Mobile Weigh Scales Project
for the BC Ministry of Transportation

Andre Santos, P.Eng., Project Engineer
Cory Clark, P.Eng., Senior Project Engineer

ISL Engineering and Land Services
#201, 8506 - 200th Street
Langley, BC V2Y 0M1

Paper prepared for presentation at the
"***Geometric Design - Emerging Issues"*** Session

of the 2015 Conference of the
Transportation Association of Canada
Charlottetown, Prince Edward Island

Abstract

The Province of British Columbia's *Commercial Vehicle Safety and Enforcement* (CVSE) branch recently developed a new enforcement strategy consisting of the use of mobile weigh scales. Consequently, the BC Ministry of Transportation and Infrastructure (MOTI) initiated a project to construct mobile weigh scale sites throughout the Lower Mainland. At each site, CVSE officers will enforce transportation laws that govern the safe and legal operations of commercial trucking. The mobile enforcement is designed to be fast and effective, and CVSE officers will rotate between various mobile sites to minimize bypass opportunities for violators.

The *general* location of each site was strategically selected to be along an existing highway, interchange ramp, or pullout, and therefore, each site is considered to be an addition to the existing highway infrastructure. A detailed engineering assessment, consisting of maximizing available sight distance and acceleration and deceleration lengths, often within limited space, was critical in selecting the safest possible *specific* location for each site.

Given that the individual sites will be operated intermittently and at random, typically for no more than a few hours at a time, careful consideration was given to prevent the general public from misidentifying the pullouts as an additional travel lane or exit ramp. The general signing and illumination design approach minimizes attracting general road users to each site, as vehicles using a pullout unnecessarily could create an unsafe scenario.

MOTI collaborated with CVSE to develop a Commercial Vehicle Inspection Station (CVIS) Design Guide which included geometric guidelines to aid in the design of mobile weigh scales. Each site had its own physical constraints, requiring site specific designs for pullout lengths and widths, and entrance and exit tapers.

Existing posted speeds and traffic volumes, as well as expected truck usage and off-tracking, played a role in the specific design parameters developed for each site to provide sufficiently safe operations for CVSE personnel and truck drivers. When each site is in use, CVSE officers will have a presence, aiding truck drivers to decelerate in advance of the site, as well as pull into and exit the site. The CVSE officers will act as traffic control to ensure the safety of all road users travelling through the site.

The mobile weigh scale project required a unique approach to balancing site constraints and design guidelines, while keeping public safety a priority.

1.0 Background

ISL Engineering and Land Services Ltd. (ISL) was retained by the BC Ministry of Transportation and Infrastructure (MOTI) and the Commercial Vehicle Safety and Enforcement (CVSE) to complete the detailed design for nine mobile weigh scale sites. The project was initiated in alignment with CVSE's newly developed enforcement strategy based on the use of mobile scales and pullouts located on heavy truck routes throughout Metro Vancouver / Lower Mainland.

A total of nine mobile weigh scale sites are included in this project, as listed below, and shown in Figure 1. Each site is located within the Lower Mainland and on a major numbered highway or at a major interchange.

- Site 1 - Highway 91 at 64 Avenue SB Ramps
- Site 2 - Highway 91 NB: North of Highway 10
- Site 3 - Highway 91 EB onto Highway 91A NB
- Site 5 - Highway 10 at 232 St (on-ramp to Highway 1 EB)
- Site 6A - 264th Street on-ramp to Highway 1 WB
- Site 6B - 264th Street on-ramp to Highway 1 EB
- Site 7 - Highway 1 WB Brake Check – West Vancouver
- Site 9A – Highway 99 and Ladner Trunk Road WB On-ramp
- Site 9B – Highway 99 and Ladner Trunk Road South

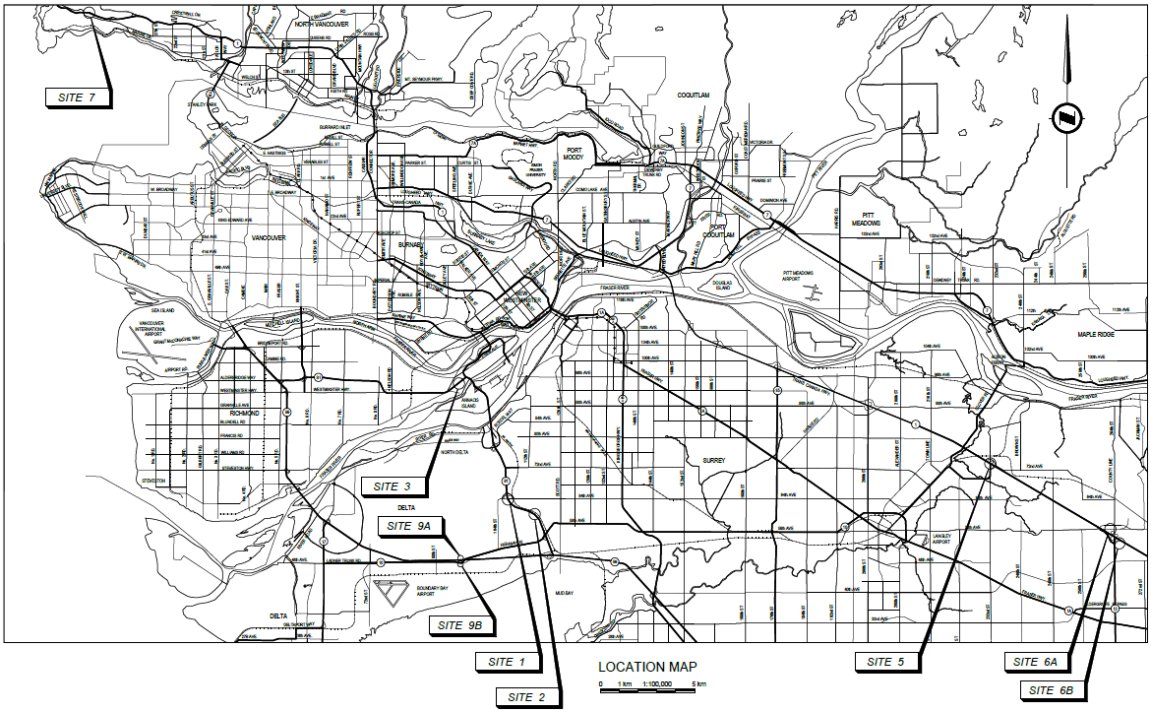


Figure 1: Map of Metro Vancouver Showing Proposed Mobile Weigh Scale Sites

CVSE officers are provincial law enforcement and peace officers who are responsible to enforce transportation laws that govern the safe and legal operations of commercial trucking within the Province of BC. CVSE has developed and will be implementing a new enforcement strategy based on the use of mobile scales. Permanent scales will be utilized in conjunction with mobile enforcement sites that are strategically located at key potential bypass locations which target would-be violators. The mobile enforcement is designed to be fast and effective, and CVSE officers will rotate between various mobile

sites to minimize bypass opportunities for violators. Individual mobile sites will be operated intermittently and at random, typically for no more than a few hours at a time.

Approximately 50 stops per day are conducted by CVSE officers. Most stops are conducted on existing highway shoulders and on/off ramps. The mobile weigh scale pullouts will provide a safer facility for officers to conduct their inspections.

