East Porpoise Bay & Sechelt Inlet Rd Improvement

Client: BC Ministry of Transportation and Infrastructure

DRAINAGE DESIGN MEMORANDUM

IFT% Detailed Design

PROFESSIONAL PROVINCE OF T. LIU #34037 BRITISH COLUMBIA ENGINEER
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1002642

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PA	2023-07-19	Drywell Drainage Design Memo	TL
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PC	2023-09-14	Drywell Drainage Design Memo	TL
PD	2024-02-14	Drainage Design Memo	TL

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1.0 INTRODUCTION

1.1 Background

AtkinsRéalis has been retained by the BC Ministry of Transportation and Infrastructure (MoTI) to execute the East Porpoise Bay Road / Sechelt Inlet Road Improvements project. The project is located in Sechelt and stretches for approximately 780 m on East Porpoise Bay Road / Sechelt Inlet Road from Xenichen Avenue to Delta Avenue. The provincial road right-of-way bisects shíshálh Nation (*s*N) Lands Number 2.

The memorandum on drainage design details the drywell capacity proposed in the vicinity of Sechelt Inlet Road and Delta Road intersection and outlines the planned drainage system to collect and transport runoff from the contributing drainage area. Additionally, the report evaluates the width of the ponding near the intersection of Kunut Avenue and Sechelt Inlet Road, and storm sewer design along East Porpoise Bay Road between Xenichen Avenue and Delta Road.

1.2 Objectives

The objectives of drainage design for this project are to upgrade and /or propose a drainage system to meet the requirements in accordance with BC MoTI's design guidelines and construction standards including:

- BC Supplement to TAC Geometric Design Guide (MoTI, 2019);
- Standard Specifications for Highway Construction Volume 1 and 2 (MoTI, 2020); and
- District of Sechelt Subdivision and Development Control Servicing Standards (Bylaw No. 430, 2003).

1.3 Information and Data

The background information and data used to complete the drainage analysis of the highway project includes the following:

- Rainfall Data Considering Climate Change: IDF Data from Sechelt Aerodrome Rainfall Station projecting from 2023 to 2098, Scenario RCP 8.5, IDF Climate Change Tool by Western University, Ontario (http://www.idf-cc-uwo.ca/Map);
- Orthophotos for the highway corridor;
- District of Sechelt, GIS data (https://gis.sechelt.ca/portal/apps/webappviewer);

2.0 SITE DESCRIPTION

2.1 Project Area

The E Porpoise Bay Road and Sechelt Inlet Road Improvement Project is located between the Xenichen Avenue on Southwest direction and Delta Road on Northeast direction in Sechelt, BC (herein after referred to as “the Project”), as shown on Figure 2.1 Existing E. Porpoise Bay Road. The Project encompasses various tasks aimed at enhancing the Road’s efficiency and safety. It involves widening and realignment of the existing East Porpoise Bay Road between the Xenichen Avenue on Southwest direction and Delta Road on Northeast direction to accommodate increased traffic flow.

Figure 2- 1 Existing E. Porpoise Bay Rd and Sechelt Inlet Road Intersection

Overall drainage within the project limits and surrounding areas drains northwest through the storm mains located at E. Porpoise Bay Road and overland flow towards the Ocean.

2.1.1 Existing Highway Drainage

There is no well-defined surface and underground sewer system for the existing East Porpoise Bay Road and Sechelt Inlet Road within the project limits. Currently, there are two existing CBs connected to the existing storm manhole near the intersection of Xenichen Avenue and East Porpoise Bay Road. There is an existing 250mm storm sewer between Schetxwen Road and Tsulich Drive across the East Propoise Bay Road with a headwall to discharge to the west. Between Tsulich Drive and Delta Road, no storm system is available.

From Xenichen Avenue to Schetxwen Road, the E. Porpoise Bay Road surface runoff flows generally towards the southwest direction. Between Schetxwen Road and Chawilin Avenue the road surface flow towards Tsulich Drive with an outfall discharge to the Ocean. While east of Chawilin Avenue, the runoff flows eastward away from the project site towards Delta Road.
From the google earth contour map, there is a significant catchment area that flows in a southwest direction towards the E. Porpoise Bay Road. This outside catchment area is a well established residential and commercial area within the District of Sechelt and shíshálh Nation (*s*N) lands. There was no existing drainage information from the outside catchment is available to the AtkinsRéalis design team.

But during the course of highway design development, the MOTI project manager coordinated with the District of Sechelt and shíshálh Nation (*s*N) regarding how to accommodate the outside drainage to the highway. *s*N requested to include 400 L/s flow at the intersection of Schetxwen Road and E. Porpoise Bay Road to the downstream sewer. District of Sechelt requested approximately 0.06 ha drainage area on the east side of the highway between Chawilin Ave and Delta Road to be considered to the highway sewer system.

Except those two areas with flows to be accommodated by the highway drainage, it has been assumed that the outside catchment area on the southeast side has its own drainage system and outfall to drain to the Ocean during the drainage design of this project.

3.0 STORMWATER DRAINAGE DESIGN CRITERIA

The stormwater drainage system for the project has been designed to manage stormwater runoff. Stormwater drainage elements comprise the following:

- Storm Sewers and Subdrains
- Catch basins
- Stormwater Storage and Treatment

The stormwater drainage design criteria shall conform to BC MoTI's guidelines and standards summarized as the following section.

3.1 Design Criteria for Storm Sewers

In accordance with BC MoTI's Supplement to TAC Geometric Design Guide, the design criteria for storm sewer are as follows:

- The storm sewers are to be designed to pass the 25-year flow discharge without surcharging;
- The minimum catch basin lead is 200 mm in diameter, with a minimum slope of 0.5%;
- The minimum size of the main pipe is 250 mm in diameter, with a minimum slope of 0.5%;
- The minimum depth of cover for a storm drain equals 1.5 m in traveled areas and 1.0 m elsewhere;
- The minimum velocity should be greater than 0.6 m/s, and the maximum velocity should be less than 5 m/s.

For this E. Porpoise Bay Road and Sechelt Inlet Road Intersection Improvement project, the storm sewers need to be sized to accommodate the, and 25-year flow discharge considering climate change without surcharging.

3.2 Design Criteria for Catch Basins

In accordance with BC MoTI's Supplement to TAC Geometric Design Guide, the design criteria for catch basins are as follows:

- The runoff for highway pavements is computed by the Rational Formula Method using a runoff coefficient (C) equal to 0.95 and a minimum time of concentration equal to 5 minutes;

- The maximum ponding width at the catch basin or spillway is equal to 65% of the paved shoulder width with a minimum of 1.2 m;
- The method for catch basin spacing calculations is based on BC MoTI's Supplement to TAC Geometric Design Guide, Section 1050G.

3.3 Storage Requirement

The proposed plan entails collecting storm runoff between Chawilin Avenue and Delta Road using a drywell. This drywell is collected from three CB's and one of the CB near Chawilin Avenue is connected via a 300mm storm perforated pipe to accommodate design flows from all contributing drainage areas with consideration of climate change. The drywell is proposed to be located at the intersection of Sechelt Inlet Road and Delta Road's northwest side.

The capacity of infiltration basin shall be designed to ensure there is no flooding and surcharging occurs during the 25-year storm event with climate change.

3.4 Water Quality Requirement

Run-off quality treatment for highway or land development drainage is good practice and is often mandated by Federal, Provincial, or regional guidelines or permits.

In accordance with MoTI, Infiltrate and treat the storm runoff onsite from the 2-year water quality storm event before discharging it into watercourses.

There is no water quality treatment facility was proposed for this Project.

4.0 METHODOLOGY AND HYDRAULIC ANALYSES

4.1 Design Storm

4.1.1 Historical Rainfall Data

Based on the Environment Canada IDF Map, the nearest rainfall station for the project area is the Sechelt Aerodrome Rainfall Station. The IDF table without climate change for the Sechelt Aerodrome station is shown in Table 4-1. Table 4-2 lists the historical rainfall depths, and Table 4-3 lists the coefficients of the historical interpolation equations.

