



## MEMO

**TO:** Dickson Chung, M.Eng., P.Eng., Sr. Highway Designer, BC MOTI  
**FROM:** Justin Murray, P.Eng., Hydrotechnical Engineer  
Kevin Henshaw, P.Eng., Hydrotechnical Team Lead  
**SUBJECT:** **BC Hwy 11 Flood Repairs: Road Surface Drainage Adequacy, Rev.1 (DRAFT)**  
**DATE:** **February 14, 2024**

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## GENERAL

A section of Highway 11 between Clayburn Road and Valley Road was damaged in the November 2021 flooding events. The BC Ministry of Transportation and Infrastructure requested WSP to inspect this section of the highway on November 18, 2021, to assess the conditions in advance of opening a portion of the highway to traffic, and to recommend long-term repairs.

The site visit and review memo dated November 25, 2021, and background information review determined that EPS fill had been used as lightweight fill on the highway embankments which had lifted in high floodwaters. To open the highway to two lanes of traffic in the southbound direction, it was recommended subgrade stability was assessed for the presence of sinkholes or other defects which would indicate instability. Following the assessment, recommendations were made that the areas adjacent to the proposed travelled lanes and the heaved lanes were to be backfilled with free-draining granular material to allow drainage, while providing support to the existing road grade. WSP has developed flood repair drawings dated June 5 and 6, 2023, to address the EPS fill and repair the road for long-term use.

A finalized, stamped hydrotechnical memo titled “**BC Hwy 11 Flood Repairs: Road Surface Drainage Adequacy**” was previously issued for this project on July 20, 2023, for the Northbound Lane only, between chainages 10+140 and 10+240. This memo labelled “Revision 1” supersedes the previously issued memo and accounts for an updated highway design and extended project limits between 09+960 near the Valley Road Intersection and 10+520, for both the Northbound and Southbound lanes of the highway.

This updated memo details the methodology used to assess the road surface drainage barrier spacing for these new project limits against short-duration extreme rainfall projected to the 2080’s. A climate change design criteria sheet has also been completed to accompany this memo.



## BACKGROUND INFORMATION

Inputs were derived from the following information sources:

- BC MoTI Project No. 14031-0001 drawings titled “Highway 11 Willband Creek Flood Repairs”, dated January 16, 2024.
- BC MoTI Project No. 11313-0001 Drawings titled “Mission-Abbotsford Highway No. 11 Sumas Way to Clayburn Road” dated April 11, 2006. Specifically, drawing numbers R1-491-105, R1-491-202, and R1-491-307.
- Historical Rainfall Intensity-Duration-Frequency (IDF) data for Abbotsford A, ID:1100030 (Version 3.30, 2022)
- Historical and Projected Rainfall IDF for Abbotsford A, and Ungauged Estimates at the Project area, provided by IDF\_CC (Version 7.0, Western University) and
- BC Supplement to Transport Association of Canada (TAC) Guidelines for Road Surface Drainage Spacing of Depressed/Undepressed BC Freeway Grates (BCTAC 1050, 2021).
- Federal Highway Administration’s Hydraulic Engineering Circular No. 22, Third Edition, Urban Drainage Design Manual, Section 4, “Pavement Drainage” (Revised August 2013).

