UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Chancellor Boulevard / East Mall Intersection Redesign

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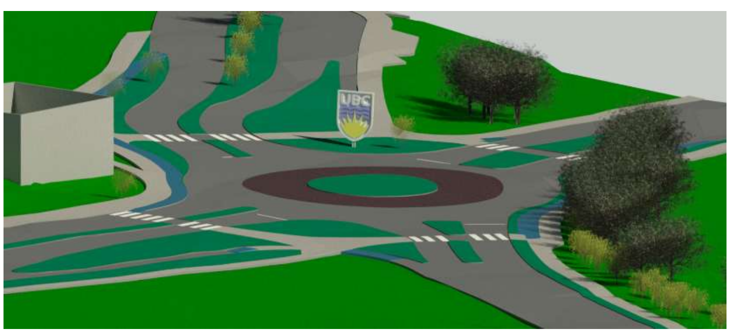
Executive Summary

The redesign of the **Chancellor Boulevard, East Mall, and NW Marine Drive intersection** addresses critical issues of safety, functionality, and environmental sustainability at a key gateway to UBC's Point Grey campus. As its present configuration features highway-style design elements, the intersection prioritizes vehicular traffic and compromises safety, usability, and environmental integrity, requiring a transformative approach to meet the evolving needs of the campus and its surrounding community.

To achieve these objectives, three conceptual designs were evaluated: a four-way signalized intersection, a single-lane roundabout, and an extended roundabout. These designs were evaluated based on the **key project objectives** as follows: **prioritizing active travel modes, reducing vehicle travel speeds, providing a gateway to the UBC neighborhood,** and **retaining all rainwater on site** for up to a 100-year storm event.

The **preferred design** replaces the existing intersection with a **single-lane roundabout.** It leverages its geometry to reduce vehicle speeds, minimizes conflict points to improve safety, and provides a central location for the inclusion of a representative gateway to UBC. Additionally, the proposed design incorporates stormwater management solutions with the capacity to contain a 100-year storm event on site, ensuring environmental sustainability by mitigating cliff erosion augmented by inadequate water retention. Furthermore, the design emphasizes active transportation, with dedicated spaces for pedestrians and cyclists integrated throughout the intersection layout.

This final design report outlines the intersection design objectives and considerations, the rationale for the preferred design, the assumed final cost and scheduling for the design, and the proposed next steps in transitioning to the construction phase. The proposed redesign aligns with UBC's vision for **safety, sustainability, and community-focused development.**



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1. Introduction

1.1 Project Background and Site Description

The intersection of Chancellor Boulevard, East Mall, and NW Marine Drive serves as a secondary gateway to UBC's Point Grey campus. The current intersection is ill suited to accommodate the active transportation needs of a growing campus, as it was designed with highway-style elements due to a planned ferry terminal that never materialized. As such, the intersection prioritizes vehicular traffic, leading to safety concerns for pedestrians, cyclists, and other active transportation users. Additionally, insufficient stormwater management has exacerbated environmental issues surrounding the site, such as the erosion of the nearby cliffs.

This project aims to redesign the intersection to prioritize active travel modes, reduce vehicle travel speeds, provide a gateway to the UBC neighborhood, and retain all rainwater on site for a 100-year storm event. This was achieved while following the current BC Ministry of Transportation and Infrastructure (MoTI) design requirements. The proposed redesign addresses these key design objectives while reflecting the campus' commitment to safety, connectivity, and environmental responsibility.

1.2 Key Issues and Design Objectives

The main objective for our design process is to provide an updated design that meets the current BC Ministry of Transportation and Infrastructure design requirements for the intersection at Chancellor Boulevard, East Mall, and NW Marine Drive.

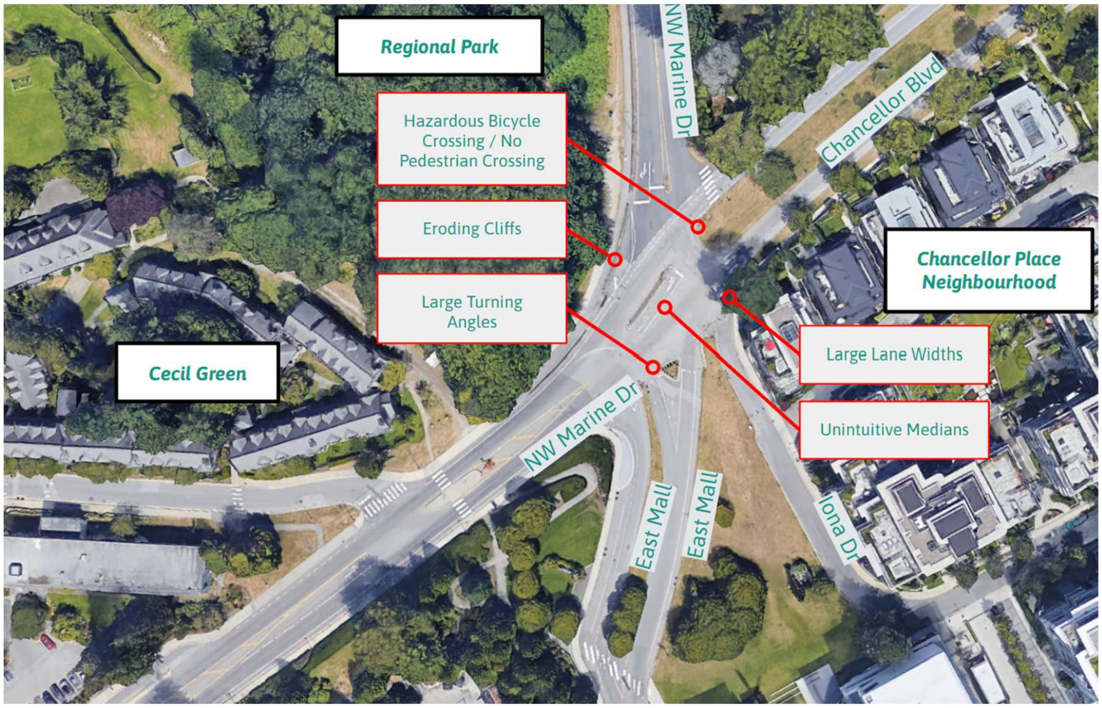


Figure 1: Summary of Key Issues

The existing intersection, shown in Figure 1, faces several key challenges that compromise safety, functionality, and sustainability. Its unconventional configuration and large size creates confusing navigation and ambiguous right-of-way situations, which increase the likelihood of collisions. Wide travel lanes encourage high vehicle speeds, leading to a higher probability of speeding-related accidents. Poorly placed pedestrian crossings and the lack of dedicated cycling infrastructure exacerbate these issues, creating hazards for non-motorized users, such as unsafe crossing conditions and the need to navigate through high-speed traffic. Designed to prioritize vehicular traffic, the intersection no longer supports the needs of a growing UBC campus and its surrounding neighborhoods, such as Cecil Green and Chancellor Place.

The redesign will prioritize the needs of active transportation users by providing safer and more intuitive infrastructure for walking and cycling. In addition, various measures to reduce vehicle speeds will be added to improve safety for all road users. The project will also incorporate a gateway feature, with a minimum height of eight meters, to enhance the feeling of arrival and sense of community at UBC.

Another key objective for the project is the inclusion of a rainwater retention system to fulfill the needs of the expanded rainwater catchment area for the redesigned intersection. The system will retain and reuse all rainwater on site for up to a 100-year storm event, addressing the ongoing erosion of the cliffs in the regional park adjacent to the intersection.

Given that the new intersection design may require a different footprint, the preservation of existing trees and vegetation will be prioritized. Where removal is unavoidable, replanting efforts will focus on selecting native, drought-resistant, and low-maintenance plant species to promote environmental integrity.

2. Site and Project Overview

2.1 Site Constraints and Opportunities

One of the most significant constraints at the Chancellor Boulevard, East Mall, and NW Marine Drive intersection is the ongoing erosion of the cliffs within the regional park located northwest of the site. Insufficient stormwater management has exacerbated this issue, and any redesign must incorporate a robust stormwater retention system capable of managing a 100-year storm event to mitigate further erosion. Additionally, the natural flow paths in the surrounding area present a challenge, as they may conflict with the proposed stormwater management systems, requiring innovative solutions to balance hydrological needs.

Another key constraint involves minimizing traffic disruptions during the construction phase. The intersection serves as a critical gateway to UBC as it experiences substantial daily traffic volumes, including transit buses, private vehicles, and active transportation users. Prolonged disruption could significantly impact campus operations and the surrounding neighborhoods. This necessitates a construction plan that carefully phases work to maximize accessibility for all user groups while ensuring safety throughout the project.

Timely project completion is also a critical consideration, given the intersection's importance to UBC and its role in supporting the Campus Vision 2050 goals. Delays could hinder broader campus initiatives and prolong the challenges posed by the current intersection configuration. Efficient coordination between contractors, stakeholders, and project managers will be essential to achieving timely results while addressing the complex constraints of the site.

Despite these challenges, the project presents several opportunities. Incorporating a state-of-the-art stormwater management system will not only mitigate environmental risks but also demonstrate UBC’s commitment to sustainable infrastructure. Additionally, optimizing the intersection's geometry will improve long-term safety and functionality for all users, enhancing the site’s value as a key gateway to the campus.

2.2 Current Intersection Observations and Demand

Figure 2: Site Visit Photos

On October 9th, 2024, a site visit was conducted to view the current site conditions and gather data. Traffic data was collected at the Chancellor Boulevard, East Mall, and NW Marine Drive intersection, providing insights into its current usage for different types of transportation. The intersection experiences substantial vehicular activity during peak hours, with approximately 500 vehicles observed per hour in both the morning and evening periods. Trucks constituted a small but notable portion of this traffic, primarily travelling on the major road from through movements, or right turns from NW Marine Drive. These high volumes show the intersection's importance as a key gateway to UBC and its surrounding neighborhoods. See Appendix C for a full table of traffic flow observations.

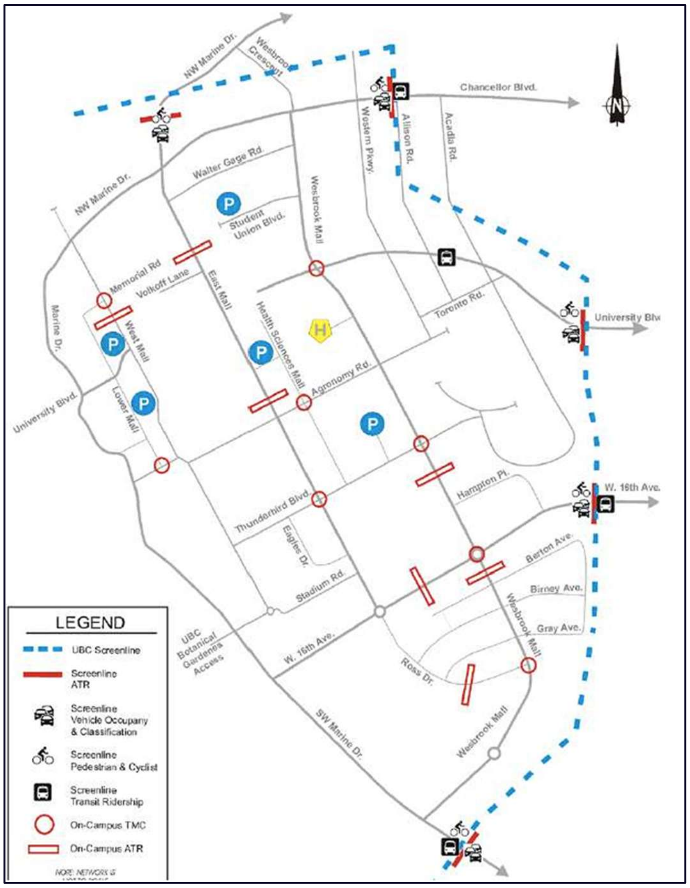
Pedestrian and cyclist activity was also recorded, reflecting the growing use of active transportation in the area. Pedestrian crossings were frequent, particularly along the northern and eastern sides of the intersection. However, the only marked crosswalk nearby is on the east side of the intersections. Pedestrian movements while crossing the north and south sides of the intersection were undesirable for pedestrians, and crossing on the west side of the intersection was notably unsafe. Cyclists were observed to travel in all directions but faced challenges due to the absence of dedicated cycling infrastructure, and the need to navigate busy vehicle lanes. The implementation of dedicated crossings and enhanced signage would increase safety and comfort while effectively guiding all road users.

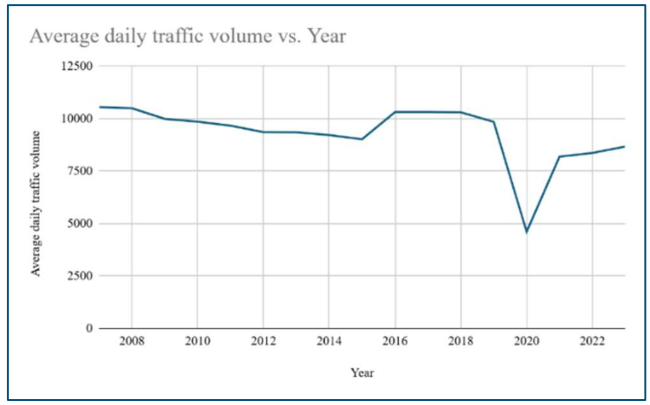
The data highlights the intersection's role in managing high multimodal demand, serving commuters, residents, and UBC campus visitors. While the vehicular traffic dominates overall volumes, the presence of active transportation users further emphasizes the need for a redesign that accommodates all modes of travel. Addressing these current demands is critical to improving safety, efficiency, and accessibility at this vital access point to the campus.

2.3 Future Design Capacity Year and Rationale

In 2007, UBC began tracking traffic data at the NW Marine Drive, Chancellor Boulevard and East Mall intersection. Figure 3 below shows the area in which data was collected. The screen line, denoted by the dashed is the location where volume of cars travelling through is collected.

Historical traffic data, shown in Figure 4, was collected by Creative Transportation Solutions Ltd. Their reports contain the average daily traffic volume (ADTV) for major intersections around UBC. The ADTV data for Chancellor Boulevard was selected as the traffic input for the final intersection design, as it is the closest approximation for the intersection of NW Marine Drive, Chancellor Boulevard and East Mall. As the location of the screen line is a significant distance from the intersection, the ADTV may be slightly different as cars enter the smaller roads that connect to Chancellor Drive. To ensure the final intersection design accurately accounts for the discrepancy, a factor of 0.85 was applied to the traffic counts as a way of accounting for the slight drop in vehicle traffic.





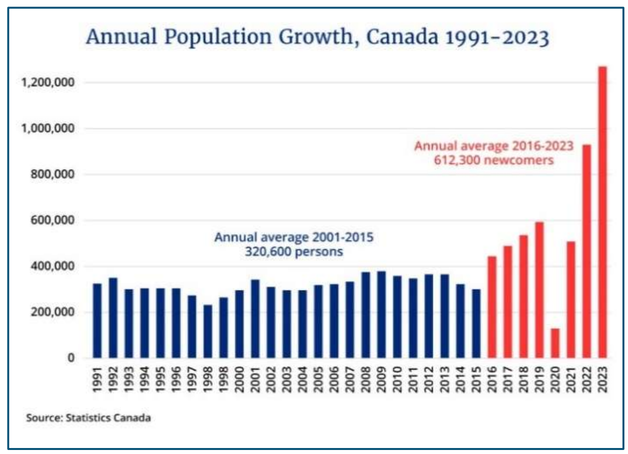


Figure 3, 4, and 5: Traffic Data Collection Locations (left), Historical Traffic Volumes (top right), and Annual Population Growth (bottom right) Graphs

As shown in Figure 4, the intersection experienced a steady decline in the ADTV until 2016. This slow decline in average traffic volume can be attributed to UBC's initiative to prioritize multimodal transportation. Beginning in 1997, this initiative promoted transportation modes that would reduce the traffic volume, like carpooling and public transportation. In 2016, a sharp increase of users is present within the ADTV, which can be attributed to a general population increase in Vancouver, Canada as seen in Figure 5. The drastic plumet in ADTV at the intersection in 2020 is due to the Covid-19 lockdown. Currently, there is a gradual increase back to the travel patterns before the lockdown. As this trend is a new development, it is difficult to ensure an accurate estimate of the future ADTV. However, with the initiation of Campus Vision 2050 in late

2021, an upward trend in the ADTV is expected to occur. Due to the continual increase in the general population, and aforementioned Campus Vision 2050 expansion, there is reason to believe that there will be a significant increase in activity at UBC. However, a reduction in the ADTV in the future is expected due to the extension of the Millennium line Skytrain towards UBC.

Taking these factors into account, a model was created to predicts future demand. Using the previous ADTV data from UBC's annual Transportation Progress Reports, an estimate of the uniform rate of increase in vehicular traffic was calculated. Through these calculations, the increase in demand was projected to be about 200 vehicles per year which equates to a uniform rate of 2.4% per year. This rate of increase is a conservative estimate to ensure the final design meets the requirements for a design year of 2050. At the 2050 design year, the ADTV was projected to be approximately 15,000 at this intersection. This can mitigate a potential demand spike like the one that occurred in 2016.

2.4 Geotechnical Analysis

The 2002 report from Piteau Associates regarding the hydrogeological and geotechnical assessment of the area surrounding the intersection concluded that the de-watering wells currently in place are effective at reducing the erosion of the cliffs at UBC. The report states that water which infiltrates into the ground travels through the till on the surface to the upper aquifer and then to the lower aquifer. During this process, a small portion of the water would be discharged from the upper aquifer and would potentially cause local slope instability. On the other hand, most of the water would be discharged from the lower aquifer with no observable adverse effects. The dewatering wells that are currently in use divert the discharge in the upper aquifer towards the lower aquifer and thus prevent the discharge from affecting the cliff's face.

The report notes that the NW Marine Drive and Chancellor Boulevard intersection is in a specific area called Graham's Gully. According to the report, this area behaves like a "drain" and distorts the natural flow pattern in the upper aquifer layer. Although the "drain" flows towards the cliffs, it does not cause slope instability directly. However, the piping in the area could freeze during the winter which causes pore water pressure to accumulate in the surrounding soil. When the pipes thaw, the sudden release of water may lead to slope instability. With the restriction of being unable to dispel the stormwater to the existing storm sewer system until a later time and the requirement to retain all rainwater on site, a stormwater management system will need to be created from scratch in order to satisfy the geotechnical requirements.

The report provides little information when it comes to geotechnical analysis and recommendations for new construction within the area. It only states that the first 5 meters from the surface is till. The final design was made with the assumption that the material beneath the till consists entirely of sand. Therefore, for most of the construction area, a 95% dry density compaction specification is recommended for the in-situ soil. In specific areas with concentrated loads such as the water detention tank or the UBC sign, a 98% dry density compaction specification for the in-situ soil is recommended.

2.5 Stakeholder Analysis

Before starting the design process for the project, the rights holders and stakeholders were identified for the project in order to achieve a better understanding and definition of the project objectives regarding its users, owners, and decision makers. Stakeholders were split into three categories: rightsholders, major stakeholders, and minor stakeholders to better organize and prioritize engagement activities.

Table 1: Stakeholder Table

Stakeholder Name or Group	Role
Rights Holders	
Chan Centre	Adjacent facility with high pedestrian activity.
First Nations Tribe (Musqueam Indian Band)	Rights holder, landowner, and cultural advisor.
UBC Board of Governors	Owner, Funder, and Decision-Maker.
UBC Senate	Long-term planning and policy guidance.
UBC Campus and Community Planning	Owner, Decision-Maker, and project coordinator.
UBC Transportation Committee	Decision-Maker for transportation policies.
University Endowment Lands Administration	Owner and Decision-Maker for land use.
Major Stakeholders	
Neighboring Residents	Adjacent community affected by traffic and noise.
TransLink	Transit operator and stakeholder in multimodal design.
UBC Building Operations & Facilities Management	Long-term maintainer and operations coordinator.
BC MOTI	Owner and Regulator for design standards.
Minor Stakeholders	
General Public & Event Demands	User group affected by intersection accessibility.
Metro Vancouver	Regional environmental and planner advisor.
Utility Operators	Providers of essential services, impacted by construction.
UBC Students & AMS	Key user group and representatives of campus.

3. Conceptual Design Process

3.1 Considered Designs

After considering the site's constraints and project objectives stated in Section 1.2, an initial brainstorming session was carried out to explore the feasibility of various intersection designs within the space allotted. Active transportation design considerations were incorporated for select intersection designs during this phase. Although, many multimodal design considerations were completed at a later stage of the design process.

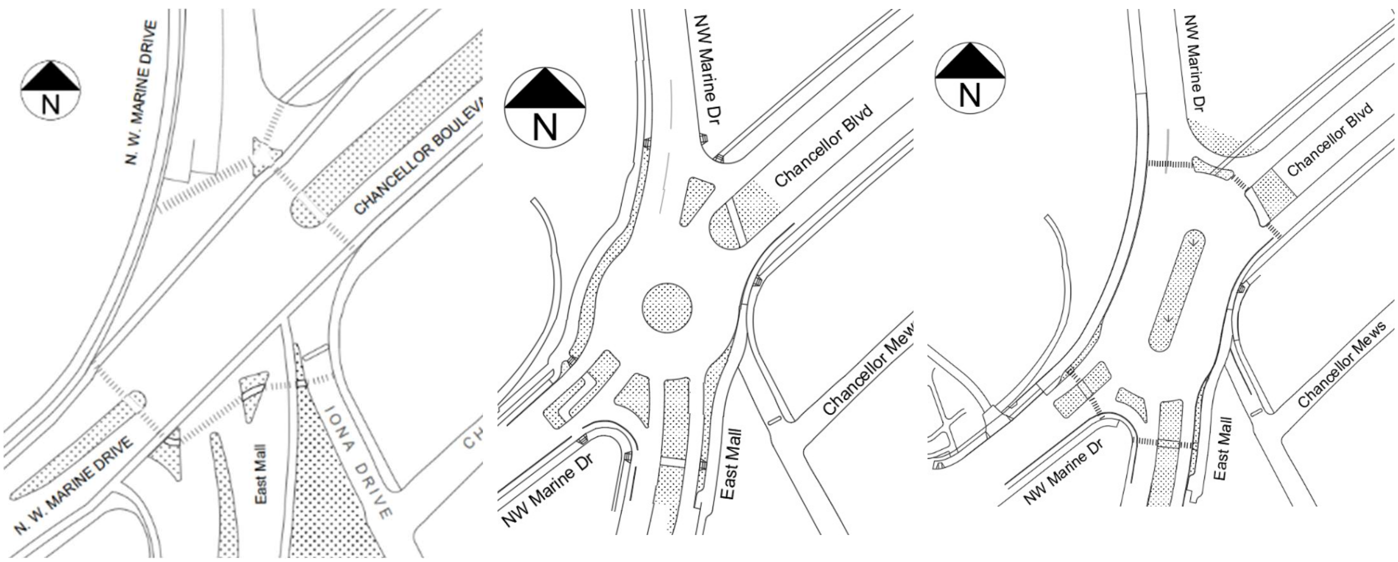


Figure 6: Conceptual Intersection Designs

The top three initial designs/sketches were selected to be further developed into conceptual designs and evaluated using a Weighted Design Matrix (WDM) in order to select the preferred design. The initial designs chosen consists of a 4-way signalized intersection, a roundabout and a figure eight design, as shown in Figure 6. During the conceptual design phase, the designs were refined with a particular focus on elements that improve pedestrian safety, speed reduction, and multimodal integration. Additional details added during this stage include bike lanes and multimodal integration, lane widths, roundabout diameters, and sidewalks. Moreover, cost estimates and a rudimentary level of service (LOS) analysis were prepared for each design during this phase.

To determine the preferred conceptual design, a Weighted Design Matrix (WDM) was utilized to assess each intersection design against key objectives from clients and additional objectives aligning with stakeholder values. Throught this analysis the roundabout was found to be the most beneficial.

Table 2: Weighted Design Matrix

Factors	Weight	Signalized Intersection	Roundabout	Extended Roundabout
Driver Speed Reduction	x8	6	9	7
Multimodal Clarity & Integration	x8	8	6	5
Gateway Ability - Intersection	x4	6	8	7
Water Management Ability & Environmental Concerns	x7	9	8	7
Construction & Operation Costs	x4	6	6	4
Overall Safety Increase	x6	7	9	6
Future Demand Capabilities	x3	9	8	8
Weighted Totals	x40	7.3	7.9	6.3

3.2 Overview of Selected Design

The roundabout scored the highest for driver speed reduction as its geometry guides drivers to slow down before entering, unlike a signalized intersection, where drivers may speed up at a yellow light. However, the signalized intersection excelled in the multimodal integration criteria, as it allows for the pedestrian crossings and bike lanes to be placed directly at the intersection. In contrast, both roundabout designs place crossings further away due to sight line considerations and require cyclists to stop and use the pedestrian crosswalks and multi-use paths to maneuver around the north side of the roundabout. For overall safety, the roundabout outperformed the signalized intersection due to its speed reduction measures and fewer conflict points between pedestrians and drivers, which will result in less accidents. On the other hand, the extended roundabout received a comparatively low score as its unique design may cause confusion and accidents for drivers.

For the gateway ability category, the roundabout scored the highest because it allows for the gateway sign to be placed at the center of the intersection. In comparison, the signalized intersection requires the sign to be placed off-center or outside the intersection, reducing visibility. The roundabout also doesn't require signalized traffic lights, allowing users within the intersection to focus more on the signage.

The scores for water management capability and environmental considerations were primarily influence by the anticipated catchment area of each design. A larger paved area would result in greater volumes of rainwater to manage. Consequently, the signalized intersection design received the highest score in this category, followed by the single-lane roundabout, which has a relatively smaller pavement area.

In summary, as shown in the above WDM, the roundabout was selected as the preferred design due to its high scores in driver speed reduction, gateway ability and overall safety increase aligning with the key design objectives.

4. Key Design Considerations

4.1 Technical

As stated previously in Section 1.2, the team's main objective is to provide an updated intersection design that improves safety and usability for all users while also meeting the current BC MoTI guideline. Priority will continue to be placed on active modes of transportation, while ensuring the new intersection design allows for accommodation of large trucks and emergency vehicles and future traffic needs. Some key issues with the current intersection the design is intended to resolve include:

- Unintuitive layout which causes confusion for users.
- Undesirable locations of pedestrian crossings.
- Large lane widths and highway style roads enabling high travel speeds, particularly on Chancellor Boulevard.
- Poor accommodation for the predicted rise in pedestrian and multimodal traffic.

4.2 Regulatory

When designing the intersection project, adherence to relevant guidelines and standards was essential to ensure functionality, safety, and compliance with best practices. The recommended intersection roadway design was informed by the requirements included in the 2020 British Columbia Ministry of Transportation and Infrastructure (BC MoTI) design guidelines, incorporating standards for road geometry, traffic control, and accessibility. Additionally, the final design follows the 2020 Transportation Association of Canada (TAC) Geometric Design Guide and BC's Active Transportation Design Guide, to emphasize safe and efficient multi-modal transportation and while incorporating provisions for pedestrians, cyclists, and transit users. With respect to pavement design, the Pavement Structure Design Guidelines Technical Circular T-01/05 (BC MoTI) was followed to meet design requirements while allowing for savings in construction cost and future applications of cost-effective rehabilitation strategies. For the design of the water management system, the chosen design adheres to the City of Vancouver's Engineering Design Manual's regulations, along with the 2022 Master Municipal Construction Document (MMCD) standards. Design of the gateway sign used the 2019 CSA A23.3:19 and 2024 CSA S16:24 standards to optimize the signage footing and connections against the maximum design loads calculated using the equations found in the 2024 National Building Code of Canada (NBCC) document. The use of these regulations ensures that the intersection, signage, and water management system meet safety and operational standards.

4.3 Environmental

A key environmental consideration when designing the intersection was to meet the project objective of retaining all rainwater on site for a 100-year storm event. Presently, based on previous analysis using LiDAR data obtained from the City of Vancouver, the area surrounding the intersection is graded such that the existing catch basins within the intersection receive stormwater runoff from the upstream areas of East Mall and Chancellor Boulevard. Therefore, if any catch basins are to be removed in the design, care must be taken to ensure that the stormwater retention system is sized to accommodate the runoff from catchment areas that may extend outside the proposed construction area.

Another key consideration when designing the stormwater retention system was to adhere to UBC's Integrated Stormwater Management Plan (ISMP). One of the three main goals presented in the ISMP is to reduce the flow of water off-campus through the construction of underground detention tanks, surface level dry/ephemeral ponds and green rainwater infrastructure such as bioswales, raingardens or rainwater tree trenches. The ISMP also notes that the intersection is a low point for UBC's north catchment storm sewer system and is currently modelled to experience significant flooding during a 100-year storm event. To mitigate the flooding and its accompanying erosive effects on the adjacent cliffs in the regional park and the Spanish Banks beaches, the ISMP recommends constructing a 1000 m^3 stormwater detention tank at the intersection to fully capture rainwater runoff at the site and offset surface flooding caused by the undersized storm sewer system located upstream of the intersection.

A third key consideration that relates to sizing the stormwater detention tank was that TAC recommends that highways should be designed for 1 in 200-year storm events. However, when considering the design lifecycle of the intersection, its urban setting, as well as the project objectives set forth by the client, it was determined that a system designed to manage a 100-year storm event was more appropriate.

An additional consideration was the impact of the new design on the existing vegetation. The final design minimized any changes to the existing vegetation, and any vegetation that is removed will be replanted.

4.4 Societal Aspects

When designing the intersection at UBC, key considerations were given to enhancing societal well-being by creating a space that fosters connection, safety, and inclusivity. The design prioritizes active transportation for all ages and ability levels through incorporating features such as pedestrian-friendly crosswalks, multi-use paths, and seamless connectivity for different transit options. These elements encourage walking, cycling, and other sustainable modes of transportation while reducing reliance on cars. UBC signage was also implemented into the intersection to better invoke a feeling on arrival. The signage is made of materials reflecting the university's past and its diverse cultural values. Engagement with stakeholders, including students, staff, residents, and Indigenous groups, ensured the final design reflected shared values and needs and promotes a sense of belonging and collaboration in the campus community.

The design process also prioritized stakeholder concerns while ensuring the project is delivered within an acceptable cost and timeline. Future maintenance, safety, efficiency, and traffic management during construction were key considerations, and integrated to meet stakeholder expectations effectively.

5. Detailed Intersection Design

5.1 Intersection Design Overview

Our final design, as shown in Figure 10, consists of a single lane roundabout. The asphalt lane will be 7.15m wide and circle a 12.25m diameter island, with an additional truck apron of 5.5m to be made of brick stamped concrete on the between the island and lane. The design also features additional curves on both the east mall and chancellor boulevard.

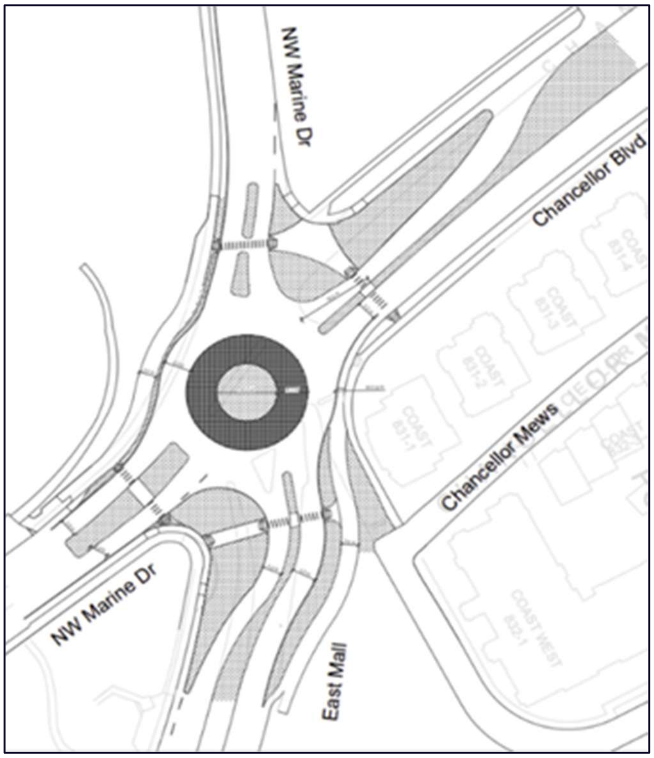


Figure 7: Proposed Intersection Design

The proposed design additionally excels at improving multimodal safety and connectivity by moving the pedestrian intersections closer to the intersection, adding an additional pedestrian intersection on NW Marine Drive and East Mall, and creating segregated pedestrian/bike lines on East Mall. Additionally, Pedestrian islands on Chancellor Blvd, NW Marine Drive (W), and East Mall have been included to increase pedestrian safety along the intersection.

In addition, a stormwater management system is in place to accommodate extreme weather events and a sign showing the UBC crest will be erected on the southwest corner of the intersection to ensure a sense of arrival at UBC within the gateway.

Figure 8: 3D Model of Intersection Design

5.2 Intersection Design's Key Components and Parameters

5.2.1 Geometric design elements

The roundabout features an outer diameter of 36 m and a central island of 12.2 m. A 6.1 m radius apron will be installed on the outside of the middle island, allowing for a lane width of 5.5 m to accommodate the larger turns of a WB-20 vehicle while maintaining a visually appropriate size for passenger vehicles. To prevent the roundabout from being mistaken as a double lane roundabout, the truck apron will have a surface layer of brick stamped concrete instead of asphalt. The apron radius, greater than the 2.0m required by TAC guidelines, is raised by 75mm to allow car wheels to roll over while maintaining vehicle control. The apron grading continues the 2% outward slope of the roundabout, ensuring seamless integration with the central island.

Following the BC Supplement to TAC Geometric Design Guide, the roundabout was designed to allow for the movement of a WB-20 vehicle so that large semi-truck and emergency vehicles can safely navigate the roundabout. However, restriction will apply to certain movements. Due to the nature of the horizontal deflection on East Mall, signage will be installed to prohibit large semi-trucks from entering. Similarly, signage will also be installed to prohibit semi-trucks from making the acute right turn from Chancellor Boulevard into NW Marine Drive, as the turning angle is incapable of supporting this movement. Signs will be installed around the roundabout to warn truck drivers.

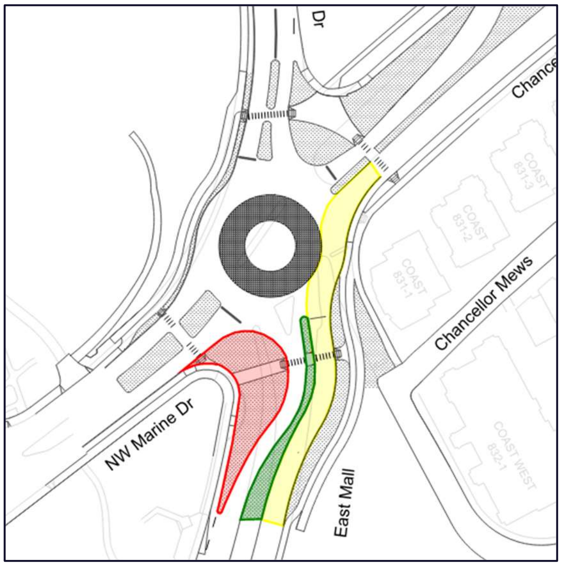


Figure 9: Speed Reduction and Traffic Calming Measures 1

Our new design incorporates several adjustments to enhance traffic calming, reduce speeds, and improve safety within the intersection. These changes were implemented by creating smoother approach angles and ensuring adequate spacing between roundabout entrances to promote controlled driving, which reduced sudden manoeuvres and improves the predictability of traffic flow for all road users. The connection from East Mall and Chancellor Boulevard to the roundabout, highlighted in yellow in Figure 11, now features a curved path designed to slow vehicles and promote safer navigation through the intersection. On Chancellor Boulevard, the incoming westbound lane will curve slightly inwards, acting as a traffic calming device as it adds horizontal deflection to the road. This design also provides adequate spacing between roundabout entrances, reducing congestion and improving flow.

An additional median island between the lanes on East Mall (highlighted in green in Figure 11) reduces lane widths, which encourages lower driver speeds and provides a safe rest area for pedestrians. The realignment of East Mall and NW Marine Drive addresses the previously acute intersection angle by extending the land area (highlighted in red) to create a smoother, more intuitive connection. This adjustment improves traffic flow and enhances safety for both vehicles and pedestrians.

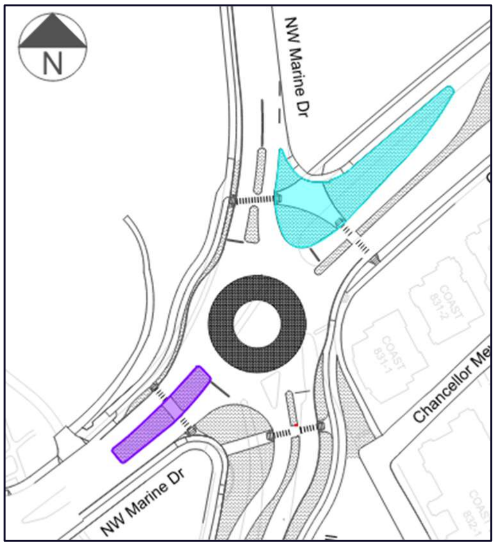


Figure 10: Speed Reduction and Traffic Calming Measures 2

On Chancellor Boulevard, the added curve introduces horizontal deflection, reducing vehicle speeds and mitigates the awkward reflex angle drivers previously faced without a dedicated right-turn lane. Vehicles entering the roundabout are required to reduce speeds via the added horizontal deflection. Furthermore, the existing median island between the lanes narrows as it approaches the roundabout, further reducing vehicles speed. Like the new land area at the corner of East Mall and NW Marine Dr, an enlarged area has been added to provide protection for active transportation modes, while shaping the geometry of entry lanes to reduce vehicular speeds. This area, shown in cyan in the figure above, enhances the usability of the roundabout for active transportation modes.

West of the roundabout on NW Marine Drive, the existing painted median has been upgraded and extended into a new median island, highlighted in purple in Figure 12. This improvement reduces the likelihood of head-on collisions by further separating opposing traffic flows and slowing speeds through narrower lanes. The median island will also serve as a pedestrian refuge, which will be further discussed in the active transportation design section.

Below is the traffic signage plan for the new intersection, the detailed drawing can be found in the appendix. The traffic signage plan shown below both incorporates new and existing signage. The new signs to be installed can be grouped into four categories: signage for pedestrians and active transportation, standard roundabout signage, truck-specific signage, and existing signage on NW Marine Drive and East Mall for the existing medians.

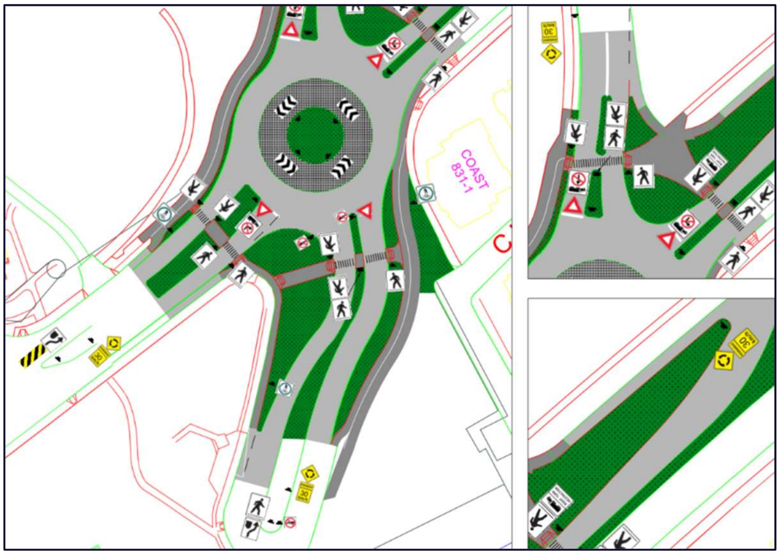


Figure 11: Traffic Signage Plan

The signage for the intersection was designed to meet BC MOTI standards, with roundabout signage warning starting well before the minimum 70 m before the intersection (assuming a conservative 60 km/hr traffic speed) and yield signs before the intersection. Additionally, the curved road on East Mall was not designed to accommodate trucks, which therefore require signage restricting trucks from entering. Signage next to the yield signs on Chancellor Blvd and both NW Marine Drive are included to ensure drivers understand the limitation, with additional signage at both north and south entrances of East Mall to ensure no trucks enter the road. Below is the final takeoff of the traffic management signage within the proposed intersection.

Table 3: Traffic Signage Takeoff

Sign Type	Signage Definition	Quantity	Sign Type	Signage Definition	Quantity
B-R-102	Shared Pathway (Bike/Ped)	3	R-124-1Ru	No Trucks Allowed – Right Turn	1
PS-003-L	Pedestrian Crosswalk - Left	9	R-125-1R	Truck Right Turn Restriction	1
PS-003-R	Pedestrian Crosswalk - Right	8	Rb-R-500-3	Roundabout One Way - 3 Arrows	4
R-014-R	Median symbol RIGHT ARROW	2	Rb-W-500	Roundabout	4
R-2	Yield Sign	4	Rb-W-500-Ta	Roundabout	4
R-123-1u	No Trucks Allowed	3	Rb-W-500-Tb	Roundabout / Low Speed	4
R-124-1Au	No Trucks Allowed - Ahead	1	W-0540L	Hazard Marker - Left	1
R-124-1Lu	No Trucks Allowed – Left Turn	1	Total Number of Signs		50

5.2.2 Active Transportation Design

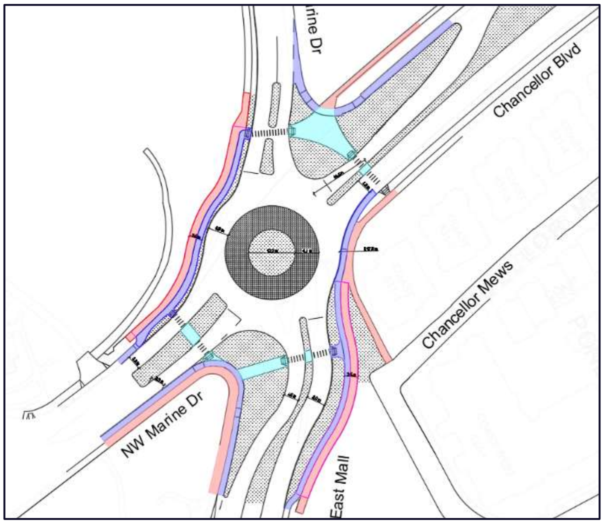


Figure 12: Active Transportation Pathways Diagram

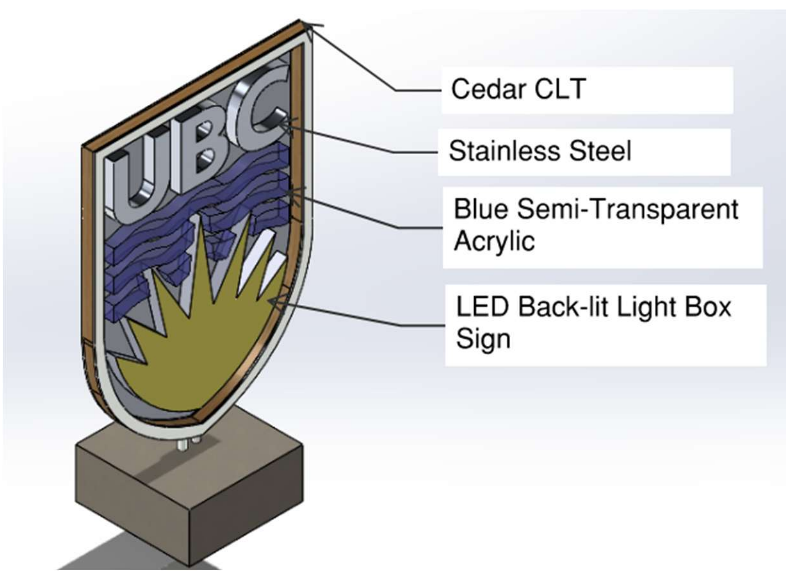
A key objective of the final detailed design was to promote active transportation. A new bike lane will be added on the northwest and southeast sides of the intersection. There will be transition points allowing cyclists to choose between riding into the roundabout or using the bike lanes and pedestrian crosswalks to navigate through the roundabout. If a cyclist chooses to ride in the bike paths, a ramp will raise the path to curb level, further improving safety. After travelling through the roundabout, cyclists on Chancellor and NW Marine Drive (W) will be able to continue riding on the existing bike lanes. Cyclists on East Mall and NW Marine Drive (N) will need to merge onto the existing roads using the new merging areas. Clear signage will be present to warn drivers and cyclists of the merging area.

The 1.5 m bike lanes will be adjacent to the 2.0 m pedestrian pathway, and the paths will be separated using line markings and symbols clearly delineating sides between bikers and pedestrians. The south pedestrian/bike path is also clearly segregated from the roundabout intersection to increase safety. Bike paths from East Mall to Chancellor Boulevard westbound will end before the roundabout, and a ramp will naturally transition cyclists between the added bike lanes and existing bike infrastructure. While the existing westbound bike lane on Chancellor Boulevard will end, an added pedestrian crossing will allow cyclists to move across the road and continue using the bike paths on the northwest side. At specific locations, bike lanes will now be separated from the road with a curb, protecting the cyclist at the transition from the roundabout to the existing roads. Cyclist turning right from NW Marine Drive (W) and Chancellor Blvd will now be using a segregated, raised bike lane on the new island, protecting them from traffic.

