UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Chancellor Boulevard & East Mall Redesign

Pacific Pathway Consulting Ltd.

University of British Columbia

CIVL 446

2025-04-07

EXECUTIVE SUMMARY

The **Chancellor Boulevard and East Mall Intersection Redesign** aims to address safety, functionality, and aesthetic concerns at the Northern entrance to the University of British Columbia's Point Grey campus in Vancouver, BC. Pacific Pathway Consulting Ltd. has developed a detailed design that balances active transportation priorities, environmental sustainability, and community needs, while adhering to UBC Campus and Community Planning (C+CP) objectives and BC Ministry of Transportation and Infrastructure (MoTI) standards.

On October 25th, Pacific Pathway Consulting presented three conceptual design options to the client and stakeholders at a public meeting, with a signalized intersection emerging as the preferred option based on its ability to meet all design objectives. This choice was validated through stakeholder feedback and technical analysis. The final detailed design reflects input from rightsholders, including UBC C+CP and the Musqueam First Nation, as well as stakeholders, including the Chan Center for the Performing Arts, residents, UBC faculty and students.

Key achievements of the detailed design include:

1. **Enhancing Active Transportation**: The design prioritizes pedestrians and cyclists through features such as fully protected crossings and leading pedestrian intervals ensuring safe and accessible travel for users of all ages and abilities.
2. **Reducing Vehicle Speeds**: Geometric modifications are incorporated to align vehicle speeds with the 50 km/h limit, addressing safety concerns at the intersection.
3. **Sustainable Rainwater Management**: A comprehensive rainwater management system, including an underground storage tank and a ladder marsh, is designed to retain all rainwater on-site, mitigating cliff erosion and supporting UBC's sustainability goals.
4. **Creating a Gateway to UBC**: A breathtaking 8.8-meter-tall gateway sign integrates architectural and landscaping elements, reinforcing the intersection's role as a welcoming landmark to the UBC campus.

Projected for completion by September 2025, the project's phased construction plan minimizes disruptions while ensuring timely delivery. Pacific Pathway Consulting is confident that a Class "A" cost estimate of **$2,058,700** will be attainable as we do not expect additional overhead costs caused by delays.

The final detailed design aligns with UBC's Vision 2050 and Transportation 2040 goals, creating a safer, more sustainable, and visually distinct intersection that serves the campus and broader community.

Table of Contents

1 FIGURES

2 TABLES

3 INTRODUCTION

The intersection of Chancellor Boulevard and East Mall/NW Marine Drive is located at the Northern end of the University of British Columbia (UBC) in Vancouver, BC. It is bound on the North by the University Endowment Lands and Pacific Sprit Regional Park, a mix of single-family housing and natural park space. On the South, it is bound by UBC's campus consisting of private multi-family housing and the Chan Center for the Performing Arts. The land on which the intersection is located is the traditional, ancestral, and unceded territory of the xwməθkwəy̓əm (Musqueam) People. A site plan showing the intersection configuration and surrounding land use can be seen in **Figure 1**.

***Figure 1** – Site Overview*

The intersection is currently side-street stop controlled with the West leg of NW Marine Drive and Chancellor Boulevard constituting the main road. East Mall and the West leg of NW Marine Drive are under the control of UBC Campus and Community Planning (C+CP) while the North leg of NW Marine Drive and Chancellor Boulevard are the property of the BC Ministry of Transportation and Infrastructure (MoTI). There are limited pedestrian and active transportation features at the intersection with a single marked unsignalized pedestrian crossing on the East leg of Chancellor, and a painted bike lane running through the intersection on Chancellor's north side. Currently, the intersection serves as a minor gateway to UBC's Point Grey campus.

UBC Campus and Community Planning has identified several key issues with this intersection and has hired Pacific Pathway Consulting Ltd. to complete a new intersection design that will both address these issues and meet the current BC MoTI standards. This report outlines the design and consultation process that has been completed to date and presents the final detailed design.

3.1 Design Objectives

As communicated by UBC C+CP, the detailed design needs to accomplish the following four primary objectives illustrated in **Figure 2**:

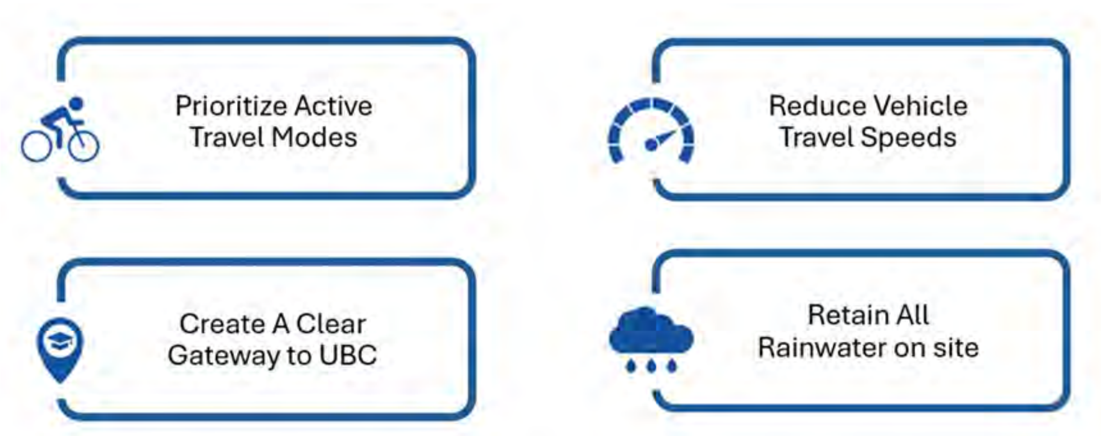


***Figure 2** – Design Objectives*

3.1.1 Prioritize Active Travel Modes

Creating an intuitive design is crucial to encourage active travel modes, a key priority identified by UBC C+CP. Currently, the intersection's pedestrian and cycling facilities are inadequate, with just one unsignalized crosswalk and a painted bike lane, and an unmarked side road serving as a de facto bike lane without proper signage or control. UBC's 2020 Vancouver Campus Plan and 2014 Transportation Plan emphasize prioritizing active transportation and reducing single-occupant vehicle use. Pacific Pathway Consulting aims to align the new intersection design with these goals, enhancing active transportation facilities.

3.1.2 Reduce Vehicle Travel Speeds

The roads leading to this area, including Chancellor Boulevard and NW Marine Drive, were originally designed for high speeds, conflicting with current land use and creating a speed-related safety issue. To address this, the team has incorporated geometric design elements such as adjusting curve radius and intersection controls to reduce speeds. The current intersection layout is also unintuitive, causing driver confusion and safety risks, worsened by the angled alignment of intersecting roads. The new design prioritizes predictable intersection controls aligned with nearby intersections, enhancing safety by reducing the cognitive workload of motorists.

3.1.3 Retain All Rainwater on Site

***Figure 3** – LiDAR Data Showing Cliff Erosion at UBC*

Cliff erosion on the northwest end of the intersection due to runoff (depicted in **Figure 3**) is a concern for UBC, which seeks a shift to a natural stormwater management approach as outlined in the 2020 Vancouver Campus Plan. This approach aims to treat rainwater as a resource, repurposing it for uses like irrigation. The new design includes a stormwater management system that collects rainwater and runoff, complying with UBC standards. It will be built to handle a predicted increase in winter precipitation due to climate change with capacity for a 100-year storm event.

3.1.4 Create a Clear Gateway to UBC

Creating a sense of arrival to the UBC campus is a vital component of our design. Currently, there is no clear indication that commuters are arriving at UBC at the Chancellor Blvd / East Mall intersection. Our design includes an 8-meter tall UBC sign that will clearly mark the intersection as a gateway to UBC. The design is visually pleasing and large enough to attract commuter's attention. The structural concrete footing design for the sign is also included in this report.

3.2 PROJECT CONSIDERATIONS

The following section outlines the specific project assumption and constraints.

3.2.1 Project Constraints

Specific project requirements requested by the clients are summarized into negotiable and non-negotiable constraints as shown in the table below. The first column highlights all the categories that the team had the choice of modifying, and the second column are items that must be met in the design.

Negotiable Constraints	Non-Negotiable Constraints
- Design for UBC gateway signage (footing included) - Geometry of road intersection - Mechanism for rainwater catchment and renewal - Surrounding scenery and environment (vegetation, art, etc.)	- Property limitations (including existing utilities) - Meet MoTI standards for safety - Environmental damage should be minimized - Design for 100-year storm event - UBC gateway must be at least 8 meters tall - Address stakeholder concerns and requirements

3.2.2 Project Assumptions

These key assumptions for this design have been made based on instruction provided by UBC C+CP at various design review meetings and in the project documentation:

- Existing utility infrastructure is not known in the project area. For this reason, it is assumed **there will be no changes to existing underground utilities and the existing utility infrastructure will not interfere with this detailed design.**
- As communicated to Pacific Pathway by UBC C+CP at a design review meeting, **the property line on the NW corner is assumed to be 10 meters west of the existing back of walk.** This distance is greater than the distance to the existing tree line (7 m), therefore **the existing tree line was used as the property line constraint on the NW corner for this detailed design.** All other corners use the existing back of walk as the property line.
- Due to the lack of underground utility information, it is assumed that **the new stormwater retention system will be able to tie-in to the existing storm system at some location.**

3.3 STAKEHOLDER ENGAGEMENT

The following section addresses who Pacific Pathway Consulting Ltd. have identified as rightsholders and stakeholders on this project, and the ways we have communicated with them and the broader community throughout the design process.

3.3.1 Musqueam First Nation

As previously stated in **Section 1.0**, the intersection of Chancellor Boulevard and East Mall is located on the traditional, ancestral, unceded territory of the xʷməθkʷəy̓əm (Musqueam) First Nation. For this reason, we have considered the Musqueam First Nation to be a rightsholder on this project and, as such, have engaged with them throughout the entire planning and design process. In all our present and future interactions with the Musqueam First Nation, we commit to treat them as our partner and practice allyship by advancing reconciliation through any avenues available to us.

3.3.2 Stakeholder Identification

Table 1 below identifies the project's stakeholders, their level of influence, and the priority assigned to each by Pacific Pathway. A priority level of one is reserved for project rightsholders, who have been treated as partners throughout the project's duration. The remaining levels of priority indicate stakeholders' level of control over key project decisions. The table also includes the overall interest level of the various groups as expressed to the team at various public engagement meetings.

***Table 1** – List of Project Stakeholders*

Stakeholder	Priority	Interest	Influence
UBC C+CP	1	High	High
BC MoTI	1	High	High
Musqueam First Nation	1	High	High
Adjacent Landowners and Residents	2	High	Medium
The Chan Centre for the Performing Arts	2	Medium	Low
UBC Students and Faculty	2	Medium	Medium
Goods Delivery Companies	3	Medium	Low

3.4 STANDARDS AND SOFTWARE

Table 2 below lists the relevant standards, plans, and design guides that were used in the completion of this design.

***Table 2 -** Standards, Plans, and Design Guides Used in Design*

Design Component	Standards, Plans, and Design Guides
Transportation System	• UBC Campus Vision 2050, *UBC (2023)* • 2014 UBC Transportation Plan, *UBC (2014)* • BC Active Transportation Design Guide, *BC Ministry of Transportation and Infrastructure (2019)* • Electrical and Traffic Engineering Manual Section 400 Signal Design, *BC Ministry of Transportation and Infrastructure (2019)* • TAC Geometric Design Guide for Canadian Roads, *Transportation Association of Canada (2017)* • BC Supplement to TAC Geometric Design Guide for Canadian Roads, *BC Ministry of Transportation and Infrastructure (2019)* • Engineering Design Manual, *City of Vancouver (2019)* • Standard Detail Drawings Roadworks, *City of Vancouver (2019)*
Rainwater Management	• Engineering Design Manual, *City of Vancouver (2019)* • Vancouver Campus Integrated Stormwater Management Plan – *UBC (2017)* • MMCD 2019
Gateway	• CSA S16:19 – *Design of Steet Structures (2019)* • NBC 2020 (Part 4) – *Structural Steel Design Requirements* • CSA A23:3:19 – *Design of Concrete Structures (2019)* • NBC 2020 (Part 4) – *Concrete Design Requirements* • CSA S806-12 – *Design and Construction of Building Structures with Fiber-Reinforced Polymers (2012)*

Table 3 below indicates the software programs the team utilized in completion of this design, while **Table 4** highlights individual team member contributions.

Table 3 *- Software Programs Used in Design*

Design Component	Software
Transportation System	• Synchro • Civil 3D • AutoTURN • Revit • Twin Motion
Rainwater Management	• Civil 3D • ArcGIS
Gateway	• SketchUp
Construction Plan	• GaantProject • Bluebeam

Table 4 *– Individual Team Member Contributions*

Name	Contributions
Alex Ireton	Civil 3D surface, stormwater analysis, water storage design & tank sizing, document formatting, cost estimate.
Ben Raffler	Project schedule, construction phasing, traffic plans, construction signage plans, cost estimate, landscaping, ladder marsh planting plan, conceptual gateway designs, traffic count.
Francesca Elloso	AutoCAD drawing set, signalized conceptual design, structural calculation and drawing, ladder marsh sizing, gateway standards, traffic count.
Vincent Chieu	AutoCAD drawing set, synchro analysis, phasing plan, rainwater retention, bi-modal overpass conceptual design, traffic count.
Yuen Lam Peri Lo	Signage and signals drawing, preliminary gateway design and calculations, and service life maintenance plan.
Addison Hiller	Transportation system design, 3D renderings, swept path analysis, roundabout conceptual design, cost estimate, stakeholder engagement.

4 CONCEPTUAL DESIGN ALTERNATIVES

Three potential design options were developed and compared against one another. Using a decision-making matrix based on the project's primary objectives, the team identified the preferred design option and presented their findings to the client and the public on October 25th. **Figure 4**, **Figure 5**, and **Figure 6** correspond to the **Signalized Intersection**, **Dogbone Roundabout**, and **Bi-Modal Overpass** respectively – these conceptual designs are depicted below, and ranked by the score they received from the decision-making matrix:

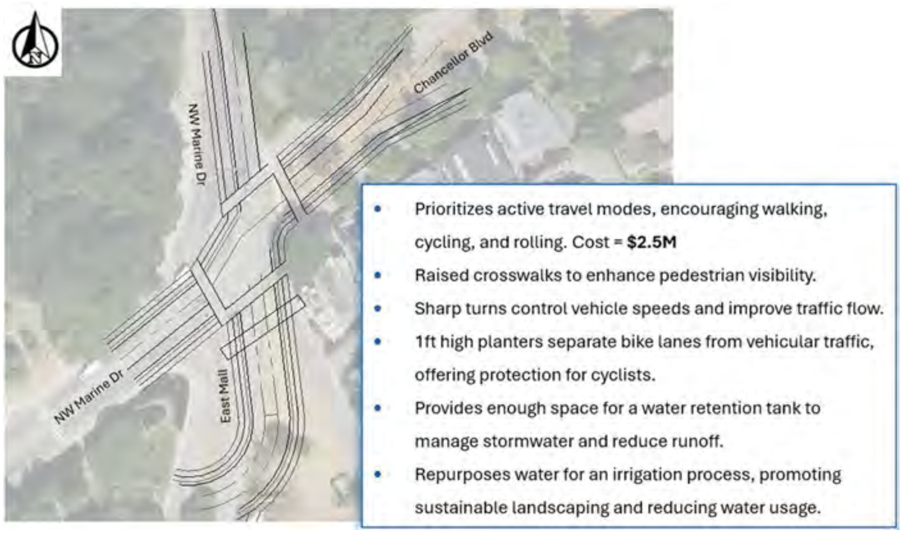


Figure 4 *– Signalized Intersection Concept: Rank =1, Score = 79.5%*

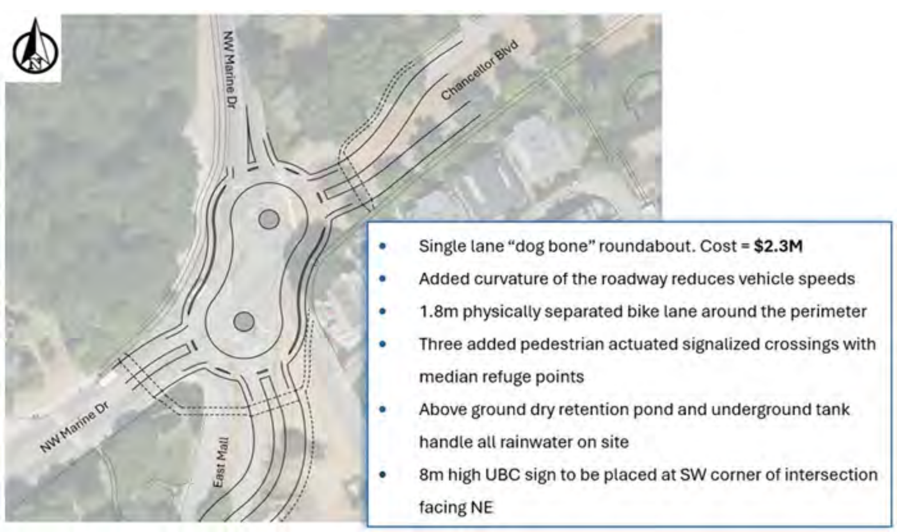


Figure 5 *– Dogbone Roundabout Concept: Rank = 2, Score = 73.5%*

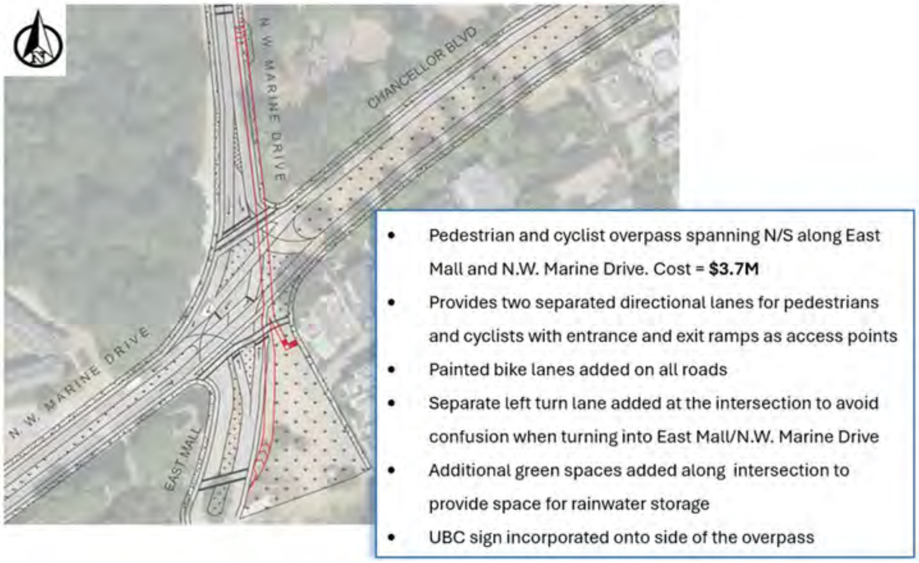


Figure 6 *– Bi-Modal Overpass Concept: Rank = 3, Score = 63.5%*

4.1 SELECTED CONCEPTUAL DESIGN AND APPROACH

The signalized intersection was the recommended option to advance to preliminary and detailed design because it received the highest score when evaluated on the eight criteria shown below in **Figure 7**.

Criteria	Weight (%)	Roundabout		Signalized		Bimodal Overpass	
		Rating	Score	Rating	Score	Rating	Score
Active Mode Safety	20%	2	8%	5	20%	5	20%
Water Retention	20%	5	20%	4	16%	1	4%
Reduce Vehicle Speeds	20%	5	20%	4	16%	4	16%
Clear UBC Gateway	15%	4	12%	3	9%	4	12%
Design Cost	7.5%	3	4.5%	2	3%	1	1.5%
Intuitive Design	7.5%	2	3%	5	7.5%	2	3%
Impact of Construction	5%	3	3%	4	4%	5	5%
Maintenance	5%	3	3%	4	4%	2	2%
	Total	27	73.5%	31	79.5%	24	63.5%

Figure 7 *– Conceptual Design Decision-Making Matrix*

5 Detailed Design Description

The final detailed design is a fully protected signalized intersection. The signals are semi-actuated by pedestrian push buttons, bicycle loop detectors, and vehicle loop detectors on the north and south legs while eastbound and westbound traffic constitutes the primary phase. Straight-faced, curb-lined planter medians physically separate pedestrians and cyclists from traffic. An 8-meter high UBC sign is located on the SW corner of the intersection spanning overtop of a ladder-marsh that provides 106 m^3 of above-ground rainwater retention. An underground storage tank located on the NE corner of the intersection provides 1106 m^3 of storage for large rainfall events. The design of the overall transportation system can be seen below in **Figure 8**. Please refer to the attached drawing set for detailed drawings of all other design components. This section describes the various components of the transportation system, rainwater management, and gateway designs in detail.

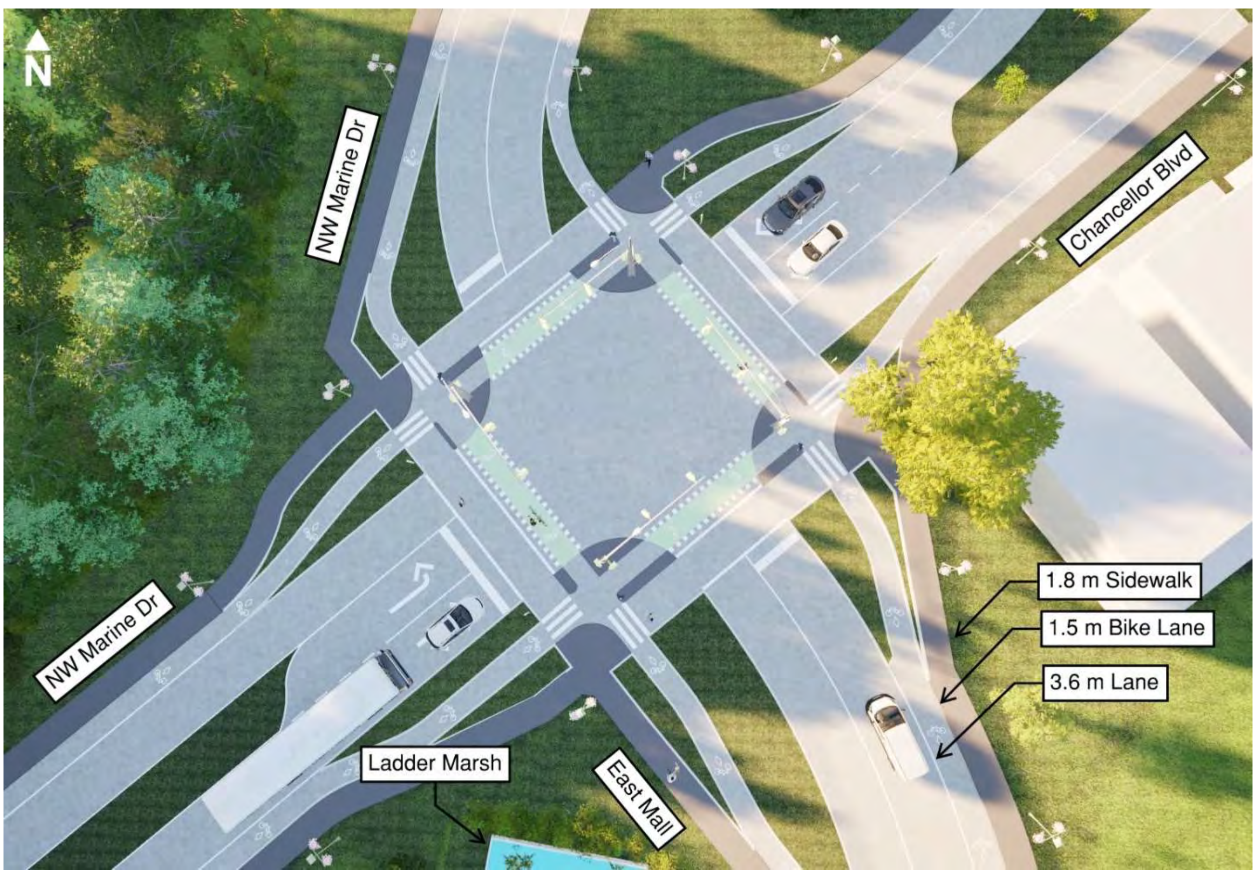


Figure 8 - *Detailed Design Overview*

5.1 TRANSPORTATION SYSTEM DESIGN

The following section outlines the features of the new intersection's transportation system.

5.1.1 Lane Configuration and Geometry

The lane configuration and geometry of this intersection have been designed to reduce vehicle travel speeds and make the intersection safe and more accessible for active modes. Single lane approaches with widths of 3.6 m are provided on all four legs of the intersection with two short left turn storage lanes on the east and west legs. This configuration balances the need for short pedestrian and bicycle crossing distances, which increases safety and the overall attractiveness of the intersection for active modes, with the need to provide adequate vehicle capacity. Small corner radii of 5 m have been utilized on all four corners to reduce travel speeds when maneuvering through the intersection. This, in addition to the added curvature of the approaching alignments, works to discourage drivers from travelling at excessive speeds. **Figure 9** below highlights these key features at the intersection.

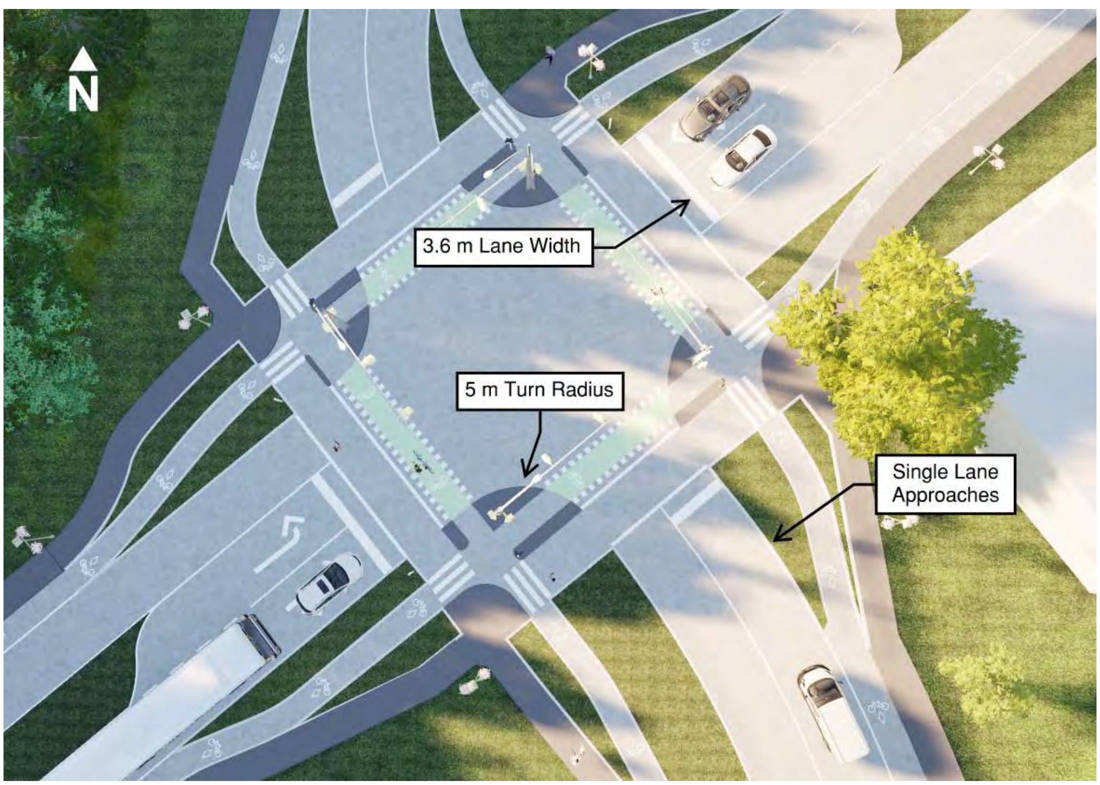


Figure 9 *- Lane Configuration and Geometry*

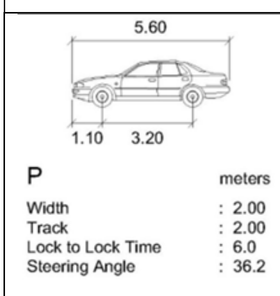
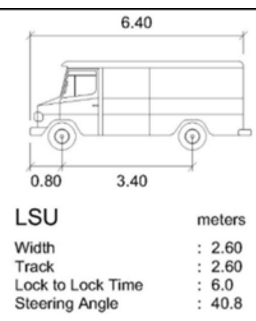
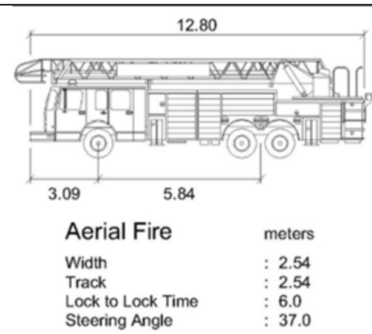
5.1.1.1 Design Vehicle

As outlined in the BC Active Transportation Design guide, the design vehicle is the "largest and least maneuverable vehicle that frequently uses the road" (2019). The largest vehicle observed to frequently maneuver this intersection is a TransLink bus, as route 68 runs along NW Marine Drive. However, because this vehicle does not have to make any turns at the intersection, the next largest vehicle was selected.

Based on the observations made during the team's site inspections and traffic counting, a reasonable design vehicle for this intersection is a single unit truck. The TAC Geometric Design guide has three types of single unit trucks: light single unit truck (LSU), medium single unit truck (MSU), and heavy single unit truck (HSU). As the main transportation objectives of this intersection redesign are to reduce vehicle speeds and encourage active travel modes, the team selected an LSU as the design vehicle as that would allow for the smaller curb radii of 5 m which aided in achieving these objectives.

