NW Marine Drive/Chancellor Boulevard/East Mall Intersection Redesign

Aaron Chen, Daniel Waine, Gerad van Agteren, Janet Jorgensen, Kanish Mathur, Pearl Ranchal

University of British Columbia

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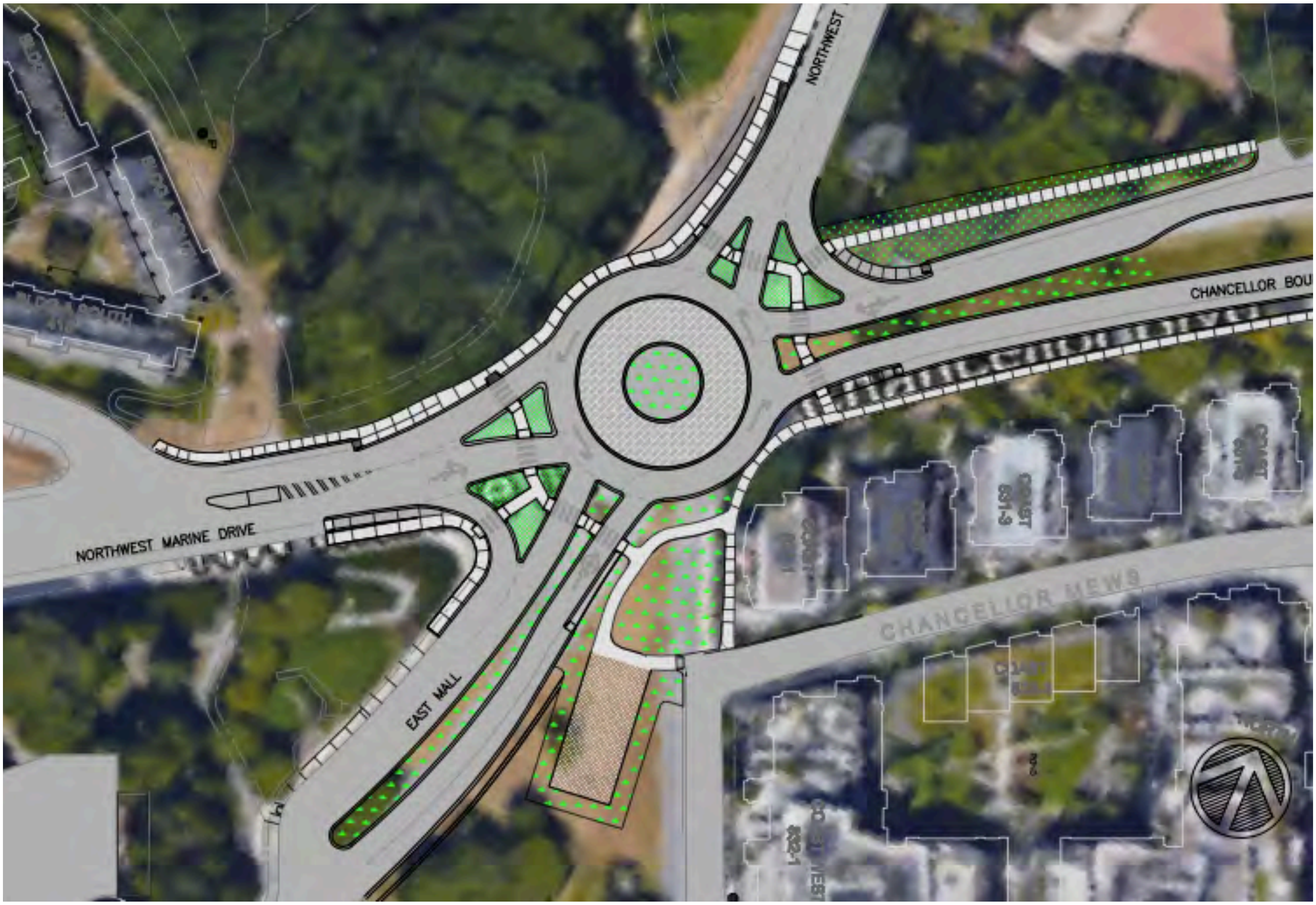

NW Marine Drive/Chancellor Boulevard/East Mall Intersection Redesign

Detailed Design Report

Client: UBC SEEDS Sustainability Program & UBC Campus and Community Planning

Proponent: Van Augustine Consultants (Team #5)

Aaron Chen
Daniel Waine
Gerad van Agteren
Janet Jorgensen
Kanish Mathur
Pearl Ranchal

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Executive Summary

Van Augustine Consultants proposes the construction of a single lane roundabout at the intersection of NW Marine Drive, East Mall, and Chancellor Boulevard in order to provide a safer alternative to the current non-standard intersection layout. The single lane roundabout increases user safety by reducing vehicle speeds, reducing the number of conflict areas, and decreasing potential collision angles to angles less than 90 degrees. The new design also creates less driver confusion, and promotes sustainability by better accommodating pedestrians and cyclists. Stormwater management was a major criteria and was considered in depth during the design phase. This report builds on the Detailed Design Summary Report and Presentation delivered to UBC Campus and Community Planning February 29, 2016.

A major development since the preliminary design phase was the proposal of a bike parking facility, the Bike Garden. This showcase gateway feature realizes UBC's mission for sustainability and commitment to alternative modes of transportation. This facility provides storage for 84 bikes north of Allard Hall. The Bike Garden is a steel frame structure featuring a green roof and integration with the newly proposed stormwater management system. An Issued for Tender Structural and envelope drawing set is included in the report.

In a stormwater management context, cliff erosion along the northern edge of the campus has been a major concern for UBC. Therefore, minimizing infiltration and controlling surface runoff were key design parameters. Specifically, the detailed stormwater management design provides a reduction in the volume of runoff by lowering the impervious-to-pervious area ratio through the addition of rain gardens and pervious pavers, and better collection of surface run-off by adding six new catch basins. Furthermore, the additional captured stormwater will be diverted through a Stormceptor Oil and Grit separator and to an 800m^3 underground stormwater detention facility allowing for attenuation and controlled release of stormwater to the minor system during high flow events. The project team has consulted with the Langley Concrete Group and Ibrium Systems for the sizing of the Stormceptor system to ensure water quality standards are sufficient to use captured stormwater for irrigation of the on-site landscaping, the bike garden green roof, and the Rose Garden. For the detailed design of the proposal, guidance was sought from the UBC 2015 Integrated Stormwater Management Plan and the Metro Vancouver 2012 Stormwater Source Control Guidelines.

The project (roundabout, Bike Garden, landscaping and drainage) is estimated to cost $1.59 million for a September 2016 delivery. In terms of construction staging, Bike Garden construction begins May 1st, 2016, and roadwork beings June 3rd, 2016. This staging avoids potential conflicts between roadwork and the traffic surges associated with the annual UBC graduation ceremonies hosted at Chan Centre situated to the immediate southwest of the subject intersection. Furthermore, the majority of all roadwork will be performed with comprehensive traffic management and only periodic detours and partial closures. The redesigned intersection will be commissioned in time for September 1st.

Van Augustine Consultants will continue to involve stakeholders in the final stages of design. Crossing agreement requests will be sent to utility providers and a meeting will be setup with Metro Vancouver to mitigate any right-of-way conflicts. The project team will also seek input on the construction staging plan from the stakeholders including nearby residents, intersection users, and nearby event facility managers. Their input will be essential in ensuring that the construction of the new roundabout will be efficient and user friendly. The engagement plan involves a public open house, an online feedback forum, and the creation of the project website with information and updates regarding the project.

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List of Abbreviations

BC	British Columbia
BCBC	British Columbia Building Code
CCC	Construction Completion Certificate
CSA	Canadian Standards Association
ESAL	Equivalent Single Axial Loading
FHWA	Federal Highway Association (for the United States)
IFC	Issued For Construction
IFT	Issue for Tender
ISMP	Integrated Stormwater Management Plan
MoTI	Ministry of Transportation and Infrastructure (for the Province of British Columbia)
MSU	Medium Single Unit Truck (refer to TAC Geometric Design Manual)
NBCC	National Building Code of Canada
NW	Northwest
RAP	Reclaimed Asphalt Pavement
TAC	Transportation Association of Canada
WB-19	Semitrailer Classification (refer to TAC Geometric Design Manual)
WB-21	Semitrailer Classification (refer to TAC Geometric Design Manual)
UBC	University of British Columbia

1.0 Introduction

Van Augustine Consultants has been retained by UBC Campus and Community Planning to redesign the NW Marine Drive, Chancellor Blvd. and East Mall Intersection. This report summarizes the detailed design of the intersection with the intent to provide details for UBC Campus and Community Planning and other stakeholders.

1.1 Project Objectives

Located at the north end of campus, the intersection sits at the confluence of UBC Campus, the University Endowment Lands and Pacific Spirit Park and serves as one of the five gateways to UBC's Point Grey Campus. The primary objective of this redesign project is to propose a safer and more efficient alternative to the current layout of the intersection. This redesign aims to better accommodate all elements of the traffic spectrum including heavy vehicles, bikes and pedestrians while aligning the intersection space with UBC's sustainability and transportation goals.

1.2 Project Scope

As mentioned earlier, the current non-standard configuration of the intersection results in inefficient and unsafe operation during peak periods. This detailed design report builds on the results and feedback from the NW Marine Drive / Chancellor Boulevard / East Mall Intersection Redesign Detailed Design Summary Report from February 2016, and covers the scope of work outlined below:

- Gather, review and forecast existing site and traffic data.
- Model existing site and traffic conditions to test prospective intersection configurations, control types, and orientations.
- Select and develop the best-suited intersection design using the client-submitted design criteria.
- Develop a detailed design roadway concept that offers operational improvements to the existing intersection and features the intersection as a gateway to UBC's Point Grey Campus.
- Deliver the Bike Garden's structural design complete with the green roof, and in accordance with CSA A23.3-14 and CSA S16-14.
- Prepare a stakeholder engagement and communication plan.
- Prepare detailed cost and construction schedules with a construction start date of May 1, 2016.
- Prepare a set of issued-for-tender design drawings complete with sections, plans, elevations, and details for the roadwork, the associated pavement structure, and the Bike Garden.

1.3 Report Organization

The layout of this report follows the key stages in the design process. It begins with a clear outline of the existing site conditions and identifies key considerations addressed in the design process. The next section outlines design criteria and lists the design standards reinvent to the intersection design. Section 4 summarized work completed in the conceptual and preliminary design phases and the recommendations put fourth in the Preliminary Design Report.

Section 5, highlights key elements of the roadway design that were refined during th detailed design process. A key feature of the proposed roundabout is an integrated stormwater management system outlined in Section 6. The stormwater system ties the roadway and the gateway feature together into the underground stormwater storage tank. The gateway feature, the Bike Garden, is described in Section 7, which includes details on architecture considerations and structural design.

Section eight covers the construction planning efforts that assure the project is ready for a May 1, 2016 Start Date. Included in this section is a detailed construction schedule, construction phasing plan, pre-tender cost estimate, risk assessment and stakeholder engagement strategy. The report's final section provides a summary of the key project elements and outlines final revision process that will lead to the issue of the project tender.

A set of construction drawing have been prepared for review prior to the issue of tender April 11, 2016. A list of drawings is included below; the full drawing package can be found in Appendix A. Additional design detailed and supporting information in provided in Appendix B through J.

Issue for Tender Drawing Set (Refer to Appendix A)

A0	Plan Rendering
A1	Traffic and Signing
A2	Geometric Design
A3.1	Existing Storm System
A3.2	Proposed Storm Water Management Plan
A4	IP Ratio
A5	Phase 3: Removals and Detour Road Construction
A6	Phase 4: South Chancellor BLVD Construction
A7	Phase 5: East Mall Construction
A8	Phase 6: NE Marine Drive Construction
A9	Phase 7 Roundabout Construction
A10	Phase8: North Chancellor BLVD and East Mall Construction
A11	Roadway Sections
S0	UBC Bike Garden 3D View
S1	UBC Bike Garden Ground Floor
S2	UBC Bike Garden Roof Framing
S3	UBC Bike Garden West Elevation
D1	Roof Assembly 1
D2	Roof Assembly 2
D3	Wall Assembly 1
D4	Asphalt Assemblies
D5	Rain Garden Details

1.4 Team Contributions To Detailed Design

The following table summarizes the contributions of each team member to development of the detailed design and the compilation of this report. Contributions are organized by report sections and identify primary and secondary contributors as well and reviewer roles.. Separate categories have been included for drafting as a considerable amount of time and effort was dedicated to this task.

Table 1:Project Team Contributions to Detailed Design

Report Component	Primary Contributor	Secondary Contributor	Reviewer
Executive Summary	DW	PR	JJ
1.0 Introduction	KM	GVA	DW
2.0 Existing Conditions	PR	JJ	GVA
3.0 Design Criteria	GVA	JJ	PR
4.0 Preliminary Design Recommendations	KM	DW	JJ
5.0 Roadway Design	GVA	JJ	PR
6.0 Stormwater Design	JJ	AC	GVA
7.0 Gateway Feature	DW	KM	GVA
8.0 Construction Planning	PR	GVA	JJ
9.0 Closing	JJ	PR	KM
Design / Project Element	**Primary Contributor**	**Secondary Contributor**	**Reviewer**
Roadway Design – Geometric Layout	GVA	DW	KM
Roadway Design – Pavement Structure	GVA	DW	KM
Pedestrian/Cycling Facilities + Signage	GVA	JJ	PR
Stormwater Design – Overland Flow	JJ	PR	GVA
Stormwater Design – Minor System Upgrades	JJ	AC	GVA
Stormwater Design – Rain Gardens	JJ	PR	GVA
Bike Garden – Structural Design	KM/DW	GVA	PR
Bike Garden – Envelope + Green Roof	GVA	KM/DW	JJ
Roadway Design Drawings & Drafting	GVA	JJ	DW
Gateway Feature Drawings & Rendering	KM/DW	GVA	PR
Quantities and Cost Estimate	PR	KM	JJ
Construction Schedule & Staging	JJ	GVA	DW
Stakeholder Engagement Strategy	JJ	DW	KM
Risk Assessment	PR	KM	DW
Report Compilation	PR	KM	All

2.0 Existing Conditions and Design Constraints

Located at the north end of campus, the intersection sits at the confluence of UBC Campus, the University Endowment Lands and Pacific Spirit Park as shown in Figure 1. Figure 2 identifies adjacent landowners and facilities including the Chan Centre of Preforming Arts, Allard Hall Law School, Chancellor Place University Neighborhood and University Endowment Lands and Metro Vancouver as the owner of Pacific Spirit Park. The intersection itself is maintained and operated by BC Ministry of Transportation Infrastructure (MoTI). This section provides an overview of the site features relevant to the intersection redesign.

Figure 1: Land Ownership near Project Intersection (UBC, 2012)

Figure 2: Aerial View if Exiting Intersection (Image Source: Google Maps)

2.1 Transportation Infrastructure

The intersection in question is at the north end of campus, at the end of East Mall. Chancellor Boulevard begins at the intersection and heads east, NW Marine approaches from the west and turns north. The east-west roads have right of way, and the north-south roads are controlled by stop signs. The intersection slopes down south to north, and is relatively flat east to west. Key aspects of the roadway network are described below:

- **Roadway Classification**: the through route on NW Marine Dr. and Chancellor Blvd. as a community shuttle route; the western leg of NW Marine Dr. as a collector road; and both the northern leg of NW Marine Dr. and Chancellor Blvd. as arterial roads with bike traffic (UBC, 2014).
- **Cycling Facilities:** Bike lanes are clearly marked for bike traffic in all direction for roads east, west, and south of the subject intersection. However, no separate bike lane is provided along either direction of the northern leg of NW Marine Dr.
- **Pedestrian Facilities:** A pedestrian crosswalk across Chancellor Blvd. is situated to the immediate east of the intersection. For the western leg of Marine Dr, and East Mall, pedestrian crosswalks are moved 60m and 80m away from the intersection, respectively. No crosswalk is present across the northern part of NW Marine Dr.
- **Transit**: Two transit stops, one for either direction, are present west of the intersection along NW Marine Dr. These two stops are the only transit access stops present within a 400m radius of the intersection and are part of Tranlink’s community shuttle route.
- **Emergency Vehicle Access**: An emergency vehicle access point is along westbound NW Marine drive on the West side of the intersection.

2.2 Utilities

The high density of utilities present at the intersection is an important design consideration. Figure 3 below proves a schematic of the existing utilities present of the intersection. The deep and shallow utilities present within the project boundary are summarized below.

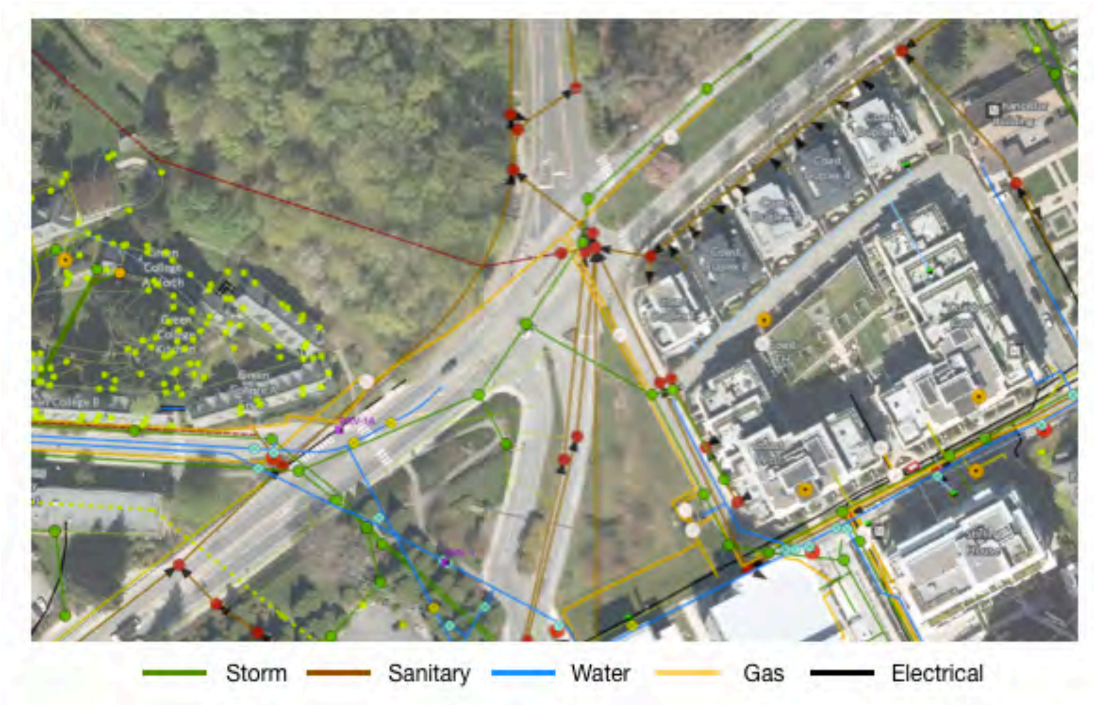


Figure 3: Exiting Utilities
(Image Source: Krista Falkner, 2015)

- **Deep Utilities:** Several sanitary lines converge at the center of the intersection. A storm main zigzags across the intersection connecting a series of manholes and several small feeder lines. Each of these two utilities are connected through a large number of manholes across the project site. Two water mains are present to on the west side of the project site but are unlikely to impact the project.

- **Shallow Utilities**: There are several streetlights of varying decorative standards lining the streets on the three sides of the intersection while the northern alignment of NW Marine Drive does not have street lighting. Two gas lines, one along either shoulder, are embedded along Cecil Green Park Rd. to the south west of the intersection. These lines are fed by a line buried along the western shoulder of Iona Drive. Two power and electrical ducts are installed south of the East Mall pedestrian crosswalk. Additionally, a small portion of the sidewalk along the northern shoulder of NW Marine Dr.'s western alignment.

2.3 Key Design Constraints

The existing, non-standard intersection configuration and surrounding project area presents a number of issues and constraints that have been addressed through the design process. Key site constraints and design considerations are summarized below and identified in Figure 4. Specific site details documented through site visits are included in Appendix B for further reference.

- Shifts in horizontal alignment across the intersection and skewed approaches on the north and south sides of the intersection,
- Insufficient connectivity of pedestrian facilities,
- Excessive signage and an unconventional centre median that are inconsistent with user expectation,
- Surface drainage and ponding on the north curb alignment observed during site visits,
- Bus stops and emergency vehicle access points that need to be accommodated throughout construction.
- A lager number of landowners and university facilities and stakeholders to engage throughout design and construction processes.

Figure 4: Key Site Constraints and Design Considerations

3.0 Design Criteria

Throughout the conceptual, preliminary and detailed design phases; the project team has worked to address these key site concerns by evaluating all design decisions using a comprehensive set of design criteria. This section includes a brief overview of each design criteria category as well summary design guidelines and regulatory considerations relevant to the project.

3.1 Design Criteria

Using objectives outlined in the RFP, as well as the goals and targets outlined in the 2014 Transportation Plan, UBC Campus Plan, and UBC Land Use Plan, the project team has established a comprehensive set of design criteria. These criteria have been organized into three broad categories: safety, operational efficiency and sustainability as shown below in Table 2. A comprehensive list of design criteria can be found in the Preliminary Design Report.

Table 2: Design Criteria

Safety	Operational Efficiency	Sustainability: Tipple Bottom Line
• Collision points and severity • Intersection sight distance • Signage • Lighting • Emergency Access	• Synchro Outputs: v/c ratio, LOS, Delay and Queue Length • Accommodation of event volumes • Accommodation of cyclists, pedestrians and transit	• Social: Gateway Feature, Traffic Noise, protection of pedestrian core, constructability • Economic: Capital costs, life cycle cost, risk/uncertainty • Environmental: change in impervious area, stormwater management, and alignment with UBC planning objectives.

Typically, Van Augustine Consultants would recommend that the design criteria be developed in consultation with UBC Campus and Community Planning and targeted stakeholder groups. However, schedule constraints and project limitations did not permit such engagement at the design development stage. As extensive stakeholder engagement was completed as part of the 2014 UBC Transpiration Plan and the construction of the 16^{th} Avenue Westbrook Mall roundabout. Stakeholder reports from the 16^{th} Avenue Roundabout construction and targets and goals outlined in UBC planning documents were assumed to represent stakeholder interests and used to inform the priority weighting in the evaluation of the intersection.

3.2 Regulatory Considerations and Design Standards

UBC Planning Documents including the UBC 20-Year Sustainability Strategy (2015), UBC Campus Plan (2012) and the UBC Transportation Plan (2014) have been foundational to the design development process. Key documents that have been used to establish technical design criteria and minimum design standards for specific design elements are included below:

Roadway Design

- Transportation Association of Canada (TAC) Geometric Design Guidelines (1999)
- BC Ministry of Transportation Supplement to TAC Geometric Design Guidelines (2007)
- Kansas Roundabout Design Manual (2014)
- MoTI Manual of Standard Traffic Signs and Pavement Markings (2000)
- MoTI Pavement Strucutre Design Guidelines (2015)
- As requested by UBC, all intersection movements were designed to accommodate a WB-17 design vehicle with through movements along Chancellor Blvd and NW Marine Drive able to accommodate a WB-20 design vehicle.

Stormwater Design

- DFO Canada Urban Stormwater Management Guidelines and Best Practices, (2001)
- BC Stormwater Management Guidebook (2002)
- Metro Vancouver Stormwater Source Control Guideline (2012)
- UBC Integrated Stormwater Management Plan (2015)

Structural Design

- National Building Code of Canada (2010)
- British Columbia Building Code (2012)
- CSA A 23.3-14 Design of Concrete Structures (2014)
- CSA S16-09 Steel Design Handbook – 10th Edition (2009)
- CSA S136-12 North American Specification for the Design of Cold-Formed Steel Structural Members

As a retrofit project where design standards for new construction could not be met, emphasis was placed on demonstrating an improvement in safety and performance over the existing condition.

4.0 Preliminary Design Recommendations

During the conceptual design phase, the Project Team considered three intersection options. These designs were evaluated against the design criteria and a single lane roundabout was selected as a preferred option. The preliminary design phase largely focused on developing the geometric configuration of the roundabout to optimize the operational efficiency and safety design criteria. This section summarizes the options considered, key aspects of the early design development and justification for the proposed design. A detailed account of the preliminary design decisions can be found in the Preliminary Design Report submitted to the UBC SEEDs Sustainability Program on December 4, 2015.

4.1 Traffic Forecasting

Design traffic volumes for the 2030 horizon were generated by augmenting the client-supplied traffic counts with the campus growth projections identified in the UBC 2014 Transportation Plan and data from UBC Transportation Status Reports. A summary historical transportation trends to and from UBC Campus and the forecasted percent change in intersection volumes at the project intersection between 2014 and 2030 is provided in Figure 5 and Table 3 respectively.

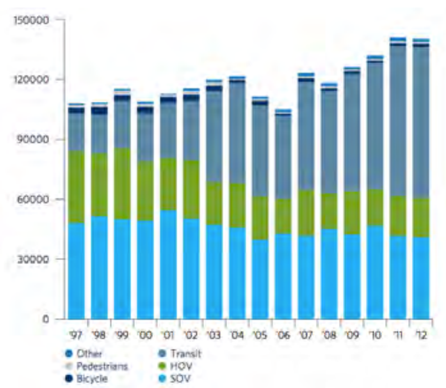


Figure 5 Daily Person Trips to UBC 1997-2012 (UBC, 2014)

Table 3: Projected Change in Intersection Volumes 2014 - 2030

Mode Choice	Percent Change 2014 - 2030
SOV	-14%
Heavy Vehicles	38%
Bikes	-37%
Pedestrians	-27%

As the subject intersection provides thoroughfare for the Chan Centre and the Museum of Anthropology (MOA), additional trips were generated and distributed around the intersection to account for attendance at events held at both facilities. This produced an additional 473 passenger moving through the intersection in the east-west direction and an additional 53 passenger cars accessing the event facilities via the North Leg of NW Marine Drive. Event volumes both arriving and leaving the campus were modeled in conjunction with p.m. peak hour traffic to ensure the proposed intersection configurations are able to accommodate higher than normal traffic volumes both during and outside of peak hour traffic.

4.2 Intersection Options and Evaluation

Three intersection concepts were developed to address the safety and operational efficiency issues at the intersection. As required by BC Ministry of Transportation, a roundabout was considered as a first option. Two convention intersection configurations were also developed. Each conventional layout offered options for either signal or two-way stop controls with restrictions to intersections movements where required to ensure safety. Figures of each conceptual design option are included in Appendix C.

The a.m. and p.m. peak hour operating conditions at the intersection were modeled using the Synchro software package based on the methodology outlined in the Transportation Research Board Highway Capacity Manual. The existing intersection configuration and each proposed configuration was assessed based on the level of operating service (LOS), volume to capacity ratio (v/c), average vehicle delay and 95th percentile queue length. These assessments were performed for current traffic volumes, design volumes at the 2030 horizon year, and also under event volume spikes. Detailed outputs from the traffic analysis can be found in the Preliminary Design Report.

In order to numerically and objectively evaluate the design options a Multi-Criteria Decision Matrix (MCDM) was implemented. This process allows for an objective and logical approach to the determination of a recommendation. The design criteria were evaluated by weighing and normalizing the assigned scores for each criterion. Evaluation results were normalized at two levels, within each design criteria category, and again between categories based on both the priority assigned to each individual criterion and to the criteria categories. Table 4 summarizes the evaluation results based the overall design criteria categories. A more detailed explanation the design evaluation can be found in the Preliminary Design Report.

Table 4: Multi-Criteria Decision Matrix Results

Criteria Category	Priority	Option 1	Option 2	Option 3
Safety	5.00	8.9	6.6	7.7
Operational Efficiency	3.50	9.1	6.7	7.7
Sustainability	1.50	7.3	8.5	7.4
Total	10	8.7	6.9	7.7

4.3 Recommendations

Based on the results of the MCDM, a single lane roundabout (option 1) configuration was recommended. The key design features of the proposed preliminary design are summarized below:

Safety benefits include:

- Forced reduction in speed upon approach giving drivers more time to react and avoid potential conflicts with other vehicles, bikers, and pedestrians.
- A reduction in the number of potential conflict points between vehicles, bikes, and pedestrians and the elimination of more severe head-on and T-bone types of collisions.
- Shorter crossing distances and reduce crossing delays which intern reduces the number of illegal pedestrian crossings.

Operational efficiency benefits include:

- Reduced traffic delays and queue lengths. Traffic models indicate that a single lane roundabout provides equivalent or improved LOS under peak hour and event traffic demands.
- Increased capacity. The roundabout significantly outperformed the conventional intersection options under higher event volumes in the Syncro traffic models

Sustainability features include:

- Increased in total pervious area due to narrower lanes and opportunities to use permeable paving stones at the truck apron.
- Reduced noise and emissions due to lever speeds, less idling and less instances where vehicles will be required to accelerate from a stopped position.
- The added pervious area around the roundabout creates opportunities to use landscaping features for a natural systems approach to stormwater management.

The key detailed design features summarized in the remaining sections of this report build on the design features identified above. They focus on optimizing the intersection layout with emphasis on promoting safety, efficiently and sustainability while advancing the design elements to the tender ready stage.

5.0 Roadway Design

Building on the geometric initial layout established in the preliminary design phase, elements of the overall roadway layout have been finalized to a tender ready stage. Conformance to UBC's goals regarding the corridor has been maintained and the final curb and asphalt layout details have been measured against all criteria developed in earlier design stages. This criterion includes the fundamental elements discussed in the preliminary design: optimization of safety, operational efficiently and sustainability features of the intersection. The categories critical to the road design are described in the following section and include the roundabout geometry, pedestrian and cyclist connectivity, roadway material selection, grading requirements for the roadway profile and utility coordination. A high level image of the new layout, updated from the preliminary design, has been included below in Figure 6.

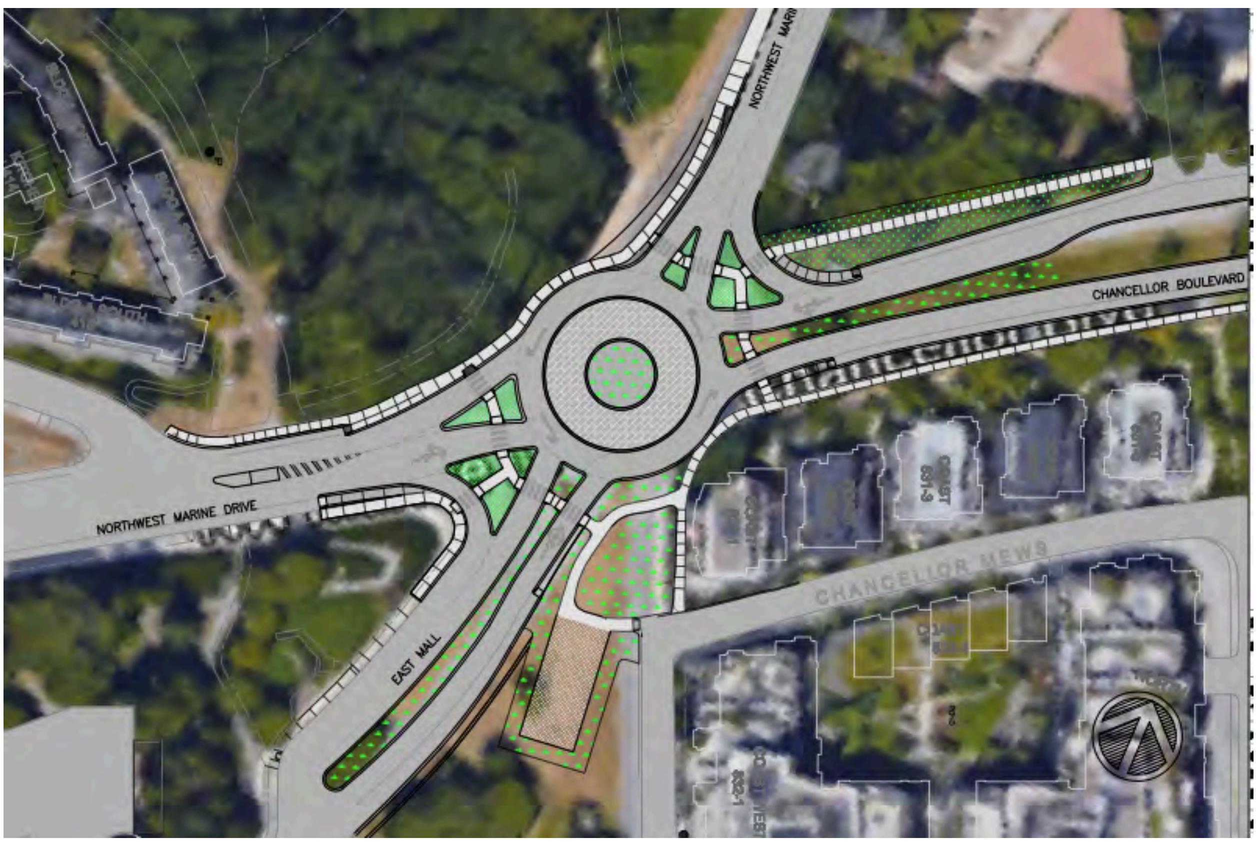


Figure 6: Proposed Intersection Layout

5.1 Geometric Design

During the detailed design, curb and lane positions were finalized based on the parameters defined in the preliminary design. These parameters not only maximize the capacity and the safety of the proposed design, but also implement the ideal geometric layout. The proposed geometric configuration encourages drivers to enter and circulate the roundabout at controlled speeds. Such controlled traffic movement maintains a desirable level of safety around the intersection without compromising its operational efficiency.

Like the safety requirements, the operational efficiency requirements determined in the earlier design stages have also been maintained in the final layout. This is a critical aspect of the design because while the reduced speeds boost safety, they also have the potential to compromise the efficiency of traffic flow. Thus, to maintain unobstructed flow, optimum parameters for roundabout size and position, ideal vehicle turn path and fastest path were computed in the preliminary design and have now been implemented in detail as outlined in the final geometric layout. Further to this, the final version of the curb layout, proposed as part of the detailed design, has been reviewed for compliance with the three criteria noted above. The final design parameters are summarized in the table below.

Table 5: Geometric Design Summary

Design Parameter	Roundabout Element	Dimension
Size and Position Optimization	Inscribed Circle Diameter	37 m
Turn Path Analysis	Truck Apron Diameter	26 m
	Raised Central Island Diameter	6.4 m
	Circulatory Lane Width	4.6 m
Fastest Path Analysis	Approach Lane Width	3.7 m
	Entry Defection Radii	30m – 60m
	Exit Defection Radii	60m – 90m
	Approach Speed	50 km/hr
	Circulatory Speed	30 km/h
Curb and Gutter	Inner Roundabout Curb	200mm Standard C&G
	Truck Apron Curb	Roll Face C&G
	Approach and Median Curbs	200mm Standard C&G
Pedestrian & Cycling Facilities	Bike Lane Width	1.5 m
	Sidewalk/Pathway Width	2.0 m
	Crosswalks	3.0 m

5.2 Survey Layout and Site Profile

Survey points indicating the exact positions of the curbs at each critical road curve location are shown on Drawing A2 in Appendix A. Worth noting is that the survey points reference the original datum of the site determined from the original CAD layout and will be used for construction layout survey. The contractor will be required to complete a detailed site survey prior to the commencement of the roadway construction to confirm the proposed pavement tie-in points and final grade elevations. Cross-sections of both east-west and north-south directions of the roundabout are provided in Drawing A11 Appendix A. The pre-construction site survey noted above will also confirm the vertical alignment of the proposed cross-sections. In addition, the topographical information from the said survey will help confirm that the proposed design does not alter the existing drainage pattern undesirably.

5.3 Pedestrian and Cycling Connectivity

An emphasis on pedestrians and cyclists in the development of the overall intersection design has been maintained throughout the preliminary and detailed design phases. This objective was addressed in the geometric design by reducing the speed of vehicles circulating the roundabout, creating a safer crossing environment for both pedestrians and cyclists. Additional features that promote pedestrian and cycling connectivity and safety are shown on Drawing A1 in Appendix A and are summarized below:

- **Pedestrian Treatments*:*** Pedestrian crossings have been accommodated on all sides of the intersection, oriented perpendicular to the lanes to minimize crossing distances. The final layouts of the crosswalks include ramps indicated at all required locations to accommodate wheelchairs. The final positions of the crosswalks were determined based on an optimized layout to reduce travel time and the potential for jaywalking.

- **Acoustic Pedestrian Crossing Signals*:*** Finding sufficient gaps in traffic to enable safe crossing is a particularly difficult task for visually impaired users. Due to high peak hour east-west traffic volumes, acoustic pedestrian crossing signals are proposed along all north-south pedestrian crossings.

- **Bike Treatments**: As not all cyclists will be comfortable merging into existing traffic and navigating the roundabout in the circulatory lane, bicycle ramps have been provided at each approach leg. The dedicated bike lanes terminate at the ramps, and the cyclist is given the option of merging into the regular traffic stream or exit in the roadway via the ramp. The ramp configuration, shown in Figure 7 below, is constant with those proposed by Bunt & Associates (2016) in the design of the Chancellor Blvd and Westbrook Mall roundabout.

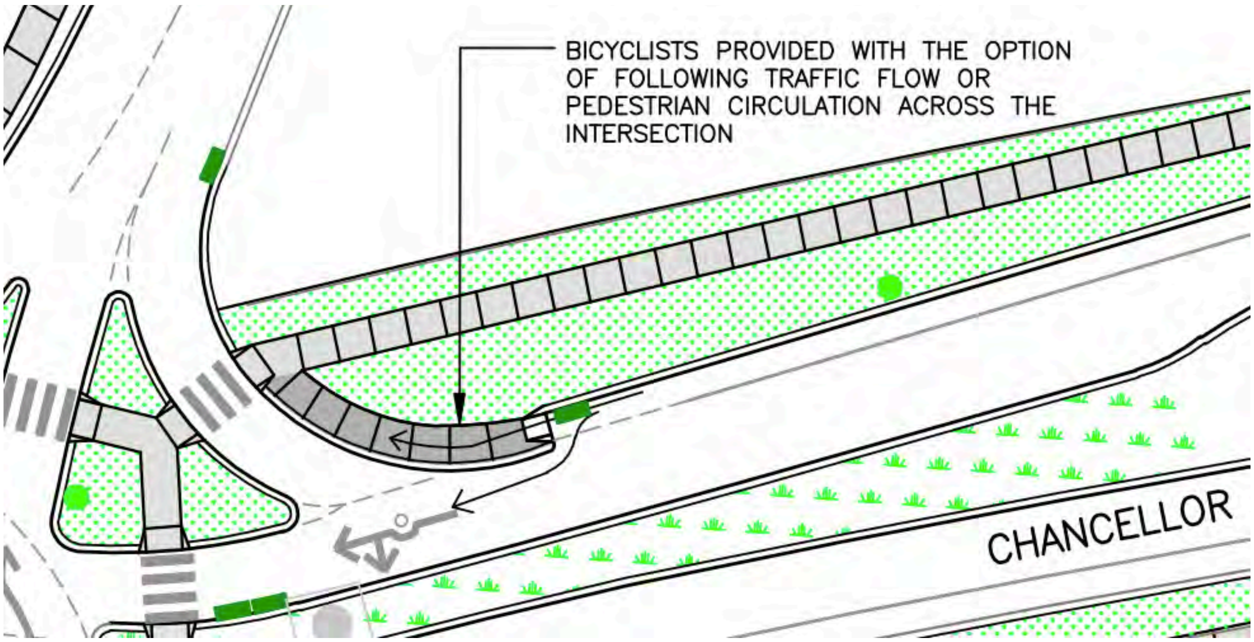


Figure 7: Cyclist Ramp Detail

5.4 Pavement Design

Pavement types are specified based on road classification and the anticipated traffic loading over a 20-year design life. Traffic loading is measured in equivalent single axial loads (ESALs). While the volumes through the intersection are relatively low, since Chancellor Blvd and NW Marine Drive are designated truck routes, the pavement design has been based of MoTI Type A Pavement (2015). A summary of the proposed pavement structure based on MoTI Guidelines is provided in Table 6. The proposed design includes MoTI's new provisions for the use of reclaimed asphalt pavement (RAP) material in hot mix asphalt construction. The pavement design will need to be confirmed by geotechnical sub-consultant through asphalt cores to ensure structural performance and tie in to the existing structure.