Another consideration for active transportation is pedestrian convenience and safety, which was addressed within the final intersection design through the inclusion of median islands and additional crosswalks. The new median islands on all approaches reduce vehicle speeds and provide resting points for pedestrians. The existing intersection crosswalks were relocated to be closer to the intersection, resulting in more direct travel routes. Compared to the existing intersection, there now exists a shorter, more natural path, improving the likelihood of pedestrians using the marked crosswalks. These changes can improve the efficiency of travel for active transportation modes, while reducing the likelihood of an accident. The crosswalks were placed allow vehicles to yield to pedestrians while maintain a 3 meters gap from the roundabout lane. Additionally, a new segregated sidewalk will be added west of East Mall to further improve the accessibility of the intersection. This sidewalk will connect to the existing sidewalk further up the road, making travel for pedestrians more efficient. Finally, all curb letdowns will have new tactile strips installed within them, helping with improving the safety of the roundabout for the visually impaired.

5.3 Gateway Signage Design

To add a gateway aspect to the intersection, new UBC signage was designed to welcome people to UBC and create a feeling of arrival. The design for the UBC gateway sign draws inspiration from the UBC crest, which depicts ocean waves beneath a setting sun, representing a community dedicated to creating a positive impact locally and globally through education, research, and innovation. The sign is planned to be located at the southwest corner of the intersection. A 3D model of the signage design is shown in Figure 13, alongside the materials that were chosen for the design.



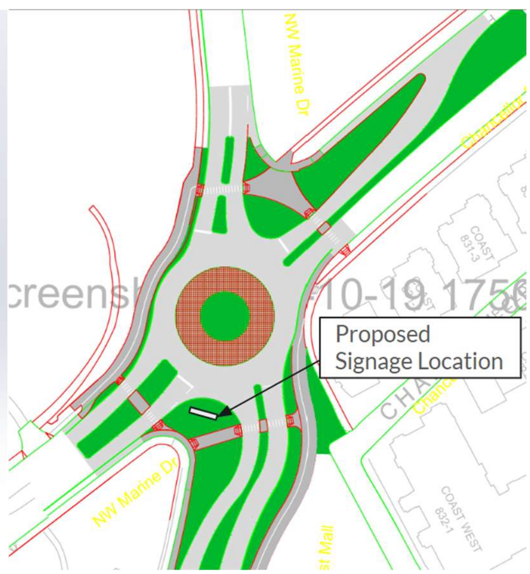


Figure 13 and 14: 3D Model of Signage Design with Specified Materials and Location of Gateway Signage

5.3.1 Gateway Signage Material Choices

Alongside the crest symbolism, different materials were included within the signage design to represent different part of UBC. The cedar frame of the sign represents the land that UBC stands on. Red cedars, native to coastal British Columbia, can grow up to 70 meters tall and live up to 1000 years old. The longevity reflects the longstanding history and prosperous future of UBC. Cedar is also a key natural resource within British Columbia and has an integral role within the coastal First Nations. The Coast Salish have a creation story for cedar trees, where the Creator recognized a good and generous man’s kindness. The Creator declared that a red cedar tree will grow where he's buried, akin to UBC's creation based on the University Site Act from the BC government.

The blue semi-transparent acrylic used for the waves of the UBC Crest also represents the current student body and alumni. Flowing in and out of UBC, every person going through its programs become elevated, taking the university's values with them to help interpret and influence society. The usage of acrylic, a relatively new material when compared to steel and lumber, represents the difference of age between the student body when compared to both the land UBC stands on and the institution itself. Its transparency represents the malleability of the student body's sense of self when coming to UBC and shows the stainless steel behind the acrylic, representing how UBC imprints skills and knowledge onto their student body to bring forth within their future work.

The sun within the crest represents the ideas and breakthroughs found within UBC. Unlike the rest of the signage materials, the sun is a back-lit light box made of disparate materials, representing all the different types of thought being advanced within UBC, from scientific theories to historical analyses to critical theories. Dynamic LED lighting also allows the sign to change colors to reflect the university's initiative in supporting different causes throughout the year, such as rainbow for pride month or orange for orange shirt day. Additional covers to the light box can also be used to support causes with more detailed symbols. This adaptability turns the sign into a powerful symbol of UBC's ideals, welcoming students, faculty, and visitors while embodying the university's values.

Stainless steel is used for the UBC name and structural elements to represent UBC as an institution. Propping up the rest of the sign components, it represents the hard work of all current UBC staff and connected institutions to elevate the ideals and student body within the university. It's unbroken shape and uniform material property represents the cohesion of the university's divisions and staff in the pursuit of UBC's goals and demonstration of the institution's values.

5.3.2 Gateway Signage Structural Design

The structure itself is built with a W310 x 129 steel frame and a 25mm steel plate in the center from which the plastic sign components are mounted to. Two 0.5m HS178 x 178 x 13 steel columns are located at the base of the sign for support which are fastened to the foundation with a 300mm x 300mm x 13mm steel base plate anchored with 4-20mm diameter epoxy set anchor bolts at 350mm embedment. A footing of 3m x 3m x 1.3m with 30MPa concrete and 26-20mm diameter reinforcing spanning 2.85mm spaced at 114mm each way is to be placed on the lower layer to ensure flexural demand is satisfied.

5.4 Stormwater Management

To mitigate environmental concerns of cliff erosion, the final intersection design implements a stormwater retention tank and catch basin system. The stormwater management plan is designed to retain the runoff of a 100-year storm's demand of the catchment area of the intersection and release the stormwater into the existing stormwater management system. The retained rainwater is designed to release after the storm, when the existing stormwater system is less encumbered. Catch basins will be installed around the intersection to collect runoff into the retention tank and two manholes will be installed for future facility and maintenance.

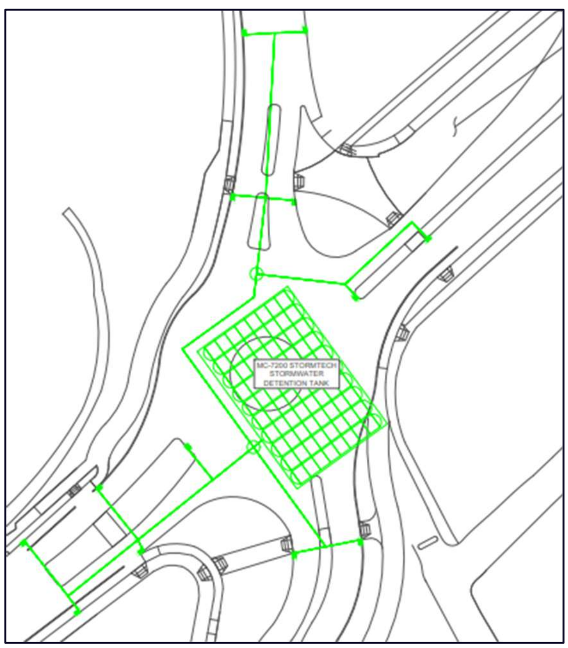


Figure 15: Stormwater Management Design and Location of New Catch Basins

The intersection was designed to guide the rainwater into newly created low points surrounding the roundabout. These low points will have catch basins installed to collect and transport rainwater to the storage tanks.

To provide adequate surface drainage, a target slope of 2% or greater was chosen as it's the standard TAC crossfall value for roads. The target slope was achieved throughout the intersection except for the eastbound portion of NW Marine Dr. (West), where a 1% longitudinal slope was used, as the existing sidewalk constrained the slope of the new road.

Catch basins were generally included on the higher edge of both ends of the intersection crosswalks to capture upstream stormwater runoff before it enters the crosswalk, improving pedestrian safety. Furthermore, two catch basins were added at the edge of the roundabout to meet the catch basin catchment area requirements outlined in the City of Vancouver's Engineering Design Manual. Additional catch basins were also included at the edge of the construction area on the western and northern leg of the intersection to ensure that all rainwater is retained on site.

Afterwards, the rainwater will be directed from the catch basins into a stormwater detention tank through a series of pipes. The size and slope of the pipes were determined based on flow requirements, which were calculated using the catchment area of the catch basins, runoff coefficients for the ground surface types, and an intensity-duration frequency (IDF) curve. The City of Vancouver's 2100 IDF curve was selected because of its proximity to UBC and its established use for onsite stormwater management design in Vancouver. Additionally, this IDF curve incorporates climate change projections, ensuring the stormwater infrastructure remains effective throughout the design lifecycle of the intersection. In particular, the 5-minute 100-year storm event was chosen as a shorter storm duration produces a larger intensity of rain, and thus a larger instantaneous flow demand on the pipes.

For the stormwater detention tank, a series of 80 MC-7200 prefabricated plastic tanks below the intersection were chosen as the primary means of retaining all rainwater on site. The prefabricated tanks will be surrounded by structural soil to prevent settlement as well as a geotextile liner to prevent infiltration, helping to protect the nearby cliffs from erosion. The prefabricated plastic tanks were selected over a cast-in-place concrete design because it allows for faster installation, improving scheduling and allowing the intersection to remain open to active transportation users through phased construction. In contrast to the pipes, the 24-hour 100-year storm event from the City of Vancouver's 2100 IDF curve was used to size the tank as a longer storm duration produces a larger volume of water. In addition, a key design consideration when sizing the tank was to include the upstream catchment areas from the intersection that would now be managed by the new storm system due to the removal of existing catch basins. Detailed stormwater analysis calculations and sample drawings can be found in Appendix D and E.

The water stored in the tank will be gradually discharged into the existing storm sewer system within the intersection after the storm passes. During the design phase, the construction of a new outfall within Pacific Spirit Regional Park, located to the northwest of the intersection, was proposed but ultimately rejected due to complex regulatory, environmental, and economic challenges. This included the need for permits from Metro Vancouver and the Federal government (through Fisheries and Oceans Canada), which would have significantly delayed the project timeline. Additionally, the outfall would have required cutting down trees, increasing environmental costs, and acquiring land, adding economic burdens.

5.5.1 - Green Rainwater Infrastructure

In addition to the stormwater detention tank, green rainwater infrastructure will also be used to collect, store and manage stormwater within the intersection. A raingarden will be included at the center of the roundabout which has about 120 m^2 of permeable area. The raingarden can retain a total of 43 m^3 of rainfall. The water is expected to be completely stored in the void spaces between the soil particles and the gravel with no ponding required. The growing medium will be 60 cm deep, and the rock pit will be 60 cm deep. The water is expected to evaporate at a rate of 1 mm/day or equivalently 0.12 m^3/day and infiltration will be at a rate of 4 m^3/day. Additionally, a catch basin that is set 15 centimeters above the soil has been included as a contingency and safety factor for the design.

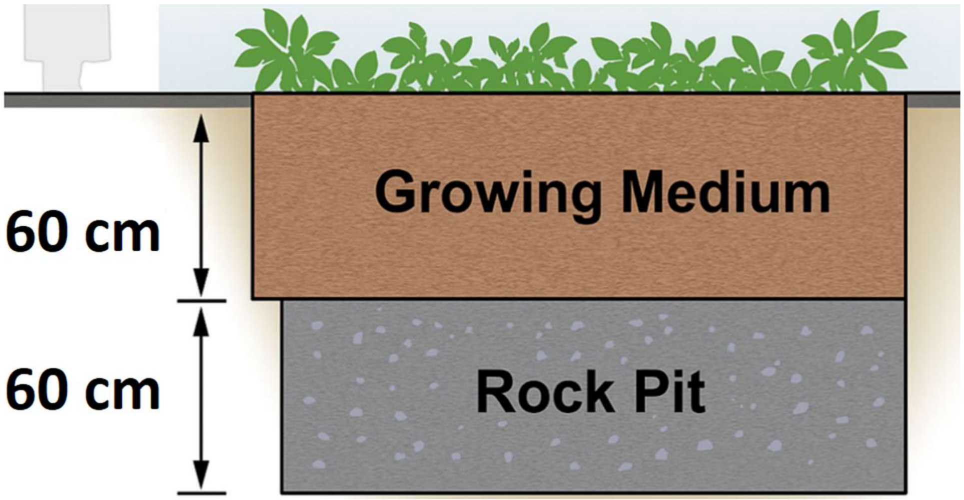


Figure 16. Raingarden Visualization

6. Final Proposed Design Computational Analysis

6.1 Level of Service Analysis

To conduct the level of service analysis and ensure capability of the new intersection design, SIDRA Intersection was used to determine the intersections level of service. SIDRA Intersection is a specialized traffic engineering software used for the analysis, design, and evaluation of various intersection types. The software is highly detailed, providing insights into multimodal traffic scenarios by considering vehicles, active transportation modes and intersection geometry. SIDRA's advanced capabilities provides valuable insights, allowing for further improvements the safety, efficiency, and sustainability of the preferred design. Figure 15 below shows the model of the roundabout used in the analysis.

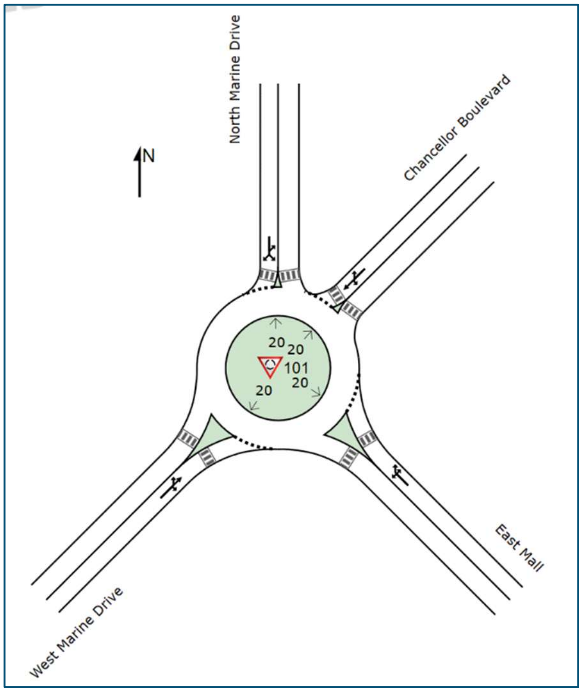


Figure 17. Roundabout Intersection in SIDRA Analysis

Using several key parameters of the final roundabout design, within SIDRA an approximate recreation of roundabout was modeled and tested. Inputs for the analysis include lane widths, middle island diameter, circulating width, entry angle and entry radius. This, in combination with the peak hour traffic count volumes were then input into a SIDRA analysis. The vehicles counts were adjusted to passenger car units (pcu) in SIDRA based on the type of vehicle. The table below shows the equivalent pcu for each type of travel mode analysed.

Table 4: Equivalent Passenger Car Units for SIDRA Analysis

Type of Travel Mode	Equivalent Passenger Car Units
Bike	0.5
Typical Passenger Vehicle	1.0
Heavy Vehicle	1.65

After adjusted traffic counts is inputted into SIDRA, an analysis was conducted to determine the level of service (LOS) of the roundabout for each approach. The LOS of the entire roundabout was determined by averaging the LOS of each approach. The analysis was performed for the current demand (2025), 30 years later (2055), 50 years later (2075) and 70 years later (2095). The model assumed a uniform rate increase in demand of approximately 2.4% per year for all directions. The analysis accounted for both morning and afternoon traffic counts. It determined that the morning count reached lower levels of service faster due to higher demand, thus the morning counts were used as the controlling factor in the model.

The level of service (LOS) of the modelled final intersection design is as follows:

- Current demand: LOS A
- 30 years later (2055): LOS B
- 50 years later (2075): LOS C
- 70 years later (2095): LOS F

With a design year of 2050, and a conservative estimate of a 2.4% increase in demand per year, the modelled intersection provides an adequate level of service for the design year. Adding additional lanes would improve the level of service, however, a higher capacity roundabout could induce demand as drivers seek the shortest route. This could negatively impact the safety and experience of other road users, especially active transportation modes.

6.2 Turning Radius Analysis

To conduct the turning radius analysis of the proposed roundabout, Autodesk Vehicle Tracking software was used to simulate the movements of a WB-20 truck. The analysis validated the design's ability to accommodate the truck's turning movements for both eastbound and westbound traffic. This approach ensured that the roundabout geometry met the functional requirements for larger vehicles while maintaining the compact design necessary for the site constraints. The results confirmed the ability of the design to accommodating heavy vehicle traffic. Detailed drawings are available in Appendix A.

7. Construction Management

7.1 Construction Schedule and Phasing Plan

The proposed construction plan for the proposed intersection design starts on **April 2026** and will be completed by **September 2026**. Although this schedule results in a slight delay to the project, it allows for a portion of the intersection to remain open throughout the construction phase. Additionally, the slight delay results in a longer lead time after tendering, which minimizes additional costs associated with short notice hirings. Scheduling the construction phase during the summer of 2026 will also allow for a partial closure of the intersection, when there is a period of lower demand. This will reduce disruptions compared to the closure of the intersection during the fall and winter terms and avoid the additional costs of a severely accelerated schedule. The plan for this intersection design is for the construction to be completed in three phases, as shown in Table 4 and Figure 16. The first phase will focus on south side of the intersection and the water management solutions, while the second phase focuses on the north side of the intersection and the third focuses on signage and landscape installation.

By the end of the second phase, the intersection is expected to be fully operational for the beginning of the 2026-2027 school year. However, during phases 1 and 2 traffic disruptions will be necessary to construct the new intersection. Both phases plan to close only one lane in the east-west direction but will allow for two-way traffic through the use of traffic management personnel during normal working hours (7AM-7PM). During the first phase, NW Marine Drive (North) will remain open, and traffic on NW Marine Drive (West) and Chancellor Boulevard will be able to always use the westbound lanes. The second phase allows for vehicles to travel on the eastbound lanes for NW Marine Drive (West) and Chancellor Boulevard. Additionally, East Mall will be fully open to traffic. More details are found in section 7.4.

During Phase three, the roundabout will be fully operational during the day. After working hours, traffic will be slightly impeded as crews work on the center island, medians, and landscaping areas.

Table 5: Construction Phase Table

Phase	Start Date	End Date	Duration	Work Definition
1	4/20/26	7/03/26	10	Initial Site Set-up, Traffic Management, Site Excavation, Partial Water Management Tanks Installation, Intersection Roadwork (including road gravel, asphalt pour, line painting, etc.), Sidewalk & Pedestrian Area Pours.
2	7/06/26	8/28/26	8	Changes in Traffic Management & Site Areas, Demolition, Excavation, Extension of Water Management Catchment and Completion of Water Tank Installation, Infill and Intersection Roadwork, Installation of New Fencing.
3	6/22/26	9/28/26	15	Signage Installation, Landscaping Installation, Reconstruction of Chancellor Blvd Median, Site Demobilization.

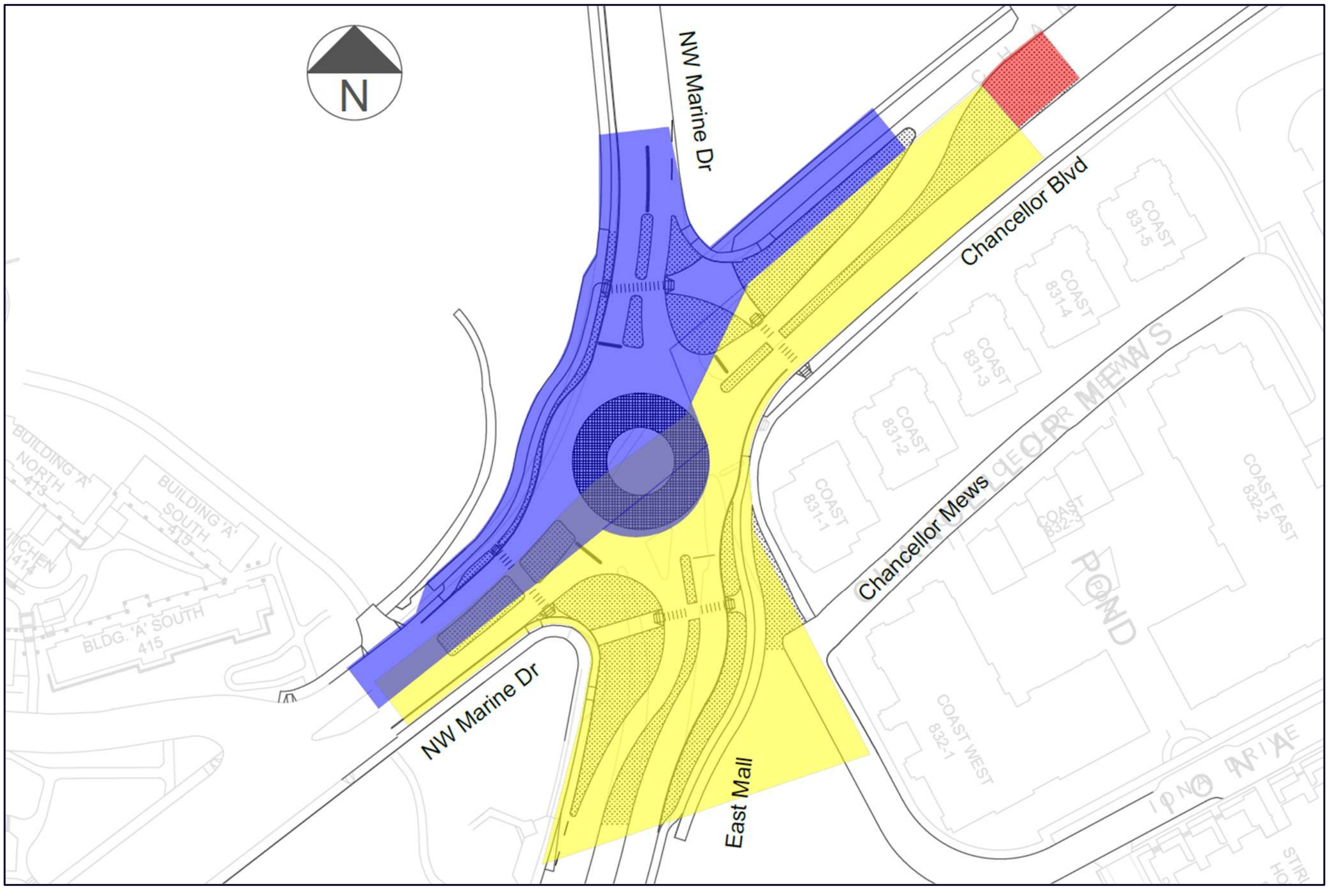


Figure 18: Site Phasing Plan

7.2 Construction Schedule

Below is a summary for the detailed schedule in Figure 16. Major milestone includes:

- Construction Start: April 20th, 2026
- Phase 1 Intersection Closure: April 22nd, 2026
- Phase 1 Roadwork Completion: July 3rd, 2026
- Phase 2 Intersection Closure: July 6th, 2026
- Phase 2 Completion: August 26th, 2026
- Intersection Reopening: September 3rd, 2026
- Signage On Site Installation: August 31st, 2026
- Substantial Completion: September 16th 2026

The implementation schedule for the redesigned intersection at Chancellor Boulevard, East Mall, and NW Marine Drive has been carefully structured to minimize traffic disruption by avoiding peak traffic volumes during the fall and winter terms. Construction is divided into distinct phases, and strategically timed to reduce the impact on students, faculty, and residents while ensuring steady progress. Construction notices are planned to be distributed by April 6th, 2026, construction work is planned to begin on April 20th, 2026 and substantial completion is anticipated to be achieved by September 16th, 2026. Key milestones include the completion of stormwater management systems, roadwork, gateway construction, and final signage installation.

The first phase, spanning late April to July 2026, will focus on the south side of the intersection, installation of the signage foundation, and the partial installation of stormwater management infrastructure. This phase includes excavation, utility relocation, and initial roadwork. During this time temporary traffic measures will allow limited through-traffic and increased congestion will be expected.

The second phase, scheduled from July to late August 2026 and will address roadway reconstruction and the completion of the stormwater management system. Both phases are timed to occur during the summer academic break when traffic volumes on campus are lower. Efforts will be made to keep key routes open for essential traffic, including transit and emergency vehicles. However, lane closures will likely cause congestion.

Finalization and reopening are planned for August through September 2026. During this phase, signage installation, landscaping, and final inspections will be completed. The intersection will reopen to traffic by September 3rd, 2026, with remaining work focused on refining aesthetic aspects of the project.

7.3 Traffic Management Plan

To control the traffic going through the Chancellor Boulevard, East Mall, and NW Marine Drive intersection during the construction of the intersection, we have developed four traffic management plans, based on the phase of construction and time of day. Only phase one and two have traffic management plans as most of the phase three work will be done during off hours and will not require access to the traffic lanes. Below are the locations of the intersections where cars will be turned away during construction.

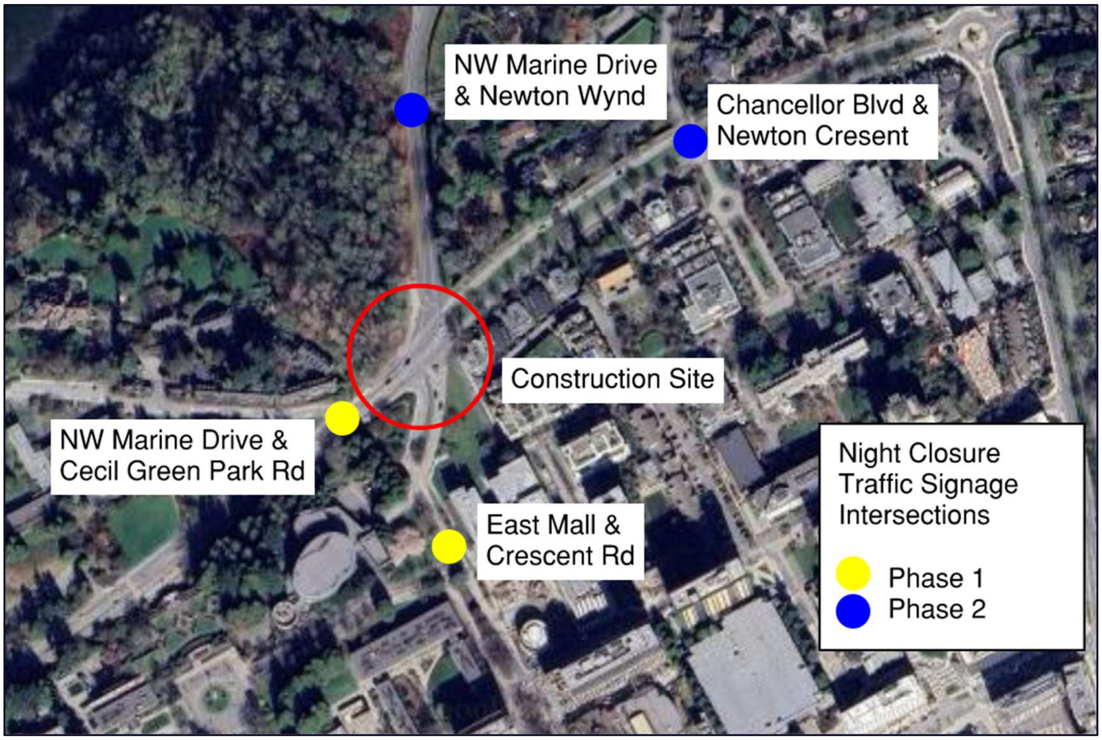


Figure 19: Night Closure Traffic Signage Intersections

During phase one and two, accommodations area planned two-way traffic in the east west direction during standard working hours (7AM-7PM), while one way traffic will operate during off hours (7PM-7AM). Phase one will keep the westbound lane on NW Marine Drive and Chancellor Boulevard and open. During the day, three traffic management personnel (with one worker placed on either EW side of the intersection and one at the center of the intersection) will control flow through the westbound lane to allow for two-way travel. Figure 20 shows the proposed phase one daytime traffic signage and personnel plan.

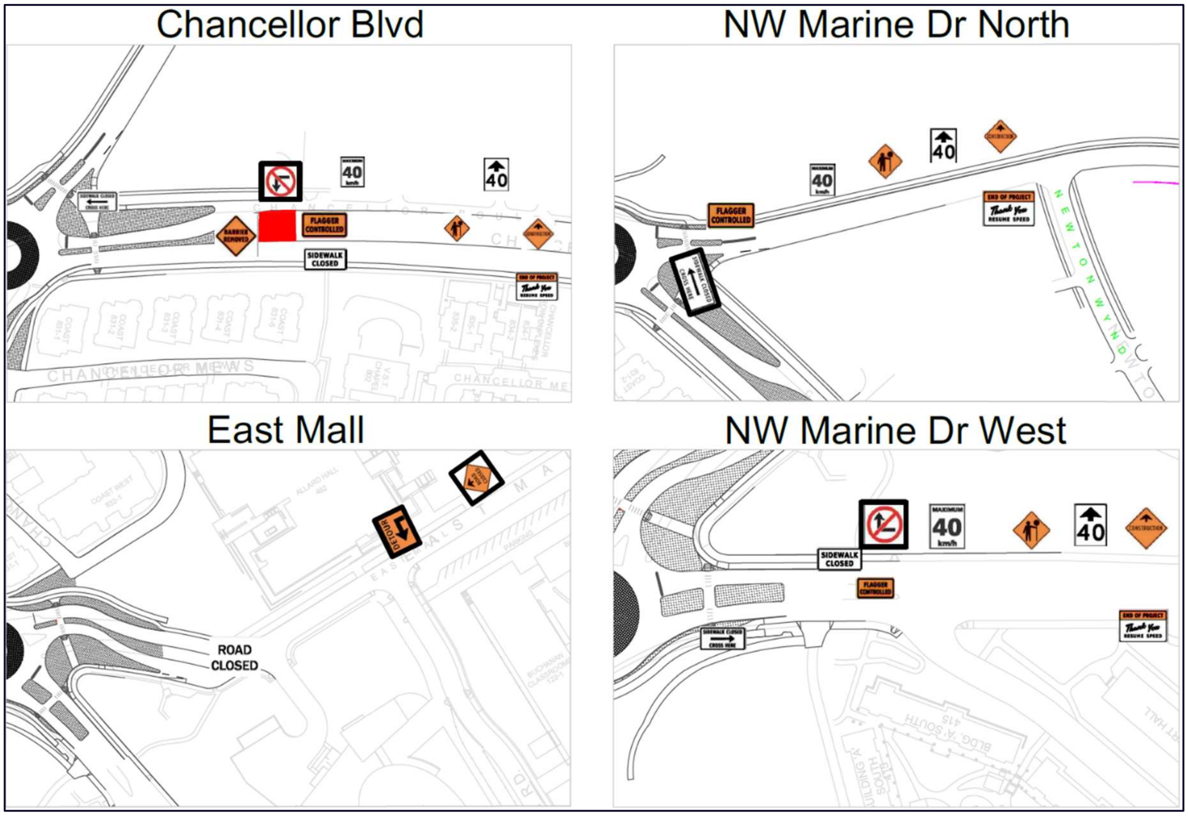


Figure 20: Phase 1 Daytime Traffic Signage Plan

Phase one of the construction phasing requires East Mall to be closed throughout and NW Marine Drive and Cecil Green Park Rd. intersection to be closed at night. During the night, traffic signage will be placed at the NW Marine Drive and Cecil Green Park Rd. intersection to deter drivers away from the construction site. Traffic signage will be placed at the East Mall and Cresent Rd. intersection throughout the construction phase as well, to ensure no drivers enter east mall through the south side of the intersection. Trucks and other vehicles will be expected to U-turn through Chancellor Boulevard, but pedestrians and active transport users will be able to use the sidewalk on the west side of East Mall, and the existing crosswalk on NW Marine Drive to access Tower Beach.

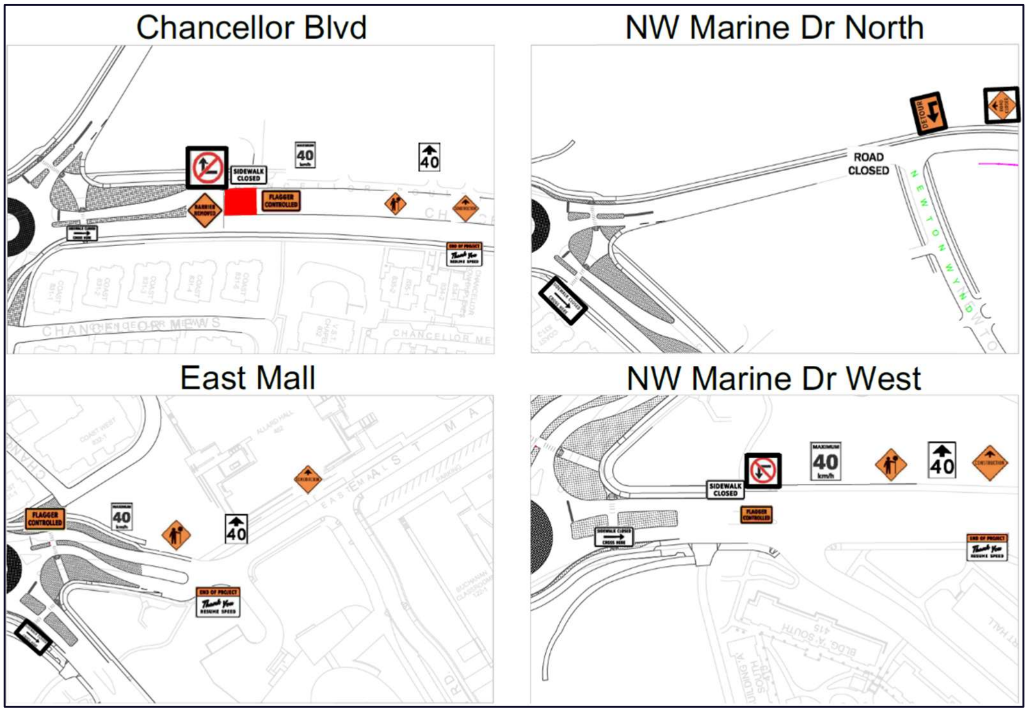


Figure 21: Phase 2 Daytime Traffic Signage Plan

Phase two's traffic management plan is similar to phase one's plan. During phase two, traffic personnel will be placed at the same locations as phase one, except the management plan will be flipped to control two-way access on the east bound lane. Traffic signage will be placed at the Chancellor Blvd. and Newton Cresent intersection at night and all day at NW Marine Drive and Newton Wynd. to reroute drivers. During this time East Mall will be fully reopened. Pedestrians and active transport will be able to use the sidewalks on East Mall and the existing crosswalk on NW Marine Drive to access Tower Beach for most of the phase. However, for a three week period, pedestrians will be redirected to Trail 4 until the expedited construction of the pedestrian sidewalk is completed.

The only portions of phase three that may require traffic management is during the gateway signage erection and the remediation of Chancellor Boulevard's median. If lane space is required during phase three on Chancellor Blvd., the traffic lane will be displaced to temporarily take up the bike line while the median remediation is done. During the gateway signage erection, it's expected for the roundabout to be closed for one evening between 1AM and 6AM, with peak hours not affected during this work.

7.4 Stakeholder Engagement, Consultation, and Communication Plan

The redesigned intersection at Chancellor Boulevard, East Mall, and NW Marine Drive will prioritize transparent communication and collaboration with stakeholders throughout the project lifecycle. Key groups identified include UBC Campus and Community Planning, TransLink, neighboring residents, and rights holders like the Musqueam Indian Band. Active engagement will be prioritised to ensure all stakeholder needs are addressed.

Engagement and Consultation will involve regular meetings, community forums, and surveys. Decision-makers, such as UBC's Board of Governors, will guide high-level design decisions, while local users and residents will provide feedback on operational and safety issues. Rights holders will be consulted to ensure cultural and environmental considerations are respected.

Communication Channels will include a centralized project website for updates, digital tools like SiteDocs for real-time progress tracking, and email newsletters for public notifications. Regular briefings will keep stakeholders informed of milestones, timelines, and potential disruptions.

Stakeholder input will be reviewed biannually during construction and annually post-completion to ensure the project continues to meet the community's needs. The plan will emphasize collaboration, transparency, and accountability to deliver infrastructure that aligns with UBC's sustainability goals.

7.5 Quality Management & Documentation Plan

During construction, monitoring will focus on safety, schedule adherence, and environmental compliance. Field-Level Risk Assessments (FLRAs) will be conducted daily to identify and address site-specific risks. SiteDocs or similar digital platforms will streamline documentation of safety hazards, progress updates, and corrective actions. Regular safety briefings will ensure all workers are informed of evolving site conditions and protocols. Weekly progress reviews will track alignment with the construction schedule, with any deviations promptly addressed to prevent delays. Environmental compliance will be monitored through inspections of erosion control measures and stormwater systems, with results documented in SiteDocs or equivalent software to ensure regulatory standards are maintained. Stakeholders, including UBC's Campus and Community Planning and TransLink, will receive regular updates to maintain transparency and address concerns as they arise. This structured approach ensures safe, efficient construction while minimizing disruptions and maintaining compliance.

7.6 Class A Cost Estimate

The Class A cost estimate has been developed by breaking down construction components into relevant categories such as general costs, stormwater management, roadwork, signage, landscaping, and utilities. These estimates are based on past BC/Alberta project averages and commercial supplier pricing. Adjustments have been applied for location factors, price indices, and anticipated variances, ensuring the estimate reflects current market conditions.

The estimation process is detailed in a full upload of the spreadsheet included in the appendix. A general contingency of 10% has been applied to all categories to account for unforeseen conditions, particularly those related to excavation and stormwater installation. Additionally, adjustments for regional differences in pricing have been considered through location factor modifications. Sales tax has also been accounted for in the final calculation.

The total estimated cost for the intersection redesign is approximately $5,088,000. This estimate excludes design fees but includes all construction costs, materials, labour, and applicable sales taxes. Further refinement of this estimate is anticipated as the design progresses and more detailed supplier quotes become available, ensuring a comprehensive and robust assessment of anticipated costs for the proposed redesign.

Table 6: Class A Cost Estimate Summary

Category	Total Cost ($)
General Costs	2,667,000
Removals	318,000
Water Management Installation	223,000
Roadwork and Multimodal Construction	875,000
Gateway Sign Construction	88,000
Contingencies and Taxes	918,000
Project Cost	**5,088,000**

7.7 Final Deliverables

To ensure all deliverables will be constructed within the final deliverable, the contractual obligation of each deliverable will likely be delegated to different subtrades. To ensure completion of the final products, a recommended distribution of the final deliverables follow the following delineation as shown in table 6.

Table 7: Final Deliverable Spread According to CSI Divisions

Subtrade Division	Work	Scope of work
1 – General Conditions	Installation of Signage Concrete	Formwork and Pour for Gateway Signage Footing and Traffic Signage when necessary. 2-year warranty.
2 – Existing Conditions	Demolition of Existing Intersection	Demolition and excavation of existing and temporary additions within the intersection.
3 – Concrete Supply	Supply of Concrete and Subgrade	Supply of concrete and asphalt for roadwork, sidewalks, curbs, and signage. 2 year warranty of materials.
3 – Concrete Formwork and Pour	Roadwork Formwork and Pour	Installation of subgrade, asphalt, and concrete for sidewalks, curbs, and intersection. 2-year warranty and supply of subgrade required.

10 - Signage	Supply and Installation of Gateway Signage	Installation of gateway signage, including connections to foundation. 5-year warranty and signed engineering letter.
	Supply and Installation of Traffic Signage	Installation of traffic signage. 2-year warranty.
26 - Electrical	Installation of Lighting	Installation of new lighting system within the intersection (to be determined). 5-year warranty.
31 - Earthworks	Excavation of Intersection	Excavation of existing intersection in two phases for water management and roadwork scopes.
32 - Landscaping	Landscaping of Intersection	Landscaping of new intersection, including grass, bushes, flowers, and more.
	Raingarden Installation	Installation of raingarden system.
32 - Fencing	Supply and Installation of Fence	Installation of new fencing along the north cliffside.
33 - Utilities	Connection of Water Tank to Stormwater System	Connection of water tanks to city stormwater management system and delaying mechanism for wastewater control.
	Connection of Signage and Lighting	Connection of signage and lighting systems to city electricity system.
	Redistribution of Utilities During Construction	Redistribution of utilities during exaction and construction.
45 – Wastewater Equipment	Stormwater Retention Tanks, Manholes, Catch Basins, and Connections	Supply and Installation of retention tanks, catch basins, manholes, and connections between catch basins and tanks.

Exceptions for specific details of the work apply. For example, the repouring of the Chancellor Blvd median curb during phase three is expected to be done by the general contractor, along with some wastewater

7.8 Construction Risk Assessment

Below is the summary of the construction risk assessment for the intersection redesign project. Although potential high impact risks exist, the project is categorized as a low-risk project as most high and medium risk occur early within the project timeline, allowing for the time required for changes to absorbed within the project timeline.

Table 8: Construction Risk Assessment Summary

Phase	Impact	Risk	Explanation
Phase 1	High	Demolition & Excavation	Unforeseen underground utilities or unstable soil could delay excavation and require design changes.
	High	Roadwork & Pavement Installation	Weather-dependent work may face delays due to rain or extreme temperatures affecting material setting
Phase 2	Medium	Traffic Flow Adjustments	Public confusion/congestion may occur from shifting detours/lane changes.
	Medium	Partial Water Tank Installation	Coordination issues with concurrent construction could delay progress.
	Low	Accidental Damage of Phase 1 Work	Unforeseen damage from material transfers and regular work.
Phase 3	Medium	Gateway Landmark Fabrication	Material supply or fabrication delays may impact the final project timeline.
	Low	Landscaping & Site Restoration	Minor delays due to late material deliveries or seasonal planting restrictions.
	Low	Adjustments & Stakeholder Approvals	Last-minute modifications could extend project completion.

7.9 Service-Life Maintenance Plan

This section outlines the maintenance requirements and estimated service-life costs for the redesigned Chancellor Boulevard, East Mall, and NW Marine Drive intersection. The plan addresses the anticipated inspection intervals, preventative maintenance activities, and long-term performance expectations of key design components. Its purpose is to support sustained functionality, safety, and environmental performance over a projected service life of 25 to 30 years.

7.9.1. Pavement and Road Surface

The asphalt roadway and multi-use paths are expected to last approximately 25-30 years with routine maintenance. Visual inspections should be conducted annually to monitor surface conditions such as cracking, rutting, or potholing. Crack sealing is recommended every five years to prevent water infiltration. Resurfacing (milling and overlay) may be required once during the service life, around year 20, depending on observed wear and traffic loads.

7.9.2. Stormwater Management System

Stormwater infrastructure, including catch basins, manholes, and the underground detention tank, should be inspected and cleaned twice annually, ideally in the spring and fall. Structural inspections of the detention tank should occur every ten years, with visual reviews of surface drainage conditions conducted more frequently. Rain gardens should be monitored seasonally for erosion, ponding, and vegetation health.

7.9.3. Active Transportation Infrastructure

Bike lanes and pedestrian walkways require biannual inspections for surface wear, debris, and visibility of pavement markings. Pavement markings should be repainted every five years. Curb letdowns and tactile warning strips should be checked annually to ensure compliance with accessibility standards.

7.9.4. Signage and Gateway Monument

The UBC gateway sign and other traffic signage will require periodic inspections for structural integrity, fading, or damage. LED lighting elements should be tested semi-annually and replaced approximately every 10 to 15 years. Signage surfaces may require cleaning or refinishing depending on weather and UV exposure.

7.9.5. Landscape and Green Infrastructure

Landscaped areas and the rain garden should be maintained on a seasonal basis, with weeding, pruning, and replanting as required. Vegetation inspections should occur at least quarterly during the growing season to ensure continued infiltration performance and site aesthetics.