In addition to the design vehicle, the BC Active Transportation Design Guide also outlines the need for a control vehicle (the largest vehicle that infrequently navigates the intersection) and a managed vehicle (the vehicle that most commonly uses the road) (2019). For the cycling lanes, a standard bicycle was used as the design vehicle. The selected vehicles for these purposes are summarized in **Table 5**.

***Table 5** – Design Vehicles. Image Sources: (City of Toronto, 2017), (BC MoTI, 2019)*

Managed Vehicle	Design Vehicle	Control Vehicle	Active Transportation Design Vehicle
			

This set of vehicles was used to constrain the intersection geometry design. Both the design vehicle (LSU) and managed vehicle (P) can navigate the intersection at normal operating speeds without making any extra maneuvers. The control vehicle (aerial fire truck) can navigate the intersection by taking up more than one lane to make some of the turns. It's reasonable to assume this is possible as the control vehicle is an emergency vehicle and, therefore, traffic will conduct itself accordingly to provide the vehicle with the space required to complete such maneuvers. Swept path analyses for the design and control vehicles are included in **Appendix A**.

5.1.1.2 Large Truck Turning Maneuvers

Large single unit trucks will be able to complete right turns at the intersection by occupying part of the adjacent turning lane on the approach. This situation is expected to be rare based on the team's field observations and the surrounding land use and therefore it is not expected to cause any significant delays or other issues. Trucks with trailers, however, will not be able to complete right turns due to the compact intersection geometry.

While their expected frequency is very low, these units must be considered as the Chan Center for the Performing Arts (located on the SW corner of the intersection) occasionally receives large trucks for the setup of concerts and other events. This concern was communicated to Pacific Pathway by The Chan Centre at conceptual design public presentation. To handle this, the following truck and trailer delivery plan has been established in **Figure 10** on the following page.

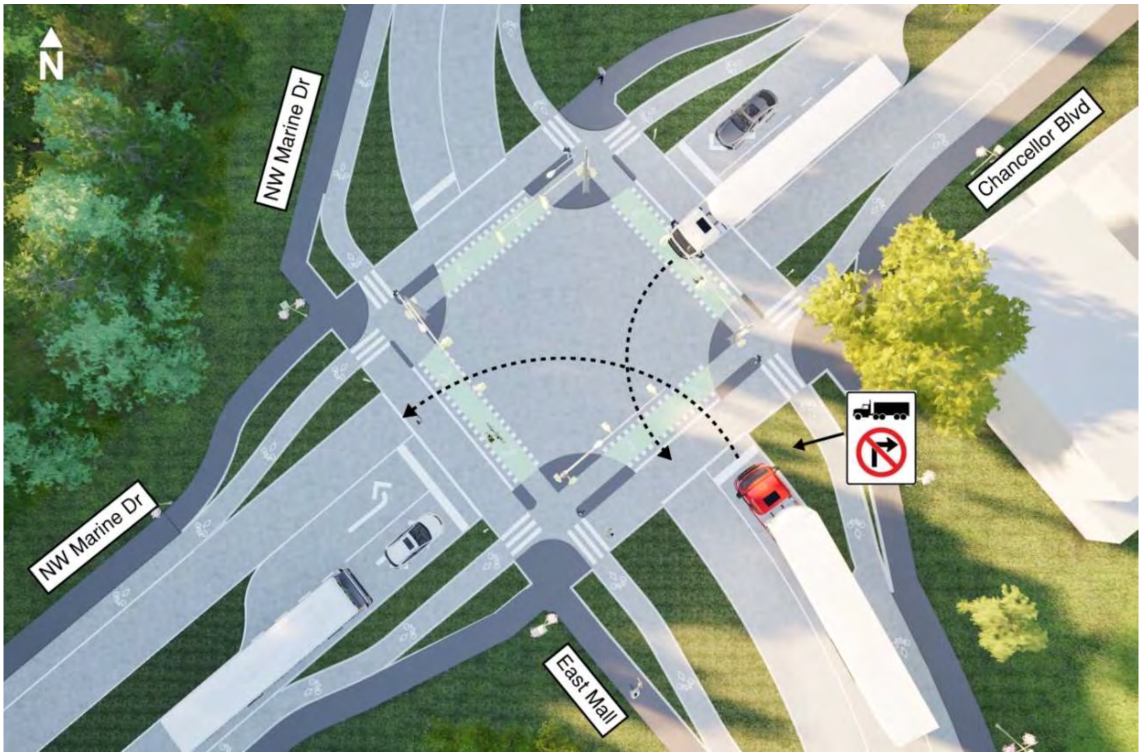


Figure 10 *- Large Truck Turning Plan*

These truck and trailer units will have no issue navigating the left turn geometry at the intersection. For this reason, all delivery trucks headed to the Chan Centre will be instructed to approach from the east. They will then be restricted to only turning left when leaving the Chan Centre where their route along NW Marine Drive will take them out of UBC Point Grey Campus through SW Marine Drive.

5.1.2 Cyclist Facilities

This fully protected intersection design, compliant with the requirements established in the BC Active Transportation Design Guide, provides a safe crossing point for active travelers of all ages and abilities. **Figure 11** on the following page highlights the cycling facilities and relevant signage that are provided at each leg of the protected intersection. The feature located at each number is explained below the figure.

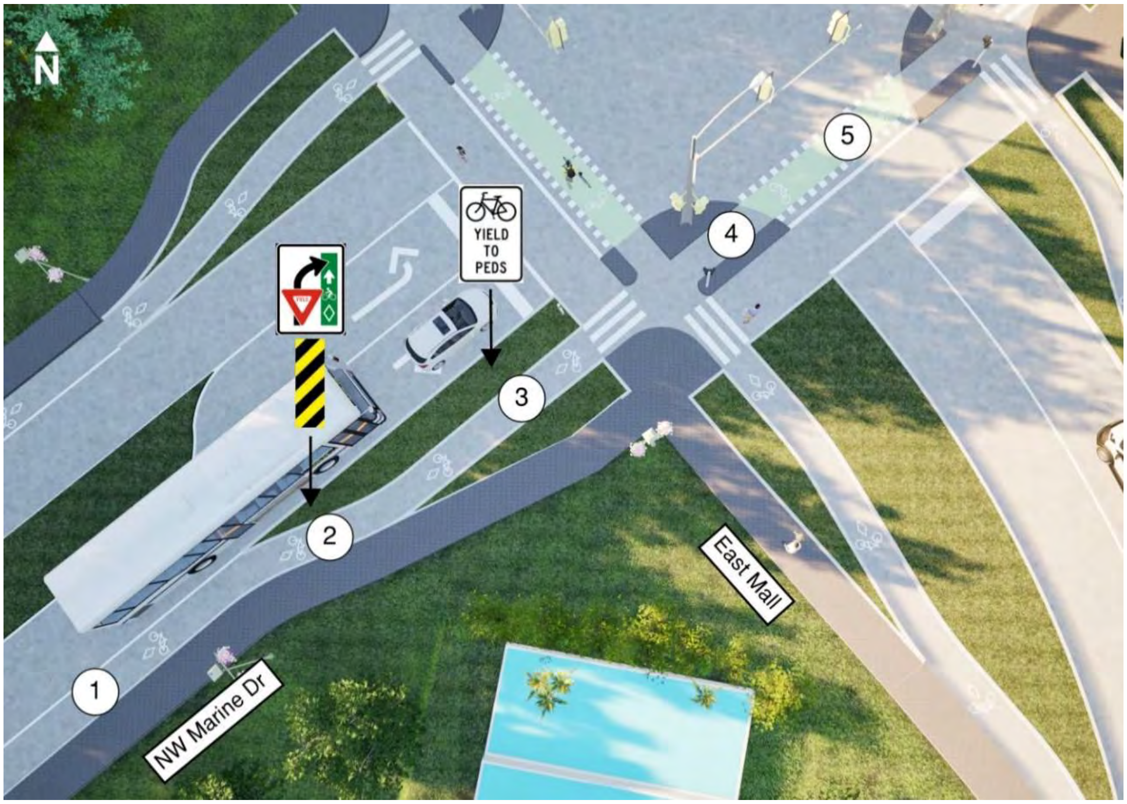


Figure 11 *- Cyclist Facilities*

1) 1.5-meter-wide existing paint separated bike lanes tie-in to the protected intersection. These separated bike lanes exist on the east, south, and west legs. On the north leg, where there is no existing paint separated bike lane, the existing alignment and lane width have been modified to allow for the creation of a 1.5m wide paint separated bike lane approaching the intersection.
2) A 3:1 approach taper bends the paint separated bike lane away from the roadway creating a physically separated bike lane. The taper is created by a straight-faced concrete curb and planter median.
3) A straight segment (greater than or equal to 5 m in length) before the intersection allows the cyclists time to get aligned with the crossing.
4) A forward bicycle queueing area with loop detectors that trigger the pedestrian/cyclist crossing signal (on the minor road only).
5) A 1.5-meter-wide enhanced cross-ride designed to BC Active Transportation Design Guide standards allows cyclists to cross the road safely without needing to dismount.

These features are provided for cyclists at all four legs of the intersection and meet the minimum requirements specified in sections G.4 and G.5 of the BC Active Transportation Design Guide. An exception was made in the SE corner, where the space restriction with the property line only allowed for a 4.5-meter-long straight segment before the intersection. The team determined this to be an allowable exception given that it is small in magnitude and the curvature of the approach alignment will reduce approaching cyclists travel speeds.

5.1.3 Pedestrian Facilities

Figure 12 highlights the pedestrian facilities that are provided at each leg of the protected intersection. The feature located at each number is explained below the figure.

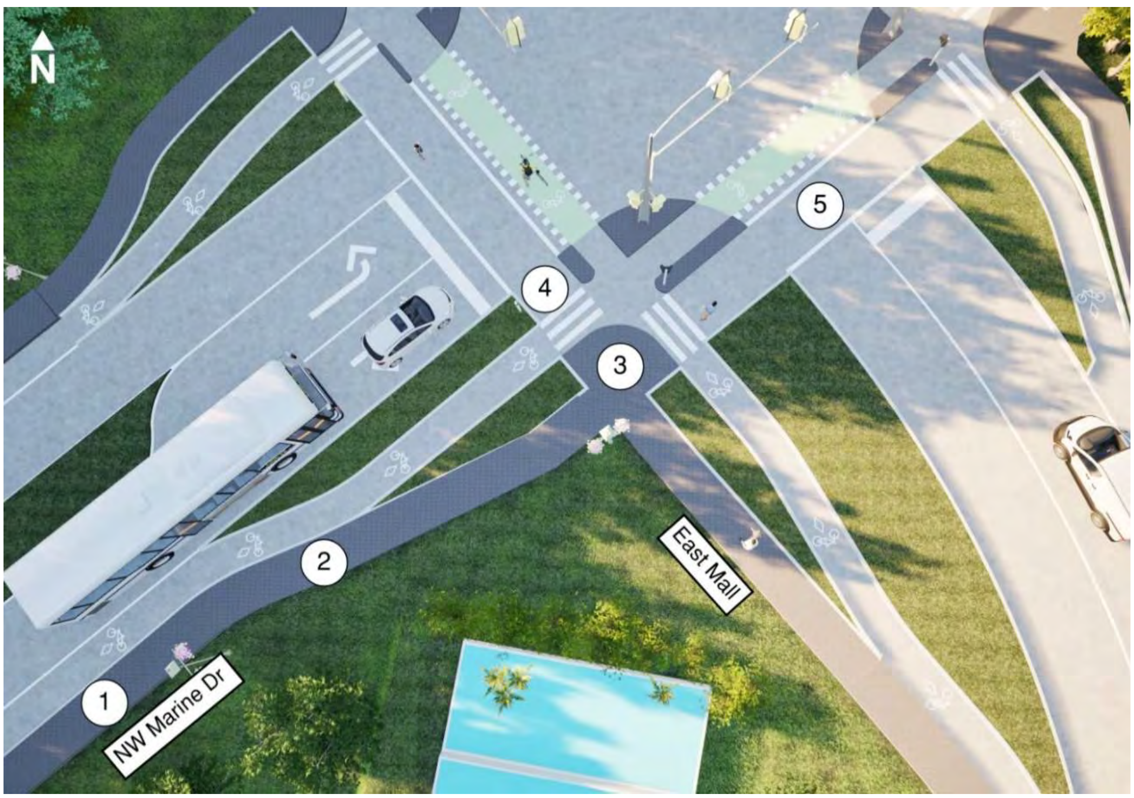


Figure 12 - *Pedestrian Facilities*

1) A 1.8-meter-wide straight-faced monolithic sidewalk ties-in to the protected intersection. These sidewalks exist on the south and west legs of the intersection. Narrower asphalt walkways that exist on the north and east legs will be tied-in to the 1.8-meter-wide concrete walkways as they approach the intersection.

2) A 3:1 approach taper bends the sidewalk away from the roadway creating physical separation.
3) Curb let-downs and tactile mats provide a safe transition from the sidewalk level to the road level for the crossing. Pavement markings alert cyclists that pedestrians have the right-of-way where pedestrians cross the bike lanes.
4) Accessible pedestrian signals are provided on a traffic signal pole located on the planter median that separates the driving and bike lanes (on the east and west legs only). These will provide auditory, visual, and tactile information to visual or hearing-impaired pedestrians allowing them to cross when it is safe to do so.
5) A 3-meter-wide crosswalk provides adequate space for pedestrians to safely cross the road separate from cyclists.

These features are provided for pedestrians at all four legs of the intersection and will ensure that pedestrians of all ages and abilities will be able to safely navigate the road crossing.

5.1.4 Signal Timing and Phasing Plan

The signal phasing and timing plans were generated through Synchro 6 to allow for optimal travel time and minimize delay. A leading pedestrian interval (LPI) of 5 seconds was added to allow for safer pedestrian and cyclist crossing. The parameters and results used for Synchro will be explained further in **Section 3.1.7.3**. There are a total of 4 phases: Eastbound and Westbound with permissive left turns, Northbound and Southbound with permissive left turns, and LPI phases in between each transition, refer to **Figure 13** on the following page (or **Appendix D**) for the full diagram.

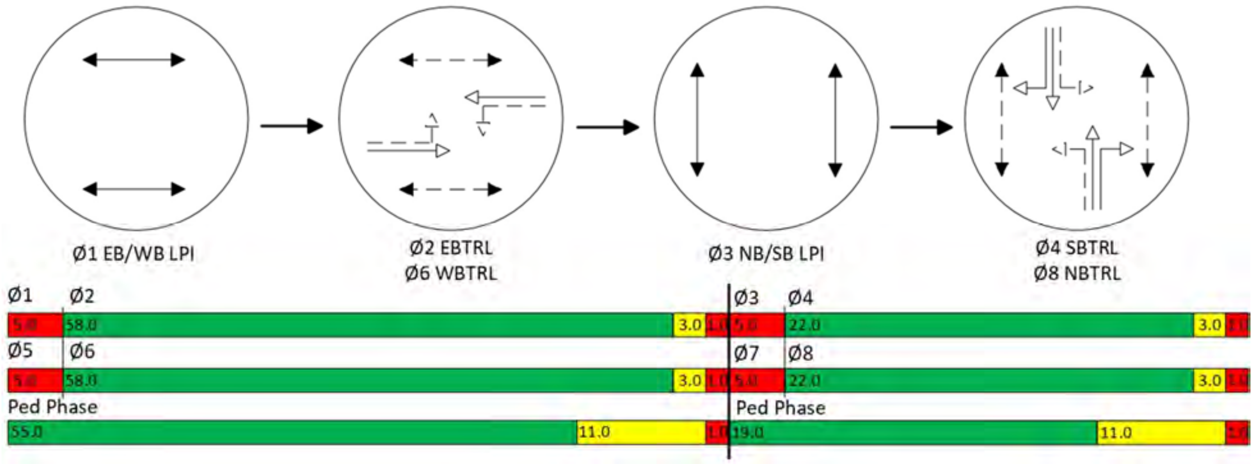


***Figure 13** - Signal Timing and Phasing Plan*

The Eastbound and Westbound direction is set to be the major road with the longest green time to maximize vehicle flow. The E/W bound lanes will have a maximum green time of 58 seconds and a minimum of 22 seconds. The N/S bound lanes will have a maximum green time of 22 seconds and a minimum of 13 seconds. The green time can be terminated any time after the minimum length has been reached. Pedestrian and cyclist crossings will occur during the respective green phases with a minimum walk time of 7 seconds and a "flash don't walk" time of 11 seconds in addition to the previously mentioned 5 second LPI. The total cycle length is 98 seconds, and this will be consistent throughout the day because it will be sufficient for both AM and PM peak volumes. This configuration results in a **Level of Service B,** which is the ideal level for both construction costs and serviceability. Further explanation of level of service is covered in **Section 3.1.7.3**.

The intersection will be semi-actuated by bicycle loop detectors, vehicle detectors, and pedestrian push buttons on the north and south legs to allow for termination of max green times. There are separate signal heads for pedestrians and cyclists. These facilities are identified on the following page in **Figure 14**.

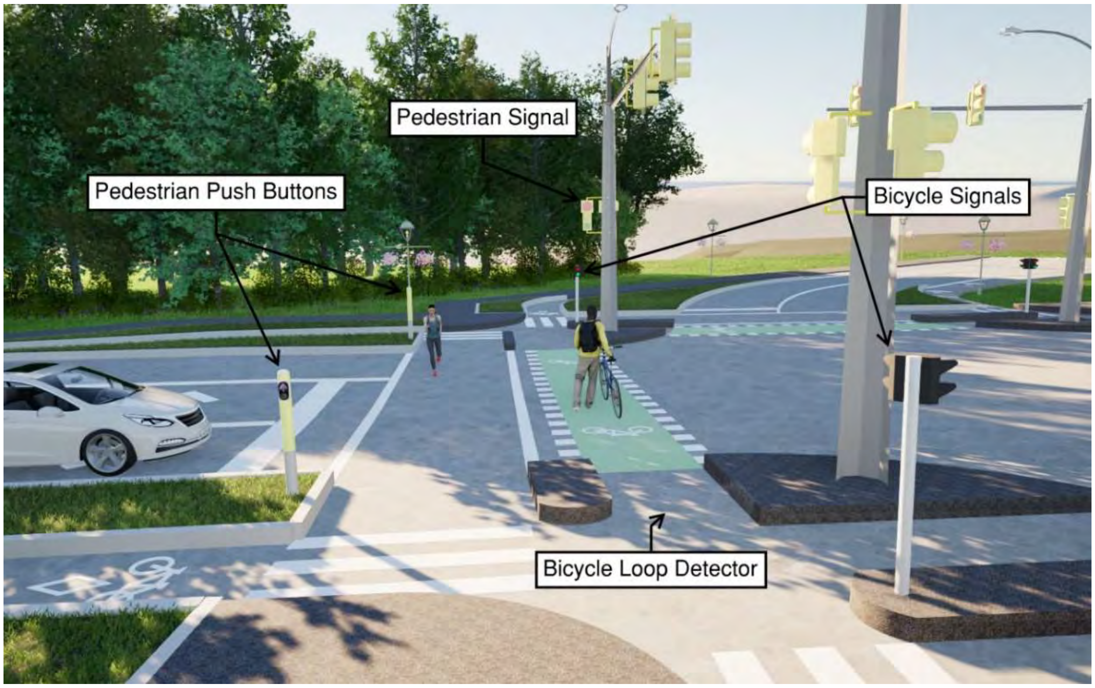


Figure 14 - *Pedestrian and Cyclist Signals*

5.1.5 Pavement Design

The road pavement structure will be the same as illustrated in the City of Vancouver Standard Detail Drawing R2.2 (refer to **Appendix E**) for a typical cross section of a higher-zoned street. This pavement construction was selected over the BC MoTI standard detail for road pavement since the City of Vancouver has a more suitable design for an arterial road such as the project site. The main difference is found in the layer underneath the asphalt paving where there is an extra layer of concrete. The additional concrete and thickness are included to account for heavy traffic volumes and vehicles such as buses which are expected to travel through this intersection. The cross-section will consist of 4 layers in order from top to bottom: a 50mm asphalt pavement, a 90mm concrete base mix, a 150mm crushed granular base, and a 300mm crushed granular sub-base. Full details of the cross-section are found in **Drawing 7** of the CAD Drawings. The road will be crowned with a 2% slope to allow drainage to either side. A type "A" curb and gutter (refer to **Drawing 13**) will be constructed on both ends of the road which is a standard design in BC and City of Vancouver.

5.1.6 Streetlighting Design

A preliminary streetlighting plan has been developed as part of the detailed design. This preliminary plan identifies the location and type of streetlighting fixtures that will be required. The plan incorporates decorative lighting fixtures similar to those that are currently installed at East Mall and Chancellor Blvd to illuminate the sidewalk and bike lanes. At the intersection, four large streetlights are mounted on top of the four traffic lights poles. This plan preserves the aesthetic of the neighborhood while ensuring visibility and safety for all road users at night. **Figure 15** below shows the preliminary streetlighting plan.

Figure 15 – *Preliminary Streetlighting Design*

5.1.7 Intersection Capacity Analysis

To ensure the new intersection design can adequately handle current and future traffic volumes, the team conducted a capacity analysis using Synchro Studio 6. The following sections detail the processes involved in collecting current data and projecting future volumes as well as the results of the analysis.

5.1.7.1 Existing Traffic Volumes

A manual count was conducted for current traffic volumes during the AM and PM peak hours of Wednesday, October 2nd. Data that was included in the count are vehicles (passenger car, buses, or trucks), cyclists, and pedestrians. **Figure 16** & **Figure 17** report the counts that were gathered for each peak hour. These numbers were used to determine future traffic growth, and the capacity the new intersection design needs to accommodate. The count shows that most traffic flow enters UBC during the AM peak hour, while the majority of flow exits during the PM peak hour. It can also be observed that heavier overall volumes occur during the PM peak hour and much of the delays come from the left turn into the residential areas, and the turns out of campus. Pedestrian and cyclist activity were consistent for both peak hours.

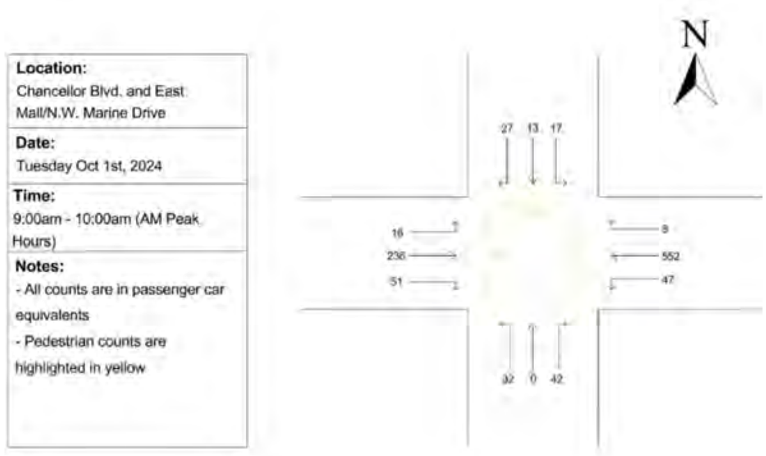


***Figure 16**: AM Peak Hour Traffic Volume*

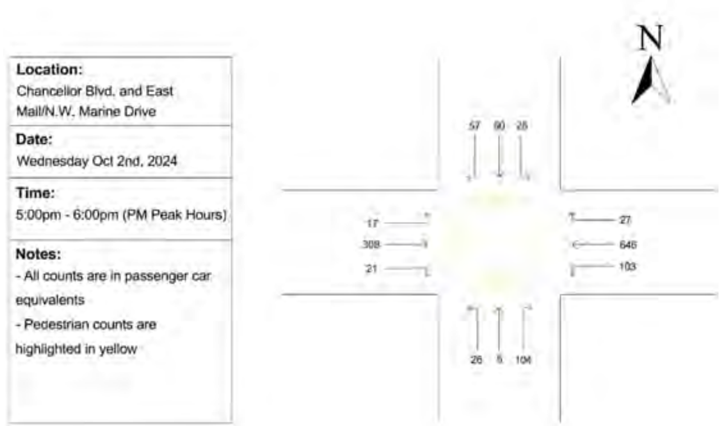


***Figure 17**: PM Peak Hour Traffic Volume*

5.1.7.2 Demand Forecasting

While the current traffic count is useful for understanding the performance of the existing intersection, a demand forecast was required as the new intersection is designed to accommodate traffic volumes in the year 2050. To create the prediction model, forecasts for UBC campus population and the Vancouver 2040 Transportation Plan were used for vehicle and active mode split growth. According to a report by UBC C+CP for their Campus Vision 2050, it states that as of February 2022, UBC has a population of roughly 80,000 people and by 2050, they are looking to increase that amount by 40%. This will come in the form of new housing and rental units which means vehicle population and traffic demand will also grow proportionally.

More growth is expected for active transportation since additional facilities will be built leading into UBC such as the rapid transit strategy outlined in the UBC Campus Vision 2050. The expansion includes the extension of the Millennium Line Skytrain to campus and the focus is to shift transportation away from cars. Thus increase in cyclists and pedestrians are expected for the intersection with a decrease in personal vehicle travel.

Implementing transit options does have a significant impact on how people choose to travel to their destination as shown in UBC Transportation Status Report in 2012 (**Figure 18**). In the span of 15 years, transit ridership increased by 37% and this number will continue to grow with improved infrastructure. Another survey also showed that the primary mode of travel across campus is by walking (**Figure 19**).

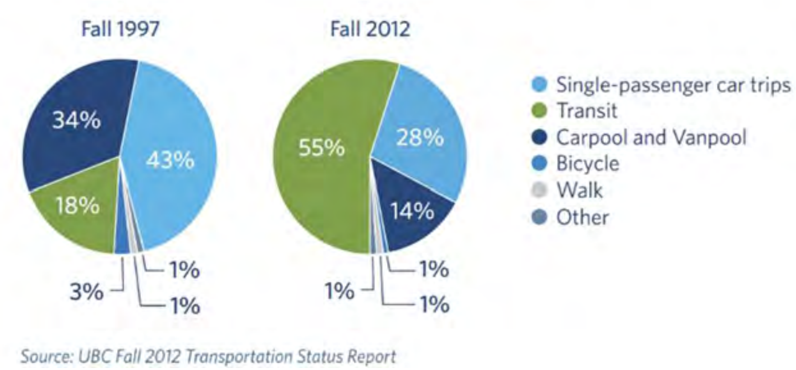


Figure 19: *UBC Report on Travel Mode Usage*

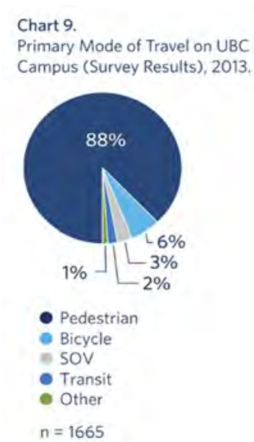


Figure 18: *UBC Survey on Campus Mobility*

In their 2014 Transportation Plan, UBC set a target goal of having at least two-thirds of all trips be completed by walking, cycling, or transiting. The intersection will need to accommodate this increase in active mode demand in order to align with UBC C+CP's vision. Using the projected percentage increase in population, the proportion of current volumes to population levels, and the projected mode split, the growth factor for the intersection was determined to be a **vehicle increase of 10%**, a **cycling increase of 15%**, and a **walking increase of 17%.** Vehicle percentage was still increased and this is due to an overall growth in population which will still result in increased cars, however, more volumes in cycling and pedestrians are expected in the long-term projections.

5.1.7.3 Synchro Analysis Results

Using the traffic count given from **Section 3.1.7.1** and the demand growth from **Section 3.1.7.2**, a Synchro analysis was conducted to evaluate the level of service of the intersection. **Table 6** below summarizes the key takeaways from the Synchro model and further parameters will be listed in **Appendix G**. The lane configuration was altered to match the final design which features a 10m storage lane for right turns on the N/S approach and a 10m storage lane for left turn on the West leg.

***Table 6** - Level of Service Summary*

PM Peak Hours (Curr.)	Northbound	Southbound	Eastbound	Westbound	Average
Total Vehicle Volume [#/hr]	135	132	776	346	347
Total Cyclist Volume [#/hr]	55	4	22	47	32
Total Ped. Volume [#/hr]	48	48	26	57	45
Total Delay [s]	53.9	24.9	15.2	11.3	105.3
Level of Service	D	C	A	A	**B**
PM Peak Hours (Future.)					
Total Vehicle Volume [#/hr]	161	158	927	413	415
Total Cyclist Volume [#/hr]	63	5	25	54	37
Total Ped. Volume [#/hr]	56	56	26	55	48
Total Delay [s]	68.7	29.9	26.2	19	36.0
Level of Service	E	C	B	A	**C**

The information for PM peak hours are shown as this timeframe is the critical volume for the intersection as mentioned in **Section 3.1.7.1.** As population growth increases, it is expected that the intersection transitions from a level of service B to a level of service C. This falls within a reasonable range that is both transportation and cost efficient. A LOS of A or B would mean delay times well below 30 seconds, while this may seem ideal, it would suggest that the road has been over-designed and under-utilized, which only results in higher costs. A LOS C is the recommended rank as it provides adequate capacity without unnecessary delays for users. By designing for a LOS C, driver's speed can also be decreased as it corresponds to a lower overall speed of the intersection which meets the required project objective.