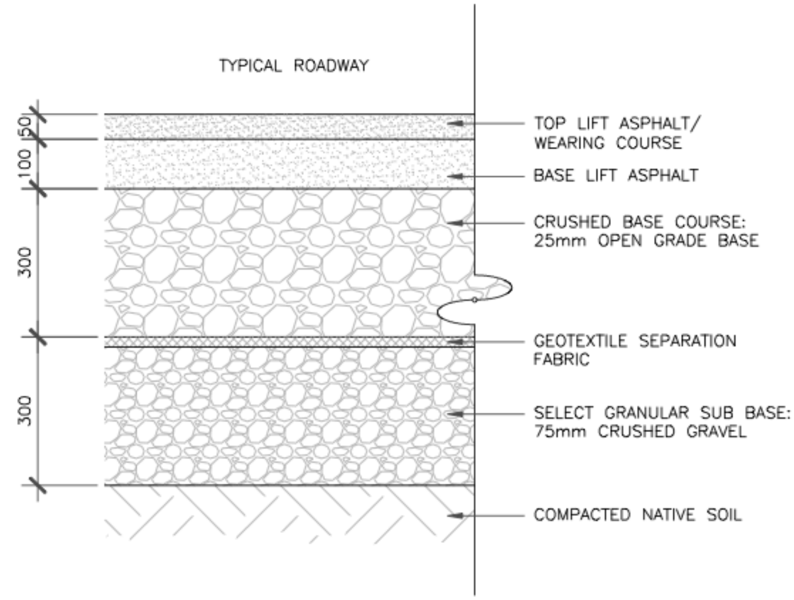


Figure 8: Typical Pavement Section

Table 6: Pavement Material Specifications

Structural Element	Material	Thickness
Top Lift Asphalt	Hot Mix Asphalt with PG 58-28 Binder 30% RAP Content	50mm
Base Lift Asphalt	Hot Mix Asphalt with PG 58-28 Binder 30% RAP Content	100mm
Crushed Base Course	25mm Open Graded Base	300mm
Separation Fabric	Geotextile Fabric Material	-
Select Granular Sub-Base	75mm Crushed Gravel	300mm

The final design of the roundabout truck apron consists of a mountable curb installed at its perimeter as well as visually distinct paving stones so large trucks can navigate turns. Drainage at this location will be facilitated through the use of permeable pavers and a perforated perimeter drainage pipe directed towards the storm drainage system. See Drawing D4 for a detailed layout of truck apron materials including sub-base, geotextile overlays, and aggregate bedding layers.

Colored paving stones, in place of a standard asphalt or concrete road surface, are proposed for the truck apron to provide a visually distinct surface. This will discourage drivers in standard sized vehicles from using the truck apron. The stone color will also be distinctly different from the concrete sidewalks to discourage pedestrians from crossing into the interior of the roundabout.

5.5 Utility Coordination

Utility coordination will be a critical element to address early on in the construction process. The utility schematic released by UBC Campus and Community Planning revealed that the intersection hosts a significantly dense network of both deep and shallow utilities comprised of storm, sewer, water, electrical, and fiber cable services. No information, however, is available for the depths and offsets associated with any utility. Thus, the contractor is required to seek utility depths and offsets through crossing agreements with individual utility providers.

Aside from catchbasin relocations, all other existing deep utility infrastructure will be largely unaffected by the proposed intersection upgrades. Manhole rims and valve stems, however, will need to be adjusted to match the final grade profile. Locations of manholes and valves have been estimated based on site visits and utility schematics provided by UBC Campus and Community Planning. The contractor must verify these locations prior to construction. Given the uncertainty in the depths and offsets associated with the existing storm and sewer mains under the intersection, assumptions had to be made in the course of the detailed design of the proposed integrated stormwater management system. Some of the key assumptions governing the risks associated with the proposed design are as follows:

- It is assumed that the sanitary main is significantly deeper than the storm main running underneath the intersection. This is a reasonable assumption on the part of the proposed design because it generally holds true in most existing utility corridors in the Metro Vancouver area. However, the expectation that the utility layout underneath the subject intersection conforms to standard practice does not mitigate the risk associated with this assumption. Therefore, the contractor must obtain the alignments and depths of the storm and sewer utilities from the relevant utility owners, and verify the depths and locations using ground-penetrating radar prior to commencing roadwork.

- At the time of the detailed design the condition of the existing catchbasins and manholes was estimated through visual inspections. Based on the results of such inspections, the need for replacing or salvaging the catchbasins and manholes was determined. In assuming a particular piece of infrastructure to be worth salvaging, it was assumed that its associated pipework was also worth salvaging. Such assumptions may be confirmed or refuted only on the basis of inspections performed through excavation.

6.0 Integrated Stormwater Management Strategy

The proposed stormwater strategy is inspired by the UBC 20-Year Sustainability Strategy and Board of Governors Policy #39 which encourage a natural systems approach to managing stormwater on campus (UBC 2014b). The design achieves provincial and federal volume control, rate control and water quality objectives through a integrated system of absorbent landscaping features, minor system upgrades and the installation of a Stormceptror oil and grit separator and underground stormwater detention facility. Futhermore, the Stomceptor and modular underground detention system ialows for on-site stormwater re-use and is pre-qualified for LEED credits under the Sustainable Site, Water Efficiency and Material and Resources categories (Stormceptor, 2015, StormTrap, 2011b). Stormwater Drawings are included in Appendix A (Drawings A3.1, A3.2 and A4) and additional design details are provided in Appendix D.

6.1 Existing Conditions

The recently released UBC Integrated Stormwater Management Plan recognizes distinct challenges for the Point Grey Campus. The NW Marine Dr/Chancellor Blvd/East Mall intersection is situated within the north campus catchment shown in red in Figure 9 below. The minor storm system in the north catchment area is channeled thought the Spiral Drain to an outfall at the lower cliff face. Surface runoff in proximity to the intersection generally flows north toward NW marine Drive and Pacific Spirit Park.

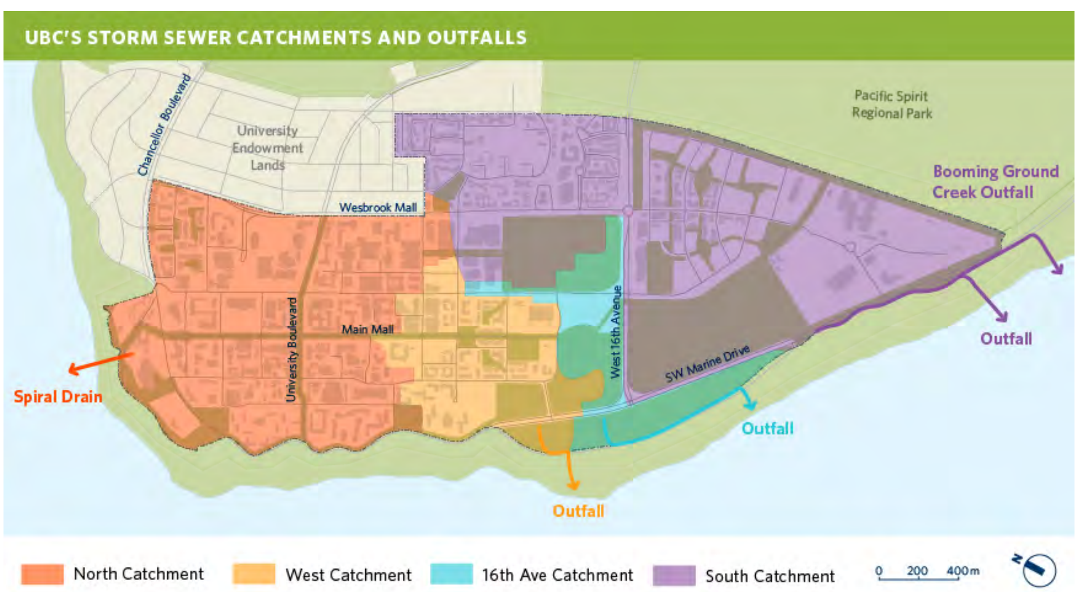


Figure 9: UBC Storm Sewer Catchments
(UBC Energy and Water Services, 2016)

This of campus is particularly vulnerable to cliff erosion through both overland and infiltrated flows. Subsurface conditions along the Point Grey peninsula consist of approximately 0.5m of topsoil, underlain by up to 30m of glacial till followed by a Quadra Sand unit. This Qaudra sand unit creates upper and lower aquifers that are separated by the impermeable layer of silt. The aquifers are tilted towards the north and west resulting in sub-surface water that flows the cliff face in Pacific Spirit Park casing subsurface seepage erosion (Russel, 2005). This phenomenon is shown in Figure 10.

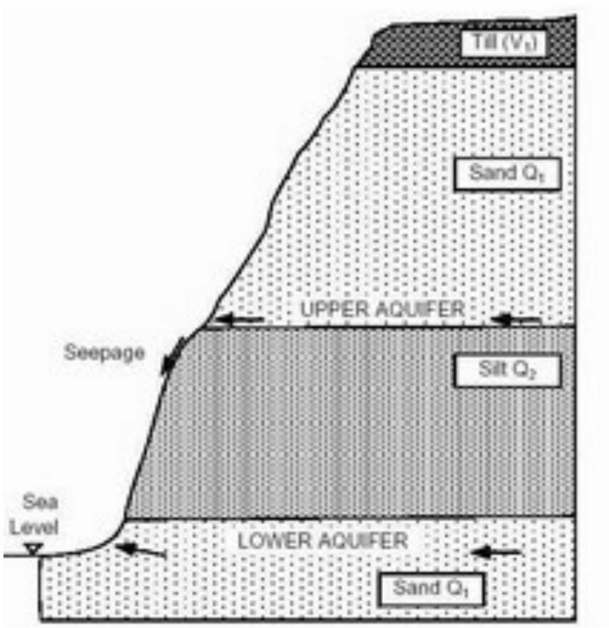


Figure 10: Point Grey Subsurface Conditions (Russel, 2005)

Figure 11: Ponding Along North Curb Alignment (Documented September 21, 2015)

In addition to subsurface drainage concerns, there are a number of surface drainage issues that need to be addressed. The localized ponding due to poor surface grading shown in Figure 11 was noted on a site visit on September 21, 2015. The UBC Overland Flow Study completed by Urban Systems in 2012, identified the project intersection as prone to approximately 680 m^3 will flood the intersection in a 1:100 year storm event (Bell, 2012). This area is of particular concern as there currently no way to stop overland flows from entering Pacific Spirit Park and travelling down Marine drive where it spills over the cliffs and onto the Spanish Bank Beaches.

An extensive stromwater assessment of the project area completed as a part of the UBC ISMP. Study results indicate that minor system undersized for current demand leading to heighted flooding risks in storms larger than a 1:10 year event. The ISMP recommends that a stormwater detention facility be built in this location to detain excess stormwater in high flow events. The facility would attenuate its release of stormwater into the storm system to lessen the demand on the Spiral Drain during high flow events.

6.2 Technical Guidelines and Site Specific Targets

Urban stormwater runoff is regulated at the federal, provincial and municipal levels. The Department of Fisheries and Oceans (DFO) and the BC Ministry of Water, Land and Air Protection outline specific guidelines and targets regarding the reduction of runoff volume and rates, the conveyance of peak flows during high flow events and water quality. These guidelines are summarized below in Table 7.

Table 7: Federal and Provincial Stromwater Design Guidelines and Targets

Level	Federal Guidelines & Targets	Provincial Guidelines & Targets
Reference Document	*DFO Urban Stormwater Management Guidelines and Best Practices, 2001*	*BC Stormwater Management Guidebook, 2002*
Volume Reduction	Retain the 6-month/24-hour post-development volume from impervious areas on-site and infiltrate to ground.	Capture 0 to 50% of the MAR at the source (building lots and streets) and infiltrate, evaporate, or reuse it.
Runoff Rate Control	Reduce post-development flows to pre-development levels for the 6-mth24-hr, 2-yr/24-hr, and 5 yr/24-hr precipitation events.	Store 50% to 100% of MAR runoff and release at a rate that approximates the natural forested condition.
Peak Flow Conveyance	None	Ensure that the drainage system is able to convey extreme storm events (up to 100-yr. return period) with only minimal damage to property.
Water Quality	Collect and treat the volume of the 24-hour precipitation event equaling 90% of the total rainfall from impervious areas with suitable BMPs.	Refer to DFO Requirements
Notes:	MAR = Mean Annual Rainfall ,1:2.33 year storm event (1:2 year storm event used for design)	

At the local level, the Metro Vancouver Stormwater Source Control Guideline (2012) and the UBC Integrated Stormwater Management Plan (2015) defer to the targets set out by DFO and BC Ministry of Water, Land and Air Protection and promote the use of low impact stormwater features such as absorptive landscaping and stormwater reuse. Furthermore, UBC's 20-year sustainability strategy UBC Board of Governors Policy #39 places a strong emphasis on a natural systems approach to Stormwater management on campus.

In lieu for detailed topographic information for all upstream and downstream catchment areas, the proposed strategy aims to demonstrate an improvement relative to the exiting site conditions and accommodate future upstream and downstream improvements. Overall the objective of the design is to demonstrate a "Positive Net Impact" post-development scenario through the following design targets:

- **Volume Reduction and Peak Flow Conveyance**: short term onsite storage is can accommodate 100% of the MAR and 100% of the 1:100 year runoff volume,
- **Runoff Rate Reduction***:* there is a reduction in peak flow rates in the major system with no notable increase in minor system,
- **Water Quality**: a minimum of 85% of TSS is removed from 100% of the 100-yr, 24-hr runoff volume.

To assist in stormwater design and evaluation site scale stormwater runoff model has been generated using XPSWMM and a water quality model was creating using PCSWMM. The models utilize a Horton infiltration model and the native glacial till soil has been assumed to have similar hydraulic conductivity to silty clay type soil to simulate the low permeability indicated by Russel (2005). Model results and design details can be found in Appendix D.

6.3 Absorbent Landscaping and Pervious Surface Cover

The narrow lanes that reduce traffic speeds and improve intersection safety also reduce overall asphalt surface area and allow the addition of more landscaped pervious surface cover. In total the propped intersection adds an additional 910 m^2 of pervious surface cover to the intersection through a combination of landscaped medians and islands, permeable paving stones at the truck apron and the elimination of the pavement on the lower stretch of Iona Dr. Drawing A4 in Appendix A shows the change in pervious and impervious surface cover between pre and post development conditions.

This increase in permeable surface cover reduces runoff rates in the post-development condition. Table 8 provides a comparison of the pre-and post development flow rates under the 5min and 24 hour 1:2 year (MAR) and 1:100 year design storms. Overall the reduction in I/P ratio from 1.19 to 0.90 creates a 8% reduction in post development flow rates when compared to pre-development flows. The flow rates have been established using rational method analysis and localized catchment areas. Results should be confirmed with continuous simulation modeling once upstream catchment date is available.

Table 8: Pre vs Post Development Flow Rates

Design Storm		Pre-Development Flow (L/s)	Post-Development Flow (L/s)
1:2 year	5 min	95.4	87.5
	24 hour	6.14	5.63
1:100 year	5 min	224.5	206.0
	24 hour	11.3	10.4

To mitigate, cliff erosion concerns, 1215 m^2 of the landscaped area has been converted into rain gardens. The rain garden areas have been sized and designed as retention facilities that provide temporary storage for 50% of the rainfall volume in a 1:2 year storm event. A typical cross section of the rain garden is shown below in Figure 12.

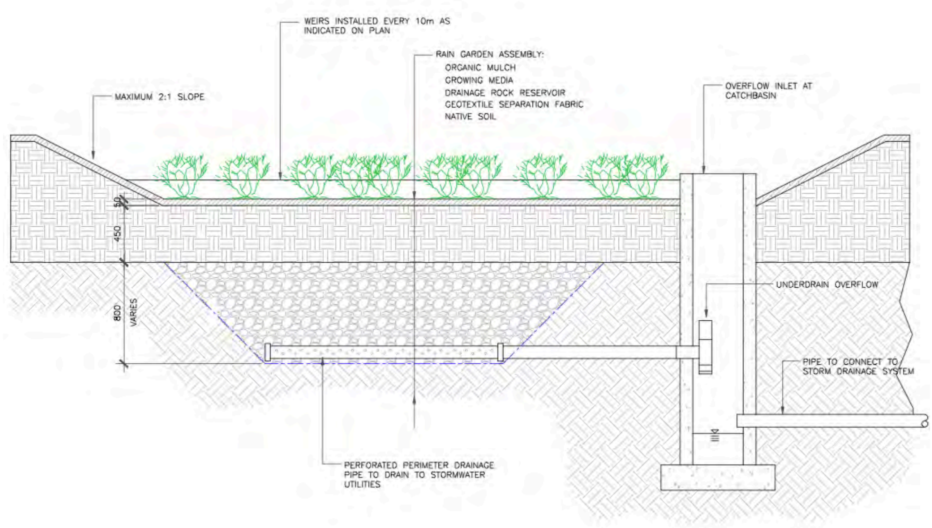


Figure 12: Typical Rain Garden Detail

The rain gardens have been sized using Metro Vancouver Stormwater Source Control Guideline (2012) and rock trench depths are indicated on Drawing A3.2 in Appendix A. The layer of geotextile fabric at the base of the assembly prevents infiltration while the perforated drainpipe carries retained flows to the minor system at a controlled rate. The perforated drainpipe, orifice, and pipes tying into the minor system control the release into the existing system. As the system is currently at capacity, controlling the release rates is critical to the design. These sizing for the perforated drains and orifice are to be determined once the system can be model in conjunction with the downstream pipe flows in the existing minor system.

Growing medium and plant species are to be determined by UBC Landscape Architects and must comply with the approved list of rain garden species in Metro Vancouver Stormwater Source Control Guideline (2012). As per Metro Vancouver Guidelines, the growing medium must have a minimum hydraulic conductivity of 70mm/hr (2012). As indicated on Drawing A3.2 in Appendix A, concrete weirs are to be installed at 10m intervals along all rain gardens installed south of the intersection. The weirs promote uniform capture and prevent erosion of the growing medium along the rain gardens installed on the sloped regions in front of Allard Hall. Weirs are to be installed as per the Metro Vancouver Stormwater Source Control Guideline (2012).

Additional landscaped areas indicated on Drawing A3.2 are to be hydro-seeded as per UBC landscape standards. As indicated in Section 5.0, permeable pavers will be installed around the truck apron of the roundabout. A detail for the truck apron is shown below in Figure 13. The depth of the sub-base will be established by the geotechnical sub-consultant once asphalt cores are taken to ensure the structure can accommodate the required ESAL loading and the desired hydraulic conductivity for stormwater capture.

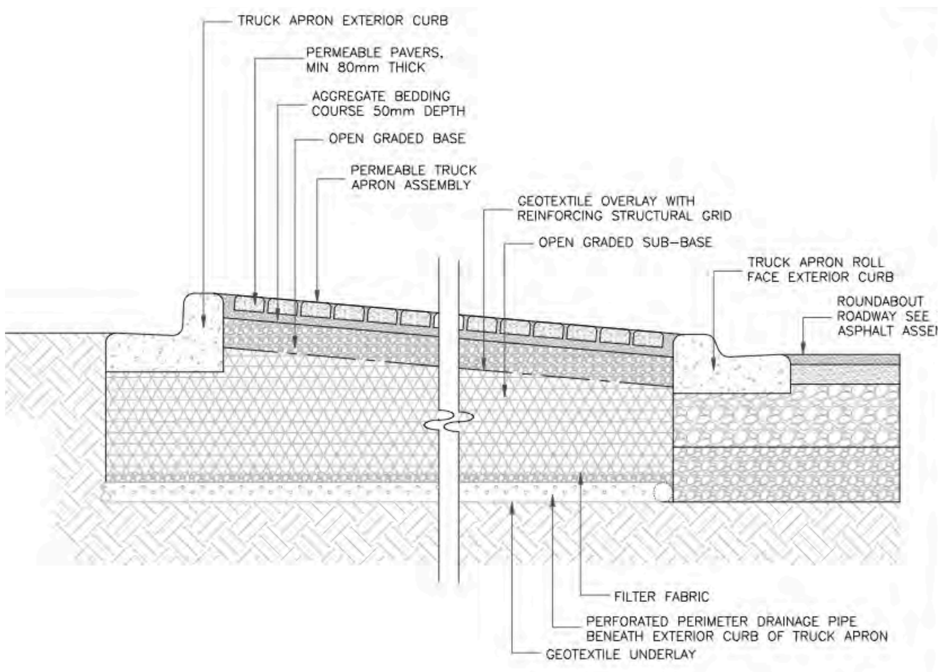


Figure 13: Permeable Truck Apron Detail

6.4 Catchbasin Relocations

Due to the realignment of curbs in proximity to the intersection, 11 catchbasin will need to be relocated and five new catchbasin will be installed. The project team has completed an initial visual inspection of the exiting catchbasin and determined that two if the Type C twin catchbasins along East Mall are in good enough condition to be savaged and reused on-site. The remainder of the relocated catchbasin will need to be replaced during construction. The existing and proposed catchbasin layouts and sizing are presented in Drawing A3.1 and A3.2.

By adding five new catchbasin to the site, upgrading three single catchbasin to double catchbasin, the proposed design captures 30% more runoff volume than the pre-development condition. Furthermore, the catchbasins located at the base of each bike ramp will act as localized trap lows in high flow events. This will allow up to 0.15m of ponding to occur, significantly increasing capture rates at these locations during large storm events as shown by the capture curves presented in Figure 14.

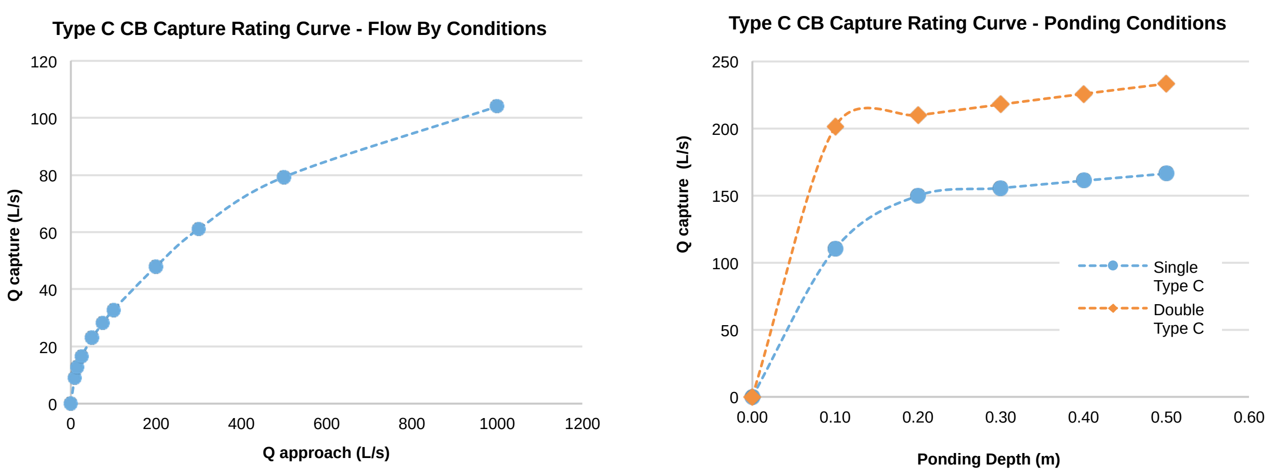


Figure 14: Type C Catchbasin Capture Curves

Exiting ponding issues will be mitigated though milling and resurfacing of the top lift of asphalt tying into the catchbasins identified on Drawing A3.2. To help control subsurface drainage beneath the road structure, perimeter drains will be installed beneath all new curbs that tie into a new catchbasin. All proposed catchbasins use single or double standard 1.2m barrels with bike-proof Type C frame and covers. Catchbasins and perimeter drains are to be installed as per the most recent edition of the Municipal Master Design Specification.

6.5 On-site Stormwater Treatment and Detention

To mitigate the increased demand on the minor system due to increased stormwater capture through catchbasins and rain gardens, the proposed stormwater upgrades include the installation of an 800 m^3 StromTank undergrad stormwater detention facility and Furthermore, to meet water quality objectives, a STC 9000 Stormceptor oil and grit separator will be installed upstream of the stormwater tank.

Figure 15: Double Trap StormTrap System (StromTrap, 2011a)

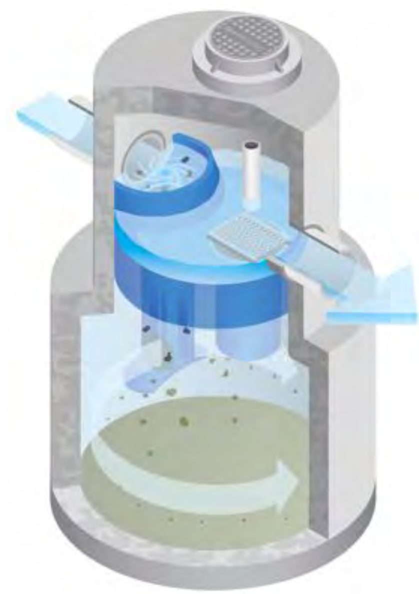


Figure 16: Stormceptor Oil and Grit Separator System (Imbrium Systems, 2015)

An extra bypass pipe will be installed in Manholes four and nine as shown on Drawing A3.2. By installing this bypass line at a lower invert than the exiting mainline, the bypass line will divert stormwater water collected upstream of Manhole 4 to be diverted through an STC 9000 Stormceptor oil and grit separator and to the stormwater detention tank. The STC 9000 is capable of treating 100% of the diverted stormwater runoff and removing 88% of the TSS content. PCSWMM Model results and a construction detail for the STC 9000 system are provided in Appendix D.

The 6 m by 45m by 3m StromTrap Double Trap detention facility has been sized to provide both flood protection and irrigation capacity. The modular precast system is made of designed with a duel exit pipe connecting to Manhole two (refer to Drawing A3.2) which limits the retained stormwater volume at 120 m^3 for irrigation purposes during normal flow conditions and allow larger volumes to be retained for flood control during large storm events. This system will ensure that anticipated 680 m^3 runoff from a 1:100 year storm event can be accommodated at all times. The installation of Stormceptor upstream of the detention facility will ensure water to the tank during high frequency, low intensity events is of sufficient quality to be recycled through a purple pipe system an used to irrigate the nearby rose garden and landscaped areas around the Chan Centre. The StormTrap system pre-qualified for LEED credits under the Sustainable Site, Water Efficiency and Material and Resources categories (StormTrap, 2011b).

7.0 Gateway Feature

The Bike Garden provides UBC with a gateway feature to campus that is functional, aesthetically attractive, and aligns with UBC's mission to promote sustainability. The Bike Garden provides secure storage for up to 84 bicycles near the campus core.. A key feature of the Bike Garden is the integration of the structure into the area's stormwater management strategy through its green roof and nearby rain gardens. The proposed design includes the structural design complete with enclosures, green roof and drainage details. The structure and surrounding landscaping is shown in Figure 17. Detailed structural plans and elevations of the structure may be found in Appendix A.

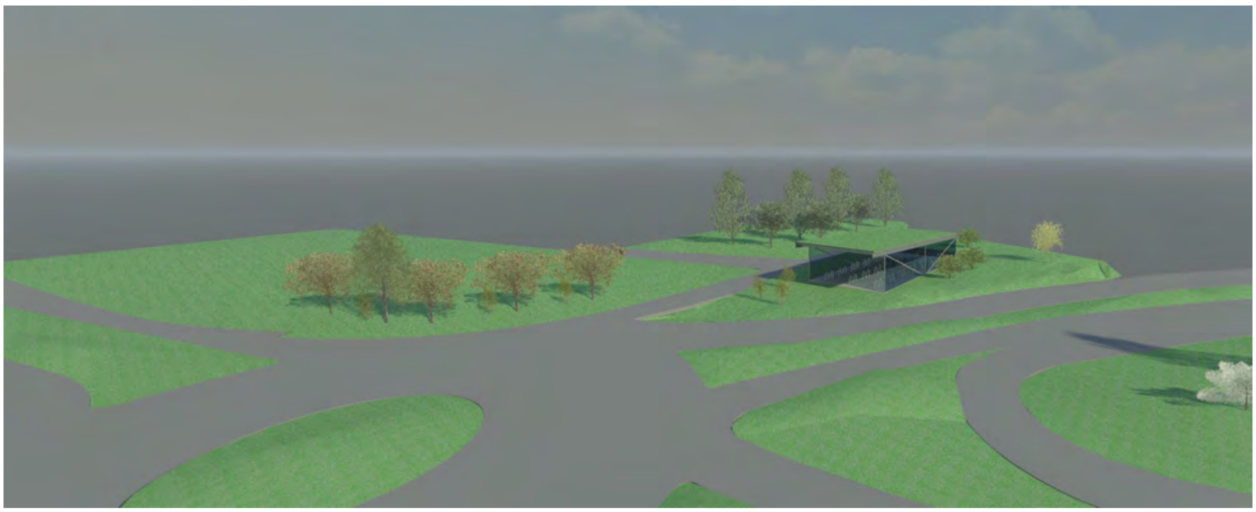


Figure 17: Bike Garden and Surroundings

7.1 Integration With UBC Planning Objectives

Justification for the design of the Bike Garden was provided by the following documents published by UBC: the UBC Transportation Plan, the UBC Vancouver Campus Plan, the UBC Land Use Plan, and the UBC 20-Year Sustainability Strategy. Policy C2 of the UBC Transportation Plan (2014) states that investments in bike racks and secure parking either under cover or in parkades shall be made a priority, and that a minimum of 25% of UBC's bike racks shall be covered. This policy refers to, and summarizes requirements outlined in the UBC Vancouver Campus Plan, and the UBC Land Use Plan. Also, the UBC 20-Year Sustainability Strategy makes it a goal to campus with restricted vehicular access by facilitating alternative means of transportation such as cycling. The use of a green roof covered bike parkade is an efficient way to support UBC policy and produce an aesthetically pleasing gateway feature that can be enjoyed by cyclist and non-cyclist members of the public.

7.2 Structural Design

The Bike Garden features elements of timber, glass, concrete, and steel. Structural steel framing was chosen as the main structural system due to the relatively heavy loads of the green roof, and the long spans required in creating the open space of the interior. The structure was designed according to the 2012 British Columbia Building Code (BCBC), and its corresponding relevant adopted materials standard including: CSA S16-09 Design of Steel Structures, CSA S136-12 North American Specification for the Design of Cold-Formed Steel Structural Members, and CSA A23.3-14 Design of Concrete Structures. As per BCBC 2012, the design life of the structure is 50 years.

The structure was modelled in SAP2000 with wind, seismic, snow, dead, and live loads as specified from the 2012 BCBC. The structural members were designed for the forces obtained from this model. Appendix E contains the structural calculations for the design of the joists, girders, columns, braces, and steel composite decking. Table 9 below summarizes the design loading (ULS is Ultimate Limit States and SLS is Serviceability Limit States).

Table 9: Summary of Design Loading

Load	Size
ULS Snow Load	1.31 *kPa*
SLS Snow Load	1.48 *kPa*
ULS Wind Load	0.38 *kPa*
SLS Wind Load	0.36 *kPa*
Deck Weight Dead Load	1.62 *kPa*
Joist Weight Dead Load	1.28 *kPa*
Soil Weight Dead Load	2.20 *kPa*
Girder Weight Dead Load	0.65 *kN/m*
Glass Wall Weight Dead Load	0.32 *kPa*
Column Weight Dead Load	1.26 *kN*
Earthquake Base Shear (Distributed Over Each Roof Dimension)	338 *kN*
Roof Live Load	1.00 *kPa*

A steel composite deck supports the green roof assembly, which is in turn is supported by steel wide-flange joists (W460x52) spanning east to west. These joists frame into W530x66 girders running north-south. The following Figure 18 outlines the steel framing of the roof.

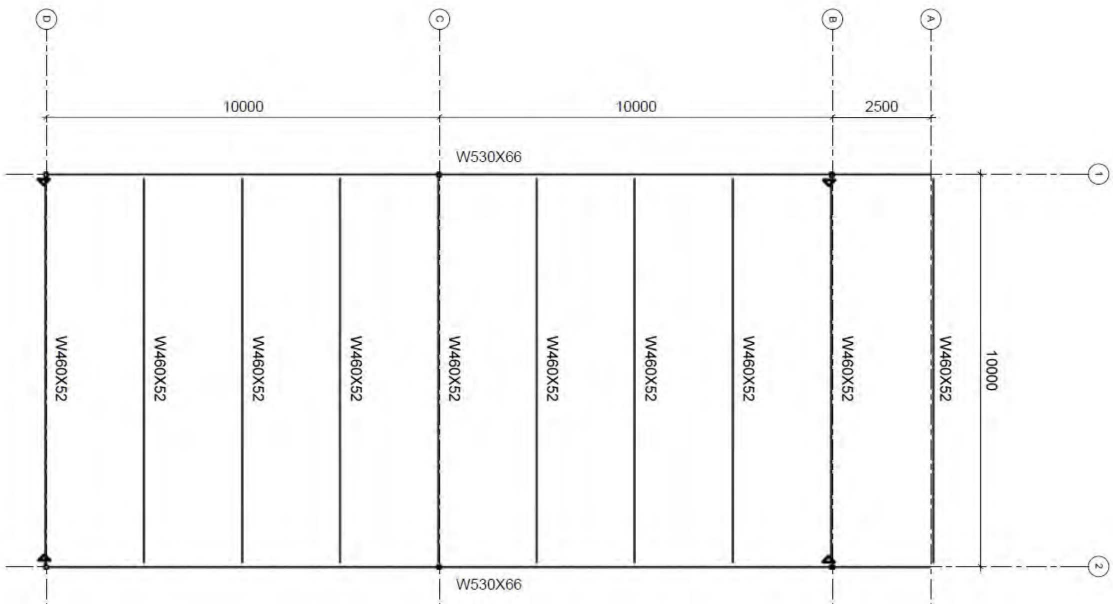


Figure 18: Roof Framing Plan

These girders are continuous along the entire length of the structure and rest on top of the six Hollow Structural Steel (HSS) columns, which direct the gravity loads to the footings and, finally, the ground. The lateral resistance in the longitudinal direction of the structure is provided by HSS braces, which resist loads in compression and tension. Figure 19 shows the west elevation of the structure with the lateral bracing.

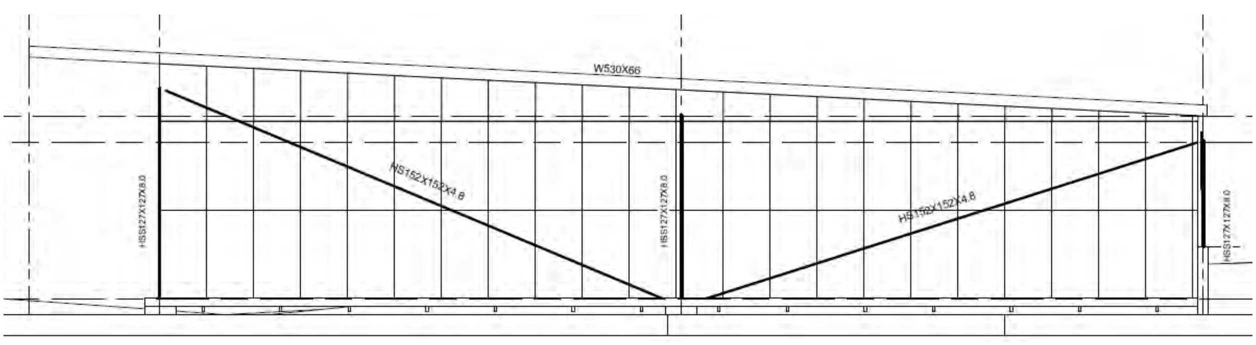


Figure 19: West Elevation

In the transverse direction, moment frames at each end of the structure provide lateral resistance to seismic and wind loads. The connections between all steel and concrete elements are to be designed by the steel fabricator based on the loads specified in the drawings. Details are provided in Appendix A and show the parapet framing on the roof and the retaining wall design on the south end of the structure. The retaining wall and footings can be designed in full once the geotechnical sub-consultant has provided the relevant soil properties. The geotechnical consultant may require a site investigation to be completed prior to the start of construction. They may perform this investigation with boreholes.

7.3 Architectural, Landscape and Sustainability Considerations

The architectural design of the Bike Garden was inspired by the natural surroundings of the site, including both the terrain and the natural vegetation. Furthermore, the Bike Garden was designed to uphold UBC's vision of sustainability and green design. Taking advantage of the site's natural grade, the structure appears to emerge from the terrain with a gentle upward sloping roofline.

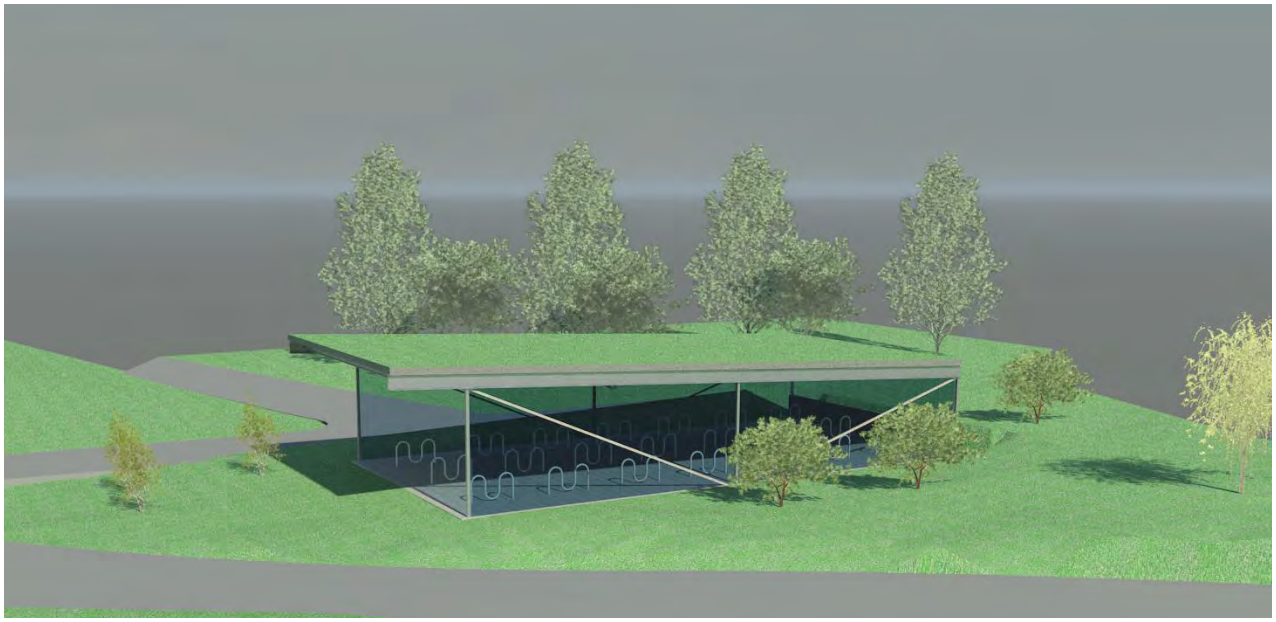


Figure 20: Bike Garden North West View

Architectural finishes are designed to match the material palate specified for UBC's Contemporary District in which it is situated (UBC, 2012). The vertical faces of the structure were left as open as possible, and filled in with glazing on the long sides. This maximizes the amount of natural light in the interior, thus reducing the need for artificial lighting, and reducing the electrical demand. The roof parapet and the soffit are clad in locally sourced cedar siding as detailed in Figure 21; the cedar siding was chosen to convey a contemporary west coast feeling.