7.9.6. Estimated Lifecycle Maintenance Costs

Total estimated maintenance costs over 30 years range from **$350,000 to $500,000**, accounting for scheduled inspections, routine repairs, and periodic resurfacing. Approximate allocations are as follows:

- Road surface and pavement upkeep: $160,000
- Stormwater system maintenance: $100,000
- Landscaping and raingarden maintenance: $75,000
- Signage, lighting, and public features: $50,000

Appendix A: Signage Structural Calculations

Load Definitions

Dead Load:

Structure Self Weight: $Sw := \left(7.8\ m \cdot 5.7\ m \cdot 0.025\ m \cdot 7700\ \frac{kg}{m^3} \cdot 9.81\ \frac{m}{s^2}\right) = 84.0\ kN$

Snow Load: N/A

Live Load: N/A

Wind Load:

$q := \frac{1}{2} \cdot 1.225\ \frac{kg}{m^3} \cdot \left(26\ \frac{m}{s}\right)^2 = 0.414\ kPa$

$Ce := 1 \quad Cpl := -0.5 \quad Ct := 1 \quad Cel := \left(\frac{7.8}{10}\right)^{0.2} = 0.9515 \quad Cg := 1.4 \quad Cp := 0.8 \quad Iw := 1$

Windward Face: $pw := Iw \cdot q \cdot Ce \cdot Ct \cdot Cg \cdot Cp = 0.4637\ kPa$

Leeward Face: $pl := Iw \cdot q \cdot Cel \cdot Ct \cdot Cg \cdot Cpl = -0.2758\ kPa$

Pressure: $P := pw + |pl| = 0.7395\ kPa$

Seismic:

Site Class C

BCBC 4.1.8.18: Category 3 non-structural components - external and internal ornamentation and appendages

$C\_p := 1 \quad Ar := 2.5 \quad Rp := 2.5 \quad Ax := 1$

$Sp := C\_p \cdot Ar \cdot \frac{Ax}{Rp} = 1$

$Fa := 1 \quad Sa := 0.91 \quad Ie := 1 \quad Wp := 84\ kN$

$Vp := 0.3 \cdot Fa \cdot Sa \cdot Ie \cdot Sp \cdot Wp$

$Vp = 22.932\ kN$

$h := 8\ m$

$Md := Vp \cdot \frac{h}{2} \quad Md = 91.728\ kN\ m$

Footing Design

Sign Height $Hs := 7.8\ m$

Sign Width $Ws := 5.7\ m$

Sign Area $As := Hs \cdot Ws = 44.46\ m^2$

Soil Bearing $\delta := 200\ kPa$

Footing Width: $Bf := 3\ m$

Footing Depth $Df := 1.3\ m$

Concrete Density $\rho := 2400\ \frac{kg}{m^3}$

Gravity $g := 9.81\ \frac{m}{s^2}$

Service Load:

$$Ps := Sw + Bf^2 \cdot Df \cdot \rho \cdot g = 359.4\ kN$$

$$Ms := As \cdot P \cdot \frac{1}{2} \cdot Hs = 128.2\ m\ kN$$

Factored Load:

Load Case 1:

$$Pf1 := 1.4 \cdot Ps = 503.1938\ kN$$

Load Case 2:

$$Pf2 := 1.25 \cdot Ps = 449.2802\ kN$$

$$Mf2 := 0.4 \cdot Ms = 51.2914\ kN\ m$$

Load Case 3:

$$Pf3 := 1.25 \cdot Ps = 449.2802\ kN$$

$$Mf3 := 0.4 \cdot Ms = 51.2914\ kN\ m$$

Load Case 4:

$$Pf4 := 1.25 \cdot Ps = 449.2802\ kN$$

$$Mf4 := 1.4 \cdot Ms = 179.5198\ kN\ m$$

Load Case 5:

$$Pf5 := 1.0 \cdot Ps = 359.4242\ kN$$

$$Mf5 := 1.0 \cdot Md = 91.728\ kN\ m$$

Eccentricity:

$$E := \frac{Ms}{Ps} = 0.3568\ m$$

$$E \le \frac{Bf}{6} = 1$$

Bearing Pressure:

$$Bf > \left(\frac{Ps}{\delta}\right)^{0.5} = 1$$

One Way Shear Check:

$Davg := 1300\ mm - 75\ mm - 20\ mm = 1.205\ m$ $\quad\Phi c := 0.65$

$Dmin := Davg - 0.5 \cdot 20\ mm = 1.195\ m$ $\quad fc := 30\ Mpa$

$Dv := 0.9 \cdot Dmin = 1.0755\ m$

Size Factor: $Dv \geq \frac{Bf}{4} = 1$ $\quad \beta := 0.21$

$\Phi c \cdot \beta \cdot 3 \cdot 1.08 \cdot 30^{0.5} \cdot 1000 = 2422.3578$

$Vr1 := 2442.4\ kN$

$Vf1 := \frac{Pf1}{Bf} \cdot \left(\frac{Bf}{2} - Dv \right) = 71.2019\ kN$ $\quad Vr1 > Vf1 = 1$

Two Way Shear Check:

$Vf2 := \frac{Pf1}{Bf^2} \cdot \left(Bf^2 - Davg^2 \right) = 422.0105\ kN$

$0.38 \cdot \Phi c \cdot 30^{0.5} \cdot 1.205 \cdot 5 \cdot 1000 = 8151.0702$

$Vr2 := 7043\ kN$ $\quad Vr2 > Vf2 = 1$

Flexural Design

$Av := 0.002 \cdot (Bf \cdot Df) = 7800\ mm^2$

20M Bars: $\frac{Av}{300\ mm^2} = 26$ $\quad$ Use 26 - 20 M Bars

Spacing: $\frac{Bf}{26} = 0.1154\ m$ $\quad$ Use 114 mm

$\beta_1 c = \frac{\phi_s f_y A_s}{\alpha_1 \phi_c f_c'\ b}$ $\quad 340 \cdot 26 \cdot \frac{300}{0.81 \cdot 0.65 \cdot 30 \cdot 3000} = 55.9671$ $\quad 0.5 \cdot Df = 0.65\ m$

$M := \frac{Pf4}{8} \cdot Bf + Mf4 = 347.9999\ m\ kN$

$Mr := 340\ MPa \cdot 26 \cdot 300\ mm^2 \cdot \left(Dmin - \frac{56.8}{2}\ mm \right) = 3093.8232\ kN\ m$

$Mr \geq M = 1$

Bearing Capacity:

$Fb := 0.85 \cdot 0.65 \cdot 30\ MPa \cdot 300\ mm \cdot 300\ mm \cdot 2 = 2983.5\ kN$

Frame Design:

$qf := \frac{As \cdot P \cdot 1.4}{2 \cdot Hs} = 2.9507 \cdot \frac{1}{m} \, kN$ Max Deflection: $\frac{Hs}{240} = 0.0325 \, m$

$Vx := 23 \, kN$ $Mx := 89.7 \, kNm$

W310x129

$Vr := 787 \, kN$ $Mrf := 550 \, kNm$

$0.9 \cdot 0.6 \cdot 350 \cdot 318 \cdot \frac{13.1}{1000} = 787.3362$ $0.9 \cdot 0.9 \cdot 1940 \cdot \frac{350}{1000} = 549.99$

$Vr \geq Vx = 1$ $Mrf \geq Mx = 1$

$D := 2950 \cdot \frac{7.8^4}{\left(8 \cdot 2 \cdot 10^{11} \cdot 308 \cdot 10^6 \cdot 10^{-9}\right)} \cdot 1000 = 0.0222$ $D \leq 0.0325 = 1$

Post Design

Height $0.5 \cdot m$ Class 1,2 $Ad := 7970 \, mm^2$

$Mfx := 90 \, kN \, m$ $Cf := 251.5 \, kN$ $u := 1$

HS178x178x13

Cross Sectional Stregth:

$Cr := 0.9 \cdot 7970 \, mm^2 \cdot 350 \, MPa = 2510.55 \, kN$

$Mrx := 0.9 \cdot 484 \, mm^3 \cdot 10^3 \cdot 350 \, MPa = 152.46 \, kN \, m$

$\frac{Mfx}{Mrx} = 0.5903$ $\frac{Cf}{Cr} + 0.85 \cdot u \cdot \frac{Mfx}{Mrx} = 0.6019$

Cross Sectional Stregth:

$Cr := 0.9 \cdot 7970 \, mm^2 \cdot 350 \, MPa = 2510.55 \, kN$

$Mrx := 0.9 \cdot 484 \, mm^3 \cdot 10^3 \cdot 350 \, MPa = 152.46 \, kN \, m$

$\frac{Mfx}{Mrx} = 0.5903$ $\frac{Cf}{Cr} + 0.85 \cdot u \cdot \frac{Mfx}{Mrx} = 0.6019$

In Plane Member Strength:

$$\lambda := \frac{500}{66.5} \cdot \left(\frac{350}{\left(\pi^2 \cdot 200000 \right)} \right)^{0.5} = 0.1001$$

$$Cr1 := 0.9 \cdot Ad \cdot 350\ \text{MPa} \cdot \left(1 + \lambda^{1.34 \cdot 2} \right)^{-\frac{1}{1.34}} = 2506.6303\ \text{kN}$$

$$\frac{Cf}{Cr1} + 0.85 \cdot u \cdot \frac{Mfx}{Mrx} = 0.6021$$

Lateral Torsional Buckling

Hight/Rx $\frac{500}{66.5} = 7.5188$

Steel Plate Design

Displacement

$$w_{\max} = w\left(L_x/2, L_y/2\right) = c_1 \frac{p\mathit{Min}\left(L_x, L_y\right)^4}{Eh^3}$$

where values of c_1 are listed in the following table.

$\mathrm{Max}(L_x/L_y, L_y/L_x)$	1.0	1.2	1.4	1.6	1.8	2.0	∞
c_1	0.0138	0.0188	0.0226	0.0251	0.0267	0.0277	0.0284

Hence, w_{max} = 5.52245840519 mm ≈ 5.52 mm

Stress

$$\sigma_{\max} = \sigma\left(\text{center of long edge, near surface}\right) = c_2 \frac{p\mathit{Min}\left(L_x, L_y\right)^2}{h^2}$$

where values of c_2 are listed in the following table.

$\mathrm{Max}(L_x/L_y, L_y/L_x)$	1.0	1.2	1.4	1.6	1.8	2.0	∞
c_2	0.3078	0.3834	0.4356	0.4680	0.4872	0.4974	0.5000

Hence, σ_{max} = 16.4962858158 MPa ≈ 16.5 MPa

SIMPSON Strong-Tie

Anchor Designer™ for Concrete Software
Version 3.3.2410.2

Company:	SvenHardy Consulting	Date:	11/29/2024
Engineer:	Luca Faccone	Page:	1
Project:	CIVL 445 Capstone Preliminary Design		
Address:			
Phone:			
E-mail:			

1.Project information

Project description:
Location:
Design name: Design

Comment:

2. Input Data & Anchor Parameters

General
Design method:ACI 318-19
Units: Imperial units

Anchor Information:
Anchor type: Cast-in-place
Material: AB_H
Diameter (inch): 0.750
Effective Embedment depth, h_{ef} (inch): 14.000
Anchor category: -
Anchor ductility: Yes
h_{min} (inch): 16.25
C_{min} (inch): 4.50
S_{min} (inch): 4.50

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 13.78
State: Uncracked
Compressive strength, f'_c (psi): 4500
Reinforcement condition: B tension, B shear
Supplemental edge reinforcement: No
Reinforcement provided at corners: No
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: No
Ignore 6do requirement: No
Build-up grout pad: No

Base Plate
Length x Width x Thickness (inch): 12.00 x 12.00 x 1.50
Yield stress: 50763 psi

Profile type/size: 7X7X1/2

Recommended Anchor
Anchor Name: PAB Pre-Assembled Anchor Bolt - PAB6H (3/4"Ø)

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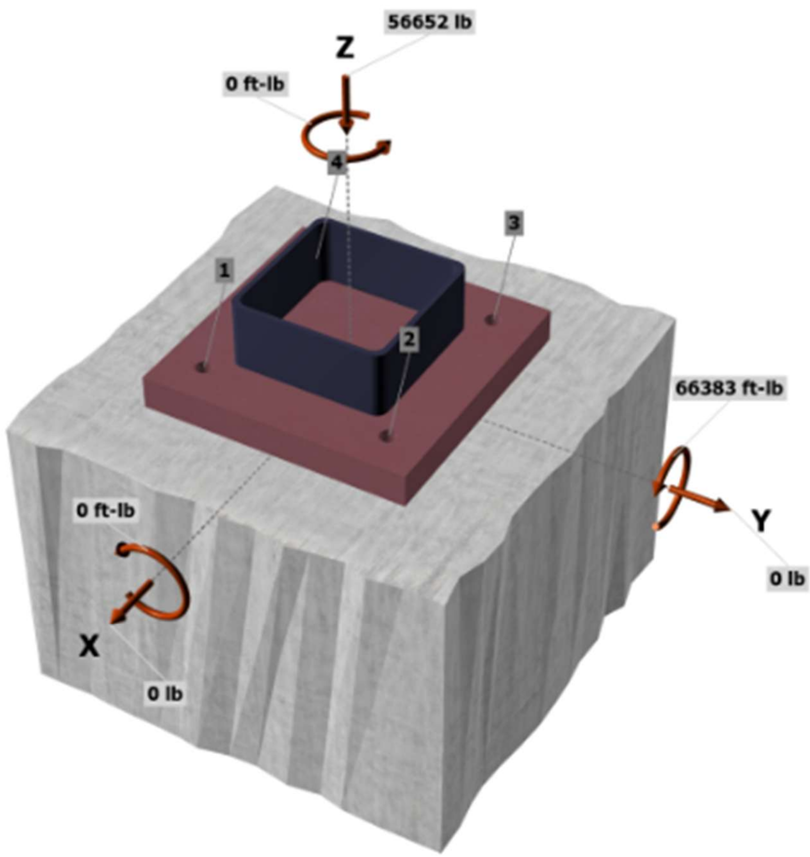
Address:			
Phone:			
E-mail:			

Load and Geometry
Load factor source: ACI 318 Section 5.3
Load combination: not set
Seismic design: No
Anchors subjected to sustained tension: Not applicable
Apply entire shear load at front row: No
Anchors only resisting wind and/or seismic loads: No

Strength level loads:

N_{ua} [lb]:	-56652
V_{uax} [lb]:	0
V_{uay} [lb]:	0
M_{ux} [ft-lb]:	0
M_{uy} [ft-lb]:	66383
M_{uz} [ft-lb]:	0

<Figure 1>



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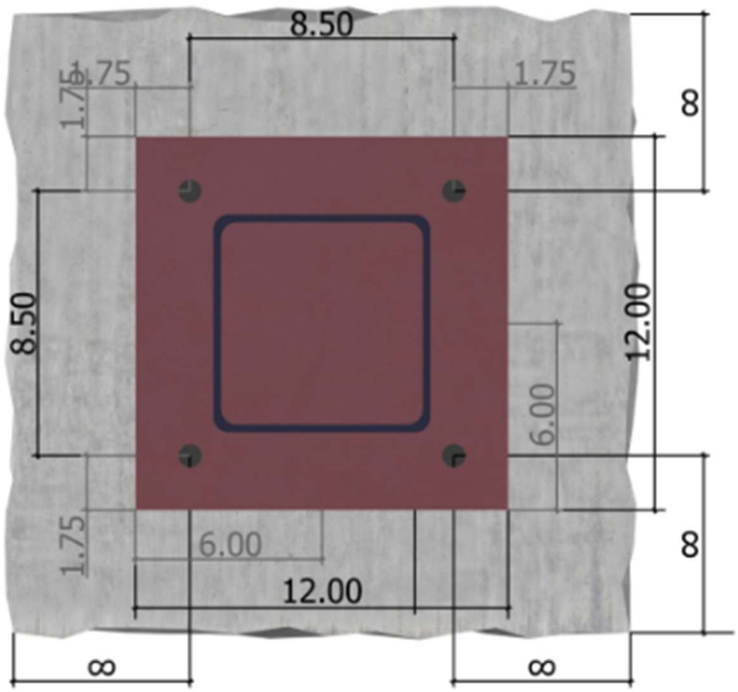
<Figure 2>

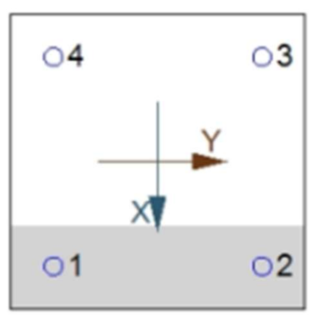


3. Resulting Anchor Forces

Anchor	Tension load, N_{ua} (lb)	Shear load x, V_{uax} (lb)	Shear load y, V_{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (lb)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	28557.1	0.0	0.0	0.0
4	28557.1	0.0	0.0	0.0
Sum	57114.3	0.0	0.0	0.0

Maximum concrete compression strain (‰): 1.28
Maximum concrete compression stress (psi): 5584
Resultant tension force (lb): 57114
Resultant compression force (lb): 113766
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00

<Figure 3>



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Version 3.3.2410.2

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4. Steel Strength of Anchor in Tension (Sec. 17.6.1)

N_{sa} (lb)	ϕ	ϕN_{sa} (lb)
40080	0.75	30060

5. Concrete Breakout Strength of Anchor in Tension (Sec. 17.6.2)

$N_b = 16\lambda_a\sqrt{f'_c}h_{ef}^{5/3}$ (Eq. 17.6.2.2.1)

λ_a	f'_c (psi)	h_{ef} (in)	N_b (lb)
1.00	4500	14.000	87285

$\phi N_{cbg} = \phi\,(A_{Nc}/A_{Nco})\,\Psi_{ec,N}\Psi_{ed,N}\Psi_{c,N}\Psi_{cp,N}N_b$ (Sec. 17.5.1.2 & Eq. 17.6.2.1a)

A_{Nc} (in^2)	A_{Nco} (in^2)	$c_{a,min}$ (in)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕN_{cbg} (lb)
2334.19	1764.00	-	1.000	1.000	1.25	1.000	87285	0.70	101061

6. Pullout Strength of Anchor in Tension (Sec. 17.6.3)

$\phi N_{pn} = \phi\Psi_{c,P}N_p = \phi\Psi_{c,P}8A_{brg}f'_c$ (Sec. 17.5.1.2, Eq. 17.6.3.1 & 17.6.3.2.2a)

$\Psi_{c,P}$	A_{brg} (in^2)	f'_c (psi)	ϕ	ϕN_{pn} (lb)
1.4	3.53	4500	0.70	124680

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11. Results

Interaction of Tensile and Shear Forces (Sec. 17.8)

Tension	Factored Load, N_{ua} (lb)	Design Strength, ϕN_n (lb)	Ratio	Status
Steel	**28557**	**30060**	**0.95**	**Pass (Governs)**
Concrete breakout	57114	101061	0.57	Pass
Pullout	28557	124680	0.23	Pass

PAB6H (3/4"Ø) with hef = 14.000 inch meets the selected design criteria.

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Address:			
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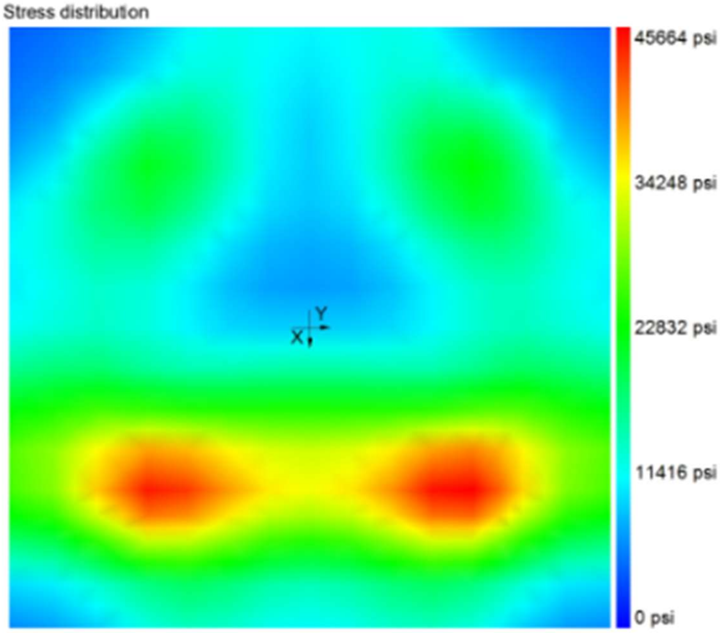
Base Plate Thickness

Required base plate thickness: 0.5 inches

Steel	**50763 psi**
Maximum stress	**45664 psi**
Calculated plate thickness	**1.342 inch**

Stress distribution



For ACI and CSA design methods, maximum base plate stress is limited to 0.9 times yield stress.
For ETAG design method, maximum base plate stress is limited to yield stress divide by 1.5.
Plate stress is derived using Von Mises theory.

$$\sigma_{xx} = \frac{F_{xx}}{t} + \frac{6M_{xx}}{t^2} \text{ (@ bottom) or } \sigma_{xx} = \frac{F_{xx}}{t} - \frac{6M_{xx}}{t^2} \text{ (@ top)}$$

$$\sigma_{yy} = \frac{F_{yy}}{t} + \frac{6M_{yy}}{t^2} \text{ (@bottom) or } \sigma_{yy} = \frac{F_{yy}}{t} - \frac{6M_{yy}}{t^2} \text{ (@ top)}$$

$$\sigma_{xy} = \frac{F_{xy}}{t} + \frac{6M_{xy}}{t^2} \text{ (@bottom) or } \sigma_{xy} = \frac{F_{xy}}{t} - \frac{6M_{xy}}{t^2} \text{ (@ top)}$$

$$\sigma_{xz} = \frac{V_x}{t}$$

$$\sigma_{yz} = \frac{V_y}{t}$$

$\sigma_{xx}, \sigma_{yy}, \sigma_{xy}$ as follows:

$$S_1 = \frac{\sigma_{xx} + \sigma_{yy}}{2} + \sqrt{\left(\frac{\sigma_{xx} - \sigma_{yy}}{2}\right)^2 + \sigma_{xy}^2}$$

$$S_2 = \frac{\sigma_{xx} + \sigma_{yy}}{2} - \sqrt{\left(\frac{\sigma_{xx} - \sigma_{yy}}{2}\right)^2 + \sigma_{xy}^2}$$

$$S_3 = 0$$

$$\sigma_{Von Mises} = \sqrt{\frac{(S_1 - S_2)^2 + (S_1 - S_3)^2 + (S_2 - S_3)^2}{2}}$$

12. Warnings

- Calculated concrete compression stress exceeds the permissible bearing stress of Φ 0.85f'c per ACI 318 Section 22.8.3.

- Designer must exercise own judgement to determine if this design is suitable.

Appendix B: Sidra Analysis Reports (Now-2095)

MOVEMENT SUMMARY

Site: 101 [Site1 (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

New Site
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
SouthEast: East Mall															
21	L2	All MCs	29	3.4	29	3.4	0.067	4.1	LOS A	0.4	2.3	0.46	0.28	0.46	11.1
23a	R1	All MCs	12	0.0	12	0.0	0.067	3.9	LOS A	0.4	2.3	0.46	0.28	0.46	25.2
23	R2	All MCs	28	3.6	28	3.6	0.067	4.1	LOS A	0.4	2.3	0.46	0.28	0.46	19.7
Approach			69	2.9	69	2.9	0.067	4.1	LOS A	0.4	2.3	0.46	0.28	0.46	16.2
NorthEast: Chancellor Boulevard															
24	L2	All MCs	39	2.6	39	2.6	0.412	6.3	LOS A	3.4	24.3	0.28	0.10	0.28	18.2
25	T1	All MCs	527	3.4	527	3.4	0.412	6.3	LOS A	3.4	24.3	0.28	0.10	0.28	18.4
26b	R3	All MCs	4	0.0	4	0.0	0.412	6.2	LOS A	3.4	24.3	0.28	0.10	0.28	27.7
Approach			570	3.3	570	3.3	0.412	6.3	LOS A	3.4	24.3	0.28	0.10	0.28	18.4
North: North Marine Drive															
7b	L3	All MCs	9	0.0	9	0.0	0.069	4.3	LOS A	0.4	3.1	0.68	0.52	0.68	24.1
7a	L1	All MCs	8	0.0	8	0.0	0.069	4.3	LOS A	0.4	3.1	0.68	0.52	0.68	23.2
9a	R1	All MCs	27	48.1	27	48.1	0.069	8.0	LOS A	0.4	3.1	0.68	0.52	0.68	24.8
Approach			44	29.5	44	29.5	0.069	6.4	LOS A	0.4	3.1	0.68	0.52	0.68	24.4
SouthWest: West Marine Drive															
30a	L1	All MCs	20	5.0	20	5.0	0.230	4.7	LOS A	1.5	10.4	0.23	0.08	0.23	28.9
31	T1	All MCs	242	4.0	242	4.0	0.230	4.7	LOS A	1.5	10.4	0.23	0.08	0.23	23.8
32	R2	All MCs	39	0.0	39	0.0	0.230	4.5	LOS A	1.5	10.4	0.23	0.08	0.23	20.8
Approach			301	3.5	301	3.5	0.230	4.7	LOS A	1.5	10.4	0.23	0.08	0.23	23.9
All Vehicles			984	4.5	984	4.5	0.412	5.6	LOS A	3.4	24.3	0.30	0.13	0.30	20.0

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: HCM Delay Formula (Stopline Delay: Geometric Delay is not included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 101 [Site1 (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

New Site
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 30 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total	HV]	Arrival Flows [Total	HV]	Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh.	Dist]	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
SouthEast: East Mall															
21	L2	All MCs	50	3.4	50	3.4	0.139	5.6	LOS A	0.8	5.2	0.63	0.44	0.63	10.3
23a	R1	All MCs	21	0.0	21	0.0	0.139	5.4	LOS A	0.8	5.2	0.63	0.44	0.63	23.4
23	R2	All MCs	48	3.6	48	3.6	0.139	5.6	LOS A	0.8	5.2	0.63	0.44	0.63	17.6
Approach			119	2.9	119	2.9	0.139	5.6	LOS A	0.8	5.2	0.63	0.44	0.63	15.0
NorthEast: Chancellor Boulevard															
24	L2	All MCs	67	2.6	67	2.6	0.742	13.4	LOS B	10.6	75.6	0.64	0.31	0.64	12.0
25	T1	All MCs	906	3.4	906	3.4	0.742	13.4	LOS B	10.6	75.6	0.64	0.31	0.64	13.1
26b	R3	All MCs	7	0.0	7	0.0	0.742	13.2	LOS B	10.6	75.6	0.64	0.31	0.64	20.7
Approach			980	3.3	980	3.3	0.742	13.4	LOS B	10.6	75.6	0.64	0.31	0.64	13.1
North: North Marine Drive															
7b	L3	All MCs	15	0.0	15	0.0	0.222	10.2	LOS B	1.4	11.8	0.93	0.80	0.93	18.1
7a	L1	All MCs	14	0.0	14	0.0	0.222	10.2	LOS B	1.4	11.8	0.93	0.80	0.93	17.0
9a	R1	All MCs	46	48.1	46	48.1	0.222	18.0	LOS B	1.4	11.8	0.93	0.80	0.93	18.5
Approach			76	29.5	76	29.5	0.222	14.6	LOS B	1.4	11.8	0.93	0.80	0.93	18.1
SouthWest: West Marine Drive															
30a	L1	All MCs	34	5.0	34	5.0	0.417	7.0	LOS A	3.5	24.3	0.40	0.18	0.40	25.9
31	T1	All MCs	416	4.0	416	4.0	0.417	7.0	LOS A	3.5	24.3	0.40	0.18	0.40	20.3
32	R2	All MCs	67	0.0	67	0.0	0.417	6.8	LOS A	3.5	24.3	0.40	0.18	0.40	17.4
Approach			518	3.5	518	3.5	0.417	6.9	LOS A	3.5	24.3	0.40	0.18	0.40	20.5
All Vehicles			1692	4.5	1692	4.5	0.742	10.9	LOS B	10.6	75.6	0.58	0.30	0.58	15.2

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: HCM Delay Formula (Stopline Delay: Geometric Delay is not included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 101 [Site1 (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

New Site
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 50 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	Demand Flows HV] %	Arrival Flows [Total veh/h	Arrival Flows HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	95% Back Of Queue Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
SouthEast: East Mall															
21	L2	All MCs	64	3.4	64	3.4	0.206	7.2	LOS A	1.3	8.4	0.74	0.56	0.74	9.7
23a	R1	All MCs	26	0.0	26	0.0	0.206	6.9	LOS A	1.3	8.4	0.74	0.56	0.74	21.8
23	R2	All MCs	62	3.6	62	3.6	0.206	7.2	LOS A	1.3	8.4	0.74	0.56	0.74	15.8
Approach			152	2.9	152	2.9	0.206	7.2	LOS A	1.3	8.4	0.74	0.56	0.74	13.8
NorthEast: Chancellor Boulevard															
24	L2	All MCs	86	2.6	86	2.6	0.979	43.8	LOS D [11]	59.1	419.7	1.00	1.26	1.62	4.9
25	T1	All MCs	1159	3.4	1159	3.4	0.979	43.8	LOS D [11]	59.1	419.7	1.00	1.26	1.62	5.9
26b	R3	All MCs	9	0.0	9	0.0	0.979	43.6	LOS D [11]	59.1	419.7	1.00	1.26	1.62	9.9
Approach			1254	3.3	1254	3.3	0.979	43.8	LOS D [11]	59.1	419.7	1.00	1.26	1.62	5.8
North: North Marine Drive															
7b	L3	All MCs	20	0.0	20	0.0	0.602	45.2	LOS D [11]	4.8	39.4	1.00	1.07	1.28	8.1
7a	L1	All MCs	18	0.0	18	0.0	0.602	45.2	LOS D [11]	4.8	39.4	1.00	1.07	1.28	7.4
9a	R1	All MCs	59	48.1	59	48.1	0.602	62.5	LOS E [11]	4.8	39.4	1.00	1.07	1.28	8.2
Approach			97	29.5	97	29.5	0.602	55.1	LOS E [11]	4.8	39.4	1.00	1.07	1.28	8.0
SouthWest: West Marine Drive															
30a	L1	All MCs	44	5.0	44	5.0	0.554	9.4	LOS A	5.7	39.7	0.55	0.27	0.55	23.3
31	T1	All MCs	532	4.0	532	4.0	0.554	9.3	LOS A	5.7	39.7	0.55	0.27	0.55	17.6
32	R2	All MCs	86	0.0	86	0.0	0.554	9.1	LOS A	5.7	39.7	0.55	0.27	0.55	14.8
Approach			662	3.5	662	3.5	0.554	9.3	LOS A	5.7	39.7	0.55	0.27	0.55	17.8
All Vehicles			2165	4.5	2165	4.5	0.979	31.2	LOS C	59.1	419.7	0.85	0.90	1.22	7.8

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: HCM Delay Formula (Stopline Delay: Geometric Delay is not included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

11 Level of Service is worse than the Level of Service Target specified in the Parameter Settings dialog.

MOVEMENT SUMMARY

Site: 101 [Site1 (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

New Site
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 70 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
SouthEast: East Mall															
21	L2	All MCs	78	3.4	78	3.4	0.297	9.7	LOS A	2.1	13.2	0.85	0.67	0.85	8.8
23a	R1	All MCs	32	0.0	32	0.0	0.297	9.4	LOS A	2.1	13.2	0.85	0.67	0.85	19.6
23	R2	All MCs	75	3.6	75	3.6	0.297	9.8	LOS A	2.1	13.2	0.85	0.67	0.85	13.6
Approach			185	2.9	185	2.9	0.297	9.7	LOS A	2.1	13.2	0.85	0.67	0.85	12.3
NorthEast: Chancellor Boulevard															
24	L2	All MCs	105	2.6	105	2.6	1.230	221.5	LOS F[11]	221.6	1573.7	1.00	4.12	6.07	1.1
25	T1	All MCs	1412	3.4	1412	3.4	1.230	221.5	LOS F[11]	221.6	1573.7	1.00	4.12	6.07	1.4
26b	R3	All MCs	11	0.0	11	0.0	1.230	221.3	LOS F[11]	221.6	1573.7	1.00	4.12	6.07	2.4
Approach			1528	3.3	1528	3.3	1.230	221.5	LOS F[11]	221.6	1573.7	1.00	4.12	6.07	1.4
North: North Marine Drive															
7b	L3	All MCs	24	0.0	24	0.0	0.742	66.0	LOS E[11]	6.4	52.8	1.00	1.17	1.48	6.3
7a	L1	All MCs	21	0.0	21	0.0	0.742	66.0	LOS E[11]	6.4	52.8	1.00	1.17	1.48	5.7
9a	R1	All MCs	72	48.1	72	48.1	0.742	83.6	LOS F[11]	6.4	52.8	1.00	1.17	1.48	6.4
Approach			118	29.5	118	29.5	0.742	76.1	LOS F[11]	6.4	52.8	1.00	1.17	1.48	6.2
SouthWest: West Marine Drive															
30a	L1	All MCs	54	5.0	54	5.0	0.673	12.2	LOS B	8.2	57.2	0.67	0.35	0.67	20.9
31	T1	All MCs	649	4.0	649	4.0	0.673	12.1	LOS B	8.2	57.2	0.67	0.35	0.67	15.2
32	R2	All MCs	105	0.0	105	0.0	0.673	11.9	LOS B	8.2	57.2	0.67	0.35	0.67	12.7
Approach			807	3.5	807	3.5	0.673	12.1	LOS B	8.2	57.2	0.67	0.35	0.67	15.4
All Vehicles			2637	4.5	2637	4.5	1.230	136.1	LOS F[11]	221.6	1573.7	0.89	2.59	3.85	2.2

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Roundabout LOS Method: SIDRA Roundabout LOS.
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: HCM Delay Formula (Stopline Delay: Geometric Delay is not included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

11 Level of Service is worse than the Level of Service Target specified in the Parameter Settings dialog.

Appendix C: October 9th 2024 Traffic Count Data

October 9th, 8:00-9:20AM Data:

		8:00 - 8:0	8:05- 8:10	8:10 - 8:1	8:15 - 8:2	8:20 - 8:2	8:25 - 8:3	8:30 - 8:3	8:35 - 8:4	8:40 - 8:4	8:45 - 8:5	8:50 - 8:5	8:55 - 9:0	9:00 - 9:0	9:05 - 9:1	9:10 - 9:1	9:15-9:20	TOTAL
	Car	11	6	13	9	11	10	11	16	23	15	22	23	16	16	11	11	224
	Bike	0	0	2	2	0	0	0	1	0	0	0	0	2	1	0	0	8
W-E	Truck	1	1	1	0	1	0	0	0	0	2	2	0	0	1	0	1	10
	Car	0	0	0	1	1	0	1	1	0	1	2	1	3	0	1	1	13
	Bike	0	1	0	0	2	1	0	0	0	0	0	0	1	0	1	0	6
W-N	Truck	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Car	0	0	2	1	1	3	4	3	3	4	2	4	3	5	0	1	36
	Bike	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	3
W-S	Truck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Car	0	0	2	2	2	2	0	1	4	0	7	1	2	2	0	0	25
	Bike	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	3
S-W	Truck	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Car	0	0	1	0	1	0	1	3	1	2	1	1	0	2	0	0	13
	Bike	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
N-W	Truck	0	0	0	0	2	0	2	2	1	2	0	0	2	1	1	0	13
	Car	20	20	27	23	36	30	25	36	35	27	35	35	54	46	26	25	500
	Bike	1	0	0	0	1	0	2	0	1	0	4	0	0	0	0	0	9
E-W	Truck	2	1	2	0	2	1	1	2	1	2	2	0	2	0	0	0	18
	Car	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	3
	Bike	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
E-N	Truck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Car	1	1	2	0	0	5	1	3	4	2	1	4	2	4	2	3	35
	Bike	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	3
E-S	Truck	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	Car	0	0	0	1	1	2	0	1	1	1	1	0	1	0	0	0	9
	Bike	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N-E	Truck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Car	0	0	2	1	1	2	3	2	2	2	2	5	2	0	1	1	26
	Bike	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
S-E	Truck	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	Car	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	3
	Bike	0	0	0	0	0	0	0	1	1	1	0	0	1	1	0	0	5
N-S	Truck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Car	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	2
	Bike	0	0	0	1	4	3	0	0	1	0	1	0	0	0	0	0	10
S-N	Truck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
																	Grand Tot	984

October 9th, 5:00PM-6:00 Data:

		5:00-5:05	5:05-5:10	5:10-5:15	5:15-5:20	5:20-5:25	5:25-5:30	5:30-5:35	5:35-5:40	5:40-5:45	5:45-5:50	5:50-5:55	5:55-6:00	TOTAL	
	Car	2	1	2	4	0	3	3	1	2	2	2	2	24	
	Bike	0	1	0	0	0	0	0	0	0	0	0	0	1	
W-S	Truck	0	0	0	0	0	0	0	0	0	0	0	0	0	W-S
	Car	2	2	4	2	3	0	2	2	1	0	0	0	18	
	Bike	1	0	0	2	1	1	0	1	0	0	0	0	6	
W-N	Truck	0	0	0	0	0	0	0	0	0	0	0	0	0	W-N
	Car	41	46	43	59	34	38	26	32	30	22	26	34	431	
	Bike	0	1	0	0	2	0	1	0	0	1	0	2	7	
W-E	Truck	0	1	0	0	0	1	0	2	1	0	0	0	5	W-E
	Car	3	1	1	1	3	3	1	1	0	1	3	1	19	
	Bike	0	0	0	1	0	0	0	1	0	0	0	0	2	
S-W	Truck	0	0	0	0	0	0	0	0	0	0	0	0	0	S-W
	Car	0	1	0	1	0	3	0	1	0	0	0	0	6	
	Bike	2	0	3	2	1	1	2	1	1	0	0	0	13	
S-N	Truck	0	0	0	0	0	0	0	0	0	0	0	0	0	S-N
	Car	0	4	5	6	0	1	8	2	4	4	4	1	39	
	Bike	2	1	0	0	0	3	0	3	1	0	0	0	10	
S-E	Truck	0	0	0	0	0	0	0	0	0	0	0	0	0	S-E
	Car	19	19	20	19	24	17	13	14	12	20	17	16	210	
	Bike	0	2	0	0	0	0	0	0	0	0	0	0	2	
E-W	Truck	0	0	0	0	0	0	0	0	0	0	0	0	0	E-W
	Car	1	0	2	3	0	0	1	3	0	2	3	3	18	
	Bike	0	0	0	1	0	0	0	0	0	0	0	0	1	
E-S	Truck	0	0	0	0	0	0	0	0	0	0	0	0	0	E-S
	Car	1	0	0	1	0	0	0	3	0	0	1	1	7	
	Bike	0	0	0	0	0	0	0	0	0	0	0	0	0	
E-N	Truck	1	0	0	0	0	0	0	0	0	0	0	0	1	E-N
	Car	0	1	3	4	1	4	0	1	2	3	2	1	22	
	Bike	1	1	2	0	0	0	0	0	0	0	0	0	4	
N-W	Truck	0	0	0	0	1	0	0	0	0	0	0	0	1	N-W
	Car	3	3	0	0	0	2	0	2	2	0	3	2	17	
	Bike	0	1	0	0	0	0	1	0	0	0	1	0	3	
N-E	Truck	0	0	0	0	1	0	0	0	0	0	0	0	1	N-E
	Car	1	1	0	1	0	1	0	0	0	0	1	0	5	
	Bike	0	0	0	0	0	0	0	0	0	0	0	2	2	
N-S	Truck	0	0	0	0	0	0	0	0	0	0	0	0	0	N-S
N		6	3	2	2	1	0	8	3	0	0	0	0	25	N
E		2	1	2	0	0	0	9	3	1	0	0	1	19	E
S		2	4	0	2	0	0	0	1	0	1	1	1	12	S
W	Pedestrian	0	0	0	0	0	0	7	0	0	7	1	0	15	W
												Grand Total		946	

Appendix D: Stormwater System & Raingarden Calculations

CIVL 445 - STORM SYSTEM CALCULATIONS

Q_design = CIA

C = Runoff Coefficient	
Asphalt Streets	0.83
Average (2-7%) Lawns	0.13
Drives and Walks	0.8
Concrete Streets	0.88

I = A * T^B	IDF Curve	City of Vancouver 2100 IDF - Took 5min storm b/c it produces the most instantaneous demand
T = Time (hours)	0.0833333	
A = Coefficient	46.64	
B = Coefficient	-0.568	
I = Rainfall Intensity (mm/hr)	191.31	
I = Rainfall Intensity (m/s)	5.31412E-05	

A = Tributary Drainage Area (m^2)	Asphalt	Lawn	Walks	Concrete Streets	Total Area	Q_design
CB 1	86.59	29.5188	50.86	0	166.9688	0.00618537
CB 2	76.59	26.07	36.12	0	138.78	0.00509384
CB 3	83.49	69.79	78.23	0	231.51	0.00749043
CB 4	118.69	178.1	62.82	0	359.61	0.00913612
CB 5	184.18	30.26	2.4	87.12	303.96	0.01250884
CB 6	222.32	75.46	105.75	148.45	551.98	0.02176510
CB 7	278.06	111.62	2.6	71.15	463.43	0.01647336
CB 8	139.66	33.73	61.01	0	234.4	0.00898674
CB 9	268.79	36.98	61.04	0	366.81	0.01470603
CB10	216.48	251.46	71.9	0	539.84	0.01434217
CB11	205.59	185.08	157.7	0	548.37	0.01705088
CB12	351.79	87.37	91.14	127.97	658.27	0.02597909
CB13	741.17	86.55	0	0	827.72	0.03328883

Q_design (Flow Demand)	m^3/s
PIPE 1	0.0112792
PIPE 2	0.0279058
PIPE 3	0.0404146
PIPE 4	0.0236928
PIPE 5	0.0619312
PIPE 6	0.0332888
PIPE 7	0.0592679
PIPE 8	0.1211991
PIPE 9	0.1211991
PIPE 10	0.0313931
PIPE 11 to stormwater retention tank	0.1930068

Manning's Formula

Q_capacity = (1/n)*R^(2/3)*s^(1/2)*A

n = Manning's Roughness Coefficient

R = Hydraulic Radius = Cross-Sectional Flow Area (A) / Wetted Perimeter (W)

s = Slope

A = Cross-Sectional Flow Area

Min Permissible Slope = 0.005

Q_capacity	n	Diameter (mm)	Radius (m)	A	W	R	s	Q_capacity	Q_demand	Q_cap >= Qdem?
PIPE 1	0.013	250	0.125	0.049	0.785	0.0625	0.030	0.102	0.0113	YES
PIPE 2	0.013	250	0.125	0.049	0.785	0.0625	0.030	0.103	0.0279	YES
PIPE 3	0.013	250	0.125	0.049	0.785	0.0625	0.030	0.103	0.0404	YES
PIPE 4	0.013	250	0.125	0.049	0.785	0.0625	0.005	0.041	0.0237	YES
PIPE 5	0.013	375	0.1875	0.110	1.178	0.09375	0.005	0.121	0.0619	YES
PIPE 6	0.013	250	0.125	0.049	0.785	0.0625	0.030	0.103	0.0333	YES
PIPE 7	0.013	250	0.125	0.049	0.785	0.0625	0.030	0.103	0.0593	YES
PIPE 8	0.013	375	0.1875	0.110	1.178	0.09375	0.005	0.125	0.1212	YES
PIPE 9	0.013	375	0.1875	0.110	1.178	0.09375	0.005	0.127	0.1212	YES
PIPE 10	0.013	250	0.125	0.049	0.785	0.0625	0.096	0.184	0.0314	YES
PIPE 11 to stormwater retention tank	0.013	600	0.3	0.283	1.885	0.15	0.010	0.614	0.1930	YES

Velocity Check	A (m^2)	Q_capacity (m^3/s)	Velocity (m/s)
PIPE 1	0.049	0.102	2.09
PIPE 2	0.049	0.103	2.10
PIPE 3	0.049	0.103	2.10
PIPE 4	0.049	0.041	0.84
PIPE 5	0.110	0.121	1.09
PIPE 6	0.049	0.103	2.09
PIPE 7	0.049	0.103	2.10
PIPE 8	0.110	0.125	1.14
PIPE 9	0.110	0.127	1.15
PIPE 10	0.049	0.184	3.76
PIPE 11 to stormwater retention tank	0.283	0.614	2.17

Formula

Velocity = Q_capacity / Cross-Sectional Flow Area (A)

Min Permissible Velocity

0.76 m/s

Max Permissible Velocity

4.6 m/s

Elevations (m)	Surface Elev	Inlet	Length	Outlet	Slope (%)	Notes
CB 1	73.89	72.39	11.65	71.2	10.2	Inlet = Surface Elev - 1.5m
CB 2	73.94	72.44	3.27	71.2	37.9	Min Permissible Slope = 2%
CB 3	74.17	72.67	10.85	70.77	17.5	
CB 4	74.13	72.63	2.06	70.77	90.3	
CB 5	74.53	73.03	6.81	70.29	40.2	
CB 6	73.22	71.72	5.51	70.34	25.0	
CB 7	73.34	71.84	5.85	70.34	25.6	
CB 8	72.12	70.62	5.23	70.47	2.9	
CB 9	72.08	70.58	5.19	70.47	2.1	
CB 10	75.3	73.8	5.53	71.98	32.9	
CB 11	75.3	73.8	6	71.98	30.3	
CB 12	74.1	72.6	2.82	70.72	66.7	
CB 13	74.76	73.26	3.63	71.17	57.6	

Elevations (m)	Inlet	Length	Outlet	Slope (%)			
PIPE 1	71.2	14.49	70.77	3.0	Min. Permissible Slope = 0.005		
PIPE 2	70.77	16.05	70.29	3.0			
PIPE 3	70.29	8.64	70.03	3.0	Min. MH drops based on pipe alignment deflection		
PIPE 4	70.47	27.23	70.34	0.5	0°	10	mm
PIPE 5	70.34	12.65	70.28	0.5	<= 45°	30	mm
PIPE 6	71.17	15.06	70.72	3.0	45° - 90°	50	mm
PIPE 7	70.72	14.62	70.28	3.0			
MH 1	70.28		70.23				
PIPE 8	70.23	3.91	70.21	0.5			
PIPE 9	70.21	34.51	70.03	0.5			
PIPE 10	71.98	20.26	70.03	9.6			
MH 2	70.03		69.98				
PIPE 11 to stormwater retention tank	69.98	1	69.97	1.0			

Sizing the Stormwater Detention Tank

Q_design = CIA * T

C = Runoff Coefficient	
Asphalt Streets	0.83
Average (2-7%) Lawns	0.13
Drives and Walks	0.8
Concrete Streets	0.88

I = A * T^B	IDF Curve	City of Vancouver 2100 IDF - Took 24h storm b/c it produces the most volume
T = Time (hours)	24	
A = Coefficient	46.64	
B = Coefficient	-0.568	
I = Rainfall Intensity (mm/hr)	7.67	
I = Rainfall Intensity (m/s)	2.13057E-06	

A = Tributary Drainage Area (m^2)	Asphalt	Lawn	Walks	Concrete Streets	Total Area	Q_design
CB 1	86.59	29.5188	50.86	0	166.9688	0.00024799
CB 2	76.59	26.07	36.12	0	138.78	0.00020423
CB 3	83.49	69.79	78.23	0	231.51	0.00030031
CB 4	118.69	178.1	62.82	0	359.61	0.00036629
CB 5	271.3	6.73	2.4	23.53	303.96	0.00052983
CB 6	370.77	35.34	105.75	40.12	551.98	0.00092092
CB 7	349.21	92.68	2.6	18.94	463.43	0.00068315
CB 8	139.66	33.73	61.01	0	234.4	0.00036030
CB 9	268.79	36.98	61.04	0	366.81	0.00058960
CB10	216.48	251.46	71.9	0	539.84	0.00057502
CB11	205.59	185.08	157.7	0	548.37	0.00068362
CB12	479.76	53.06	91.14	34.31	658.27	0.00108276
CB13	741.17	86.55	0	0	827.72	0.00133464

