UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Detailed Design Report SW Marine Drive and 16th Avenue

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Executive Summary

Our team is pleased to present our proposed redesign for the West 16th Avenue and Southwest (SW) Marine Drive intersection. Our design focuses on enhancing safety, improving traffic flow, and creating a more inclusive environment for road users. By implementing a roundabout design, the authors aim to address the current challenges of the intersection while setting a precedent for future intersection redesigns in Metro Vancouver and beyond.

The author's design choices were made carefully, considering present and future traffic volumes, and aiming to optimize intersection footprint and prioritize active transportation. The roadway geometry incorporates 30-metre approach curves to slow down approaching vehicles safely, while a 50 m radius exit curve facilitates smooth acceleration onto SW Marine Drive. Furthermore, by enhancing pedestrian pathways and implementing physically separated bicycle lanes, our group aims to create a safer and more accessible environment for non-motorized road users. This aligns with our commitment to promoting sustainable transportation solutions and fostering a more equitable transportation system. The roundabout design also includes a gateway structure to improve aesthetics, and a stormwater management system to minimize environmental impact and enhance sustainability.

Scheduled for completion by September 12th, 2024, this transformative project represents a significant investment in our community's transportation infrastructure. The project's total cost is estimated at 4.4 million dollars. The group's dedication to innovation and excellence is evident in every aspect of our design, from the optimized roadway geometry to the integration of cutting-edge stormwater management techniques.

Table of Contents

List of Figures

List of Tables

1.0 Introduction

1.1 Project Overview

Initially designed for ferry traffic, the SW Marine Drive and West 16th Avenue intersection falls short of meeting the evolving needs of the University of British Columbia (UBC) community. Its original highway layout poses accessibility and safety challenges as road users enter an urban and pedestrian-centric campus space. Our team aims to create a safer and more inviting intersection for cyclists and pedestrians, which aligns with the British Columbia Ministry of Transportation and Infrastructure's (BC MoTI) requirements and *UBC's 2050 Campus Vision* over a design life of 40 years.

The authors and UBC Social Ecological Economic Development Studies (SEEDS) recognize the redesign as an opportunity to introduce a road-spanning welcome structure which will alert drivers that they are entering the UBC Point Grey campus. Additionally, we will revitalize the current stormwater management system to mitigate cliff erosion.

Figure 1: Current Intersection (Google Earth Image)

1.2 Project Objectives

The objectives outlined in consultation with UBC SEEDS and relevant stakeholder groups informed key design objectives. Specifically, we aim to:

- Shift transportation priority to active mode users, outlined in the *British Columbia Ministry of Transportation and Infrastructure's Supplement to the TAC Manual.*
- Improve the safety of all road users, especially by reducing vehicle speeds.
- Improve the intersection aesthetic and university presence, including the addition of a road spanning welcome structure.
- Catch and recycle rainwater, promoting sustainability.
- Partner with applicable governing bodies, such as MoTI, UBC SEEDS, and the Musqueam community.

1.3 Existing Conditions

SW Marine Drive is currently designed as a four-lane highway with large grassy medians and a posted speed limit of 80 kilometres per hour (km/hr). Currently, the intersection is controlled by traffic lights. The design's lane configuration is shown in Figure 1. It consists of:

1. Southern leg: two channelized right-turn lanes and two through lanes
2. Eastern leg: one channelized right-turn lane and two left-turn lanes
3. Northern leg: two through lanes and one left-turn lane

The on-site pedestrian infrastructure consists of interconnected pathways on the eastern side of SW Marine Drive as well as both sides of West 16th Avenue, linked by crosswalks at the traffic signal. The pedestrian features are overshadowed by a car-centric design.

The intersection has shoulder bicycle lanes on all approaches, which consist of painted lines and are not physically divided from the existing roadway. The conditions are unsafe for cyclists since they have to merge with high-speed traffic at some locations. The absence of clear demarcation puts cyclist's safety at risk.

1.4 Design Constraints

The design shall adhere to all applicable design standards in the *Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads* and *British Columbia Ministry of Transportation and Infrastructure's Supplement to the TAC*. To mitigate cliffside erosion, as outlined in 2002 Piteau's Geotechnical Report, the project will adhere to the 35-degree setback from the toe of the cliff to minimize stability concerns for the cliff face. Additionally, setbacks from the UBC Botanical Garden and the UBC Farm must not be encroached.

Since the intersection is classified as a "Disaster Response Route" by the lower mainland municipalities, ensuring that speed is reduced while allowing emergency services quick access through this corridor is essential. Additionally, because this corridor includes the second busiest bus route (Translink's R4 Rapid Bus), the intersection must easily accommodate the increased turning radii of articulated buses throughout the intersection.

Furthermore, this project will contribute to the objectives outlined in the *UBC 2050 Campus Vision Plan*. The ever-growing UBC campus is expected to have an increase in students and staff, doubling the population by 2050. Therefore, ensuring this intersection can handle the capacity required in the future is crucial. With 7,100 new housing units planned for campus (not inclusive of student housing upgrades), efficient and safe movement around campus must be considered with new and upgraded infrastructure. Additionally, West 16th Avenue is a wildlife pathway between Pacific Spirit Regional Park and UBC's Farm and Research Forest. Utilizing the "Complete Streets" framework will help maintain this corridor while managing congestion and prioritizing safety for all road users.

1.5 Design Criteria

In the conceptual design phase, key design criteria were identified through consultation with stakeholders and UBC SEEDS. The criteria focuses on providing safe, accessible travel for various modes of transportation, while mitigating environmental concerns and shortening timelines. Our design criteria, listed in order of significance, is presented the below figure.

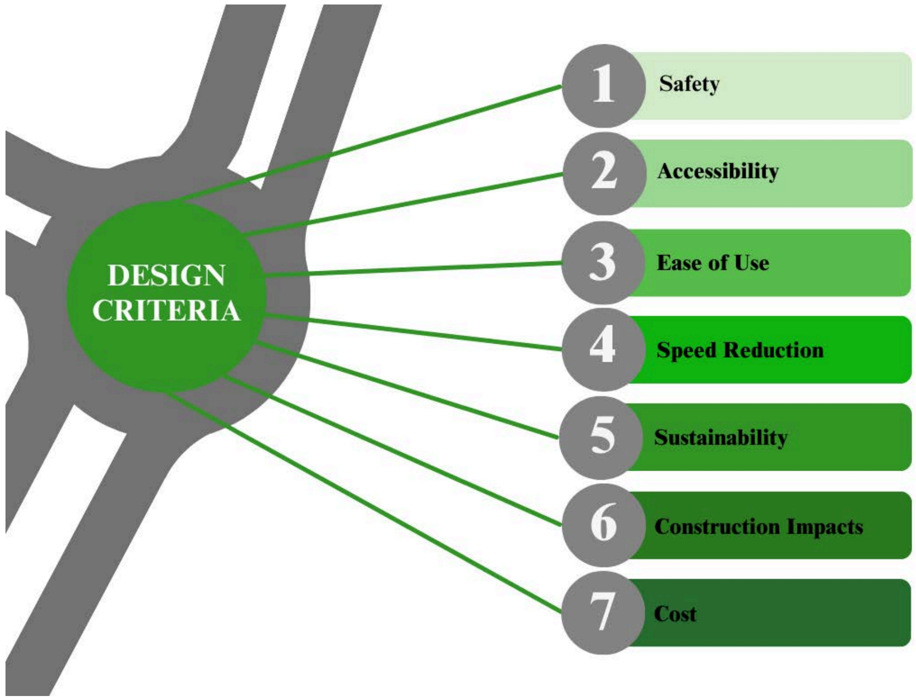

Figure 2: Design Criteria

The criteria remained the focus of the author's design throughout the detailed design process. This report will discuss how our design prioritizes safety, accessibility, and environmental stewardship.

1.6 Stakeholder Consultation

The project stakeholders we identified are: the clients, the Musqueam community, commuters of various modes, UBC students and staff, the UBC Botanical Gardens, the nearby elementary and high school, and local environmental activist groups. While all parties are stakeholders, the clients and the Musqueam community are also rightsholders and require a more thorough engagement.

An engagement was planned for each stakeholder group mentioned above. Results from this engagement were used to determine the design criteria and their relative importance, leading to the design criteria shown in Figure 2.

1.7 Standards and Softwares

We used the following design guidance and standards in order to complete the design.

Table 1: Relevant Standards, Design Guidance, and Reference Documents

Design Aspect	Standards, Design Guidance, Reference Documents
Intersection	● *UBC 2050 Campus Vision* ● Transportation Association of Canada's (TAC) *Geometric Design Guide for Canadian Roads, 2017 Third Edition* ● *British Columbia's Supplement to TAC Geometric Design Guide, 2019 third edition* ● Translink's *Bus Infrastructure Design Guidelines* ● AASHTO *Policy on Geometric Design Highways and Streets (7th Edition, 2018)* ● *Manual of Uniform Traffic Control Devices (MUTCD)* ● *Ministry of Transportation Infrastructure's Standard Specifications for Highway Construction, 2020* ● *Ministry of Transportation Infrastructure Traffic Management Manual for Work on Roadways, 2020* ● *Ministry of Transportation Infrastructure Manual of Standard Traffic Signs and Pavement Markings*
Gateway	● *National Building Code of Canada (NBC-2015) 2015* ● *Canadian Standards of Associations Design of Concrete Structures 2014 (CSA A23.3-14)* ● *Canadian Standards of Associations Engineering Design in Wood 2019 (CSA O86-19)* ● *Canadian Standards of Associations Design of Steel Structures 2014 (CSA S16-19)*
Stormwater Management	● *Vancouver Engineering Design Manual* ● *Vancouver Standard Detail Drawings Storm and Sanitary Sewers* ● *Ministry of Transportation Infrastructure's (MoTI) Standard Specifications for Highway Construction, 2020*

The team also used the following software to assist with the design, renderings and drawings.

Table 2: Software Used in Design

Design Aspect	Software	
Intersection	• SIDRA • Vistro • Civil 3D	• AutoCAD • AutoTurn • Revit and Twinmotion
Gateway	• AutoCAD	• CSI ETABS

2.0 Intersection Design

2.1 Description

Our roadway redesign of the West 16th Avenue and SW Marine Drive intersection focuses on enhancing the intersection for road users. The design adheres to all relevant design standards outlined in the Transportation Association of Canada's (TAC) *Geometric Design Guide for Canadian Roads, 2017 Third Edition*, and follows the requirements for roundabouts outlined in the *British Columbia's Supplement to TAC Geometric Design Guide, 2019 third edition*.

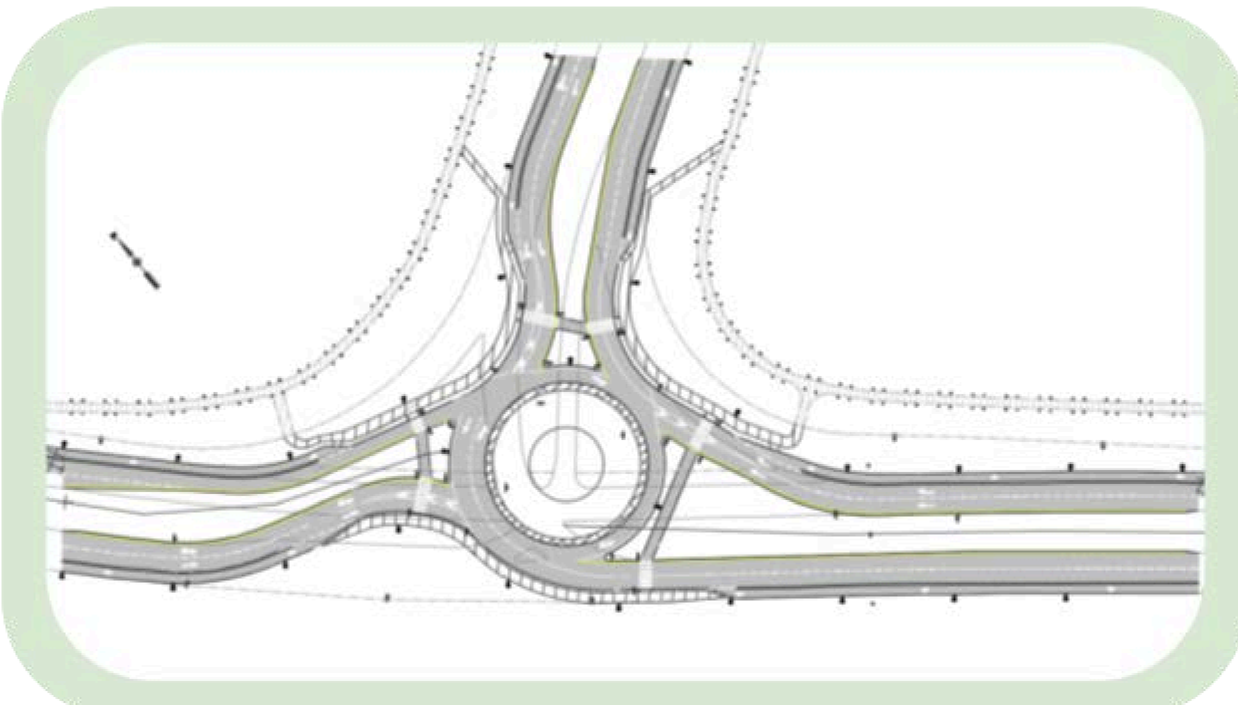

Figure 3: Intersection Overview

The roundabout design features two entrance lanes on all three approaches, with two exit lanes on all legs except for the northbound vehicle exit. The one lane on the northbound exit was determined to be most suitable for the intersection as present and future traffic volumes did not warrant the additional lanes, taking up valuable footprint space. Additionally, this design choice placed an emphasis on minimizing the intersection footprint and prioritizing active transportation.

2.1.1 Roadway Geometry

The roadway geometry of the roundabout design follows all relevant design standards identified in Table 1. The focus when designing the geometry of the roundabout was slowing down motor vehicles entering campus and keeping vehicles moving at a steady state. The speed reduction has been achieved using 30 m approach curves, which will slow down motor vehicles. 30 m was chosen as the appropriate radius per the TAC Geometric Design Guide to slow vehicles safely without risk of oversteering or losing control.

The southbound exit path is designed at a 50 m radius exit curve to assist vehicles in accelerating from roundabout speeds to the posted speed of 80 km/hr on SW Marine Drive. The roundabout is located slightly northeast of the centreline of SW Marine Drive, which accounts for the roundabout width being slightly larger than the existing intersection. Without shifting the roundabout to the east, the roundabout would likely intrude into the forest on the existing west side of the right of way and negatively affect the western cliffs, ultimately leading to additional cliffside erosion.

2.1.2 Roundabout Geometry

The inscribed circle diameter (ICD) was chosen to be approximately 60 m, with an inner circle radius of 20 m, a 2 m truck apron, and 9 m of lane width. Lane widths will be split, with the inside lane being 4.0 m and the outside lane being 5.1 m per the TAC Design Guideline recommended split. The ICD range adheres to Translink's *Bus Infrastructure Design Guidelines* which states that a roundabout should have a minimum ICD 32 m. These dimensions will accommodate the WB-20 design vehicle, which was verified with a swept path analysis in AutoTurn.

To minimize intersection footprint and slow oncoming traffic, the lane sizing has been kept to a minimum while still ensuring sufficient width for large vehicles, such as the WB-20 design vehicle and Translink's buses. The roundabout is asymmetrical, with two circulating lanes on the northbound side of the roundabout. The two circulating lanes in this section were chosen given the high peak afternoon traffic making a westbound left turn from West 16th Avenue to SW Marine Drive. Having two lanes on the northbound side will permit "channeling" vehicles into proper lanes before entering the roundabout and prevents dangerous merging activity within the intersection. When vehicles enter westbound, the left lane is for exclusive left-turn movements (or u-turns), while the right lane can either be used for both right or left turns. The single-lane circulating legs have been designed in areas with the least vehicle movement. The benefit of using single circulating lanes is that it allows for an unimpeded (no yielding required) northbound right turn movement compared to two circulating lanes in these section

As many large construction vehicles, such as trucks and trailers, use this roundabout, it was determined that using gore striping on all approaches would benefit all users. Gore striping aims to "reduce the wheel path conflicts between cars and large trucks" (Transportation Association of Canada, 2017). As suggested throughout the design manual, the entry curve radius has been designed at 30 m, allowing for the navigation of large trucks. The two-metre truck apron will also be 50 mm in height and sloped to 1% to accommodate low-boy trailers.

2.1.3 Speed Reduction Methods

At the intersection, a tight turning radius has been implemented at the roundabout, forcing drivers to slow down while still allowing for maneuverability for large trucks. Speed reduction signage, including a reduced approaching speed limit of 50 km/hr, will be displayed ahead of time, paired with flashing orange lights warning drivers of the approaching roundabout and warning drivers to slow down. Should the need arise, additional electronic signs such as speed radar signs could be implemented temporarily in consultation with MoTI and University RCMP, especially around high traffic days, to get approaching vehicles to slow down.

2.1.4 Pedestrian and Bicycle Accommodation

Figure 4: Pedestrian Paths

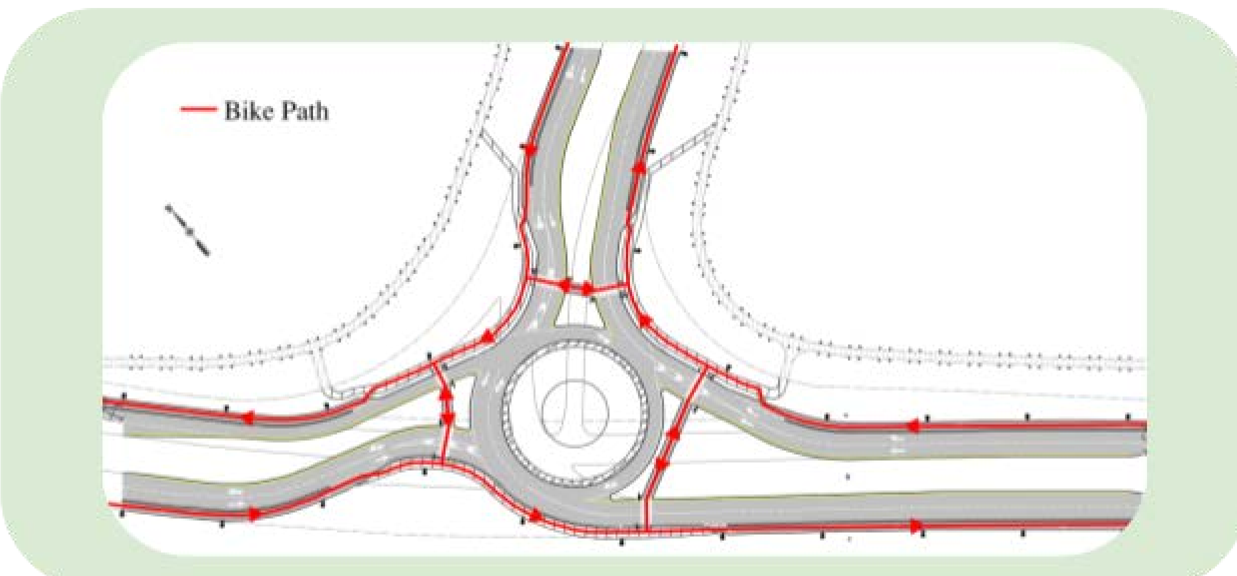

Figure 5: Cyclist Paths

Active mobility has been prioritized and incorporated throughout the design with the goal of increasing the number of bicycles using the area, and increasing safety of cyclists by minimizing vehicle and cyclist conflicts. The bicycle lanes will tie into the existing shoulder bicycle lanes on SW Marine Drive and West 16th Avenue and will feature a 2.5 m wide protected bicycle lane with a 0.5 m wide physical divider, as recommended by the TAC standards. The divider between vehicle and bicycle lanes will use a 460 mm precast concrete low barrier (SP941-01.01.02) to physically separate bicycles from vehicular traffic. Figure 6 below illustrates the implementation of these barriers. The barriers will provide protection when cars are slowing down and approaching the intersection – a location which would most likely have a motor vehicle collision. Additionally, barriers will have holes at the bottom to facilitate water flow into the gutter system. The concrete divider will be present between the limits of construction and the roundabout and will be signed in accordance with Ministry standards to ensure vehicles and bicycles are directed to their respective lanes.

Figure 6: Proposed SW Marine Drive - North Approach (Revit Render)

Our team considered the inclusion of a bicycle-accessible shoulder, protected bicycle lane, or bicycle path. According to the TAC Manual, either of these facilities would be suitable in the context of the intersection with posted speeds ranging from 50 km/hr to 80 km/hr. However, it was determined that constructing a multi-use path (MUP) would not be practical due to the existing tie-in points on SW Marine Drive and West 16th Avenue, considering that currently there are single-directional shoulder bicycle lanes. Therefore, per the TAC Manual, a protected bicycle lane would be the best option, allowing for easy expansion to the remainder of SW Marine Drive and West 16th Avenue beyond the future limits of construction. Additionally, it ensures pedestrians and bicycles cannot cross anywhere except the controlled crossing locations, ensuring the safety of all road users.

Before approaching the roundabout, the bicycle lane will converge with the existing sidewalk at a minimum of 15 m before the crosswalk, where it will become the 3.0 m wide shared-use sidewalk per the BC Supplement to TAC – Figure 740.J. Bicycles may use the standard 3.0 m wide zebra crossing to cross the respective lanes of traffic which will provide sufficient room for two bicycles and pedestrians to cross the roadway at the same time. On the west side of the intersection, there is a 0.6 m buffer between the roadway and the shared-use sidewalk, while on the east side, there is a 1.5 m buffer. In the event that a bicycle decides to avoid using the crossride, they may choose to ride in the roundabout, in which case they may easily enter the circulating lanes. The lane setup has been chosen to allow for ease of navigation of bicycles should they choose this route, with the minimum number of lane changes required.

While cyclists have traditionally used SW Marine Drive as a travel route between campus and the Dunbar Southlands area, there is not a large pedestrian population which accesses the intersection. For pedestrians, two tie-ins to the existing sidewalk on the southeast corner have been placed to avoid the need to double back and cross a drainage ditch. On the west side, there are no sidewalks beyond the bicycle ramps as there is currently no existing sidewalks along the corridor; however, pedestrian facilities can easily be expanded to this section in the future should demand arise. For safety accommodations, a recommended setback of the bicycle and pedestrian crossing is located at approximately six metres from the intersection itself. Push buttons with illuminated flashing warning lights will be on all approaches to provide visibility for pedestrians and cyclists crossing the roadway, especially during low-visibility periods.

2.1.5 Aesthetics and Amenities

Beyond the gateway discussed in Section 4, aesthetics and amenities have been incorporated into the design to add value to this campus space. Across the western leg of the intersection on both sides of the road, there is an illuminated pedestrian pathway with wooden arches. Arches are spaced nine metres apart and stand three metres tall, with overhead lighting. The posts will be made 500 mm by 500 mm untreated cedar and will have the potential for Indigenous carving and artwork with further collaboration with local Indigenous artists.

Figure 7: Pedestrian Arches (Revit & TwinMotion Render)

Additionally, the authors plan to use the current space in both a productive, inexpensive, and aesthetically-pleasing way by adding community planter box gardens on the pathway. Community gardens (in the form of planter boxes) will be provided along the length of the pedestrian paths, which promote sustainability and work towards UBC's goal of ending food insecurity on campus. They will be leased and maintained by community members, managed passively by UBC. The water fountain, located at the centre of the roundabout, is also designed with a focus on environmental consciousness and aesthetics. It recycles rainwater that would otherwise contribute to cliffside erosion and is part of a system which delivers rainwater to UBC Botanical Gardens for irrigation. See Section 3 for information on the complete stormwater management system.

Figure 8: Water Fountain View (Revit & TwinMotion Render)

2.1.6 Lighting Design

According to *UBC Campus Vision 2050*, "good lighting supports a vibrant urban experience and improved nighttime safety," and was therefore of the utmost priority within this design. This perspective is also supported by MoTI requirements, which indicate that intersections (including roundabouts) require full lighting schemes.

Figure 9: Roundabout Lighting (Twinmotion Render)

Traditional street lights (luminaires) will be placed on the outer extents of the new roadway construction outside of bicycle lanes on all sides of the intersection, illuminating the road during the evening. MoTI requires lighting configuration in accordance with IESNA RP-8. Our design meets this standard and uses 11.0 m tall poles on both sides of the roadway to account for the illumination areas of the vehicle travel lanes, bicycle lane, and median. This follows the current lighting scheme, with the two additional locations identified for light poles within the median just outside the roundabout.

By placing them on the outside of bicycle lanes, we also ensure the bicycle lanes are adequately lit, allowing cyclists to safely use the intersection in the evening and be visible to intersection users. Since the posts are placed behind the bicycle-lane barricade, in contrast to an alternate placement at the center of the medians, they will not be a vehicle crash hazard

As shown in Figure 7, our design includes a separate lighting system for pedestrians to allow them to safely and comfortably use the intersection during low-light hours. This is important not only to the users of the intersection, but also to the Indigenous community (see *UBC 2050 Campus Vision*).

2.2 Modelling

2.2.1 SIDRA and Vistro Traffic Modelling

Traffic modelling influenced roundabout geometry, lane numbers and widths, and speeds. Per stakeholder requirements, our design aimed to facilitate traffic at a Level of Service (LOS) of D or greater while reducing design speeds, over at least a 40 year period. This was done using SIDRA and Vistro traffic analysis softwares, with a capacity analysis run using *Highway Capacity Manual 6th Edition*.

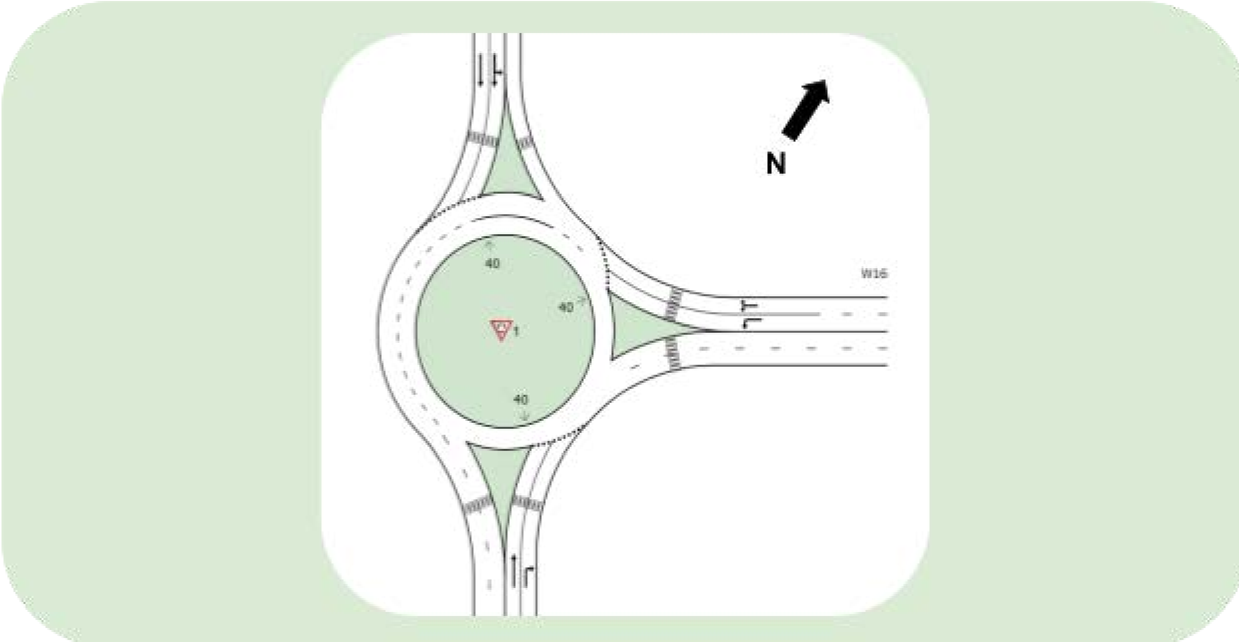

Figure 10: Traffic Modelling using SIDRA

2.2.1.1 Design Assumptions and Inputs

Traffic count information was taken between September 2023 to January 2024 for weekday rush hour traffic (8-10am, and 3-5:30pm). The maximum counts were averaged to obtain the peak rush hour traffic volume.

Estimated traffic growth was applied as a growth factor each year for the life of the intersection. Per *UBC 2050 Campus Vision*, the University strives for zero increases to traffic through better public transit, most notably, the future SkyTrain. However, for a conservative design, the authors have assumed a traffic growth coefficient of 1.0%, ultimately leading to an increase of traffic of roughly 45% in 2065.

This assumption is safe but not unreasonably conservative given the uncertainty in transit development. The service life (forty years) of the intersection is very sensitive to small changes in annual traffic growth, as shown on Figure 11. The SIDRA modelling results show the estimated peak hour traffic at years 2024, 2040, and 2065 during morning and afternoon peak hours (see Appendix A). Design speeds are 50 km/hr and the posted limit is 30 km/hr within the roundabout.

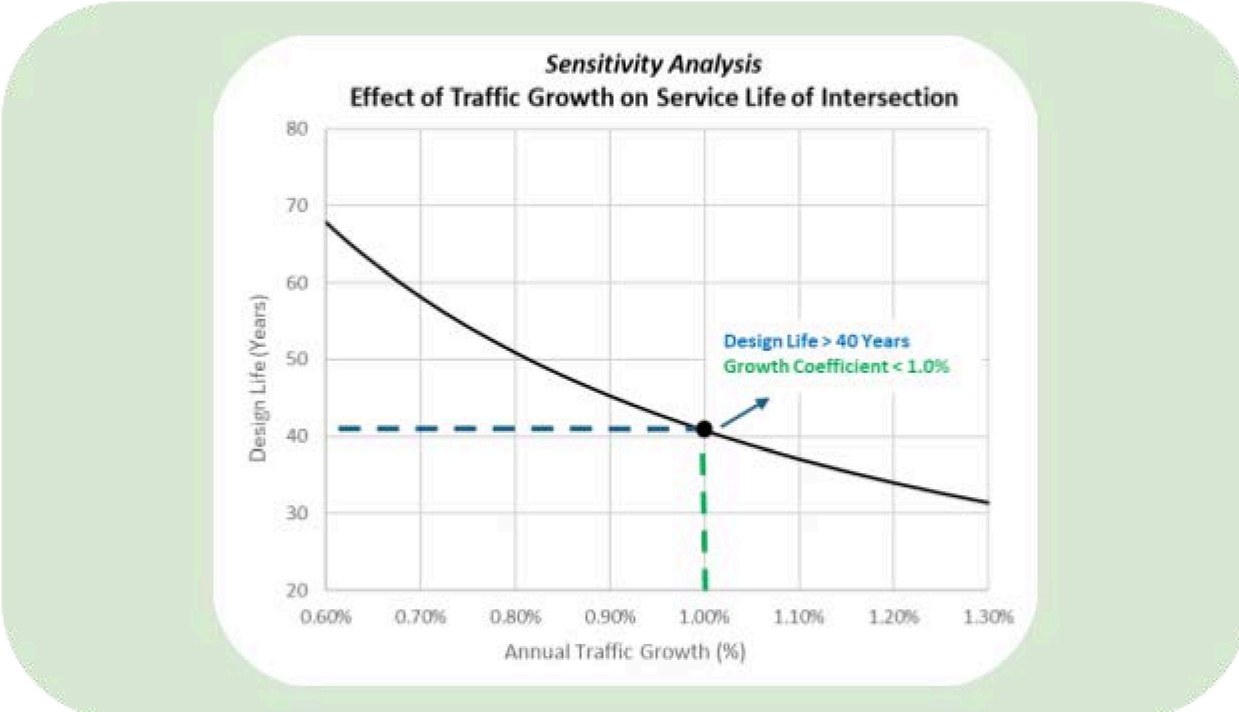

Figure 11: Service Life and Traffic Growth Sensitivity Analysis

2.2.1.2 Design Outputs and Critical Scenarios

The configuration of lanes was chosen based on iterative testing until the minimum number of lanes which can support a LOS of D or greater in all movement concerning the peak 2065 traffic was determined. This resulted in the lane configuration presented in Table 3. Two approach lanes were chosen in each leg primarily to facilitate the two possible turning options. In the west leg, both lanes support a left turn movement based on afternoon rush hour data, which concerns vehicles exiting campus. In the south leg, the decision to restrict the left lane to straight movements only was chosen to prevent collision paths with cyclists entering the roundabout.

Based on projected growth, the most critical scenario is the northbound right turn movement during the morning rush hour. Our design successfully manages this and all other movements within the forty year time horizon. See Appendix A for lane summary information from SIDRA, including LOS and delays for all movements in years 2024, 2040, and 2065.

Table 3: Summary of Modelling Results: Detailed Intersection Design

Year	Morning Rush Hour Scenario		Afternoon Rush Hour Scenario	
	Worst Lane Delay Time (s)	Worst Lane LOS	Worst Lane Delay Time (s)	Worst Lane LOS
2024	3.5	A	2.9	B
2040	5.6	B	15.8	B
2065	20.0	C	17.5	C

2.2.2 AutoTurn

All vehicle movements were verified using AutoTurn to ensure that the standard design vehicle, WB-20 vehicle could safely navigate the roundabout. As shown in Figure 12, the swept path analysis shows ample clearance for the design vehicle; the other swept path analyses can be found in the design drawing submission package.

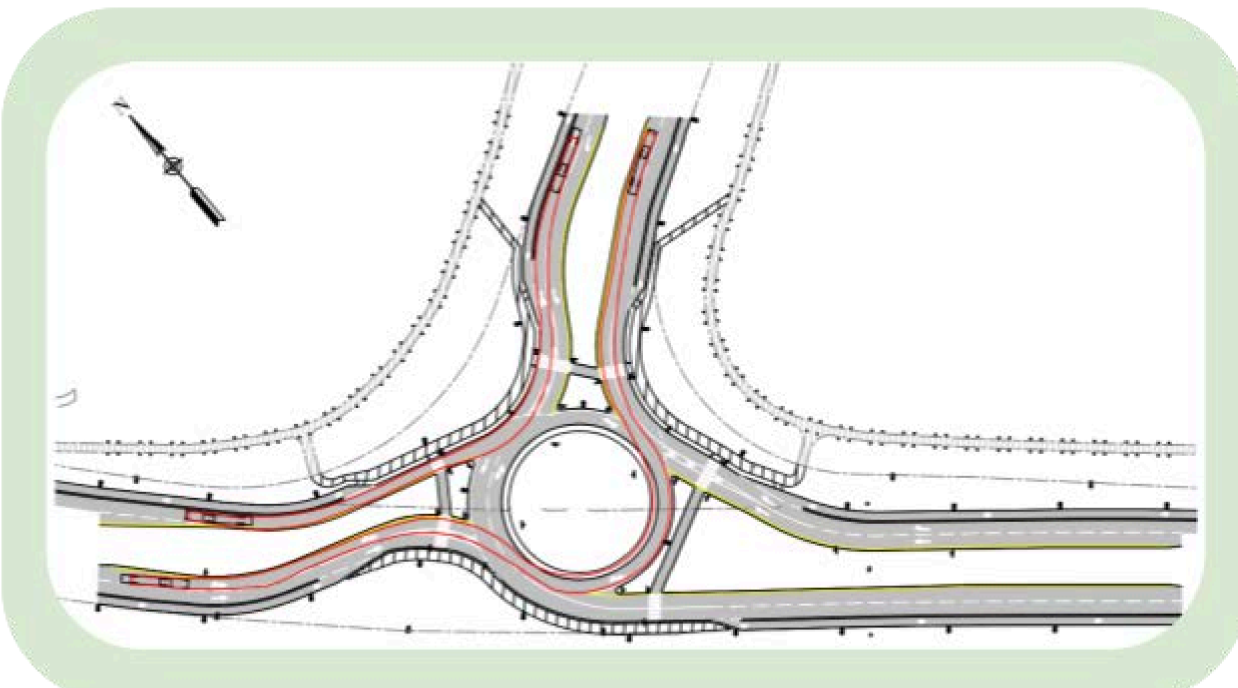

Figure 12: AutoTurn

3.0 Stormwater Management Design

3.1 System Overview

The on-site stormwater management system is a robust network of pipes, catch basins, with a collection tank and pump designed to ensure all stormwater runoff is discharged efficiently, mitigating cliffside erosion. The system works towards the UBC goal of a more sustainable future by promoting water reuse initiatives within the network. The final system layout is shown in Figure 13. The details for all labeled pipes can be found in Section 3.2.4.

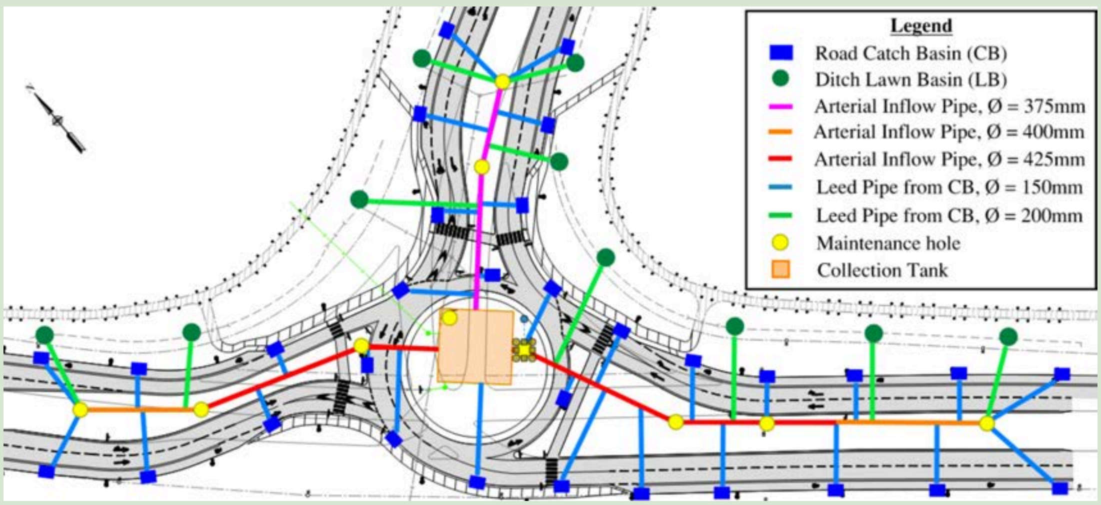

Figure 13: Inflow Pipe Summary

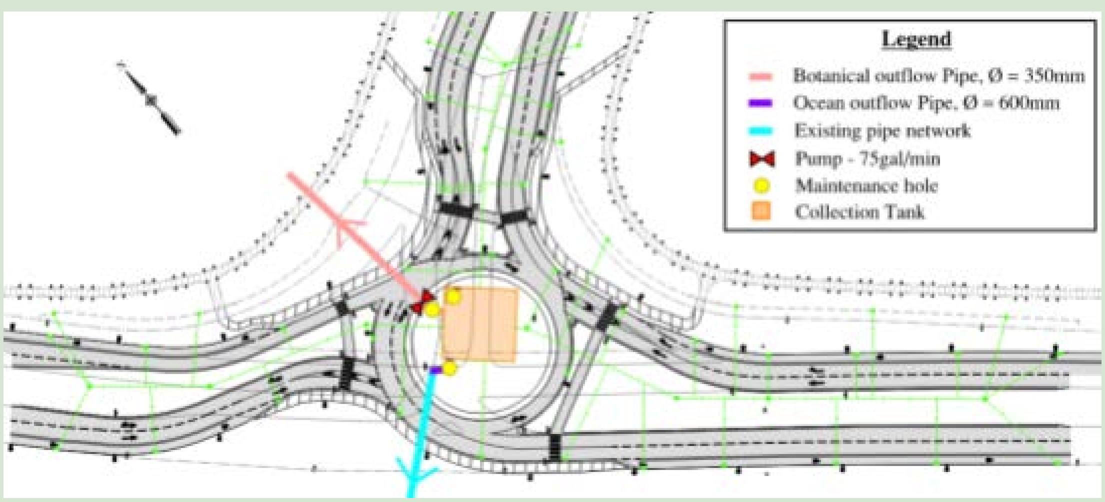

Figure 14: Outflow Pipe Summary

In the above system, runoff from the intersection roads, medians, and nearby tributary area, is collected at catch basins and lawn basins located throughout the intersection. Once water is collected at a catch basin, it is filtered via a series of grates, to remove large debris, as well as hydrodynamic separators, to remove the oils and greases present in road runoff, ensuring that the collected water will not cause blockages within the system. Water is then delivered to one of three main arterial stormwater pipes which run through the medians and lead directly to the collection tank at the center of the roundabout. By placing the pipes along the medians, we are facilitating easy maintenance and ensuring no road closures are needed should a repair need to be conducted.