5.2 Rainwater Management System Design

The water retention system illustrated in **Figure 20** is capable of handling a 100-year storm event based on historical climate data for UBC. From our analysis, the underground storage tank (highlighted in blue) has been sized to accommodate 1106 m^3 of water. This will ensure that stormwater does not infiltrate into the soil or contribute to the erosion of the cliffs located to the north of the intersection. The design was strongly influenced by the Integrated Stormwater Management Plan developed by UBC Campus + Community Planning. Some of the key takeaways include the following goals:

Figure 20 - *Water Retention System*

- Reduce the impacts of stormwater flows off campus (through rainwater detention)
- Maintain or preferably enhance water quality at campus boundaries
- Incorporate natural hydrologic cycle into the long-term planning & design of system

5.2.1 Hydrologic Analysis

This section details how the predicted volume requirements for the rainwater retention system were determined.

5.2.1.1 Catchment Area

To determine the catchment area for the intersection, a water drop analysis was conducted in Civil 3D. Essentially, this is a way of illustrating the path that water would take as it flows through the intersection. After generating a substantial number of potential pathways, it became possible to see where the water began to converge (this point would be used as the point of concentration for determining the design flow). A summary of the delineated catchment area is illustrated in **Figure 21**.

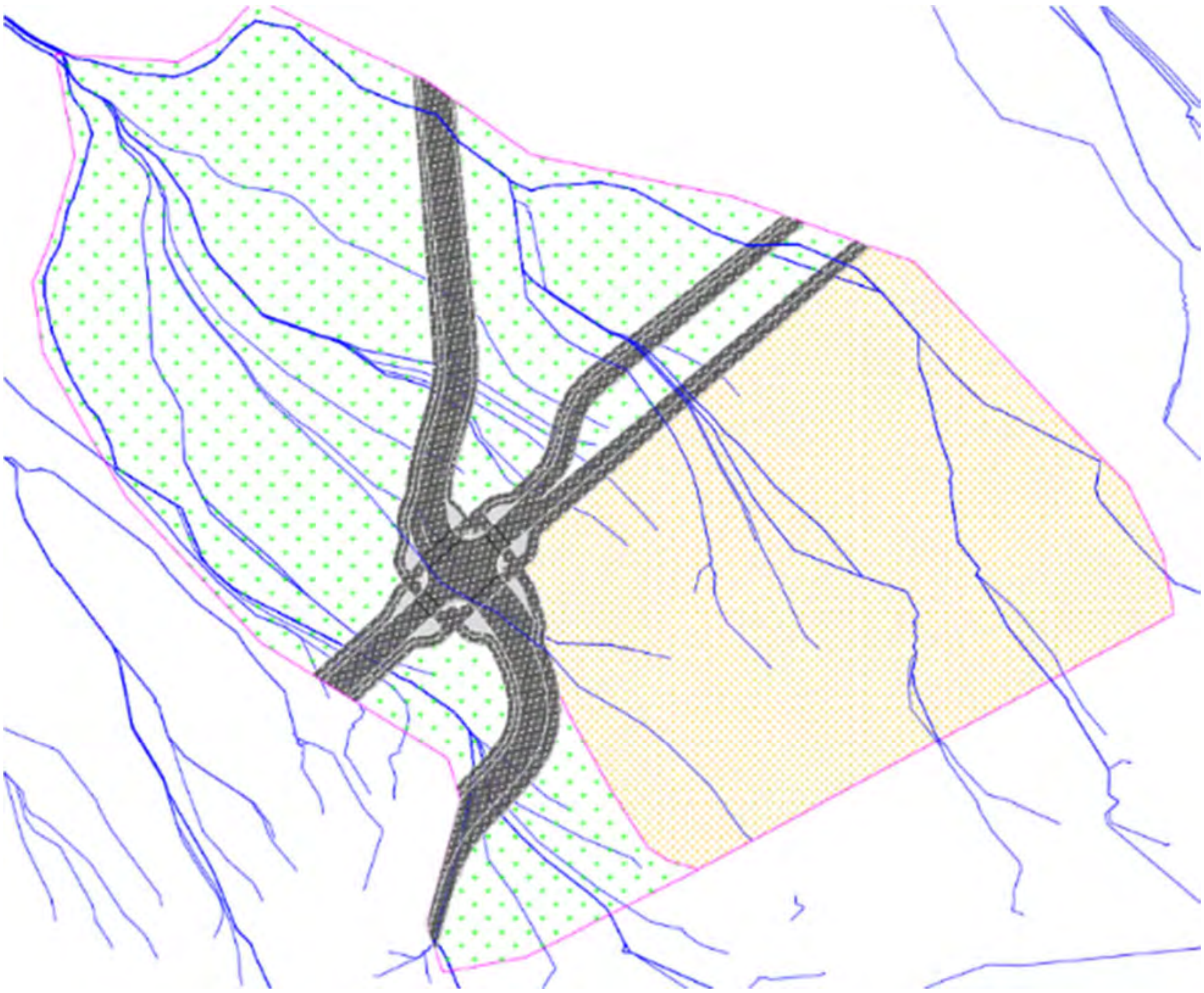


Figure 21 *– Approximate Delineation of Catchment Area for Intersection*

Furthermore, the approximate areas of each section (along with the corresponding runoff coefficients) are summarized in **Table 7** on the following page.

Table 7 – Catchment Area Runoff Coefficients

Region	Area (m²)	Runoff Coefficient
Multi Unit Residential	15902.83	0.5
Grassland/Unimproved	20880.72	0.2
Concrete/Asphalt	5169.572	0.8

5.2.1.2 Design Flows

Using the overland flow method, it was possible to determine the time of concentration for the catchment area (outlined in **Appendix B**). This was achieved by estimating the velocity for each region using a nomograph developed by the U.S. Department of Agriculture (United States Department of Agriculture, 1986), seen in **Figure 22**.

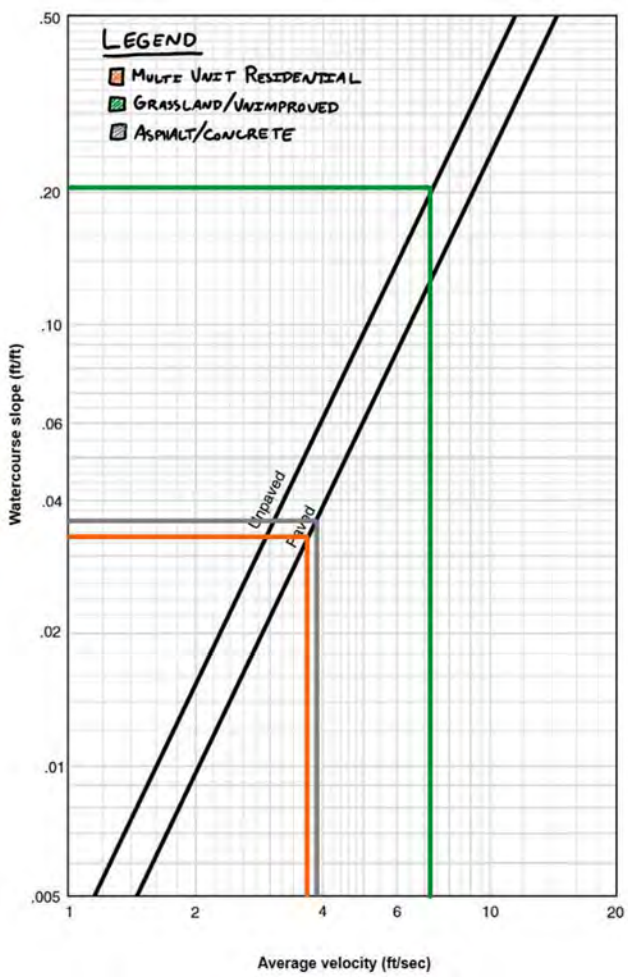


***Figure 22** – Average Velocities for Estimating Travel Time*

The total time for a water drop to flow from the furthest location in the catchment area to the point of concentration was approximately 2 hours. From here, a storm duration was assumed using the Modified Rational Method (which recognizes that the duration of a storm is often longer than the time of concentration, particularly with respect to smaller catchment areas less than 8 hectares). In this case, the duration of the 100-year design storm was twice the length of the time of concentration.

In summary, a total required storage volume of **1106 m³** was calculated using a 2022 IDF curve for UBC. This can be seen in **Figure 23** (located on **Page 28**).

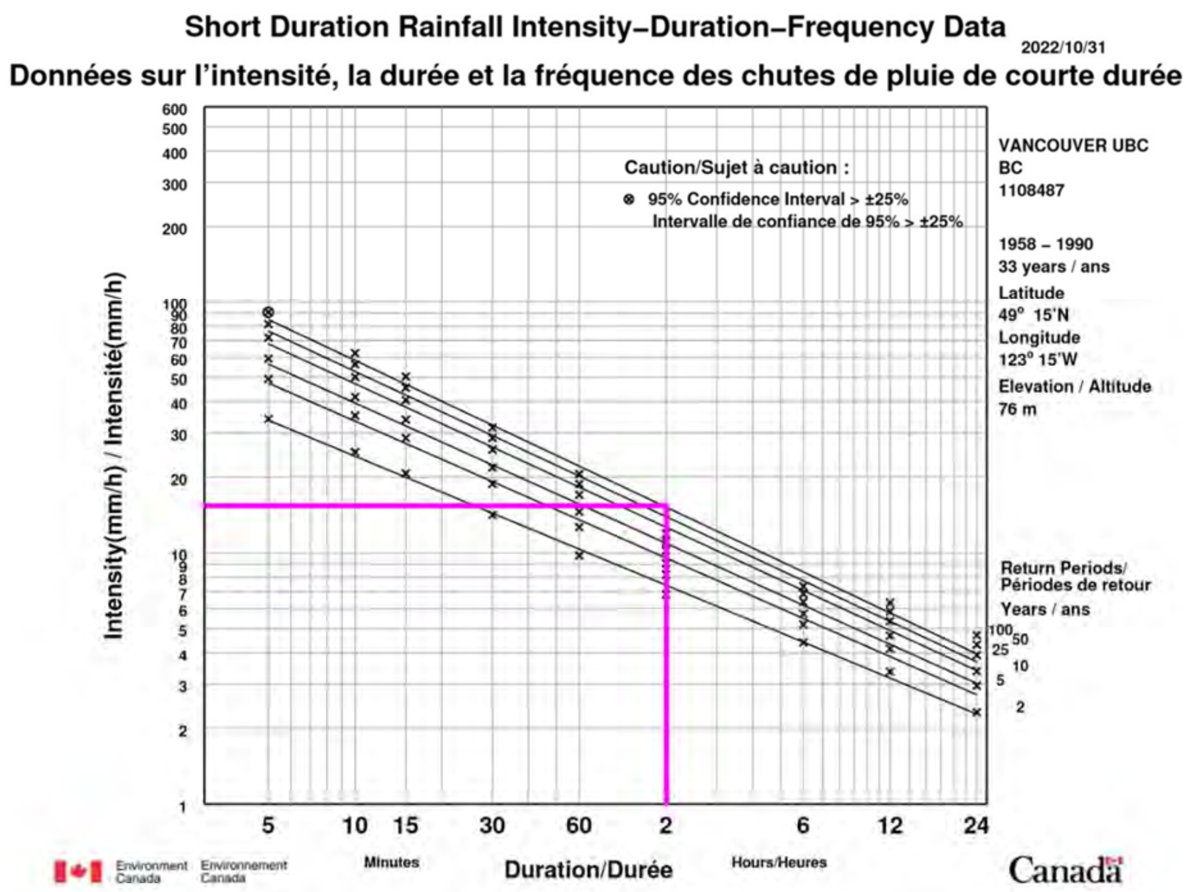


***Figure 23** – IDF Curve for the University of British Columbia (Vancouver)*

5.2.2 Geotechnical Analysis

As mentioned previously, the intersection is situated on the Point Grey Peninsula which has features of sea cliffs and the Pacific Spirit Park. Sediments were deposited by a retreating glacial ice sheet and the Fraser River further deposited layers of clay, silt, and sand (Piteau, 2002). The surface of the cliffs, which is where the intersection will be situated on, is roughly 60m above mean sea level. The layers consist of silt and clay at the base, sand above that, and near the surface are glacial deposits (dense sands, silt, clay, and some boulders). This is important to know for the footing design of the UBC gateway sign as well as any excavation that must be completed. The soil must provide enough bearing capacity to support the sign, and any boulders that are found in the intersection may raise the cost of excavation. The footing and intersection design is expected to reach the third layer of soil which will reveal layers of silt, clay, gravel, and fine to coarse sand. When it comes to permeability of the soil, the third layer (Quadra Sand Unit 1) has been tested to have moderate drainage conditions and is mostly uniform throughout. This must be considered for rainwater catchment and stormwater design. **Figure 24** shows the profile of the sediments from base sea level to the surface.

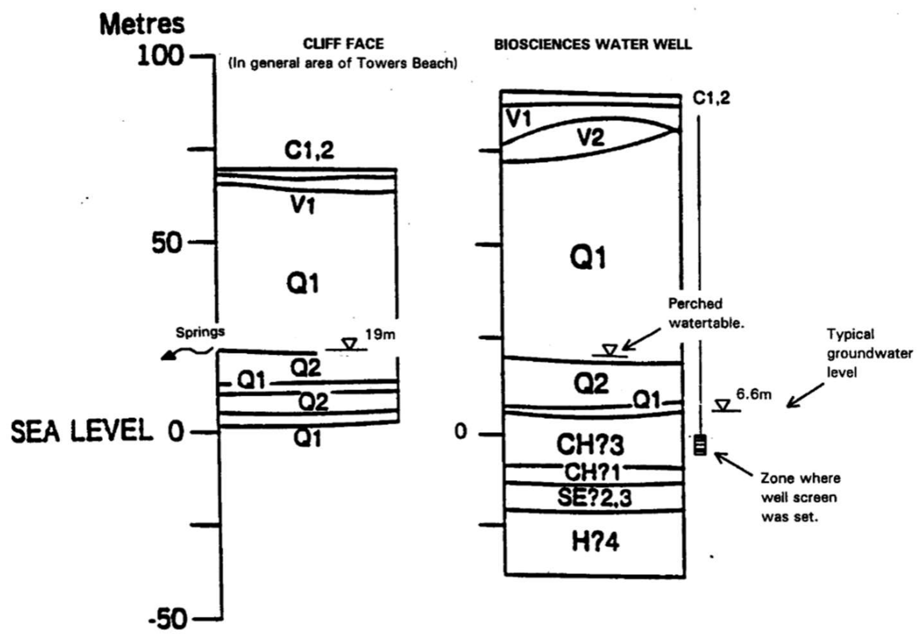


Figure 24 *- Typical Profile of Unconsolidated Sediments*

5.2.2.1 Borehole Report

Deep drill holes were conducted over 6 different locations to provide a regional profile of the area (Piteau, 2002). Two main methods were used for the 6 drill holes with the first 3 using a sonic drilling rig and the other 3 using a mud-rotary rig. The difference between the two tests is that the first utilizes an air rotary system to provide a continuous sample and the other pushes the mud out to the surface which can be extracted. The purpose of these tests was to determine the water table level which is significant for stormwater management and design. In addition, **Appendix C** shows borehole locations from North to South with the focus being on the North end of the chart, as that is where the intersection design is located. Takeaways from the figure include the location of the upper and lower aquifer, and depth of water table.

5.2.3 Ladder Marsh

The Ladder Marsh is an integral component of the rainwater management system, designed to retain and regulate stormwater flows. It enhances water control efficiency while contributing to the site's visual appeal. Moreover, the rain garden's natural filtration removes many common pollutants in surface runoff. **Figure 25** depicts its final design.

Figure 25 *– Ladder Marsh Rendering*

5.2.3.1 Dimensions, Area, and Storage Capacity

The Ladder Marsh consists of four cascading levels, with each step shaped to optimize both water storage and controlled flow. The dimensions are as follows:

- Step Heights: 0.25 m, 0.50 m, 0.75 m, and 1.00 m
- Step Length: 4.25 m
- Step Width: 10 meters
- Total Surface Area: 10 m x 17 m = 170 m^2
- Storage Capacity: The ladder marsh can hold up to 106m^3 of water.

5.2.3.2 Functionality

The marsh is designed with a 2% slope on each step surface to facilitate smooth water flow. This ensures that:

- **Water Flow**: Cascades down from the highest point (1.0 m) to the lowest (0.25 m) in a controlled manner.
- **Catch Basins (CBs)**: Excess water overflows into a CB located at the low end of the ladder marsh, ensuring seamless integration with the stormwater drainage system.

5.2.3.3 Integration with UBC

The Ladder Marsh seamlessly complements the UBC Gateway and enhances the surrounding athletics facilities with its ecological and visual benefits. Following the landscaping plan outlined in **Section 3.2.4**, the ladder marsh integrates native plants, including bushes and water plants, alongside stormwater retention and aesthetic features to promote sustainability and enhance the space.

5.2.4 Landscaping

Landscaping for the UBC gateway, and areas surrounding the intersection, are designed to meet the plans laid out in the UBC Campus Vision 2050. An important factor of the Vision is to deepen UBC's relationship with the Musqueam Indian Band, who helped to develop it. Through this engagement, UBC has set an initiative to develop "connected landscapes" that aims to "shift from manicured to indigenous landscapes" (UBC, 2023).

Increased biodiversity by using native species will provide a nature-based solution for rainwater management. Currently, the Musqueam and UBC are developing an indigenous plant list to use for future projects, however, it is not complete. Therefore, we will be referring to the "recommended plant list" provided by the City of Vancouver to select the plant species. This list includes suggestions for plants located close to intersections, where the height should be less than 2 ft to maintain good visibility for commuters.

The removal of 7 trees is necessary to implement our design changes, however, we plan to increase the biodiversity of the area by planting 14 trees of various local species. Additionally, we will relocate several plaques and integrate them into our landscaping plan.

5.2.4.1 Ladder Marsh Planting Plan

The ladder marsh will incorporate a rock bed with plants around the sides of the marsh. Plants located in the ladder marsh must be drought resistant to help with rainwater management, while also thriving in moist soil conditions. Additionally, drought resistant plants require less maintenance during the dry summer months. However, the ladder marsh will require semi-annual maintenance to trim plants and remove material. Performance issues for the ladder marsh may arise if it is not cleaned and maintained, as material will build up and block water flow routes. The selected plants do not exceed a height of 1m to ensure that they do not block sightlines for commuters. A comprehensive planting guide for the ladder marsh plan is available in **Appendix L**. Additional plant species may be added upon the client's request.

5.2.5 Storage Tank and Infiltration System

A storage tank fabricated from Bolt-A-Plate® corrugated steel pipe will be used to contain up to **1339 m^3** of surface runoff. This is approximately 20% larger than the anticipated volumetric requirement of **1106 m^3** to accommodate for future weather trends and a greater prevalence of atmospheric rivers in the lower mainland. The diameter of the tank will 8.02 meters, and it will have a length of 26.5 m.

With the tank in place, there are a few different approaches for how to deal with rainwater infiltration and the prevention of cliff erosion. One possibility would be to simply tie into the existing storm system (spiral drain). Another option would be to allow for the slow infiltration of the storage tank into deeper soil using a combination of 3" drain rock, geotextile fabric, and perforated CSP. This would serve to remove pollutants (in conjunction with pretreatment from the bioswales and Ladder Marsh) before percolating into an aquifer, replenishing groundwater and reducing the stress on the current storm system.

5.3 UBC GATEWAY DESIGN

The gateway design serves as a welcoming and iconic structure at the entrance of The University of British Columbia. This section provides an overview of the design, and the technical details involved in constructing the gateway, including the sign, footing, and connection designs.

5.3.1 Signage Dimensions and Materials

The gateway is located on the SE corner of the intersection, oriented to face towards NW Marine Drive, and is positioned above the ladder marsh. A rendering of the design can be seen in **Figure 26**.

Figure 26 – *UBC Gateway Sign and Ladder Marsh Rendering*

The gateway design is an impressive structure with the following specifications:

- Dimensions: 8.8 m tall and 15 m wide.
- Sign Panel: Constructed from fiberglass-reinforced plastic (FRP), the panel measures 2 m in height, 13 m in width, and 0.15 m in thickness.

- Lettering: Features the 0.3 m tall wording "WELCOME TO" at the top and the 0.4 m tall text "THE UNIVERSITY OF BRITISH COLUMBIA," made of fiberglass-reinforced plastic (FRP).
- Element: Includes a separate line measuring 12 m in width, 0.15 m in height, and 0.15 m in thickness, also made of fiberglass-reinforced plastic (FRP).
- Columns: Two lightweight concrete columns, each 8 m tall with a cross-section of 1 m by 1 m.

The gateway sign design adheres to the UBC Sign Design Standard for both typeface and colors. The lettering utilizes the Whitney font family, specifically Whitney Semibold, and Whitney Bold, in accordance with UBC branding guidelines. For the sign's color palette:

- The front face of the sign panel and the column is rendered in Wayfinding Blue (PMS 648C, C100-M62-Y0-K52, RAL 5002).
- The lettering will be in White (C0-M0-Y0-K0) for high visibility and contrast.
- The supporting elements, such as the base or accents, incorporate Parking Entrance Green (PMS 3415C) for a complementary look.

5.3.2 Structural Design of Footing

Based on the borehole log, the third soil layer consists of compact sand, which provides sufficient bearing capacity for the footing. Consequently, the footing is designed to be placed at this soil layer, with the columns extending 4 meters below the ground surface. The allowable bearing capacity of the soil is predicted to be 150 kPa.

For the total dead load calculations, the density of lightweight concrete is assumed to be 18 kN/m^3, and the density of FRP is assumed to be 20 kN/m^3. The total dead load of the sign is calculated to be 619.7 kN. Utilizing wind pressure, seismic factors, and snow load data from the BC Building Code climate design tables, the following loads were determined:

- **Wind Load**: 38.95 kN
- **Seismic Load**: 267.33 kN
- **Snow Load**: 13.87 kN

The governing factored load for each column's footing was calculated as 800 kN. The final footing design dimensions were determined to be 2 m × 2 m × 1 m, reinforced with 7-20M steel reinforcing bars and constructed with concrete of 25 MPa compressive strength to ensure adequate structural strength and compliance with design standards. **Figure 27** illustrates the detailed design and reinforcement layout of the footing. Detailed calculations and analysis for the footing design are provided in **Appendix F**.

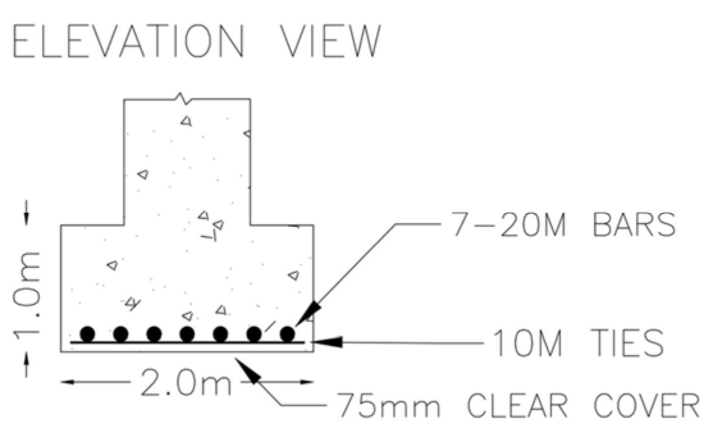


Figure 27 - *Design Summary for Footings*

5.3.3 Structural Design of Connections

The structural connections for the lettering, elements, panels, and cubes are designed to ensure secure load transfer and durability. Each connection employs a combination of adhesive bonding and mechanical fasteners to provide redundancy and resistance to applied loads. Adhesive bonding enhances load distribution, while mechanical fasteners ensure additional stability and long-term reliability for outdoor conditions. On the next page, **Table 8** shows an overview of all connection designs for this signage.

***Table 8** – Overview of Connection Designs*

Connection	Connection Design	Details
Lettering-to-Panel	Adhesive Bonding + 4 - M12 Studs	Adhesive applied to the back of each letter; 4 - M12 studs placed at each corner, drilled from the back of the panel into the letters; edge distance: 0.018 m; stud length: 0.2 m.
Element-to-Panel	Adhesive Bonding + 6- M12 Studs	Adhesive applied to the back of the element; 6 M12 studs arranged in two rows, drilled from the back of the panel into the element; horizontal spacing: 5.982 m; vertical spacing: 0.114 m. Each stud is placed 0.018 m away from the edge.
Panel-to-Column	Adhesive Bonding + L-Shaped Connectors (200 mm × 200 mm × 10 mm)	Adhesive applied along the side surface of the panel to the column; 6 connectors (3 front, 3 back). Four M12 bolts are used per connector (two bolts per leg); bolts are embedded 0.1 m, with an edge distance of 0.018 m.
Cube-to-Column	Adhesive Bonding + L-Shaped Connectors (200 mm × 200 mm × 10 mm.)	Adhesive applied to the bottom of the cube; 4 connectors placed at the midpoint of each side of the cube; bolts embedded 0.1 m, with an edge distance of 0.018 m. Four M12 bolts are used per connector (two bolts per leg).

The structural connections utilize 3M Scotch-Weld DP420 epoxy adhesive for all bonding applications. This adhesive is selected for its exceptional durability and a shear strength of 31.03 MPa, making it suitable for both structural stability and long-term outdoor performance. The adhesive ensures uniform load distribution and enhances the overall strength of each connection. All M12 bolts used in these designs are Grade 8.8, providing a tensile strength of 800 MPa and a shear strength suitable for high-load applications.

The L-shaped connectors, used in the panel-to-column and cube-to-column connections, are hot-dip galvanized steel with dimensions of 200 mm × 200 mm × 10 mm. Each connector has an assumed shear strength of 150 kN. The lettering-to-panel connection uses the heaviest letter, "M," as the design example, demonstrating that the same approach applies to all letters on the Gateway sign. By assuming the load distributed uniformly, the panel-to-column and cube-to-column designs are mirrored for the second column.

6 PROJECT MANAGEMENT

6.1 PROJECT SCHEDULE

The project will begin construction on May 1st, 2025, and is estimated to be finished by September 27th, 2025. Due to increased demand in September once UBC opens the winter semester, the work week will be Monday-Saturday.

Work will be completed in three main phases with work for the UBC Gateway and ladder marsh starting in phase 2 and ending during phase 3. Phase 1 includes roadwork for the north leg of the intersection (N.W. Marine Dr) and installing the water retention tank. Phase 2 consists of roadwork for the east and south legs of the intersection. Phase 2 requires substantial earthworks to adjust the alignment of the south leg which provides an opportunity to begin working on the UBC gateway and ladder marsh, located on the southwest corner of the intersection. Phase 3, the west leg of the intersection, will be completed in two smaller Phases, 3a & 3b. This allows for one lane to be open for most of the duration of Phase 3, limiting interruptions to local traffic. The phase locations are seen in **Figure 28**. Additionally, we have planned detour routes to manage traffic flow during construction which can be seen in **Appendix M**, along with signage plans for each phase. The full construction schedule for each phase can be viewed in **Appendices I, J, K, and L.**

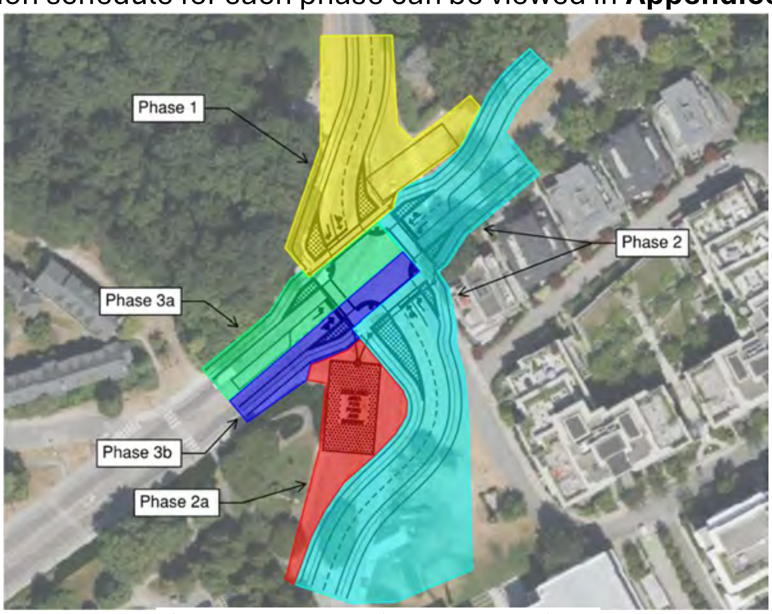


***Figure 28** – Construction Phase Locations*

6.2 PROJECT CHARTER

Pacific Pathway Consulting has provided a basic project charter outlining important items for the project. It includes information on current issues, project goals, project scope, high-level requirements and risks, project assumptions, and key milestones. We consider items detailed in the project charter as non-negotiable. Please see **Appendix P** for the full project charter.

7 COST ESTIMATE

The following Class "A" cost estimate depicted in **Table 9** was developed using the 2018 RSMeans historical data adjusted for Vancouver, BC. It is important to note that each line item includes the cost of labor, materials, and equipment required to complete a single unit of work.

