Attachment 1

May 31, 2024

WSP File No.: CA0002646.9368

Engineering Technologist
Municipality of North Cowichan
7030 Trans-Canada Highway
Duncan, BC
V9L 6A1

Attention: Colton Kuhne, A.Sc.T.

Subject: Genoa Bay Road Slope Stabilization – Options Report

INTRODUCTION AND BACKGROUND

Following our April 19, 2024 meeting and your email of April 15, 2024, WSP Canada Inc. (WSP) provides this technical memo as it pertains to the above noted subject.

In general, the project comprises an approximate 110m long, narrow section of Genoa Bay Road that has been showing signs of slope stability issues for many years. The intent is to stabilize this section of road such that the community of Genoa Bay has safe road access to and from the community. Engineering concepts are currently being prepared to address this safety concern and are expected ultimately to result in a widening of the roadway, pending appropriate jurisdictional reviews and approvals, funding and confirmation of a feasible solution. In the interim, mitigation strategies are required to allow for the safe passage of traffic through this section of roadway.

A portion of a 50 mm diameter watermain that serves the community of Genoa Bay has been temporarily placed on the road surface and part of the project may include burying the watermain in an alignment at the centre of the southbound lane.

To the west of the roadway, a steep rock wall limits the ability for a vehicle to pullover and allow an opposing vehicle to pass. To the east of the roadway, a steep embankment exists with no shoulder and heavy vegetation and leads to Genoa Bay. The slight curvature of the roadway combined with the vegetation and rock wall limits some of the vehicular sight distance, and collectively result in a roadway safety concern that requires mitigation. A Google Streetview of the subject section of roadway is provided below:

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At the time of this memo, WSP had completed and submitted 50% design drawings to MNC on January 12, 2024 with review comments submitted back to WSP on January 19, 2024. The 50% design drawings included two phases: Phase 1 included Tecco Mesh with Anchors and a road widening comprising a geosynthetically reinforced soil (GRS) retaining wall for about 65 m; and Phase 2 included Tecco Mesh with Anchors and a road widening with a GRS wall for the remaining 45 m. Since that time there have been multiple discussions and meetings on WSP's comment resolutions, further questions from the MNC, and what direction the design should head before it is issued for tender. It is understood that the main challenge in establishing a final design is the available funding to complete various phases of construction. At present, Phase 1 design now includes Tecco Mesh and anchors to stabilize the road prism for the full road length of 110m. It also includes relocating the community waterline from the east side to the west side of the road. Phase 2, which would occur at some point in the future, would include widening the road by including a GRS retaining wall of varied height that would be located above the Tecco Mesh reinforcement.

The intent of this memo is to provide the Municipality of North Cowichan (MNC) with sufficient information so they can make an informed decision on a path forward for the project.

ROADSIDE BARRIER

WSP has reviewed options for roadside barrier on the east side of Genoa Bay Road due to the narrow lanes/shoulder, steep drop-off, and water hazard at the base of the slope. The BC Supplement to TAC includes a roadside barrier index nomograph that considers road geometry, traffic patterns, environmental conditions and fill slopes to determine if a roadside barrier is warranted; a barrier is generally needed if the index exceeds 90. Two conditions were assessed for the project: one on a tangent and another on the curve at the south end of the works. The barrier indexes calculated were 100 and 166 respectively, indicating that barrier should be installed throughout the project limits.

Three roadside barrier types have been considered for the project: concrete barriers, W-beam, and cable barriers. Any barrier installation would require a flare at the start and end, the geometry of which depends on the road design speed. Cable barriers are not considered feasible for the project as they require large concrete anchor blocks at end points, slopes of 6:1 or flatter, and are to be located in areas without edge drop-offs. W-beam barriers is permitted for installation at the top of a maximum 2:1 slope and can be located at the shoulder of the breakpoint, provided that the post length is increased; however, careful consideration is required to interface the posts with any geotechnical stabilization works such as Tecco Mesh or GRS systems. Pre-cast concrete barriers are considered the most feasible for this project as they can be locally sourced, quickly deployed, and relocated if necessary.

For new construction, the setback distance from the lane edge to a roadside barrier is 1.3m; however, this can be reduced to 0.5m for low volume roads in existing, constrained conditions. BC Ministry of Transportation recommends lane widths of 3.25m with a 0.5m shoulder. In the current condition, the paved roadway varies from 5.0 to 5.4m wide with an approximately 0.3m shoulder before a steep (1:1 to 2:1) drop-off.

Sufficient shoulder is not available in the current road configuration to permit the installation of barrier without significant road widening. An alternate configuration could include single lane alternating traffic with barrier provided on the eastern edge of the northbound lane. This option is discussed further in subsequent sections of this report.

Additional data on roadside barriers is included in the appendix, as well as the roadside barrier index nomograph.

WATERMAIN REPLACEMENT

The project includes replacement of an existing non-potable 50 mm watermain that provides raw water to the Genoa Bay community, which is currently fed via a temporary overland pipe on the east side of the road. This pipe has minimal mechanical and frost protection and will hinder slope stabilization construction activities. To facilitate construction of the selected slope stabilization program, it is recommended that the temporary overland pipe be relocated to the west side of the road to reduce the potential for a strike by construction equipment. Any temporary road crossings should be in a trench with minimum 600 mm cover and temporary asphalt restoration. If the temporary watermain is anticipated to be in place through the winter months, additional frost protection measures are recommended.

Final replacement of the watermain is planned to be in the middle of the southbound lane with 900 mm cover to reduce the risk of impacts related to future settlement/slides. This alignment is expected to avoid trenching through bedrock and provide for asphalt restoration outside the southbound wheel path. Final replacement of the waterline could be completed with the slope stabilization or deferred if project budgets are not available.

Expected cost for temporary relocation of overland pipe to the west side of the road by MNC forces: $10,000

Expected cost for permanent watermain replacement, ~120m: $40,000 – 50,000

GEOTECHNICAL OPTIONS

The following provide several options for the municipality to consider. Each option has a risk statement and relative cost to construct associated with it. A rough breakdown of these costs is presented in Table 1 in the Cost Summary section of this memo. The options are arranged in order of WSP's preference to reduce the overall risk.

OPTION 1 – STABILIZE ROAD PRISM AND WIDEN ROAD

DESCRIPTION (W/ GRS)

WSP's preferred option is to clear and grub the slope and stabilize the entire 110m length of road with Tecco Mesh and anchors and to widen the road to accommodate two lane traffic with pre-cast concrete barriers. The road widening will require a GRS retaining wall structure of varied height to accommodate the existing terrain and provide sufficient road width for two lane traffic plus the concrete barriers. A road width of about 7.6m will be required and the watermain would be installed into the middle of the southbound lane. This option will require complete removal of the existing pavement structure in stages and reconstructing it after the slope has been stabilized. This option has been submitted at the 50% design stage but would include both Phase 1 and 2 to make up the 110m road length.

This option will require some coordination work with the contractor who installs the Tecco Mesh and anchors to minimize closing the current single lane traffic for extended periods of time.

Magnetic extensometer instrumentation (3) would be installed towards the shoulder of the road to monitor for signs of upwards caving of the existing fill below the Tecco Mesh and anchors.

RISKS

All options carry some risks since the bulk of the existing slope fill would remain in place, with only the top approximate 5m being anchored to stabilize the road prism. Of all the options, the risks associated with this option would be minimal and related to regular road maintenance and monitoring of the extensometers. A monitoring threshold for the instrumentation would be provided to MNC, but with proper construction, the stabilized road prism is expected to remain stable for decades.

The construction costs (including a 20% contingency) for this option are expected to be in the order of $3.0 million.

OPTION 2 – STABILIZE ROAD PRISM WITH ONE LANE ALTERNATING TRAFFIC

DESCRIPTION

WSP's second preference of options includes stabilize the entire 110m length of road with Tecco Mesh and anchors and having single lane alternating traffic on the west lane through this section of road. Asphalt would be removed in this lane, the surface compacted, and the watermain would be relocated to the center of the single lane. Some surface regrading and asphalt placed at the surface. Concrete barriers would be placed slightly into the east lane from center to safely direct traffic away from the steep slope that will be stripped of all trees. Some form of traffic management (as described below) will be required.

Magnetic extensometer instrumentation (3) would be installed towards the shoulder of the road to monitor for signs of upwards caving of the existing fill below the Tecco Mesh and anchors.

With this option, there will be an expectation that this would be a temporary condition and that the road would eventually be widened as per Option 1.

RISKS

The risks associated with this option will depend on several factors that includes what traffic management system is selected and what state the pavement structure is left in. All will require an acceptance of risk by the MNC. A brief description of each factor in order of lower to higher risk is provided below as sub-options:

1. Single lane traffic on the west lane with permanent traffic lights, stripping existing asphalt, compacting the exposed base course materials, installing the watermain, and resurfacing with asphalt. Additional considerations should be given replacing the subgrade and installing the GRS in this lane. This will aid in future construction of the east lane as the GRS will stand vertical which will aid the temporary cuts required to construct the GRS wall and widening of the road.

   The risks associated with this sub-option would be minimal for vehicle traffic and related to regular road maintenance and monitoring of the extensometers. There will need to be some notification for any pedestrian traffic to stay away from the crest of the slope and walk (if necessary) close to the boundaries of the concrete barriers (i.e. within a well marked area close to the concrete no-post barriers in the northbound lane).

   Estimated cost for this sub-option (including a 20% contingency) is: $2.3 to $2.5 million.