Q_design (Flow Demand)	m^3/s
PIPE 1	0.0004522
PIPE 2	0.0011188
PIPE 3	0.0016486
PIPE 4	0.0009499
PIPE 5	0.0025540
PIPE 6	0.0013346
PIPE 7	0.0024174
PIPE 8	0.0049714
PIPE 9	0.0049714
PIPE 10	0.0012586
PIPE 11 to stormwater retention tank	0.0078786

Manning's Formula

Q_capacity = (1/n)*R^(2/3)*s^(1/2)*A

n = Manning's Roughness Coefficient
R = Hydraulic Radius = Cross-Sectional Flow Area (A) / Wetted Perimeter (W)
s = Slope
A = Cross-Sectional Flow Area

T = Storm Duration	24	h
Volume Required	680.72	m^3

MC-7200 Tank	Quantity	Volume (m^3)
Chambers	82	7.56
End Caps	20	3.26
Total Volume	685.12	m^3

CIVL 445 - BIOSWALE CALCULATIONS

Q_design = CIA

C = Runoff Coefficient	
Asphalt Streets	0.83
Average (2-7%) Lawns	0.13
Drives and Walks	0.8
Concrete Streets	0.88

I = A * T^B	IDF Curve	
T = Time (hours)	24	
A = Coefficient	46.64	
B = Coefficient	-0.568	
I = Rainfall Intensity (mm/hr)	7.67	
I = Rainfall Intensity (m/s)	2.13057E-06	

City of Vancouver 2100 IDF - Took 24h storm b/c it produces the most volume

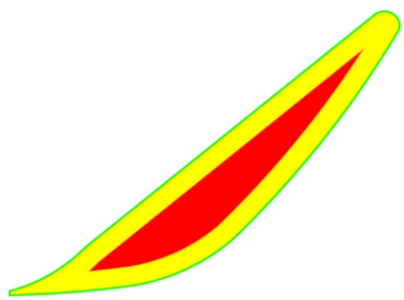
A = Tributary Drainage Area (m^2)	Asphalt	Lawn	Walks	Concrete Streets	Total Area	Q_design	
Bioswale	586.94	0	0	0	586.94	0.00104	m^3/s

Storm Duration	24	h
Volume Needed	89.7	m^3

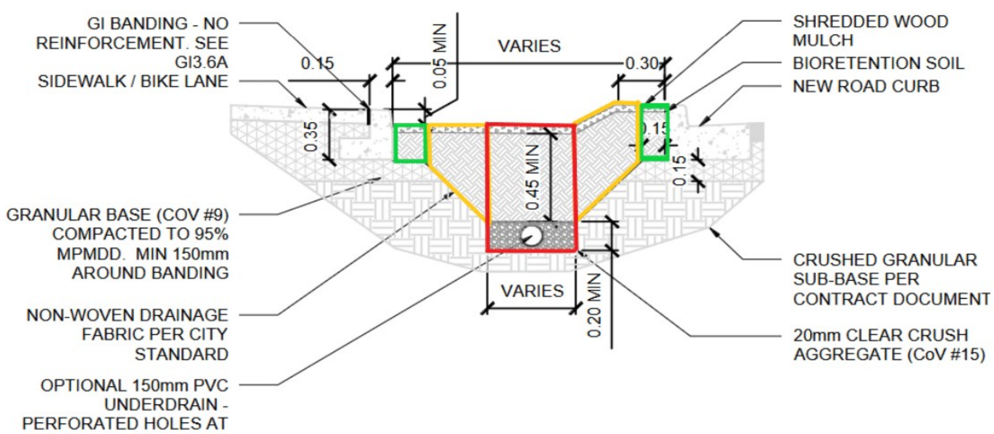
Region area measured in AutoCAD

Bioswale Capacity		
Soil Void Ratio	0.3	
Gravel Void Ratio	0.35	
Soil Depth	1.5	m
Gravel Depth	1	m

	Area (m^2)	Capacity (m^3)
Region 1	12.2	1.10
Region 2	106.39	33.51
Region 3	70.61	56.49



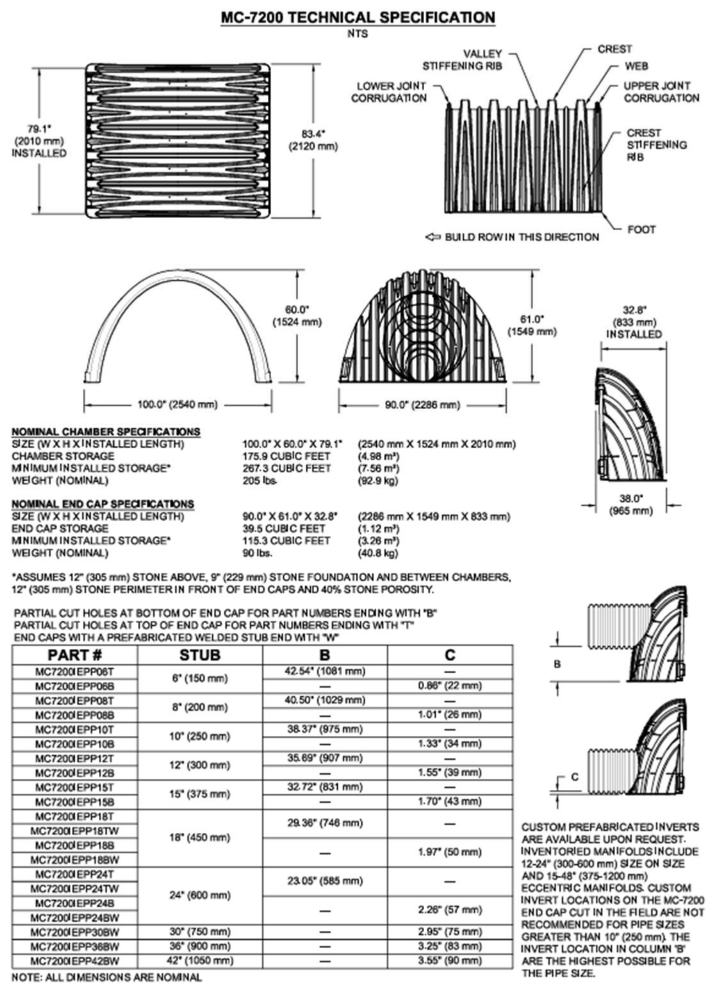
Total Capacity	91.1	m^3



B-B: STANDARD SWALE SECTION

area	116.899	M2						
input volume (M^3)	0		Impervious Area (%)	0.65				
rain garden width (m)	1							
evapouration (m^3)	0.1169		rate (mm/d)	1	impervious area			
growing med	14.0278		**depth of growing med**	0.6	field cap	0.25	wilt cap	0.05
rock pit	24.5487		**depth of rock pit (m)**	0.6	porosity	0.35		
infiltration	4.20835		sat. hydrulic conduct	1.5				
capture Volume (m^3)	**42.9018**							

Appendix E: Supplementary Stormwater Design Information



NOMINAL CHAMBER SPECIFICATIONS

SIZE (W X H X INSTALLED LENGTH)	100.0" X 60.0" X 79.1"	(2540 mm X 1524 mm X 2010 mm)
CHAMBER STORAGE	175.9 CUBIC FEET	(4.98 m³)
MINIMUM INSTALLED STORAGE*	267.3 CUBIC FEET	(7.56 m³)
WEIGHT (NOMINAL)	205 lbs.	(92.9 kg)

NOMINAL END CAP SPECIFICATIONS

SIZE (W X H X INSTALLED LENGTH)	90.0" X 61.0" X 32.8"	(2286 mm X 1549 mm X 833 mm)
END CAP STORAGE	39.5 CUBIC FEET	(1.12 m³)
MINIMUM INSTALLED STORAGE*	115.3 CUBIC FEET	(3.26 m³)
WEIGHT (NOMINAL)	90 lbs.	(40.8 kg)

*ASSUMES 12" (305 mm) STONE ABOVE, 9" (229 mm) STONE FOUNDATION AND BETWEEN CHAMBERS, 12" (305 mm) STONE PERIMETER IN FRONT OF END CAPS AND 40% STONE POROSITY.

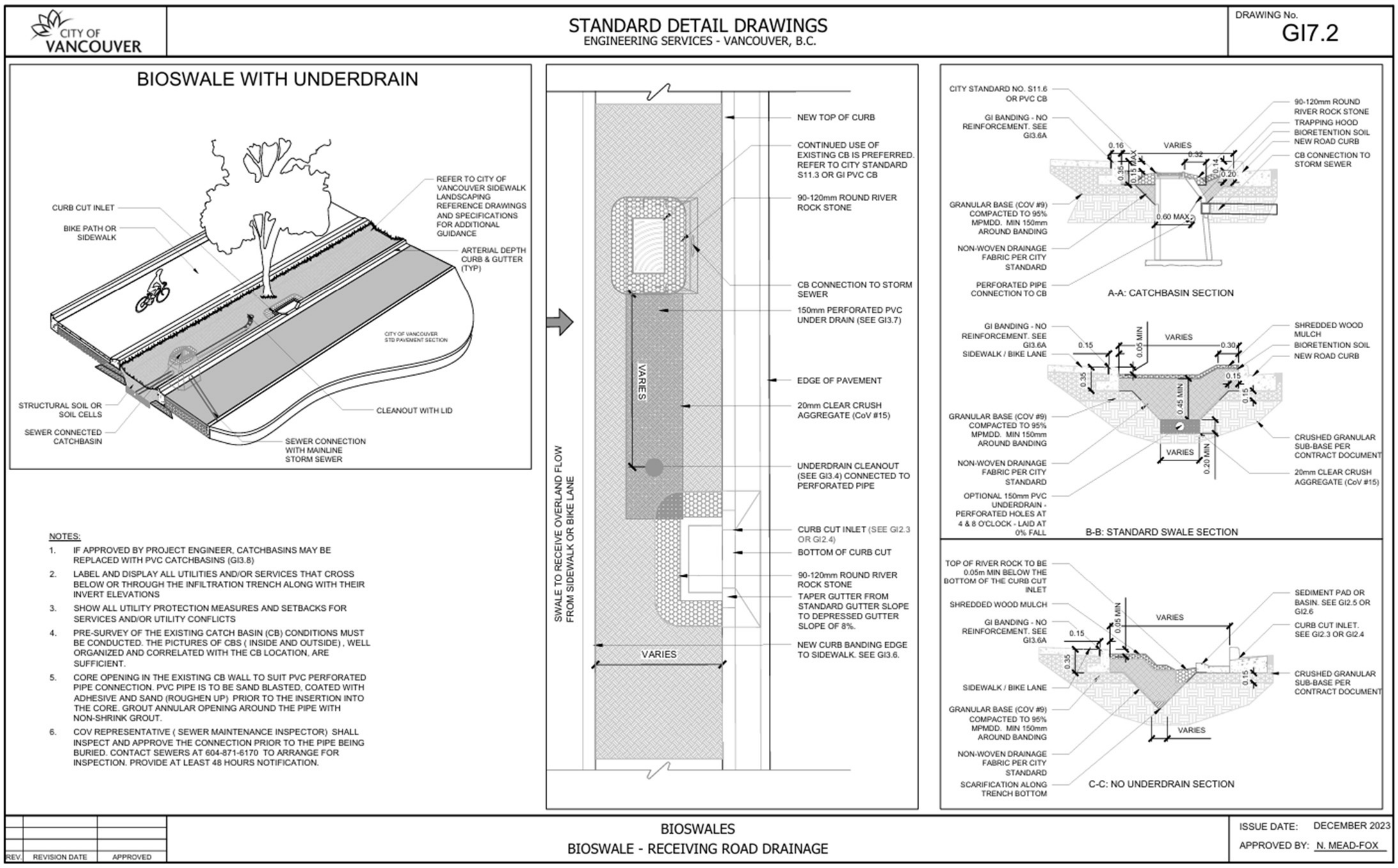
PARTIAL CUT HOLES AT BOTTOM OF END CAP FOR PART NUMBERS ENDING WITH "B"
PARTIAL CUT HOLES AT TOP OF END CAP FOR PART NUMBERS ENDING WITH "T"
END CAPS WITH A PREFABRICATED WELDED STUB END WITH "W"

PART #	STUB	B	C
MC7200IEPP06T	6" (150 mm)	42.54" (1081 mm)	—
MC7200IEPP06B		—	0.86" (22 mm)
MC7200IEPP08T	8" (200 mm)	40.50" (1029 mm)	—
MC7200IEPP08B		—	1.01" (26 mm)
MC7200IEPP10T	10" (250 mm)	38.37" (975 mm)	—
MC7200IEPP10B		—	1.33" (34 mm)
MC7200IEPP12T	12" (300 mm)	35.69" (907 mm)	—
MC7200IEPP12B		—	1.55" (39 mm)
MC7200IEPP15T	15" (375 mm)	32.72" (831 mm)	—
MC7200IEPP15B		—	1.70" (43 mm)
MC7200IEPP18T	18" (450 mm)	29.36" (746 mm)	—
MC7200IEPP18TW			
MC7200IEPP18B		—	1.97" (50 mm)
MC7200IEPP18BW			
MC7200IEPP24T	24" (600 mm)	23.05" (585 mm)	—
MC7200IEPP24TW			
MC7200IEPP24B		—	2.26" (57 mm)
MC7200IEPP24BW			
MC7200IEPP30BW	30" (750 mm)	—	2.95" (75 mm)
MC7200IEPP36BW	36" (900 mm)	—	3.25" (83 mm)
MC7200IEPP42BW	42" (1050 mm)	—	3.55" (90 mm)

NOTE: ALL DIMENSIONS ARE NOMINAL

CUSTOM PREFABRICATED INVERTS ARE AVAILABLE UPON REQUEST. INVENTORIED MANIFOLDS INCLUDE 12-24" (300-600 mm) SIZE ON SIZE AND 15-48" (375-1200 mm) ECCENTRIC MANIFOLDS. CUSTOM INVERT LOCATIONS ON THE MC-7200 END CAP CUT IN THE FIELD ARE NOT RECOMMENDED FOR PIPE SIZES GREATER THAN 10" (250 mm). THE INVERT LOCATION IN COLUMN 'B' ARE THE HIGHEST POSSIBLE FOR THE PIPE SIZE.

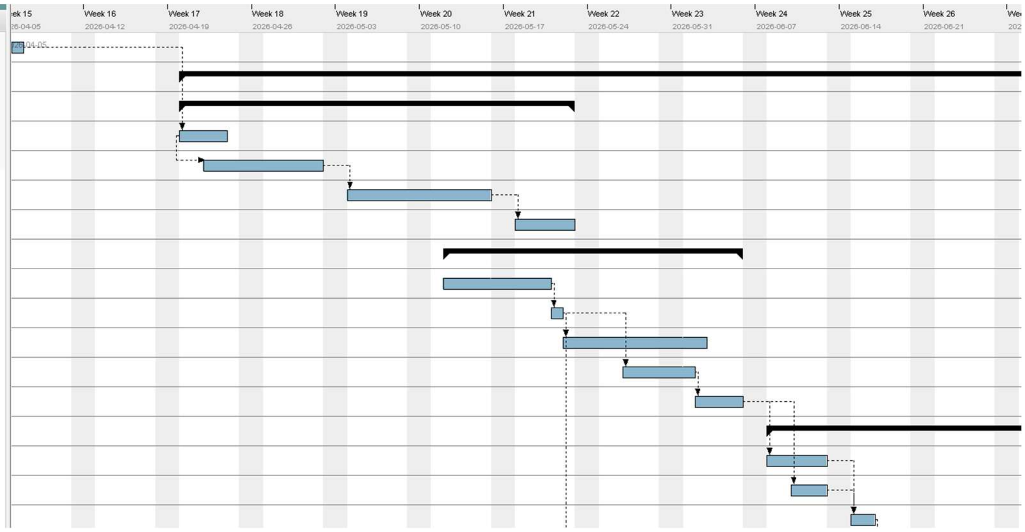
MC-7200 Stormwater Tank Technical Specification Detail



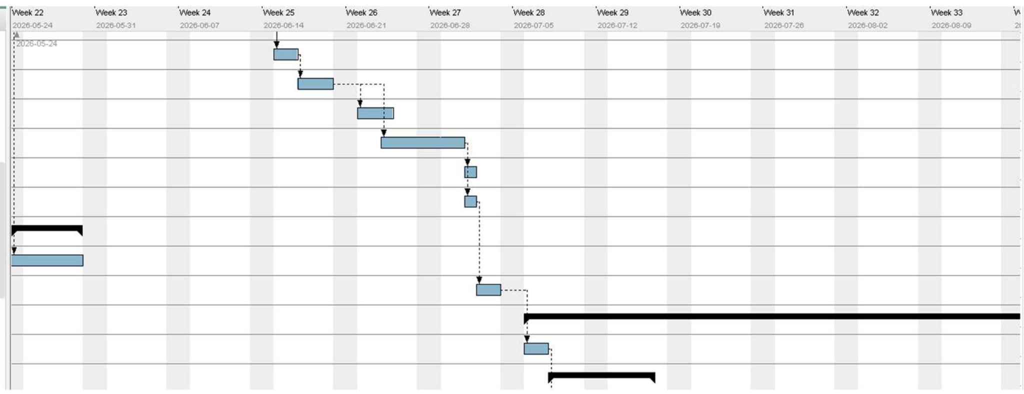
City of Vancouver Standard Bioswale with Underdrain Detail

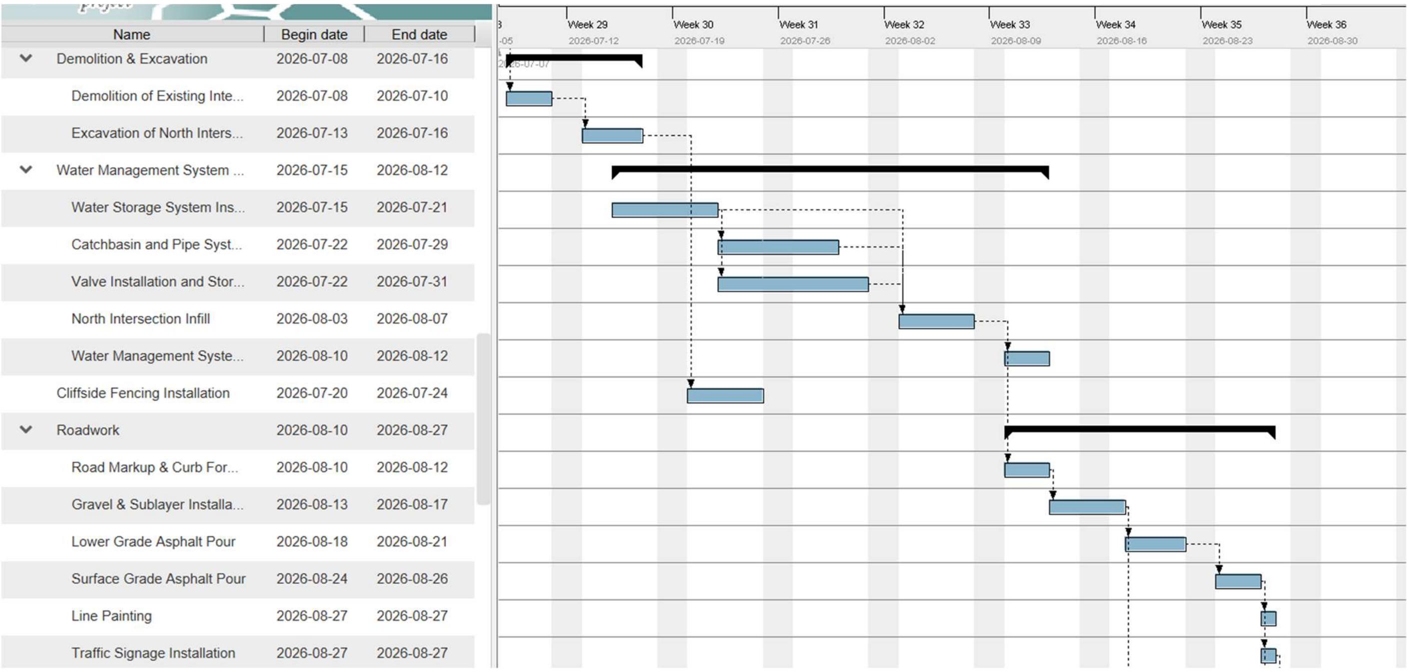
Appendix F: Project Schedule

Name	Begin date	End date
Inital Construction Notification	2026-04-06	2026-04-06
Phase 1: South Intersection & ...	2026-04-20	2026-07-03
Demolition & Excavation	2026-04-20	2026-05-22
Site Office & Traffic Mana...	2026-04-20	2026-04-23
Demolition of South Inters...	2026-04-22	2026-05-01
Excavation of South Inters...	2026-05-04	2026-05-15
Demolition of East Mall, lo...	2026-05-18	2026-05-22
Water Management Installati...	2026-05-12	2026-06-05
Water Tank System Asse...	2026-05-12	2026-05-20
Water Tank Temporary C...	2026-05-21	2026-05-21
Catchbasin and Pipe Syst...	2026-05-22	2026-06-02
Intersection Infill	2026-05-27	2026-06-01
Roadway Infill	2026-06-02	2026-06-05
Roadwork	2026-06-08	2026-07-01
Roadway Soil Compaction	2026-06-08	2026-06-12
Road Markup & Curb For...	2026-06-10	2026-06-12
Gravel & Sublayer Installa...	2026-06-15	2026-06-16

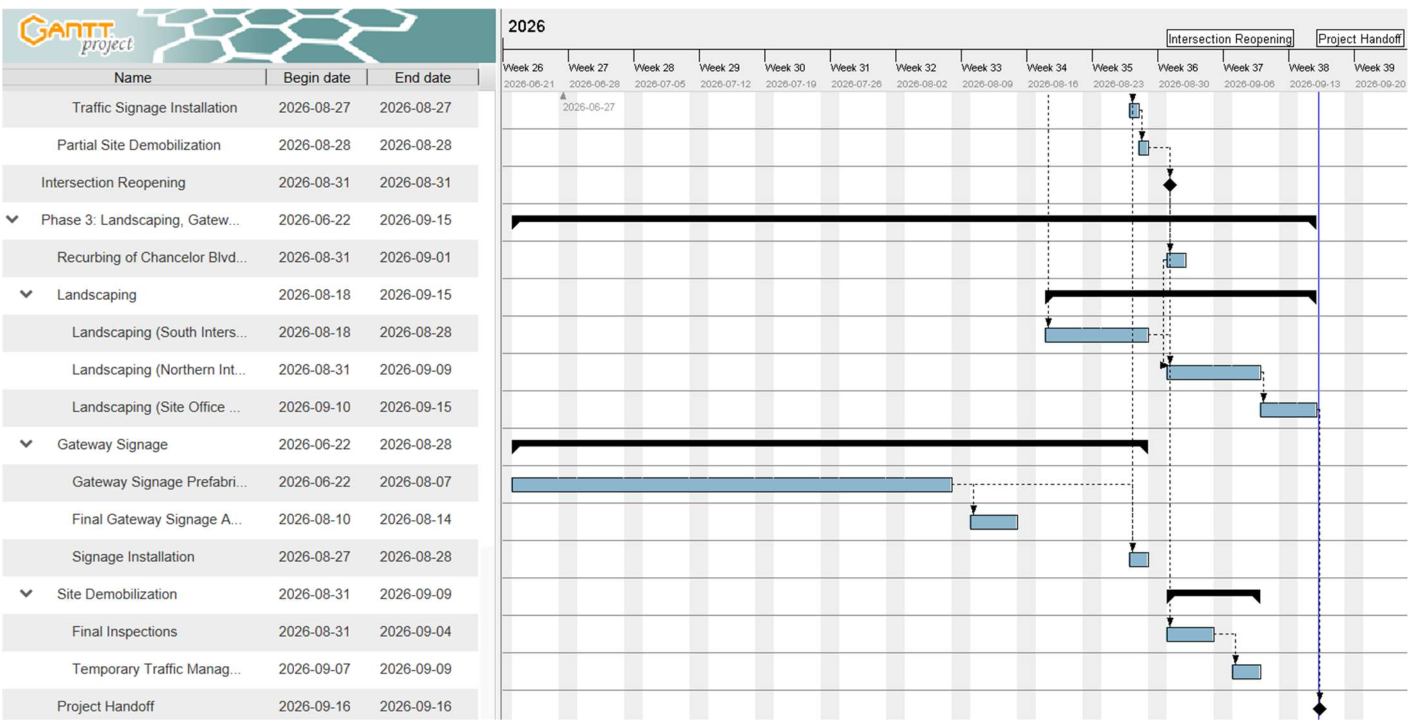


Name	Begin date	End date
Gravel & Sublayer Installa...	2026-06-15	2026-06-16
Lower Course Concrete P...	2026-06-17	2026-06-19
Surface Course Asphalt P...	2026-06-22	2026-06-24
Concrete Sidewalk & Cur...	2026-06-24	2026-06-30
Line Painting	2026-07-01	2026-07-01
Pernament Traffic Signag...	2026-07-01	2026-07-01
Gateway Signage Footing	2026-05-22	2026-05-29
Gateway Signage Footing...	2026-05-22	2026-05-29
Partial Project Handoff	2026-07-02	2026-07-03
Phase 2: North Intersection & ...	2026-07-06	2026-08-28
Traffic Management and Te...	2026-07-06	2026-07-07
Demolition & Excavation	2026-07-08	2026-07-16





Name	Begin date	End date
Demolition & Excavation	2026-07-08	2026-07-16
Demolition of Existing Inte...	2026-07-08	2026-07-10
Excavation of North Inters...	2026-07-13	2026-07-16
Water Management System ...	2026-07-15	2026-08-12
Water Storage System Ins...	2026-07-15	2026-07-21
Catchbasin and Pipe Syst...	2026-07-22	2026-07-29
Valve Installation and Stor...	2026-07-22	2026-07-31
North Intersection Infill	2026-08-03	2026-08-07
Water Management Syste...	2026-08-10	2026-08-12
Cliffside Fencing Installation	2026-07-20	2026-07-24
Roadwork	2026-08-10	2026-08-27
Road Markup & Curb For...	2026-08-10	2026-08-12
Gravel & Sublayer Installa...	2026-08-13	2026-08-17
Lower Grade Asphalt Pour	2026-08-18	2026-08-21
Surface Grade Asphalt Pour	2026-08-24	2026-08-26
Line Painting	2026-08-27	2026-08-27
Traffic Signage Installation	2026-08-27	2026-08-27



Name	Begin date	End date
Traffic Signage Installation	2026-08-27	2026-08-27
Partial Site Demobilization	2026-08-28	2026-08-28
Intersection Reopening	2026-08-31	2026-08-31
Phase 3: Landscaping, Gatew...	2026-06-22	2026-09-15
Recurbing of Chancelor Blvd...	2026-08-31	2026-09-01
Landscaping	2026-08-18	2026-09-15
Landscaping (South Inters...	2026-08-18	2026-08-28
Landscaping (Northern Int...	2026-08-31	2026-09-09
Landscaping (Site Office ...	2026-09-10	2026-09-15
Gateway Signage	2026-06-22	2026-08-28
Gateway Signage Prefabri...	2026-06-22	2026-08-07
Final Gateway Signage A...	2026-08-10	2026-08-14
Signage Installation	2026-08-27	2026-08-28
Site Demobilization	2026-08-31	2026-09-09
Final Inspections	2026-08-31	2026-09-04
Temporary Traffic Manag...	2026-09-07	2026-09-09
Project Handoff	2026-09-16	2026-09-16

Appendix G: Class A Cost Estimate

Section Description	Item	Sub-Item	Quantity	Unit	Unit Cost ($)	Total Cost ($)
General Costs						
	Site Mobilization and Demobilization					
		Equipment Transport to Site	1	LS	50693	51000
		Temporary Office & Storage Setup	500	sqft	475	237000
		Utility Connections (Power)	1	LS	944	1000
		Utility Connections (Water)	6	months	425	3000
		Initial Safety & Environmental Setup	1	LS	314755	315000
		Site Cleanup & Facility Removal	1	LS	75923	76000
		Portapotty & Cleaning	18	month-units	236	4000
	Safety and Traffic Control					
		Traffic Control Planning	21	weeks	1162	24000
		Traffic Control Personnel (Flaggers & Supervisors)	3	worker	52700	158000
		Standard Traffic Signs	21	weeks	2100	44000

Section Description	Item	Sub-Item	Quantity	Unit	Unit Cost ($)	Total Cost ($)
		Traffic Cones	21	weeks	560	12000
		Barricades	21	weeks	2100	44000
		Portable Traffic Signals	21	weeks	2520	53000
		Temporary Road Markings (Painted Lanes)	500	m	2.30	1000
	General Contractor Costs					
		Project Management & Supervision	1	LS % 10	753516	754000
		Administrative & Legal Costs	1	LS % 15	600000	600000
		Permitting & Compliance Fees	1	LS	100000	100000
	Environmental Compensation					
		Habitat Restoration (e.g., tree planting, wetland restoration)	3770	m^2	26	97000
		Stormwater Management Fees (Municipal Compliance)	1	LS	5000	5000
		Erosion & Sediment Control Measures	1	LS	18000	18000

Section Description	Item	Sub-Item	Quantity	Unit	Unit Cost ($)	Total Cost ($)
		Environmental Monitoring & Reporting	1	LS	13290	13000
	Stakeholder Engagement and Consultation					
		Public Meetings (Venue, Facilitators, Materials)	2	EA	8000	16000
		Stakeholder Workshops	3	EA	2000	6000
		Indigenous Consultation & Engagement	1	LS	20000	20000
		Public Communication (Website, Flyers, Surveys)	1	LS	14470	14000
Removals						
	Asphalt Removal and Disposal		3,231	M2	65.38	211000
	Curb and Gutter Removal and Disposal		354	LM	37.36	13000
	Concrete Sidewalk Removal and Disposal		112	M2	52.31	6000

Section Description	Item	Sub-Item	Quantity	Unit	Unit Cost ($)	Total Cost ($)
	Landscaping Removal and Disposal		1435	M2	11.68	17000
	Till Excavation and Relocation		6106	M3	11.68	71000
Water Management Installation						
	Stormwater Retention Tanks and Connections					
		Stormwater Retention - MC-7200 Tank	21	EA	5268	111000
		200 mm Dia PVC - CB Leads	74.4	M	22.76	2000
		Catchbasins - BC MoTI - Standard Detail Drawing SP582-02.02	4	EA	992	4000
		250mm dia PVC - Storm Main Connection	137	M	31.21	4000
		375mm dia PVC - Storm Main Connection	51	M	83.59	4000
		600mm dia HDPE - Storm Main Connection	1	M	160	160

Section Description	Item	Sub-Item	Quantity	Unit	Unit Cost ($)	Total Cost ($)
		Manholes - BC MoTI - Standard Detail Drawing SP582-03.01	2	EA	4000	8000
	Raingarden & Landscaping		500	m²	180	90000
Roadwork & Multimodal Construction						
	Roadwork					
		Supply, Placement, and Grading of Gravel	2148	M2	28.02	60000
		Asphalt Top Pavement Course	2148	M2	74.72	161000
		Asphalt Bottom Pavement Course	2148	M2	74.72	161000
		Asphalt Tack Coat	2148	M2	7.00	15000
		Truck Apron - 100mm Brick Stamped Concrete	444	M2	95	42000
		Line Painting	2000	ft	1.00	2000
	Sidewalk & Gutter Construction					
		Supply, Placement, and Grading of Gravel	628	M2	28.02	18000

Section Description	Item	Sub-Item	Quantity	Unit	Unit Cost ($)	Total Cost ($)
		Concrete Form and Pour for Curb and Gutter	625	M2	146	91000
		Concrete Form and Pour for 1.8m Sidewalk	628	M2	169	106000
		Tactile Tiles	12	EA	278	3000
	Infill & Roadway Base Material					
		Granular Base Fill	99.4	M3	900	89000
		Structural Fill	45	M3	450	20000
	Misc.					
		Topsoil and Landscaping Placement	1558	M2	28.02	44000
		Seeding and Landscaping	1	LS	50000	50000
		Traffic Signage Supply and Install	1	LS	12000	12000
		New Fencing - Supply and Install	77	LM	14.94	1000
Gateway Sign Construction						
	Materials					

Section Description	Item	Sub-Item	Quantity	Unit	Unit Cost ($)	Total Cost ($)
		30Mpa Concrete	12	M3	432	5000
		20M Rebar	150	M	59.68	9000
		W310x129 Steel Frame	22	M	660	15000
		300mmx300mmx13mm Base Plate	2	EA	450	1000
		PAB6H (3/4") Anchors Bolts	8	EA	73.5	1000
		HSS178x178x13 Column	1	M	780	1000
		8mx6mx0.025m Steel Plate	1.2	M3	15000	18000
		Sign Components	1	EA	12000	12000
	Installation					
		Frame Fabrication and Erection	1	LS	24000	24000
		Concrete Formwork and Pour	12	M3	70	1000
		Electrical Hookup	1	LS	2000	2000

Section Description	Item	Sub-Item	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Contingencies & Taxes						
	Contingency (10%)					417,000
	PST (7%)					292,000
	GST (5%)					209,000
Project Total						5,088,000

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Appendix I: Issued For Construction Drawing Package

GENERAL NOTES

1. ANY SIGNIFICANT REVISIONS TO THESE DRAWINGS MUST BE APPROVED BY THE OWNER'S ENGINEER, WHO SHALL REVIEW ANY CHANGES WITH THE MUNICIPAL ENGINEER, PRIOR TO ANY CONSTRUCTION.
2. WORKSAFE BC IS TO BE GIVEN NOTICE OF CONSTRUCTION PRIOR TO THE START OF CONSTRUCTION.
3. CONSTRUCTION MAY NOT COMMENCE PRIOR TO THE ISSUANCE OF A "PERMISSION TO CONSTRUCT" OR A "NOTIFICATION TO PROCEED".
4. EXISTING UNDERGROUND UTILITIES ARE TO BE LOCATED (EXCAVATED AND SURVEYED) PRIOR TO INSTALLING ANY NEW UNDERGROUND SERVICES. ANY DISCREPANCY IN ELEVATION OR LOCATION IS TO BE REFERRED TO THE OWNER'S ENGINEER.
5. RESIDENTS AFFECTED BY THE PROPOSED CONSTRUCTION ARE TO BE NOTIFIED BY THE CONTRACTOR IN WRITING TWO COMPLETE WORKING WEEKS PRIOR TO THE START OF CONSTRUCTION AND PROVIDED WITH THE CONTRACTOR'S PHONE NUMBER AND SCHEDULE.
6. THE OWNER AND CONTRACTOR WILL BE HELD RESPONSIBLE FOR THE REPAIR OF ANY DAMAGE CAUSED TO EXISTING STREETS OR SERVICES BY CONSTRUCTION EQUIPMENT AND/OR TRUCKS HAULING MATERIALS TO THE SITE. THIS WILL INCLUDE DAILY CLEANING AND SWEEPING OF EXISTING ROADS OF DIRT AND DEBRIS CAUSED BY CONSTRUCTION ACTIVITY.
7. TRAFFIC CONTROL IS TO BE MAINTAINED AT ALL TIMES WHEN WORKING ON MUNICIPAL RIGHTS-OF-WAY (SIGNS, BARRICADES, CERTIFIED FLAG PERSONS). A HIGHWAY USE PERMIT MUST BE OBTAINED FROM THE TOWNSHIP OF LANGLEY ENGINEERING DEPARTMENT PRIOR TO WORKS WITHIN THE MUNICIPAL RIGHT-OF-WAY.
8. CONSTRUCTION IN AND CLOSE TO A WATERCOURSE MUST RECEIVE PRIOR APPROVAL FROM THE PROVINCIAL MINISTRY OF ENVIRONMENT AND/OR THE FEDERAL DEPT. OF FISHERIES AND OCEANS, WHERE APPLICABLE, BEFORE THE TOWNSHIP OF LANGLEY ACCEPTS OWNER'S CIVIL PLANS.
9. PERMANENT STREET, TRAFFIC AND ADVISORY SIGNS AND PAVEMENT MARKINGS REQUIRED BUT NOT NECESSARILY SHOWN ON THE DRAWINGS, MUST BE INSTALLED BY THE TOWNSHIP OF LANGLEY, AND ALL COSTS CHARGED TO OWNER, UNLESS OTHERWISE NOTED.
10. LEGAL SURVEY POSTS, MONUMENTS, STAKES AND INTEGRATED SURVEY MONUMENTS ARE TO BE REPLACED IF DESTROYED OR DAMAGED DURING CONSTRUCTION AT THE OWNER'S EXPENSE; THIS WORK IS TO BE UNDERTAKEN BY A B.C. LAND SURVEYOR UNLESS OTHERWISE NOTED.
11. TOWNSHIP OF LANGLEY'S SURVEY MONUMENTS ARE TO BE PROTECTED AND A MINIMUM OF 2.5m CLEARANCE SHOULD BE MAINTAINED. GROUND DISTURBANCE WORKS WITHIN THE 2.5m CLEARANCE RESULT IN THE MONUMENT CONSIDERED DESTROYED OR DAMAGED, AND THE CONTRACTOR MUST NOTIFY THE MUNICIPAL INSPECTOR AT LEAST 72 HOURS IN ADVANCE OF SCHEDULING WORK AFFECTING THEM.
12. MATERIAL SUPPLIED AND CONSTRUCTION PERFORMED ARE TO BE IN ACCORDANCE WITH THE SUBDIVISION & DEVELOPMENT SERVICING BYLAW, MMCD SPECIFICATIONS, AND APPLICABLE DESIGN CRITERIA AND SPECIFICATION STANDARD DRAWINGS IN EFFECT AT THE TIME OF DRAWING ACCEPTANCE.
13. THE TOWNSHIP OF LANGLEY HAS A LIST OF APPROVED MATERIALS AND PRODUCTS AS LISTED IN SCHEDULE "D" OF THE SUBDIVISION AND DEVELOPMENT SERVICING BYLAW. ONLY THOSE MATERIALS ON THE LIST OR, IF NOT ON THE LIST, SPECIFIED WITHIN THE MMCD MASTER MUNICIPAL SPECIFICATIONS MAY BE USED IN THE WORKS.
14. APPROVED GRANULAR MATERIAL MUST BE USED FOR BACKFILL IN TRENCHES WHEN INSIDE ROAD LIMITS. APPROVED NATIVE MATERIAL MAY BE USED ONLY AS CONFIRMED IN WRITING BY A GEOTECHNICAL ENGINEER, AND ACCEPTED BY THE MUNICIPAL ENGINEER.
15. WHERE UTILITY OR SERVICE CROSSINGS ARE REQUIRED ACROSS EXISTING PAVEMENT, AUGERING AND JACKING ARE REQUIRED UNLESS THE OWNER'S CONTRACTOR RECEIVES APPROVAL FROM THE MUNICIPAL ENGINEER FOR OPEN CUT OPERATIONS. ALL EXISTING PAVEMENT, BOULEVARDS, DRIVEWAYS, ETC. WHICH ARE DISTURBED DURING CONSTRUCTION MUST BE RESTORED TO ORIGINAL OR BETTER CONDITION, WHERE NO IMPROVEMENT IS OTHERWISE PROPOSED UNDER THIS CONTRACT. EXISTING DRIVEWAYS MUST BE SHAPED ACROSS THE WIDTH OF BOULEVARD TO FORM A SMOOTH TRANSITION WITH NEW PAVEMENT. THE FINISHED PAVEMENT SURFACE OVER TRENCH EXCAVATIONS MUST BLEND IN SMOOTHLY WITH EXISTING PAVEMENT.
16. WHERE INFILLING OF DITCHES ETC. IS REQUIRED OR PROPOSED, AND WHERE SERVICES ARE CONSTRUCTED IN FILL SECTIONS, THE FILL MATERIAL MUST BE APPROVED GRANULAR MATERIAL PLACED IN LIFTS NOT EXCEEDING 300mm AND COMPACTED TO 95% MODIFIED PROCTOR DENSITY.
17. NEW SERVICE CONNECTIONS ARE TO BE LOCATED AT CENTRE-LINE OF LOT FRONTAGE AS SHOWN ON TOWNSHIP OF LANGLEY SUBDIVISION AND DEVELOPMENT SERVICING BYLAW STANDARDS, OR AS NOTED ON DRAWINGS.
18. FIGURED DIMENSIONS SHALL GOVERN OVER SCALED DIMENSIONS.
19. OFFSETS AND SIZES OF ALL EXISTING MAINS, CONNECTIONS AND OTHER UTILITIES MUST BE DEPICTED ON THE KEY PLAN.
20. ALL REFERENCES TO MMCD REFER TO THE MOST RECENT EDITION.
21. ALL REFERENCES TO MMCD MASTER MUNICIPAL SPECIFICATIONS INCLUDE TOWNSHIP OF LANGLEY SUPPLEMENTARY SPECIFICATIONS, WHICH SUPERCEDE THE MMCD SPECIFICATIONS.

LOT GRADING

1. FOR URBAN DEVELOPMENT, LOTS ARE TO BE GRADED TO DESIGN GRADES AT CONTROL POINTS AND +/- 100mm BETWEEN CONTROL POINTS PRIOR TO THE INSPECTION FOR SUBSTANTIAL COMPLETION, UNLESS OTHERWISE NOTED.
2. LOTS ARE TO BE GRADED TO A MINIMUM SLOPE OF 2.0%. LOT GRADING MUST BE UNIFORM AND CONSISTENT.
3. GRADING IS TO MEET EXISTING GROUND ELEVATIONS AT PROPERTY LINES COMMON WITH ADJOINING PROPERTIES UNLESS OTHERWISE NOTED. WHERE GRADING DOES NOT MEET EXISTING GROUND ELEVATIONS, APPROPRIATE PROTECTION MEASURES ARE TO BE TAKEN BY THE CONTRACTOR, TO THE SATISFACTION OF THE MUNICIPAL ENGINEER.
4. LOTS MARKED WITH THE "FILL" SYMBOL ARE SUBJECT TO BUILDING DEPARTMENT REVIEW AND MAY REQUIRE AN ENGINEERED FOUNDATION/FOOTINGS DESIGN BY A QUALIFIED GEOTECHNICAL ENGINEER.
5. MINIMUM BUILDING ELEVATION (M.B.E.) FOR LOTS ARE SET IN ACCORDANCE WITH THE SUBDIVISION AND DEVELOPMENT SERVICING BYLAW.
6. RAIN WATER LEADERS ARE TO DISCHARGE TO SPLASH PADS UNLESS OTHERWISE APPROVED.
7. THE "HOUSE BUILDER" IS RESPONSIBLE FOR FINAL LOT GRADING WHICH MAY INCLUDE CONSTRUCTION OF INDIVIDUAL SWALES ON EACH LOT AS NOTED. ALL DEVELOPER'S SWALES ARE TO BE RESTORED TO LINE AND GRADE AND ARE TO BE RE-SODDED IF REQUIRED.

ROADWORKS

1. THE CONTRACTOR IS TO ENGAGE A GEOTECHNICAL ENGINEER TO PERFORM IN-PLACE TESTING DURING THE PREPARATION OF THE SUBGRADE AND CONSTRUCTION OF THE ROAD STRUCTURE TO VERIFY THE ADEQUACY OF THE PROPOSED AND EXISTING ROAD STRUCTURE AND SUBGRADE.
2. CHANGES OF GRADE ARE TO BE FORMED BY SMOOTH VERTICAL CURVES. GRADE TRANSITIONS ARE TO BE FORMED TO BE UNNOTICEABLE TO VEHICULAR TRAFFIC WHEN BEING TRAVERSED.
3. LOOSE OR ORGANIC MATERIAL IS TO BE EXCAVATED FROM ROADWAY PRISM.
4. GRANULAR SUB-BASE AND OTHER BASE MATERIALS MUST BE COMPACTED TO 95% MODIFIED PROCTOR DENSITY.
5. THE ROAD BASE MUST EXTEND A MINIMUM OF 0.3m BEYOND THE SIDEWALK AND/OR CURB & GUTTER.
6. CATCH BASIN ELEVATIONS GIVEN ARE FOR TOP OF RIM. RIM IS TO BE SET 30mm BELOW GUTTER GRADE.
7. EXISTING VALVE BOXES, MANHOLES, ETC, WITHIN THE RIGHT-OF-WAY ARE TO BE ADJUSTED TO FINISHED GRADE.
8. BENKELMAN BEAM TESTING WILL BE REQUIRED TO CONFIRM THE SUITABILITY OF THE ROAD STRUCTURE PRIOR TO PAVING.
9. PLACEMENT OF ASPHALT CONCRETE AND PORTLAND CEMENT CONCRETE IS TO BE UNDERTAKEN ONLY WHEN WEATHER CONDITIONS ARE IN CONFORMANCE WITH MMCD SPECIFICATIONS.
10. UNLESS OTHERWISE ACCEPTED BY THE MUNICIPAL ENGINEER, ASPHALT CONCRETE IS TO BE LAID IN A MINIMUM OF 2 LIFTS TO A MAXIMUM OF 85mm PER LIFT AND A MINIMUM OF 35mm PER LIFT.
11. TIE-INS TO EXISTING PAVEMENT ARE TO BE MADE IN ACCORDANCE WITH THE TOWNSHIP OF LANGLEY PAVEMENT CUT POLICY NO. 05-116.
12. ASPHALT TAPERS TO BE CONSTRUCTED TO PAVEMENT DESIGN SPECIFICATIONS AS SHOWN IN THE SUBDIVISION AND DEVELOPMENT SERVICING BYLAW.
13. MACHINERY AND MATERIALS MUST NOT BE PARKED OR PLACED IN THE MUNICIPAL RIGHT-OF-WAY OVERNIGHT WHERE POSSIBLE. ANY SUCH PLACEMENT WILL REQUIRE A HIGHWAY USE PERMIT AND ILLUMINATED BARRICADES AND SIGNAGE.