2.0 Location Determination / CVSE Intent

ISL Engineering developed and analyzed options for numerous sites by means of a viability analysis. This included many of the mobile weigh scale (MWS) sites listed in the previous section. In total, 26 options were developed for 10 MWS sites. Options were considered for both right-side and left-side pullouts. Right-side pullouts were selected for most of the sites; left-side pullouts were selected for Sites 3 and 5 due to physical constraints.

Discussed below is CVSE's intent and general location for each of the nine sites selected to proceed to the detailed design phase.

Site 1 – Highway 91 at 64 Avenue SB Ramps

The site on southbound Highway 91, south of 72 Avenue, is intended as an overflow site for the permanent Nordel Way Scale. The mobile scale will capture traffic from north of the Fraser River via the Alex Fraser Bridge headed to Delta, Surrey, and Highway 99; as well as traffic from Delta and Surrey headed to Highway 99 and the Canada/USA border crossing. Figure 2 shows the location of Site 1 at the Highway 91 / 64th Avenue Interchange.

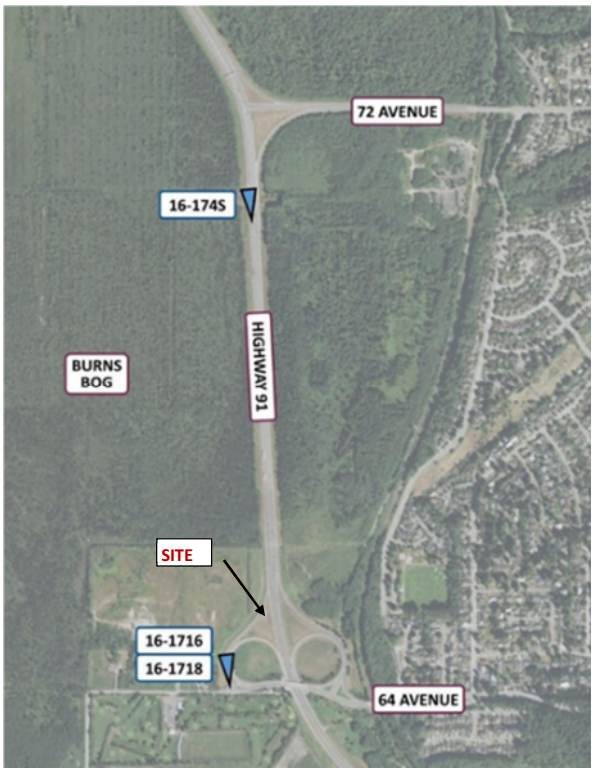


Figure 2: Location of Site 1 on Highway 91 in North Delta, BC

Highway 91 is a four-lane Rural Arterial Divided (RAD) highway with a posted speed of 90 km/hr. Highway 91 is a major traffic route that connects municipalities south of the Fraser River to municipalities north of the Fraser River.

Site 2 – Highway 91 NB: North of Highway 10

CVSE intends to repurpose an existing pullout northbound on Highway 91, between the Highway 10 and 64th Avenue Interchanges, to function as a mobile weigh scale site and provide some truck parking. The existing pullout is shown in the Figure 3.

The existing pullout diverge is located 150m from the Highway 10 on-ramp merge, and is 1080m long including diverge and merge tapers. The 64th Avenue off-ramp diverge is located 750m from the pullout merge.

The existing pullout is currently misused as an informal truck stop/rest area. The pullout was originally designed as a permanent weigh scale site. There is a bypass lane through the pullout which will be maintained. The bypass lane is separated from the useable pullout area with a rollover curb.

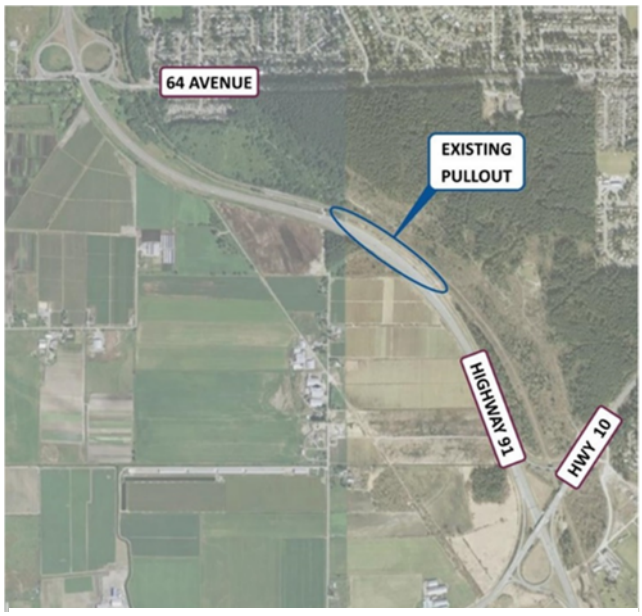


Figure 3: Location of Site 2 / Existing Pullout on Highway 91 in North Delta, BC

Site 3 – Highway 91 EB onto Highway 91A NB

The site on eastbound Highway 91 (ie the "East-West Connector"), is intended to capture traffic from two primary areas: Highway 91 traffic headed to Annacis Island or Highway 91A, and Westminster Highway traffic headed to Annacis Island or Highway 91A.

Highway 91 diverges into two streams: one to Annacis Island/Highway 91A and the other to the Alex Fraser Bridge. This pullout is proposed on the two-lane stream headed to Annacis Island or Highway 91A. The Westminster Highway ramp connects to the Highway 91 eastbound stream and proceeds to distribute traffic to Annacis Island and Highway 91A. The location of Site 3 is shown in Figure 4.

The Highway 91 eastbound stream has a posted speed of 80 km/hr, the exit to Annacis Island has an advisory speed of 60 km/hr, and the curves leading to Highway 91A are signed with curve warning signs.

Figure 4: Location of Site 3 on Highway 91 in North Richmond, BC

Site 5 – Highway 10 at 232 St (on-ramp to Highway 1 EB)

The site is intended to capture truck traffic headed from Surrey/Langley to eastbound Highway 1. Site 5 is shown in Figure 5.

Traffic from northbound 232 Street (Highway 10) and eastbound 72 Avenue use the 232nd eastbound on-ramp to access Highway 1. On-ramp traffic from 232nd Street is free flow. Ramp traffic from 72 avenue is controlled by the two-way stop controlled intersection at 232nd Street. A local trailer park uses the on-ramp to access their property. A westbound lane provides access to 232nd Street for the trailer park. Two-way traffic on the on-ramp posed a challenge for locating the mobile weigh scale.

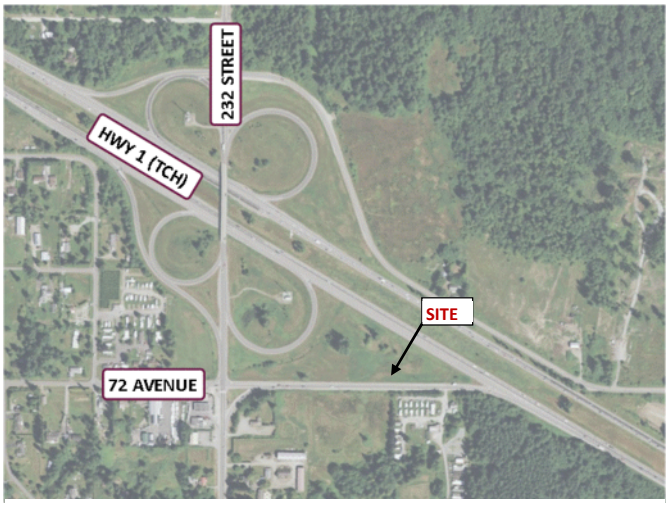


Figure 5: Location of Site 5 at the Highway 1 / 232nd Street Interchange in Langley, BC

Site 6A – 264th Street on-ramp to Highway 1 WB

CVSE intends this site to primarily capture traffic from the 264th Street industrial park to westbound Highway 1. Site 6A is shown in Figure 6.