Table 4- 1 Historical IDF Rainfall Data at Sechelt Aerodrome Rainfall Station

Duration/Return Period Time (Year)	Intensity (mm/h)					
	2- year	5-year	10-year	25-year	50-year	100-year
5 min	34.81	44.75	53.08	65.96	77.11	89.89
10 min	24.65	31.42	36.89	45.11	52.02	59.76
15 min	20.14	25.55	29.82	36.13	41.32	47.06
30 min	14.26	17.94	20.72	24.71	27.87	31.29
1 h	10.10	12.60	14.40	16.90	18.80	20.80
2 h	7.15	8.85	10.01	11.56	12.68	13.83
6 h	4.14	5.05	5.62	6.33	6.79	7.24
12 h	2.93	3.55	3.91	4.33	4.58	4.81
24 h	2.07	2.49	2.71	2.96	3.09	3.20

Table 4- 2 Historical Rainfall Depth at Sechelt Aerodrome Rainfall Station

Duration/Return Period Time (Year)	Rainfall Depth (mm)					
	2	5	10	25	50	100
5 min	2.90	3.73	4.42	5.50	6.43	5.50
10 min	4.11	5.24	6.15	7.52	8.67	9.96
15 min	5.04	6.39	7.45	9.03	10.33	11.77
30 min	7.13	8.97	10.36	12.35	13.94	15.64
1 h	10.10	12.60	14.40	16.90	18.80	20.80
2 h	14.30	17.70	20.01	23.12	25.36	27.66
6 h	24.83	30.32	33.73	37.98	40.77	43.44
12 h	35.16	42.58	46.88	51.96	55.00	57.76
24 h	49.80	59.80	65.16	71.08	74.20	76.79

Table 4- 3 Coefficients of Interpolation Equations for Historical Rainfall Intensity at Sechelt Aerodrome Station

Constant	Constants A, B and t_0 by Return Period					
	2- year	5-year	10-year	25-year	50-year	100-year
A	10.10	12.60	14.40	16.90	18.80	20.80
B	-0.499	-0.51	-0.525	-0.548	-0.568	-0.589
t_0	0	0	0	0	0	0

4.1.2 Climate Change

In order to consider the impacts of climate change, the design of the drainage system is based on IDF data projected to the year of 2098. The selection of the projected 75 year was based on durability consideration of a culvert. According to BC Supplement to TAC Geometric Design Guide (2019), 1040 Culvert Design, the structural design life of a culvert shall be 75 years.

The rainfall data projection for the period from 2023 to 2098 utilizes the IDF-CC Tool provided by the Western University, Ontario. For the climate modeling analysis, the RCP 8.5 Scenario has been chosen, which represents the most severe climate change impacts.

Table 4-4 lists the projected IDF data, Table 4-5 lists the coefficients of the projected interpolation equations, and Table 4-6 lists the projected rainfall depths. Those projected rainfall data have been used for the post development drainage analysis like sizing storm sewer, drywell design and estimating runoff peaks and volumes. As indicated in the Table-4.7, we can clearly see a consistent trend of increasing rainfall intensity when comparing projected IDF to historical IDF across various return periods. For example, at the 2-year return period, the rainfall intensity is 16% increase for a 24-hour duration; at the 50-year return period, the intensity is 21% increase for a 24-hour duration; and at the 100-year return period, the intensity is 23% increase for a 24-hour duration. These findings suggest a clear tendency toward more intense rainfall events in the future.

Table 4- 4 Projected IDF at Sechelt Aerodrome Rainfall Station with Climate Change

Duration/Return Period Time (Year)	Intensity (mm/h)					
	2- year	5-year	10-year	25-year	50-year	100-year
5 min	15.27	52.43	63.03	78.45	92.24	106.60
10 min	64.77	36.84	43.81	53.73	62.31	71.21
15 min	49.36	29.97	35.41	43.06	49.53	56.24
30 min	31.03	21.06	24.61	29.49	33.46	37.57
1 h	19.50	14.80	17.10	20.20	22.60	25.10
2 h	12.26	10.40	11.88	13.84	15.27	16.77
6 h	5.87	5.95	6.68	7.59	8.20	8.85
12 h	3.69	4.18	4.64	5.20	5.54	5.91
24 h	2.32	2.94	3.22	3.56	3.74	3.95

Table 4- 5 Coefficients of Interpolation Equations for Projected Rainfall Intensity at Sechelt Aerodrome with Climate Change

Constant	Constants A, B and t_0 by Return Period					
	2- year	5-year	10-year	25-year	50-year	100-year
A	19.50	14.80	17.10	20.20	22.60	25.10
B	-0.670	-0.51	-0.525	-0.546	-0.566	-0.582
t_0	1.357	0	0	0	0	0

The rainfall intensity is estimated from the IDF relationship:

$$I = A*(T+t_0)^B$$

where I = rainfall intensity (mm/h)

T = rainfall duration (h)

A, B and t_0 are constants.

Table 4- 6 Projected Rainfall Depth at Sechelt Aerodrome Rainfall Station with Climate Change

Duration/Return Period Time (Year)	Rainfall Depth (mm)					
	2	**5**	**10**	**25**	**50**	**100**
5 min	1.27	4.37	5.25	6.54	7.69	8.88
10 min	10.80	6.14	7.30	8.96	10.38	11.87
15 min	12.34	7.49	8.85	10.77	12.38	14.06
30 min	15.51	10.53	12.30	14.75	16.73	18.79
1 h	19.50	14.80	17.10	20.20	22.60	25.10
2 h	24.51	20.80	23.77	27.67	30.53	33.54
6 h	35.22	35.67	40.05	45.57	49.18	53.08
12 h	44.28	50.13	55.67	62.42	66.45	70.92
24 h	55.66	70.46	77.37	85.50	89.77	94.75

Table 4- 7 Percentage Increase in Rainfall Intensity at Sechelt Aerodrome Rainfall Station with Climate Change

Duration/Return Period Time (Year)	Percentage (%) Increase in Rainfall Intensity from Historical Data to Projected Data					
(years)	2- year	5-year	10-year	25-year	50-year	100-year
5 min	16	17	19	19	20	19
10 min	16	17	19	19	20	19
15 min	16	17	19	19	20	20
30 min	16	17	19	19	20	20
1 h	16	17	19	20	20	21
2 h	16	17	19	20	20	21
3h	16	17	19	20	20	22
6 h	16	18	19	20	21	22

Duration/Return Period Time (Year)	Percentage (%) Increase in Rainfall Intensity from Historical Data to Projected Data					
12 h	16	18	19	20	21	23
24 h	16	18	19	20	21	23

4.2 Methodology

In order to evaluate the adequacy of the existing storm sewer for post-development scenario, with consideration for climate change, a comprehensive analysis was conducted. The interconnected storm sewer, drywell, and culverts along the E Porpoise Bay Road and Sechelt Inlet Road were examined by using the method described below.

4.2.1 Rational Method:

To assess storm sewer capabilities, the Rational Method was employed, to estimate storm runoff peak flow rates. The design peak flows can be used to evaluate the storm sewer's sufficiency.

$$Q_P = CIA/360$$

Q_P – Peak Flow (m^3/s)
C – Runoff Coefficient
I – Rainfall Intensity (mm/hr)
P – Total Precipitation (mm)
Tc – Time of Concentration (hr)
A – Drainage Area (ha)

The estimated design flows for 1-25 year and1-100 year storm events for post-development conditions are discussed in Section 5, Proposed Drainage and Stormwater Management System, and were used in evaluation storm sewer capacities.

4.2.2 PCSWMM

Hydrological and hydraulic modeling was used to estimate the storge requirements for the drywell. PCSWMM is an advanced modeling software for stormwater management, wastewater, and watershed system. It incorporates a modern, powerful GIS engine that works seamlessly with the latest GIS data formats, and provides intelligent tools for streamlining model development, optimization, and analysis in a comprehensive range of applications.

Integrating the full EPA SWMM engine, PCSWMM accounts for various hydrologic processes including:

- Precipitation;
- Evaporation;
- Snow accumulation and melting;
- Infiltration into unsaturated soil layers and percolation of this infiltrated water into groundwater layers;
- Interflow; and
- Non-linear reservoir routing of overland flow.

Handling networks of unlimited size, it contains a flexible set of hydraulic modelling capabilities, including:

- A wide variety of standard closed and open conduit shapes;
- Natural channels;
- Special elements such as culverts, storage/treatment units, flow dividers, pumps, weirs and orifices;
- Kinematic wave or full dynamic wave flow routing methods; and
- Various flow regimes, including backwater and surcharge conditions, reverse flows, and surface ponding.

