UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

SW Marine Drive & 16th Avenue Intersection Redesign

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CIVL 446

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Executive Summary

This final design report presents the culmination of a collaborative effort between The team and UBC Campus and Community Planning (CCP), marking a significant milestone in the transformative redesign of the SW Marine Drive & 16th Avenue intersection. Central to this vision is the creation of an infrastructure that exemplifies safe, multi-modal transportation, embraces sustainable practices, and enhances the spatial quality of the UBC campus.

The final design features a shifted intersection accommodating a stormwater detention pond at the low point of the project scope to reduce cliffside erosion risk and manage water sustainably on-site with little maintenance. Active transportation is promoted through extended trails, cross-ride crossings, and realigned bike lanes – all converging to encourage a shift towards more sustainable transit options. The roundabout varies from one to two lanes, depending on the leg to better accommodate specific traffic demands, slow drivers down by introducing some congestion, and decrease crossing distances for cyclists. There will be rectangular rapid flashing beacons (RRFB) on W 16th Ave. along with signage warning drivers to decrease speed to 30 kph, enhancing the safety of pedestrians and cyclists crossing. The desired speed from SIDRA analysis is 38.7 kph. Lastly, all lane widths will be decreased to 4 m and the northbound leg of SW Marine Dr. will be decreased to one lane to further reduce driver comfort and vehicular speeds. Aesthetically, the design integrates a visual "gateway" into the campus, complete with Musqueam art, providing users of a sense of arrival and indigenous presence on campus.

The team' engagement strategy has proven to be effective and has been instrumental in shaping a design that not only meets technical and functional requirements but also resonates with the cultural and social fabric of the campus community. The total estimated cost is $3,105,800, calculated based on material costs, hourly rates, and fixed fees. Construction will begin May 1, 2024, with completion estimated to be the September 27, 2024.

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1.0 Introduction

With the transition from the preliminary design to the detailed design, this report delineates the intricate journey of refining the intersection design to meet the goals set by UBC Campus and Community Planning. The team' design strategy is rigorously informed by a comprehensive traffic analysis, which has honed the understanding of the current and future needs of the UBC community. This data-driven approach ensures that every aspect of the design is grounded in practicality while aspiring to visionary ideals.

Figure 1: 3D Render of Intersection

In the following pages, the multifaceted design elements are elaborated on that converge to form this final design (Figure 1). From the stormwater management system to the community-centric gateway, each component is a deliberate stroke in the canvas of UBC's future. Furthermore, through meticulous cost analysis, resources are optimized to deliver value without compromising quality. The streamlined construction schedule ensures timely execution, driven by proactive project management and a dedication to meeting deadlines. With a focus on minimizing disruption, the construction plan employs innovative methodologies to seamlessly integrate the project into the campus landscape.

2.0 Overview of the Site and Final Design Objectives

The SW Marine Dr. and 16th Ave. intersection, a critical juncture, has long required adaptation to meet evolving needs. Despite its historical significance, the intersection has faced challenges, including speeding, compromised pedestrian safety, and a lack of clear markers denoting arrival at UBC. To address these issues, The team undertakes the Redesign of the 16th Ave. and SW Marine Dr. Intersection as part of UBC Campus and Community Planning's initiative. An ariel view of the existing intersection is in Figure 2 below.

Figure 2: Ariel View of Intersection (CIVL 445 2023W Project 3, 2023)

2.1 Key Objectives

The primary goal is to promote safe multi-modal transportation, prioritizing biking, rolling, and walking. This objective aligns with sustainability goals, fostering healthier and environmentally friendly commuting options. Our design philosophy is guided by these two key principles.

1. **Reducing Impervious Areas and Enhancing Pedestrian Accessibility**

The design will minimize impervious areas and improve pedestrian accessibility, contributing to a more sustainable and pedestrian-friendly urban environment. This supports the creation of complete streets and an overall increase in livability. As a result of this, travel speeds will be reduced, and active modes of transportation will be encouraged.

2. **Integration with UBC Campus Vision 2050**

The final design is meticulously crafted to align seamlessly with the UBC Campus Vision 2050. Emphasis is placed on creating complete streets, expanding green spaces, reducing single occupancy vehicle usage, and meeting all client requirements.

2.2 Key Component

Figure 3 depicts our overall project process. Please see below for a progress summary of key components.

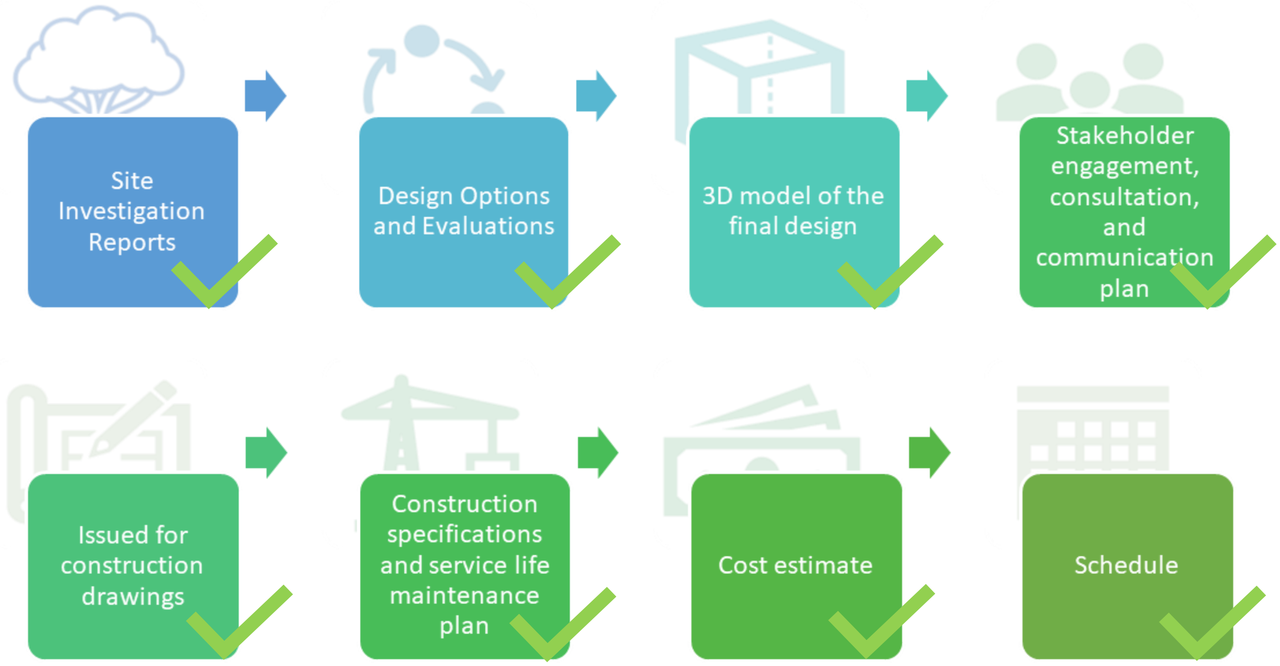

Figure 3: Updated Design Process

2.2.1 Technical Analysis

A thorough technical analysis was conducted, leveraging site visits, peak traffic counts, LIDAR information, and GIS data. The proposed design pulls from the three conceptual designs that were previously developed, adhering to design requirements, and considering technical, economical, construction planning, and regulatory aspects.

2.2.2 Stakeholder Engagement

Continuous engagement with stakeholders throughout and after the project, including the Musqueam community and nearby residents, is prioritized. The design process integrates their perspectives, ensuring cultural heritage is respected, and community needs are addressed.

2.2.3 Safety Optimization

The design prioritizes safety through measures such as reduced speeds by minimizing lane widths, dedicated bike lanes, and signalized crossings. A weighted decision matrix is employed to choose the most optimal design solution.

2.2.4 Stormwater Management

Stormwater will be managed by incorporating a detention pond, swales, and green infrastructure to address environmental concerns and aid in mitigating cliffside erosion.

2.2.5 Structural and Geotechnical Design

A structural footing is included in the design for the UBC gateway. To ensure safety and longevity, The team will adhere to the NBCC 2020 and CSA A23.3 for the structural design components.

2.3 Design Criteria and Adherence

Table 1 below summarizes the design criteria used for the project.

Table 1: Expanded Design Criteria and Adherence

Criteria	Description
Non-negotiable Design Criteria	
Emergency Response Accessibility	Recognizing SW Marine Dr. as a provincial disastrous response route, the design prioritizes swift and unimpeded access for emergency services.
Seamless Transition to UBC Campus	Ensuring a seamless transition from a highway road to an urban environment with clear signals marking entry into the University of British Columbia (UBC).
Adherence to Codes and Guidelines	Fundamental to the design process is strict adherence to Federal, Provincial, and UBC codes and guidelines, ensuring legal compliance and noting that UBC is governed on Federal lands.
Negotiable Design Criteria	
Cost Considerations	With a focus on improving multi-modal transportation and mitigating potential negative environmental effects, cost considerations take precedence among negotiable criteria.
Resulting Level of Service (LOS)	Addressing the diverse transportation needs of the community, the negotiable criterion of LOS from the final design emphasizes optimizing functionality. Recognizing the intersection's lower volume, the design adapts to ensure an efficient and tailored approach that meets specific site requirements, ultimately resulting in an optimized LOS.
Intersection Optimization	Rather than rigidly adhering to a single traffic-controlling measure, the approach considers a range of design options, including but not limited to roundabouts, ensuring flexibility in meeting the specific requirements of the intersection and avoiding over-engineering.

2.4 Community and Environmental Aspects

In the final design of the SW Marine Dr. and 16th Ave. Intersection, a profound emphasis is placed on community and environmental considerations, acknowledging the intersection's role as a dynamic focal point within the University of British Columbia's evolving landscape.

Efforts to continuously engage in meaningful dialogue, including after the conclusion of the project, with the Musqueam community and neighboring residents are fundamental aspects of our design process. This inclusive approach will incorporate diverse perspectives into the design, respecting cultural heritage, and addressing the unique needs of the local community. This plan, addressed in **Section 10**, is our roadmap for stakeholder engagement and ensures ongoing dialogue with the Musqueam community, nearby residents, and other stakeholders.

A notable feature within the community and environmental aspects is the incorporation of the UBC gateway sign. This sign serves not only as a welcoming landmark but also as a symbol of the Musqueam presence on campus. Designed by local Indigenous artists, the gateway sign adds a distinctive element that aligns with the rich heritage of the Musqueam people and creates a sense of arrival for those entering the UBC campus.

Environmental sustainability is a cornerstone of the final design. Adhering to non-negotiable criteria, the stormwater management plan mitigates cliffside erosion by retaining stormwater on-site. The design reduces impervious areas, avoids tree removal, and maintains the current buffer to the Botanical Gardens, underscoring our dedication to environmental stewardship.

3.0 Final Design

The final design (Figure 4) is emerging as the optimal choice due to its notable performance across key evaluation categories. Anchored by the shifted roundabout design, our approach carefully addresses safety, traffic flow, active mode accessibility, stormwater management, transit orientation, environmental impacts, aesthetics, and cost considerations.

Figure 4: 3D Render of the Final Design

3.1 Intersection Design

The shifted roundabout design serves as the optimal solution to ensure safety for all road users. It not only reduces vehicular speeds, but also enhances traffic flow through a comprehensive layout. The design prioritizes active mode accessibility, with signalized crossings and dedicated lanes for cyclists, contributing to a safer and more accessible intersection.

3.2 Stormwater Management

Due to the shifted design, an advanced stormwater management plan can be seamlessly integrated, aligning with environmental impacts and sustainability considerations. A detention pond, positioned at the bottom of the natural slope, facilitates efficient runoff without compromising the ecological integrity of the site.

3.3 Transit-Oriented Design

Considering the transit-oriented decision criterion, the design places an emphasis on facilitating public transportation. The roundabout design eliminates confusion from the current design which ensures a smooth flow for buses and emergency responders, thereby contributing to an efficient transit-oriented intersection.

3.4 Environmental Stewardship

Environmental impacts are mitigated through a commitment to stewardship. The design avoids tree removal, reduces impervious areas, and increases the current buffer to the Botanical Gardens. These measures not only preserve the natural aesthetics but also enhance the overall environmental sustainability of the intersection.

3.5 Aesthetics and Community Engagement

Aesthetic considerations are intrinsic to the design, with a UBC gateway sign strategically placed at the roundabout center. This element, designed by local Indigenous artists, not only adds to the visual appeal, but also serves as a cultural symbol, fostering community engagement and inclusivity.

3.6 Gateway Design

The expansive central area of the roundabout presents a unique opportunity for strategic placement of the artwork, serving as a powerful means to communicate to incoming road users who are entering the UBC Campus —an ancestral land of the Musqueam people. The artwork enhances the visual appeal of the intersection and alerts drivers of the roundabout up ahead.

3.7 Cost-Effectiveness

By carefully balancing the decision criterion of cost, the design remains cost-effective while addressing safety, aesthetics, and sustainability. The shifted roundabout design optimizes functionality, ensuring a cost-efficient solution without compromising the quality of the intersection. This is evident in our Class A cost estimate below.

In conclusion, the proposed design meticulously addresses the decision criteria, offering a well-rounded, adaptable, and transformative solution for the SW Marine Dr. and 16th Ave. Intersection. It envisions an intersection that not only meets immediate needs, but also contributes to the broader goals of safety, sustainability, and community well-being.

3.8 Layout Design Features

Key layout features of the design include minimizing the existing medians so that the extra space can accommodate the realignment of the traffic lanes for the shifted design. This also provides room for the proposed detention pond at the west side of the intersection. In addition, the existing shoulder lane will be converted to a bike lane with buffering space. Furthermore, with the new roundabout layout, cycling facilities were updated with cross-rides (with permission from the Ministry of Transportation and Infrastructure) on all legs of the intersection and newly aligned bike lanes. Additionally, a Rapid Rectangular Flashing Beacon, RRFB, installation and extension of trail path as a paved Multi-Use Path for crossings on 16th Avenue will be included. Lastly, a key change from the preliminary design and the final design is the elimination of the second lane for northbound-north leg movements; this is to achieve a seamless tie-in with the existing infrastructure that is beyond the work of scope. The intersection of SW Marine Dr and Stadium Rd will require a median extension along Stadium Rd and updated road markings (i.e., zebra stripe crossing, stop bar, etc.) to accommodate the shrunken intersection.

3.9 Dimensions

Basic dimensions of the proposed design can be found below (Table 2).

Table 2: Basic Layout Dimensions (in meters)

Bike/Pedestrian Facilities	**Bike Lane**	1.80
	Bike Lane Buffers	0.60
	Multi-Use Path Width	5.50
Roundabout Dimensions	**Inner Island Diameter**	30.00
	Outer Island Diameter	36.00
	Outer Edge Diameter	56.00
Road Dimensions	**Roundabout Traffic Lanes**	4.50 or 6.0
	Traffic Lanes	3.70

Bike lane and roundabout dimensions were recommended by the British Columbia Active Transportation Design Guide from the British Columbia Ministry of Transportation and Infrastructure. The roundabout traffic lane width changes from 4.50 m for the two-lane portion to 6.0 m for the one-lane portion of the roundabout. The traffic lane widths approaching the roundabout will continue to be 3.70 m with the aid of channelization buffering in between the two lanes; widths of channelization buffer markings vary per approach.

3.10 Intersection Lighting

Lighting is a critical component in the design of active transportation infrastructure, enhancing the safety, comfort, and aesthetics of pedestrian and cycling paths. The lighting strategy was developed with a keen focus on providing a secure, visually comfortable environment for all users while complying with the British Columbia Active Transportation Design Guide standards.

The approach taken to lighting design at the UBC intersection considered several key principles and considerations, as highlighted in the BC Active Transportation Design Guide. The team aims to ensure optimal positioning integrating the lighting seamlessly with the surrounding environment to enhance safety without contributing to light pollution. Following the guidelines, the street lighting components comprise the base, post, and fixture, with considerations for energy efficiency, maintenance, and vandalism resistance. The selected streetlamps are designed with LED technology to minimize energy consumption. Illuminance design for the final design is found detailed below in Table 3.

Table 3: Design Lighting Illuminance Requirements

Area Description	Minimum Average Horizontal Illuminance (Lux) Recommended	Designed Illuminance (Lux)	Max. Horizontal Uniformity (Avg. to Min. Illuminance)	Compliance
Walkways and Bikeways	5.0	5.0	10.0:1	Yes
Pedestrian Stairs (If applicable)	5.0	N/A (Not applicable to project)	10.0:1	N/A
Pedestrian and Cyclist Tunnels (If applicable)	43.0	N/A (Not applicable to project)	10.0:1	N/A
Intersections	5.0 (Enhanced to ensure visibility)	10.0	10.0:1	Yes

Consistent with the recommended illuminance levels for walkways and bikeways in the BC Active Transportation Design Guide, the design ensures a minimum average horizontal illuminance of 5.0 lux across the intersection. This level is maintained to ensure visibility and safety without excessive brightness, adhering to a maximum horizontal uniformity ratio of 10.0:1 to avoid significant light level disparities that could impair visibility or comfort.

4.0 Transportation Design

Transportation Design highlights the considerations that were made to target the key project objectives and to justify the key parameters of the proposed design.

4.1 Historical Data Analysis

The historical data analysis serves as the cornerstone of the design process, providing crucial insights into the current and projected transportation demands at the SW Marine Drive and 16th Avenue intersection. Through a comprehensive data-driven approach, The team has meticulously examined various factors influencing traffic flow, including population growth projections, mode split trends, future mode probability, and peak hour traffic patterns. The analysis lays the groundwork for a future-ready infrastructure that can adapt to evolving needs. The current and future traffic counts can be seen detailed below in Table 4 and Table 5.

Table 4: Current Traffic Analysis

Traffic	SW Marine Drive				16th Avenue			
	East Bound		West Bound		East Bound		West Bound	
	AM	PM	AM	PM	AM	PM	AM	PM
Peak Hour	522	355	240	448	774	402	473	685
Weekday AVG	4498		4076		6008		6830	
AADT	3174		2876		4239		4819	
Total AADT	**15105**							

Table 5: Future Traffic Analysis

Traffic	SW Marine Drive				16th Avenue			
	East Bound		West Bound		East Bound		West Bound	
	AM	PM	AM	PM	AM	PM	AM	PM
Peak Hour	700	476	457	853	784	407	479	694
Weekday AVG	6031		7758		6085		6917	
AADT	4255		5474		4293		4881	
Total AADT	20756							

Table 6: Calculated Parameters for Traffic Model

Vehicle Traffic Growth Rate (%)		
North Leg	2.5	
East Leg	2.9	
South Leg	1.6	
Pedestrian Traffic Growth Rate (%)		
North Leg	5.6	
East Leg	5.6	
South Leg	5.6	
Peak Hour Factor for Vehicles (%)		
North Leg	**Left-Turn Movement:** 72.2	**Thru Movement:** 60.1
East Leg	**Left-Turn Movement:** 76.7	**Right-Turn Movement:** 88.2
South Leg	**Thru Movement:** 81.3	**Right-Turn Movement:** 82.2

Given parameter of expected speed of 60 kph apply. In Table 6, parameters affecting the traffic model were calculated. Sample calculations can be found in **Appendix A**.

Pedestrian growth rates are predicted to be higher as active transportation facilities will be updated to attract more foot traffic. A sample calculation can be found in **Appendix A**. The lowest growth rate calculated was used for this model.

4.1.1 Growth Projections

Building upon the current traffic analysis, future traffic demands based on population growth projections and mode split trends were extrapolated. Utilizing modeling techniques, such as regression analysis and Monte Carlo simulations, the traffic volumes were forecasted up to 2050 with a high degree of accuracy and reliability. These projections serve as a crucial foundation for designing infrastructure that can accommodate future growth while maintaining optimal traffic flow and are seen detailed below in Figure 5.

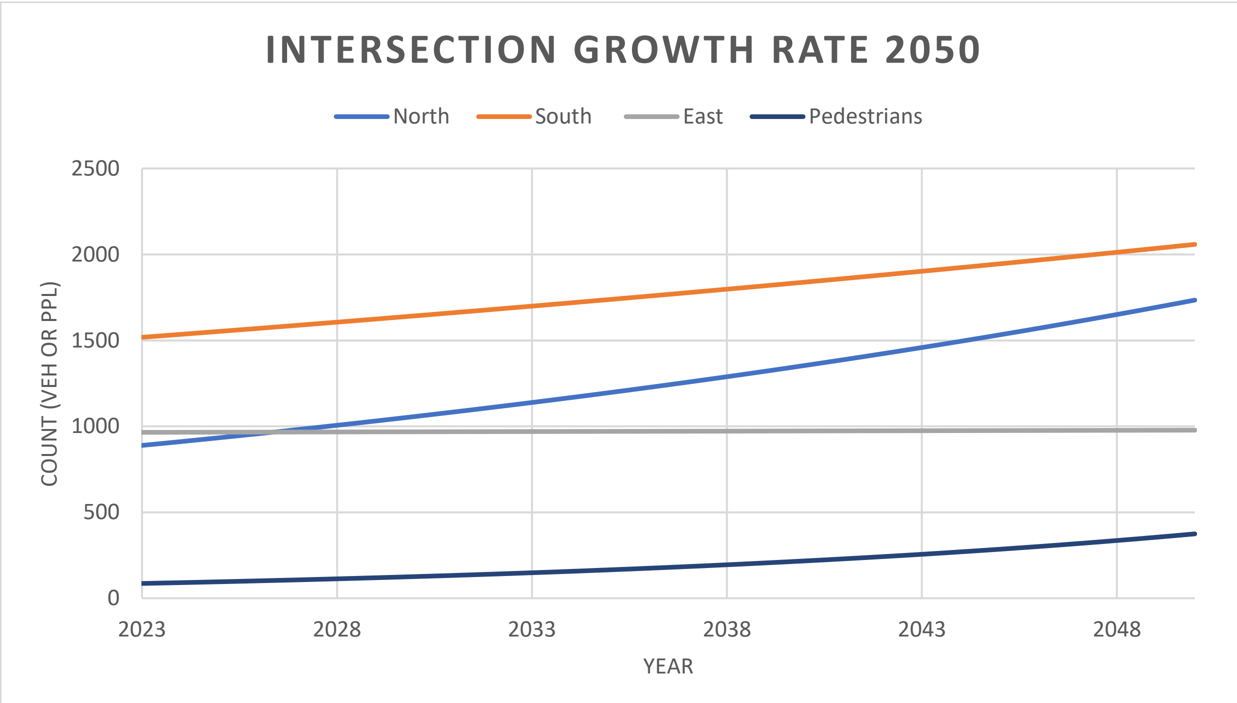

Figure 5: Intersection Growth Projections 2050

4.1.2 Summary of Projected Growth Rates and Probability Models

The analysis summary provides a detailed overview of the projected growth rates for different modes of transportation to the year 2050. The regression model for population growth, based on historical data for Vancouver, forecasts a steady increase in population to 3,488,149 by 2050. Furthermore, the Monte Carlo simulations estimate the probabilities of growth rates for single-occupancy vehicles (SOV), transit, and pedestrians, accounting for variability and uncertainty in the data, detailed in Figure 6. The findings indicate a higher probability of increased pedestrian and bus traffic, aligning with sustainable transportation initiatives and population growth trends.

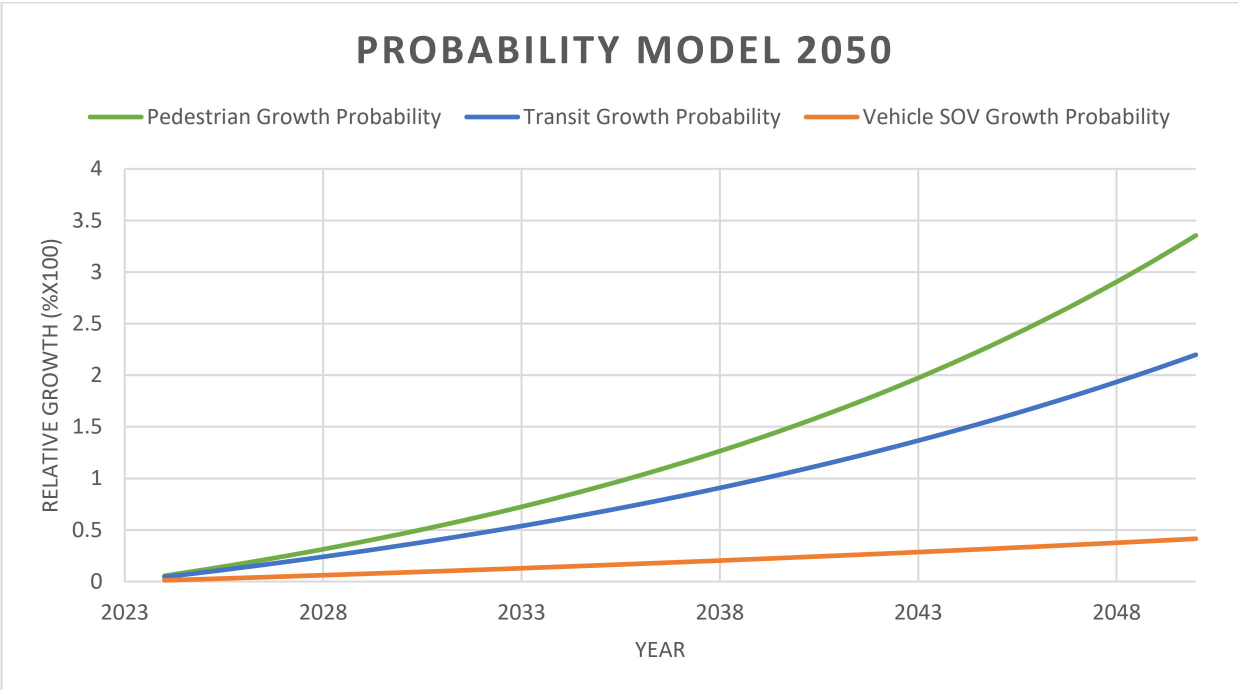

Figure 6: Probability Simulations 2050

4.1.3 Design Implications

The insights gleaned from the traffic analysis directly influence the design decisions for the intersection. From lane configurations to signal timing optimization, every aspect of the design is meticulously calibrated to enhance traffic efficiency, safety, and sustainability. By aligning the infrastructure with projected traffic demands, it ensures that the intersection remains functional and resilient in the face of evolving transportation trends.

4.2 Transportation Planning Analysis

The transportation planning analysis consists of providing technical justification by utilizing the results determined from Section 4.1 to provide initial modeling parameters for the SIDRA software analysis and completing a crosswalk warrant.