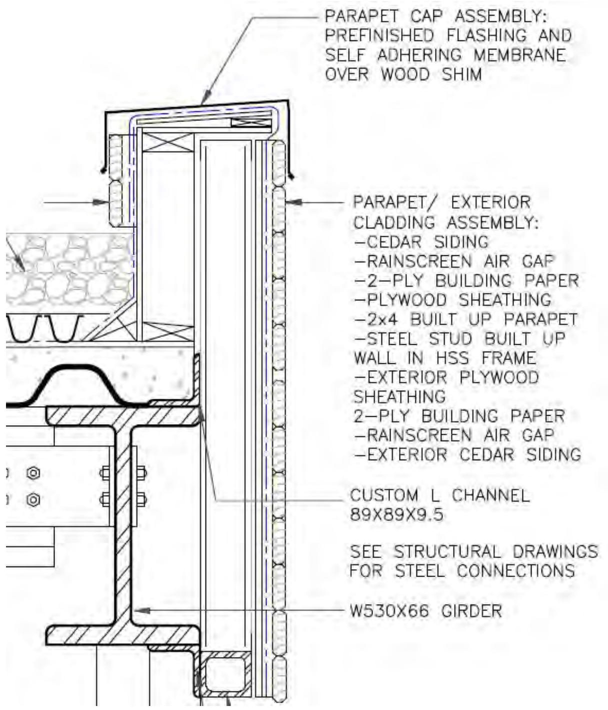


Figure 21: Cedar Siding Detail

Due to the need to limit the amount of stormwater infiltration in the area, the Project Team developed a design that integrated the Bike Garden into the site's Stormwater Management Plan. The structure features a green roof that is designed to capture 90% of rainwater in a 1:2 year event. This excess water then flows from the roof is distributed to rain gardens adjacent to the structure. Any water not retained by the rain gardens is collected by a system of geotextile and perforated pipes, which connect to the main stormwater system.

Table 10 identifies plant sepcied selected for the green roof. These species have been selected in accordance with BC Landscape Standard, current edition, Section 11 - Landscape over Structures, BC Standard for Extensive Green Roofs as per the UBC Technical Guidelines for Green Roofs (2015). These species maximize the water retention time for controlled release during a storm event while also minimizing the amount of required maintenance.

Table 10: Green Roof Planting Schedule

Planting Schedule	Sourced From
Bearskin Fescue	UBC Botanical Gardens
Blue Gamma Grass	
Blue Sedge	
Mountain Moss Sedum	

8.0 Construction Planning

The overall constructability of the intersection has been a key consideration throughout the design stages of the project. A number of considerations have been taken into account while developing the construction phasing and the traffic management strategies. These strategies are expected to simplify construction staging, help minimize construction costs, and achieve the desired timelines. This section presents four key aspects of construction planning: a detailed construction schedule and phasing plan, a pre-tender cost estimate, a comprehensive risk assessment and a stakeholder management plan

8.1 Construction Schedule

Detailed design work and tender preparation has been fast tracked to accommodate a May 1, 2016 Construction start date, as requested by UBC Campus and Community Planning. The project is now ready to go to tender on April 11, 2016. This accommodates a minimum two tender period, and approximately a week for bid evaluation and project award ahead of the May 1st construction start date.

Special consideration given to graduation ceremonies that are set to take place May 25th – May 27th and May 30th – June 1st, 2016 at the Chan Centre. To minimize conflicts between ongoing roadwork and the traffic surges associated with the graduation ceremonies, construction will be limited to the bike garden during the month of May with the roadworks beginning June 2, 2016. Such strategic construction phasing also provides the contractor more time for mobilization, site investigation and material procurement for the proposed roadwork. Van Augustine estimates a three-month period for all proposed roadwork and the associated utility work. An interim construction completion date of September XX will be written into the contract documents to ensure the intersection is operational before the start of the 2016 – 2017 school year.

With roadway constriction and landscaping completed by the first week of September, Construction Completion Certificate (CCC) inspections are scheduled to span all of September. All deficiencies reported during these inspections will be remediated promptly. After the issuance of the CCC, as-built surveys will be performed in October, following which as-built drawings will be delivered to UBC Campus and Community and MoTI. Key milestones for the tender and construction period are indicated in Table 11. A Gnatt Chart and a with a detailed timeline of all construction activities is included in Appendix F.

Table 11: Key Project Milestones

Project Milestone	Start Date	Completion Date
IFT Review and Revisions	April 8, 2016	April 10, 2016
Tender Period	April 11, 2016	April 25, 2016
Contract Award	April 29, 2016	April 29, 2016
Gateway Construction	May 5, 2016	June 3, 2016
Roadway Construction	June 3, 2016	August 17, 2016
Site Landscaping	August 17, 2016	August 30, 2016
CCC Inspections and Deficiency Review	August 31, 2016	September 30, 2016
Construction Completion	October 3, 2016	October 31, 2016

8.2 Construction Staging Plan

A construction staging plan has been included in the tender package to provide clarity and guidance to constructors in establishing their construction bids. The staging plan will also be used to support stakeholder engagement activities. Construction sequencing takes has been established in accordance with UBC's Traffic Management Plan Guidelines for Events and Construction and aims to minimize lane closures and disruption during peak operating hours and maintain public safety at all times. Figure 22, provides an overview of the proposed construction sequencing.

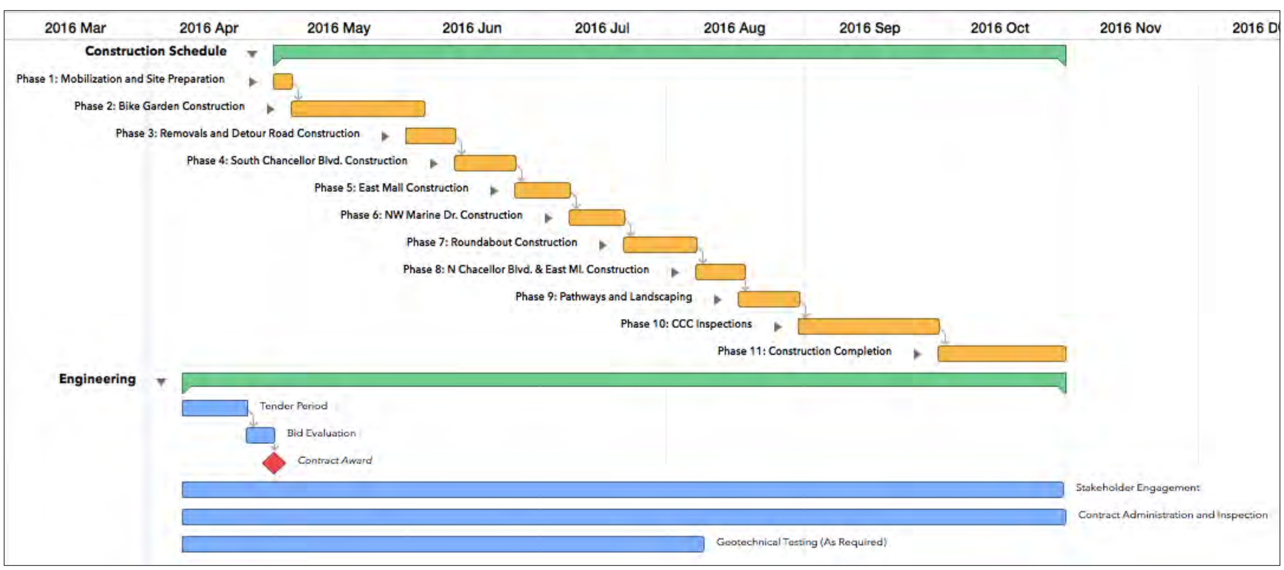


Figure 22: Construction Phasing

Key aspects of the proposed staging strategy are identified below. Drawings have also been prepared for each phase of the road construction and are included in Appendix A.

- Work zones, as indicated on the phasing plans, has been limited to the minimum required 0.5m outside of the immediate construction area to minimize the need for lane closures and detours.
- A temporary detour road is to be constructed across the Chancellor Blvd. median to accommodate two way traffic along Chancellor Blvd. while the stormwater detention facility is installed.
- The contractor will be required to complete tasks that require single lane alternating traffic during non-peak hours only (between 10am and 3pm). During peak hours, the contractor must arrange the work zone in these stages to accommodate two-way traffic.
- Stakeholder engagement will take place throughout the duration of construction to ensure all intersection users and nearby residents and facilities are aware of changes to traffic and pedestrian patterns from one phase to the next.

The phasing strategy is designed to be a high level-planning tool for contractors. Upon contract award, the contractor will be required to submit a detailed Traffic Control Plan, Public Communication Plan, Incident Response Plan, and Implementation Plan. These documents must clearly indicate all necessary traffic and pedestrian detours, signage, temporary barriers and traffic management personal.

8.3 Pre-Tender Cost Estimate

The Class C cost estimate reported at the conclusion of the preliminary design stage has been revised to a construction ready version that is reflective of the features developed during the detailed design of the project. As per the summarized cost breakdown in Table 12, the project will be delivered, by September 2016, at a net cost of $1.59 million.

Table 12: Pre-Tender Cost Estimate

Item	Description	Estimated Cost
P1	Development Permit	$1,500
P2	Excavation & Backfill Permits	$2,500
P3	Erosion and Sediment Control Permit	$500
P4	Traffic Management Permit	$500
P5	Building Permit for Bike Park Gateway	$2,000
P6	Streets and Landscape Permit	$500
	Permitting Subtotal	**$7,500**

Item	Description	Estimated Cost
C1	Mobilization, Demobilization and Removals	$268,000
C2	Earthworks	$23,000
C3	Concrete & Roadwork	$284,925
C4	Detour Road	$7,236
C5	Underground Works	$113,300
C6	Temporary Traffic and Pedestrian Traffic Control	$20,000
C7	Streetlighting	$21,000
C8	Erosion & Sediment Control and Landscaping	$131,700
C9	Bike Garden Construction	$276,000
C10	Miscellaneous Items – Record Drawings	$5,000
C11	Provisional Items	$404,000
	Construction Subtotal	**$1,448,800**
E1	Engineering Fees – Contract Administration and Testing (10%)	$144,880
	Engineering & Project Management Subtotal	**$144,880**
	Total Estimate (2016 Dollars)	**$1,593,680**
	Annual Operation and Maintenance Costs (0.7%)	**$10,200**

As shown in Table 12, the final estimate is based on a construction cost of $1.45 million. A Schedule of Quantities and full breakdown of the Pre-Tender Cost Estimate can be found in Appendix G. Worth noting is that the final construction cost estimate includes provisional items worth $404,000. The provisional items, which include a proposed underground stormwater management facility, are recommended, but optional and may be removed from the scope of work on the project owners' request. Furthermore, in keeping with MoTI guidelines, the contract administration fees for the construction phase have been estimated at 10% percent of the total construction cost.

In addition to the construction and engineering costs, the permitting costs for the project are estimated to be $7,500. Required permits include a Development Permit for the overall Site, A Streets and Landscape Permit and a Building Permit for the Bike Garden. As the Bike Garden is to be used for bike storage only, the project is exempt from UBC's Infrastructure Impact Charge, Community Amenity Charge and Regional Sewerage Levy. The relevant permit application forms are included in Appendix H.

The principal revisions made to the cost estimate as part of the detailed design process are as follows:

- A refined estimate of the supply and install costs for the gateway feature – the Bike Garden.
- Adjustment of the costs to account for the fast-tracking of activities for individual construction phases.
- Refinement of construction cost associated with rain gardens around the Bike Garden.
- Updated quantities for the supply and install of new catch basins and manholes.
- A more accurate estimate of concrete, asphalt, and landscape addition and removal.
- Elimination of the contingency buffer.

For the post-construction period, the annual maintenance costs of the intersection are estimated at 0.7% of the net construction costs, in accordance with MoTI guidelines. Any uncertainty in quantities and project elements that remains at the time of tender will be accounted for as cash allowance items in the contract documents.

8.4 Risk Assessment

A comprehensive risk analysis has been completed as part of the construction planning process. Key project risks are outlined below. A complete Risk Register is included in Appendix I.

Table 13: Key Project Risks

Key Project Risks	Probability	Consequence
Pacific Spirit Park Encroachment	Medium	High
Permit and Crossing Agreement Delays	High	Medium
Runoff Catchment Size	High	Low
Deep Utility Elevations	Medium	High
Probability: Refers to likelihood of occurrence Consequence: Refers to impact to both project schedule and budget		

- **Pacific Spirit Park Encroachment:** Specific right-of-way information is not currently available for NW Marine Dr. The position of the inscribed circle of the roundabout has been optimized to minimize impact on adjacent properties however there may be a small amount of encroachment onto the Metro Vancouver property the existing curb alignments and the east-west property line shown on UBC base maps. This area is highlighted in red in Figure 23 below. While it is likely that the right-of-way actually extends beyond the construction limits, property encroachment will need to be confirmed during pre-construction site investigations. If property appropriation is required, the schedule for proposed roadwork may suffer delays. However, the project team is confident that the benefits to Pacific Sprit Park in terms of safer access for park users and improved stormwater management far outweigh the minimal encroachment area and the probability that encroachment will become a major project issue has been rated as medium.

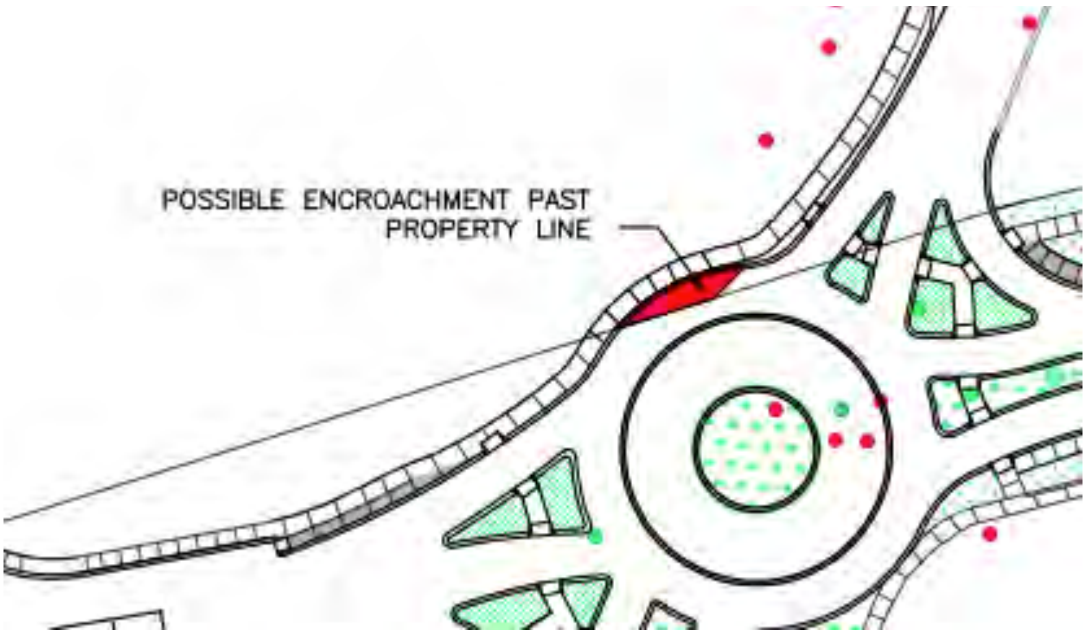


Figure 23: Possible Property Encroachment Area

- **Permit and Crossing Agreement Delays:** All proposed roadworks and developmental works are subject to permit processes. Thus, risks are associated with delays in permit deliveries. Due to the heavy density of underground utilities under the intersection, several parties will need to be coordinated with for obtaining permits for construction around their respective utilities. Specifically, Metro Vancouver, BC Hydro, FortisBC, and UBC operations will need to be consulted for: work around their shallow utilities, the grade adjustment of their manholes, the relocation of catch basins in the stormwater management system, and the extensions of the associated stormwater leads. Delays due to the permit application reviews and the associated inspections may also push roadworks schedule into September.
- **Runoff Catchment Size***:* Since detailed topographic and pipe profile information is not available at this stage of the project, the stormwater modelling has been completed using localized catchment areas. There is a high likelihood that these catchment areas are undersized. To mitigate this risk, models have been executed using the required 1:2yr and 1:100 year at the 24 hour intensity level as well as the 5 min intensity. 5 min intensity level givens an overestimate of peak flow rates to provide

a conservative upper bound for the model. Furthermore, the underground stormwater detention facility has been sized using the 1:100 year flood volume estimated by Urban Systems using an overland flow model for the entire campus. Based on these mitigation measures, the risk consequence level has been rated as low.

- **Deep Utility Elevations.** In the design of the minor system it has been assumed that the proposed upgrades can be accommodated around the existing infrastructure. It is assumed that the existing manhole barrel depths and mainline inverts to accommodate the bypass system that directs water to the underground detention facility. If invert elevations or manhole depths are not able to suppor the proposed system, an alternative configuration will need to be design. The density of utilities and the intersection and integration of utility upgrades with each of the construction phases render this a medium probability and high consequence risk. Sequencing the roadworks after the completion of the Bike Garden helps mitigate this risk as the month of May is available for detailed utility survey and any necessary design revisions.

8.5 Stakeholder Engagement

Early and proactive stakeholder engagement is crucial to efficiently and sustainably executing the construction phase within the constraints of the project budget and schedule. The stakeholder registry created during the preliminary design phase to identify all project stakeholders is included in Appendix J. This document was used to tailor an engagement strategy to the particular interests and role of each stakeholder group.

As joint owners of the intersection right-of-way, MoTI and the Musqueam First Nation are key stakeholders in the tender review and final construction approval process. Based on current and past use of the site as part of the provincial road network, the project team does not anticipate any major objections to the project on behalf of the Musqueam First Nation. However, the pre-construction investigation will provide an opportunity to revisit historic use of the area and determine if the project area holds any special cultural significance for the Musqueam Indian Band. This assessment provides a forum to identify existing or future impacts and establish reconciliation measures in collaboration the Musquean Indian Band, if necessary.

The preliminary design report proposed a comprehensive stakeholder engagement plan based on the project phasing, as illustrated in Figure. 24. The objectives and the timing of each engagement activity were carefully planned based on the anticipated project impacts as well as the interest and level of influence of each stakeholder group central to the planned activity. The engagement plan is inclusive and ensures the right information gets distributed at the right time to keep the project on schedule. Phases 1, 2, and 3 have been completed through the conceptual, preliminary, and detailed design processes. Phase 4 and 5 will be ongoing throughout the construction process.

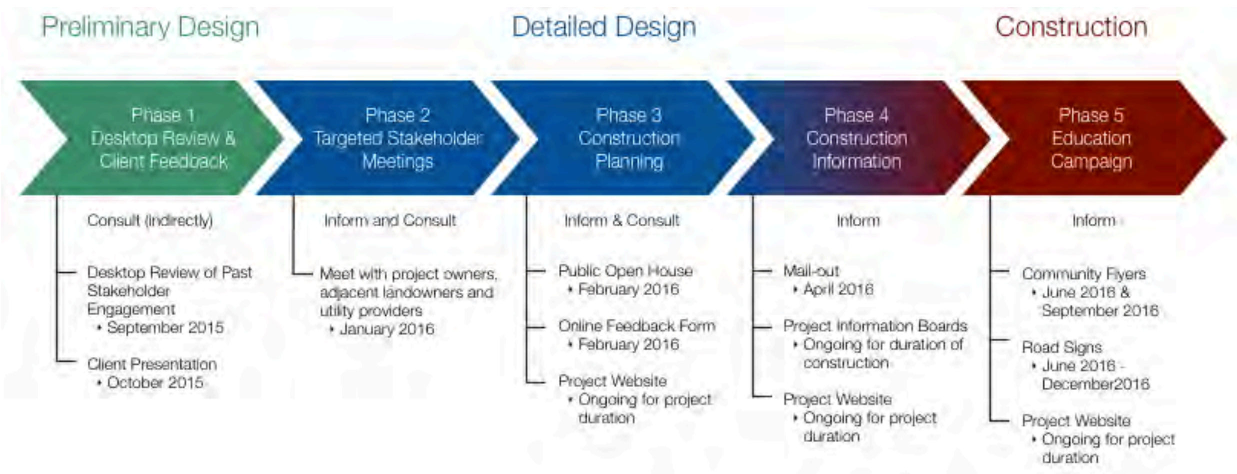


Figure 24: Stakeholder Engagement Plan

Key Aspects of the remaining stakeholder engagement phases include:

- ***Phase 4 – Construction Information:*** The project team will work with UBC to ensure all relevant construction information lane closures and detours are distributed to stakeholders in the days leading up to construction and at the start of every new construction stage. Nearby residents, intersection users and adjacent landowners or building occupants will be specifically targeted in this phase along with the information dissemination measures enacted for the general public through the project website.

- ***Phase 5– Education Campaign*:** While there are three existing roundabouts on UBC Campus, roundabouts are a fairly recent addition to the campus roadway network. Many jurisdictions in Canada have found that educating users prior to and during the first months of installation can reduce undesirable driver behaviour and complaints. Public education will be achieved though a combination of road signs, community flyers, web materials and staging construction. These measures will allow drivers to see the roundabout evolve and drive through it during construction. This phase will begin when road construction begins and will continue for the first four months of operation.

9.0 Closing

Van Augustine Consultants proposes a roundabout for the redesign of NW Marine Dr.-East Mall-Chancellor Blvd. intersection. The roundabout incorporates several features to improve intersection safety, operational efficiency, and sustainability. Most notably, roundabout geometry is optimized for safer use; proposed lane widths, turning and entry/exit radii are engineered for reduced traffic speeds. While reducing vehicular collision risk, slower traffic also makes the intersection safer for cyclists and pedestrians. Furthermore, the addition of a bike parking facility featuring a green roof is proposed as the gateway feature for the intersection. Named the Bike Garden, the structure will house 84 bikes and will reflect UBC's continued commitment to sustain green building design and alternate transport modes.

Overall, the redesigned intersection adds 910 m^2 of pervious area to the site and 1215 m^2 of landscaped area is converted to rain gardens to retain stormwater and mitigate existing cliff erosion issues north of the intersection. New catchbasins are also being added to increase stormwater capture. Most of the captured stormwater will be diverted through a Stormceptor Oil and Grit separator to an 800m^3 underground stormwater detention facility located under Chancellor Blvd. east of the roundabout. This will allow for controlled release of stormwater into the already at-capacity stormwater network in the area. The storage tank also provides opportunity for utilizing any collected water for irrigation of the proposed as well as existing landscape

By the pre-tender cost estimate, this proposed redesign will require an investment of $1.59 million for a September 2016 delivery. In terms of construction staging, Bike Garden construction begins May 1st, 2016, and roadwork beings June 3rd, 2016. This staging avoids potential conflicts between roadwork and the traffic surges associated with the annual UBC graduation ceremonies hosted at Chan Centre situated to the immediate southwest of the intersection. Additionally, all roadwork will be performed with comprehensive traffic management, and only periodic detours and partial closures. Finally, the redesigned intersection will be commissioned on September 1st, in time for the 2016-17 school year.

Van Augustine Consultants will continue to involve stakeholders in the final stages of design. Crossing agreement requests will be sent to utility providers and a meeting will be setup between the Ministry of Transportation and Infrastructure and Metro Vancouver to mitigate the right-of-way conflicts. In addition, the project team will also seek input on the construction staging plan from the stakeholders including nearby residents, intersection users, and nearby event facility managers. Their feedback will ensure that the construction of the new roundabout is efficient and user friendly. The stakeholder engagement plan involves a public open house, an online feedback forum hosted on a public website with detailed information and periodic updates on the project.

Van Augustine Consultants have designed the project and planned the construction conservatively to mitigate risks and minimize impact to the schedule and budget. The proposed roundabout, stormwater management system, and Bike Garden will showcase UBC's goals and commitment towards sustainable and safe design to all those entering the campus.

References

Bell, J. (2012). *Overland Flow Route Assessment – Final*. Vancouver: Urban Systems

BC Landscape & Nursery Association, (2012). *BC Landscape Standard*. Surrey: BC Landscape & Nursery Association

BC Ministry of Transportation and Infrustructure. (2013). *Project Cost Estimating Guidelines Version 01.02.* Project Management Support Services. Vancouver: BC Ministry of Transportation and Infrustructure.

BCG Engineering Inc. (2009). *Metro Vancouver Regional IDF Curves, Metro Vancouver Climate Stations: Phase 1 Final.* Burnaby: Metro Vancouver.

British Columbia Codes, (2012). *BC Building Code – 2012*. Victoria: Province of British Columbia.

British Columbia Ministry of Water, Land and Air Protection, (2002). *Stormwater Planning: A Guidebook for British Columbia.* Victoria: Province of British Columbia.

Bunt & Associates. (2016). *UBC CIVL 446 Presentation.* Vancouver: Bunt & Associates.

CSA Group, (2009). *CAN/CSA S16-09 - Design of steel structures: Seventh Edition 2009.* Vancouver: CSA Group

CSA Group, (2004). *CAN/CSA-A23.3-04 (R2010) - Design of Concrete Structures: Fifth Edition 2004.* Vancouver: CSA Group

CSA Group, (2012). *CAN/CSA S136-12 - North American specification for the design of cold-formed steel structural members and S136.1-12 - Commentary on North American specification for the design of cold-formed steel structural members, 2012.* Vancouver: CSA Group

Fisheries and Oceans Canada, (2001). *Urban Stormwater Management Guidelines.* Vancouver: Fisheries and Oceans Canada

Geological Survey of Canada. (1998). *Geo-Map Vancouver*. Vancouver: Natural Resources Canada.

Imbrium, (2015). Stormceptor STC Technical Manual. Imbrium Systems LLC.

Kittleton Associates Inc. (2014). *Kansas Roundabout Guide: Second Edition 2014.* Kansas Department of Transportation.

Lanac Consultants, Kerr Wood Leidel Associates Ltd. & Goya Ngan, (2012). *Stormwater Source Control Guidelines 2012*. Vancouver: Metro Vancouver.

Ministry of Transportaion and Infrustructure (MoTI). (2015). *Pavement Strucutre Design Guidelines.* Geotechnical, Materials and Pavement Engineering. Vancouver: Government of British Columbia.

Ministry of Transportaion and Infrustructure (MoTI). (2000). *Manual of Standard Traffic Signs and Pavement Markings.* Geotechnical, Materials and Pavement Engineering. Vancouver: Government of British Columbia.

National Research Council Canada, (2010). *NRCC, National Building Code - Canada*, Ottawa: National Research Council Canada

Russel, P. (2005). *A Sustainable Drainage Strategy for the South Campus Neighborhood*. Vancouver: Aplin & Martin Consultants Ltd. & Holland Barrs Planning Group Inc.

StormTrap, (2011a). *StormTrap System Installation Guide.* Holcim: Humes Water Solutions.

StormTrap, (2011b). *StromTrap LEED Contribution.* Retrieved March, 2016 fron: http://stormtrap.com/sustainability/leed-accreditation/.

University of British Columbia (UBC). (2006). *16th Avenue Consultaiton Report.* Campus and Community Planning. Vancouver: University of British Columbia.

Univeristy of British Columbia (UBC). (2012). *UBC Campus Plan, Vancouver Campus.* The University of British Columbia, Vanouver. UBC.

Univeristy of British Columbia (UBC). (2014a). *Integrated Stromwater Managmenet Plan.* The University of British Columbia, UBC Sustaiability and Engineering, UBC Campus + Community Planning. Vancouver: UBC.

Univeristy of British Columbia (UBC). (2014a). *UBC Transportation Plan, Vancouver Campus.* The University of British Columbia, UBC Campus + Community Planning. Vancouver: UBC.

University of British Columbia (UBC). (2014b). *UBC 20-Year Sustainability Strategy.* Vancouver: University of British Columbia.

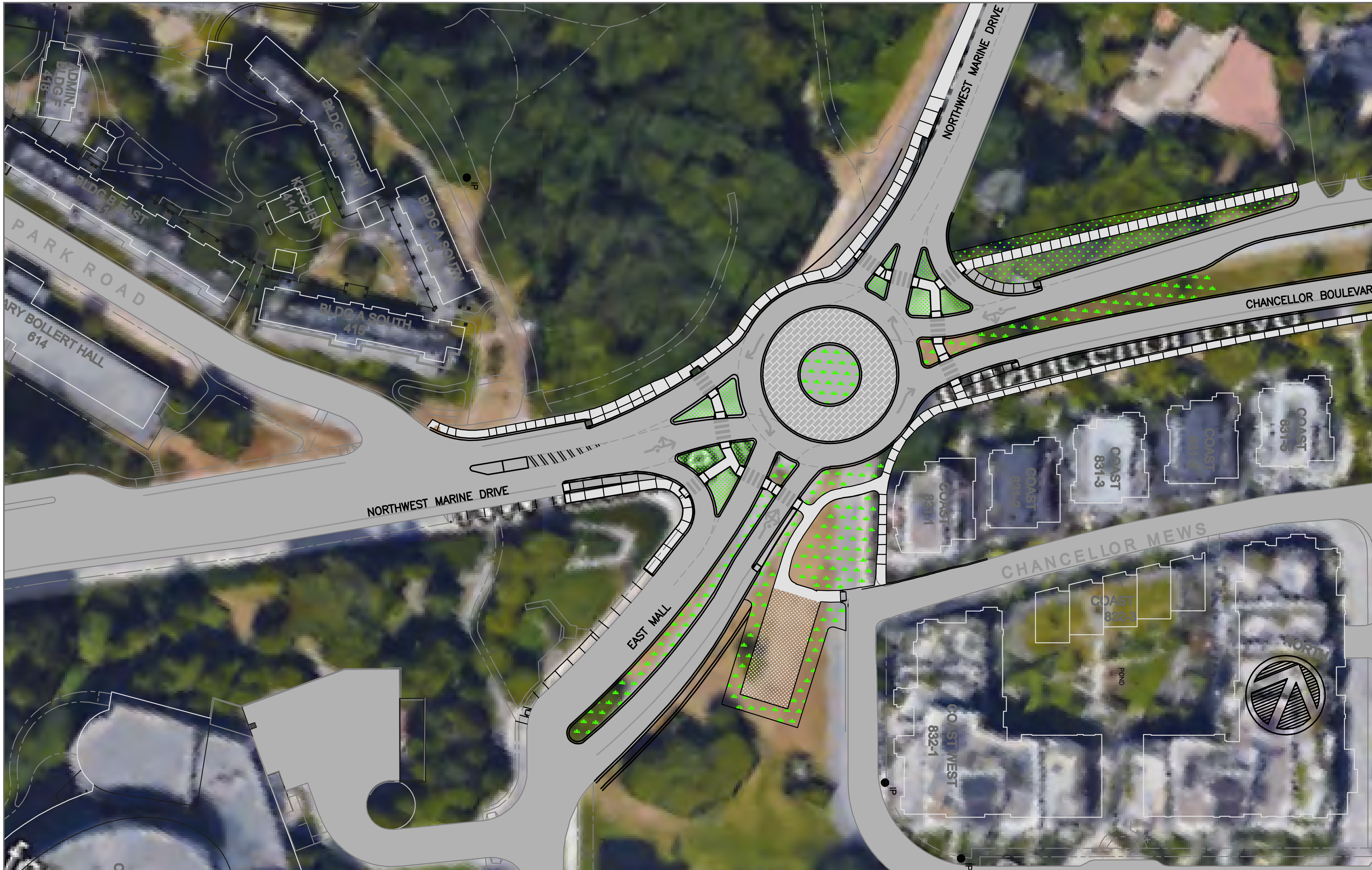
Univeristy of British Columbia (UBC), (2015). *Miscellaneous Sections* (*Section 02999): UBC Technical Guidelines – 2015 Edition.* Vancouver: University of British Columbia.

Univeristy of British Columbia (UBC) Energy & Water Services, (2015). *UBC Catchments.* Retrived April, 2016 from: http://energy.ubc.ca/ubcs-utility-infrastructure/storm-sewer/

WDO. (2013). *Waste Diversion Ontario's 2013 Stakeholder Engagement Plan.* Toronto: Waste Diversion Ontario.

APPENDIX A

IFT Drawing Set



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PLAN RENDERING

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SUBMISSION TITLE:

DETAILED DESIGN
TEAM 5

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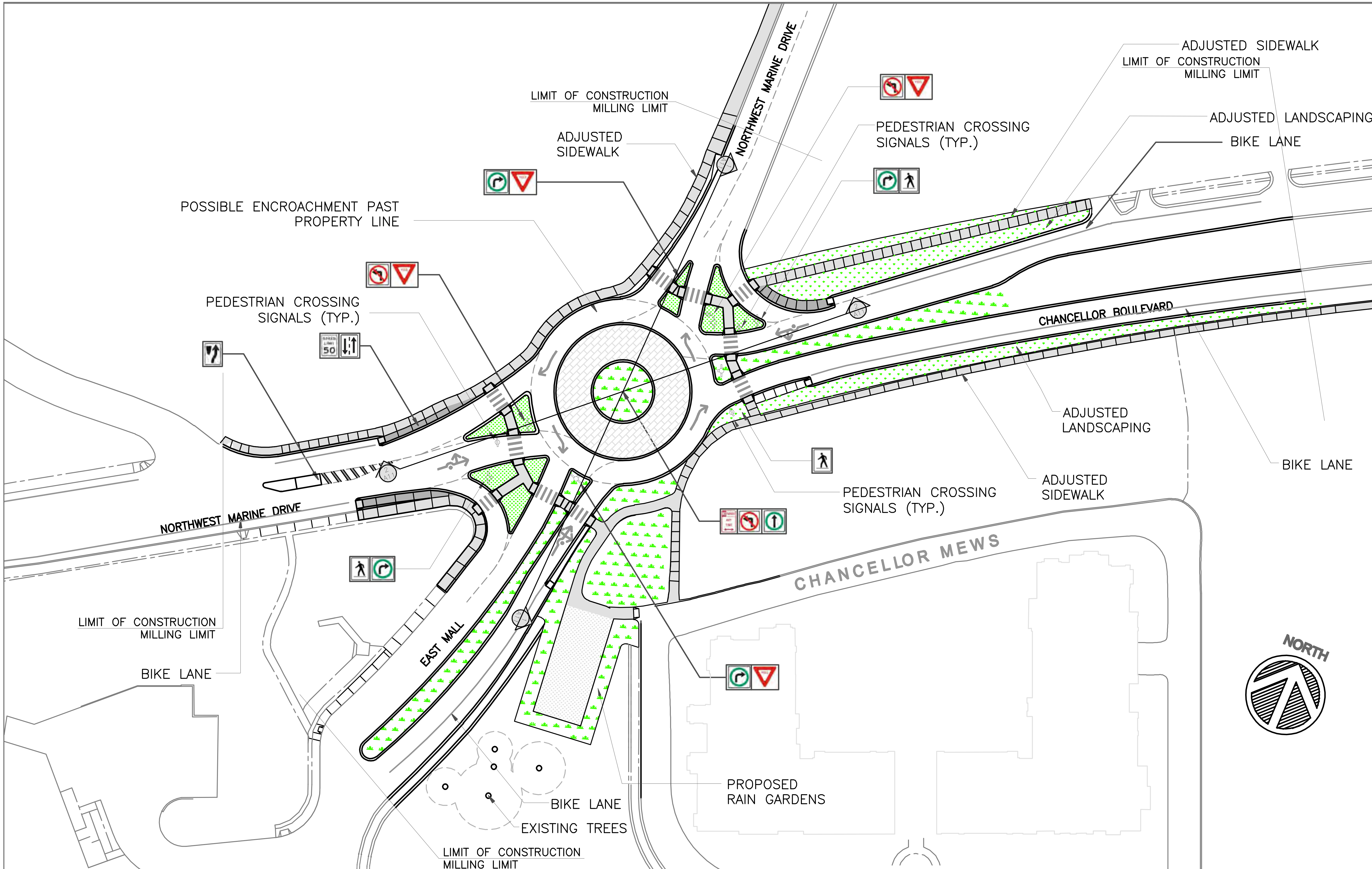

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SIGNAGE AND TRAFFIC FLOW PLAN

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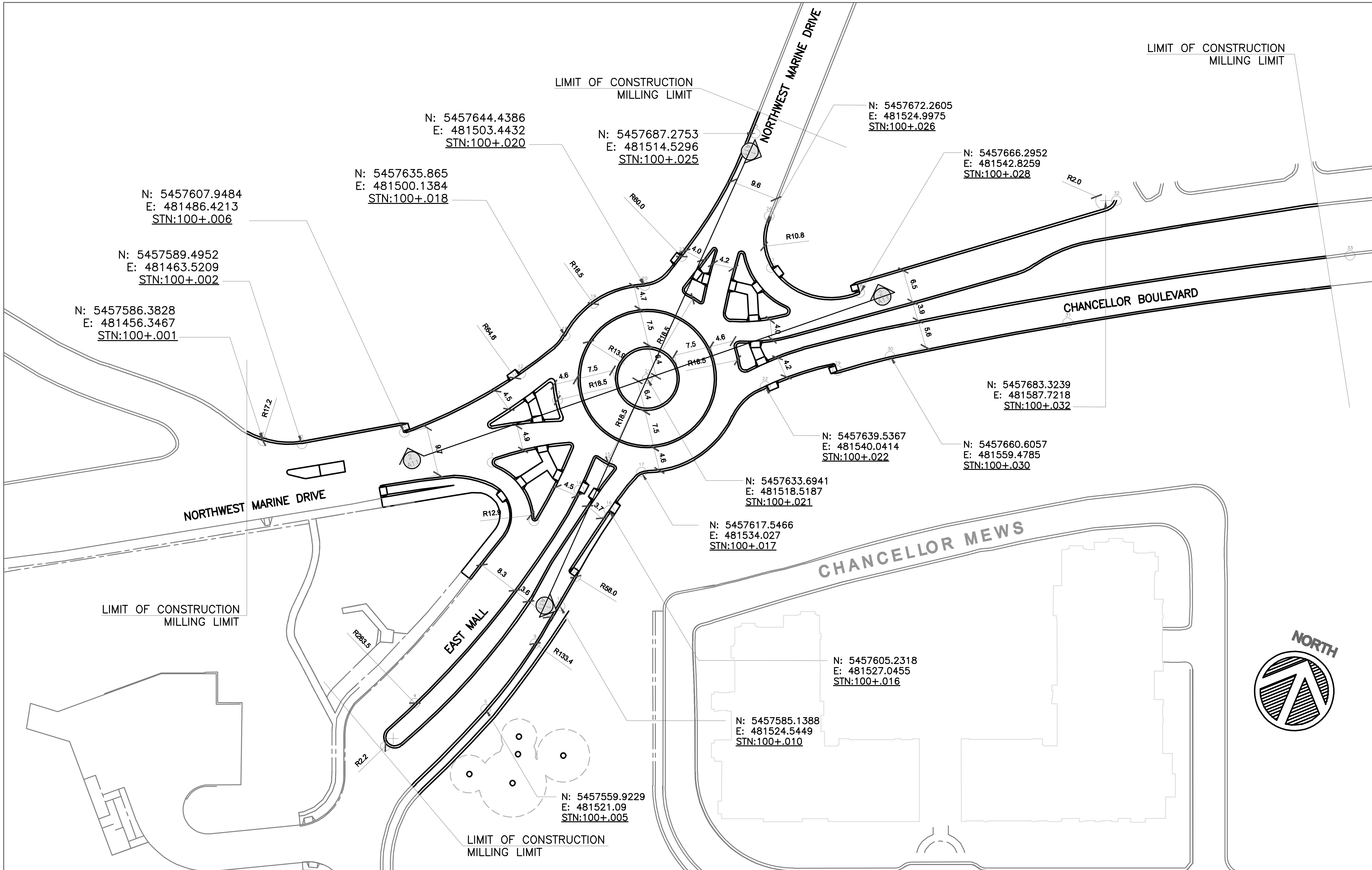