5.0 PROPOSED DRAINAGE AND STORMWATER MANAGEMENT SYSTEM

5.1 Sub-Catchment Characteristics and Peak Design Flows

The proposed drainage system for the East Porpoise Bay and Sechelt Inlet Improvement project focused on three drainage components to ensure its sufficiency including 1) storm sewer design, 2) a dry well design, and 3) the ponding depth at one critical location near Kunut Avenue and Sechelt Inlet Road.

The project area has been divided to sub-catchment based on the roadway grading design. The Proposed Sub-Catchment Plan in Appendix A summarizes the proposed sub-catchment characteristics including sub-catchment numbers, areas, and impervious ratios. Those sub-catchment characteristics were used in Rational Method and/or PCSWM model to calculate the design flows for sizing storm sewers, drywell, and to estimate required storage volumes.

Drainage sub-catchments for the Project under proposed conditions have been delineated using existing contours and proposed contours and road alignments. Figures in Appendix A show post-development sub-catchment plans, and Table 5-1 summarize the post development sub-catchment data. The impervious ratio for each sub-catchment was calculated based on existing land use type using aerial-photo, and new proposed pavement areas.

Table 5- 1 Post-development Sub-catchment data

Catchment No.	Catchment Area (ha)	Impervious Ratio (%)
C1	0.05	54.59
C2	0.05	62.04
C3	0.14	67.48
C4	0.10	82.81
C5	0.11	68.88
C6	0.08	83.52

Catchment No.	Catchment Area (ha)	Impervious Ratio (%)
C7	0.09	65.51
C8	0.06	89.13
C9	0.06	72.25
C10	0.04	72.55
C11	0.07	66.35
C12	0.05	90.00
C13	0.04	66.19
C14	0.03	90.00
C15	0.20	68.28
C16	0.18	78.90
C17	0.07	71.47
C18	0.06	77.90
C19	0.06	56.69

The peak design flow for each of sub-catchment from post-development has been calculated using Rational Method and are summarized in Table 5-2. The peak flows have been used in sizing proposed sewers. Design flow calculation sheets can be found in Appendix B Calculation sheets I, Storm Sewer Design Flow Calculation with Climate Change.

Table 5- 2 Post-development Sub-catchment and Design Flow with Climate Change

Catchment No.	Catchment Area (ha)	Design Flow (m^3/s)	
		25-Years	100-Years
C1	0.05	0.006	0.010
C2	0.05	0.006	0.010
C3	0.14	0.018	0.029
C4	0.10	0.016	0.024

Catchment No.	Catchment Area (ha)	Design Flow (m^3/s)	
		25-Years	100-Years
C5	0.11	0.014	0.022
C6	0.08	0.011	0.017
C7	0.09	0.010	0.015
C8	0.06	0.009	0.013
C9	0.06	0.007	0.010
C10	0.04	0.005	0.008
C11	0.07	0.007	0.011
C12	0.05	0.007	0.010
C13	0.04	0.004	0.007
C14	0.03	0.004	0.006
C15	0.20	0.028	0.045
C16	0.18	0.028	0.042
C17	0.07	0.009	0.015
C18	0.06	0.010	0.015
C19	0.06	0.008	0.013

5.2 Post-Development Storm Conveyance System

Drainage analysis was conducted for the post-development scenario at the East Porpoise Bay Road and Sechelt Inlet Road, extending from Xenichen Avenue to Delta Avenue, which comprises catch basins, and storm sewers. Peak flows, accounting for climate change effects, were estimated for the sub-catchments and assigned to individual inlets. The storm sewer system was analyzed to accommodate the flow from the 1:25-year storm event without surcharging.

Sewer Design Calculation

The storm sewers as proposed along East Porpoise Bay and Sechelt Inlet Road has the capacity to handle flows for the 25 -year storm event. For details and calculations regarding storm sewer design flow considerations with respect to climate change, please refer to Appendix B, I.

Between Chawilin Ave and Delta Road, where a 300mm perforated storm sewer is proposed, the design flow for both the 25-year and 100-year return periods has been calculated. The respective flow rates of 0.012 m^3/s and 0.020 m^3/s fall comfortably within the capacity of the proposed sewer, which is designed to handle up to 0.099 m^3/s. This perforated pipe is connected to the proposed drywell located near the Delta Road.

From Chawilin Ave to Schetxwen Road, the proposed storm sizes varying from 250 mm to 750 mm are intended to manage increased flow rates resulting from climate change. All sewers in this section have the capacity to handle the 25 year and 100-year design flows. With design flows of 0.520 m^3/s for the 25-year return period and 0.585 m^3/s for the 100-year return period, these flows align well within the capacity of the proposed 750mm storm outfall sewer, which is capable of handling up to 1.118 m^3/s with a slope of 1.01%. Additionally, the flow from these catchments incorporates the 0.4 m^3/s design flow from external catchment provided by the shíshálh Nation (*s*N).

For the proposed storm sewer connecting MH-8 to MH-7, the design flows for both the 25-year and 100-year return periods are 0.042 m^3/s and 0.067 m^3/s respectively. The capacity of the proposed sewer is sufficient to manage the 25-year flow rate, which is within the capacity of 0.046 m^3/s. However, for the 100-year return period, it is insufficient and might surcharge.

For the section between Schetxwen Road and Xenichen Ave along E. Porpoise Bay Road, the proposed 250mm storm sewer system is proposed to handle design flows of 0.056 m^3/s for the 25-year return period and 0.087 m^3/s for the 100-year return period. These flow rates are within the capacity of the proposed 250mm storm sewer, which is designed to accommodate up to 0.159 m^3/s with a slope of 23.58%.

5.3 Infiltration and Storage Requirement

5.3.1 Site Description of the drywell

Existing Drainage:

Existing drainage along the East side of Sechelt Inlet Road between the Chawilin Avenue and Delta Road is draining into a private property.

Proposed Drainage:

The development included 100% covered by the pavement of catchment size 0.0526 ha. One drywell is proposed of diameter 1220mm connected by the inflow perforation pipe of size 300mm. The layout is provided in Figure 5.1, and drainage sub-catchment area towards to the proposed drywell is shown in Figure 5.2.

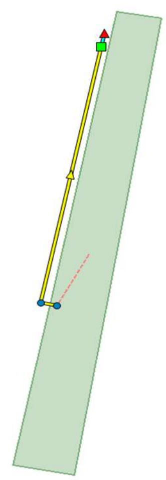


Figure 5- 1 Proposed Drywell Near the Intersection of Sechelt Inlet Road and Delta Road

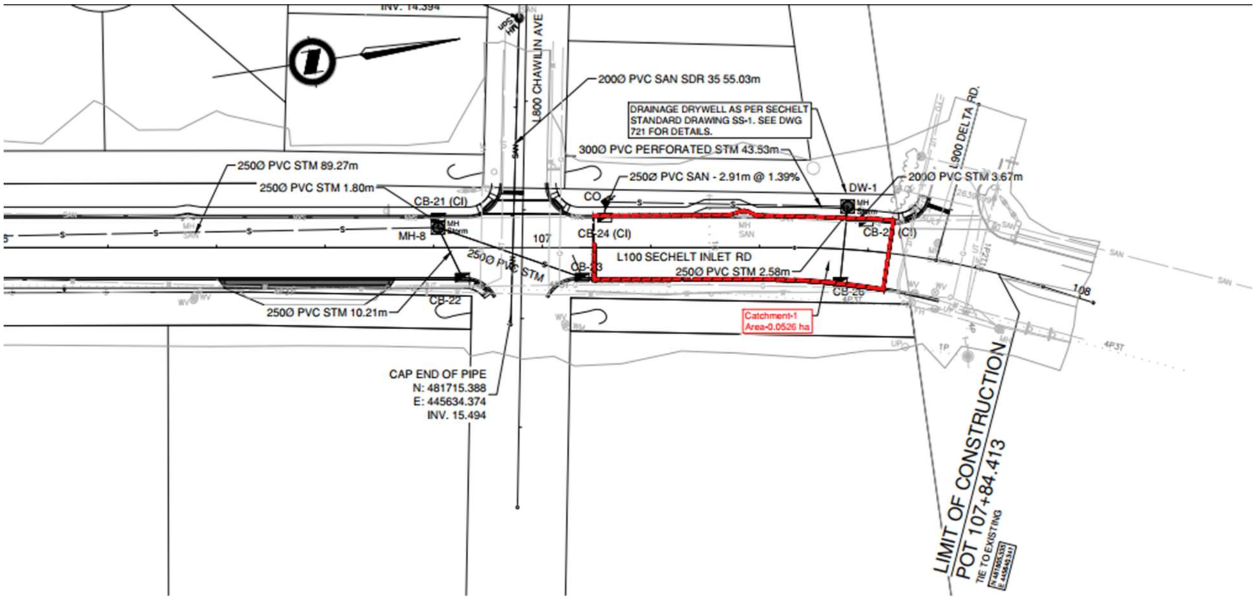


Figure 5- 2 Proposed Sub-Catchment Plan for the Drywell

5.3.2 Proposed Drywell

The proposed drywell has been designed to achieve the stormwater quantity and quality objective. The proposed drywell capacity is checked for the 25-year return period with the aim to store and infiltrate storm runoff onsite. A 300mm perforation pipe is proposed to capture the runoff from the sub-catchment.