Table 9 *- RSMeans Estimate for Transportation Items*

Quantity	Item Code	Item Description	Unit	Extended Total	Extended Total O&P
125	320610100310	Sidewalks, driveways, and patios, cast-in-place with 6 x 6 - W1.4 mesh, broomed finish, 3000 psi, 4" thick, excludes base	m2	$ 12,943.88	$ 8,110.00
2368	321123230100	Base course drainage layers, aggregate base course for roadways and large paved areas, stone, compacted, 3/4" stone base, to 6" deep	m2	$ 53,706.24	$ 28,794.88
2368	321123230304	Base course drainage layers, aggregate base course for roadways and large paved areas, stone, compacted, 3" stone base, to 12" deep	m2	$ 126,408.58	$ 67,606.40
2368	321126130560	Asphalt paving, plant mixed asphaltic base courses for roadways and large paved areas, bituminous concrete, 8" thick	m2	$ 249,037.82	$ 132,821.12
634	321613130410	Cast-in place concrete curbs & gutters, concrete, steel forms, straight, 6" x 18", includes concrete	m	$ 51,072.50	$ 18,081.68
215	321613130410	Cast-in place concrete curbs & gutters, concrete, steel forms, radius, 6" x 18", includes concrete	m	$ 22,696.91	$ 14,207.20
6	344113101410	Traffic signals, controller, design, and underground conduits, includes miscellaneous signage and adjacent	signal	$ 300,784.05	$ 328,885.20

20	260590106910	Outdoor post lamp, residential, fixture, #14/2 type NM cable, 10.7 m, incl post	Ea.	$ 18,130.98	$ 10,372.00
1610	312316130062	Excavating, trench of continuous footing, common earth, 0.57 m3 excavator, 300 mm to 1200 mm deep, excludes sheeting or dewatering	Bm3	$ 30,800.91	$ 19,239.50
200	329119130700	Topsoil placement and grading, loam or topsoil, screened, 100 mm deep, furnish and place, truck dumped	m2	$ 1,999.20	$ 1,102.00
1800	024113175050	Demolish, remove pavement & curb, remove bituminous pavement, 100 mm to 150 mm thick, excludes hauling and disposal fees	m2	$ 40,861.80	$ 26,298.00
1	017123131400	Boundary & survey markers, crew for roadway layout, 4 person crew	Day	$ 3,401.14	$ 2,447.24
				Total =	$ 1,569,809.23

To adjust for inflation, the following equation was used:

$$Adjusted\ Amount = Original\ Amount\ \times \frac{CPI\ in\ 2024}{CPI\ in\ 2018}$$

In this case, the Consumer Price Index was 133.4 for 2018, and 161.8 for 2024 (Statistics Canada, 2024). This results in a total of approximately **$1,569,800** for the RSMeans portion of the Class "A" Estimate.

Due to the highly specialized & custom nature of the 8.02 m diameter CSP water storage tank, the unit rate does not fall into standard pricing models. Since there is limited pricing information available, this estimate includes an alternative approach based on the price of bulk industrial steel (which can fluctuate dramatically). Assuming a wall thickness of 1 cm, the total volume of steel is approximately 6.65 m^3. The density of steel is around 7850 kg/m^3, which results in a weight of 52.3 tonnes. If the price of bulk industrial steel is $1000/tonne, then the total cost of the tank should be **$52,300**. This brings the total cost of the water retention system to **$107,100.**

Similarly, both the Ladder Marsh and the UBC Gateway Sign are extremely niche with minimal pricing information available (aside from the cost of the raw materials). As such, the cost estimate has been summarized in **Table 10**.

Table 10 *- UBC Gateway and Ladder Marsh Estimate*

Quantity	Description	Unit	Cost/Unit	Total	Total O&P
73.512	Concrete	m3	763.75	$ 56,144.79	$ 22,457.92
41	Fiber reinforced polymer	m2	35	$ 1,435.00	$ 861.00
161.6	Rebar	m	20	$ 3,232.00	$ 1,939.20
1	UBC Sign	each	10,000	$ 10,000.00	$ 6,000.00
	Landscaping	lump	7,000	$ 7,000.00	$ 4,200.00
				Total =	$ 113,269.91

A full cost estimate summary is provided in **Table 11**.

Table 11 *– Summary of Each Component for the Class "A" Cost Estimate*

Class "A" Cost Estimate Component	Cost
RSMeans Items	$1,569,800
Water Retention System	$107,100
UBC Gateway and Ladder Marsh	$113,300
Contingency	$268,500
Total Estimate	$2,058,700

This results in a grand total of **$2,058,700** for the Class "A" Cost Estimate.

8 SERVICE LIFE MAINTENANCE PLAN

The Service Life Maintenance Plan provides a framework for maintaining the key infrastructure elements of the redesigned intersection. It supports UBC Campus and Community Planning's long-term sustainability goals by ensuring continued functionality, user safety, and system reliability. **Table 12** outlines maintenance recommendations assuming the intersection enters service in **Fall 2025** with a **design life of 100 years**.

***Table 12** –Service Life Maintenance Plan*

Component	Recommended Maintenance Activity	Frequency
Pavement Surface	- Inspect for cracks, potholes and wear	Twice a year
	- Re-paving and resurfacing as needed	Every 10–15 years
	- Seal cracks and patch surface damage	As needed
Sidewalks & Bike Paths	- Check for surface settlement, trip hazards and drainage issues	Annually
Traffic Signals	- Test push buttons, detectors and signal timing	Monthly
Street Lighting	- Lamp and electrical Inspection	Annually
	- Fixture cleaning and alignment check	Annually
Underground Storage Tank	- Inspect access hatch and tank integrity	Annually
	- Sediment removal	Every 3–5 years
Ladder Marsh	- Remove debris and plant overgrowth	Twice per year
	- Inspect for standing water, sediment buildup, and overflow capacity	Twice per year
	- Inspect concrete footing and FRP panels	Every 3 years

9 REFERENCES

BC MoTI. (2019). *BC Supplement to TAC Geometric Design Guide* (3 ed.). BC MoTI. Retrieved from https://www2.gov.bc.ca/assets/gov/driving-and-transportation/transportation-infrastructure/engineering-standards-and-guidelines/highway-design-and-survey/tac/tac-2019-supplement/bctac2019-bcsupplementtotac.pdf

BC MoTI. (2019). *British Columbia Active Transportation Design Guide.* BC MoTI. Retrieved from https://www2.gov.bc.ca/assets/gov/driving-and-transportation/funding-engagement-permits/grants-funding/cycling-infrastructure-funding/active-transportation-guide/2019-06-14_bcatdg_compiled_digital.pdf

Canadian Standards Association. (n.d.). *Design and Construction of Steel Structures (CSA S16:24).* CSA Group.

Canadian Standards Association. (n.d.). *Design of Concrete Structures (CSA A23.3-19).* CSA Group.

City of Toronto. (2017). *Road Engineering Design Guidelines 6.0 Curb Radii Guideline.*

City of Vancouver. (2012). *Transportation 2040*. Retrieved from https://vancouver.ca/files/cov/transportation_2040_plan_as_adopted_by_council.pdf

City of Vancouver. (2019). *Engineering Design Manual.* City of Vancouver. Retrieved from https://vancouver.ca/files/cov/engineering-design-manual.PDF

City of Vancouver. (2019). *Standard Detaill Drawings Roadworks.* City of Vancouver. Retrieved from https://vancouver.ca/files/cov/standard-detail-drawings-roadworks.pdf

Piteau, A. (2002, Sept). *Hydrogeological and Geotechnical Assessment of Northwest Area UBC Campus, Vancouver*.

Statistics Canada. (2024, November 22). *Consumer Price Index Portal*. Retrieved from https://www.statcan.gc.ca/en/subjects-start/prices_and_price_indexes/consumer_price_indexes

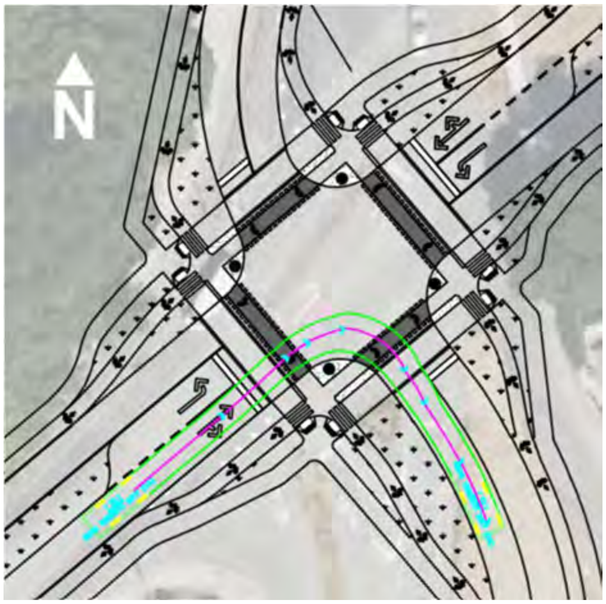
Transportation Association of Canada. (2020). *Geometric Design Guide for Canadian Roads (GDG)*. TAC.

UBC Campus and Community Planning. (2022, February). *UBC Campus Vision 2050*. Retrieved from https://planning.ubc.ca/sites/default/files/2024-06/CV2050_CAC_Meeting_Minutes_02242022.pdf

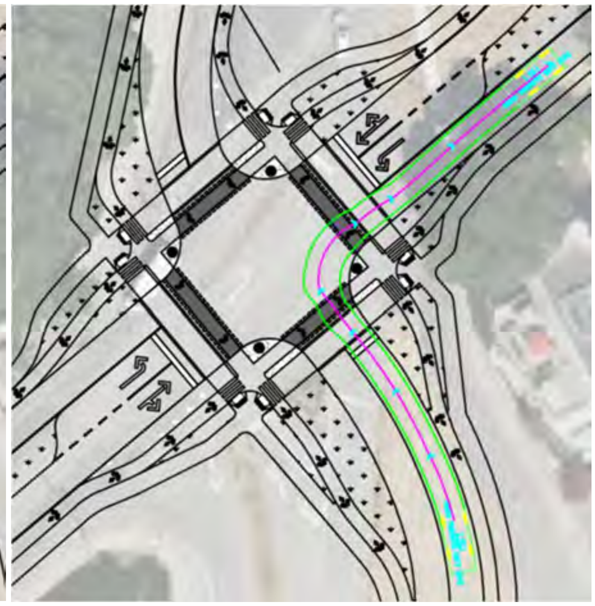
United States Department of Agriculture. (1986, June). *Urban Hydrology for Small Watersheds*. Retrieved from https://www.nrc.gov/docs/ML1421/ML14219A437.pdf

University of British Columbia Campus and Community Planning. (2014). *UBC Transportation Plan*.

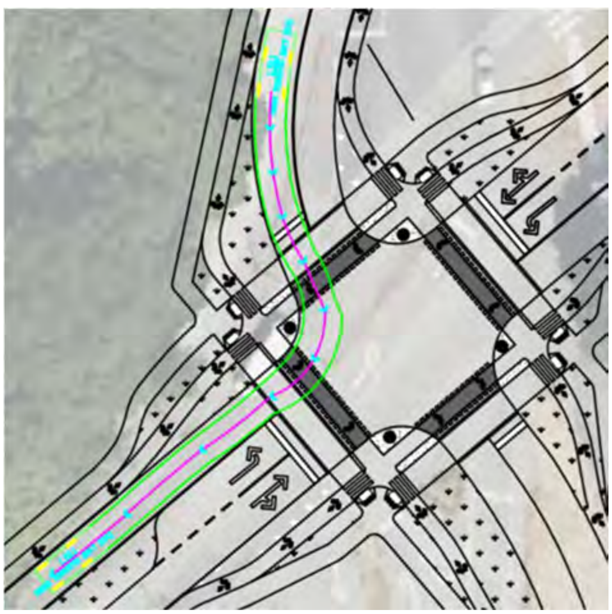
APPENDIX A – SWEPT PATH ANALYSES



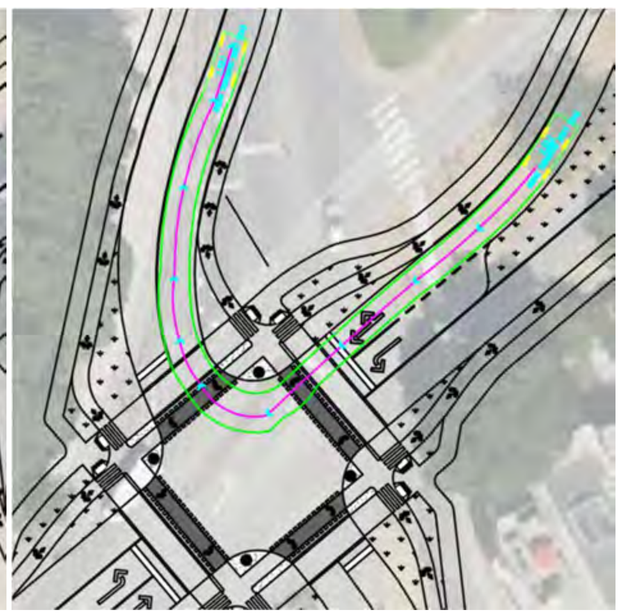
Design Vehicle EBR



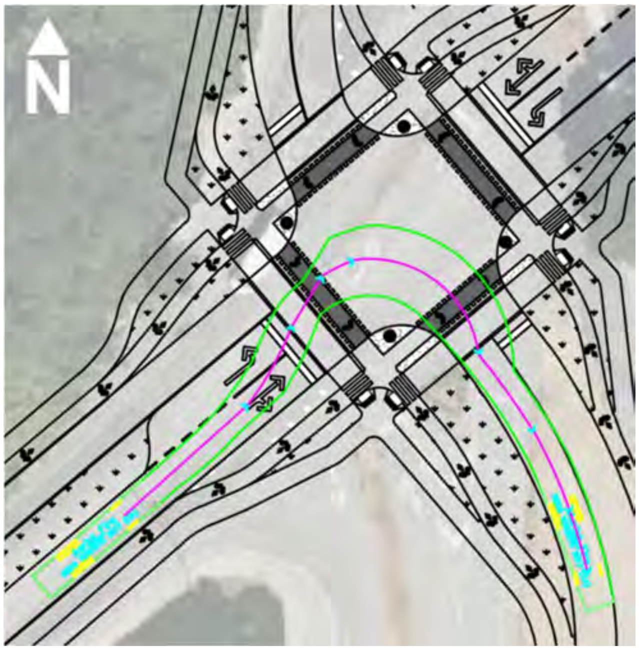
Design Vehicle NBR



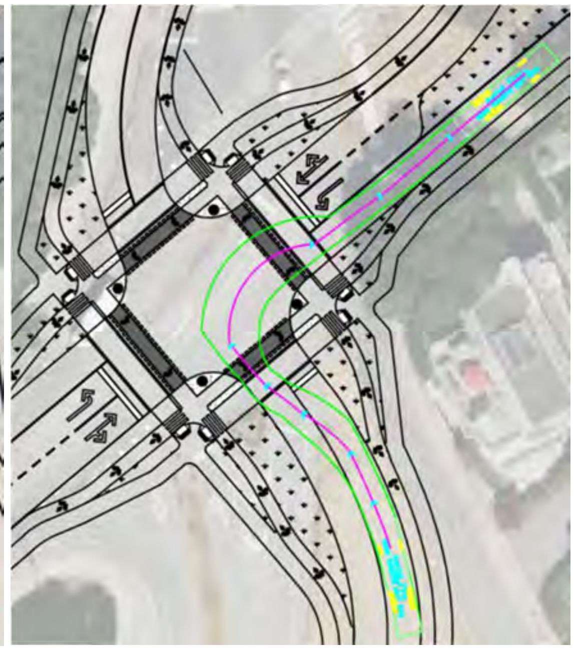
Design Vehicle SBR



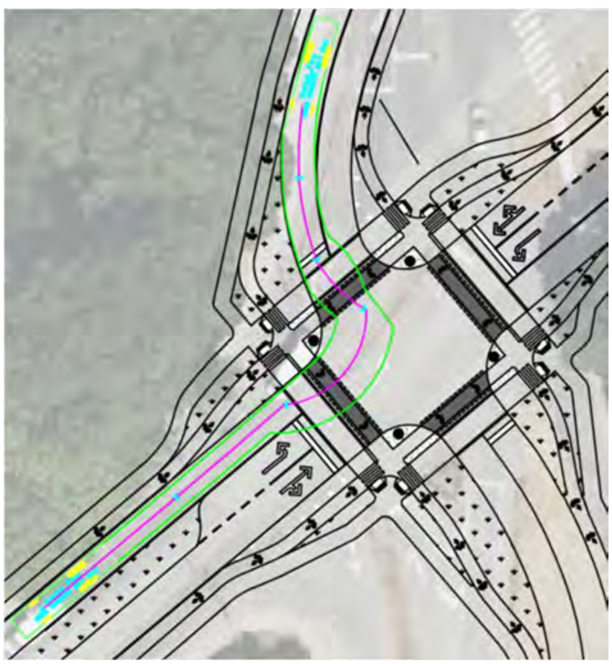
Design Vehicle WBR



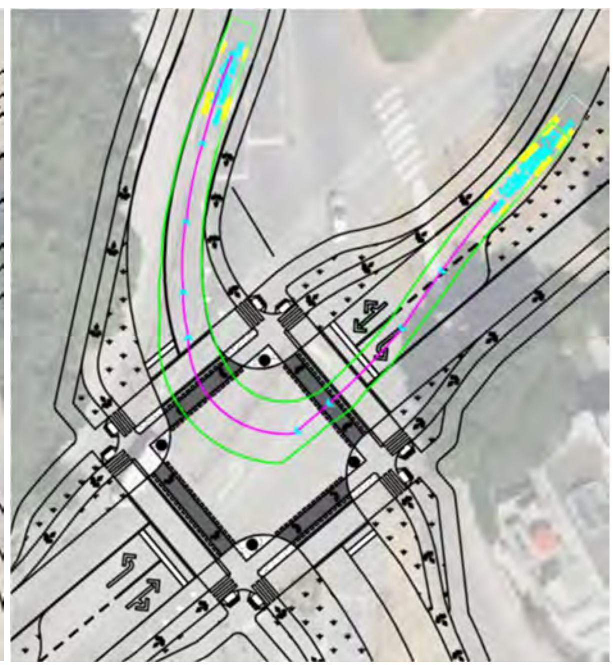
Fire Truck EBR



Fire Truck NBR



Fire Truck SBR



Fire Truck WBR

APPENDIX B – HYDROLOGY EXCEL TABLES

Multi Unit Residential

Starting Elevation	81.9983
Final Elevation	77.3736
Length (m)	139.8765
Length (ft)	458.9124
Slope	0.033063
Velocity (ft/s)	3.6
Time (s)	1652.085

Grassland/Unimproved

Starting Elevation	73
Final Elevation	37
Length (m)	177.0074
Length (ft)	580.733
Slope	0.203381
Velocity (ft/s)	7.25
Time (s)	4210.314

Asphalt/Concrete

Starting Elevation	77.3736
Final Elevation	73
Length (m)	121.1511
Length (ft)	397.4774
Slope	0.0361
Velocity (ft/s)	3.8
Time (s)	1510.414

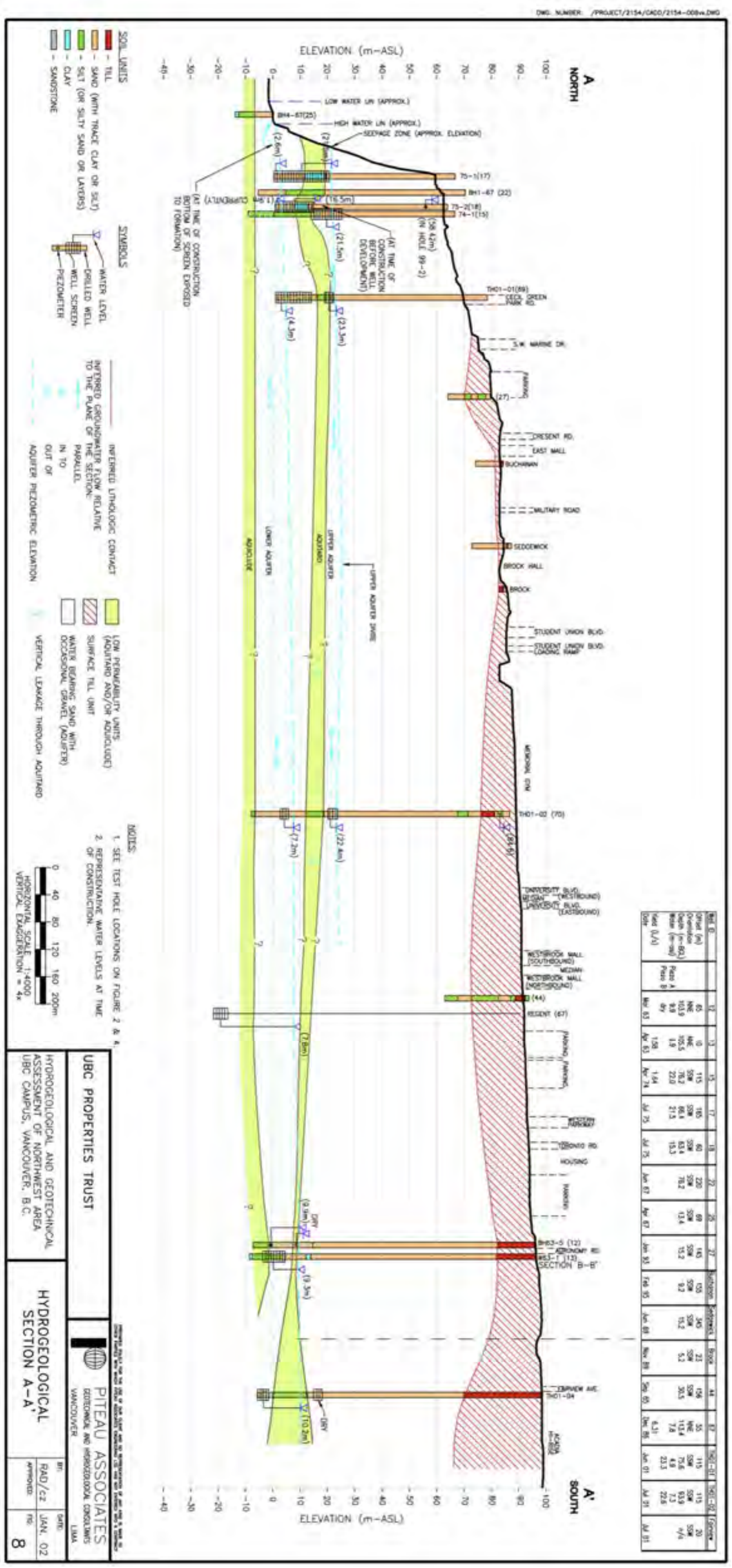
Time of Concentration (hr) **2.048004**

Total Area	41953.12	m^2	Runoff Coefficient	Hectares
Multi Unit Residential	15902.83	m^2	0.5	1.590283
Grassland/Unimproved	20880.72	m^2	0.2	2.088072
Concrete/Asphalt	5169.572	m^2	0.8	0.516957

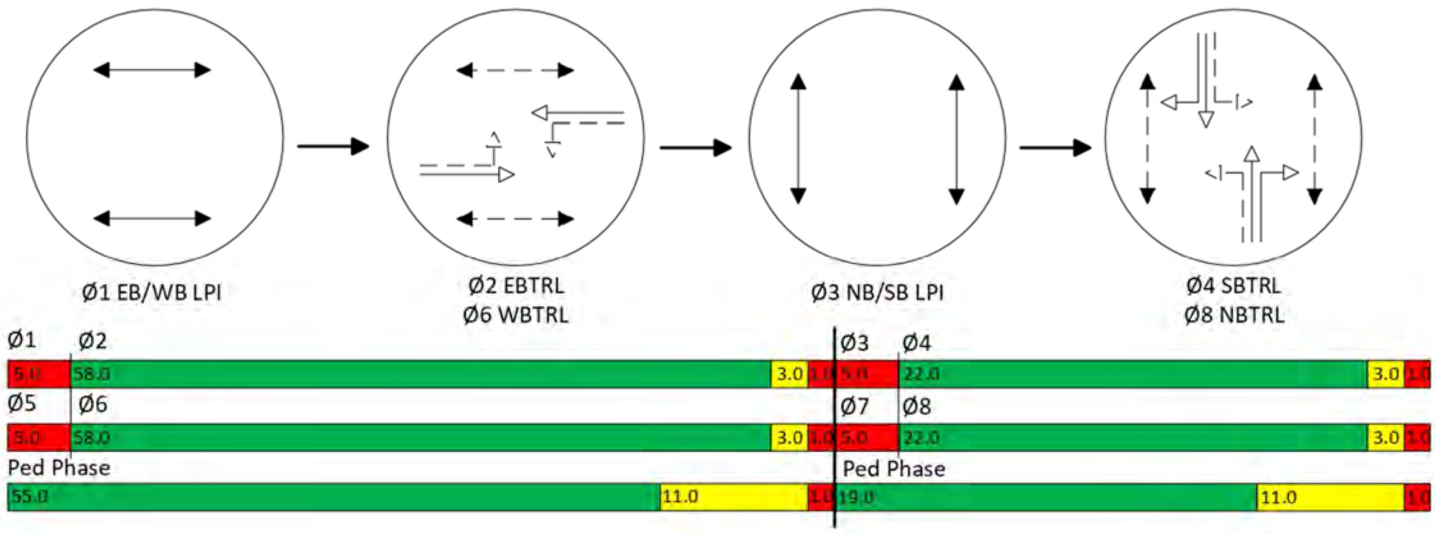
Intensity	17	mm
Modified Runoff Coefficient	0.387652	

Peak Runoff	**0.076799**	**m^3/s**

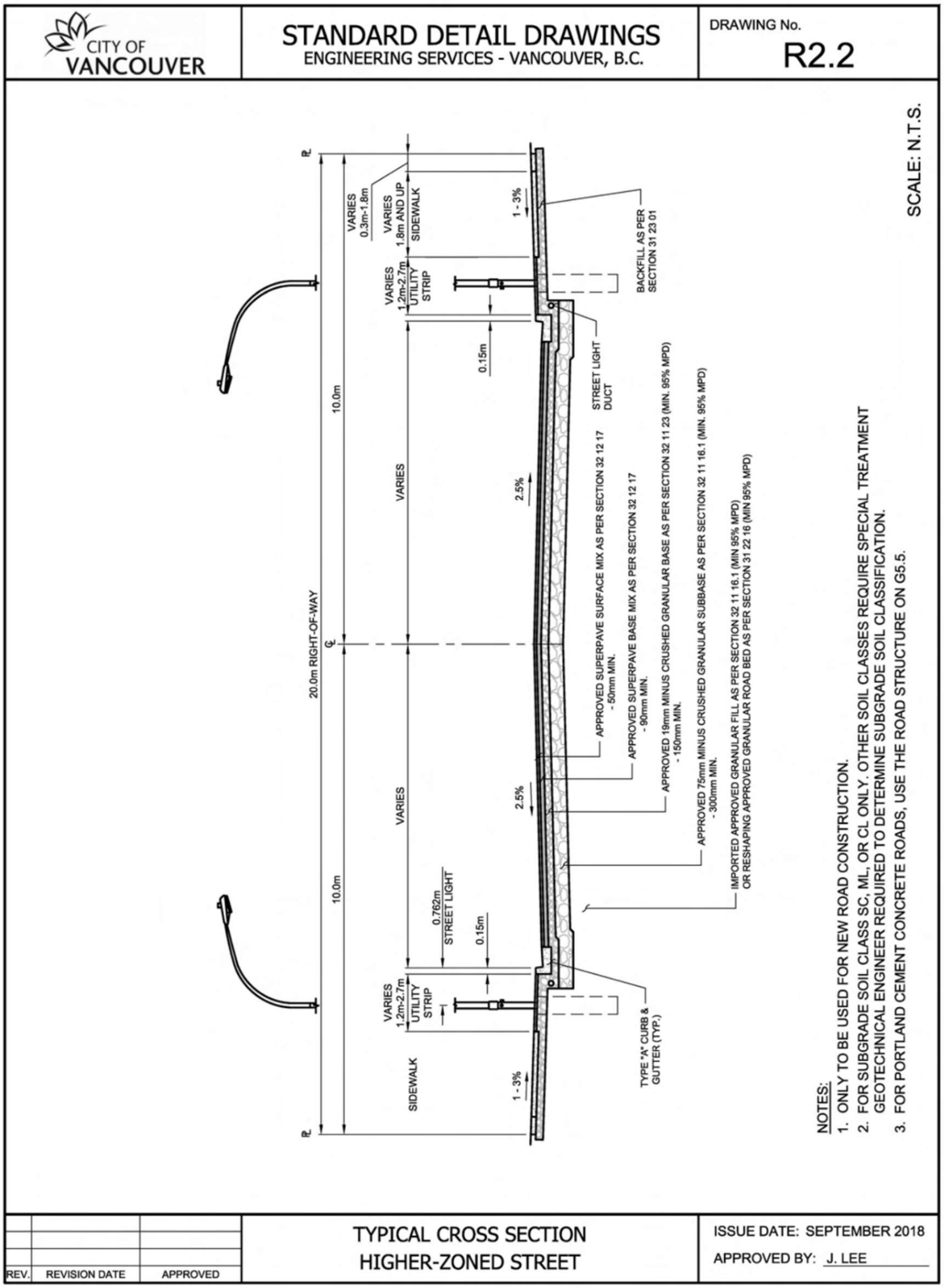
APPENDIX C – HYDROGEOLOGICAL SECTION A-A (PITEAU)



APPENDIX D – SIGNAL TIMING & PHASING PLAN



APPENDIX E – VANCOUVER STANDARD DETAIL DRAWING R2.2



APPENDIX F – STRUCTURAL HAND CALCULATIONS

UBC Gate Way Sign Footing Design Calculations

Dead load:

Volume of Panel + Letting. (Material: FRP)

$= (2 \times 13 \times 0.15) m^3 + (0.6849 m^2)$ ← from 3D software

$= 4.5849$ //.

Weight of Panel + lettering

$= 4.5849 \times 20 \ kN/m^3$

$= 91.7 \ kN$ //.

Volume of column (Material: light weight concrete)

$= (1m \times 1m \times 12m)$

$= 12m$

Column Weight (per column)

$= 12 \ m^3 \times 18 \ kN/m^3$

$= 216 \ kN$

2 Column weight $= 216 \times 2 = 432 \ kN$ (Material: FRP)

Cube Weight (per cube)

$= (0.8^3) \times 20 \ kN/m^3$

$= 48 \ kN$ //.

2 Cube weight $= 24.2 \ kN$.

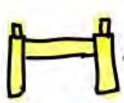
DL/per column: $619.7 \ kN / 2 = 309.85 \ kN$

Total Dead Load: $91.7 + 432 + 96 \ kN = 619.7 \ kN$ //.