2. Single lane traffic on the west lane with temporary traffic lights, installing the watermain, and resurfacing with asphalt.

   The risks associated with this sub-option are associated with maintaining the temporary traffic lights, potential traffic accidents associated with failed traffic lights, potentially additional road maintenance associated with pot holes from collapsing of loose base materials and borehole subsidence, and monitoring of the extensometers. There will need to be some notification for any pedestrian traffic to stay away from the crest of the slope and walk (if necessary) close to the boundaries of the concrete barriers (i.e. within a well marked area close to the concrete no-post barriers in the northbound lane).

   Estimated cost for this sub-option (including a 20% contingency) is: $2.1 to $2.3 million.

3. Single lane traffic on the west lane with temporary stop signs, installing the watermain, and resurfacing with asphalt.

   The risks associated with this sub-option are associated with maintaining the stop signs, potential traffic accidents associated with poor sight lines, damaged or poorly visible stop signs, potentially additional road maintenance associated with pot holes from collapsing of loose base materials and borehole subsidence, and monitoring of the extensometers. There will need to be some notification for any pedestrian traffic to stay away from the crest of the slope and walk (if necessary) close to the boundaries of the concrete barriers (i.e. within a well marked area close to the concrete no-post barriers in the northbound lane).

   Estimated cost for this sub-option (including a 20% contingency) is: $2.05 to $2.25 million.

OPTION 3 – STABILIZE ROAD PRISM WITH TWO LANES AND NO WIDENING

DESCRIPTION

Option 3 includes stabilize the entire 110m length of road with Tecco Mesh and anchors, regrading and re-compacting the entire road with an asphalt surface to achieve the original road width. The watermain would be relocated to the center of the southbound lane. The trees would be removed from the slope and there would be no roadside barriers due to insufficient road width or slope conditions. Essentially the road prism would be globally stable and would be in a similar state to the pre-lane shut down condition. However, the visual appearance would be different to traffic since the roadside tress will have been removed.

Magnetic extensometer instrumentation (3) would be installed towards the shoulder of the road to monitor for signs of upwards caving of the existing fill below the Tecco Mesh and anchors.

With this option, there will be an expectation that this would be a temporary condition and that the road would eventually be widened as per Option 1.

RISKS

This option has considerable risks to life safety given that the narrow road would have no roadside barriers adjacent to a steep slope down to the ocean. There would also be visual perception of an unsafe road given the removal of trees. In addition, although the road prism would be globally stable, the base coarse materials would remain in a loose state and there would be a future risk of road subsidence, particularly in the northbound lane where the subsidence could be in the order of 300 mm to 500 mm. This road subsidence could lead to vehicle damage, or potentially cause a worse accident involving loss of life.

WSP does not recommend this option and any risks and associated consequences would need to be accepted and managed by the MNC.

The construction costs for this option are expected to be in the order of $1.65 to $1.85 million.

OPTION 4 – DO NOTHING

DESCRIPTION

This option has considerable risks to life safety and assumes that the MNC does nothing to improve the stability of the road and the northbound lane continues to fail through ongoing slope creep. Collapse of the loose subgrade and road greater than 1m in vertical can be expected in this lane. The functionality of the southbound lane would be questionable after this type of failure to the northbound lane due to lack of adjacent road support.

RISKS

The MNC would assume all the risk and associated consequences related to this option.

SINGLE LANE ALTERNATING TRAFFIC OPTIONS

If single lane alternating traffic (SLAT) is required, there are three options for traffic control:

OPTION A: PORTABLE TRAFFIC SIGNALS

Portable traffic signals are often deployed in active construction zones to manage traffic flow and support construction activities. These devices can be solar-powered or use a generator. Two devices are expected to be required, with readily available backups in case of failure. However, their temporary nature can limit their usage to a few months, and routine checks (daily or possibly more frequently) may be required to confirm functionality and operations, and that the units have not been damaged or removed. Should permanent measures require a construction period greater than the recommended usage requirements of these devices, full replacement will be necessary. The devices may also need to be secured to their deployment locations and potential covered or secured storage accommodations for incremental weather. The 2 devices should be coordinated and timed appropriately to provide a green, permissive phase for one direction at a time with adequate clearance time to allow the 1-lane section of roadway to be cleared of traffic before allowing the opposing direction of travel to proceed.

Expected cost: $50,000 to purchase a pair, or $3,500 per month rental. Backup devices may also be required to readily deploy in the event of equipment failure.

OPTION B: PERMANENT TRAFFIC SIGNALS

A more permanent traffic signal at each end of the study area is a more appropriate solution should the expected mitigation strategy require a more extensive time period, such as greater than the functional use of portable traffic signal. Permanent traffic signals would require being hardwired into a steady power source, which may be feasible given the observed overhead power lines. The traffic signals would also require some roadway construction at each end of the study area to structurally secure the foundations of the posts. The operations of the permanent traffic signals would be comparable to the portable traffic signals and could be decommissioned once the widening is complete. The permanent traffic signals can potentially last for a number of years, allowing for more time if needed for the widening and road rehabilitation to be completed. The cost for permanent traffic signals is expected to be greater than the cost of portable traffic signals, but is dependent on the operating conditions and maintenance needs of the portable traffic signals.

Expected cost: $200,000 including power, conduit, and fixtures.

OPTION C: TEMPORARY STOP SIGNS

Temporary stop signs, along with supporting signage to indicate the one-lane operations of the corridor, can also be considered. While a significantly lower cost compared to portable and permanent traffic signals, their effectiveness at improving the safety for the 1-lane section of the corridor is limited, and they rely heavily on driver compliance. As sight distances are limited, a vehicle may enter the 1-lane section of the roadway unaware that a vehicle has also entered from the opposing direction. With no ability for a vehicle to pull over in this section of roadway, this can result in one vehicle being required to reverse to allow the opposing vehicle to pass. Given the limited sight conditions along the corridor, Routine inspections to confirm the stop signs are adequately functioning and positioned will also be required. Similar to the other measures, the stop signs and supporting signage can be removed once the permanent roadway improvements have been constructed. As such, temporary stop signs were considered a potential solution that can provide cost savings, however they are not recommended in this location as the local site conditions will limit and may potentially worsen the roadway safety by conveying a false sense of safety along the corridor.

Expected cost: $10,000, with additional costs for backup devices to deploy should signs be damaged.

NEXT STEPS FOR SLAT ASSESSMENT:

Our proposed next steps consist of the following:

- Review the traffic data and survey data to confirm site operating conditions and constraints.
- Assess the initial 3 traffic options outlined above to assess viability and constructability, including a review of the potential safety, operational benefits, budget constraints, and level of risk that the municipality can accept.
- Consider the expected construction schedule for permanent improvements to the roadway.
- Determine if any additional alternative options should be considered.
- Develop a recommended strategy for interim solutions.
- Prepare a high-level cost estimate for interim solutions.
- Prepare a detailed implementation plan for recommendations.

CONSTRUCTABILITY REVIEW

In discussion with a contractor who performs this type of stability work (Dynamite Construction), and Geobrugg Canada (supplier and technical experts for the TECCO mesh system, the first three options are all constructable and have been built in similar settings. Examples of these have been previously provided to the MNC. The challenging part of construction will be planning and scheduling the work such that it limits disturbance to traffic flow to and from the community of Genoa Bay. Sequence of construction will largely be up to the contractor who is awarded the work, but conceptually WSP would envision the following as a potential construction sequence for Option 1:

1. Establish a traffic management plan for approval by North Cowichan;
2. Establish one lane alternating traffic on the southbound lane with maximum road shutdown durations established, if required;
3. Clearing and grubbing the vegetation on the slope;
4. Localized grading of the slope (if required);
5. Installation of rock anchors;
6. Installation of TECCO mesh and fasten to anchors;
7. Strip the asphalt from the northbound lane, compact the surface and temporary grade;
8. Temporarily hang the overland watermain from the rock face;
9. Direct single lane alternating traffic to the northbound lane with appropriate signage, temporary barriers, lighting;
10. Strip the asphalt, base and subbase materials and cut part subgrade down to about 1.0m depth in the southbound lane.
11. Surface compact the existing subgrade in the southbound lane and install four layers of geosynthetically reinforced soil (GRS);
12. Install the watermain towards the center of the southbound lane by excavating through the GRS;
13. Backfill the watermain and bring the southbound lane to approximate subgrade of the pavement structure (i.e., before subbase, base, and asphalt);
14. Direct traffic to the southbound lane for single lane alternating traffic;
15. Excavate subgrade in the northbound lane to prepare for construction of the GRS retaining wall;
16. Construct the GRS retaining wall and road in the northbound lane up to the pavement structure subgrade (i.e., prior to placement of subbase, base, and asphalt);
17. Bring road to grade prior to asphalt (will require single lane alternating traffic);
18. Install instrumentation in shoulder of northbound lane;
19. Surface with asphalt and install roadside barriers, lane marking, etc.

COST SUMMARY

The following Table 1 provides an approximate breakdown of costs associated with each option. These costs are based on information that has previously been provided to WSP on this project (Dynamite Construction, Geobrugg, Advicas), or experience with other projects.