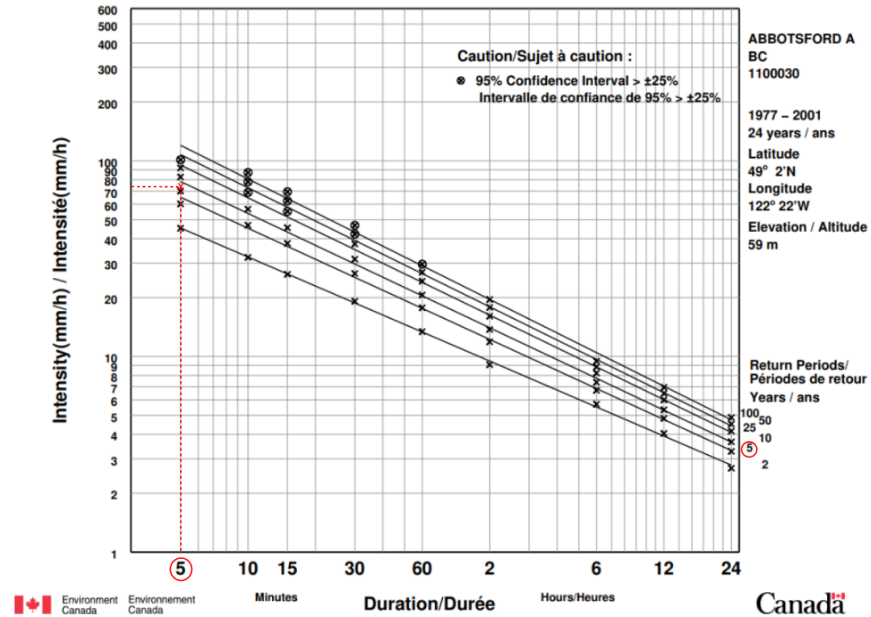
## HYDROLOGY AND CLIMATE CHANGE IMPACTS

Hydrologic conditions were estimated using the Environment and Climate Change Canada (ECCC) meteorological station at Abbotsford, BC as the baseline data to characterize the design rainfall intensity in this table. The Abbotsford A (ID: 1100030) intensity-duration-frequency IDF curves draw from 24 years of data between 1977 and 2001.

The historical rainfall intensity for a 5-minute, 5-year return period short-duration extreme precipitation event is 60.20 mm/hr. The projected value for SSP5.85 in the 2080’s was determined to be 74.25 mm/hr from IDF\_CC, or a 23% increase due to climate change.

The figure below shows the historical and projected 5-minute, 5-year return period event.

**Short Duration Rainfall Intensity–Duration–Frequency Data**  
 2022/10/31  
**Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée**



**Figure 1: Abbotsford A IDF Curve and Projected Design Value for 2080's Overlaid on Historical IDF Curve**

## SLOTTED BARRIER SPACING MODEL DEVELOPMENT

Drawings supplied by WSP’s Highways discipline, dated January 16, 2024, were used to determine model input parameters using the proposed barrier extents, road width contributing runoff, and longitudinal and crossfall slopes. The highway near 10+240 in both the Northbound and Southbound directions appear to generate the most ponding potential, primarily due to a shallow longitudinal slope and wide paved areas contributing runoff. The barrier analysis model inputs are listed below for both directions:

Drainage Barrier Spacing Model Inputs:

- Northbound Highway Geometry for Outside Barrier Spacing:
  - Effective width of Contributing Area: 16.9 m
  - Paved Shoulder Width: 2.5 m
  - Road Width Crossfall: 0.025 m/m (crown near Centreline)
  - Longitudinal Grade: 0.00106 m/m
  - Manning’s roughness for impermeable road surface: 0.02
  - Width Weighted Runoff Coefficient: 0.95

- Southbound Highway Geometry for Outside Barrier Spacing:
  - Effective width of Contributing Area: 14.8 m
  - Paved Shoulder Width: 2.5 m
  - Road Width Crossfall: 0.025 m/m (crown near Centreline)
  - Longitudinal Grade: 0.00106 m/m
  - Manning's roughness for impermeable road surface: 0.02
  - Width Weighted Runoff Coefficient: 0.95
- Roadway Ponding Maximum (BC Supplement to TAC):
  - 65% Shoulder Width (or a minimum 1.2 m): 1.6 m (for shoulder width 2.5 m above)
  - 5-minute, 5-year extreme precipitation intensity with climate change increase (SSP5 8.5, 2080's): 74.25 mm/h, discussed below

The drainage barrier spacing is determined such that the ponding width was limited to the maximum allowable ponding width of 1.6 m described above. This design assumes a loss of efficiency of 50% to due to clogging or vegetative growth.