The ramp provides access to Highway 1 westbound for traffic in the 264th Street area north of Highway 1. The industrial park north of Highway 1 is a major contributor of the ramp traffic. Traffic is controlled by the signalized intersection at 264 Street/56 Avenue (WB on-ramp). West of the intersection 56 Avenue functions as the westbound on-ramp to Highway 1 and access to three private driveways. In addition to the westbound lane, there is an eastbound lane for the private driveways to access 264 Street. West of 264 Street, 56 Avenue is considered to be the acceleration lane for the Highway 1 as the merge is a direct taper.

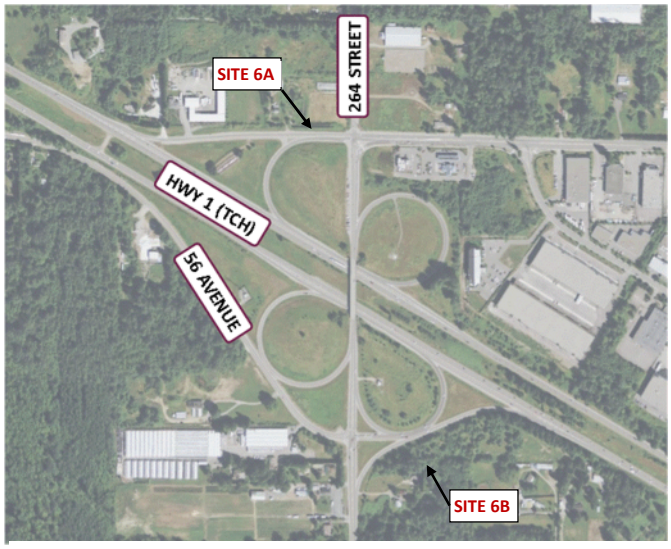


Figure 6: Location of Site 6A and Site 6B at the Highway 1 / 264th Street Interchange in Langley, BC

Site 6B – 264th Street on-ramp to Highway 1 EB

The proposed mobile scale is intended to capture traffic from the Highway 13 Canada/USA border headed eastbound on Highway 1. Site 6B is shown in Figure 6.

The on-ramp provides access to eastbound Highway 1 for traffic in the 264th Street area south of the highway. The target traffic from northbound 264th Street enters the ramp from a free flow right-turn lane, yields to 56 Avenue traffic entering the ramp then continues to merge with the collector/distributor lane prior to merging with Highway 1. The intersection of 56 Avenue and 264th Street is signalized.

Site 7 - Highway 1 WB Brake Check – West Vancouver

CVSE intends to repurpose an existing brake check to include a designated area for CVSE roadside inspections. This site, shown in Figure 7, will capture traffic heading westbound on Highway 1 through West Vancouver.

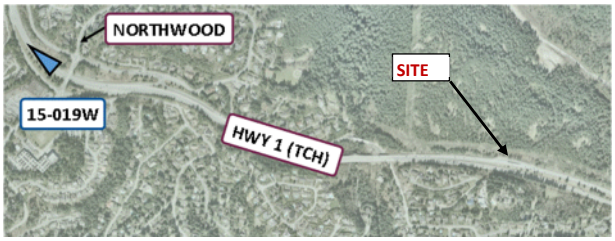


Figure 7: Location of Site 7 on Highway 1 in West Vancouver, BC

Highway 1 is a four-lane Rural Arterial Divided (RAD) highway with a posted speed of 90 km/hr. This particular location is currently used as a brake check and has existing deceleration and acceleration lanes. Rock faces on both sides of the existing brake check constrain modifications to the existing physical area.

Site 9A – Highway 99 and Ladner Trunk Road WB On-ramp

CVSE intends to rebuild the embankment and road structure of an old westbound on-ramp to Highway 99 northbound from Ladner Trunk Road as a mobile weigh scale site (a new on-ramp was recently constructed adjacent to the old ramp). This site, shown in Figure 8, will capture traffic heading northbound on Highway 99 from westbound Ladner Trunk Road.

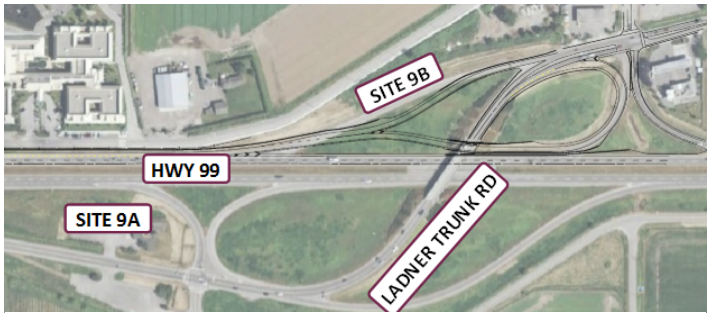


Figure 8: Location of Site 9A and Site 9B at the Ladner Trunk Road / Highway 99 Interchange in Delta, BC

Traffic from westbound Ladner Trunk Road uses the on-ramp to access Highway 99 northbound. On-ramp traffic is controlled by a traffic signal at Ladner Trunk Road and 96th Avenue.

Site 9B – Highway 99 and Ladner Trunk Road South

CVSE intends to rebuild a parking lot type area located south of Highway 99 in the southwest corner of the intersection of Ladner Trunk Road and Hornby Drive. This site, shown in Figure 8, will capture traffic heading northbound and southbound on Highway 99 from eastbound Ladner Trunk Road.

Traffic from eastbound Ladner Trunk Road use the on-ramps to access Highway 99 northbound or southbound. On-ramp traffic is controlled by a traffic signal at Ladner Trunk Road and Hornby Drive.

3.0 Design Guidelines / Parameters

In addition to the BC Supplement to TAC and TAC guidelines, the Ministry in collaboration with CVSE has developed a Commercial Vehicle Inspection Station Design Guide, updated April 2009 for the design of mobile and permanent weigh scales. Within the mobile weigh scale section, Figure 14 outlines the two geometry configurations for mobile weigh scales.

Draft revisions of Figure 14 were provided by MOTI to ISL during the design stages to clarify when each layout is intended to be used – the result is based on traffic volumes. A 15:1 entrance and exit taper is used for roadways with an AADT less than 5000 (ie. low volume), and a dedicated deceleration lane and acceleration lane is used for roadways with an AADT greater than 5000 (ie. high volume).

In July 2014, the Ministry issued an updated Section 900 Auxiliary Facilities Chapter to the MOTI BC Supplement to TAC Geometric Design Guide. Section 950 Commercial Vehicle Inspection Sites includes Figure 950.A (**see Exhibit 1**) that provided guidelines for mobile weigh scale pull-outs. This new figure is very similar to the to the latest updated draft Figure 14 mentioned above. Figure 950.A was used for the detailed design phase.