The central collection tank, which is 20 m x 20 m x 4.5 m, is where all water is sent before it is discharged to one of three locations. The collection tank is a large risk mitigation feature which was designed to hold all of the stormwater runoff present during large storming events, as further detailed in Section 3.2.3. This ensures that should there be any blockages in an outflow pipe, the maintenance crew will have enough time to repair the blockage before water overflows.

Once water is collected in the central tank, it is then sent to three separate locations, as indicated in Figure 14. Firstly, water will be pulled directly from the tank to run a fountain at the center of the roundabout. Calculations for the volume of water stored in the collection tank to service the fountain year round are detailed in Appendix B and maintenance plans are detailed in Section 6.4.

The secondary water reuse initiative, sending water to the UBC Botanical Gardens, aims to end food scarcity on campus. Water will be sent directly via a pump to two 25 m^3 tanks located on site for further filtration by the UBC botanical gardens. Purified water will then be used on site to irrigate vegetation. A sensor at UBC Botanical Gardens will relay to the pump when it must supply water.

Lastly, during heavier rainfall months, any excess water which is not retained for fountain use or sent to the UBC Botanical Gardens will be connected to the original network of pipes and discharged to the ocean. This connection pipe will include a sensor at the collection tank entrance location, alerting service workers when water outflow is less than the inflow into the tank, indicating there is a blockage within the system. This will provide service with ample time to conduct repairs before water begins to backup in the collection tank, as outlined in Section 6.4.2.

3.2 Calculations, Modelling and Results

3.2.1 Precipitation Rate

To determine a 100-year precipitation rate for the given intersection, we first analyzed historic rainfall data available from the UBC and Vancouver archives. The largest daily precipitation in the last century was found and then adjusted to account for climate change. As estimated by the Government of Canada, the UBC area will experience a 10% increase in rain intensity for singular rainfall events due to climate change; therefore creating a "climate change factor" of 1.1.

Our historical analysis results were then compared to Vancouver standards to determine which rate governs. In Section 5.2.2.2 of the *Vancouver Engineering Design Manual,* rainfall intensity is mapped out for years: 2014, 2050 and 2100. Since 2050 is closest to our design life, values from that intensity, duration, frequency (IDF) curve were used. As recommended in the manual, the system should be designed to handle a 1 hr, 2 hr and 5 hr storm; this data is shown in Table 4, with calculations explaining the procedure present in Appendix B.

Table 4: Precipitation Rates

Time (T) – hrs	Intensity (I) – mm/hr	Intensity (I) – mm/sec
1	38.76	0.108
2	26.27	0.073
5	15.71	0.044

The Vancouver design values are much higher than the hand-tabulated results for the area, and will therefore govern the design of the stormwater system.

3.2.2 Spacing of Catch Basins

The proposed system consists of two different types of catch basins (CB), each designed to handle a different type of flow. The catch basins located in the curb, as shown in blue in Figure 15, are designed to collect all of the runoff from the crown road and median. The design and sizing of each CB is taken from the Vancouver Standard "Precast Concrete Catch Basin", drawing S11.2 while spacing and location is guided by the *Vancouver Engineering Design Manual* Section 5.4.4.

Each CB is spaced closer than the typical spacing of 60 m, since the catchment areas were larger than normal when considering the median and bike lanes. All catchment areas assigned to a CB are within the range of 250 m^2 to 500 m^2 per the *Vancouver Engineering Design Manual*. The locations of the CB's and their catchment areas are shown in the figure below. Detailed calculations are provided in Appendix B

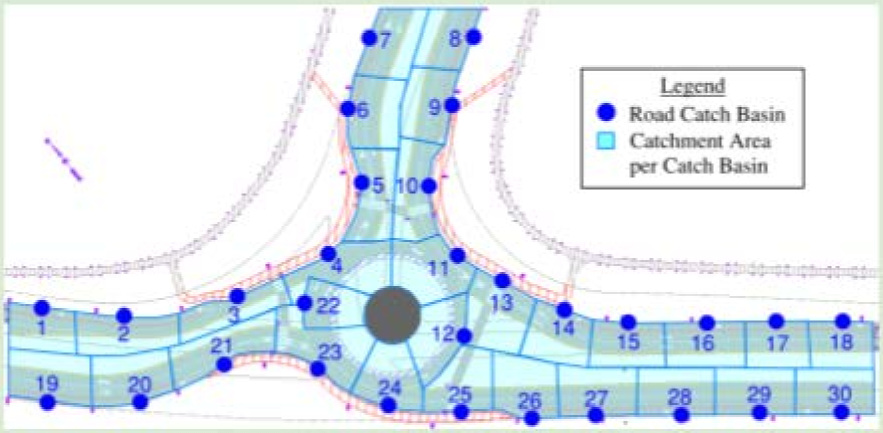

Figure 15: Road Curb Catch Basin Catchment Areas

The other type of water catchment device, shown in green in Figure 17, are lawn basins. These are placed along the existing runoff collection ditches located on the north eastern and south eastern sides of the intersection. Since the intersection is a low-point, we determined the areas for each of the three ditches which drain into the intersection. This is shown in the following figure.

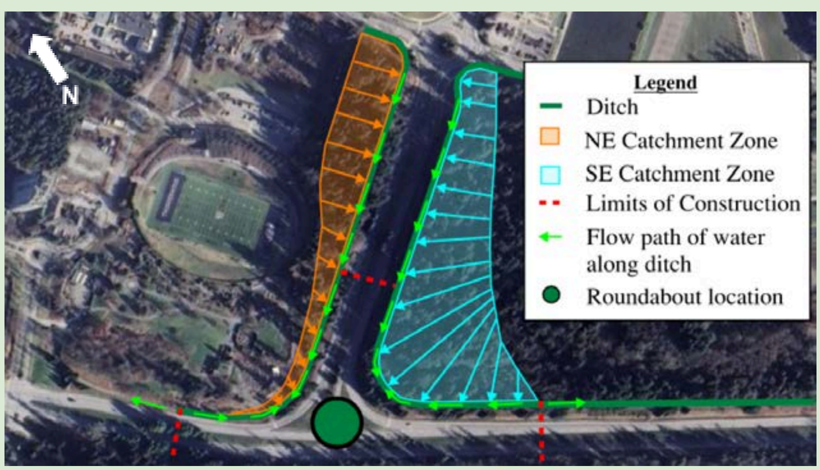

Figure 16: Stormwater Ditch and Catchment Zones

The number of catch basins needed for this catchment area was also determined via the *Vancouver Engineering Design Manual*. Multiple catch basins are needed to account for the volume of water collected in each drain. To determine the number needed, we referred back to Section 5.4.4 of the *Vancouver Engineering Design Manual*. Since the catchment areas per CB listed are based off of road runoff in the manual, we adjusted the maximum and minimum catchment areas based on the change in runoff coefficient between the road and the vegetated terrain.

A summary of lawn basin spacing can be found in the following figure.

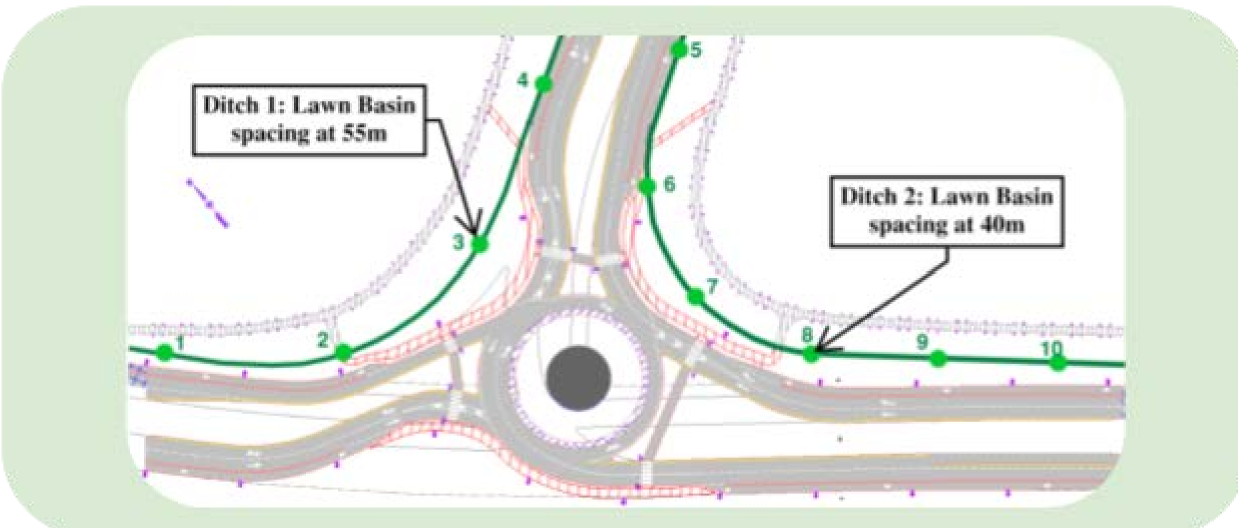

Figure 17: Ditch Lawn Basin Spacing

The inflow into each CB was determined by multiplying the precipitation rate by the respective catchment area and the runoff coefficient. As per the *Vancouver Design Manual*, and an analysis of slopes and soil conditions explained in the 2002 Piteau Geotechnical Report, coefficient values for the asphalt roadway, the medians, and the sloped hillside are 0.83, 0.13 and 0.18, respectively.

3.2.2.1 Catch Basins Design Outside Design Footprint

As stated within the drawing package, our team will only be designing and implementing catch basins for the road and median runoff within the footprint of our design. While our piping network, collection tank and pump all account for the total volume of water which slopes and drains into the intersection, it remains the responsibility of UBC to implement the catch basins and piping to the central storage tank in these locations outside of the construction boundaries. The team is willing to add this to the scope pending further discussion with UBC.

3.2.3 Collection Tank Sizing

To size the collection tank, the total area of pavement runoff, median runoff, and forest runoff was respectively calculated. The volume of water needed to be collected to retain all of the volume for a 1-hr storm, 2-hr storm and 5-hr storm were each tabulated as shown in Table 5.

Table 5: Collection Tank Volumes

Time collected (hrs)	Total Area*runoff coefficient (m^2)	Infiltration Rate (mm/hr)	Volume collected (m^3)
1	21,332	38.76	827
2	21,332	26.27	1,121
5	21,332	15.71	1,676

After analysis, the worst case volume collected would be 1,676 m^3 with the 5-hr rainfall event. The stormwater management system therefore includes a 21 m x 21 m x 4 m tank (total capacity is 1764 m^3).

3.2.4 Pipe Sizing Calculations

To determine pipe sizing for the inflow arterial pipes within the system, the “Rational Method” was used, as per the *Vancouver Engineering Design Manual*. This method analyzed every point along a main pipe where flow is connected, as well as the subsequent time needed for that flow to get to the outlet of the piping network. Through the use of the Vancouver IDF curve for a 100-yr storm in 2050, our team was able to assess the pipe flow capacity as well as the velocity at every point along an arterial pipe. Through iterations with the pipe diameter, our group ensured that all pipes had a demand to capacity ratio less than 1.0, as well as a velocity in the acceptable ranges of 0.76 to 4.6 m/s.

Outflow pipes were determined using Bernoulli’s theorem, analyzing the velocity, pressure, head loss and head gain due to pumps along the entire system.

All pipe slopes started at a standard 0.5%, which is the city’s minimum slope value. Slopes were then increased to match the local topography, as well as to increase pipe capacity where needed. No slope exceeds the industry standard of 5%. The only pipe which is considered slope so suit grade will be the UBC Botanical Gardens outflow pipe, as it will be sloped upwards and flow will be pushed through the pipe via a pump, outlined in Section 3.2.5.

Due to the sizing of both the inflow and outflow pipes, material was assigned based on the *Vancouver Engineering Design Manual*'s Section 5.4.2.1. For pipes less than 375 mm in diameter, typical PVC SDR35 was used, while pipes exceeding that diameter are reinforced concrete pipe (RCP).

A summary of all final pipe sizings is shown below. All calculations can be found in Appendix B.

Table 6: Summary of Pipe Sizing

Pipe		Diameter (mm)	Length (m)	Slope (%)	Material
Inflow Pipes	Inflow Pipe North Segment 1	400	62	2.0	RCP
	Inflow Pipe North Segment 2	425	74	2.0	RCP
	Inflow Pipe East	375	66	5.0	RCP
	Inflow Pipe South Segment 1	400	72	1.5	RCP
	Inflow Pipe South Segment 2	425	35	1.5	RCP
Outflow Pipes	UBC Botanical Gardens Outflow Pipe	350	65	Slope to suit grade	PVC
	Ocean Outflow Pipe	600	8	0.5	RCP

Please note that per the above table, the northern and southern inflow pipes were both upsized midway through the system as a result of demand exceeding capacity at those locations.

The leads are the only pipes missing from the above table as they vary based on if they are coming from a catch or lawn basin. As per 5.4.4.3 of the *Vancouver Engineering Design Manual*, all leads have been assigned the minimum slope of 2% and the typical diameter of 150 mm for catch basin leads or 200 mm for lawn basin leads. All leads are to be installed at a depth of 1.5 m below the surface and are all less than the specified 30 m in length. Due to the diameter selection, material for both lead types will be PVC.

3.2.5 Pump Sizing

One pump is needed within the system to get the water from the collection tank to the UBC Botanical Gardens. To size the pipe, our team analyzed Bernoulli's equation. By selecting a pipe diameter and a desired flow, the only variable unsolved within the system is the pressure head. The desired flow rate of 0.33 m^3 per min was selected strategically in order to fill up UBC Botanical's Gardens two 50 m^3 collection tanks with fresh water for reuse on site every two and a half hours. This will provide ample time for the Botanical Gardens to further purify water and use it on site before additional water is needed. The diameter of the outflow pipe, 350 mm, was selected based on precedent for a system of this nature as well as to fulfill velocity requirements.

The pipe head was then calculated as shown in Appendix B using Bernoulli's equation mentioned above which encompasses a static head value along with a Hazen Williams pipe loss value. A pump was then sourced by comparing the pump head and flow rate to pump curves provided by Grundfos manufacturers. The final selected pump is the GrundFos Inline single stage pump - TP 50-180/ 2 A-F-Z-BQBE-FW1 which has a flow of 0.3381m3/min for the desired head of 9.33 m. The pump curve, shown below, shows an efficiency of 72.5% is achieved with the selected pump.

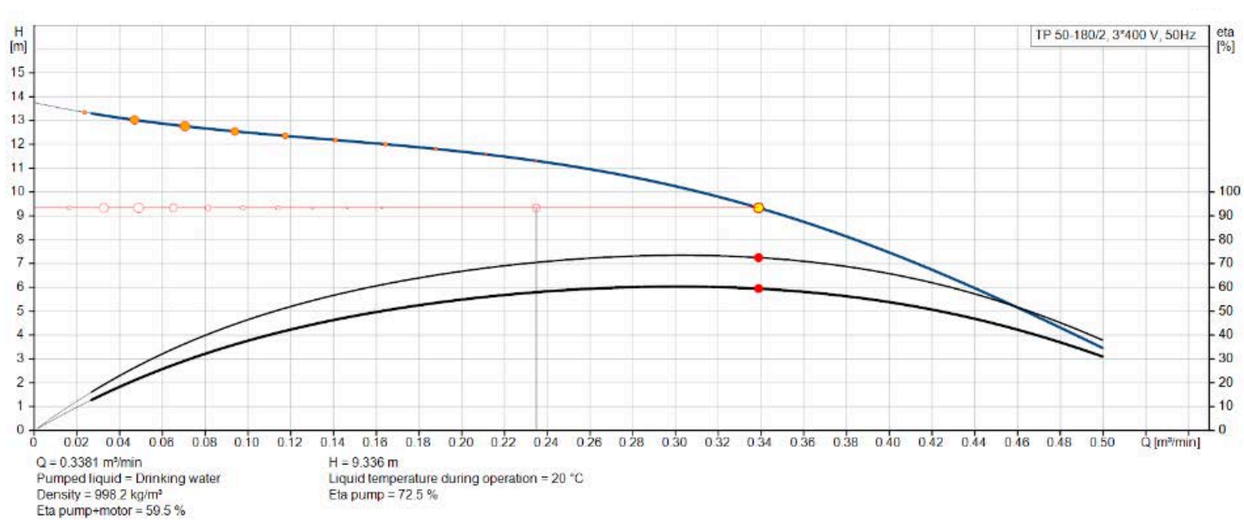

Figure 18: Pump Curve (Grundfos™ Pump Supplier)

4.0 Gateway Design

4.1 Description

Figure 19: Design of Gateway Structure

The Gateway at UBC is an architectural marvel that captures the essence of the university's pride and commitment to excellence. The "curve," comprises a 600 mm by 1500 mm double-curvature treated spruce-fir glulam beam with etchings of all faculty names and specializations distributed throughout its visible faces, and continuous pot lighting built into the structure. The design incorporates inclined V-shaped central columns supported by concrete pedestals, adding both stability and visual interest to the structure. These columns not only serve a functional purpose but also contribute to the overall aesthetic appeal of the gateway.

The gloss aluminum "UBC" lettering, prominently displayed atop the structure, acts as a beacon, welcoming visitors and instilling a sense of belonging among students, faculty, and staff alike. The reflective surface of the aluminum further enhances its visibility, especially during the night when it is illuminated by the structure's integrated lighting.

The gateway is designed with a clearance of 6.5 metres to comply with MoTI standards, ensuring a safe passage for trucks, cars, cyclists, and pedestrians alike.

In essence, the Gateway stands as more than just a physical structure; it is a symbol of UBC's enduring legacy, sustainability, and dedication to pushing the boundaries of aesthetic innovation. As visitors pass beneath its graceful arches, the structure will not only welcome them into a community that values excellence, diversity, and the pursuit of knowledge, but will boldly exhibit UBC's pride of being one of the top performing post-secondary institutions. Figure 20 illustrates the key features of the proposed gateway design, while the attached drawings detail this further.

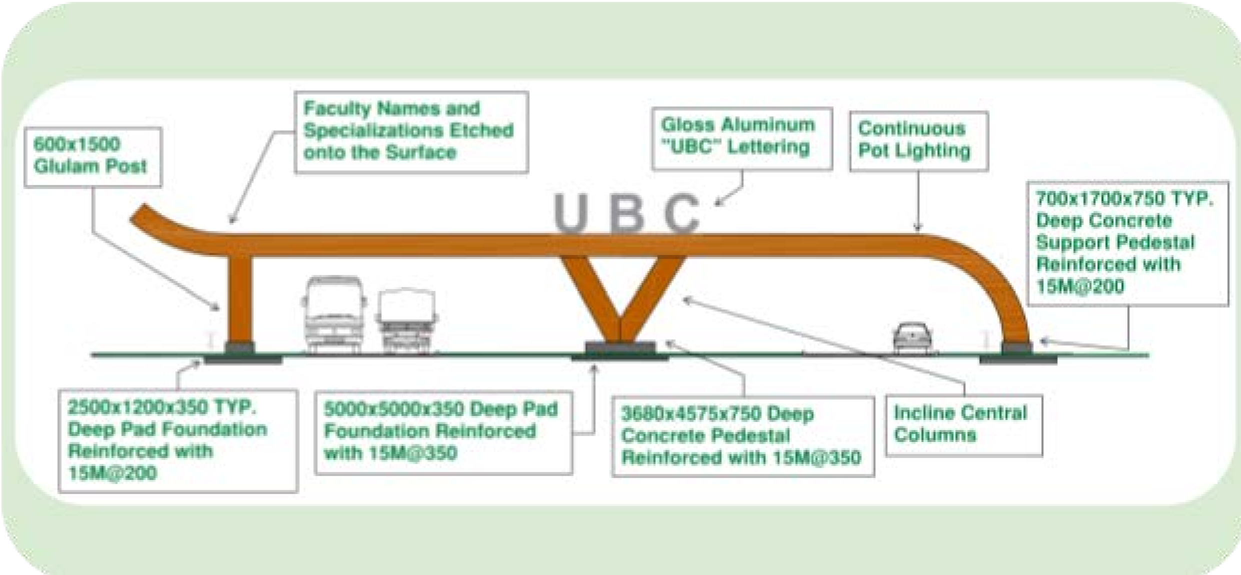

Figure 20: Gateway Structure Elements

4.2 Modelling

Our approach to designing the Gateway at UBC was guided by the National Building Code of Canada (NBC) 2015 and the British Columbia Building Code (BCBC) 2018, ensuring a solid regulatory foundation for safety and durability. Utilizing CSI ETABS software, we conducted a modal history response spectrum analysis tailored to Site Class D conditions at UBC Vancouver. This analysis provided crucial insights into the structure's dynamic response to seismic forces, specifically accounting for the site's geological characteristics. Design parameters were precisely calibrated to withstand a 2% in 50-year earthquake event, with load combinations carefully selected according to NBC Clause 4.8.1, incorporating 1.0DL (dead load) and 1.0E (earthquake load).

4.3 Technical Considerations

The authors adhered to Canadian Standards Association (CSA) guidelines for wood (O86-19), steel (CSA S-19), and concrete (CSA A23.3) design, ensuring structural robustness. Connections within the structure were engineered to ASTM A325 standards to guarantee strength under load.

Employing sectional analysis techniques, our group optimized each structural component's strength and stability under various loading conditions. Base plates were designed using HILTI PROFIS software, ensuring accurate calculations for secure connections between the structure and its foundations. The technical specifications pertaining to elements of the structure can be found in Appendix G, while the design drawings can be found in the attached drawings package.

4.4 Design Outputs

The authors rigorous design process resulted in a Gateway structure that surpasses safety, durability, and regulatory standards. With thorough planning, comprehensive analysis, and strict adherence to industry best practices, we designed the Gateway to confidently withstand seismic events and environmental challenges, even with an impressive 20 m long span.

The glulam utilized for the Gateway structure is douglas spruce fir-larch grade 20F-E. The glulam to glulam connections within the Gateway structure consist of base plates which are further secured to the glulam beams with custom-designed and fabricated bolted knife plate connections, as detailed in Appendix C. The base plates measure 800 mm x 1800 mm x 15 mm and are embedded with two rows of ten anchors, utilizing HILTI HIT-RE 500 V3 + HAS-V-36 (ASTM F1554 Gr.36) 3/4" anchors. Each anchor is embedded at a depth of 380 mm. The glulam to glulam connections within the Gateway structure consist of reinforced with custom-designed and fabricated bolted knife plate connections, as detailed in Appendix C. The custom-designed knife plates are 15mm thick and utilize the same HILTI HIT-RE 500 V3 + HAS-V-36 (ASTM F1554 Gr.36) 3/4" nuts and bolts for secure fastening. These connections ensure secure and reliable joints, enhancing the overall structural integrity of the Gateway.

The table below exhibits the design of the concrete pedestal and pad footing for the Gateway structure.

Table 7: Dimensions of Concrete Pedestals and Pad Footings

Element	Respective Concrete Pedestal	Respective Pad Footing
Central Column	• 3680mm x 4575mm x 750mm Deep • Reinforced with 15M@350	• 5000mm x 5000mm x 350mm Deep • Reinforced with 15M@350
Post Adjacent to Northbound Lanes	• 700mm x 1500mm x 750mm Deep • Reinforced with 15M@350	• 2500mm x 1200mm x 350mm Deep • Reinforced with 15M@350
Post Adjacent to Southbound Lanes	• 700mm x 1500mm x 750mm Deep • Reinforced with 15M@350	• 2500mm x 1200mm x 350mm Deep • Reinforced With 15M@350

All concrete pedestals and footings feature a compressive strength (f'c) of 25 MPa and have a clear cover of 75 mm. The steel used for reinforcing throughout the structure is standard 400 MPa.

The UBC sign, made of gloss aluminum, will be anchored to the glulam using drive bits and has been strategically designed in terms of its height and letter spacing to be both visually appealing and to minimize the effects of air pressure causing the aluminum to deform.

5.0 Integrated Design Overview

The overall design, which includes the intersection detailing, stormwater management plan, and gateway, is shown the below figure. 3-D modelling software Revit was used to provide a more holistic view of the design. This prevents the possibility of conflicts and provides more visual clarity on all features.

Figure 21: Intersection Overview

The intersection is the culmination of a design approach centred on stakeholders needs for traffic management, climate resilience, and community leadership. Its iconic structure and innovative water reuse initiatives are symbolic of the University's leadership in advancing climate science and structural design. The traffic management anticipates UBC's, and more broadly, Vancouver's emphasis on accessible and active modes of travel.

6.0 Construction Management

6.1 Traffic Management Plan

The staging and construction plan was designed in order to minimize construction impacts, especially to campus commuters. As our client has requested, we intend to prioritize keeping all intersection movements open during the construction phase. Recognizing that this is a complex task, a Traffic Management Plan (TMP) has been formed to ensure efficient and practical construction phasing. Additionally, it sets forth a framework to notify local residents and other relevant stakeholders to ensure that they are aware of construction activities and can plan accordingly. Our team plans to close movements during times of the year when campus experiences lower vehicle numbers such as the summer.

Consequently, the TMP includes four main stages of construction:

- Phase I – construction of a temporary roadway
- Phase II – east roundabout construction
- Phase III – west roundabout construction
- Phase IV – median restoration and removal of turning lanes

During Phase I, a temporary roadway will be constructed at Station 0 + 250 m on SW Marine Drive which will allow northbound vehicles to cross over and use the existing southbound lanes during Phase II. No significant impacts to traffic are expected during this phase as all movements will remain open, with one northbound and southbound lane closed south of the intersection to facilitate the construction of the temporary roadway. Refer to Appendix D for detailed closures and construction plan.

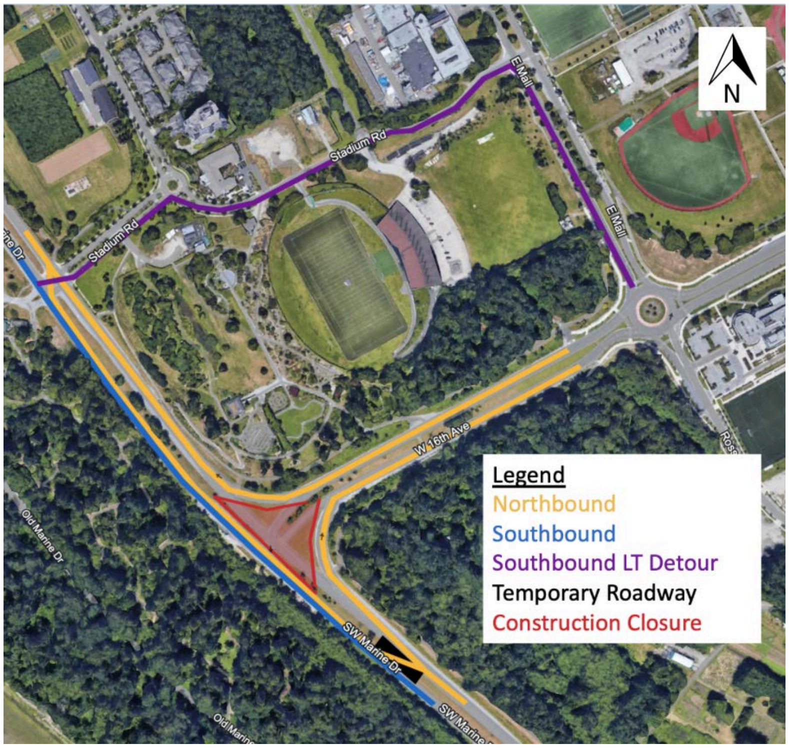

Figure 22: Phase II detour routes

To facilitate the east roundabout construction during Phase II, parts of the intersection will be inaccessible and need to be closed. All movements will remain open, except for the southbound left turn and westbound left turn movements. Southbound left turning vehicles will be detoured by marking a left turn at Stadium Road, taking the first exit at the roundabout and finally turning right at West Mall. Given that the southbound left turn movement does not experience significant volumes, we do not anticipate any significant queuing forming to make the left turn at Stadium Road or congestion on the detour route. Additionally, westbound left turn vehicles will detour via Wesbrook Mall, including the Translink R4 Rapidbus, which will make all local 49 bus stops on Wesbrook Mall. While the number of vehicles making this left turn is significant, Wesbrook Mall is a suitable route for all large vehicles and is presently used by many construction vehicles. To mitigate long queues, the signal timing at Wesbrook Mall and SW Marine Drive may need to be adjusted to better reflect detoured vehicle volumes.

Figure 23: Phase III detour routes

Once the eastern part of the roundabout has been constructed in Phase I, northbound traffic will begin to use the new intersection. The western part of the roundabout will be constructed and all southbound and westbound left turn vehicles will be required to detour via Stadium Road, West Mall, West 16th Avenue and Wesbrook Mall. Considering the number of vehicles, temporary traffic signals will be installed at the intersection of SW Marine Drive and Stadium Road to assist vehicles making the left turn. Similar to Phase I, Phase IV will involve lane closures to assist in removing the temporary median crossover and the removal of the existing turning lanes, however, we do not anticipate significant traffic impacts as all vehicle movements will remain open.

6.2 Permitting

It is imperative to obtain the necessary permits prior to entering the construction phase. This entails compliance with all federal, provincial and local regulations that govern road and infrastructure development. Additionally, obtaining permits from relevant authorities is a crucial step to ensure successful and timely execution of the project. The preparation of traffic management plans, zoning regulation, and assessments of the project's environmental impact are some of the main requirements for these permits. Table 8 entails the primary permits necessary for the implementation of this project.

Table 8: Required Permits and Corresponding Authorities

Authority	Requirement
British Columbia Ministry of Transportation and Infrastructure	Acceptance of Detailed Design, including lighting, roadworks, stormwater, and structural designs
UBC Campus and Community Planning	Development, Street Use, and Electrical Permits
British Columbia Ministry of Transportation and Infrastructure	Lane Closure Request
Government of British Columbia	Environmental Management Act Permit
UBC Campus and Community Planning	Permits for street, excavation, landscape and infrastructure work
Utility Companies or Regulatory Authorities	Utility Permits

6.3 Environmental Management

6.3.1 Erosion and Sediment Control Plan

In order to minimize the environmental impact and preserve water quality during construction activities, it is essential to implement measures to control erosion and sediment. Thorough planning has been undertaken to identify primary erosion and sediment sources and address their impacts. Installing erosion control blankets is one practical way to stop erosion along cliffsides. They are easy to install and helpful in preventing soil erosion and decreasing silt accumulation. To trap and control sediments that are swept away during rainstorms, temporary sediment traps will be installed. Additionally, silt fences will line the west side of the construction limits and prevent erosion. Contractor is to ensure that no sediment leaves the site via vehicle tracking or other methods. Catch basin sediment socks will be installed on all catch basins (existing or new) and to be maintained as needed.

6.3.2 Utilities Management Plan

The team has executed a thorough examination of the infrastructure beneath the construction site to accurately identify and map out the underground utility infrastructure. This approach aims to minimize potential risks or disruptions during the construction process. Also, given the surrounding tree cover and the insufficient lighting on the sidewalk trails during nighttime, the team has devised a new lighting scheme for both the roundabout and sidewalks. This adjustment to the existing lighting system will maintain a well-lit and secure environment for all road users at the intersection. Flashing crosswalk lights will be installed at all crosswalks to ensure the safety of pedestrians, especially during times of high foot traffic.

BC-One Call is required prior to any construction works. Locating and marking locations of existing utilities is required and dictated within the drawing package.

6.3.3 Waste Containment Management

The preservation of the surrounding environment significantly relies on the proper handling of construction materials and waste. The construction plan incorporates efficient waste management strategies, which align with UBC's Zero Waste Action Plan. These initiatives involve recycling, adoption of sustainable strategies, and waste reduction to lessen the environmental impact of waste disposal. Routine environmental inspection will be conducted prior to and after construction to address any contamination and limit its spread.

6.3.4 Air and Noise Pollution

To minimize disruption to the surrounding environment, plans will be put in place to manage air and noise pollution, in accordance with the Canadian Environmental Protection Act and University Neighbourhoods Association (UNA) Noise Control Bylaw. In order to preserve air quality, the team recommends the usage of low-emission machinery and the employment of dust control measures to minimize the spread of construction dust. Also, to mitigate construction noise, noise barriers will be installed surrounding the site. Construction activities will be scheduled during the day, with nighttime construction avoided whenever possible.

Additionally, fuel efficient construction machinery could be sourced for the project including hybrid electric or battery electric equipment which would decrease tailpipe greenhouse gas emissions and limit noise pollution in the Wesbrook neighbourhood during construction.

6.4 Maintenance Plan

6.4.1 Intersection

The intersection maintenance plan consists of routine inspection for deficiencies within the road structure, curbs, pedestrian features, community gardens, and arches. With proper construction, maintenance costs will be minimal, accounting primarily for milling and paving. A surface mill and repave (top layer of asphalt), and a full-depth mill should be done alternatively at intervals of 15-20 years.

6.4.2 Storm Water Management Life

The stormwater management system requires rigorous maintenance to ensure all pipe and filter systems are without blockage and allow the full flow of water through at the designed rate, mitigating any chance of water back up, overflow, or cliffside erosion. To maintain a working system, monthly inspections of the intersection will be conducted - preferably scheduled during rain events. All catch and lawn basins will be inspected during this time for any water backup, and the removal of accumulated sediment will be conducted. During these inspections, both the grate filters and hydrodynamic separators will be attended to, conducting filter cleaning and replacement when necessary, and removing the collected built up oils and grease from the hydrodynamic separators.

On a schedule determined by the UBC landscaping teams, the areas surrounding the lawn basins will be weeded, grass will be cut, and any fallen leaves or debris will be collected. This will mitigate the chance of blockages within the filters.

Semi annual maintenance of the collection tank will be conducted. A service worker will enter via the man hole located at the center of the roundabout and assess the collection tank for any erosion or chances of water leakage/tears to the waterproofing membrane. During these maintenance sessions, any debris and sediment build up which managed to pass through the multi filter system will be collected and discarded.

Lastly, to ensure pipes do not have any blockages, an annual flush of the system will be conducted. This will be done before heavy rainfall months, in September to ensure the system is running smoothly before larger storm events occur. Additionally, should the sensor located at the ocean discharge pipe notify service workers that there is a blockage during a storming event, maintenance staff will go directly to site and work to clear the blockage before there is backup within the collection tank.

6.4.3 Fountain Life and Maintenance

The roundabout fountain will be cleaned monthly, to mitigate buildup of algae and remove any debris which has fallen into the fountain. During these cleanings, water features will be tested to detect any pressure issues or blockages in outflow spigots. Should issues be detected, mechanical service workers will be called in to test the equipment and maintain the motors and pumps via a panel located at the side of the fountain.

On a bi-annual basis, or if there is a warning detected by a flow sensor, maintenance workers will enter via the man hole located at the roundabout into the collection tank. The connection between the water tank and the collection tank will be inspected for wear and tear and any buildup.

6.4.4 Structure Maintenance and Service Life

To ensure the longevity and sustainability of the UBC Gateway structure, the authors will implement maintenance measures tailored to its spruce- fir glulam components. Adhering to strict moisture content guidelines, the structure will undergo treatment only when its moisture content is below 16%, ensuring optimal performance. Utilizing eco-friendly surface treatments like translucent coatings and natural wood oils, sourced from sustainable materials, the structure will be shielded from moisture while minimizing environmental impact.

Inspections will be conducted every six months to assess glulam surfaces, with recoating performed as necessary to mitigate risks from moisture, sun exposure, and temperature fluctuations. Maintaining the gloss aluminum “UBC” sign will involve cleaning every 6 months with a mild detergent solution (1 L per m^2), applying protective coatings every 2-3 years (0.5 L per m^2), and bi-annually inspections (15 min per m^2). By prioritizing these maintenance practices, we will not only prolong the lifespan and aesthetic appeal of the UBC Gateway structure but also minimize its environmental footprint in alignment with sustainable principles.

7.0 Class A Estimate

The Class A cost estimate, attached in Appendix E for the roundabout project calculates all necessary expenses, leading to a grand total of 4.4 million dollars. This total encompasses a detailed account of construction and material costs, factoring in a 5% contingency for unforeseen expenditures, which ensures a comprehensive financial buffer. The cost estimate for the project comprises a material quantity take-off and a construction cost take-off. The breakdown of material and construction costs is illustrated in the pie charts below.