Table 1: Rough Breakdown of Costs for the listed Options

OPTION	COST ITEM	COST BREAKDOWN
1. Stabilize Road Prism and Widen Road	1. Anchors and Tecco mesh, traffic management, clearing and grubbing;	$1,600,000
	2. GRS retaining wall and backfill;	$600,000
	3. Watermain replacement;	$50,000
	4. Pavement structure with 50mm asphalt and a concrete barrier;	$100,000
	5. Instrumentation	$10,000
	6. 20% contingency	$472,000
	7. 4% engineering fees	$94,400
	TOTAL	**$2,964,400**
2. Stabilize Road Prism with Single Lane Alternating Traffic	1. Anchors and Tecco mesh, traffic management, clearing and grubbing;	$1,600,000
	2. Sawcut asphalt, remove pavement structure, compact surface, place pavement structure with 50mm asphalt and concrete barrier;	$100,000
	3. Watermain replacement;	$50,000
	4. Permanent traffic control lights*;	$200,000
	5. Instrumentation	$10,000
	6. 20% contingency	$392,000
	7. 4% engineering fees	$78,400
	TOTAL	**$2,430,400**
3. Stabilize Road Prism With Two Lanes And No Widening	1. Anchors and Tecco mesh, traffic management, clearing and grubbing;	$1,600,000
	2. Regrade surface by placing additional asphalt on surface.	$70,000
	3. Watermain replacement;	$50,000
	4. 20% contingency	$344,000
	5. 4% engineering fees	$68,800
	TOTAL	**$2,132,800**
4. Do Nothing	Managed completely by the Municipality of North Cowichan	Not applicable.

*alternate options discussed that will have an impact on cost includes temporary lights (about $40,000), stop signs (about $10,000).

FUTURE WORK

WSP anticipates that we will discuss this memo with the MNC and the MNC will then decide on how it would like to proceed with this section of road. Based on that decision, WSP will prepare a set of drawings and specifications for the option that is chosen (assuming that it will be either Option 1 or Option 2). These drawings and specifications will be used to tender the work.

CLOSING AND TERMS

This report was prepared as an extension to our service contract with the Municipality of North Cowichan for this project.

Yours sincerely,

WSP Canada Inc.

EGBC Permit to Practice No. 1000200

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List of Appendices:
Appendix A – Excerpt from TAC Geometric Design Guide

APPENDIX

A

EXCERPT FROM TAC GEOMETRIC DESIGN GUIDE

510.07 CROSS SECTION ELEMENTS

Cross-section Types

The majority of low-volume roads built in British Columbia are two-lane, two-way LVRs. Refer to Figure 510.P. One-lane LVRs are very seldom designed and are, therefore, not covered in this chapter.

The designer should not design a one lane LVR without the approval of the Chief Engineer or the Director, Highway Design & Survey Engineering.

A) Two-lane LVRs

The roadway widths are dependent on the design speed, the amount of truck traffic and the type of surface. The shoulder width is the minimum that will provide lateral support for the pavement. There is no allowance for emergency parking as there are ample gaps in the opposing traffic stream to permit a safe passage around parked vehicles.

B) One-lane LVRs

One-lane LVRs are not common but they may be suitable in very special circumstances when the right-of-way is limited, such as in very rough terrain. One-lane LVRs can be designed for one-way or two-way traffic.

C) Peace District LVRs

(refer to Technical Circular T-3/03)

Within the Peace District, concerns were raised with the traditional roadway template having a paved surface that is too narrow, and side slopes that are too steep, to properly accommodate the large vehicles in use by agriculture and industry. Where economically feasible, the Peace District template will incorporate a 9.0 metre hard surfaced top with 3 or 4 to 1 side slopes. Refer to Figure 510.Q.

Certain factors may make this new template more expensive. These factors include right-of-way requirements, very large fills or large excavations. In addition, there may be some low volume local or primarily residential roads where industrial or agricultural traffic volumes are low enough that the Peace District template is deemed to be an inappropriate standard.

Where the costs associated with the new template are felt to be excessive, or where industrial or agricultural traffic volumes are low enough not to warrant application of the full template width, options for incremental improvement will be discussed with stakeholders to determine the best value approach on specific roads or sections of roads.

Exceptions to this standard will only be considered, as outlined above, after stakeholder consultation and review of appropriate road template standards to be applied for the given road. At a minimum, stakeholder consultations will include MLAs, the Regional Transportation Advisory Committee, and Rural Roads Task Forces.

Exceptions must be approved by the Chief Engineer, or designate.

Cross Section Elements for LVRs

Refer to Figure 510.P with these two tables.

Table 510.K Cross Section Elements for Two-lane LVRs - Gravel Top

Design Speed (km/h)	Roadway Width(1) (m)		Normal X-Fall (m/m)	Fill Slope(2)
	ADTT>15(3)	ADTT<15(3)		
80 - 90	8.0	7.5(4)	0.04	2:1
30 - 70(5)	7.5(4)	7.0(4)	0.04	2:1

Table 510.L Cross Section Elements for Two-lane LVRs - Paved Top

Design Speed (km/h)	Lane Width(1) (m)		Unpaved(1) Shoulder (m)	Normal X-Fall (m/m)	Fill Slope(2)
	ADTT>15(3)	ADTT<15(3)			
80 - 90	3.6	3.5	0.5	0.02	2:1
50 - 60 - 70(5)	3.5	3.25(4)	0.5	0.02	2:1
30 -40(5)	3.25(4)	3.25(4)	0.5	0.02	2:1

(1) Where CRB is used, widen the roadway or pavement by 0.6 m on the barrier side of the roadway.

(2) In mountainous terrain, when fill heights exceed 3.0 metres or when environmental, R/W or other economic constraints dictate, a slope of 1.5:1 may be appropriate. For high fill heights, the traffic barrier warrant should be examined. Maximum side slopes of 1.25:1 are suggested for rock grading.

Maximum back slopes of 1.5:1 are suggested for earth grading if the stability of local soils permits. For cut sections in solid rock, refer to the appropriate drawing in Chapter 400.

(3) ADTT = Average Daily Truck Traffic. A truck is defined as a Medium Single Unit (MSU) or larger vehicle. See Chapter 2 Section 2.4 in the *TAC Geometric Design Guide* and Section 720 in this Manual for a discussion on Design Vehicles.

(4) To avoid shoulder degradation on paved LVRs and crossing of centreline on gravel LVRs, these widths should be increased on curves. The amount of additional widening is related to curvature and speed. See Chapter 3 Section 3.2.5 of the *TAC Geometric Design Guide* for a discussion on Lane Widening on Curves.

(5) Approval from the regional Executive Director or the project Technical Review Committee is required for design speeds less than 80 km/h.

510.08 CLEAR ZONE

There is no clear zone applied to LVRs with regards to slope treatment. However, the utility pole offset is applied. Utility poles must be placed within 2 metres of the R/W or 3 metres from the toe of fill, whichever gives the greater offset from the lane edge.

510.09 BARRIER FLARES

The flares for both roadside barrier and bridge ends are a function of volumes under 200 ADT and are shown in Table 510.N. For the "2/3" flare, the flare rate or angle has been maintained, while the length and thus the offset have been reduced.

For the "1/3" flare, the "2/3" Ya has been kept, with the minimal Xa to develop the offset. This Xa is a function of the connection flexure between pieces of barrier. Figure 510.M shows the decision tree to the appropriate treatment.

Where a full flare or a "2/3" flare is required, the designer should evaluate the economics of using the required Xa with an attenuator and no flare. To simplify the comparison, evaluate capital costs of the flare vs. capital cost of the attenuator, without a flare. See 510.12 for Flare Adjustment rationale.

510.10 ROADSIDE BARRIER

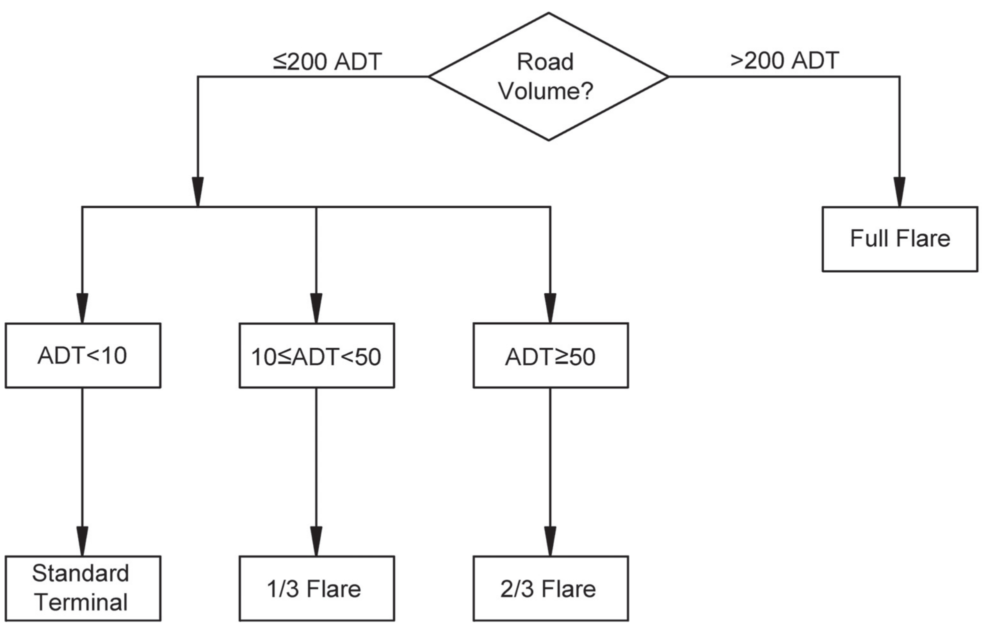
Barrier need is determined with the Roadside Barrier Index Warrant, in Chapter 600, Safety Elements. To accommodate the barrier, add 0.6 metres width to the side of the road where the barrier is to be placed.