Signing / Illumination Considerations

Given that the individual sites will be operated intermittently and at random, typically for no more than a few hours at a time, careful consideration was given to prevent the general public from misidentifying the pullouts as an additional travel lane or exit ramp. The general signing and illumination design approach minimizes attracting general road users to each site, as vehicles using a pullout unnecessarily could create an unsafe scenario.

In general, CVSE has indicated that no additional lighting is needed for their intended operation at each site. CVSE officers use flash lights regardless to inspect areas under commercial vehicles. Signing was kept to a minimum with ‘No Parking’ and ‘Authorized Vehicles Only’ signs.

4.0 Site Specific Design:

Site 1 – Highway 91 at 64 Avenue SB Ramps

The CVSE mobile weigh scale (ie. pullout) is in-between the Highway 91 SB off-ramp to 64th Avenue and the Highway 91 SB on-ramp from 64th Avenue. The controlling curves of the off-ramp and on-ramp are suitable for a speed of about 65 km/hr and 45 km/hr, respectively. Available acceleration and deceleration lengths are shown in Figure 9.

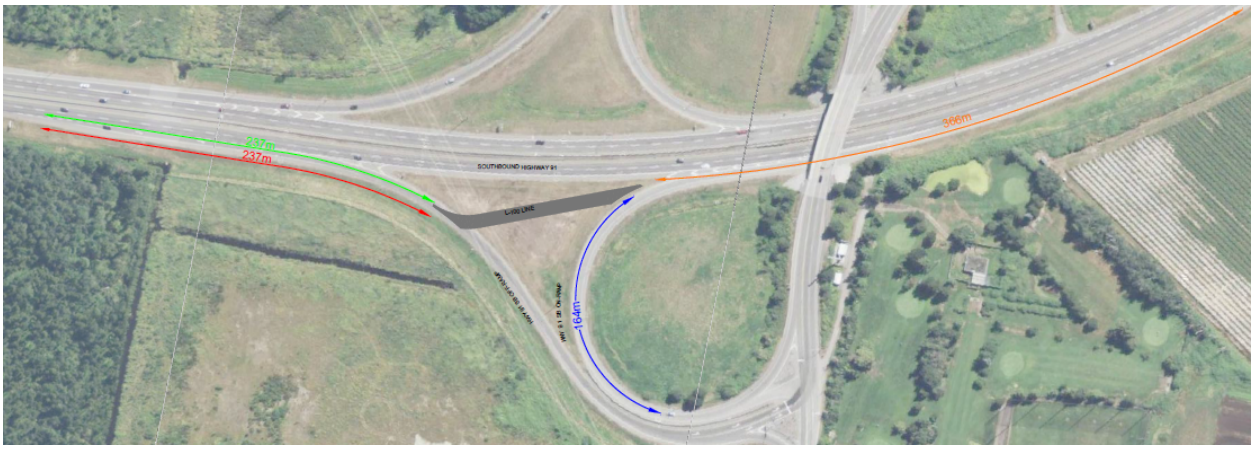


Figure 9: Acceleration and Deceleration Lengths for Site 1

The pullout entrance is located away from the gore (partially up the ramp) to assist drivers' 'natural path' to continue on the off-ramp. The pullout is situated to maintain a 9.0m clearzone for Highway 91 with the exception of the connection to the existing on-ramp. Although the pullout encroaches on the highway clearzone, the proposed slopes remain recoverable.

As shown in Figure 10, an 8m wide pullout with 50m storage has been designed as requested by CVSE at this location; the width is in accordance with draft CVSE design guide Figure 14. The entry speed into the pullout is controlled by the curve and superelevation transitions giving an entry speed of 20 km/hr. The exit speed from the pullout to the Highway 91 on-ramp is controlled by the vertical curve and superelevation transition rate.

The superelevation transition from the ramp to reverse crown through the pullout achieves TAC Table 2.3.2.1 guidelines for 50 km/hr (ie. max superelevation transition of 0.02 every 10m). The design profile has a vertical curve at the pullout entry suitable for 60km/hr followed by a 0.8% tangent and a vertical curve suitable for 50km/hr on the pullout exit to the existing on-ramp.

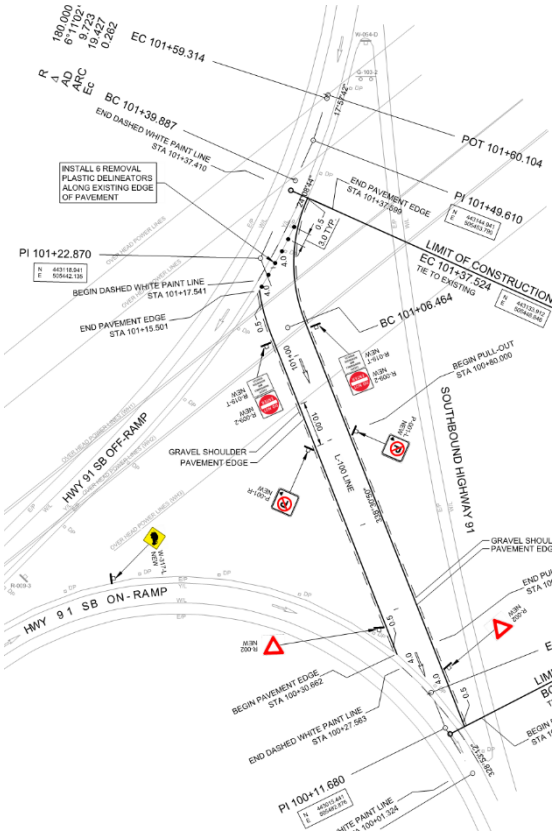


Figure 10: Design of Site 1

Signing Strategy: There is a concern that public may misuse the pullout; however the entry has been situated on a curve in the opposite direction of the off-ramp. The

design includes ‘Do Not Enter’ signs and ‘No Parking’ signs along with removable plastic delineator to restrict access.

CVSE Site Specific Protocol: The site will be used for emergency vehicle interactions only. In the unlikely instance that a stationary event would take place, CVSE officers would be required at the ramp exits to direct commercial vehicles off the highway and into the pullout.

Site 2 – Highway 91 NB: North of Highway 10

The existing pullout’s geometry is built in accordance with the CVSE design guideline (Figure 14) for 100 km/hr, 10 km/hr more than the posted speed limit of 90 km/hr. The provided deceleration is 200m and the provided acceleration is 380m, both lengths include the taper and auxiliary lane. In between the deceleration and acceleration the pullout’s useable area is 500m long.

As the self-weigh scale component has been removed from the project, the site will be treated as a mobile weigh scale facility. Due to the wide width (~13m) between the rollover curb and edge of pavement, lane markings are proposed to distinguish the “no stopping” / through lane (4.5 to 5m wide) from two parallel parking lanes (each ~4m wide).

The configuration will allow the pullout to provide two functions: a mobile weigh scale, and an informal rest area.

CVSE Site Specific Protocol: Given the large size and deceleration length associated with the existing facilty, as well as its secondary use, as an informal rest area, removable “Report to Scale” and “Open/Closed” signs will be used to direct commercial vehicles into the site.