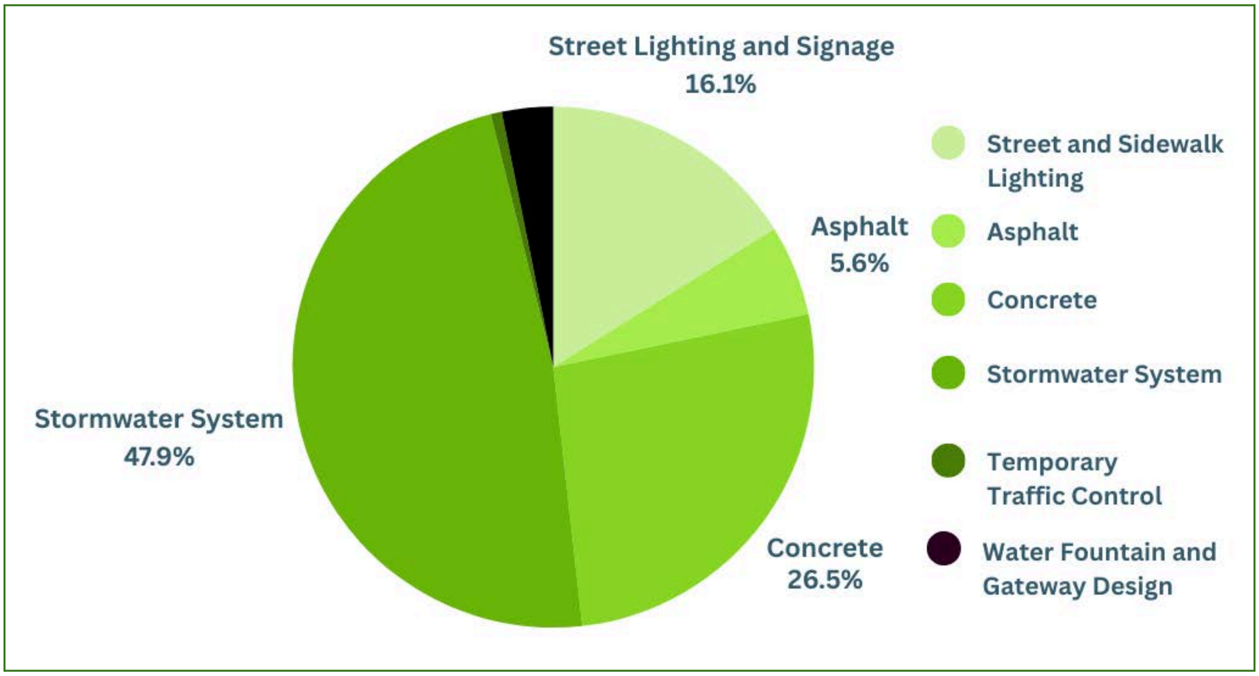

Figure 24: Material Cost Breakdown

Key areas of expenditure include stormwater system components and concrete materials. Extensive construction activities ranging from asphalt paving to compaction, the rental of crucial equipment, and engineering management comprise the majority of construction cost.

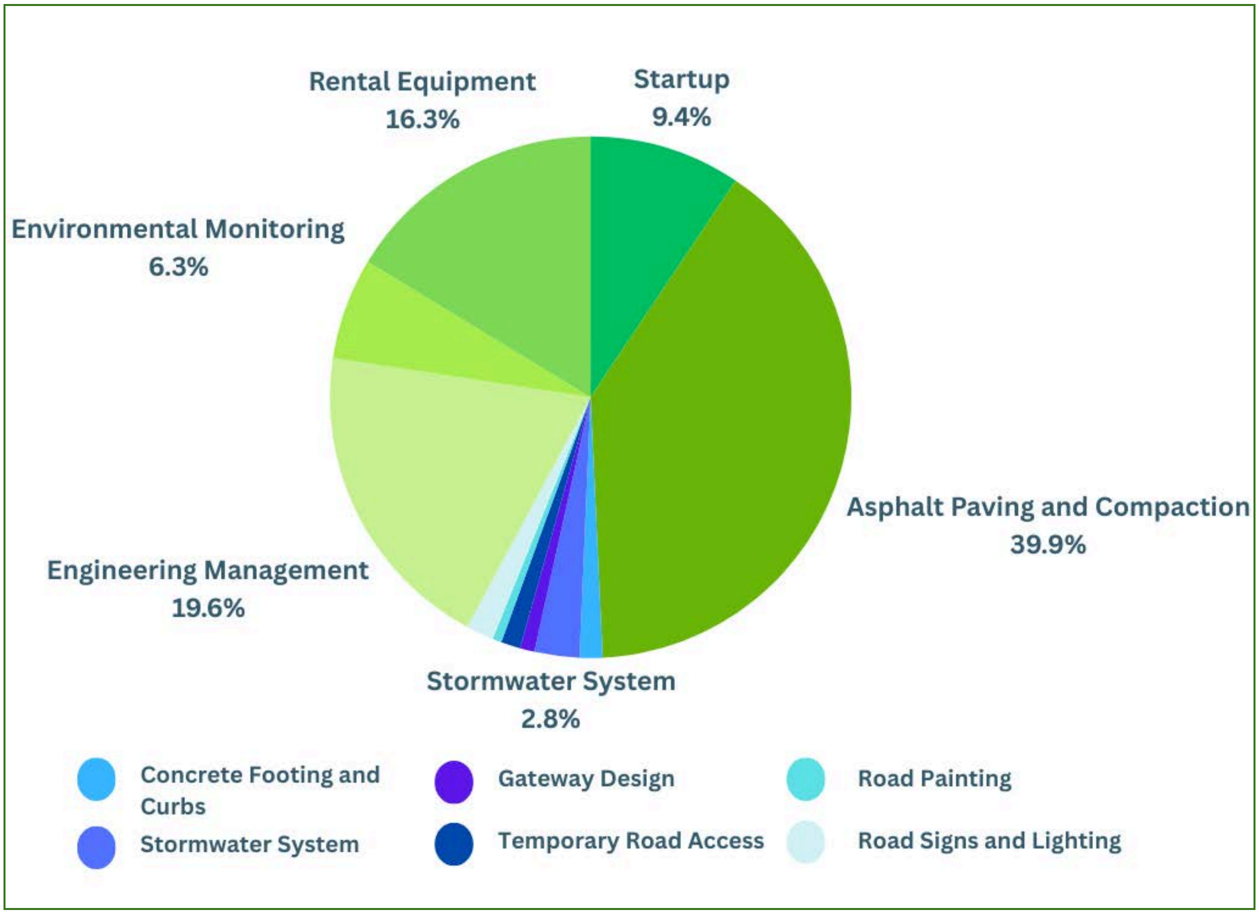

Figure 25: Construction Cost Breakdown

Additionally, the estimate includes the costs for obtaining permits and professional engineering services, essential for project management and coordination. Post-construction maintenance costs of $17K per year are also considered, emphasizing the project’s commitment to long-term success. Overall, the estimate reflects a well-rounded approach to budgeting, highlighting detailed planning and financial foresight to ensure the project's completion within the projected costs.

8.0 Construction Schedule

The construction of the roundabout at West 16th and SW Marine Drive, starting in May 2024, is structured into four distinct phases encompassing a series of stages designed to enhance traffic flow and safety.

Figure 26: Summarized Gantt Chart of the Roundabout Construction

The project phases are broken down into their detailed stages below.

Phase 1 includes stages 1 to 5:

- Stage 1: Site Preparation and Surveying, where the site will be cleared, and surveys will be conducted to ensure accurate planning and execution.
- Stage 2: Temporary Road Setup, which aims to manage the traffic flow effectively by redirecting it during the construction process.
- Stage 3: Storm Water Tank Foundation and Installation takes precedence, focusing on laying the groundwork for effective stormwater management.
- Stage 4: Roadway Construction, involving milling, filling, and paving activities to construct the roundabout's main roadway.

- Stage 5: Curbing and Island Construction, which adds structural and aesthetic elements to the roundabout through the construction of curbs and islands.

Traffic Management Plan phases II and III both occur during Stage 4 for their corresponding work areas A and B, respectively.

Phase 2 includes stages 6 and 7:

- Stage 6: Gateway Design Construction, introducing an architectural gateway to enhance the entrance's visual appeal.
- Stage 7: Water Fountain Construction, which focuses on creating a central water feature to beautify and serve as a landmark within the roundabout.

Phase 3 includes stages 8 to 9:

- Stage 8: Landscaping and Irrigation, where attention is turned to the aesthetic aspects through landscaping and the installation of irrigation systems.
- Stage 9: Lighting and Signage Installation is crucial for safety and navigability, involving the setup of street lighting and clear signage.
- Stage 10: Opening of Completed Section marks the transition to public use, with careful planning to ensure a smooth introduction of traffic to the newly constructed roundabout.

Phase 4 includes stage 11:

- Stage 11: Post-construction Monitoring and Maintenance, focusing on monitoring the roundabout's performance and addressing any emergent issues to ensure its long-term effectiveness and durability. This phase is essential for the project's success, allowing for adjustments based on actual traffic flow and the operational environment.

The construction schedule was optimized to allow for simultaneous completion of multiple tasks to limit costs from heavy machinery and equipment. By utilizing our equipment and machinery efficiently, we are fostering sustainability by minimizing energy consumption and reducing waste generation. This approach ensures that we're operating in an environmentally conscious manner while maximizing productivity, and accelerating timelines.

The duration of each phase as well as each stage is detailed in the construction schedule and the Gantt chart attached in Appendix F. Each phase and its corresponding stages are crafted to ensure the project's seamless execution, from groundwork to the grand opening and beyond, highlighting the project's commitment to improving infrastructure and public safety.

9.0 Conclusion

Southwest Marine Drive and West 16th Avenue requires a design which accounts for active mobility, climate resilience, and community engagement. Currently, the car-centric design fails to meet evolving stakeholders needs. Our design approach is centred on stakeholder concerns, following all relevant design guidance and standards. Additionally, we used detailed models and renders to aid our design and ensure there were no conflicts.

Our solution is a multi-lane roundabout with pedestrian-controlled crosswalks and includes divided bike lanes to promote active mobility. The roadway geometry has been carefully selected for users to avoid necessary backups or delays. Additionally, the geometry of the roadway will slow down vehicles approaching campus to keep speeds under control. Pedestrian features such as community gardens and luminous arches have been implemented to upgrade aesthetics in the area. A new lighting scheme has been crafted to address the need for enhanced visibility and safety.

Our group included a state-of-the-art gateway, providing an enhanced sense of identity to commuters. The iconic design is sourced with environmentally conscious materials, such as engineered wood products. Additionally, we have a stormwater management system that will reinvent how cliff erosion is managed, with value added through rainwater harvesting for UBC Botanical Gardens.

Our team is confident that our design will bring a major improvement to the intersection, making it more accessible for all users. Our design is at the forefront of innovation and will redefine the safety of the intersection and other intersections worldwide. Our team is confident that all users of the intersection and neighbourhood residents will immediately recognize the benefits that can be found in the intersection redesign.

Anticipated Traffic Delays for Morning Rush Hour

Year 2024

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: SW Marine (S)															
Lane 1	623	9.0	623	9.0	1199	0.519	100	8.5	LOS A	3.5	25.1	Full	500	0.0	0.0
Lane 2[d]	639	12.0	639	12.0	1181	0.541	100	8.9	LOS A	3.7	28.0	Full	500	0.0	0.0
Approach	1261	10.5	1261	10.5		0.541		8.7	LOS A	3.7	28.0				
East: W16															
Lane 1	190	15.0	190	15.0	673	0.283	100	8.8	LOS A	1.0	7.8	Full	500	0.0	0.0
Lane 2[d]	209	4.7	209	4.7	739	0.283	100	8.2	LOS A	1.1	7.9	Full	500	0.0	0.0
Approach	399	9.6	399	9.6		0.283		8.5	LOS A	1.1	7.9				
North: SW Marine (N)															
Lane 1	144	6.6	144	6.6	972	0.148	100	5.1	LOS A	0.6	4.0	Full	500	0.0	0.0
Lane 2[d]	143	7.0	143	7.0	969	0.148	100	5.1	LOS A	0.6	4.0	Full	500	0.0	0.0
Approach	287	6.8	287	6.8		0.148		5.1	LOS A	0.6	4.0				
All Vehicles	1947	9.8	1947	9.8		0.541		8.1	LOS A	3.7	28.0				

Year 2040

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: SW Marine (S)															
Lane 1	731	9.0	731	9.0	1162	0.629	100	10.9	LOS B	5.1	37.0	Full	500	0.0	0.0
Lane 2[d]	750	12.0	750	12.0	1144	0.655	100	11.7	LOS B	5.6	42.2	Full	500	0.0	0.0
Approach	1481	10.5	1481	10.5		0.655		11.3	LOS B	5.6	42.2				
East: W16															
Lane 1	219	15.1	219	15.1	604	0.363	100	11.1	LOS B	1.5	11.4	Full	500	0.0	0.0
Lane 2[d]	243	4.7	243	4.7	669	0.363	100	10.2	LOS B	1.6	11.5	Full	500	0.0	0.0
Approach	462	9.6	462	9.6		0.363		10.6	LOS B	1.6	11.5				
North: SW Marine (N)															
Lane 1	166	6.6	166	6.6	915	0.182	100	5.7	LOS A	0.7	4.9	Full	500	0.0	0.0
Lane 2[d]	166	7.0	166	7.0	913	0.182	100	5.7	LOS A	0.7	5.0	Full	500	0.0	0.0
Approach	333	6.8	333	6.8		0.182		5.7	LOS A	0.7	5.0				
All Vehicles	2275	9.8	2275	9.8		0.655		10.4	LOS B	5.6	42.2				

Year 2065

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: SW Marine (S)															
Lane 1	894	9.0	894	9.0	1122	0.796	100	17.6	LOS B	10.1	72.3	Full	500	0.0	0.0
Lane 2[d]	916	12.0	916	12.0	1105	0.829	100	20.0	LOS C	11.7	88.1	Full	500	0.0	0.0
Approach	1810	10.5	1810	10.5		0.829		18.8	LOS B	11.7	88.1				
East: W16															
Lane 1	262	15.1	262	15.1	515	0.508	100	16.6	LOS B	2.3	18.0	Full	500	0.0	0.0
Lane 2[d]	295	4.7	295	4.7	579	0.508	100	15.0	LOS B	2.6	18.7	Full	500	0.0	0.0
Approach	557	9.6	557	9.6		0.508		15.8	LOS B	2.6	18.7				
North: SW Marine (N)															
Lane 1	201	6.6	201	6.6	846	0.237	100	6.7	LOS A	0.9	6.5	Full	500	0.0	0.0
Lane 2[d]	200	7.0	200	7.0	843	0.237	100	6.8	LOS A	0.9	6.5	Full	500	0.0	0.0
Approach	401	6.8	401	6.8		0.237		6.8	LOS A	0.9	6.5				
All Vehicles	2767	9.8	2767	9.8		0.829		16.4	LOS B	11.7	88.1				

Anticipated Traffic Delays for Afternoon Rush Hour

Year 2024

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: SW Marine (S)															
Lane 1	255	9.0	255	9.0	896	0.285	100	7.0	LOS A	1.2	8.4	Full	500	0.0	0.0
Lane 2[d]	377	12.0	377	12.0	877	0.431	100	9.3	LOS A	2.2	16.6	Full	500	0.0	0.0
Approach	633	10.8	633	10.8		0.431		8.4	LOS A	2.2	16.6				
East: W16															
Lane 1	296	16.8	296	16.8	935	0.317	100	7.2	LOS A	1.3	10.3	Full	500	0.0	0.0
Lane 2[d]	318	5.7	318	5.7	1003	0.317	100	6.8	LOS A	1.4	10.1	Full	500	0.0	0.0
Approach	615	11.0	615	11.0		0.317		7.0	LOS A	1.4	10.3				
North: SW Marine (N)															
Lane 1[d]	373	6.0	373	6.0	774	0.482	100	11.3	LOS B	2.9	20.8	Full	500	0.0	0.0
Lane 2	149	7.0	149	7.0	767	0.194	40[5]	6.8	LOS A	0.7	5.2	Full	500	0.0	0.0
Approach	522	6.3	522	6.3		0.482		10.0	LOS B	2.9	20.8				
All Vehicles	1769	9.5	1769	9.5		0.482		8.4	LOS A	2.9	20.8				

Year 2040

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: SW Marine (S)															
Lane 1	296	9.0	296	9.0	836	0.354	100	8.4	LOS A	1.5	10.7	Full	500	0.0	0.0
Lane 2[d]	437	12.0	437	12.0	817	0.535	100	12.0	LOS B	3.7	28.1	Full	500	0.0	0.0
Approach	733	10.8	733	10.8		0.535		10.6	LOS B	3.7	28.1				
East: W16															
Lane 1	343	16.8	343	16.8	882	0.389	100	8.6	LOS A	1.7	13.1	Full	500	0.0	0.0
Lane 2[d]	369	5.7	369	5.7	949	0.389	100	8.1	LOS A	1.8	12.9	Full	500	0.0	0.0
Approach	712	11.0	712	11.0		0.389		8.3	LOS A	1.8	13.1				
North: SW Marine (N)															
Lane 1[d]	432	6.0	432	6.0	709	0.609	100	15.8	LOS B	4.5	32.3	Full	500	0.0	0.0
Lane 2	172	7.0	172	7.0	703	0.245	40[5]	8.0	LOS A	0.9	6.6	Full	500	0.0	0.0
Approach	605	6.3	605	6.3		0.609		13.6	LOS B	4.5	32.3				
All Vehicles	2049	9.5	2049	9.5		0.609		10.7	LOS B	4.5	32.3				

Year 2065

Lane Use and Performance

	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh	Dist] m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: SW Marine (S)															
Lane 1	356	9.0	356	9.0	762	0.468	100	11.1	LOS B	2.6	18.8	Full	500	0.0	0.0
Lane 2[d]	527	12.0	527	12.0	743	0.709	100	19.5	LOS B	7.0	52.7	Full	500	0.0	0.0
Approach	883	10.8	883	10.8		0.709		16.1	LOS B	7.0	52.7				
East: W16															
Lane 1	412	16.8	412	16.8	823	0.501	100	11.2	LOS B	3.2	24.7	Full	500	0.0	0.0
Lane 2[d]	446	5.7	446	5.7	890	0.501	100	10.5	LOS B	3.3	23.5	Full	500	0.0	0.0
Approach	858	11.0	858	11.0		0.501		10.8	LOS B	3.3	24.7				
North: SW Marine (N)															
Lane 1[d]	521	6.0	521	6.0	628	0.829	100	33.5	LOS C	9.4	67.4	Full	500	0.0	0.0
Lane 2	208	7.0	208	7.0	622	0.334	40[5]	10.3	LOS B	1.4	9.8	Full	500	0.0	0.0
Approach	729	6.3	729	6.3		0.829		26.9	LOS C	9.4	67.4				
All Vehicles	2470	9.5	2470	9.5		0.829		17.5	LOS B	9.4	67.4				

Appendix B: Stormwater System Design

Appendix B - Stormwater System Design

Rainfall Calculations

Finding rainfall intensity - Method 1 based on precedent data

Rainwater Data	UBC Piteau Rain fall data 1961-1990 - (mm)	Vancouver adjusted data 1960-2020 - mm	
Largest Daily	88.1	92.66814815	
Max percipitation /day	132.5154519		
Max percipitation /hour	5.52147716	*does not govern	

Rainwater Factors of Safety	
Climate Change Factor	1.1
Safety Factor	1.3

Finding rainfall intensity - Method 2 based on Vancouver building code 100yr storm, using 2050 data

Time (T) - hrs	A	B	I (mm/hr)	I (mm/sec)	
1	38.76	-0.561	38.760	0.108	*governs
2	38.76	-0.561	26.273	0.073	
5	38.76	-0.561	15.713	0.044	

Road Catch Basin's

Runoff coefficient for roadway	0.83
Runoff coefficient for median	0.13

Catchbasin (#)	Pipe designation	Area of pavement (m2)	Area of soil (m2)	Total Area (m2)	Area x C	Distance from arterial outflow point include lead (m)	Leads to arterial pipe (1:N, 2:E, 3:S)
1	1	210.32	160.01	370.33	195.3669	123.85	1
2	1	249.02	222.63	471.65	235.6285	100.7	1
3	1	197.92	192.85	390.77	189.3441	50.8	1
4	1	267.91	227.07	494.98	251.8844	26.7	2
5	1	298.54	188.54	487.08	272.2984	43.4	2
6	1	287.16	160.46	447.62	259.2026	76.2	2
7	1	284	151.37	435.37	255.3981	84.9	2
8	2	274.32	129.95	404.27	244.5791	95.4	2
9	2	299.01	156.34	455.35	268.5025	76.7	2
10	2	265.48	188.54	454.02	244.8586	44.3	2
11	2	256.35	243.37	499.72	244.4086	28.3	3
12	2	156.41	266.11	422.52	164.4146	23.6	3
13	2	183.82	277.61	461.43	188.6599	46.1	3
14	2	237.93	252.64	490.57	230.3251	72.8	3
15	2	286.19	143.56	429.75	256.2005	90.2	3
16	2	310.91	143.1	454.01	276.6583	117.3	3
17	2	235.66	129.33	364.99	212.4107	145.7	3
18	2	248.6	139.31	387.91	224.4483	157.8	3
19	3	314.67	185.07	499.74	285.2352	125.1	1
20	3	330.8	168.94	499.74	296.5262	97.7	1
21	3	338.8	151.3	490.1	300.873	64.6	1
22	1	188.21	162.29	350.5	177.312	20.6	1
23	3	371.78	115.9	487.68	323.6444	38.8	1
24	3	273.36	213.09	486.45	254.5905	46.7	3
25	3	207.41	236.02	443.43	202.8329	56.7	3
26	3	233.8	219.68	453.48	222.6124	65.7	3
27	3	300.23	170.39	470.62	271.3416	85.9	3
28	3	320.31	149.35	469.66	285.2728	115.4	3
29	3	339.03	134.18	473.21	298.8383	143.1	3
30	3	320.08	115.36	435.44	280.6632	162.1	3

Sum for Road CB's		
Total Area	23248.87	m2
Total Area*Runoff Coefficient	13513.2811	m2

Ditch Lawn Basin's

Runoff Coefficient for hillside	0.18

Segment	Area (m2)	Area x C (m2)	# CB"s needed	Spacing of CB (m)
1	15402	2772.36	9	56.88888889
2	24241	4363.38	14	39.78571429

Sum for Road CB's		
Total Area	39643	m2
Total Area*C	7135.74	m2

LB within intersecton scope	Segment	Area (m2)	Area*c (m2)	Distance from arterial outflow point include lead (m)	Leads to arterial pipe (1:N, 2:E, 3:S)
1	1	1711.333333	308.04	119	1
2	1	1711.333333	308.04	80.5	1
3	1	1711.333333	308.04	59.3	2
4	1	1711.333333	308.04	84.5	2
10	2	1731.5	311.67	100.3	2
9	2	1731.5	311.67	64.6	2
8	2	1731.5	311.67	44.9	2
7	2	1731.5	311.67	94.6	3
6	2	1731.5	311.67	133.1	3
5	2	1731.5	311.67	170.8	3

Collection Tank Calculations

Volume collected for all different storms			
Total Area*C (m2)	20649.0211	20649.0211	20649.0211
Infiltration rate (mm/s)	38.760	26.273	15.713
time (hrs)	1	2	5
Volume collected	800.3560578	1085.014156	1622.299627

Collection Tank Sizing	
width of collection tank (m)	21
length of collection tank (m)	21
height of collection tank (m)	4
Total volume collection tank (m)	1764

Additional Info Derived

Depth in Storage Tank Needed to Hold Fountain Water		
Area of water feature	314.1592654	m2
Volume for water feature	235.619449	m3
Evapotranspitaion for 1 month	42.16017341	m
Effect of climate change	1.1	FOS
4 months of evapo	168.6406936	x total volume
Total Volume needed	404.2601427	m3
Tank height	21	m
Tank Width	21	m
Depth needed before pump	0.9166896659	m

Flow properties for Pipe Sizing	
Area*C draining into pipe 1 (N pipe	2620.0103
Area*C draining into pipe 2 (E pipe	13480.3231
Area*C draining into pipe 3 (S pipe	4548.6877
total area	20649.0211
max flow through pipe 1	0.2820877756
max flow through pipe 2	1.451381454
max flow through pipe 3	0.4897420424
Max flow through entire sys	2.223211272

Outlet Pipe Hand Calcs

Values	Ocean Discharge Pipe	UBC Botanical Pipe	
Tested diameter (m)	**0.6**	**0.35**	
A2 - area of pipe (m2)	0.2827433388	0.09621127502	
Elevation point 1 - at catch basin (m)	67.7	67.666	
Elevation point 2 - at discharge location (m)	67.4	77	
Length of pipe (m)	6.4	58.3	
Q flow (m3/s)	2.223211272	0.005635	
change in height (m)	0.3	9.334	
Tank Area - Area 1	7.86300141	0.05856901906	
velocity 1 (m/s)	0.2827433388	0.09621127502	
Re = pvD/miu	169646.0033	33673.94626	
Find RPR - relative pipe roughness = e/D	0.00004166666667	0.00007142857143	
Friction factor using moody diagram	0.045	0.028	
Head Loss (m)	0.001955811514	0.002200449869	*hL = fLv^2/2Dg

Tested Value	Velocity (Bernoulli's) - m/s	Pump Head (Bernoulli's) - m
Results	2.434660299	9.33620045

Rational Method

General parameters

mannings n	0.013

Pipe 1 - Pipe north of roundabout

Locations: CB or LB	Number of CB or LB	C*A (Ha.)	Accum. Total C*A (Ha.)	Time of Concentration Tc (min)	Total Time STc (min)	Intensity I(100) (mm/hr)	Design Flow Q(100) (L/s)	Pipe Diameter D (mm)	Slope S (%)	Pipe Capacity Qcap (L/s)	Vcap (m/s)	Slope Ratio Q(100)/Qcap (%)
CB/LB	CB:1,19; LB:1	0.7886421	0.7886421	10	10.000	110.000	241.167	**400**	1.5	255.05	2.029657706	0.946
CB	2	0.47165	1.2602921	10	20.000	70.000	245.253	**400**	1.5	255.05	2.029657706	0.962
CB	20	0.49974	1.7600321	10	30.000	59.000	288.680	**425**	1.5	299.81	2.113369463	0.963
LB	2	0.30804	2.0680721	10	40.000	48.000	275.964	**425**	1.5	299.81	2.113369463	0.920
CB	21	0.300873	2.3689451	10	50.000	44.000	289.769	**425**	1.5	299.81	2.113369463	0.967
CB	3	0.01893441	2.38787951	10	60.000	38.000	252.256	**425**	1.5	299.81	2.113369463	0.841
CB	22	0.0177312	2.40561071	10	70.000	36.000	240.754	**425**	1.5	299.81	2.113369463	0.803
CB	23	0.03236444	2.43797515	10	80.000	34	230.4374112	**425**	1.5	299.8079668	2.113369463	0.7686167036

Pipe 3 - Pipe south of roundabout

Locations: CB or LB	Number of CB or LB	C*A (Ha.)	Accum. Total C*A (Ha.)	Time of Concentration Tc (min)	Total Time STc (min)	Intensity I(100) (mm/hr)	Design Flow Q(100) (L/s)	Pipe Diameter D (mm)	Slope S (%)	Pipe Capacity Qcap (L/s)	Vcap (m/s)	Q(100)/Qcap (%)
CB/LB	CB:18,30, LB: 10	0.8167815	0.8167815	10	10.000	110.000	249.772	**400**	1.5	255.05	2.029657706	0.979
CB	17	0.2124107	1.0291922	10	20.000	70.000	200.281	**400**	1.5	255.05	2.029657706	0.785
CB	29	0.2988383	1.3280305	10	30.000	59.000	217.824	**400**	1.5	255.05	2.029657706	0.854
LB	9	0.31167	1.6397005	10	40.000	48.000	218.802	**400**	1.5	255.05	2.029657706	0.858
CB	16	0.2766583	1.9163588	10	50.000	44.000	234.409	**400**	1.5	255.05	2.029657706	0.919
CB	28	0.2852728	2.2016316	10	60.000	38.000	232.580	**400**	1.5	255.05	2.029657706	0.912
CB	15	0.2562005	2.4578321	10	70.000	36.000	245.980	**400**	1.5	255.05	2.029657706	0.964
LB	8	0.31167	2.7695021	10	80.000	34.000	261.773	**425**	1.5	299.81	2.113369463	0.873
CB	14	0.2303251	2.9998272	10	90.000	33.000	275.204	**425**	1.5	299.81	2.113369463	0.918
CB	26	0.2226124	3.2224396	10	100.000	32.000	286.668	**425**	1.5	299.81	2.113369463	0.956
CB	13	0.1886599	3.4110995	10	110.000	30.000	284.486	**425**	1.5	299.81	2.113369463	0.949
CB	25	0.2028329	3.6139324	10	120.000	27.000	271.262	**425**	1.5	299.81	2.113369463	0.905
CB	12	0.1644146	3.778347	10	130.000	26.000	273.099	**425**	1.5	299.81	2.113369463	0.911
CB	11	0.2444086	4.0227556	10	140.000	25.000	279.582	**425**	1.5	299.81	2.113369463	0.933

Pipe 2- Pipe North East of Roundabout

Locations												
CB or LB	Number of CB or LB	C*A	Accum. Total C*A	Time of Concentration Tc	Total Time STc	Intensity I(100)	Design Flow Q(100)	Pipe Diameter D	Slope S	Pipe Capacity Qcap	Vcap	Q(100)/ Qcap
		(Ha.)	(Ha.)	(min)	(min)	(mm/hr)	(L/s)	(mm)	(%)	(L/s)	(m/s)	(%)
All eastern attachments	CB:7,8 LB: 4,5	1.1196872	1.1196872	60	120.000	110.000	342.400	**375**	5.0	392.04	3.549575015	0.873
	9	0.2685025	1.3881897	10	130.000	70.000	270.142	**375**	5.0	392.04	3.549575015	0.689
	6	0.2592026	1.6473923	10	140.000	59.000	270.205	**375**	5.0	392.04	3.549575015	0.689
LB	6	0.31167	1.9590623	10	150.000	48.000	261.417	**375**	5.0	392.04	3.549575015	0.667
	5	0.2722984	2.2313607	10	160.000	44.000	272.940	**375**	5.0	392.04	3.549575015	0.696
	10	0.2448586	2.4762193	10	170.000	38.000	261.588	**375**	5.0	392.04	3.549575015	0.667
LB	3	0.30804	2.7842593	10	180.000	36.000	278.649	**375**	5.0	392.04	3.549575015	0.711
LB	7	0.31167	3.0959293	10	190.000	34.000	292.627	**375**	5.0	392.04	3.549575015	0.746
	4	0.2518844	3.3478137	10	200.000	33.000	307.128	**375**	5.0	392.04	3.549575015	0.783

Appendix C: Gateway Design

Gateway Structure's Edge Column' Footing

Loading					
Fx	65	*kN*	**Mx**	220	*kNm*
Fy	5	*kN*	**My**	25	*kNm*
Fz	130	*kN*	**Mz**	5	*kNm*

Material Properties		
Concrete Strenght (fc')	25	*Mpa*
Rebar Strenght (fy)	400	*MPa*

Foundation Geometry								
Pedastal Length	1700	*mm*	**Footing Length**	2500	*mm*	**Total Foundation Volume**	1050000000	*mm^3*
Pedastal Width	800	*mm*	**Footing Width**	1200	*mm*	**Total Foundation Footprint**	3000000	*mm^2*
			Footing Thickness	350	*mm*	**Zx**	17864583333	*mm^3*
						Zy	8575000000	*mm^3*

One Way Shear			
Effective Depth	260.00	*mm*	
Effective Shear Depth	234.00	*mm*	
Distance to Shear	166.00	*mm*	
psoil	58.56	*KPa*	
Demand	11.67	*kN*	
Demand + External	76.67	*kN*	
Beta Factor	0.18		
One Way Shear Resistance	166.59	*kN*	**Yes**
Utilization	46%		

Two Way Shear			
da	1830.00	*mm*	
db	930.00	*mm*	
Punching Shear Area	1298100.00	*mm^2*	
Shear Force Demand	76.02	*kN*	
Shear Demnd + Exter	141.02	*kN*	
Nf	0.10	*MPa*	
Beta c	2.13		
Resistance	1.199	*Mpa*	**Yes**
Utilization	8%		

Moment Resistance			
Span 1	400.00	*mm*	
Span 2	200.00	*mm*	
Demand	11.71	*kNm*	
Demand + External	231.71	*kNm*	
Asmin	1750.00	*mm^2*	
As	1800.00	*mm^2*	
Spacing (WRT to Asmin)	277.78	*mm*	
Spacing (WRT to Demand)	150.00	*mm*	
Normalized As	3333.33	*mm^2*	
Tr	612.00	*kN*	
a1	0.81		
B1c	18.54	*mm*	
Mr	284.16	*kNm*	**Yes**
Utilization	82%		

Bearing Resistance			
A2/A1	*2*		
Resistance	82875.00	*kN*	
Demand	154.675	*kN*	**Yes**
Utilization	0%		

Waterfountain's Pad Concrete Footing

Loading					
Fx	65	*kN*	**Mx**	200	*kNm*
Fy	5	*kN*	**My**	200	*kNm*
Fz	6688.159269	*kN*	**Mz**	200	*kNm*

Material Properties		
Concrete Strenght (fc')	25	*Mpa*
Rebar Strenght (fy)	400	*MPa*

Foundation Geometry								
Normalized Tank Width	20000	*mm*	**Footing Length**	21000	*mm*	**Total Foundation Volume**	66150000000	*mm^3*
Normalized Tank Lenght	20000	*mm*	**Footing Width**	21000	*mm*	**Total Foundation Footprint**	441000000	*mm^2*
			Footing Thickness	150	*mm*	**Zx**	11812500000	*mm^3*
						Zy	11812500000	*mm^3*

One Way Shear			
Effective Depth	60.00	*mm*	
Effective Shear Depth	54.00	*mm*	
Distance to Shear	446.00	*mm*	
psoil	49.03	*KPa*	
Demand	459.20	*kN*	
Demand + External	524.20	*kN*	
Beta Factor	0.22		
One Way Shear Resistance	799.68	*kN*	**Yes**
Utilization	66%		

Two Way Shear			
da	20030.00	*mm*	
db	20030.00	*mm*	
Punching Shear Area	39799100.00	*mm^2*	
Shear Force Demand	1951.28	*kN*	
Shear Demnd + Exter	2016.28	*kN*	
Nf	0.42	*MPa*	
Beta c	1.00		
Resistance	1.235	*Mpa*	**Yes**
Utilization	34%		

Moment Resistance			
Span 1	500.00	*mm*	
Span 2	500.00	*mm*	
Demand	128.70	*kNm*	
Demand + External	328.70	*kNm*	
Asmin	6300.00	*mm^2*	
As	6400.00	*mm^2*	
Spacing (WRT to Asmin)	656.25	*mm*	
Spacing (WRT to Demand)	500.00	*mm*	
Normalized As	8400.00	*mm^2*	
Tr	2176.00	*kN*	
a1	0.81		
B1c	7.85	*mm*	
Mr	160.15	*kNm*	**No**
Utilization	205%		

Bearing Resistance			
A2/A1	*1.1025*		
Resistance	6715672.03	*kN*	
Demand	8242.684269	*kN*	**Yes**
Utilization	0%		

Water Tank's Pad Concrete Footing

Loading

Fx	0	*kN*	**Mx**	200	*kNm*
Fy	0	*kN*	**My**	200	*kNm*
Fz	38851.93816	*kN*	**Mz**	200	*kNm*

Material Properties

Concrete Strenght (fc')	25	*Mpa*
Rebar Strenght (fy)	400	*MPa*

Foundation Geometry

Tank Lenght	25000	*mm*	**Footing Length**	26000	*mm*	**Total Foundation Volume**	101400000000	*mm^3*
Tank Width	25000	*mm*	**Footing Width**	26000	*mm*	**Total Foundation Footprint**	676000000	*mm^2*
			Footing Thickness	150	*mm*	**Zx**	14625000000	*mm^3*
						Zy	14625000000	*mm^3*

One Way Shear

Effective Depth	60.00	*mm*	
Effective Shear Depth	54.00	*mm*	
Distance to Shear	446.00	*mm*	
psoil	84.82	*KPa*	
Demand	983.62	*kN*	
Demand + External	983.62	*kN*	
Beta Factor	0.22		
One Way Shear Resistance	990.08	*kN*	**Yes**
Utilization	99%		

Bearing Resistance

A2/A1	*1.0816*		
Resistance	10099169.60	*kN*	
Demand	38851.94	*kN*	**Yes**
Utilization	0%		

Two Way Shear

da	25030.00	*mm*	
db	25030.00	*mm*	
Punching Shear Area	49499100.00	*mm^2*	
Shear Force Demand	4198.70	*kN*	
Shear Demnd + Exter	4198.70	*kN*	
Nf	0.70	*MPa*	
Beta c	1.00		
Resistance	1.235	*Mpa*	**Yes**
Utilization	57%		

Moment Resistance

Span 1	500.00	*mm*	
Span 2	500.00	*mm*	
Demand	275.68	*kNm*	
Demand + External	475.68	*kNm*	
Asmin	7800.00	*mm^2*	
As	7800.00	*mm^2*	
Spacing (WRT to Asmin)	666.67	*mm*	
Spacing (WRT to Demand)	150.00	*mm*	
Normalized As	34666.67	*mm^2*	
Tr	2652.00	*kN*	
a1	0.81		
B1c	7.73	*mm*	
Mr	661.67	*kNm*	**Yes**
Utilization	72%		

Gateway Structure's Central Column's Pad Concrete Foundation

Loading

Fx	80	*kN*	**Mx**	50	*kNm*
Fy	40	*kN*	**My**	250	*kNm*
Fz	250	*kN*	**Mz**	10	*kNm*

Material Properties

Concrete Strenght (fc')	25	*Mpa*
Rebar Strenght (fy)	400	*MPa*

Foundation Geometry

Pedastal Length	4580	*mm*	**Footing Length**	5000	*mm*	**Total Foundation Volume**	8750000000	*mm^3*
Pedastal Width	3680	*mm*	**Footing Width**	5000	*mm*	**Total Foundation Footprint**	25000000	*mm^2*
			Footing Thickness	350	*mm*	**Zx**	35729166667	*mm^3*
						Zy	35729166667	*mm^3*

One Way Shear

Effective Depth	260.00	*mm*	
Effective Shear Depth	234.00	*mm*	
Distance to Shear	-24.00	*mm*	
psoil	18.40	*KPa*	
Demand	-2.21	*kN*	
Demand + External	77.79	*kN*	
Beta Factor	0.18		
One Way Shear Resistance	694.11	*kN*	**Yes**
Utilization	11%		

Bearing Resistance

A2/A1	*1.483292197*		
Resistance	512199.34	*kN*	
Demand	455.625	*kN*	**Yes**
Utilization	0%		

Two Way Shear

da	4710.00	*mm*	
db	3797.00	*mm*	
Punching Shear Area	7116130.00	*mm^2*	
Shear Force Demand	130.91	*kN*	
Shear Demnd + Exter	210.91	*kN*	
Nf	0.05	*MPa*	
Beta c	1.24		
Resistance	1.24	*Mpa*	**Yes**
Utilization	4%		