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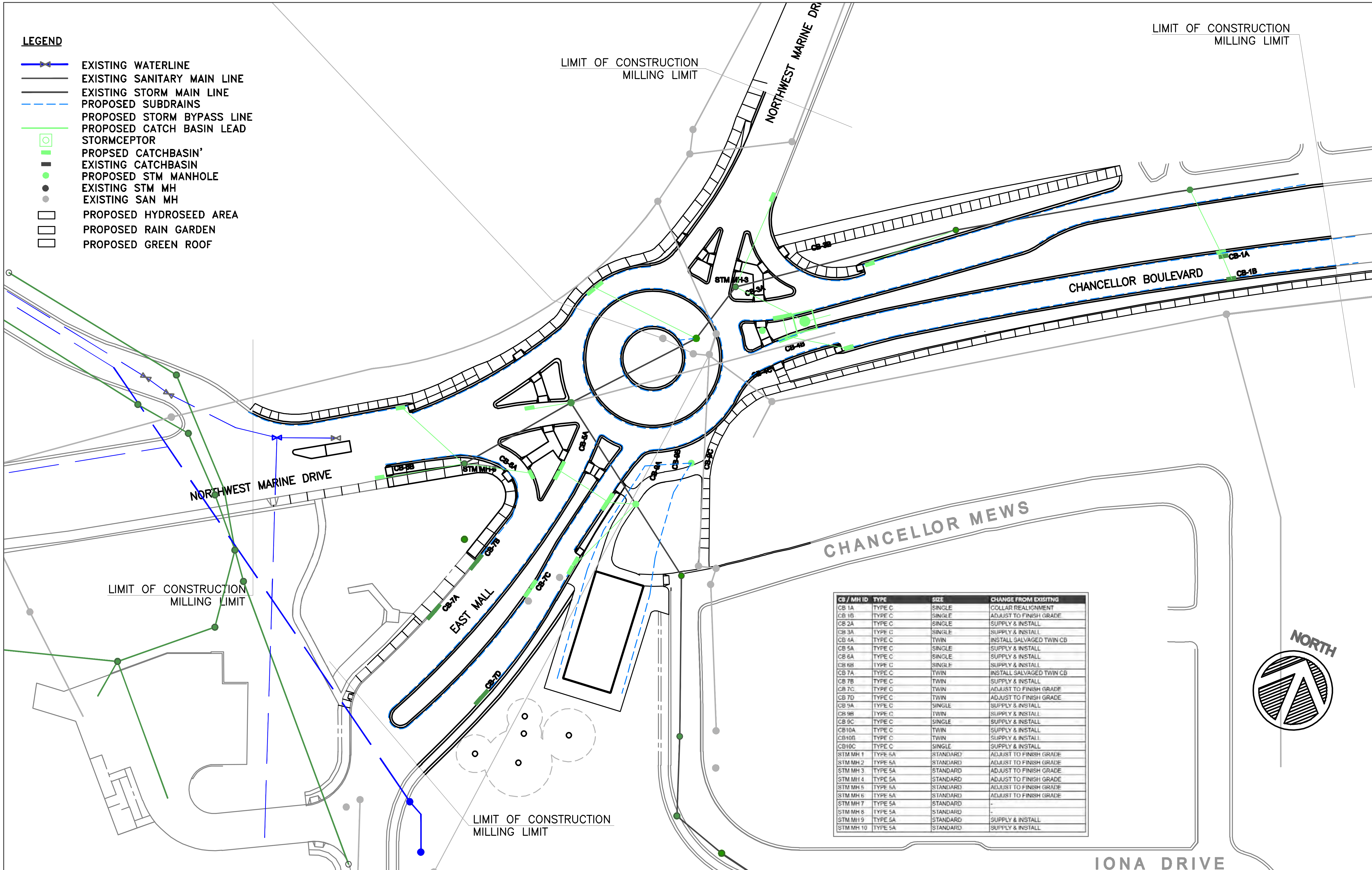

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CB 1A	TYPE C	SINGLE	COLLAR REALIGNMENT
CB 1B	TYPE C	SINGLE	ADJUST TO FINISH GRADE
CB 2A	TYPE C	SINGLE	SUPPLY & INSTALL
CB 3A	TYPE C	SINGLE	SUPPLY & INSTALL
CB 4A	TYPE C	TWIN	INSTALL SALVAGED TWIN CB
CB 5A	TYPE C	SINGLE	SUPPLY & INSTALL
CB 6A	TYPE C	SINGLE	SUPPLY & INSTALL
CB 6B	TYPE C	SINGLE	SUPPLY & INSTALL
CB 7A	TYPE C	TWIN	INSTALL SALVAGED TWIN CB
CB 7B	TYPE C	TWIN	SUPPLY & INSTALL
CB 7C	TYPE C	TWIN	ADJUST TO FINISH GRADE
CB 7D	TYPE C	TWIN	ADJUST TO FINISH GRADE
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CB 9B	TYPE C	TWIN	SUPPLY & INSTALL
CB 9C	TYPE C	SINGLE	SUPPLY & INSTALL
CB10A	TYPE C	TWIN	SUPPLY & INSTALL
CB10B	TYPE C	TWIN	SUPPLY & INSTALL
CB10C	TYPE C	SINGLE	SUPPLY & INSTALL
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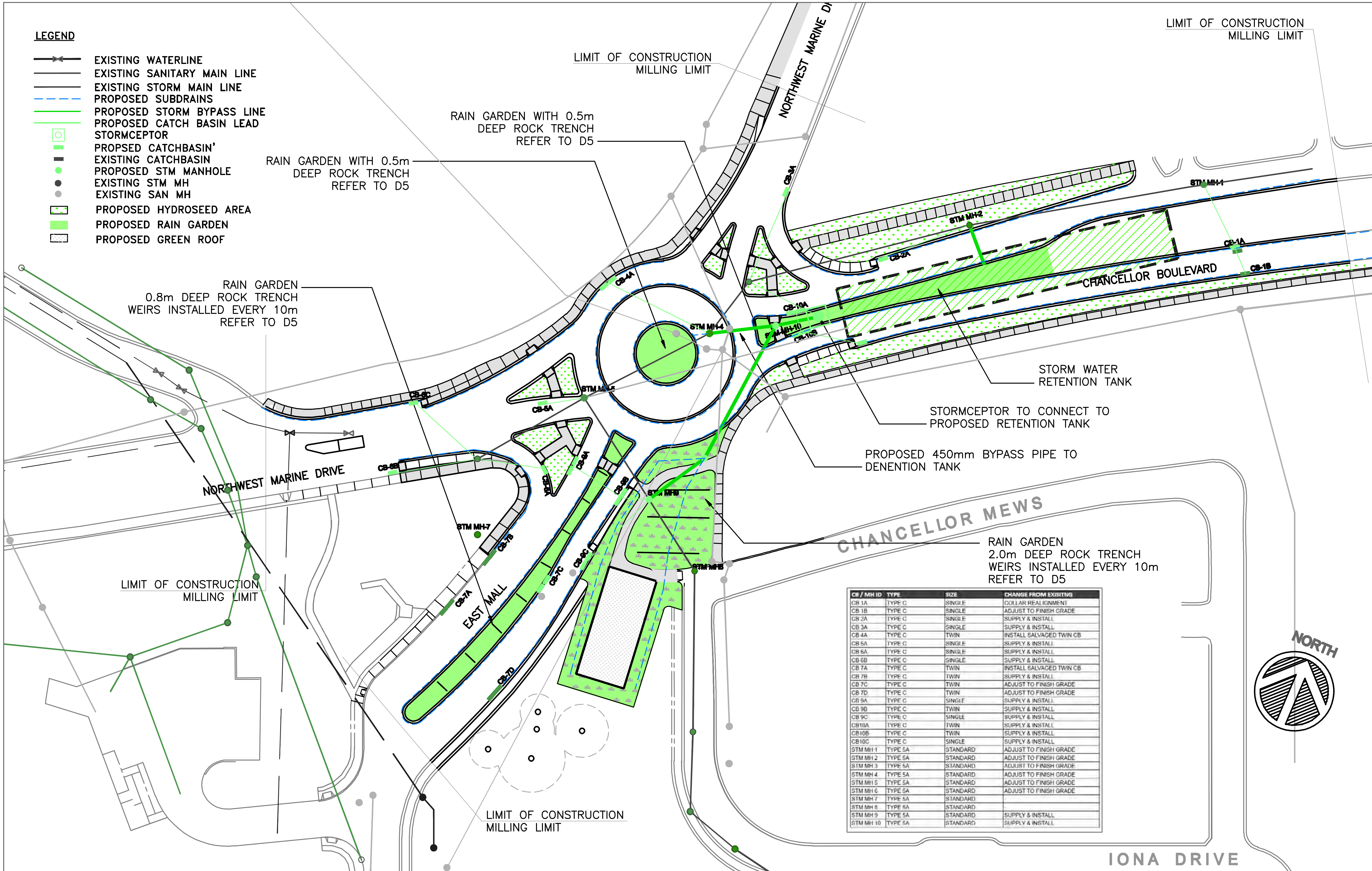

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CB 3A	TYPE C	SINGLE	SUPPLY & INSTALL
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CB 6A	TYPE C	SINGLE	SUPPLY & INSTALL
CB 6B	TYPE C	SINGLE	SUPPLY & INSTALL
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CB 7B	TYPE C	TWIN	SUPPLY & INSTALL
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PROPOSED STORM WATER MANAGEMENT PLAN

SCALE:

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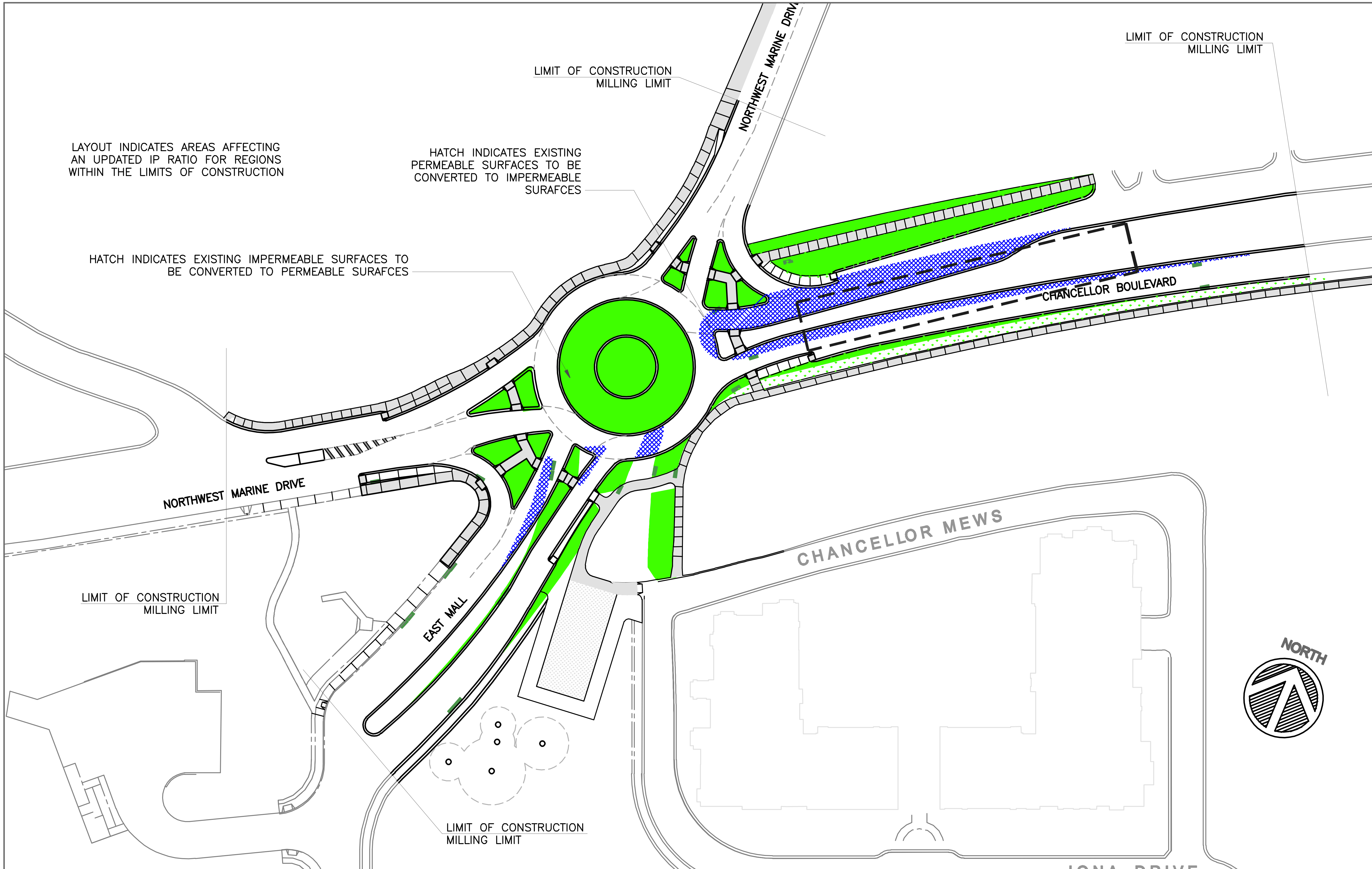

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SCALE:

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CHANCELLOR BLVD, EAST MALL, NW MARINE DR INTERSECTION DESIGN

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DETAILED DESIGN
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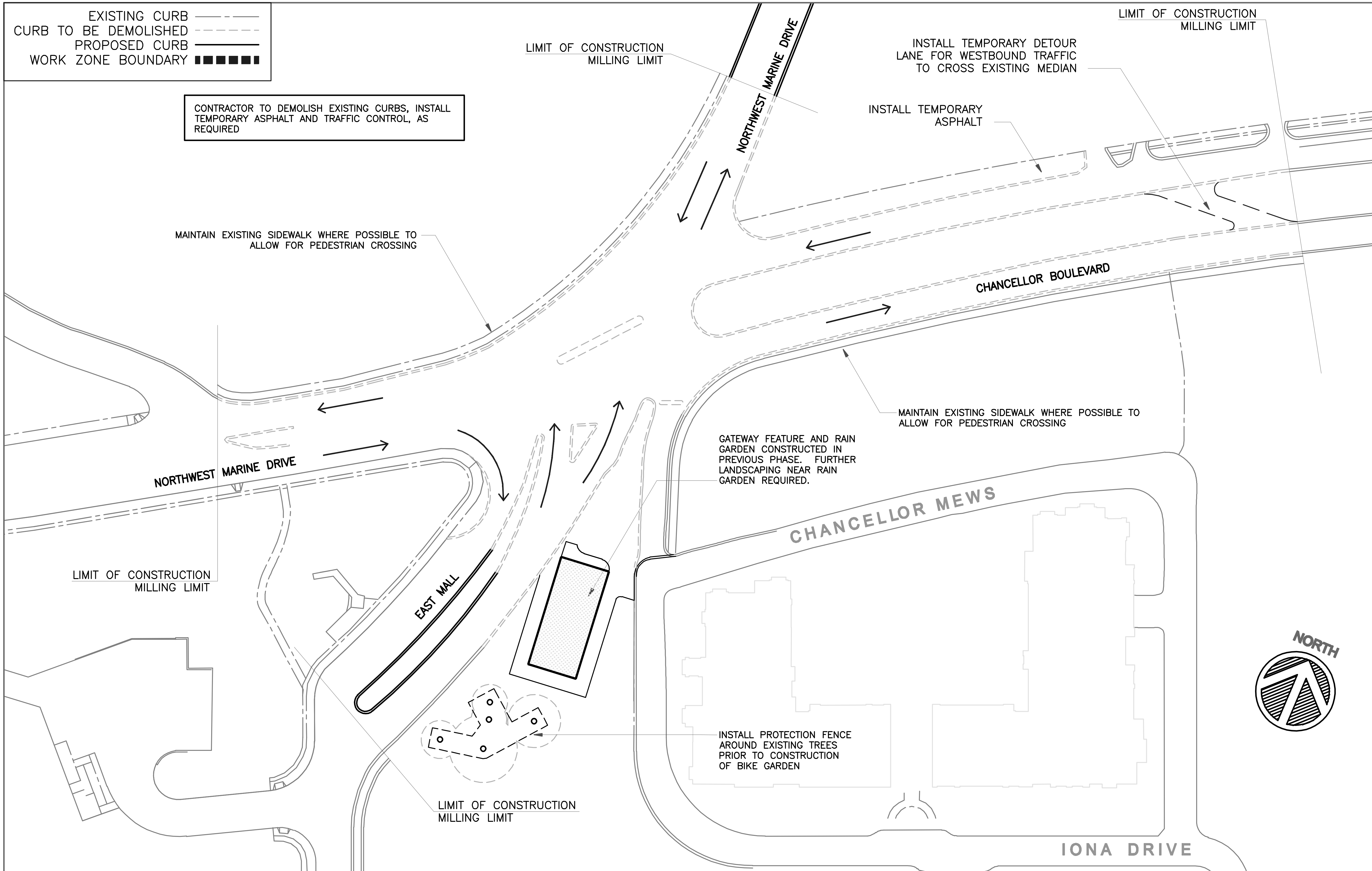

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PHASE 3 REMOVALS AND DETOUR ROAD CONST.

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CHANCELLOR BLVD, EAST
MALL, NW MARINE DR INTERSECTION DESIGN

SUBMISSION TITLE:
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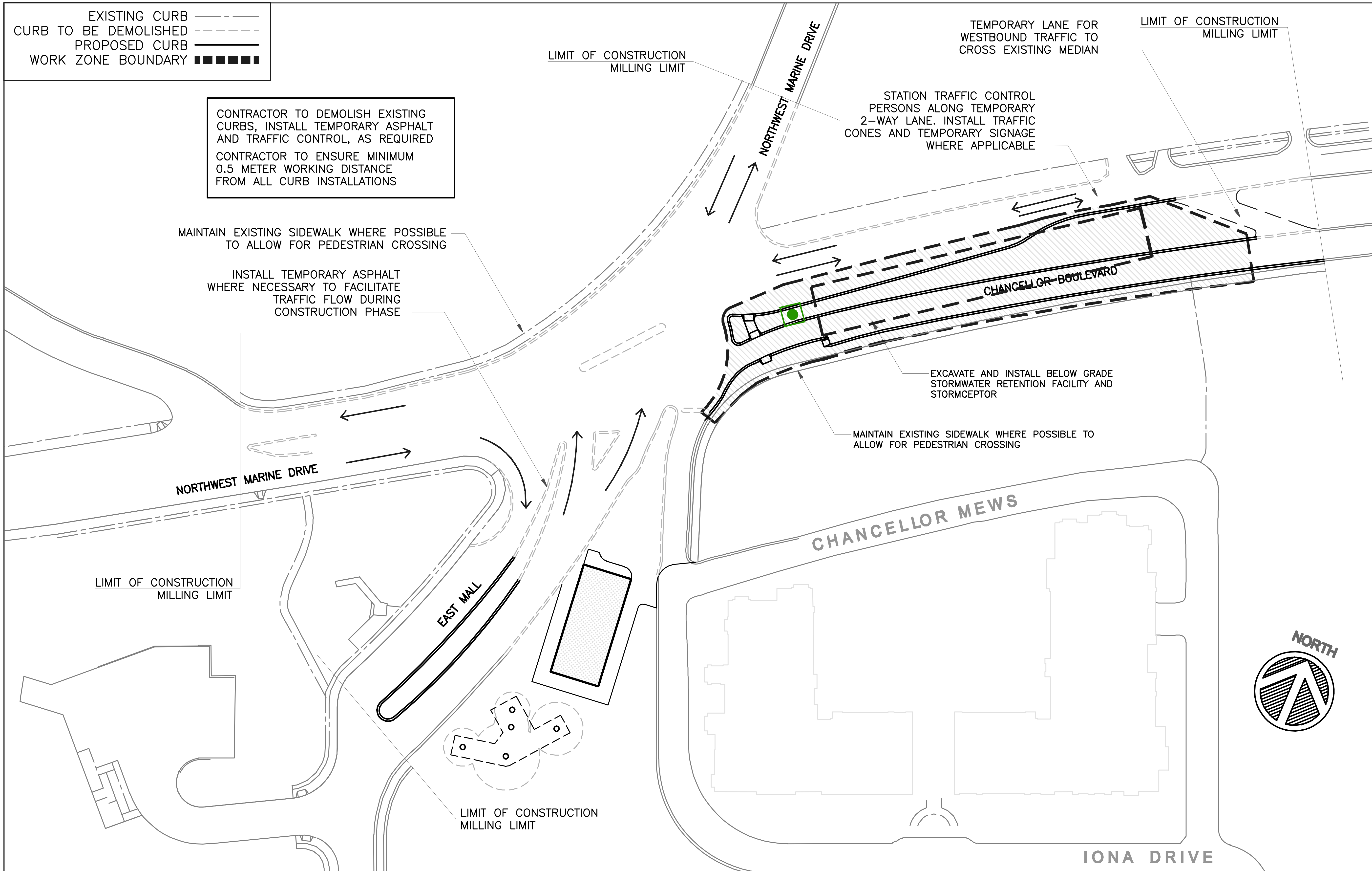

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ISSUE FOR CONSTRUCTION	XX/16

DRAWING TITLE

PHASE 4 SOUTH CHANCELLOR BLVD CONST.

SCALE:

1 : 750

PROJECT

CHANCELLOR BLVD, EAST **MALL, NW MARINE DR INTERSECTION DESIGN**

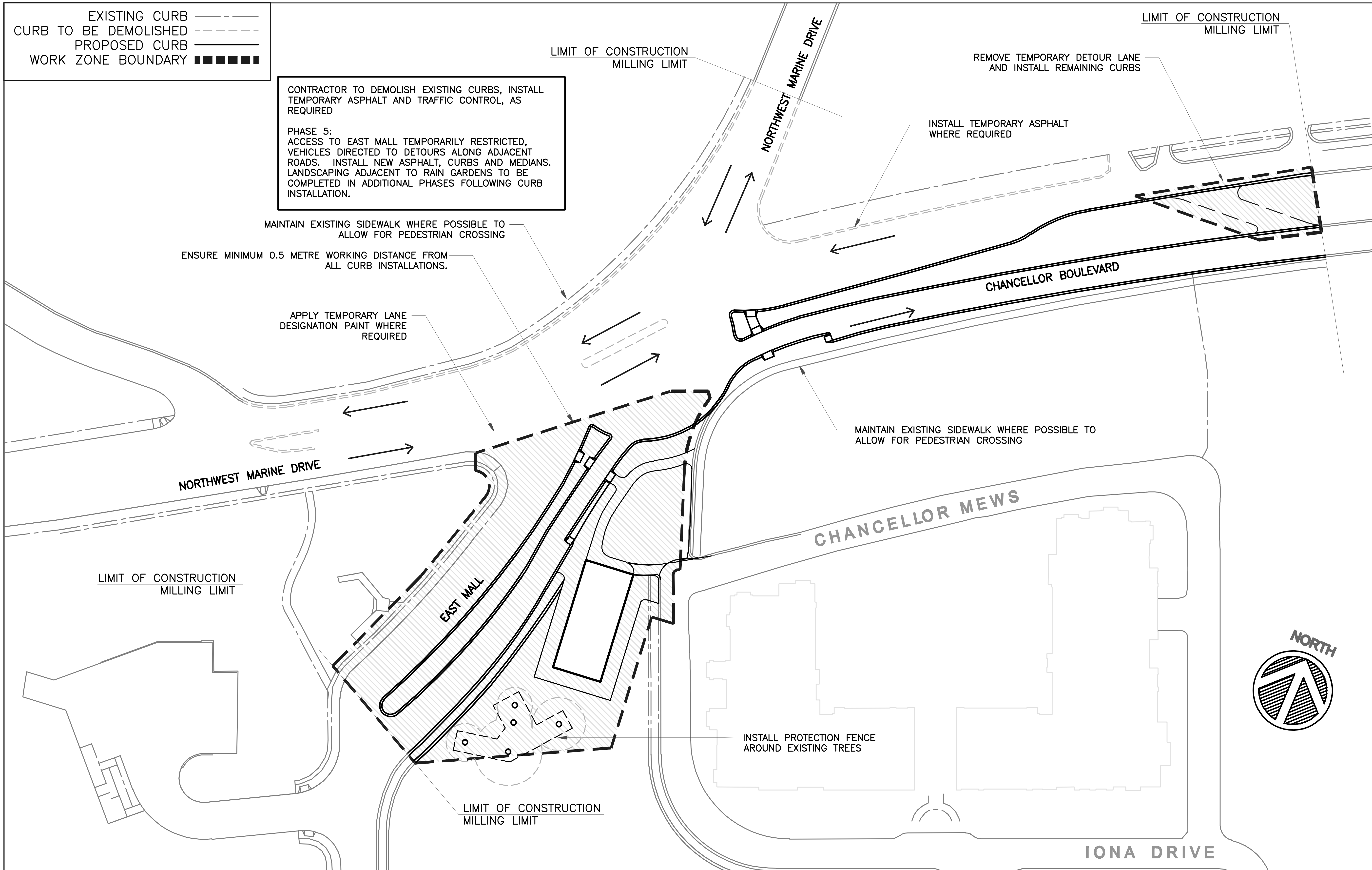
SUBMISSION TITLE:

DETAILED DESIGN
TEAM 5

DATE

APRIL 2016

A6



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DRAWING REVISIONS:

ISSUE FOR CLIENT REVIEW 1	XX/15
INTERMEDIATE DESIGN REVIEW 1	XX/16
INTERMEDIATE DESIGN REVIEW 2	XX/16
ISSUE FOR BID	XX/16
ISSUE FOR CONSTRUCTION	XX/16

DRAWING TITLE

PHASE 5 EAST MALL CONSTRUCTION

SCALE:

1 : 750

PROJECT

CHANCELLOR BLVD, EAST **MALL, NW MARINE DR INTERSECTION DESIGN**

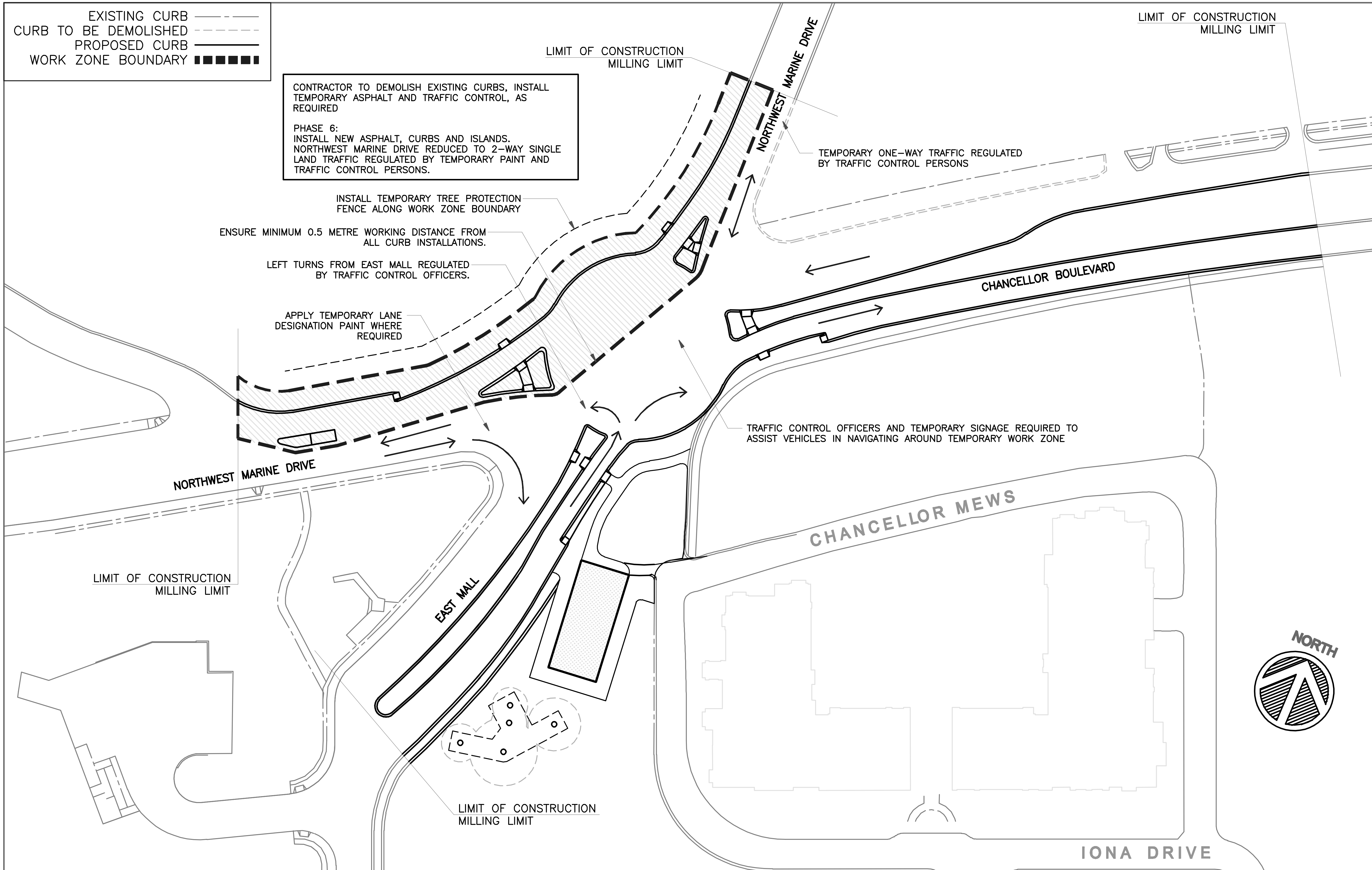
SUBMISSION TITLE:

DETAILED DESIGN **TEAM 5**

DATE

APRIL 2016

A7



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UBC

DRAWING REVISIONS:

ISSUE FOR CLIENT REVIEW 1	XX/15
INTERMEDIATE DESIGN REVIEW 1	XX/16
INTERMEDIATE DESIGN REVIEW 2	XX/16
ISSUE FOR BID	XX/16
ISSUE FOR CONSTRUCTION	XX/16

DRAWING TITLE

NW MARINE DRIVE CONSTRUCTION

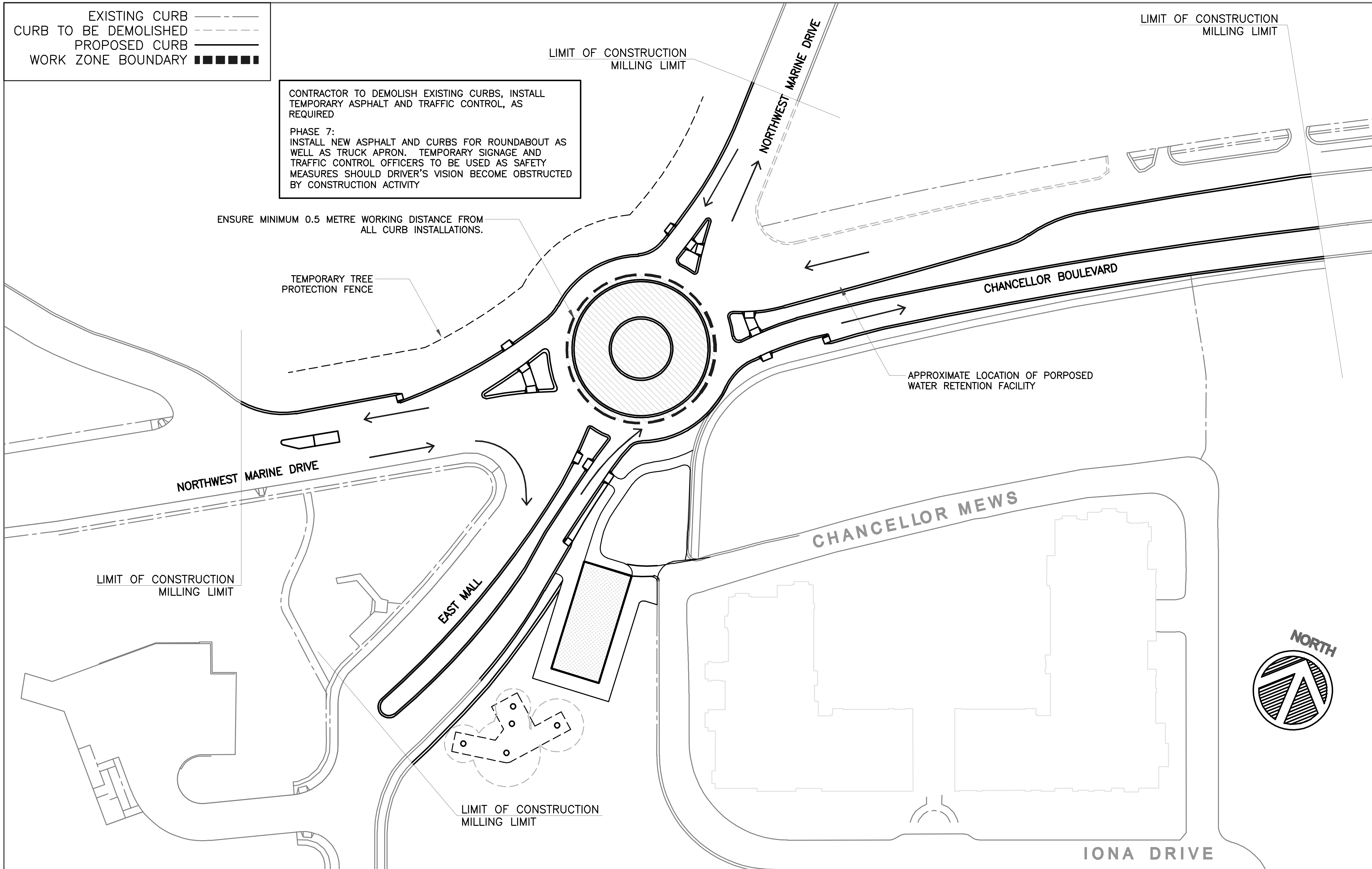
SCALE:
1 : 750

PROJECT
CHANCELLOR BLVD, EAST **MALL, NW MARINE DR INTERSECTION DESIGN**

SUBMISSION TITLE:
DETAILED DESIGN
TEAM 5

DATE
APRIL 2016

A8



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DRAWING REVISIONS:

ISSUE FOR CLIENT REVIEW 1	XX/15
INTERMEDIATE DESIGN REVIEW 1	XX/16
INTERMEDIATE DESIGN REVIEW 2	XX/16
ISSUE FOR BID	XX/16
ISSUE FOR CONSTRUCTION	XX/16

DRAWING TITLE

PHASE 7 ROUNDABOUT CONSTRUCTION

SCALE:

1 : 750

PROJECT

CHANCELLOR BLVD, EAST **MALL, NW MARINE DR INTERSECTION DESIGN**

SUBMISSION TITLE:

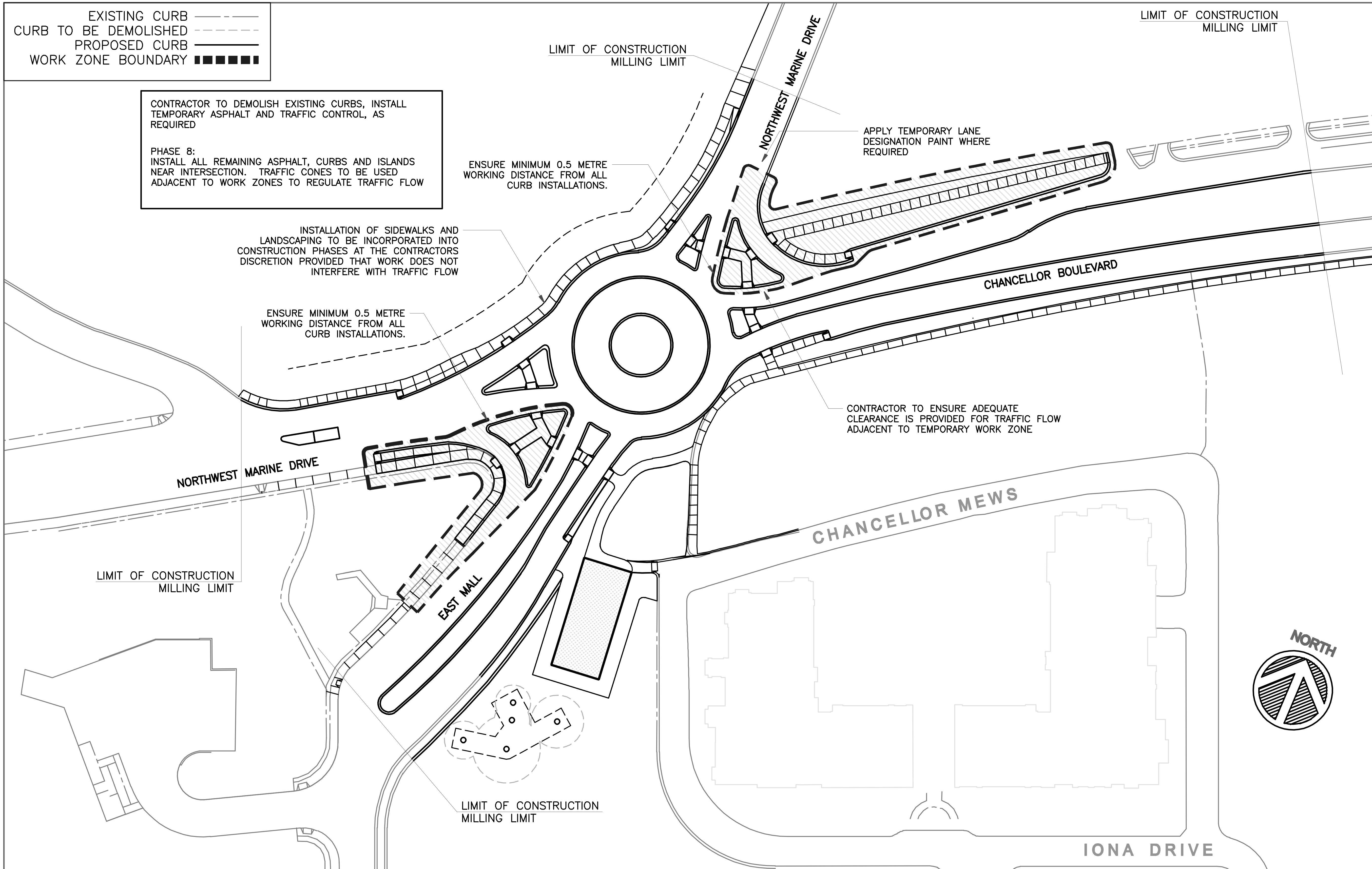
DETAILED DESIGN

TEAM 5

DATE

APRIL 2016

A9



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DRAWING REVISIONS:

ISSUE FOR CLIENT REVIEW 1	XX/15
INTERMEDIATE DESIGN REVIEW 1	XX/16
INTERMEDIATE DESIGN REVIEW 2	XX/16
ISSUE FOR BID	XX/16
ISSUE FOR CONSTRUCTION	XX/16

DRAWING TITLE

PHASE 8, 9 N. CHANCELLOR BLVD & E. MALL CONST.