Wind Pressure:

$q = 0.45 \ kN/m^2$. ← from Design Guideline

Exposed Surface Area:



$43.28 m^2$. (Front + Back) ← from software

$8.64 m^2$ (Sides) ← from software

Total Wind Load:

(Assume wind acts on one face at a time)

$F_w = \max(F_{w \, front/back}, F_{w \, side})$

$F_w = F_{w \, front/back}$ ← larger area

$F_w = q \cdot C_d \cdot A$

$C_d = 2$ ← Assumed drag coefficient

$F_w = 0.45 (2)(43.28)$

$= 38.952 \ kN$

Assumed load distributed equally

F_w column: $38.952 / 2 = 19.476 \ kN$

Parameters:			
Dead Load:	309.85	kN	Per Column
Wind Load:	19.476	kN	Per Column
Seismic Load:	267.33	kN	Per Column
Snow Load:	6.985	kN	Per Column

Load Combinations				Factored Load:	
Case 1:	1.4D	433.79	kN	796.0979	kN
Case 2:	1.25D + 1.5L + 1.0S	654.64	kN		
Case 3:	1.25D + 1.5S + 0.4W	796.10	kN		
Case 4:	1.25D + 1.4W + 0.5S	418.07	kN		
Case 5:	1.0D + 1.0E + 0.25S	578.93	kN		

Design		
Bearing Capacity:	150	kN/m^2
Unfactored Load=	603.6	kN
Minimum Length of Dimension per Column=	2.0	m

Parameters for Footing					
Factored Load:	796.1				
f'_c=	25	MPa			
column size=	1000				
footing depth=	1000	mm	Footing width=	2000	mm
Bar Size=	20	M			
Bar Nom. Area=	300	mm^2			
Concrete Cover=	75	mm			
Beta=	0.21				
Concrete Resistance Factor=	0.65				

Calculation for Footing		
d_{avg}=	905	mm
d_{ess}=	895	mm
d_v=	805.5	mm
Projection Length=	0	mm
Projection Width=	0	mm

One Way Shear Check		
V_r=	1099.5	kN
$P_f/A_{footing}$=	199.0	kN
Project-d_v=	805.5	mm
V_f=	801.6	kN

Two Way Shear Check		
b_0=	7620	mm
Area outside critical section=	3.8	m^2
V_f=	746.3	kN
Size effect=	1.1	<2 No size Effect
Case 1=	0.6	
Case 2=	0.7	
Case 3=	0.4	USE
V_r=	8516.7	

Flexure Design			
A_{smin}=	4000		
# of Bars=	13.33	14	
14 - 20M Bars			
A_s=	4200		
B_1c=	51.7	<	447.5
M_r=	591.0	kNm	
M_f=	99.5	KNm	

Bearing			
F_b=	27625.0	kN	
P_f=	796.1	kN	No Dowels Needed

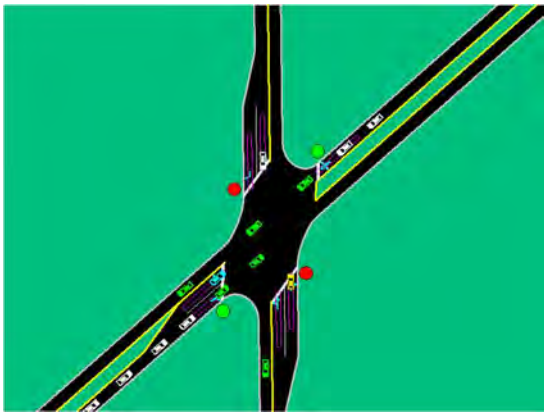
Design Summary	
Footing:	2mx2mx1m
Column:	1mx1m
Clear Cover:	75 mm
Bars	14-20M Bars
Bar Spacing:	120.8 mm

Soil Capacity								
Parameters:								
Soil Bearing Capacity=	500		N_c=	30.14		Footing, b=	2	
Unit Weight of Soil=	18		N_q=	18.4		Footing Area=	4	
Theta=	30		N_γ=	15.7				

Ultimate Bearing Capacity Calculation:		
q_u=	613.8	kN/m^2
Ultimate Load Capacity		
Q_u=	2455.2	kN
Safety Factor=	6.2	

APPENDIX G – SYNCHRO INFORMATION

Lane configuration:



PM Existing Volume Window:

LANE WINDOW	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)												
Ideal Satd. Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (m)	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
Grade (%)	—	0	—	—	0	—	—	0	—	—	0	—
Area Type	—	Other	—	—	Other	—	—	Other	—	—	Other	—
Storage Length (m)	10.0	—	0.0	10.0	—	0.0	0.0	—	0.0	0.0	—	0.0
Storage Lanes (#)	1	—	—	1	—	—	—	—	—	—	—	—
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	15.0	15.0	—	15.0	15.0	—	15.0	15.0	—	15.0	15.0	—
Trailing Detector (m)	0.0	0.0	—	0.0	0.0	—	0.0	0.0	—	0.0	0.0	—
Turning Speed (km/h)	25	—	15	25	—	15	25	—	15	25	—	15

PM Existing Timing Window:

Options >	
Controller Type:	Semi Act-Uncoord
Cycle Length:	90.0
Actuated C.L.:	80.1
Natural C.L.:	70.0
Max v/c Ratio:	0.78
Int. Delay:	14.0
Int. LOS:	B
ICU	68.2%
ICU LOS	C
☐ Lock Timings	

TIMING WINDOW	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	PED	HOLD
Lanes and Sharing (#RL)													—	—
Traffic Volume (vph)	103	646	27	21	308	17	104	5	26	25	50	57	—	—
Turn Type	Perm	—	—	Perm	—	—	Perm	—	—	Perm	—	—	—	—
Protected Phases		2	—		6	—		8	—		4	—		1 3 5 7
Permitted Phases	2		—	6		—	8		—	4		—	—	—
Detector Phases	2	2	—	6	6	—	8	8	—	4	4	—	—	—
Minimum Initial (s)	4.0	4.0	—	4.0	4.0	—	4.0	4.0	—	4.0	4.0	—	—	—
Minimum Split (s)	22.0	22.0	—	22.0	22.0	—	22.0	22.0	—	22.0	22.0	—	—	—
Total Split (s)	58.0	58.0	—	58.0	58.0	—	22.0	22.0	—	22.0	22.0	—	—	20.0
Yellow Time (s)	3.5	3.5	—	3.5	3.5	—	3.5	3.5	—	3.5	3.5	—	—	—
All-Red Time (s)	0.5	0.5	—	0.5	0.5	—	0.5	0.5	—	0.5	0.5	—	—	—
Total Delay (s)	5.7	9.5	—	5.7	5.6	—	—	53.9	—	—	24.9	—	—	—
Level of Service	A	A	—	A	A	—	—	D	—	—	C	—	—	—
Approach Delay (s)	—	9.0	—	—	5.6	—	—	53.9	—	—	24.9	—	—	—
Approach LOS	—	A	—	—	A	—	—	D	—	—	C	—	—	—

PM Growth Volume Window:

LANE WINDOW	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)	↰	↱		↰	↱			✥			✥	
Ideal Satd. Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (m)	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
Grade (%)	—	0	—	—	0	—	—	0	—	—	0	—
Area Type	—	Other	—	—	Other	—	—	Other	—	—	Other	—
Storage Length (m)	10.0	—	0.0	10.0	—	0.0	0.0	—	0.0	0.0	—	0.0
Storage Lanes (#)	1	—	—	1	—	—	—	—	—	—	—	—
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Leading Detector (m)	15.0	15.0	—	15.0	15.0	—	15.0	15.0	—	15.0	15.0	—
Trailing Detector (m)	0.0	0.0	—	0.0	0.0	—	0.0	0.0	—	0.0	0.0	—
Turning Speed (km/h)	25	—	15	25	—	15	25	—	15	25	—	15

PM Growth Timing Window:

Options >

Controller Type: Semi Act-Uncoord

Cycle Length: 90.0

Actuated C.L.: 88.2

Natural C.L.: 70.0

Max v/c Ratio: 0.85

Int. Delay: 20.7

Int. LOS: C

ICU 68.2%

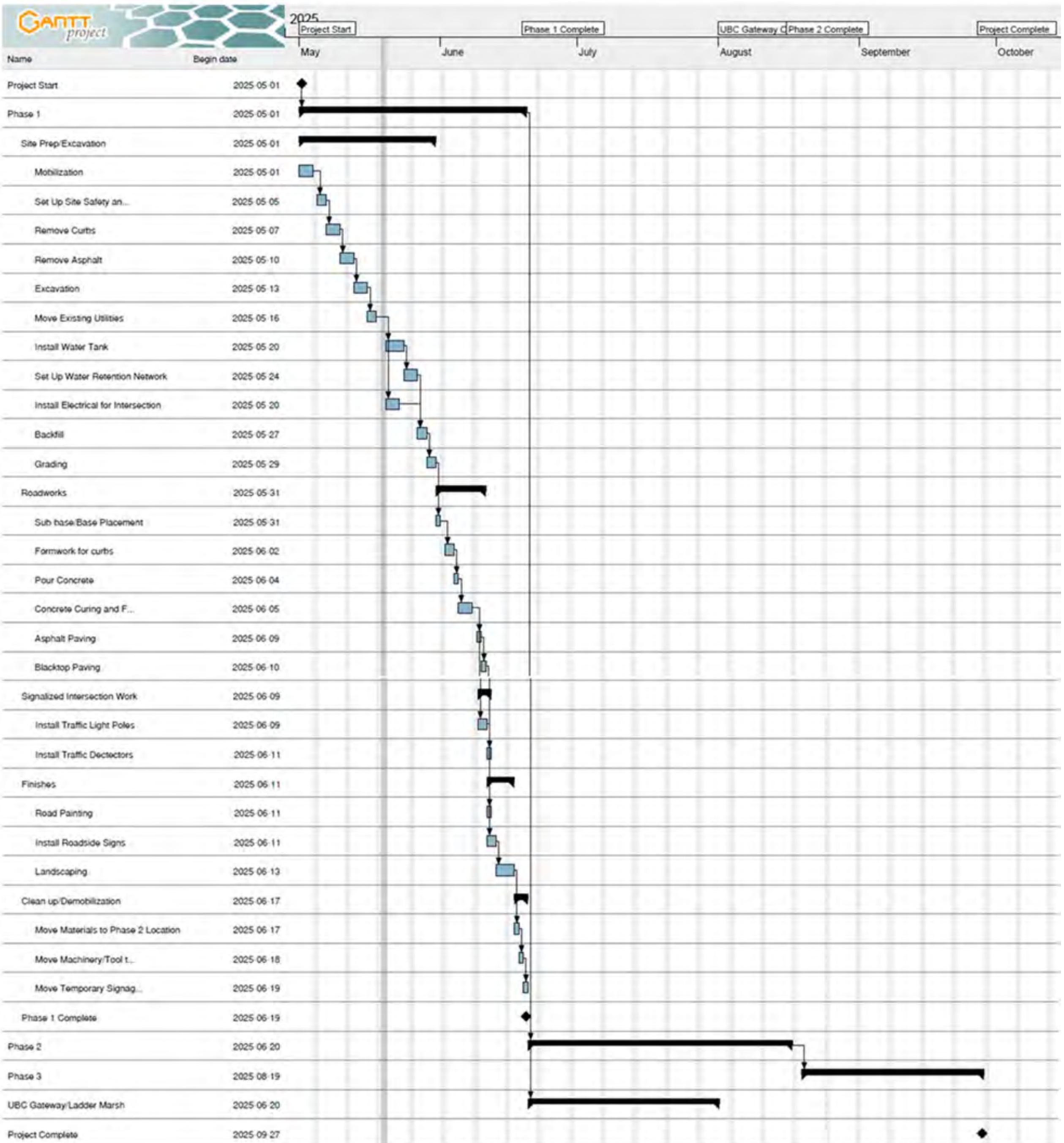
ICU LOS C

☐ Lock Timings

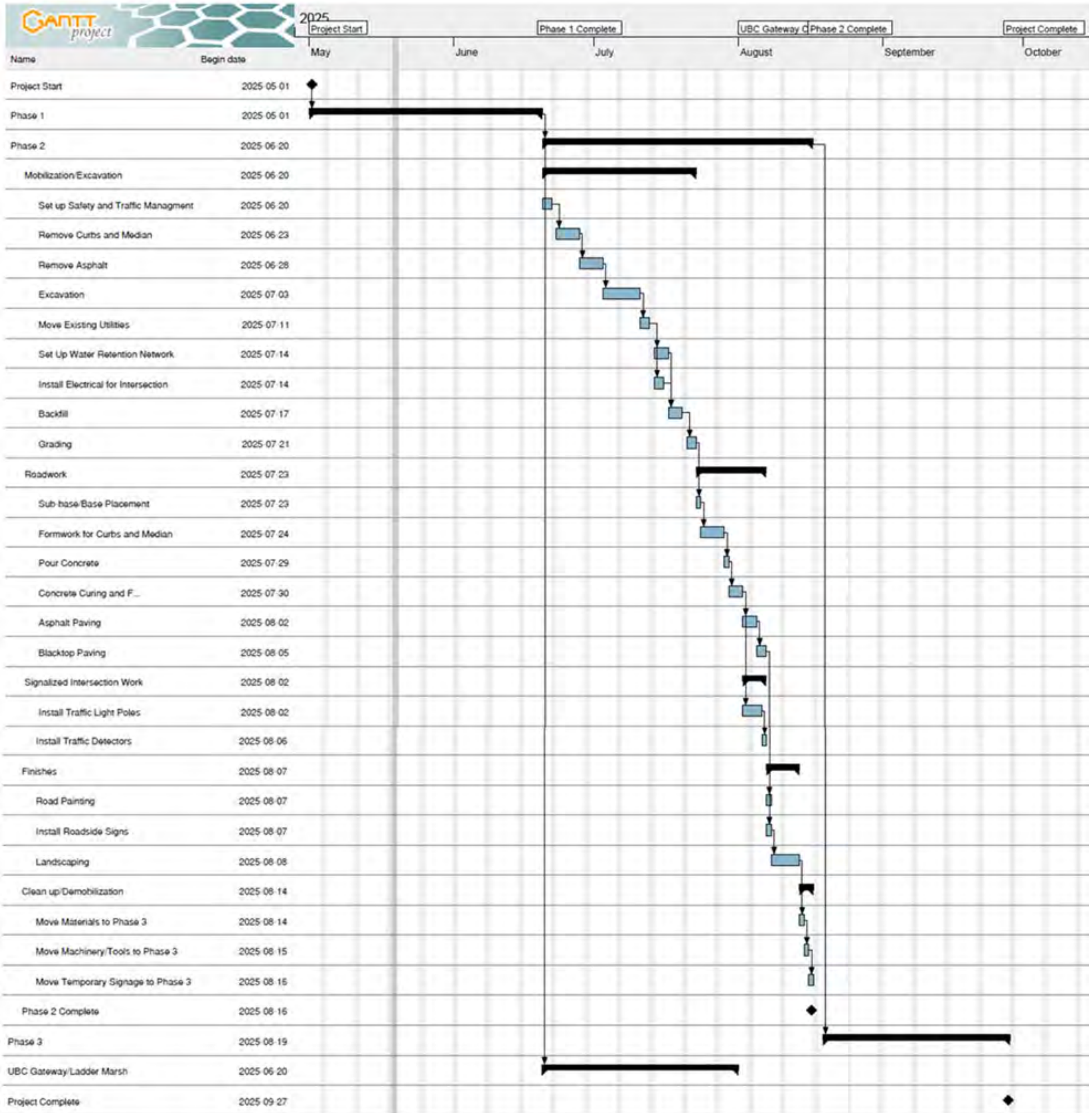
TIMING WINDOW	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	PED	HOLD
Lanes and Sharing (#RL)	↰	↱		↰	↱			✥			✥		—	—
Traffic Volume (vph)	103	646	27	21	308	17	104	5	26	25	50	57	—	—
Turn Type	Perm	—	—	Perm	—	—	Perm	—	—	Perm	—	—	—	—
Protected Phases		2	—		6	—		8	—		4	—		1 3 5 7
Permitted Phases	2		—	6		—	8		—	4		—	—	—
Detector Phases	2	2	—	6	6	—	8	8	—	4	4	—	—	—
Minimum Initial (s)	4.0	4.0	—	4.0	4.0	—	4.0	4.0	—	4.0	4.0	—	—	—
Minimum Split (s)	22.0	22.0	—	22.0	22.0	—	22.0	22.0	—	22.0	22.0	—	—	—
Total Split (s)	58.0	58.0	—	58.0	58.0	—	22.0	22.0	—	22.0	22.0	—	—	20.0
Yellow Time (s)	3.5	3.5	—	3.5	3.5	—	3.5	3.5	—	3.5	3.5	—	—	—
All-Red Time (s)	0.5	0.5	—	0.5	0.5	—	0.5	0.5	—	0.5	0.5	—	—	—

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	PED	HOLD
Total Delay (s)	9.7	16.5	—	9.3	9.7	—	—	68.7	—	—	29.9	—	—	—
Level of Service	A	B	—	A	A	—	—	E	—	—	C	—	—	—
Approach Delay (s)	—	15.6	—	—	9.7	—	—	68.7	—	—	29.9	—	—	—
Approach LOS	—	B	—	—	A	—	—	E	—	—	C	—	—	—

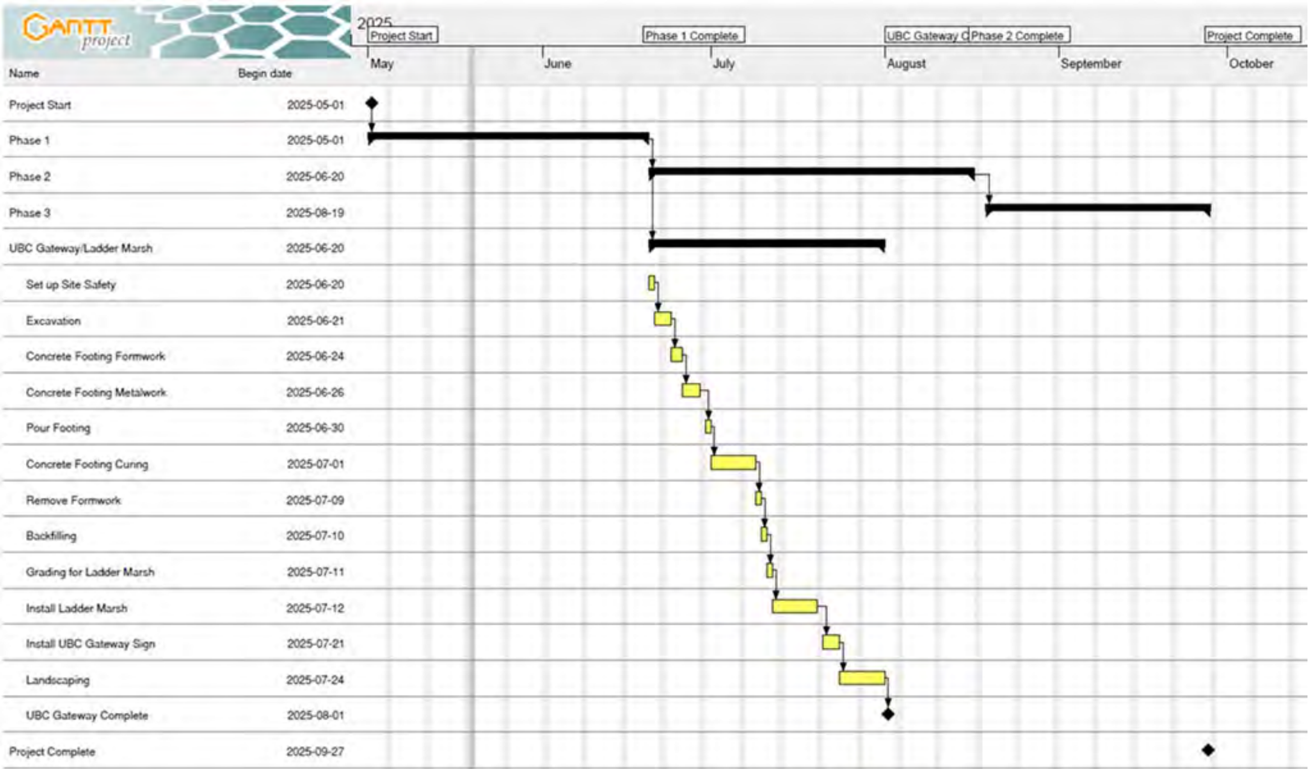
APPENDIX H – PHASE 1



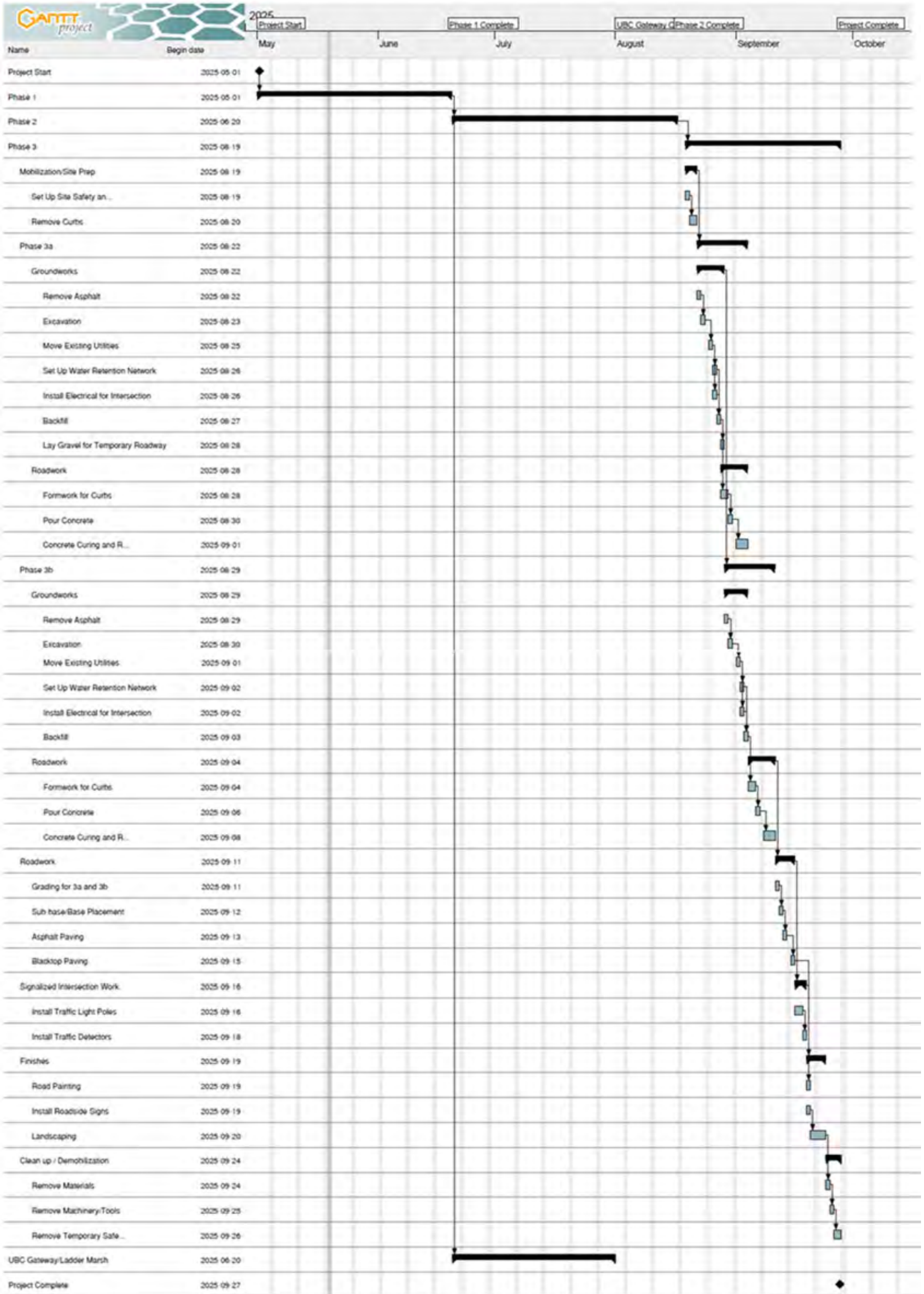
APPENDIX I – PHASE 2



APPENDIX J – PHASE 2A (UBC GATEWAY)