Moment Resistance

Span 1	210.00	*mm*	
Span 2	660.00	*mm*	
Demand	20.03	*kNm*	
Demand + External	270.03	*kNm*	
Asmin	3500.00	*mm^2*	
As	3600.00	*mm^2*	
Spacing (WRT to Asmin)	277.78	*mm*	
Spacing (WRT to Demand)	300.00	*mm*	
Normalized As	3333.33	*mm^2*	
Tr	1224.00	*kN*	
a1	0.81		
B1c	18.54	*mm*	
Mr	284.16	*kNm*	**Yes**
Utilization	95%		

Moment Resistance of the Beam = $M_r = \min(M_{r1}, M_{r2})$

Where $M_{r1} = \phi F_b (K_D K_H K_{Sb} K_T) S K_x K_L$ — CSA 086-19 Cl. 7.5.6.1

$M_{r2} = \phi F_b (K_D K_H K_{Sb} K_T) S K_x K_{Zbg}$ — CSA 086-19 Cl. 7.5.6.1

- $M_{r1} = \phi F_b (K_D K_H K_{Sb} K_T) S K_x K_L$
  - ↳ $M_{r1+} = \phi F_{b+} (1/6\, bd^2) K_x K_L$
  - ↳ $M_{r1+} = 0.9 \times 25.60\ MPa \times (1/6 \times 1500\ mm \times (600\ mm)^2) \times 1.00 \times 1.00$
    - ↳ $M_{r1+} = 2073.60\ kNm \approx 2070\ kNm$
    - ↳ $M_{r1-} = 1555.20\ kNm \approx 1555\ kNm$
- $M_{r2+} = \phi F_b (K_D K_H K_{Sb} K_T) S K_x K_{Zbg}$
  - ↳ $M_{r1} = \phi F_{b+} (1/6\, bd^2) S K_x K_{Zbg}$
  - ↳ $M_{r1+} = 0.9 \times 25.60 MPa (1/6 \times 1500\ mm \times (600\ mm)^2) \times 1.00 \times 0.72$
    - ↳ $M_{r2+} = 1492.99\ kNm \approx 1429\ kNm$
    - ↳ $M_{r2-} = 1119.74\ kNm \approx 1119\ kNm$

↳ $M_{r+} = \min(M_{r1+}, M_{r2+}) = \min(2070\ kNm, 1429\ kNm) = M_{r2+}$

$M_{r-} = \min(M_{r1-}, M_{r2-}) = \min(1555\ kNm, 1119\ kNm) = M_{r2-}$

Positive Moment Resistance = $M_{r+} = 1429\ kNm$

Negative Moment Resistance = $M_{r-} = 1119\ kNm$

$\phi = 0.90$		CSA 086-19
$f_{b+} = 25.6\ MPa$	for D.F.L 20f-E	CSA 086-19 Table 7.2
$f_{b-} = 19.2\ MPa$	for D.F.L 20f-E	CSA 086-19 Table 7.2
$K_D = 1.15$	Short-Term Duration	CSA 086-19 Table 5.1
$K_H = 1.00$	Not more than 610mm Apart	CSA 086-19 Cl. 7.4.4
$K_{Sb} = 1.00$	Service Condition for Bending	CSA 086-19 Table 7.3
$K_T = 1.00$	Preservative Treated Wet-Service	CSA 086-19 Table 6.11
$K_x = 1.00$	for Uncurved Beams	CSA 086-19 Cl. 7.5.6.5.2
$K_L = f[C_B = (L_e d b^{-2})^{1/2}]$ ↦ $K_L = 1.00$		CSA 086-19 Cl. 7.5.6.4.4
↳ $C_B = (1.92 \times 20{,}000\ mm \times 1500\ mm \times (600\ mm)^{-2})^{1/2}$		CSA 086-19 Cl. 7.5.6.4.3
↳ $C_B = 12.65$ of Which $L_e = 1.92a$		CSA 086-19 Table 7.4
$K_{Zbg} = (130/b)^{1/10} (610/d)^{1/10} (9100/L)^{1/10}$		CSA 086-19 7.5.6.5.1
↳ $K_{Zbg} = (130/1500)^{1/10} (610/600)^{1/10} (9100/20000)^{1/10} = 0.72 < 1.30$		

Since L is the Distance Between Zero Moment Points which would be less than 20,000mm, Using 20,000 mm is a Conservative Underestimate of K_{Zbg}. Also 20,000 in itself is Conservative

Shear Control at Supports (Shear Resistance)

- $W_r = \phi F_v (K_D K_H K_{Sv} K_T) 0.48 A_g C_v Z^{-0.18}$
  - ↳ $W_r = \phi F_v 0.48 (bd) C_v (bdL)^{-0.18}$
  - ↳ $W_r = 0.9 \times 2\ MPa \times 0.48 \times (1500\ mm \times 600\ mm)(\quad)(1500\ mm \times 600\ mm \times 20{,}000\ mm)^{-0.18}$
  - ↳ $W_r = 0.9 \times \quad MPa \times 0.48 \times (900{,}000\ mm^2)(\quad)(1.80 \times 10^{10}\ mm^3)^{-0.18}$
    - ↳ $W_r = \quad kN \approx \quad kN$

Where

$F_v = 2\ MPa$ D.F.L 20f-E — CSA 086-19 Table 7.2

$C_v = 1.825\, W_f \left(\frac{L}{\Sigma G_i}\right)^{0.2}$ Static Load — CSA 086-19 Cl. 7.5.7.6

↳ $\Sigma G_i = \sum_{i=1} a_i [V_{A_i}^5 + V_{B_i}^4 + 4V_{C_i}^5]$ — Convert all kN to N

↳ ΣG_i:
- $G_1 = (2.82\ m)[(180\ kN)^5 + (90\ kN)^4 + (0\ kN)^5] = 5.328 \times 10^{26}$
- $G_2 = (1.18\ m)[(0\ kN)^5 + (38\ kN)^4 + (76\ kN)^5] = 2.992 \times 10^{24}$
- $G_3 = (2.00\ m)[(76\ kN)^5 + (119\ kN)^4 + (162\ kN)^5] = 2.232 \times 10^{26}$

↳ $C_v = 1.825 (64.307 \frac{kN}{m} \times 2m + 64.307 \frac{kN}{m} \times 2m + 42.637 \frac{kN}{m} \times 2m) \left(\frac{L}{\Sigma G_i}\right)^{0.2}$

↳ $C_v = 1.825 (3.425 \times 10^5\ N)(6m / 7.590 \times 10^{26}) = 3.763$

b) Utilization of Vertical Post Under Gravity + Lateral Load

Axial Load Transferred to Column $C_{D-4} = P_F =$

Axial Resistance = $P_r = \phi F_c A K_{Zcg} K_c = \phi f_c (K_D K_H K_{Sc} K_T) A K_{Zcg} K_c$

↳ $P_r = 0.8 \times 30.2\ MPa \times (600\ mm \times 1500\ mm) \times 0.540 \times 0.948 = 11{,}131\ kN$

Utilization = $P_F / P_r = 130\ kN / 1124\ kN = 0.1156 \approx 12\%$

Where

$f_c = 30.20\ MPa$	D.F.L 20f-E	CSA 086-19 Table 7.2
$K_D = 1.00$	Standard Load Duration	CSA 086-19 Table 5.1
$K_H = 1.00$	Not more than 610mm Apart	CSA 086-19 Cl. 7.4.4
$K_{Sc} =$		CSA 086-19 Table 7.3
$K_T = 1.00$	For Treated Wet Conditions	CSA 086-19 Cl. 7.4.3
$K_{Zcg} = 0.68 Z^{-0.13}$		CSA 086-19 Cl. 7.5.8.5
↳ $K_{Zcg} = 0.68(600 \times 1500 \times 6500)^{-0.13} = 0.540$		
$K_c = (1 + F_c K_{Zcg} C_c^3 (35 E_{05} K_{SE} K_T)^{-1})^{-1}$		CSA 086-19 Cl. 6.5.5.2.5
↳ of Which $E = 12000\ MPa$ and $E_{05} = 10788\ MPa$		CSA 086-19 Table 7.2
$C_c = \frac{6500mm}{600mm} = 10.833$ ↦ Governs K_c		CSA 086-19 Cl. 7.5.8.2
↳ $K_c = (1 + (30.2 \times 0.540 \times 10.833^3 (35 \times 10788\ MPa \times 1 \times 1)^{-1})^{-1} = 0.948$		

Axial Resistance = $P_r = \phi F_{cp} (K_D K_c K_H K_{Sc} K_T) A K_{Zcg} K_c$

↳ $P_r = 0.80 \times 30.2\ MPa \times 1 \times 1 \times 1 \times 1 \times (365\ mm \times 912\ mm) \times 0.56 \times 0.92$

↳ $P_r = 4143\ kN$

Utilization = $P_F / P_r = (175\ kN)/(4143\ kN) = 0.043$

Where

$F_{cp} = 7.00\ MPa$	D.F.L 20f-E	CSA 086-19
$K_{Dc} = 1.00$	Standard Term	CSA 086-19 Table 5.1
$K_H = 1.00$	More than 610 mm	CSA 086-19 Cl. 7.4.4
$K_{Sc} = 1.00$	Dry Service Condition	CSA 086-19 Table 7.3
$K_T = 1.00$	Dry Service Untreated	CSA 086-19
$K_{Zcg} = \min(0.68 Z^{-0.13}, 1)$		CSA 086-19 Cl. 7.5.8.5
↳ $K_{Zcg} = \min(0.68(365 \times 912 \times 13500\ mm^3)^{-0.13}, 1)$		
↳ $K_{Zcg} = \min(0.56, 1) = 0.56$		
$K_c = (1 + F_c K_{Zcg} C_c^3 (35 E_{05} K_{SE} K_T)^{-1})^{-1}$		CSA 086-19 Cl. 6.5.5.2.5
↳ $K_c = (1 + 30.2\ MPa \times 1 \times 0.56 \times (\frac{4500}{365})^3 (35 \times 10788\ MPa \times 1 \times 1)^{-1})^{-1} = 0.92$		

Bending Moment Resistance = $M_r = \min(M_{r1}, M_{r2})$

Where $M_{r1} = \phi F_b (K_D K_H K_{Sb} K_T) S K_x K_L$ — CSA 086-19 Cl. 7.5.6.1

$M_{r2} = \phi F_b (K_D K_H K_{Sb} K_T) S K_x K_{Zbg}$ — CSA 086-19 Cl. 7.5.6.1

- $M_{r1} = \phi F_b (K_D K_H K_{Sb} K_T) S K_x K_L$
  - ↳ $M_{r1+} = \phi F_{b+} (1/6\, bd^2) K_x K_L$
  - ↳ $M_{r1+} = 0.9 \times 25.60\ MPa \times (1/6 \times 1500\ mm \times (600\ mm)^2) \times 1.00 \times 1.00$
    - ↳ $M_{r1} = 2304\ kNm$
- $M_{r2+} = \phi F_b (K_D K_H K_{Sb} K_T) S K_x K_{Zbg}$
  - ↳ $M_{r1} = \phi F_{b+} (1/6\, bd^2) S K_x K_{Zbg}$
  - ↳ $M_{r1+} = 0.9 \times 25.60 MPa (1/6 \times 1500\ mm \times (600\ mm)^2) \times 1.00 \times 0.811$
    - ↳ $M_{r2+} = 1681\ kN$

$M_{r+} = \min(M_{r1+}, M_{r2+}) = \min(2304\ kNm, 1681\ kNm) = M_{r2+}$

↳ Positive Moment Resistance = $M_{r+} = 1681\ kNm$

$\phi = 0.90$		CSA 086-19
$f_{b+} = 25.6\ MPa$	for D.F.L 20f-E	CSA 086-19 Table 7.2
$K_D = 1.00$	Standard Load Duration	CSA 086-19 Table 5.1
$K_H = 1.00$	Not more than 610mm Apart	CSA 086-19 Cl. 7.4.4
$K_{Sb} = 1.00$	Service Condition for Bending	CSA 086-19 Table 7.3
$K_T = 1.00$	Treated Wet Condition	CSA 086-19 Cl. 7.4.3
$K_x = 1.00$	for Uncurved Beams	CSA 086-19 Cl. 7.5.6.5.2
$K_L = 1.00$	Simply Supported Uniform	CSA 086-19 Cl. 7.5.6.4.4
$K_{Zbg} = \min[(\frac{130}{b})^{1/10} (\frac{610}{d})^{1/10} (\frac{9100}{L})^{1/10}, 1.3]$		CSA 086-19 Cl. 7.5.6.5.1
↳ $K_{Zbg} = \min[(\frac{130}{1500})^{1/10} (\frac{610}{600})^{1/10} (\frac{9100}{6500})^{1/10}, 1.3] = 0.811$		

Utilization

↳ $\frac{P_F}{P_r} + \frac{M_F}{M_r}\left(\frac{1}{1 - P_F/P_E}\right) = \frac{175\ kN}{4143\ kN} + \frac{1627\ kNm}{609\ kNm}\left(\frac{1}{1 - 175\ kN/121300\ kN}\right) = 2.72 = 272\%$

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Company:		Page:	1
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Feb 27, 2024 (1)	Date:	2/27/2024
Fastening point:			

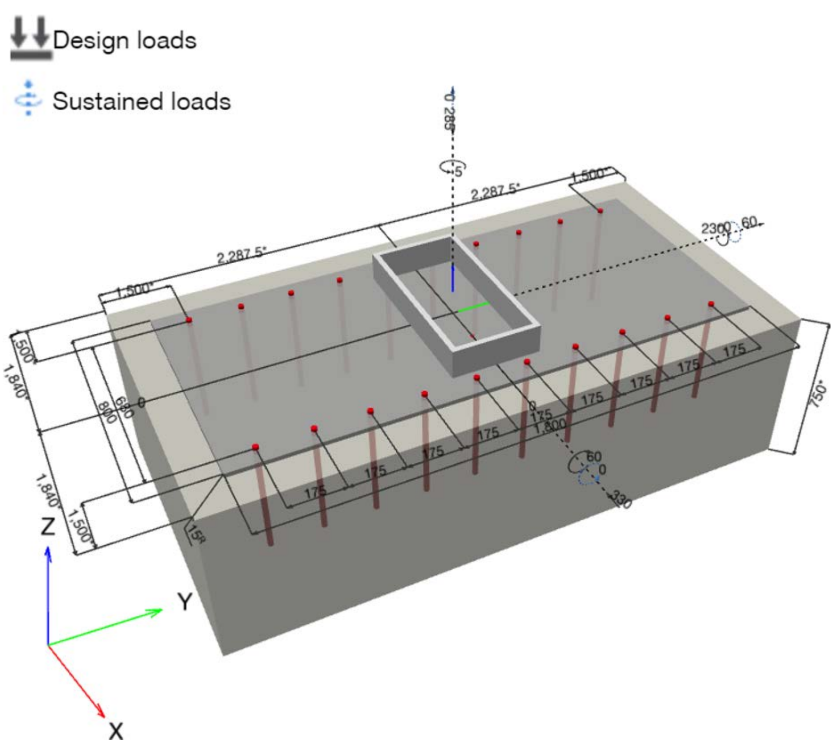
Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-RE 500 V3 + HAS-V-36 (ASTM F1554 Gr.36) 3/4**
Item number:	not available (element) / 2123401 HIT-RE 500 V3 (adhesive)
Effective embedment depth:	$h_{ef,act}$ = 380.0 mm ($h_{ef,limit}$ = - mm)
Material:	ASTM F1554 Grade 36
Evaluation Service Report:	ESR-3814
Issued I Valid:	- | -
Proof:	Design Method CSA A23.3-14 / Chem.
Stand-off installation:	e_b = 0.0 mm (no stand-off); t = 15.0 mm
Anchor plate[R] :	l_x x l_y x t = 800.0 mm x 1,800.0 mm x 15.0 mm; (Recommended plate thickness: not calculated)
Profile:	Rectangular HSS (AISC), HSS24X12X.750; (L x W x T) = 609.6 mm x 304.8 mm x 19.1 mm
Base material:	cracked concrete, f_c' = 34.47 N/mm^2; h = 750.0 mm, Temp. short/long: 20/20 °C
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present
	edge reinforcement: none or < 15M bar

[R] - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [mm] & Loading [kN, kNm]



Traffic Management Plan

Project: Southwest Marine Drive and West 16th Avenue Redesign

Phase 1 – Temporary Median Construction

1.1 Description of Movements and Closures

- Installation of temporary median to allow for northbound vehicles to crossover to the existing southbound travel lanes.
- One vehicle travel lane will remain open in both directions.
- No detours.

Phase 1 Detail Diagram

1.2 Detail A (Southwest Marine Drive, Northbound Lanes)

- Dynamic Message Sign (DMS): “LEFT LANE CLOSED AHEAD”
- Follow closure diagram presented below:

Section 9: Traffic Control Layouts – Multilane Divided Roadways

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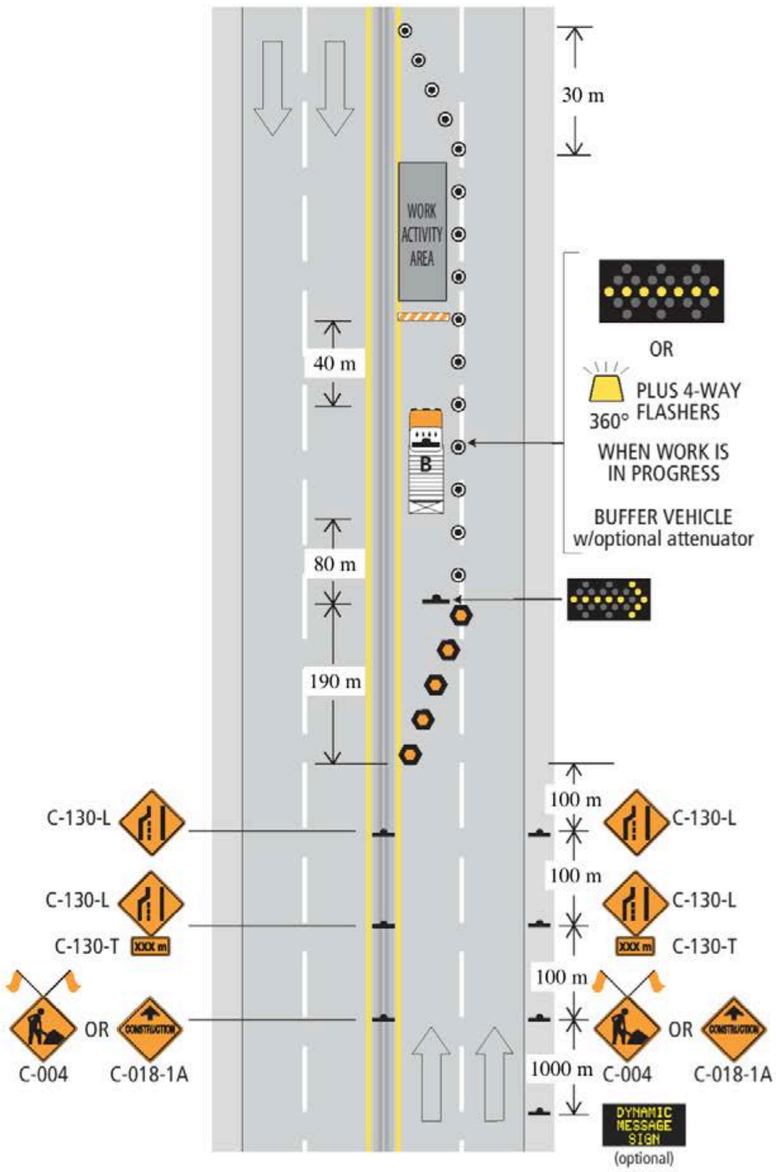
Figure 9.7: Left Lane Closed – Short and Long Duration

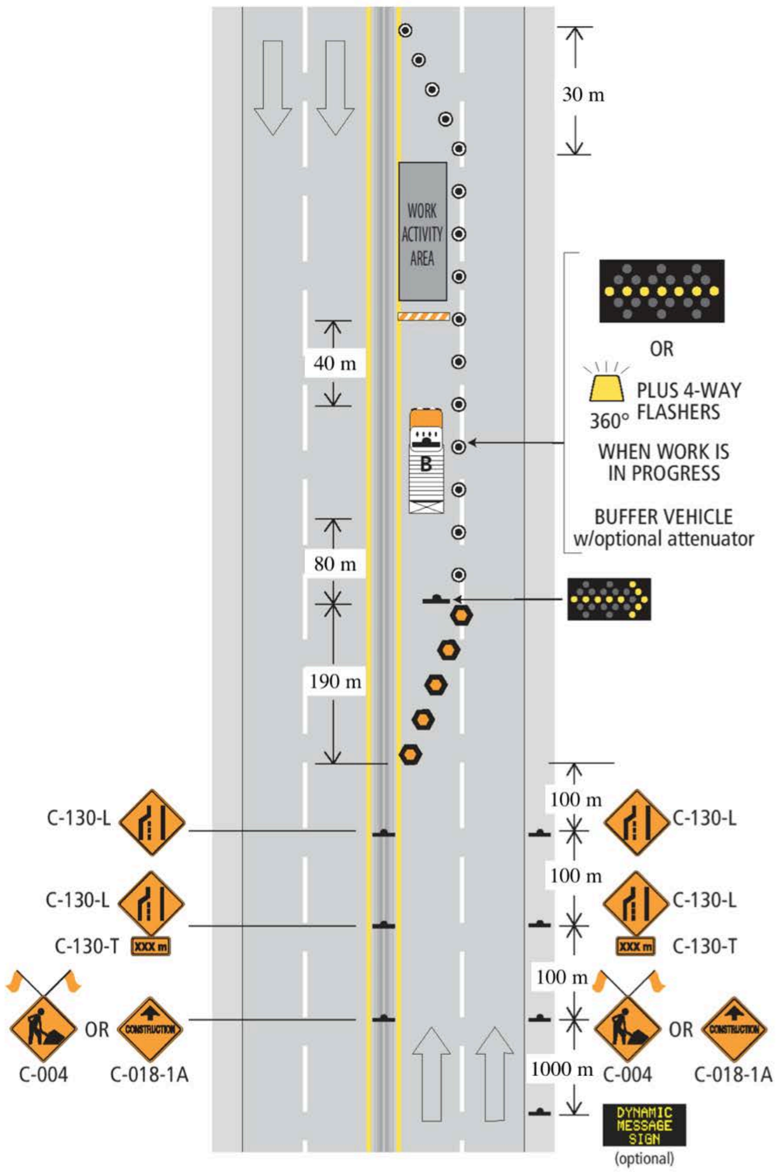


Traffic Management Manual for Work on Roadways *2020* 9-15

1.3 Detail B (Southwest Marine Drive, southbound lanes)

- DMS: “LEFT LANE CLOSED AHEAD”
- Follow closure diagram presented below:

Figure 9.7: Left Lane Closed – Short and Long Duration



Phase 2 – Eastern Roundabout Construction

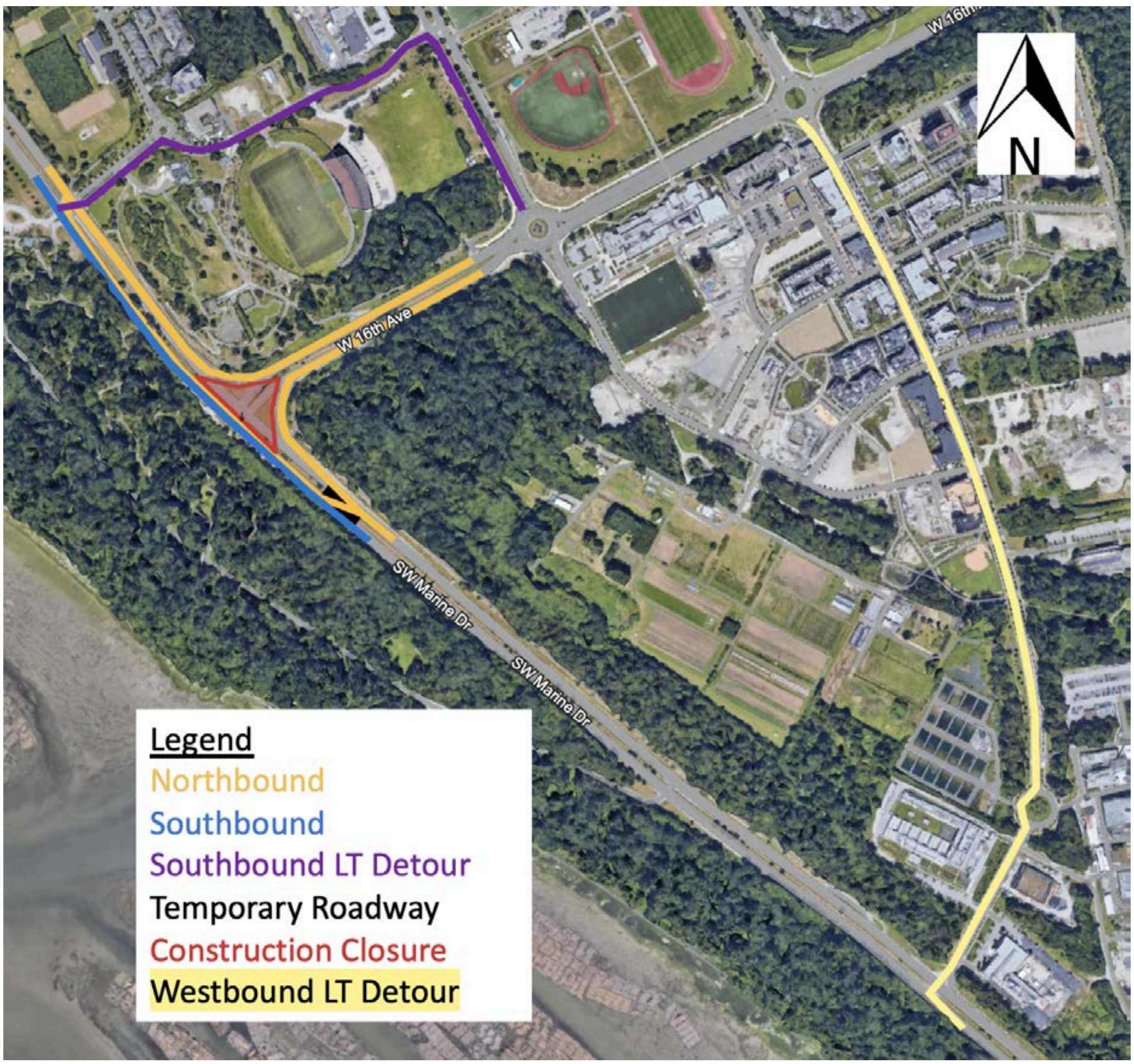
2.1 Description of Movements and Closures

- Northbound straight vehicles detoured onto existing southbound lanes.
- Northbound right turn vehicles have the left lane closed (proceed on existing northbound roadway).
- Southbound left turn detoured on left turn at Stadium Road.
- Westbound left turn detoured on Wesbrook Mall (Detail E).

Phase 2 Detail Diagram

2.2 Detour Routes

- Detour arrow signage located on:
    - o Southbound Southwest Marine Drive,
    - o Eastbound Stadium Road (west of Lower Mall),
    - o Eastbound Stadium Road (west of West Mall),
    - o Southbound West Mall (north of West 16th Avenue),
    - o Eastbound West 16th Avenue (west of Wesbrook Mall),
    - o Westbound West 16th Avenue (east of Wesbrook Mall),
    - o Southbound Wesbrook Mall (north of West 16th Avenue),
    - o Southbound Wesbrook Mall (at Birney Avenue, Gray Avenue, Ross Drive and TRIUMF roundabout).
- Detours follow the diagram presented below:



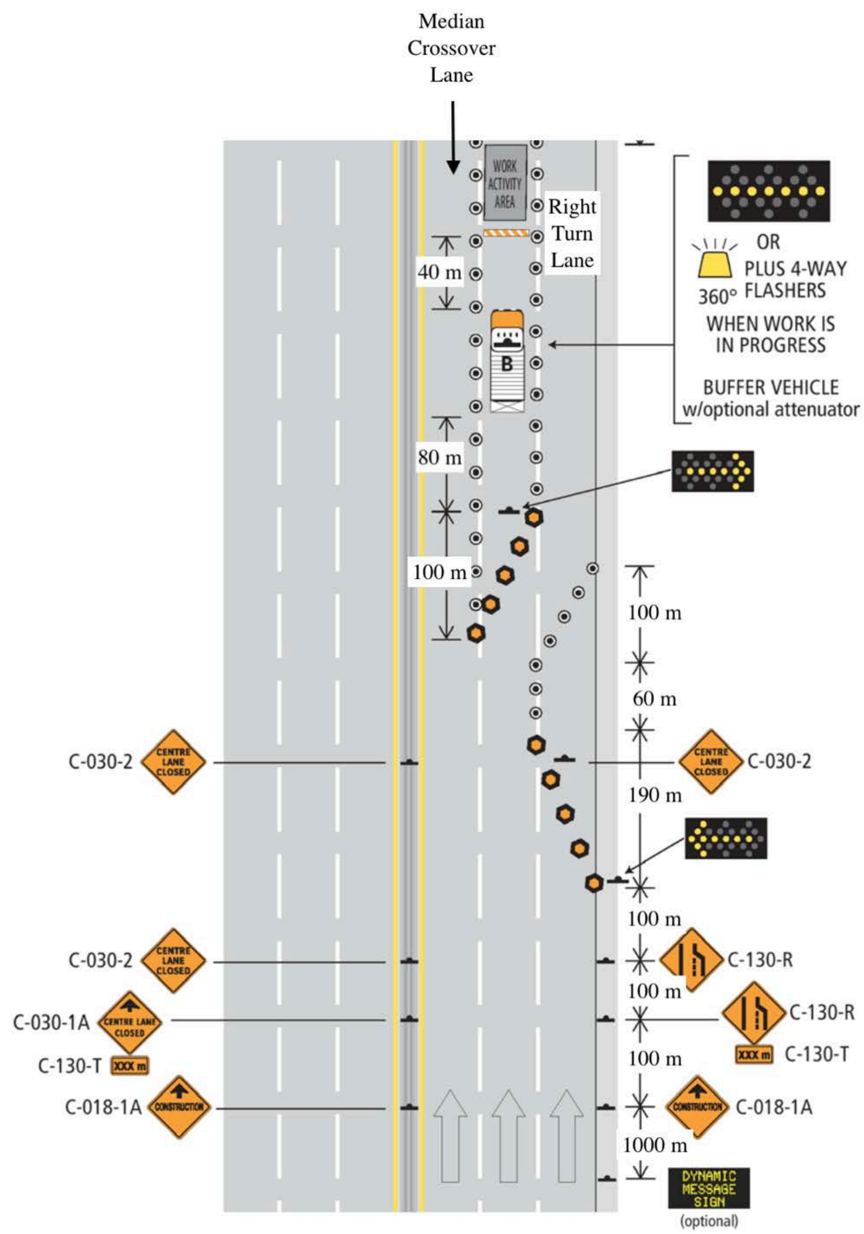
Phase 2 Detour Routes

2.3 Detail C (Southwest Marine Drive, northbound lanes)

- DMS shall dictate “RIGHT TURN KEEP RIGHT” & “THRU TRAFFIC KEEP LEFT” alternating
- Follow closure diagram presented below:

Section 9: Traffic Control Layouts – Multilane Divided Roadways — BRITISH COLUMBIA Ministry of Transportation and Infrastructure

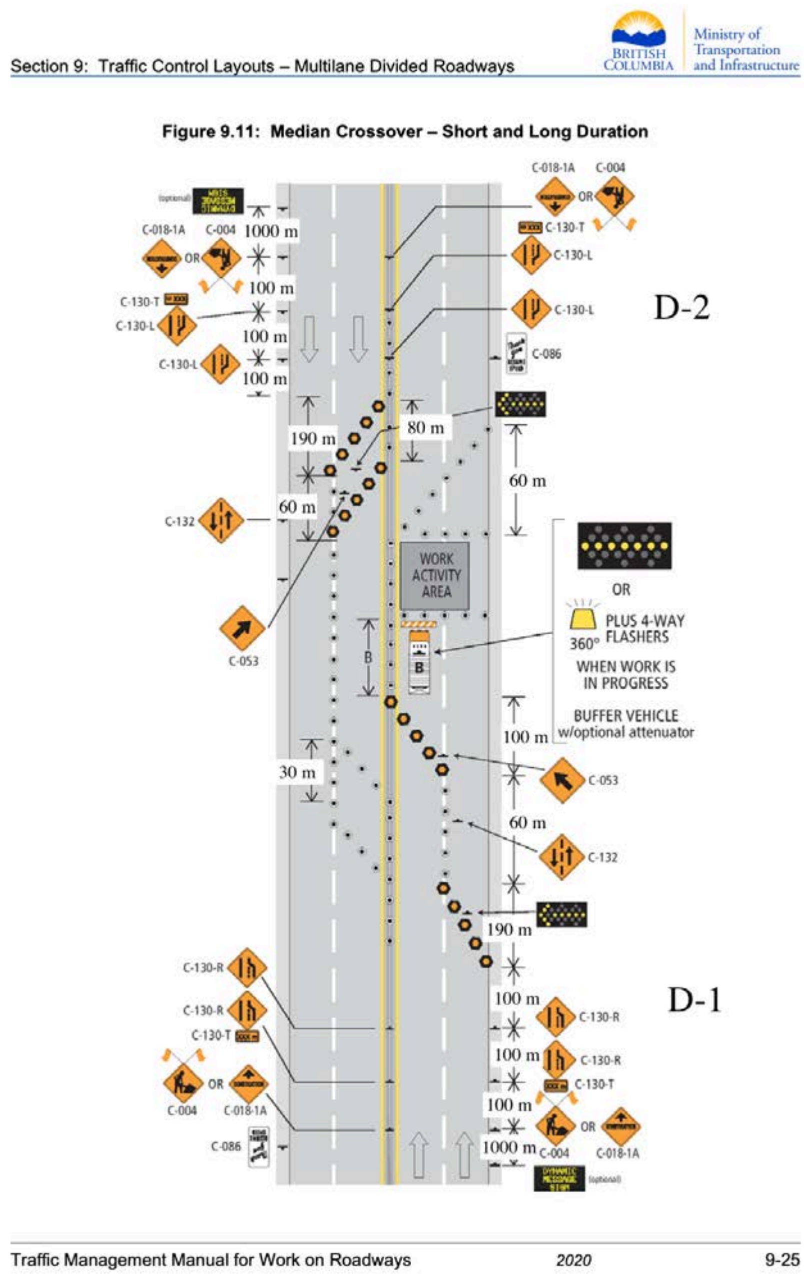
Figure 9.9: Centre Lane Closure (≥ 70 km/h) – Short and Long Duration



Traffic Management Manual for Work on Roadways *2020* 9-19

Detail D-1, D-2 (Southwest Marine Drive, looking northbound)

- DMS #1: “LEFT LANE CLOSED AHEAD” (for southbound lanes),
- DMS #2: “MERGE LEFT AHEAD” (northbound lanes)
- Closure Diagram is presented below. See notes for D1 and D2



Detail E (Southwest Marine Drive, looking southbound, 1000 m north of the Stadium Road and Southwest Marine Drive intersection)

- DMS shall dictate: “LEFT TURN CLOSED AT W 16 AVE” & “DETOUR ON STADIUM ROAD”
- Detour signage in position in the southbound lanes of Southwest Marine Drive, eastbound lanes of Stadium Road with 100 m spacing.

Phase 3 – Western Roundabout Construction

3.1 Description of Movements and Closures

- All northbound lanes and movements open using the newly constructed eastern half of the roundabout, except for the existing right turning lane.
- All southbound vehicles detoured via Stadium Road, West Mall, West 16th Avenue and Wesbrook Mall.
- Temporary traffic signals (Class 1 Portable Signal) installed to allow southbound vehicles to make the left turn.

Phase 3 Detail Diagram

3.2 Detour Routes

- Detour arrow signage located on:
  - o Southbound Southwest Marine Drive (see Detail F),
  - o Eastbound Stadium Road (west of Lower Mall),
  - o Eastbound Stadium Road (west of West Mall),
  - o Southbound West Mall (north of West 16th Avenue),
  - o Eastbound West 16th Avenue (west of Wesbrook Mall),
  - o Southbound Wesbrook Mall (at Birney Avenue, Gray Avenue, Ross Drive and TRIUMF roundabout).
- Detours follow the diagram presented below:

Phase 3 Detour Routes

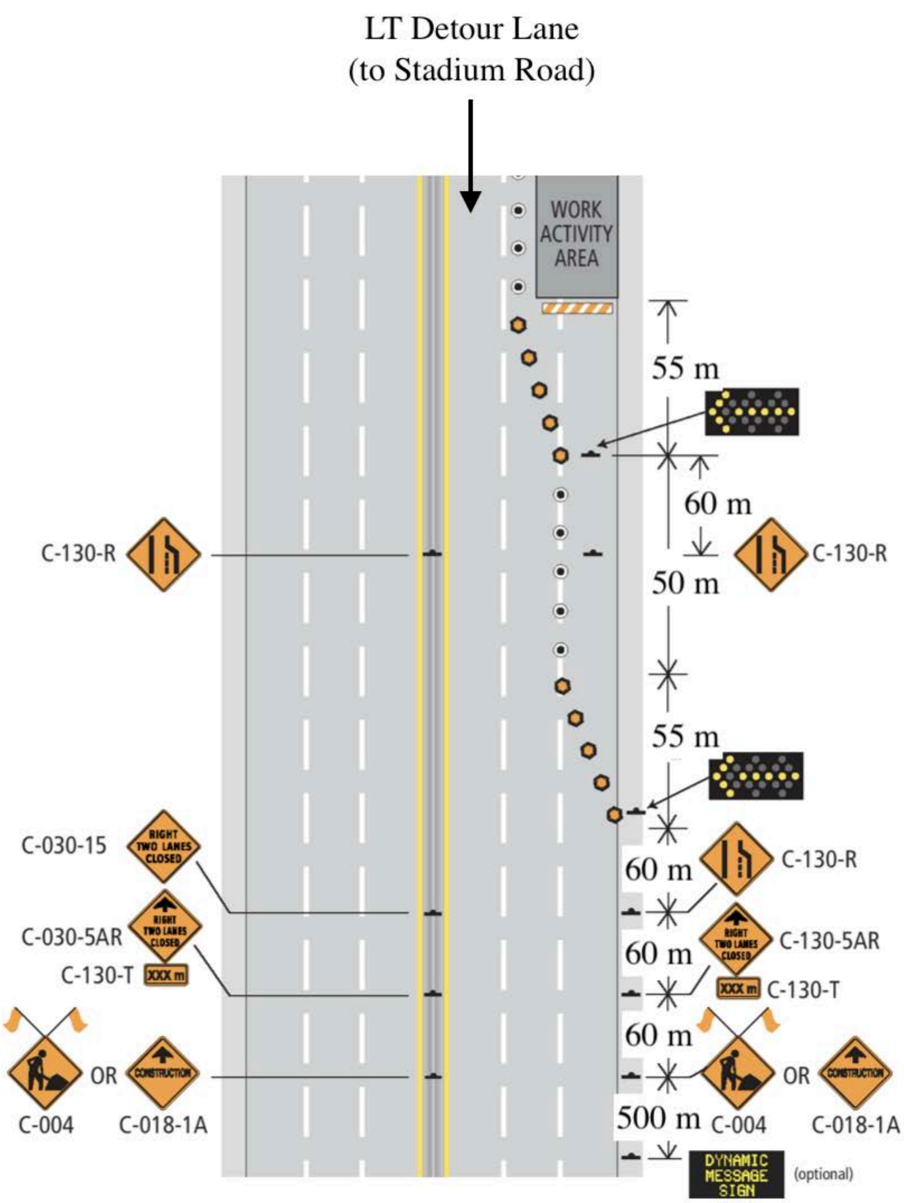
Detail F (Southbound Southwest Marine Drive, looking southbound)

- DMS #1 shall dictate: “ROAD CLOSED AHEAD” & “ALL VEHICLES STAY LEFT”
- DMS #2 shall dictate: “FOLLOW DETOUR SIGNS”
- Follow the figure presented below for closure details:

Section 9: Traffic Control Layouts – Multilane Divided Roadways

BRITISH COLUMBIA | Ministry of Transportation and Infrastructure

Figure 9.10.1: Double Right Lane Closure – Short and Long Duration



Traffic Management Manual for Work on Roadways 2020 9-21

Phase 4 – Median Restoration & Removal of Turning Lanes

4.1 Description of Movements and Closures

- Median restoration of temporary roadway – left lane closed in both directions.
- Removal of existing turning lanes.