## MODEL RESULTS

### DRAINAGE BARRIER SPACING

The recommended spacing per the drainage model is a minimum of 8.5 m, which can be translated to approximately 1 drainage slot barrier (CRB-H) for every two unslotted CRBs. It is therefore recommended that the sequencing of outside barriers on this section of highway consist of alternating one drainage-slotted barrier and one regular barrier at a minimum, to ensure proper drainage into the 2080s. It is also acceptable to implement continuous drainage slotted barriers, if desired. The use of CDB barriers with a higher drainage opening is not necessary considering the number of CRB-H being recommended, the grade of the highway and the potential vehicle safety issues that a larger drainage opening may present.

The MoTI design criteria sheet for climate change resilience is attached.

### EMBANKMENT EROSION CONTROL

In the reviewed drawings, it appeared to be that the highway embankment slope is relatively short and generally 3H:1V, or 2H:1V in areas with road widening as part of this Project. Based on WSP's November 2021 site visit, the existing highway embankment was covered with grass, which protects the shallow embankment from erosion.

If the minimum drainage barrier spacing is implemented and disturbed embankment revegetation is established, erosion of the embankment is not anticipated to be an issue on sideslopes. Sideslopes must be re-vegetated to prevent erosion and covered with rolled erosion protective covering until vegetation is established.

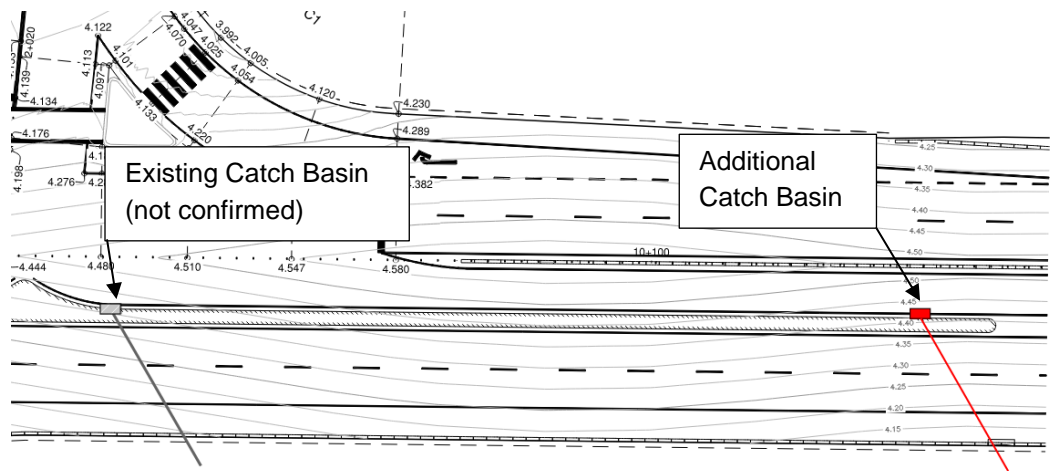
## HIGHWAY 11 NORTHBOUND ACCELERATION LANE CATCH BASIN

Runoff in the northbound acceleration lane is split near 10+090, with a portion flowing south toward the existing catch basin, and the remainder flowing north toward the end of the median, which is to be extended as part of the work.