Site 3 – Highway 91 EB onto Highway 91A NB

The pullout is located on the north side of the Highway 91 stream to Highway 91A/Annacis Island, and achieves the *low volume* CVSE design guideline geometry which is based on a 120m entrance and exit taper. Although the traffic volumes for this site suggest using the high volume criteria, the low volume criteria is used to minimize impact to utilities and the surrounding landscape. In addition, CVSE currently uses the maintenance pullouts as mobile inspection locations which are as low as 14m long by 3.7m wide with an 22m taper in and out. The designed pullout is shown in Figure 11.

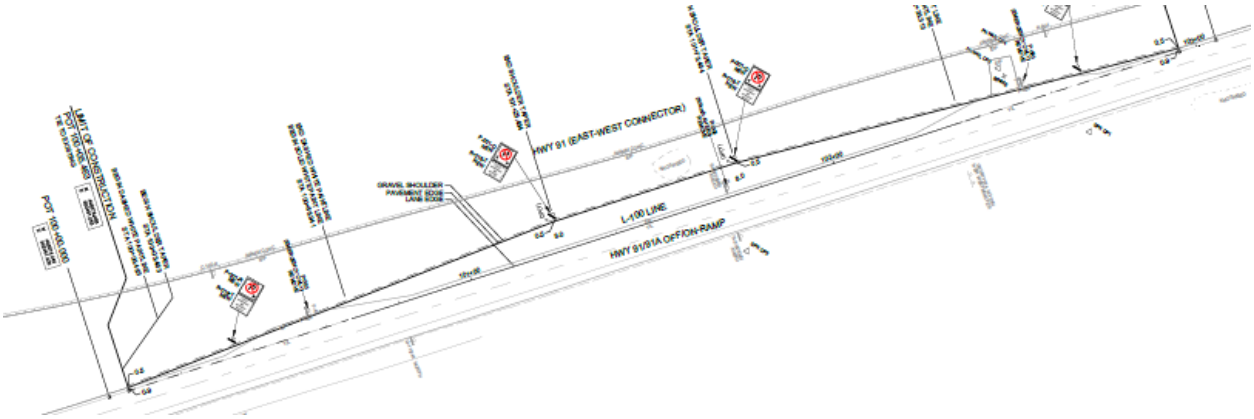


Figure 11: Design of Site 3

Weaving Analysis- Traffic weaving analysis using Highway Capacity Software (HCM) was completed to determine the performance of the weaving operation in 2014 associated with the pullout being located on the left-side, while the downstream exit to Annacis Island utilized the right-lane. The assumptions and parameters adopted in this HCS analysis included a weaving Type B, two weaving lanes, and a free-flow speed of 80 km/hr. Weaving Type B means that weaving vehicles in one direction must make one lane

change to successfully complete the weaving maneuver. The weaving maneuvers are between the pullout (left side) and the highway slow lane (right side); the intent is for the maneuvers to be completed in advance of the pullout and Annacis Island exit.

It was assumed that all traffic entering the pullout would weave from the slow lane – weaving in segment length of 95 metres. Meanwhile, all traffic exiting the pullout would weave to the slow lane and travel to Annacis Island – weaving out segment length of 120 metres (worst case condition). Peak hour traffic volumes for the through lanes on Highway 91 were estimated as 10% of the projected AADT volume. A total of 20 vehicles were estimated using the pullout each hour, with 25% of those vehicles as trucks it equates to 5 trucks per hour.

For both 95m and 120m weaving segments, the weaving analysis indicated the weaves between the pullout and the slow lane will operate at LOS B during the 2014 peak hour. The average weaving speed is estimated to be between 64 and 66 km/hr and the average Highway 91 travel speed (non-weaving speed) is between 81 to 82 km/hr. Furthermore, a sensitivity analysis, with annual growths of 2% and 3% were considered to determine the performance in the design year.

CVSE Site Specific Protocol: Priority will be given to vehicles approaching the pullout in the left lane, so that lane changes and traffic confusion are avoided. CVSE officers will need to operate the facility appropriately to offset the fact that dedicated deceleration and acceleration are not provided. Given that the pullout is after a curve and underpass, traffic flow, weather, and visibility will factor into when the site is operated by CVSE.

Site 5 – Highway 10 at 232 St (on-ramp to Highway 1 EB)

The MWS pull-out is effectively placed in the median of the proposed intersection and ramp improvements. The EB lanes remain and the WB lane from the trailer park is shifted north. The pullout geometry does not achieve either the low volume or high volume CVSE guideline; however, it works within the site constraints and minimizes the design modification to the proposed intersection and ramp improvements. Available acceleration and deceleration lengths are shown in Figure 12.

Figure 12: Acceleration and Deceleration Lengths for Site 5

The pullout has a 50m entrance and exit taper. Based on the turning movement a WB-20 can enter the pullout at 50 km/hr and exit at 50 km/hr. The pullout merge is located 80m away from the start of the controlling curve; based on TAC Table 2.4.6.5 this suggests traffic is operating around 55 km/hr which may cause conflict with the traffic in the collector/distributor lane. From the controlling curve there is an additional 90m to the merge with the collector/distributer lane. Traffic is not required to merge onto Highway 1, as the collector/distributer lane becomes the truck climbing lane. This provides slower moving trucks from the pullout an opportunity to enter Highway 1 in a lane intended for slow moving trucks.

Due to the required change in geometry for the WB direction, the WB lane was designed with horizontal radii of 200m, with a 2% normal crown. Due to the proximity of the trailer park driveway, this low speed geometry (30km/h) is considered suitable at this location. A 6.0m wide pullout, as shown in Figure 13, has been used to reduce the construction limits helping as well to avoid the high pressure gas lines.

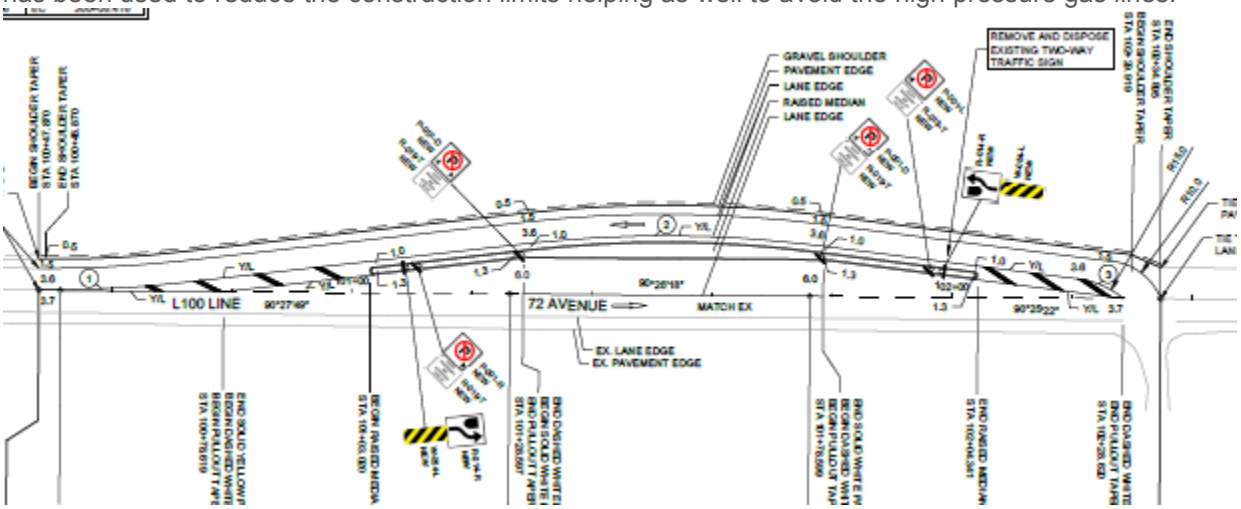


Figure 13: Design of Site 5

CVSE Site Specific Protocol: CVSE officers will need to operate the facility appropriately to offset the fact that the facility does not meet either low volume or high volume guidelines. Traffic flow, weather, and visibility will factor into when the site is operated by CVSE.