4.2.1 Layout Design Justifications

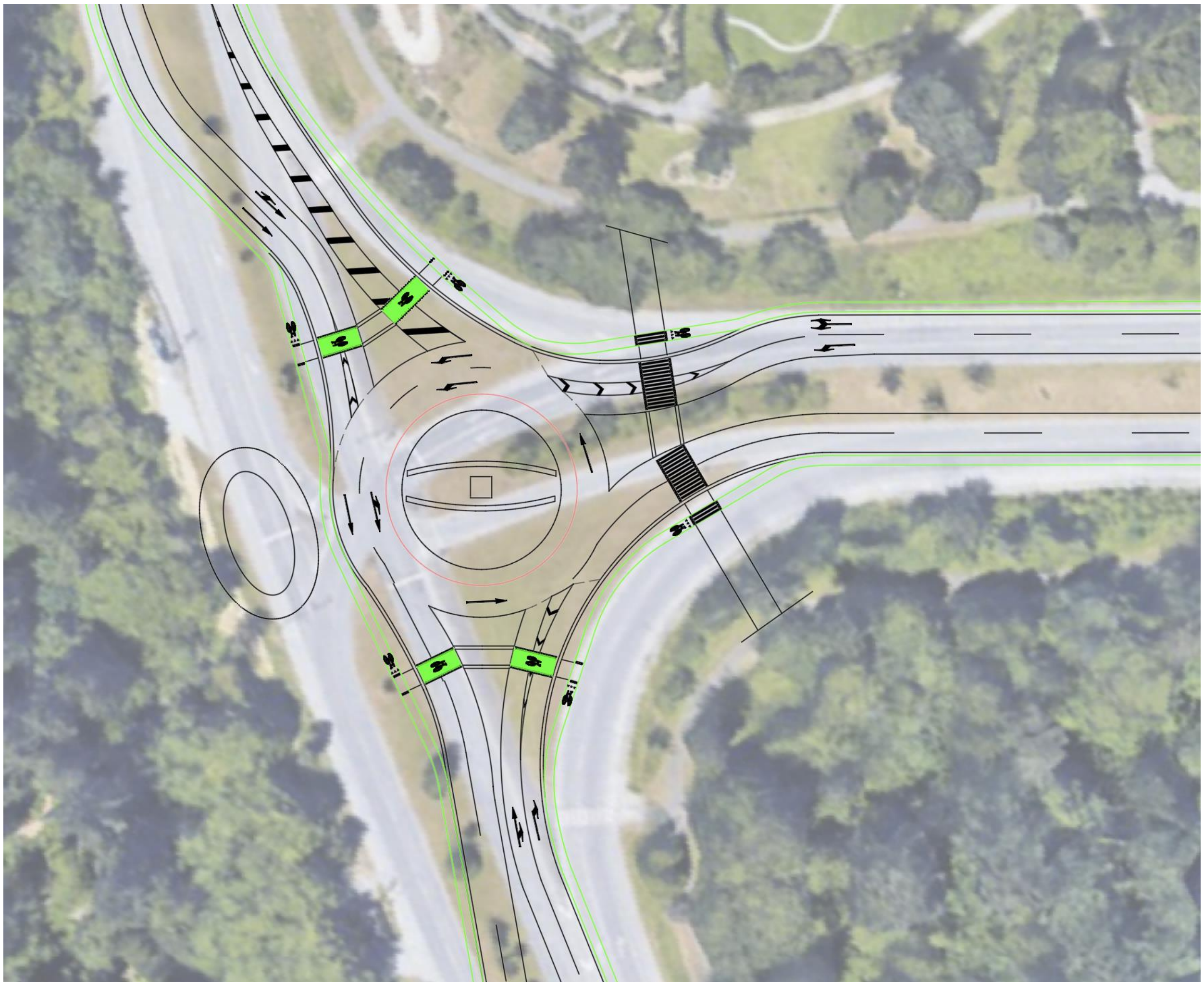

Figure 7: Overview of Final Design

Figure 7 showcases the updated key design features that will be summarized with its rationale in Table 7, noting changes made from the preliminary design.

Table 7: Updated Rationale of Design Features of Final Design

Key Design Feature	Rationale
Shifting Intersection	• Additional space for detention pond • Opportunity to build a scenic intersection to attract foot traffic
Changing Horizontal Alignment	• Slow down incoming vehicle traffic • Entering roundabout at better viewing angle for roundabout traffic
Minimizing Medians	• Shorter crossing distance • Extra space for other design features
Lane Configurations	• The 2nd northbound lane on the north leg was removed to tie in with the merging lane north of the intersection. • Reduction of lanes within roundabout to reduce conflict points and improve traffic flow
Updated Active Transportation Facilities	• Extended the northeast and southeast trails with a paved multi-use path for the continued journey towards crossing along 16th Ave to tie in previous elements • Cross-ride crossings (with special permission from MOTI) are provided on each leg to accommodate cyclist traffic flow. • Realigned bike lanes to provide space for cyclists or pedestrians waiting to cross • Installation of RRFB on the east leg to provide additional awareness of active modes of transportation
Pavement Markings	• Channelizing buffer markings for enhanced guidance and speed reduction by visually narrowing the road • Yield lines on bike lanes to indicate incoming traffic has right-of-way for improved safety and speed reduction approaching conflict points • Green conflict zone pavement markings for cross-rides on the north and south legs to alert vehicles approaching the roundabout • Buffer markings between cyclists and vehicles throughout the work of scope

4.2.2 Traffic Model Parameters

Historical traffic data from 2021 and 2022 provided by UBC were compared with the recorded 2023 traffic data (completed on October 5, 2023) to determine these calculations. On-sight analysis was used to determine the vehicle percentage breakdown and it can be found below (Table 8).

Table 8: % of Road Usage per Vehicle Type

Intersection Leg	% of Road Usage Compared to Total Traffic	
North	**Left-Turn Movement**	**Thru Movement**
	Light Vehicle: 95 **Heavy Vehicle:** 5 **Buses:** 0 **Cyclist:** 0	**Light Vehicle:** 87 **Heavy Vehicle:** 5 **Buses:** 0 **Cyclist:** 9
East	**Left-Turn Movement**	**Right-Turn Movement**
	Light Vehicle: 70 **Heavy Vehicle**: 5 **Buses:** 25 **Cyclist:** 0	**Light Vehicle:** 85 **Heavy Vehicle:** 5 **Buses:** 0 **Cyclist:** 10
South	**Thru Movement**	**Right-Turn Movement**
	Light Vehicle: 95 **Heavy Vehicle:** 5 **Buses:** 0 **Cyclist:** 0	**Light Vehicle:** 69 **Heavy Vehicle:** 5 **Buses:** 25 **Cyclist:** 1

The desirable level of service, LOS, was determined by identifying the study area as commuter/mobility corridor where transit vehicles are prioritized the highest and cyclist traffic are prioritized second highest (Bigazzi, 2022). Other categories compared to the category of commuter/mobility corridor can be found in Figure 8. Overall, this provides a desired LOS of C.

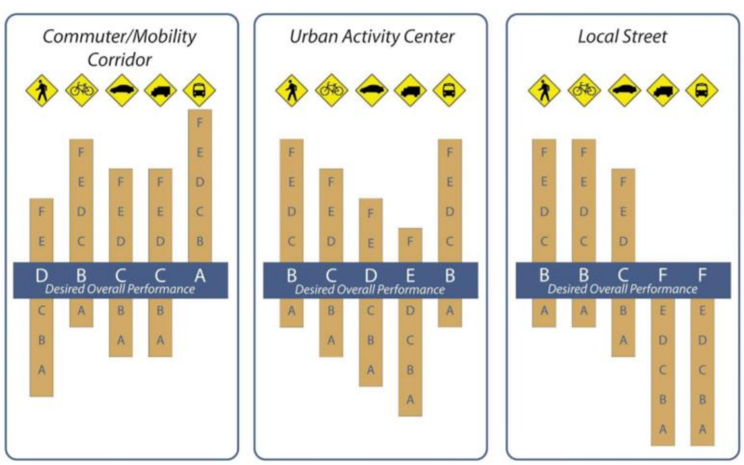

Figure 8: LOS Targets for Specific Modes of Transportation and their Location

4.2.3 Pedestrian Facilities

A crosswalk warrant found in the "Pedestrian Crossing Control Manual for British Columbia (1994)" by the British Columbia Ministry of Transportation and Infrastructure was completed and can be found in **Appendix A**.

4.2.4 Traffic Model Simulation – Sidra Software

Parameters found in the previous subsection were used for the traffic model in the Sidra Software. Analysis of the software accounts for traffic growth for the Final Design Year of 2050. A summary of key results can be found in Table 9.

Table 9: SIDRA Modelling Results

Intersection LOS	Avg. Travel Speed (kph)	Desired Speed (kph)
C	38.7	58.3

The SIDRA report can be found in **Appendix B**.

4.2.5 Discussion of Results

Through the traffic modeling analysis process found in the SIDRA software, it is confirmed that the final design passes the LOS required. Furthermore, the desired speed found in the SIDRA software is confirmed to be 58.3 kph, which is within the speed limit on both 16th Ave. and SW Marine Dr.

The crosswalk warrant determined that no crossing control was warranted due to the low pedestrian traffic that was recorded during the recorded traffic count. However, because the intersection is a major gateway to UBC's campus, it was overruled, and a special crosswalk will be constructed. Similar roundabouts nearby use the same system for pedestrian crossings. Additionally, after reconstruction, there is an expected increase in pedestrians due to justifications found in **Section 5.2**. Therefore, an RRFB system will be installed on the east leg of the intersection regardless of the observed foot traffic.

4.3 Updated Active Transportation Facilities

The trails on the northeast and southeast corners will be extended with a paved Multi-Use Pathway, MUP; this newly constructed pathway reduces the distance traveled for journeys crossing 16th Ave. This new path is illustrated in Figure 9.

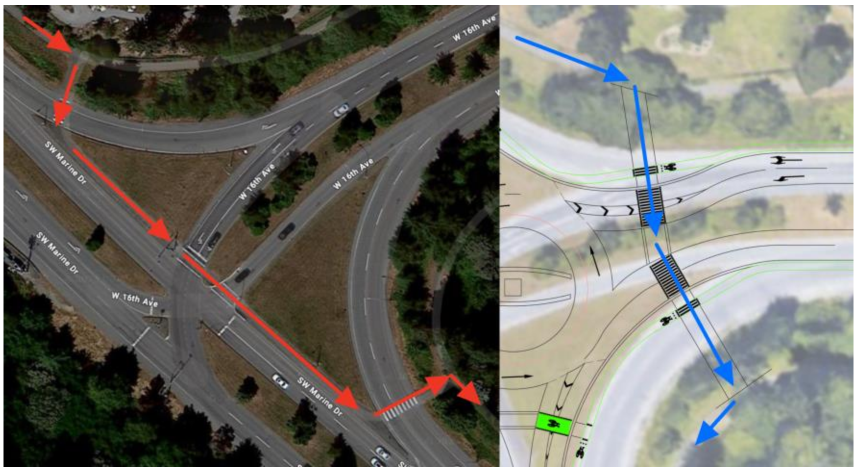

Figure 9: Comparing Pedestrian Path of Existing and Final Design for Southbound Movement

Additionally, pedestrian attractiveness will be enhanced as the final gateway intersection will include features such as added vegetation and an artwork design as a part of the welcome sign.

Furthermore, the final design incorporates cross-rides at each crossing for every leg of the intersection. This feature required special permission from the Ministry of Transportation and Infrastructure as cross-rides are typically not allowed on provincial roads. Fortunately, this feature, allows minimal interruption for cyclist movements.

Figure 10: Suggested Cross-rides on South Leg

Figure 11: Combined Cross-ride with Zebra Crossing

For the north and south legs of the intersection, green conflict zone pavement markings will be included for their cross-rides to alert approaching vehicles. A 3D render of the typical pavement markings and cross-ride of the north and south legs can be found in Figure 10.

For the east leg, the cross-ride is combined with zebra stripes as pedestrians are expected to cross at the same location. Due to this combination, the crossing itself is designed to be wider (at 5.0 m) than typical widths for zebra crossings or cross-rides alone. This will allow journeys coming from the trails and MUP to continue more easily. A 3D render of the suggested crossing can be found in Figure 11.

Due to the roundabout design, new cycling facilities were required to accommodate cycling movements that are not typical to regular intersections while minimally interfering with a cyclist's journey. Therefore, the last update on Active Transportation Facilities is the reconfigured bike lanes within the scope of the project. The anticipated cycling movements for left turns are highlighted in Figure 12. The bike symbol pavement marking will face incoming cyclists to suggest the correct direction when crossing along the cross-ride.

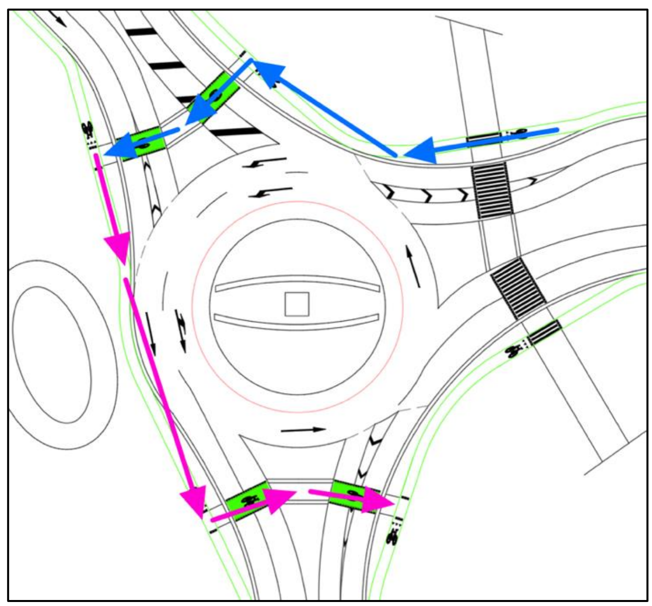

Figure 12: Anticipated Cycling Movements for Left-Turns

Moreover, each crossing will have a 2.5-metre-wide concrete waiting area to mitigate any conflicting points of incoming active modes of traffic. Yield pavement markings will be on the bike lanes to indicate which traffic has right-of-way to minimize collisions and to slow down approaching cycling traffic towards the intersection. A 3D render of suggested facilities can be found in Figure 13.

Figure 13: Suggested Concrete Waiting Area and Yield Markings on Bike Lanes

4.4 Traffic Control Devices

The signage was designed in conformance and reference to the Manual of Standard Traffic Signs and Pavement Markings, Ministry of Transportation and Highways, BC, 2000. Per Section 3.1 of the manual, for signage to be effective it must: fulfill a need, command attention and respect, convey a clear and simple message, and allow adequate time for a proper response. All the signage was designed with the principles in mind. Furthermore, signs will not be contradictory or confusing for the usage of the public. Signage will be designed to fulfill the needs of these five categories per Section 1.3 of the manual: Regulatory, Warning, Information, School/Pedestrian, and Temporary Conditions. The regulatory signage for speed limits will be 50 kph, with warning signage of 30 kph as drivers approach the intersection. As SW Marine Dr is a provincial jurisdiction, the regulatory speed limit will not be below 50 kph. There will be information signage at every roundabout exit, as well as including directions to the nearest hospital. There will be abundant Pedestrian and cyclist signage to provide drivers with sufficient warning and stop distance. Temporary signage is discussed in Section 10.1, as part of the traffic management plan. A drawing of the signage and road markings is enclosed in **Appendix G**.

4.5 Tie-In Work

The MUP extension for the trails is included as a consideration for the tie-in of existing elements of the intersection. In addition to this, the roundabout design will accommodate only one lane for northbound movements on the north leg (this is a key change from the preliminary design to the final design) and can be found in Figure 14.

Therefore, additional reconstruction of the roadway along SW Marine Dr north of the intersection must be included as this will provide a seamless transition from existing to new elements. The reconstruction includes converting a portion of the existing second lane (for northbound movements on the north leg) to the suggested bike lanes plus buffer markings; any remaining pavement not required for the bike lane will be removed and repurposed to additional greenery.

During this process, the intersection of SW Marine Dr and Stadium Rd will need to be tightened, so the existing median from Stadium Rd will be extended to align with the new bike lanes. The existing sidewalks will remain in the same place. An overview of SW Marine Dr & Stadium Rd can be found in Figure 15.

Figure 14: Reducing to One Lane for Northbound Movement

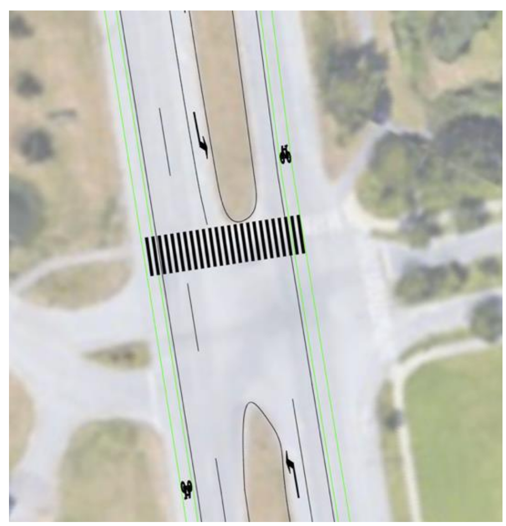

Figure 15: SW Marine Dr and Stadium Rd Intersection Redesign

5.0 Drainage Design

The methodology employed in designing the stormwater drainage system involves a strategic relocation of the roundabout to the east, creating space for a stormwater detention pond. This pond promotes stormwater infiltration rather than runoff, mitigating the risk of cliffside erosion.

The initial step involved catchment area delineation in QGIS, utilizing the UBC Digital Elevation Model (DEM) projected to UTM 10N for precise area assessments. Utilizing the Saga toolbox, The team enhanced the Digital Elevation Model (DEM) by filtering out noise and subsequently conducted a hydrologic analysis. The results of the flow path analysis can be found in Figure 16. This analysis helped identify the flow path and catchment area, resulting in an idealized total area of 2.07 ha.

It is crucial to highlight that this idealized area does not account for regions that are already efficiently drained by the existing infrastructure. As depicted in the figure below, stormwater naturally flows westward toward the cliff. Currently, the drainage system is presumed to direct stormwater toward the road median of 16th Ave. From there, the water is collected along the broader median on SW Marine Dr., gradually infiltrating into the water table over time.

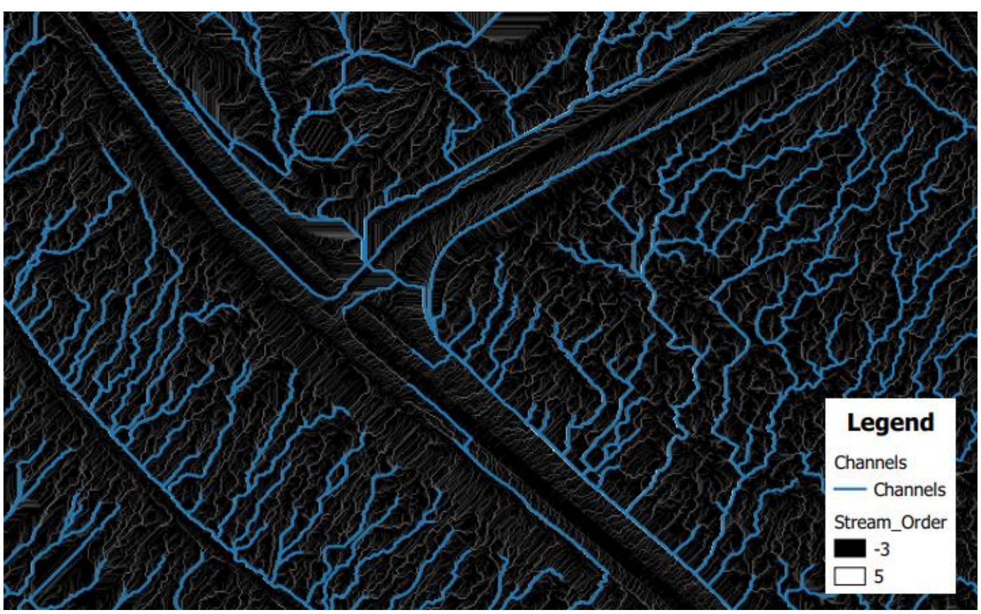

Figure 16: Hydraulic Flow Paths of the Surrounding Area

Continuing the process within GIS, the flow path was calculated from the furthest point away from the proposed detention pond location, considering the change in elevation to obtain the gradient. Subsequently, Manning's Equation, $V = \frac{1}{n}R^{\frac{2}{3}}S^{\frac{1}{2}}$, was applied to determine flow velocity, facilitating the computation of the time of concentration. The Rational Method was employed to determine the maximum discharge, considering an average runoff coefficient of 0.22 for the drainage basin by assuming a 6:4 ratio of asphalt to grassland. IDF curves for the UBC station were obtained using the IDF_CC Tool 7.0. Data used for design calculations can be found in **Appendix C**.

Building upon this information, The team selected 2, 10, and 100-year rainfall events, optimizing the pond size using the Rational Method and intensity events ranging from 5 minutes to 24 hours. Assumptions included the direct proportionality of calculated runoff to rainfall intensity, uniform rainfall intensity throughout the storm, the frequency of peak discharge occurrence aligning with the rainfall event, and uniform rainfall distribution over the drainage area.

According to the BC Stormwater Planning Manual, peak flows must be bypassed within 24 hours and allow the infiltration practice to meet the 24-hour drawdown requirement. To meet this requirement, the design incorporates layers of fine sand, pea gravel, and river stone, achieving an average infiltration rate of 5 cm/hr. The maximum required volume, identified for the 100-year rainfall event over 24 hours, amounted to 360 m^3. Consequently, the design dimensions were established as an elliptical pond that is 24 m in length, 12 m in width, and 1.5 m in depth. Detailed design calculations are enclosed in **Appendix C**.

In adherence to the guidelines outlined in the BC Stormwater Planning Manual, the detention pond's slope is crucially designed to be 1:3 or less, facilitating slope stability and effective stormwater management. With a depth of 1.5 meters, this slope ensures that erosion is minimized, and sedimentation is controlled within the pond. The design incorporates an outer ellipse extending 4.5 meters beyond the inner ellipse to accommodate this slope requirement adequately. Maintaining this gradient is essential for preventing erosion along the pond's banks, ensuring long-term stability. Detailed design drawings for the detention pond can be found in **Appendix G**.

A vegetative buffer consisting of native plants such as willow, red osier dogwood, and Pacific ninebark, contribute to the filtration of pollutants and provide habitat support for local wildlife. These plants aid in the breakdown of hydrocarbons from potential fuel spills, thereby improving water quality within the pond. Moreover, careful consideration has been given to pond maintenance requirements to ensure its long-term functionality. Access points strategically located on the east and west sides of the detention pond facilitate sediment removal and periodic inspection of hydraulic structures.

To prevent overflow across road surfaces, pipelines are needed to transport the stormwater to the detention pond. The initial steps in designing stormwater pipelines involve a hydrological analysis, where the catchment area is divided into sub-areas. The subsequent step involves pipe sizing using adapted versions of Manning's equation, guiding the selection of appropriate pipe diameters. Concrete is selected as the pipe material due to its low cost and high durability. A sample calculation can be found in **Appendix C**. A summary of pipe design details can be found in Table 10.

Table 10: Drainage Pipeline Configuration

Area Number	Area (ha)	Pipe Length (m)	Pipe Diameter (mm)	Material
1	0.262	30	203.2	Concrete
2	0.310	32	203.2	Concrete
3	0.169	30	152.4	Concrete
4	0.200	37	152.4	Concrete

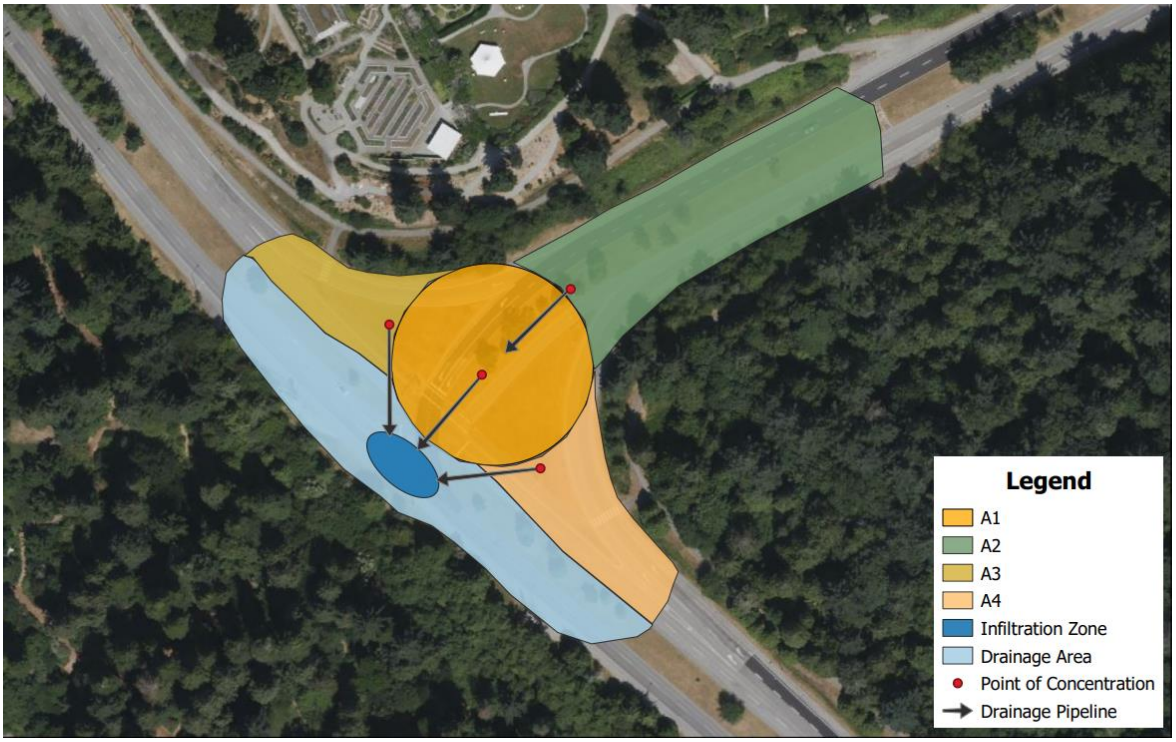

Figure 17: Aerial View of Drainage Sub-Areas and Pipeline Layout

In Figure 17 shown above, the catchment area is divided into five distinct areas. Precipitation within sub-areas numbered 1 to 4 will naturally drain towards the point of concentration within each area. The point of concentration is designed to be the lowest point within each sub-area, with 1" bar screen at the pipe intake to catch debris. All pipes transport stormwater to the detention pond by gravity; no pumps are used in the design. The drainage area west of the roundabout requires no pipelines. All precipitation within this area flows towards the infiltration zone of the detention pond, where highly permeable materials are used to maximize infiltration.