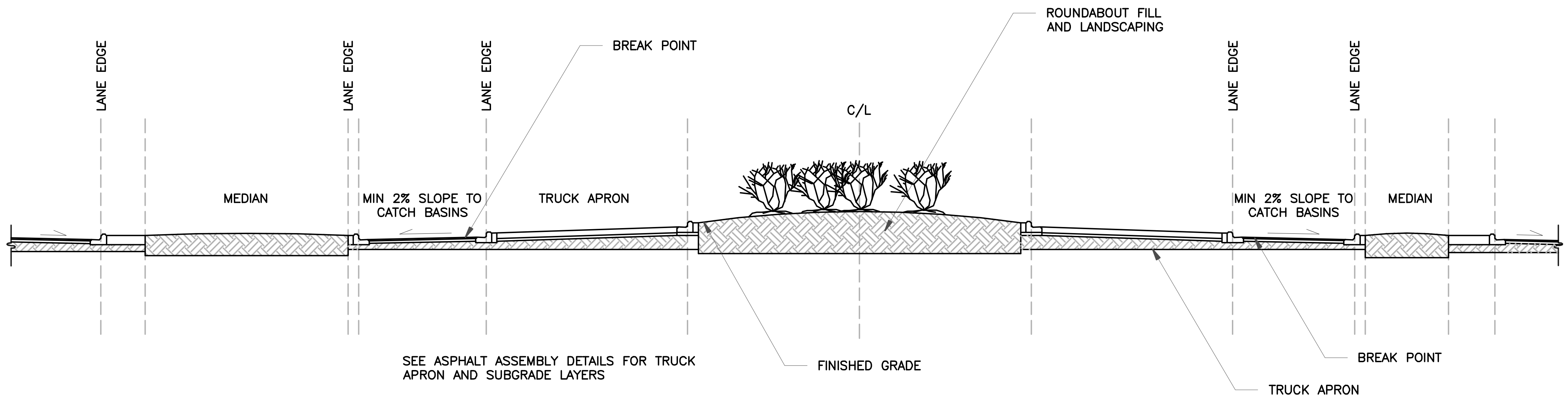
SCALE:
1 : 750

PROJECT
CHANCELLOR BLVD, EAST
MALL, NW MARINE DR INTERSECTION DESIGN

SUBMISSION TITLE:
DETAILED DESIGN
TEAM 5

DATE
APRIL 2016

A10



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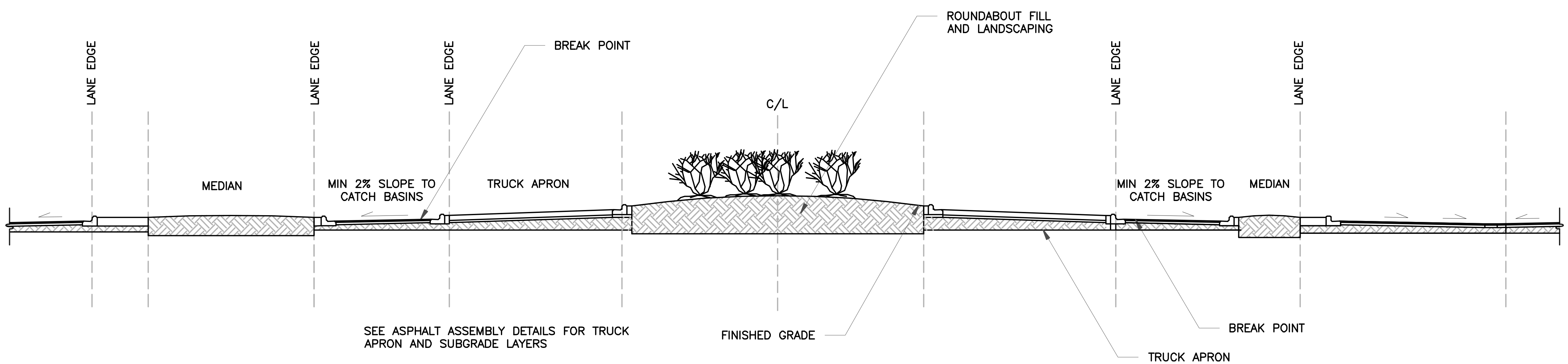
A11
FINISHED GRADE N–S ROADWAY SECTION
SCALE AS NOTED



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A11
FINISHED GRADE E–W ROADWAY SECTION
SCALE AS NOTED

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DRAWING REVISIONS:

ISSUE FOR CLIENT REVIEW 1	XX/15
INTERMEDIATE DESIGN REVIEW 1	XX/16
INTERMEDIATE DESIGN REVIEW 2	XX/16
ISSUE FOR BID	XX/16
ISSUE FOR CONSTRUCTION	XX/16

DRAWING TITLE

ROADWAY CROSS SECTIONS

SCALE:

1 : 200

PROJECT

CHANCELLOR BLVD, EAST MALL, NW MARINE DR INTERSECTION DESIGN

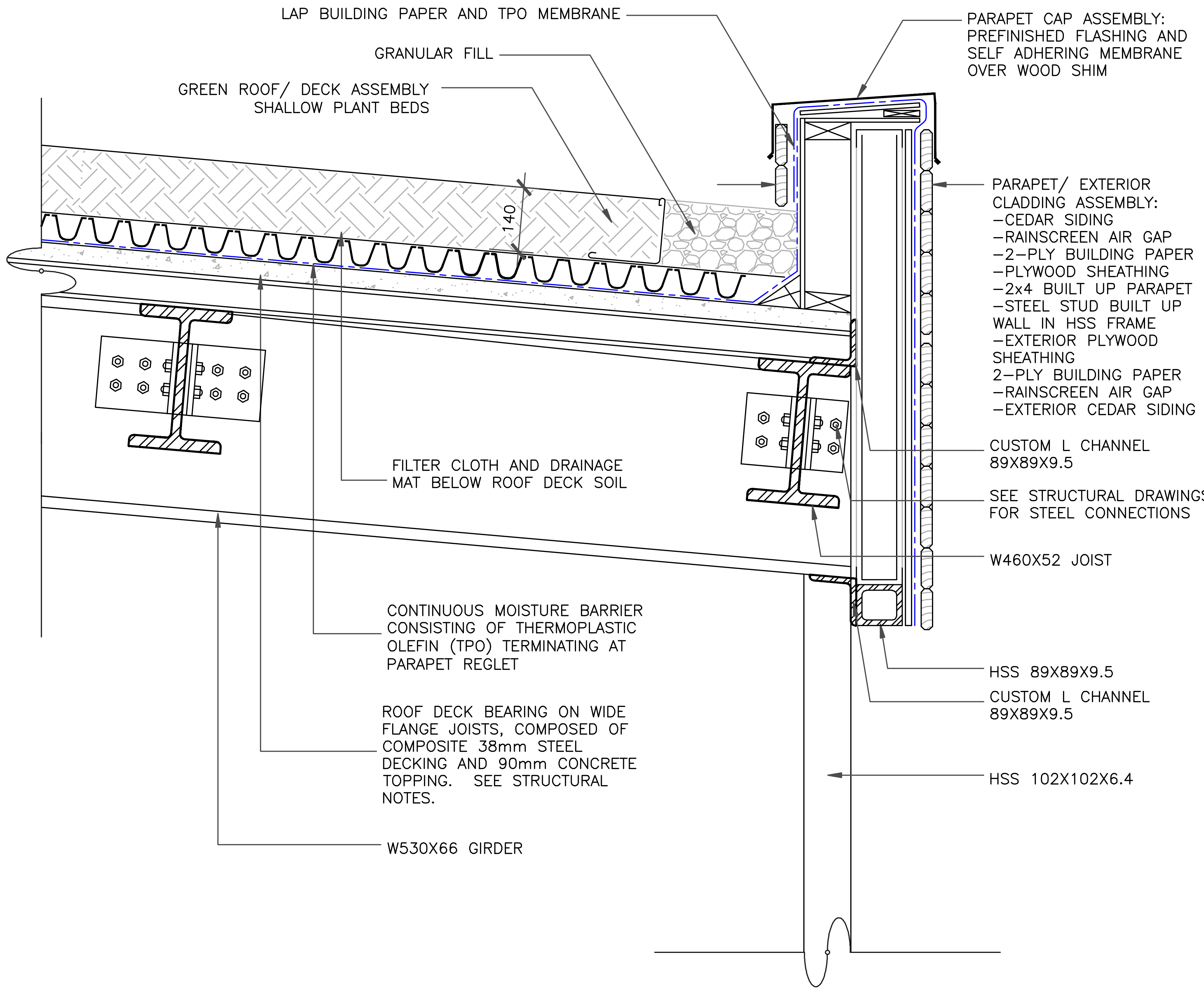
SUBMISSION TITLE:

DETAILED DESIGN TEAM 5

DATE

APRIL 2016

A11



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DRAWING REVISIONS:

ISSUE FOR CLIENT REVIEW 1	XX/15
INTERMEDIATE DESIGN REVIEW 1	XX/16
INTERMEDIATE DESIGN REVIEW 2	XX/16
ISSUE FOR BID	XX/16
ISSUE FOR CONSTRUCTION	XX/16

DRAWING TITLE

BIKE GARDEN GREEN ROOF ASSEMBLY

SCALE:

1 : 10

PROJECT

CHANCELLOR BLVD, EAST MALL, NW MARINE DR INTERSECTION DESIGN

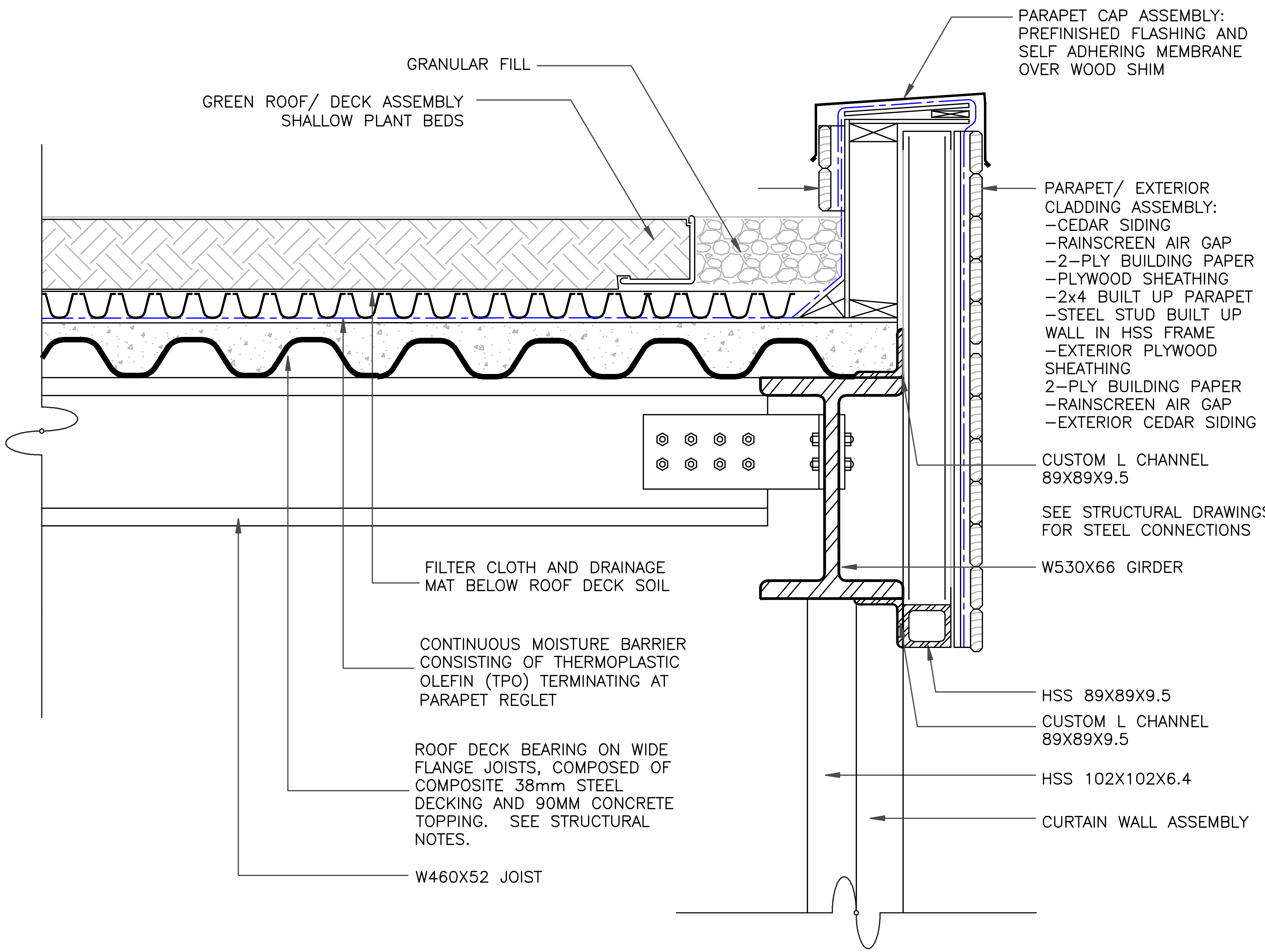
SUBMISSION TITLE:

DETAILED DESIGN TEAM 5

DATE

APRIL 2016

D1



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DRAWING REVISIONS:

ISSUE FOR CLIENT REVIEW 1	XX/ 15
INTERMEDIATE DESIGN REVIEW 1	XX/ 16
INTERMEDIATE DESIGN REVIEW 2	XX/ 16
ISSUE FOR BID	XX/ 16
ISSUE FOR CONSTRUCTION	XX/ 16

DRAWING TITLE

BIKE GARDEN GREEN ROOF ASSEMBLY

SCALE:

1 : 10

PROJECT

CHANCELLOR BLVD, EAST MALL, NW MARINE DR INTERSECTION DESIGN

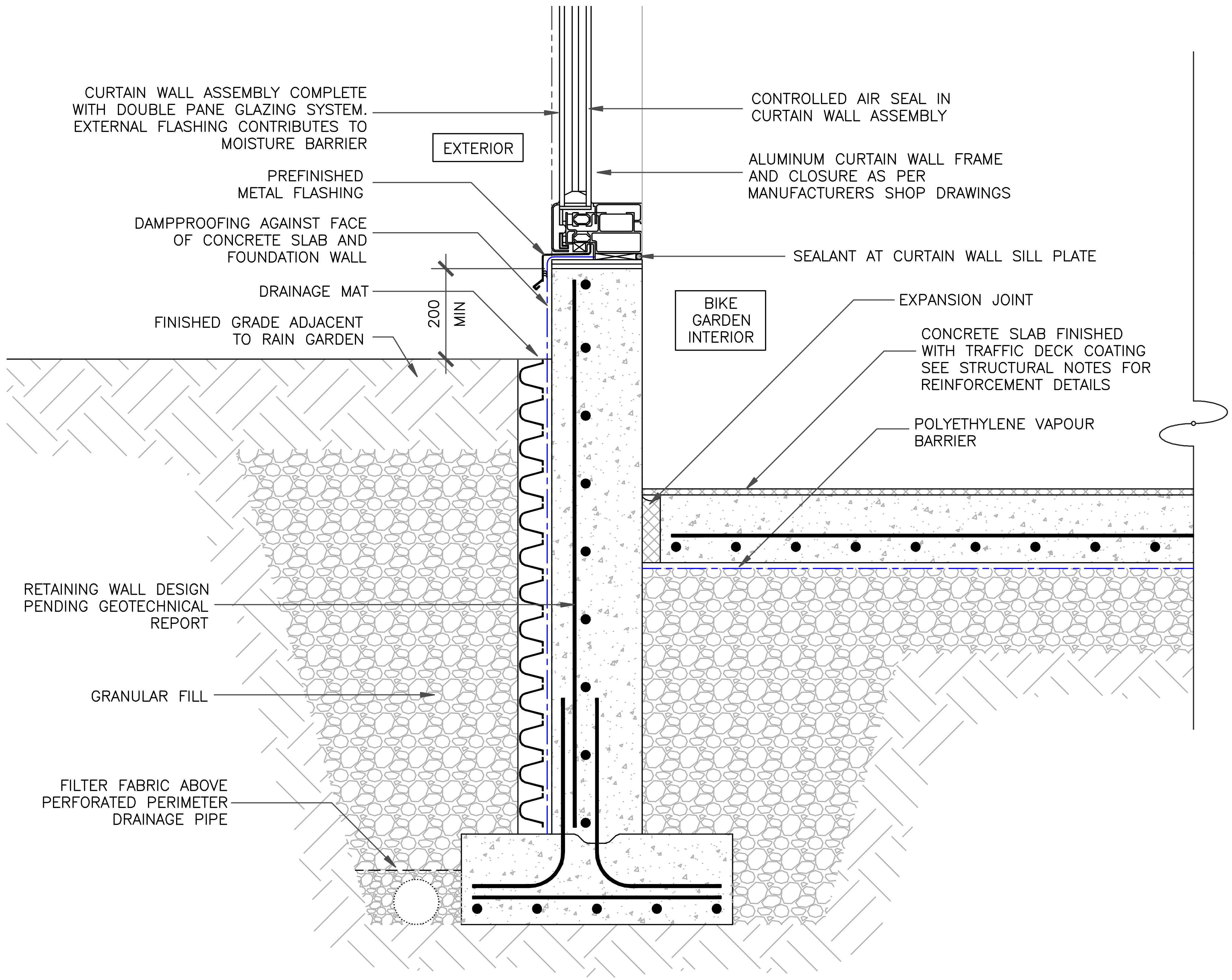
SUBMISSION TITLE:

DETAILED DESIGN TEAM 5

DATE

APRIL 2016

D2



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DRAWING REVISIONS:

ISSUE FOR CLIENT REVIEW 1	XX/15
INTERMEDIATE DESIGN REVIEW 1	XX/16
INTERMEDIATE DESIGN REVIEW 2	XX/16
ISSUE FOR BID	XX/16
ISSUE FOR CONSTRUCTION	XX/16

DRAWING TITLE

BIKE GARDEN FOUNDATION & CURTAIN WALL ASSEMBLY

SCALE:

1 : 10

PROJECT

CHANCELLOR BLVD, EAST MALL, NW MARINE DR INTERSECTION DESIGN

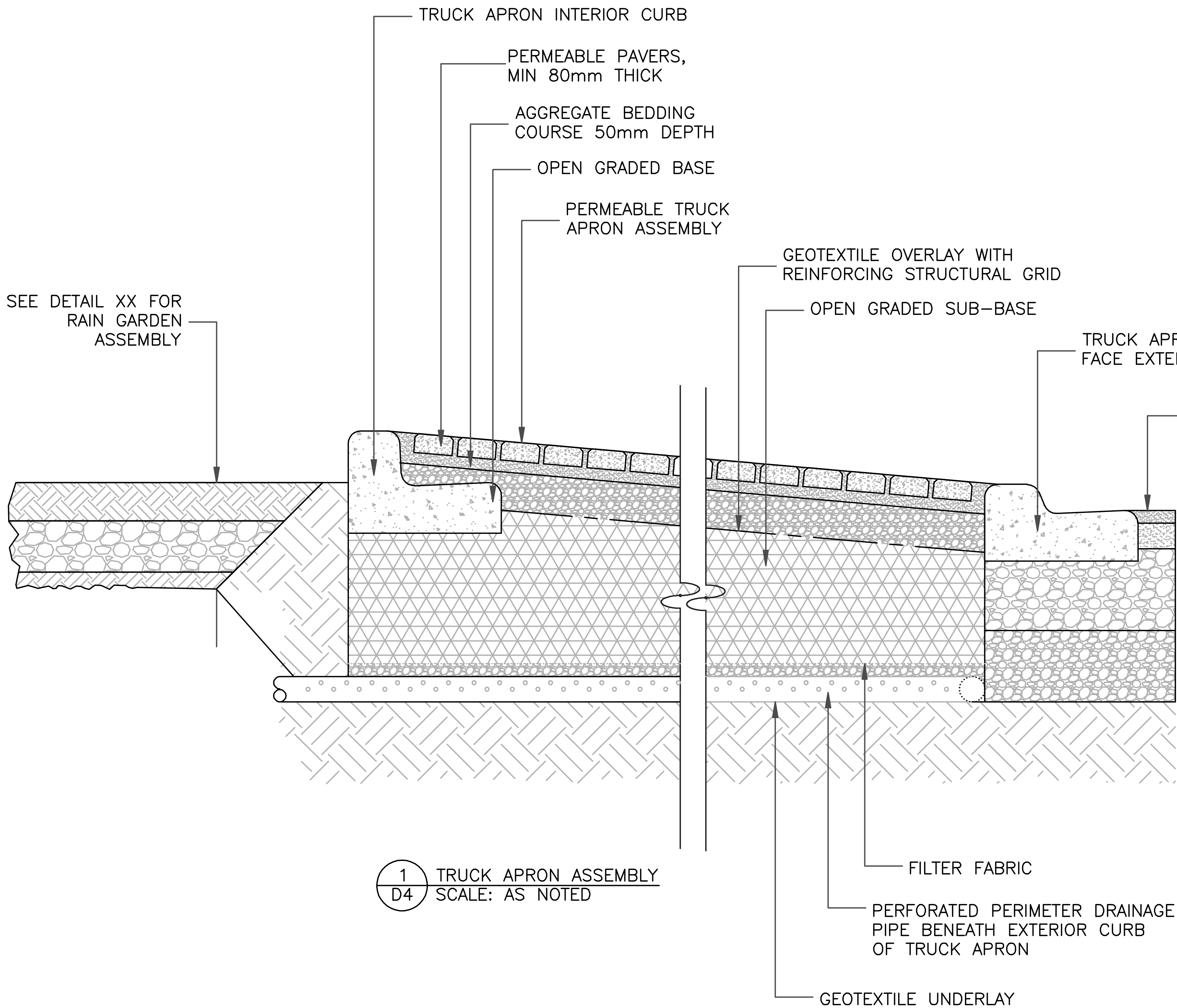
SUBMISSION TITLE:

DETAILED DESIGN TEAM 5

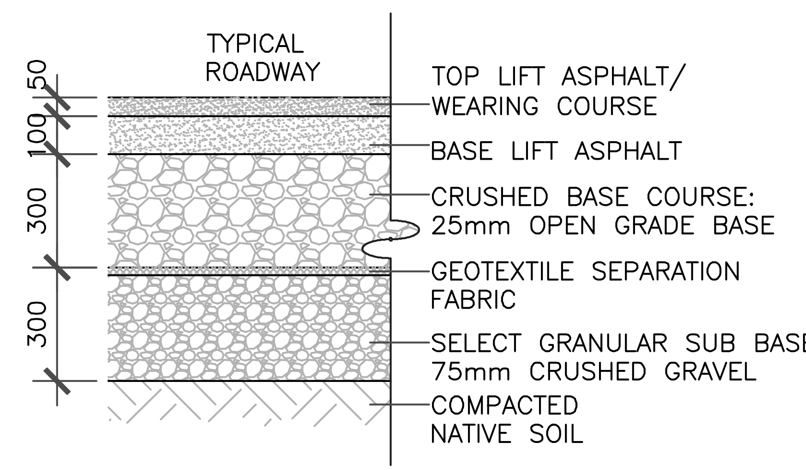
DATE

APRIL 2016

D3



1
D4
TRUCK APRON ASSEMBLY
SCALE: AS NOTED



2
D4
TYPICAL ASPHALT ASSEMBLY
SCALE: AS NOTED

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DRAWING REVISIONS:

ISSUE FOR CLIENT REVIEW 1	XX/15
INTERMEDIATE DESIGN REVIEW 1	XX/16
INTERMEDIATE DESIGN REVIEW 2	XX/16
ISSUE FOR BID	XX/16
ISSUE FOR CONSTRUCTION	XX/16

DRAWING TITLE

ROADWAY ASSEMBLIES

SCALE:

1 : 20

PROJECT

CHANCELLOR BLVD, EAST MALL, NW MARINE DR INTERSECTION DESIGN

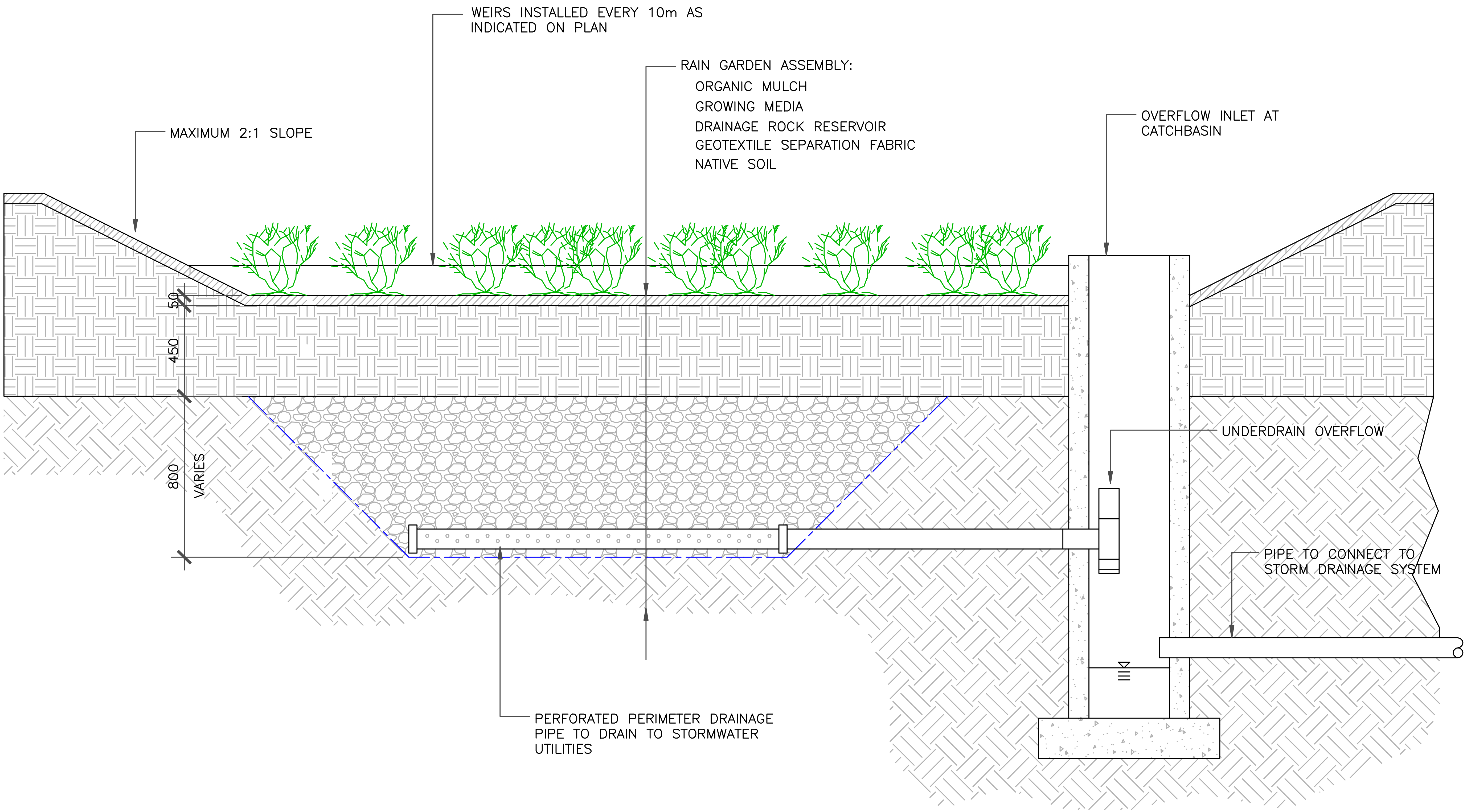
SUBMISSION TITLE:

DETAILED DESIGN TEAM 5

DATE

APRIL 2016

D4



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DRAWING REVISIONS:

ISSUE FOR CLIENT REVIEW 1	XX/15
INTERMEDIATE DESIGN REVIEW 1	XX/16
INTERMEDIATE DESIGN REVIEW 2	XX/16
ISSUE FOR BID	XX/16
ISSUE FOR CONSTRUCTION	XX/16

DRAWING TITLE
RAIN GARDEN ASSEMBLIES

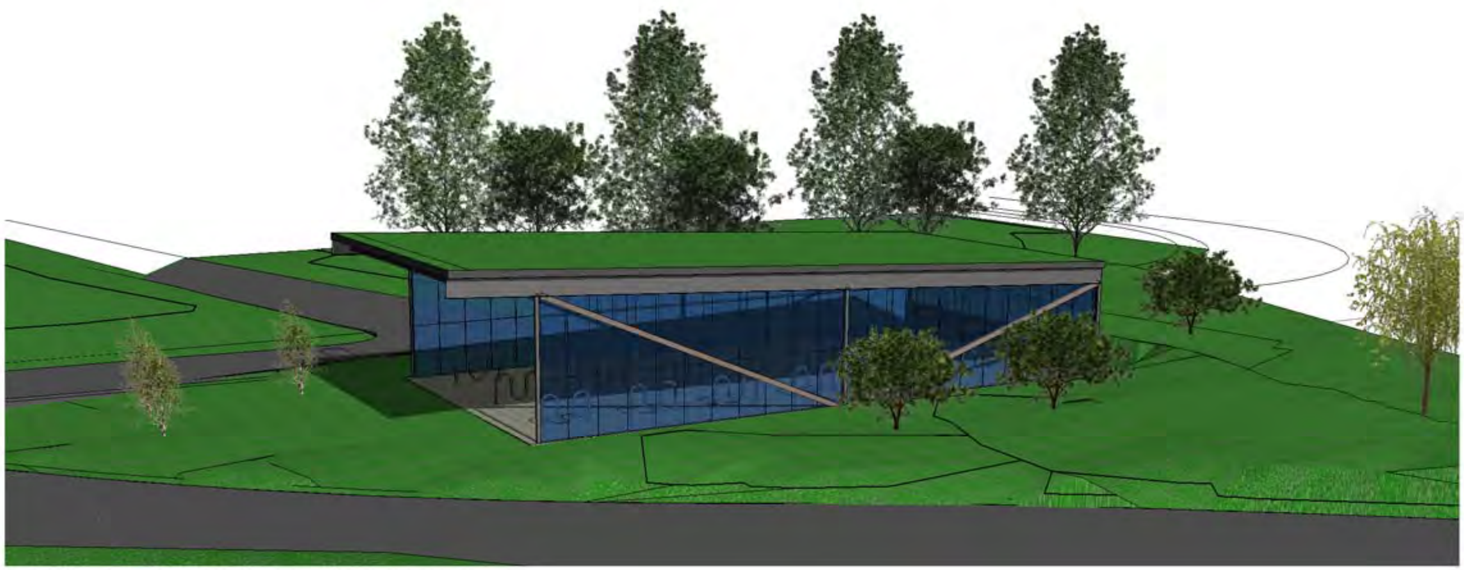
SCALE:
1 : 10

PROJECT
CHANCELLOR BLVD, EAST MALL, NW MARINE DR INTERSECTION DESIGN

SUBMISSION TITLE:
DETAILED DESIGN TEAM 5

DATE
APRIL 2016

D5



1 3D VIEW

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604.111.2332
604.123.1234
vanaugustineconsultants@se.com

No.	Description	Date

UBC

Bike Garden

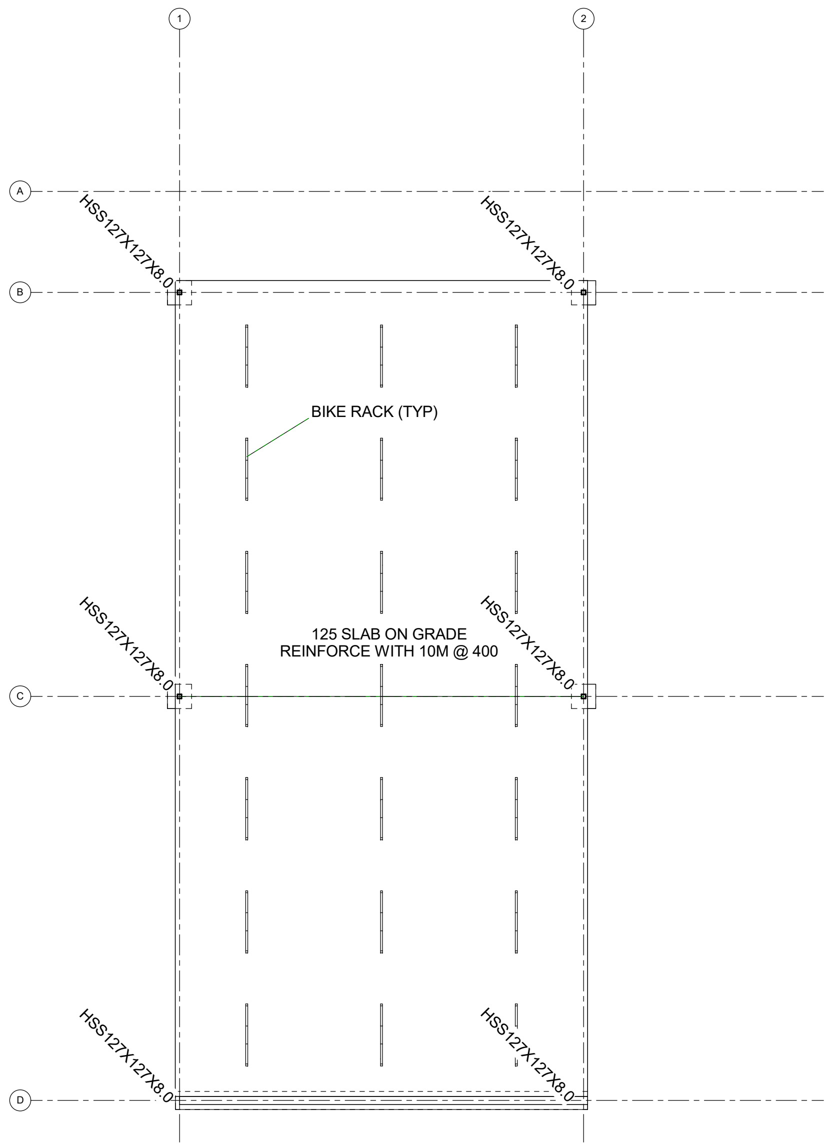
3D VIEW

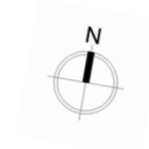
Project number	0001
Date	08/04/2016
Drawn by	KM/DW
Checked by	GVA

S0

Scale

2016-04-02 3:42:38 PM





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No.	Description	Date

UBC

Bike Garden

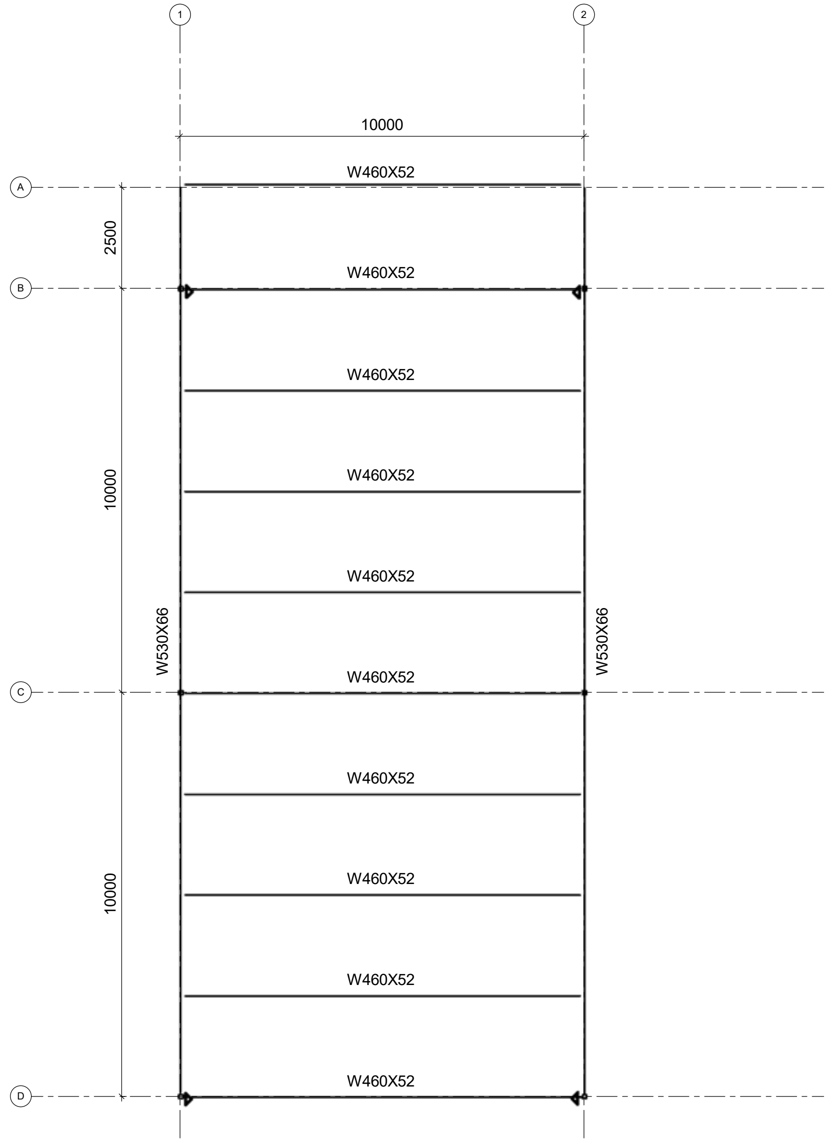
GROUND FLOOR

Project number	0001
Date	08/04/2016
Drawn by	KM/DW
Checked by	GVA

S1

Scale	1 : 40

2016-04-02 3:42:45 PM



Level 4
1 : 40

STRUCTURAL STEEL NOTES

1. STEEL DECK:
   90 CONCRETE TOPPING R/W 10M @ 400 E/W MID-HEIGHT
   CANAM P-3615x0.76 COMPOSITE STEEL DECK (OR PRE-APPROVED EQUIVALENT)
   #10 SCREWS @ 300
   HILTI ENP2 @ 225 ON PERIMETER
2. DESIGN OF ALL CONNECTIONS TO BE PROVIDED BY FABRICATOR.
3. PROVIDE SHEAR CONNECTIONS FOR 50% OF THE BEAM'S SHEAR CAPACITY.
4. PROVIDE MOMENT CONNECTIOS FOR 100% OF THE BEAM'S MOMENT CAPACITY.
5. CONFIRM ALL ROOF ELEVATIONS, STEPS, SLOPES, EDGE LOCATIONS, AND OPENINGS WITH ARCHITECTURAL AND OTHER CONSULTANTS DRAWINGS.
6. ALL CONNECTIONS TO TRANSFER LOADS TO CL BEAM, CL COLUMN, OR FACE OF PL.