Infiltration capacity depends to a great extent on soil type, initial moisture content, and surface vegetation. The Geotechnical Report shows that the soil consists of mainly sandy, gravel, and silts but the report doesn't define the infiltration value, so a standard value of infiltration rate recommended by PCSWMM is used. Therefore, the maximum infiltration rate of 76.2 mm/hour, and the minimum infiltration rate of 3.3 mm/hr are used for the Sand (PCSWMM Resource Centre), and the Decay Constant 2 has been used for Horton's Infiltration Equation in the PCSWMM model and summarized in Table 5.3.

Table 5- 3 Horton's Infiltration Parameters

Maximum Infiltration Rate f0 (mm/hour)	Minimum Infiltration Rate fc (mm/hour)	Decay Constant k
76.2	3.3	2

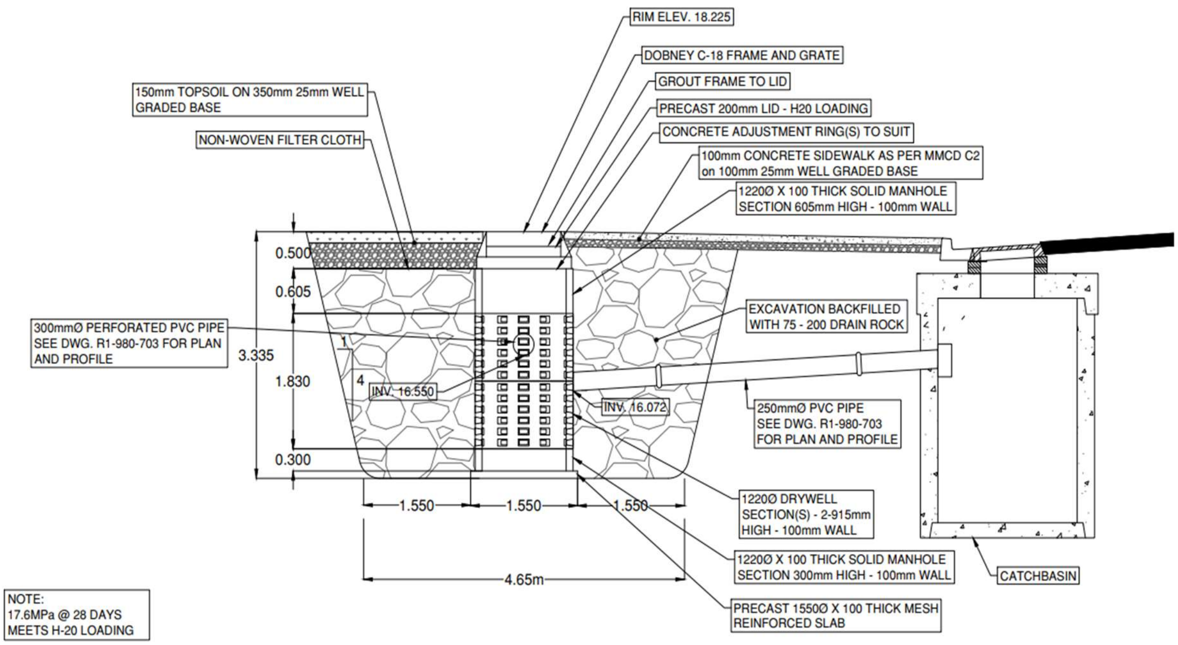


Figure 5- 3 Drywell Details

The model used a drywell of 1.22 m in diameter at the bottom as provided in Figure 5.3. Assuming the side slope is 0.25:1, and a 40% void ratio for the backfill drain rock. Table 5.4 summarize the stage storage and the required storage volumes of the infiltration drywell.

Table 5- 4 Drywell Stage-Storage Relationship

Note	Water Surface Invert Elevation (m)	Drywell Depth (m)	Total Storage Area	Storage Volume (m3)
Bottom of Drywell	14.89	0	7.49	0.76
	14.99	0.1	7.64	1.53
	15.09	0.2	7.79	2.32
	15.19	0.3	7.94	3.12
	15.29	0.4	8.09	3.94
	15.39	0.5	8.24	4.77
	15.49	0.6	8.39	5.62
	15.59	0.7	8.55	6.48
	15.69	0.8	8.71	7.39
	15.79	0.9	8.87	8.26
25 year HWL	15.89	1	9.03	8.32
	15.99	1.1	9.19	9.15
	16.09	1.2	9.36	10.04
	16.19	1.3	9.52	10.93
	16.29	1.4	9.69	11.82
	16.39	1.5	9.86	12.71
	16.49	1.6	10.03	13.60
	16.59	1.7	10.20	14.50
	16.69	1.8	10.37	15.40
	16.79	1.9	10.55	16.30
	16.89	2	10.72	17.20
	16.99	2.1	10.90	18.10
	17.09	2.2	11.08	19.00
	17.19	2.3	11.26	19.91
	17.29	2.4	11.45	20.81
	17.39	2.5	11.63	21.63
	17.49	2.6	11.82	22.77
	17.59	2.7	12.01	23.89
	17.69	2.8	12.19	24.66

Based on the modeling report, the result is summarized as follows:

- During the 1:25-year storm event, the catchment for the drywell on Sechelt Inlet Road generates a total runoff of 0.01 m^3/s. The maximum runoff depth reached by the drywell is 1.01m and with a storage volume of 8.32 m^3, it is capable to retain all the runoff volume from the 1:25-year event.

The graphs depicting the peak volume and depth generated from the PCSWMM model are presented in Figure 5.2.

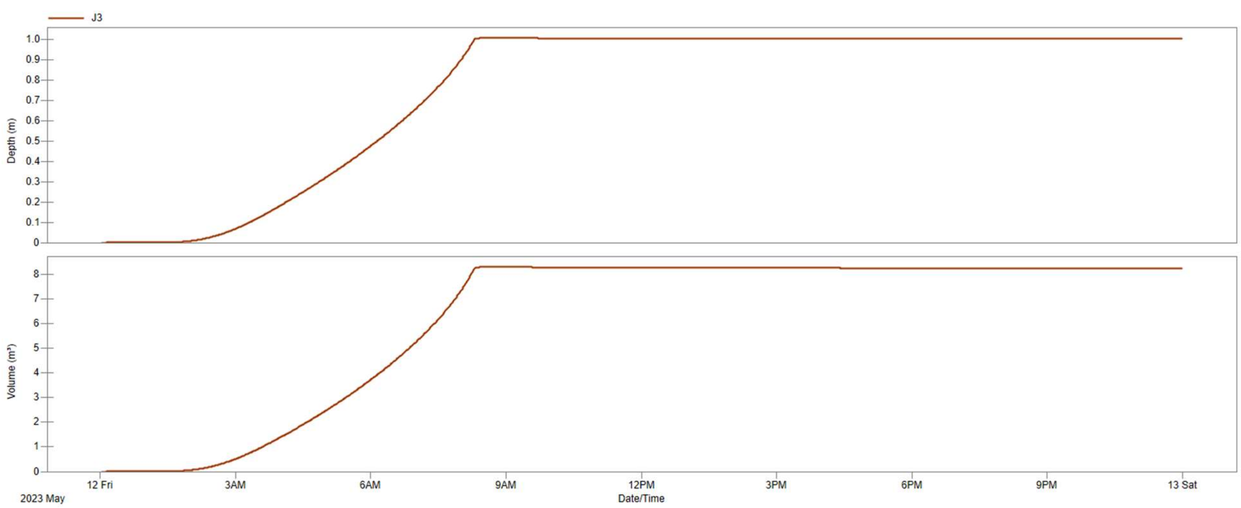


Figure 5- 4 Peak Volume/Depth of Drywell Storage

5.4 Ponding Width in Pavement

A reduced gutter is present around the alignment marker 105+65 to avoid the conflict with a manhole, near the intersection of Kunut Avenue and Sechelt Inlet Road. Please refer to the Figure 5.5 for location of the reduced gutter.