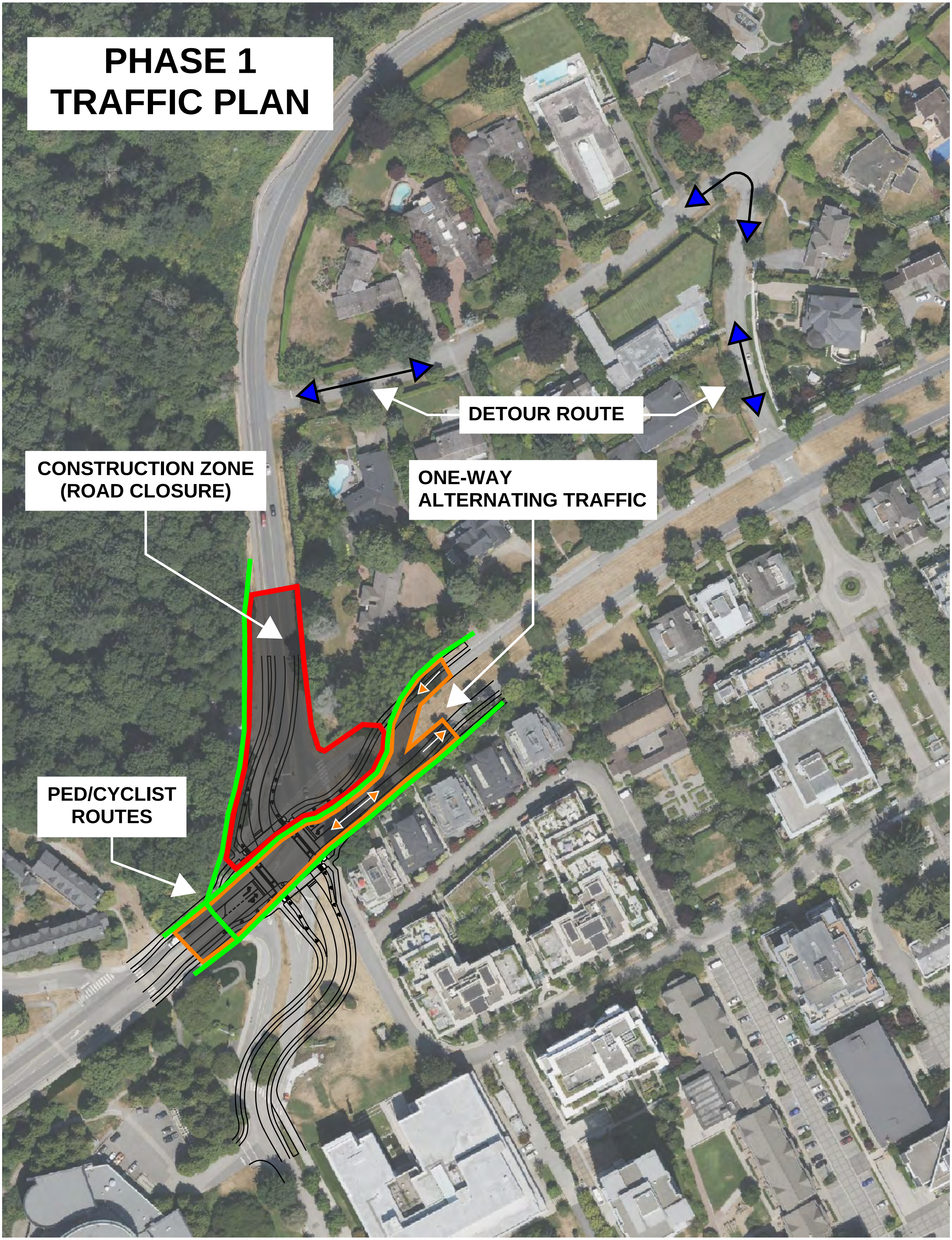


APPENDIX K – PHASE 3A & 3B

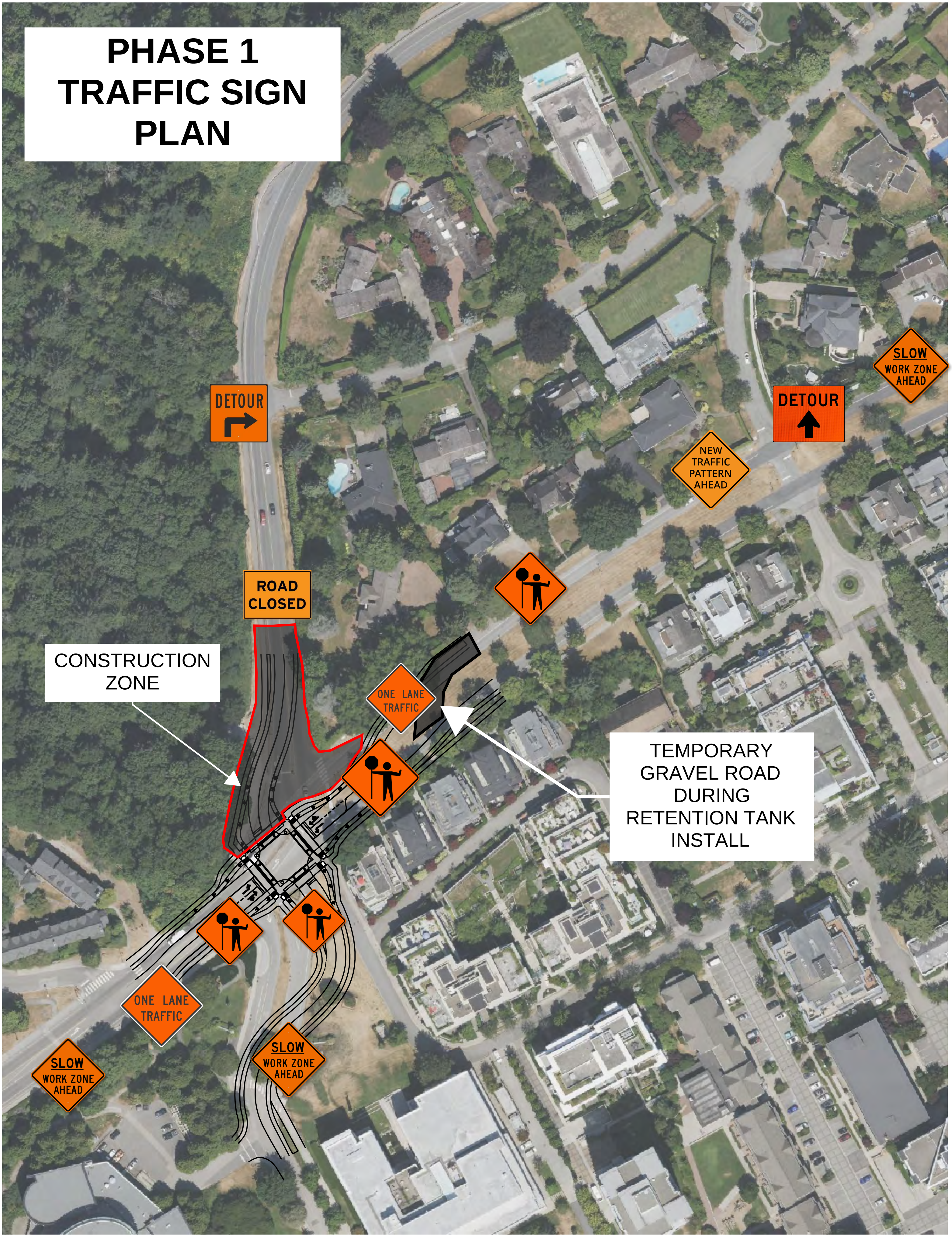


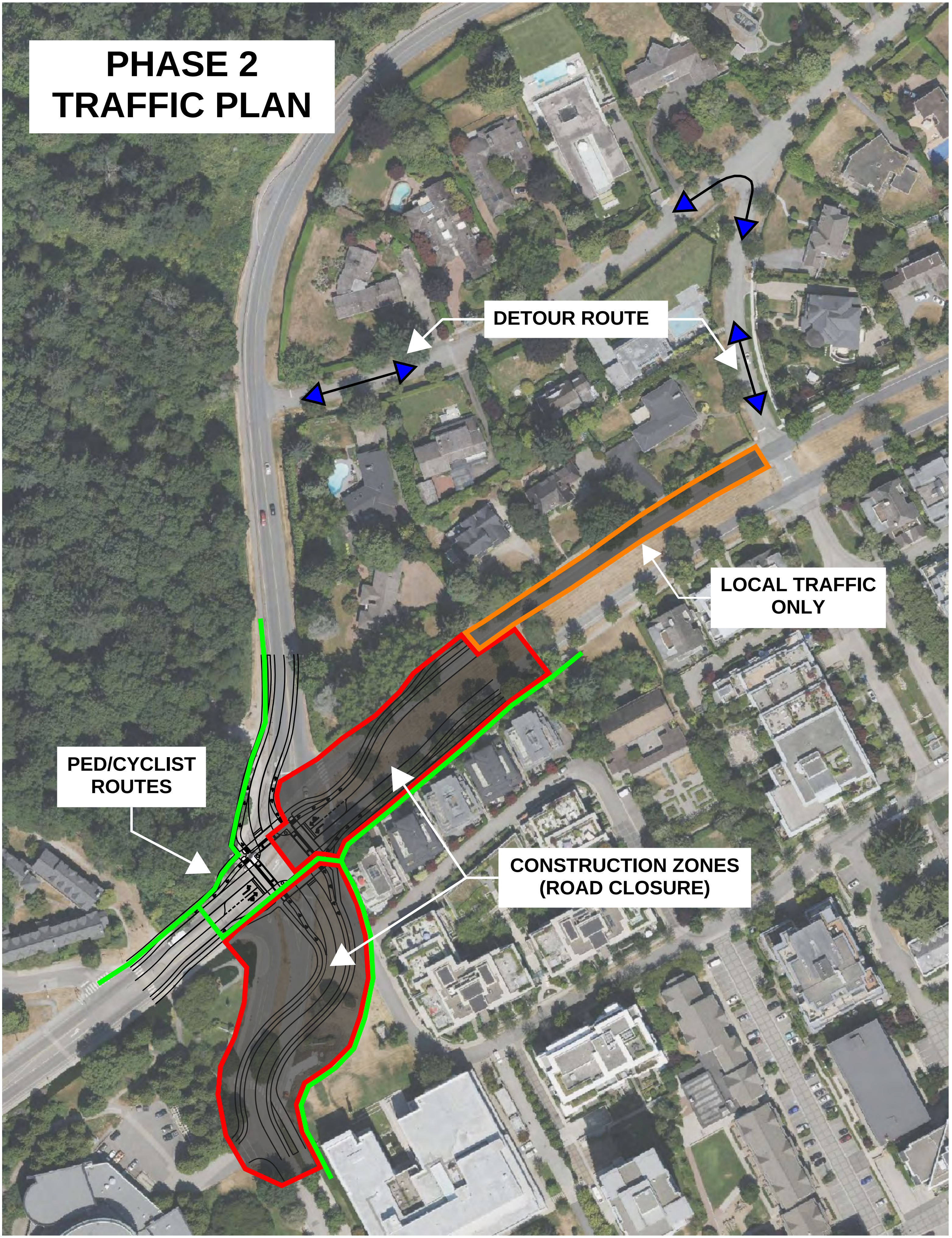
APPENDIX L – LADDER MARSH PLANTING PLAN

Botanical Name (Common name)	Height (m)	Flower Colour	Bloom Season	Traits	Plant Type
Mahonia nervosa (Longleaf Mahonia)	0.46	Yellow	Spring	Evergreen; provides winter interest; native to BC; tolerates varying moisture levels	Shrub
Potentilla fruticosa (Cinquefoil)	1	Various	Summer	Easy care; blooms all summer; drought-tolerant; thrives in full sun; adaptable to various soil conditions	Shrub
Spiraea japonica (Japanese Spirea)	0.6	Pink	Spring	Deciduous shrub; hardy; enjoys full sun; drought-tolerant; adaptable to various soil conditions	Shrub
Cistus x corbariensis (Rock Rose)	0.9	White-Yellow	Summer	Evergreen; provides winter interest; thrives in full sun; drought-tolerant; suitable for varying moisture conditions	Shrub
Cistus 'Silver Pink' (Silver Pink Rock Rose)	0.9	Silver/Pink	Summer	Evergreen; provides winter interest; thrives in full sun; drought-tolerant; suitable for varying moisture conditions	Shrub
Lavandula angustifolia 'Hidcote' (English Lavender)	0.6	Purple	Summer	Evergreen; provides winter interest; thrives in full sun; drought-tolerant; suitable for varying moisture conditions	Herbaceous Perennial
Lavandula angustifolia 'Munstead' (Munstead Lavender)	0.46	Blue/Purple	Summer	Evergreen; provides winter interest; thrives in full sun; drought-tolerant; suitable for varying moisture conditions	Herbaceous Perennial
Rosmarinus officinalis 'Prostratus' (Creeping Rosemary)	0.15	Blue	Summer	Evergreen; provides winter interest; thrives in full sun; drought-tolerant; suitable for varying moisture conditions	Herbaceous Perennial
Thymus vulgaris (Common Thyme)	0.3	Purple	Summer	Evergreen; drought-tolerant; thrives in full sun; suitable for varying moisture conditions	Herbaceous Perennial

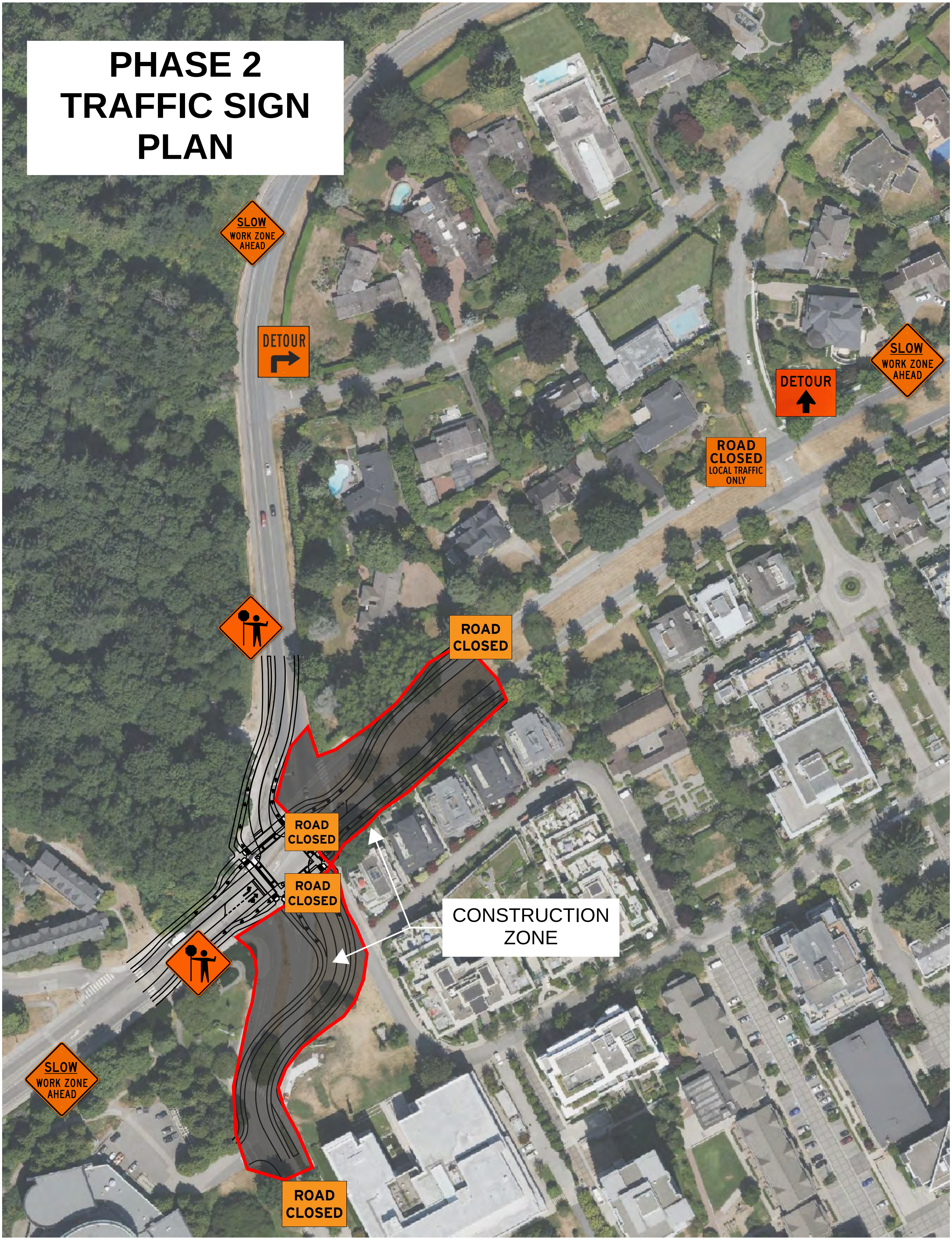

PHASE 1
TRAFFIC PLAN
DETOUR ROUTE
CONSTRUCTION ZONE
(ROAD CLOSURE)
ONE-WAY
ALTERNATING TRAFFIC
PED/CYCLIST
ROUTES

PHASE 1 TRAFFIC SIGN PLAN

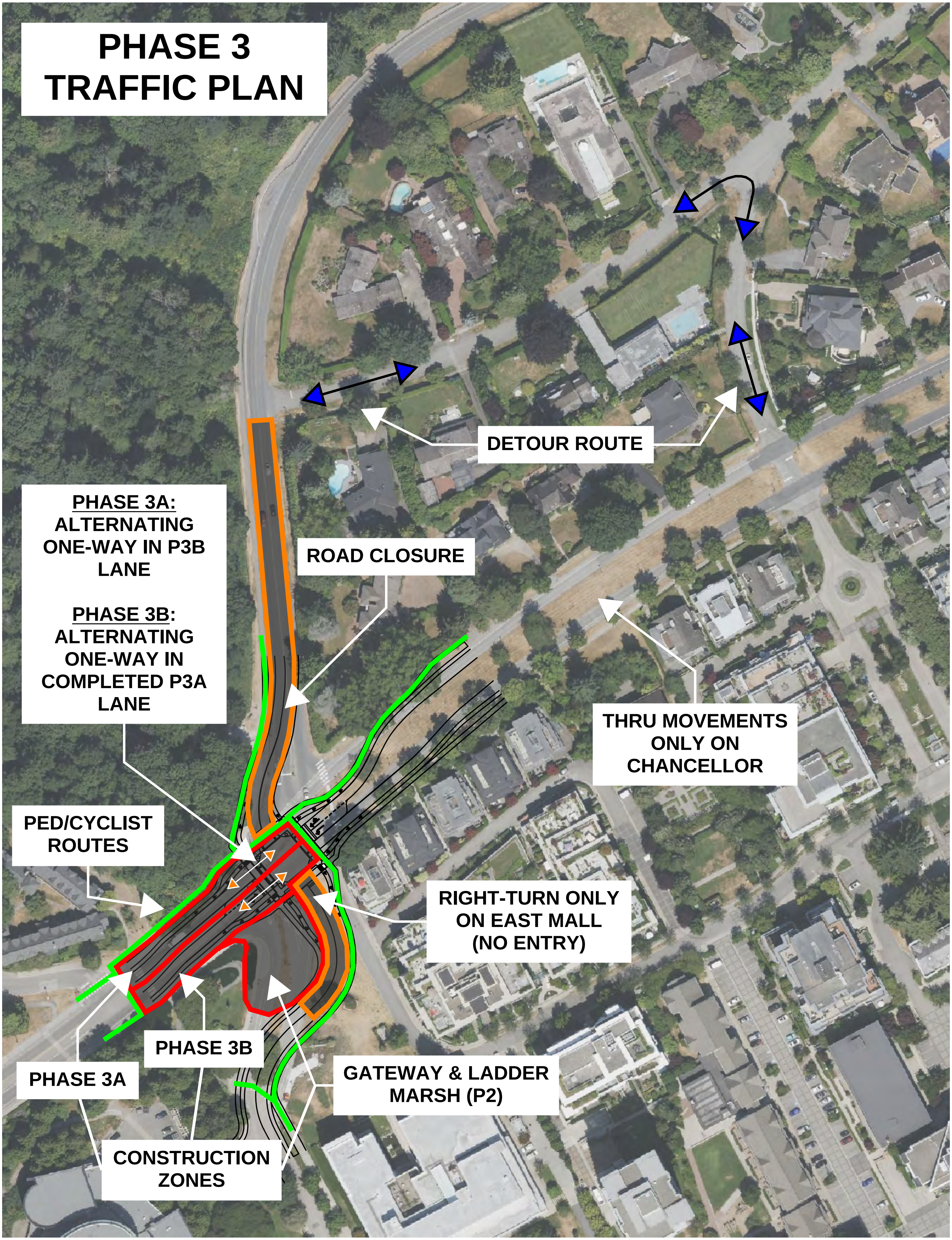



PHASE 2
TRAFFIC PLAN
DETOUR ROUTE
LOCAL TRAFFIC
ONLY
PED/CYCLIST
ROUTES
CONSTRUCTION ZONES
(ROAD CLOSURE)

PHASE 2 TRAFFIC SIGN PLAN



PHASE 3 TRAFFIC PLAN

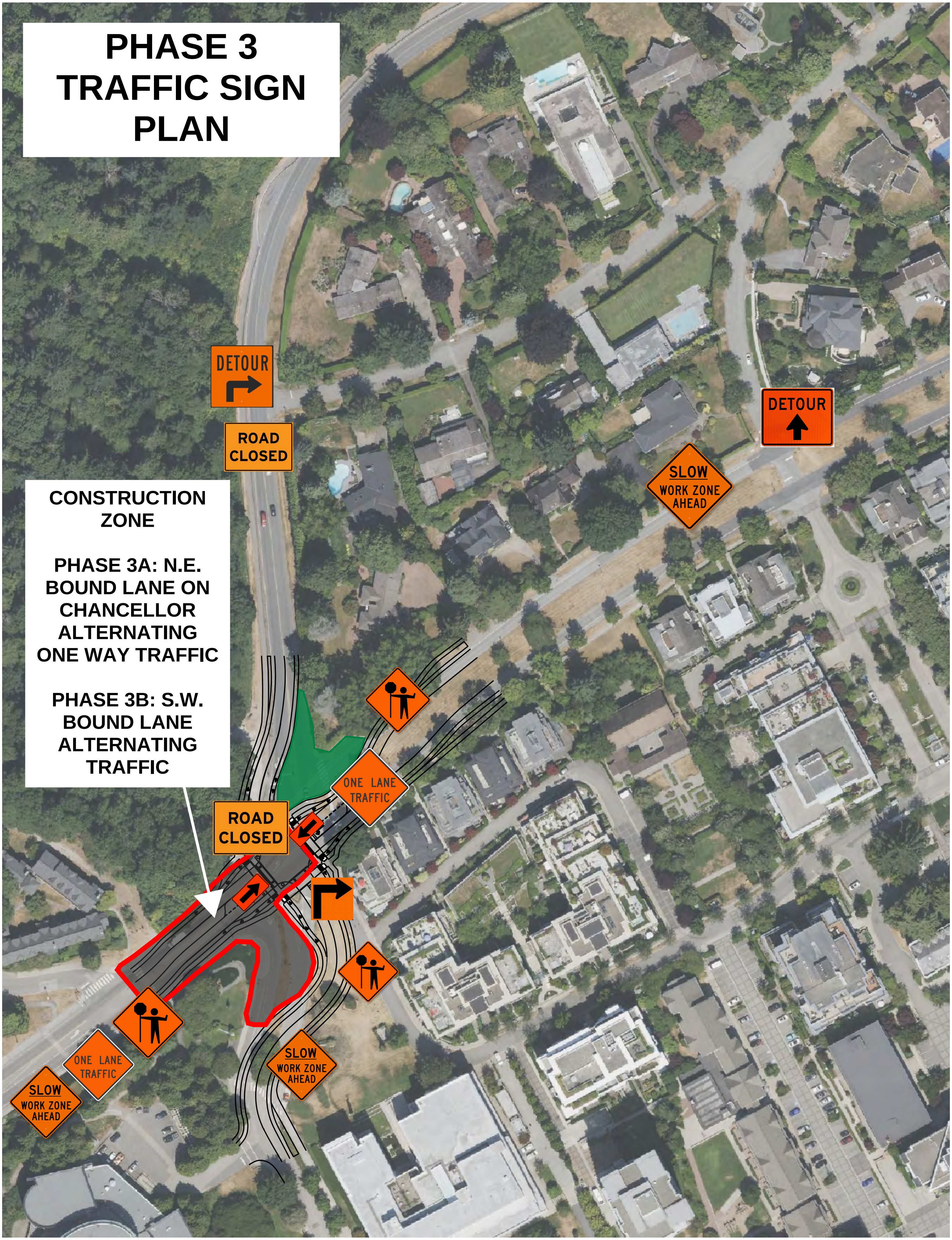


PHASE 3 TRAFFIC SIGN PLAN

CONSTRUCTION ZONE

PHASE 3A: N.E. BOUND LANE ON CHANCELLOR ALTERNATING ONE WAY TRAFFIC

PHASE 3B: S.W. BOUND LANE ALTERNATING TRAFFIC



View from north corner of intersection looking south towards UBC campus

Overhead view of intersection with north at the top of the page

View of NW Marine Drive pedestrian and cyclist crossing from north side of intersection looking south

Gateway and ladder marsh as seen from East Mall looking southwest

Gateway and ladder marsh as seen from East Mall looking southwest

Night time view from north corner of intersection looking south towards UBC campus

Night time view of gateway and ladder marsh as seen from East Mall looking southwest

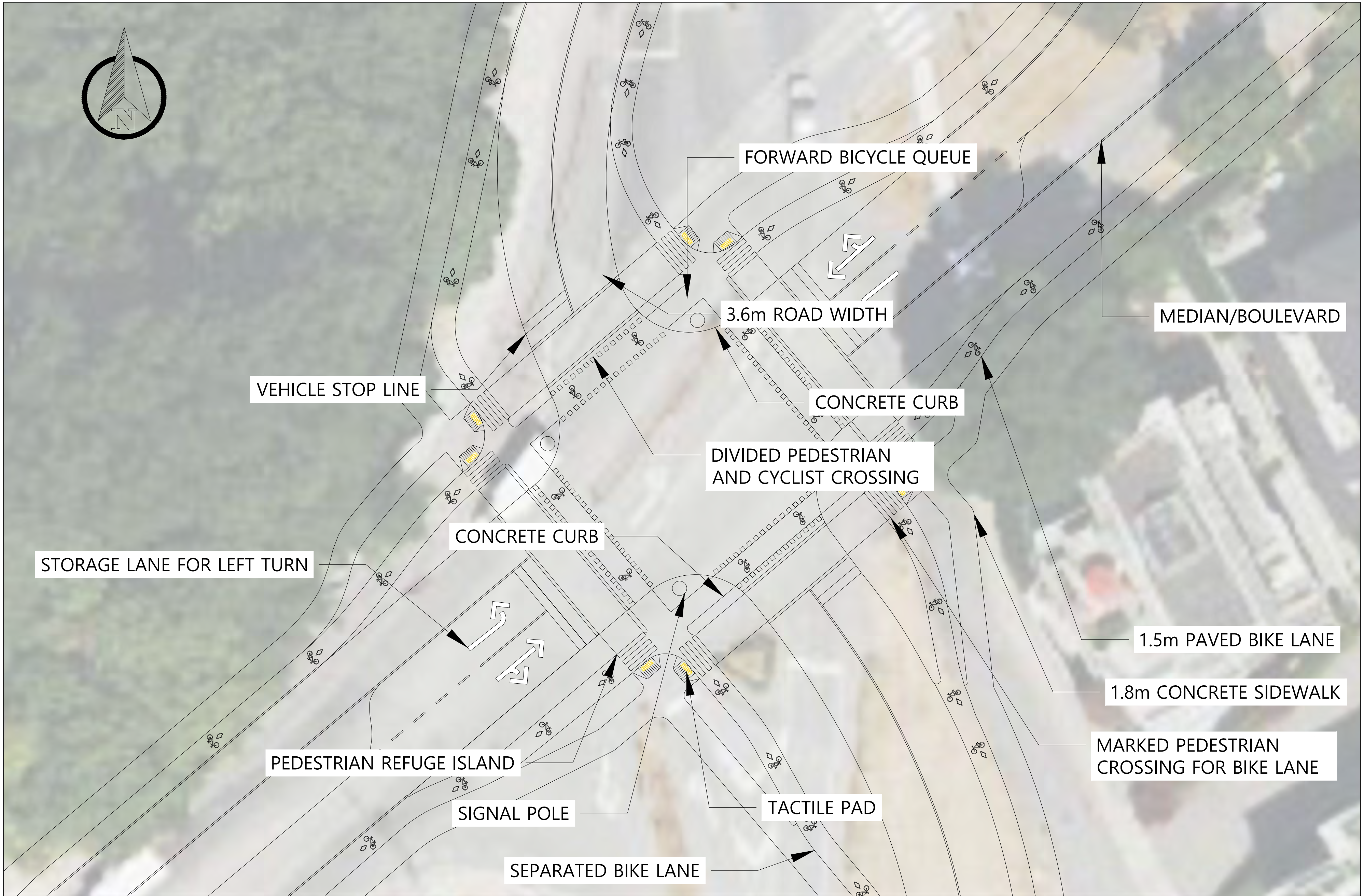
DRAWING INDEX:

PACIFIC PATHWAY CONSULTING LTD.

DRAWING INDEX

REV.	DESCRIPTION	DATE
1		04/07/2025

THE UNIVERSITY OF BRITISH COLUMBIA SEEDS



PACIFIC PATHWAY CONSULTING LTD.

NOTES:

CHANCELLOR BOULEVARD & EAST MALL INTERSECTION REDESIGN

REV.	DESCRIPTION	DATE

THE UNIVERSITY OF BRITISH COLUMBIA SEEDS

GENERAL NOTES:

1. INSPECTION AND APPROVAL: ALL WORK MUST PASS INSPECTION BY THE MINISTRY OF TRANSPORTATION, BRITISH COLUMBIA (MOTI) AND THE CONSULTANT, ACTING ON BEHALF OF THE OWNER, THE UNIVERSITY OF BRITISH COLUMBIA (UBC).
2. MATERIALS AND SPECIFICATIONS: ALL MATERIALS USED SHALL CONFORM TO THE MOTI APPROVED PRODUCTS LIST, UNLESS SUPERSEDED BY THE PROJECT'S CONSTRUCTION SPECIFICATIONS.
3. MATERIAL SUBSTITUTION: ANY MATERIAL SUBSTITUTION MUST BE APPROVED BY BOTH THE CONSULTANT AND MOTI REPRESENTATIVES PRIOR TO USE.
4. DISCREPANCIES AND CLARIFICATIONS: IN THE EVENT OF PERCEIVED AMBIGUITY OR DISCREPANCIES BETWEEN THE CONSTRUCTION SPECIFICATIONS AND DRAWINGS, THE CONSULTANT MUST BE NOTIFIED FOR REVIEW BEFORE PROCEEDING WITH THE WORK.
5. ADVANCE NOTIFICATIONS: THE CONTRACTOR MUST NOTIFY THE CONSULTANT AT LEAST THREE (3) DAYS IN ADVANCE BEFORE STARTING THE FOLLOWING ACTIVITIES:
   - ROAD CLOSURES AND DETOURS
   - INSTALLATION OF FOOTINGS FOR THE GATEWAY
   - INSTALLATION OF STORMWATER TANK SLAB
   - BACKFILL OF STORMWATER TANK
   - INSTALLATION OF POND TANK SLAB
   - INSTALLATION OF GLULAM ELEMENTS
   - PAVING
   - DELIVERY OF STORMWATER PIPING MATERIALS AND PUMP
   - GRADING OF POND
   - INSTALLATION OF STORMWATER POND
6. EXCAVATION REQUIREMENTS: BC ONE CALL IS REQUIRED (BY LAW) PRIOR TO ANY EXCAVATION ACTIVITIES TO LOCATE UNDERGROUND UTILITIES.
7. WORKPLACE SAFETY: ALL CONSTRUCTION ACTIVITIES SHALL CONFORM TO WORKSAFE BC REGULATIONS. THE CONTRACTOR MUST BE REGISTERED WITH WORKSAFE BC AND NOTIFY THEM PRIOR TO CONSTRUCTION.
8. SITE CLEANLINESS: THE CONTRACTOR SHALL MAINTAIN A CLEAN WORKSITE, FREE OF CONSTRUCTION DEBRIS, AND ENSURE THAT THE SITE IS SWEPT AS NEEDED, ESPECIALLY FOLLOWING HEAVY EQUIPMENT USE.
9. PERMITS AND APPROVALS: THE CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND MUST PROVIDE RELEVANT APPROVALS TO THE CONSULTANT.
10. DAMAGE TO STREET INFRASTRUCTURE: THE CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRING ANY DAMAGE CAUSED TO THE STREET BY CONSTRUCTION EQUIPMENT OR WORK ACTIVITIES, INCLUDING POTENTIAL STREET SWEEPING TO REMOVE CONSTRUCTION DEBRIS.
11. TRAFFIC CONTROL: THE CONTRACTOR IS RESPONSIBLE FOR IMPLEMENTING TRAFFIC CONTROL IN ACCORDANCE WITH THE PROPOSED TRAFFIC MANAGEMENT PLAN. IF AN ALTERNATE PLAN IS PROPOSED, IT MUST BE SUBMITTED FOR APPROVAL WITH ANY JUSTIFICATION, ADDED VALUE, AND COST IMPLICATIONS.
12. AS-BUILT INFORMATION: THE CONTRACTOR MUST PROVIDE ALL NECESSARY INFORMATION (E.G., DIMENSIONS, MATERIALS,) TO ENSURE ACCURATE AS-BUILT CONDITIONS. THE CONSULTANT WILL PREPARE THE FINAL AS-BUILT DRAWINGS.
13. TREE PROTECTION: TREES TO BE PRESERVED SHALL BE SURROUNDED BY SNOW FENCING. EXCAVATION OR DISRUPTION WITHIN THE DRIP LINE OF TREES MUST BE PERFORMED UNDER THE SUPERVISION OF A QUALIFIED ARBORIST.
14. MEASUREMENT AND UNITS: THE METRIC SYSTEM IS USED THROUGHOUT ALL DRAWINGS. ELEVATIONS AND STATIONS ARE SHOWN IN METRES, WHILE OTHER DIMENSIONS ARE IN MILLIMETRES, UNLESS STATED OTHERWISE.
15. COORDINATION WITH OTHER DRAWINGS: THE CONTRACTOR SHALL REVIEW THE STRUCTURAL DRAWINGS IN CONJUNCTION WITH ALL RELEVANT CONTRACT DOCUMENTS. REFER TO CIVIL, MECHANICAL, AND ELECTRICAL DRAWINGS FOR DETAILS OF OPENINGS, SLEEVES, AND OTHER COMPONENTS NOT SHOWN ON THE STRUCTURAL DRAWINGS.
16. VERIFICATION OF DIMENSIONS: THE CONTRACTOR MUST CONFIRM ALL EQUIPMENT DIMENSIONS AND CRITICAL DETAILS PRIOR TO CONSTRUCTION AND REPORT ANY DISCREPANCIES TO THE CONSULTANT FOR APPROVAL BEFORE PROCEEDING.
17. INSPECTION NOTICES: THE CONTRACTOR MUST NOTIFY THE STRUCTURAL DESIGNER 24 HOURS IN ADVANCE OF ANY INSPECTIONS REQUIRED.
18. VERIFICATION OF SITE CONDITIONS: THE CONTRACTOR MUST VERIFY THE SIZE AND LOCATION OF ALL INSERTS, DRAINS, OPENINGS, AND RECESSES, AS SHOWN ON THE DRAWINGS.
19. FORMWORK AND TEMPORARY STRUCTURES: THE DRAWINGS SHOW COMPLETED STRUCTURES ONLY. THE CONTRACTOR IS RESPONSIBLE FOR DESIGNING AND IMPLEMENTING FORMWORK, SHORING, AND ANY OTHER TEMPORARY STRUCTURES REQUIRED DURING CONSTRUCTION. ALL SUCH TEMPORARY STRUCTURES MUST BE DESIGNED TO RESIST CONSTRUCTION LOADS.
20. TEMPORARY SHORING AND BRACING: IF TEMPORARY SHORING OR BRACING IS REQUIRED, THE CONTRACTOR MUST SUBMIT DETAILS TO THE CONSULTANT FOR REVIEW. THE CONTRACTOR MUST ENGAGE A PROFESSIONAL ENGINEER REGISTERED IN BRITISH COLUMBIA TO DESIGN AND TAKE RESPONSIBILITY FOR TEMPORARY SHORING AND BRACING.
21. ORDER OF PRECEDENCE: CONSTRUCTION OF THE WORKS SHALL FOLLOW THIS ORDER OF PRECEDENCE:
   - DRAWINGS AND DRAWING NOTES
   - GENERAL NOTES
   - PROJECT CONSTRUCTION SPECIFICATIONS
22. PLAN DIMENSIONS: ALL PLAN DIMENSIONS ARE MEASURED HORIZONTALLY, UNLESS STATED OTHERWISE.
23. ALL CONSTRUCTION AND MATERIALS SHALL BE IN ACCORDANCE WITH:
   - THE MASTER MUNICIPAL CONSTRUCTION DOCUMENT AND STANDARD DETAIL DRAWINGS
   - BC MOTI STANDARD 2020 STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION
   - BC MOTI ELECTRICAL AND TRAFFIC ENGINEERING MANUAL
   - WORKSAFE BC, LATEST EDITION
   - BC ACTIVE TRANSPORTATION DESIGN GUIDE

DRAWING NOTES – EARTHWORKS & GRADING

1. IN AREAS WITH SETBACKS, AND DISCHARGES TO CREEKS, STREAMS, AND WATERCOURSES, APPROVAL FROM FEDERAL AND PROVINCIAL AUTHORITIES MAY BE NECESSARY. THE CONTRACTOR IS RESPONSIBLE FOR ENGAGING A CERTIFIED ENVIRONMENTAL PROFESSIONAL TO CONDUCT ESSENTIAL STUDIES AND SECURE ANY REQUIRED PERMITS AND APPROVALS BEFORE COMMENCING CONSTRUCTION.
2. A GEOTECHNICAL CONSULTANT MUST ASSESS AND AUTHORIZE THE NATURAL SUBGRADE BEFORE PLACEMENT OF FILL
3. A GEOTECHNICAL CONSULTANT MUST REVIEW AND APPROVE FILL MATERIAL BEFORE INITIATING THE MATERIAL USE. THE CONSULTANT IS RESPONSIBLE OF ENGAGING AND OBTAINING ALL APPROVALS BEFORE COMMENCEMENT.
4. ENSURE THAT ALL PROPOSED GRADING ALIGNS WITH THE EXISTING GROUND ELEVATIONS, UNLESS STATED OTHERWISE.
5. PROOF ROLLING SHOULD INVOLVE AT LEAST FOUR PASSES OF A VIBRATORY SMOOTH DRUM ROLLER FOR THE DETECTION OF UNSTABLE OR "SOFT" AREAS.