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No.	Description	Date

UBC

Bike Garden

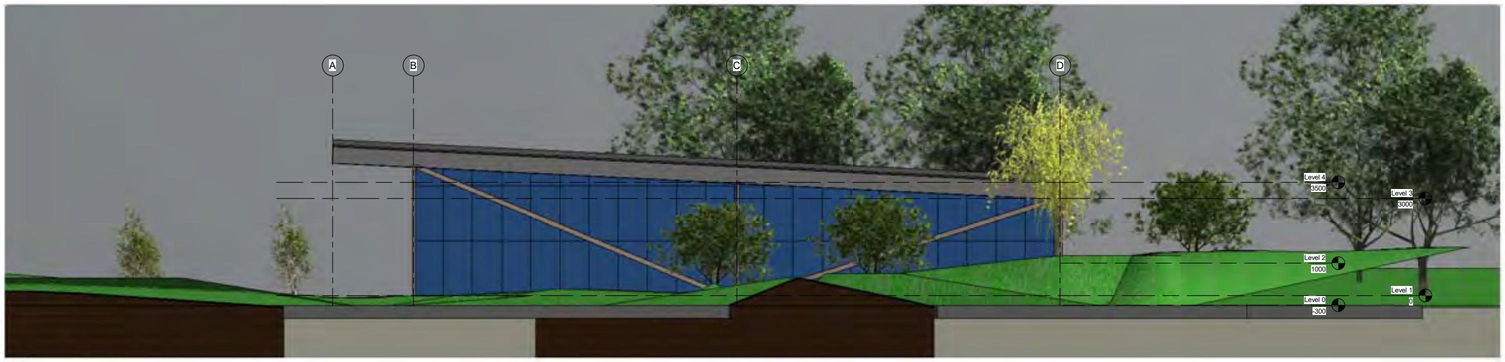
ROOF FRAMING

Project number	0001
Date	08/04/2016
Drawn by	KM/DW
Checked by	GVA

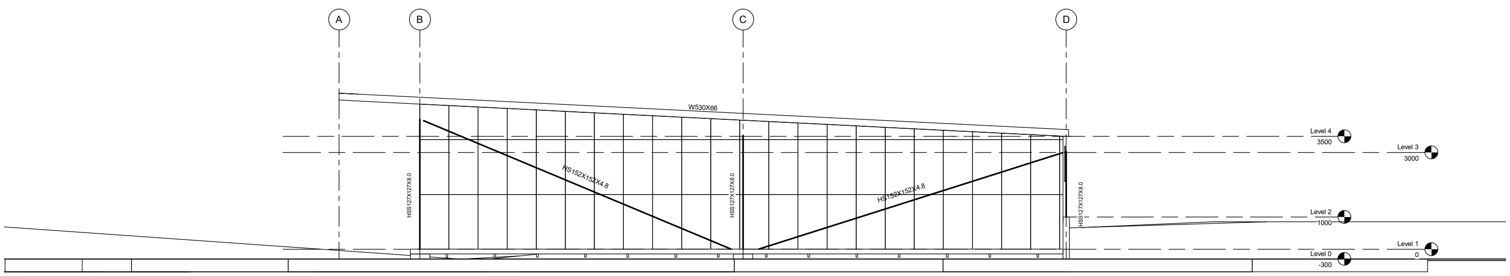
S2

Scale	1 : 40

2016-04-02 3:55:36 PM



1 WEST ELEVATION
1 : 50



2 WEST STRUCTURAL ELEVATION
1 : 50

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No.	Description	Date

UBC

Bike Garden

WEST ELEVATION

Project number	0001
Date	08/04/2016
Drawn by	KM/DW
Checked by	GVA

S3

Scale	1 : 50

2016-04-02 3:43:27 PM

APPENDIX B

Site Photos

Site Visit – September 21, 2015

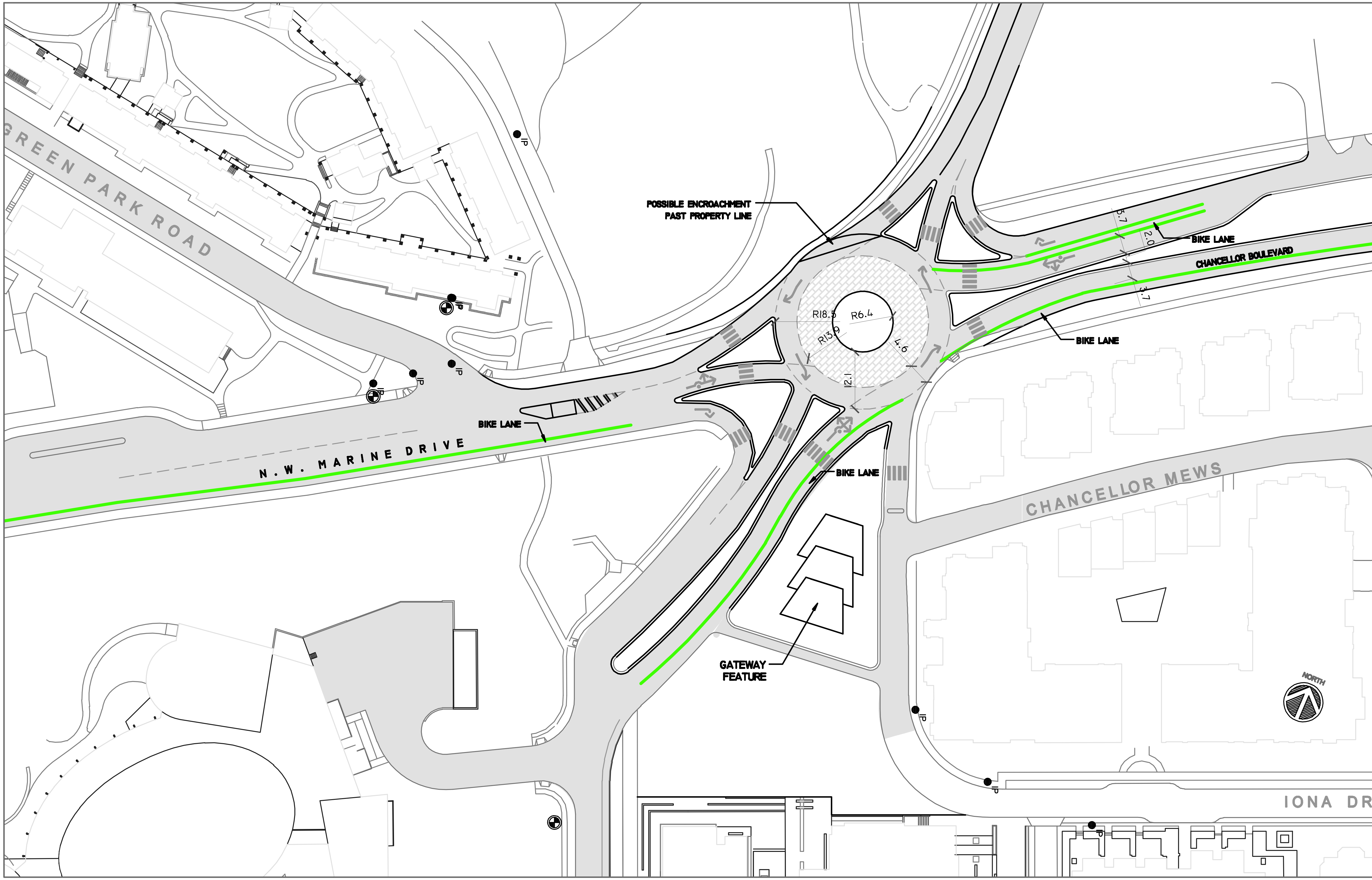





Site Visit – February 2, 2016

APPENDIX C

Conceptual Design Options



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PROJECT

CHANCELLOR BLVD, EAST

MALL, NW MARINE DR

INTERSECTION DESIGN

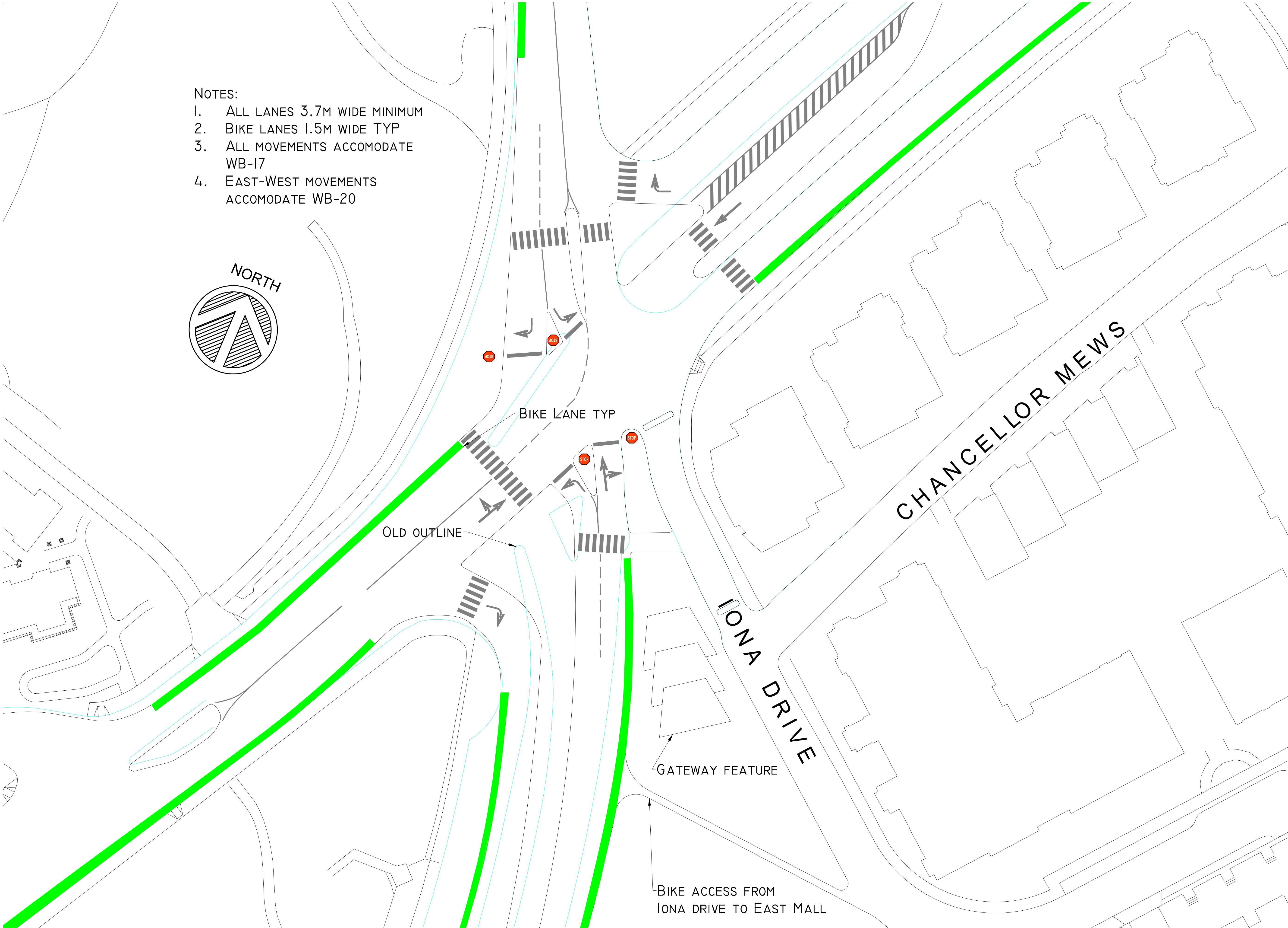
DRAWING TITLE:

CONCEPTUAL DESIGN

TEAM 5

DATE

OCTOBER 2015



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PROJECT

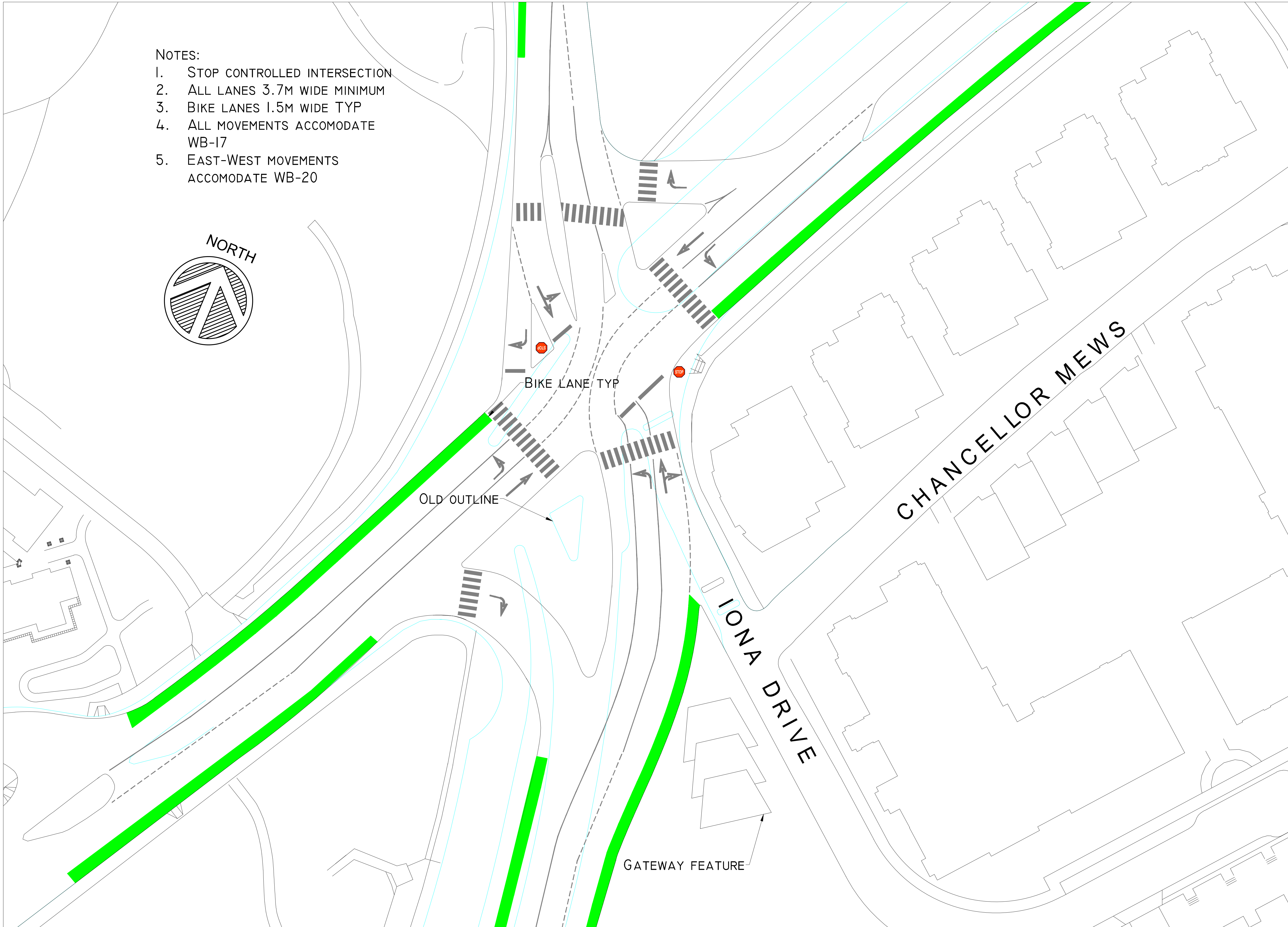
CHANCELLOR BLVD, EAST MALL, NW MARINE DR INTERSECTION DESIGN

DRAWING TITLE: FIGURE 4

CONCEPTUAL DESIGN TEAM 5

DATE

OCTOBER 2015



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PROJECT

CHANCELLOR BLVD, EAST MALL, NW MARINE DR INTERSECTION DESIGN

DRAWING TITLE:

FIGURE

CONCEPTUAL DESIGN

TEAM 5

DATE

OCTOBER 2015

APPENDIX D

Stormwater Design

ORTHOPHOTO (2009)

LIDAR SURVEY (2010)

University of British Columbia

Legend

	Assessed Level of Risk		
Category	Low	Medium	High
Building	★	★	★
Potential Overflow			
Item No. *	1-1	1-1	1-1

Overland flow
Potential Flooding / Ponding

Infrastructure

Building Footprint

Storm Structures

MH (modeled)
Catch Basin (not modeled)
Structure (not modeled)
Storm Main (modeled)
Storm Main (not modeled)
Ditch (modeled)
Ditch (not modeled)

Identified Stormwater Flooding Locations

High
Moderate
Low
magnitude of flood volume

Anticipated Flood Volumes

10yr: 10m^3
100yr: 100m^3

Elevation Colour Banding

>= 80m
<= 57m

* Refer to Table 1 for further detail

URBANSYSTEMS.

Overland Flow Route Assessment *Area 6*

THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.

0 25 50 100 Meters

1:1,500

N

Figure 6.0

U:\Projects_VAN\1332\0309\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\ReportFigures\Figure 06 - Area6.mxd Last revised by: bpauls on 17/03/2011 at 8:44:45 AM

XP-SWMM Input Parameter Summary

Project:	UBC Intersection Upgrade
Project No.:	25839
XP-SWMM File:	

		% Impervious	Runoff Coefficient - Source: BCMoTI Supplemnt to TAC
Land Use Date	Asphalt/concrete	95.0%	0.95
	Permeable Pavement	45.0%	0.30
	Grass/Landscaping - Flat Slope (2%)	15.0%	0.12
	Grass/Landscaping - Steep Slope (7%)	15.0%	0.22
	Rain Garden	5.0%	0.05

Rainfall Intensity Data		5min	24hr
	1:2 Year	40.4	2.6
	1:100 Year	95.1	4.8

			North	East	South	West
Catchment Areas	Pre-Development	Asphalt/concrete	0.116	0.308	0.184	0.196
		Grass/Landscaping	0.000	0.128	0.271	0.091
		Total	0.116	0.436	0.455	0.287
	Post-Development	Asphalt/concrete	0.116	0.264	0.158	0.164
		Permeable Pavement	0.000	0.022	0.002	0.022
		Grass/Landscaping	0.000	0.124	0.206	0.096
		Rain Garden	0.000	0.026	0.090	0.006
		Total	0.116	0.436	0.455	0.287

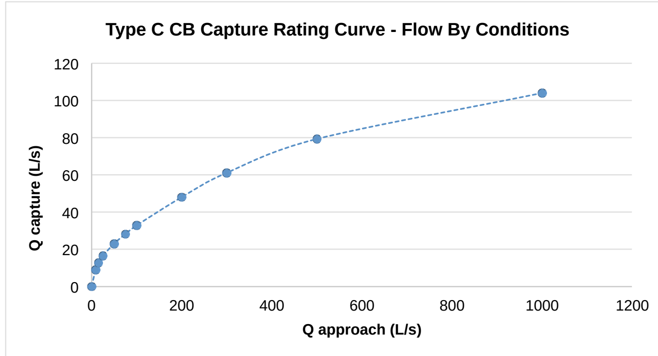
Runoff Mode - Drainage Areas											Model Outputs:			
Runoff Node Name	Area Label	Area (ha)	Impervious (%)	Runoff Coefficient	Flow Path Length (m)	Average Width (m)	Slope (%)	Routing Method	Rainfall	Intensity (mm/hr)	Runoff (L/s)	Runoff (L/s/ha)	Reduction in Runoff	
Design Storm: 1:100 yr , 5min														
Pre-Development Flow														
North	N	0.116	95%	0.95	84	14	7.0%	Runoff	100-Year, 24-Hour	95.1	29.105	250.692		
East	E	0.436	72%	0.71	125	35	2.0%	Runoff	100-Year, 24-Hour	95.1	81.428	186.633		
South	S	0.455	47%	0.52	72	63	5.0%	Runoff	100-Year, 24-Hour	95.1	61.920	136.118		
West	W	0.287	70%	0.69	45	64	2.0%	Runoff	100-Year, 24-Hour	95.1	52.022	181.389		
Total		**1.294**	**65%**	**0.66**							**224.476**	**173.461**		
Post-Development														
North	N	0.116	95%	0.95	84	14	7.0%	Runoff	100-Year, 24-Hour	95.1	29.111	250.742		
East	E	0.436	64%	0.66	125	35	2.0%	Runoff	100-Year, 24-Hour	95.1	75.582	173.233		
South	S	0.455	41%	0.44	72	63	5.0%	Runoff	100-Year, 24-Hour	95.1	52.833	116.142		
West	W	0.287	63%	0.64	45	64	2.0%	Runoff	100-Year, 24-Hour	95.1	48.433	168.874		
Total		**1.294**	**58%**	**0.60**							**205.959**	**159.152**	**18.517**	**8%**
Design Storm: 1:100 yr ,24 hr														
Pre-Development Flow														
North	N	0.116	95%	0.95	84	14	7.0%	Runoff	100-Year, 24-Hour	4.8	1.469	12.653		
East	E	0.436	72%	0.71	125	35	2.0%	Runoff	100-Year, 24-Hour	4.8	4.110	9.420		
South	S	0.455	47%	0.52	72	63	5.0%	Runoff	100-Year, 24-Hour	4.8	3.125	6.870		
West	W	0.287	70%	0.69	45	64	2.0%	Runoff	100-Year, 24-Hour	4.8	2.626	9.155		
Total		**1.294**	**65%**	**0.66**							**11.330**	**8.755**		
Post-Development														
North	N	0.116	95%	0.95	84	14	7.0%	Runoff	100-Year, 24-Hour	4.8	1.469	12.656		
East	E	0.436	64%	0.66	125	35	2.0%	Runoff	100-Year, 24-Hour	4.8	3.815	8.744		
South	S	0.455	41%	0.44	72	63	5.0%	Runoff	100-Year, 24-Hour	4.8	2.667	5.862		
West	W	0.287	63%	0.64	45	64	2.0%	Runoff	100-Year, 24-Hour	4.8	2.445	8.524		
Total		**1.294**	**58%**	**0.60**							**10.395**	**8.033**	**0.935**	**8%**
Design Storm: 1:2 yr , 5min														
Pre-Development Flow														
North	N	0.116	95%	0.95	84	14	7.0%	Runoff	100-Year, 24-Hour	40.4	12.364	106.498		
East	E	0.436	72%	0.71	125	35	2.0%	Runoff	100-Year, 24-Hour	40.4	34.592	79.285		
South	S	0.455	47%	0.52	72	63	5.0%	Runoff	100-Year, 24-Hour	40.4	26.305	57.825		
West	W	0.287	70%	0.69	45	64	2.0%	Runoff	100-Year, 24-Hour	40.4	22.100	77.057		
Total		**1.294**	**65%**	**0.66**							**95.361**	**73.689**		
Post-Development														
North	N	0.116	95%	0.95	84	14	7.0%	Runoff	100-Year, 24-Hour	40.4	12.367	106.519		
East	E	0.436	64%	0.66	125	35	2.0%	Runoff	100-Year, 24-Hour	40.4	32.108	73.592		
South	S	0.455	41%	0.44	72	63	5.0%	Runoff	100-Year, 24-Hour	40.4	22.444	49.339		
West	W	0.287	63%	0.64	45	64	2.0%	Runoff	100-Year, 24-Hour	40.4	20.575	71.740		
Total		**1.294**	**58%**	**0.60**							**87.495**	**67.610**	**7.866**	**8%**
Design Storm: 1:2 yr , 24 hr														
Pre-Development Flow														
North	N	0.116	95%	0.95	84	14	7.0%	Runoff	100-Year, 24-Hour	2.6	0.796	6.854		
East	E	0.436	72%	0.71	125	35	2.0%	Runoff	100-Year, 24-Hour	2.6	2.226	5.102		
South	S	0.455	47%	0.52	72	63	5.0%	Runoff	100-Year, 24-Hour	2.6	1.693	3.721		
West	W	0.287	70%	0.69	45	64	2.0%	Runoff	100-Year, 24-Hour	2.6	1.422	4.959		
Total		**1.294**	**65%**	**0.66**							**6.137**	**4.742**		
Post-Development														
North	N	0.116	95%	0.95	84	14	7.0%	Runoff	100-Year, 24-Hour	2.6	0.796	6.855		
East	E	0.436	64%	0.66	125	35	2.0%	Runoff	100-Year, 24-Hour	2.6	2.066	4.736		
South	S	0.455	41%	0.44	72	63	5.0%	Runoff	100-Year, 24-Hour	2.6	1.444	3.175		
West	W	0.287	63%	0.64	45	64	2.0%	Runoff	100-Year, 24-Hour	2.6	1.324	4.617		
Total		**1.294**	**58%**	**0.60**							**5.631**	**4.351**	**0.506**	**8%**

INLET CAPTURE DATA

Catchbasins under Flow-By Conditions (with no ICD)

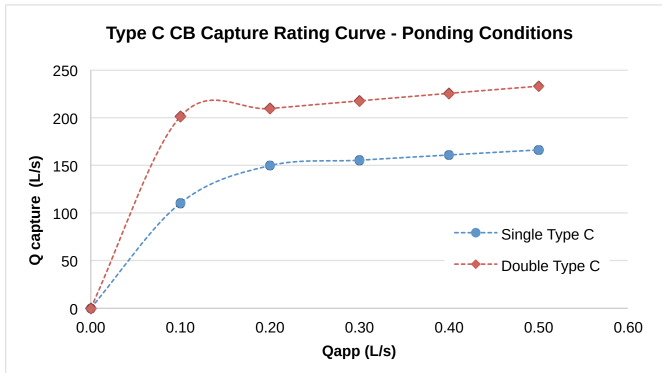
TYPE C & K

Qapp (l/s)	Qcap (l/s)	Capture Efficincecy %
0	0	
9	9	100%
15	13	85%
25	17	66%
50	23	46%
75	28	38%
100	33	33%
200	48	24%
300	61	20%
500	79	16%
1000	104	10%



Catchbasins under Ponding Conditions (with no ICD)

Ponding Depth (m)	**Capture Rate (l/s) Single Type C**	**Double Type C**
0.00	0	0
0.10	110	201
0.20	150	210
0.30	156	218
0.40	161	226
0.50	166	233



Catchbasin Capture for High Intensity Rain Event - 1:100yr, 5min

Catchment	Ha	Total # of CBs	Runoff (L/s)	Runoff (L/s/ha)	inlets/ha	Qapp (L/s/inlet)	Q Capture/inlet	Q capture - Total (L/s)	Capture Efficiency
Pre-Development									
N	0.1161	0	29.11	250.69	0.0	0.0	0.00	0.000	
E	0.4363	5	81.43	186.63	11.5	37.3	10.37	51.845	
S	0.4549	6	61.92	136.12	13.2	22.7	7.48	44.874	
W	0.2868	1	52.02	181.39	3.5	181.4	36.09	36.086	
Total	1.2941	12	224.476					132.805	59%
N	0.1161	1	29.11	250.74	8.6	62.7	15.55	15.554	
E	0.4363	6	75.58	173.23	13.8	28.9	11.01	66.038	
S	0.4549	6	52.83	116.14	13.2	19.4	9.11	54.688	
W	0.2868	4	48.43	168.87	13.9	42.2	13.62	54.493	
Total	1.2941	17	205.959					190.773	93%

Increase in Capture Effciency 33%

Additional Water Captures 30%

Detailed Stormceptor Sizing Report – UBC

Project Information & Location			
Project Name	UBC Intersection Redesign	**Project Number**	487
City		**State/ Province**	British Columbia
Country	Canada	**Date**	2/28/2016
Designer Information		**EOR Information (optional)**	
Name	Janet Jorgensen	**Name**	
Company	UBC	**Company**	
Phone #	778-874-2315	**Phone #**	
Email	janetjorgensen@gmail.com	**Email**	

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	UBC
Recommended Stormceptor Model	STC 9000
Target TSS Removal (%)	85.0
TSS Removal (%) Provided	88
PSD	City of Victoria PSD
Rainfall Station	VANCOUVER - KITSILANO HI

The recommended Stormceptor model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

Stormceptor Sizing Summary

Stormceptor Model	% TSS Removal Provided	% Runoff Volume Captured Provided
STC 300	55	95
STC 750	67	99
STC 1000	69	99
STC 1500	69	99
STC 2000	73	100
STC 3000	75	100
STC 4000	80	100
STC 5000	81	100
STC 6000	83	100
STC 9000	88	100
STC 10000	88	100
STC 14000	91	100
Stormceptor MAX	Custom	Custom

Stormceptor

The Stormceptor oil and sediment separator is sized to treat stormwater runoff by removing pollutants through gravity separation and flotation. Stormceptor's patented design generates positive TSS removal for each rainfall event, including large storms. Significant levels of pollutants such as heavy metals, free oils and nutrients are prevented from entering natural water resources and the re-suspension of previously captured sediment (scour) does not occur.
Stormceptor provides a high level of TSS removal for small frequent storm events that represent the majority of annual rainfall volume and pollutant load. Positive treatment continues for large infrequent events, however, such events have little impact on the average annual TSS removal as they represent a small percentage of the total runoff volume and pollutant load.

Design Methodology

Stormceptor is sized using PCSWMM for Stormceptor, a continuous simulation model based on US EPA SWMM. The program calculates hydrology using local historical rainfall data and specified site parameters. With US EPA SWMM's precision, every Stormceptor unit is designed to achieve a defined water quality objective. The TSS removal data presented follows US EPA guidelines to reduce the average annual TSS load. The Stormceptor's unit process for TSS removal is settling. The settling model calculates TSS removal by analyzing:

- Site parameters
- Continuous historical rainfall data, including duration, distribution, peaks & inter-event dry periods
- Particle size distribution, and associated settling velocities (Stokes Law, corrected for drag)
- TSS load
- Detention time of the system

Hydrology Analysis

PCSWMM for Stormceptor calculates annual hydrology with the US EPA SWMM and local continuous historical rainfall data. Performance calculations of Stormceptor are based on the average annual removal of TSS for the selected site parameters. The Stormceptor is engineered to capture sediment particles by treating the required average annual runoff volume, ensuring positive removal efficiency is maintained during each rainfall event, and preventing negative removal efficiency (scour).
Smaller recurring storms account for the majority of rainfall events and average annual runoff volume, as observed in the historical rainfall data analyses presented in this section.

Rainfall Station

State/Province	British Columbia	**Total Number of Rainfall Events**	5128
Rainfall Station Name	VANCOUVER - KITSILANO HI	**Total Rainfall (mm)**	24905.7
Station ID #	4201	**Average Annual Rainfall (mm)**	1245.3
Coordinates	49°15'N, 123°9'W	**Total Evaporation (mm)**	1241.4
Elevation (ft)		**Total Infiltration (mm)**	10472.5
Years of Rainfall Data	20	**Total Rainfall that is Runoff**	13191.8

Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

Drainage Area	
Total Area (ha)	1.29
Imperviousness %	58.0

Up Stream Storage	
Storage (ha-m)	Discharge (cms)
0.020	0.000

Water Quality Objective	
TSS Removal (%)	85.0
Runoff Volume Capture (%)	90.00
Oil Spill Capture Volume (L)	
Peak Conveyed Flow Rate (L/s)	
Water Quality Flow Rate (L/s)	

Up Stream Flow Diversion	
Max. Flow to Stormceptor (cms)	

Design Details	
Stormceptor Inlet Invert Elev (m)	
Stormceptor Outlet Invert Elev (m)	
Stormceptor Rim Elev (m)	
Normal Water Level Elevation (m)	
Pipe Diameter (mm)	
Pipe Material	
Multiple Inlets (Y/N)	Yes
Grate Inlet (Y/N)	No

Particle Size Distribution (PSD)

Removing the smallest fraction of particulates from runoff ensures the majority of pollutants, such as metals, hydrocarbons and nutrients are captured. The table below identifies the Particle Size Distribution (PSD) that was selected to define TSS removal for the Stormceptor design.

City of Victoria PSD		
Particle Diameter (microns)	Distribution %	Specific Gravity
3.0	10.0	2.65
10.0	23.0	2.65
33.0	25.0	2.65
67.0	11.0	2.65
100.0	12.0	2.65
333.0	11.0	2.65
500.0	8.0	2.65

Site Name	UBC

Site Details

Drainage Area	
Total Area (ha)	1.29
Imperviousness %	58.0

Surface Characteristics	
Width (m)	227.00
Slope %	2
Impervious Depression Storage (mm)	0.508
Pervious Depression Storage (mm)	5.08
Impervious Manning's n	0.015
Pervious Manning's n	0.25

Maintenance Frequency	
Maintenance Frequency (months) >	12

Infiltration Parameters	
Horton's equation is used to estimate infiltration	
Max. Infiltration Rate (mm/hr)	61.98
Min. Infiltration Rate (mm/hr)	10.16
Decay Rate (1/sec)	0.00055
Regeneration Rate (1/sec)	0.01

Evaporation	
Daily Evaporation Rate (mm/day)	2.54

Dry Weather Flow	
Dry Weather Flow (lps)	0

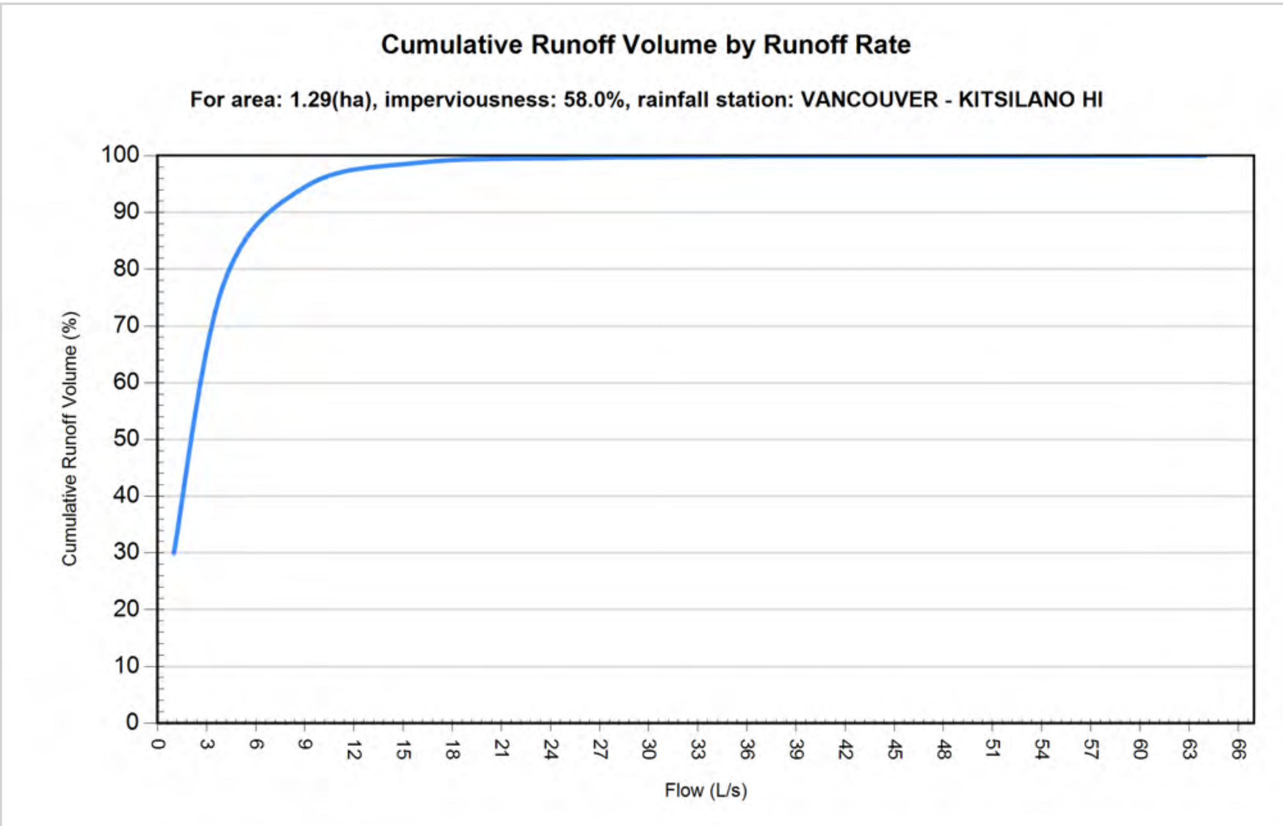
Winter Months	
Winter Infiltration	0

TSS Loading Parameters	
TSS Loading Function	

Buildup/Wash-off Parameters	
Target Event Mean Conc. (EMC) mg/L	
Exponential Buildup Power	
Exponential Washoff Exponent	

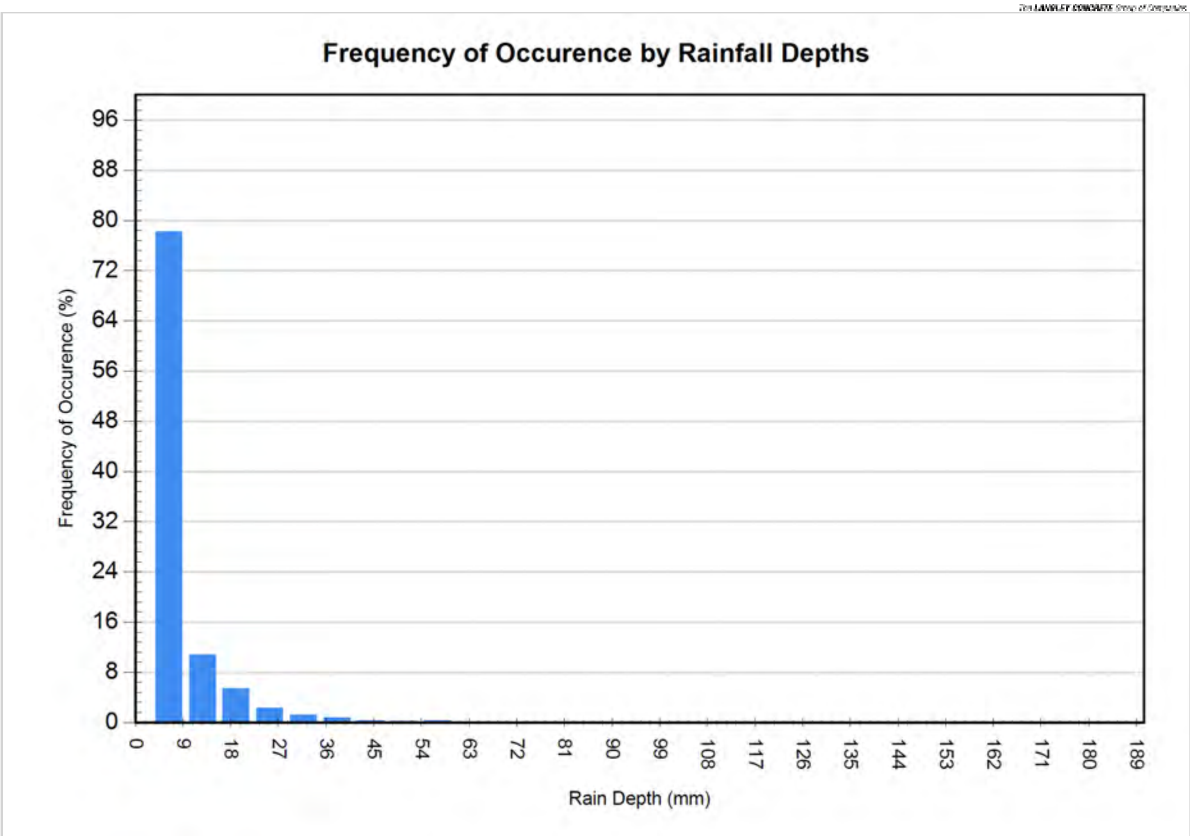
TSS Availability Parameters	
Availability Constant A	
Availability Factor B	
Availability Exponent C	
Min. Particle Size Affected by Availability (micron)	

Cumulative Runoff Volume by Runoff Rate			
Runoff Rate (L/s)	Runoff Volume (m^3)	Volume Over (m^3)	Cumulative Runoff Volume (%)
1	51.362	119.671	30.0
4	131.807	39.214	77.1
9	161.507	9.507	94.5
16	168.871	2.125	98.8
25	170.339	0.656	99.6
36	170.755	0.24	99.9
49	170.888	0.107	99.9
64	170.939	0.056	100.0



Rainfall Event Analysis

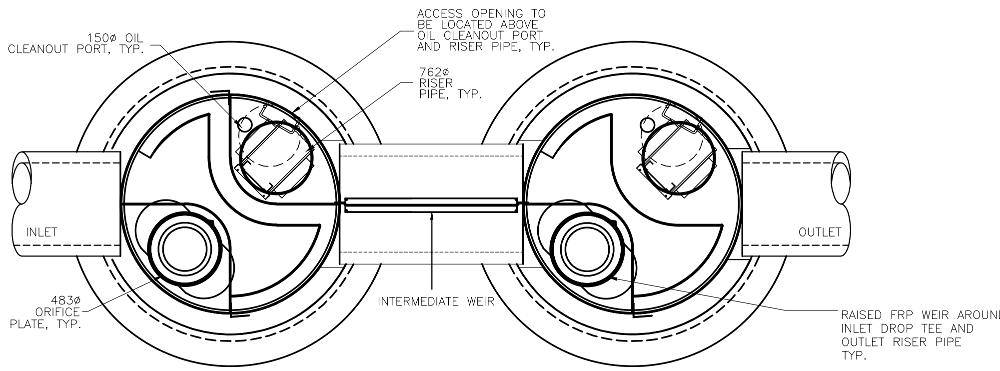
Rainfall Depth (mm)	No. of Events	Percentage of Total Events (%)	Total Volume (mm)	Percentage of Annual Volume (%)
6.35	4012	78.2	6090	24.5
12.70	555	10.8	5038	20.2
19.05	275	5.4	4288	17.2
25.40	119	2.3	2641	10.6
31.75	63	1.2	1790	7.2
38.10	43	0.8	1499	6.0
44.45	16	0.3	664	2.7
50.80	10	0.2	475	1.9
57.15	15	0.3	806	3.2
63.50	5	0.1	296	1.2
69.85	3	0.1	196	0.8
76.20	3	0.1	219	0.9
82.55	3	0.1	240	1.0
88.90	1	0.0	86	0.3
95.25	2	0.0	182	0.7
101.60	0	0.0	0	0.0
107.95	1	0.0	104	0.4
114.30	0	0.0	0	0.0
120.65	1	0.0	120	0.5
127.00	0	0.0	0	0.0
133.35	0	0.0	0	0.0
139.70	0	0.0	0	0.0
146.05	0	0.0	0	0.0
152.40	0	0.0	0	0.0
158.75	0	0.0	0	0.0
165.10	0	0.0	0	0.0
171.45	1	0.0	170	0.7
177.80	0	0.0	0	0.0
184.15	0	0.0	0	0.0



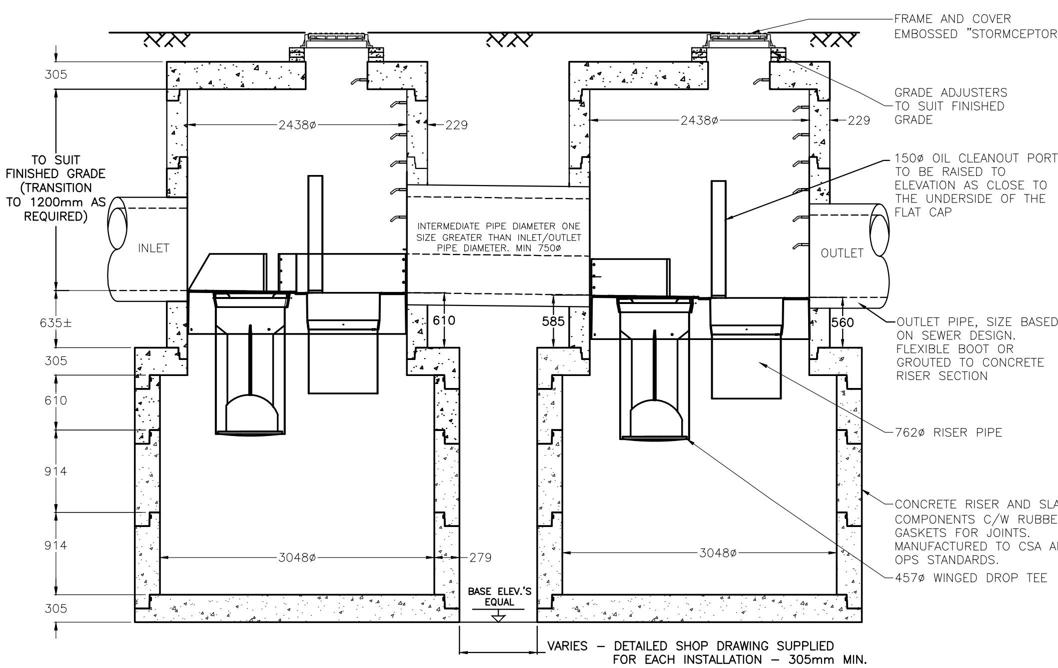
For Stormceptor Specifications and Drawings Please Visit:
http://www.imbriumsystems.com/technical-specifications