6.0 Gateway Design

The intersection at SW Marine Dr. and 16th Ave. holds significant cultural and historical importance as the gateway to the UBC Campus and the ancestral, unceded territory of the Musqueam people. The UBC Signage, characterized by a refined twenty-eight-letter design, aims to effectively convey to oncoming road users that they are entering the UBC Campus. The signage is strategically positioned facing the north and southbound legs of the roundabout to alert drivers who may be entering the roundabout at speeds above the limit. A render of the planned signage can be found in Figure 18 below.

Figure 18: Rendering of Gateway Design

The signage itself will be fabricated predominantly from aluminum and will be situated atop a concrete pedestal reinforced with steel rebar, designed to CSA23.3 and NBC2020 standards. Considering the dimensions of each letter and the density of aluminum, a conservative assumption of factored gravity is linearly distributed across the entirety of the structure.

The selection of aluminum for signage is grounded in a strategic combination of key benefits. Its lightweight nature facilitates easy handling and installation, ensuring practicality in various signage applications. Simultaneously, aluminum's inherent durability and resistance to weathering make it a reliable choice for outdoor signage, guaranteeing a prolonged lifespan and maintaining a polished appearance despite environmental challenges.

Moreover, the low cost associated with aluminum signage, coupled with its recyclability, not only contributes to cost-effectiveness but also aligns with sustainability goals. The material's recyclability underscores a commitment to reducing environmental impact, offering an eco-friendly option for businesses and organizations conscious of their ecological footprint.

Concrete has been selected as the preferred material for the structural elements, leveraging the pre-existing roundabout design that incorporates concrete elements. This not only streamlines the construction process but also aligns with considerations of lower maintenance costs over the long term when compared to alternate materials such as steel.

In tandem with the UBC signage, a secondary platform is proposed at the center of the roundabout. This secondary feature is intended to serve as a platform for the Musqueam people to express their presence on the land through canvas drawings or other symbolic representations, fostering a meaningful connection between the signage installation and the cultural heritage of the Musqueam people. This platform has been designed to bear a superimposed dead load of 5kpa to adequately support any envisioned artwork requested by the Musqueam community. Table 11 summarizes the critical capacity and demand of the First Nations Platform.

Table 11: Structural Capacity and Demand

Element	Component	Demand	Capacity	Capacity / Demand
Slab	One-way Bending Resistance (KN)	14.2	24.1	0.6
Beam	Bending Resistance (KN)	27.9	33.9	0.8
Beam	Shear Resistance (KN)	50	299.8	0.17
Column	Axial Compression (KN)	278.4	531.3	0.52
Footing	One-Way Shear Resistance (MPa)	12	20	0.6
Footing	Two-Way Shear Resistance (MPa)	0.68	1.24	0.55

The hydrogeological and geotechnical assessment conducted in 2002 for the Northwest Area of the UBC Campus confirms the presence of surface till in the designated area of interest. Although sand is present at lower elevations, GIS Data validates that the predominant top surface elevation aligns with the till level. Importantly, the project design precludes the necessity for deep excavations to reach sand elevation. The maximum allowable bearing pressure for the till has been set at 200 kPa by CSA standards, ensuring the project's compliance with geotechnical requirements,

7.0 Schedule

7.1 Construction Phase Plan

It is required that at least one lane is open in all directions throughout construction. To facilitate this, The team has developed a 4 phased construction plan, as seen below in Figure 19 and in Drawing M5 of **Appendix G**.

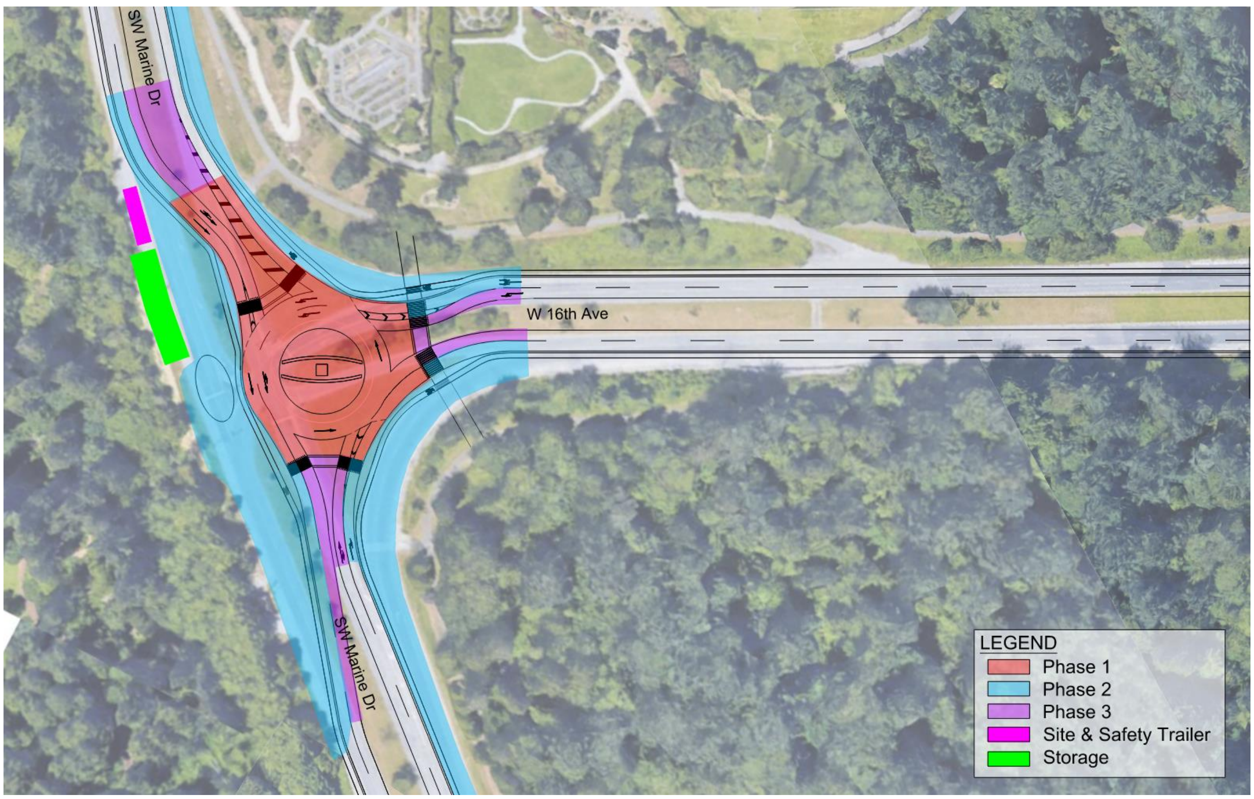

Figure 19: Construction Phase Plan

The list below summarizes the construction that occurs in each phase:

- Phase 1: Roundabout and drainage pipes
- Phase 2: Exterior vehicle lanes, bike lanes, and detention pond
- Phase 3: Interior vehicle lanes

- Phase 4: Road markings, signs, landscaping, gateway, lighting

A detailed traffic management plan explaining how road users will maneuver the intersection during construction is in Section 10.1.

7.2 Schedule Overview

Figure 20 below is an overview of the construction schedule with major phase completion milestones. The proposed construction period will last approximately 108 days (about 3 and a half months), starting on May 1 and finishing on September 27, 2024. For a full detailed construction schedule, please see Appendix E.

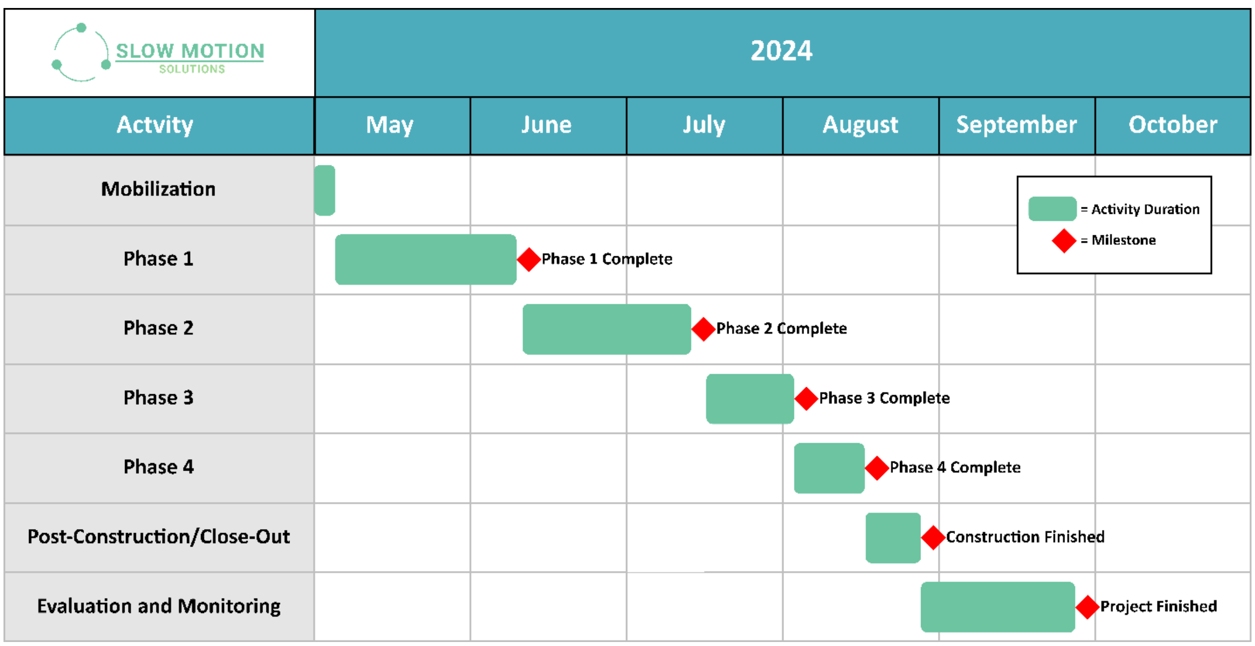

Figure 2020: Construction Schedule Overview

8.0 Cost Estimate

8.1 Construction Costs

The team has prepared a class A cost estimate to break down the anticipated construction costs for the project. The final estimated cost for the intersection redesign is $3,106,000 including PST and a 10% contingency. This estimate considers all permitting, project management, traffic management, labor, and material costs required to complete the project. The full cost estimate is in **Appendix F** and a summary is located below in Table 11.

Table 11: Construction Cost Summary

DESCRIPTION OF WORK		AMOUNT
Section 1 - General Requirements	$	722,400
Section 2 - Grading	$	943,700
Section 3 - Drainage	$	213,700
Section 4 - Paving	$	606,200
Section 5 - Landscaping	$	32,400
Section 6 - Gateway	$	97,500
Section 7- Signage and Signals	$	145,500
Section 8 - Temporary Roads	$	62,000
Sub-Total	**$**	**2,823,400**
Contingency - 10%	**$**	**282,400**
Total Cost	**$**	**3,105,800**

8.2 Operating and Maintenance Costs

The completed intersection redesign will have operating and maintenance costs over the service life. The detention pond and drainage system will require an annual debris cleanout to keep the system clear and fully functioning. Additionally, every year the drainage system will require an engineering inspection for damage and potential repairs. Severe repairs will require updated engineering designs.

The RRFB’s will require an annual inspection for electrical issues and require maintenance when necessary. The road surface will require annual maintenance to fix potholes, cracks, and road markings. The vegetation at the intersection will require regular maintenance, with frequent visits in the spring and summer. Additionally, there will be a monthly electricity cost to run the streetlights and RRFB’s. The estimated cost for operation and maintenance is in **Appendix G** and a summary is located below in Table 12. Overall, The team has estimated an annual operation and maintenance cost of $28,500.

Table 12: Operating and Maintenance Cost Summary

DESCRIPTION OF WORK	AMOUNT	
Drainage Maintenace & Inspection	$	7,000
Singal Maintenance & Inspection	$	1,500
Road Maintenance	$	2,000
Vegetation Control	$	13,000
Electricity	$	1,100
Sub Total	$	24,600
Contingency - 10%	$	2,500
Total Cost	**$**	**27,100**

9.0 Consultation Plan

The success of the SW Marine Dr. and 16th Ave. intersection redesign lies in fostering an inclusive and collaborative design process. The significance of stakeholder input and a commitment to a comprehensive consultation plan that integrates diverse perspectives, especially from the Musqueam community and nearby residents, is acknowledged (as seen in Figure 22).

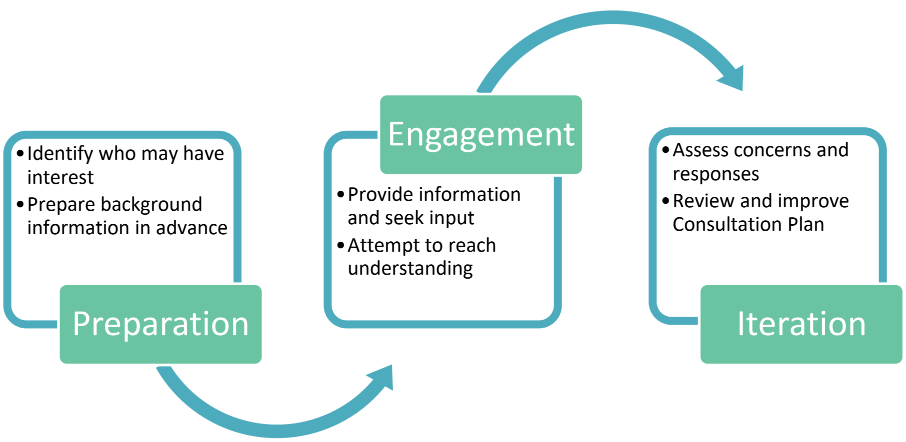

Figure 21: Consultation Roadmap (Yaworsky, Plenary 5, 2023)

Building upon the preliminary design's foundation, The team will sustain and expand stakeholder consultation post-project completion. Stakeholders are categorized by interest levels for effective communication throughout and beyond the project lifecycle.

In our ongoing engagement, a balance of transparency and cultural sensitivity, particularly with the Musqueam community, acknowledging the importance of their heritage in the project area.

Regularly scheduled meetings, accessible digital platforms, and targeted surveys will form the backbone of the communication strategy, ensuring that feedback is continually gathered and integrated. This dynamic, adaptable engagement process is designed to reflect the collective vision and meet the practical needs of all stakeholders, from residents to daily commuters and environmental groups. Our iterative design approach will integrate community input at every stage, reinforcing the project's commitment to cultural respect, inclusivity, and environmental sustainability.

10.0 Project Management Documentation

An excellent project management plan will be necessary to maintain the flow of traffic during construction and increase the efficiency of the detailed design process.

10.1 Traffic Management Plan

During construction of the intersection, The team wants to ensure safety and minimize disturbances for all road users; to achieve this, a comprehensive traffic management plan (TMP) was developed. As discussed in section 7.1, the construction will take place in 4 key phases to ensure that at least one lane is open in all directions throughout construction. Detailed traffic management drawings can be found on pages M1-M4 of **Appendix G**. The drawings illustrate temporary roads, all construction signs, the location of traffic control people, direction of traffic flow, and the construction area.

During working hours, The team will have one traffic control person on each leg of the intersection to manage traffic. Additionally, it will be ensured that emergency vehicles will always be able to access the intersection without delays.

The site will have a safety trailer and site office for the construction safety officer and site superintendent on the northwest side of the intersection. There will be a temporary storage area south of the site offices.

10.1.1 Phase 1

Phase 1 is the most complex traffic management plan, as it does not use the existing or future intersection design, instead it uses a temporary intersection south of the existing one. This design is the most optimal solution as it allows for construction of the roundabout while minimizing traffic disturbances. The intersection will be managed by 3 traffic control people, one for each direction. Figure 23 below illustrates phase 1 of construction.

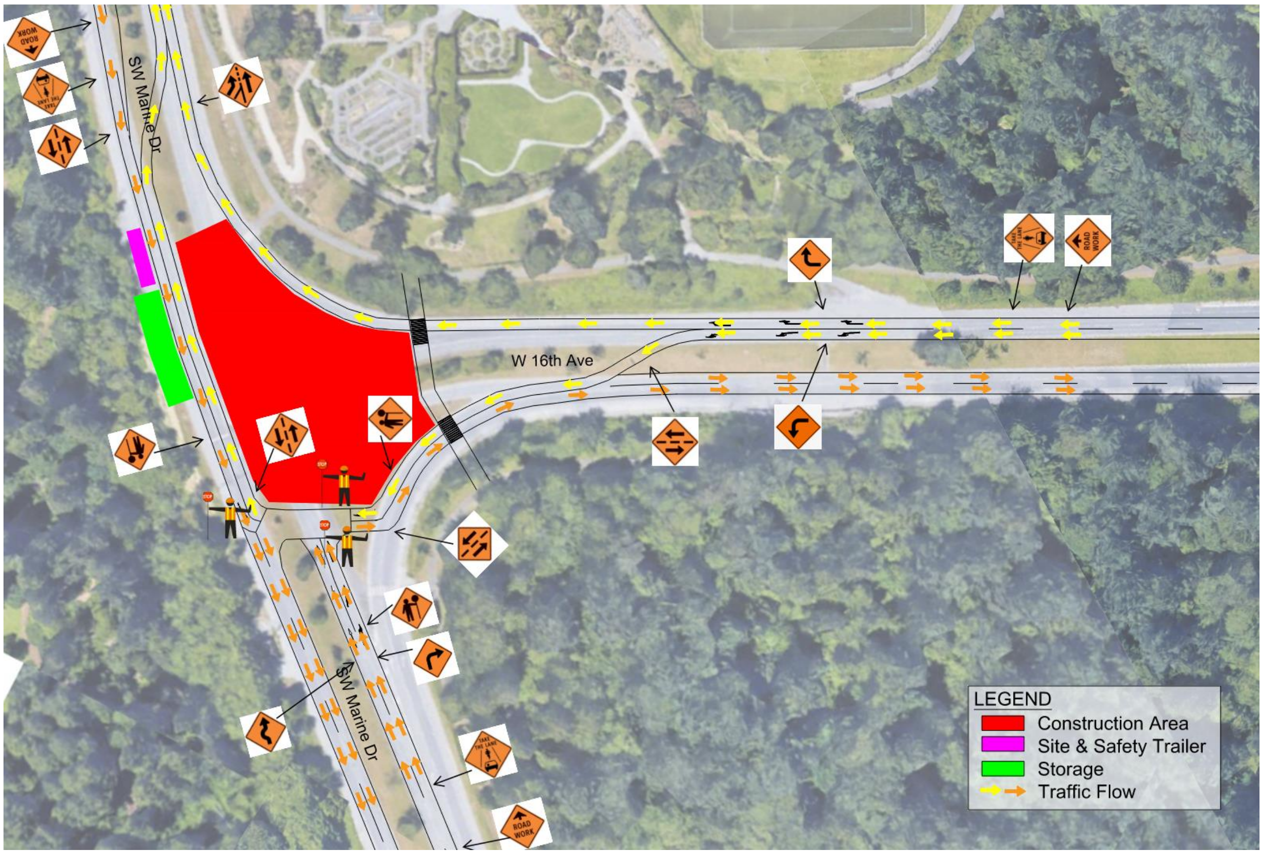

Figure 22: Phase 1 TMP

Table 13 below summarizes the vehicle movements during Phase 1. Cyclists will take the road and make the same movement as vehicles.

Table 13: Phase 1 Vehicle Movements

Leg	Direction	Movement
East	Right	Use existing right turn lane
	Left	Rerouted onto existing right turn lane onto W 16th Ave., and cross at the temporary intersection
South	Right	Use temporary intersection and existing right turn lane
	Straight	Use temporary intersection and is rerouted onto existing southbound lane.
North	Left	Uses temporary intersection and existing right turn lane onto W16th Ave.
	Straight	Uses temporary intersection

10.1.2 Phase 2

Phase 2 will use the newly constructed roundabout to convey traffic. It will be single lane traffic while the bicycle lanes, exterior vehicle lanes, and detention pond are constructed. Temporary roads will be used as the lanes approaching the roundabout. Like phase 1, cyclists will take the road and make the same movement as vehicles. The intersection will be managed by 3 traffic control people, one for each direction. Figure 24 below illustrates phase 2 of construction.

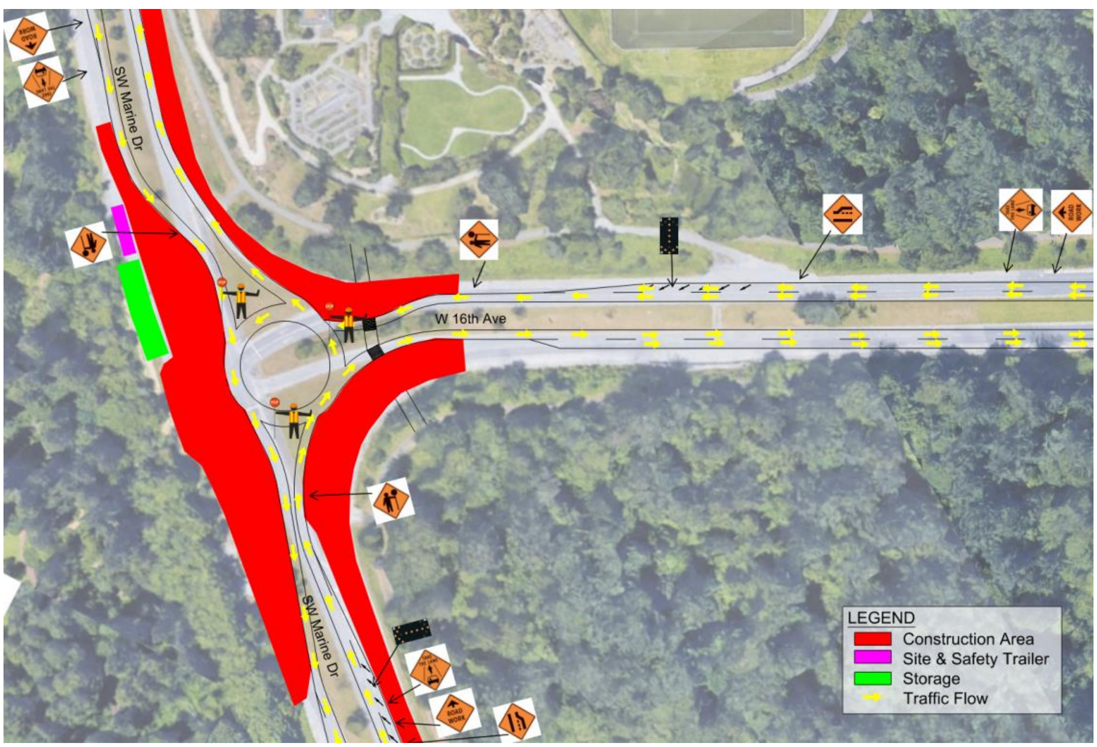

Figure 23: Phase 2 TMP

10.1.3 Phase 3

Phase 3 will use the constructed roundabout and newly constructed exterior approaching lanes to convey traffic. It will be single lane traffic while the interior vehicle lanes are constructed. Cyclists will use the newly constructed bicycle lanes. The intersection will be managed by 3 traffic control people, one for each direction. Figure 25 below illustrates phase 3 of construction.

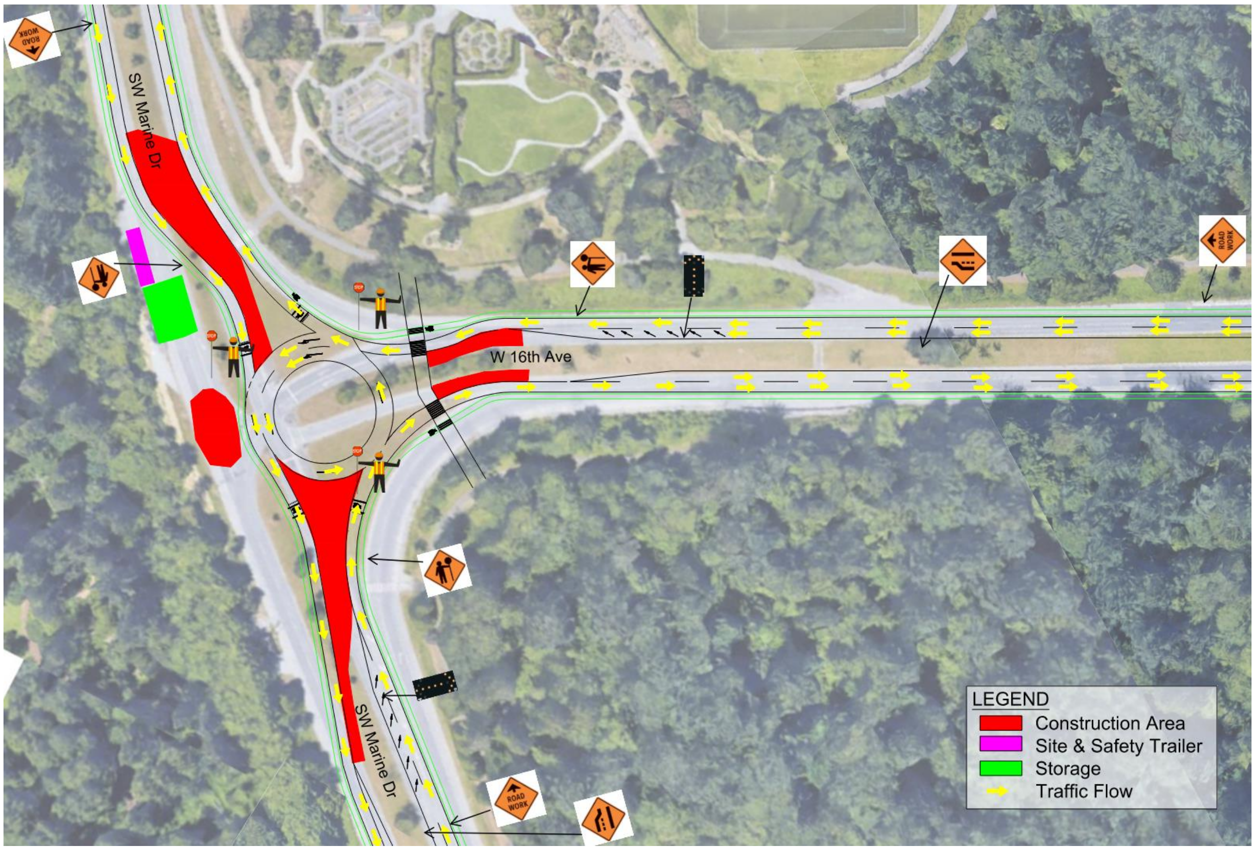

Figure 24: Phase 3 TMP

10.1.4 Phase 4

In phase 4, all roadwork will be complete and road users will use all newly constructed roads. There will still be 3 traffic control people to manage traffic since construction work will continue (road markings, landscaping, and gateway).