DRAWING NOTES – ROADWORKS

1. IMPLEMENT SMOOTH VERTICAL AND HORIZONTAL CURVES TO SHAPE CHANGES IN GRADE AND DIRECTION.
2. EXECUTE EARTHWORKS ACCORDING TO THE CONTRACT DOCUMENTS, WHICH INVOLVE TASKS SUCH AS REMOVING LOOSE OR DETRIMENTAL MATERIALS, ADDRESSING SOFT SPOTS, COMPACTING, AND GRADING SLOPES.
3. ADHERE TO MMCD SPECIFICATIONS FOR ALL SUB-BASE ROAD AND GRANULAR BASE MATERIALS.
4. EXTEND THE ROAD SUB-BASE AND BASE A MINIMUM OF 0.3 METRES BEYOND THE ROAD EDGE OR CURB AND GUTTER.
5. CONNECT TO EXISTING PAVEMENT BY CUTTING BACK TO SOUND MATERIAL AS REQUIRED TO CREATE A TIDY VERTICAL FACE.

DRAWING NOTES – STORM SEWER

1. THE CONTRACTOR IS RESPONSIBLE FOR PERFORMING TIE-INS AND CONNECTIONS TO EXISTING STORM SEWERS UNDER THE SUPERVISION AND DIRECTION OF THE MINISTRY.
2. ALL DRAIN PIPE SHALL BE OF FIRST QUALITY, AND FREE FROM DEFECTS OF ANY KIND.
3. ENSURE A MINIMUM SLOPE OF 0.5% ON CATCH BASIN LEADS.
4. PREVENT THE ENTRY OF CONTAMINANTS INTO THE MINISTRY'S SEWER SYSTEM.
5. INCLUDE INSPECTION CHAMBERS FOR COMPLETENESS IN STORM SERVICE CONNECTIONS.

DRAWING NOTES – CONCRETE REINFORCEMENT

1. GALVANIZED REINFORCEMENT STEEL SHALL CONFORM TO THE REQUIREMENTS OF ASTM A767M-CLASS II COATING, AS PER SECTION 412.11.03.
2. REINFORCEMENT BARS SHALL BE CUT AND BENT TO THE SHAPES SHOWN ON THE DRAWINGS, AND SHALL BE BENT COLD UNLESS OTHERWISE PERMITTED, AS PER SECTION 412.31
3. TOLERANCES FOR PLACING REINFORCEMENT SHALL, UNLESS STATED OTHERWISE, BE SHOWN IN TABLE 412-D OF SECTION 412.33.01.
4. CONCRETE COVER FOR REINFORCING STEEL SHALL BE IN ACCORDANCE WITH SECTION 412.33.03 AND THE MINISTRY "BRIDGE STANDARDS AND PROCEDURE MANUAL – SUPPLEMENT TO CHBDC S6".
5. SPECIAL REQUIREMENTS FOR SPLICING, SUCH AS PARTICULAR LOCATIONS FOR SPLICES, USE OF OVERLENGTH BARS, OR SPECIAL LAP LENGTHS, SHALL BE AS SHOWN ON THE DRAWINGS, AS PER SECTION 412.34.
6. SPLICES UB BARS LARGER THAN 35M SHALL BE FASTENED WITH MECHANICAL COUPLERS OR WELDED. THE DETAIL OF SUCH SPLICES SHALL BE SUBJECT TO ACCEPTANCE BY THE MINISTRY REPRESENTATIVE.

DRAWING NOTES – REINFORCED CAST-IN-PLACE CONCRETE

1. CONCRETE SUPPLIED SHALL CONFORM TO CSA A23.3:19 SPECIFICATIONS.
2. THE MAXIMUM NOMINAL SIZE OF COARSE AGGREGATE SHALL BE 20 MILLIMETRE AND MEET THE GRADING REQUIREMENTS OF CSA A23.3:19. COARSE AGGREGATES SHALL BE UNIFORMLY GRADED AND NOT MORE THAN 1% SHALL PASS A 75 MICROMETRE SIEVE.
3. WATER TO BE USED FOR MIXING AND CURING CONCRETE OR GROUT SHALL BE POTABLE AND CONFORM TO THE SPECIFICATIONS OF CSA A23.3:19.
4. CEMENTITOUS MATERIALS SHALL CONFORM TO THE REQUIREMENTS OF CSA A23.3:19
5. ALL CONCRETE SHALL BE MIXED THOROUGHLY UNTIL IT IS UNIFORM IN APPEARANCE.
6. THE MAXIMUM TIME ALLOWED FOR ALL TYPES OF CONCRETE TO BE DELIVERED TO THE SITE, INCLUDING THE TIME REQUIRED TO DISCHARGE, SHALL NOT EXCEED 90 MINUTES AFTER BATCHING.
7. THE STRUCTURE SHALL NOT BE OPENED TO TRAFFIC UNTIL THE CONCRETE HAS ATTAINED A MINIMUM COMPRESSIVE STRENGTH OF 100% OF THE DESIGN STRENGTH.

DRAWING NOTES – PAVEMENT MARKINGS & SIGNAGE PLANS

1. ALL SIGNAGE RECOMMENDATIONS SHOULD BE COMPLEMENTED BY REFERENCE TO SPECIFICATIONS FOR STANDARD HIGHWAY SIGN MATERIALS, FABRICATION, AND SUPPLY BY THE MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE.
2. PRESERVE ALL CURRENTLY INSTATED SIGNS, AND REMOVE ANY SURPLUS FOLLOWING THE COMPLETION OF THE PROJECT TO THE MINISTRY.
3. THE MINISTRY IS RESPONSIBLE FOR REMOVING EXISTING CONFLICTING PAVEMENT MARKINGS.
4. SIGNS SHALL BE CLEARLY AND PERMANENTLY LABELED OR ENGRAVED WITH AN IDENTIFICATION CODING.
5. WHITE PAINT MUST CONFORM TO US FEDERAL SPECIFICATION 595B WHITE 17886.
6. YELLOW PAINT MUST CONFORM TO US FEDERAL SPECIFICATION 595B YELLOW 33538.
7. ALL SIGNAGE MUST BE RETRO-REFLECTIVE TO SHOW THE SAME COLOUR, SHAPE, AND MESSAGE AT NIGHT AS THEY APPEAR IN DAYLIGHT.
8. ROAD STUDS TO BE PLACED IN ACCORDANCE TO MINISTRY STANDARDS.

DRAWING NOTES – STREETLIGHTING

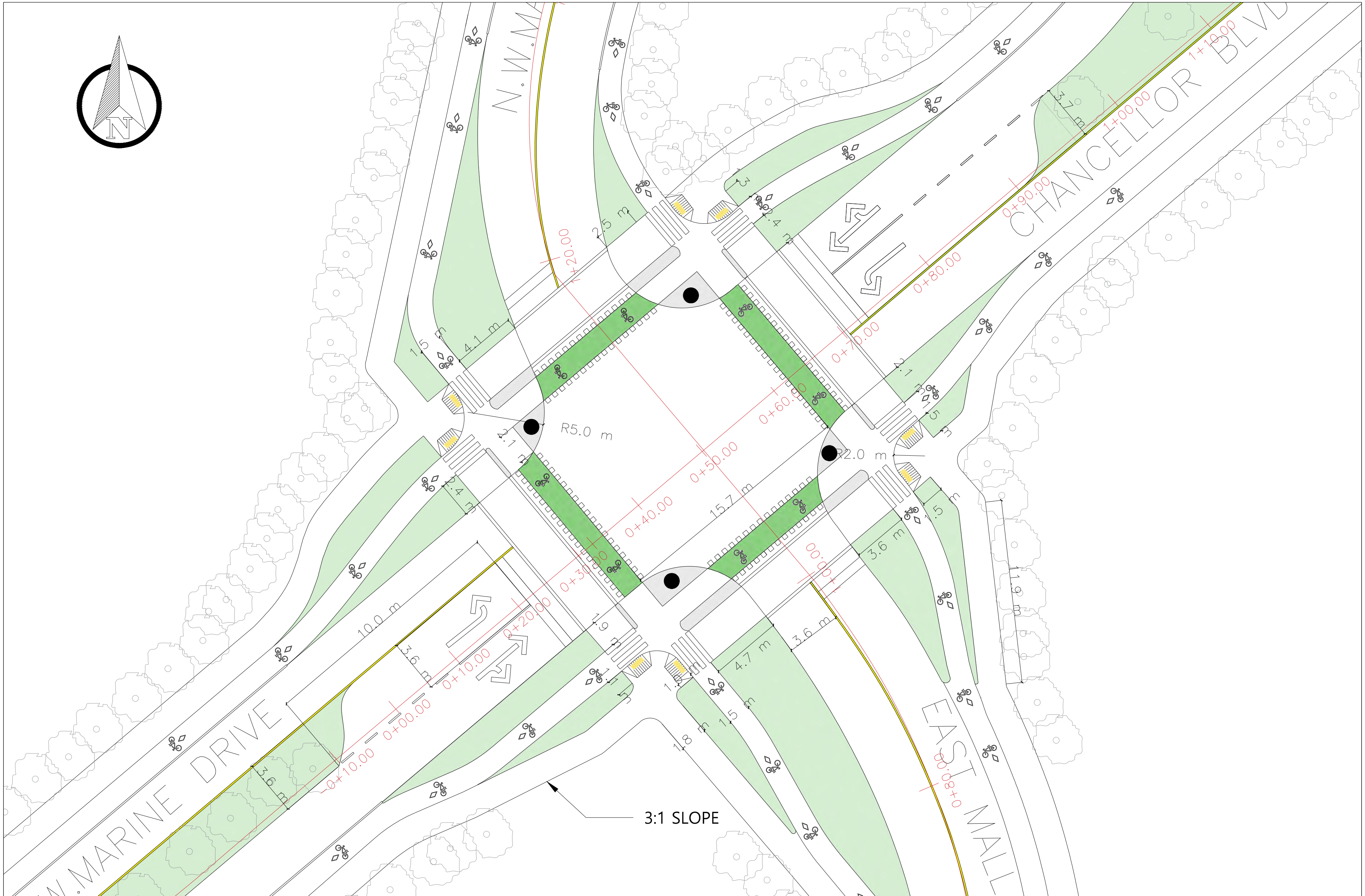
1. LED LIGHTING TO BE USED AT ALL NEW LIGHTING INSTALLATIONS. REFER TO SECTION 504 OF THE MOTI ELECTRICAL SIGNING MATERIAL STANDARDS FOR THE MATERIALS SPECIFICATION FOR LED ROADWAY LUMINARIES.
2. DESIGN OF STREET LIGHTING SHALL REFERENCE THE MOST CURRENT VERSION OF THE MINISTRY'S RECOGNIZED PRODUCTS LIST AND PROCUREMENT SERVICES CORPORATE SUPPLE ARRANGEMENT TO ENSURE THAT THE LATEST EQUIPMENT IS USED FOR NEW DESIGNS.

PACIFIC PATHWAY CONSULTING LTD.

GENERAL NOTES

REV.	DESCRIPTION	DATE
1		04/07/2025

THE UNIVERSITY OF BRITISH COLUMBIA SEEDS



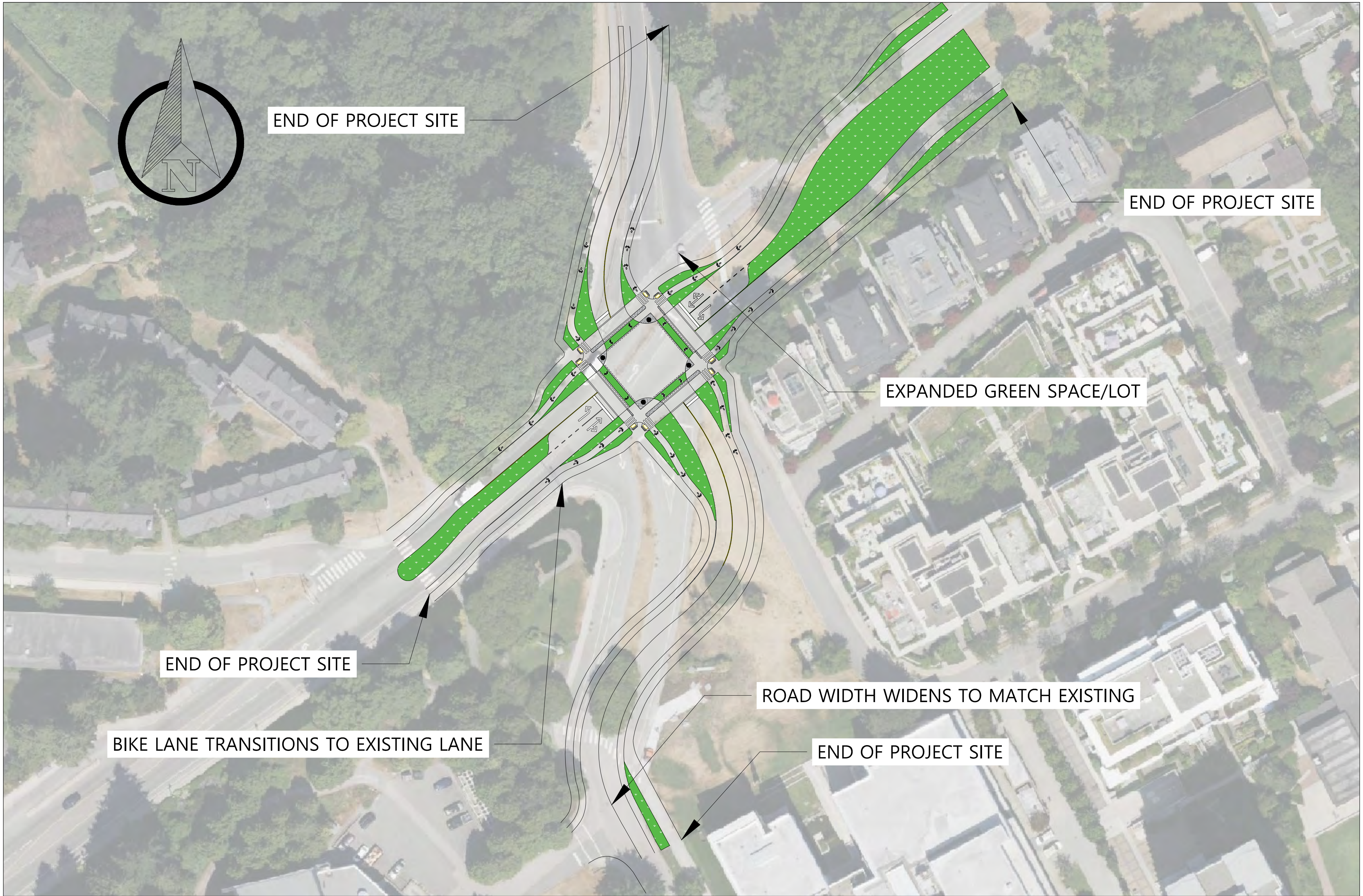
PACIFIC PATHWAY CONSULTING LTD.

NOTES:
- SCALE: N.T.S
- ISSUED FOR CONSTRUCTION
- ALL UNITS ARE IN METERS UNLESS STATED OTHERWISE
- REFER TO STANDARD DRAWING DETAILS FOR CURB AND SIDEWALK DESIGN
- TAPER ROAD TO MATCH EXISTING AT END OF PROJECT SITES

INTERSECTION DIMENSIONS

REV.	DESCRIPTION	DATE
1		04/07/2025

THE UNIVERSITY OF BRITISH COLUMBIA SEEDS



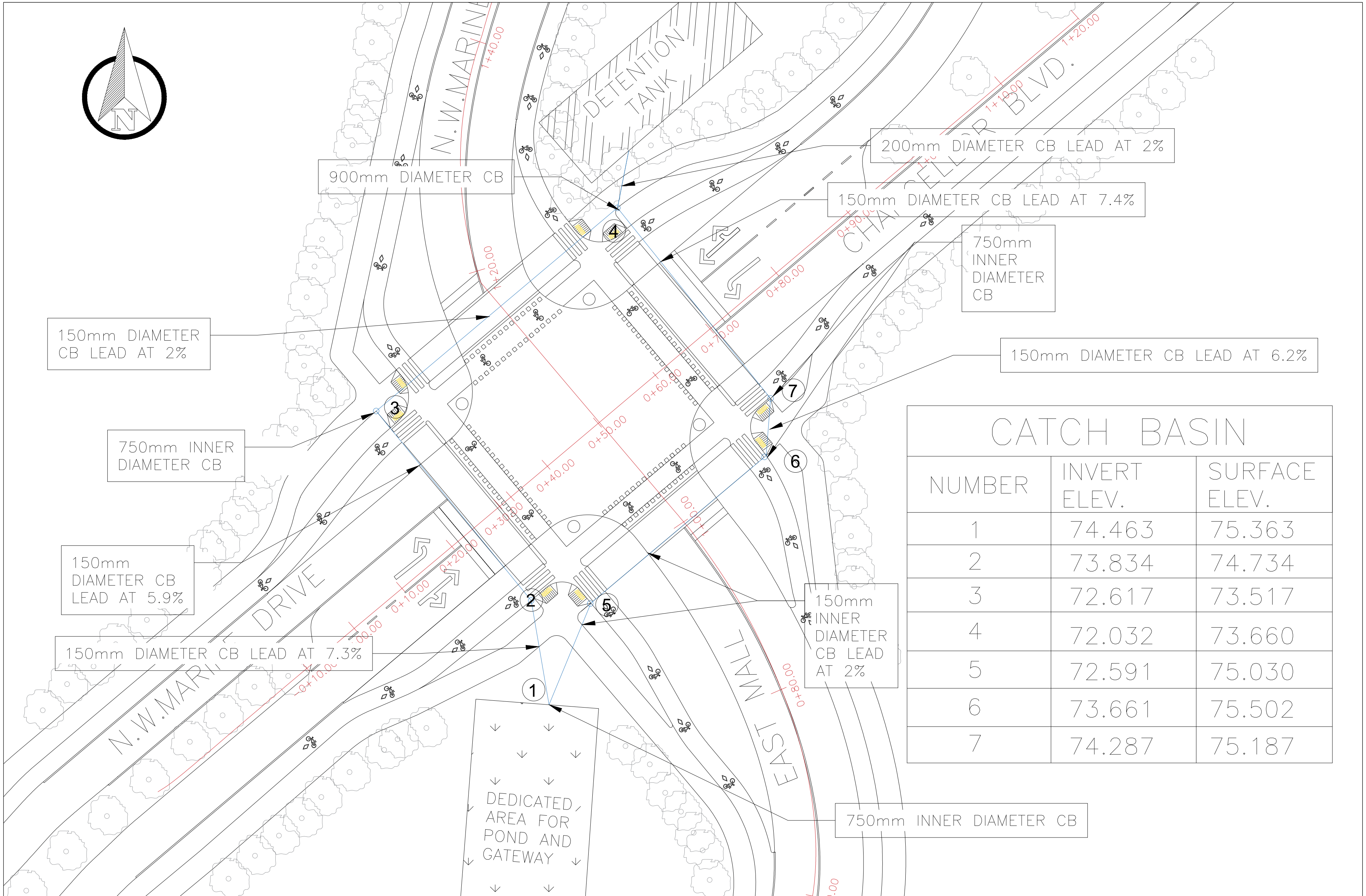
PACIFIC PATHWAY CONSULTING LTD.

NOTES:

TIE–IN TO EXISTING INFRASSTRUCTURE

REV.	DESCRIPTION	DATE
1		04/07/2025

THE UNIVERSITY OF BRITISH COLUMBIA SEEDS



CATCH BASIN		
NUMBER	INVERT ELEV.	SURFACE ELEV.
1	74.463	75.363
2	73.834	74.734
3	72.617	73.517
4	72.032	73.660
5	72.591	75.030
6	73.661	75.502
7	74.287	75.187

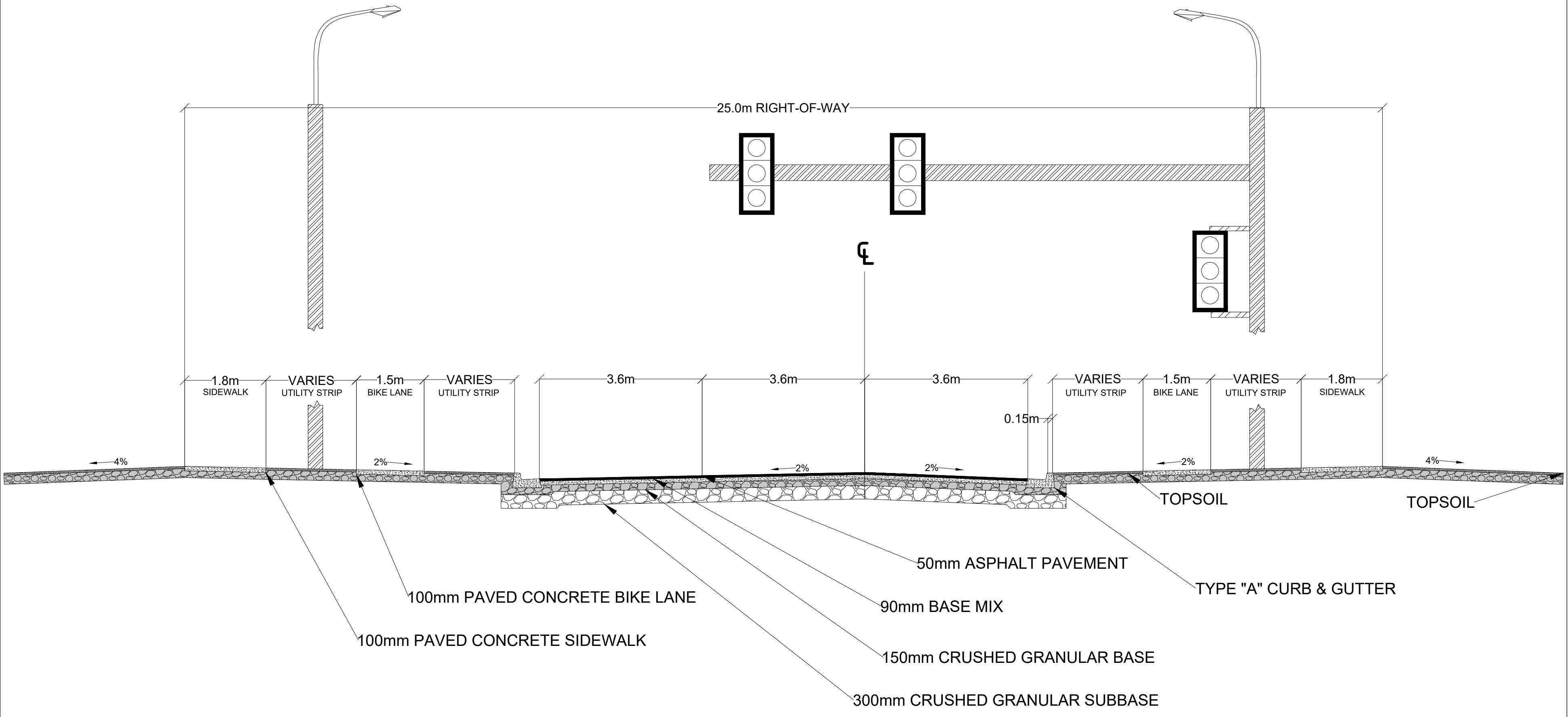
PACIFIC PATHWAY CONSULTING LTD.

NOTES:
- SCALE: N.T.S.
- ISSUED FOR CONSTRUCTION.
- ALL UNITS ARE IN METERS UNLESS STATED OTHERWISE.
- LOCATION OF GATEWAY AND DETENTION TANK SHOULD BE LOCATED BASED ON DRAWING UNLESS LIMITED BY SURFACE CONDITIONS

STORM WATER PLAN AND LOCATION OF GATEWAY

REV.	DESCRIPTION	DATE
1		04/07/2025

THE UNIVERSITY OF BRITISH COLUMBIA SEEDS



PACIFIC PATHWAY CONSULTING LTD.