WATERWORKS

1. FOR TYPICAL "UTILITY TRENCH" SECTION DETAIL, SEE MMCD STANDARD DETAIL DRAWING. PAVEMENT RESTORATION TO BE IN ACCORDANCE WITH THE TOWNSHIP OF LANGLEY PAVEMENT CUT POLICY NO. 05-116.
2. WATERMAIN MATERIALS MUST CONFORM TO MMCD MASTER MUNICIPAL SPECIFICATIONS, AND SCHEDULE "D" OF THE SUBDIVISION AND DEVELOPMENT SERVICING BYLAW.
3. TIE-INS OF PROPOSED MAINS AND SERVICE CONNECTIONS TO EXISTING WATERMAINS WILL BE PERFORMED BY THE TOWNSHIP OF LANGLEY AT THE OWNER'S EXPENSE. ALL REQUIRED FITTINGS TO BE SUPPLIED BY THE TOWNSHIP OF LANGLEY AT OWNER'S COST.
4. NEW WATERMAIN IS TO BE INSTALLED WITHIN 2.0m OF EXISTING WATERMAIN AT CONNECTION LOCATION EXCEPT AS ACCEPTED BY THE MUNICIPAL ENGINEER.
5. THE CONTRACTOR MUST ENSURE NEW WATERMAIN ELEVATION AND GRADE MATCHES EXISTING WATERMAIN ELEVATION AND GRADE AT THE CONNECTION LOCATION.
6. THE CONTRACTOR MUST EXPOSE AND CONFIRM ELEVATION & OFFSET OF ALL UTILITIES BETWEEN NEW WATERMAIN & EXISTING WATERMAIN AT THE CONNECTION LOCATION.
7. CONNECTIONS MUST NOT BE MADE WITHIN 1.0m OF EXISTING CONNECTIONS, BENDS, VALVES, OR OTHER SYSTEM FITTINGS.
8. CONNECTIONS MUST BE PERPENDICULAR TO MAIN, EXCEPT AS ACCEPTED BY THE MUNICIPAL ENGINEER.
9. MINIMUM COVER ON WATERMAINS IS TO BE 1.2m.
10. SERVICE CONNECTIONS ARE TO BE 25mm DIAMETER UNLESS OTHERWISE NOTED.
11. WATER SERVICE CONNECTIONS ARE TO BE SET SO THAT AN ADJUSTMENT OF 200mm ABOVE FINAL GRADE IS AVAILABLE BY THE TELESCOPING BURY-BOX, MINIMUM DEPTH 0.80m, MAXIMUM DEPTH 1.0m.
12. HYDRANTS IN URBAN AREAS MUST BE SUPPLIED WITH THE CORRECT DEPTH OF BURY TO MEET FINAL BOULEVARD GRADES. FOR HYDRANT DETAILS, SEE MMCD STANDARD DETAIL DRAWING. HYDRANTS IN RURAL AREAS; REFER TO SUPPLEMENTAL DRAWING TLW1.
13. THRUST BLOCKS AS SHOWN ON MMCD STANDARD DRAWING ARE TO BE LOCATED AT VALVES, BENDS, TEES, WYES, REDUCERS AND PLUGS. REVERSE THRUST BLOCKS ARE REQUIRED ON CAPS AND BLOWOFFS (REFER TO TOWNSHIP OF LANGLEY SUPPLEMENTARY DRAWINGS FOR THRUST BLOCK AREA FOR DETAILS).
14. HYDRANTS MUST HAVE A 1.2m OFFSET FROM PROPERTY LINE UNLESS OTHERWISE NOTED. DURING CONSTRUCTION, AND AT ANY TIME PRIOR TO ACCEPTANCE OF WATERMAINS BY THE TOWNSHIP OF LANGLEY, THE CONTRACTOR SHALL INSTALL A 300mm X 300mm SQUARE 19mm SHEET OF PLYWOOD (PAINTED WHITE) OVER THE PUMPER NOZZLE OF EACH HYDRANT TO INDICATE THAT THE HYDRANT IS NOT IN SERVICE. HYDRANTS TO HAVE A STORZ QUICK RELEASE NOZZLE INSTALLED.
15. THE CONTRACTOR MUST ENSURE THAT ALL SECTIONS OF LINES HAVE TEST POINTS AND TEMPORARY BLOW-OFFS SUITABLE TO ENSURE ADEQUATE PRESSURE TESTING, CHLORINATION AND FLUSHING. DISCHARGE OF CHLORINATED WATER IS NOT PERMITTED INTO DITCHES, STORM SEWERS OR WATERCOURSES UNLESS NEUTRALIZED WITH SODIUM THIOSULPHATE OR APPROVED EQUIVALENT ACCEPTED BY THE MUNICIPAL ENGINEER.
16. TESTING AND CHLORINATION OF WATERMAINS IS THE RESPONSIBILITY OF THE CONTRACTOR WITH INSPECTION AUTHORIZED BY THE MUNICIPAL ENGINEER. WATERMAINS MUST PASS PRESSURE AND BACTERIOLOGICAL TESTING BEFORE CONNECTION IS MADE TO EXISTING WATER SYSTEM.
17. WHERE APPLICABLE, ALL SERVICE CONNECTIONS ARE TO BE MARKED ON THE CURB WITH A 2mm DEEP SAW CUT AND A 50mm x 100mm STAKE 0.3m FROM PROPERTY LINE. BOTH ARE TO BE PAINTED BLUE.
18. SERVICE CONNECTION PIPE MUST BE AS PER APPROVED LIST OF PRODUCTS, EXCEPT AS ACCEPTED BY THE MUNICIPAL ENGINEER. THE TYPE OF CURB STOP AND BURY BOX NOTED ON THE APPROVED DRAWING SHALL BE USED IN ALL CASES, UNLESS AN ALTERNATIVE IS ACCEPTED BY THE MUNICIPAL ENGINEER.

STORM SEWER

1. STORM SEWER MATERIALS ARE TO CONFORM TO THE MMCD SPECIFICATIONS AND SCHEDULE "D" OF THE SUBDIVISION AND DEVELOPMENT SERVICING BYLAW.
2. FOR TYPICAL "UTILITY TRENCH" SECTION DETAIL, SEE MMCD STANDARD DETAIL DRAWING. PAVEMENT RESTORATION TO BE IN ACCORDANCE WITH THE TOWNSHIP OF LANGLEY PAVEMENT CUT POLICY NO. 05-116.
3. EXISTING DRAINS FROM PRIVATE PROPERTIES ARE TO BE TIED INTO THE NEW STORM SYSTEM WHEN INFILLING EXISTING DITCHES, CONNECTIONS ARE NOT TO PROTRUDE INTO MAIN.
4. FOR TYPICAL CATCH BASIN DETAILS REFER TO MMCD STANDARD DETAIL DRAWING UNLESS OTHERWISE SPECIFIED BY MUNICIPAL ENGINEER.
5. FOR TYPICAL DETAILS OF ALL STORM SEWER CONNECTIONS, SEE TOWNSHIP OF LANGLEY SUPPLEMENTARY DRAWING.
6. ALL SINGLE CATCH BASIN LEADS ARE TO BE MINIMUM 200mm DIAMETER, ALL DOUBLE CATCH BASIN LEADS ARE TO BE MINIMUM 250mm DIAMETER. NO CURVES OR BENDS ARE PERMITTED IN THE LEADS.
7. ALL STORM SEWER SERVICE CONNECTIONS ARE TO BE MINIMUM 100mm DIAMETER, IF STORM SEWER CONNECTION IS TO A LAWN BASIN, CONNECTIONS ARE TO BE A MIN 150mm DIAMETER, FOR RESIDENTIAL AND 150mm FOR INDUSTRIAL/COMMERCIAL.
8. DIAMETER OF ALL STORM SEWER MANHOLES MUST CONFORM TO THE MMCD STANDARD DETAIL DRAWING UNLESS OTHERWISE NOTED.
9. TIE-INS OF MAINS TO EXISTING STORM SEWER SYSTEMS ARE TO BE PERFORMED BY THE CONTRACTOR.
10. MANUFACTURED WYES ARE TO BE USED ON STORM PIPE UNDER 450mm DIAMETER.
11. STORM SEWERS ARE TO BE CONSTRUCTED WITH SEALED JOINTS UNLESS OTHERWISE SPECIFIED ON THE DESIGN DRAWINGS.
12. WHERE APPLICABLE ALL STORM SEWER CONNECTIONS ARE TO BE MARKED BY ALL OF THE FOLLOWING - 2mm DEEP SAW CUT ON THE CURB, 50mm x 100mm STAKE (PAINTED GREEN) AND PLACED AT END OF PIPE, AND THE END OF THE PIPE TO BE CAPPED AND PAINTED GREEN. STORM IC LID IS ALSO PAINTED GREEN.
13. TOP OF INSPECTION CHAMBER STANDPIPES IS TO BE CONSTRUCTED TO 600mm ABOVE FINAL LOT GRADE.
14. SEWER MAINS AND CONNECTIONS TO BE VIDEO INSPECTED PRIOR TO USE. CONTRACTOR TO PROVIDE A VIDEO COPY ON DVD TO THE TOWNSHIP OF LANGLEY.

SANITARY SEWER

1. SANITARY SEWER MATERIALS MUST CONFORM TO THE MMCD SPECIFICATIONS AND SCHEDULE "D" OF THE SUBDIVISION AND DEVELOPMENT SERVICING BYLAW.
2. MANHOLE DETAILS TO BE IN ACCORDANCE WITH MMCD STANDARD DETAIL DRAWINGS.
3. TYPICAL DETAILS OF ALL SEWER CONNECTIONS TO BE IN ACCORDANCE WITH MMCD STANDARD DETAIL DRAWING.
4. FOR TYPICAL "UTILITY TRENCH" SECTION DETAIL SEE MMCD STANDARD DETAIL DRAWING. PAVEMENT RESTORATION TO BE IN ACCORDANCE WITH THE TOWNSHIP OF LANGLEY PAVEMENT CUT POLICY NO. 05-116.
5. SERVICE CONNECTIONS ARE TO BE 100mm DIAMETER FOR RESIDENTIAL AND MINIMUM 150mm DIAMETER FOR INDUSTRIAL/COMMERCIAL, UNLESS OTHERWISE NOTED.
6. TOP OF INSPECTION CHAMBER STANDPIPES ARE TO BE CONSTRUCTED TO 600mm ABOVE FINAL LOT GRADE.
7. NEW SEWER LINES TIED INTO EXISTING LINES MUST BE PLUGGED UNTIL THEY ARE TESTED, FLUSHED AND ACCEPTED BY THE TOWNSHIP OF LANGLEY.
8. SERVICE CONNECTIONS MUST BE MADE TO THE MAIN WHEREVER POSSIBLE. SHOULD A CONNECTION HAVE TO BE MADE TO A MANHOLE, IT MUST BE AT A HIGHER ELEVATION THAN THE CROWN OF THE HIGHEST SEWER MAIN ENTERING THE MANHOLE.
9. TIE-INS OF PROPOSED MAINS TO EXISTING SANITARY SEWER MAINS ARE TO BE PERFORMED BY THE CONTRACTOR UNLESS OTHERWISE DIRECTED.
10. TESTING IS THE RESPONSIBILITY OF THE CONTRACTOR WITH INSPECTION AUTHORIZED BY THE MUNICIPAL ENGINEER. SEWER MAINS MUST PASS PRESSURE TESTING BEFORE CONNECTION IS MADE TO EXISTING SEWER SYSTEM.
11. THE CONTRACTOR MUST DISCONNECT AND SEAL ABANDONED SERVICES TO THE ACCEPTANCE OF THE MUNICIPAL ENGINEER.
12. CONNECTIONS TO MAIN MUST BE PERPENDICULAR TO MAIN EXCEPT AS ACCEPTED BY THE MUNICIPAL ENGINEER.
13. WHERE APPLICABLE, ALL SANITARY SEWER CONNECTIONS ARE TO BE MARKED BY ALL OF THE FOLLOWING - 2mm DEEP SAW CUT ON CURB, 50mm x 100mm STAKE (PAINTED RED) AT END OF PIPE, AND THE END OF THE PIPE TO BE PAINTED RED. SANITARY I.C. LID IS ALSO PAINTED RED.
14. CONTRACTOR IS RESPONSIBLE FOR ENSURING OWNER'S ENGINEER OR TOWNSHIP INSPECTOR IS PRESENT TO WITNESS SERVICE CONNECTION TIE-INS TO EXISTING SEWERS.
15. SEWER MAINS AND CONNECTIONS TO BE VIDEO INSPECTED PRIOR TO USE. CONTRACTOR TO PROVIDE A VIDEO COPY ON DVD TO THE TOWNSHIP OF LANGLEY.

NOTE: WHEN CONVERTING METRIC TO IMPERIAL ELEVATIONS INCLUDE 91.62 FEET TO THE IMPERIAL GEODETIC BASE.
FOR DETAILS REFER TO UBC MONUMENT - PLAN STANDARD NO.01-01

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THE UNIVERSITY OF BRITISH COLUMBIA
INFRASTRUCTURE DEVELOPMENT

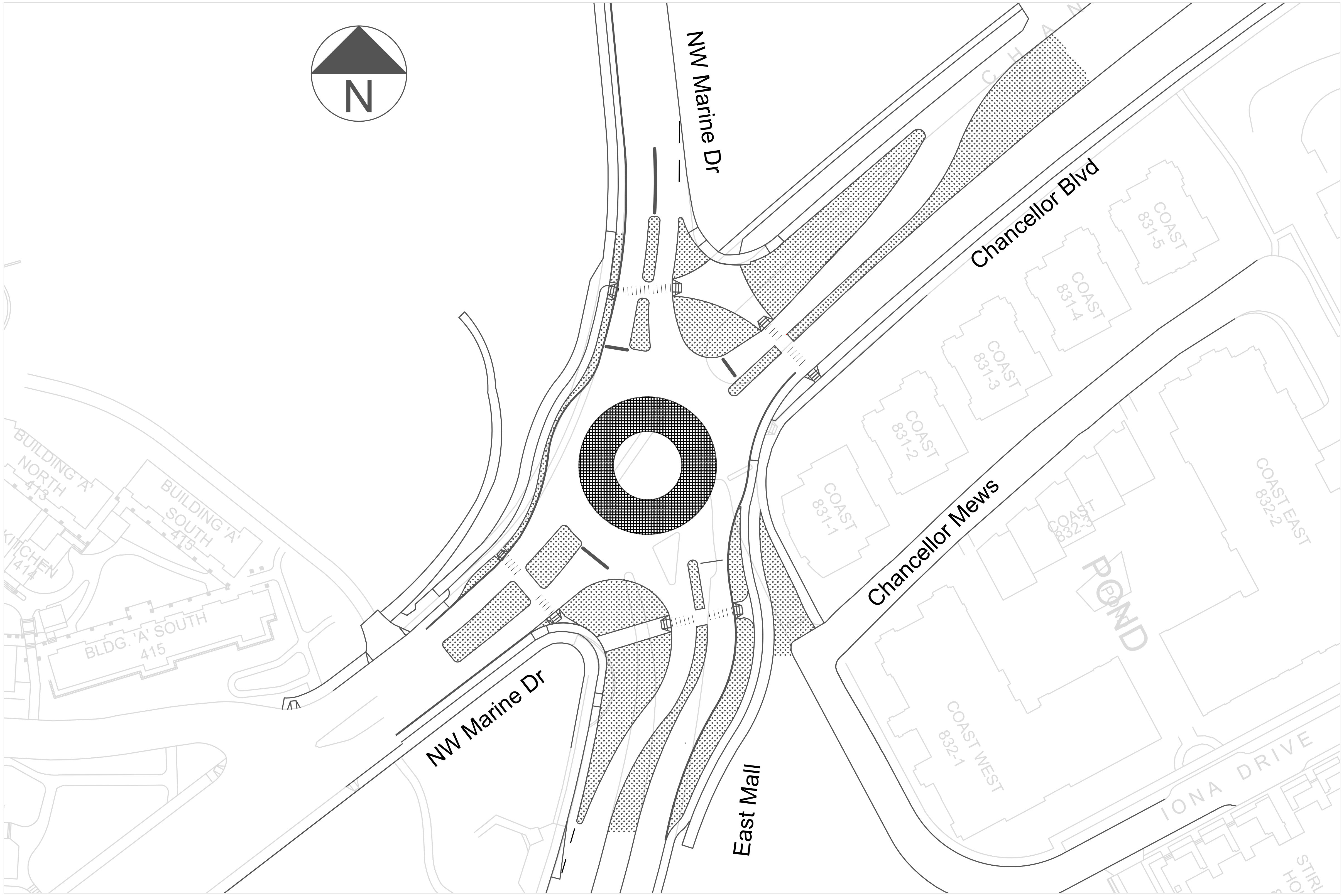
NO	DESCRIPTION	DATE	BY
2	ISSUED FOR CONSTRUCTION	25–04–05	JM
1	ISSUED FOR PRELIMINARY DESIGN	24–12–07	JM

SCALE: 0 1:250 25m

N

SITE PLAN 1

PAGE
01



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THE UNIVERSITY OF BRITISH COLUMBIA
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2	ISSUED FOR CONSTRUCTION	25–04–05	JM
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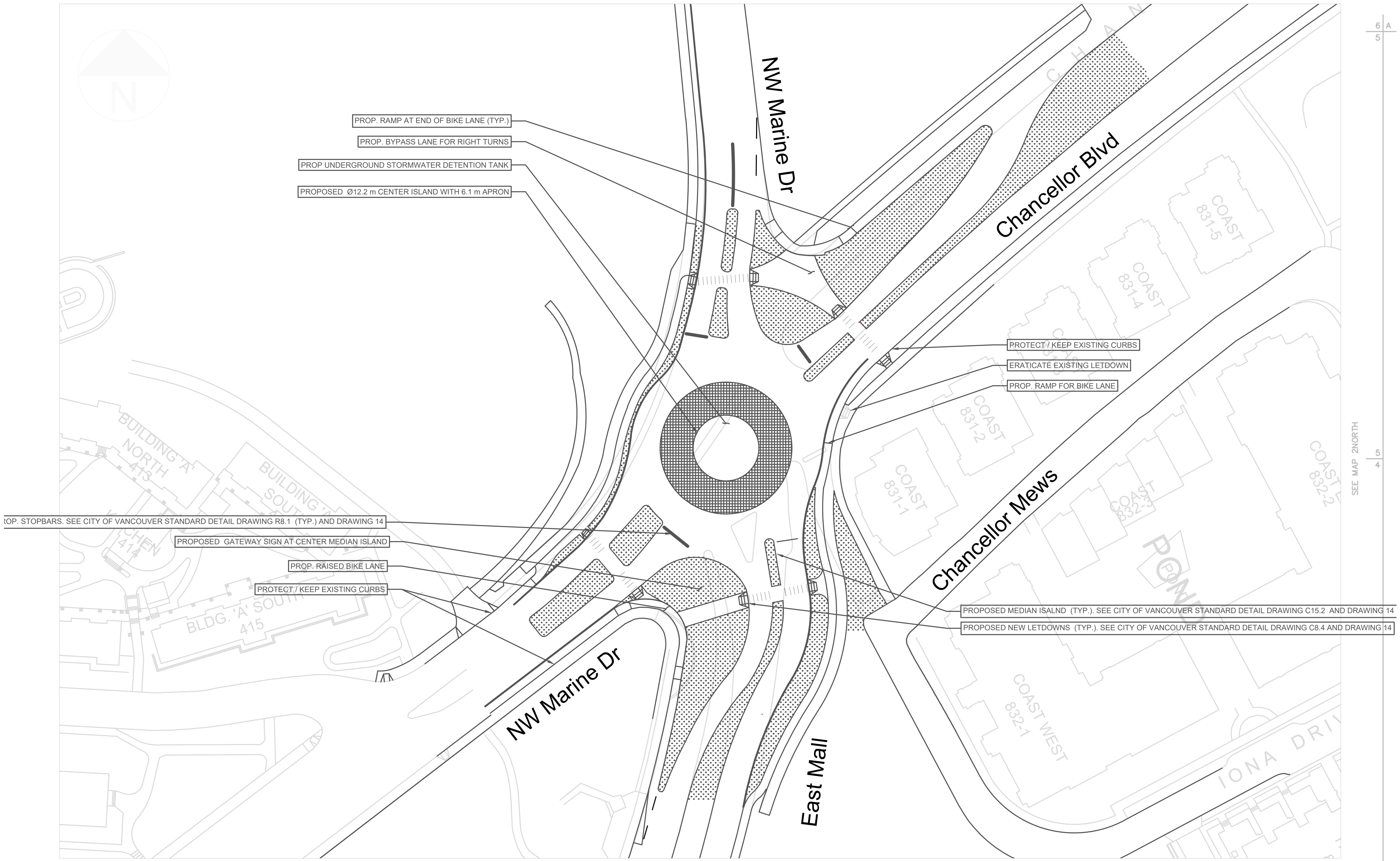
SCALE: 0 1:250 25m

SITE PLAN 2



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THE UNIVERSITY OF BRITISH COLUMBIA
INFRASTRUCTURE DEVELOPMENT

NO	DESCRIPTION	DATE	BY
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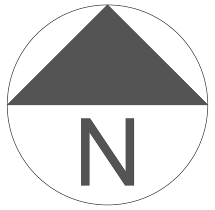
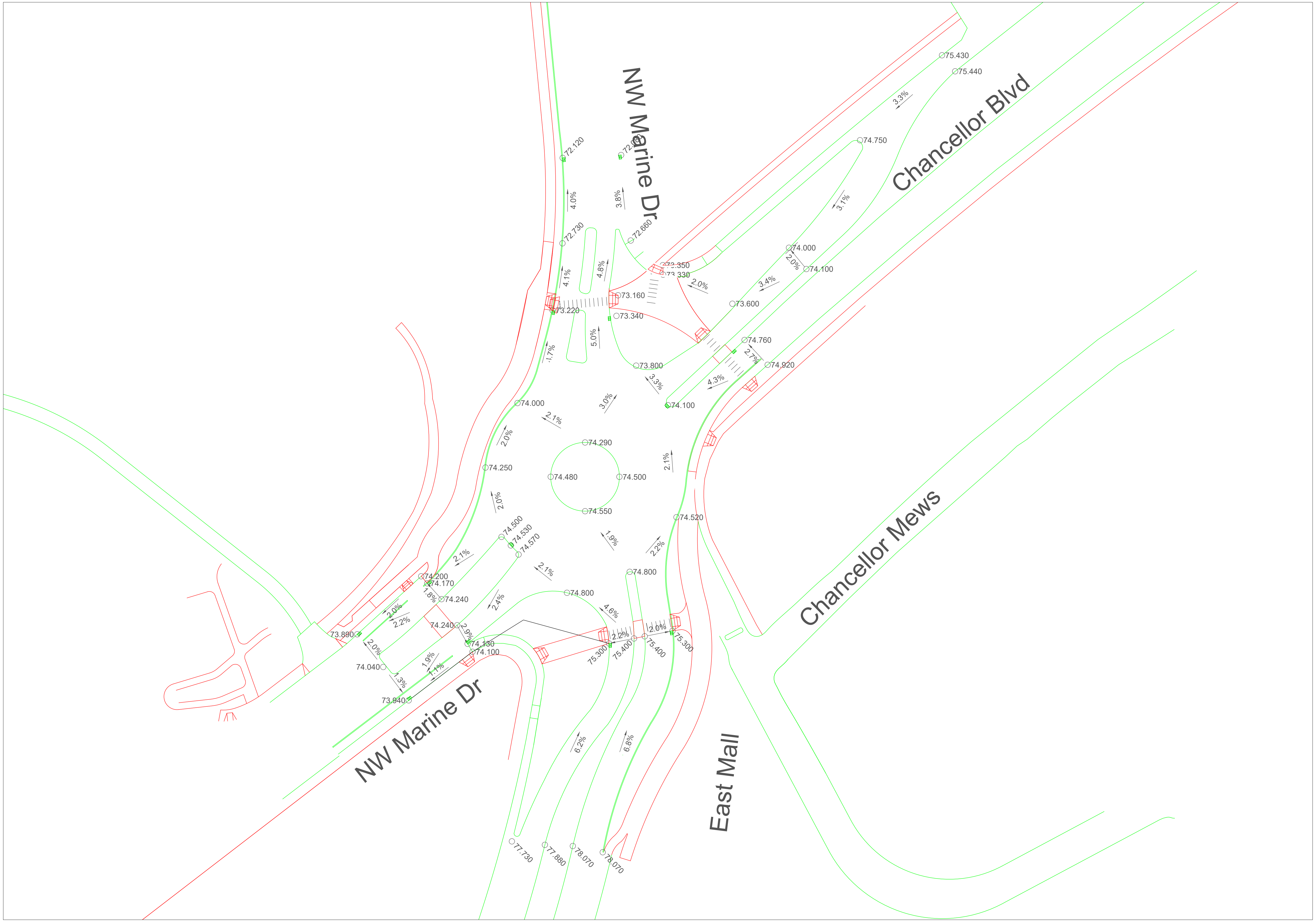
SCALE: 0 1:250 25m

SITE PLAN 3

PAGE
03





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INFRASTRUCTURE DEVELOPMENT

NO	DESCRIPTION	DATE	BY
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SECTOR INDEX

			13	14	23			
4NORTH	4	5	12	15	22	24	30	
3NORTH	3	6	11	16	21	25	29	31
2NORTH	2	7	10	17	20	26	28	
	1	8	9	18	19	27		
	1WEST	8WEST						

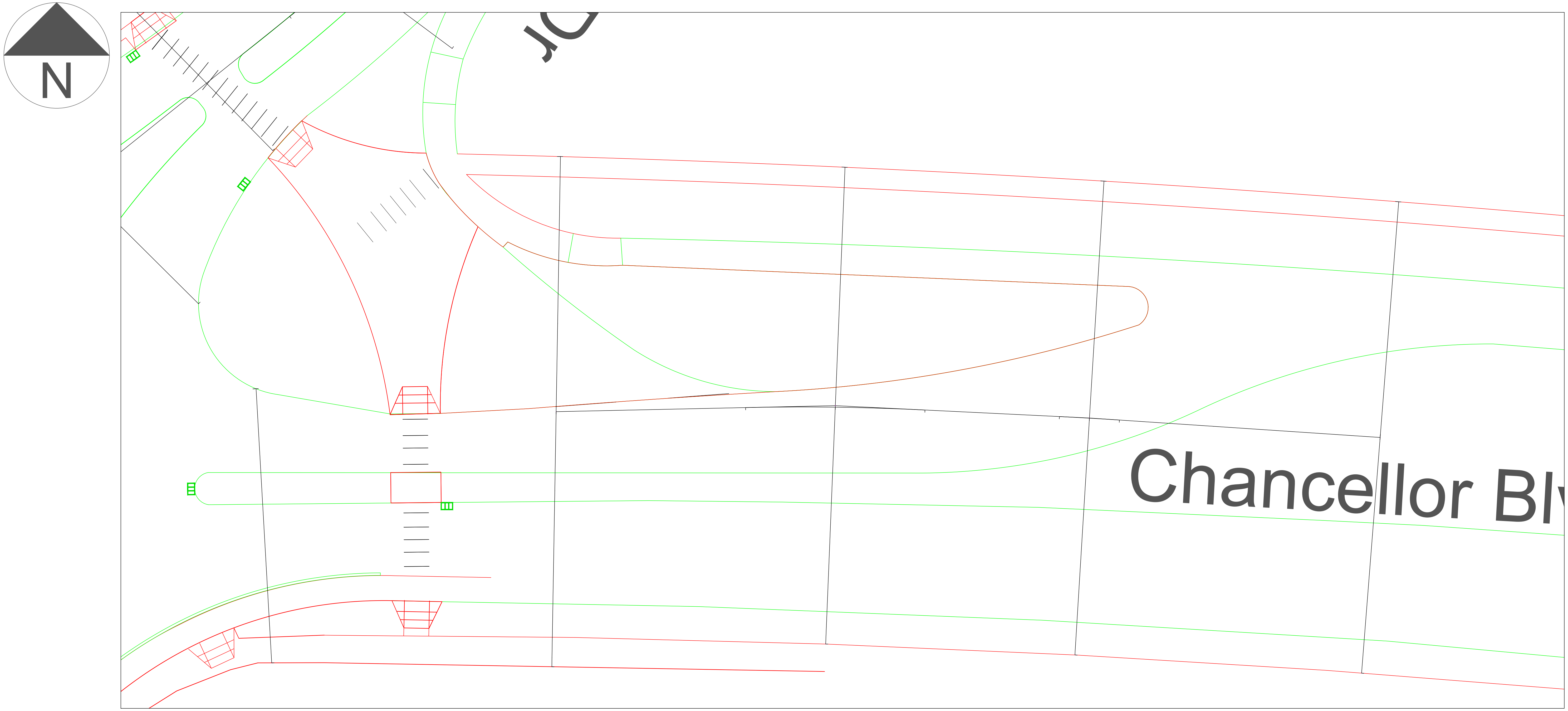
SCALE: 1:600 1"= 50'

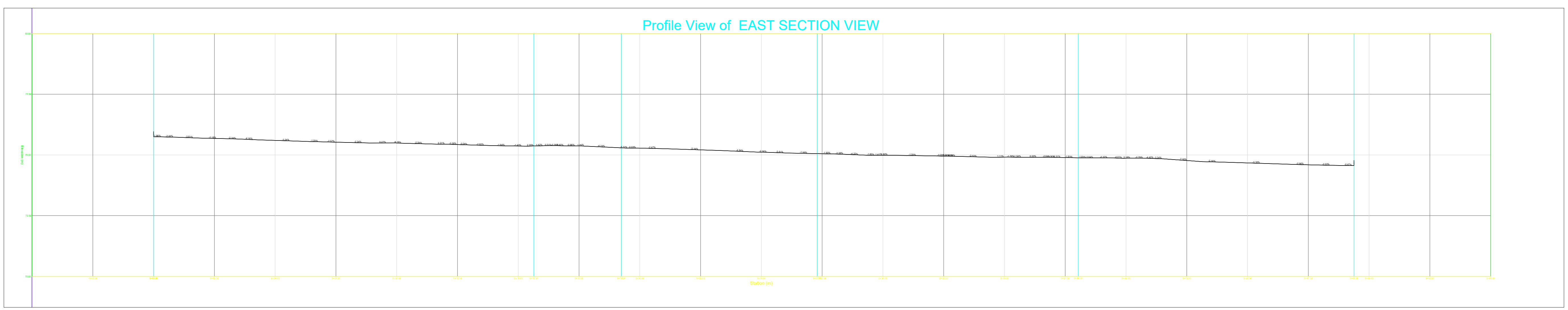
0 10 20 30 40 50 METRES
0 50 100 150 FEET

UBC NORTH

SITE GRADING

SECTOR 04





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INFRASTRUCTURE DEVELOPMENT

NO	DESCRIPTION	DATE	BY
2	ISSUED FOR CONSTRUCTION	25–04–05	LF
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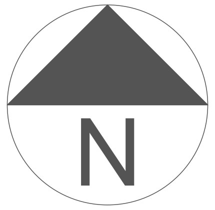
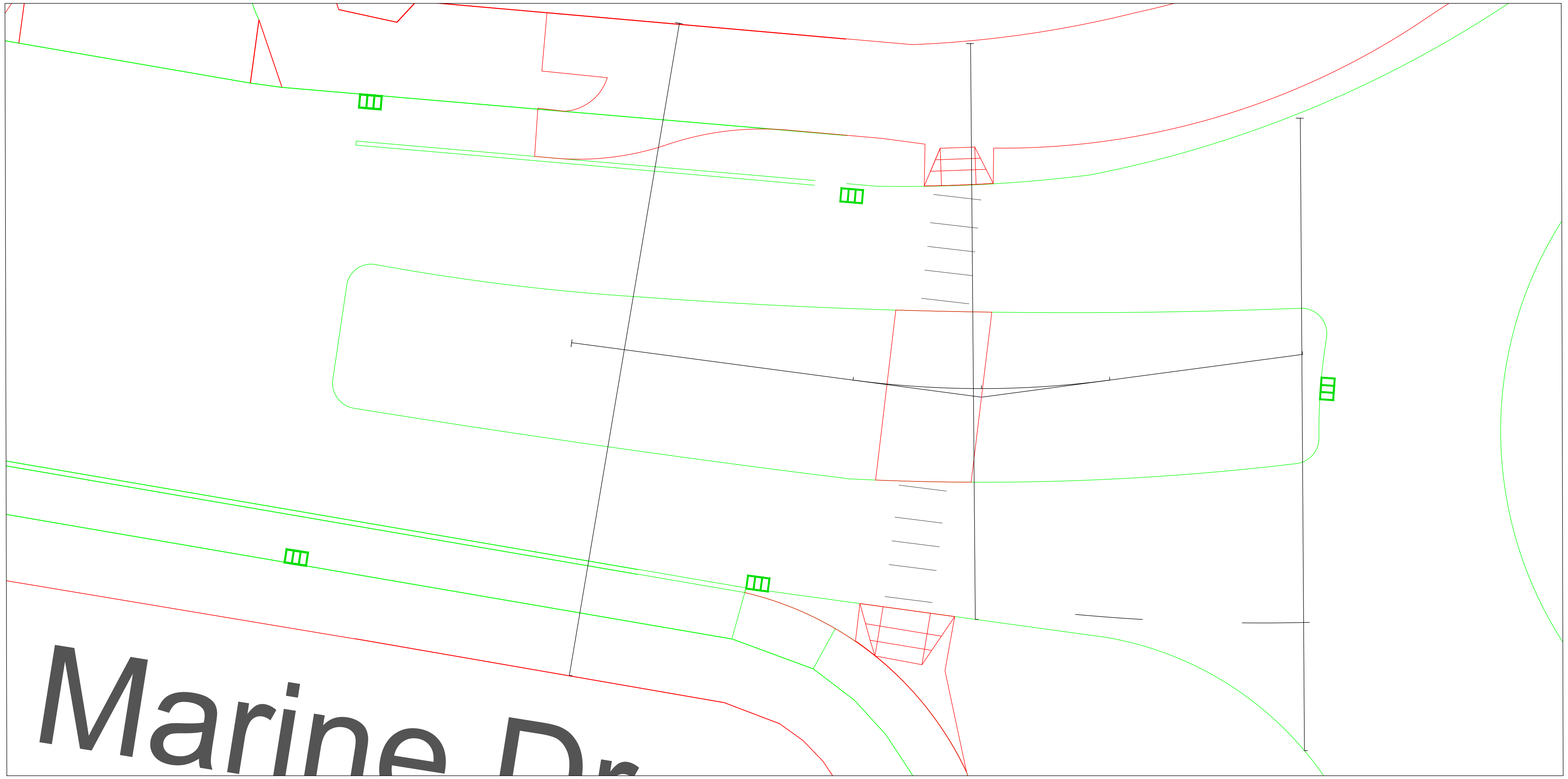
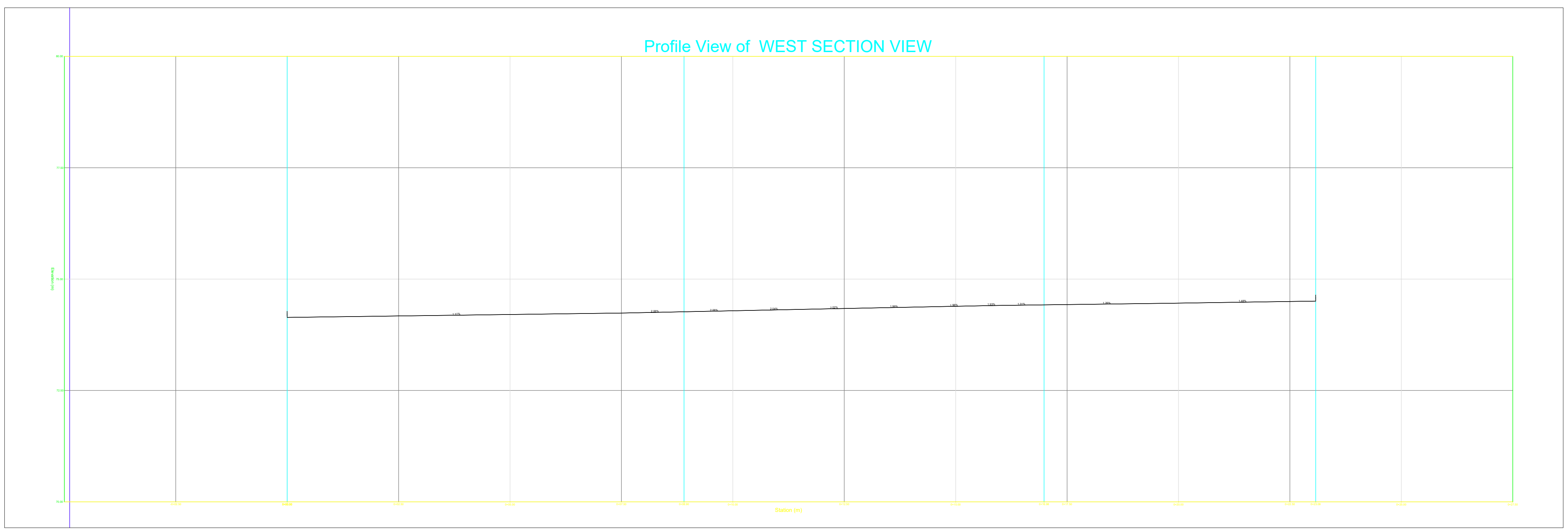
SCALE: 0 1:250 25m

PROFILE 1 (CHANCELLOR)







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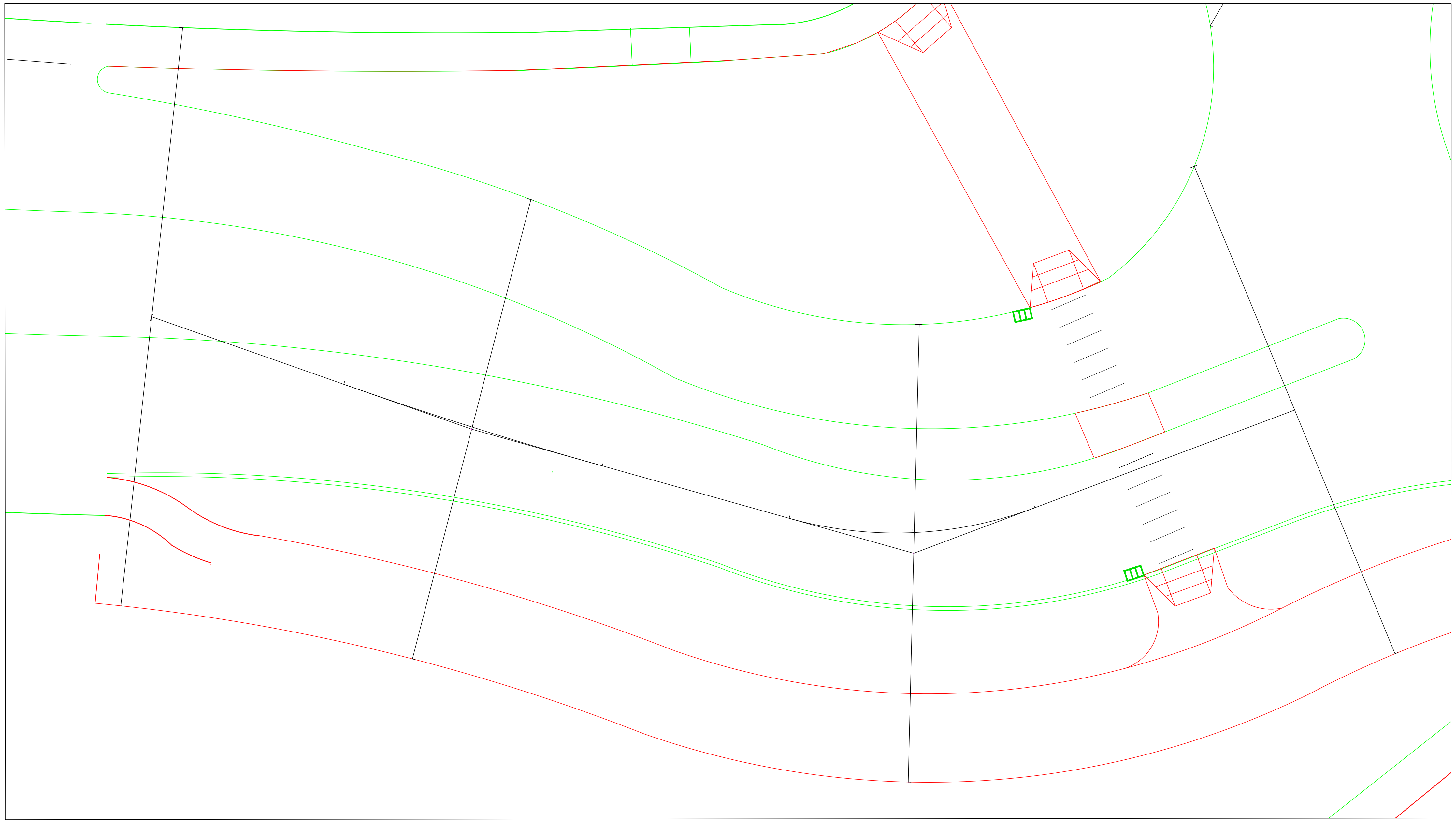
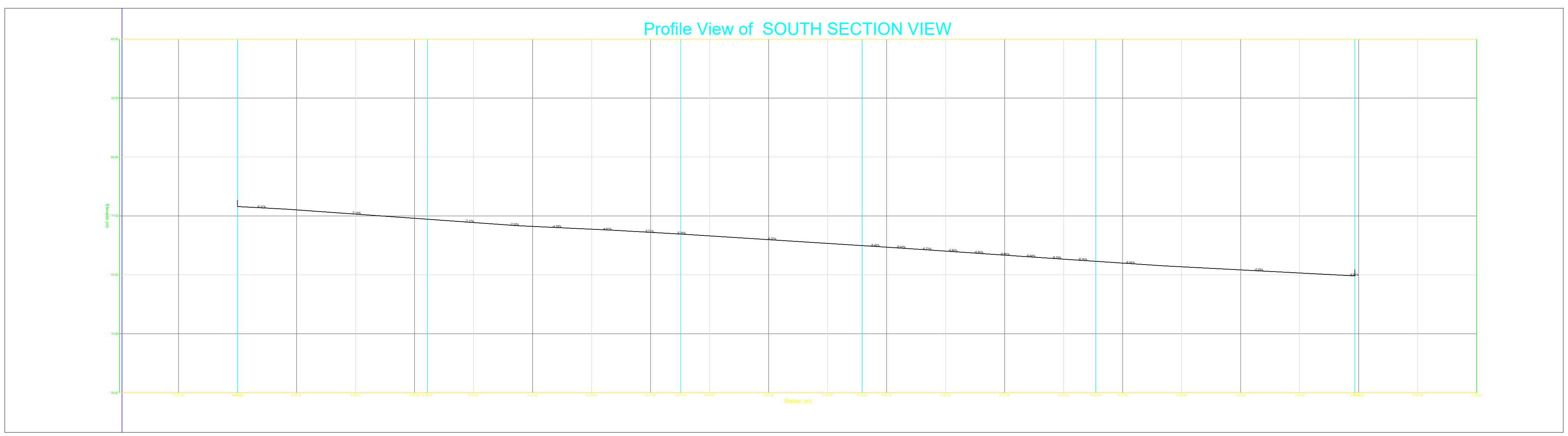
SCALE: 0 1:250 25m

PROFILE 2 (NEW MARINE DR N)