10.2 High Level Risks

The project high-level risks are detailed below in Table 14 below. The risk level scores are depicted in Table 15 below. It is crucial to continuously assess and manage these risks throughout the project lifecycle, implementing mitigation strategies and contingency plans as needed. Regular communication with stakeholders and a proactive risk management approach will contribute to successful risk mitigation and project outcomes.

Table 14: Risk Level Matrix

Risk Level	Score
Low	1-6
Medium	7-12
High	13-20
Critical	21-25

Table 15: Risk Level Scoring

Risk	Score	Risk Level
Regulatory Compliance Changes	19	High
Stakeholder Concerns and Consultation	18	High
Environmental Impact	15	High
Cost Overruns, Construction Challenges	11	Medium
Design Optimization	6	Low
Utility and Infrastructure Conflicts	5	Low
Multimodal Transportation Integration	12	Medium

Consultation Plan and Stakeholder Concerns: The complexity of stakeholder engagement, especially with the Musqueam community and nearby residents, poses a risk. Differing opinions or unanticipated concerns may require additional time and resources for resolution. Public reactions to the redesigned intersection, particularly concerning changes to traffic flow or aesthetic elements, could result in community resistance or negative media attention, affecting the project's overall success. As stakeholders are of high importance, the risk level scores 18.

Environmental Impact: Despite efforts to minimize environmental impacts, unexpected ecological challenges or unanticipated effects on local habitats could emerge, leading to project delays or modifications. Due to non-negotiable environmental criteria, the risk level scores 15.

Cost Overruns and Construction Challenges: Unpredicted factors, such as unforeseen environmental challenges or changes in construction material costs, may lead to budget overruns, requiring adjustments to the financial plan. Budget and costs must be controlled, risk level scores 11.

11.0 Work Breakdown Structure

Figure 26 below shows the work breakdown structure for the intersection redesign, outlining key tasks and subtasks.

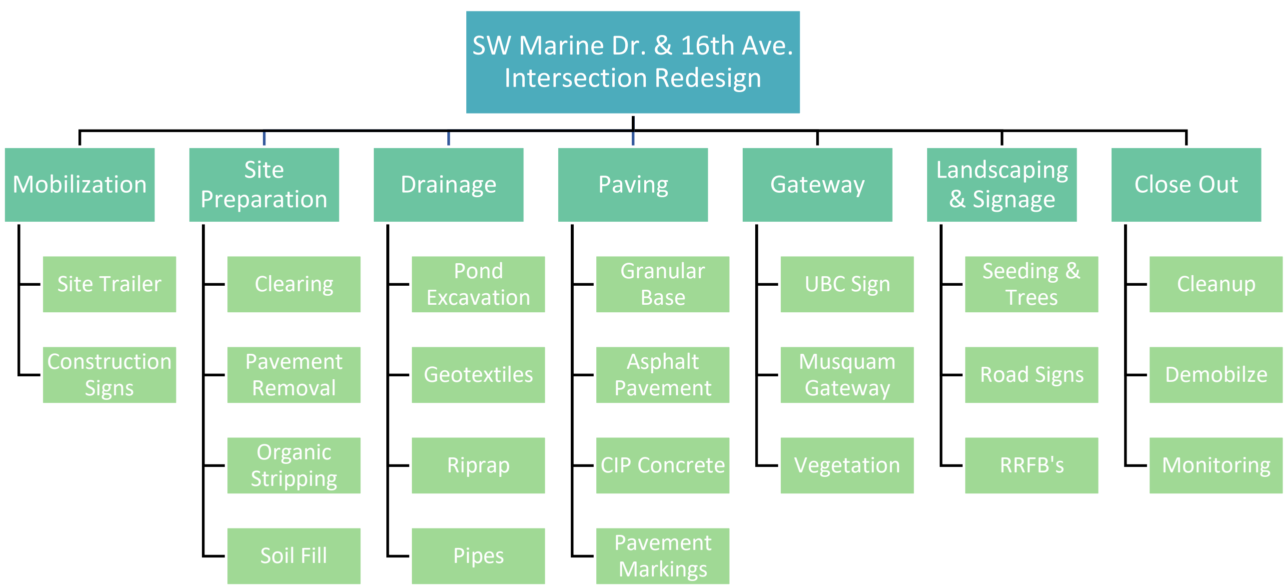

Figure 25: Work Breakdown Structure

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Appendix A: Traffic Analysis Calculations

Sample Calculation for Vehicle Traffic Growth

South Leg – Northbound Traffic Data on SW Marine Dr. (Towards Intersection):

- Chosen peak days of the week: Tuesday to Thursday (for 2021 and 2022 data)
    - Average traffic counts of the chosen days were used.
    - Chosen peak hours: 3 – 6 PM
- 2023 traffic data recorded on Thursday, October 5 from 3 – 6 PM.

Table A1: Average Traffic Count from 3 – 6 PM of 2021 & 2022 + their Average Rate of Change

Time	Oct. 26, 2021	Oct. 24, 2022	Difference	Change (%)	Avg. Change (%)
3 PM	620	918	298	48.1	
4 PM	598	904	206	51.1	46.8
5 PM	607	858	251	41.4	

Table A2: Average Traffic Count from 3 – 6 PM of 2022 & 2023 + their Average Rate of Change

Time	Oct. 24, 2024	Oct. 05, 2023	Difference	Change (%)	Avg. Change (%)
3 PM	918	565	-353	-38.5	
4 PM	904	571	-333	-36.8	-37.1
5 PM	858	548	-310	-36.1	

An average between the 2021+2022 and 2022+2023 data gave an overall growth of 4.86% over three years. Therefore, an equivalent rate per year was calculated:

$$Equivalent\ Rate\ of\ Change\ per\ year = \left[(1 + 0.04861)^{\frac{1}{3}} - 1\right] * 100 = 1.595 = 1.6\%$$

Please note that southbound traffic (away from the intersection) was calculated with the same methodology, but it yielded negative growth rates between 2021, 2022 and 2023. Therefore, for the purposes of realism, it was ignored.

Sample Peak Hour Factor Calculation

East Leg – Westbound Traffic Data on 16th Ave. (Left-Turn Movement):

Table A3: 15- Minute Breakdown of Highest Traffic Count from October 5, 2023 Traffic Data

Time	Left-Turn Traffic Count
5:00 PM	173
5:15 PM	148
5:30 PM	103
5:45 PM	107
Total	531

Peak Hour Factor, PHF, calculated below:

$$PHF = \frac{531}{173 * 4} * 100 = 76.7\%$$

<u>Sample Calculation for Pedestrian Traffic Growth</u>

There were no historical pedestrian traffic counts provided from 2021 or 2022 to the recorded traffic count on October 5, 2023. Therefore, observed pedestrian traffic will be compared to the additional pedestrian traffic that will exist after cyclists must dismount and use the crosswalk to continue to their destination. This only affects the southbound-left, northbound-through, and westbound-left travel movements.

South Leg – Northbound Traffic Data on SW Marine Dr. (Through Movement):

Table A4: 15-Minute Breakdown of Highest Cyclist Count with Corresponding Pedestrian Count from Oct. 5, 2023, Traffic Data

Time	Pedestrian Count	Cyclist Count	Total
5:00 PM	0	5	5
5:15 PM	1	2	3
5:30 PM	0	10	10
5:45 PM	0	1	1

Pedestrian count and cyclist count were added up for sum of 19 counts for 5 – 6 PM. Like the sample calculation of vehicle traffic growth, the difference is compared to the original value:

$$Growth\ Rate = \frac{19 - 18}{18} * 100 = 5.56 = 5.6\%$$

Sample Crosswalk Warrant

East Leg Crossing – Westbound Traffic Data on 16^{th} Ave & NB + SB Pedestrian Count:

Parameters:

- Traffic Volume (3 PM – Left & Right Turn Movements): 584 veh/hr = 600 veh/hr
- Pedestrian Count (3 PM – NB & SB on SW Marine Dr.) = 2 adults = 2 EAUs
- Roadway Cross-Section: 4 lanes @ 16 m wide
- Signal Progression
    - Currently: Uncoordinated Signal – Pattern B
    - Proposed: None – Pattern A
- Speed Limit: 60 kph
- Population: 11,000 (UBC Planning, 2020)

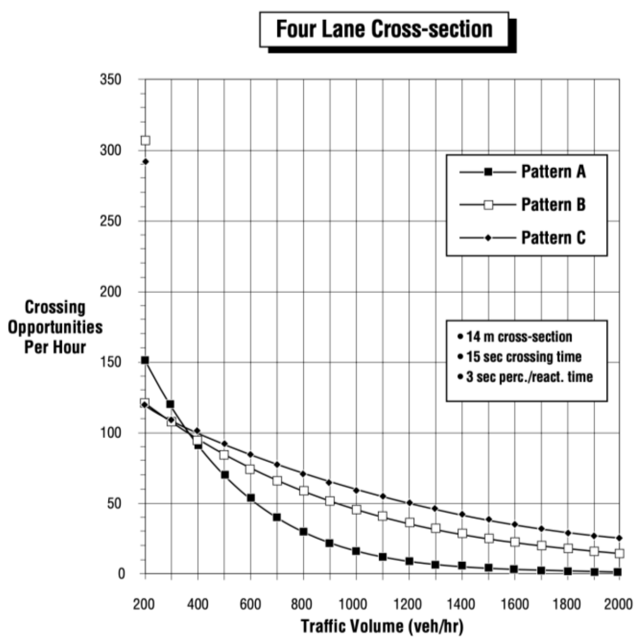


Figure A1: Estimated Crossing Opportunities for a 4 Lane Cross-Section

With the use of the previous parameters and Figure A1, it is determined that there are approximately 55 to 75 crossing opportunities per hour based on Pattern A and B, respectively.

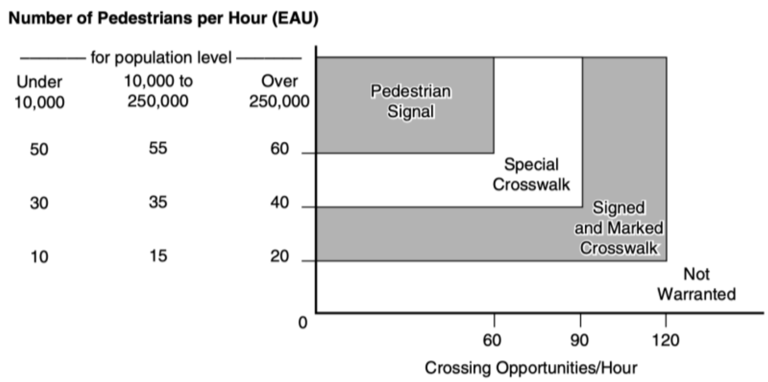


Figure A2: Pedestrian Crossing Control Warrant Chart

Based on Figure A2 and only having 2 EAUs for this crossing, it is not warranted to have any kind of crossing control.

Appendix B: Sidra Software Report

INTERSECTION SUMMARY

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

Output produced by SIDRA INTERSECTION Version: 9.1.4.221

New Site
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 26 years

Intersection Performance - Hourly Values

Performance Measure	Vehicles:	All MCs	Persons
Travel Speed (Average)	km/h	38.7	46.3 km/h
Travel Distance (Total)	veh-km/h	3722.9	17560.4 pers-km/h
Travel Time (Total)	veh-h/h	96.1	379.3 pers-h/h
Desired Speed	km/h	58.3	
Speed Efficiency		0.66	
Travel Time Index		6.27	
Congestion Coefficient		1.50	
Demand Flows (Total)	veh/h	3539	16684 pers/h
Arrival Flows (Total)	veh/h	3539	
Percent Heavy Vehicles (Demand)	%	17.2	
Percent Heavy Vehicles (Arrivals)	%	17.2	
Degree of Saturation		1.109	
Practical Spare Capacity	%	-23.3	
Effective Intersection Capacity	veh/h	3193	
Control Delay (Total)	veh-h/h	31.24	81.13 pers-h/h
Control Delay (Average)	sec	31.8	17.5 sec
Control Delay (Worst Lane by MC)	sec	72.8	
Control Delay (Worst Movement by MC)	sec	82.8	82.8 sec
Geometric Delay (Average)	sec	5.8	
Stop-Line Delay (Average)	sec	26.0	
Idling Time (Average)	sec	13.8	
Intersection Level of Service (LOS)		LOS C	
95% Back of Queue - Veh (Worst Lane)	veh	34.8	
95% Back of Queue - Dist (Worst Lane)	m	235.5	
Ave. Que Storage Ratio (Worst Lane)		0.19	
Effective Stops (Total)	veh/h	4440	13717 pers/h
Effective Stop Rate		1.25	0.82
Proportion Queued		0.80	0.73
Performance Index		204.9	204.9
Cost (Total)	$/h	12325.03	12325.03 $/h
Fuel Consumption (Total)	L/h	528.5	
Carbon Dioxide (Total)	kg/h	1255.6	
Hydrocarbons (Total)	kg/h	0.156	
Carbon Monoxide (Total)	kg/h	1.52	
NOx (Total)	kg/h	3.831	

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.
Intersection LOS value for Vehicles is based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand effects.
In Network analysis, Arrival Flows will be reduced if Upstream Capacity Constraint exists.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
Site Model Variability Index (Average value of largest changes in Lane Degrees of Saturation from the third to the last Main (Timing-Capacity) Iterations): 5.7 %
Number of Iterations: 8 (Maximum: 10)
Largest change in Lane Degrees of Saturation for the last three Flow-Capacity Iterations: 3.1% 1.7% 0.9%

Appendix C: Drainage Design Calculations

Manning's Equation – Overland Flow Velocity

$$v = \frac{1}{n} \times R^{\frac{2}{3}} \times S^{\frac{1}{2}}$$

$where:$

$v = average\ velocity -\ m/s$

$n = Manning'roughness\ coefficient$

$S = slope -\ m/m$

$R = hydraulic\ radius - m$

$$\rightarrow v = \frac{1}{0.2} \times 0.30^{\frac{2}{3}} \times 0.027^{\frac{1}{2}} = 0.37\ m/s$$

Peak Discharge 100 year 24 hour – Rational Method

$$Q = \frac{CIA}{Z}$$

$where:$

$Q = peak\ discharge - m^3/s$

$C = runoff\ coefficient$

$I = average\ rainfall\ intensity -\ mm/hr$

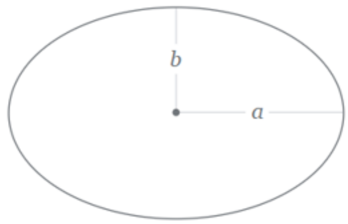
$Z = 360$

$$\rightarrow Q = \frac{0.22 \times 5.17 \times 2.07}{360} = 0.0065\ m^3/s$$

Pond Area

$A_i = \pi ab$

$where:$



$a = longer\ arm - m$

$b = shorter\ arm - m$

$\rightarrow A_i = \pi \times 12 \times 6 = 226.19m^2$

Maximum Required Pond Capacity

$V = Qt - A_i r_i t$

$where$:

$V = volume\ required\ m^3$

$Q = peak\ discharge - m^3/s$

$t = rainfall\ duration - s$

$A_i = detention\ pond\ area - \ m^2$

$r_i = rate\ of\ infiltration - m/s$

$\rightarrow V = 0.0065 \times 1440 - 226.19 \times 0.00504 \times 1440 = 289.28m^3$

Design Volume

$V = dA_i$

$where$:

$V = design\ volume - \ m^3$

$d = pond\ depth - m$

$A_i = detention\ pond\ area - \ m^2$

$\rightarrow V = dA_i = 289.28 \times 1.5 = 339.29m^3$

Pipe Sizing 10” Pipeline

$$Q_1 = \frac{A_1}{A_T} Q_T$$

$where:$

$A_1 = Area\ 1$

$A_T = Total\ catchment\ area$

$$\rightarrow Q_1 = \frac{0.262}{2.07} \times 0.0065 = 0.00082 m^3/s$$

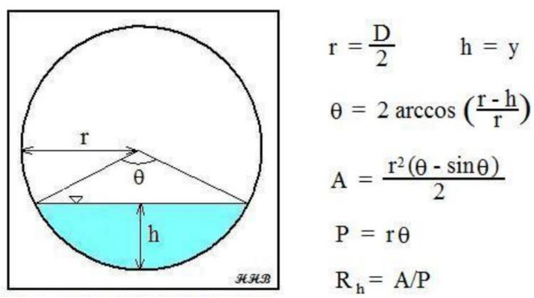


Figure C1 26: The Manning Equation for Partially Full Pipe Flow Calculations

$$Q_1 = A_{p1} v_1$$

$where: A_{p1} = wetted\ area\ of\ pipe\ 1$

$$Q_1 = A_{p1} \times \frac{1}{n} \times R^{\frac{2}{3}} \times S^{\frac{1}{2}}$$

$$Q_1 = 2\,\mathrm{acos}\left(\frac{r-h}{r}\right) \times \frac{1}{n} \times \left(\frac{\left[r^2\left(2\,\mathrm{acos}\left(\frac{r-h}{r}\right) - \sin\left(2\,\mathrm{acos}\left(\frac{r-h}{r}\right)\right)\right]/2}{r 2\,\mathrm{acos}\left(\frac{r-h}{r}\right)}\right)^{\frac{2}{3}} \times S^{\frac{1}{2}}$$

$Using\ an\ iterative\ process:$

$r \leq 86.3mm\ \rightarrow d \leq 172.6mm$

$$\rightarrow Hence, \qquad choose\ 8"\ diameter\ 203.2mm$$

Appendix D: Gateway Design Calculations

Column Axial Compression Check:

$$Superimposed\ Dead\ Load: 5\ kpa$$

$$Slab\ +\ Beam\ Weight: 7kpa$$

$$Snow\ Load: 1.6kpa$$

$$Critical\ Load\ Combination: 1.25D\ +\ 1.5S\ =\ 1.25(7+5)+1.5(1.6)=\ 17.4\ kpa$$

$$P_f\ =\ 17.4kpa\ *\ 16m^2\ = 278.4\ KN$$

$$P_{ro}\ =\ 0.8(\alpha_1\theta_c f_c A_c+\theta_s f_y A_s =$$

$$=\ 0.8(0.812\ *\ 0.65*25mpa*40000mm^2+0.85*400mpa\ *400mm^2)\ =\ 531.3\ KN$$

One-way Slab Bending Resistance Check:

$$Superimposed\ Dead\ Load: 5\ kn/m$$

$$Slab\ Weight: 3.5\ kn/m$$

$$Snow\ Load: 1.6\ kn/m$$

$$Critical\ Load\ Combination: 1.25D\ +\ 1.5S\ =\ 1.25(3.5\ +\ 5)+1.5(1.6)=\ 13.1\ kn/m$$

$$M_f\ =\ q*l_n^2/12\ =\ 13.1\ kn/m\ \ *\ 3.6m^2\ /\ 12\ =\ 14.2\ knm$$

$$\alpha_1=0.1825\ for\ 25\ mpa\ Concrete$$

$$\beta_1=0.9075\ for\ 25\ mpa\ Concrete$$

$$\beta_{1C}=\frac{\theta_s f_y A_s}{\alpha_1\theta_c f_c' b}=0.85*400\ mpa*10*\frac{300mm^2}{0.8125*0.65*25\ mpa*4000\ mm}=19.3$$

$$c=21.3\ mm$$

$$\frac{c}{d_{avg}}<\frac{700}{(700+f_y)}$$

$$0.05<0.64\ \ steel\ yields$$

$$M_r = \theta_s f_y A_s \left(d_{avg} - \frac{\beta_1 c}{2}\right) = 0.85 * 400\ mpa * 600\ mm^2 \left(205\ mm - \frac{77.3\ mm}{2}\right)$$

$$= 24.1\ knm$$

Beam Bending Resistance Check:

$$Superimposed\ Dead\ Load: 10\ kn/m$$

$$Slab\ +\ Beam\ Weight: 7kn/m$$

$$Snow\ Load: 3.2\ kn/m$$

$$Critical\ Load\ Combination: 1.25D\ +\ 1.5S\ =\ 1.25(17) + 1.5(3.2) =\ 26.9\ kn/m$$

$$M_f\ =\ q * l_n^2/12\ = 27\ kn/m\ \ *\ 3.7m^2\ /\ 12\ =\ 27.9\ knm$$

$$\alpha_1 = 0.1825\ for\ 25\ mpa\ Concrete$$

$$\beta_1 = 0.9075\ for\ 25\ mpa\ Concrete$$

$$\beta_{1C} = \frac{\theta_s f_y A_s}{\alpha_1 \theta_c f_c' b} = 0.85 * 400\ mpa * 10 * \frac{300mm^2}{0.8125 * 0.65 * 25\ mpa * 4000\ mm} = 19.3$$

$$c = 21.3\ mm$$

$$\frac{c}{d_{avg}} < \frac{700}{\left(700 + f_y\right)}$$

$$0.05 < 0.64\ \ steel\ yields$$

$$M_r = \theta_s f_y A_s \left(d_{avg} - \frac{\beta_1 c}{2}\right) = 0.85 * 400\ mpa * 666\ mm^2 \left(115\ mm - \frac{17.2\ mm}{2}\right) = 33.9knm$$

Beam Shear Check:

$$\boldsymbol{V_f\ =\ q * l_n/2\ = 26.9\ kn/m\ \ *\ 3.7m/\ 2\ =\ 50\ kn}$$

$$Factored\ Shear\ Resistance\ = V_r =\ 0.25\theta_c f_c' b_w d_v$$

$$=\ 0.25 * 0.65 * 25mpa * 200mm * 185mm\ = 299.8KN$$

Footing Effective Depth:

$$d_1 = t_f - c - d_{b\ trans} - \frac{d_{b\ long}}{2} = 160\ mm - 75\ mm - 25\ mm - \frac{25\ mm}{2} = 47.5mm$$

$$d_2 = t_f - c - \frac{d_{b\ trans}}{2} = 160\ mm - 75\ mm - \frac{25\ mm}{2} = 72.5mm$$

$$d_{avg} = (d_1 + d_2)/2 = 60\ mm$$

Footing One-Way Shear Check:

$$Factored\ Shear\ Demand = V_f = \frac{P_f}{A_f} L_f \left(\frac{Lf - Lc}{2} - d_v\right)$$

$$V_f = 189\ kpa * 0.54m * \left(\frac{0.54\ m -\ 0.2\ m}{2} - 0.0.54\ m\right) = 12\ kn$$

$$Factored\ Shear\ Resistance\ = V_r = V_C =\ \theta_c \varphi \sqrt{f_C'} B d_v$$

$$V_c = 0.65 * 1 * 0.21 * \sqrt{25mpa} * 540mm * 54mm = 20\ kn$$

Footing Two-Way Shear Check:

$$Factored\ Shear\ Demand\ =\ V_f = \left(A_f - A_{col\ \&\ \frac{d}{2}}\right) * \frac{P_f}{A\_f}$$

$$V_f = (291600mm^2 - 260mm\ *\ 260mm) * (189\ kpa) \approx 42375\ N$$

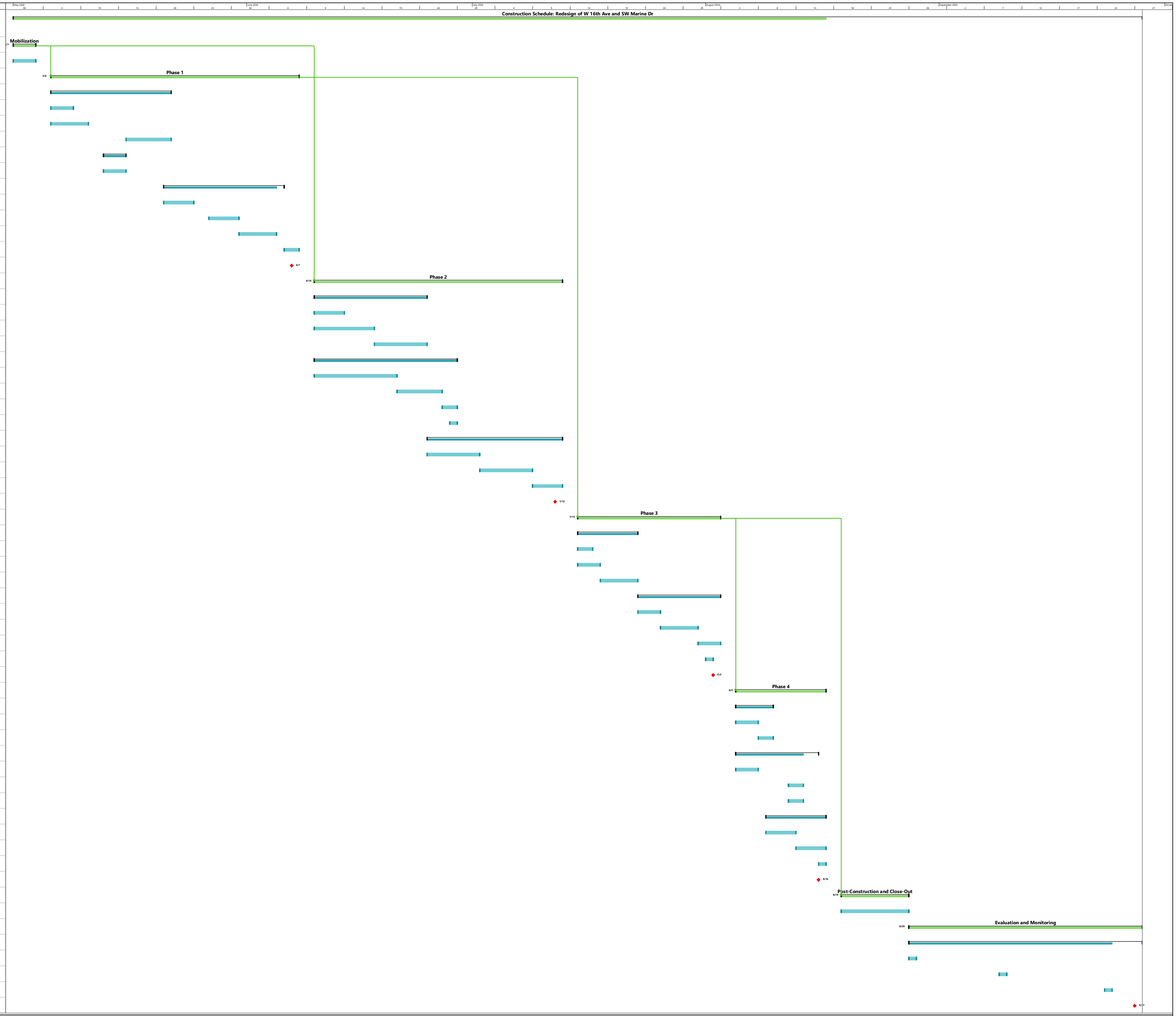
$$\tau_f = \frac{V_f}{b_o d\_avg}$$

$$\tau_f = \frac{42375\ N}{60mm * 1040\ mm} = 0.68\ mpa$$

$$Factored\ Shear\ Resistance\ =\ \tau_r = V_c = 0.38\varphi * \theta_c \sqrt{25} = 0.38 * 1 * 0.65 * \sqrt{25}$$
$$= 1.24\ mpa$$