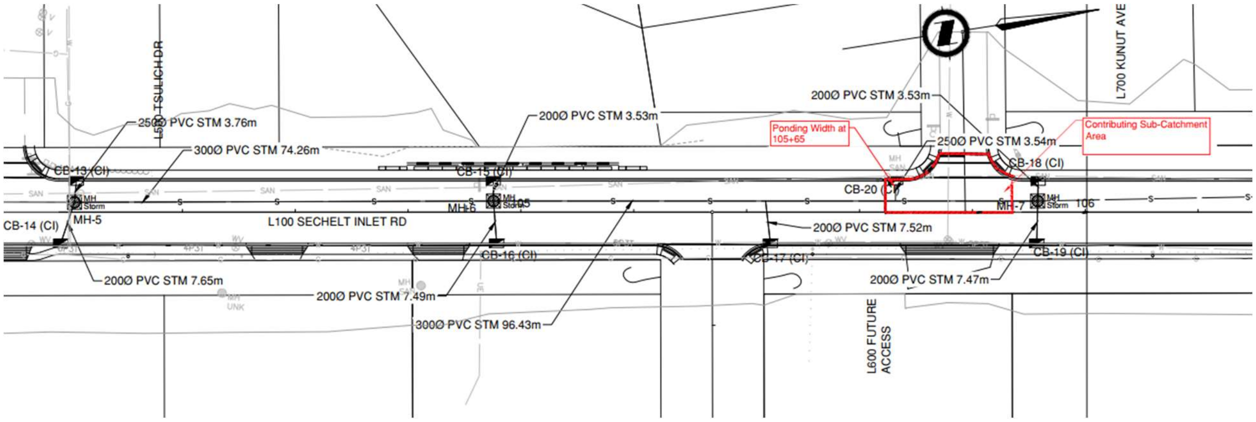


Figure 5- 5 Reduced Gutter Location and Contributing Sub-Catchment Area

The calculation of the ponding width is derived from the reduction in width of the gutter pan, which has been decreased from 300mm to 150mm. A new catch basin is proposed to collect the runoff from the surrounding area to reduce the potential of ponding due to the reduced gutter.

The ponding width in the pavement is determined by applying the Manning Equation, considering a 75-year projection period to account for Climate Change conditions. The calculation is conducted for a specific catchment area of 176 m^2, utilizing a runoff coefficient of 0.95. Following Manning's parameters are used:

Manning's roughness coefficient, n= 0.015
Longitudinal Slope (m/m), S= 0.02
Pavement cross slope, Sx= 0.02

The resulting flow depth (Y) and ponding width (T) are computed for return periods of 5 years, 10 years, 25 years, 50 years, and 100 years. The obtained values for flow depth and ponding width for each return period are presented below.

Table 5- 5 Ponding Width

Parameters	For T = 5 Yrs.	For T = 10 Yrs.	For T = 25 Yrs.	For T = 50 Yrs.	For T = 100 Yrs.
	Paved	**Paved**	**Paved**	**Paved**	**Paved**
Intensity mm/hr.	52.42	63.03	78.44	92.24	106.60
Flow Rate (Q) m^3/sec	0.0024	0.0029	0.0036	0.0043	0.0050
Flow Depth (Y) m	0.015	0.016	0.017	0.019	0.020
Ponding Width (T) m	0.751	0.805	0.874	0.928	0.980

For the 25-year return period, the rainfall intensity is 78.44 mm/hr, the flow rate (Q) is 0.0036 m^3/s, the flow depth (Y) is 0.017 m, and the ponding width (T) is 0.874 m.

For the 5-year return period, the rainfall intensity is 52.42 mm/hr, the flow rate (Q) is 0.0024 m^3/s, the flow depth (Y) is 0.015 m, and the ponding width (T) is 0.751 m.

The analysis reveals that the reduced gutter situated at the alignment marker 105+65, near the intersection of Kunut Avenue and Sechelt Inlet Road, leads to an increase in the width of ponding towards the paved shoulder. This expansion surpasses the capacity of the 150mm gutter. Consequently, at this location the road could be susceptible to issues related to water ponding.

To effectively manage the flow and avoid the potential of water ponding to the paved shoulder, it becomes imperative to consider the installation of a new catch basin prior to the location of the gutter reduction. The proposed catch basin is expected to drain storm runoff away and reduce the ponding width, therefore ensuring the safety and functionality of the roadway.

6.0 SUMMARIES AND CONCLUSIONS

The E Porpoise Bay Road and Sechelt Inlet Road Improvement Project in Sechelt, BC aims to make significant changes to the intersection. This includes widening the road between the Xenichen Avenue and Delta Road. The change in the intersection will result in changes in the horizontal and vertical alignments of the road and associated drainage systems. The drainage design shall comply with BC MoTI's Supplement to TAC Geometric Design Guide.

The proposed drainage system for the East Porpoise Bay and Sechelt Inlet Improvement project focused on three drainage components to ensure its sufficiency including 1) storm sewer design, 2) a dry well design, and 3) the ponding depth at one critical location near the intersection of Kunut Avenue and Sechelt Inlet Road.

The drainage storm sewer analysis, conducted using the Rational Method, estimates storm runoff peak flow rates for sizing the highway storm conveyance system. To account for the impacts of climate change, the design of the drainage system is based on IDF data projected to the year 2098. The projected 75-year design life span for the culvert, as per the BC Supplement to TAC Geometric Design Guide, ensures the system's durability.

The drainage drywell design focused on evaluating a proposed drywell capacity near the intersection of Sechelt Inlet Road and Delta Road. The storm sewer along the Sechelt Inlet Road between Chawlin Avenue and Delta Road is connected and ultimately flow into the proposed drywell via a perforated pipe. PCSWMM computer model was used to estimate storm runoff peak flow rates for sizing the perforated pipe and runoff volume for sizing the drywell.

In conclusion, the proposed drywell and storm drainage system in the East Porpoise Bay Road and Sechelt Inlet Road will meet the criteria in accordance with BC MoTI's Supplement to TAC Geometric Design Guide, and are summarized as follows:

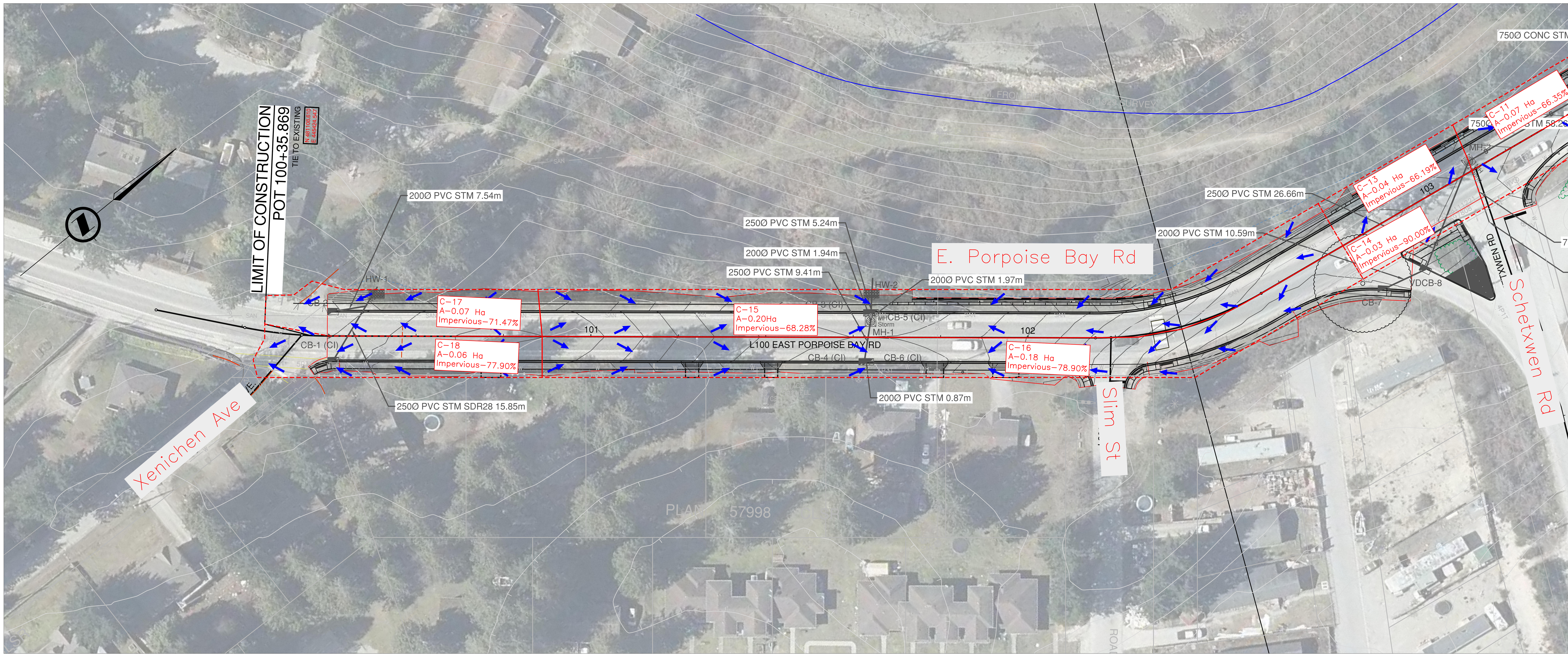
- The storm sewers have been designed to pass the 25-year flow discharge without surcharging;

- The proposed drywell will have the capacity to infiltrate storm runoff from the 25-year storm event;
- The maximum ponding width at the catch basin prior to the reduced curb near the intersection of Kunut Avenue and Sechelt Inlet Road, is equal to or less than 65% of the paved shoulder width with a minimum of 1.2 m for the 5-year design storm event; and
- The proposed catch basin is expected to drain storm runoff away and reduce the ponding width, therefore avoid the potential of water ponding to the paved shoulder.

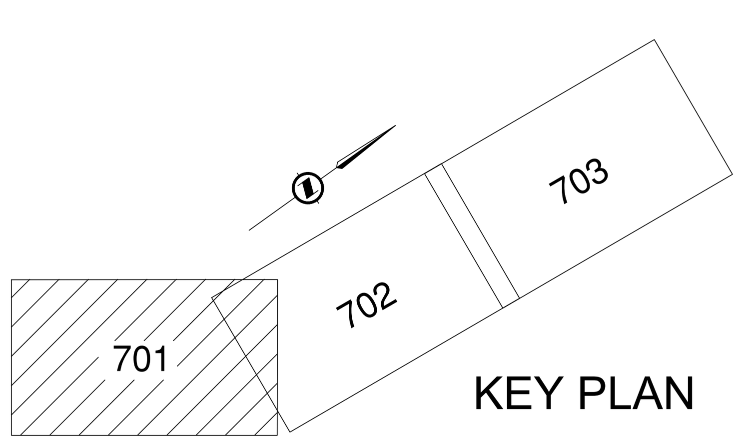
It should be noted that the outside catchment area to southeast of the highway was not included in the drainage design calculation due to insufficient information available. But during the course of highway design development, AtkinsRéalis project manager coordinated with the District of Sechelt and shíshálh Nation(*s*N) regarding how to accommodate the outside drainage to the highway. shíshálh Nation (*s*N) requested to include 400 L/s flow at the intersection of Schetxwen Road and E. Porpoise Bay Road to the downstream sewer. District of Sechelt requested approximately 0.06 ha drainage area on the east side of the highway between Chawilin Ave and Delta Road to be considered to the highway sewer system. Flows from those two locations have been incorporated in the highway sewer calculation.

In conclusion, the proposed storm sewer along East Porpoise Bay Road and Sechelt Inlet Road, and the drywell proposed at the intersection of Sechelt Inlet Road and Delta Road will meet the criteria in accordance with BC MoTI’s Supplement to TAC Geometric Design Guide.

Appendix A Sub-Catchment Plan



Sub-Catchment



KEY PLAN

AtkinsRéalis

Suite 1100 - 745 Thurlow St.
Vancouver | British Columbia
V6E 0C5 | Canada

Certified ISO 9001

SCALE 0 5 H 1:500 25m
0 1 V 1:100 5m

CAD FILENAME PR-CATCHMENT PLAN_R1-980-701 TO 731
PLOT DATE 2024-02-06

REV	DATE	REVISIONS	NAME
PA	2/6/2024	Issued for IFT Drainage Design Report	TL

BRITISH COLUMBIA

MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
SOUTH COAST REGION
HIGHWAY ENGINEERING AND GEOMATICS

SENIOR DESIGNER
DATE 2024-02-06

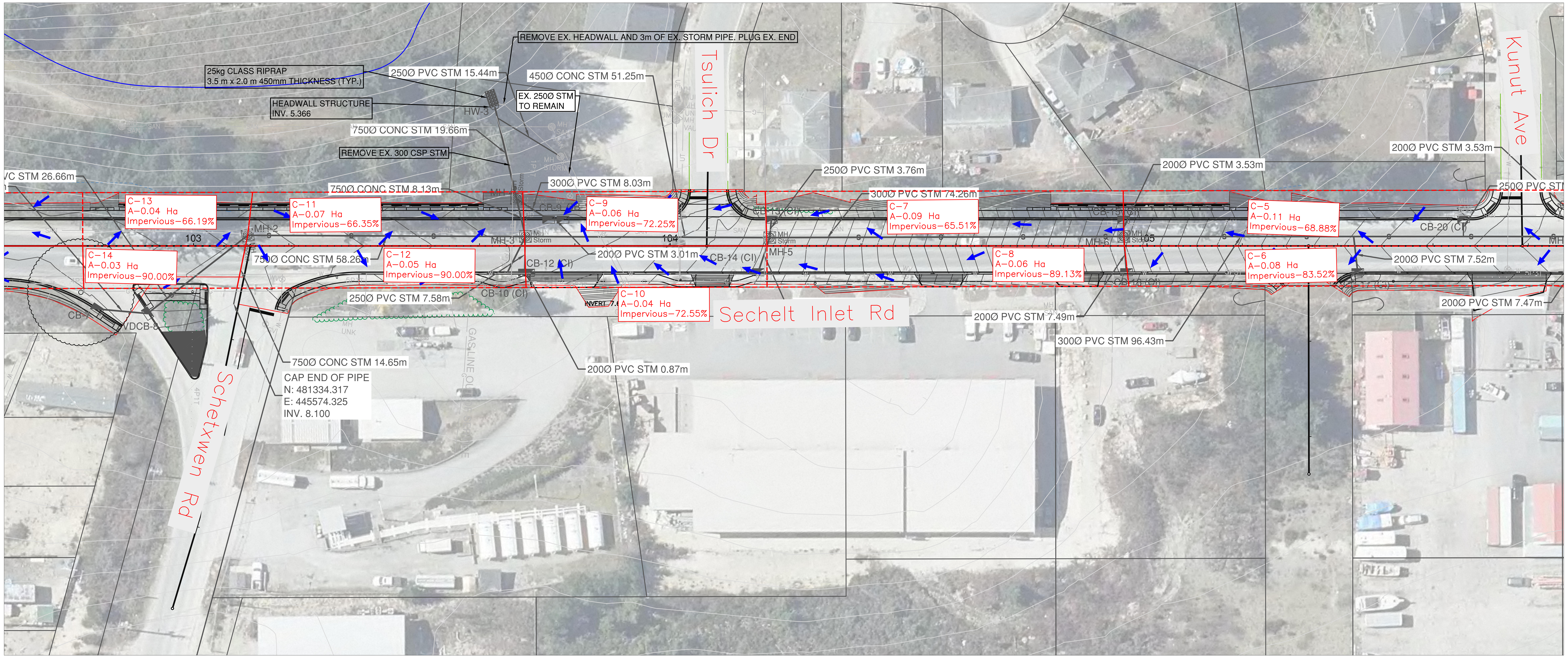
DESIGNED D. GURUNG DATE 2024-02-06
QUALITY CONTROL T. LIU DATE 2024-02-06
QUALITY ASSURANCE R.WANG DATE 2024-02-06
DRAWN Z. JIANG DATE 2024-02-06