Phase 4 Detail Diagram

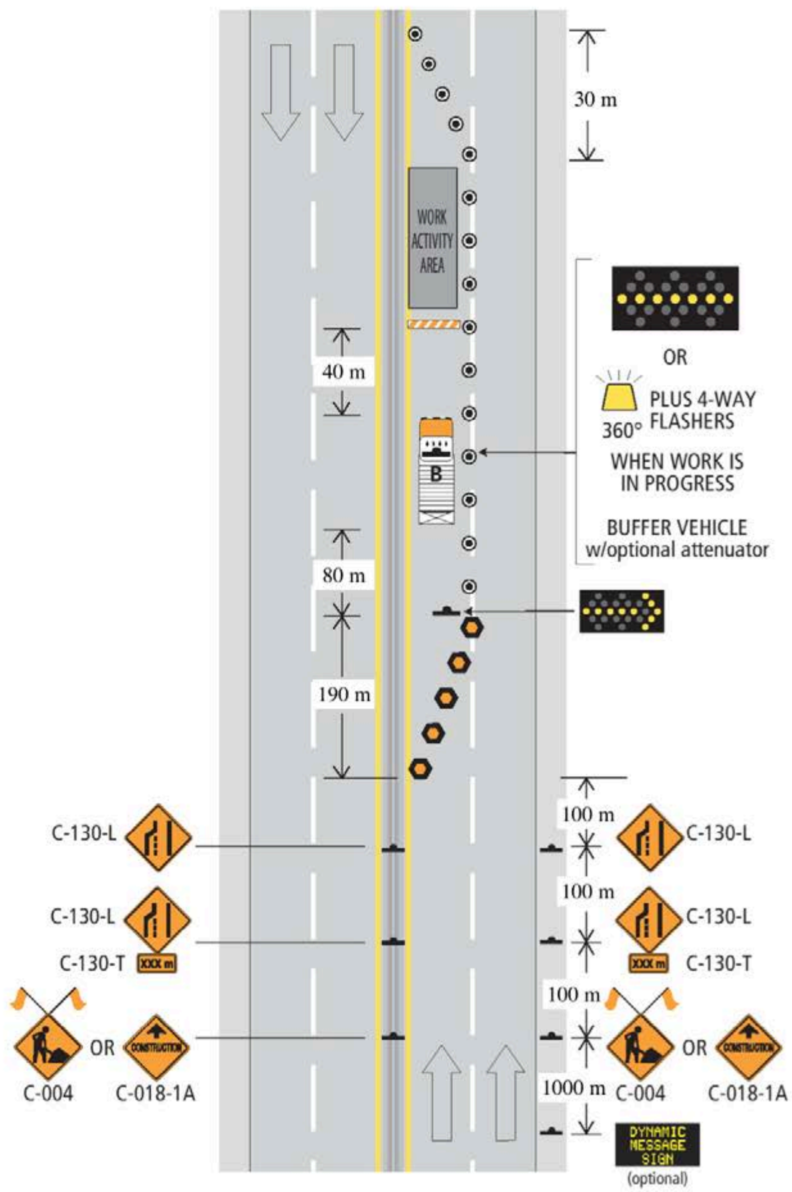
Detail G (Southwest Marine Drive, northbound lanes)

- DMS shall dictate: "LEFT LANE CLOSED AHEAD"
- Follow the figure presented below for closure details:

Section 9: Traffic Control Layouts – Multilane Divided Roadways

British Columbia — Ministry of Transportation and Infrastructure

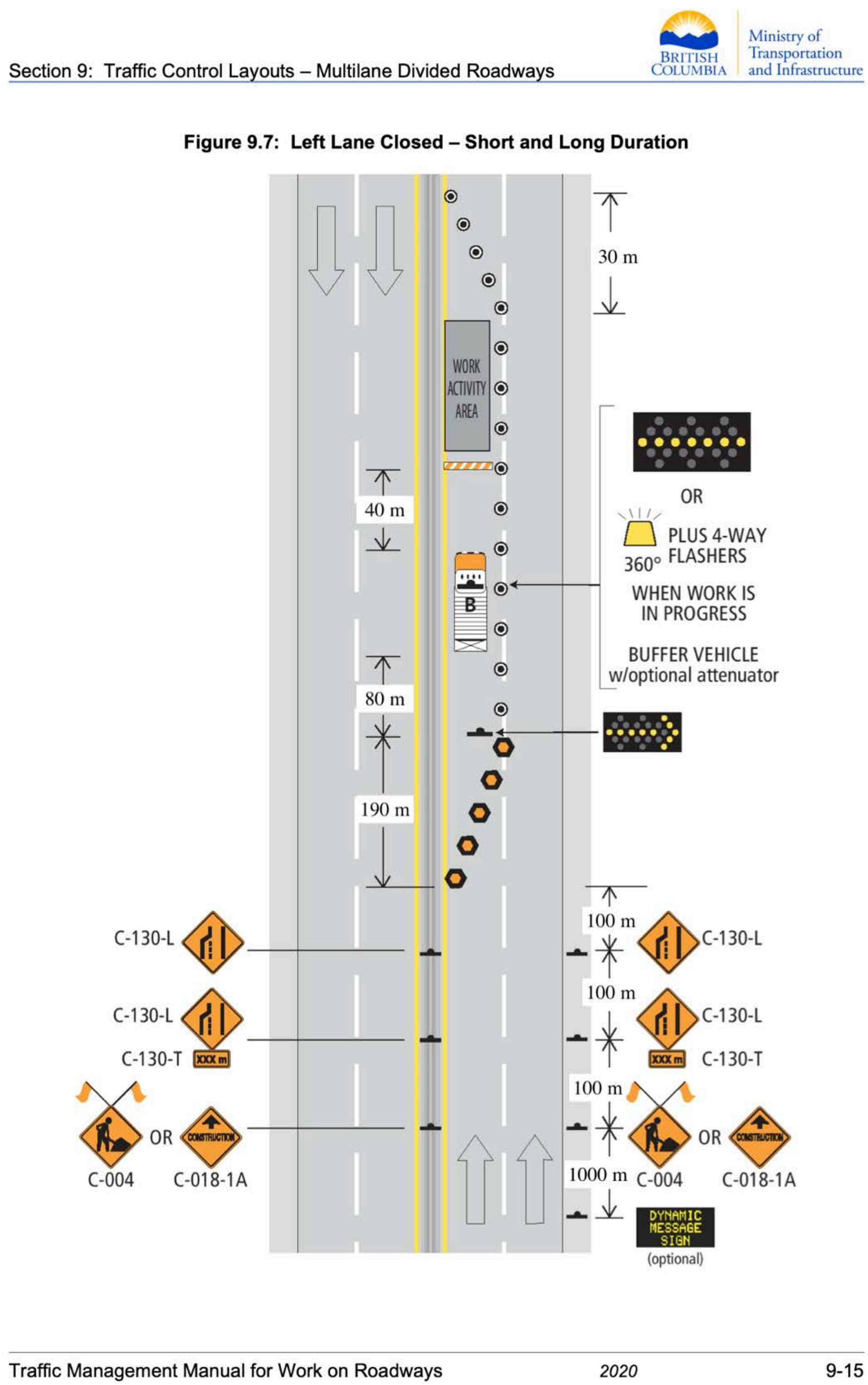
Figure 9.7: Left Lane Closed – Short and Long Duration



Traffic Management Manual for Work on Roadways 2020 9-15

Detail H (Southwest Marine Drive, southbound lanes)

- DMS shall dictate: “LEFT LANE CLOSED AHEAD”
- Follow the figure presented below for closure details:



Appendix E: Cost Estimate

Construction and Material Cost Estimate

		Activity Step	% of Cost	Personnel	Unit	Quantity	Unit Cost	Cost	Contingency (%)	Contingency	Total Cost
Quantity Takeoff/Material	Asphalt	Roundabout Lanes				156.3		15625.0	0.15	2343.75	
		Northbound Lanes		Paving Technicians	Tonnes	319.5	100.00	31950.0	0.15	4792.50	
		Southbound Lanes				162.8		16275.0	0.15	2441.25	
		Westbound Lanes	5.62%	Asphalt Paver Machines		200.3		20025.0	0.15	3003.75	$96,456.25
	Concrete	Islands		Masons and Carpenters		45.00		13500	0.15	2025	
		Footings			Cubic Meters	35.00	300.00	10500	0.15	1575	
		Center Water Tank		Concrete Pumps		1,200.00		360000	0.15	54000	
		Water Fountain and Roundabout	26.47%	Pump Operator		36.00		10800	0.15	1620	$454,020.00
	Gateway Design and Water Fountain	Glulam for Gateway Design			meters	80.00	105.00	8400	0.15	1260	
		UBC Sign			LS	1.00	15,000.00	15000	0.15	2250	
		Water Fountain Pipes			meters	20.00	62.22	1244.4	0.15	186.66	
		Pump System			LS	1.00	2,000.00	2000	0.15	300	
		Drainage Pipe System		Carpenters, Laborers,	meters	10.00	62.22	622.2	0.15	93.33	
		Lighting System	3.17%	Plumbers, Landscapers	LS	1.00	20,000.00	20000	0.15	3000	$54,356.59
	Street Lighting & Signage	Pre-fabricated and Carved Sidewalk Arches			LS	42.00	1,500.00	63000	0.15	9450	
		Crossing Signs			LS	12.00	103.00	1236	0.1	123.6	
		Speed Limit Signs			LS	5.00	70.00	350	0.1	35	
		Directional Signs		Electricians, Laborers, Artists	LS	5.00	77.00	385	0.1	38.5	
		Lighting Poles	16.09%	Electricians, Laborers	LS	74.00	2,500.00	185000	0.1	18500	$275,950.00
	Stormwater System	350 mm Pipes			meters	65.00	164.88	10716.9	0.05	535.8	
		375 mm Pipes			meters	66.00	165.63	10931.3	0.05	546.6	
		400 mm Pipes			meters	134.00	1,812.50	242875.0	0.05	12143.8	
		425 mm Pipes			meters	109.00	3,750.00	408750	0.05	20437.5	
		600 mm Pipes			meters	8.00	4,500.00	36000	0.05	1800	
		Manholes			LS	10.00	1,700.00	17000	0.05	850	
		Hydrodynamic Separators			LS	3.00	15,000.00	45000	0.1	4500	
		Pump System		Carpenters, Laborers,	LS	1.00	3,000.00	3000	0.05	150	
		Prefab Water Tanks	47.87%	Plumbers, Landscapers	cubic meters	45.00	120.00	5400	0.1	540	$821,176.78
	Temporary Traffic Control	Traffic Barriers			LS	25.00	250.00	6250	0.15	937.5	
		Temporary Light Towers			LS	4.00	140.00	560	0.15	84	
		Traffic Signs	0.62%	Laborers	LS	25.00	100.00	2500	0.15	375	$10,706.50
Permits	Permit Documents	Permit Applications			LS	1.00	12,000.00	12000	0.15	1800	
		Permit Review Process	0.17%	General Contractor	days	14.00	500.00	7000	0.15	1050	$2,850.00
Total Materials Cost + Permitting											$1,715,516.12

Construction Activities

		Activity Step	% of Cost	Personnel	# of Personnel	Number of Shifts	Base Rate	Duration (hours)	Contingency (%)	Total Activity Hours	Total Cost
Construction	Startup			Senior Surveyor	1	2.00	85.00	10	0.12	20	
		Surveying	0.26%	Junior Surveyor	2	2.00	68.00	10	0.12	20	$5,967.00
				Labor Foreman	2	7.00	85.00	15	0.12	210	
				Excavators	2	7.00	200.00	15	0.12	210	
				Excavator Operator	2	7.00	90.00	15	0.12	210	
		Excavations and Grading	9.14%	Laborers	10	7.00	75.00	15	0.12	1050	$212,625.00
	Asphalt			Laborers - Mill Machine	4	5.00	75.00	20	0.12	400	
				Mill Machine Drivers	2	5.00	90.00	20	0.12	200	
				Mill Machine	2	5.00	1,000.00	20	0.12	200	
		Asphalt Milling		Trucks	2	5.00	100.00	20	0.12	200	
				General Foreman	1	30.00	100.00	20	0.12	600	
		Asphalt Paving		Senior Paver Technician	2	30.00	100.00	20	0.12	1200	
				Junior Paver Technician	5	30.00	90.00	20	0.12	3000	
		Asphalt Compacting	39.94%	Compacting Machine	2	30.00	75.00	20	0.12	1200	$929,200.00
	Concrete			General Carpenter Foreman	1	4.00	90.00	10	0.12	200	
		Concrete Islands and Water Fountain Formwork	0.95%	Carpenter Journeyman	4	4.00	80.00	10	0.12	190	$22,140.00
		Concrete Pours for Islands and Fountain		Masonry Foreman	1	3.00	85.00	10	0.12	30	
			0.46%	Masonry Journeyman	3	3.00	60.00	10	0.12	90	$10,732.50
	Stormwater System			Labor Foreman	1	6.00	85.00	15	0.12	90	
		Water Tank and Piping Installation		Laborers	2	6.00	75.00	15	0.12	180	
			1.70%	Crane Operator	1	6.00	90.00	15	0.12	90	$39,487.50
		Pipe and System Assembly		Labor Foreman	1	6.00	85.00	15	0.12	90	
			1.08%	Plumber	2	6.00	75.00	15	0.12	180	$25,030.90
	Gateway Design	Excavations		Labor Foreman	1	4.00	85.00	10	0.12	40	
		Footing and Structure Placements	0.89%	Laborers	4	4.00	75.00	10	0.12	160	$20,790.00
	Temporary Road Access			Laborers	4	3.00	75.00	15	0.12	45	
		Route Clearance and Paving		Excavator Operator	1	2.00	80.00	15	0.12	30	
			1.19%	Paving Technician	3	2.00	100.00	15	0.12	90	$27,700.00
	Road Painting	Pedestrian Crossings, Bike Lanes and Roads		Painter Foreman	1	3.00	100.00	10	0.12	30	
			0.56%	Painter Journeyman	3	3.00	100.00	10	0.12	90	$13,092.00
	Road Signs and Lighting	Pedestrian Crossings		Laborer Foreman	1	3.00	85.00	10	0.12	30	
		Street Lighting		Electrician Foreman	1	3.00	150.00	10	0.12	30	
		Sidewalk Arches Installation		Electricians	4	5.00	100.00	10	0.12	200	
		Speed Control	1.72%	Laborers	3	3.00	75.00	10	0.12	90	$40,000.00
	Engineering Management	Supervision		Project Manager	1	1	150,000	0.75	0.12		
				Project Engineer	1	1	110,000	0.75	0.12		$455,625.00
		Traffic Management Plan		Field Engineers	2	1	70,000	0.75	0.12		
			19.58%	Superintendents	1	1	120,000	0.75	0.12		
	Environmental	Monitoring		Senior Environmental Monitor	1	1	80,000	0.75	0.12		$146,812.50
			6.31%	Junior Environmental Monitor	1	1	65,000	0.75	0.12		
	Rental Equipment	Asphalt Paver		Paver Operator	1	30	800	8	0.12	240	
		Asphalt Compactor		Compactor Operator	1	30	300	8	0.12	240	
		Excavator (8 TON) 18,000 LB)		Operator	1	50	525	8	0.12	400	$377,515.20
		Power Generator 45 kVA			1	120	263	8	0.12	960	
		Pipe Layer		Machine Operator	1	5	2000	8	0.12	40	
		Man Lift	16.23%	Certified Operator	1	15	260	8	0.12	120	
Total Construction Cost											$2,326,717.60

	Activity Step	% of Cost	Personnel Class	Unit	Quantity	Unit Cost	Cost	Contingency (%)	Contingency	Total Cost
Maintenance	Filters, Pumps and Pipes		Senior Plumbers	/Month	36.00	150.00	5400	0.15	810	
	Painting		Senior Painters	/Month	12.00	100.00	1200	0.15	180	
	Pavement		Pavement Technicians	/Month	12.00	120.00	1440	0.15	216	
	Landscaping	0.40%	Landscapers	/Month	24.00	300.00	7200	0.15	1080	$17,526.00

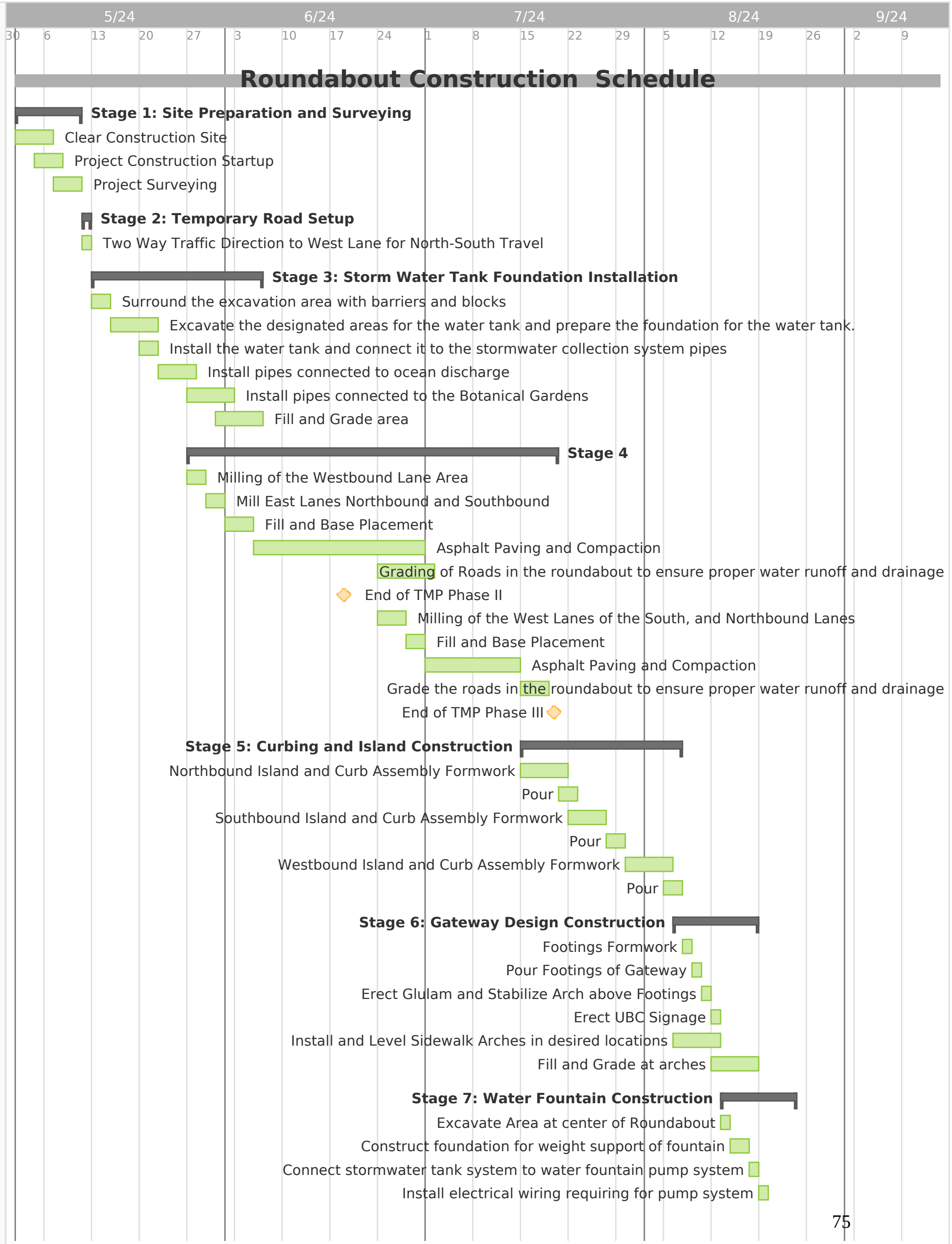
Total Cost		$4,059,759.72
Inflation and Escalation 3.5%	3.5%	$142,091.59
GST 5%	5%	$202,987.99
GRAND TOTAL COST		**$4,404,839.30**

Appendix F: Project Schedule

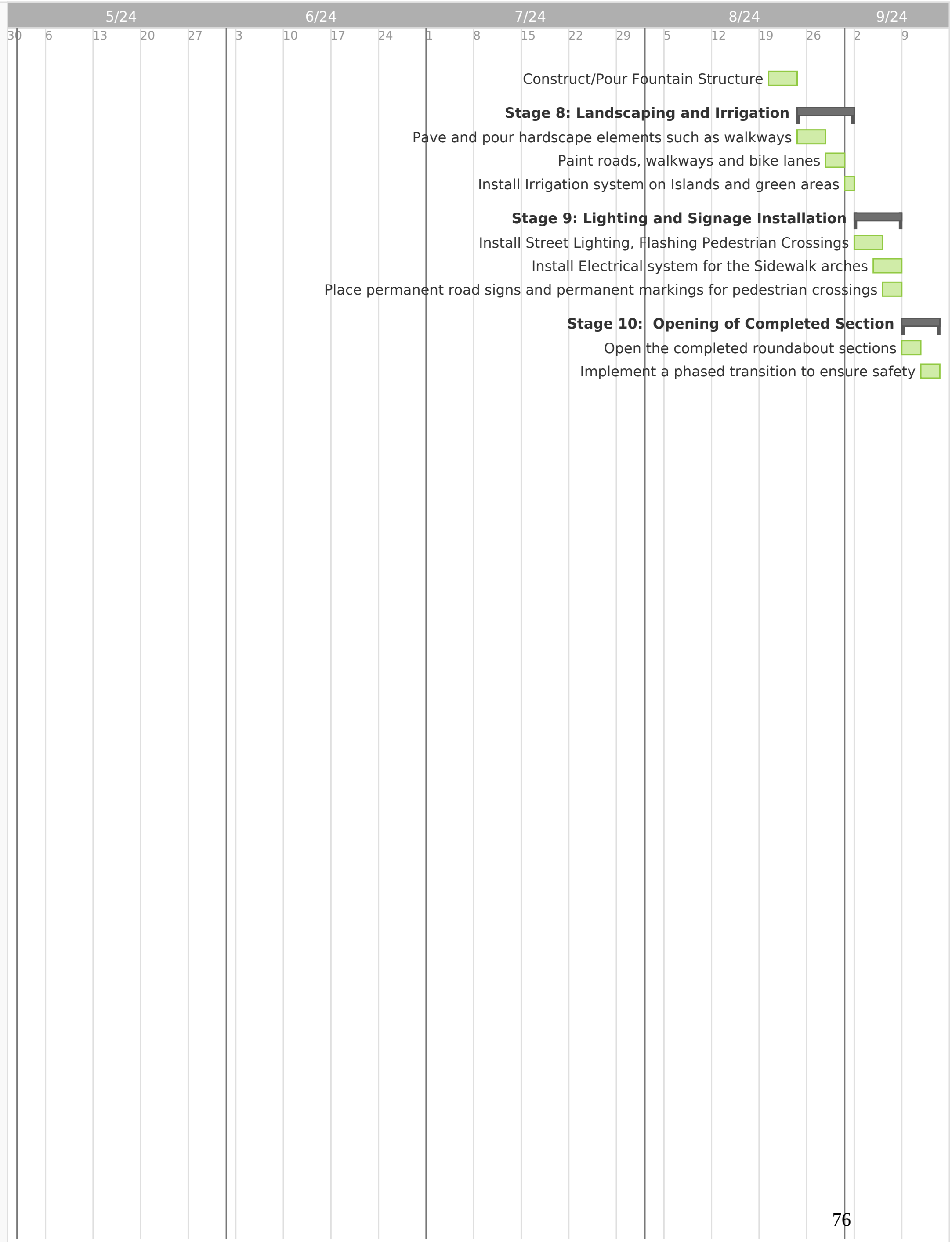
Construction Schedule

Project	Phase	Stages		Milestone	Starting	Ending	Number of Days
Roundabout Construction Schedule	***Phase 1***	***Stage 1: Site Preparation, and Surveying***		Project Construction Startup; Clear the construction site for the roundabout, water tank, fountain, gateway, and the new road	5/1/2024	5/6/2024	5
				Perform required surveys and elevation checks	5/7/2024	5/9/2024	2
		Stage 2: Temporary Road Setup		Direct two way traffic to west lane to allow South-North Travel	5/10/2024	5/11/2024	1
		Stage 3: Storm Water Tank Foundation and Installation		Surround the excavation area with barriers and blocks	5/13/2024	5/14/2024	1
				Excavate the designated areas for the water tank and prepare the foundation for the water tar	5/15/2024	5/21/2024	5
				Install the water tank	5/20/2024	5/21/2024	2
				Install Pipes connected to ocean discharge pipes	5/22/2024	5/27/2024	4
				Install pipes connected to the Botanical Garden	5/23/2024	5/31/2024	6
				Fill and Grade area	5/30/2024	6/5/2024	5
		Stage 4: Roadway Construction	***Work Area A***	Milling of the Westbound Lane Area	5/27/2024	5/28/2024	2
				Mill East Lanes Northbound and Southbound	5/29/2024	5/30/2024	2
				Fill and Base Placement	5/31/2024	6/5/2024	3
				Asphalt Paving and Compaction	6/5/2024	6/28/2024	20
				Grading of Roads in the roundabout to ensure proper water runoff and drainage	6/24/2024	7/1/2024	5
				End of TMP Phase II			
			Work Area B	Milling of the West Lanes of the South, and Northbound Lanes	6/24/2024	6/26/2024	2
				Fill and Base Placement	6/27/2024	6/28/2024	1
				Asphalt Paving and Compaction	7/1/2024	7/12/2024	8
				Grade the roads in the roundabout to ensure proper water runoff and drainage	7/11/2024	7/17/2024	2
				End of TMP Phase III			
		Stage 5: Curbing and Island Construction	***Northbound Island and Curbs***	Formwork Assembly	7/15/2024	7/19/2024	4
				Pour	7/19/2024	7/22/2024	3
			Southbound Island and Curbs	Formwork Assembly	7/22/2024	7/25/2024	3
				Pour	7/26/2024	7/29/2024	1
			Westbound Island and Curbs	Formwork Assembly	7/29/2024	8/5/2024	3
				Pour	8/5/2024	8/6/2024	1
	Phase 2	***Stage 6: Gateway and Sidewalk Arches Construction***		Footings Formwork	8/7/2024	8/8/2024	1
				Pour footings of the gateway design on different ends of the South Approach	8/9/2024	8/9/2024	1
				Erect Glulam and stabilize arch above footings spanning the entire section	8/12/2024	8/13/2024	1
				Erect UBC Sign above arch structure	8/12/2024	8/13/2024	1
				Install and Level Sidewalk Arches in desired locations	8/6/2024	8/12/2024	6
				Fill and Grade at arches	8/12/2024	8/16/2024	5
		Stage 7: Water Fountain Construction		Excavate area at center of roundabout	8/13/2024	8/13/2024	1
				Construct foundation for weight support of fountain	8/14/2024	8/15/2024	2
				Connect stormwater tank system to water fountain pump system	8/16/2024	8/16/2024	1
				Install electrical wiring requiring for pump system	8/19/2024	8/19/2024	1
				Construct/Pour Fountain Structure	8/20/2024	8/22/2024	3
	Phase 3	***Stage 8: Landscaping, Painting and Irrigation***		Pave and pour hardscape elements such as walkways	8/23/2024	8/27/2024	3
				Paint roads, walkways and bike lanes	8/28/2024	8/29/2024	2
				Install Irrigation system on Islands and green areas	8/30/2024	8/30/2024	1
		Stage 9: Lighting and Signage Installation		Install Street Lighting, Flashing Pedestrian Crossings	9/2/2024	9/4/2024	3
				Install Electrical system for the Sidewalk arches	9/4/2024	9/6/2024	3
				Place permanent road signs and permanent markings for pedestrian crossings	9/6/2024	9/9/2024	2
		Stage 10: Opening of Completed Section		Open the completed roundabout sections	9/9/2024	9/10/2024	2
				Implement a phased transition to ensure safety	9/11/2024	9/12/2024	2
	Phase 4	***Stage 11: Post-construction Monitoring and Maintenance***		Monitor traffic flow and address any issues	9/13/2024	10/11/2024	30
				Implement regular maintenance for the completed sections	Monthly	Monthly	30

Roundabout Construction Schedule	start	end	0h	0%
Stage 1: Site Preparation and Surveying	**01/05/24**	**09/05/24**	**0h**	**0%**
Clear Construction Site	01/05	06/05	0	0%
Project Construction Startup	03/05	07/05	0	0%
Project Surveying	07/05	09/05	0	0%
Stage 2: Temporary Road Setup	**10/05/24**	**11/05/24**	**0h**	**0%**
Two Way Traffic Direction to West Lane for Nort...	10/05	11/05	0	0%
Stage 3: Storm Water Tank Foundation Instal...	**13/05/24**	**05/06/24**	**0h**	**0%**
Surround the excavation area with barriers and ...	13/05	14/05	0	0%
Excavate the designated areas for the water tan...	15/05	21/05	0	0%
Install the water tank and connect it to the stor...	20/05	21/05	0	0%
Install pipes connected to ocean discharge	22/05	27/05	0	0%
Install pipes connected to the Botanical Gardens	27/05	31/05	0	0%
Fill and Grade area	30/05	05/06	0	0%
Stage 4	**27/05/24**	**18/07/24**	**0h**	**0%**
Milling of the Westbound Lane Area	27/05	28/05	0	0%
Mill East Lanes Northbound and Southbound	29/05	30/05	0	0%
Fill and Base Placement	31/05	04/06	0	0%
Asphalt Paving and Compaction	05/06	28/06	0	0%
Grading of Roads in the roundabout to ensure p...	24/06	01/07	0	0%
End of TMP Phase II	18/06	18/06	0	0%
Milling of the West Lanes of the South, and Nort...	24/06	26/06	0	0%
Fill and Base Placement	27/06	28/06	0	0%
Asphalt Paving and Compaction	01/07	12/07	0	0%
Grade the roads in the roundabout to ensure pr...	15/07	17/07	0	0%
End of TMP Phase III	18/07	18/07	0	0%
Stage 5: Curbing and Island Construction	**15/07/24**	**06/08/24**	**0h**	**0%**
Northbound Island and Curb Assembly Formwork	15/07	19/07	0	0%
Pour	19/07	22/07	0	0%
Southbound Island and Curb Assembly Formwork	22/07	25/07	0	0%
Pour	26/07	29/07	0	0%
Westbound Island and Curb Assembly Formwork	30/07	05/08	0	0%
Pour	05/08	06/08	0	0%
Stage 6: Gateway Design Construction	**06/08/24**	**16/08/24**	**0h**	**0%**
Footings Formwork	07/08	07/08	0	0%
Pour Footings of Gateway	08/08	08/08	0	0%
Erect Glulam and Stabilize Arch above Footings	09/08	09/08	0	0%
Erect UBC Signage	12/08	12/08	0	0%
Install and Level Sidewalk Arches in desired loca...	06/08	12/08	0	0%
Fill and Grade at arches	12/08	16/08	0	0%
Stage 7: Water Fountain Construction	**13/08/24**	**22/08/24**	**0h**	**0%**
Excavate Area at center of Roundabout	13/08	13/08	0	0%
Construct foundation for weight support of fount...	14/08	15/08	0	0%
Connect stormwater tank system to water fount...	16/08	16/08	0	0%
Install electrical wiring requiring for pump syst...	19/08	19/08	0	0%



Construct/Pour Fountain Structure	20/08	22/08	0	0%
Stage 8: Landscaping and Irrigation	**23/08/24**	**30/08/24**	**0h**	**0%**
Pave and pour hardscape elements such as wal...	23/08	27/08	0	0%
Paint roads, walkways and bike lanes	28/08	29/08	0	0%
Install Irrigation system on Islands and green ar...	30/08	30/08	0	0%
Stage 9: Lighting and Signage Installation	**02/09/24**	**06/09/24**	**0h**	**0%**
Install Street Lighting, Flashing Pedestrian Cross...	02/09	04/09	0	0%
Install Electrical system for the Sidewalk arches	04/09	06/09	0	0%
Place permanent road signs and permanent mar...	05/09	06/09	0	0%
Stage 10: Opening of Completed Section	**09/09/24**	**12/09/24**	**0h**	**0%**
Open the completed roundabout sections	09/09	10/09	0	0%
Implement a phased transition to ensure safety	11/09	12/09	0	0%
Stage 11: Post-construction Monitoring and ...	**-**	**-**	**0h**	**0%**
Monitor traffic flow and address any issues	-	-	0	0%
Implement regular maintenance for the complet...	-	-	0	0%



Specifications Package

Project: Southwest Marine Drive and West 16 Avenue Redesign

Section 00 00 01 GENERAL REQUIREMENTS Overview

1.0 Summary
These provisions outline the requirements for starting work and throughout the construction process.

2.0 Requirements Prior to Starting Work
The Tendering Documents outline critical requirements for accepted Contractors. They form a part of the Contract Documents and must be read in conjunction with the requirements herein. Specifically, the requirements prior to work include but are not limited to:

2.1 Bonds and Insurance:

Performance and Labour & *Materials Payment Bond* (50% of the project value) must be obtained at the time of the Tender Submission.General Liability Insurance, Builder's Risk Insurance, and Project Wrap up Insurance must be obtained at the time of the Tender Submission.

2.2: Work Safe BC:

The Accepted Contractor must adhere to the Work Safe BC Provisions and must be a registered Contractor with Worksafe BC. Certification of Registration must be provided to the Consultant within the Tender Submission

2.3: Supervision:

An experienced Site Superintendent must be present during the Construction, identified within the Tender Submission. If for any reason this superintendent is replaced, a similarly experienced Superintendent must be approved by the Consultant. The Consultant retains the right to suspend or replace the Superintendent in the case of poor supervision.

2.4: Permit:

All permits identified must be provided to the Constault at minimum 5 days prior to work which requires such permit.

2.5: Submittals and Approvals:

Submittals must be provided 20 days prior to their use (unless otherwise stated herein), allotting time for the Engineer to review them. Submittals are listed within the applicable Sections herein.

3.0 Erosion and Sediment Control Measures
All measures outlined for Erosion and Sediment Control within the drawings shall be in-place before arrival of mobilized equipment or construction activity.

4.0 Site Safety Requirements
A submittal entailing the site safety measures shall be provided to the Consultant for review before work begins. During the construction

5.0 Tree Protection
Tree protection must be in and stay in place during the construction. Snow fencing or an approved alternative is acceptable. Damaged tree fencing will be rejected.

END OF SECTION

Section 03 30 00 CONCRETE Cast In Place (CIP) Concrete

1.0 Scope of Work:
This project entails the installation of a Glulam Sign supported by Concrete Pedestals and Footings. The process encompasses supplying materials, precise mixing, and careful placement of reinforced cast in place concrete. Fabrication, temporary works, and measures for heating/cooling concrete, mix design, quality control testing, and installation of water seals/joint fillers are integral parts of this project. All activities must strictly adhere to the rigorous standards set by the CSA A23.3 specifications for reinforced cast in place concrete.

2.0 Concrete Requirements:

2.1 Concrete Plant, Equipment, and Truck Mixers:

All concrete plant facilities, equipment, and truck mixers must meticulously comply with CSA standards and the specifications outlined in this document.

2.2 Materials:

Every material used in the concrete mixture must meet stringent requirements set by CSA standards and this specification to ensure structural integrity and longevity.

2.3 Concrete Mix Design:

Mix designs must exceed CSA and specification standards to guarantee optimal performance and durability.

2.4 Production and Delivery:

From production to delivery, every phase of the concrete process must meet CSA and specification standards to uphold the integrity of the final product.

3.0 Contractor's Performance Criteria:

Contractors must submit comprehensive performance criteria for each mix design, covering parameters such as placeability, workability, slump, slump retention time, and set time to ensure compliance with project requirements.

4.0 Compliance with Standards:

The project relies on reference standards such as ASTM and CSA. All reference standards must be current at the time of tender advertisement to ensure adherence to industry best practices. Specific references include:

- MoTI: Standard Specifications for Highway Construction - Section 905 "Timber - Glued Laminated"
- ASTM C 29: Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
- ASTM C 40: Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
- ASTM C 42: Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- ASTM C 70: Standard Test Method for Surface Moisture in Fine Aggregate
- ASTM C 88: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
- ASTM C 117: Standard Test Method for Materials Finer than 75µm (No. 200) Sieve in Mineral Aggregates by Washing
- ASTM C 127: Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
- ASTM C 128: Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine
- ASTM C 586: Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks as Concrete Aggregates (RockCylinder Method)
- ASTM D 5821: Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
- ASTM D 6928: Standard Test Method for Resistance of Coarse Aggregate to Degradation by Abrasion in the MicroDeval Apparatus
- ASTM D 7428: Standard Test Method for Resistance of Fine Aggregate to Degradation by Abrasion in the MicroDeval Apparatus

These references provide a comprehensive framework for testing, evaluation, and quality control throughout the project.

5.0 Materials:

5.1 Fine Aggregate:

Fine aggregate used in the concrete mixture must conform to CSA grading requirements for uniformity and consistency.