Appendix E: Schedule

ID	Task Name	Duration	Start	Finish
1	**Construction Schedule: Redesign of W 16th Ave and SW Marine Dr**	**108 days**	**Wed 5/1/24**	**Fri 9/27/24**
2	**Mobilization**	**3 days**	**Wed 5/1/24**	**Fri 5/3/24**
3	**1.0 Transporting Machinery and Site Trailer**	**3 days**	**Wed 5/1/24**	**Fri 5/3/24**
4	**Phase 1**	**25 days**	**Mon 5/6/24**	**Fri 6/7/24**
5	**1.0 Site Preparation**	**12 days**	**Mon 5/6/24**	**Tue 5/21/24**
6	1.1 Clearing and Grubbing	3 days	Mon 5/6/24	Wed 5/8/24
7	1.2 Removal of Existing Works	5 days	Mon 5/6/24	Fri 5/10/24
8	1.3 Grading and Compaction	4 days	Thu 5/16/24	Tue 5/21/24
9	**2.0 Drainage**	**3 days**	**Mon 5/13/24**	**Wed 5/15/24**
10	2.1 Installation of Pre-Concrete Pipes	3 days	Mon 5/13/24	Wed 5/15/24
11	**3.0 Paving**	**12 days**	**Tue 5/21/24**	**Wed 6/5/24**
12	3.1 Laying Down Sub-base Layer	4 days	Tue 5/21/24	Fri 5/24/24
13	3.2 Paving with Asphalt	4 days	Mon 5/27/24	Thu 5/30/24
14	3.3 Laying Down Concrete Curb and Sidewalk	3 days	Fri 5/31/24	Tue 6/4/24
15	**4.0 Site Inspection No.1**	2 days	Thu 6/6/24	Fri 6/7/24
16	**5.0 Phase 1 Complete**	**0 days**	**Fri 6/7/24**	**Fri 6/7/24**
17	**Phase 2**	**25 days**	**Mon 6/10/24**	**Fri 7/12/24**
18	**1.0 Site Preparation**	**11 days**	**Mon 6/10/24**	**Mon 6/24/24**
19	1.1 Clearing and Grubbing	4 days	Mon 6/10/24	Thu 6/13/24
20	1.2 Removal of Existing Works	6 days	Mon 6/10/24	Mon 6/17/24
21	1.3 Grading and Compaction	5 days	Tue 6/18/24	Mon 6/24/24
22	**2.0 Drainage**	**15 days**	**Mon 6/10/24**	**Fri 6/28/24**
23	2.1 Excavation and Grading of Retention Pond Area	9 days	Mon 6/10/24	Thu 6/20/24
24	2.2 Laying Down Filter Fabric and Installing Riprap	4 days	Fri 6/21/24	Wed 6/26/24
25	2.3 Planting Aquatic Vegetation	2 days	Thu 6/27/24	Fri 6/28/24
26	**3.0 Site Inspection No. 2**	1 day	Fri 6/28/24	Fri 6/28/24
27	**4.0 Paving**	**14 days**	**Tue 6/25/24**	**Fri 7/12/24**
28	3.1 Laying Down Sub-base Layer	5 days	Tue 6/25/24	Mon 7/1/24
29	3.2 Paving with Asphalt	5 days	Tue 7/2/24	Mon 7/8/24
30	3.3 Laying Down Concrete Curb and Sidewalk	4 days	Tue 7/9/24	Fri 7/12/24
31	**5.0 Phase 2 Complete**	**0 days**	**Fri 7/12/24**	**Fri 7/12/24**
32	**Phase 3**	**15 days**	**Mon 7/15/24**	**Fri 8/2/24**
33	**1.0 Site Preparation**	**6 days**	**Mon 7/15/24**	**Mon 7/22/24**
34	1.1 Clearing and Grubbing	2 days	Mon 7/15/24	Tue 7/16/24
35	1.2 Removal of Existing Works	3 days	Mon 7/15/24	Wed 7/17/24
36	1.3 Grading and Compaction	3 days	Thu 7/18/24	Mon 7/22/24
37	**2.0 Paving**	**9 days**	**Tue 7/23/24**	**Fri 8/2/24**
38	3.1 Laying Down Sub-base Layer	3 days	Tue 7/23/24	Thu 7/25/24
39	3.2 Paving with Asphalt	3 days	Fri 7/26/24	Tue 7/30/24
40	3.3 Laying Down Concrete Curb and Sidewalk	3 days	Wed 7/31/24	Fri 8/2/24
41	**3.0 Site Inspection No. 3**	1 day	Thu 8/1/24	Thu 8/1/24
42	**4.0 Phase 3 Complete**	**0 days**	**Fri 8/2/24**	**Fri 8/2/24**
43	**Phase 4**	**10 days**	**Mon 8/5/24**	**Fri 8/16/24**
44	**1.0 UBC Sign Installation**	**5 days**	**Mon 8/5/24**	**Fri 8/9/24**
45	1.1 Installation of Cast-in-Place Concrete Footing	3 days	Mon 8/5/24	Wed 8/7/24
46	1.2 Installation of UBC Sign	2 days	Thu 8/8/24	Fri 8/9/24
47	**2.0 Musqueam Gateway Installation**	**9 days**	**Mon 8/5/24**	**Thu 8/15/24**
48	2.1 Installation of Cast-in-Place Concrete Footing	3 days	Mon 8/5/24	Wed 8/7/24
49	2.2 Installation of Musqueam Gateway	2 days	Mon 8/12/24	Tue 8/13/24
50	2.3 Planting Roundabout Vegetation	2 days	Mon 8/12/24	Tue 8/13/24
51	**3.0 Signage and Signaling**	**6 days**	**Fri 8/9/24**	**Fri 8/16/24**
52	3.1 Install Road Signs	2 days	Fri 8/9/24	Mon 8/12/24
53	3.2 Install Street Lights and RRFB	4 days	Tue 8/13/24	Fri 8/16/24
54	**4.0 Site Inspection No. 4**	1 day	Fri 8/16/24	Fri 8/16/24
55	**5.0 Phase 4 Complete**	**0 days**	**Fri 8/16/24**	**Fri 8/16/24**
56	**Post-Construction and Close-Out**	**7 days**	**Mon 8/19/24**	**Tue 8/27/24**
57	**1.0 Cleanup and Demobilization**	**7 days**	**Mon 8/19/24**	**Tue 8/27/24**
58	**Evaluation and Monitoring**	**23 days**	**Wed 8/28/24**	**Fri 9/27/24**
59	**1.0 Final Inspections**	**23 days**	**Wed 8/28/24**	**Fri 9/27/24**
60	1.1 Inspection No. 1	1 day	Wed 8/28/24	Wed 8/28/24
61	1.2 Inspection No. 2	1 day	Mon 9/9/24	Mon 9/9/24
62	1.3 Inspection No. 3	1 day	Mon 9/23/24	Mon 9/23/24
63	**FINISH**	**0 days**	**Fri 9/27/24**	**Fri 9/27/24**



Project:
Date: Mon 4/8/24

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

Appendix F: Cost Estimate

Redesign of 16th Ave & SW Marine Dr Intersection
Class A Cost Estimate
April 4th, 2024

	DESCRIPTION OF WORK	UNIT	UNIT PRICE	QUANTITY	AMOUNT
	SECTION 1 - GENERAL REQUIREMENTS				
1.01	**Project Management**				
1.01.01	Project Manager	hrs	$ 80	160	$ 12,800
1.01.02	Project Coordinator	hrs	$ 60	640	$ 38,400
1.01.03	Site Superintendent	hrs	$ 100	480	$ 48,000
1.01.04	Construction Safety Officer	hrs	$ 70	480	$ 33,600
1.01.05	Project Management Fee (5% of Construction Cost)	L.S	$ 128,200	100%	$ 128,200
1.02	**Permitting**	L.S	$ 58,500	100%	$ 58,500
1.03	**Mobilization (5% of Construction Cost)**	LS	$ 105,100	100%	$ 105,100
1.04	**Traffic Management**	LS	$ 129,600	100%	$ 129,600
1.05	**Quality Management (4% of Construction Cost)**	LS	$ 84,100	100%	$ 84,100
1.06	**Environmental Management (4% of Construction Cost)**	LS	$ 84,100	100%	$ 84,100
	SECTION 1 TOTAL				**$ 722,400**
	SECTION 2 - GRADING				
2.01	**Clearing and Grubbing**	m2	$ 10	4300	$ 43,000
2.02	**Removal of Existing Works**				
2.02.01	Removal of Existing Pavement	m2	$ 20	14350	$ 287,000
2.02.02	Removal of Existing Signs	L.S	$ 2,500	100%	$ 2,500
2.02.03	Removal of Existing intersection Signal	L.S	$ 10,000	100%	$ 10,000
2.03	**Soil**				
2.03.01	Organic Stripping	m3	$ 35	2800	$ 98,000
2.03.02	Soil Fill	m3	$ 50	2800	$ 140,000
2.04	**Granular Materials**				
2.04.01	Select Granular Sub Base	m3	$ 70	2270	$ 158,900
2.04.02	Crushed Base Course	m3	$ 90	2270	$ 204,300
	SECTION 2 TOTAL				**$ 943,700**
	SECTION 3 - DRAINAGE				
3.01	**Soil**				
3.01.01	Soil Excavation	m3	$ 50	820	$ 41,000
3.01.02	Soil Fill	m3	$ 50	300	$ 15,000
3.02	**Precast Concrete Pipes**				
3.02.01	6" dia circular pipe	m	$ 400	67	$ 26,800
3.02.02	8" dia circular pipe	m	$ 600	62	$ 37,200
3.02.03	Bar Screen	each	$ 500	4	$ 2,000
3.03	**Riprap**				
3.03.01	Class 10 kg Riprap	m3	$ 65	450	$ 29,300
3.03.01	Class 25 kg Riprap	m3	$ 80	510	$ 40,800
3.04	**Filter Fabrics**				
3.04.01	Geotextile	m2	$ 25	440	$ 11,000
3.04.02	Erosion Control Blanket	m2	$ 18	230	$ 4,200
3.05	**Plants**				
3.05.01	Wetland Plants	m2	$ 80	80	$ 6,400
	SECTION 3 TOTAL				**$ 213,700**

	SECTION 4 - PAVING						
4.01	**Asphalt Mix Aggregate**	tonne	$	30	2270	$	68,100
4.02	**Emulsified Penetrating Primer**	L	$	2.50	11340	$	28,400
4.03	**Tack Coat**	L	$	2.50	3780	$	9,500
4.04	**Joint Sealant**	L	$	10	170	$	1,700
4.05	**Asphalt Pavement (2 lifts)**	tonne	$	200	2270	$	454,000
4.06	**Cast In Place Concrete**						
4.06.01	Curbs	m3	$	500	20	$	10,000
4.06.02	Sidewalk	m3	$	500	45	$	22,500
4.07	**Pavement Markings**	L.S	$	12,000	100%	$	12,000
	SECTION 4 TOTAL					**$**	**606,200**
	SECTION 5 - LANDSCAPING						
5.01	**Vegetation Seeding**	m2	$	2	11290	$	22,600
5.03	**Trees**	each	$	150	12	$	1,800
5.04	**Roundabout Vegetation**	L.S	$	8,000	100%	$	8,000
	SECTION 5 TOTAL					**$**	**32,400**
	SECTION 6 - GATEWAY						
6.01	**UBC Sign**						
6.01.01	Cast In Place Concrete Footing	m3	$	500	40	$	20,000
6.01.02	Aluminum UBC Lettering	each	$	1,000	46	$	46,000
6.02	**Musqueam Gateway**						
6.02.01	Cast In Place Concrete Footing	m3	$	500	3	$	1,500
6.02.02	Musqueam Art (Allowance)	L.S	$	30,000	100%	$	30,000
	SECTION 6 TOTAL					**$**	**97,500**
	SECTION 7 - SIGNAGE & SIGNALING						
7.01	**RRFB**	each	$	35,000	3	$	105,000
7.02	**Road Signs**	each	$	500	21	$	10,500
7.03	**Street Light Relocation**	L.S	$	30,000	100%	$	30,000
	SECTION 7 TOTAL					**$**	**145,500**
	SECTION 8 - TEMPORARY ROADS						
8.01	**Crushed Base**	m3	$	90	290	$	26,100
8.02	**Geotextile Fabric**	m2	$	15	1420	$	21,300
8.03	**Emulsifying Tack Coat**	L	$	3	2200	$	6,600
8.04	**Road Markings**	L.S	$	8,000	100%	$	8,000
	SECTION 8 TOTAL					**$**	**62,000**
	Summary of Cost Estimate						
	SECTION 1 - GENERAL REQUIREMENTS					$	722,400
	SECTION 2 - GRADING					$	943,700
	SECTION 3 - DRAINAGE					$	213,700
	SECTION 4 - PAVING					$	606,200
	SECTION 5 - LANDSCAPING					$	32,400
	SECTION 6 - GATEWAY					$	97,500
	SECTION 7 - SIGNAGE & SIGNALING					$	145,500
	SECTION 8 - TEMPORARY ROADS					$	62,000
	SUB-TOTAL CONSTRUCTION COST					**$**	**2,823,400**
	Contingency - 10%					**$**	**282,400**
	TOTAL CONSTRUCTION COST					**$**	**3,105,800**

ANNUAL OPERATING & MAINTENANCE								
	DESCRIPTION OF WORK	**UNIT**		**UNIT PRICE**	**QUANTITY**		**AMOUNT**
	Drainage							
	System Clearing	visit	$	2,000	1	$	2,000
	Inspection	visit	$	2,500	1	$	2,500
	Repairs	each	$	25,000	0.1	$	2,500
	Drainage Total					**$**	**7,000**
	Signal							
	Inspection	visit	$	1,000	1	$	1,000
	Maintenance	each	$	5,000	0.1	$	500
	Signal Total					**$**	**1,500**
	Road							
	Maintenance	each	$	10,000	0.2	$	2,000
	Road Total					**$**	**2,000**
	Vegetation Control							
	Spring	visit	$	1,000	6	$	6,000
	Summer	visit	$	1,000	4	$	4,000
	Fall	visit	$	1,000	2	$	2,000
	Winter	visit	$	1,000	1	$	1,000
	Vegetation Control Total					**$**	**13,000**
	Electricity							
	Electricity	days	$	3	365	$	1,100
	Electricity Total					**$**	**1,100**
	SUB-TOTAL					**$**	**24,600**
	Contingency - 10%					**$**	**2,500**
	TOTAL ANNUAL OPERATING & MAINTENANCE COST					**$**	**27,100**

Appendix G: Detailed Design Drawings

GENERAL NOTES:

1. *READ ALL STRUCTURAL/CIVIL DRAWINGS IN CONJUCTION WITH ALL CONTRACT DOCUMENTS, INCLUDING REFERENCED ELECTRICAL, MECHANCAL, 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 OF 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 NOTES FOR SIMILAR CONDITIONS.*
7. *IF DISCREPANCIES EXIST BETWEEN THESE DWGS. AND THE SPECIFICATIONS, CONTACT ENGINEER FOR REVIEW AND APPROVAL PRIOR TO PROCEEDING.*
8. *DO NOT SCALE THESE DRAWINGS.*

CONCRETE:

CODE:

CONCRETE AND REINFORCEMENT WORK SHALL CONFORM IN ALL RESPECTS TO THE CODE AND ALL REFERENCED DOCUMENTS.

a. *CONCRETE CONSTRUCTION METHODS AND DESIGN: CSA—A23.1, A23.2, A23.3.*

CURING:

ALL CONCRETE SHALL BE CURED AND PROTECTED FROM ADVERSE CONDITIONS SUCH AS RAIN, WIND, COLD AND HEAT UNDER THE GUIDANCE OF A QUALIFIED MATERIALS ENGINEER AND IN CONFORMANCE WITH CSA A23.1.

- *WHEN TEMPERATURES REACH ABOVE 25C OR BELOW 5C, EXTRA PROTECTION TO CONCRETE IS REQUIRED. CONTRACTOR TO SEEK THE ADVICE OF A MATERIALS ENGINEER.*
- *PROTECTION TO MASS CONCRETE ELEMENTS GREATER THAN 1000MM (3'-4") THICK IS REQUIRED WHEN TEMPERATURES REACH ABOVE 20C OR BELOW 5C.*
- *MASS CONCRETE ELEMENTS SHALL BE PROTECTED TO LIMIT THE INTERNAL CORE AND SURFACE TEMPERATURE DIFFERENTIAL TO WITHIN 20C. CONTRACTOR SHALL CONSULT WITH A MATERIALS ENGINEER FOR MONITORING EQUIPMENT, PROCEDURES AND PROCESSES FOR SUCH ELEMENTS.*
- *UNDER NO CIRCUMSTANCES SHALL CONCRETE BE CAST ON OR AGAINST FROZEN SOIL, FORMWORK OR REINFORCEMENT.*

MATERIAL:

- *USE OF HIGH-EARLY-STRENGTH HYDRAULIC CEMENT—TYPE HE, IS PERMITTED AT THE CONTRACTOR'S DISCRETION FOR CONSTRUCTION SCHEDULING PURPOSES.*
- *MAXIMUM AGGREGATE SIZE SHALL CONFORM TO THE TABLES. SMALLER AGGREGATE SHALL BE UTILIZED IN REGIONS OF CONGESTED REINFORCEMENT, FORMWORK, OR EMBEDDED HARDWARE.*
- *WATER SHALL BE POTABLE, AND HEATED IF NECESSARY FOR APPROPRIATE CURING.*
- *CONCRETE SHALL BE REGULAR WEIGHT.*
- *ADMIXTURES MAY BE UTILIZED AT THE DISCRETION OF THE CONCRETE SUPPLIER. HOWEVER,REGARDLESS OF THE ADMIXTURES USED, THE CONCRETE SUPPLIER SHALL REMAIN SOLELYRESPONSIBLE FOR PROVIDING CONCRETE MIXES THAT MEET ALL REQUIREMENTS OF THESE ANDOTHER DISCIPLINES DRAWINGS.*
- *ADMIXTURES CONTAINING CALCIUM CHLORIDE SHALL NOT BE USED.*
- *MIX DESIGNS SHALL BE PREPARED BY THE CONCRETE SUPPLIER.*
- *NON-SHRINK GROUT SHALL BE NON-METALLIC CEMENTITIOUS PASTE WITH A MINIMUM 7-DAY COMPRESSIVE STRENGTH OF 50 MPa.*

TESTING:

a. *ALL CONCRETE SHALL BE TESTED IN CONFORMANCE WITH THE CODE BY A TESTING AGENCY CERTIFIED BY THE CANADIAN COUNCIL OF INDEPENDENT LABORATORIES AND SHALL ALSO CONFORM TO CSA A283. TESTING PERSONNEL SHALL BE CSA-CERTIFIED.*

b. *THE TESTING AGENCY SHALL BE RETAINED BY THE CONTRACTOR UNLESS ALTERNATIVE ARRANGEMENTS ARE MADE IN ADVANCE BETWEEN THE OWNER AND CONTRACTOR.*

c. *THE CONTRACTOR SHALL FULLY COOPERATE WITH THE TESTING AGENCY TO FACILITATE APPROPRIATE TESTING.*

STEEL REINFORCEMENT:

MATERIAL:

- *SHALL BE RATED FOR 400 MPa YIELD STRESS.*
- *SHALL BE STANDARD DEFORMED BILLET STEEL BARS.*
- *SHALL NOT BE WELDED IN ANY WAY EXCEPT AS SPECIFIED, IN WHICH CASE WELDABLEREINFORCEMENT SHALL BE USED.*
- *SHALL BE FREE OF DIRT, OIL, AND OTHER DELETERIOUS MATERIAL THAT MAY INHIBIT PROPER BONDING WITH CONCRETE.*

NON-REINFORCED CIRCULAR CONCRETE PIPE SPECIFICATION:

MATERIAL STANDARD: *ASTM C14*

DESIGNED FOR: *TYPE 50 SULPHATE-RESISTANT PORTLAND CEMENT TO CSA-A3000*

PIPE SIZES AND SPECIFICATIONS:

6" DIAMETER:

- *WALL THICKNESS (T): 25MM*
- *WEIGHT: 48KG/M*

8" DIAMETER:

- *WALL THICKNESS (T): 32MM*
- *WEIGHT: 77KG/M*

COMPLIANCE:

ALL MATERIALS AND MANUFACTURING PROCESSES SHALL CONFORM TO THE REQUIREMENTS SET FORTH IN ASTM C14.

JOINTS SHALL BE COMPATIBLE WITH FLEXIBLE RUBBER GASKETS MEETING BC STANDARDS FOR WATERTIGHTNESS AND DURABILITY.

CONCRETE USED IN THE MANUFACTURING OF PIPES SHALL BE TYPE 50 SULPHATE-RESISTANT PORTLAND CEMENT ADHERING TO CSA-A3000 STANDARDS, ENSURING DURABILITY AND RESISTANCE TO CHEMICAL DEGRADATION.

CLASS:

ASSIGNMENT NO. DETAILED DESIGN

DESIGNED / DRAWN BY:

PLOT DATE: APRIL 15, 2024

ISSUES:

REV. NO	DATE	REASON
1	APR 15, 2024	DETAILED DESIGN

REFERENCE DWGS: THIS DRAWING IS BASED ON:

PROJECT DOCUMENT PROVIDED BY CIVL446 FACULTY

CLIENT:

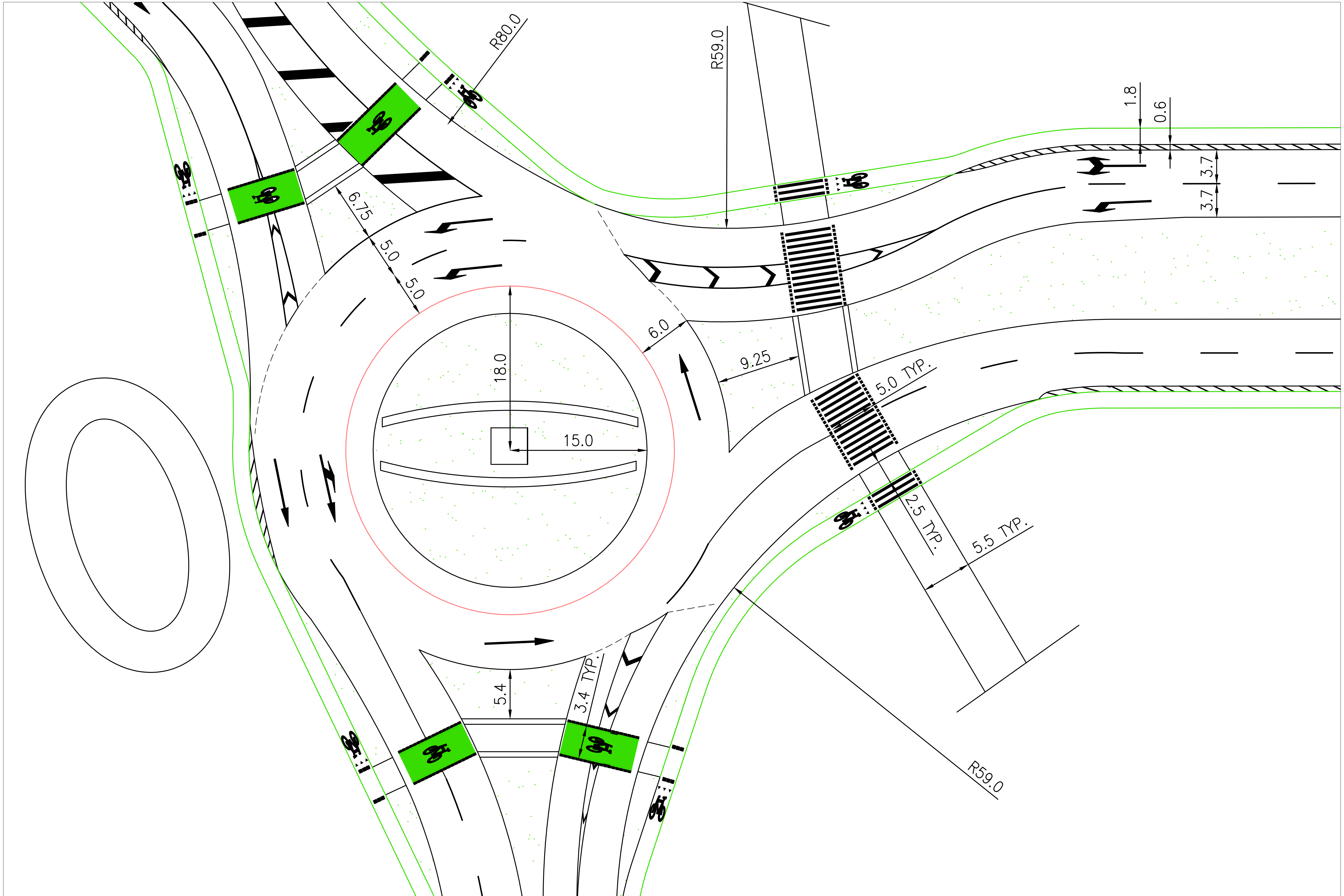
CONSULTANT:

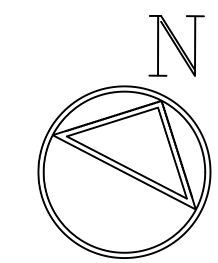
REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:

GENERAL NOTES

DWG NO.:





CLASS:

ASSIGNMENT NO. DETAILED DESIGN

DESIGNED / DRAWN BY:

PLOT DATE: APRIL 15, 2024

ISSUES:

REV. NO	DATE	REASON
A	NOV. 29, 2023	PRELIMINARY DESIGN
C	APL. 15, 2024	DETAILED DESIGN

A. NOT FOR CONSTRUCTION
B. DO NOT MEASURE FROM THIS DRAWING
C. REPORT ANY DISCREPANCIES TO THE DESIGNER

REFERENCE DWGS: THIS DRAWING IS BASED ON:

PROJECT DOCUMENT PROVIDED BY CIVL446 FACULTY

LEGEND

GRASS

CLIENT:

CONSULTANT:

PROJECT:

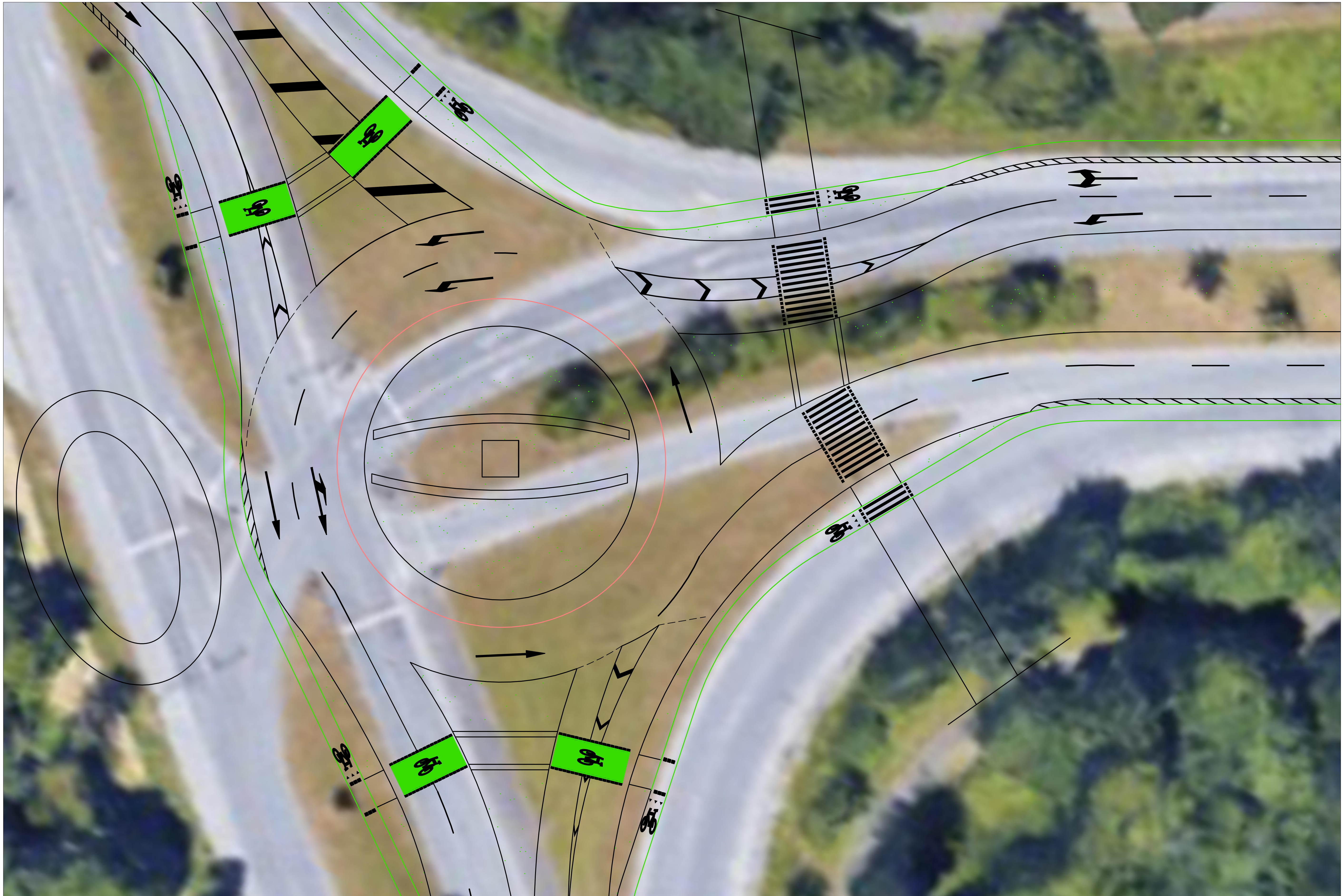
REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:

PLAN VIEW OF ROUNDABOUT

DWG NO.:

T1



GROUP: 14

CLASS CODE
CIVL 446

DATE
APR. 8, 2024

CLASS: CIVL446 2023-24 W2

ASSIGNMENT NO. FINAL DESIGN

DESIGNED / DRAWN BY: EDL, DM, RL

PLOT DATE: APR. 8, 2024

ISSUES:

REV. NO	DATE	REASON
	NOV. 29, 2023	PRELIMINARY DESIGN
	APR. 8, 2024	FINAL DESIGN

REFERENCE DWGS: THIS DRAWING IS BASED ON:
PROJECT DOCUMENT PROVIDED BY CIVL445 FACULTY

N

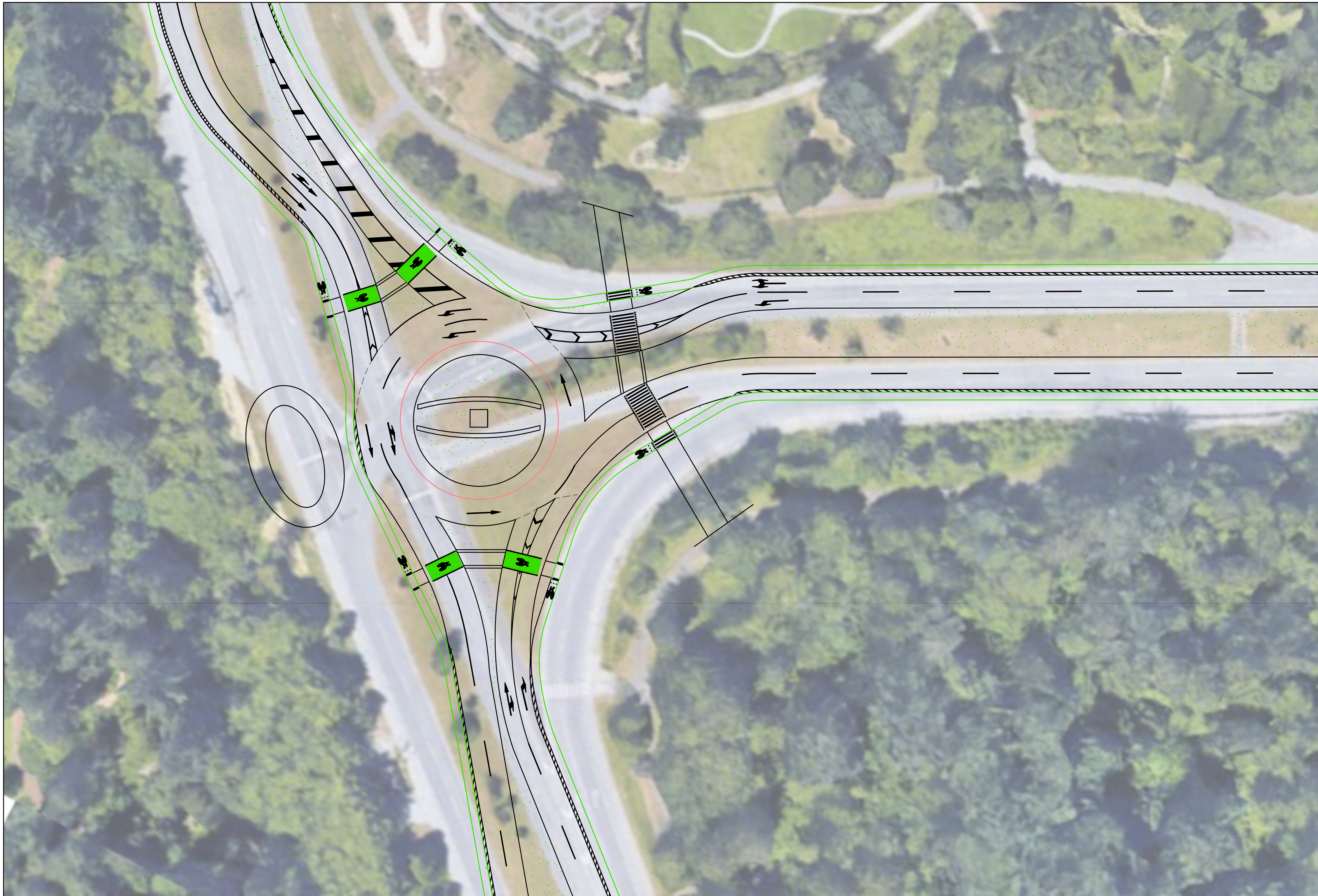
CLIENT:

CONSULTANT:

PROJECT:
REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:
PLAN VIEW OF ROUNDABOUT (EXISTING)

DWG NO.:
T2



GROUP: 14

CLASS CODE
CIVL 446

DATE
APRIL 8, 2024

CLASS: CIVL446 2023-24 W1

ASSIGNMENT NO. DETAILED DESIGN

DESIGNED / DRAWN BY: EDL, DM, RL

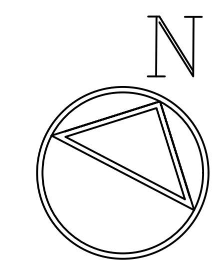
PLOT DATE: APRIL 8, 2024

ISSUES:

REV. NO	DATE	REASON
A	NOV. 29, 2023	PRELIMINARY DESIGN
C	APR. 8, 2024	FINAL DESIGN

REFERENCE DWGS: THIS DRAWING IS BASED ON:

PROJECT DOCUMENT PROVIDED BY CIVL445 FACULTY



LEGEND

GRASS

CLIENT:

CONSULTANT:

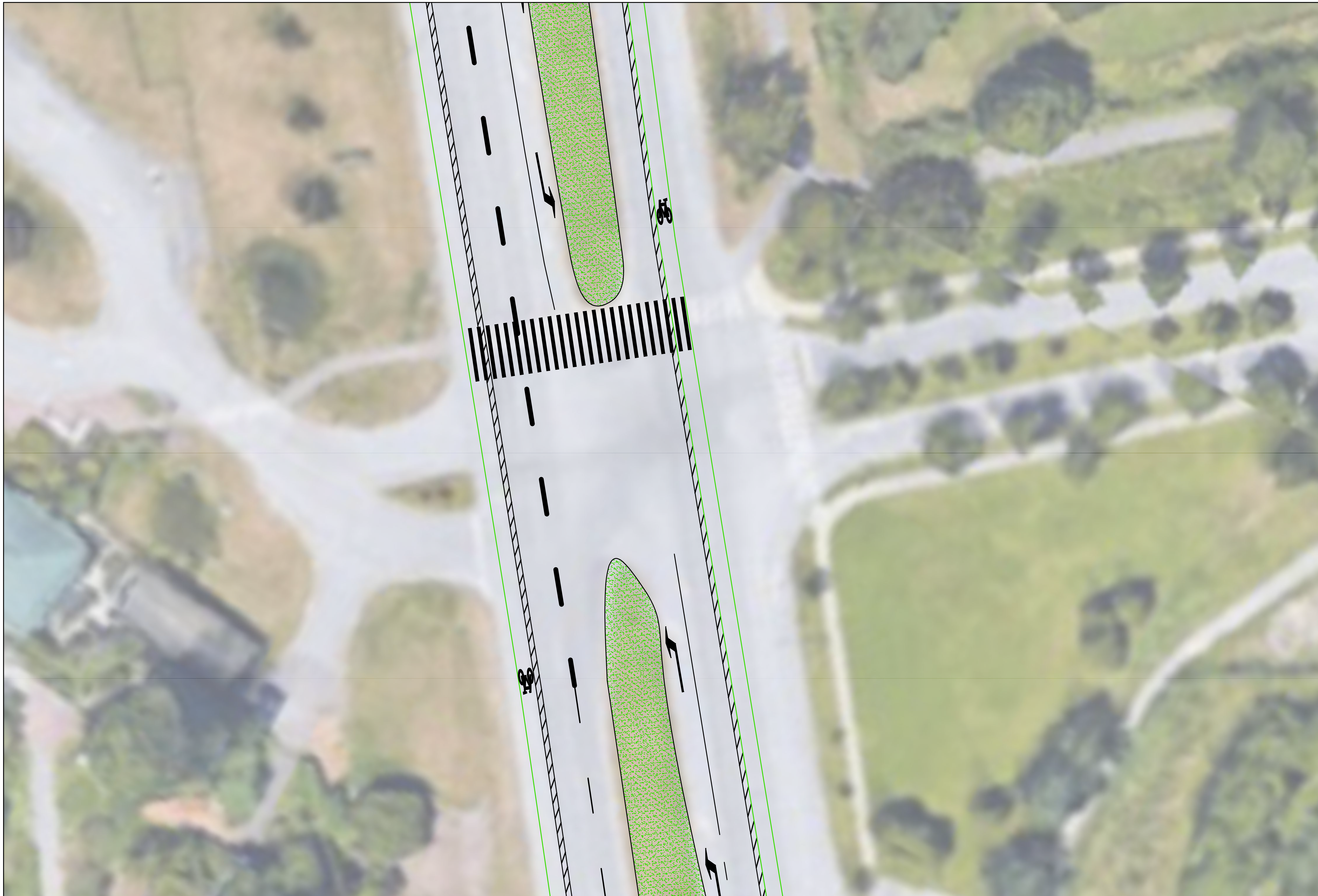
PROJECT:

REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:

PLAN VIEW OF INTERSECTION

DWG NO.: T3



GROUP: 14

CLASS CODE
CIVL 446

DATE
APRIL 8, 2024

CLASS: CIVL446 2023-24 W1

ASSIGNMENT NO. DETAILED DESIGN

DESIGNED / DRAWN BY: EDL, DM, RL

PLOT DATE: APRIL 8, 2024

ISSUES:

REV. NO	DATE	REASON
A	NOV. 29, 2023	PRELIMINARY DESIGN
C	APR. 8, 2024	FINAL DESIGN

REFERENCE DWGS: THIS DRAWING IS BASED ON:
PROJECT DOCUMENT PROVIDED BY CIVL445 FACULTY

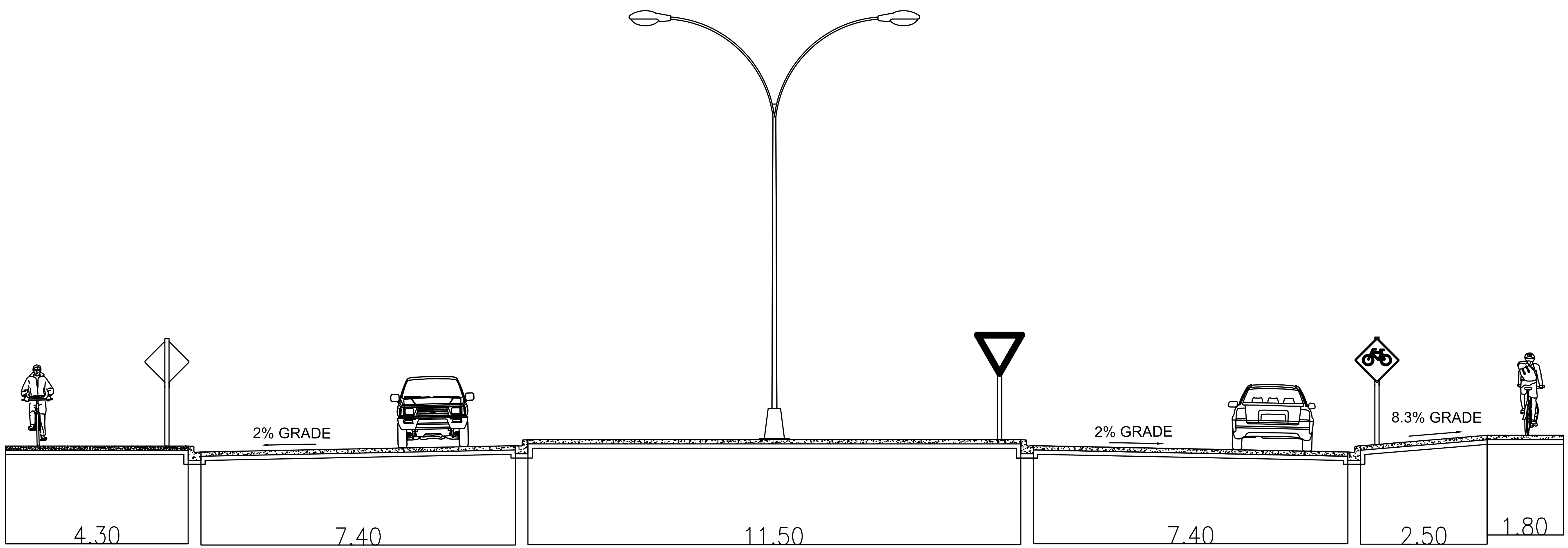
CLIENT:

CONSULTANT:

PROJECT:
REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:
PLAN VIEW OF SW MARINE DR & STADIUM RD INTERSECTION

DWG NO.:
T4



CLASS:

ASSIGNMENT NO. DETAILED DESIGN

DESIGNED / DRAWN BY:

PLOT DATE: APRIL 15, 2024

ISSUES:

REV. NO	DATE	REASON
A	DEC 7, 2023	PRELIMINARY DESIGN
C	APR 15, 2024	DETAILED DESIGN

REFERENCE DWGS: THIS DRAWING IS BASED ON:

PROJECT DOCUMENT PROVIDED BY CIVL446 FACULTY

A. NOT FOR CONSTRUCTION
B. DO NOT MEASURE FROM THIS DRAWING
C. REPORT ANY DISCREPANCIES TO THE DESIGNER

CLIENT:

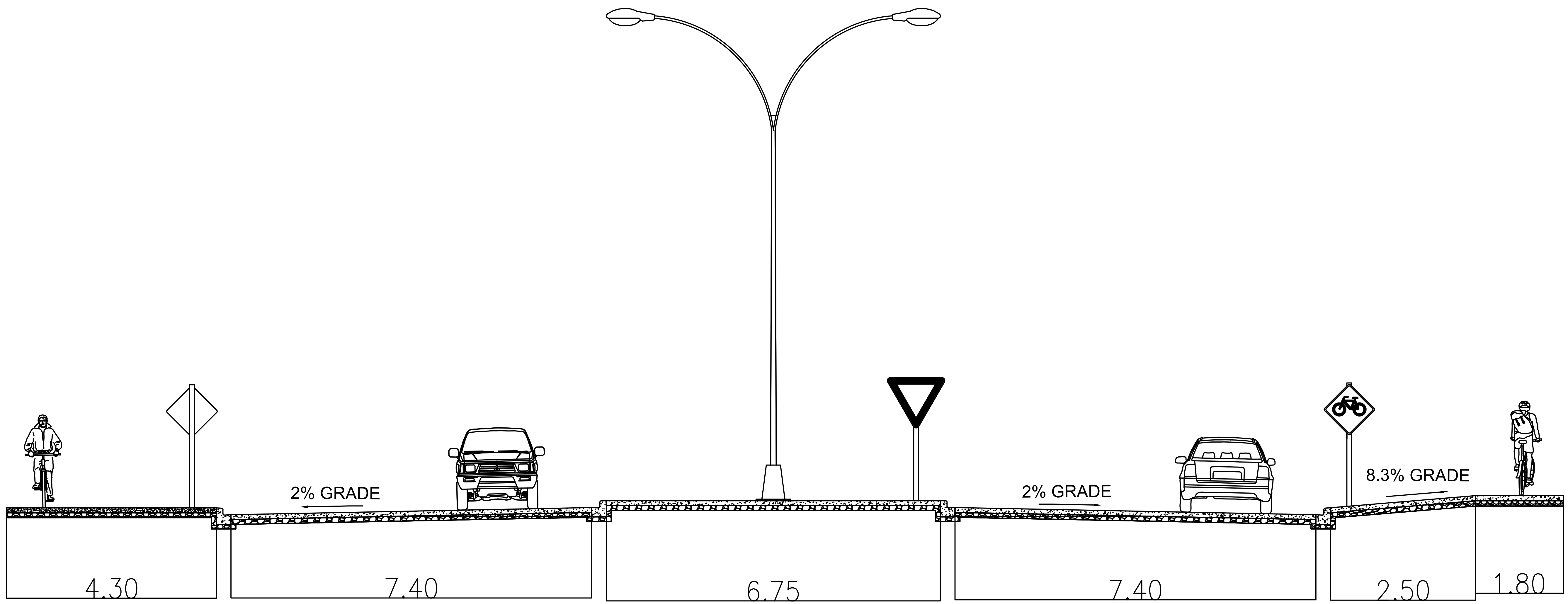
CONSULTANT:

REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:

SOUTH LEG CROSS-SECTION

DWG NO.: T5



CLASS:

ASSIGNMENT NO. DETAILED DESIGN

DESIGNED / DRAWN BY:

PLOT DATE: APRIL 15, 2024

ISSUES:

REV. NO	DATE	REASON
A	DEC 7, 2023	PRELIMINARY DESIGN
C	APR 8, 2024	DETAILED DESIGN

A. NOT FOR CONSTRUCTION
B. DO NOT MEASURE FROM THIS DRAWING
C. REPORT ANY DISCREPANCIES TO THE DESIGNER

REFERENCE DWGS: THIS DRAWING IS BASED ON:

PROJECT DOCUMENT PROVIDED BY CIVL446 FACULTY

CLIENT:

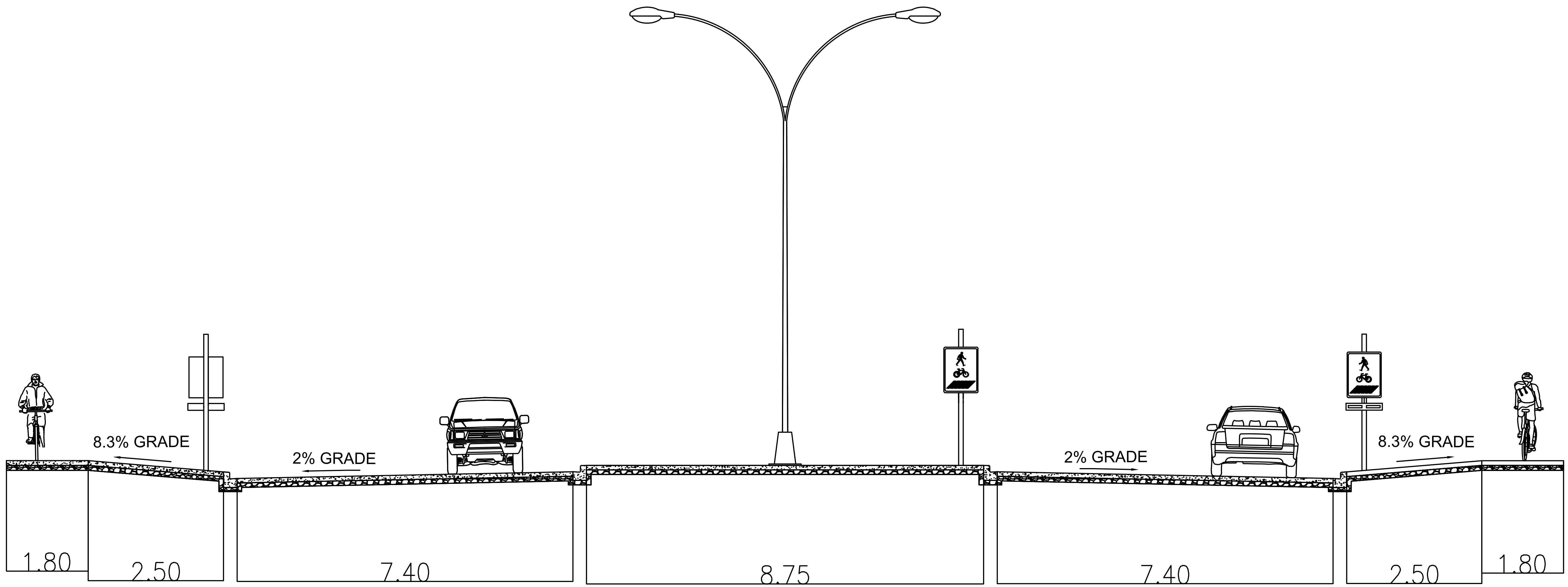
CONSULTANT:

REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:

NORTH LEG CROSS-SECTION

DWG NO.: T6



CLASS:	
ASSIGNMENT NO.	DETAILED DESIGN
DESIGNED / DRAWN BY:	
PLOT DATE: APRIL 15, 2024	

ISSUES:

REV. NO	DATE	REASON
A	DEC 7, 2023	PRELIMINARY DESIGN
C	APR 15, 2024	DETAILED DESIGN

A. NOT FOR CONSTRUCTION
B. DO NOT MEASURE FROM THIS DRAWING
C. REPORT ANY DISCREPANCIES TO THE DESIGNER

REFERENCE DWGS: THIS DRAWING IS BASED ON:

PROJECT DOCUMENT PROVIDED BY CIVL446 FACULTY

CLIENT:

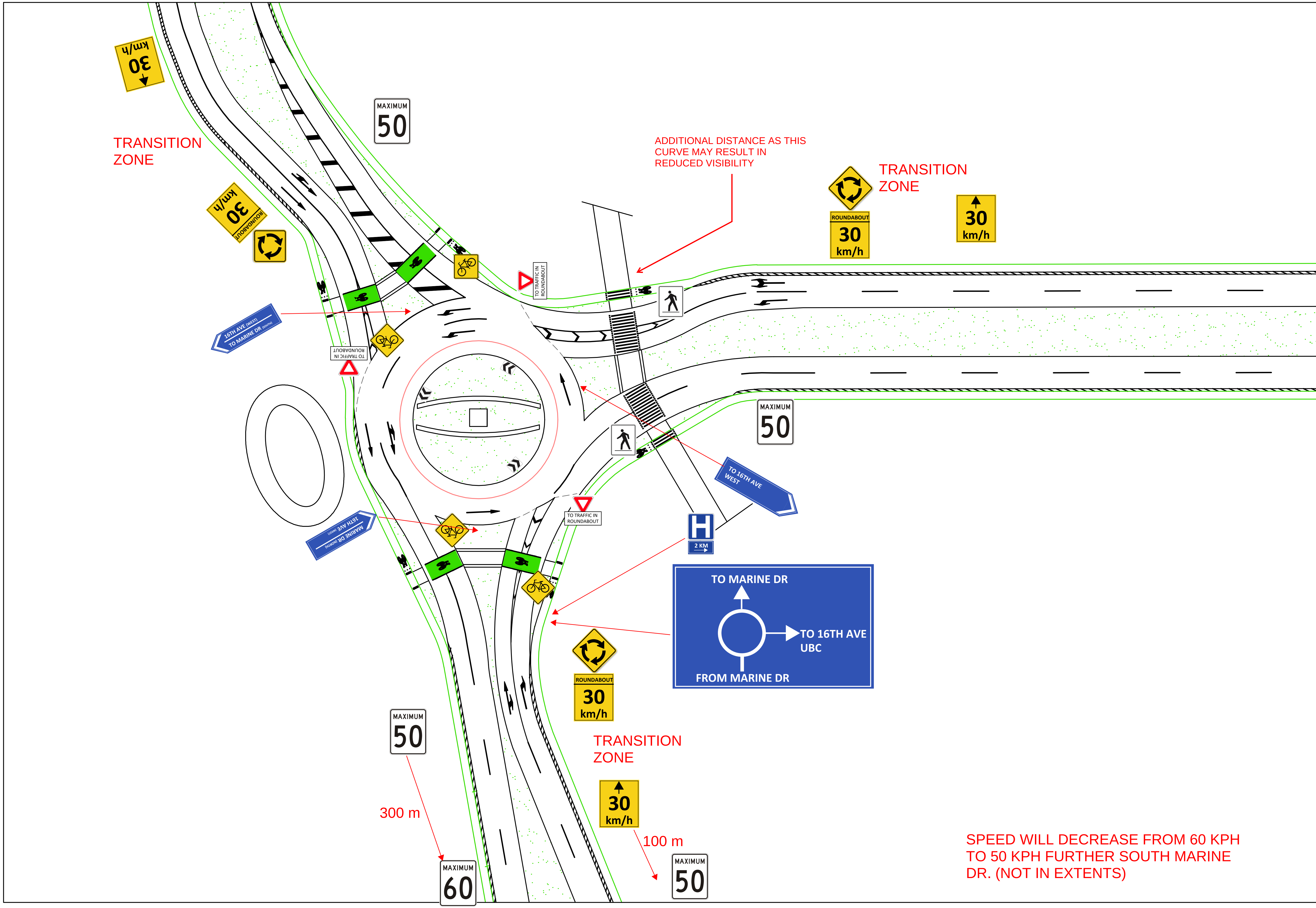
CONSULTANT:

REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:

EAST LEG CROSS-SECTION

DWG NO.: T7



CLASS:

ASSIGNMENT NO. DETAILED DESIGN

DESIGNED / DRAWN BY:

PLOT DATE: APRIL 15, 2023

ISSUES:

REV. NO	DATE	REASON
A	NOV. 29, 2023	PRELIMINARY DESIGN
C	APL. 15, 2023	DETAILED DESIGN

A. NOT FOR CONSTRUCTION
B. DO NOT MEASURE FROM THIS DRAWING
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REFERENCE DWGS: THIS DRAWING IS BASED ON:

PROJECT DOCUMENT PROVIDED BY CIVL445 FACULTY

N

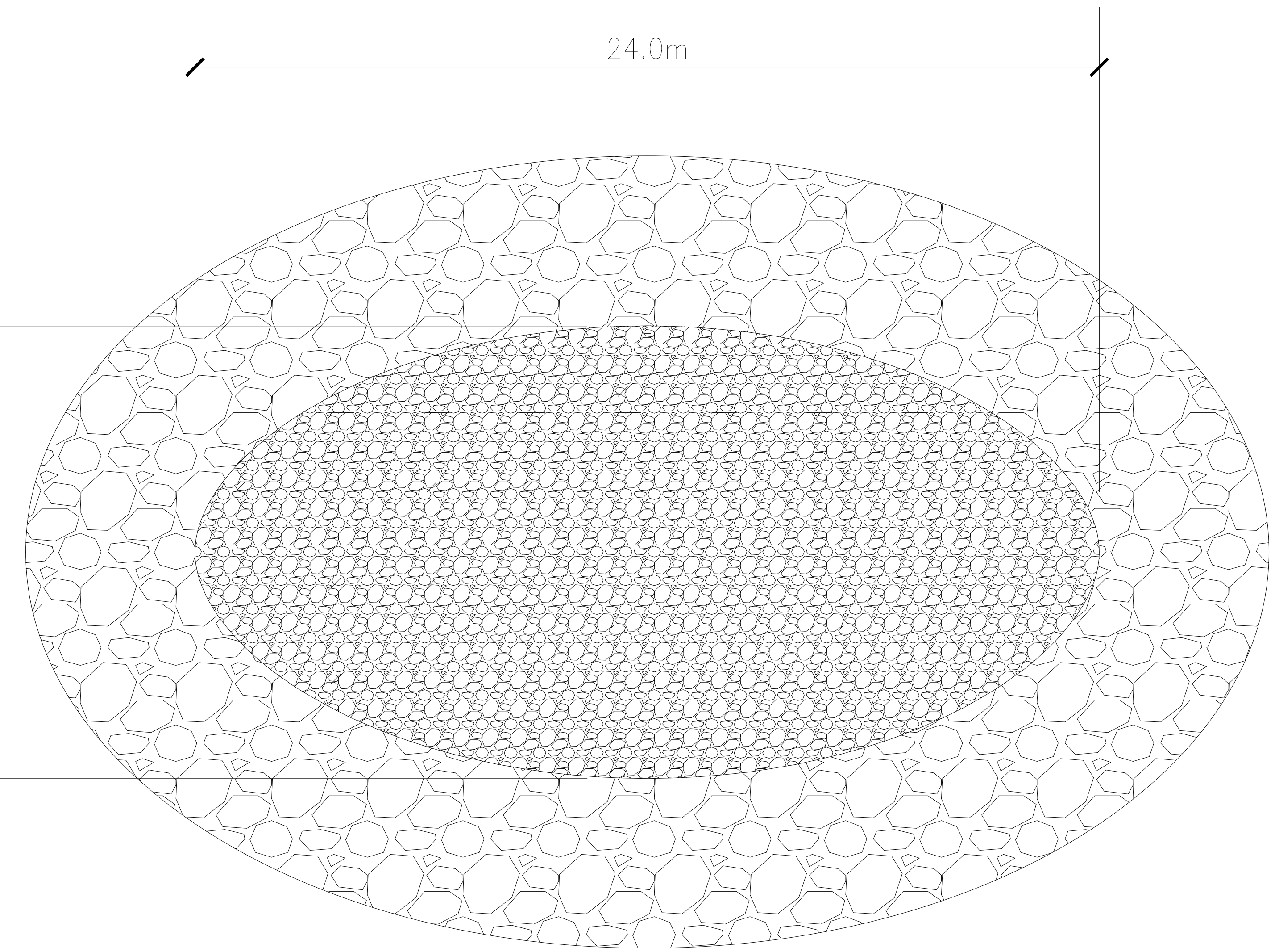
CLIENT:

CONSULTANT:

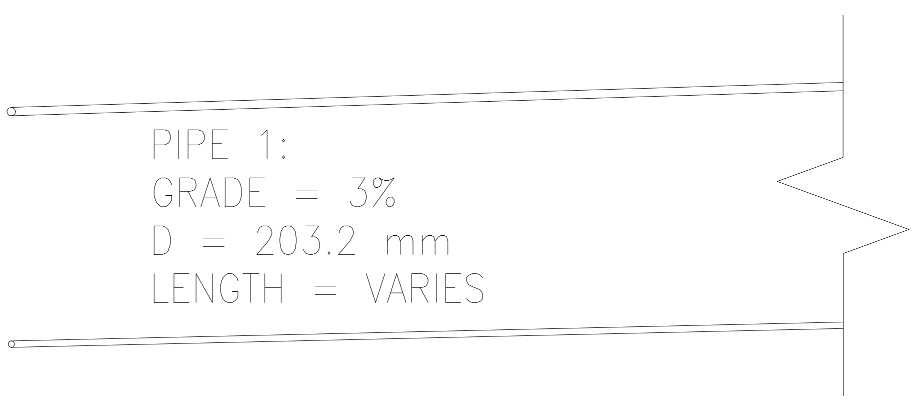
PROJECT:
REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:
SIGNAGE AND ROAD MARKING PLAN

DWG NO.: T8

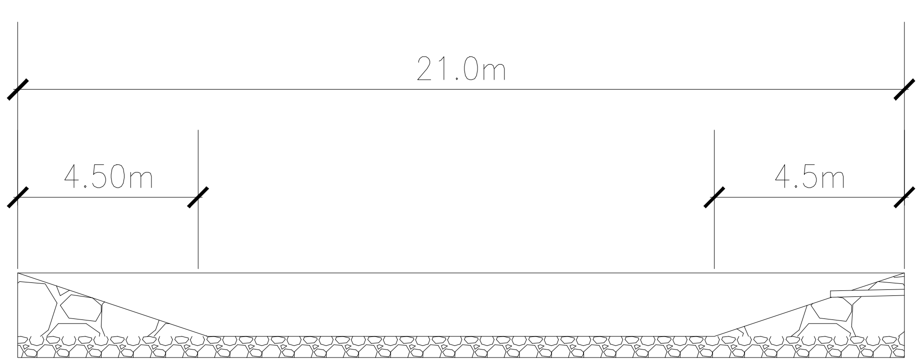


PLAN VIEW

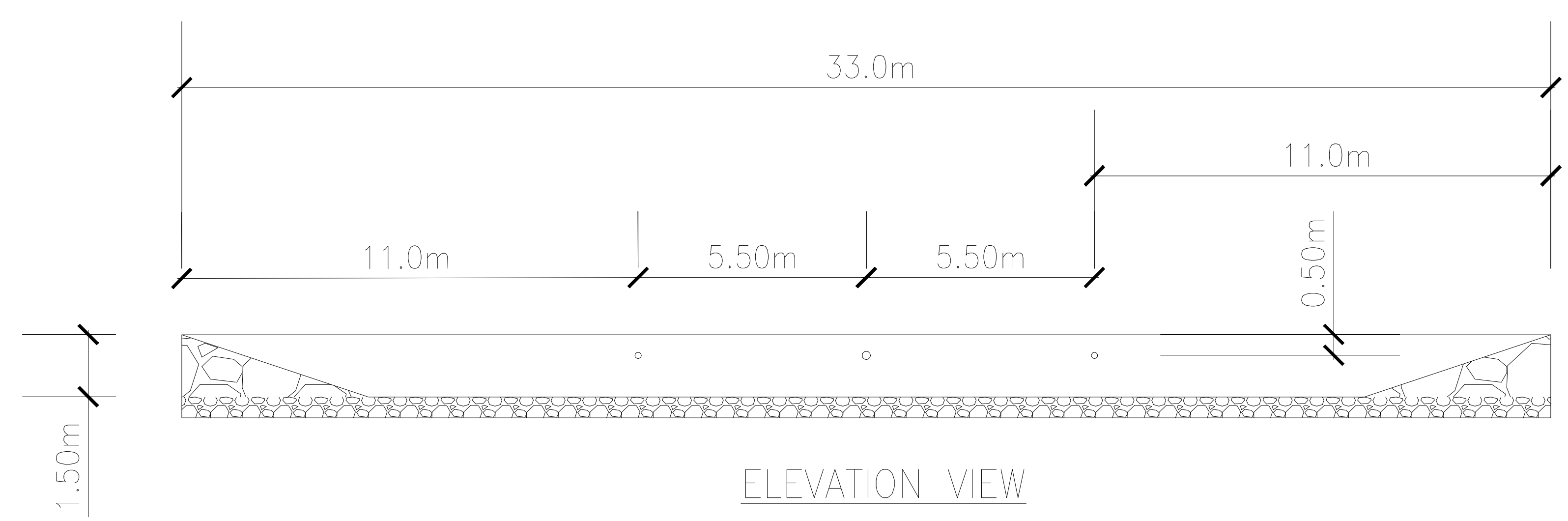


PIPE 1:
GRADE = 3%
D = 203.2 mm
LENGTH = VARIES

PIPE 2:
GRADE = 2%
D = 152.4 mm
LENGTH = VARIES



SECTION VIEW



ELEVATION VIEW

GROUP: 14

DATE
MAR. 13, 2024

CLASS: CIVL446 2023-24 W2
ASSIGNMENT NO. FINAL DESIGN
DESIGNED / DRAWN BY:
PLOT DATE: MARCH 13, 2024

ISSUES:

REV. NO	DATE	REASON
	MAR 13, 2024	POND DESIGN

REFERENCE DWGS: THIS DRAWING IS BASED ON:
PROJECT DOCUMENT PROVIDED BY CIVL445 FACULTY

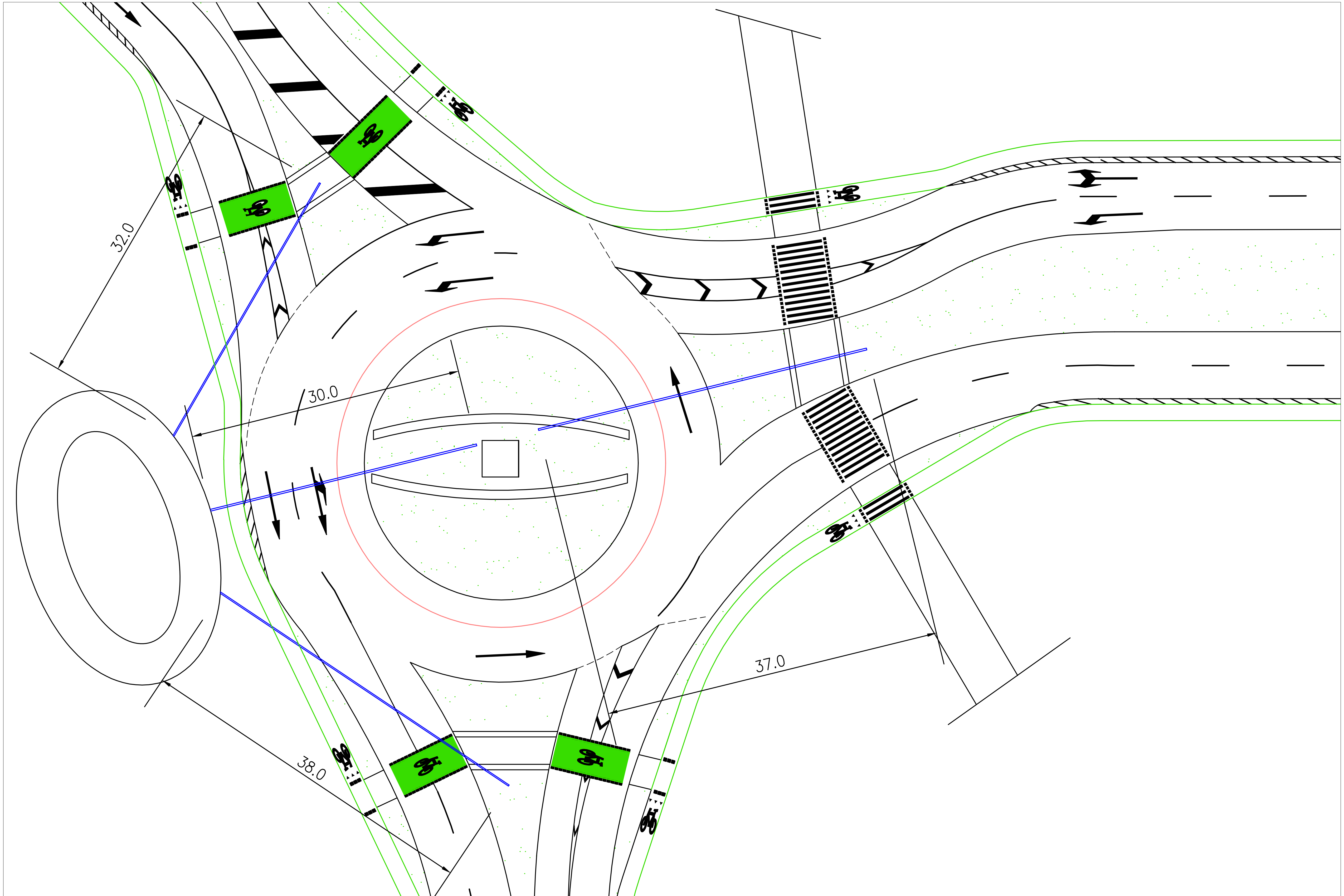
CLIENT:

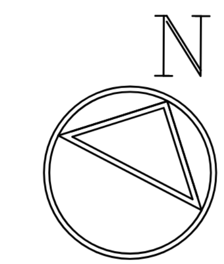
CONSULTANT:

PROJECT:
REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:
SECTION, ELEVATION, PLAN VIEW OF POND DESIGN

DWG NO.:
P1





GROUP: 14

CLASS CODE
CIVL 446

DATE
APR. 8, 2024

CLASS: CIVL446 2023-24 W2

ASSIGNMENT NO. FINAL DESIGN

DESIGNED / DRAWN BY: YC

PLOT DATE: APR. 8, 2024

ISSUES:

REV. NO	DATE	REASON
	APR. 8, 2024	DRAINAGE PLAN VIEW

REFERENCE DWGS: THIS DRAWING IS BASED ON:

PROJECT DOCUMENT PROVIDED BY CIVL445 FACULTY

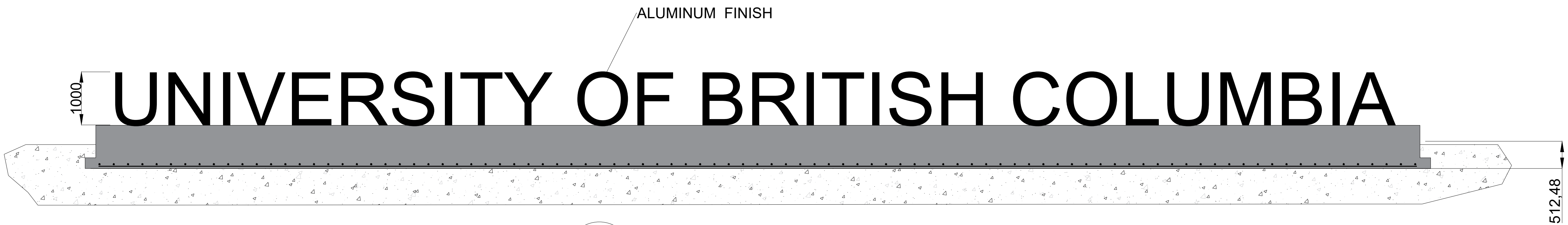
CLIENT:

CONSULTANT:

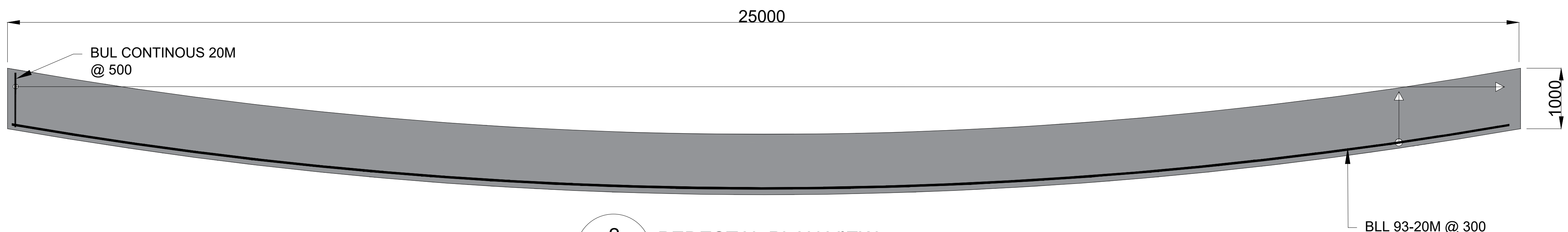
PROJECT:
REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:
PLAN VIEW OF DRAINAGE PIPES

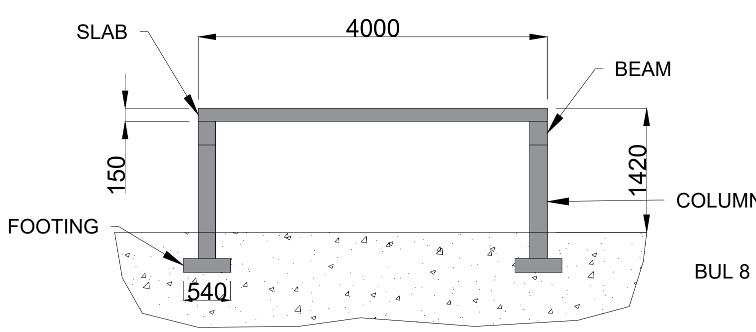
DWG NO.: P2



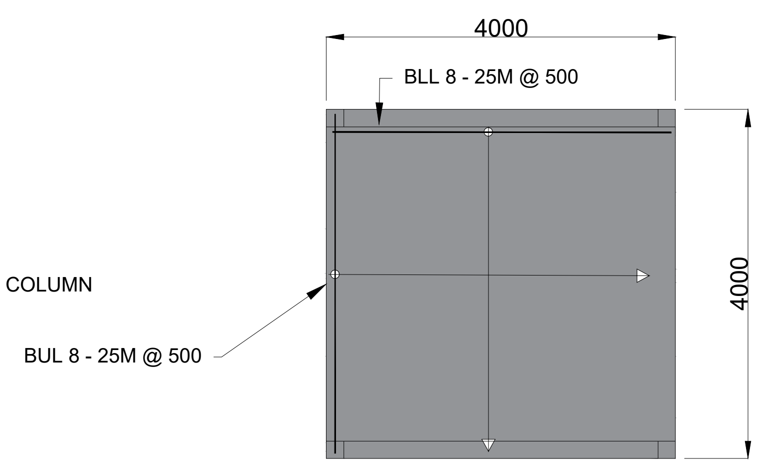
1
S.2
PEDESTAL ELEVATION VIEW
SCALE: 1:2000



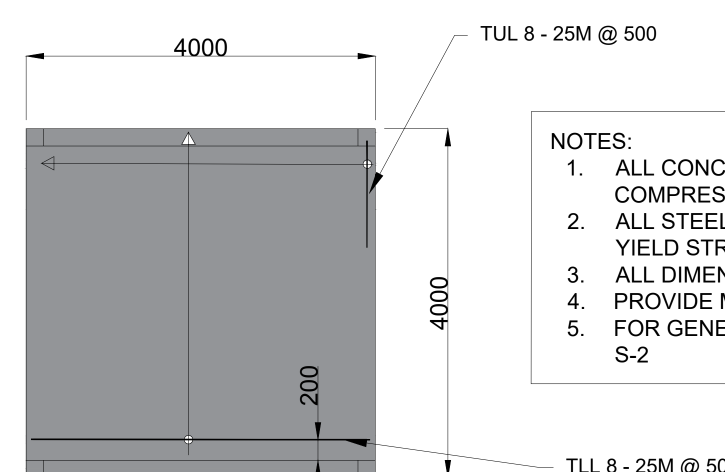
2
S.2
PEDESTAL PLAN VIEW
SCALE: 1:2000



3
S.2
FIRST NATION PLATFORM ELEVATION VIEW
SCALE: 1:2000



4
S.2
SLAB BOTTOM REINFORCEMENT LAYOUT
SCALE: 1:2000



5
S.2
SLAB TOP REINFORCEMENT LAYOUT
SCALE: 1:2000

NOTES:
1. ALL CONCRETE SHOWN WITH 28-DAY COMPRESSIVE STRENGTH OF 25MPa
2. ALL STEEL REINFORCEMENT BARS HAVE A YIELD STRENGTH OF 400MPa
3. ALL DIMENSIONS SHOWN IN MILLIMETERS
4. PROVIDE MINIMUM 30MM CLEAR COVER
5. FOR GENERAL NOTES AND TYPICAL DETAIL SEE S-2

DATE
APR. 02, 2024

ASSIGNMENT NO. DETAILED DESIGN
DESIGNED / DRAWN BY:
PLOT DATE: APR.02, 2024

ISSUES:

REV. NO	DATE	REASON
	APR. 02, 2024	DETAILED DESIGN

A. FOR CONSTRUCTION
B. DO NOT MEASURE FROM THIS DRAWING
C. REPORT ANY DISCREPANCIES TO THE DESIGNER

REFERENCE DWGS: THIS DRAWING IS BASED ON:
PROJECT DOCUMENT PROVIDED BY CIVL445 FACULTY

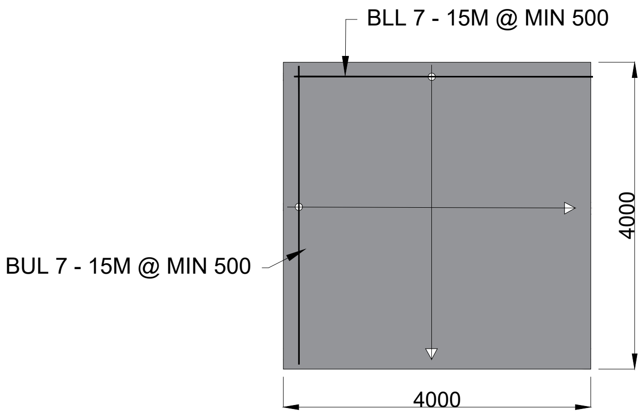
CLIENT:

CONSULTANT:

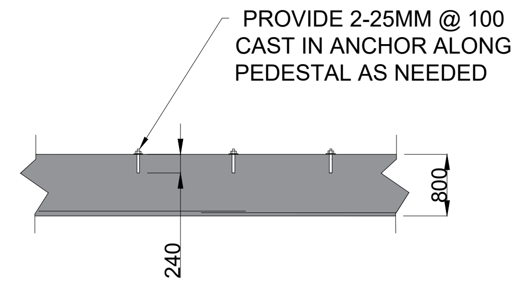
PROJECT:
REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:
Gateway Design

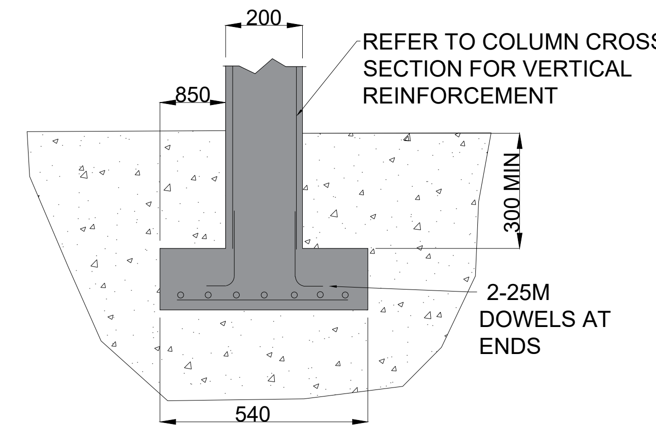
DWG NO.:
S1



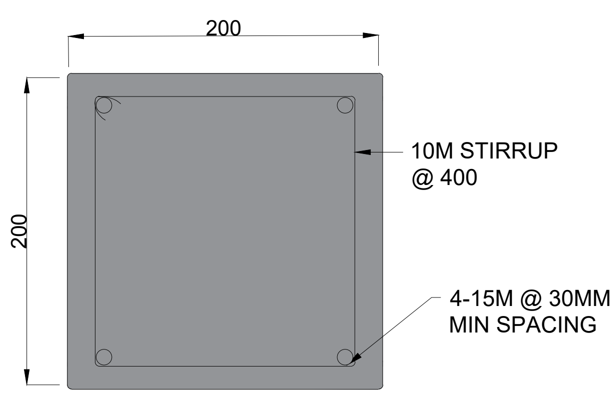
1 S.3 TYPICAL FOOTING REBAR LAYOUT
SCALE: 1:2500