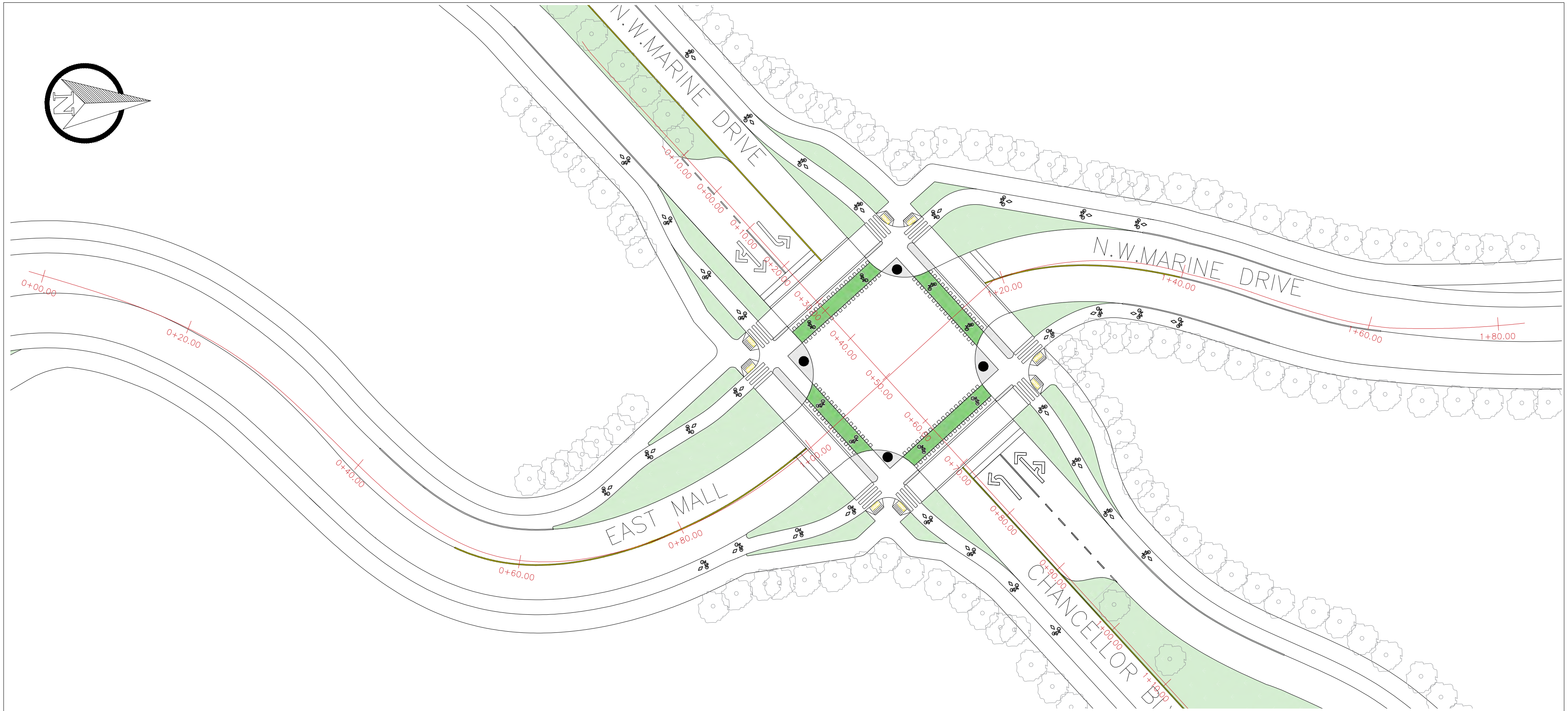
NOTES:

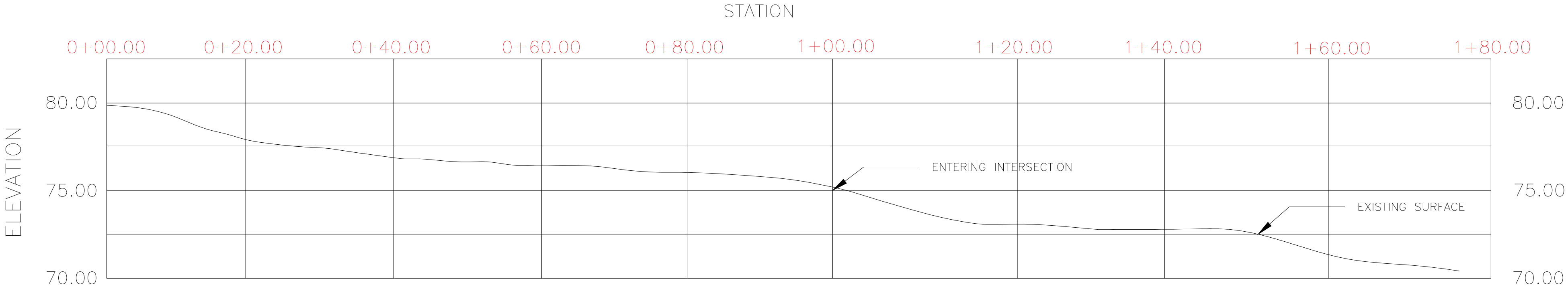
SCALE: NTS

TYPICAL CROSS-SECTION

REV.	DESCRIPTION	DATE
1		4/7/2025

THE UNIVERSITY OF BRITISH COLUMBIA SEEDS





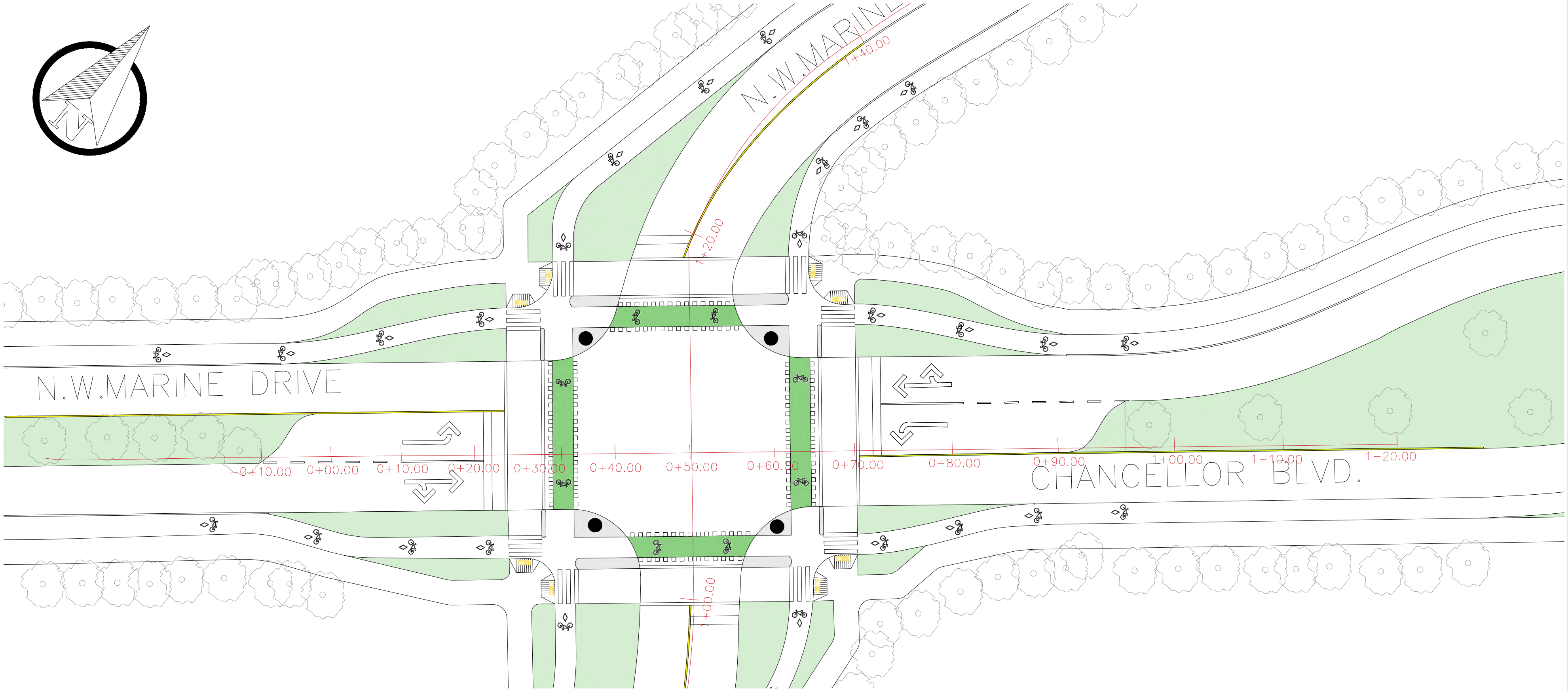
PACIFIC PATHWAY CONSULTING LTD.

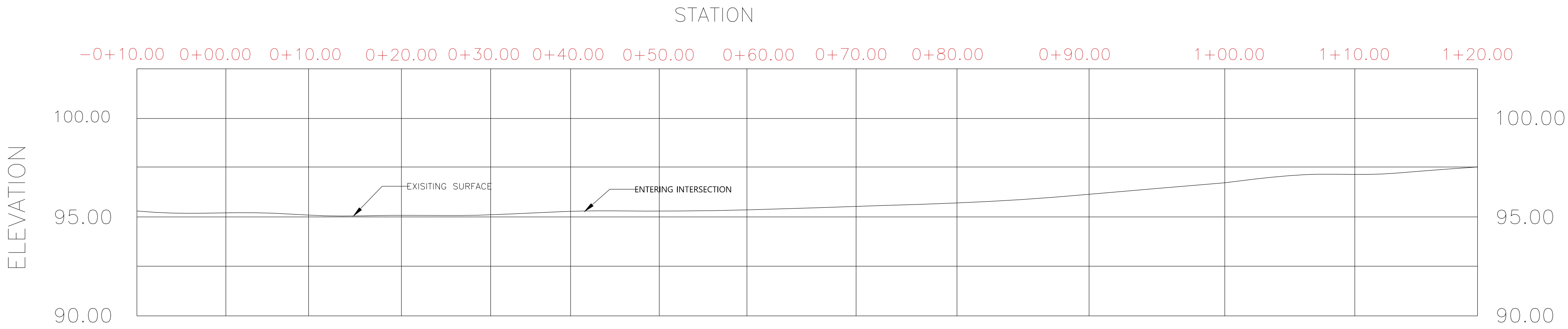
NOTES:
- SCALE: N.T.S.
- ISSUED FOR CONSTRUCTION.
- ALL UNITS ARE IN METERS UNLESS STATED OTHERWISE.
- FILL AND CUT AS NECESSARY DURING PAVEMENT TO ENSURE SMOOTH TRANSITION AND WITHIN A GRADE OF 1%

PROFILE VIEW OF EAST MALL AND N.W. MARINE DRIVE

REV.	DESCRIPTION	DATE
1		04/07/2025

THE UNIVERSITY OF BRITISH COLUMBIA SEEDS





PACIFIC PATHWAY CONSULTING LTD.

NOTES:
- SCALE: N.T.S.
- ISSUED FOR CONSTRUCTION.
- ALL UNITS ARE IN METERS UNLESS STATED OTHERWISE.
- FILL AND CUT AS NECESSARY DURING PAVEMENT TO ENSURE SMOOTH TRANSITION AND WITHIN A GRADE OF 1%

PROFILE VIEW OF N.W. MARINE DRIVE AND CHANCELLOR BLVD.

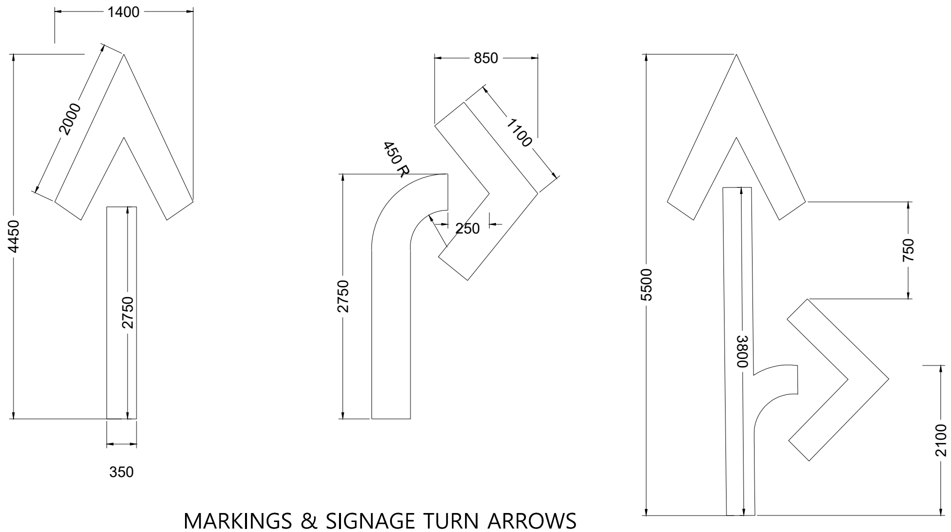
REV.	DESCRIPTION	DATE
1		04/07/2025

THE UNIVERSITY OF BRITISH COLUMBIA SEEDS

INSTALLATION OF PAVEMENT MARKINGS

TYPE	LINE DIMENSIONS (mm)	COLOR	
		WHITE	YELLOW
SOLID	100	1. EDGELINES ON THE RIGHT 2. LANE LINES PROHIBITING LANE CHANGES	1. EDGELINES ON THE LEFT 2. DIRECTIONAL DIVIDING LINES
BROKEN	100; 3.0m; 6.0m; 3.0m	1. LANE LINES	1. DIRECTIONAL DIVIDING LINES
SHORT BROKEN	100; 1.0m; 1.0m	1. CONTINUITY LINES IN MERGING AND DIVERGING AREAS 2. LEFT TURN BAYS	
DENSE BROKEN	100; 0.5m; 0.5m	1. GUIDELINES FOR INTERSECTION MOVEMENTS	1. GUIDELINES FOR INTERSECTION MOVEMENT
STOP	300	1. STOP LINES	
CROSSWALK	200	1. CROSSWALKS	
ELEPHANT'S FEET	300; 300; 300	1. BIKE CROSSINGS	

NOTE:
1. ALL DIMENSIONS IN MILLIMETERS UNLESS STATED OTHERWISE



MARKINGS & SIGNAGE TURN ARROWS

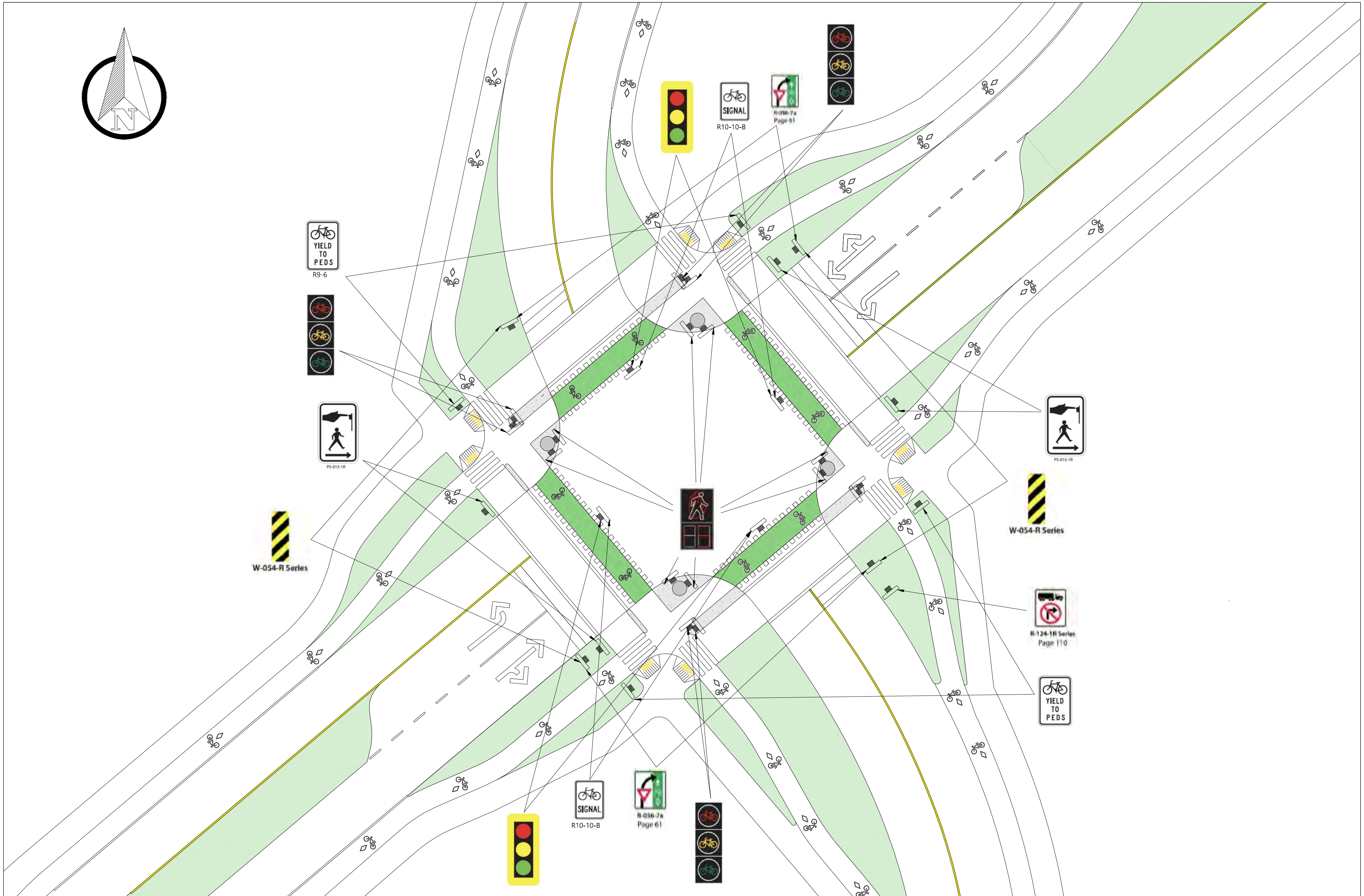
PACIFIC PATHWAY CONSULTING LTD.

NOTES:
- ISSUED FOR CONSTRUCTION
- SCALE: N.T.S

PAVEMENT MARKINGS AND SIGNAGE TURN ARROWS

REV.	DESCRIPTION	DATE
1		04/07/2025

THE UNIVERSITY OF BRITISH COLUMBIA SEEDS



PACIFIC PATHWAY CONSULTING LTD.

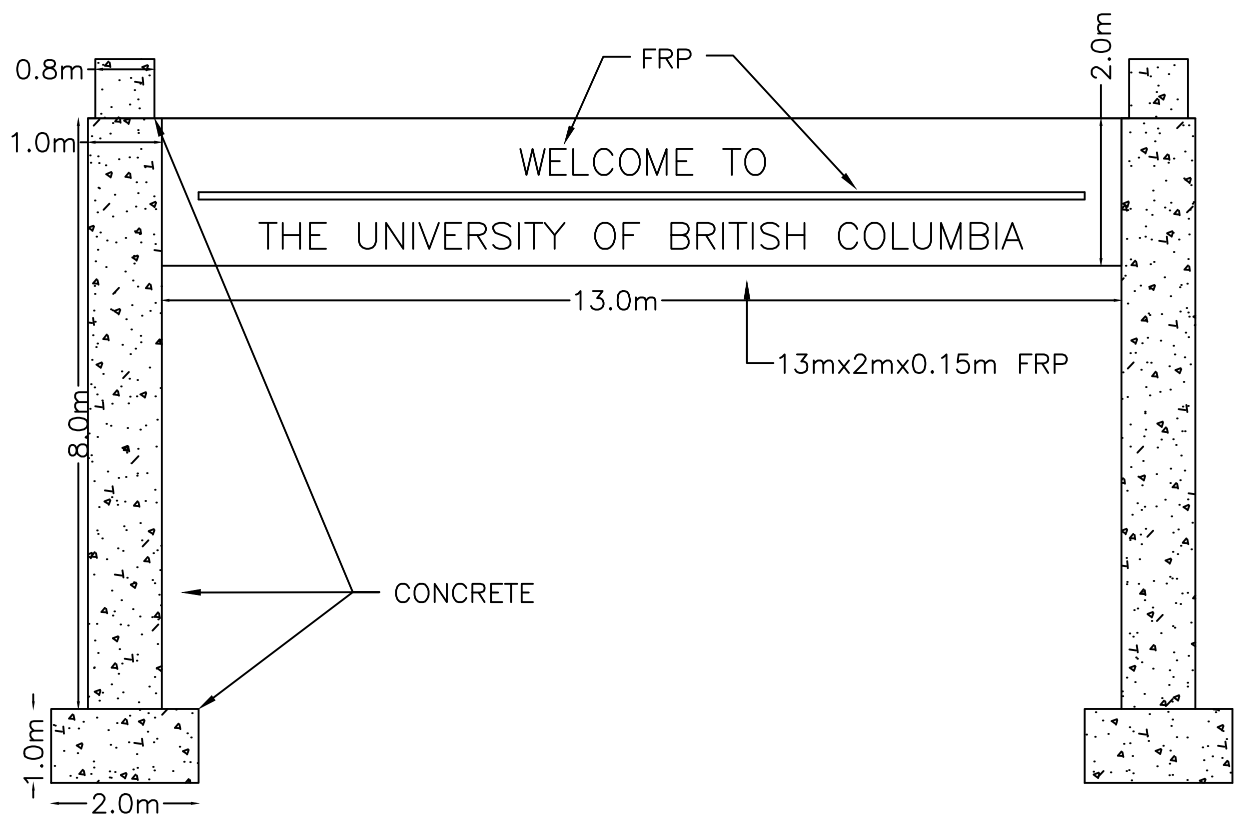
NOTES:

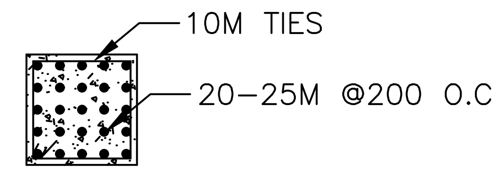
- ISSUED FOR CONSTRUCTION
- SCALE: N.T.S

SIGNAGE AND SIGNALS PLAN

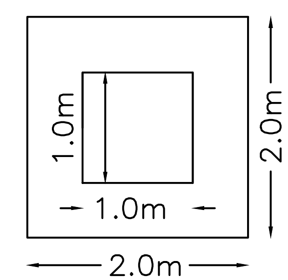
REV.	DESCRIPTION	DATE
1		04/07/2025

THE UNIVERSITY OF BRITISH COLUMBIA SEEDS

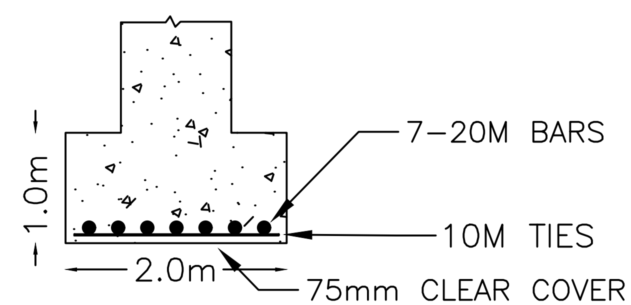




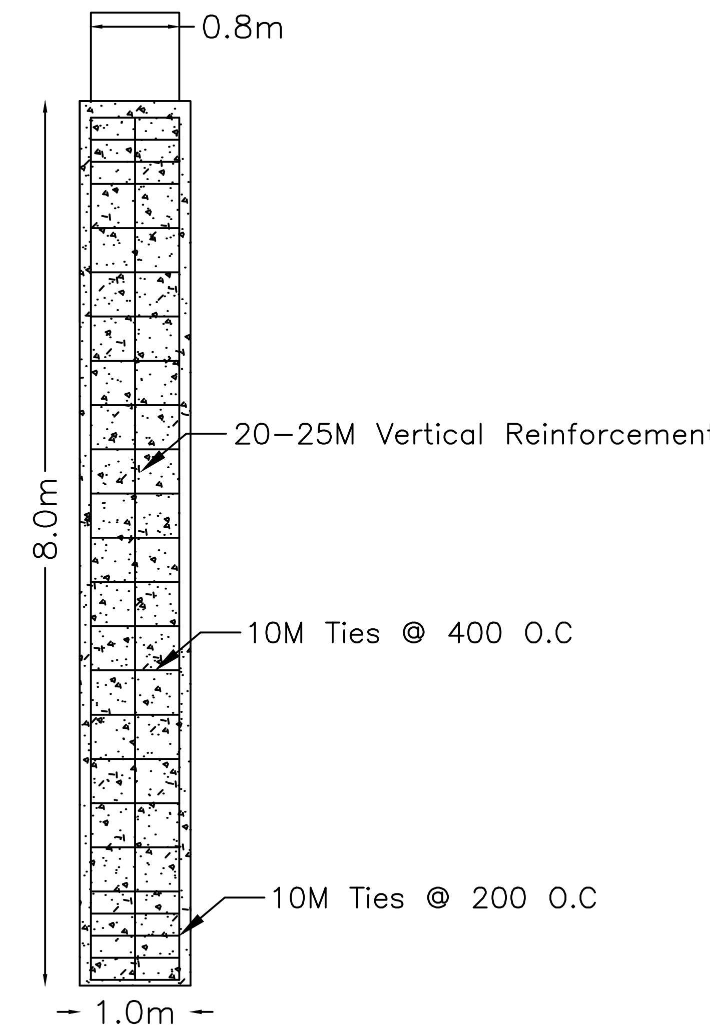
COLUMN DETAILS
(PLAN VIEW)



FOUNDATION DETAILS
(PLAN VIEW)



FOUNDATION DETAILS
(ELEVATION VIEW)



COLUMN DETAILS
(ELEVATION VIEW)

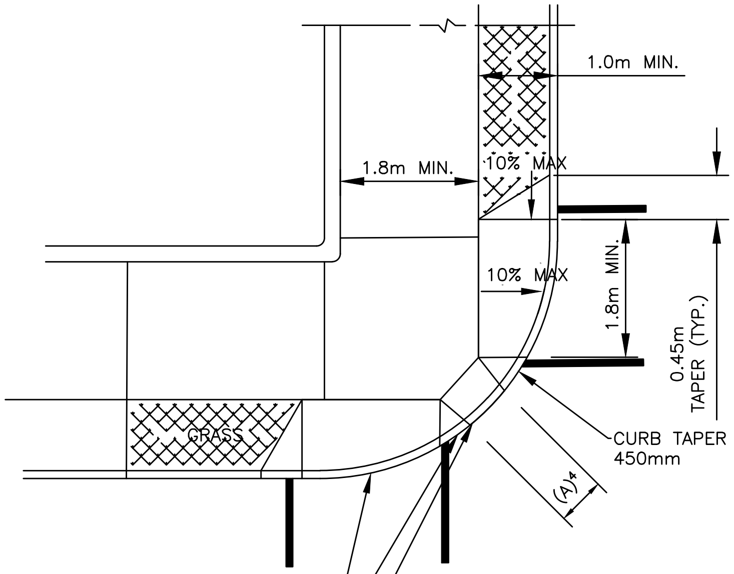
PACIFIC PATHWAY CONSULTING LTD.

NOTES:

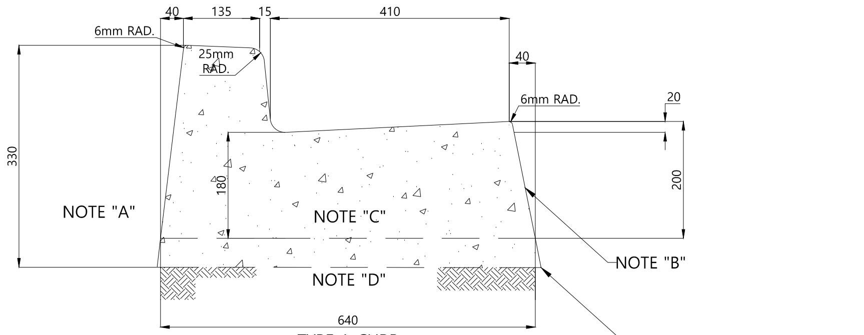
STRUCTURAL DETAILS

REV.	DESCRIPTION	DATE

THE UNIVERSITY OF BRITISH COLUMBIA C+CP



PERPENDICULAR CURB RAMP

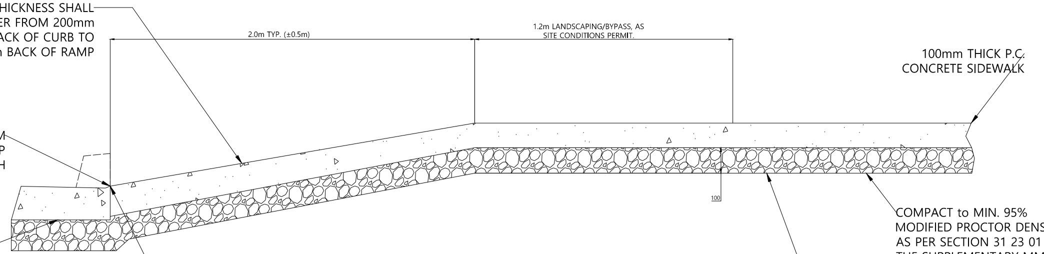


TYPE A CURB
(EXTRUDED)

NOTE "A" FOR DETAILS, SEE DWG C6.1.
NOTE "B" WHERE P.C. CONCRETE PAVEMENT BASE IS USED, CURB CONSTRUCTION SHALL BE AS SHOWN ON DWG C6.2.
NOTE "C" CONTROL JOINTS CUT AT 4.5m INTERVALS (MIN. 50 mm DEPTH).
NOTE "D" PLACE A MINIMUM OF 150mm APPROVED GRANULAR BASE AT 95% MPD (19mm MINUS CRUSHED GRANULAR). EXCAVATE 1.2m WIDE FOR CURB & GUTTER

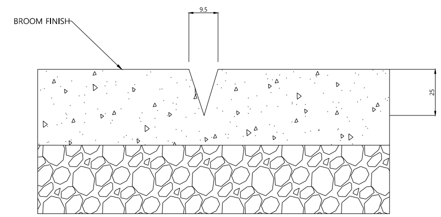
USE ONLY CITY APPROVED MIN. 32 MPa CONCRETE MIX

NOTE:
1. ALL DIMENSIONS IN MILLIMETERS UNLESS STATED OTHERWISE



CURB RAMP

NOTES:
1. STANDARD RAMP LENGTH: 2.0m TYP, (±) AT CENTRE OF RAMP.
2. RECOMMENDED RAMP SLOPE: 7.1% ± 1.2%.
3. MAX, SLOPE 8.3% (1:12) WHERE TOPOGRAPHY PERMITS
4. ADJUST LENGTH OF RAMP AS REQUIRED
5. WHEN SITE CONDITIONS DO NOT PERMIT TYPICAL LAYOUT, CONTACT CITY ENGINEER FOR APPROVAL OF DESIGN
6. ALL DIMENSIONS IN MILLIMETERS UNLESS STATED OTHERWISE



TYPICAL TROWEL SCORE MARK DETAIL

PACIFIC PATHWAY CONSULTING LTD.	NOTES: - DRAWING SCALE: N.T.S - ISSUED FOR CONSTRUCTION	STANDARD DESIGN DETAILS	REV.	DESCRIPTION	DATE	THE UNIVERSITY OF BRITISH COLUMBIA SEEDS
			1		04/07/2025	