5.2 Coarse Aggregate:

Coarse aggregate, with a maximum nominal size of 14 mm, must meet CSA grading requirements to ensure structural integrity.

5.3 Cementitious Materials:

All cementitious materials must conform rigorously to CAN/CSA A3001 and stored properly to prevent hardening or lumps.

5.4 Water:

Potable water meeting CSA requirements and free from contaminants must be used for mixing and curing.

5. Formwork:

Forms for exposed surfaces must be of high quality plywood and maintained in good condition.

6.0 Construction Method:

6.1 Mixing Concrete:

All concrete shall be mixed thoroughly until it is uniform in appearance, with all ingredients uniformly distributed.

6.2 Time of Hauling:

Concrete must be delivered within specified time limits to maintain quality and workability.

6.3 Falsework and Formwork:

All falsework and formwork must comply with CAN/CSA standards to ensure safety and stability during construction.

6.4 Pumping of Concrete:

Proper pumping techniques must be employed to ensure continuous flow without air pockets compromising structural integrity.

7.0 Cold Weather Precautions:

7.1 Mitigation

Appropriate precautions must be taken to mitigate adverse effects of cold weather on concrete, including heating aggregates, water, and concrete.

8.0 Quality Control:

8.1 Sampling:

Sampling procedures must adhere strictly to CSA standards to ensure accuracy of test results.

8.2 Cylinder Testing:

Testing procedures for making and curing test cylinders must follow CSA protocols to accurately assess concrete compressive strength.

9.0 Material Testing:

9.1 Testing Compliance

Material testing, including concrete and soils, must be conducted under the direction of the structural engineer and comply with relevant standards.

END OF SECTION

Section 03 90 00 CONCRETE Asphalt Pavement Construction

1.0 Scope of Work:

This section pertains to the supply and installation of asphalt concrete pavement, used on the roadway for vehicle travel and cyclist lanes.

2.0 Asphalt Requirements:

2.1 Materials: Asphalt concrete supplied and installed using industry best practices, conforming to MoTI requirements.

2.2 Asphalt Concrete Mix Design: Adhering to Superpave and MoTI Standards.

2.3 Production and Delivery: Following all specifications prescribed in applicable Standards.

2.4 Execution: Following industry best practice

3.0 Contractor's Performance Criteria:

3.1 Defects will remediated at the expense of the Contractor:

- Areas of water pooling will be taken as a defect and will be rejected. Remedial work will be at the contractors expense.
- Rough, unleveled pavement, or not in conformance with the grading specified in the Drawings will be rejected. (+-12mm over 3m).
- Roller Marks or pickups
- Excess or insufficient asphalt per drawings
- Cracking or Tearing

4.0 Submittals:

- Asphalt Mix Design. Submit at minimum 5 days prior to asphalt paving construction.

5.0 Compliance with Standards:

- MoTI Standard Specification for Highway Construction - Section 502 Asphalt Pavement Construction End Product Specification
- AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing and AASHTO Provisional Standards, 43rd Edition, 2024
- Superpave Series Publication – Superpave Mix Design (current version).
- Superpave Mix Design, Superpave Series No. 2" (current version)
- ASTM D2419: Standard Test Method for Sand Equivalent

6.0 Materials:

6.1 Superpave Asphalt Concrete

5.1.1: Aggregates

- Shall consist of crushed stone, gravel or combination of these or materials naturally occurring in fractured conditions.
- Free of silt, clay, deleterious materials
- Meeting requirements prescribed in MoTI Standard Specifications, Table 502-B
- Fine aggregate shall not have a sand content less than 45% following ASTM D2419
- Shall have properties in accordance with Superpave Series Publication Superpave Mix Design (current version).

6.1.2: Asphalt Mix

- Shall be in accordance with Superpave Series Publication Superpave Mix Design (current version).
- Shall not contain any materials which are banned in MoTI Specifications
- Anti-Strip is not required on this project

5.3 Tack Coat:

- From a MoTI approved supplier. Otherwise, request a substitute product.

6.0 Construction Method:

6.1 Joints

- Pavement shall be placed homogeneously (ie. no cold joints between lanes)
- Lap Splices shall be placed at longitudinal joints (tie-in locations). Surface mill 50mm depth for 500mm overlap and pave.

6.2 Compaction

- Immediately following spreading, the crushed base course aggregate shall be compacted to meet or exceed the applicable Target Density. The method of compaction to be employed may be selected by the Contractor, but shall be subject to approval by the Quality Manager and the Ministry Representative
- For each material produced and placed under SS 202, the Contractor shall determine a Target Density in accordance with the following.
  - Laboratory Density – Where the material gradation is within the applicable range, the Target Density shall be the Standard Proctor Maximum Dry Density obtained under the current ASTM D698, with oversize correction in accordance with ASTM D4718; or
  - Field Density – Where the material falls outside the applicable range of ASTM D698 and ASTM D4718, the Target Density shall be 98% of the maximum dry density achieved through field compaction at varying moisture content and varying number of compaction passes. The methodology employed in determining the field density shall be developed by the Contractor and its Quality Manager, and be subject to the approval of the Ministry Representative
- If the Contractor's methodology is not approved by the Ministry Representative, then the Contractor may propose an alternative method or the Ministry Representative may order that each lift or course of aggregate shall be continuously and thoroughly rolled until successive passes of a vibratory roller results in an increase in density of less than 10 kg/m3. The vibrating roller shall have a minimum steel drum diameter of 1.15 m, a minimum drum width of 1.5 m, and shall be capable of being loaded so as to have a gross mass of 20 kg per lineal centimeter of drum width.

7.0 Quality Control:

- Batches of Asphalt concrete shall be delivered with records of truck number, weight, date and time
- Prior to issuance of a completion certificate, the Consultant (or Ministry Representative) shall be given the aggregate quality control test, asphalt quality control test, quality control charts.
- Shall be in accordance with Appendix 502-A, Standard Specifications of Highway Construction - MoTI

8.0 Material Testing:

- The Ministry Representative may require a proof rolling, in accordance with SS 202.29, at any time to assess the performance of the grade at the Target Density.
- Where a test is specified to conform to an ASTM procedure, the correspondingly listed AASHTO test may be used, or vice versa. See Table 502-A Standard Sampling and Testing Procedures.

END OF SECTION

1.0 Scope of Work
This section outlines the framing system utilizing structural glued laminated timber, encompassing beams, headers, joists, rimboards, studs, and roof decking.

2.0 Compliance with Standards

- CSA O86 Engineering Design in Wood.
- CSA S16 Design of Steel Structures.
- Technical Design Requirements for Alberta Infrastructure Facilities (Section 1.0 "Sustainability" and "Appendix G – Green Building Standards").
- LEED Project Delivery Process Manual.
- LEED Project Delivery Process Manual – Appendices.

3.0 Design Criteria
Contractors are responsible for designing connections not indicated on drawings but necessary for completion, adhering to CSA O86 and CSA S16. Exposed connections should generally be concealed, unless pre approved by the engineer.

4.0 Submittals

- Product Data.
- Shop Drawings.
- Certificates.
- Moisture and Humidity Control Plan.
- LEED Submittals if applicable.

5.0 Quality Assurance

- Compliance with Alberta Building Code.
- Manufacturer and fabricator qualifications.

6.0 Delivery, Storage, and Handling

- Compliance with delivery and acceptance requirements.
- Storage and handling per manufacturer recommendations.

7.0 Products

7.1 Description

- Douglas FirLarch, Grade 20f-E: Materials extracted, harvested, recovered, and processed within minimum required distances to the final point of manufacture.

7.2 Materials

- Laminating Stock: Douglas FirLarch, Grade 20f-E.
- Adhesives: CSA O112.7.
- Steel for Connections: CSA G40.20/G40.21, Grade 300W or 350G.

7.3 Fabrication

- Fabricate to stress grade: 20f-E.
- Service Grade: Interior.
- Camber for Beams Spanning Over 5 meters: 1.5 to 2 times dead load deflection.
- Fabricate connection hardware to applicable requirements.

7.4 Appearance Grade
Structural glued-laminated timber shall be of commercial or industrial grade.

7.5 Factory Finishing
Apply two coats of sealer to end grain and one coat to the remainder of members.

7.6 Preservative Treatment
After fabrication, pressure treat indicated members with preservative in accordance with CAN/CSA O80 Series.

8.0 Sustainability and Green Building Requirements

- For projects not designated to use a sustainable rating system, it is still prudent to include relevant green building requirements as part of sustainability efforts.
- Review and incorporate requirements from the following documents:
- Technical Design Requirements for Alberta Infrastructure Facilities (Section 1.0 "Sustainability" and "Appendix G – Green Building Standards").
    - LEED Project Delivery Process Manual.
    - LEED Project Delivery Process Manual – Appendices.
- Ensure compliance with sustainability standards, regional material sourcing requirements, and any applicable LEED credits such as MRc7 for certified wood and EQ credits for low emitting materials.

END OF SECTION

Section 12 40 01 FURNISHINGS Pedestrian Amenities

1.0 Summary
This section outlines the supply and installation of Community Planter Boxes and Pedestrians arches as outlined on the Drawings

2.0 Compliance with Standards
CSA O86 Engineering Design in Wood.
Durable Greenbed™ Product List

3.0 Design Criteria
Contractors are responsible for designing connections not indicated on drawings but necessary for completion, adhering to CSA O86 and CSA S16. Exposed connections should generally be concealed, unless pre approved by the engineer.

4.0 Submittals
Purchase Order: Durable Greenbed™
Shop Drawings: Pedestrian Arches and Connection

5.0 Quality Assurance
Arches must pass visual inspection by the Consultant.
Community Gardens must be installed in correct locations on plan locations in excellent condition.

6.0 Products

6.1 Description

Pedestrian Arches:

- Posts: 500 x 500 mm Dimensional Lumber, Cedar
- Beams: 500 x 500 mm Dimensional Lumber, Cedar

Community Gardens:

- Prefabricated Unit: Durable Greenbed™ 4’X12’X1’ Long Rectangle Raised Garden Bed Kit | TimberTech Trim Colour: Coastline

6.3 Fabrication
Connection Between posts and beams for arches are recommended to be performed onsite. If the Contractor chooses to fabricate offset, the Consultant shall be permitted to inspect the fabrication plant and additional submittals are required to describe the process,

6.4 Preservative Treatment
After fabrication, pressure treat indicated members with preservative in accordance with CAN/CSA O80 Series.

END OF SECTION

Section 26 50 01 **ELECTRICAL** **Street Lighting**

1.0 Summary
This section outlines the supply and installation of street luminaires - DAVIT style as indicated on the drawing package.

2.0 Reference Documents
- MoTI Standard Specification for Highway Construction 2020 - Section 635
- British Columbia Electrical and Signage Material Standards - Volume 1 - Section 504 LED Roadway Luminaires

3.0 Design Criteria
The construction must be accordance with industry best practices for supply and installation.

4.0 Quality Assurance
The Consultant shall be onsite for the first installation of breakaway bases, poles and lights.

5.0 Products
See Section 635
- Breakaway bases: Type C: See drawing 1.1.3
- LED: Conforming to Section 504 LED Roadway Luminaires
- Poles: Type 2A: See Drawing 2.1.3 All Luminaires must be CSA or ULC Approved or equivilent
- Bolts and Installation Guidance: See drawing 2.1.4

6.1 Supplier
All of the following from MOTI approved suppliers

END OF SECTION

Section 31 23 01 **EARTHWORK** **Excavating, Trenching, and Backfilling**

1.0 General
This comprehensive specifications package outlines the requirements and procedures for excavating, trenching, and backfilling, ensuring compliance with regulatory standards and project specifications.

2.0 Limitations of Open Trench:
Backfilling procedures must promptly follow pipe laying, with no inactive open trench remaining for more than 5 days without Consultant approval.
- Approval is required for leaving more than one backfilled block at any time.
- The use of road plates for excavation coverage and lane restoration is generally prohibited, unless approved by an Engineer's signed letter ensuring safety and compliance with loading requirements.

2.0 Permits and Approvals:
A Condition Survey with the Consultant must precede any excavation, unless directed otherwise by the City Engineer.

3.0 Measurement and Payment:
- Payment for trench excavation by hand or hydro vacuum will be incidental unless otherwise specified.
- Payment for rock excavation will comply with Section 31 23 17 Rock Removal.
- Inspection charges from third party utility companies and external authorities will be incidental.
- Payment for additional paving and professional geotechnical services will be as per the Schedule of Quantities and Prices.
- Costs for trench width upgrading due to unstable soil conditions will be borne by the Owner or Contractor based on approval.

4.0 Inspection and Testing:
Sources and gradation curves for backfill materials must be submitted to the Consultant two weeks before construction.
Compaction tests will follow Contract Documents and City Engineer approval.
The Contractor must submit all compaction test results and certificates to the Consultant within 48 hours.

5.0 Products

5.1 General:

Refer to Section 31 05 17 Aggregates and Granular Materials and other relevant sections for additional requirements.

5.2 Use of Specified Materials:
Backfill materials for over excavated trenches shall be selected according to specified options or as directed by the City Engineer.

5.3 Site Preparation:
Pavement cutting shall confine to designated trench widths unless approved otherwise by the City Engineer.

5.4 Stockpiling:
Stockpiling must comply with environmental protection regulations.

5.5 Excavation:
- Excavations must maintain specified alignments and grades.
- Hand or hydro vacuum excavation may be required to preserve existing features or facilities.
- Disposal of pumped water and silt laden water must meet environmental standards.
- Material management and waste disposal are the responsibility of the Contractor.

5.6 Backfill and Compaction:
- Compaction equipment must be selected carefully to avoid damage to existing utilities.
- Backfilling procedures must be controlled and approved by the City Engineer.
- Backfill materials must be placed in uniform lifts and compacted to specific densities.

5.7 Surface Restoration:
- Restorations must adhere to specified standards for topsoil, seeding, sodding, and planting.
- Temporary and permanent pavement restoration must comply with surface restoration requirements.

5.8 Trenching in Peat Areas:
Street cut repairs in peat areas must adhere to specified standard detail drawings for restoration.

END OF SECTION

Section 34 00 01 TRANSPORTATION Pavement Markings, Paint, Signage

1.0 Summary
This section outlines the supply and installation of pavement markings, paint and signage.

2.0 Compliance with Standards
- ASTM B221M – Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes
- ASTM B209M – Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- ASTM D4956 – Standard Specification for Retro-reflective Sheeting for Traffic Control
- CSA 0121M-1978 – Douglas Fir Plywood
- Sign Pattern Manual, British Columbia – Sign size, shape, colours and sheeting grade
- Manual of Standard Traffic Signs & Pavement Marking – Sign application standard policy
- Standard Specifications for Highway Construction, Section 635 – Electrical and Signing, Field installation details and components for highway, structures

3.0 Design Criteria
All signage must be installed in accordance with the Consultant’s signage plan drawings.

4.0 Quality Assurance
The Contractor or any authority having jurisdiction may request a review by the Consultant of the installed signage and pavement markings to ensure compliance with the plan drawings.
The dimensions of the sign blank shall be within 1.5+/- mm of those specified and the finished sign shall be flat within a maximum allowable deflection of .005(D) where D is the maximum dimension of the sign blank in any direction. The manufacturer shall provide highway signs conforming in quality and accuracy of detail to the dimensional and tolerance requirements of the specification. Where no tolerances are specified, the standard of workmanship shall be in accordance with normally accepted good practice.

5.0 Products
Refer to the Consultant's drawings for details on signage and pavement markings requirements.

6.0 Fabrication
Fabrication of signs shall take place in accordance with BC MoTI's recognized sign suppliers

END OF SECTION

Section 46 00 01 WATER AND WASTEWATER EQUIPMENT Stormwater Management System

1.0 Summary
This section outlines the supply and installation of the stormwater system, including components such as catch basins, pipes, collection tank, and pump.

2.0 Compliance with Standards
- ASTM C76/C443 - Specification for reinforced concrete piping
- ASTM D304/D2412 - Specification for PVC SDR35 pipes
- MoTI 582.12 - Manufacture of precast concrete storm drainage products
- MoTI 583.13 - Concrete pipe and boxes
- MoTI 582.15.01 - Precast Reinforced Concrete for catch basin and manhole products
- ASTM C478 or CSA A257 - Precast Reinforced Concrete for catch basin and manhole products
- MoTI 582.93 - Manholes standards
- MoTI - 582.94 Storm Drain
- MoTI 582.36 - Backfilling for pipes
- City of Vancouver Standard Drawing S11.2 - Standard catch basin design
- MoTI SP582-03.01 - Standard precast reinforced concrete manhole
- MoTI SP582-05.04 - Standard twin inlet catch basin frame

3.0 Design Criteria
All elements are designed in accordance with the Vancouver Engineering Design Manual and based on standards provided by MoTI and ASTM.

4.0 Quality Assurance
The Contractor or any authority having jurisdiction may request a review by the Consultant of the stormwater management system to ensure compliance with the plan drawings. Manufacturer of pipes to design all connections between pipes, Typical per MoTI standards and the Concrete Pipe Installation Pocket Guide.

5.0 Products
Products sourced from the following suppliers:
- Pump: Inline single stage pump - TP 50-180/ 2 A-F-Z-BQBE-FW1 supplied by GrundFos
- 1050mm diameter prefabricated catch basins provided by the Langley Concrete Group
- 1050mm diameter prefabricated lawn basins provided by the Langley Concrete Group
- 1050mm diameter prefabricated maintenance holes provided by the Langley Concrete Group
- PVC pipe: 150mm, 200mm, and 350mm diameter pipes sourced from Emco waterworks
- Reinforced concrete pipe: 400mm, 425mm, and 600mm pipes sourced from Langley Concrete group
- Concrete mortar for piping joint: supplied by Lafarge
- Waterproofing membrane for collection tank: per W.R. Meadows
- Aggregate placed above pipes and tank: Coarse aggregate, with a maximum nominal size of 14 mm, must meet CSA grading requirements to ensure structural integrity per Lafarge
- Concrete/reinforcing/aggregate for collection tank: per section 03 30 00
- Water fountain: sourced from Tournesol
- Pipe flow sensors: provided by Keyence America
- Filtration grates: sourced from Oldcastle Infrastructure
- Hydrodynamic separators: provided by Contech Engineered Solutions

6.0 Fabrication
Fabrication of all stormwater components shall take place in accordance with BC MoTI's standards.

END OF SECTION

UBC CAMPUS AND COMMUNITY PLANNING

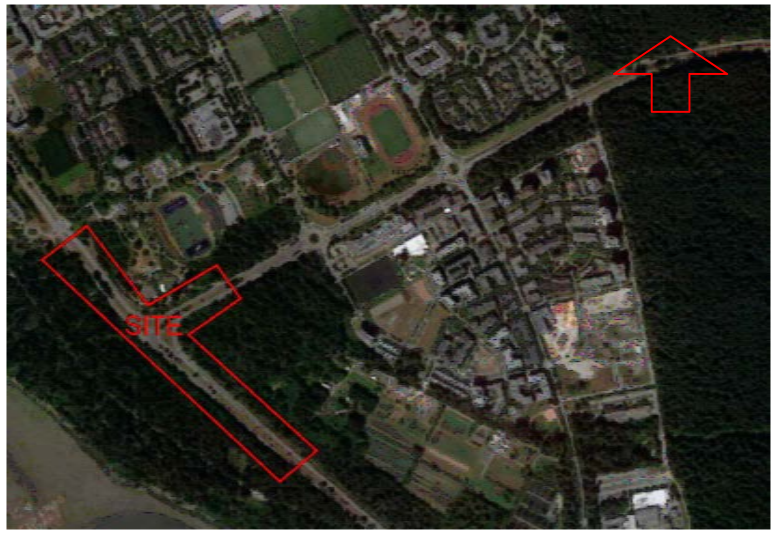
2210 WEST MALL, VANCOUVER, BC

W16TH AND SW MARINE DRIVE

ISSUED FOR DETAILED DESIGN

LEGEND

EXISTING	PROPOSED	DESCRIPTION
		EDGE OF PAVEMENT
		CURB
		STORM SEWER
		CATCH BASIN MANHOLE
		CATCH BASIN – TOP INLET
		DITCH
		SIDEWALK (CONCRETE)
		FULL DEPTH PAVEMENT
		MILL AND INLAY PAVEMENT
		RAISED TRUCK APRON
		150mm TOPSOIL AND HYDRO SEED
		ORNAMENTAL STREET LIGHT – DAVIT
		ORNAMENTAL PEDESTRIAN ARCH



SITE MAP

N.T.S

DRAWING INDEX

DWG TYPE	SHEET TITLE	DWG #	SHEET #
GENERAL NOTES	GENERAL NOTES	15–N	1
KEY PLAN	KEY PLAN	15–KP	2
ROADWORKS	ROADWORKS– W16 AND SW MARINE DRIVE	15–R1–1	3
ROADWORKS	ROADWORKS– SW MARINE DRIVE AT STADIUM RD	15–R2–1	4
ROADWORKS	ROADWORKS– SW MARINE DRIVE NORTH OF 16TH	15–R2–2	5
ROADWORKS	ROADWORKS– SW MARINE DRIVE SOUTH OF W 16TH	15–R3–1	6
ROADWORKS	ROADWORKS– SW MARINE DRIVE SOUTH OF W16TH	15–R3–2	7
MARKING/SIGNAGE	MARKING/SIGNAGE – W16 AND SW MARINE DRIVE	15–PM1–1	8
MARKING/SIGNAGE	MARKING/SIGNAGE–SW MARINE DR AT STADIUM RD	15–PM2–1	9
MARKING/SIGNAGE	MARKING/SIGNAGE–SW MARINE DR NORTH OF 16TH	15–PM2–2	10
MARKING/SIGNAGE	MARKING/SIGNAGE–SWMARINE DR SOUTH OF 16TH	15–PM3–1	11
MARKING/SIGNAGE	MARKING/SIGNAGE–SW MARINE DR SOUTH OF 16TH	15–PM3–2	12
AUTOTURN	AUTOTURN	15–AT	13
STORMWATER	STORMWATER	15–STM1	14
STRUCTURAL	STRUCTURAL– GATEWAY AND CONNECTIONS	15–STRC1	15
STRUCTURAL	STRUCTURAL– FOOTINGS	15–STRC2	16

GENERAL CONSTRUCTION NOTES:

1. ALL WORK SHALL PASS INSPECTION BY MINISTRY OF TRANSPORTATION, BRITISH COLUMBIA (MOTI) AND THE *CONSULTANT*, ACTING ON BEHALF OF THE *OWNER*, UNIVERSITY OF BRITISH COLUMBIA
2. ALL MATERIALS SHALL CONFORM TO THE MOTI APPROVED PRODUCTS UNLESS SUPERSEDED BY THE CONSTRUCTION SPECIFICATIONS
3. IN CASES OF PERCEIVED AMBIGUITY OR DISCREPANCY BETWEEN THE SPECIFICATIONS AND THE CONSTRUCTION DRAWINGS, THE CONSULTANT SHALL BE NOTIFIED FOR REVIEW PRIOR TO PROCEEDING.
4. THE CONTRACTOR MUST NOTIFY THE CONSULTANT THREE (3) DAYS PRIOR TO THE BEGINNING THE FOLLOWING WORK:
   - 4.1. ROAD CLOSURES AND DETOURS.
   - 4.2. INSTALLATION OF FOOTINGS FOR GATEWAY.
   - 4.3. INSTALLATION OF STORMWATER TANK SLAB.
   - 4.4. BACKFILL OF STORMWATER TANK
   - 4.5. INSTALLATION OF FOUNTAIN TANK SLAB.
   - 4.6. INSTALLATION OF GLULAM ELEMENTS.
   - 4.7. PAVING.
   - 4.8. DELIVERY OF STORMWATER PIPING MATERIALS AND PUMP.
   - 4.9. GRADING OF FOUNTAIN.
   - 4.10. INSTALLATION OF STORMWATER FOUNTAIN.
5. BC ONE CALL IS REQUIRED (BY LAW) PRIOR TO ANY EXCAVATION.
6. ALL CONSTRUCTION WORKS SHALL CONFORM TO WORKSAFE BC REGULATIONS. CONTRACTOR MUST BE REGISTERED WITH WORKSAFE BC. WORKSAFE BC MUST BE NOTIFIED PRIOR TO CONSTRUCTION.
7. CONTRACTOR SHALL KEEP THE WORKSITE CLEAN AND FREE OF CONSTRUCTION DEBRIS.
8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PERMIT APPROVALS AND SHALL PROVIDE ALL RELEVANT PERMITS TO THE CONSULTANT.
9. THE CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIR OF ANY DAMAGE TO THE STREET AS CAUSED BY THE CONSTRUCTION EQUIPMENT OR WORK. THIS MAY INCLUDE THE NEED FOR STREET SWEEPING OF CONSTRUCTION DEBRIS.
10. ANY MATERIAL SUBSTITUTION MUST BE APPROVED BY THE CONSULTANT AND MOTI REPRESENTATIVES.
11. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVISION OF TRAFFIC CONTROL DURING THIS TIME, IN LINE WITH THE PROPOSED TRAFFIC MANAGEMENT PLAN CONTAINED HEREIN. IF AN ALTERNATE PLAN IS SUBMITTED, PLEASE INDICATE ANY REASONING, ADDED VALUE, AND COSTS.
12. THE CONTRACTOR MUST PROVIDE ANY INFORMATION (DIMENSIONS, MATERIALS, ETC.) TO AS-BUILT CONDITIONS. THE CONSULTANT SHALL PRODUCE AS BUILT DRAWINGS.
13. TREES WHICH ARE SAVED SHALL BE SURROUNDED BY SNOW FENCING. EXCAVATION OR DISRUPTION WITHIN THE DRIP LINE OF TREES SHALL BE PERFORMED UNDER THE SUPERVISION OF AN ARBORIST.

STORMWATER

1. PIPE LAYING TOLERANCE ON DRAWING IS +- 25MM.
2. PIPE SEGMENTS SHALL BE 4 OR 6 M.
3. MATERIALS SPECIFICATIONS, TESTING, AND QUALITY ASSURANCE SHALL CONFORM TO MOTI SECTION 318 “PVC PLASTIC DRAINAGE PIPE”.
4. PUMP INSTALLATION SHALL BE PERFORMED BY A PLUMBER WITH SIMILAR PROJECT EXPERIENCE.

CONCRETE

1. CONCRETE SHALL CONFORM TO THE LATEST EDITION OF CSA A23.1 “CONCRETE MATERIALS AND METHODS OF CONCRETE CONSTRUCTION.”
2. MIX DESIGN SHALL BE SUBMITTED TO THE CONSULTANT FOR REVIEW.
3. KEEP CONCRETE CONTINUOUSLY MOIST DURING CURING.
4. VIBRATE ALL CONCRETE.
5. PROTECT CONCRETE FROM WEATHER AS PER CAN3-A23.1
6. REBAR SHALL BE CLEAN AND SECURELY IN PLACE AT THE TIME OF CONCRETE PLACEMENT.
7. SIDEWALK CONCRETE SHALL BE BROOM FINISH.
8. STORMWATER TANK CONCRETE POUR PLAN SUBMITTAL IS REQUIRED, INCLUDING METHODS OF SHORING
9. SEE THE FOLLOWING INFORMATION STRENGTH:

CONCRETE PROPERTIES		
ITEM	STRENGTH	EXPOSURE CLASS
SIDEWALK	25MPA	N
SIGNAGE FOOTING	25MPA	N
LUMINAIRE FOOTING	30MPA	N
GATEWAY FOOTING	25MPA	N
SLAB ON GRADE	25MPA	N
STORMWATER TANK	25MPA	N

REINFORCING STEEL

1. COVER SHALL BE 65 MM WHEN CAST AGAINST SOIL AND 35 MM IN OTHER APPLICATIONS, UNLESS NOTED ON DRAWINGS.
2. REINFORCING STEEL SHALL BE 350W STEEL.
3. LAP SPLICES SHALL BE PERFORMED PER RSIO MANUAL, CLASS B TENSION LAP SPLICE.
4. INTERSECTING REBAR MAY BE TIED TOGETHER USING NO. 16 WIRE GAUGE, OR SIMILAR SYSTEM SUBJECT TO THE APPROVAL OF THE CONSULTANT.

STRUCTURAL STEEL

1. BOLTS SHALL BE IN ACCORDANCE WITH ASTM A325
2. UNLESS OTHERWISE NOTED, BOLTS SHALL BE IN SNUG TIGHT POSITION.

STRUCTURAL GATEWAY

1. LIFTING DEVICE SHALL BE PROCURED AND ITS CAPACITY COMPARED TO WEIGHTS OF ELEMENTS.
2. LIFTING DEVICE SHALL OPERATE 10m AWAY FROM THE CLIFF EDGE.
3. INSTALLATION WORKPLAN SUBMITTAL MUST BE APPROVED THIRTY (30) DAYS PRIOR TO THE START OF WORK OF THE INSTALLATION OF GLULAM ELEMENTS.
4. SHOP DRAWINGS OF THE GLULAM ELEMENTS AND POT LIGHTING SYSTEM SHALL BE SUBMITTED TO THE CONSULTANT FOR APPROVAL.

ASPHALT

1. ASPHALT SHALL CONFORM TO MOTI SECTION 502 “ASPHALT PAVEMENT CONSTRUCTION (EPS)”
2. LAP SPLICES SHALL BE PROVIDED AT LOCATIONS WHERE PAVED ASPHALT TIES INTO EXISTING ASPHALT. SURFACE MILL 500 MM AND TACK COAT EDGE SURFACE.
3. TIE-IN LOCATIONS TO BE CONFIRMED WITH CONSULTANT AT PRELIMINARY SITE MEETING
4. PONDING SHALL BE TAKEN AS AN OBVIOUS DEFECT AND WILL BE REJECTED. REMEDIAL WORK SHALL BE AT THE EXPENSE OF THE CONTRACTOR.
5. ROADWAY PAVING SHALL BE HOMOGENEOUS (IE. NO COLD JOINTS BETWEEN LANES)
6. ASPHALT MIX IS AS PER SUPERPAVE STANDARDS.

PAVEMENT MARKINGS

1. ALL PAVEMENT MARKINGS AND SIGNAGE TO BE AS PER THE CURRENT EDITION OF THE MANUAL FOR UNIFORM TRAFFIC CONTROL DEVICES FOR CANADA.
2. ALL PAVEMENT MARKINGS ARE TO BE THERMOPLASTIC.
3. MAINTAIN ALL SIGNS CURRENTLY IN PLACE, REMOVE ALL SURPLUS SIGNS AT THE COMPLETION OF THE WORKS AND RETURN TO THE CITY.
4. TEMPORARY PAVEMENT MARKINGS ARE TO BE PLACED IMMEDIATELY FOLLOWING THE LAYING OF NEW ASPHALT PAVEMENT.
5. ALL EXISTING CONFLICTING PAVEMENT MARKING TO BE REMOVED BY THE CONTRACTOR AND IS CONSIDERED INCIDENTAL TO THE WORKS

ROADWORKS

1. SUBGRADE AND GRANULAR BASE MATERIALS SHALL BE COMPACTED TO AT LEAST 95% OF THEIR MODIFIED PROCTOR DRY DENSITY UNLESS NOTED OTHERWISE. 97% FOR MARSHALL MIX.
2. THE ROAD BASE SHALL EXTEND A MINIMUM OF 300mm BEYOND THE SIDEWALK AND/OR CURB AND GUTTER, WHICHEVER IS GREATER AND FILLED TO THE LEVEL OF THE SIDEWALK OR CURB FOR SUPPORT.
3. THE PROPOSED PAVEMENT STRUCTURE SHALL BE AS DESIGNATED BY THE ROADWORKS DESIGN DRAWINGS.
4. ALL VALVE BOXES, MANHOLES, JUNCTION BOXES, ETC. WITHIN THE ROAD RIGHT OF WAY SHALL BE ADJUSTED TO FINISHED GRADE UNLESS NOTED OTHERWISE.
5. THE ADJUSTMENT OF MANHOLES, VALVE COVERS, AND ALL OTHER APPURTENANCES TO SUIT NEW ASPHALT GRADES IS INCIDENTAL TO ASPHALT PAVING.
6. CONTRACTOR TO REPLACE ALL MANHOLE FRAMES AND LIDS, WATER VALVE BOXES AND COVERS, AND GAS VALVE BOXES AND COVERS WITHIN THE ROADWAY AS DIRECTED BY ENGINEER
7. THE CONTRACTOR SHALL SAWCUT THE EXISTING PAVEMENT WHERE INDICATED ON THE DRAWING.
8. CATCH BASIN RIM ELEVATIONS SHALL BE SET 30mm BELOW THE FINISHED GUTTER LINE GRADES. THE GUTTER AND ROAD SURFACE AREA TO BE SHAPED TO FORM A DISH AROUND THE INLET.
9. TIE-IN TO EXISTING PAVEMENT SHALL BE SAWCUT AND KEYED TO FORM A DEEP LAP JOINT WITH PROPOSED PAVEMENT UNLESS NOTED OTHERWISE.
10. CLEAN AND TACK-COAT ALL ASPHALT SURFACES INCLUDING JOINTS PRIOR TO PAVING.