PROPOSED SUB-CATCHMENTS PLAN

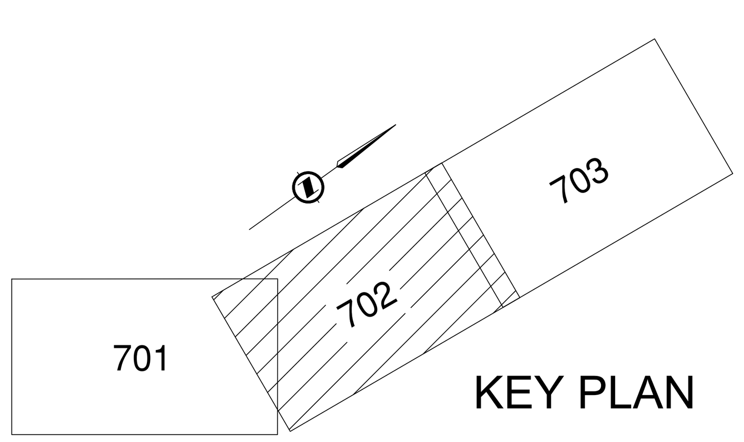
EAST PORPOISE BAY ROAD IMPROVEMENT

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
871CS0999	13004-0001	1	0000-41SK-001	PA

PLOT DATE: 2024/02/06 \\sl0262\TxProject\DATA\678324-PorpoiseBay&SechelInlet\41 - Civil Engineering\41EB - Design Calcs\Catchment Plan\CAD\PR-Catchment Plan_R1-980-701 to 731.dwg



Sub–Catchment



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SCALE 0 5 H 1:500 25m
0 1 V 1:100 5m

CAD FILENAME PR-CATCHMENT PLAN_R1-980-701 TO 731
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EAST PORPOISE BAY ROAD IMPROVEMENT

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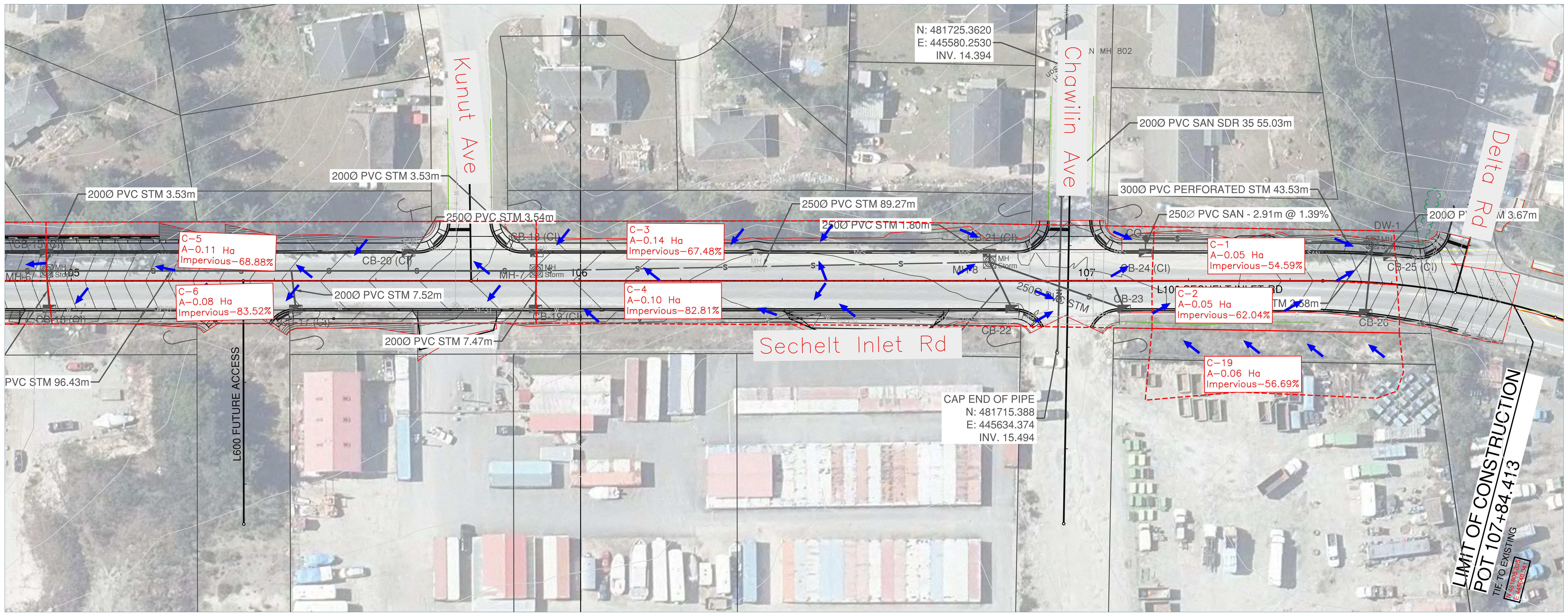
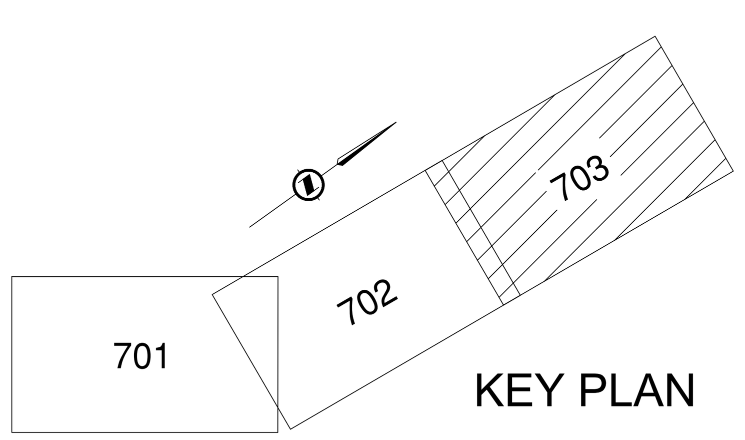


Sub-Catchment



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SCALE	H 1:500 (0 – 5 – 25m) / V 1:100 (0 – 1 – 5m)	CAD FILENAME	PR-CATCHMENT PLAN_R1-980-701 TO 731
		PLOT DATE	2024-02-06

REV	DATE	REVISIONS	NAME
PA	2/6/2024	Issued for IFT Drainage Design Report	TL

BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
SOUTH COAST REGION
HIGHWAY ENGINEERING AND GEOMATICS

SENIOR DESIGNER
DATE 2024-02-06

DESIGNED	D. GURUNG	DATE	2024-02-06
QUALITY CONTROL	T. LIU	DATE	2024-02-06
QUALITY ASSURANCE	R.WANG	DATE	2024-02-06
DRAWN	Z. JIANG	DATE	2024-02-06

PROPOSED SUB-CATCHMENTS PLAN

EAST PORPOISE BAY ROAD IMPROVEMENT

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
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Appendix B Calculation Sheet

I Storm Sewer Design Flow Calculation with Climate Change

CLIENT:	BC MOTI	**PROJECT No.:**	678324
PROJECT:	East Porpoise Bay Rd	**DATE:**	2/02/2024
DESIGNED BY:	DG	**CHECKED BY:**	TL

Existing Storm Sewer Design - Considering Climate Change

Q=	Runoff (m3/s)	Φ=	Pipe Diameter (mm)
R=	Runoff Coeff x Soil Adjustment Factor (SAF)	n=	Roughness Coefficient
A=	Area (ha)	s=	Slope of Pipe (%)
I=	Rain Intensity (mm/h)	V=	Velocity (m/s)
N=	0.00278	L=	Length (m)

