or decomposition must be removed or stabilized to the satisfaction of the CPR.

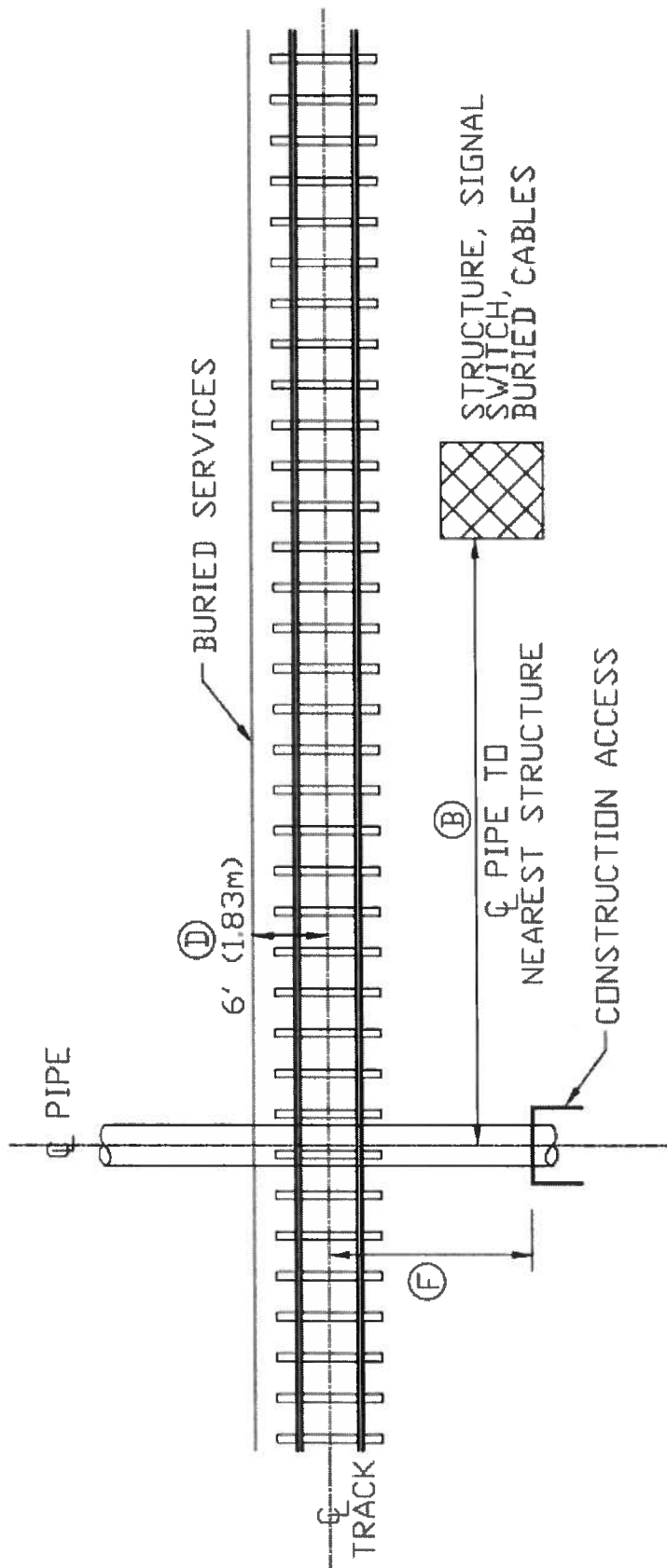


Figure 1 – Plan of the proposed pipe crossing

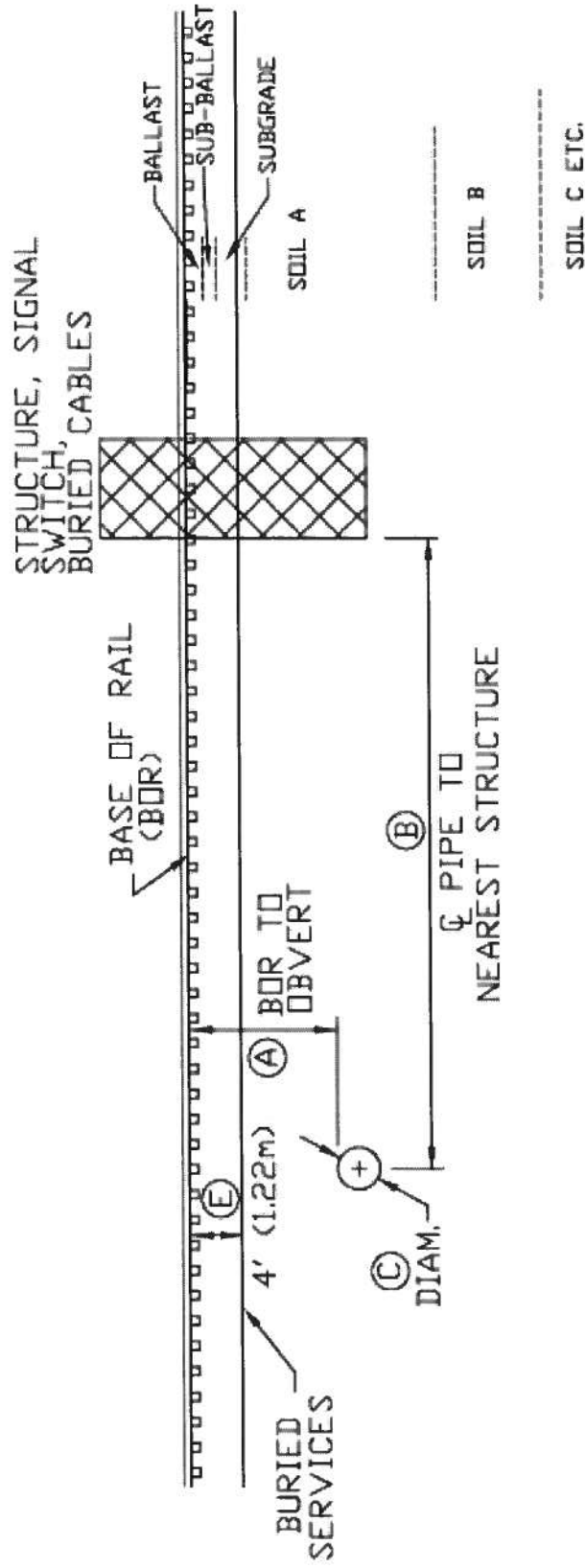