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THE UNIVERSITY OF BRITISH COLUMBIA
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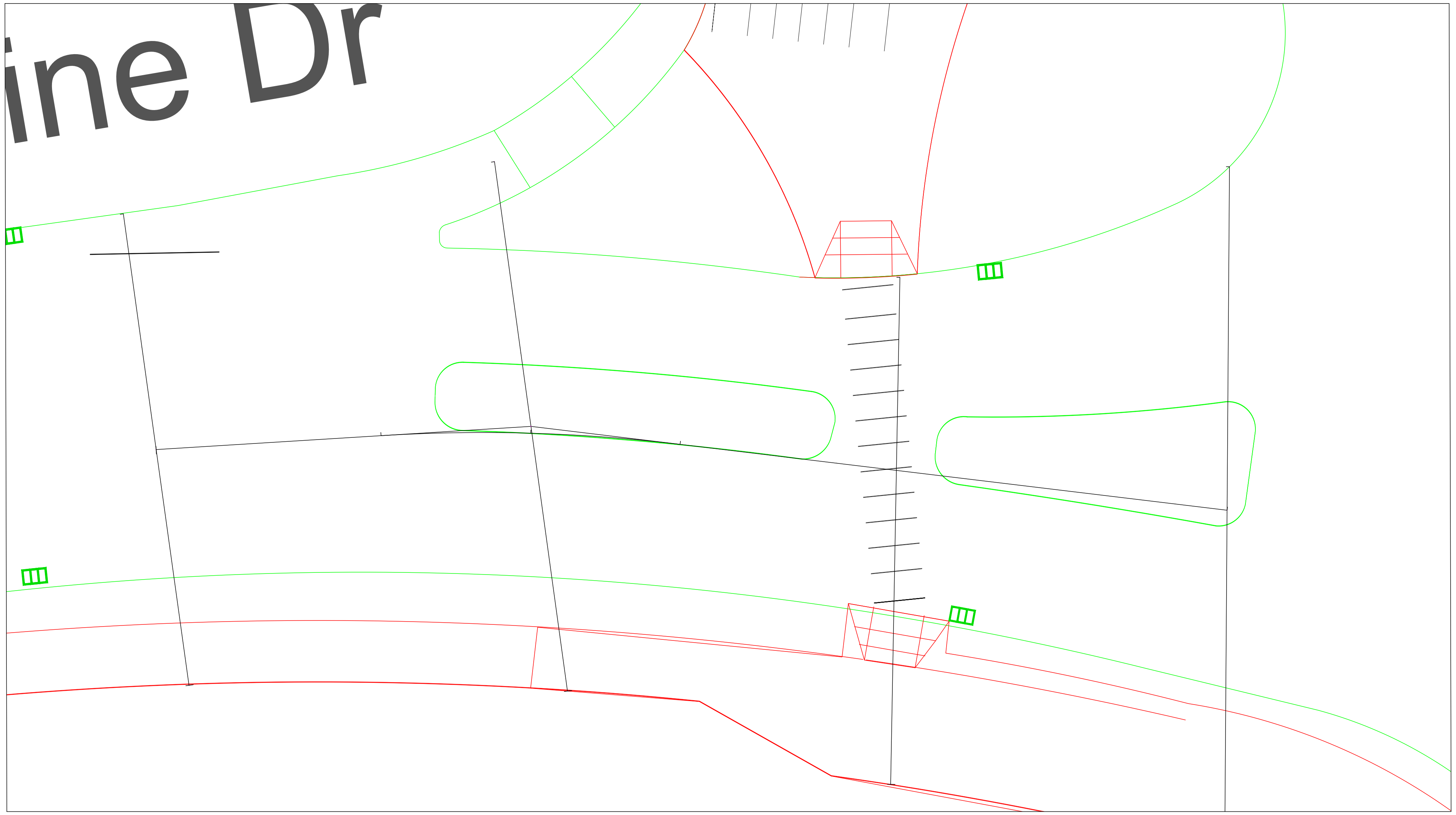
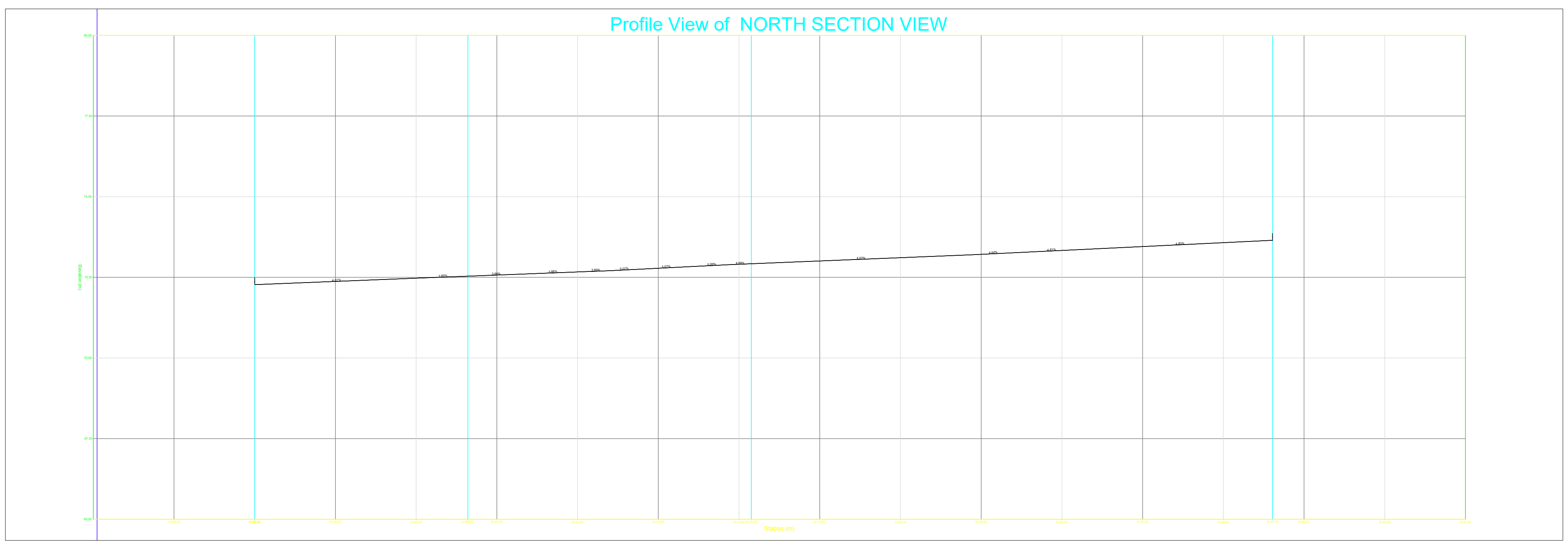
SCALE: 0 1:250 25m

PROFILE 3 (EAST MALL)





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THE UNIVERSITY OF BRITISH COLUMBIA
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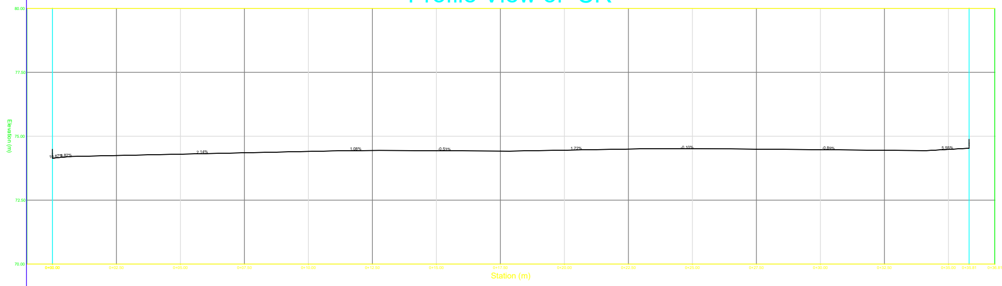
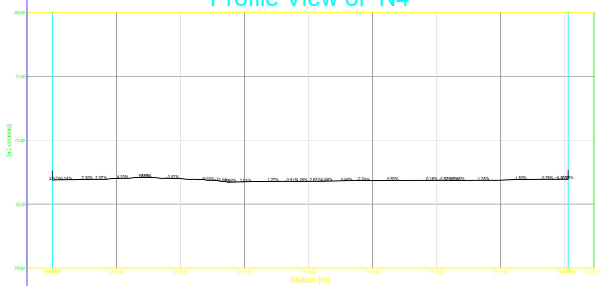
SCALE: 0 1:250 25m

PROFILE 2 (NEW MARINE DR W)

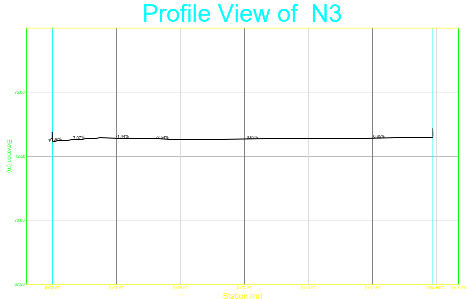
Profile View of CR



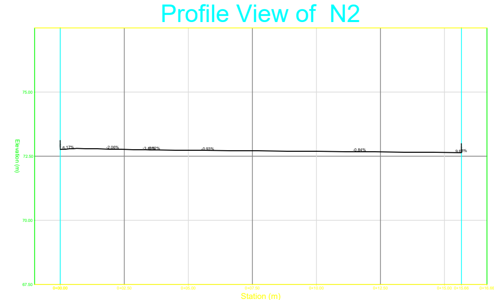
Profile View of N4



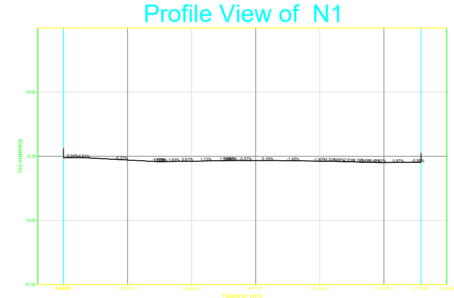
Profile View of N3



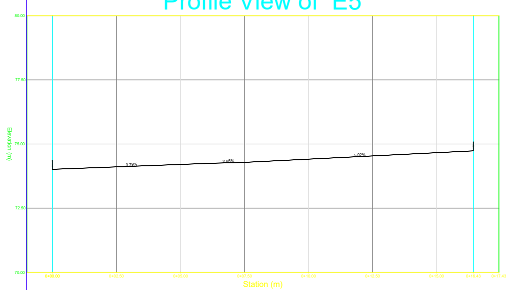
Profile View of N2



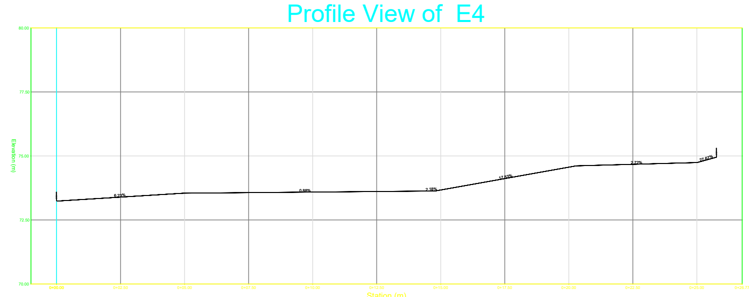
Profile View of N1



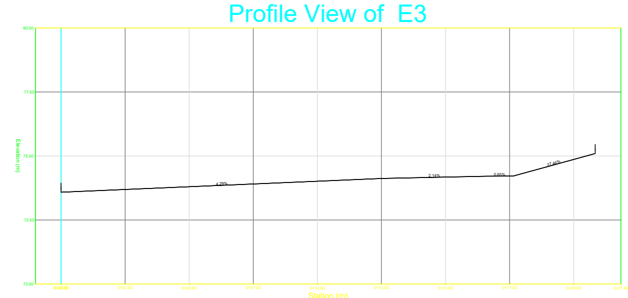
Profile View of E5



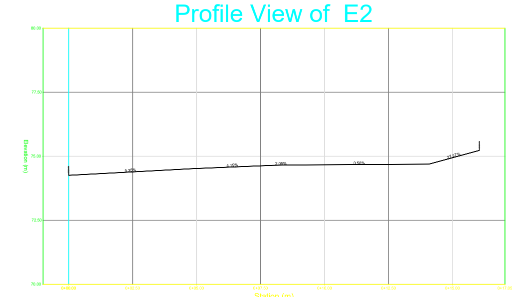
Profile View of E4



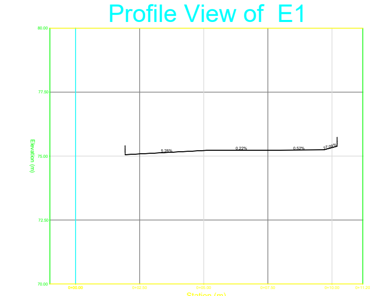
Profile View of E3



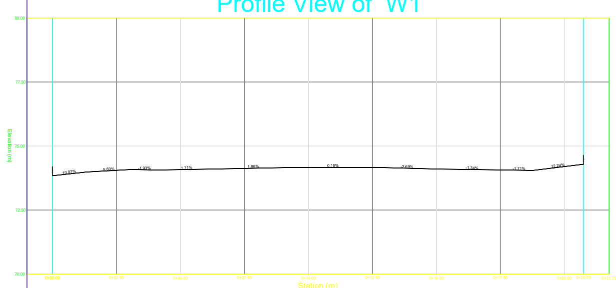
Profile View of E2



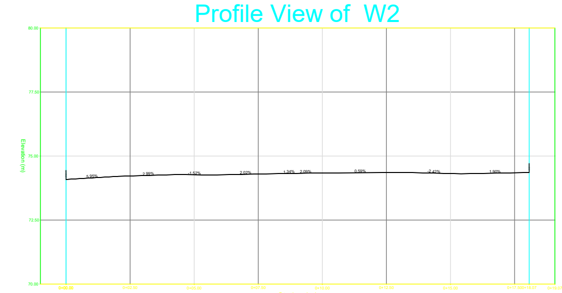
Profile View of E1



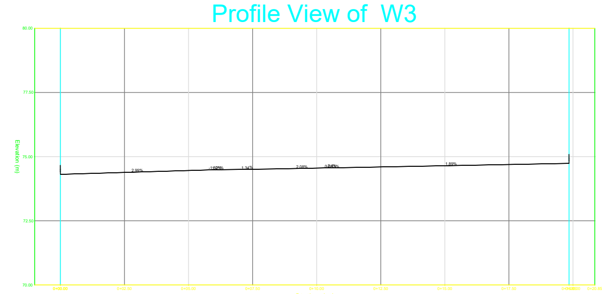
Profile View of W1



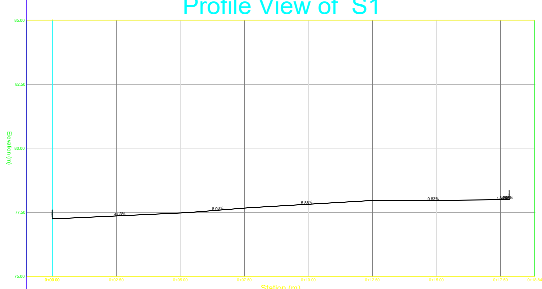
Profile View of W2



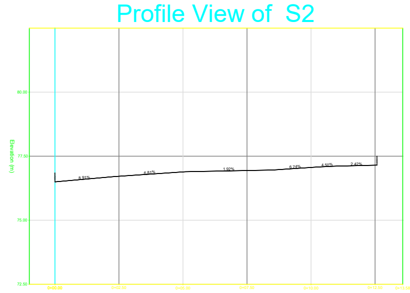
Profile View of W3



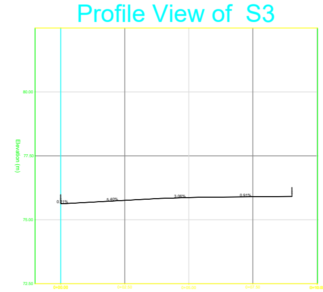
Profile View of S1



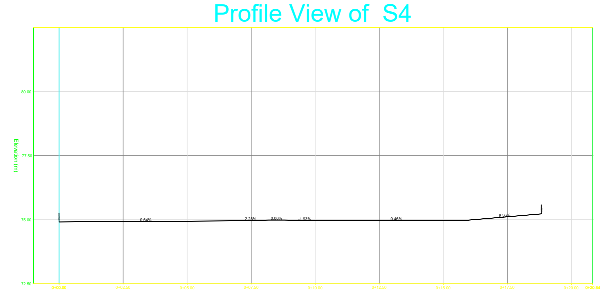
Profile View of S2



Profile View of S3



Profile View of S4



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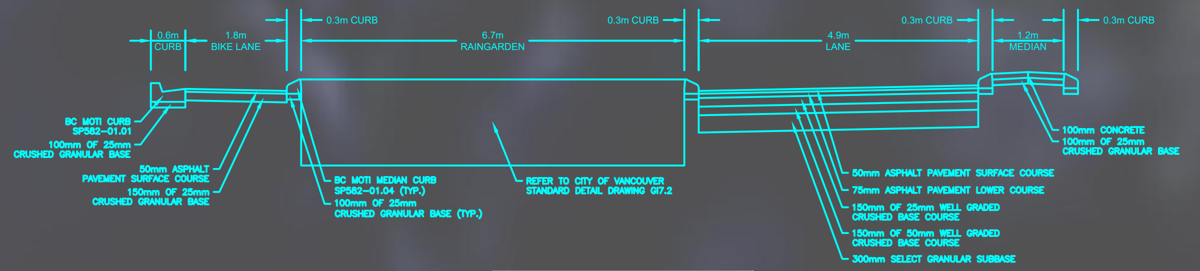
THE UNIVERSITY OF BRITISH COLUMBIA
INFRASTRUCTURE DEVELOPMENT

NO	DESCRIPTION	DATE	BY
2	ISSUED FOR CONSTRUCTION	25–04–05	LF
1	ISSUED FOR PRELIMINARY DESIGN	24–12–07	JM

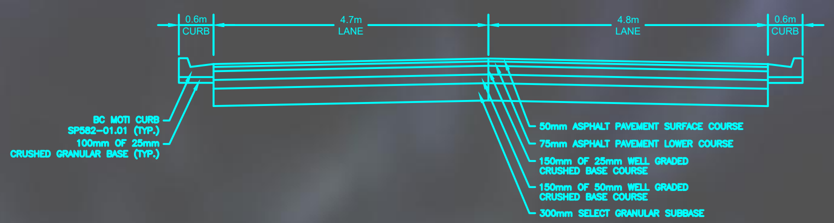
SCALE: 0 1:250 25m

N

SECTION



SECTION A-A
SCALE 1:20



SECTION B-B
SCALE 1:20

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THE UNIVERSITY OF BRITISH COLUMBIA
INFRASTRUCTURE DEVELOPMENT

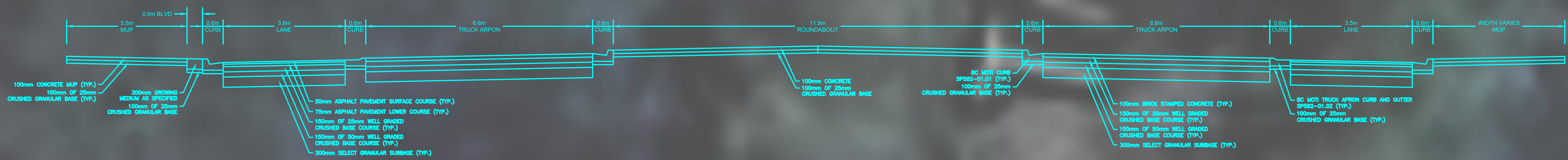
NO	DESCRIPTION	DATE	BY
2	ISSUED FOR CONSTRUCTION	25-04-05	AC
1	ISSUED FOR PRELIMINARY DESIGN	24-12-07	AC

SECTOR INDEX

SCALE: 1:600 1"= 50'

X–SECTION 1

SECTOR 10



SECTION C-C
SCALE 1:20

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SECTOR INDEX

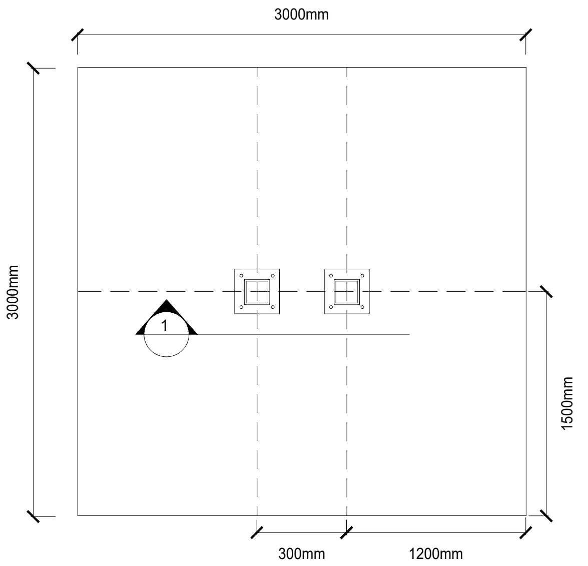
			13	14	23			
4NORTH	4	5	12	15	22	24	30	
3NORTH	3	6	11	16	21	25	29	31
2NORTH	2	7	10	17	20	26	28	
	1	8	9	18	19	27		
	1WEST	8WEST						

SCALE: 1:600 1"= 50'
0 10 20 30 40 50 METRES
0 50 100 150 FEET

X–SECTION 2

SECTOR
11

SEE MAP 4



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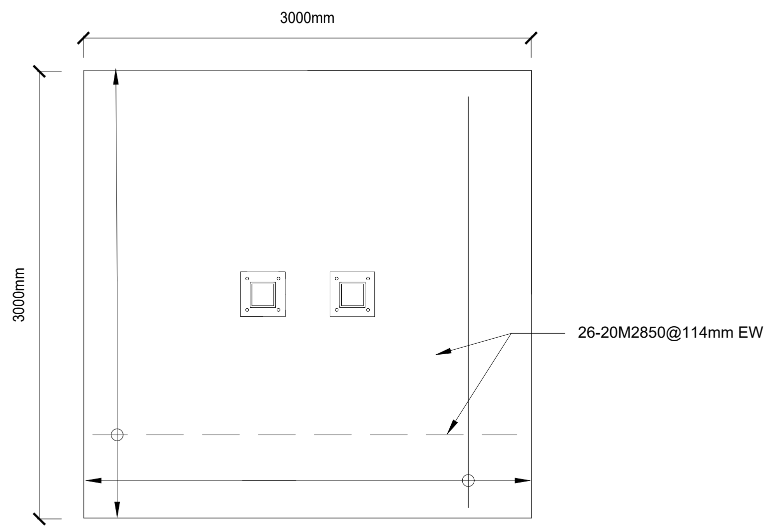

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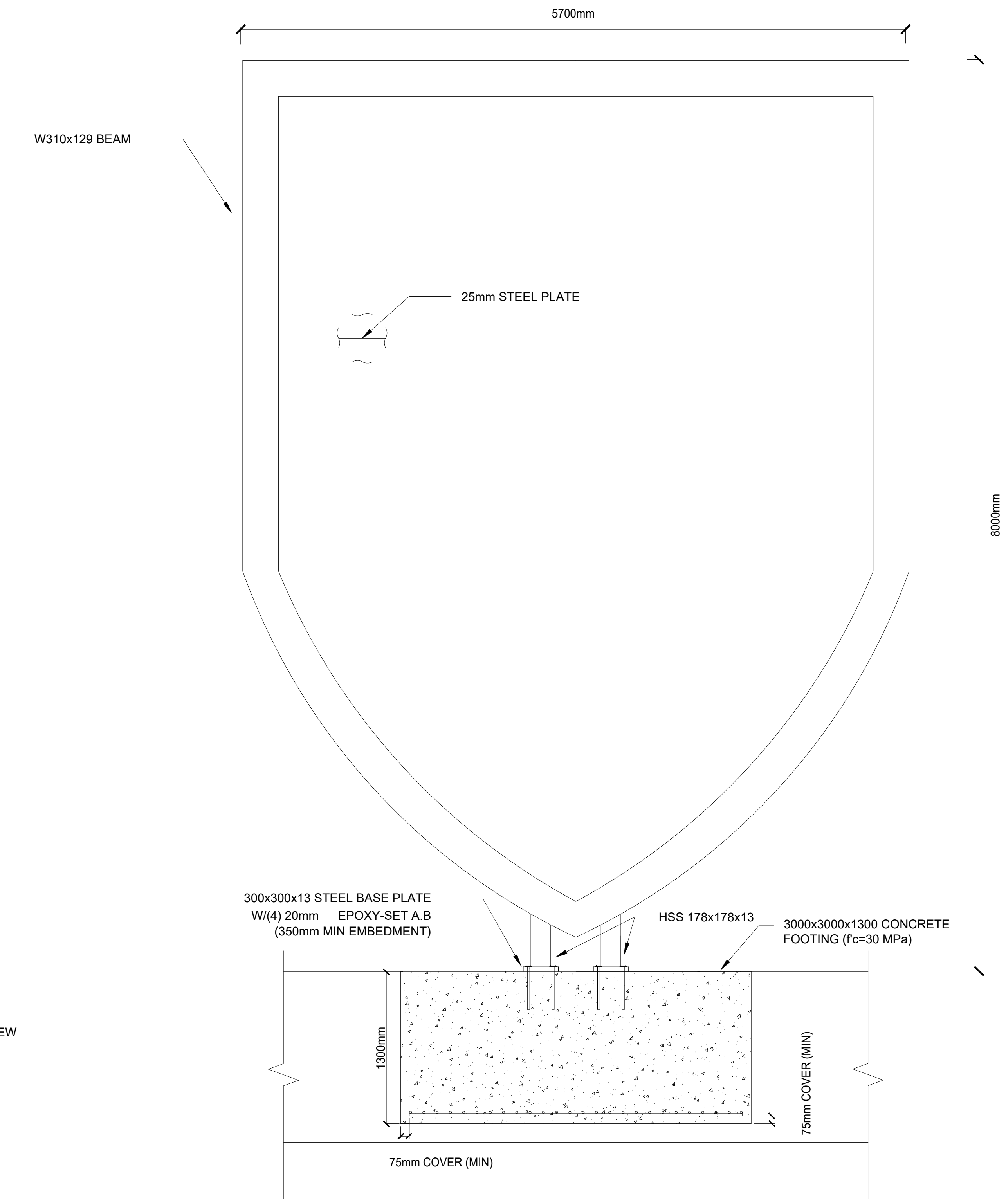

1 FOOTING DETAIL

SEE MAP 3NORTH

SEE MAP 6

SEE MAP 2

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THE UNIVERSITY OF BRITISH COLUMBIA
INFRASTRUCTURE DEVELOPMENT

NO	DESCRIPTION	DATE	BY
01	ISSUED FOR CONSTRUCTION	02 APR 25	LF
01	FOOTING DESIGN	06 DEC 24	LF

SECTOR INDEX

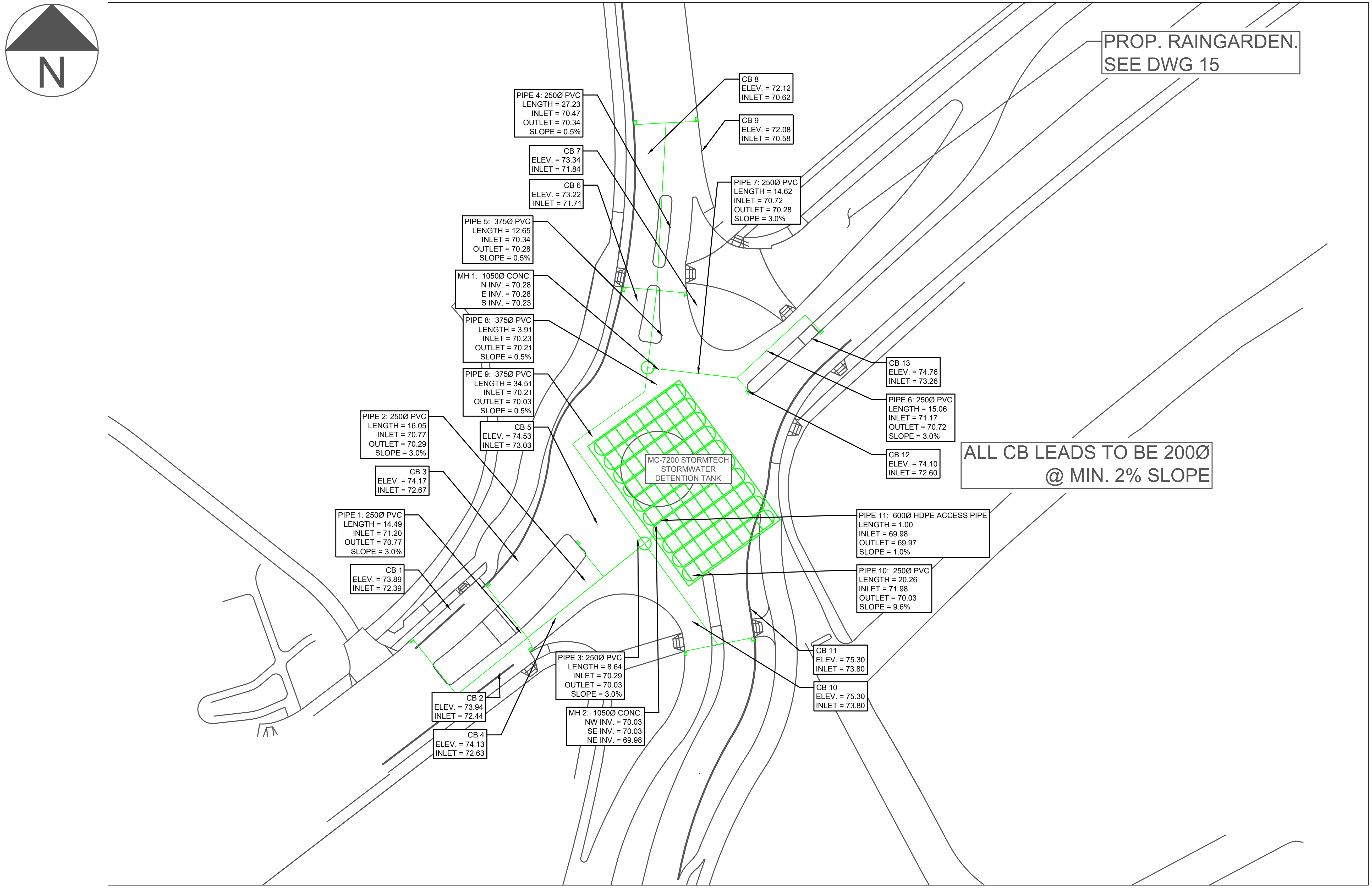
			13	14	23			
4NORTH	4	5	12	15	22	24	30	
3NORTH	3	6	11	16	21	25	29	31
2NORTH	2	7	10	17	20	26	28	
	1	8	9	18	19	27		
	1WEST	8WEST						

SCALE: 1:600 1"= 50'

0 10 20 30 40 50 METRES
0 50 100 150 FEET

SIGN DESIGN

SECTOR 12



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THE UNIVERSITY OF BRITISH COLUMBIA
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2NORTH	2	7	10	17	20	26	28	
	1	8	9	18	19	27		
	1WEST	2WEST						

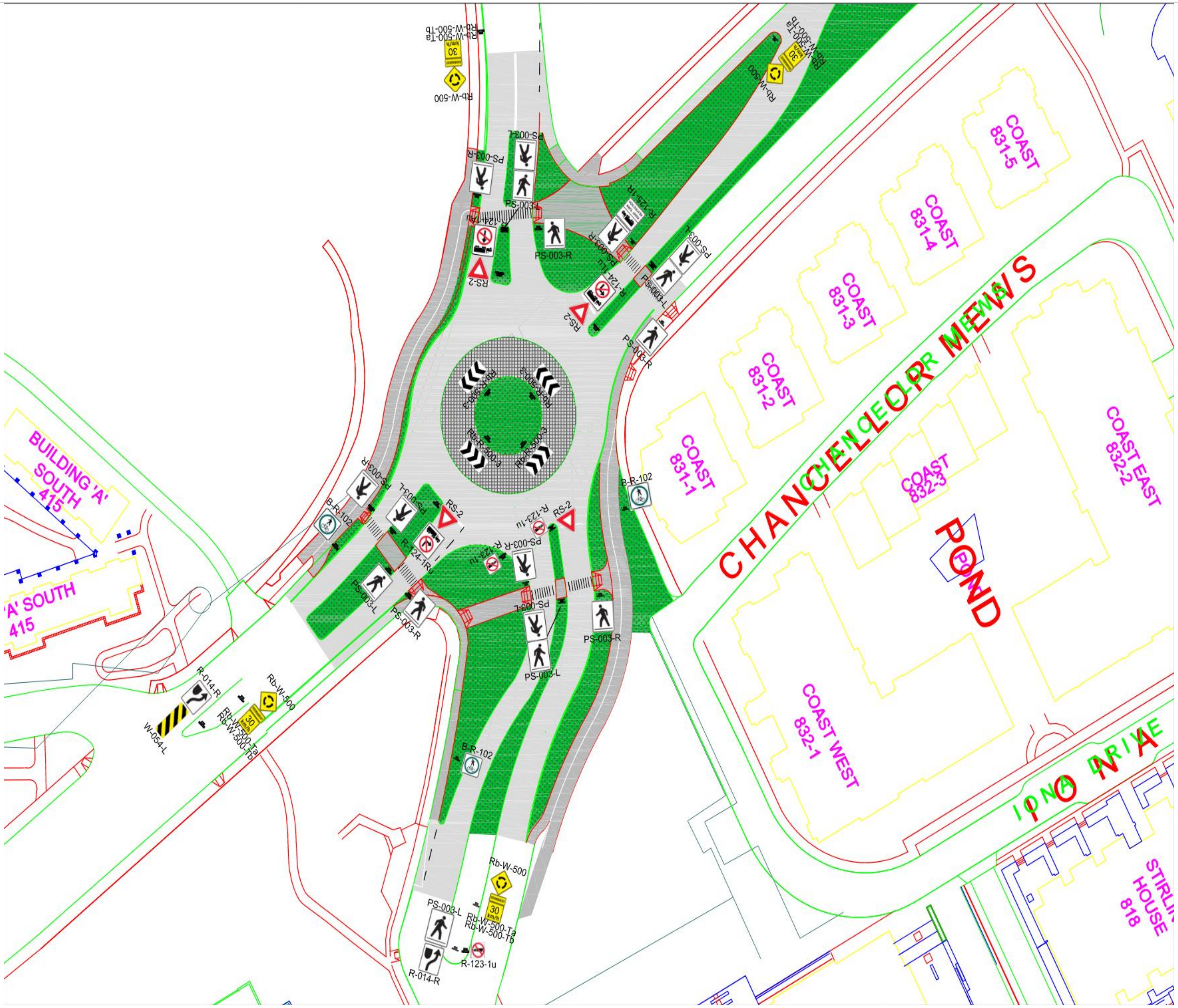
SCALE: 1:600 1"= 50'

0 10 20 30 40 50 METRES
0 50 100 150 FEET

UBC NORTH

STORM

SECTOR
13



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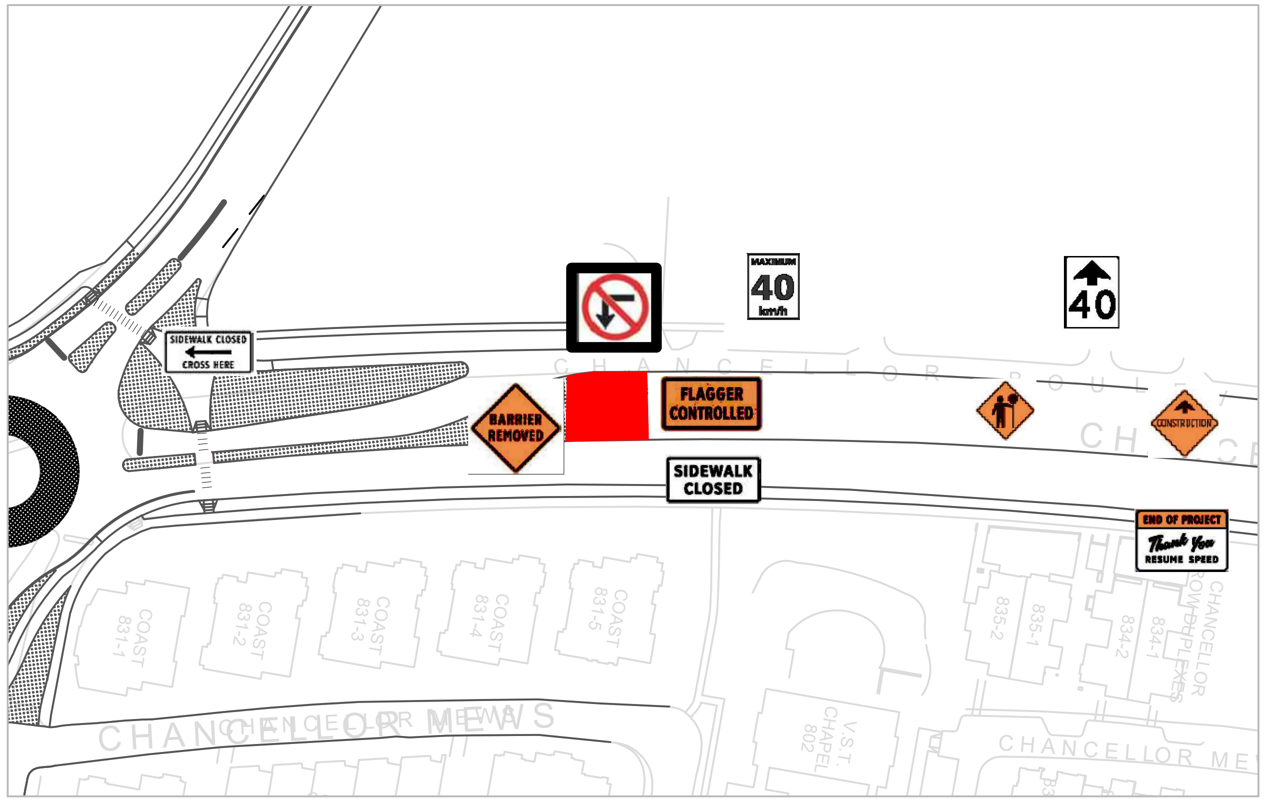
SCALE: 0 1:250 25m

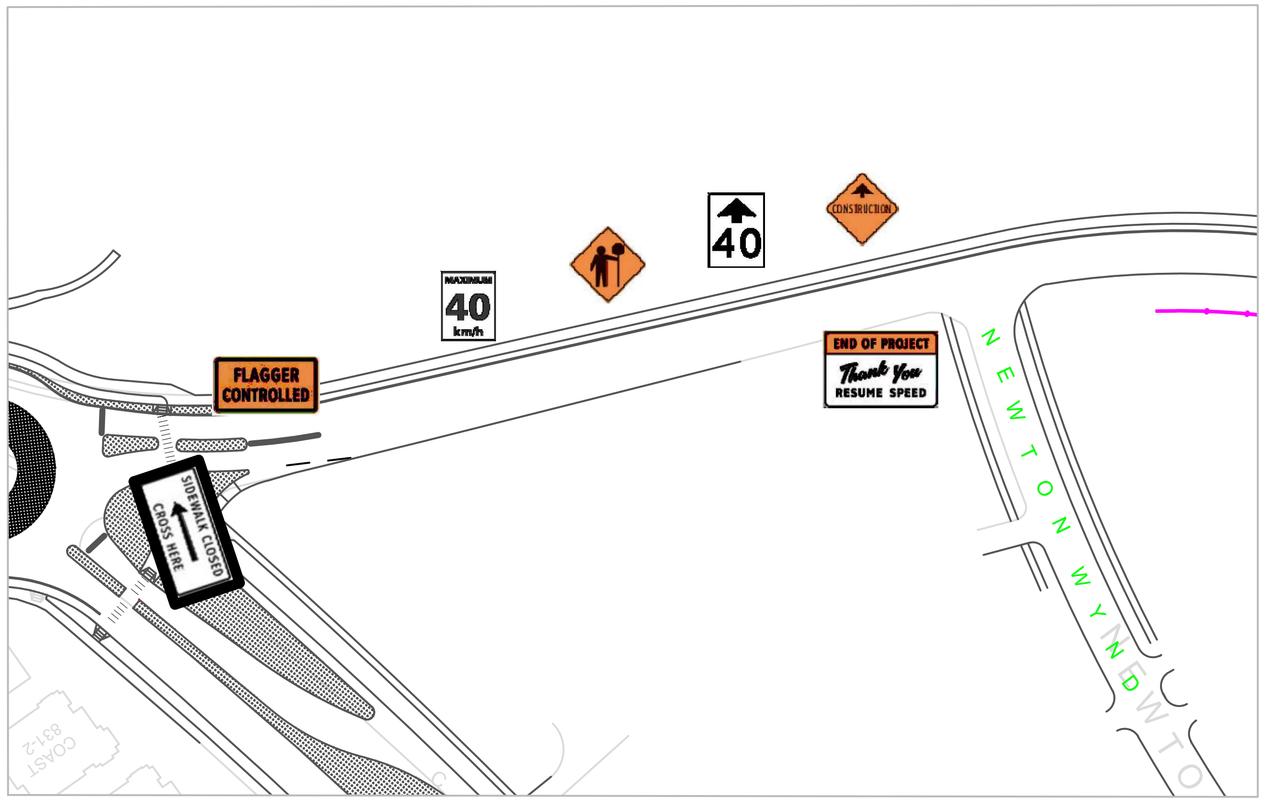
N

SIGNAGE PLAN

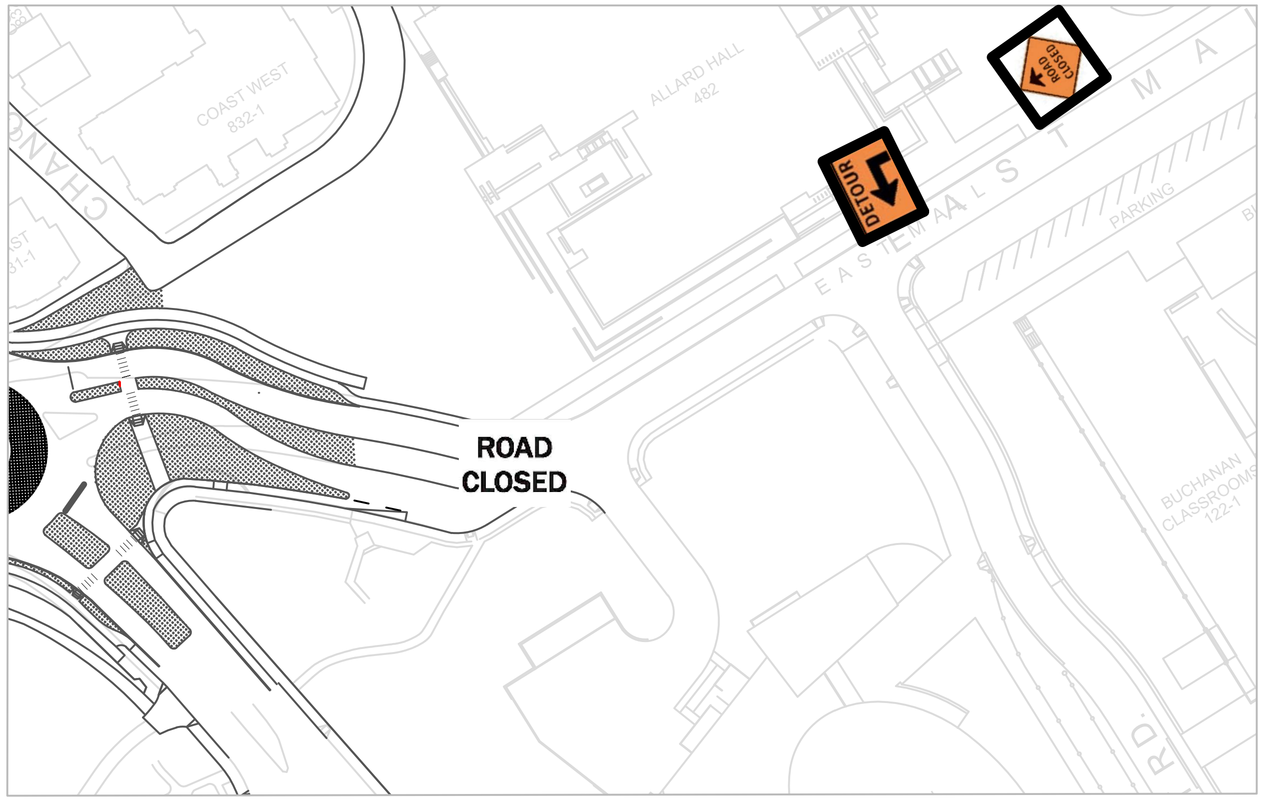
Chancellor Blvd



NW Marine Dr North



East Mall



NW Marine Dr West

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NO	DESCRIPTION	DATE	BY
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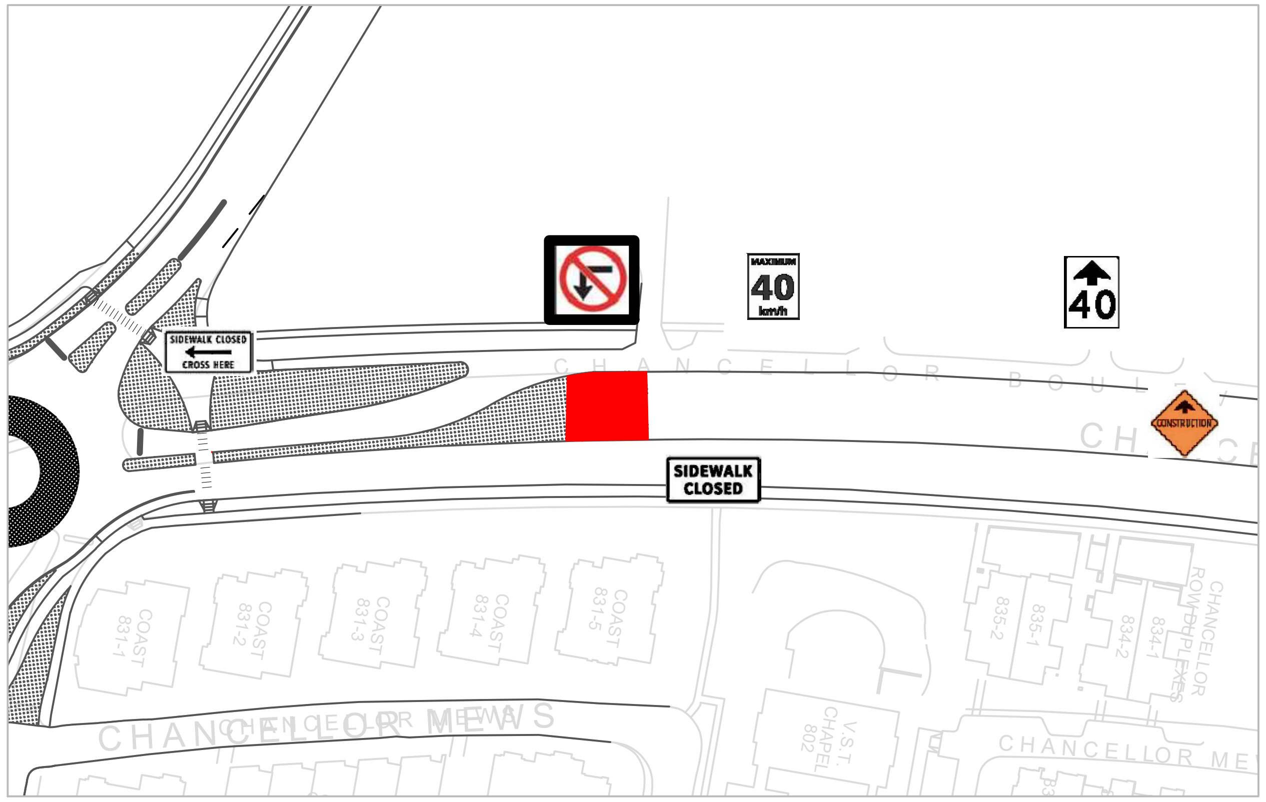
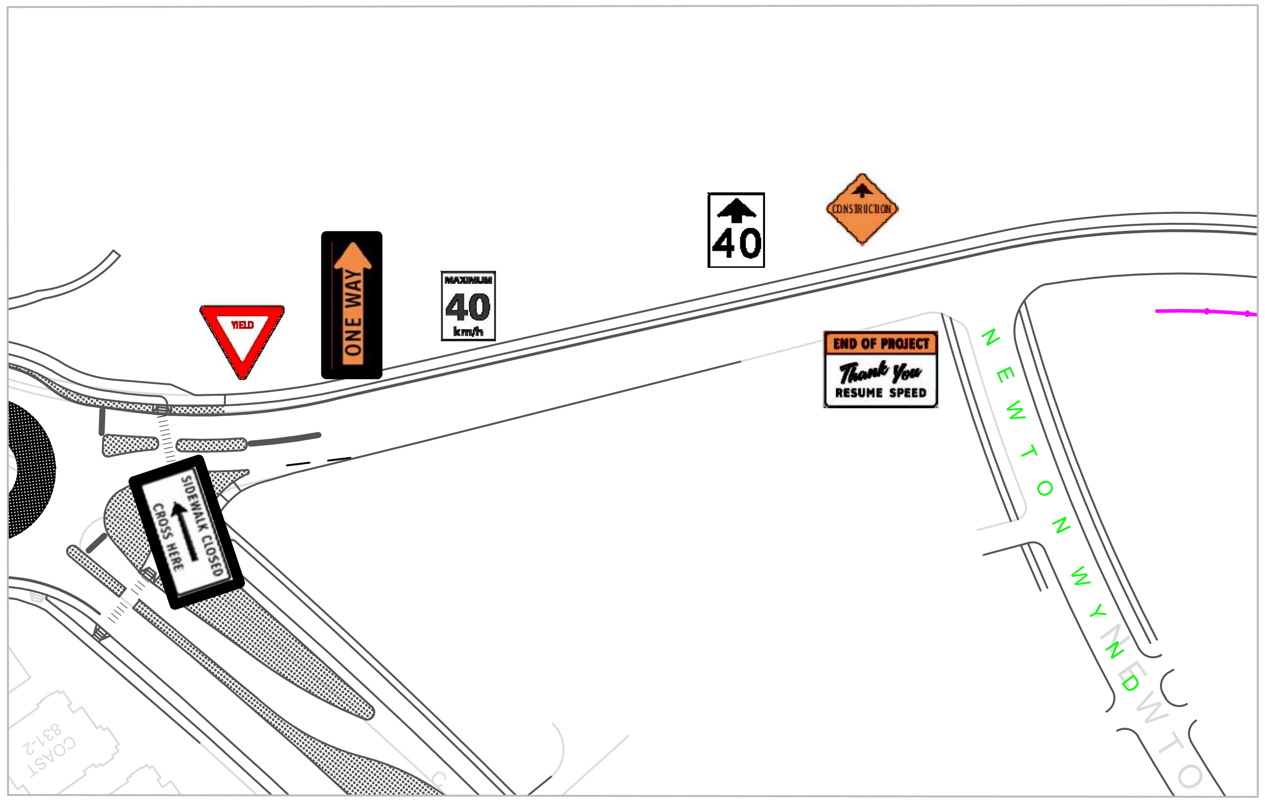
SCALE: 0 1:250 25m