510.11 LOW-VOLUME BRIDGES

All bridges shall have an end treatment. Figure 510.M is the decision tree to the appropriate treatment on bridges.

The Structural Engineering Branch and Traffic & Highway Safety Branch are to be contacted regarding connection details to various bridge ends.

Figure 510.M Barrier Flare Decision Tree



Full Flares are shown in Chapter 600: Figure 640.C for Roadside Barrier and Figure 640.D for Bridge Ends. Reduced flares are shown in Tables 510.N. The notations "2/3" and "1/3" are nominal descriptors; the actual lengths are a function of discrete barrier pieces, connection details and the ability to flex the barrier at their individual connections.

610
SAFETY BARRIERS

610.01 ROADSIDE BARRIER INDEX NOMOGRAPH

The nomograph in Figure 610.A is used to determine a barrier need index number based on the roadside conditions. Prior to referring to Figure 610.A, the designer should design the roadside according to the Clear Zone guidelines outlined in section 620 Roadside Safety. The roadside barrier index should only be evaluated in locations where it is not cost effective to achieve the clear zone distance.

610.02 CONCRETE LOW BARRIER INSTALLATIONS

610.02.01 Background

This section deals with expanding the highway locations where the 460 mm Concrete Low Barrier (CLB) may be installed (refer to the Standard Specifications for Highway Construction, drawing SP941.01.01.02). CLBs are currently permitted to be installed:

a. in left turn slots as a form of median barrier on multi-lane roads;

b. on the inside of curves alongside ditches in rock-cuts;

c. in parking areas to form boundaries and contain traffic.

From a review and analysis of the performance of the CLB in computer modeling and practical service experience of their use in many B.C. locations, it has been decided to expand their installation to situations where they could contribute to road safety. (1)

610.02.02 Supplementary Guidelines for Installing Concrete Low Barrier on the Outside Shoulder of Highways

A. Required Conditions:

In addition to locations listed in 610.02.01, the CLB will be permitted when two critical conditions are met. These are:

i. The Design Speed or Posted Speed Limit is not greater than 70 km/h.

ii. The B.C. Warrant Index value is less than 90. No lower limit warrant will be required, i.e. CLBs may be installed for much lower index values than 90.

B. Application Guidelines

a) The CLB may be installed instead of curb and gutter where vehicles riding over the curb may enter a hazardous area. CLB will not be installed if vehicles are permitted to park beside the curb. On 2-lane roads, the face of the Concrete Bullnose (CBN) (SP 941-01.01.01) will continue to the face of the curb. On multi-lane roads, the inside face of the CBN will be placed 25 mm in front of the curb face when the traffic flow direction is from the CBN to the curb & gutter. When the traffic flow is from the curb & gutter to the CBN, the inside face of the CBN will be placed 25 mm behind the curb & gutter face. The CBN and CLB should be placed on pavement with 50 mm minimum paved width behind the barriers.

b) The CLB may be installed to prevent vehicles from striking frangible luminaire poles.

Roadside barrier assessment and analysis,
Jeff Somerville, P.Eng., April 9, 2024

c) The CLB may be considered for installation along unnumbered roads where the maximum winter or summer ADT is less than 1,500 vehicles per day, usually on School bus routes. It is advisable that CLB not be used on roads where the posted or unposted (i.e. statutory) speed limit is greater than 70 km/h. The CBN and CLB units may be ordered and used without the 100 mm drainage holes in locations where local surface drainage and catch basins are provided. They will not need any further treatment to function as drainage curbs.

d) Approach and Opposing flare layouts will be required when the CBN and CLB are the terminals of barrier installations, i.e. when no curb and gutter is present. The dimensions of flares are to generally conform to those listed in Figure 640.C. The number of units may differ from those listed in Figure 640.C to account for CLB pieces being longer than CRB pieces. In most cases, this will result in a longer flare length. In th
for tl

e) The
CMB
BC
High

Figure 610.A Roadside Barrier Index Nomograph

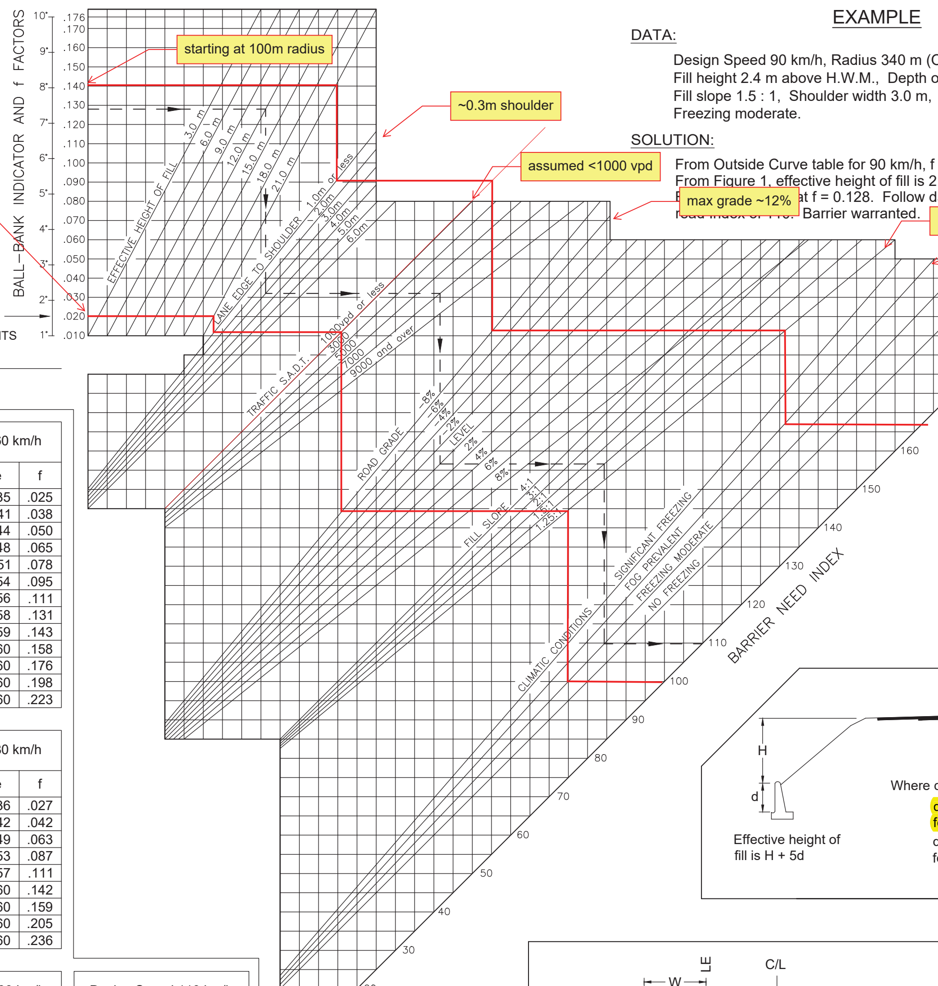
N.T.S.

BARRIER USUALLY NOT WARRANTED

1. When in a cut or on a fill with less than 3m effective height.
2. When fill slope is 4:1 or flatter.
3. When Barrier Need Index is less than 90.

The Principal Highway Safety Engineer should be consulted when barrier is being considered for the above situations.

NOTE:
Do not extrapolate beyond the minimum or maximum values shown on the nomograph. For f > 0.176 (ball-bank 10°) to max. f of 0.220, use the Barrier Warrant Calculator spreadsheet.



EXAMPLE

DATA:

Design Speed 90 km/h, Radius 340 m (Outside Curve),
Fill height 2.4 m above H.W.M., Depth of still water 1.2 m,
Fill slope 1.5 : 1, Shoulder width 3.0 m, S.A.D.T. 7000 vpd,
Freezing moderate.

SOLUTION:

From Outside Curve table for 90 km/h, f = 0.128 for 340 m radius.
From Figure 1, effective height of fill is 2.4 + (8 x 1.2) = 12 m
F[illegible] at f = 0.128. Follow dashed line through to road index of 110. Barrier warranted.