DRAWING NOT TO BE USED FOR CONSTRUCTION

THE STORMCEPTOR SYSTEM IS PROTECTED BY ONE OR MORE OF THE FOLLOWING PATENTS:
United States Patent No. 5,753,115 • 5,849,181 • 6,068,765 • 6,371,690 • 7,582,216 • 7,666,303 | Australia Patent No. 693,164 • 707,133 • 729,096 • 779,401 • 289,647 • 2008,279,378 • 2008,288,900 |
Canadian Patent No. 2,009,280 • 2,137,942 • 2,175,277 • 2,180,305 • 2,180,383 • 2,206,338 • 2,327,768 | Indonesian Patent No. 007058 | Japan Patent No. 3581233 • 9-11476 |
Korea Patent No. 10-1451593 • 0519212 | Malaysia Patent No. 118987 | New Zealand Patent No. 314,646 • 583,583 • 583,008 | South African Patent No. 2010/00683 • 2010/01796 |



PLAN VIEW



SECTION VIEW

Stormceptor®

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WWW.IMBRIUMSYSTEMS.COM
605 GLOBAL WAY, SUITE 113, LINTHICUM, MD 21231
USA 888-279-8826 CA 800-565-4801 INTL +1-416-960-9900

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STANDARD MODEL

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				OF 1

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APPENDIX E

Structural Design

Bike Garden Loading and Structural Framing Design

Loading (According to BCBC 2006)

Snow Load (1 in 50 year)

$S_s := 1.8\ kPa$
$S_r := 0.2\ kPa$
$C_b := 0.8$ (Small Roof - Ic < 70m)
$I_{su} := 0.8$ (ULS Low Importance Factor)
$I_{ss} := 0.9$ (SLS Low importance Factor)
$C_w := 1.0$
$C_s := 1.0$ (Roof Angle = 2.9°)
$C_a := 1.0$ (Standard Loading)

$S_u := I_{su} \cdot \left(S_s \cdot \left(C_b \cdot C_w \cdot C_s \cdot C_a\right) + S_r\right) = 1.312\ kPa$ (ULS)
$S_s := I_{ss} \cdot \left(S_s \cdot \left(C_b \cdot C_w \cdot C_s \cdot C_a\right) + S_r\right) = 1.476\ kPa$ (SLS)

Wind Load (1 in 50 year)

$q := 0.48\ kPa$
$I_{wu} := 0.8$ (ULS Low Importance Factor)
$I_{ws} := 0.75$ (SLS Low importance Factor)
$l := 22.6\ m$ (Length)
$w := 10\ m$ (Width)
$h := (4800 + 2700) \cdot (0.5) \cdot 0.001 = 3.75\ m$ (Average Roof Height from Ground Level)

$$C_e := 0.7 \cdot \left(\frac{h}{12}\right)^{0.3} = 0.494$$

$C_g := 2.0$ (For Both External and Internal Pressures)
$C_p := 1.0$ (For Both External and Internal Pressures)

$p_u := I_{wu} \cdot q \cdot C_e \cdot C_g \cdot C_p = 0.379\ kPa$ (ULS)
$p_s := I_{ws} \cdot q \cdot C_e \cdot C_g \cdot C_p = 0.356\ kPa$ (SLS)

Dead Load

$DL_D := 1.62\ kPa$ (Based on 38mm, 0.76mm thick Deck with 90mm Slab - Canam P-3615)
$DL_J := 1.275\ kPa$ (Based on W460x52 Joists Spaced at 2.5m)

$DL_S := 15.7\ \frac{kN}{m^3} \cdot 140\ mm = 2.198\ kPa$ (140mm Soil Depth)

$DL_G := 0.645\ \frac{kN}{m}$ (Based on W530x66 Girders)

$DL_{Gl} := 0.320\ kPa$ (Based on Glass of 12mm Thickness)

$DL_C := 0.279\ kN \cdot m^{-1} \cdot 4.5\ m = 1.256\ kN$ (Based on HSS127x127x8.0 of 4.5m Max. Height)

Earthquake Load (1 in 100 year)

$A_R := l \cdot w = 226\ m^2$ (Area of Roof)
$A_W := l \cdot 3.75\ m = 84.75\ m^2$ (Area of Wall Determined with the Average Roof Height))
$N_G := 2$ (Number of Girders)
$N_C := 6$ (Number of Columns)

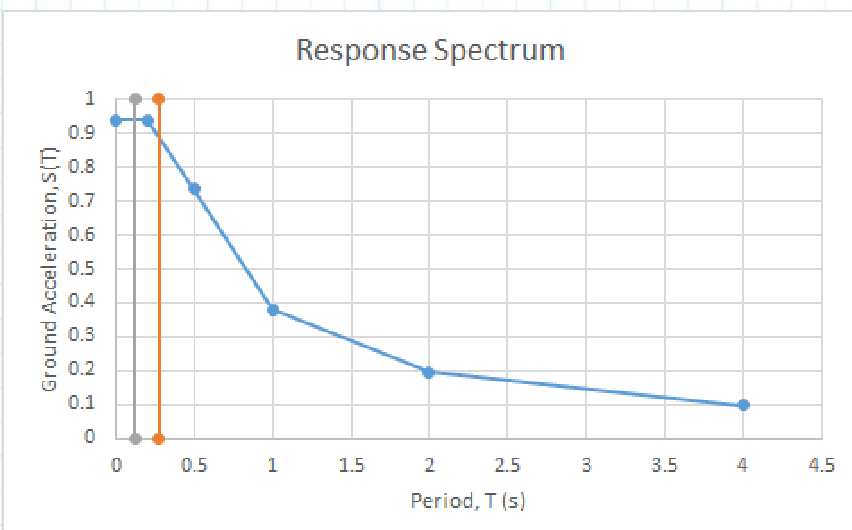
$DL_{Total} := \left(DL_D + DL_J + DL_S\right) \cdot A_R + DL_G \cdot N_G \cdot l + DL_C \cdot N_C + DL_{Gl} \cdot A_W \cdot 2 = \left(1.242 \cdot 10^3\right)\ kN$
$W_{Total} := DL_{Total} + 0.25 \cdot S_u \cdot A_R = \left(1.316 \cdot 10^3\right)\ kN$

$Sa_{0.2} := 0.94$ (Seismic Data for Vancouver)
$Sa_{0.5} := 0.64$ (Seismic Data for Vancouver)
$Sa_{1.0} := 0.33$ (Seismic Data for Vancouver)
$Sa_{2.0} := 0.17$ (Seismic Data for Vancouver)
$I_E := 0.8$ (Low Importance Factor for both SLS and ULS)
$F_a := 1.0$ (Site Class C)
$F_v := 1.0$ (Site Class C)

Conservatively using 4.8 m as the height:
$T_{AT} := 0.085 \cdot (4.8)^{0.75} = 0.276\ s$ (Transverse Direction Fundamental Period - Moment Frame)
$T_{AL} := 0.025 \cdot 4.8 = 0.12\ s$ (Longitudinal Direction Fundamental Period - Braced Frame)

Since the structure is less than 60m in height and has a fundamental period of less than 2 seconds in each of the orthogonal directions, calculations may proceed using the equivalent static procedure.

Using the following graph to find the corresponding Acceleration:



$S\left(T_{AT}\right) := 0.94$ (Ground Acceleration for the Transverse Direction)
$S\left(T_{AL}\right) := 0.89$ (Ground Acceleration for the Longitudinal Direction)

$R_d := 1.5$ (Conventional Construction of Moment Frames, Braced Frames, or Shear Walls)
$R_o := 1.3$ (Conventional Construction of Moment Frames, Braced Frames, or Shear Walls)

$M_V := 1.0$ (Sa(0.2)/Sa(2.0) < 8 and Ta < 1.0 for Both Directions)

$$V_{Min} := \frac{\left(Sa_{2.0} \cdot M_V \cdot I_E \cdot W_{Total}\right)}{R_d \cdot R_o} = 91.788\ kN$$

$$V_{Max} := \frac{\left(\frac{2}{3} \cdot Sa_{0.2} \cdot I_E \cdot W_{Total}\right)}{R_d \cdot R_o} = 338.354\ kN$$

$$V_T := \frac{\left(S\left(T_{AT}\right) \cdot M_V \cdot I_E \cdot W_{Total}\right)}{R_d \cdot R_o} = 480.535\ kN$$

$$V_L := \frac{\left(S\left(T_{AL}\right) \cdot M_V \cdot I_E \cdot W_{Total}\right)}{R_d \cdot R_o} = 480.535\ kN$$

Since the base shear for both transerse and longitudinal directions are larger than Vmax, the base shear in both directions is:

$V := V_{Max} = 338\ kN$

Since the structure is only one storey, the base shear is equal to the total laterial load at the roof in each span direction.

Live Load

$LL := 1.0\ kPa$ (For Roofs)

Summary of Loading

$S_u = 1.312\ kPa$	(ULS Snow Load)
$S_s = 1.476\ kPa$	(SLS Snow Load)
$p_u = 0.379\ kPa$	(ULS Wind Load)
$p_s = 0.356\ kPa$	(SLS Wind Load)
$DL_D = 1.62\ kPa$	(Deck Weight DL)
$DL_J = 1.275\ kPa$	(Joist Weight DL)
$DL_S = 2.198\ kPa$	(Soil Weight DL)
$DL_G = 0.645\ kN \cdot m^{-1}$	(Girder Weight DL)
$DL_{Gl} = 0.32\ kPa$	(Glass Wall Weight DL)
$DL_C = 1.256\ kN$	(Column Weight DL)
$V = 338\ kN$	(Earthquake Base Shear to be Distributed Over Each Roof Dimension)
$LL = 1.000\ kPa$	(Roof LL)

Member Design

Deck Design

Load Case 3 Governs; 1.25 DL Factor Increased to 1.50 for Soil:

$1.5 \cdot DL_S + 1.5 \cdot S_u + 0.5 \cdot LL = 5.765\ kPa$

Based on the Canam Joist Catalog, the P-3615 Composite Deck of a 0.76mm thickness and 90mm thick slab has a capacity of 6.42 kPa for a 3m clear span, which is greater than the factored dead load of 5.765 kPa.

The self weight of this product is 1.62 kPa which is the same as the assumed weight of the deck and slab. Therefore, this product is acceptable. Note that the slab thickness of 90mm is taken from the bottom of the steel deck.

Use Canam P-3615 38mm (0.76mm Thick) Steel Deck with 90mm 20 MPa Concrete Slab and 10M Bars at 400mm each way, mid-height for crack control.

Joist Design

Bending Resistance Check:

Load Case 3 Governs; 1.25 DL Factor Increased to 1.50 for Soil:

$1.5 \cdot (DL_S) + 1.25 \cdot (DL_D) + 1.5 \cdot S_u + 0.5 \cdot LL = 7.79\ kPa$

Total Uniformly Distributed Factored Load (Joists Spaced at 2.5m):

$$7.79\ kPa \cdot 2500\ mm = 19.475\ \frac{kN}{m}$$

Total of the Uniformly Distributed Factored Load (Unsupported Length of 10m):

$$19.475\ \frac{kN}{m} \cdot 10\ m = 194.75\ kN$$

Based on the Handbook of Steel Construction pg. 5-131, a W460x52 joist can carry a total factored load of 271 kN, which is greater than the total factored load, above.

Shear Resistance Check:

Shear Load = $19.475\ \frac{kN}{m} \cdot \frac{w}{2} = 97.375\ kN$

Based on the Handbook of Steel Construction pg. 5-131, a W460x52 joist can carry a total factored load of 680 kN, which is greater than the above factored shear load.

Deflection Check:

Deflection Limit $= \frac{w}{180} = 55.556\ mm$

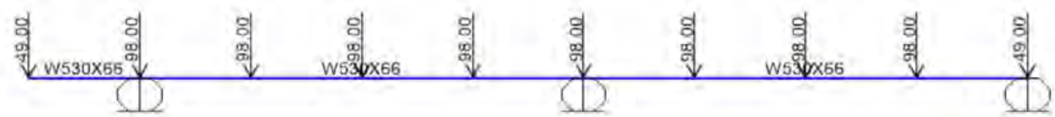
Based on the Handbook of Steel Construction pg. 5-131, a W460x52 joist has an approximate deflection of 54 mm, which is less than the deflection limit.

Therefore, 10m W460x52 joists spaced at 2.5m has an acceptable resistance and deflection.

Use 350W W460x52 Joists Spaced at 2500 mm.

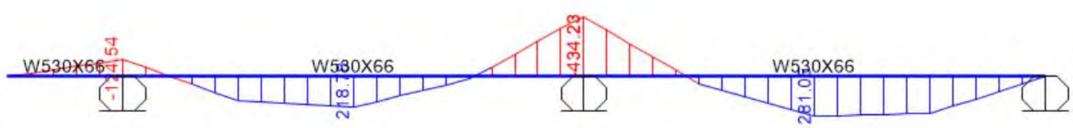
Girder Design

Each W530x66 girder will have point loads of 98 kN every 2.5m due to the joists, and point loads of 49 kN at each end of the girder due to the end joists. The girders were modelled as follows:



The reaction at the canteliver support is: $R1 := 268\ kN$
The reaction at the centre support is: $R2 := 473\ kN$
The reaction at the end support is: $R3 := 156\ kN$

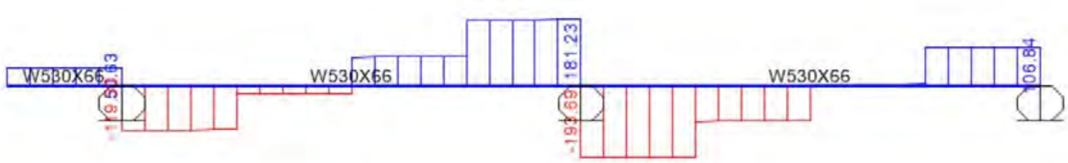
The bending moment diagram is as follows, which a maximum factored moment of 434 kN-m:



Based on the Handbook of Steel Construction pg. 5-96, the moment resistance for an unsupported length of 2.5m (the girder is laterally supported every 2.5m by the joists), is 444 kN-m.

Since Mr > Mf, the beam has an adequate bending resistance.

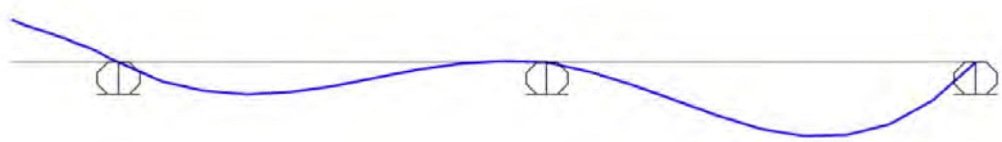
The shear force diagram is as follows, which has a maximum factored shear of 194 kN:



Based on the Handbook of Steel Construction pg. 5-96, the shear resistance is 927 kN.
Since Vr > Vf, the beam has an adequate shear resistance.

The maximum deflection (based on the ULS factored loads) as shown in the following diagram is 32.4 mm.

Note that this deflection will be higher than the deflection from service loads.



The maximum permissible deflection based on the largest unsupported length of 10m is the same as for the joists, which is 56 mm.

Since the deflection from ULS factored loads is less than the deflection limit, the W530x66 girders are acceptable.

Use 350W W530x66 Girders.

<u>Column Design</u>

Based on the girder support reactions, the max factored load is:

$Pf := R1 = 268\ kN$

The largest column is 4.5m and is pin-pin supported (k=1). Therefore:

$kL := 4500\ mm$

Based on the Handbook of Steel Construction pg. 4-52, an HSS 127x127x8.0 has an axial resistance of:

$Pr := 484\ kN$

Since Pr > Pf, the column is acceptable.

Use 350W HSS 127x127x8.0 Columns.

Lateral Design

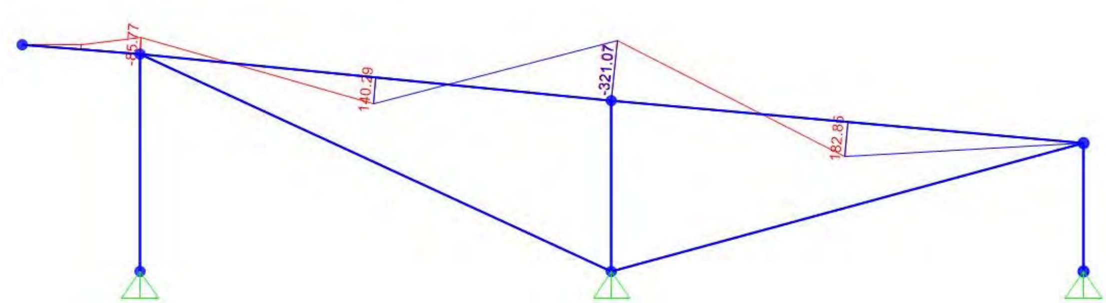
The frames are modelled in SAP2000 using the loads from page 3 with:

- Wind pressure applied on the south glass wall with half of the load spreading to the roof and the other half transferred to the ground.
- Both the roof component of the wind load and the earthquake load are distributed over the full length of the 22.5 m roof.
- All load cases are checked and the governing load case is discussed in these calculations.

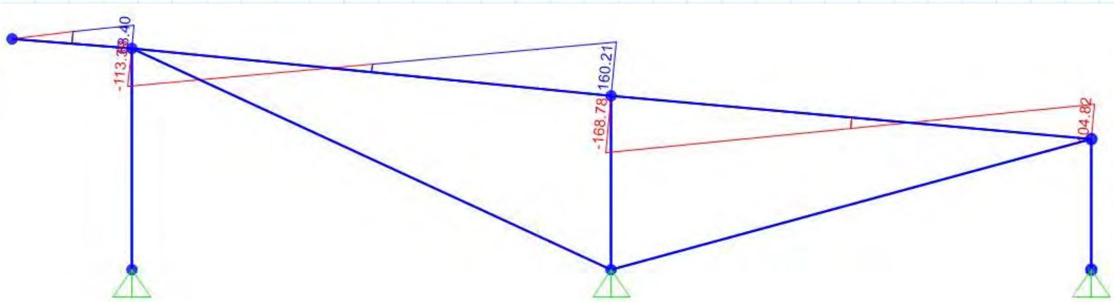
After the SAP2000 analysis, it was found that Load Case 5 (1.0DL + 1.0EQ+ 0.5LLL) was the critical load case.

The following area the Moment Force, Shear Force, and Axial Force Diagrams of the structure:

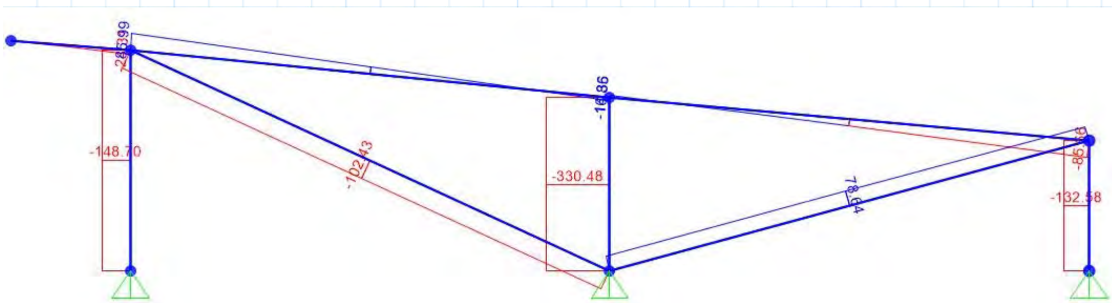
Moment Force Diagram (Units in kN-m)



Shear Force Diagram (Units in kN)



Axial Force Diagram (Units in kN)



Based on the above three diagrams, the following are determined:

- The maximum moment developed in the girders from this load case is 321 kN-m, which is less than the previously determined moment of 444 kN-m.
- The maximum shear developed in the girders from this load case is 169 kN, which is less than the previously determined shear of 194 kN.
- The maximum axial force developed in the HSS columns is 331 kN from this load case, which is more than the previously determined axial load of 268 kN, but less than the axial resistance of the columns of 484 kN.
- The maximum axial load in the braces is 102.43 kN.
- The maximum axial load in the girders is 86 kN.

Therefore:

- The columns are adequate for this load case,
- The girders need to be checked for combined axial and bending (Af = 86 kN, Mf = 321 kN-m for this load case),
- And the braces need to be designed for an axial load of 102.43 kN.

Girder Axial Compression and Bending Check

Axial resistance calculated from CSA S16-09:

$\phi_s := 0.9$

$A_G := 8370\ mm^2$ (Area of Girder: W530x66)

$F_y := 350\ MPa$ (350W Steel)

$E := 200000\ MPa$ (Modulus of Elasticity of Steel)

$I_x := 351 \cdot 10^6\ mm^4$ (Moment of Inertia for W530x66 About its X-Axis

$k := 1$ (Pin-Pin)

$l_{gird} := 2.5\ m$ (Laterally Supported by Joists at 2.5 m intervals)

$r_x := 205\ mm$ (Radius of Gyration)

$n := 1.34$ (Hot-Rolled Structural Sections)

$$F_e := \frac{(3.14 \cdot E)}{\left(\frac{(k \cdot l_{gird})}{r_x}\right)^2} = \left(4.223 \cdot 10^3\right)\ MPa$$

$\lambda_a := 0$

$$\lambda_b := \sqrt[2]{\left(\frac{F_y}{F_e}\right)} = 0.288$$

$C_f := 86\ kN$ (Axial Force from Load Case 5)

$M_r := 444\ kN \cdot m$ (Moment Resistance from Page 5)

$M_f := 321\ kN \cdot m$ (Moment Force from Load Case 5)

$\omega_1 := 1.0$ (Girder Subjected to Series of Point Loads)

$$C_e := \frac{\left(3.14^2 \cdot E \cdot I_x\right)}{l_{gird}^{\ 2}} = \left(1.107 \cdot 10^5\right)\ kN$$

$$U_{1x} := \frac{(\omega_1)}{\left(1 - \frac{C_f}{C_e}\right)} = 1.001$$

Cross-Sectional Strength:

$$C_{ra} := \phi_s \cdot A_G \cdot F_y \cdot \left(1 + \lambda_a^{2 \cdot n}\right)^{\frac{-1}{n}} = \left(2.637 \cdot 10^3\right)\ kN$$

$$\frac{C_f}{C_{ra}} + \frac{(0.85 \cdot U_{1x} \cdot M_f)}{M_r} = 0.648$$

This value is less than one so the girder has an acceptable cross-sectional strength.

Overall Member Strength and Laterial Torsional Buckling Strength (Same Since k=1)

$$C_{rb} := \phi_s \cdot A_G \cdot F_y \cdot \left(1 + \lambda_b^{2 \cdot n}\right)^{\frac{-1}{n}} = \left(2.569 \cdot 10^3\right)\ kN$$

$$\frac{C_f}{C_{rb}} + \frac{(0.85 \cdot U_{1x} \cdot M_f)}{M_r} = 0.648$$

This value is less than one so the girder has acceptable overall and lateral torsional buckling strengths.

Therefore, the **350W W530x66** column is acceptable under the loads from Load Case 5.

Brace Design

From the SAP2000 model, the maximum axial load in the braces is:

$A_f := 102.43\ kN$

From the Handbook of Steel Construction, Pg. 4-59:

$A_r := 132\ kN$ (HSS 152x152x4.8 for a length of 11.2m which is greater than the actual length is 10.84 m, so this value is conservative)

Since Ar > Af, the selected member is adequate. Therefore:

Use HSS 152x152x4.8 Braces

Diaphragm Design Check for Lateral Loads

For the diaphragm, it only needs to be designed for the lateral loads developed from wind or earthquake. For this structure, the governing load case is Load Case 5 (1.0*Earthquake):

$V = 338.354\ kN$

Distributing the Earthquake load over the length of the structure for the Transverse direction:

$$w_{et} := \frac{V}{l} = 14.971\ \frac{kN}{m}$$

Distributing the Earthquake load over the width of the structure for the Longitudinal direction:

$$w_{el} := \frac{V}{w} = 33.835\ \frac{kN}{m}$$

As before, use Canam P-3615 38mm (0.76mm Thick) Steel Deck with 90mm Concrete Slab.

For connections, refer to the SDI Diaphragm Design Manual 3rd Edition which specifies this design for the loading outlined above:

Current Diaphragm Resistance Check:
Unfactored Resistance of Diaphragm: $5595\ plf$

$$\phi_d := 0.5$$
$$Sr := \phi_d \cdot 5495\ plf = 40.097\ \frac{kN}{m}$$

This is higher than the factored load from the earthquake as specified above (34 kN/m); therefore, the currently selected Canam diaphragm is adequate.

Side-Lap Connector Spacing
Spacing of connections should be the minimum of 5/span and 300mm. Therefore, for the side-lap connections, use #10 screws spaced at min (5/10m = 500, 300) = 300mm.

Perimeter Connector Spacing

$$\phi_d := 0.55$$

$$S_f := \frac{(w_{et} \cdot l)}{2 \cdot w} = 16.918\ \frac{kN}{m}$$ (Linear Load Along Edges from Transverse Earthquake Load)

$$Q_f := 7.08\ kN$$ (Connector Resistance of Hilti ENP2)

$$sp := \frac{(\phi_d \cdot Q_f)}{S_f} = 230\ mm$$ (Maximum Connector Spacing)

Therefore, use the current deck design with the following connection specifications:
- Side Lap Connections with #10 Screws Spaced at 300mm
- Perimeter Connections with Hilti ENP2 Spaced at 225 mm

Design Summary:

Deck:
Canam P-3615 38mm (0.76mm Thick) Steel Deck with 90mm Concrete Slab
Perimeter Connectors: Hilti ENP2 Spaced at 225 mm
Side-Lap Connectors: #10 Screws Spaced at 300 mm

Joists:
350W W460x52 10 m Long Joists Spaced at 2500 mm

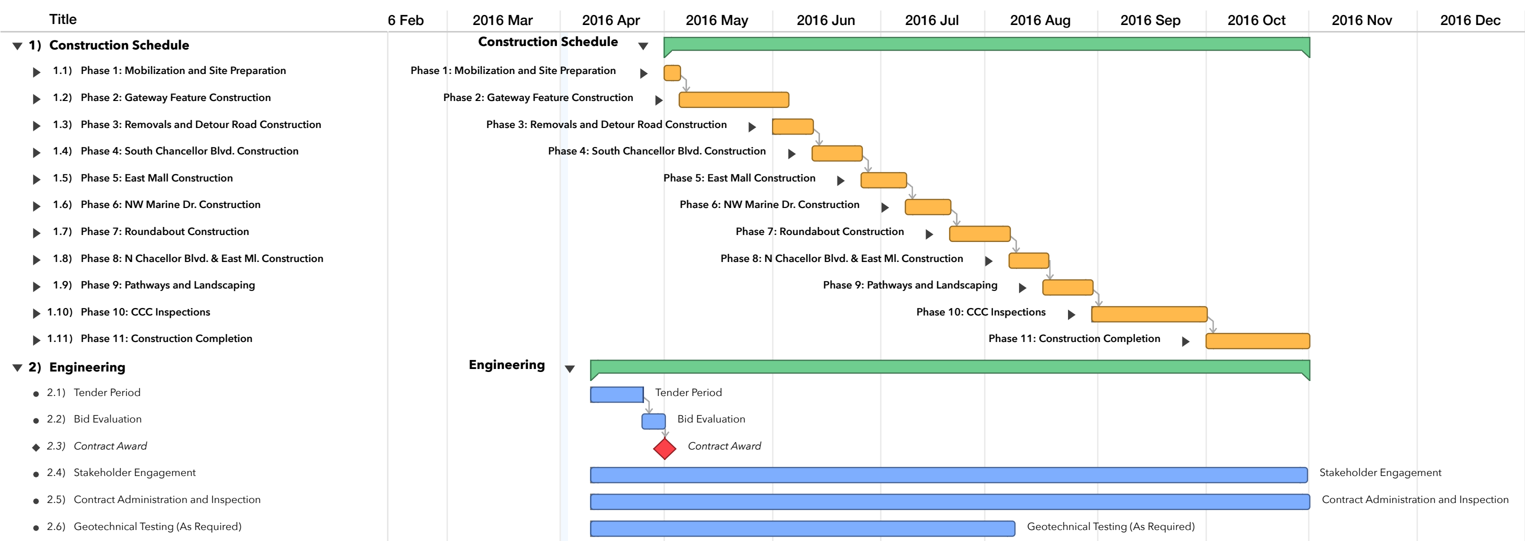
Girders:
350W W530x66 22.5 m Long Girders

Columns:
350W HSS 127x127x8.0 Columns of Varying Height up to 4.5 m

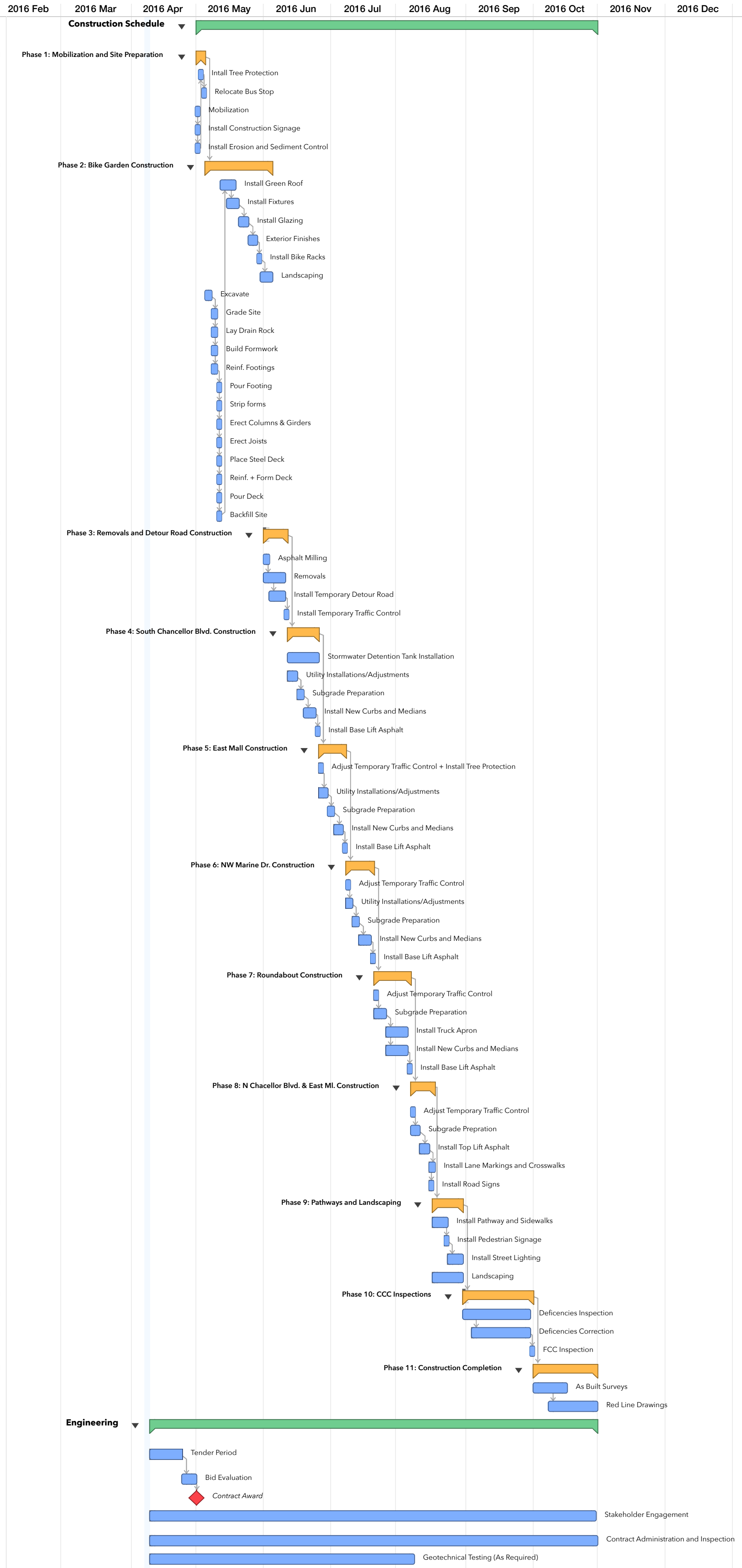
Braces:
350W HSS 152x152x4.8 Braces

APPENDIX F

Construction Schedule


Title
6 Feb
2016 Mar
2016 Apr
2016 May
2016 Jun
2016 Jul
2016 Aug
2016 Sep
2016 Oct
2016 Nov
2016 Dec
1) Construction Schedule
1.1) Phase 1: Mobilization and Site Preparation
1.2) Phase 2: Gateway Feature Construction
1.3) Phase 3: Removals and Detour Road Construction
1.4) Phase 4: South Chancellor Blvd. Construction
1.5) Phase 5: East Mall Construction
1.6) Phase 6: NW Marine Dr. Construction
1.7) Phase 7: Roundabout Construction
1.8) Phase 8: N Chacellor Blvd. & East Ml. Construction
1.9) Phase 9: Pathways and Landscaping
1.10) Phase 10: CCC Inspections
1.11) Phase 11: Construction Completion
2) Engineering
2.1) Tender Period
2.2) Bid Evaluation
2.3) Contract Award
2.4) Stakeholder Engagement
2.5) Contract Administration and Inspection
2.6) Geotechnical Testing (As Required)
Construction Schedule
Phase 1: Mobilization and Site Preparation
Phase 2: Gateway Feature Construction
Phase 3: Removals and Detour Road Construction
Phase 4: South Chancellor Blvd. Construction
Phase 5: East Mall Construction
Phase 6: NW Marine Dr. Construction
Phase 7: Roundabout Construction
Phase 8: N Chacellor Blvd. & East Ml. Construction
Phase 9: Pathways and Landscaping
Phase 10: CCC Inspections
Phase 11: Construction Completion
Engineering
Tender Period
Bid Evaluation
Contract Award
Stakeholder Engagement
Contract Administration and Inspection
Geotechnical Testing (As Required)

Title	Start	End
1) Construction Schedule	**2016-05-02, 8:00 AM**	**2016-10-31, 5:00 PM**
1.1) Phase 1: Mobilization and Site Preparation	**2016-05-02, 8:00 AM**	2016-05-04, 5:00 PM
1.1.1) Intall Tree Protection	2016-05-03, 8:00 AM	2016-05-03, 5:00 PM
1.1.2) Relocate Bus Stop	2016-05-04, 8:00 AM	2016-05-04, 5:00 PM
1.1.3) Mobilization	2016-05-02, 8:00 AM	2016-05-02, 5:00 PM
1.1.4) Install Construction Signage	2016-05-02, 8:00 AM	2016-05-02, 5:00 PM
1.1.5) Install Erosion and Sediment Control	2016-05-02, 8:00 AM	2016-05-02, 5:00 PM
1.2) Phase 2: Bike Garden Construction	**2016-05-05, 8:00 AM**	2016-06-03, 5:00 PM
1.2.1) Install Green Roof	2016-05-12, 8:00 AM	2016-05-18, 5:00 PM
1.2.2) Install Fixtures	2016-05-16, 8:00 AM	2016-05-19, 5:00 PM
1.2.3) Install Glazing	2016-05-20, 8:00 AM	2016-05-24, 5:00 PM
1.2.4) Exterior Finishes	2016-05-25, 8:00 AM	2016-05-27, 5:00 PM
1.2.5) Install Bike Racks	2016-05-30, 8:00 AM	2016-05-30, 5:00 PM
1.2.6) Landscaping	2016-05-31, 8:00 AM	2016-06-03, 5:00 PM
1.2.7) Excavate	2016-05-05, 8:00 AM	2016-05-06, 5:00 PM
1.2.8) Grade Site	2016-05-09, 8:00 AM	2016-05-10, 5:00 PM
1.2.9) Lay Drain Rock	2016-05-09, 8:00 AM	2016-05-10, 5:00 PM
1.2.10) Build Formwork	2016-05-09, 8:00 AM	2016-05-10, 5:00 PM
1.2.11) Reinf. Footings	2016-05-09, 8:00 AM	2016-05-10, 5:00 PM
1.2.12) Pour Footing	2016-05-11, 8:00 AM	2016-05-11, 5:00 PM
1.2.13) Strip forms	2016-05-11, 8:00 AM	2016-05-11, 5:00 PM
1.2.14) Erect Columns & Girders	2016-05-11, 8:00 AM	2016-05-11, 5:00 PM
1.2.15) Erect Joists	2016-05-11, 8:00 AM	2016-05-11, 5:00 PM
1.2.16) Place Steel Deck	2016-05-11, 8:00 AM	2016-05-11, 5:00 PM
1.2.17) Reinf. + Form Deck	2016-05-11, 8:00 AM	2016-05-11, 5:00 PM
1.2.18) Pour Deck	2016-05-11, 8:00 AM	2016-05-11, 5:00 PM
1.2.19) Backfill Site	2016-05-11, 8:00 AM	2016-05-11, 5:00 PM
1.3) Phase 3: Removals and Detour Road Construction	**2016-06-01, 8:00 AM**	2016-06-10, 5:00 PM
1.3.1) Asphalt Milling	2016-06-01, 8:00 AM	2016-06-02, 5:00 PM
1.3.2) Removals	2016-06-01, 8:00 AM	2016-06-09, 5:00 PM
1.3.3) Install Temporary Detour Road	2016-06-03, 8:00 AM	2016-06-09, 5:00 PM
1.3.4) Install Temporary Traffic Control	2016-06-10, 8:00 AM	2016-06-10, 5:00 PM
1.4) Phase 4: South Chancellor Blvd. Construction	**2016-06-13, 8:00 AM**	2016-06-24, 5:00 PM
1.4.1) Stormwater Detention Tank Installation	2016-06-13, 8:00 AM	2016-06-24, 5:00 PM
1.4.2) Utility Installations/Adjustments	2016-06-13, 8:00 AM	2016-06-15, 5:00 PM
1.4.3) Subgrade Preparation	2016-06-16, 8:00 AM	2016-06-17, 5:00 PM
1.4.4) Install New Curbs and Medians	2016-06-20, 8:00 AM	2016-06-23, 5:00 PM
1.4.5) Install Base Lift Asphalt	2016-06-24, 8:00 AM	2016-06-24, 5:00 PM
1.5) Phase 5: East Mall Construction	**2016-06-27, 8:00 AM**	2016-07-07, 5:00 PM
1.5.1) Adjust Temporary Traffic Control + Install Tree Protection	2016-06-27, 8:00 AM	2016-06-27, 5:00 PM
1.5.2) Utility Installations/Adjustments	2016-06-27, 8:00 AM	2016-06-29, 5:00 PM
1.5.3) Subgrade Preparation	2016-06-30, 8:00 AM	2016-07-01, 5:00 PM
1.5.4) Install New Curbs and Medians	2016-07-04, 8:00 AM	2016-07-06, 5:00 PM
1.5.5) Install Base Lift Asphalt	2016-07-07, 8:00 AM	2016-07-07, 5:00 PM
1.6) Phase 6: NW Marine Dr. Construction	**2016-07-08, 8:00 AM**	2016-07-20, 5:00 PM
1.6.1) Adjust Temporary Traffic Control	2016-07-08, 8:00 AM	2016-07-08, 5:00 PM
1.6.2) Utility Installations/Adjustments	2016-07-08, 8:00 AM	2016-07-11, 5:00 PM
1.6.3) Subgrade Preparation	2016-07-12, 8:00 AM	2016-07-13, 5:00 PM
1.6.4) Install New Curbs and Medians	2016-07-14, 8:00 AM	2016-07-19, 5:00 PM
1.6.5) Install Base Lift Asphalt	2016-07-20, 8:00 AM	2016-07-20, 5:00 PM
1.7) Phase 7: Roundabout Construction	**2016-07-21, 8:00 AM**	2016-08-05, 5:00 PM
1.7.1) Adjust Temporary Traffic Control	2016-07-21, 8:00 AM	2016-07-21, 5:00 PM
1.7.2) Subgrade Preparation	2016-07-21, 8:00 AM	2016-07-26, 5:00 PM
1.7.3) Install Truck Apron	2016-07-27, 8:00 AM	2016-08-04, 5:00 PM
1.7.4) Install New Curbs and Medians	2016-07-27, 8:00 AM	2016-08-04, 5:00 PM
1.7.5) Install Base Lift Asphalt	2016-08-05, 8:00 AM	2016-08-05, 5:00 PM
1.8) Phase 8: N Chacellor Blvd. & East Ml. Construction	**2016-08-08, 8:00 AM**	2016-08-17, 5:00 PM
1.8.1) Adjust Temporary Traffic Control	2016-08-08, 8:00 AM	2016-08-08, 5:00 PM
1.8.2) Subgrade Prepration	2016-08-08, 8:00 AM	2016-08-10, 5:00 PM
1.8.3) Install Top Lift Asphalt	2016-08-11, 8:00 AM	2016-08-15, 5:00 PM
1.8.4) Install Lane Markings and Crosswalks	2016-08-16, 8:00 AM	2016-08-17, 5:00 PM
1.8.5) Install Road Signs	2016-08-16, 8:00 AM	2016-08-16, 5:00 PM
1.9) Phase 9: Pathways and Landscaping	**2016-08-17, 8:00 AM**	2016-08-30, 5:00 PM
1.9.1) Install Pathway and Sidewalks	2016-08-17, 8:00 AM	2016-08-23, 5:00 PM
1.9.2) Install Pedestrian Signage	2016-08-23, 8:00 AM	2016-08-23, 5:00 PM
1.9.3) Install Street Lighting	2016-08-24, 8:00 AM	2016-08-30, 5:00 PM
1.9.4) Landscaping	2016-08-17, 8:00 AM	2016-08-30, 5:00 PM
1.10) Phase 10: CCC Inspections	**2016-08-31, 8:00 AM**	2016-09-30, 5:00 PM
1.10.1) Deficencies Inspection	2016-08-31, 8:00 AM	2016-09-29, 5:00 PM
1.10.2) Deficencies Correction	2016-09-05, 8:00 AM	2016-09-29, 5:00 PM
1.10.3) FCC Inspection	2016-09-30, 8:00 AM	2016-09-30, 5:00 PM
1.11) Phase 11: Construction Completion	**2016-10-03, 8:00 AM**	2016-10-31, 5:00 PM
1.11.1) As Built Surveys	2016-10-03, 8:00 AM	2016-10-17, 5:00 PM
1.11.2) Red Line Drawings	2016-10-10, 8:00 AM	2016-10-31, 5:00 PM
2) Engineering	**2016-04-11, 8:00 AM**	**2016-10-31, 5:00 PM**
2.1) Tender Period	2016-04-11, 8:00 AM	2016-04-25, 12:00 PM
2.2) Bid Evaluation	2016-04-25, 1:00 PM	2016-04-29, 5:00 PM
2.3) Contract Award	*2016-04-29, 5:00 PM*	*2016-04-29, 5:00 PM*
2.4) Stakeholder Engagement	2016-04-11, 8:00 AM	2016-10-31, 12:00 PM
2.5) Contract Administration and Inspection	2016-04-11, 8:00 AM	2016-10-31, 5:00 PM
2.6) Geotechnical Testing (As Required)	2016-04-11, 8:00 AM	2016-08-08, 5:00 PM