STAMP

No.	DATE	REVISION	BY
1	10.04.2024	ISSUED FOR DETAILED DESIGN	KK
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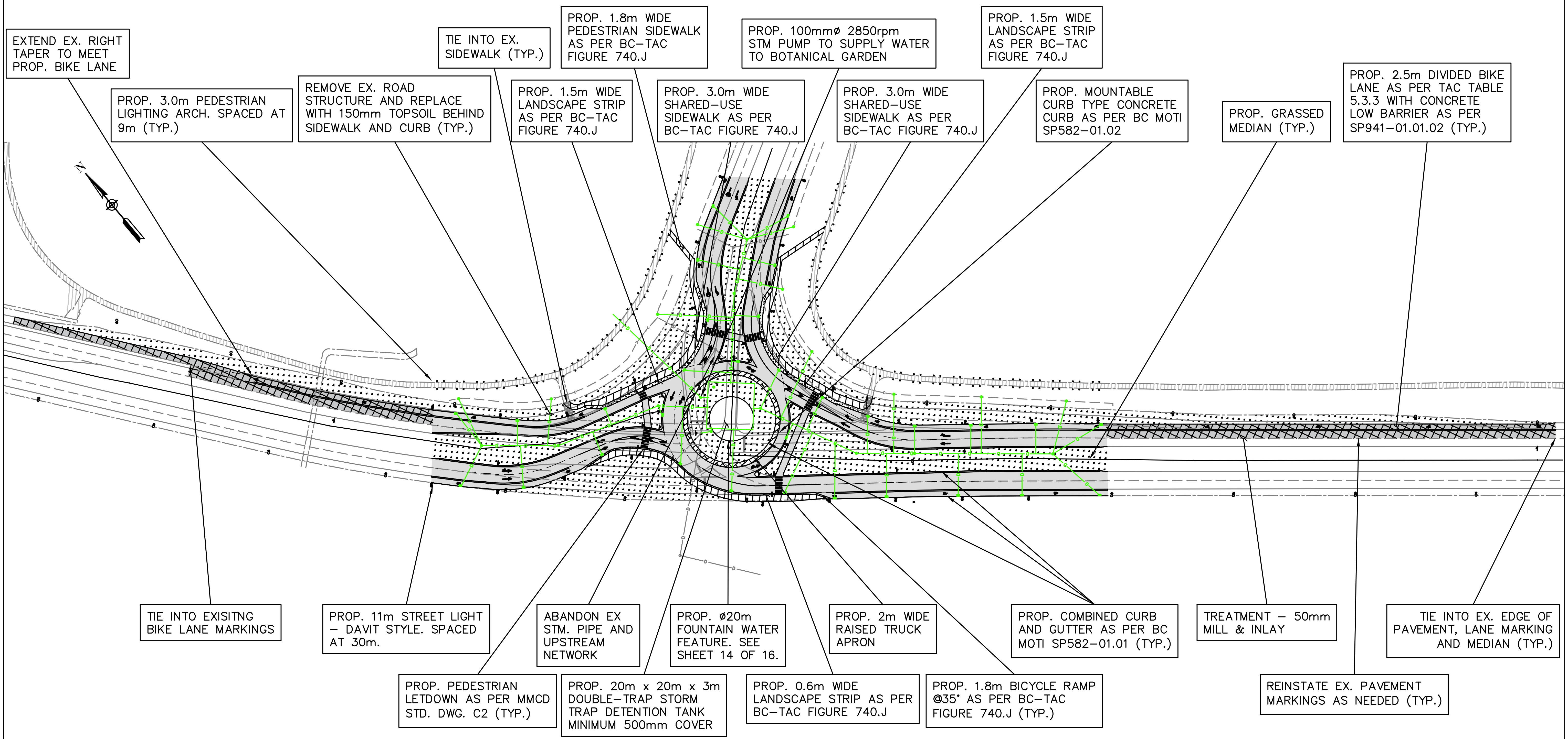
3			

CLIENT: UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

DRAWING DESCRIPTION: W16TH AND SW MARINE DRIVE GENERAL NOTES

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: 1:1750

DATE: 10-04-2024
DRAWING No. 15-N
SHEET 1 OF 16
REV No.: 1



STAMP

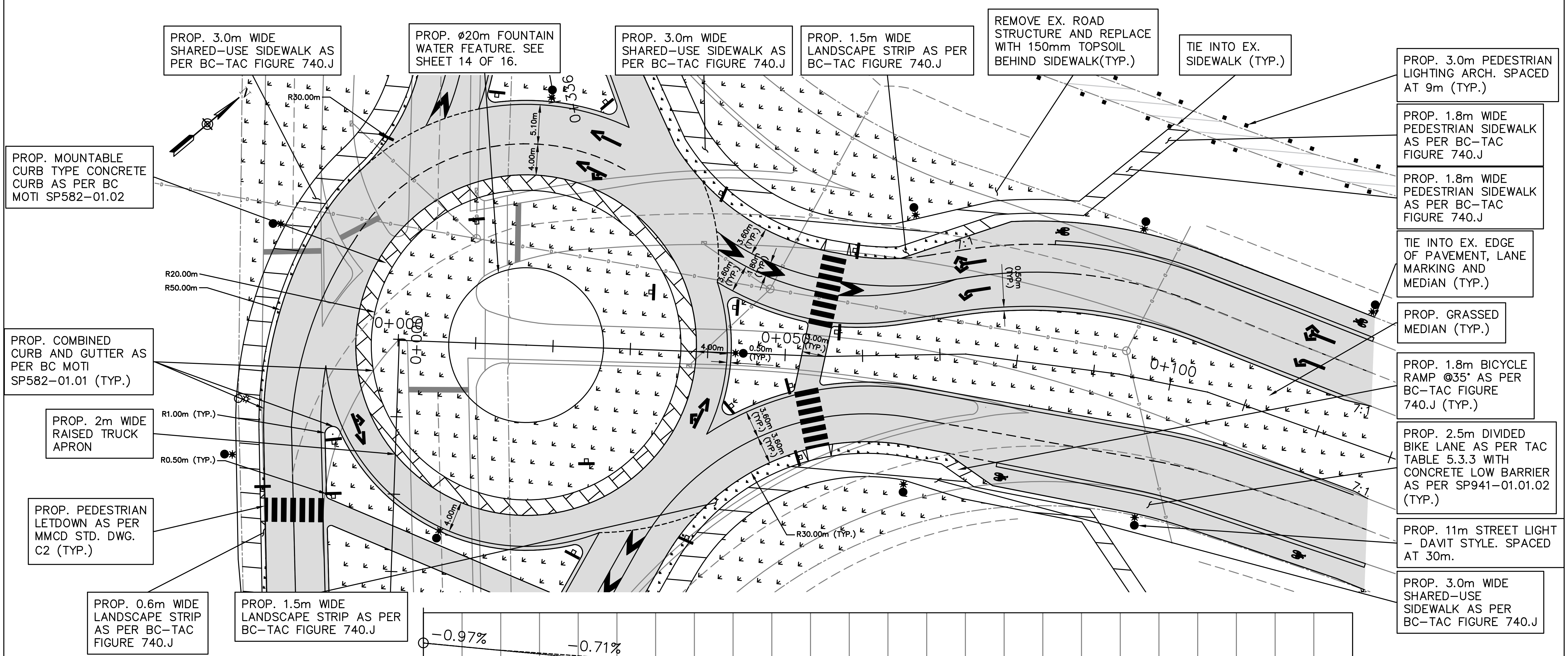
No.	DATE	REVISION	BY
1	7.12.2023	ISSUED FOR PRELIMINARY DESIGN	KK
2	10.04.2024	ISSUED FOR DETAILED DESIGN	KK
3			

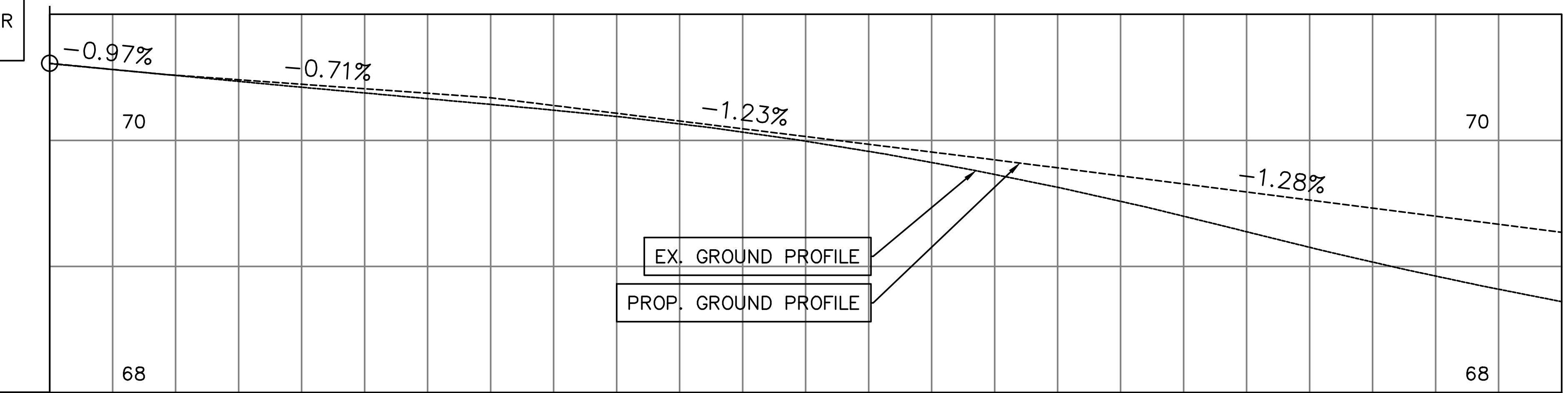
CLIENT: UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

DRAWING DESCRIPTION: W16TH AND SW MARINE DRIVE KEY PLAN

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: 1:1750

DATE: 10–04–2024
DRAWING No. 15–KP
SHEET 2 OF 16
REV No.: 2





PROP. ELEVATIONS	70.56	70.52	70.48	70.45	70.41	70.37	70.34	70.28	70.21	70.15	70.09	70.03	69.97	69.91	69.85	69.78	69.72	69.65	69.59	69.53	69.46	69.40	69.33	69.27

0+220 0+240 0+260 0+280 0+300 0+320 0+340

STAMP

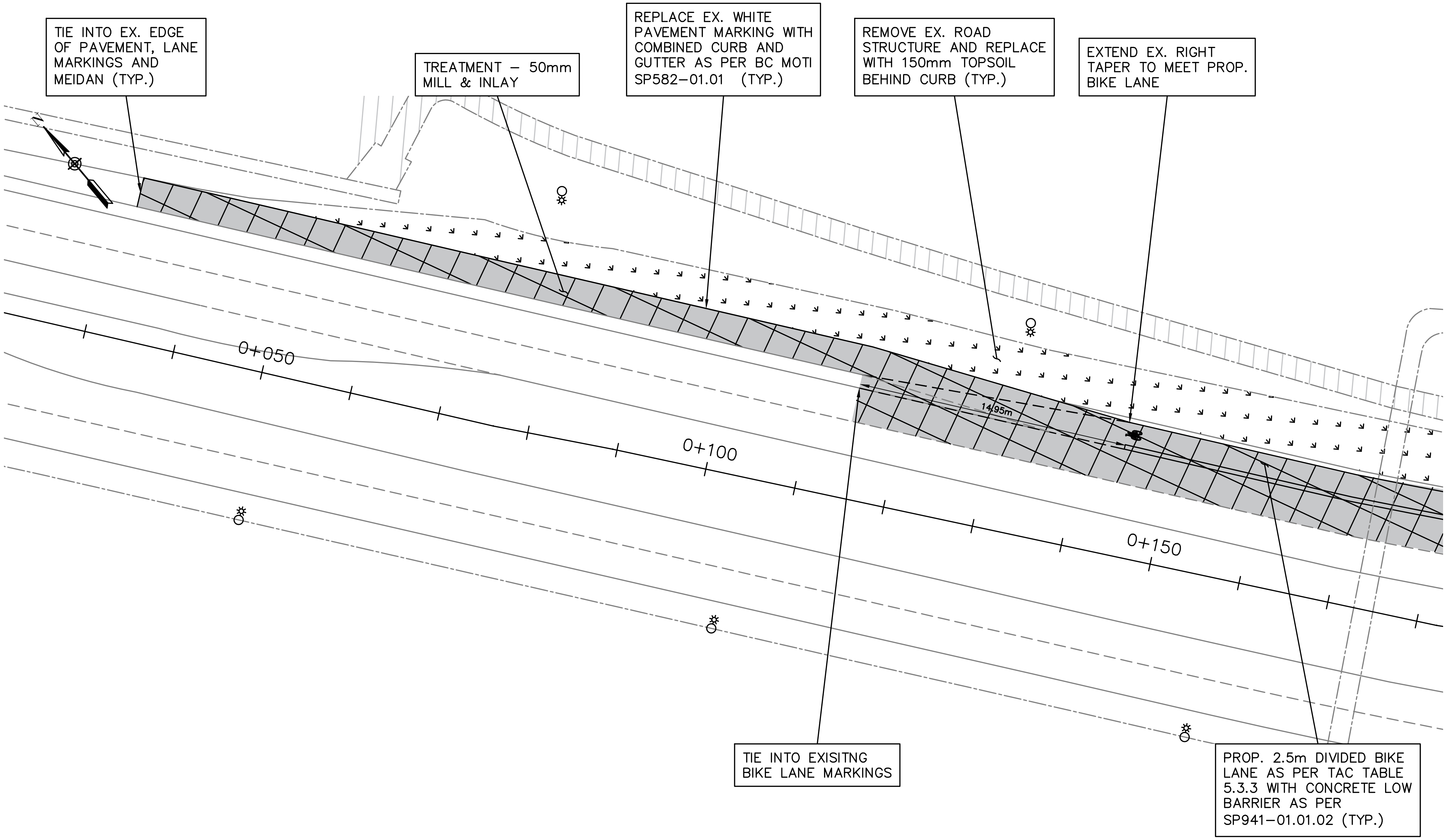
No.	DATE	REVISION	BY
1	7.12.2023	ISSUED FOR PRELIMINARY DESIGN	KK
2	10.04.2024	ISSUED FOR DETAILED DESIGN	KK
3			

CLIENT: UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

DRAWING DESCRIPTION: W16TH AND SW MARINE DRIVE ROADWORKS– W16 AND SW MARINE DRIVE

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: 1:500

DATE: 10–04–2024
DRAWING No. 15–R1–1
SHEET 3 OF 16
REV No.: 2



STAMP

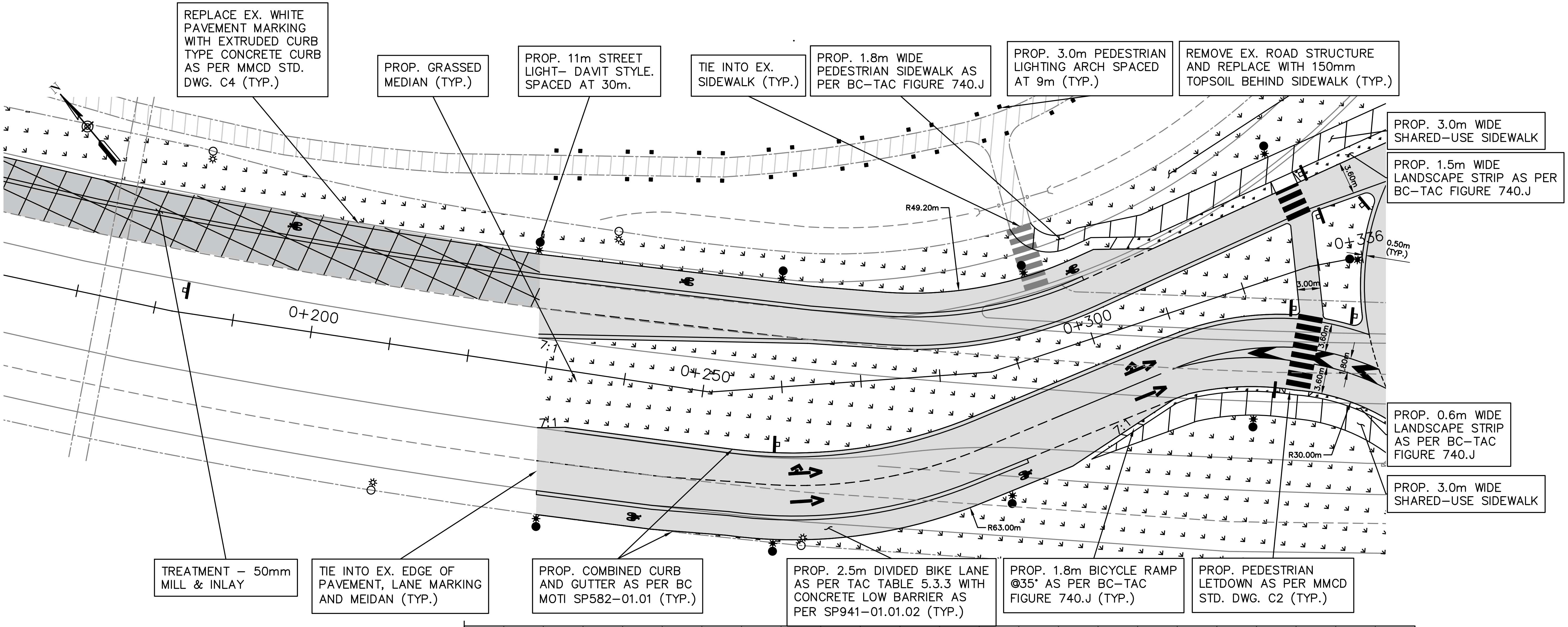
No.	DATE	REVISION	BY
1	7.12.2023	ISSUED FOR PRELIMINARY DESIGN	KK
2	10.04.2024	ISSUED FOR DETAILED DESIGN	KK
3			

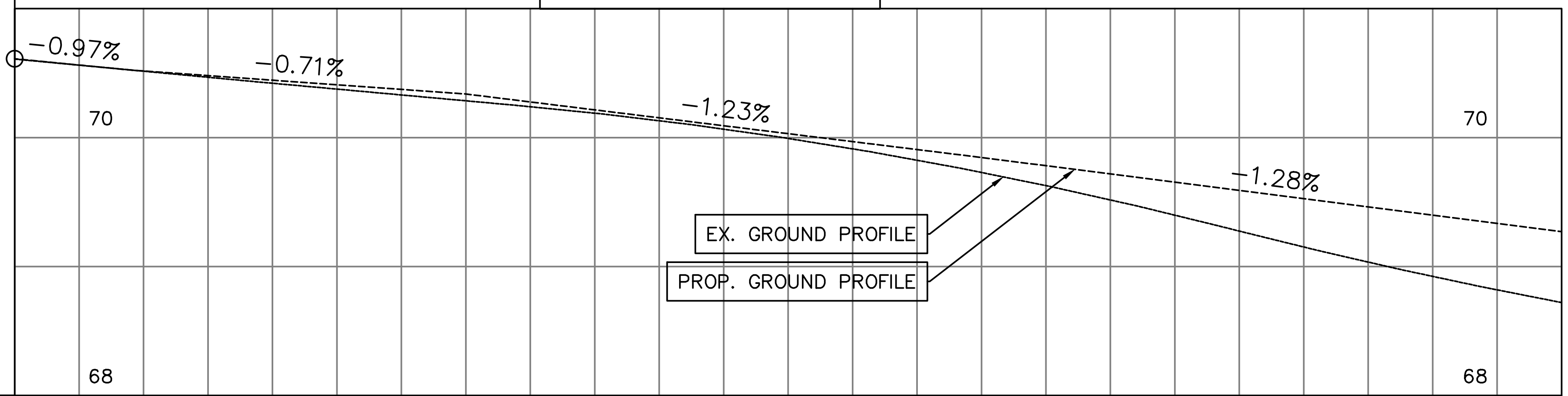
CLIENT:
UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

DRAWING DESCRIPTION:
W16TH AND SW MARINE DRIVE
ROADWORKS– SW MARINE DRIVE AT STADIUM RD

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: 1:500

DATE: 10–04–2024
DRAWING No.
15–R2–1
SHEET 4 OF 16
REV No.: 2





PROP. ELEVATIONS	70.56	70.52	70.48	70.45	70.41	70.37	70.34	70.28	70.21	70.15	70.09	70.03	69.97	69.91	69.85	69.78	69.72	69.65	69.59	69.53	69.46	69.40	69.33	69.27

0+220 0+240 0+260 0+280 0+300 0+320 0+340

STAMP

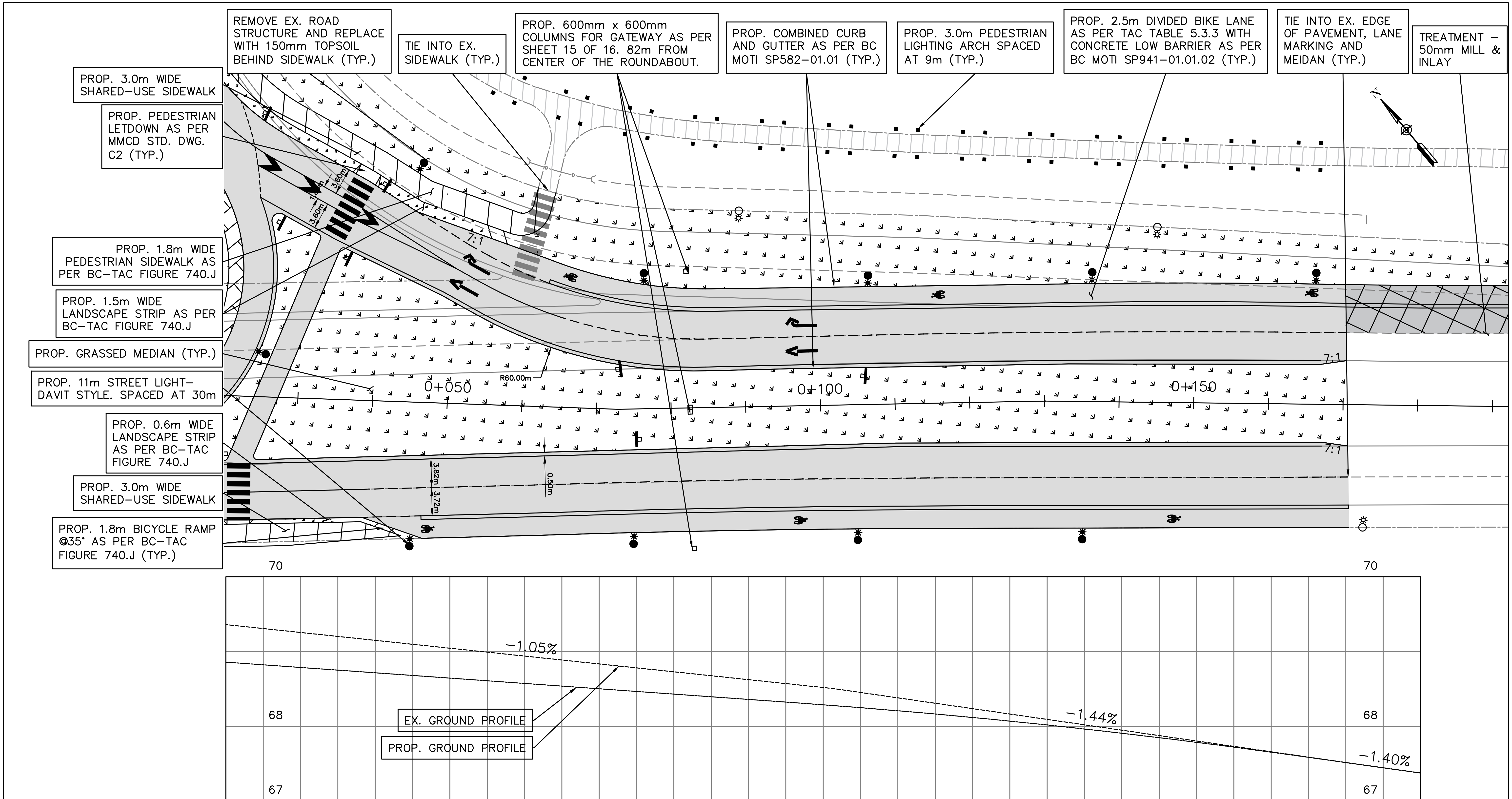
No.	DATE	REVISION	BY
1	7.12.2023	ISSUED FOR PRELIMINARY DESIGN	KK
2	10.04.2024	ISSUED FOR DETAILED DESIGN	KK
3			

CLIENT:
UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

DRAWING DESCRIPTION:
W16TH AND SW MARINE DRIVE
ROADWORKS– SW MARINE DRIVE NORTH OF 16TH

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: 1:500

DATE: 10–04–2024
DRAWING No. 15–R2–2
SHEET 5 OF 16
REV No.: 2



PROP. ELEVATIONS	69.31	69.25	69.20	69.15	69.10	69.04	68.99	68.94	68.89	68.83	68.78	68.73	68.68	68.62	68.57	68.52	68.45	68.38	68.31	68.23	68.16	68.09	68.02	67.95	67.87	67.80	67.73	67.66	67.59	67.51	67.44

0+020 0+040 0+060 0+080 0+100 0+120 0+140 0+160 0+180

STAMP

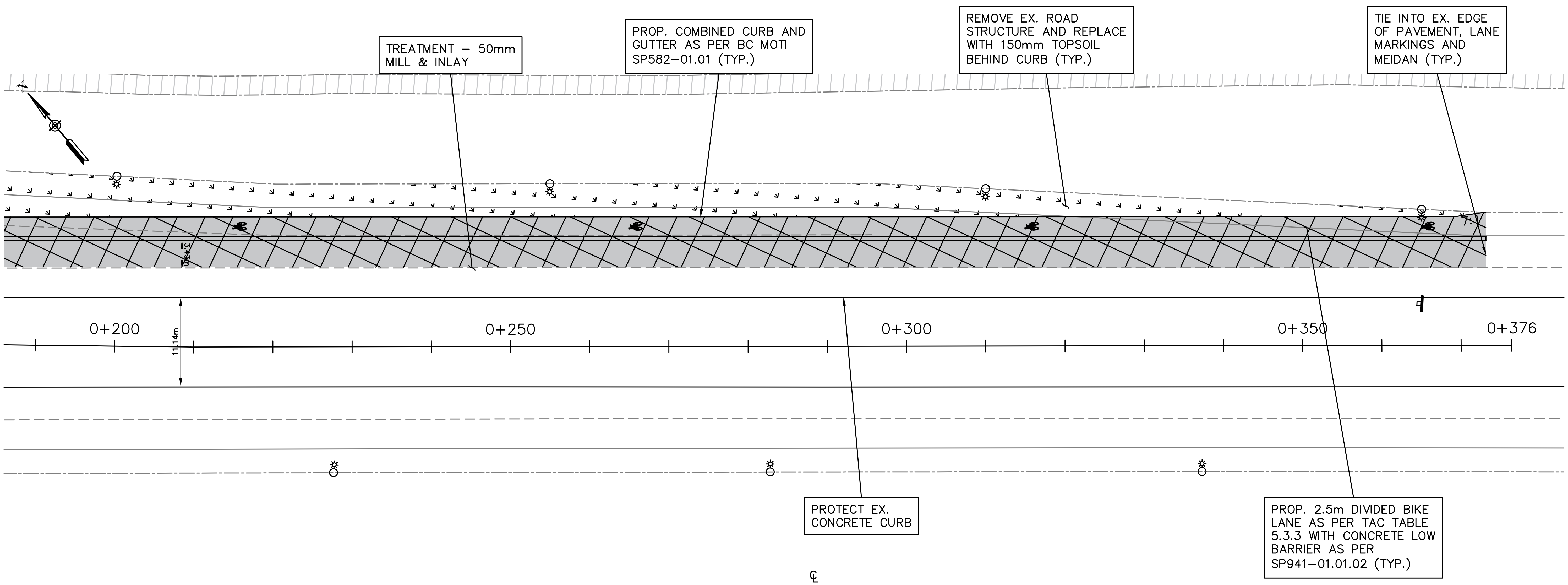
No.	DATE	REVISION	BY
1	7.12.2023	ISSUED FOR PRELIMINARY DESIGN	KK
2	10.04.2024	ISSUED FOR DETAILED DESIGN	KK
3			

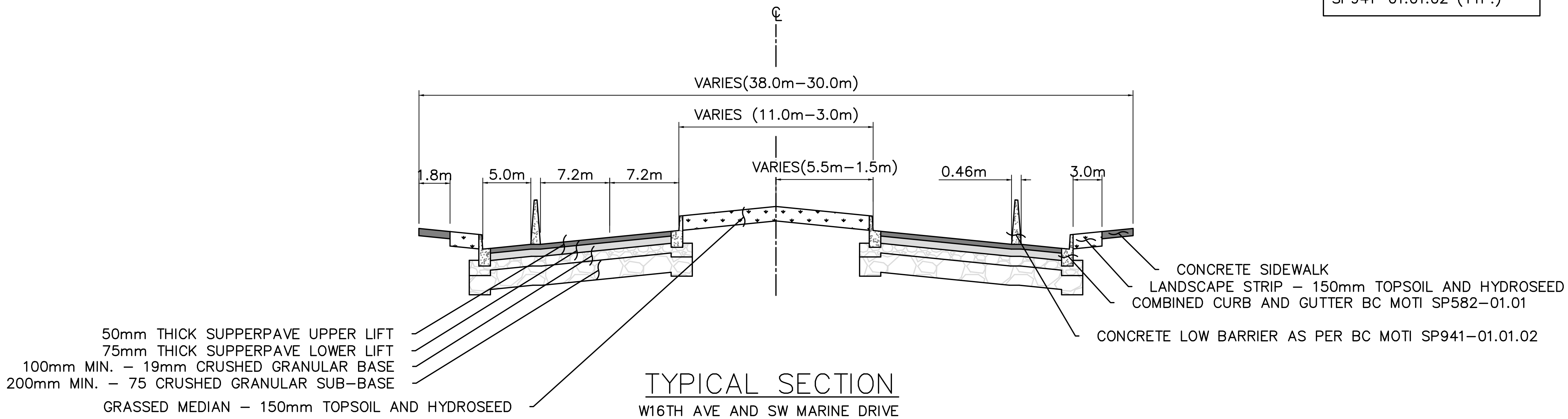
CLIENT: UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

DRAWING DESCRIPTION: W16TH AND SW MARINE DRIVE ROADWORKS– SW MARINE DRIVE SOUTH OF W 16TH

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: 1:500

DATE: 10-04-2024
DRAWING No. 15-R3-1
SHEET 6 OF 16
REV No.: 2





TYPICAL SECTION
W16TH AVE AND SW MARINE DRIVE
N.T.S

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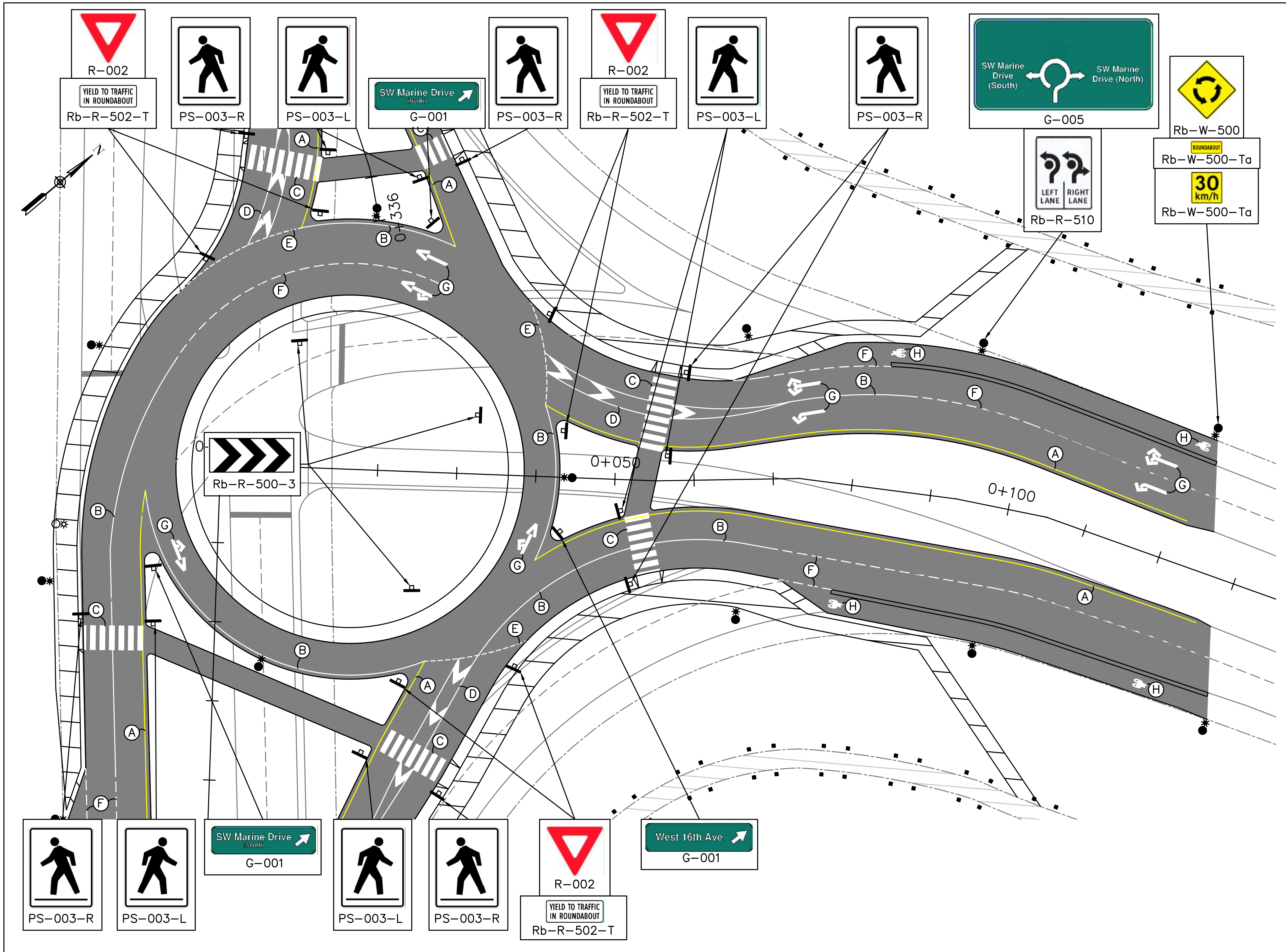
No.	DATE	REVISION	BY
1	7.12.2023	ISSUED FOR PRELIMINARY DESIGN	KK
2	10.04.2024	ISSUED FOR DETAILED DESIGN	KK
3			

CLIENT: UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

DRAWING DESCRIPTION: W16TH AND SW MARINE DRIVE
ROADWORKS– SW MARINE DRIVE SOUTH OF W16TH

DRAWN BY:	
DESIGNED BY:	
CHECKED BY:	
SCALE:	1:500

DATE: 10–04–2024
DRAWING No. 15–R3–2
SHEET 7 OF 16
REV No.: 2



KEY NOTES FOR PAVEMENT MARKING

- (A) PROP. 100mm WIDE YELLOW THERMOPLASTIC PAINTED CENTER LINE
- (B) PROP. 100mm WIDE WHITE THERMOPLASTIC PAINTED LINE
- (C) PROP. 3.0m WIDE THERMOPLASTIC ZEBRA CROSSING
- (D) PROP. 1.8m WIDE GORE AREA AS PER MOTI FIGURE 7.6
- (E) PROP. 100mm WIDE WHITE THERMOPLASTIC YIELD LINES AS PER BC-TAC FIGURE 740.K
- (F) PROP. WHITE THERMOPLASTIC URBAN LANE LINES AS PER BC-TAC FIGURE 740.K
- (G) PROP. THERMOPLASTIC LANE ARROWS AS PER BC-TAC FIGURE 740.P
- (H) PROP. THERMOPLASTIC BIKE SYMBOL

STAMP

No.	DATE	REVISION	BY
1	10.04.2024	ISSUED FOR DETAILED DESIGN	KK
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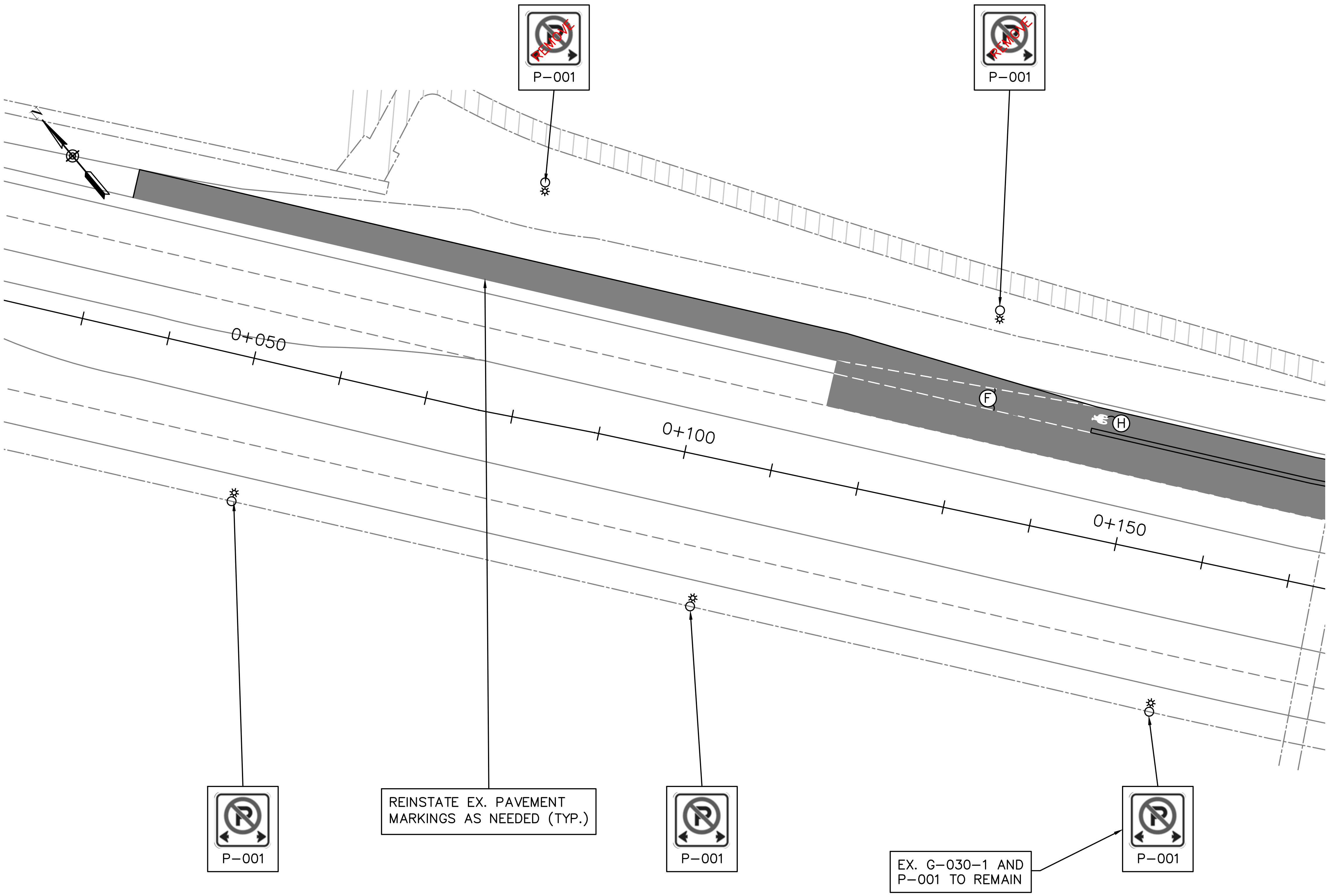
3			

CLIENT:
UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

DRAWING DESCRIPTION:
W16TH AND SW MARINE DRIVE
MARKING/SIGNAGE – W16 AND SW MARINE DRIVE

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: 1:500

DATE: 10-04-2024
DRAWING No. 15-PM1-1
SHEET 8 OF 16
REV No.: 1



KEY NOTES FOR PAVEMENT MARKING

- (A) PROP. 100mm WIDE YELLOW THERMOPLASTIC PAINTED CENTER LINE
- (B) PROP. 100mm WIDE WHITE THERMOPLASTIC PAINTED LINE
- (C) PROP. 3.0m WIDE THERMOPLASTIC ZEBRA CROSSING
- (D) PROP. 1.8m WIDE GORE AREA AS PER MOTI FIGURE 7.6
- (E) PROP. 100mm WHITE THERMOPLASTIC YIELD LINES AS PER BC-TAC FIGURE 740.K
- (F) PROP. WHITE THERMOPLASTIC URBAN LANE LINES AS PER BC-TAC FIGURE 740.K
- (G) PROP. THERMOPLASTIC LANE ARROWS AS PER BC-TAC FIGURE 740.P
- (H) PROP. THERMOPLASTIC BIKE SYMBOL

STAMP

No.	DATE	REVISION	BY
1	10.04.2024	ISSUED FOR DETAILED DESIGN	KK
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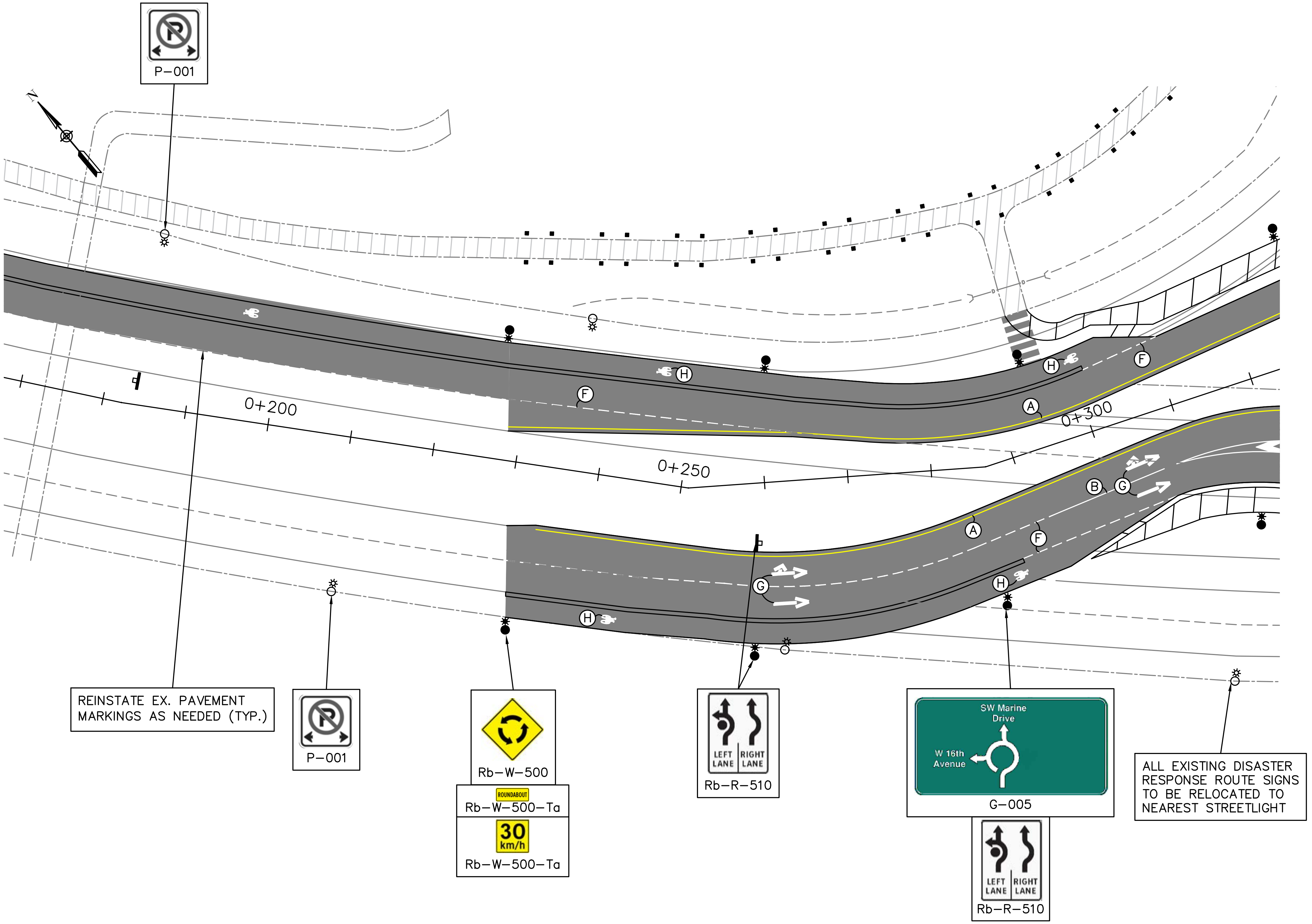
3			