OUTSIDE CURVES

For 6% max. superelevation

design speed 40 kph

initial curve (south) is R=100 but much is on a tangent

Design Speed 50 km/h			
Radius	e+f	e	f
330	.060	.035	.025
300	.066	.037	.029
250	.079	.040	.038
220	.089	.043	.047
190	.104	.046	.058
170	.116	.048	.068
150	.131	.051	.081
130	.151	.053	.098
110	.179	.056	.122
*90	.219	.060	.159
80	.246	.060	.186
75	.262	.060	.202
70	.281	.060	.221

Design Speed 60 km/h			
Radius	e+f	e	f
475	.060	.035	.025
360	.079	.041	.038
300	.094	.044	.050
250	.113	.048	.065
220	.129	.051	.078
190	.149	.054	.095
170	.167	.056	.111
150	.189	.058	.131
140	.202	.059	.143
*130	.218	.060	.158
120	.236	.060	.176
110	.258	.060	.198
100	.283	.060	.223

Design Speed 70 km/h			
Radius	e+f	e	f
630	.061	.035	.026
450	.086	.042	.043
360	.107	.047	.060
270	.143	.053	.090
230	.168	.056	.112
*190	.203	.059	.144
170	.227	.060	.167
160	.241	.060	.181
150	.257	.060	.197

Design Speed 80 km/h			
Radius	e+f	e	f
800	.063	.036	.027
600	.084	.042	.042
450	.112	.049	.063
360	.140	.053	.087
300	.168	.057	.111
*250	.202	.060	.142
230	.219	.060	.159
190	.265	.060	.205
170	.296	.060	.236

Design Speed 90 km/h			
Radius	e+f	e	f
1050	.061	.036	.025
800	.080	.042	.038
600	.106	.048	.058
450	.142	.054	.088
380	.168	.058	.110
*340	.188	.060	.128
300	.213	.060	.153
250	.255	.060	.195
230	.277	.060	.217

Design Speed 100 km/h			
Radius	e+f	e	f
1250	.063	.037	.026
1000	.079	.042	.037
800	.098	.047	.051
600	.131	.053	.078
450	.175	.059	.116
*440	.179	.060	.119
380	.207	.060	.147
340	.232	.060	.172
300	.262	.060	.202

Design Speed 110 km/h			
Radius	e+f	e	f
1500	.064	.038	.025
1000	.095	.048	.047
800	.119	.053	.066
*600	.159	.060	.099
550	.173	.060	.113
500	.191	.060	.131
450	.212	.060	.152
380	.251	.060	.191
360	.265	.060	.205

* These curve radii are minimum values for new highway design.

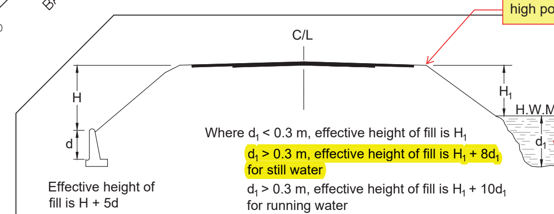
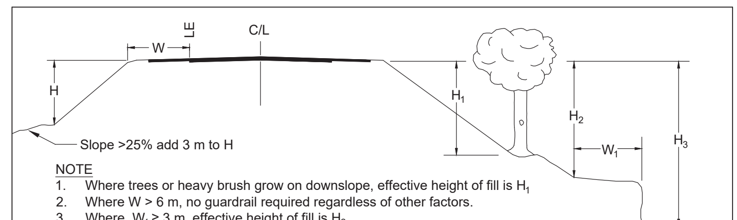


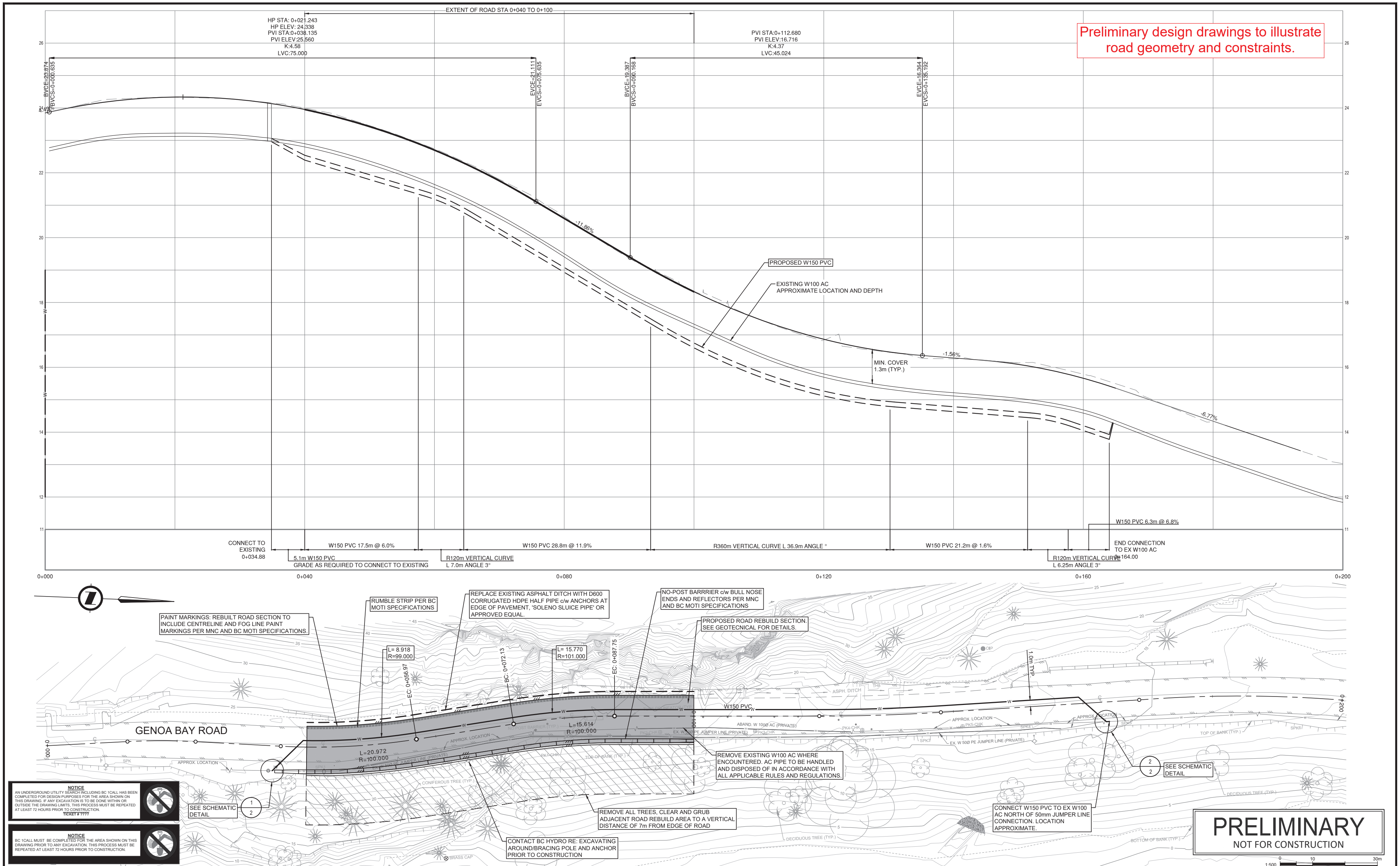
FIGURE 1



NOTE
1. Where trees or heavy brush grow on downslope, effective height of fill is H_1
2. Where W > 6 m, no guardrail required regardless of other factors.
3. Where $W_1 \geq 3$ m, effective height of fill is H_2
   $W_1 < 3$ m, effective height of fill is H_3
4. Where downslope from toe exceeds 25% (4:1), effective height of fill is H + 3 m

Genoa is ~2:1

FIGURE 2



NOTICE

AN UNDERGROUND UTILITY SEARCH INCLUDING BC 1CALL HAS BEEN COMPLETED FOR DESIGN PURPOSES FOR THE AREA SHOWN ON THIS DRAWING. IF ANY EXCAVATION IS TO BE DONE WITHIN OR OUTSIDE THE DRAWING LIMITS, THIS PROCESS MUST BE REPEATED AT LEAST 72 HOURS PRIOR TO CONSTRUCTION.
TICKET # ????

NOTICE

BC 1CALL MUST BE COMPLETED FOR THE AREA SHOWN ON THIS DRAWING PRIOR TO ANY EXCAVATION. THIS PROCESS MUST BE REPEATED AT LEAST 72 HOURS PRIOR TO CONSTRUCTION.

PRELIMINARY
NOT FOR CONSTRUCTION

1:500 — 0, 10, 30m

ISSUED FOR 50% DESIGN REVIEW

LEGEND

BARRIERS, FENCE, ROAD MARKING, HYDRO ELEC, CABLE TV, TELEPHONE, GAS, EDGE OF PAVEMENT, ASPHALT CURB, CURB AND GUTTER, SANITARY SEWER, SANITARY FORCE MAIN, STORM DRAIN, WATER MAIN, WATER VALVE, HYDRANT ASSEMBLY, WATER METER, WATER REDUCER, WATER AIR VALVE, WATER SERVICE, WATER FLUSH, SANITARY MANHOLE, SANITARY CLEANOUT, SANITARY SERVICE, STORM MANHOLE, STORM CLEANOUT, STORM SERVICE, STORM LAWN DRAIN, STORM CATCH BASIN, DITCH/SWALE, UTILITY POLE, GUY WIRE ANCHOR, POLE MOUNT LUMINAIRE, DAVIT MOUNT LUMINAIRE, SURVEY MONUMENT/CONTROL