PHASE 1 DAY

Chancellor Blvd



NW Marine Dr North



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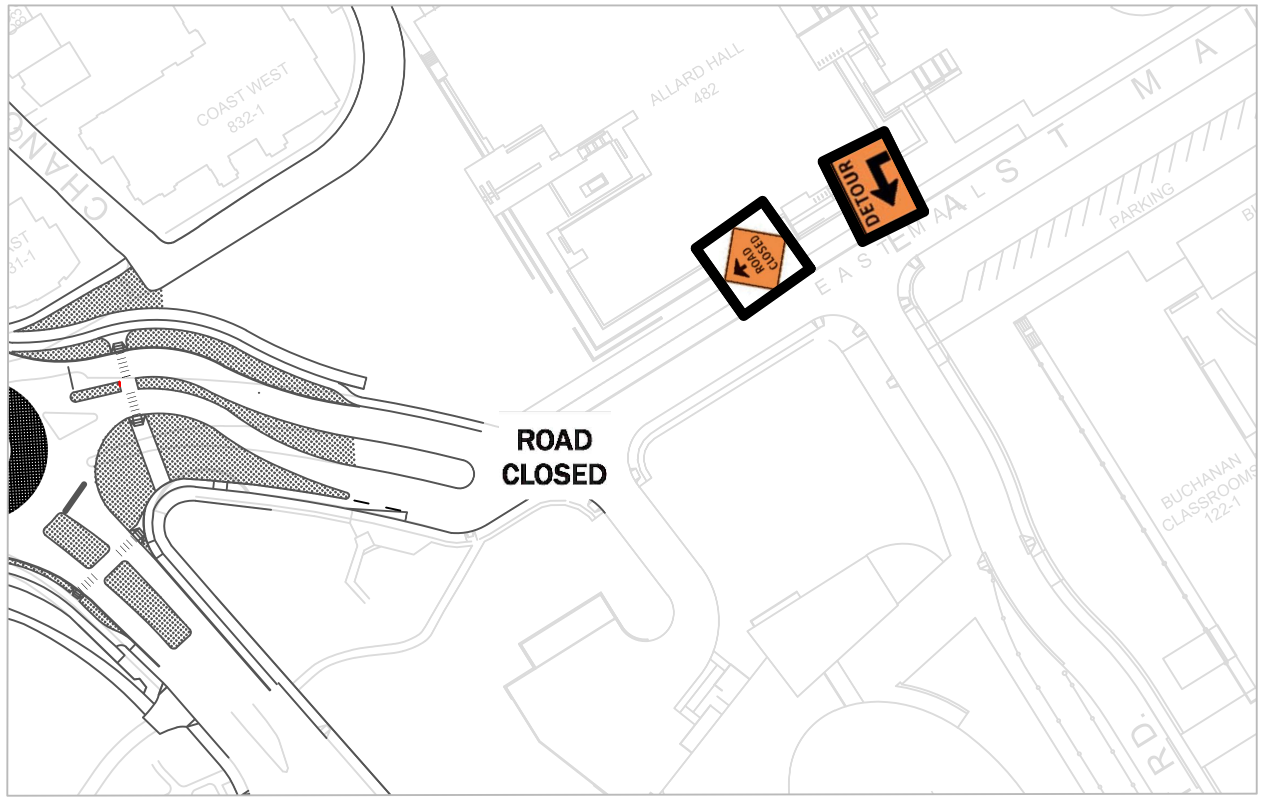

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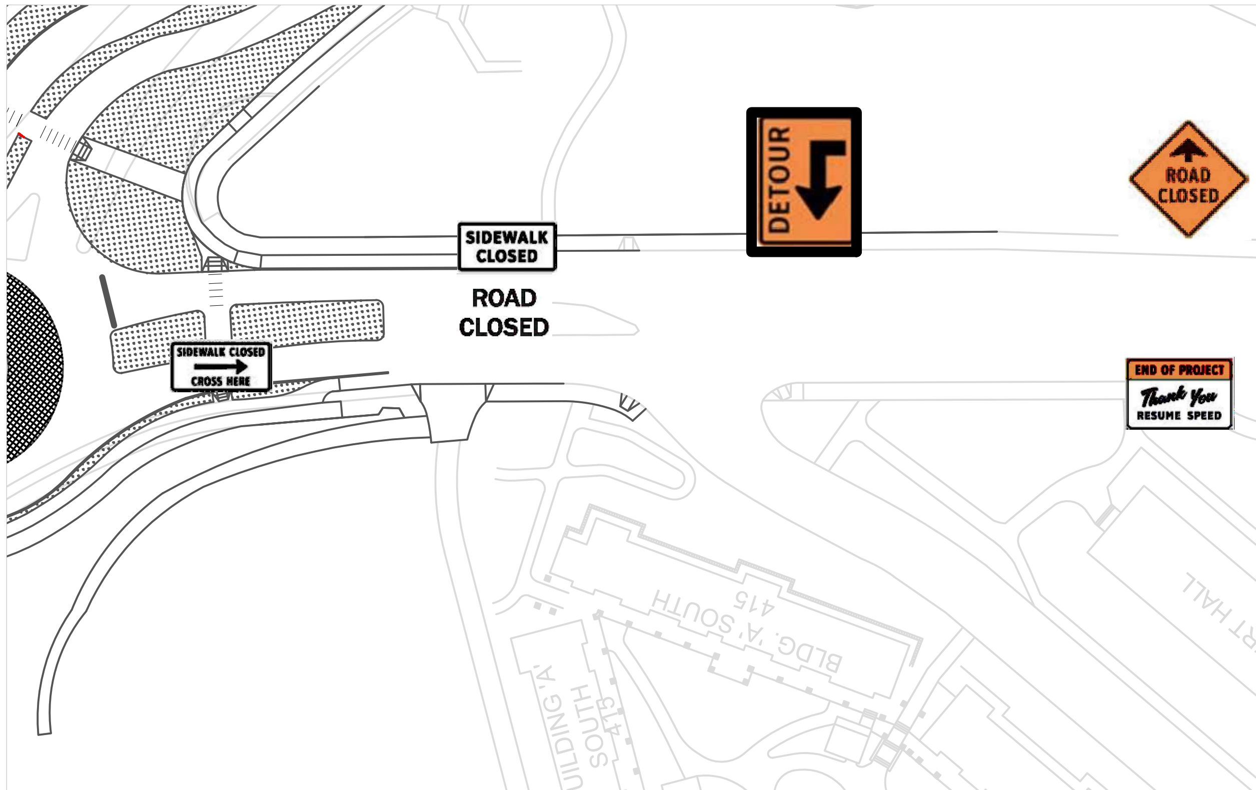

NOTE: WHEN CONVERTING METRIC TO IMPERIAL ELEVATIONS INCLUDE 91.62 FEET TO THE IMPERIAL GEODETIC BASE.
FOR DETAILS REFER TO UBC MONUMENT – PLAN STANDARD NO.01–01

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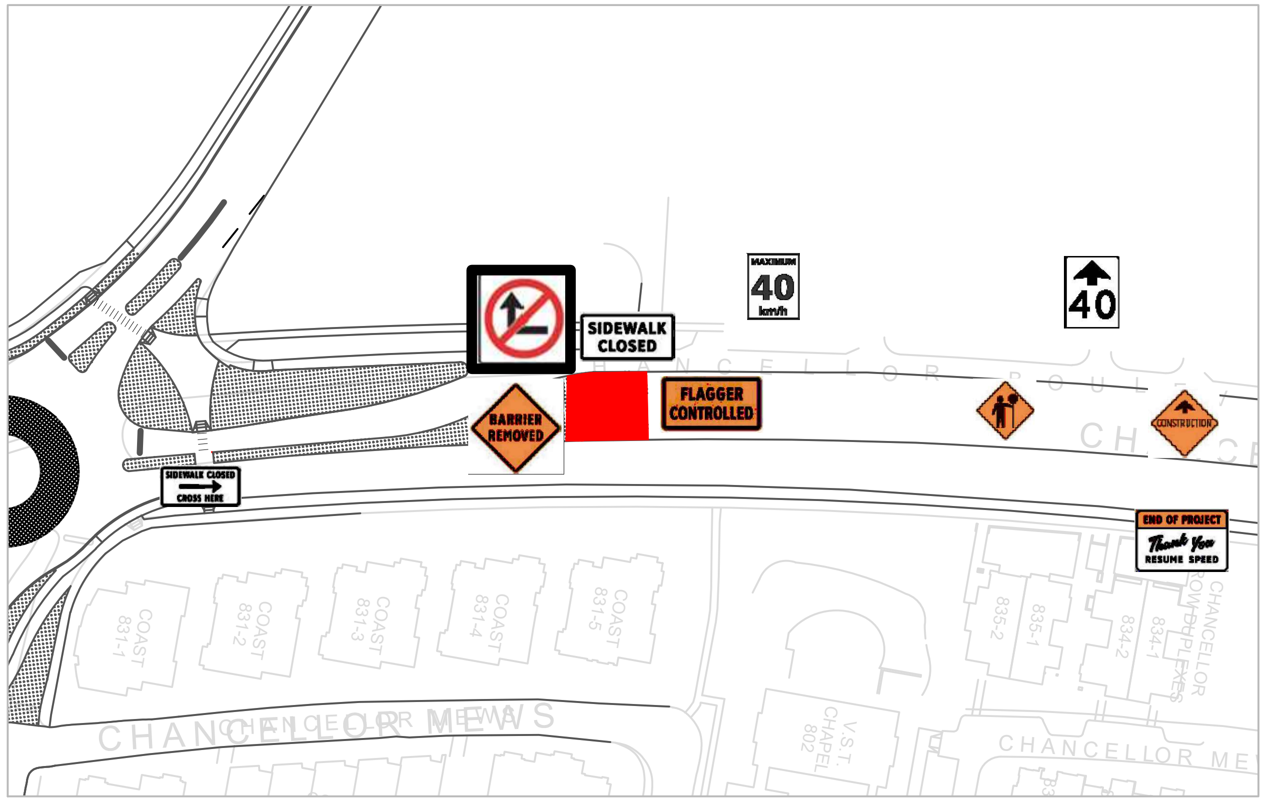
THE UNIVERSITY OF BRITISH COLUMBIA
INFRASTRUCTURE DEVELOPMENT

NO	DESCRIPTION	DATE	BY
1	ISSUED FOR PRELIMINARY DESIGN	24-12-07	JM

SCALE: 0 1:250 25m

PHASE 1 NIGHT

Chancellor Blvd



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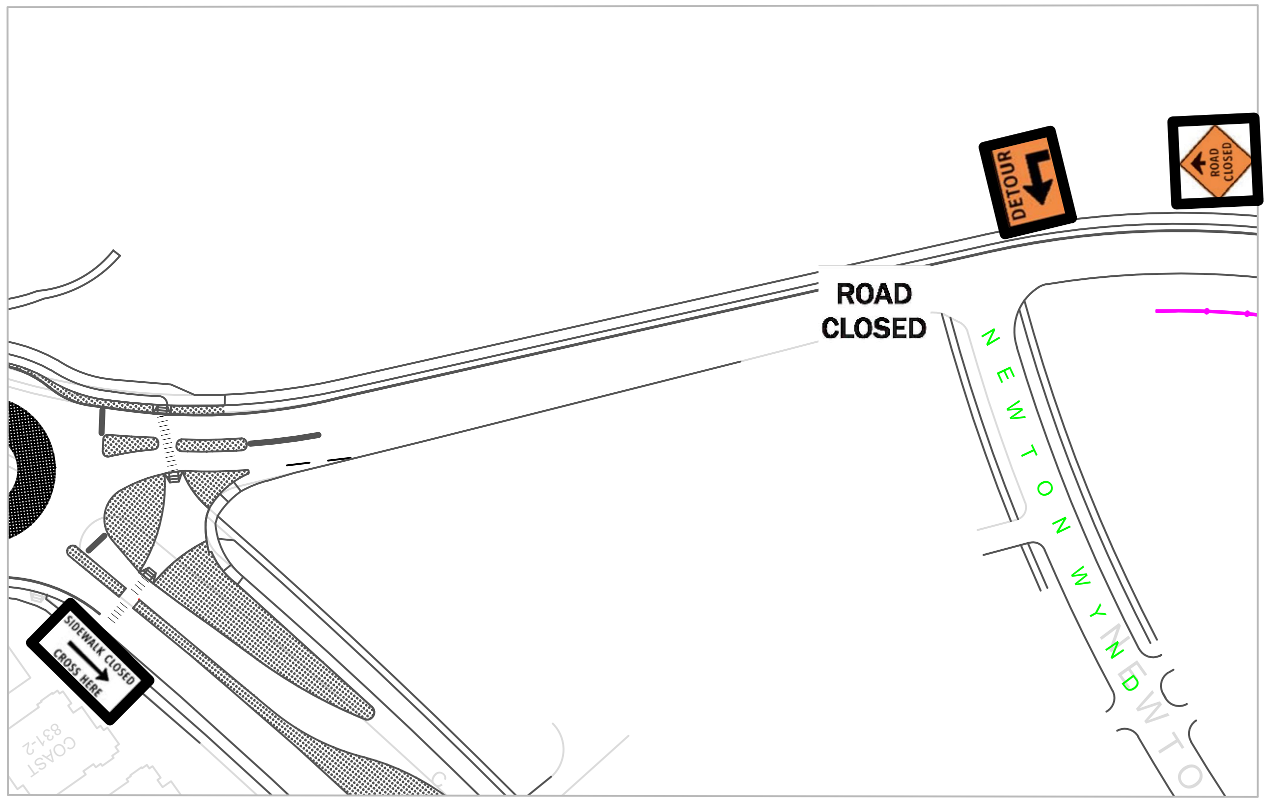

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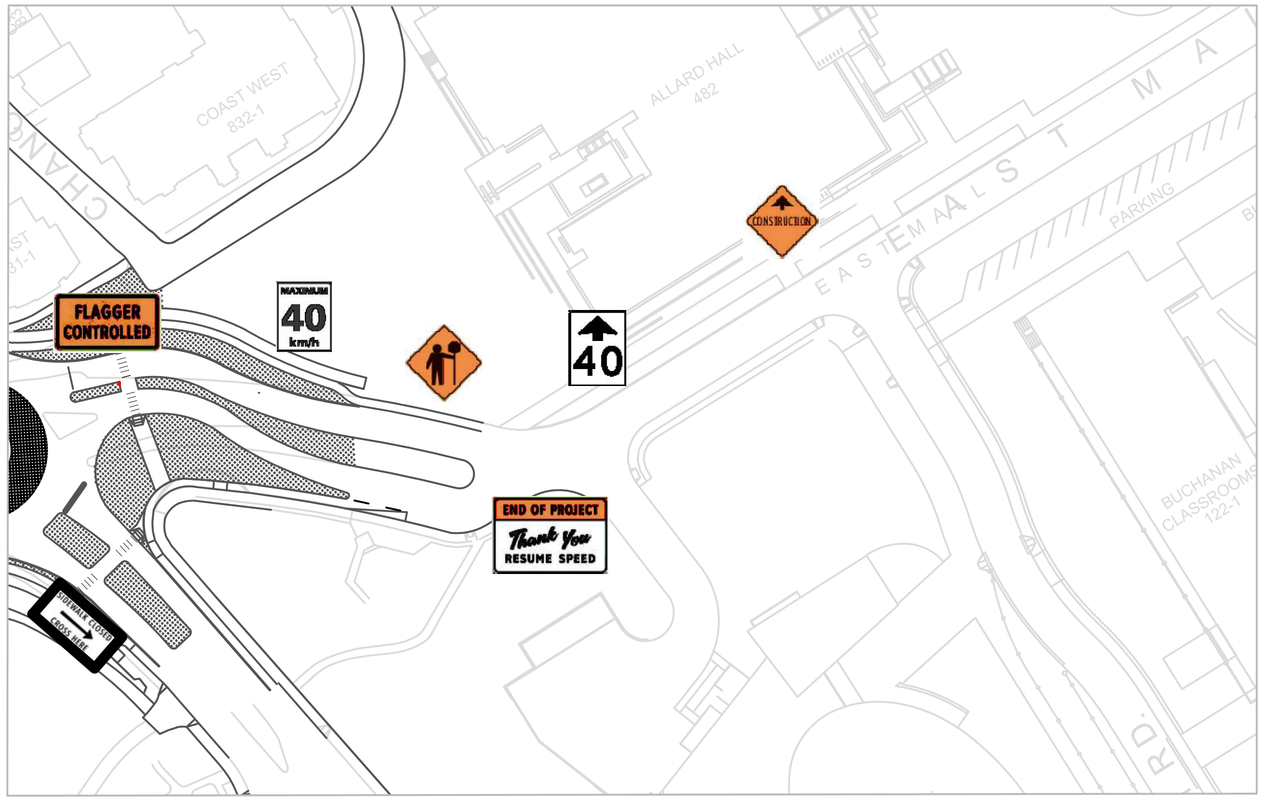

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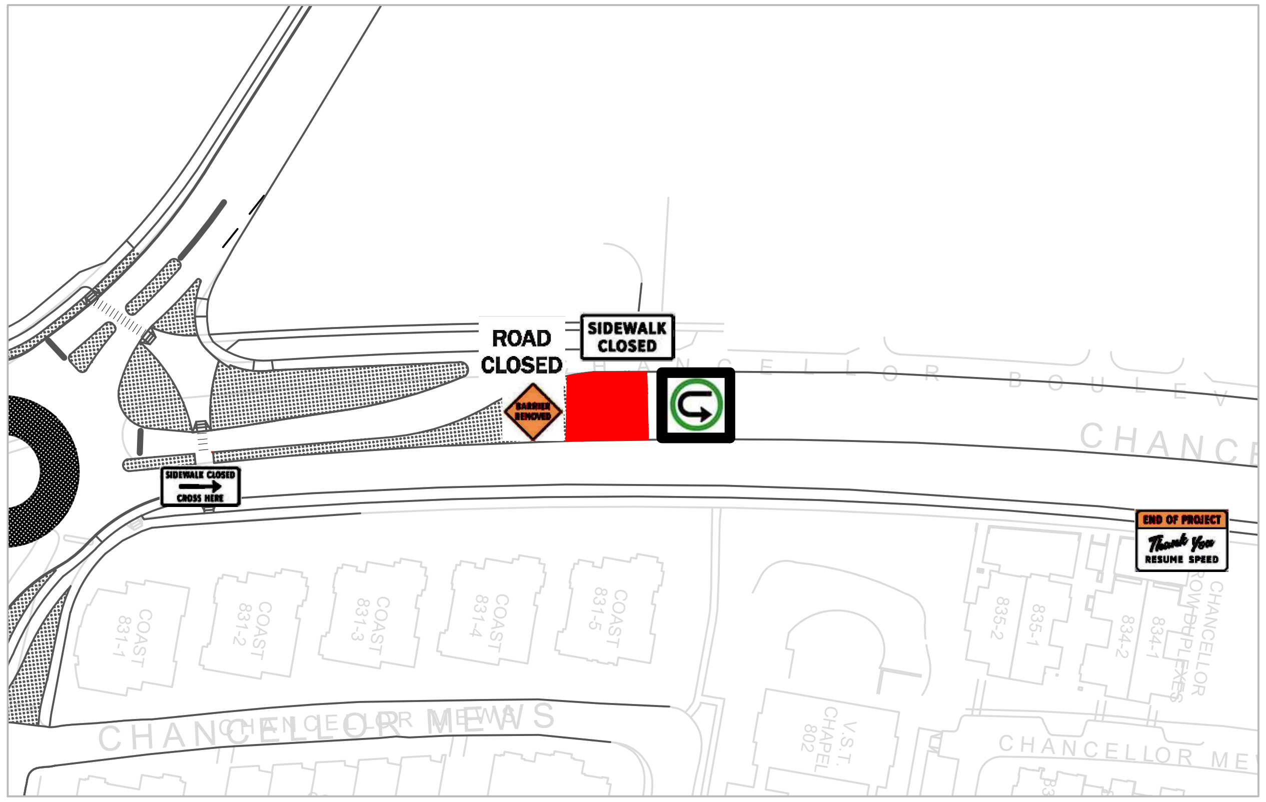
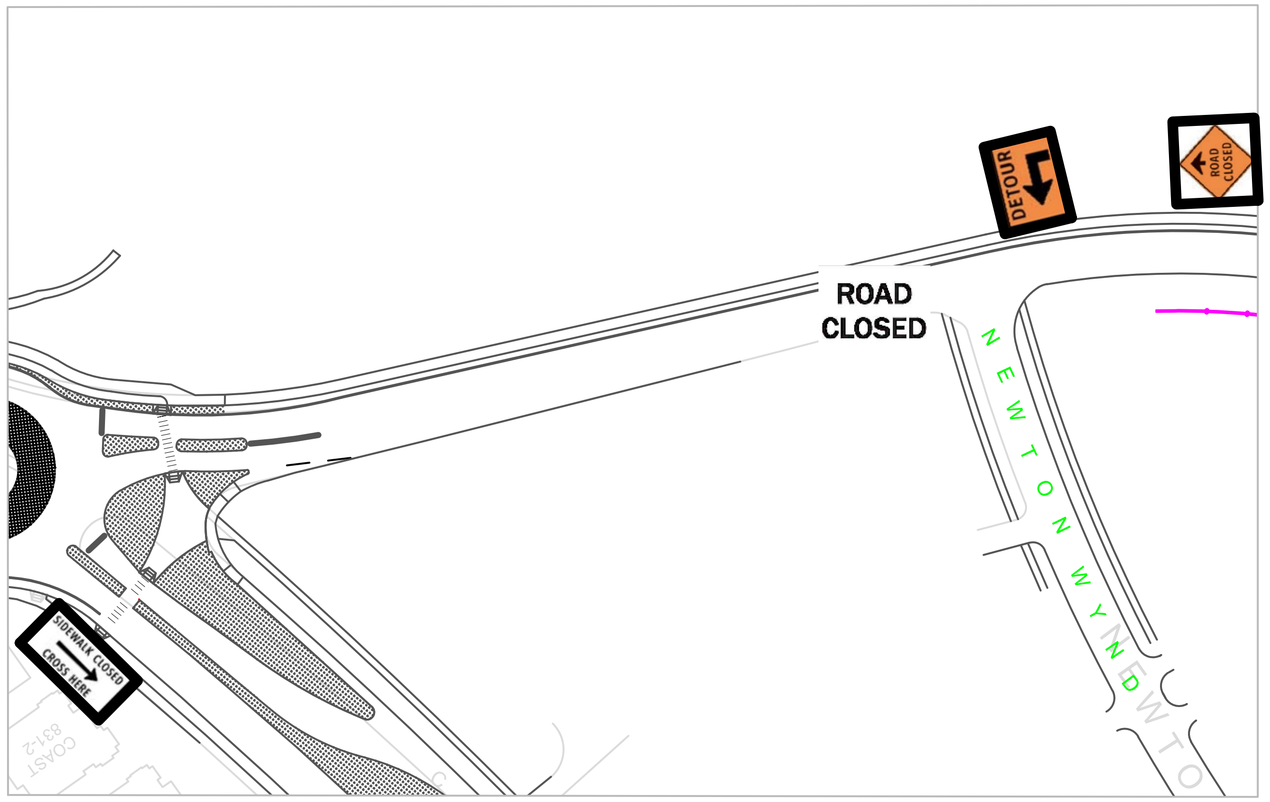


NW Marine Dr North



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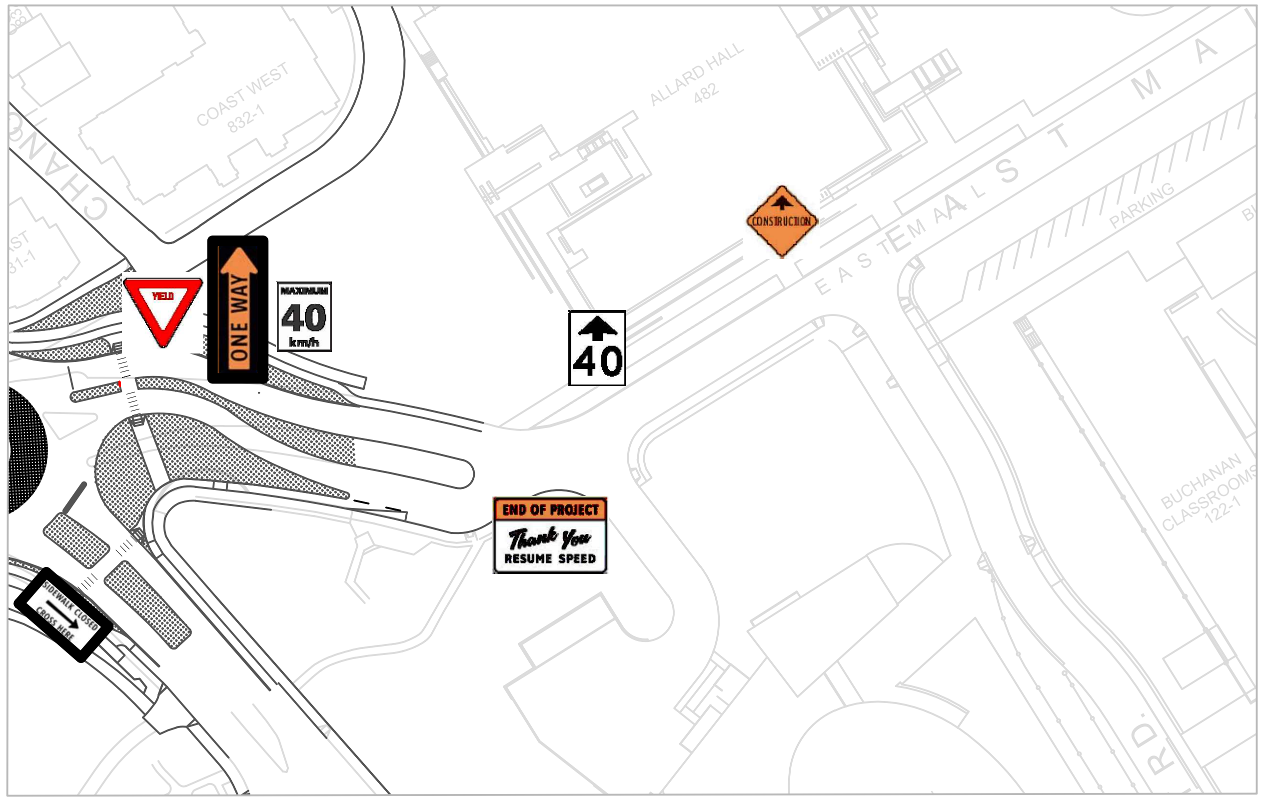

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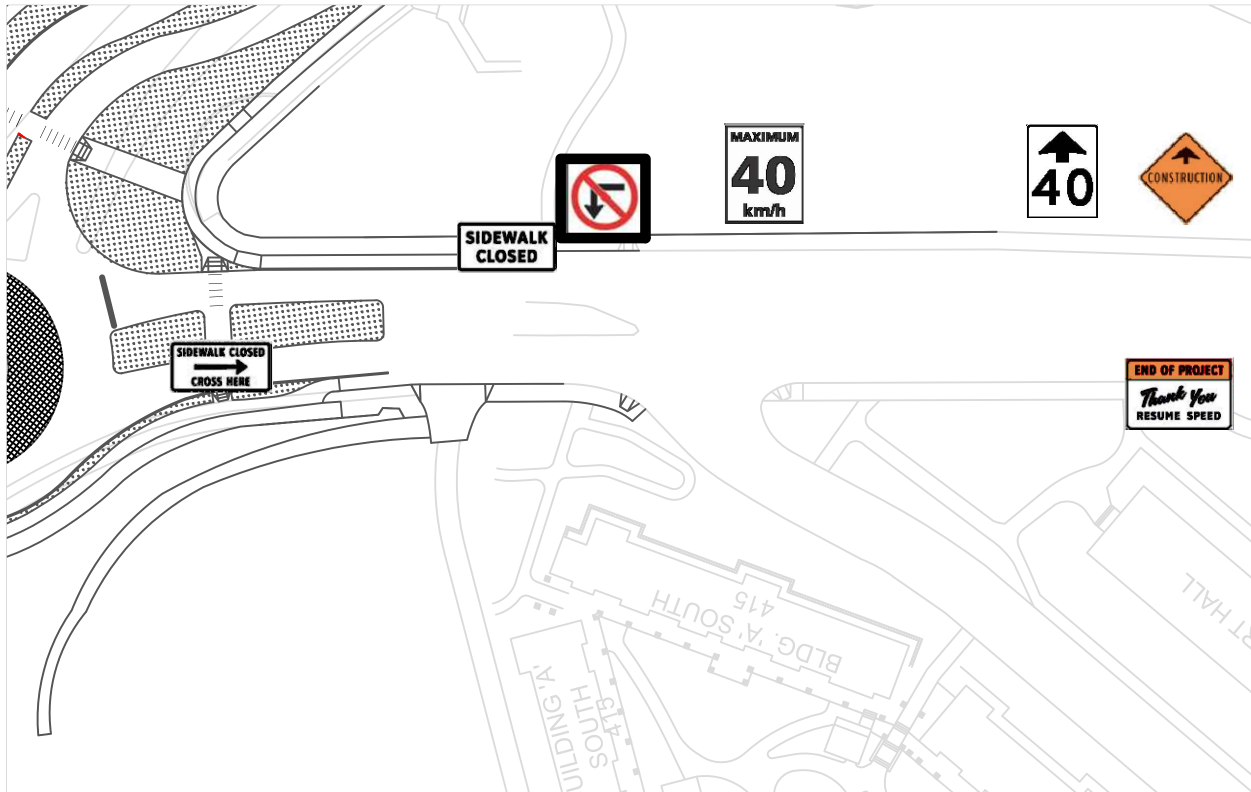

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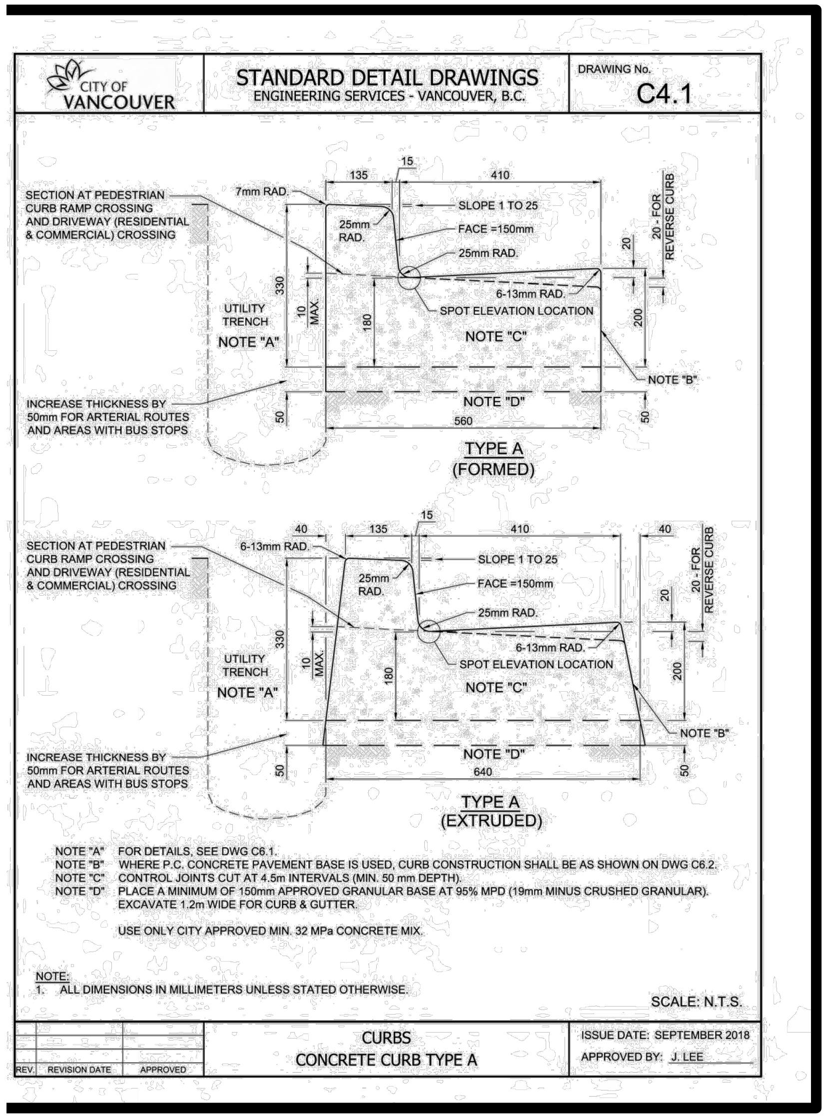
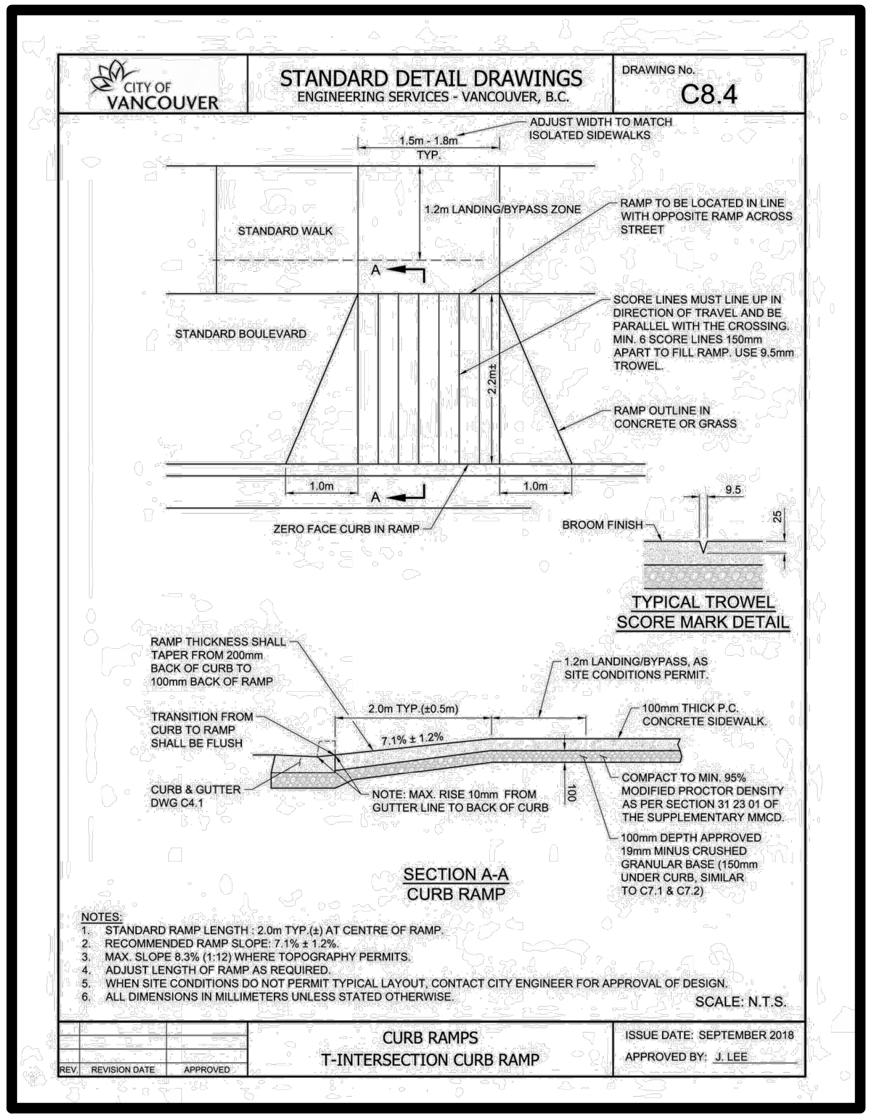
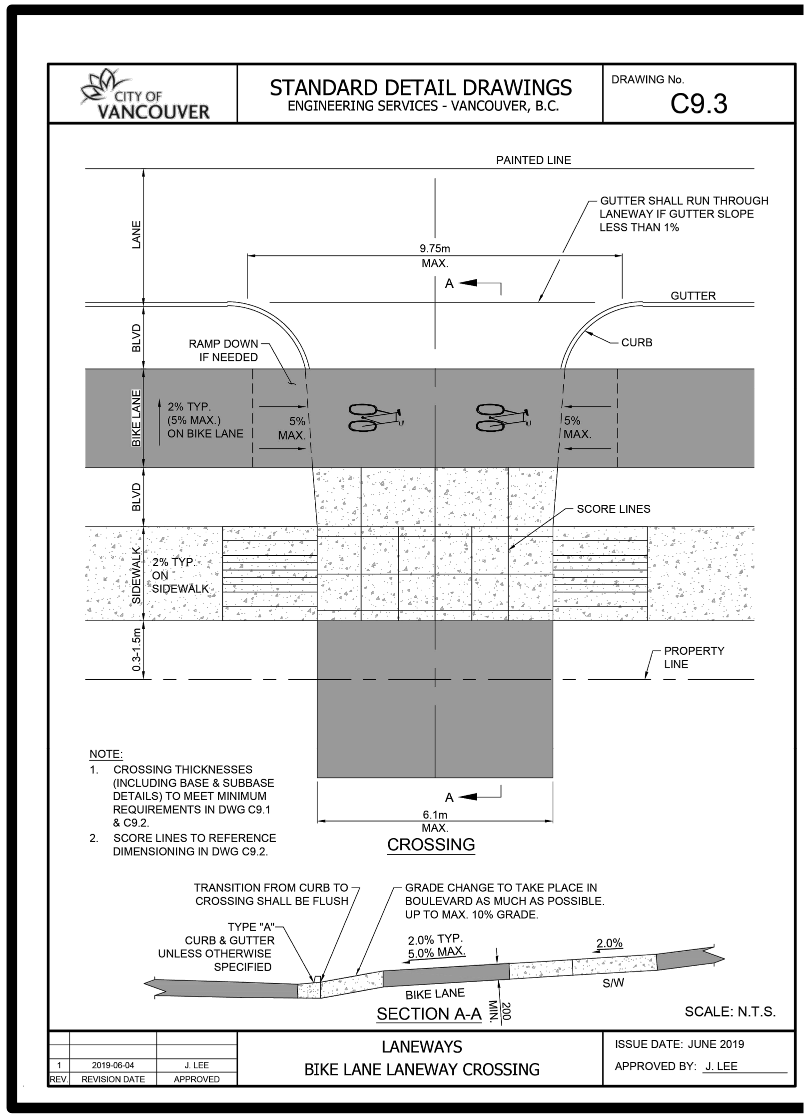
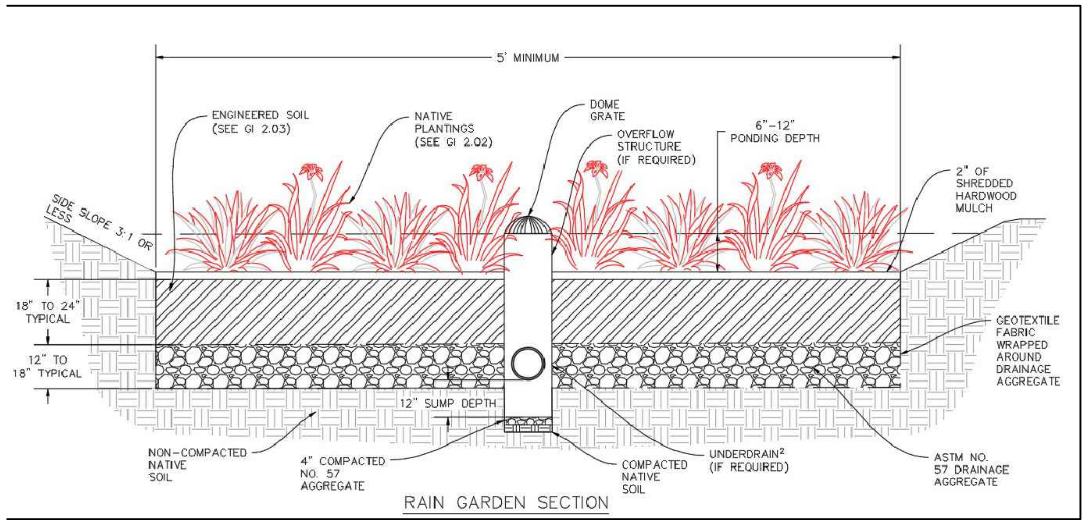

CITY OF VANCOUVER
STANDARD DETAIL DRAWINGS
ENGINEERING SERVICES - VANCOUVER, B.C.
DRAWING No.
C4.1
SECTION AT PEDESTRIAN CURB RAMP CROSSING AND DRIVEWAY (RESIDENTIAL & COMMERCIAL) CROSSING
7mm RAD.
25mm RAD.
SLOPE 1 TO 25
FACE =150mm
25mm RAD.
6-13mm RAD.
SPOT ELEVATION LOCATION
20 - FOR REVERSE CURB
UTILITY TRENCH
NOTE "A"
NOTE "C"
NOTE "D"
NOTE "B"
INCREASE THICKNESS BY 50mm FOR ARTERIAL ROUTES AND AREAS WITH BUS STOPS
TYPE A
(FORMED)
6-13mm RAD.
TYPE A
(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.
SCALE: N.T.S.
REV. REVISION DATE APPROVED
CURBS
CONCRETE CURB TYPE A
ISSUE DATE: SEPTEMBER 2018
APPROVED BY: J. LEE


CITY OF VANCOUVER
STANDARD DETAIL DRAWINGS
ENGINEERING SERVICES - VANCOUVER, B.C.
DRAWING No.
C8.4
ADJUST WIDTH TO MATCH ISOLATED SIDEWALKS
1.5m - 1.8m TYP.
STANDARD WALK
1.2m LANDING/BYPASS ZONE
RAMP TO BE LOCATED IN LINE WITH OPPOSITE RAMP ACROSS STREET
STANDARD BOULEVARD
SCORE LINES MUST LINE UP IN DIRECTION OF TRAVEL AND BE PARALLEL WITH THE CROSSING. MIN. 6 SCORE LINES 150mm APART TO FILL RAMP. USE 9.5mm TROWEL.
RAMP OUTLINE IN CONCRETE OR GRASS
1.0m
ZERO FACE CURB IN RAMP
BROOM FINISH
TYPICAL TROWEL SCORE MARK DETAIL
RAMP THICKNESS SHALL TAPER FROM 200mm BACK OF CURB TO 100mm BACK OF RAMP
1.2m LANDING/BYPASS, AS SITE CONDITIONS PERMIT.
2.0m TYP.(±0.5m)
7.1% ± 1.2%
100mm THICK P.C. CONCRETE SIDEWALK.
TRANSITION FROM CURB TO RAMP SHALL BE FLUSH
CURB & GUTTER DWG C4.1
NOTE: MAX. RISE 10mm FROM GUTTER LINE TO BACK OF CURB
COMPACT TO MIN. 95% MODIFIED PROCTOR DENSITY AS PER SECTION 31 23 01 OF THE SUPPLEMENTARY MMCD.
100mm DEPTH APPROVED 19mm MINUS CRUSHED GRANULAR BASE (150mm UNDER CURB, SIMILAR TO C7.1 & C7.2)
SECTION A-A
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.
SCALE: N.T.S.
REV. REVISION DATE APPROVED
CURB RAMPS
T-INTERSECTION CURB RAMP
ISSUE DATE: SEPTEMBER 2018
APPROVED BY: J. LEE


CITY OF VANCOUVER
STANDARD DETAIL DRAWINGS
ENGINEERING SERVICES - VANCOUVER, B.C.
DRAWING No.
C9.3
PAINTED LINE
GUTTER SHALL RUN THROUGH LANEWAY IF GUTTER SLOPE LESS THAN 1%
9.75m MAX.
LANE
GUTTER
BLVD
RAMP DOWN IF NEEDED
CURB
BIKE LANE
2% TYP. (5% MAX.) ON BIKE LANE
5% MAX.
SCORE LINES
SIDEWALK
2% TYP. ON SIDEWALK
PROPERTY LINE
NOTE:
1. CROSSING THICKNESSES (INCLUDING BASE & SUBBASE DETAILS) TO MEET MINIMUM REQUIREMENTS IN DWG C9.1 & C9.2.
2. SCORE LINES TO REFERENCE DIMENSIONING IN DWG C9.2.
6.1m MAX.
CROSSING
TRANSITION FROM CURB TO CROSSING SHALL BE FLUSH
GRADE CHANGE TO TAKE PLACE IN BOULEVARD AS MUCH AS POSSIBLE. UP TO MAX. 10% GRADE.
TYPE "A" CURB & GUTTER UNLESS OTHERWISE SPECIFIED
2.0% TYP. 5.0% MAX.
2.0%
S/W
BIKE LANE
SECTION A-A
SCALE: N.T.S.
REV. REVISION DATE APPROVED
1 2019-06-04 J. LEE
LANEWAYS
BIKE LANE LANEWAY CROSSING
ISSUE DATE: JUNE 2019
APPROVED BY: J. LEE


5' MINIMUM
ENGINEERED SOIL (SEE GI 2.03)
NATIVE PLANTINGS (SEE GI 2.02)
DOME GRATE
OVERFLOW STRUCTURE (IF REQUIRED)
6"-12" PONDING DEPTH
2" OF SHREDDED HARDWOOD MULCH
SIDE SLOPE 3:1 OR LESS
18" TO 24" TYPICAL
12" TO 18" TYPICAL
GEOTEXTILE FABRIC WRAPPED AROUND DRAINAGE AGGREGATE
12" SUMP DEPTH
NON-COMPACTED NATIVE SOIL
4" COMPACTED NO. 57 AGGREGATE
COMPACTED NATIVE SOIL
UNDERDRAIN (IF REQUIRED)
ASTM NO. 57 DRAINAGE AGGREGATE
RAIN GARDEN SECTION

GENERAL NOTES:

1. READ ALL STRUCTURAL/CIVIL DRAWINGS IN CONJUNCTION WITH ALL CONTRACT DOCUMENTS, INCLUDING REFERENCED ELECTRICAL, MECHANICAL, VENDOR DRAWINGS, AND SPECIFICATIONS
2. THE CONTRACTOR FOR ANY PORTION OF WORK SHALL VISIT THE SITE AND SHALL BE THOROUGHLY FAMILIAR WITH ALL THE PHYSICAL FEATURES THAT MAY AFFECT THE WORK IN ANY WAY.
3. FIELD MEASURE AND MAKE ADJUSTMENTS TO SUIT EXISTING CONDITIONS.
4. THE CONTRACTOR SHALL KEEP WORK SITES CLEAN AND FREE OF ALL CONSTRUCTION DEBRIS DURING THE PROCESS OF CONSTRUCTION AND LEAVE THE SITE CLEAN UPON COMPLETION OF WORK OR PORTIONS OF THE WORK.
5. CONSULTANT MUST APPROVE ALL DEVIATIONS FROM THE WORKING DRAWINGS. THE CONTRACTOR MUST KEEP AN ACCURATE RECORD OF ALL CHANGES FROM THE ORIGINAL INFORMATION SHOWN ON THE CONSTRUCTION DRAWINGS.
6. FEATURES OF CONSTRUCTION NOT FULLY SHOWN ARE OF THE SAME CHARACTER AS THOSE NOTED FOR SIMILAR CONDITIONS.
8. IF DISCREPANCIES EXIST BETWEEN THESE DWGS. AND THE SPECIFICATIONS, CONTACT ENGINEER FOR REVIEW AND APPROVAL PRIOR TO PROCEEDING.
9. DO NOT SCALE THESE DRAWINGS.