CLIENT: UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

DRAWING DESCRIPTION: W16TH AND SW MARINE DRIVE
MARKING/SIGNAGE-SW MARINE DR AT STADIUM RD

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: 1:500

DATE: 10-04-2024
DRAWING No. 15-PM2-1
SHEET 9 OF 16
REV No.: 1



KEY NOTES FOR PAVEMENT MARKING

Ⓐ PROP. 100mm WIDE YELLOW THERMOPLASTIC PAINTED CENTER LINE

Ⓑ PROP. 100mm WIDE WHITE THERMOPLASTIC PAINTED LINE

Ⓒ PROP. 3.0m WIDE THERMOPLASTIC ZEBRA CROSSING

Ⓓ PROP. 1.8m WIDE GORE AREA AS PER MOTI FIGURE 7.6

Ⓔ PROP. 100mm WHITE THERMOPLASTIC YIELD LINES AS PER BC-TAC FIGURE 740.K

Ⓕ PROP. WHITE THERMOPLASTIC URBAN LANE LINES AS PER BC-TAC FIGURE 740.K

Ⓖ PROP. THERMOPLASTIC LANE ARROWS AS PER BC-TAC FIGURE 740.P

Ⓗ PROP. THERMOPLASTIC BIKE SYMBOL

STAMP

No.	DATE	REVISION	BY
1	10.04.2024	ISSUED FOR DETAILED DESIGN	KK
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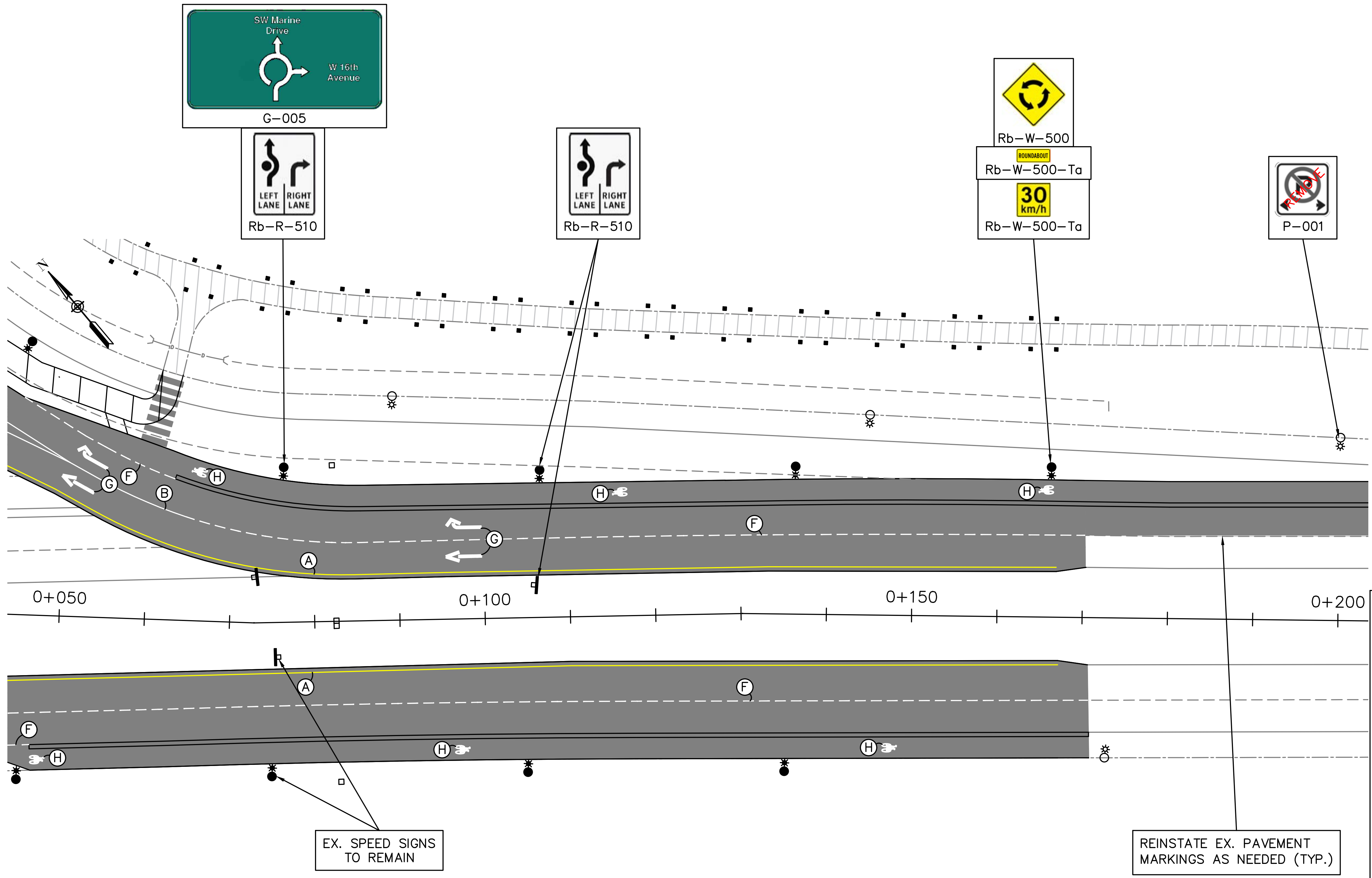
3			

CLIENT: UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

DRAWING DESCRIPTION: W16TH AND SW MARINE DRIVE
MARKING/SIGNAGE-SW MARINE DR NORTH OF 16TH

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: 1:500

DATE: 10-04-2024
DRAWING No. 15-PM2-2
SHEET 10 OF 16
REV No.: 1



KEY NOTES FOR PAVEMENT MARKING

- (A) PROP. 100mm WIDE YELLOW THERMOPLASTIC PAINTED CENTER LINE
- (B) PROP. 100mm WIDE WHITE THERMOPLASTIC PAINTED LINE
- (C) PROP. 3.0m WIDE THERMOPLASTIC ZEBRA CROSSING
- (D) PROP. 1.8m WIDE GORE AREA AS PER MOTI FIGURE 7.6
- (E) PROP. 100mm WHITE THERMOPLASTIC YIELD LINES AS PER BC-TAC FIGURE 740.K
- (F) PROP. WHITE THERMOPLASTIC URBAN LANE LINES AS PER BC-TAC FIGURE 740.K
- (G) PROP. THERMOPLASTIC LANE ARROWS AS PER BC-TAC FIGURE 740.P
- (H) PROP. THERMOPLASTIC BIKE SYMBOL

STAMP

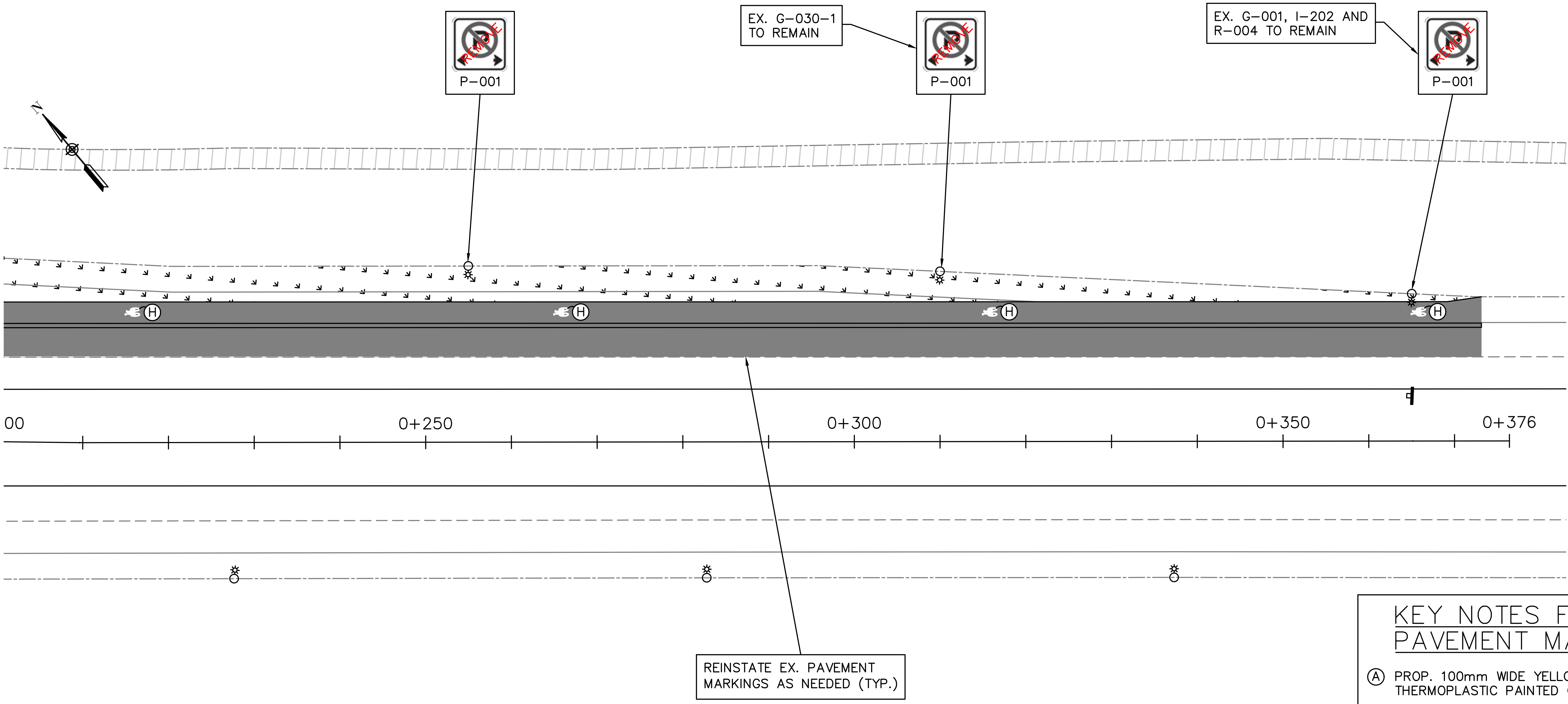
No.	DATE	REVISION	BY
1	10.04.2024	ISSUED FOR DETAILED DESIGN	KK
2			
3			

CLIENT: UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

DRAWING DESCRIPTION: W16TH AND SW MARINE DRIVE
MARKING/SIGNAGE-SWMARINE DR SOUTH OF 16TH

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: 1:500

DATE: 10-04-2024
DRAWING No. 15-PM3-1
SHEET 11 OF 16
REV No.: 1



KEY NOTES FOR PAVEMENT MARKING

- (A) PROP. 100mm WIDE YELLOW THERMOPLASTIC PAINTED CENTER LINE
- (B) PROP. 100mm WIDE WHITE THERMOPLASTIC PAINTED LINE
- (C) PROP. 3.0m WIDE THERMOPLASTIC ZEBRA CROSSING
- (D) PROP. 1.8m WIDE GORE AREA AS PER MOTI FIGURE 7.6
- (E) PROP. 100mm WHITE THERMOPLASTIC YIELD LINES AS PER BC-TAC FIGURE 740.K
- (F) PROP. WHITE THERMOPLASTIC URBAN LANE LINES AS PER BC-TAC FIGURE 740.K
- (G) PROP. THERMOPLASTIC LANE ARROWS AS PER BC-TAC FIGURE 740.P
- (H) PROP. THERMOPLASTIC BIKE SYMBOL

STAMP

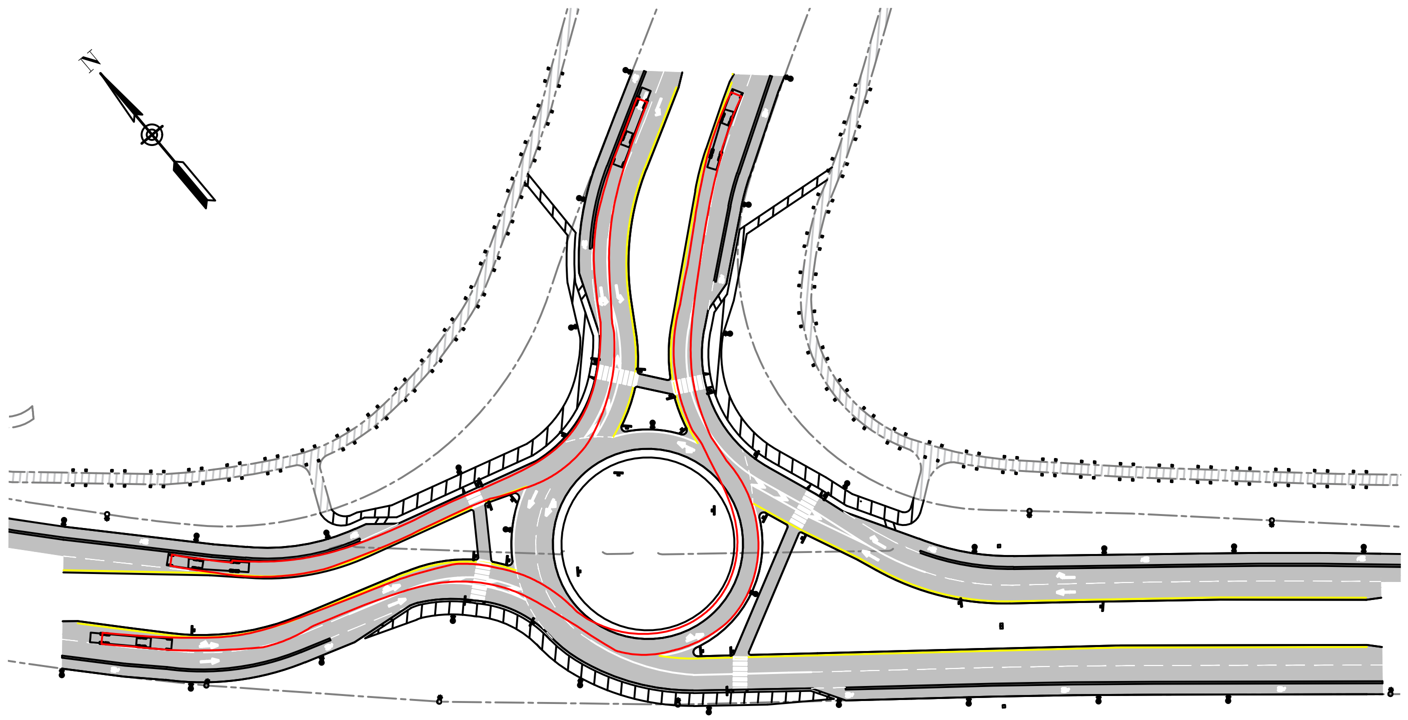
No.	DATE	REVISION	BY
1	10.04.2024	ISSUED FOR DETAILED DESIGN	KK
2			
3			

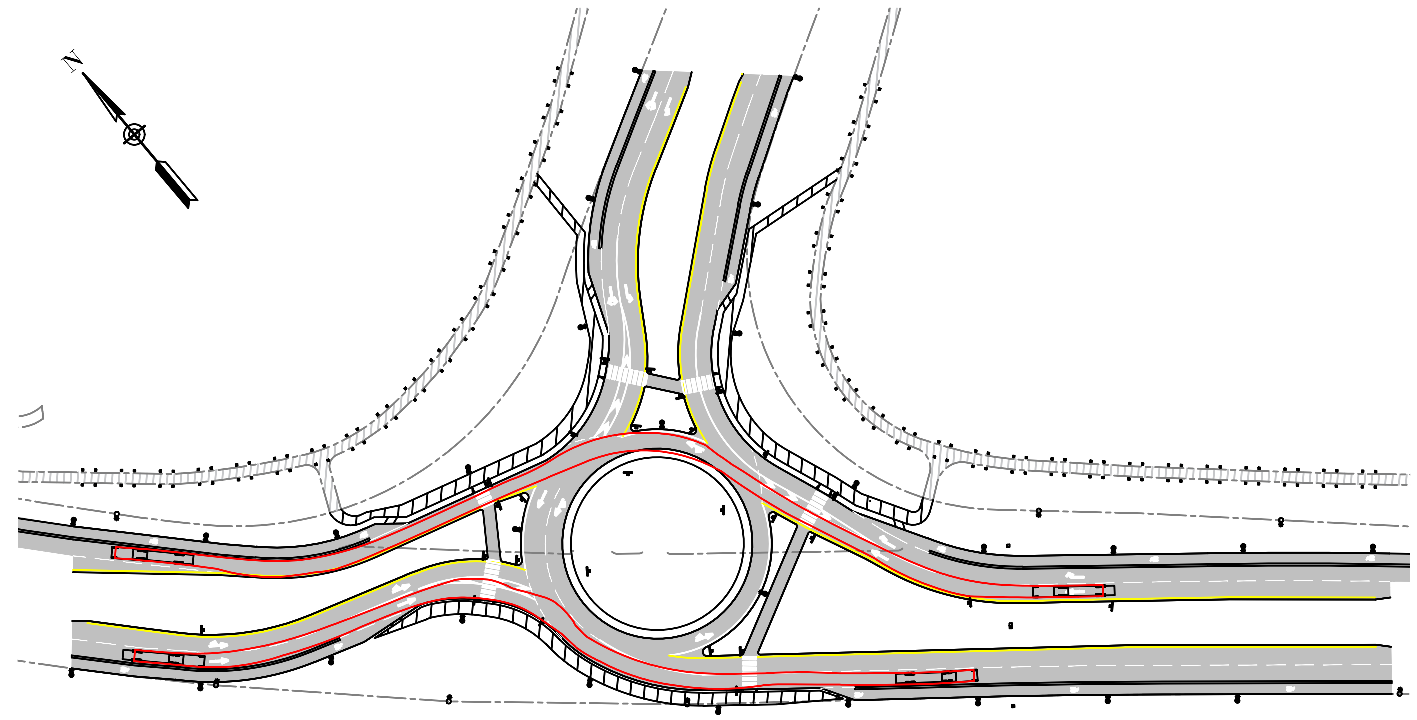
CLIENT:
UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

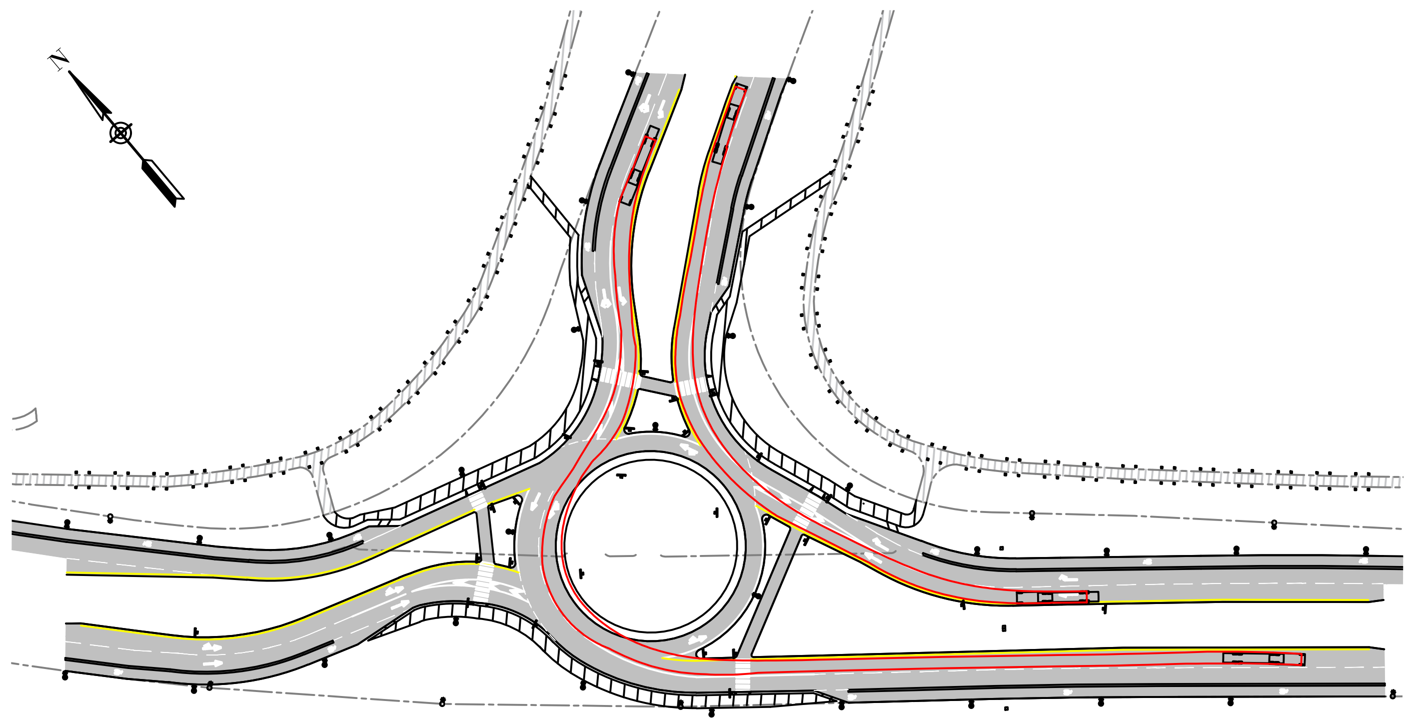
DRAWING DESCRIPTION:
W16TH AND SW MARINE DRIVE
MARKING/SIGNAGE-SW MARINE DR SOUTH OF 16TH

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: 1:500

DATE: 10-04-2024
DRAWING No. 15-PM3-2
SHEET 12 OF 16
REV No.: 1







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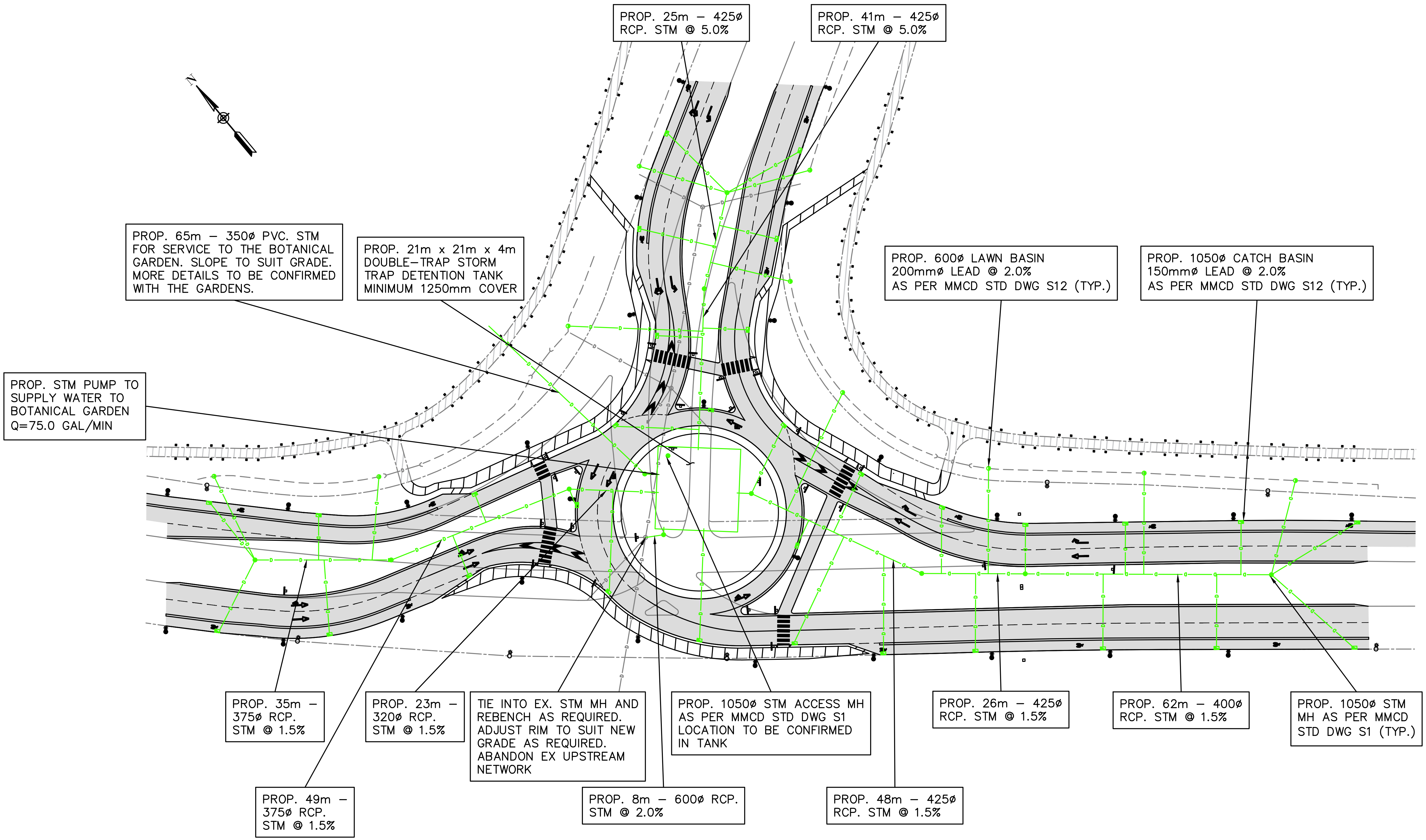
No.	DATE	REVISION	BY
1	7.12.2023	ISSUED FOR PRELIMINARY DESIGN	KK
2	10.04.2024	ISSUED FOR DETAILED DESIGN	KK
3			

CLIENT:
UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

DRAWING DESCRIPTION:
W16TH AND SW MARINE DRIVE
AUTOTURN

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: 1:1750

DATE: 10-04-2024
DRAWING No.
15-AT
SHEET 13 OF 16
REV No.: 2



STAMP

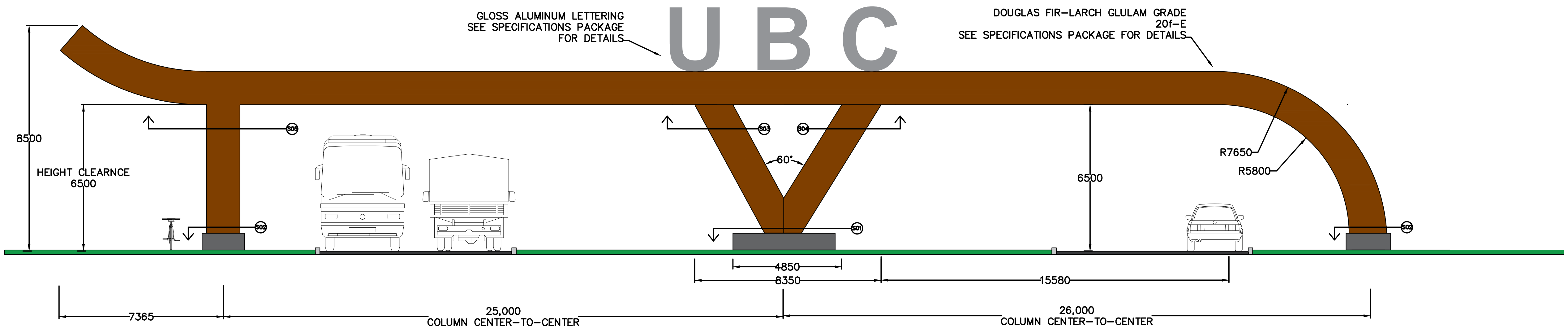
No.	DATE	REVISION	BY
1	7.12.2023	ISSUED FOR PRELIMINARY DESIGN	KK
2	10.04.2024	ISSUED FOR DETAILED DESIGN	KK
3			

CLIENT: UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

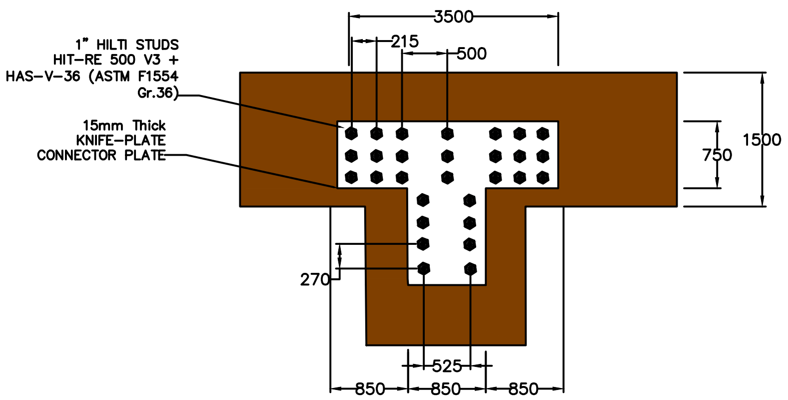
DRAWING DESCRIPTION: W16TH AND SW MARINE DRIVE STORMWATER

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: 1:1000

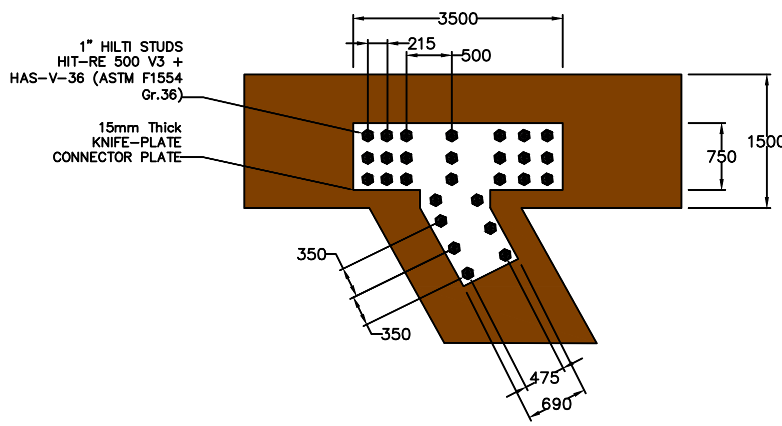
DATE: 10–04–2024
DRAWING No. 15–STM1
SHEET 14 OF 16
REV No.: 2



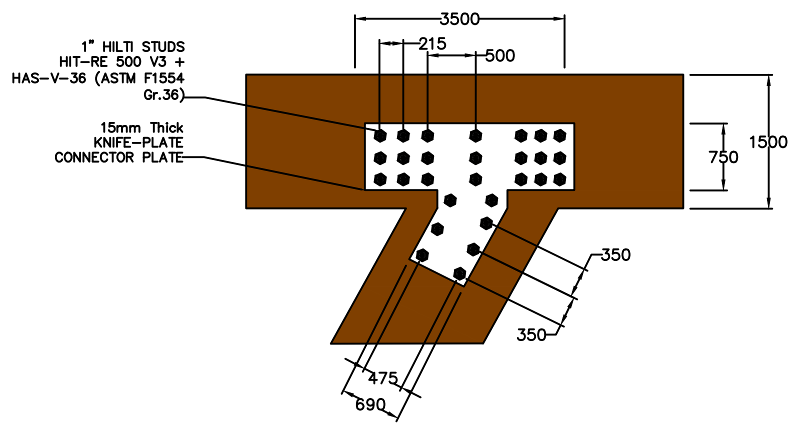
1.0 / D5.01 CONCEPTUAL ARCHITECTURAL NORTH ELEVATION VIEW
NTS



S05 GLULAM STANDARD CONNECTION DETAIL
NTS



S03 GLULAM INCLINED CONNECTION DETAIL 2
NTS



S04 GLULAM INCLINED CONNECTION DETAIL 2
NTS

STAMP

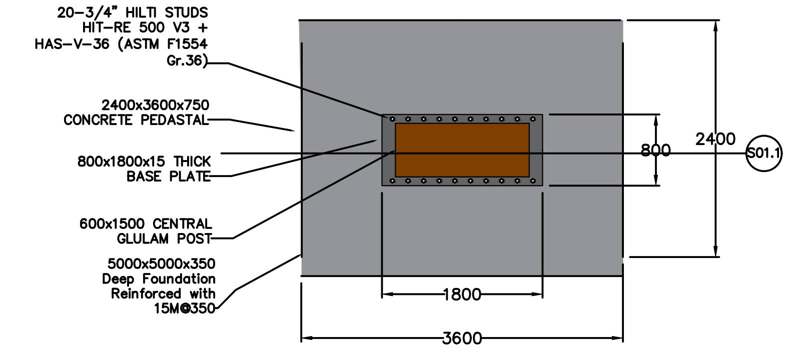
No.	DATE	REVISION	BY
1	7.12.2023	ISSUED FOR PRELIMINARY DESIGN	NS
2	10.04.2024	ISSUED FOR DETAILED DESIGN	NS
3			

CLIENT:
UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

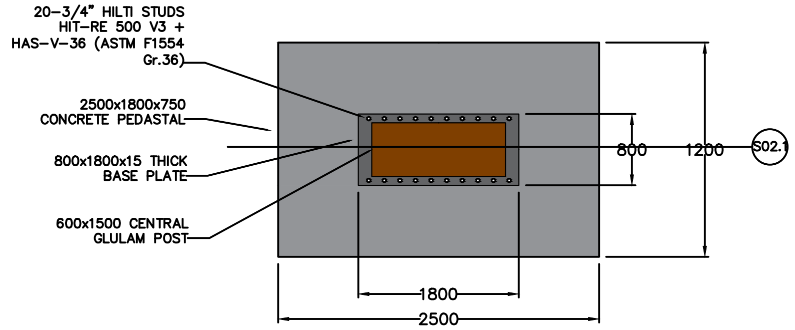
DRAWING DESCRIPTION:
W16TH AND SW MARINE DRIVE
STRUCTURAL- GATEWAY AND CONNECTIONS

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: NTS

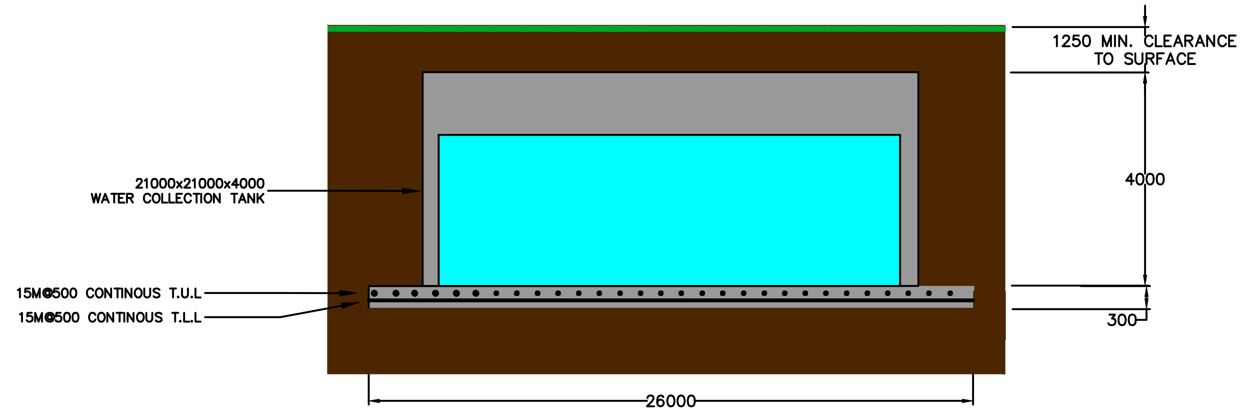
DATE: 10-04-2024
DRAWING No.
15-STRC1
SHEET 15 OF 16
REV No.: 2



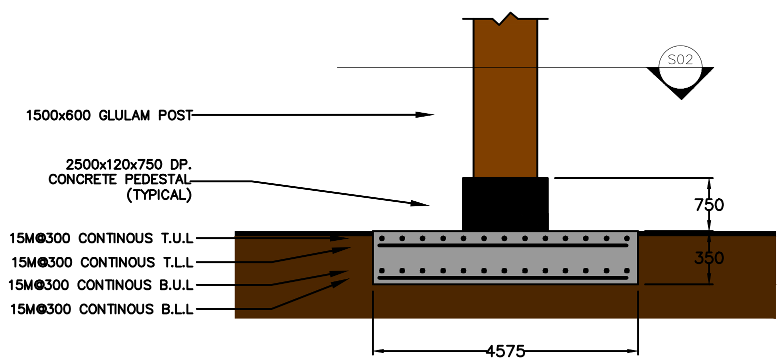
S01 CENTRAL POST PAD FOOTING SECTION VIEW
NTS



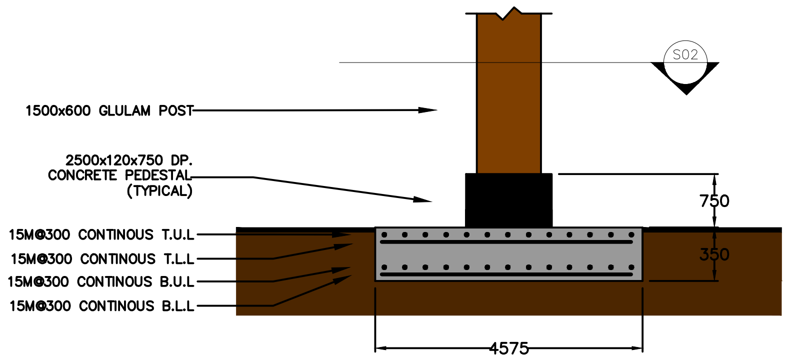
S02 EDGE POST PAD FOOTING SECTION VIEW
NTS



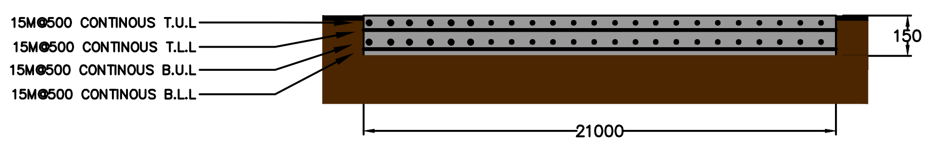
S07 COLLECTION TANK PAD FOOTINGS SECTION VIEW
NTS



S02.1 EDGE POST PAD FOOTING SECTION VIEW
NTS



S02.1 EDGE POST PAD FOOTING SECTION VIEW
NTS



S06 WATER FOUNTAIN PAD FOOTINGS SECTION VIEW
NTS

STAMP

No.	DATE	REVISION	BY
1	7.12.2023	ISSUED FOR PRELIMINARY DESIGN	NS
2	10.04.2024	ISSUED FOR DETAILED DESIGN	NS
3			

CLIENT:
UBC CAMPUS AND COMMUNITY PLANNING
2210 WEST MALL, VANCOUVER, BC

DRAWING DESCRIPTION:
W16TH AND SW MARINE DRIVE
STRUCTURAL– FOOTINGS

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: NTS

DATE: 10–04–2024
DRAWING No.
15–STRC2
SHEET 16 OF 16
REV No.: 2