CONSULTANT: MUNICIPALITY OF NORTH Cowichan

ENGINEER'S SEAL

REVISIONS			
No.	DESCRIPTION	DATE	SIGN

DESIGN:	DN
DRAWN:	SG
CHECKED:	JCS
DATE:	2023/11/30
B.M.:	GEODETIC
ELEV.:	MNC MON
SCALE:	Horz. 1:500 Vert. 1:50

PROJECT: GENOA BAY ROAD

TITLE: SITE PLAN OR PLAN / PROFILE FROM STA 0+000 TO STA 0+220

CONSULTANTS No. CA0002646.9368

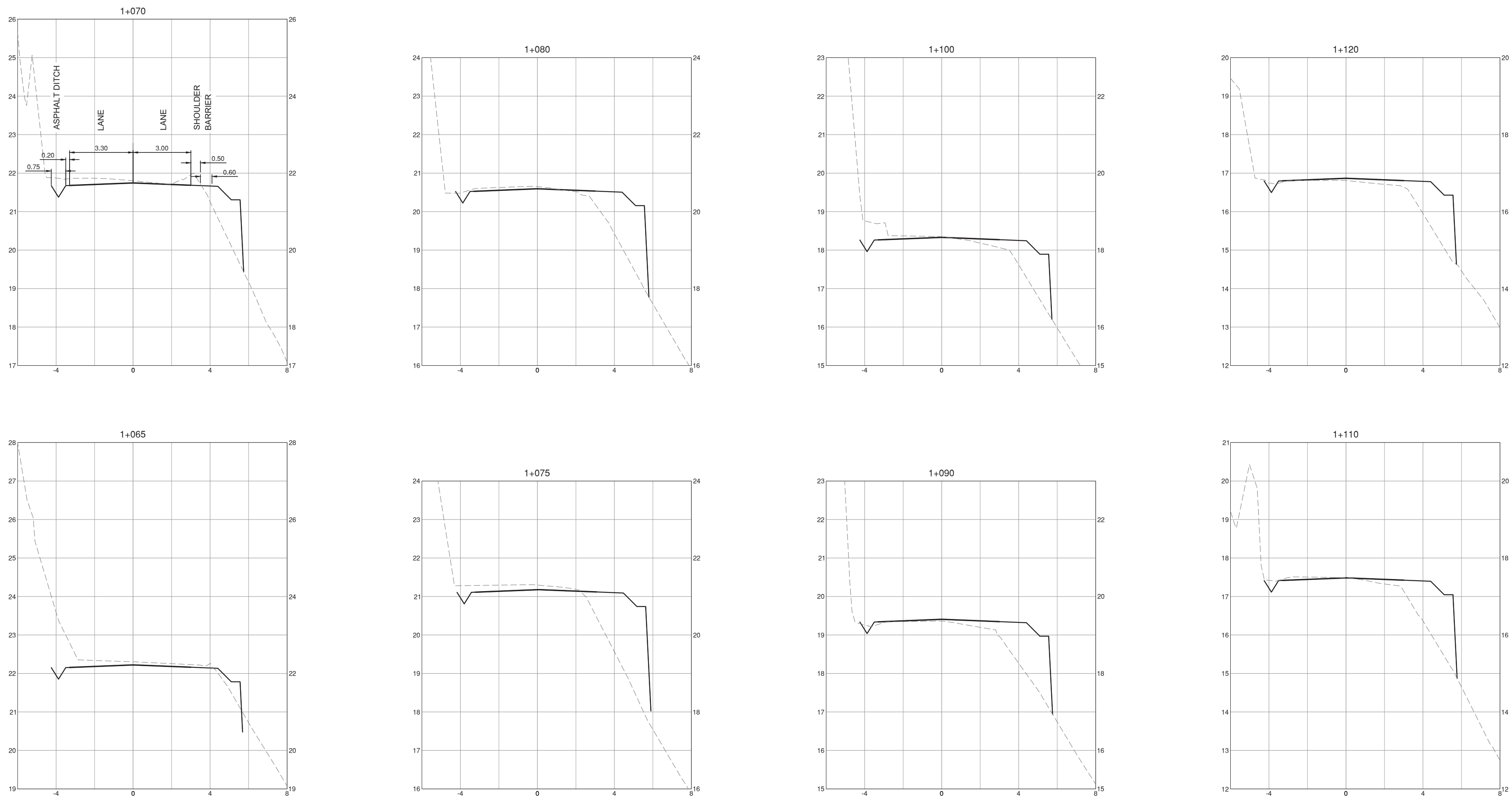
SHEET No. 2 OF 8

GRID No. # REV. No. #

N.C. No. #

DATE: 2024-01-12, 15:23 FILE: C:\Users\Stephane.Gagnon\WSP O365\CA0002646.9368 CA-MNC - Genoa Bay Road Detailed Design - Project Folders\05. Technical\Civil\9 DWG\Production\CA0002646.9368-Civil-Layout.dwg

Preliminary sections showing the recommended ultimate build-out



1:50 0 1.0 3.0m
1:100 0 2 6m

LEGEND

EXISTING	PROPOSED		EXISTING	PROPOSED		EXISTING	PROPOSED		EXISTING	PROPOSED		EXISTING	PROPOSED	
		BARRIERS			EDGE OF PAVEMENT			WATER VALVE			SANITARY MANHOLE			STORM CATCH BASIN
		FENCE			ASPHALT CURB			HYDRANT ASSEMBLY			SANITARY CLEANOUT			DITCH/SWALE
		ROAD MARKING			CURB AND GUTTER			WATER METER			SANITARY SERVICE			UTILITY POLE
		HYDRO ELEC			SANITARY SEWER			WATER REDUCER			STORM MANHOLE			GUY WIRE ANCHOR
		CABLE TV			SANITARY FORCE MAIN			WATER AIR VALVE			STORM CLEANOUT			POLE MOUNT LUMINAIRE
		TELEPHONE			STORM DRAIN			WATER SERVICE			STORM SERVICE			DAVIT MOUNT LUMINAIRE
		GAS			WATER MAIN			WATER FLUSH			STORM LAWN DRAIN			SURVEY MONUMENT/CONTROL

CONSULTANT

MUNICIPALITY OF NORTH Cowichan

ENGINEER'S SEAL

REVISIONS			
No.	DESCRIPTION	DATE	SIGN

DESIGN:	DN
DRAWN:	SG
CHECKED:	JCS
DATE:	2023/11/30
B.M.:	GEODETIC
ELEV.:	MNC MON
SCALE:	Horz. 1:100 Vert. 1:50

PROJECT: GENOA BAY ROAD

TITLE: SECTIONS FROM STA 1+065 TO STA 1+120

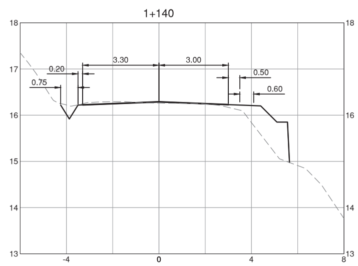
CONSULTANTS No. CA0002646.9368

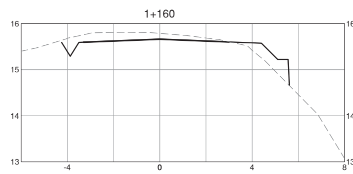
SHEET No. 2 OF 8

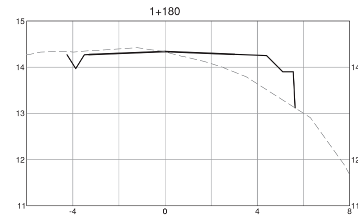
GRID No. # REV. No. #

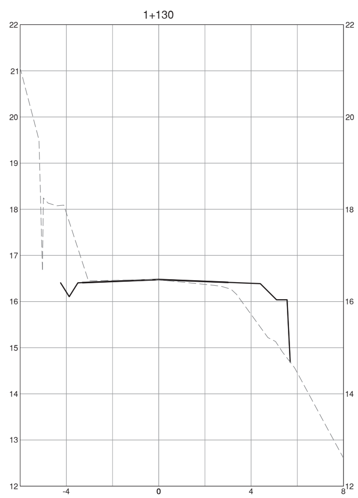
N.C. No. #

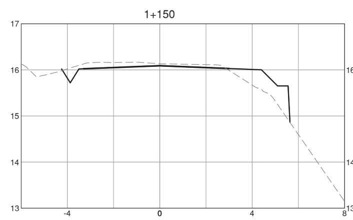
ISSUED FOR 50% DESIGN REVIEW

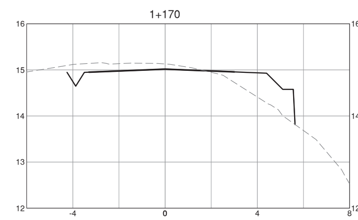


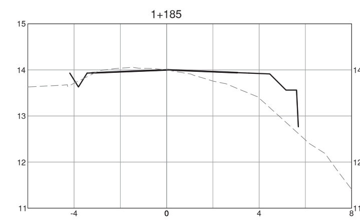












1:50 — 0, 1.0, 3.0m
1:100 — 0, 2, 6m

ISSUED FOR 50% DESIGN REVIEW

LEGEND

EXISTING	PROPOSED		EXISTING	PROPOSED		EXISTING	PROPOSED		EXISTING	PROPOSED		EXISTING	PROPOSED	
		BARRIERS			EDGE OF PAVEMENT			WATER VALVE			SANITARY MANHOLE			STORM CATCH BASIN
		FENCE			ASPHALT CURB			HYDRANT ASSEMBLY			SANITARY CLEANOUT			DITCH/SWALE
		ROAD MARKING			CURB AND GUTTER			WATER METER			SANITARY SERVICE			UTILITY POLE
		HYDRO ELEC			SANITARY SEWER			WATER REDUCER			STORM MANHOLE			GUY WIRE ANCHOR
		CABLE TV			SANITARY FORCE MAIN			WATER AIR VALVE			STORM CLEANOUT			POLE MOUNT LUMINAIRE
		TELEPHONE			STORM DRAIN			WATER SERVICE			STORM SERVICE			DAVIT MOUNT LUMINAIRE
		GAS			WATER MAIN			WATER FLUSH			STORM LAWN DRAIN			SURVEY MONUMENT/CONTROL