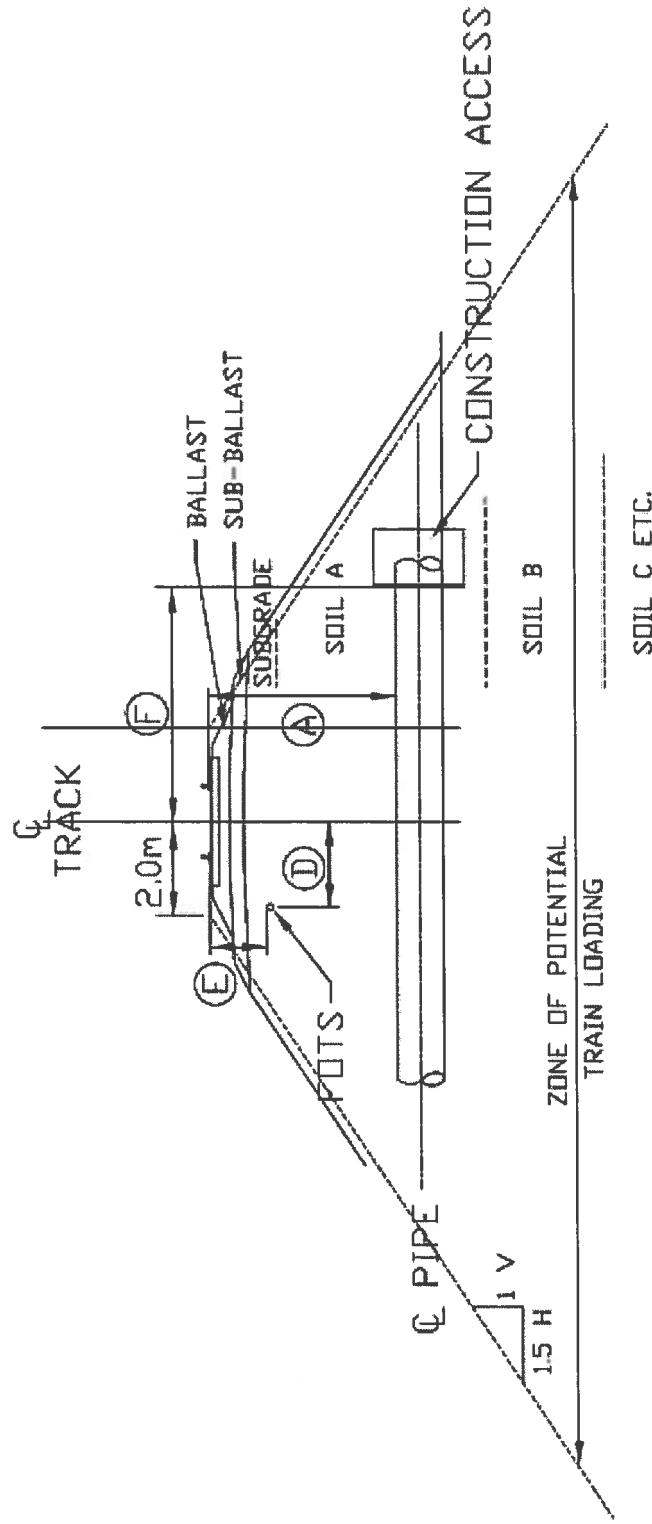


Figure 2 – Profile of the track and proposed pipe crossing along the centerline of track



**FOTS = FIBRE OPTICS TRANSMISSIONS SYSTEM**

Figure 3 – Section of Track along centerline of proposed pipe