LOCATION		CATCHMENT AREA		LAND USE & RUNOFF COEFFICIENT / AREA								TIME OF FLOW			RAINFALL			RUNOFF					EXISTING SEWER DESIGN						
		Increment Area			R			RA							Itensity (mm/hr)			Design Flow (m^3/s)											
From	To	No.	A (ha)	LAND USE	10 years	25 years	100 years	10 years	25 years	100 years	Σ RA	Ti (min)	Tt (min)	Tc (min)	10-yrs	25-yrs	100yrs	10-yrs	25-yrs	100-yrs	From MH	To MH	Capacity (m^3/s)	Diameter (mm)	Slope (m/m)	Pipe Material	n	Velocity (m/s)	Pipe Length (m)
Chawlin Ave	Delta Rd	C1	0.02	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.019	0.019	0.020	0.020	5.00	0.00	5.00	63.03	78.45	106.60	0.003	0.004	0.006									
			0.03	GRASSLAND	0.2	0.3	0.55	0.005	0.008	0.014	0.034	5.00	0.00	5.00	63.03	78.45	106.60	0.001	0.002	0.004									
		C2	0.03	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.022	0.022	0.024	0.058	5.00	0.00	5.00	63.03	78.45	106.60	0.004	0.005	0.007									
			0.02	GRASSLAND	0.2	0.3	0.55	0.004	0.006	0.010	0.068	5.00	0.00	5.00	63.03	78.45	106.60	0.001	0.001	0.003									
																		0.009	0.012	0.020	CB-24/CB-25/CB-26	DW-1	0.099	300	0.011	PVC	0.013	1.407	44.73
Schetxwen Rd	Chawlin Ave	C3	0.09	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.072	0.072	0.077	0.077	5.00	0.00	5.00	63.03	78.45	106.60	0.013	0.016	0.023									
			0.04	GRASSLAND	0.2	0.3	0.55	0.008	0.012	0.022	0.099	5.00	0.00	5.00	63.03	78.45	106.60	0.001	0.003	0.007									
		C4	0.09	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.072	0.072	0.077	0.175	5.00	0.00	5.00	63.03	78.45	106.60	0.013	0.016	0.023									
			0.01	GRASSLAND	0.2	0.3	0.55	0.002	0.003	0.006	0.181	5.00	0.00	5.00	63.03	78.45	106.60	0.000	0.001	0.002									
		C19	0.03	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.026	0.026	0.028	0.209	5.00	0.00	5.00	63.03	78.45	106.60	0.005	0.006	0.008									
			0.03	GRASSLAND	0.2	0.3	0.55	0.006	0.009	0.017	0.225	5.00	0.00	5.00	63.03	78.45	106.60	0.001	0.002	0.005									
																		0.033	0.042	0.067	MH-8	MH-7	0.046	250	0.006	PVC	0.013	0.930	89.27
		C5	0.08	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.064	0.064	0.068	0.249	5.00	1.60	6.60	54.48	67.41	90.69	0.010	0.012	0.017									
			0.04	GRASSLAND	0.2	0.3	0.55	0.007	0.011	0.019	0.268	5.00	1.60	6.60	54.48	67.41	90.69	0.001	0.002	0.005									
		C6	0.07	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.058	0.058	0.062	0.330	5.00	1.60	6.60	54.48	67.41	90.69	0.009	0.011	0.016									
			0.01	GRASSLAND	0.2	0.3	0.55	0.001	0.002	0.004	0.334	5.00	1.60	6.60	54.48	67.41	90.69	0.000	0.000	0.001									
																		0.052	0.068	0.105	MH-7	MH-6	0.171	300	0.031	PVC	0.013	2.418	96.43
		C7	0.06	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.045	0.045	0.048	0.381	5.00	2.26	7.26	51.81	63.97	85.77	0.006	0.008	0.011									
			0.03	GRASSLAND	0.2	0.3	0.55	0.006	0.009	0.017	0.398	5.00	2.26	7.26	51.81	63.97	85.77	0.001	0.002	0.004									
		C8	0.06	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.051	0.051	0.054	0.452	5.00	2.26	7.26	51.81	63.97	85.77	0.007	0.009	0.013									
			0.00	GRASSLAND	0.2	0.3	0.55	0.000	0.000	0.001	0.453	5.00	2.26	7.26	51.81	63.97	85.77	0.000	0.000	0.000									
																		0.067	0.086	0.134	MH-6	MH-5	0.238	300	0.061	PVC	0.013	3.368	74.26
		C9	0.04	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.034	0.034	0.037	0.489	5.00	2.63	7.63	50.48	62.27	83.34	0.005	0.006	0.008									
			0.02	GRASSLAND	0.2	0.3	0.55	0.003	0.005	0.008	0.498	5.00	2.63	7.63	50.48	62.27	83.34	0.000	0.001	0.002									
		C10	0.03	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.026	0.026	0.028	0.526	5.00	2.63	7.63	50.48	62.27	83.34	0.004	0.005	0.006									
			0.01	GRASSLAND	0.2	0.3	0.55	0.002	0.003	0.006	0.532	5.00	2.63	7.63	50.48	62.27	83.34	0.000	0.001	0.001									
																		0.076	0.098	0.152	MH-5	MH-3	0.332	450	0.014	CONC	0.013	2.089	51.25
		C13	0.03	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.021	0.021	0.022	0.554	5.00	3.04	8.04	49.12	60.52	80.85	0.003	0.003	0.005									
			0.01	GRASSLAND	0.2	0.3	0.55	0.003	0.004	0.007	0.561	5.00	3.04	8.04	49.12	60.52	80.85	0.000	0.001	0.002									
		C14	0.03	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.023	0.023	0.025	0.578	5.00	3.04	8.04	49.12	60.52	80.85	0.003	0.004	0.006									
			0.00	GRASSLAND	0.2	0.3	0.55	0.000	0.000	0.000	0.578	5.00	3.04	8.04	49.12	60.52	80.85	0.000	0.000	0.000									
																		0.006	0.008	0.012	CB-7/VDCB-8	MH-2	0.087	250	0.022	PVC	0.013	1.779	26.66
		Flow Discharge From First Nation	0.00															0.400	0.400	0.400									
			0.00																										
		C11	0.04	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.034	0.034	0.037	0.615	5.00	3.29	8.29	48.33	59.52	79.42	0.005	0.006	0.008									
			0.02	GRASSLAND	0.2	0.3	0.55	0.004	0.007	0.012	0.627	5.00	3.29	8.29	48.33	59.52	79.42	0.001	0.001	0.003									
		C12	0.05	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.042	0.042	0.044	0.671	5.00	3.29	8.29	48.33	59.52	79.42	0.006	0.007	0.010									
			0.00	GRASSLAND	0.2	0.3	0.55	0.000	0.000	0.000	0.671	5.00	3.29	8.29	48.33	59.52	79.42	0.000	0.000	0.000									
																		0.411	0.414	0.420	MH-2	MH-3							
																		0.494	0.520	0.585	MH-3	HW-3	1.118	750	0.010	CONC	0.013	2.531	58.26
Xenichen Ave	Schetxwen Rd	C15	0.14	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.111	0.111	0.118	0.118	5.00	0.00	5.00	63.03	78.45	106.60	0.019	0.024	0.035									
			0.06	GRASSLAND	0.2	0.3	0.55	0.013	0.019	0.035	0.153	5.00	0.00	5.00	63.03	78.45	106.60	0.002	0.004	0.010									
		C16	0.15	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.119	0.119	0.127	0.279	5.00	0.00	5.00	63.03	78.45	106.60	0.021	0.026	0.038									
			0.03	GRASSLAND	0.2	0.3	0.55	0.006	0.008	0.015	0.295	5.00	0.00	5.00	63.03	78.45	106.60	0.001	0.002	0.005									
																		0.044	0.056	0.087	MH-1	HW-2	0.159	200	0.236	PVC	0.013	5.065	5.24
Xenichen Ave	West of Xenichen Ave	C17	0.05	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.038	0.038	0.041	0.041	5.00	0.00	5.00	63.03	78.45	106.60	0.007	0.008	0.012									
			0.02	GRASSLAND	0.2	0.3	0.55	0.003	0.005	0.009	0.050	5.00	0.00	5.00	63.03	78.45	106.60	0.001	0.001	0.003									
		C18	0.05	PAVEMENT/ASPHALT	0.8	0.8	0.85	0.042	0.042	0.045	0.095	5.00	0.00	5.00	63.03	78.45	106.60	0.007	0.009	0.013									
			0.01	GRASSLAND	0.2	0.3	0.55	0.002	0.003	0.006	0.101	5.00	0.00	5.00	63.03	78.45	106.60	0.000	0.001	0.002									
																		0.015	0.019	0.030	CB-1/CB-2	HW-1	0.103	250	0.030	PVC	0.013	2.096	16.61