CONSULTANT

MUNICIPALITY OF NORTH Cowichan

ENGINEER'S

SEAL

REVISIONS

No.	DESCRIPTION	DATE	SIGN

DESIGN:	DN
DRAWN:	SG
CHECKED:	JCS
DATE:	2023/11/30
B.M.:	GEODETIC
ELEV.:	MNC MON
SCALE:	Horz. 1:100 Vert. 1:50

PROJECT: GENOA BAY ROAD

TITLE: SECTIONS FROM STA 1+130 TO STA 1+185

CONSULTANTS No. CA0002646.9368

SHEET No. - OF -

GRID No. #

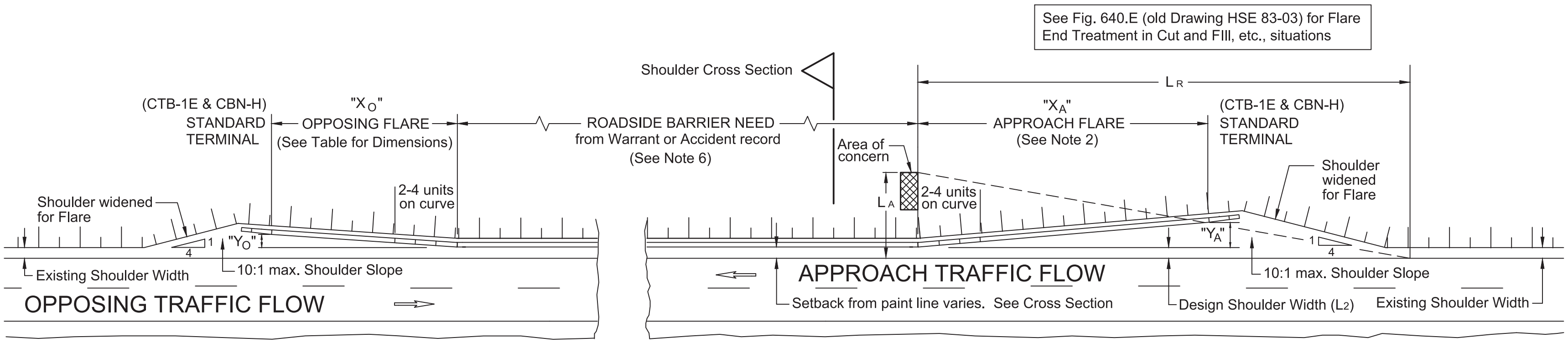
REV. No. #

N.C. No. #

Typical concrete barrier placement detail

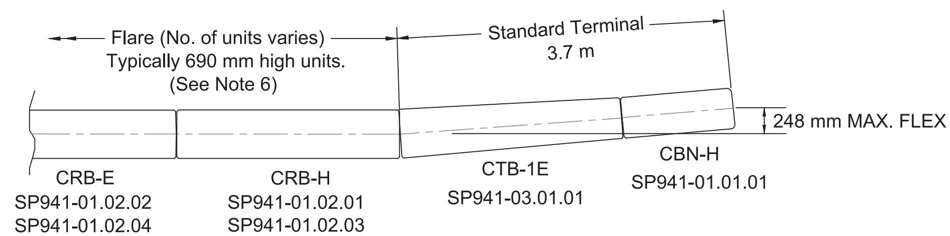
Figure 640.C Standard Layout of Flares and Terminals for Concrete Roadside Barriers

N.T.S. (old HSE 82-07A)

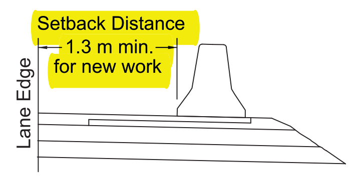


LAYOUT PLAN of PRECAST CONCRETE BARRIER FLARES
(For Assembly Elevations, see Drawing HSE 82-11 in BC MoT "Guardrail Placement Guidelines")

LAYOUT DIMENSIONS			
Travel Speed	OPPOSING FLARE		
km/h	X_O	Y_O	No. of Units
120	37.5	1.7	15
110	32.5	1.6	13
100	27.5	1.5	11
90	25.0	1.5	10
80	22.5	1.6	9
70	20.0	1.6	8
60	15.0	1.5	6
50	12.5	1.5	5



DETAILS OF STANDARD TERMINAL



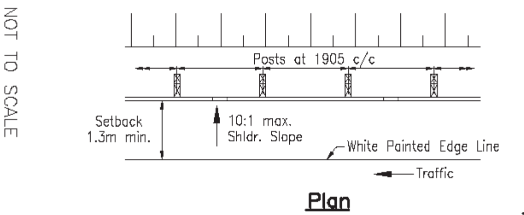
SHOULDER CROSS SECTION
(See Figure 440.F)

NOTES :

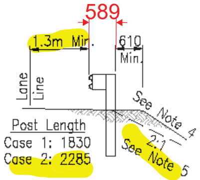
1. All dimensions in metres unless otherwise noted.
2. See Tables 640.A and 640.B for Approach Flare Layout Dimensions.
3. Table of layout dimensions is derived from 2011 AASHTO "Roadside Design Guide" based on L_R (Runout Length) for ADT > 10000, L_2 (Shoulder Width) = 1.3 m, L_A (Lateral Extent of the Area of Concern) = 9 m, and Table 5-9 Flare Rate for rigid barrier system.
4. Both Approach and Opposing Flares are required for Roadside Barrier on all undivided highways. Opposing Flare may not be required on a divided highway with Median Barrier in place or at locations that meet the criteria outlined in Section 640.02.
5. Number of units shown in table may be increased but should not be reduced.
6. Roadside barrier will usually be 690 mm high (CRB). In special cases, 810 mm high units (CMB) may be used. In this event, transition units (CTB-2) will be needed to link the CMB to the CRB.

Typical W-beam detail

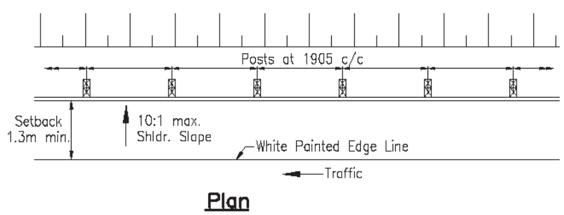
NOT TO SCALE
ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED



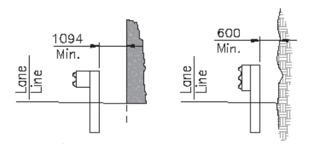
Plan



Barrier Placement Near Embankment

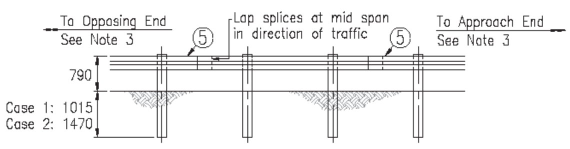


Plan

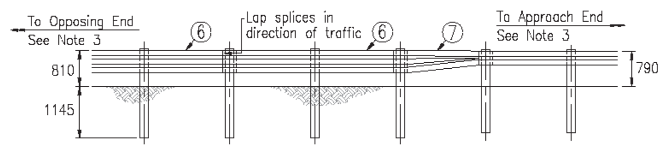


Barrier Clearance to Hazard (Fixed Object or Rock)

NOTE: The above clearances are based on a standard post spacing of 1905



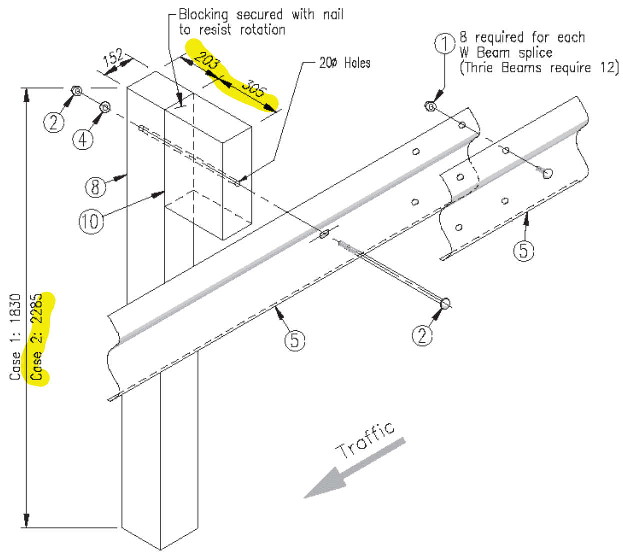
Elevation
W Beam Guardrail



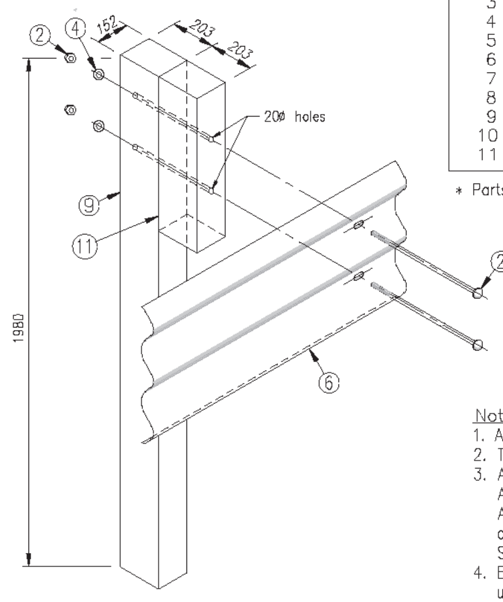
Elevation
Thrie Beam Guardrail
(with Transition to W beam)

Metal Guardrail Part List		
Part No.	* TF13 Part No.	Description
1	FBB01	16mm (5/8") Button head bolt (35mm Lg.) & Recess nut
2	FBB07	16mm (5/8") Button head bolt (530mm Lg.) & Recess nut
3	---	---
4	FWC16a	Washer for 16mm (5/8") Bolt
5	RWM04a-b	SGR38b/d 4-Space W Beam
6	RTM02a-b	SGR09c Thrie Beam
7	RWT02a-b	W-Thrie Beam Transition Section
8	PDE02/PDE18	152x203 Timber post
9	PDE03	152x203 Timber post
10	PDB11a-b	152x305 Timber blockout (360 Lg.)
11	PDB02a	152x203 Timber blockout (550 Lg.)