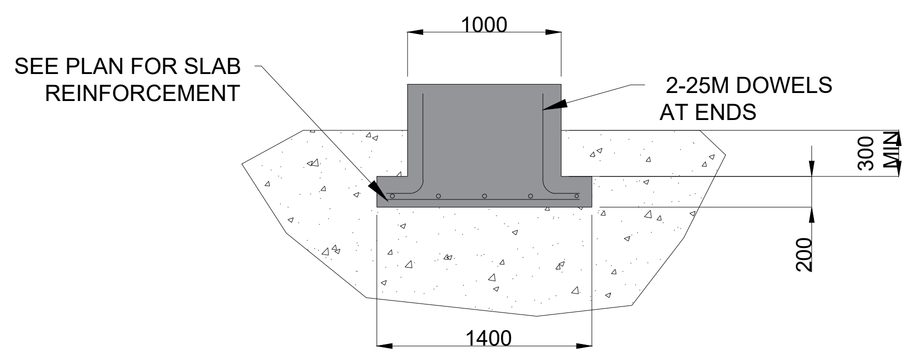
2 S.3 TYP. PEDESTAL CAST IN ANCHOR
SCALE: 1:2500



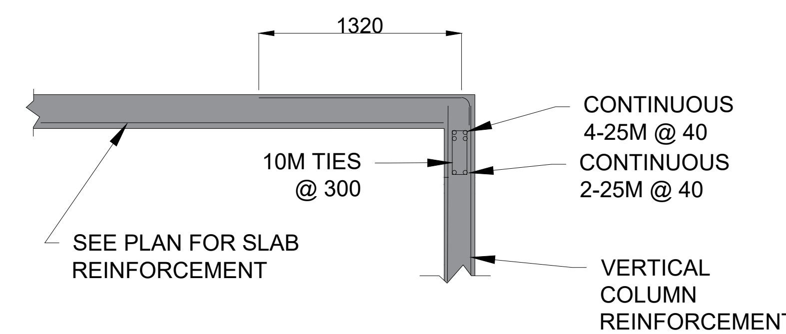
3 S.3 TYPICAL FOOTING VIEW
SCALE: 1:12500



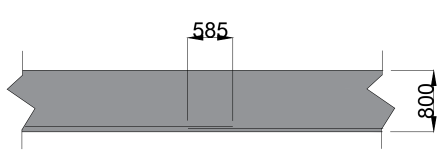
4 S.3 TYP. COLUMN CROSS SECTION
SCALE: 1:50000



5 S.3 PEDESTAL ELEVATION VIEW
SCALE: 1:5000



6 S.3 TYP. SLAB OVER COLUMN
SCALE: 1:5000



7 S.3 TYPICAL FOOTING LAPSPLICE
SCALE: 1:2500

NOTES:
1. ALL CONCRETE SHOWN WITH 28-DAY COMPRESSIVE STRENGTH OF 25MPa
2. ALL STEEL REINFORCEMENT BARS HAVE A YIELD STRENGTH OF 400MPa
3. ALL DIMENSIONS SHOWN IN MILLIMETERS
4. PROVIDE MINIMUM 30MM CLEAR COVER
5. FOR GENERAL NOTES AND TYPICAL DETAIL SEE S-2

ASSIGNMENT NO. DETAILED DESIGN
DESIGNED / DRAWN BY:
PLOT DATE: APR. 02, 2024

ISSUES:

REV. NO	DATE	REASON
	APR.02, 2024	DETAILED DESIGN

A. FOR CONSTRUCTION
B. DO NOT MEASURE FROM THIS DRAWING
C. REPORT ANY DISCREPANCIES TO THE DESIGNER

REFERENCE DWGS: THIS DRAWING IS BASED ON:
PROJECT DOCUMENT PROVIDED BY CIVL445 FACULTY

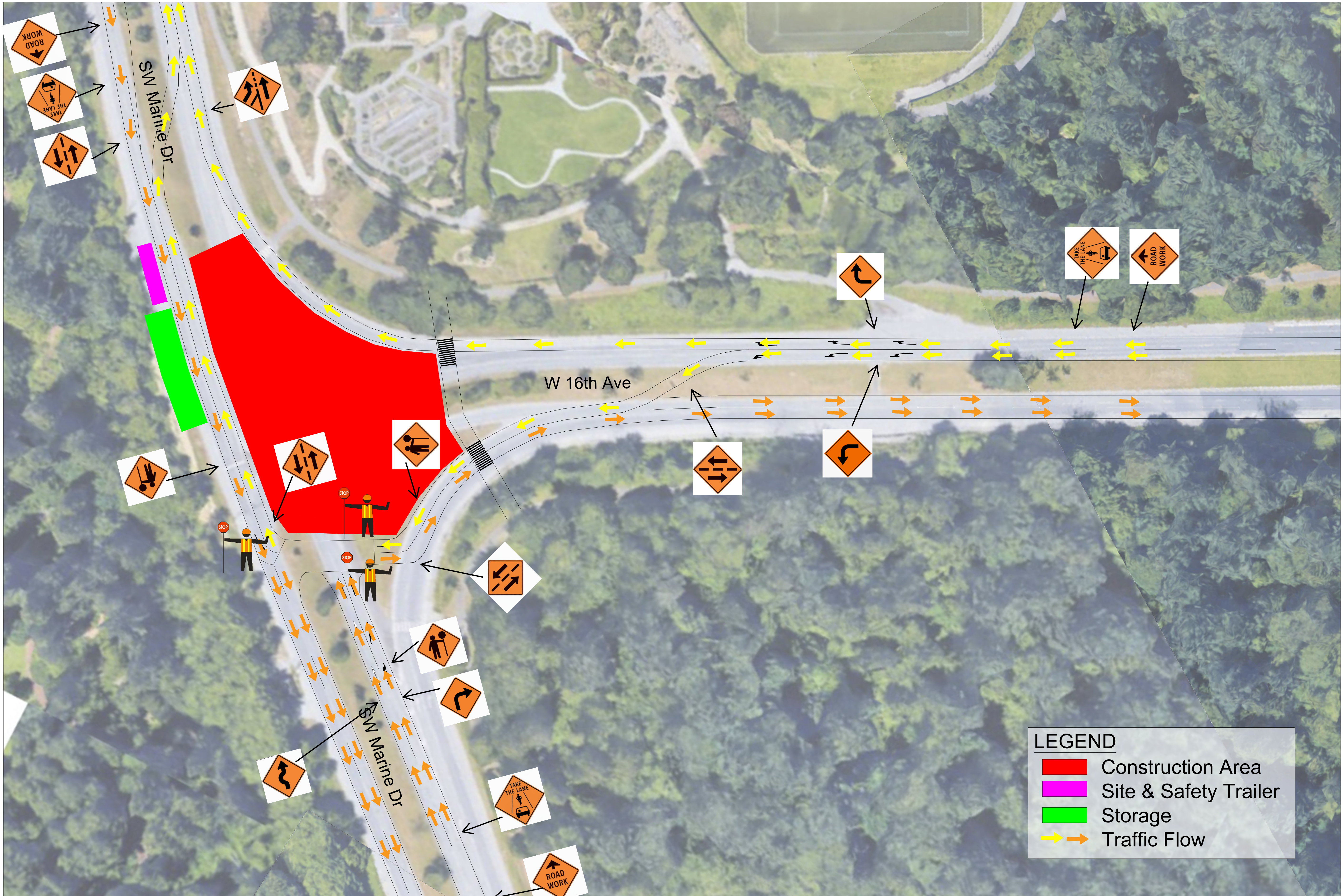
CLIENT:

CONSULTANT:

PROJECT:
REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:
TYPICAL DETAILS

DWG NO.: S2



DATE
APR 2, 2024

CLASS: CIVL446 2023-24 W2

ASSIGNMENT NO. DETAILED DESIGN

DESIGNED / DRAWN BY:

PLOT DATE: APR 2, 2024

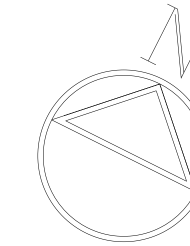
ISSUES:

REV. NO.	DATE	REASON
	APR. 2, 2024	DETAILED DESIGN

A. NOT FOR CONSTRUCTION
B. DO NOT MEASURE FROM THIS DRAWING
C. REPORT ANY DISCREPANCIES TO THE DESIGNER

REFERENCE DWGS: THIS DRAWING IS BASED ON:

PROJECT DOCUMENT PROVIDED BY CIVL446 FACULTY



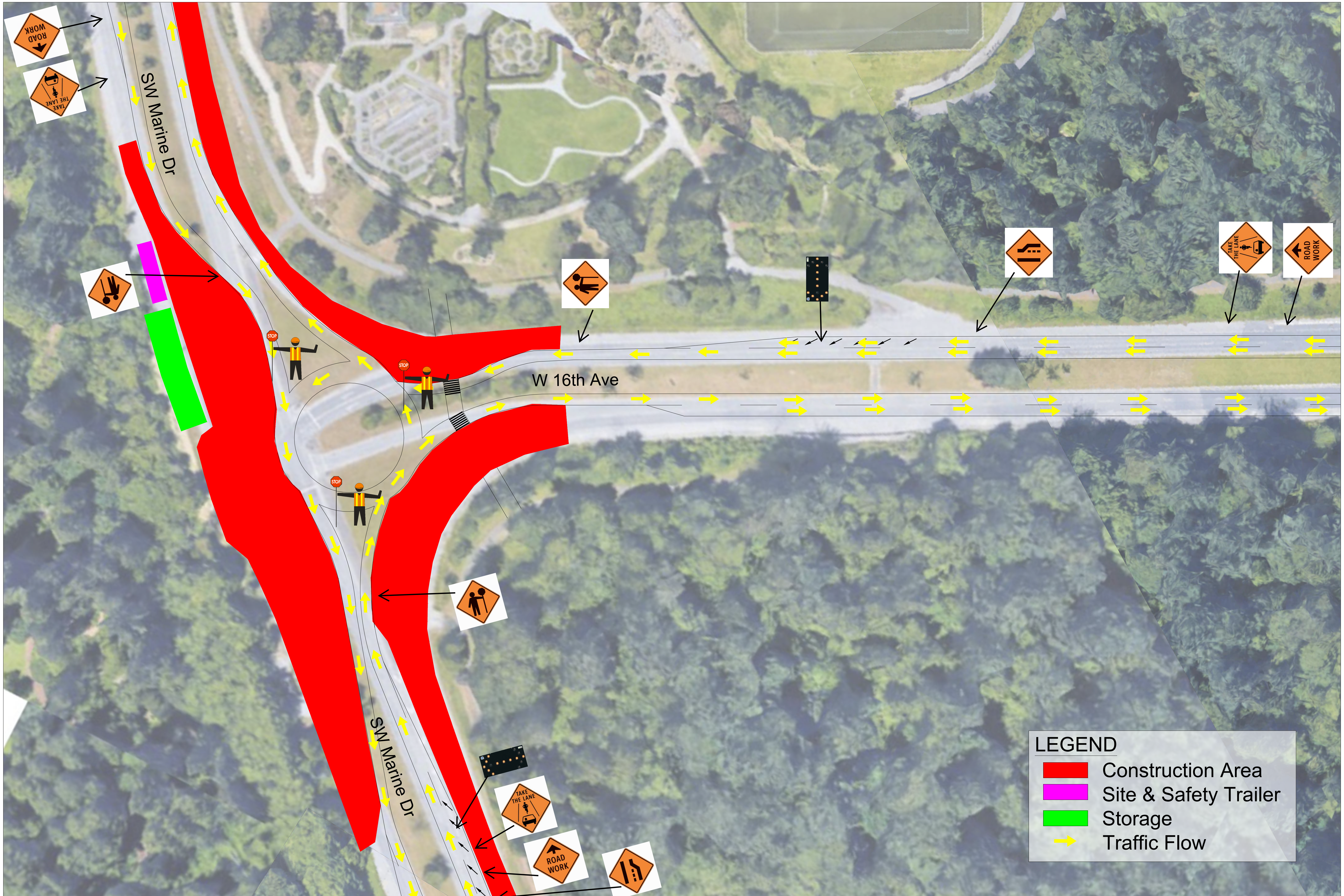
CLIENT:

CONSULTANT:

PROJECT:
REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:
TRAFFIC MANAGEMENT PLAN - PHASE 1

DWG NO.: M1



DATE
APR 2, 2024

CLASS: CIVL446 2023-24 W2

ASSIGNMENT NO. DETAILED DESIGN

DESIGNED / DRAWN BY:

PLOT DATE: APR 2, 2024

ISSUES:

REV. NO.	DATE	REASON
	APR. 2, 2024	DETAILED DESIGN

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REFERENCE DWGS: THIS DRAWING IS BASED ON:

PROJECT DOCUMENT PROVIDED BY CIVL446 FACULTY

N

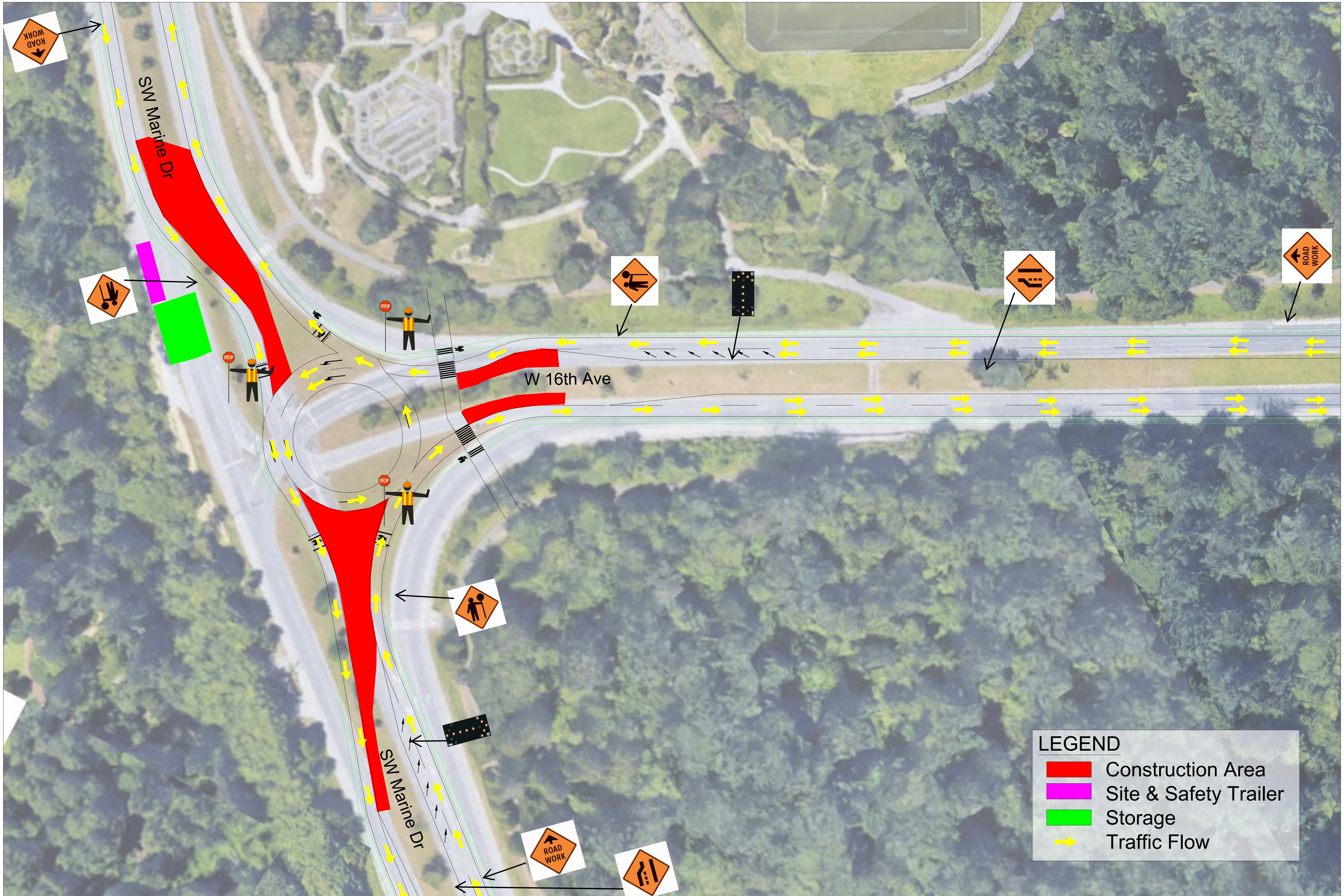
CLIENT:

CONSULTANT:

PROJECT:
REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:
TRAFFIC MANAGEMENT PLAN - PHASE 2

DWG NO.:
M2



DATE
APR 2, 2024

CLASS: CIVL446 2023-24 W2

ASSIGNMENT NO. DETAILED DESIGN

DESIGNED / DRAWN BY:

PLOT DATE: APR 2, 2024

ISSUES:

REV. NO.	DATE	REASON
	APR. 2, 2024	DETAILED DESIGN

A. NOT FOR CONSTRUCTION
B. DO NOT MEASURE FROM THIS DRAWING
C. REPORT ANY DISCREPANCIES TO THE DESIGNER

REFERENCE DWGS: THIS DRAWING IS BASED ON:

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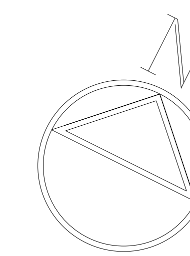


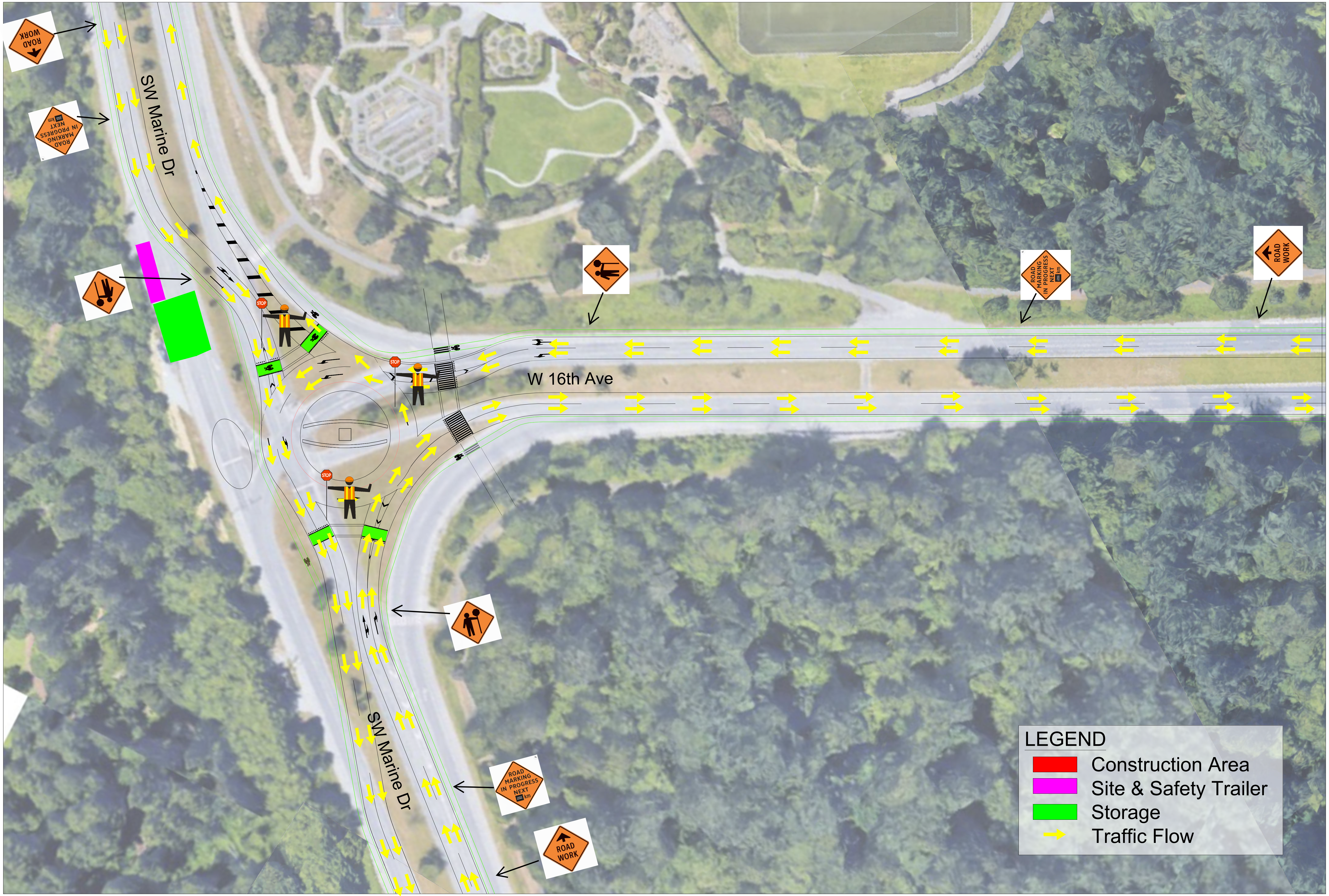
CLIENT:

CONSULTANT:

PROJECT:
REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:
TRAFFIC MANAGEMENT PLAN - PHASE 3

DWG NO.:
M3



DATE
APR 2, 2024

CLASS: CIVL446 2023-24 W2

ASSIGNMENT NO. DETAILED DESIGN

DESIGNED / DRAWN BY:

PLOT DATE: APR 2, 2024

ISSUES:

REV. NO	DATE	REASON
	APR. 2, 2024	DETAILED DESIGN

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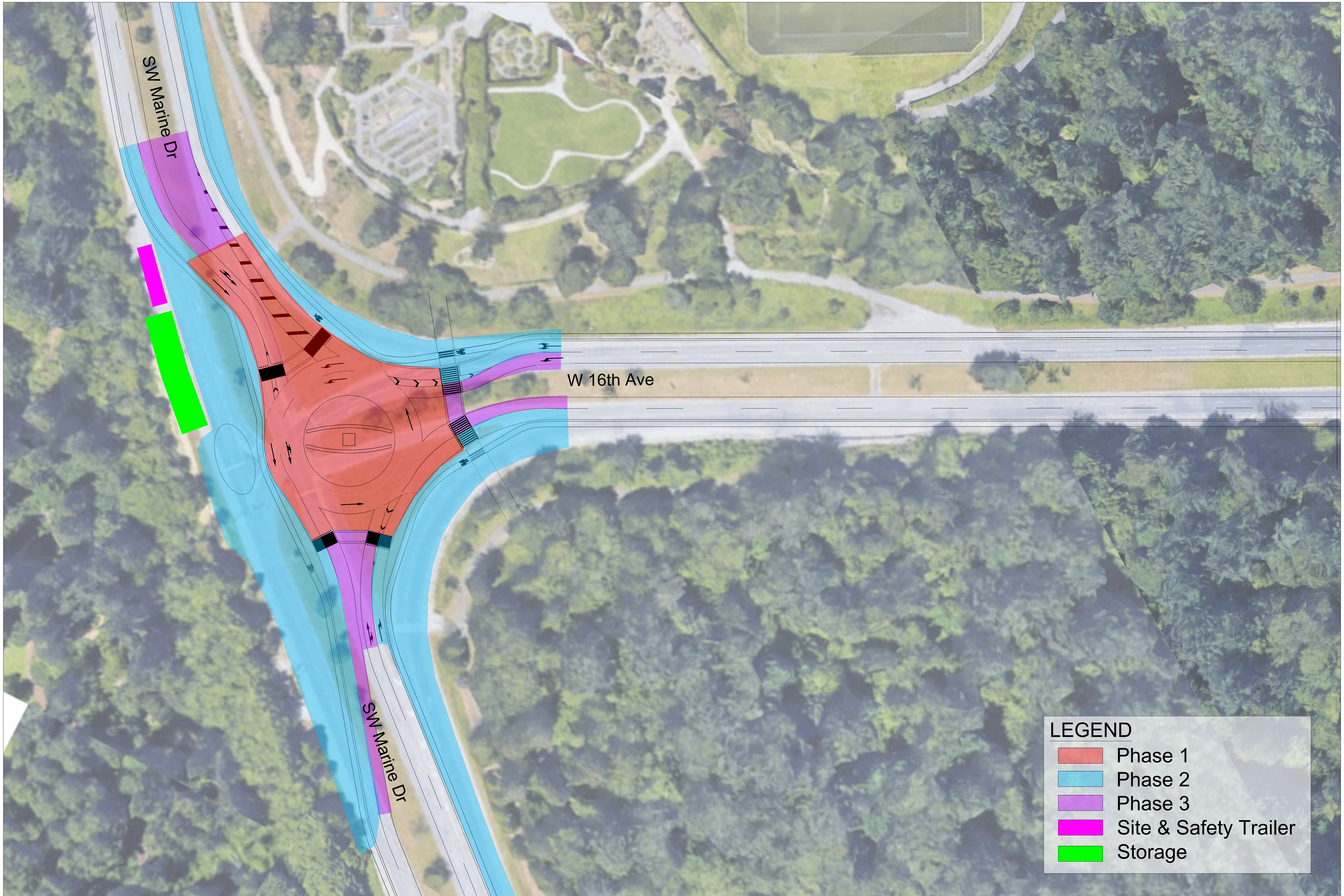
CONSULTANT:

PROJECT:
REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:
TRAFFIC MANAGEMENT PLAN - PHASE 4

DWG NO.:
M4



DATE
APR 2, 2024

CLASS: CIVL446 2023-24 W2

ASSIGNMENT NO. DETAILED DESIGN

DESIGNED / DRAWN BY: VH

PLOT DATE: APR 2, 2024

ISSUES:

REV. NO.	DATE	REASON
	APR. 2, 2024	DETAILED DESIGN

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REFERENCE DWGS: THIS DRAWING IS BASED ON:

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CLIENT:

CONSULTANT:

PROJECT:
REDESIGN OF 16th AVENUE/ SW MARINE DRIVE INTERSECTION

DRAWING TITLE:
CONSTRUCTION PHASE PLAN

DWG NO.:
M5