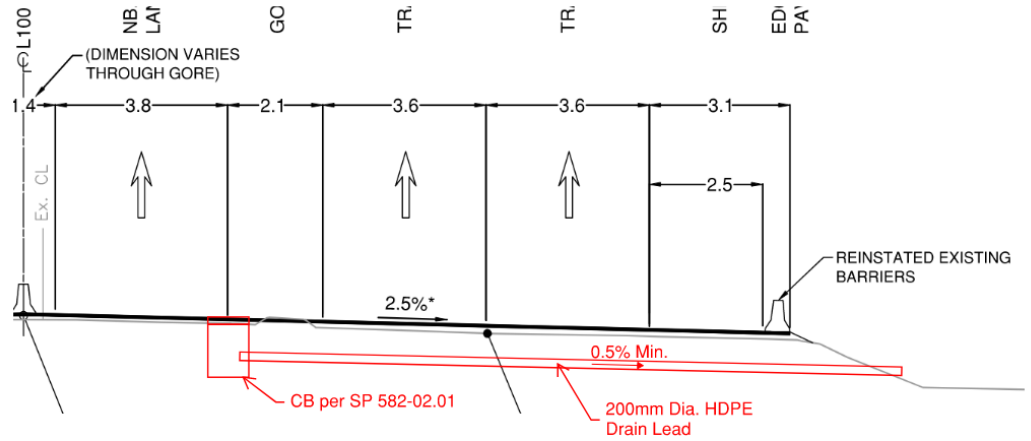
The drainage analysis indicated that for an extended median, one additional catch basin is required to limit ponding width in the northbound acceleration lane, and to capture concentrated flow before it would cross the northbound lanes adjacent to the acceleration lane.

Due to unconfirmed geometry of the existing catch basin, and the distance between catch basins, it was recommended that a new catch basin and drainage lead be installed at the end of the median. A precast catch basin per MOTI Standard Specifications SP582-02.01 is recommended near station 10+126, as well as a 200 mm diameter HDPE drainpipe at a minimum slope of 0.5% and a maximum slope of 2% per the BC Supplement to TAC, with the outlet to the east. Due to environmental constraints, riprap erosion protection is not specified at the outlet, however, disturbed areas must be re-vegetated and covered with rolled erosion protective covering to protect the sideslope until vegetation is established.

A plan view of the additional catch basin and drainage lead are shown on Figure 2, and a conceptual profile is shown on Figure 3.



**Figure 2: Plan View of Existing (Grey) and New Conceptual (Red) Catch Basin with Drainage Lead**



**Figure 3: Conceptual Profile View of New Catch Basin and Drainage Lead**

## CONCLUSIONS

It is recommended that spacing drainage barriers on each side of highway is a minimum of 8.5 m, alternating one slotted barrier (CRB-H) for each unslotted barrier, as described above. It is also acceptable to implement continuous drainage slotted barriers if desired. The use of CDB barriers with a higher drainage opening is not necessary considering the frequency number of CRB-H being recommended, the shallow grade of the highway and the potential vehicle safety issue that a larger drainage opening may present. Infrequent CDBs placed at sag points may be installed, as desired. An additional catch basin is also to be installed in the acceleration lane near chainage 10+126, as described above in Figures 2 and 3.

If the minimum drainage barrier spacing is implemented, and disturbed embankment revegetation is established, erosion of the highway embankment is not anticipated to be an issue. Sideslopes must be re-vegetated to prevent erosion and covered with rolled erosion protective covering until vegetation is established.



## SIGNATURES

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February 14, 2024

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## REFERENCES

- British Columbia Ministry of Transportation and Infrastructure, “Supplement to TAC, 2019 3<sup>rd</sup> Edition”, 2020.
- British Columbia Ministry of Transportation and Infrastructure, “2020 Standard Specifications for Highway Construction”, 2020.
- Engineers and Geoscientists of British Columbia (EGBC), “Developing Climate-Change Resilient Designs for Highway Infrastructure in British Columbia”, Version 2.0, 2020.
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- Simonovic, S.P., A. Schardong, R. Srivastav, and D. Sandink (2015), IDF\_CC Web-based Tool for Updating Intensity-Duration-Frequency Curves to Changing Climate – ver 7.0, Western University Faculty for Intelligent Decision Support and Institute for Catastrophic Loss Reduction, open access <https://www.idf-cc-uwo.ca>.