Site 6A – 264th Street on-ramp to Highway 1 WB

The pullout does not achieve either of the CVSE guidelines. The geometry includes a 25m entrance and exit taper, which is based on the WB-20 turning movement at 25 km/hr. The available acceleration length is shown in Figure 14.

Figure 14: Acceleration Length for Site 6A

The pullout merge is located approximately 180m away from the 70 km/hr controlling curve based on TAC Table 2.4.6.5 there is sufficient acceleration from a stop condition to 70 km/hr. There is 210m between the end of the controlling curve to the Highway 1 direct merge taper, based on TAC there is sufficient room for traffic to accelerate from 70 km/hr to 100 km/hr.

A 6.0 m wide pullout has been used in order to mitigate impact to utility poles and property. To mitigate conflict with the private driveway the 50m pullout storage has been extended 30m allowing clearance of the driveway before the start of the taper. The design of Site 6A is shown in Figure 15.

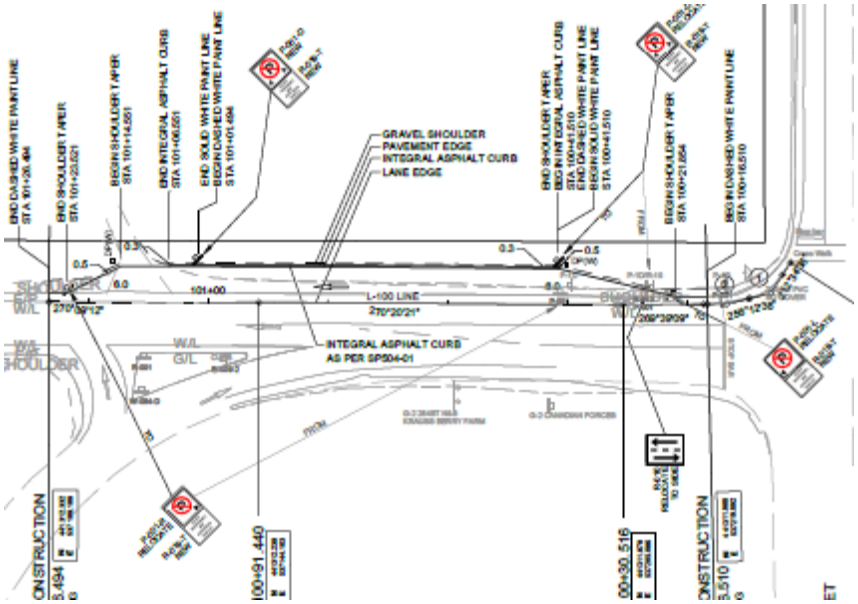


Figure 15: Design of Site 6A

CVSE Site Specific Protocol: CVSE officers will need to operate the facility appropriately to offset the fact that the facility does not meet either low volume or high volume guidelines. Traffic flow, weather, and visibility will factor into when the site is operated by CVSE.

Site 6B – 264th Street on-ramp to Highway 1 EB

The pullout utilizes the CVSE design guideline *low volume* criteria, which is recommended for a site with less than 5000 vehicles a day. A 50m storage length with 15:1 entrance and exit tapers have been allocated for this site. Available acceleration and deceleration lengths are shown in Figure 16.

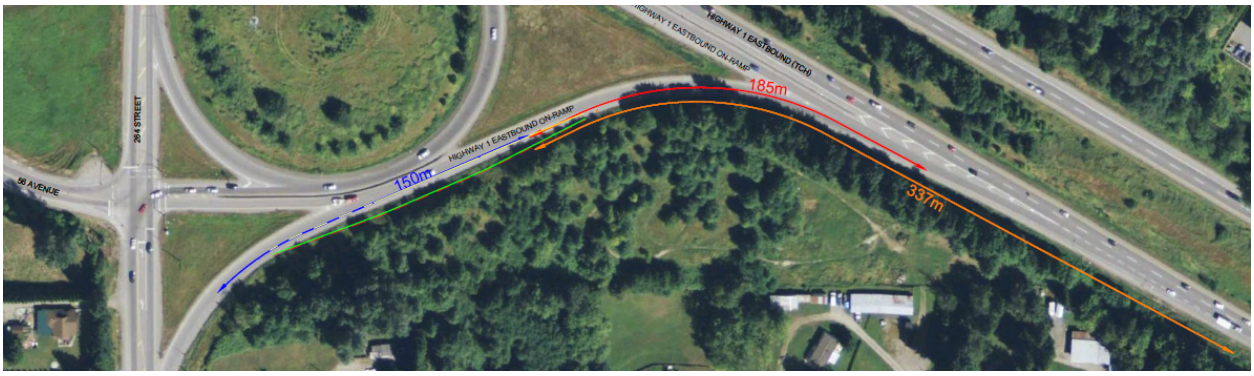


Figure 16: Acceleration and Deceleration Lengths for Site 6B

The pullout merge is located approximately 160m away from the end of the 60 km/hr controlling curve; based on TAC Table 2.4.6.5 this provides sufficient acceleration from a stop condition to 70 km/hr. There is 205m between the C/D lane merge to the Highway 1 merge which indicates from TAC there is sufficient room for traffic to accelerate from 70 km/hr to 100 km/hr.

A 6.0m wide pullout, shown in Figure 17, and realignment of the ditch has been used in order to mitigate property impact.