GENERAL MATERIALS:

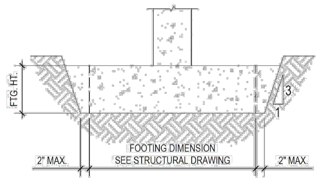
1. DELIVER MATERIALS TO JOB SITE IN DRY CONDITION. KEEP MATERIALS DRY AND CLEAN UNTIL USE.
2. BACKFILL WITH GRANULAR A UNLESS OTHERWISE NOTED ON THE DRAWINGS, COMPACT IN ONE FOOT LIFTS TO A MINIMUM 95% S.P.D.D. TO SIX INCHES BELOW TOP OF CONCRETE.
3. ALL CEMENT TO BE PORTLAND BLAST FURNACE SLAG CEMENT TO CAN-A326 BLENDED HYDRAULIC CEMENTS CONSISTING OF 75% NORMAL TYPE 10 PORTLAND CEMENT AND 25% CEMENTITIOUS HYDRAULIC SLAG.
4. ALL REINFORCING STEEL TO BE GRADE 400 DEFORMED BARS TO CAN/CSA G30.18.
5. ALL BASE GROUT TO BE "MEADOWS V1" BY W.R. MEADOWS OR APPROVED EQUAL.
6. EPOXY GROUT FOR DOWELS TO BE ANCHORFIX 2CA BY SIKA CANADA OR APPROVED EQUAL.
7. DISPOSAL OF ALL EXCAVATED MATERIAL SHALL BE OFF-SITE OTHER THAN APPROVED BACKFILL

ABBREVIATIONS:

A.B. --- ANCHOR BOLT
A.F.F. --- ABOVE FINISHED FLOOR
ALT. --- ALTERNATE
ARCH. --- ARCHITECTURAL
B.C.E. --- BOTTOM CHORD EXTENSION
B.F.F. --- BELOW FINISHED FLOOR
B.L.L. --- BOTTOM LOWER LAYER
BOT. --- BOTTOM
B.U.L. --- BOTTOM UPPER LAYER
C.A. --- COLUMN ABOVE
C.B. --- COLUMN BELOW
CANT. --- CANTILEVER
C.I.P. --- CAST IN PLACE
CONC. --- CONCRETE
CONT. --- CONTINUOUS
C.P. --- COMPLETE PENETRATION
c/c --- CENTER TO CENTER
C.L. --- CENTER LINE
CRS. --- COURSE
c/w --- COMPLETE WITH
DET. --- DETAIL
D.L. --- DEAD LOAD
do --- DO OVER (DITTO)
DP. --- DEEP (DEPTH OF MEMBER)
DWG. --- DRAWING
DWLS. --- DOWELS
EA. --- EACH
E.E. --- EACH END
E.F. --- EACH FACE
EL. --- ELEVATION
ELEV. --- ELEVATION
ELEC. --- ELECTRICAL
EMBED.-- EMBEDMENT
E.S. --- EACH SIDE
E.W. --- EACH WAY
EXIST. --- EXISTING
EX. --- EXISTING
EXT. --- EXTERIOR
EXP. JT.-- EXPANSION JOINT
F.D. --- FLOOR DRAIN
F.S. --- FAR SIDE
FTG. --- FOOTING
GALV. --- GALVANIZED
G.L. --- GRID LINE
GRAN. --- GRANULAR
HK. --- HOOK
H&V --- HORIZONTAL & VERTICAL
HORZ. --- HORIZONTAL
I.J. --- ISOLATION JOINT
INT. --- INTERIOR
JT. --- JOINT
LG. --- LONG
L.B. --- LOAD BEARING
L.L. --- LIVE LOAD
L.L.H. --- LONG LEG HORIZONTAL
L.L.V. --- LONG LEG VERTICAL
L.S.H. --- LONG SIDE HORIZONTAL
L.S.V. --- LONG SIDE VERTICAL
MANUF. - MANUFACTURER
MAX. --- MAXIMUM
MECH. --- MECHANICAL
MIN. --- MINIMUM
MIR. --- MIRROR
N.I.C. --- NOT IN CONTRACT
N.L.B. --- NON-LOAD BEARING
N.S. --- NEAR SIDE
N.T.S. --- NOT TO SCALE
O/C --- ON CENTER
OPP. --- OPPOSITE
O.W.S.J. - OPEN WEB STEEL JOIST
PL. --- PLATE
P.L. --- POINT LOAD
P.L.A. --- POINT LOAD ABOVE
P.T. --- PRESSURE TREATED
R.D. --- ROOF DRAIN
R/W --- REINFORCED WITH
S.C. --- SAW CUT CONTROL JOINT
S.D.L. --- SUPERIMPOSED DEAD LOAD
S.D.F. --- STEP DOWN FOOTING
SECT. --- SECTION
SIM. --- SIMILAR
S.J. --- SNOW LOAD
S.O.G. --- SLAB ON GRADE
SPEC. --- SPECIFICATIONS
STAG. --- STAGGERED
STIR. --- STIRRUPS
SYM. --- SYMMETRICAL
THK. --- THICK
THRU --- THROUGH
T.L.L. --- TOP LOWER LAYER
TYP. --- TYPICAL
T&B --- TOP & BOTTOM
T&G --- TONGUE & GROOVE
T.J. --- TIE JOISTS
T/O --- TOP OF
T.O.S. --- TOP OF STEEL
T.U.L. --- TOP UPPER LAYER
U.N.O. --- UNLESS NOTED OTHERWISE
ULS --- ULTIMATE LIMIT STATE
SLS --- SERVICEABILITY LIMIT STATE
U/S --- UNDERSIDE
VERT. ---- VERTICAL
W.P. ---- WORK POINT

FOUNDATIONS:

1. BEARING SURFACES MUST BE APPROVED BY THE SOILS ENGINEER IMMEDIATELY PRIOR TO CONSTRUCTION.
2. REFER TO SOILS REPORT FOR OTHER SPECIFIC DESIGN REQUIREMENTS FOR FOOTING, SOIL SLOPES, FROST PROTECTION, MINIMUM COVER, ETC.
3. UNLESS OTHERWISE SHOWN, CENTER FOOTINGS BELOW COLUMNS AND WALLS.
4. DOWELS SHALL BE PLACED BEFORE CONCRETE IS PLACED. TEMPLATES SHALL BE USED TO ENSURE CORRECT PLACEMENT OF DOWELS.
5. FOOTINGS MAY HAVE TO BE LOWERED TO ACCOMMODATE MECHANICAL OR ELECTRICAL SERVICES. SEE MECHANICAL AND ELECTRICAL DRAWINGS FOR ELEVATIONS. FOOTINGS ARE NOT TO BE UNDERMINED BY EXCAVATIONS FOR SERVICES, PITS, ETC.
6. FOOTINGS ELEVATIONS, IF SHOWN, ARE FOR BIDDING PURPOSES ONLY, ARE NOT FINAL, AND MAY VARY ACCORDING TO SITE CONDITIONS OR AS REQUIRED BY SERVICES. ALL FOOTINGS MUST BE TAKEN TO A BEARING LAYER APPROVED BY THE SOILS ENGINEER.
7. BEARING SURFACES MUST BE PROTECTED FROM FREEZING BEFORE AND AFTER FOOTINGS ARE POURED.
8. SUB-BASE DESIGN OF THE SOIL UNDER THE SLAB ON GRADE SHALL BE IN ACCORDANCE WITH THE SOIL REPORT.
9. CONCRETE PLACED UNDER WATER SHALL CONFORM TO CAN/CSA-A23.1.
10. FOOTINGS CAST DIRECTLY INTO EXCAVATIONS (WITHOUT SIDE FORMS) SHALL NOT BE LARGER THAN SHOWN BELOW:



CONCRETE:

1. ALL CONCRETE SHALL CONFORM TO CSA STANDARD A23.1 (LATEST EDITION) HAVING A MINIMUM COMPRESSIVE STRENGTH AS SHOWN BELOW (UNLESS NOTED OTHERWISE).
2. ALL CAST-IN-PLACE CONCRETE SHALL CONFORM TO THE LATEST EDITION OF CSA STANDARD A23.1. "CONCRETE MATERIALS AND METHODS OF CONCRETE CONSTRUCTION".
3. SUBMIT CONCRETE MIX DESIGN TO ENGINEER PRIOR TO PRODUCTION. NO WATER SHALL BE ADDED TO THE CONCRETE AT THE SITE.
4. SUBMIT PLACING DRAWINGS AND BAR LISTS FOR ALL REINFORCING STEEL TO RSIO MANUAL SUFFICIENTLY DETAILED AND DIMENSIONED TO PERMIT PLACING OF ALL REINFORCING WITHOUT REFERENCE TO DESIGN DRAWINGS.
5. THE OWNER WILL EMPLOY A TESTING COMPANY TO CONDUCT STRENGTH, SLUMP, MATERIAL AND AIR ENTRAINED TESTS ONCE FOR EVERY DAY CONCRETE IS POURED. STRENGTH TEST SHALL INCLUDE THREE CYLINDERS, ONE TESTED AT 7 DAYS AND TWO TESTED AT 28 DAYS IN ACCORDANCE WITH CAN3-A23.2. SLUMP AND AIR CONTENT TESTS SHALL CONSIST OF ONE SAMPLE EACH IN ACCORDANCE WITH CAN3-23.1 AND CAN3-A23.2.
6. ALL CONCRETE THAT WILL BE EXPOSED TO WEATHER SHALL HAVE A 5 TO 7% AIR ENTRAINMENT AT TIME OF PLACING.
7. BULL FLOAT CONCRETE SURFACES AND PROVIDE A LIGHT TROWEL FINISH TO PRODUCE A SMOOTH NON-SLIP SURFACE FREE FROM RIDGES, VOIDS AND MACHINE MARKS. EXTERIOR CONCRETE WALKING SURFACES SHALL HAVE A LIGHT BROOM FINISH TO CREATE A NON-SLIP SURFACE. PROVIDE ROUGH SURFACE AT COLD JOINTS.
8. KEEP CONTINUOUSLY MOIST ALL EXPOSED NON-FORMED SURFACES FOR A MINIMUM OF SEVEN CONSECUTIVE DAYS AFTER PLACEMENT OF CONCRETE UNLESS NOTED OTHERWISE.
9. ALL EXPOSED CONCRETE EDGES ARE TO HAVE A THREE-QUARTER INCH (3/4") CHAMFER UNLESS NOTED OTHERWISE.
10. WHERE NEW CONCRETE IS TO BE PLACED AGAINST EXISTING CONCRETE, EXISTING CONCRETE MUST BE THOROUGHLY CLEANED TO REMOVE OIL, GREASE AND DIRT AND BE SURFACE 'CHIPPED' A MINIMUM OF ONE-HALF (1/2) INCH PRIOR TO PLACEMENT OF NEW CONCRETE UNLESS NOTED OTHERWISE ON DRAWINGS. APPLICATION OF AN APPROVED BONDING AGENT SHALL BE APPLIED AT ALL INTERFACES BETWEEN NEW AND OLD CONCRETE.
11. PROVIDE HOT OR COLD WEATHER PROTECTION WHEN REQUIRED AS SPECIFIED IN CAN3-A23.1.
12. VIBRATE ALL CONCRETE. ENSURE ALL CONCRETE IS DENSE, FREE OF HONEY COMBING, AND THAT NO SEGREGATION OCCURS.
13. ENSURE ALL REBAR IS CLEAN SECURELY HELD IN CORRECT LOCATION DURING PLACING.
14. FOR ALL NEW OPENINGS IN SLAB-ON-GRADE PROVIDE MINIMUM 10M DOWELS AROUND PERIMETER OF OPENING, 12" LONG x 4" EMBEDMENT (FRICTION-FIT) SPACED @ 16" c/c. THE NEW CONCRETE INFILL SHALL HAVE A MINIMUM REINFORCEMENT OF WWM 6x6x$\frac{6}{6}$ (U.N.O.)

CONCRETE PROPERTIES		
ELEMENT	COMPRESSIVE STRENGHT (MPa) 28 DAYS U.N.O.	EXPOSURE CLASS
FOOTINGS	25 MPa (56 DAYS)	N
CAST-IN-PLACE DRILLED FOOTING/CAISSON	32 MPa (56 DAYS)	F-2
SLAB-ON-GRADE (INTERIOR)	25 MPa	N
SLAB-ON-GRADE (EXTERIOR)	32 MPa	C-2
RETAINING/FOUNDATION WALLS	25 MPa	F-2
MECH./ HOUSEKEEPING PADS	20 MPa	N
GRADE BEAMS	30 MPa	N

CONCRETE FORMWORK:

1. THE DESIGN AND FIELD REVIEW OF FORMWORK, SHORING AND RE-SHORING IS THE RESPONSIBILITY OF THE CONTRACTOR. RE-SHORING DRAWINGS SHALL BE SUBMITTED TO HALLEX ENGINEERING LTD. FOR THE EFFECT ON THE BASE BUILDING STRUCTURE ONLY.
2. NO COLUMN OR WALL FORMS SHALL BE REMOVED BEFORE CONCRETE HAS REACHED 10 MPa FOR ARCHITECTURAL CONCRETE OR 8 MPa FOR OTHER COLUMNS OR WALLS.
3. NO SLAB FORMS OR BEAM FORMS SHALL BE REMOVED BEFORE CONCRETE HAS REACHED 75% OF THE 28 DAY STRENGTH BEFORE STRIPPING/RE-SHORING.
4. ALL SLABS, BEAMS, GIRDERS ETC. TO BE SHORED UNTIL CONCRETE REACHED DESIGN STRENGTH.
5. NO CONCRETE MAY BE REMOVED WITH PERCUSSIVE METHODS SUCH AS CHIPPING JACK-HAMMERING WITHOUT PRIOR APPROVAL OF HALLEX ENGINEERING LTD.

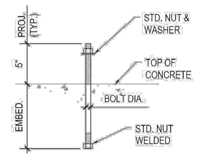
REINFORCING STEEL:

1. LAP ALL REINFORCING AS PER RSIO MANUAL, CLASS "B" TENSION LAP.
2. INTERSECTING REBAR SHALL BE TIED TOGETHER USING NO.16 U.S. WIRE GAUGE OR HEAVIER ANNEALED WIRE OR AN APPROVED PATENTED TYING SYSTEM.
3. ADEQUATELY SUPPORT REINFORCEMENT WITH PLASTIC CHAIRS, SPACERS OR HANGERS AND SECURE AGAINST DISPLACEMENT WITHIN THE TOLERANCES INDICATED IN LATEST EDITION CSA STANDARD A23.1. CONCRETE BRICKS MAY BE USED IN PLACE OF PLASTIC CHAIRS FOR SLABS ON GRADE.
4. NOTIFY THE CONSULTANT FOR SITE REVIEW OF REINFORCEMENT 24 HOURS PRIOR TO THE PLACEMENT OF CONCRETE.
5. MINIMUM COVER TO REINFORCEMENT SHALL BE 3" WHEN CONCRETE IS CAST AGAINST SOIL AND $1\frac{1}{2}$" FOR ALL OTHER APPLICATIONS. (UNLESS NOTED OTHERWISE)

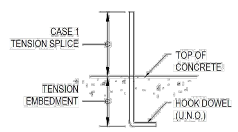
STRUCTURAL STEEL:

1. ALL WORK SHALL CONFORM TO CSA STANDARD S16 (LATEST EDITION) "LIMIT STATES DESIGN OF STEEL STRUCTURES". CONTRACTOR TO FABRICATE TO APPROVED SHOP DWGS. ONLY.
2. STEEL SHALL CONFORM TO CSA STANDARD G40.20 "GENERAL REQUIREMENTS FOR ROLLED OR WELDED STRUCTURAL QUALITY STEEL" AND TO CSA STANDARD G40.21 "STRUCTURAL QUALITY STEELS" TO THE FOLLOWING GRADES:
   HSS AND FLANGE SECTIONS - 350W (50 ksi)
   ALL OTHER HOT ROLLED SHAPES - 300W (44W)
   PLATES NOT GREATER THAN 1 1/2" THICKNESS - 300W (44W)
3. STRUCTURAL BOLTS TO BE ASTM-A325-02 SPECIFICATION FOR STRUCTURAL BOLTS. HEAT TREATED 120/105 KSI MIN. TENSILE STRENGTH. COMPLETE WITH HARDENED WASHERS AND HEAVY HEX NUTS.
4. ALL ANCHOR RODS TO ASTM-F1554 GRADE 36. ALL ANCHOR RODS TO BE HOT-DIP GALVANIZED.

TYP. ANCHOR BOLT (U.N.O.)



TYP. HOOKED DOWEL



5. ALL WELDING TO BE DONE BY A CONTRACTOR CERTIFIED BY THE CANADIAN WELDING BUREAU TO THE REQUIREMENTS OF CSA-W47.1-03 CERTIFICATION OF COMPANIES FOR FUSION WELDING OF STEEL STRUCTURES, DIVISION 1 OR 2. CONTRACTOR TO SUBMIT CURRENT CWB LETTER OF VALIDATION TO ENGINEER PRIOR TO PROCEEDING WITH ANY STEELWORK.
6. ALL ELECTRODES SHALL BE E49XX CONFORMING TO CSA STANDARD W48.
7. ALL WELDING TO BE METAL-ARC TO CSA-W59-M1989-WELDED STEEL CONSTRUCTION. (METAL-ARC WELDING). ALL WELDS SHALL BE CONTINUOUS UNLESS NOTED. MINIMUM SIZE OF FILLET WELD TO BE $\frac{3}{16}$" (5mm) OR AS REQ'D BY MATERIAL THICKNESS OR PARTS JOINED.
8. CLEAN, PRIME AND FINISH PAINT ALL NEW STEEL WORK AS PER THE FOLLOWING:
   7.1. SHOP CLEAN ALL STEEL ACCORDING TO STEEL STRUCTURAL PAINTING COUNCIL SURFACE PREPARATION No. 6, "COMMERCIAL BLAST CLEANING", OR PREPARATION No.3 "POWER WIRE BRUSH CLEANING"
   7.2. SAME DAY AS CLEANED, APPLY ONE SHOP COAT OF DEVGUARD #4160 GREY OXIDE RUST INHIBITIVE PRIMER TO A DRY FILM THICKNESS OF 2.0 TO 2.4 MILS.
   7.3 FOR EXPOSED STEEL IN THE SHOP, APPLY TWO FINISH COATS OF DEVGUARD ALKYD SEMI-GLOSS ENAMEL #4306 SERIES, 1.5 TO 2 MILS DRY FILM THICKNESS, COLOURS BY OWNER.
   7.4 AFTER ERECTION, CLEAN ALL SURFACES. TOUCH-UP ANY DAMAGED OR UNPAINTED AREAS WITH PRIMER AND TWO FINISH COATS.
9. DO NOT PAINT CONNECTION SURFACES OR SURFACES TO BE WELDED.
10. SUBMIT SHOP DRAWINGS TO ENGINEER FOR APPROVAL.
   10.1 ALL SHOP DRAWINGS SHALL BEAR A SEAL OF A REGISTERED PROFESSIONAL ENGINEER.
   10.2 THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN OF ALL CONNECTIONS.
   10.3 UNLESS OTHERWISE DETAILED OR SPECIFIED, BEAM CONNECTIONS SHALL BE DESIGNED TO RESIST THE FULL BENDING CAPACITY OF THE MEMBER IN ITS FULLY BRACED CONDITION FOR THE APPROPRIATE SPAN AS LISTED IN THE CISC HANDBOOK BEAM LOAD TABLES.
   10.4 CONNECTIONS SHALL CONFORM TO THE DETAILS IN THE CISC HANDBOOK.
   10.5 NON-STANDARD CONNECTIONS AND CONNECTIONS TO EXISTING STRUCTURAL MEMBERS SHALL BE DESIGNED AND BEAR THE SEAL OF A PROFESSIONAL ENGINEER.
   10.6 BEAM END CONNECTION DETAILS SHOWN ON THESE DRAWINGS ARE INTENDED TO SERVE AS A GUIDE ONLY. IT IS THE CONTRACTORS RESPONSIBILITY TO FIELD VERIFY ALL FINAL DIMENSIONS.
11. BEAM END CONNECTION DETAILS SHOWN ON THESE DRAWINGS ARE INTENDED TO SERVE AS A GUIDE ONLY. IT IS THE CONTRACTORS RESPONSIBILITY TO FIELD VERIFY ALL FINAL DIMENSIONS.
12. ALL EXTERIOR STEEL THAT IS EXPOSED TO WEATHER INCLUDING HANDRAILS AND GUARDS SHALL BE HOT-DIP GALVANIZED.
13. BOLTED CONNECTIONS SHALL HAVE A MINIMUM OF TWO BOLTS IN EACH CONNECTED PIECE AND BE DESIGNED AS BEARING CONNECTIONS U.N.O.
14. U.N.O. COLUMN CAP PLATES SHALL BE $\frac{1}{4}$" THICK AND COLUMN BASE PLATES SHALL BE $\frac{3}{8}$" MINIMUM THICK.
15. PROVIDE $\frac{1}{4}$" CAP PLATES FOR ALL HSS MEMBERS U.N.O.
16. DESIGN DRAWINGS INCLUDE ARCHITECTURAL, MECHANICAL, AND ELECTRICAL DRAWINGS. SEE ALSO ARCHITECTURAL DRAWINGS FOR ADDITIONAL DIMENSIONS AND DETAILS. WHERE ELEVATIONS, ROOF SLOPES, ETC. ARE SHOWN ON THE STRUCTURAL DRAWINGS, THEY MUST BE CONFIRMED WITH THE ARCHITECTURAL DRAWINGS.
17. MISCELLANEOUS MATERIALS AND ACCESSORIES ASSOCIATED WITH GOOD PRACTICE THAT ARE NOT SHOWN SHALL BE PROVIDED.
18. U.N.O. DO NOT OVERSIZE HOLES IN STEEL TO FIT ANY ANCHOR LOCATIONS, FOR COLUMN BASE PLATE HOLES, UNLESS NOTED OTHERWISE ON DRAWINGS, SEE TABLE BELOW.

HOLE SIZES FOR ANCHOR BOLTS	
BOLT SIZE (in.)	HOLE SIZE (in.)
$\frac{3}{4}$" UP TO INCLUDING 1"	DIAMETER + $\frac{5}{16}$"
OVER 1" UP TO INCLUDING 2"	DIAMETER + $\frac{1}{2}$"
OVER 2"	DIAMETER + 1"

19. PROVIDE MINIMUM L2x2x$\frac{3}{16}$" TRIMMER ANGLE (U.N.O. ON DRAWING) FOR STEEL DECK SUPPORT TYPICAL AROUND PERIMETER OF BUILDING, WELDED TO OWSJ AND/OR STEEL BEAM.
20. THE OWNER WILL EMPLOY A QUALIFIED PERSON TO INSPECT THE CONNECTIONS, INCLUDING BOLT TENSION AND WELDING, IN ACCORDANCE WITH CSA S16-01 SECTIONS 23 AND 30.

Sewer Pipe

PVC (PSM TYPE) PIPE

1. SMOOTH WALL PVC PIPE PRODUCTS AND FITTINGS SHALL CONFORM TO SECTIONS 4 AND 5 OF CSA STANDARD B182.8 FOR ALL BASIC MATERIAL REQUIREMENTS AND MANUFACTURED QUALITY AND DIMENSIONAL TOLERANCE.
2. MATERIALS USED FOR PIPE SHALL COME FROM A SINGLE COMPOUND MANUFACTURER AND SHALL HAVE CELL CLASSIFICATION AS DEFINED IN ASTM STANDARD D3034. MATERIALS USED FOR MOULDED FITTINGS SHALL COME FROM A SINGLE COMPOUND MANUFACTURER AND SHALL HAVE CELL CLASSIFICATION AS DEFINED IN ASTM STANDARD D3034.
3. NOTWITHSTANDING THE REQUIREMENTS OF SECTION 4 OF CSA STANDARD B182.8 COMPOUNDS WITH DIFFERENT CELL CLASSIFICATIONS THAN THAT NOTED ABOVE SHALL NOT BE USED WITHOUT THE PRIOR APPROVAL OF THE PROJECT ENGINEER. MINIMUM WALL THICKNESS SHALL BE AS REQUIRED FOR SDR 35 UNLESS OTHERWISE APPROVED BY THE DESIGN ENGINEER.

EARTHWORKS

1. ALL SITE EARTHWORKS RECOMMENDATIONS SHOULD BE COMPLEMENTED BY REFERENCE TO CSA M3471. ANY DELETERIOUS OR CONTAMINATED FILLING SHOULD BE STRIPPED AND DISPOSED OF IN ACCORDANCE WITH THE RECOMMENDATION PROVIDED IN OUR ENVIRONMENTAL REPORT. THE EXPOSED SUBGRADE SHOULD BE PROOF ROLLED, ANY EXISTING UNCONTROLLED FILLING AND RUBBLE BE REMOVED AND REPLACED WITH ENGINEERED FILL AS SPECIFIED BELOW. ENGINEERED FILL IS TO BE USED TO BACKFILL BATTERS AND TO RAISE THE SITE LEVEL WHERE REQUIRED.
2. WHERE CLAYS ARE EXPOSED AT SUBGRADE LEVEL, THEY WILL UNDERGO SUBSTANTIAL LOSS IN STRENGTH WHEN WET AND MAY EVEN BECOME UNTRAFFICABLE. THEREFORE, IT IS IMPORTANT TO PROVIDE GOOD AND EFFECTIVE DRAINAGE DURING CONSTRUCTION. THE PRINCIPAL AIM OF THE DRAINAGE IS TO PROMOTE RUN OFF TOWARDS DESIGNATED SUMPS BY CROSS FALLS AND TO REDUCE PONDING. FOLLOWING STRIPPING AND COMPLETION OF THE PROPOSED EXCAVATIONS, IT IS RECOMMENDED THAT THE SOIL SUBGRADE BE PROOF ROLLED AND INSPECTED BY AN EXPERIENCED GEOTECHNICAL ENGINEER. THE PROOF ROLLING SHOULD INVOLVE AT LEAST FOUR PASSES OF A VIBRATORY SMOOTH DRUM ROLLER (EG. MINIMUM 8 TONNE DEADWEIGHT) FOR THE DETECTION OF UNSTABLE OR "SOFT" AREAS.
3. SUBGRADE HEAVING MAY OCCUR DURING PROOF ROLLING IN AREAS WHERE THE CLAYS MAY HAVE BECOME "SATURATED". HEAVING AREAS SHOULD BE LOCALLY REMOVED TO A "STIFF" BASE AND REPLACED WITH ENGINEERED FILL AS DEFINED BELOW. DEPENDING ON THE EXTENT AND DEPTH OF THE HEAVING AREAS, IT MAY BE NECESSARY TO PROVIDE A BRIDGING LAYER. IF THE INSITU CLAYS EXHIBIT SHRINKAGE CRACKING, THEN THE SURFACE SHOULD BE WATERED AND ROLLED UNTIL THE SHRINKAGE CRACKS ARE NO LONGER EVIDENT. ENGINEERED FILL SHOULD ALSO BE USED WHERE IT IS PROPOSED TO RAISE THE LEVELS.

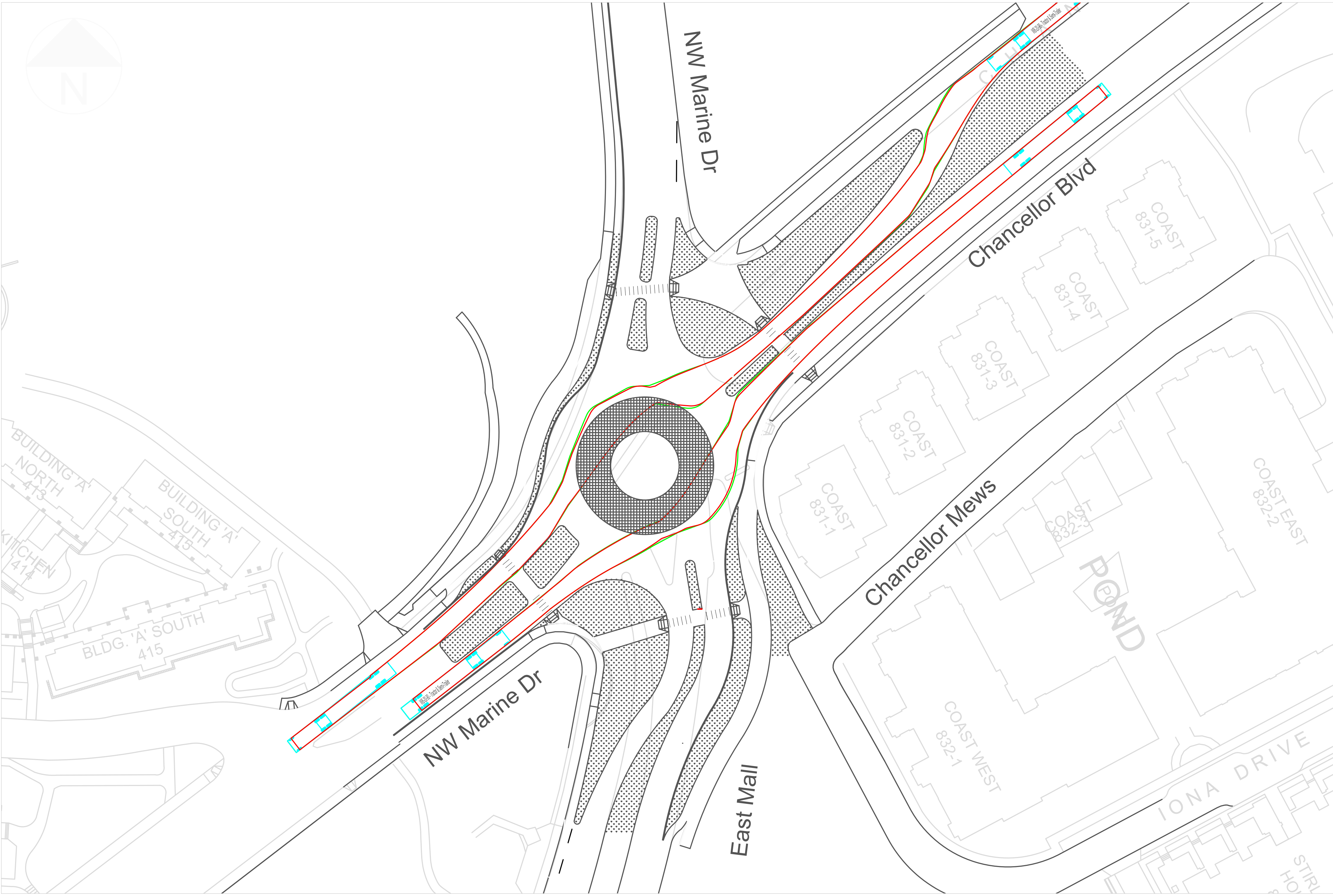
ENGINEERED FILL

1. ENGINEERED FILL SHOULD COMPRISE WELL GRADED GRANULAR MATERIAL (SANDS, RIPPED OR CRUSHED SANDSTONE), FREE OF DELETERIOUS SUBSTANCES AND HAVING A MAXIMUM PARTICLE SIZE OF "25 MM". EXCAVATED SANDS FROM THE SITE MAY BE REUSED AS FILL PROVIDED THAT ANY UNSUITABLE MATERIAL (ORGANIC CLAYS) AND ANY BUILDING RUBBLE OR DELETERIOUS MATERIAL IS EXCLUDED. THE ENGINEERED FILL, AND ANY EXCAVATION BACKFILL WHERE SUBGRADE SUPPORT IS REQUIRED, SHOULD BE COMPACTED IN LAYERS OF NOT GREATER THAN "50 MM" LOOSE THICKNESS, TO A DENSITY RATIO OF 70% OF STANDARD MAXIMUM DRY DENSITY (SMDD) OR TO A MINIMUM OF 70% DENSITY INDEX.
2. DENSITY TESTS SHOULD BE REGULARLY CARRIED OUT ON THE FILL IN ACCORDANCE OF CS FCS001 STANDARD TO CONFIRM THE ABOVE SPECIFICATIONS ARE ACHIEVED. THE FREQUENCY OF DENSITY TESTING SHOULD BE AT LEAST ONE TEST PER LAYER PER "3 M^2".

REINFORCED CAST-IN-PLACE CONCRETE

1. THE WORK SHALL CONSIST OF:
   1.1. SUPPLYING OF MATERIALS AND THE MIXING AND PLACING OF REINFORCED CAST-IN-PLACE CONCRETE AS SHOWN AND DESCRIBED ON THE DRAWINGS AND IN THIS SPECIFICATION, INCLUDING PLACING, VIBRATING, FINISHING AND CURING;
   1.2. SUPPLYING, FABRICATING, CONSTRUCTING, MAINTAINING AND REMOVING TEMPORARY WORKS, INCLUDING FALSEWORK AND FORMWORK;
   1.3. HEATING AND COOLING CONCRETE, IF NECESSARY;
   1.4. DEVELOPING CONCRETE MIX DESIGN(S) THAT MEETS THE PERFORMANCE REQUIREMENTS, INCLUDING TRIAL BATCHES;
   1.5. THE QUALITY CONTROL (QC) TESTING OF ALL MATERIALS; AND
   1.6. SUPPLYING AND INSTALLING WATER SEALS AND JOINT FILLERS (WHEN APPLICABLE).
2. MATERIALS
   2.1. FINE AGGREGATE SHALL MEET THE GRADING REQUIREMENTS OF CSA A23.1, BE GRADED UNIFORMLY AND NOT MORE THAN 3% SHALL PASS A 75 UM SIEVE.
   2.2. COARSE AGGREGATE. THE MAXIMUM NOMINAL SIZE OF COARSE AGGREGATE SHALL BE 20 MM AND MEET THE GRADING REQUIREMENTS OF CSA A23.1, TABLE 13, GROUP 5. COARSE AGGREGATE SHALL BE UNIFORMLY GRADED AND NOT MORE THAN 1% SHALL PASS A 75 UM SIEVE.
   2.3. CEMENTITIOUS MATERIALS SHALL CONFORM TO THE REQUIREMENTS OF CAN/CSA A23.1 AND SHALL BE FREE FROM LUMPS. NORMAL PORTLAND CEMENT, TYPE GU OR GUB, OR SULPHATE RESISTANT, TYPE HS OR HSB, SHALL BE SUPPLIED UNLESS OTHERWISE SPECIFIED ON THE DRAWINGS.
   2.4. WATER TO BE USED FOR MIXING AND CURING CONCRETE OR GROUT AND SATURATING THE SUBSTRATE SHALL BE POTABLE, SHALL CONFORM TO THE REQUIREMENTS OF CSA A23.1 AND SHALL BE FREE OF OIL, ALKALI, ACIDIC, ORGANIC MATERIALS OR DELETERIOUS SUBSTANCES.
   2.5. FORMS FOR EXPOSED SURFACES SHALL BE MADE OF GOOD QUALITY PLYWOOD IN "LIKE-NEW" CONDITION AND UNIFORM IN THICKNESS WITH OR WITHOUT A FORM LINER.

NOTE: WHEN CONVERTING METRIC TO IMPERIAL ELEVATIONS INCLUDE 91.62 FEET TO THE IMPERIAL GEODETIC BASE.
FOR DETAILS REFER TO UBC MONUMENT – PLAN STANDARD NO.01–01



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INFRASTRUCTURE DEVELOPMENT

NO	DESCRIPTION	DATE	BY
1	ISSUED FOR PRELIMINARY DESIGN	24-12-07	JM

SCALE: 0 1:250 25m

TURNING ANALYSIS 1

NOTE: WHEN CONVERTING METRIC TO IMPERIAL ELEVATIONS INCLUDE 91.62 FEET TO THE IMPERIAL GEODETIC BASE.
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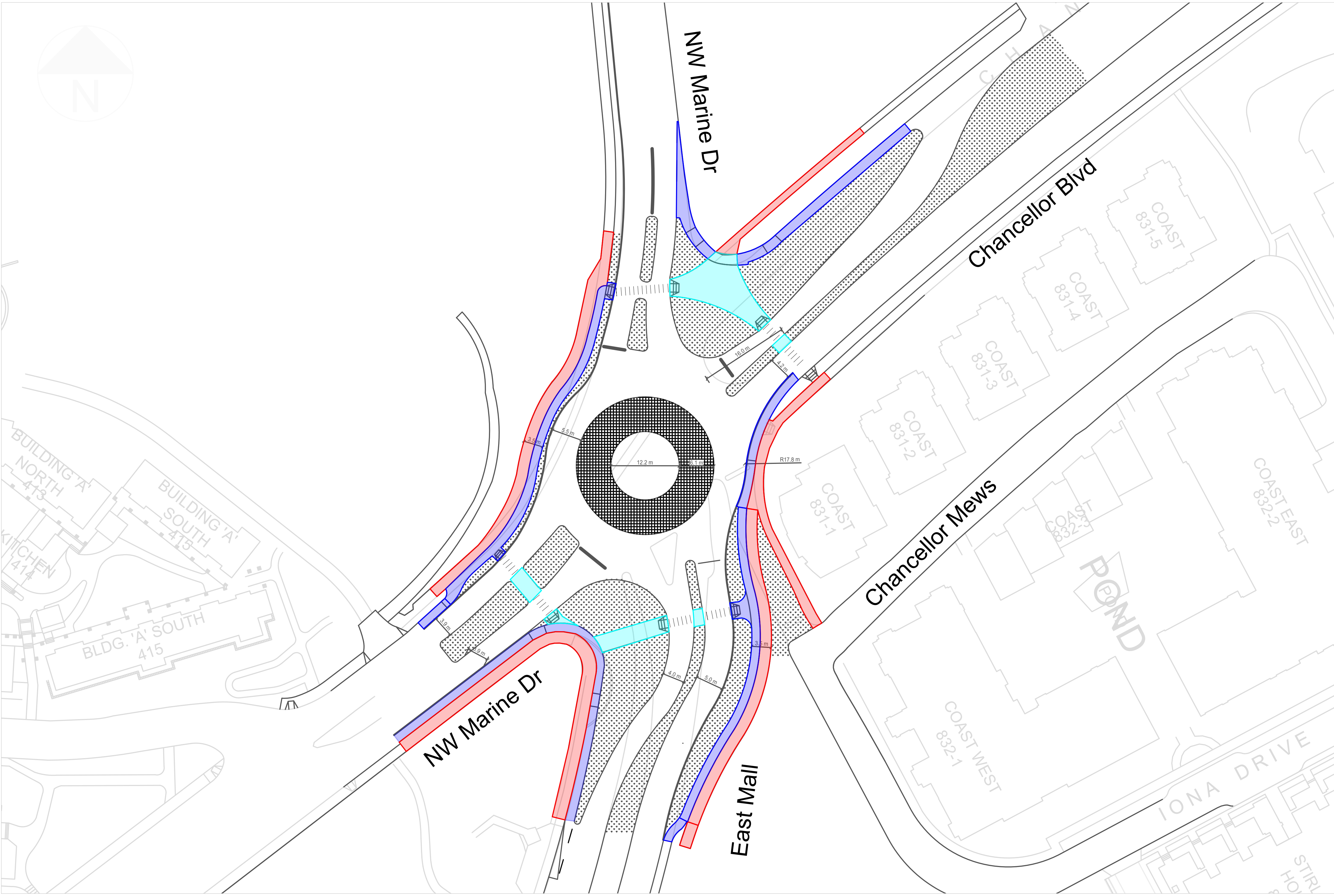
INFRASTRUCTURE DEVELOPMENT

NO	DESCRIPTION	DATE	BY
1	ISSUED FOR PRELIMINARY DESIGN	24-12-07	JM

SCALE: 0 1:250 25m

TURNING ANALYSIS 2



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NO	DESCRIPTION	DATE	BY
2	ISSUED FOR CONSTRUCTION	25-04-05	JM
1	ISSUED FOR PRELIMINARY DESIGN	24-12-07	JM

SCALE: 0 1:250 25m

ACTIVE TRANSPORTATION