* Parts list as per Task Force 13.



Exploded View of
W Beam Splice/Post Assembly
(Meets MASH 2016 TL-3)



Exploded View of
Thrie Beam Splice/Post Assembly
(Meets NCHRP 350 TL-3)

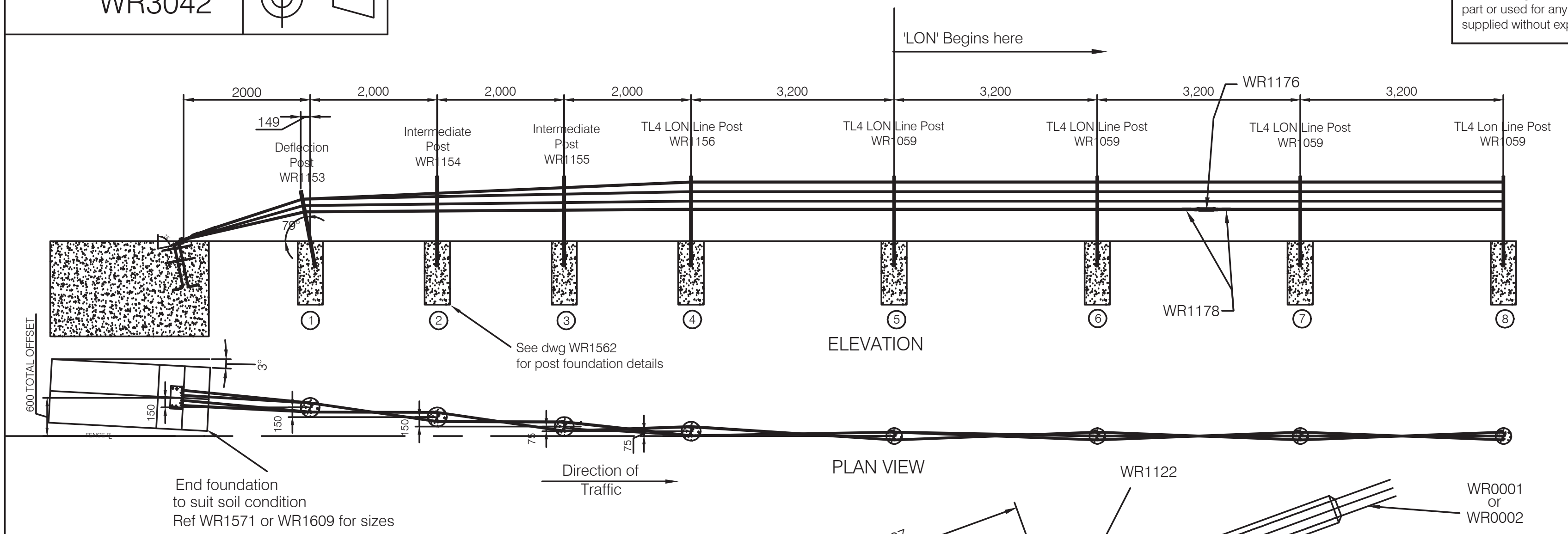
Notes:
1. All dims. are in mm unless otherwise noted.
2. This drawing to be used with Specification 312.
3. All traffic barrier installations will have an Energy Absorbing Terminal or buried end treatment at both the Approach and Opposing ends to reduce vehicle occupant hazard and provide anchorage. See Dwg. SP312-2 for details.
4. Barrier Placement Case 1: 1830 long W beam post – use when there is 0.61 m or greater shoulder width behind the post.
5. Barrier Placement Case 2: 2285 long W beam post – if side slope is 2:1 or flatter, posts may be placed at the shoulder break point.

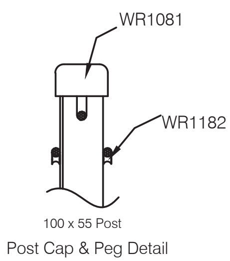
BRITISH COLUMBIA
Ministry of Transportation & Infrastructure

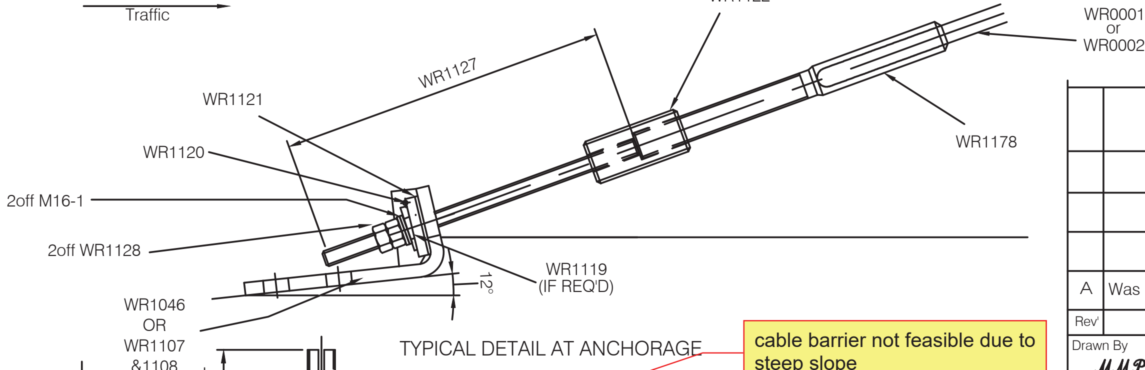
W-Beam Barrier on Timber Posts SGR38
Thrie Beam Barrier on Timber Posts SGR09
SP312-1

Typical cable barrier detail

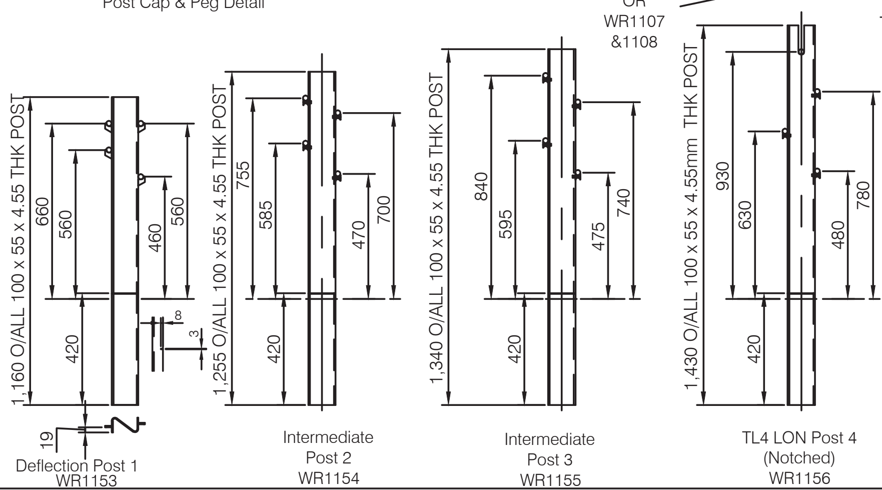
Drawing No. WR3042







cable barrier not feasible due to steep slope



NOTES

1. Wire Rope Vehicle Restraint System (WRVRS) is recommended for installations on slopes of 6:1 or flatter. The area should be relatively smooth, without edge drop-offs, abrupt slope changes, holes, debris, etc. that could prevent a vehicle from impacting the WRVRS with all wheels on the ground and suspension normal. Some filling and/or grading and compaction may be necessary. The ropes must be placed at design height above ground line. Tolerance is ± 25mm.

2. WRVRS may be installed on either side of the roadway. The radius edge of posts shall be on the approach side of traffic. Weakening cut (relief notch) at ground line on posts 1, 2, 3 & 4 to be placed toward the end anchor.

3. End terminal may be located within the horizontal clear zone. Used for TL-4 Systems only. No maximum limit to length between end terminals.

4. The 2 intermediate posts adjacent to WRGT End Terminal do not have top rope slot. All the ropes weave on either side of the posts until the first line post with a slot (post4).

5. Length of need 'LON' begins from post 4.

6. Deflection post & posts 2 to 4 to be mounted in concrete foundations with or without sockets see DWG WR3002 for details

Rev	Remarks	E.C.R.	Date	Check
A	Was Drg WR1613		30/01/12	MH

Drawn By	Date	Material
MMPeach	Jan 2012	
Scale	Finish	Weight
NTS		

Description

Brifen
NCHRP 350 - 4 Rope TL4
WRGT-FL
Flared End Terminal

hill & smith
Springvale Business & Industrial Park, Bilston, Wolverhampton. WV14 0QL.
Tel: (01902) 499400
Fax: (01902) 499419
brifen A DIVISION OF HILL & SMITH
E.mail: enq@brifen.co.uk Website: www.brifen.co.uk

Drawing No. WR3042