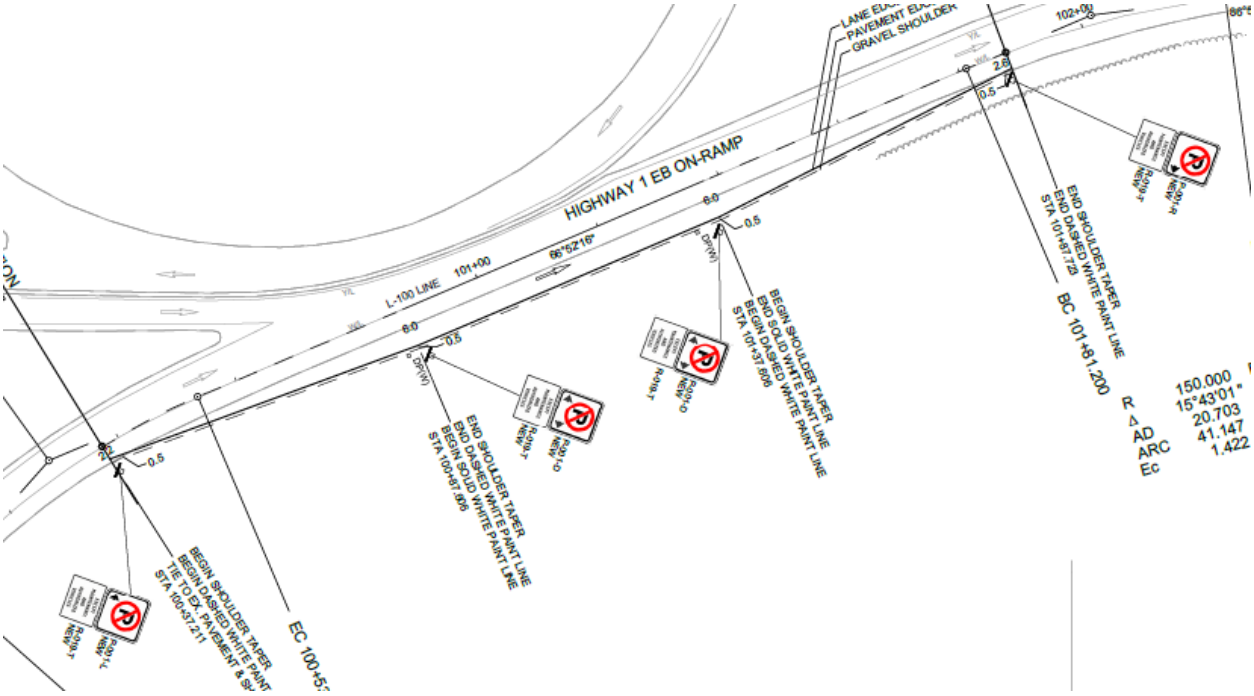


Figure 17: Design of Site 6B

CVSE Site Specific Protocol: CVSE officers will need to operate the facility appropriately to offset the fact that the facility does not meet the guidelines. Traffic flow, weather, and visibility will factor into when the site is operated by CVSE.

Site 7 – Highway 1 WB Brake Check – West Vancouver

The existing break check has a large gravel area at the egress which is used by vehicles and trucks for short stopover periods. This detailed design converts much of the existing gravel area to a paved pullout for CVSE while maintaining full capacity of the existing brake check facility. The available acceleration length is shown in Figure 18.

Figure 18: Acceleration Length for Site 7

The CVSE pullout area is located as far to the east as possible without impact to the existing brake check operation; to retain the existing acceleration length. The existing acceleration is insufficient based on the CVSE pullout guidelines. CVSE suggests for 90 km/hr, a parallel acceleration lane of 220 m with an 80m

taper should be provided. The existing geometry conforms to a 150m parallel acceleration lane with a 90m taper. A 30m storage area is provided which allows a single truck to be inspected without impact to the existing brake check operations. The design of Site 7 is shown in Figure 19.

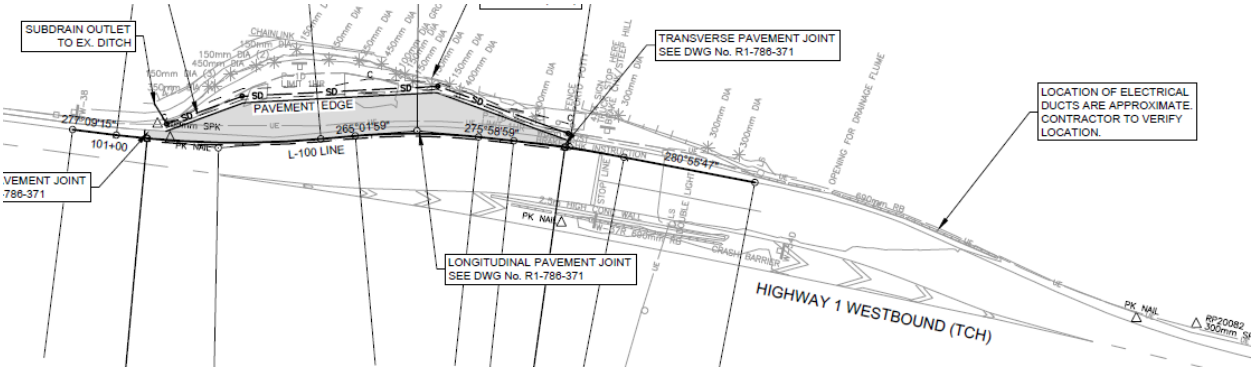


Figure 19: Design of Site 7

CVSE Site Specific Protocol: CVSE officers will need to operate the facility appropriately to offset the fact that adequate acceleration is not provided. Since all commercial vehicles are required to enter the brake check, no special guidance into the weigh scale pullout is required.

Site 9A – Highway 99 and Ladner Trunk Road WB On-ramp

The CVSE pullout is located to the north of the newly realigned highway on-ramp. The positioning is located in place of the old ramp therefore allowing the maximization of efficiencies in the detailed design. In turn this allows for less excavation and embankment requirements. As the pullout access connects with the new on-ramp, removable plastic delineators have been added to direct traffic down the on-ramp instead of into the CVSE pullout. The design of Site 9A is shown in Figure 20.

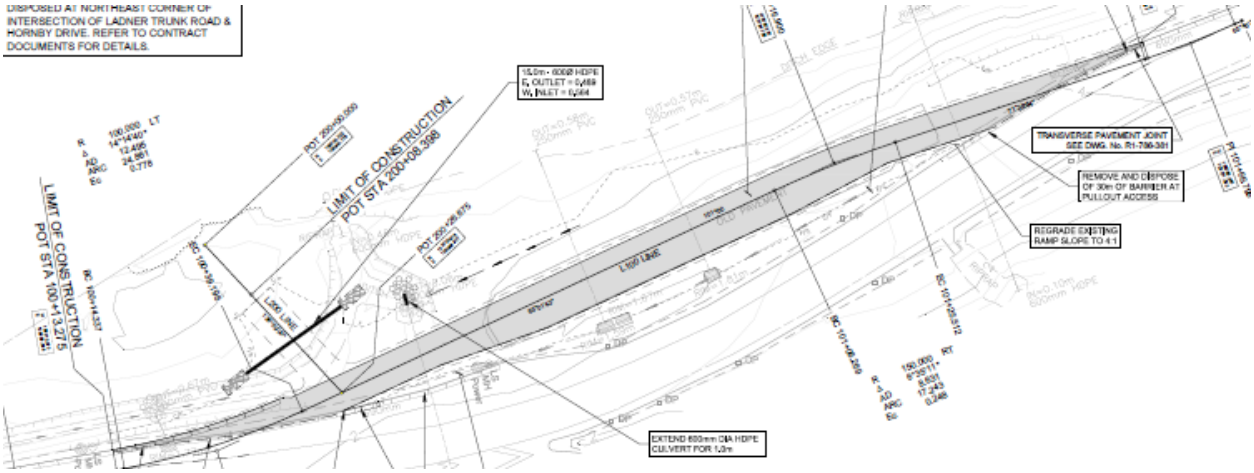


Figure 20: Design of Site 9A

CVSE Site Specific Protocol: When the pullout is in use, CVSE will remove the plastic delineators and control access to the pullout. For this site, a minimum of two patrol vehicles and two officers are required, as one patrol vehicle is to be visible on Ladner Trunk Road in advance of the ramp, and the other patrol vehicle at the exit of the pullout to aid in commercial vehicles merging with accelerating ramp traffic. Traffic flow, weather, and visibility will factor into when the site is operated by CVSE.

Site 9B – Highway 99 and Ladner Trunk Road South

The CVSE pullout is located in an existing gravel parking area. An 8.0 metre wide pullout was designed to connect the two accesses to this site. The profile for this site has been designed to meet existing ground elevations for as much of the pullout as possible. This design, shown in Figure 21, allows for CVSE requirements to be accommodated while minimizing construction requirements.

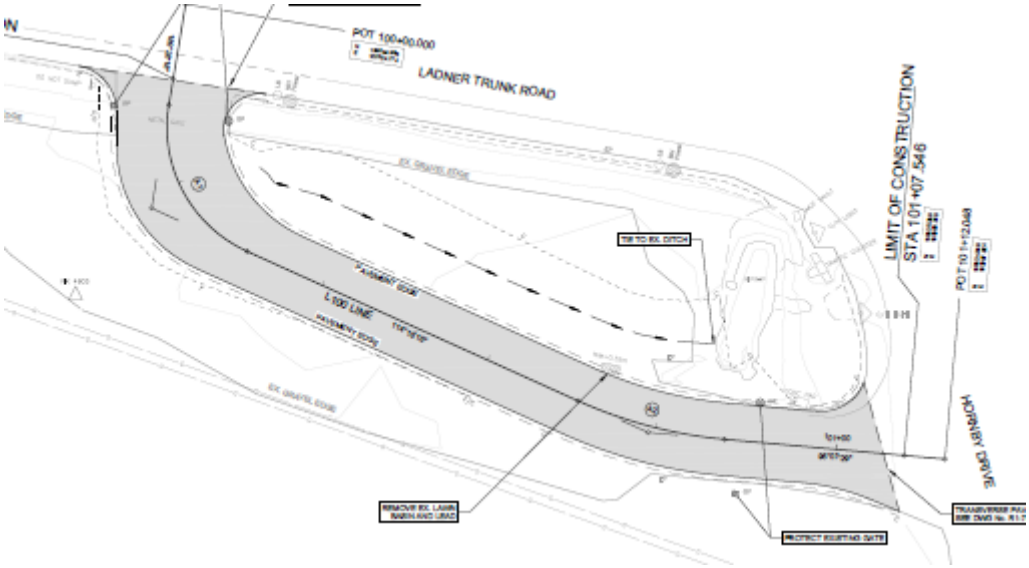


Figure 21: Design of Site 9B

CVSE Site Specific Protocol: This pullout site will make use of the existing entry gates to control access to the pullout when not in use by CVSE. Traffic flow, weather, and visibility will factor into when the site is operated by CVSE.

4.0 Conclusion

The design of the nine mobile weigh scale pullouts in British Columbia's Lower Mainland required a unique approach to balancing site constraints and design guidelines, while keeping public safety a priority. Each site posed specific physical and/or safety challenges, from meeting acceleration and deceleration guidelines, to accounting for traffic weaving. These factors played a role in each site's geometric design variances from the draft Commercial Vehicle Inspection Station design guidelines.

The location and geometrics for each site were selected to provide optimal solutions to balance the competing physical and safety challenges. A CVSE protocol was developed for each site to provide weigh scale operations that are sufficiently safe for commercial vehicle operators, officers, as well as the general public. The Mobile Weigh Scales project demonstrates that engineering judgement is required to balance competing issues and guidelines.

5.0 References

Ministry of Transportation and Infrastructure (BC MOTI). (2007) BC Supplement to TAC Geometric Design Guide

Ministry of Transportation and Infrastructure (BC MOTI). (2009) Commercial Vehicle Inspection Station Design Guide

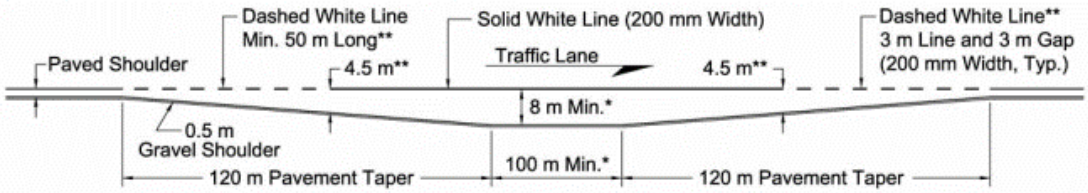
Ministry of Transportation and Infrastructure (BC MOTI). (2014) Commercial Vehicle Inspection Sites

Transportation Association of Canada (TAC). (1999) Geometric Design Guide for Canadian Roads.

Transportation Research Board (TRB). (2010) Highway Capacity Manual.

Figure 950.A Mobile Weigh Scales

GUIDELINES FOR MOBILE WEIGH SCALE PULLOUTS (EXCLUDING FREEWAYS AND EXPRESSWAYS)

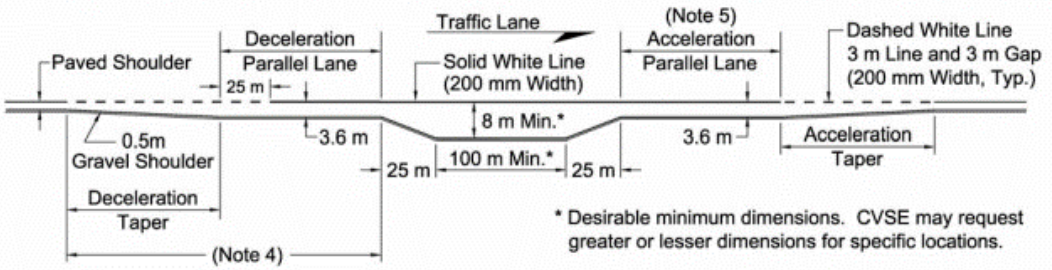


FOR TWO LANE HIGHWAYS WITH AADT ≤ 5000 ***

* Desirable minimum dimensions. CVSE may request greater or lesser dimensions for specific locations.

** Dashed line shall be 50 m long or extend to where the throat is 4.5 m wide, whichever is greater.

*** The Regional Traffic Engineer shall decide which layout is to be used. For example, the layout below may be preferred for highways with speeds ≥ 80 km/h to minimize disruption of through traffic. Conversely, the layout above may be used for highways with AADT > 5000 at the discretion of the Regional Traffic Engineer.



* Desirable minimum dimensions. CVSE may request greater or lesser dimensions for specific locations.

FOR TWO LANE HIGHWAYS WITH AADT > 5000 AND ALL MULTI-LANE HIGHWAYS

DESIGN SPEED (km/h)	DECELERATION PARALLEL LANE P.L. (m)	DECELERATION TAPER (m)	ACCELERATION PARALLEL LANE P.L. (m)	ACCELERATION TAPER (m)
60	25	50	80	55
70	50	50	120	65
80	80	50	165	70
90	120	50	220	80
100	165	50	295	85
110	195	50	375	90

NOTES:

1. For all grades less than 3%, use the P.L. length
2. Deceleration P.L. - for downgrades from 3% to 5%, use P.L. X 1.3
3. Acceleration P.L. - for up grades from 3% to 5%, use P.L. X 1.4
4. The total deceleration lengths (Taper + P.L.) are from 2011 AASHTO Green Book Table 9-22.
5. Acceleration P.L. lengths are based on attaining 85% of the design speed (ref. 2011 AASHTO Green Book Fig. 2-24). Acceleration taper lengths are from TAC Table 2.4.6.5.

Guidelines for Mobile Weigh Scale Pullout
(Figure 950.A from BC Supplement to TAC)

Exhibit 1