APPENDIX G

Pre-Tender Cost Estimate

Detailed Cost Estimate

Project: NW Marine Dr.-East Mall-Chancellor Blvd. Intersection Redesign
Client: UBC Campus + Community Planning
Owner: BC Ministry of Transportation
Consultant: Van Augustine Consultants

Date: April 8, 2016

Level of Estimate: Pre-Tender Estimate

Item		Description	Unit	Tendered Quantity	Engineer's Estimate	Extended Estimate Price
Schedule A		**Site Preparation and Removals**				
Part 1		**Mobilization/Demobilization**				
	1	Mobilization and Demobilization	L.S.	1	$ 10,000	$ 10,000
	2	Site Clearing and Grubbing	L.S.	1	$ 5,000	$ 5,000
		Subtotal Schedule A - Part 1 - Mobilization/Demobilization :				$ 15,000
Part 2		**Removals and Relocation**				
	1	Sawcut, Remove & Dispose of Existing Concrete Curb and Gutter	m	1000	$ 20	$ 20,000
	2	Sawcut, Remove & Dispose of Existing Concrete Fill	m^2	600	$ 30	$ 18,000
	3	Sawcut, Remove & Dispose of Existing Concrete Sidewalk (including Wheelchair Ramp)	m^2	600	$ 30	$ 18,000
	4	Sawcut, Remove & Dispose of Existing Asphalt Pavement	m^2	1900	$ 30	$ 57,000
	5	Asphalt Milling (0-50mm Thickness)	m^2	4,000	$ 35	$ 140,000
		Subtotal Schedule A - Part 2 - Removals and Relocation:				$ 253,000
		Total Schedule A - Site Preparation and Removals :				**$ 268,000**

Project: NW Marine Dr.-East Mall-Chancellor Blvd. Intersection Redesign
Client: UBC Campus + Community Planning
Owner: BC Ministry of Transportation
Consultant: Van Augustine Consultants

Date: April 8, 2016

Level of Estimate: Pre-Tender Estimate

Item	Description	Unit	Tendered Quantity	Engineer's Estimate	Extended Estimate Price
Schedule B	**Earthworks**				
Part 1	**Grading**				
1	Stripping (Typical 0.15mm Depth) - includes on-site stockpiling	m^3	1,000	$ 6	$ 6,000
2	Common Excavation (Cut-to-Fill)	m^3	700	$ 10	$ 7,000
3	Waste Excavation - Off-site Disposal	m^3	350	$ 20	$ 7,000
4	Subgrade Preparation for Road Structure	m^2	1,000	$ 3	$ 3,000
			Subtotal Schedule B - Part 1 - Grading:		$ 23,000
			Total Schedule B - Earthworks:		**$ 23,000**

Project: NW Marine Dr.-East Mall-Chancellor Blvd. Intersection Redesign
Client: UBC Campus + Community Planning
Owner: BC Ministry of Transportation
Consultant: Van Augustine Consultants

Date: April 8, 2016

Level of Estimate: Pre-Tender Estimate

Item		Description	Unit	Tendered Quantity	Engineer's Estimate	Extended Estimate Price
Schedule C		**Concrete and Roadworks**				
Part 1		**Gravel**				
	1	25mm - Crushed Gravel Base (150mm Thick)	t	280	$ 36	$ 10,080
	2	75mm - Crushed Gravel Sub-Base (300mm Thick)	t	480	$ 30	$ 14,400
		Subtotal Schedule C - Part 1 - Gravel:				$ 24,480
Part 2		**Asphalt Pavement**				
	1	Top Lift Asphalt - Hot-Mix Asphalt with PG 58-28 Binder and 30% RAP Content (50mm thick)	t	360	$ 140	$ 50,400
	2	Base Lift Asphalt - Hot-Mix Asphalt with PG 58-28 Binder and 30% RAP Content (300mm thick)	t	90	$ 138	$ 12,420
	3	Prime Coat	m^2	4,000	$ 2	$ 8,000
	4	Tack Coat	m^2	4,000	$ 2	$ 8,000
		Subtotal Schedule C - Part 2 - Asphalt Pavement:				$ 78,820
Part 3		**Concrete Construction**				
	1	Concrete Standard Curb with 250mm Gutter	m	1,100	$ 60	$ 66,000
	2	Concrete Median/Island Fill	m^2	75	$ 100	$ 7,500
	3	Supply and Install Concrete Sidewalk (2.00m width)	m	700	$ 150	$ 105,000
	5	Wheelchair Ramp	ea.	25	$ 125	$ 3,125
		Subtotal Schedule C - Part 3 - Concrete Construction:				$ 181,625
		Total Schedule C - Concrete and Roadworks :				**$ 284,925**

Project: NW Marine Dr.-East Mall-Chancellor Blvd. Intersection Redesign
Client: UBC Campus + Community Planning
Owner: BC Ministry of Transportation
Consultant: Van Augustine Consultants

Date: April 8, 2016

Level of Estimate: Pre-Tender Estimate

Item		Description	Unit	Tendered Quantity	Engineer's Estimate	Extended Estimate Price
Schedule D		**Detour Road**				
Part 1		**Detour Road Grading**				
	1	Common Excavation (Cut-to-Fill)	m³	20	$ 20	$ 400
	2	Subgrade Preparation for Road Structure	m²	125	$ 6	$ 750
		Subtotal Schedule D - Part 1 - Detour Road Grading :				$ 1,150
Part 2		**Detour Roadworks**				
	1	Asphalt Mix Type A with PG 58-31 Binder (140mm thick)	t	2	$ 125	$ 250
	2	25mm - Crushed Gravel Base (160mm Thick)	t	1	$ 36	$ 36
	3	Prime Coat	m²	125	$ 2	$ 250
		Subtotal Schedule D - Part 2 - Detour Roadworks :				$ 536
Part 3		**Detour Road Removals**				
	1	Asphalt Removal	m²	125	$ 30	$ 3,750
	2	Waste Excavation - Off-site Disposal	m³	60	$ 30	$ 1,800
		Subtotal Schedule D - Part 3 - Detour Road Removals :				$ 5,550
		Total Schedule D - Detour Road :				**$ 7,236**

Project: NW Marine Dr.-East Mall-Chancellor Blvd. Intersection Redesign
Client: UBC Campus + Community Planning
Owner: BC Ministry of Transportation
Consultant: Van Augustine Consultants

Date: April 8, 2016

Level of Estimate: Pre-Tender Estimate

Item		Description	Unit	Tendered Quantity	Engineer's Estimate	Extended Estimate Price
Schedule E		**Underground Works**				
Part 1		**Stormwater Infrastructure**				
	1	Supply and Install Type C Catch Basin	ea	17	$ 5,500	$ 93,500
	2	Existing Manhole Adjusted to Finished Grade	ea	17	$ 700	$ 11,900
		Subtotal Schedule E - Part 1 - Stormwater Infrastructure:				$ 93,500
Part 2		**Adjustment of Roadway Appurtenances and Waterworks**				
	1	Existing Water Valve Adjusted to Finished Grade	ea	3	$ 1,000	$ 3,000
	2	Existing Manhole Adjusted to Finished Grade	ea	14	$ 350	$ 4,900
		Subtotal Schedule E - Part 2 - Adjustment of Roadway Appurtenances and Waterworks :				$ 7,900
		Total Schedule E - Underground Works:				**$ 113,300**

Project: NW Marine Dr.-East Mall-Chancellor Blvd. Intersection Redesign
Client: UBC Campus + Community Planning
Owner: BC Ministry of Transportation
Consultant: Van Augustine Consultants

Date: April 8, 2016

Level of Estimate: Pre-Tender Estimate

Item		Description	Unit	Tendered Quantity	Engineer's Estimate		Extended Estimate Price	
Schedule F		**Temporary Traffic and Pedestrian Traffic Control**						
Part 1		**Temporary Traffic Control**						
	1	Lane Control Technicians, Construction Traffic Signs, and Traffic Management	L.S.	1	$	10,000	$	10,000
		Subtotal Schedule F - Part 1 - Temporary Traffic Control :					$	10,000
Part 2		**Temporary Pedestrian Traffic Control**						
	1	Supply and Implement Pedestrian and Cyclist Accommodation Plan and Implement Pedestrian Accommodation Measures	L.S.	1	$	10,000	$	10,000
		Subtotal Schedule F - Part 2 - Temporary Pedestrian Traffic Control :					$	10,000
		Total Schedule F - Temporary Traffic and Pedestrian Traffic Control :					**$**	**20,000**

Project: NW Marine Dr.-East Mall-Chancellor Blvd. Intersection Redesign
Client: UBC Campus + Community Planning
Owner: BC Ministry of Transportation
Consultant: Van Augustine Consultants

Date: April 8, 2016

Level of Estimate: Pre-Tender Estimate

Item	Description	Unit	Tendered Quantity	Engineer's Estimate	Extended Estimate Price
Schedule G	**Streetlighting**				
Part 1	**Poles, Lights & Bases**				
1	Relocation	ea	7	$ 3,000	$ 21,000
	Subtotal Schedule G - Part 1 - Streetlighting:				$ 21,000
	Total Schedule G - Streetlighting:				**$ 21,000**

Project: NW Marine Dr.-East Mall-Chancellor Blvd. Intersection Redesign
Client: UBC Campus + Community Planning
Owner: BC Ministry of Transportation
Consultant: Van Augustine Consultants

Date: April 8, 2016

Level of Estimate: Pre-Tender Estimate

Item		Description	Unit	Tendered Quantity	Engineer's Estimate	Extended Estimate Price
Schedule H		**Erosion and Sediment Control & Landscaping**				
Part 1		**ESC Measures**				
	1	Implement ESC Plan	L.S.	1	$ 10,000	$ 10,000
	2	Implementation of Tree Protection Plan	L.S.	1	$ 10,000	$ 10,000
		Subtotal Schedule H - Part 1 - ESC Measures:				$ 20,000
Part 2		**Landscaping**				
	1	Loam Respread	m²	2,900	$ 3	$ 8,700
	2	Seed - Hydroseed	m²	2,900	$ 2	$ 5,800
	3	Rain Gardens	m²	1,215	$ 80	$ 97,200
		Subtotal Schedule H - Part 2 - Landscaping:				$ 111,700
		Total Schedule H - Erosion and Sediment Control & Landscaping:				**$ 131,700**

Project: NW Marine Dr.-East Mall-Chancellor Blvd. Intersection Redesign
Client: UBC Campus + Community Planning
Owner: BC Ministry of Transportation
Consultant: Van Augustine Consultants

Date: April 8, 2016

Level of Estimate: Pre-Tender Estimate

Item		Description	Unit	Tendered Quantity	Engineer's Estimate	Extended Estimate Price
Schedule I		**Gateway Structure: Bike Garden**				
Part 1		**Site Prepration**				
	1	Excavating and Grading	m^3	120	$ 330.00	$ 39,600
	2	Landscaping	m^2	500	$ 20	$ 10,000
	3	Green Roof	m^2	225	$ 200	$ 45,000
		Subtotal Schedule I - Part 1 - Site Prepration:				$ 49,600
Part 2		**Structural Erection**				
	1	Steel Members	kg	13000	$ 1.40	$ 18,200
	2	Supply and Install Concrete Foundation	m^3	90	$ 150	$ 13,500
	3	Glass & Mullions	m^2	80	$ 350	$ 28,000
		Subtotal Schedule I - Part 2 - Structural Erection:				$ 59,700
		Total Schedule I - Gateway Structure: Bike Garden:				**$ 286,000**

Project: NW Marine Dr.-East Mall-Chancellor Blvd. Intersection Redesign
Client: UBC Campus + Community Planning
Owner: BC Ministry of Transportation
Consultant: Van Augustine Consultants

Date: April 8, 2016 **Level of Estimate:** Pre-Tender Estimate

Item	Description	Unit	Tendered Quantity	Engineer's Estimate	Extended Estimate Price
Schedule J	**Miscelaneous Items**				
Part 1	**Record Drawings**				
1	Record Drawings	L.S.	1	$ 5,000	$ 5,000
	Subtotal Schedule J - Part 1 - Record Drawings :				$ 5,000
	Total Schedule J - Miscelaneous Items :				**$ 5,000**

Project: NW Marine Dr.-East Mall-Chancellor Blvd. Intersection Redesign
Client: UBC Campus + Community Planning
Owner: BC Ministry of Transportation
Consultant: Van Augustine Consultants

Date: April 8, 2016

Level of Estimate: Pre-Tender Estimate

Item		Description	Unit	Tendered Quantity	Engineer's Estimate	Extended Estimate Price
Schedule K		**Provisional Items**				
Part 1		**Concrete Construction**				
	1	Fillcrete	m^3	138	$ 100	$ 13,800
		Subtotal Schedule K - Part 1 - Concrete Construction :				$ 13,800
Part 2		**Earthworks**				
	1	Imported Engineered Fill (Off-Site Source)	m^3	60	$ 25	$ 1,500
		Subtotal Schedule K - Part 2 - Earthworks:				$ 1,500
Part 3		**Underground Stormwater Detention Facility**				
	1	Excavation and Grading	L.S.	1	$ 50,000	$ 50,000
	2	Supply and Install (tank to accommodate 800m^3 water)	L.S.	1	$ 275,000	$ 275,000
	3	Stormceptor	L.S.	1	$ 30,000	$ 30,000
	4	Irrigation Plumbing	L.S.	1	$ 50,000	$ 50,000
		Subtotal Schedule K - Part 3 - Underground Stormwater Detention Facility:				$ 405,000
		Total Schedule K - Provisional Items :				**$ 420,300**

Project: NW Marine Dr.-East Mall-Chancellor Blvd. Intersection Redesign
Client: UBC Campus + Community Planning
Owner: BC Ministry of Transportation
Consultant: Van Augustine Consultants

Date: April 8, 2016

Level of Estimate: Pre-Tender Estimate

Item	Description	Unit	Tendered Quantity	Engineer's Estimate	Extended Estimate Price
			All Schedules Subtotal:		$ 1,448,761
			TOTAL TENDERED PRICE:		**$ 1,448,761**

APPENDIX H

Permit Application Forms

THE UNIVERSITY OF BRITISH COLUMBIA
Campus and Community Planning
2210 West Mall • Vancouver, B.C. • V6T 1Z4
☎ 604.822.2633 • 604.822.6119

BP # ______________

Building Permit Application Form

Please submit completed Application Form and Building Permit Application Checklist to:
Campus and Community Planning

Building Address: ____________________

Building Name: ____________________

Building Number: ____________ Development Permit #: ____________

Legal Description: ____________________

Type of Application: ☐ Demolition ☐ Alteration ☐ Addition ☐ New building ☐ Relocation ☐ Amendment ☐ Other ____________

Owner Name / Authorized Agent Name:	Phone: Email:
Applicant name:	Phone: Email:
Mailing Address:	

City:	Province:	Postal Code:	Fax:

I HEREBY AGREE THAT I WILL COMPLY WITH ALL RULES, BYLAWS, REGULATIONS AND POLICIES OF THE UNIVERSITY OF BRITISH COLUMBIA AND ALL OTHER STATUTES, RULES, BYLAWS, POLICIES AND REGULATIONS OF OTHER AUTHORITIES IN FORCE AT THE UNIVERSITY OF BRITISH COLUMBIA RELATING TO THE WORK, UNDERTAKING OR PERMISSION IN RESPECT OF WHICH THIS APPLICATION IS MADE AND THAT I WILL INDEMNIFY AND SAVE HARMLESS THE UNIVERSITY OF BRITISH COLUMBIA, ITS OFFICIALS, EMPLOYEES AND AGENTS FROM ALL CLAIMS, LIABILITIES, JUDGEMENTS, COSTS OR EXPENSES OF EVERY KIND, INCLUDING NEGLIGENCE, IN RESPECT OF ANYTHING DONE OR NOT DONE IN CONSEQUENCE OF ANY PERMISSION, PERMIT OR LICENSE ISSUED AS A RESULT OF THE APPLICATION OR THE FAILURE TO OBSERVE COMPLETELY ALL STATUTES, RULES, BYLAWS, POLICIES AND REGULATIONS RELATING TO ANY WORK OR UNDERTAKING IN RESPECT OF WHICH THIS APPLICATION IS MADE.

SIGNED AT VANCOUVER, B.C. THIS ______ DAY OF ____________ 20____

SIGNATURE OF AUTHORIZED AGENT: ____________________

Please continue application on reverse

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Project Fees

All fees where applicable (Infrastructure Impact Charge (IIC), Community Amenity Charge (CAC), and Greater Vancouver Sewerage & Drainage District (GVS&DD) Development Cost Charge must be paid prior to the issuance of a Building Permit (see Building Permit Fee Schedule).
Submit calculations for all Fees.

Building Permit Fee

Contract Value*: $

Permit fee: $ | Amount enclosed: $

Type: ☐ Institutional ☐ Non-Institutional

Payment by:
☐ Cheque** ☐ Cash ☐ PS Project#:________ ☐ BOW#:________-__ ☐ Other:________

* Refer to Building Permit Fee Schedule. Note: Contract values are required for each partial permit, if phased permits are requested.
** All fees may be paid by cheque, money order or UBC internal requisition, payable to "University of British Columbia". Building Permit application fee is non-refundable.

Project Data for IIC and CAC Fee calculation* ☐ IIC ☐ CAC ☐ N/A

Building Area**: ____________________ ft^2 **Amount: $**________________

Net New Building Area: _____________ ft^2

Classification: ☐ Market Housing ____________ ft^2 ☐ Institutional ____________ ft^2

☐ Commercial ____________ ft^2 ☐ Industry Research ____________ ft^2

☐ Separate Parking Structures __________________ ft^2

* Academic Buildings are exempt
** Refer to Building Area definition on IIC, CAC, and Regional Sewerage Levy

Project Data for Regional Sewerage Levy calculation ☐ Levy ☐ N/A

Unit Count: __________ Duplex(es) __________ Townhouse(s) __________ Apartment(s)

Non-Residential Use: ___________ square feet **Total Amount: $**_____________

In addition to fees, a refundable deposit in the amount of $1000 per drawing for as-built drawings to a maximum of $20,000 is required. Deposit will be returned upon receipt of satisfactory as-built drawings and the UBC 3D PlanMap model where applicable.

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Building Permit Fee Schedule

Contract Value: The current monetary worth of the work described on the permit application and includes finishes, roofing, electrical, plumbing, drains, heating, air conditioning, fire extinguishing systems, elevators and other equipment or materials, construction management, contractor's profit and overhead, sales taxes (except goods and services taxes), insurance, the current monetary worth of contributed labour and materials and a reasonable value for site works and improvements not included in other permits.

Non-Institutional Development

	Rate	Amount
For the first $5,000 of contract value or part thereof	$98.00	
For each $1,000 of contract value or part thereof from $5,001 to $19,999	$14.00	
For each $1,000 of contract value or part thereof from $20,000 to $49,999	$8.25	
For each $1,000 of contract value or part thereof over $50,000	$7.00	
	Total	

Institutional Development

	Rate	Amount
For the first $5,000 of contract value or part thereof	$98.00	
For each $1,000 of contract value or part thereof from $5,001 to $19,999	$14.00	
For each $1,000 of contract value or part thereof from $20,000 to $49,999	$8.25	
For each $1,000 of contract value or part thereof over $50,000.00 to $19,999,999	$7.00	
For each $1,000 of contract value or part thereof over $20,000,000	$3.80	
	Total	

Special Permit Services

For evaluation of plans, specifications, building materials, appliances, systems, equipment, methods of design and construction, pursuant to Clause 1.2.1.1.(1)(b), Division A of the 2012 BC Building Code:

For initial evaluation	$225.00
For each hour or part thereof	$113.00

For issuance of a partial permit in addition to the permit fee for the full project

For a partial permit	$200.00

Other fees

For issuance of a permit for work which has already started	Double Permit Fee
To process a Permit Amendment, rate per hour or part thereof	$113.00
Re-inspection due to faulty work or materials, rate per hour or part thereof	$75.00
Special inspection during normal business hours, per hour or part thereof	$75.00

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DP # ______________

Development Permit Application Form

Complete application form and prepare associated materials prior to scheduling an application intake meeting with the UBC Manager, Development Services.

Project Address and Building Name:
Description of Area:
Description of Project:

Applicant (authorized agent):		
Contact name:		
Mailing address:		Email:
City:	Postal Code:	Phone:
Architect:		
Contact name:		
Mailing address:		Email:
City:	Postal Code:	Phone:
Landscape Architect:		
Contact name:		
Mailing address:		Email:
City:	Postal Code:	Phone:

I, THE AUTHORIZIED AGENT, GIVE CONSENT FOR CAMPUS & COMMUNITY PLANNING TO POST DIGITAL DRAWINGS AND SUPPORTING TEXT FOR PUBLIC VIEWING ON THEIR WEBSITE.

I HEREBY AGREE THAT I WILL COMPLY WITH ALL RULES, BYLAWS, REGULATIONS AND POLICIES OF THE UNIVERSITY OF BRITISH COLUMBIA AND ALL OTHER STATUTES, RULES, BYLAWS, POLICIES AND REGULATIONS OF OTHER AUTHORITIES IN FORCE AT THE UNIVERSITY OF BRITISH COLUMBIA RELATING TO THE WORK, UNDERTAKING OR PERMISSION IN RESPECT OF WHICH THIS APPLICATION IS MADE AND THAT I WILL INDEMNIFY AND SAVE HARMLESS THE UNIVERSITY OF BRITISH COLUMBIA, ITS OFFICIALS, EMPLOYEES AND AGENTS FROM ALL CLAIMS, LIABILITIES, JUDGEMENTS, COSTS OR EXPENSES OF EVERY KIND, INCLUDING NEGLIGENCE, IN RESPECT OF ANYTHING DONE OR NOT DONE IN CONSEQUENCE OF ANY PERMISSION, PERMIT OR LICENSE ISSUED AS A RESULT OF THE APPLICATION OR THE FAILURE TO OBSERVE COMPLETELY ALL STATUTES, RULES, BYLAWS, POLICIES AND REGULATIONS RELATING TO ANY WORK OR UNDERTAKING IN RESPECT OF WHICH THIS APPLICATION IS MADE.

SIGNED AT VANCOUVER, B.C. THIS __________ DAY OF _________________ 20______

SIGNATURE OF AUTHORIZED AGENT: ____

Please continue application on reverse

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DP Fee (see Fee Schedule below): All fees must be paid prior to the issuance of a permit.

Development permit projects		
Type of application: ❑ Major (Value > $2.5 Million) ❑ Minor (Value < $2.5 Million)	❑ New Building ❑ Addition ❑ Façade Alterations only	❑ Site / Park Design ❑ Amendment ❑ DP Extension
Gross Floor Area: ft^2 or m^2	Permit fee:	Amount enclosed:
Payment by: ❑ Cheque** ❑ Cash ❑ Work Order/Project#:		

Fee Schedule:

A	**Minor Applications** (Development Permit Board approval not required)	**Fee**
	For each 100 m^2 up to 500 m^2 GFA* (or part thereof)	$350
	Additional GFA (rate per 100 m^2 or part thereof)	$150
	Maximum	$15,000
B	**Major Applications**	**Fee**
	For each 100 m^2 up to 500 m^2 GFA* (or part thereof)	$300
	Additional GFA (rate per 100 m^2 or part thereof)	$110
	Maximum	None
	REAP Applications - For Residential projects only, UBC REAP (Residential Environmental Assessment Program) certification is required. Documentation review and certification services provided by the Campus Sustainability Office (fee includes 5% GST).	$3,150 (please provide a separate cheque)
C	**Site Changes** (includes Public Realm)	**Fee**
	Up to 1,000 m^2 (rate per 200 m^2 or part thereof)	$250
	Additional area (rate per 200 m^2 or part thereof)	$85
	Maximum	$5000
D	**Alterations, Changes of Use**	**Fee**
	For each 100 m^2 GFA* (or part thereof)	$290
	Maximum	$2,350
E	**Revisions**	**Fee**
	Revisions to drawings resulting from non-compliance or insufficient information, or applicant's request	10% of fee that would apply to a new application (minimum fee $160)
F	**Minor Amendments**	**Fee**
	Amendments where less than 15% of GFA or building exterior is altered or where less than 15% of GFA use is changed	25% of fee that would apply to a new application (minimum fee $160)
G	**Extensions and Renewals**	**Fee**
	Extension of validity of development permit or renewal of a development permit which has become void	75% of fee that would apply to a new application (minimum fee $340)

* GFA = gross floor area

** Submit separate cheques for each application and make payable to the 'University of British Columbia'

Note: Where public notice in community newspapers is required as part of the Development Permit process, Campus & Community Planning will coordinate the advertising, but the applicant is responsible for all costs.

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DEVELOPMENT PERMIT APPLICATION CHECKLIST

Submission Requirements			**Comments**
Application Form	• A Development Permit Application Form must be completed and signed at time of submission.	☐	
Application Fee	• An application fee is due at time of submission.	☐	
Written Description	• A description of the project, outlining the use, site context and rationale.	☐	
Design Policy Compliance	• A brief written outline on how the project complies with the campus wide design guidelines (*Vancouver Campus Plan* Part 3) for academic projects or the design guidelines in the applicable neighbourhood plan for neighbourhood projects.	☐	
Title Search	• Copy of current title search from the Land Title Office, for each parcel involved in the proposal (include Legal description and Property Identifier).	☐	
Site Profile	• See *UBC Procedures Related to Contaminated Sites Regulation*. A Stage 1 Preliminary Site Investigation, Site Profile are required. http://riskmanagement.ubc.ca/environment/contaminated-site-procedures • Environmental Compliance Check List is required http://planning.ubc.ca/sites/planning.ubc.ca/files/documents/planning-services/forms-documents/DP-Envtl-ComplianceChecklist-Jun13.pdf	☐	
Tree Survey	• Location and identification of all existing trees and other significant plant material on-site.	☐	
Green Building Certification	• Academic: Submit LEED checklist; min. LEED Gold and 42% below MNECB http://www.sustain.ubc.ca/campus-initiatives/buildings/leed-ubc • Residential: Submit REAP checklist; min. REAP Gold http://sustain.ubc.ca/campus-initiatives/green-buildings/reap	☐	
Geotechnical Report	• Prepared by a Geotechnical Engineer for potentially hazardous or unstable areas.	☐	
Photos	• Pre-construction digital photos of site and surrounding context	☐	
DP Notification Sign	• See **Development Permit Notification Sign Guidelines** below (photo verification required).	☐	
Building Signage	• See *UBC Sign Standards and Guidelines* http://planning.ubc.ca/sites/planning.ubc.ca/files/attachments/2010_Sign_Guidelines.pdf	☐	
3D Model	• 3D digital model of the project in Sketch-Up format.	☐	

Drawing Requirements
One hardcopy set (11” x 17” and stapled only) and one digital set (email or CD of all drawings in PDF format).

Cover Sheet with Project Statistics (Data Sheet)	• Total Site Area and Site Coverage • Net and Gross Floor Area by Use • Building Height(s) • Setbacks: Front Yard, Rear Yard and Side Yards (permitted + proposed) • Number of Parking, loading and bicycle parking spaces (Class 1 + 2) (permitted + proposed) • Number of Dwelling Units, unit sizes, bedrooms per unit + CRUs • Floor Space Ratio permitted and proposed • Summary of floor areas by level and exclusions (residential projects) • List of variances requested and rationale	☐	
Context Plan	• Plan showing the relationship of the proposed buildings to surrounding developments at front, rear and sides	☐	

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Drawing Requirements (cont.)			**Comments**
Site Plan	• Address (if available) • Street name(s) • Dimensions of site • Location and dimensions of all buildings with north arrow • Required yards, setbacks and building lines • Size and location of all off street parking and loading • Access to parking and loading • Existing and finished grade levels • Treatment of open areas, courtyards, pedestrian areas, etc. • Location of garbage facilities • Location of fire hydrants and their distance from the subject site • Fire access routes or lanes • Area of proposed work if adding to an existing building (highlight)	☐	
Utilities	• Site Plan showing the adjacent existing utility lines, clearances between the building and existing utility lines and preliminary service connections to the existing utility systems (sign off by Utilities required prior to DP issuance) • Preliminary Service Connection Application Form to be submitted to Utilities. • *Residential projects only*: Submit a copy of the completed Energy Service Agreement with Corix Multi-Utility Services Inc.	☐	
Survey Plan	• Street address, street name(s) and location • Dimensions of site and site area, including north arrow • Location and dimensions of all existing buildings on the site • Ultimate property line • Lane dedications, registered easements, encroachments and right-of-ways must be indicated on the surveys • Location of existing street crossings • Existing grades at each of the four corners of the site • Existing grades at each corner of the existing and/or proposed principle building envelope	☐	
Shadow Analysis	• Spring / Summer at 10 am, 12 pm and 2 pm	☐	
Floor Plans	• All storeys including all levels of underground parking • All door, window and skylight locations • Location of vents, bay or box windows, air conditioning units and/or condensing units	☐	
Roof Plan	• Dimensions • Elevations of roof parapet, mechanical, elevator/stair housing, amenity areas	☐	
Elevations	• Elevation of front, rear, two sides and courtyard (if applicable) • Floor levels and height above and below finished grades • Exterior finishing details and materials • Elevation on each floor level, peak of pitched roof or parapet wall of flat roof • Door and window details and sizes • Weather protection • Accessory building details • Sign Location	☐	
Sections	• Longitudinal and cross sections • Details of vaulted areas and adjacent attic spaces • Envelope or height protrusions • Bay window, window seats and window well details	☐	
Landscape Plans	• Provide a full Landscape Plan illustrating both common and botanical names, sizes and quantity of all proposed plant material • Proposed plant material, paved surfaces and materials, other landscape elements and existing/proposed trees must be shown on Landscape Plan • Existing site contours, landscaping and material to be removed, include size, common name and location • All landscape elements and details, including new/existing surfaces to be retained, enclosures, site furniture, fences and structures	☐	
Lighting	• Proposed Lighting Plan is to comply with Lighting Guidelines (*Vancouver Campus Plan* Part 3 Sec. 2.5.2)	☐	

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DEVELOPMENT PERMIT NOTIFICATION SIGN GUIDELINES *

From *UBC Development & Building Regulations*, Section 1.10 Public Process: The applicant shall erect information signs in the specified format on or immediately adjacent to the site in location(s) approved by the Manager, Development Services for Development Permits. The sign must be in place no later than 1 week after submission of the application and shall remain until the project is complete or withdrawn, whichever comes first.

Size: The standard size is 4' x 8' (1.2 m x 2.4 m).

Lettering: The lettering is to be Helvetica and is to be black on a white background.

Construction Specifications: Standard format is a freestanding sign supported only by posts or poles where the top of the sign does not exceed 9 feet (2.75 m) in height above grade. All signs must be erected in a safe manner and be structurally sound to withstand wind and weather.

Location: Signs must be placed within the boundaries of the site, approximately but not closer than 6 feet (1.82 m) from any property line and such that it does not interfere with pedestrian or vehicular traffic. The sign must be located so that it can be clearly read from streets or lanes and be clear of all site obstructions. Where site is bounded by more than one street or corridor, more than one sign may be required.

Content: Signs must contain the information in the standard sign layout template below.

Prior to installation the applicant or agent must:

1. Submit a drawing of the proposed sign(s) and map indicating its (their) location to Campus & Community Planning (C&CP) for approval.
2. Advise in advance of the date of posting and call to confirm when the sign has been erected.

Following installation of all approved signs the applicant or agent must:

1. Submit dated photographs of all signage to C&CP.

Removal of Signs: The sign must be removed from the site at the applicant's cost 14 days after issuance of DP.

*** Note:** DP notification signs are not usually required for minor DP Applications; please check with C&CP.

Development Permit Sign Layout

⇦ **8 ft** ⇨

NOTICE OF DEVELOPMENT PERMIT APPLICATION – No. DP *XXXXX*

(Name of the development)

(Applicant's name) have applied to the University of British Columbia for a Development Permit to construct (building type, storeys & units).
The total building area is _________ m^2.
Anticipated start of construction date

Public Open House
Date + Time:
Location:
Development Permit Board meeting details if applicable.

Developer's name:
Contact number:

For more information contact:
Karen Russell, Manager, Development Services
Campus & Community Planning
2210 West Mall, Vancouver, B.C. V6T 1Z4
Phone: (604) 822-1586, Fax: (604) 822-6119
Email: Karen.Russell@ubc.ca
http://www.planning.ubc.ca

Site Plan (24"x24")

Includes north arrow, street names, building names, lot dimensions & 'You are here'.

Site boundary in red, proposed building footprint in bold & crosshatched and existing building footprints

⇧ **4 ft** ⇩

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SLP # ____________

Streets and Landscape Permit Application Form

Complete application form and submit with all required materials to Campus and Community Planning.

Location (street address, legal address, cross streets, and/or place name):	
Scope of Work (A description of the project, the rationale for the project, proposed changes and improvements):	
Expected Start Date:	**Expected Completion Date:**
Type of Project: ☐ **New SLP Project** ☐ **SLP Amendment** ☐ **SLP Extension** **DP #** (if applicable): ______________	

Applicant (authorized agent):		
Contact name:		
Mailing address:		Email:
City:	Postal Code:	Phone:
Contractor:		
Contact name:		
Mailing address:		Email:
City:	Postal Code:	Phone:
Other:		
Contact name:		
Mailing address:		Email:
City:	Postal Code:	Phone:

I HEREBY AGREE THAT I WILL COMPLY WITH ALL RULES, BYLAWS, REGULATIONS AND POLICIES OF THE UNIVERSITY OF BRITISH COLUMBIA AND ALL OTHER STATUTES, RULES, BYLAWS, POLICIES AND REGULATIONS OF OTHER AUTHORITIES IN FORCE AT THE UNIVERSITY OF BRITISH COLUMBIA RELATING TO THE WORK, UNDERTAKING OR PERMISSION IN RESPECT OF WHICH THIS APPLICATION IS MADE AND THAT I WILL INDEMNIFY AND SAVE HARMLESS THE UNIVERSITY OF BRITISH COLUMBIA, ITS OFFICIALS, EMPLOYEES AND AGENTS FROM ALL CLAIMS, LIABILITIES, JUDGEMENTS, COSTS OR EXPENSES OF EVERY KIND, INCLUDING NEGLIGENCE, IN RESPECT OF ANYTHING DONE OR NOT DONE IN CONSEQUENCE OF ANY PERMISSION, PERMIT OR LICENSE ISSUED AS A RESULT OF THE APPLICATION OR THE FAILURE TO OBSERVE COMPLETELY ALL STATUTES, RULES, BYLAWS, POLICIES AND REGULATIONS RELATING TO ANY WORK OR UNDERTAKING IN RESPECT OF WHICH THIS APPLICATION IS MADE.

SIGNED AT VANCOUVER, B.C. THIS _______ DAY OF ______________ 20________

SIGNATURE OF AUTHORIZED AGENT: ____

THE UNIVERSITY OF BRITISH COLUMBIA
Campus and Community Planning
2210 West Mall • Vancouver, B.C. • V6T 1Z4
☏ 604.822.8228 • 604.822.6119

SLP Fees and Deposits

Total Construction Value: $______________________
(including all soft costs such as consultancy, project management etc.)

SLP Fee

Construction Value	%	Calculation
For the first portion up to $250,000 (minimum $250)	1.5%	
For the next portion from $250,000 to $500,000	1.00%	
For the next portion from $500,001 to $1,000,000	0.5%	
For the next portion from $1,000,001 to $2,000,000	0.25%	
For the next portion from $2,000,001 to $3,000,000	0.125%	
For the next portion over $3,000,000	0.05%	
	Total Fee:	$______________________

SLP Amendment Fee	Calculation
10% of additional construction value (if applicable) or $160	
Total Fee:	$______________________

Non-refundable Damage Deposit Fee ($200.00)*: $______________________

* For all UBC managed projects with a construction value under $250,000 only.
Letter of Undertaking is required.

Refundable Damage Deposit

Construction Value	%	Calculation
For the first portion up to $250,000	8%	
For the next portion from $250,000 to $500,000	4%	
For the next portion from $500,001 to $1,000,000	2%	
For the next portion over $1,000,000	1%	
	Total Damage Deposit:	$______________________

Refundable Record Drawings Deposit

Record Drawings	
$1,000 for each record drawing to be submitted upon project completion up to a maximum of $20,000	______ # of drawings
Total Record Drawings Deposit:	$______________________

Total Fees and Deposits: $______________________

Payment by: ☐ Cheque ☐ Cash ☐ Work Order / Project # ____________________

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Streets and Landscape Permit Application Checklist

Submission Requirements			Comments
Application Form	• Streets and Landscape Permit Application Form (completed and signed)	☐	
DP Issued	• Development Permit issued (if applicable) DP #____________	☐	
Application Fee	• Due at time of submission (see SLP Fees and Deposits)	☐	
Deposits	• Due at time of submission (see SLP Fees and Deposits)	☐	
Drawings Required	- One hardcopy set (11" x 17") and one digital set (all drawings in PDF format). - SLP Application submission documents must be at 95% completion. - Issued for Construction (IFC) drawings are required prior to the issuance of the Streets and Landscape Permit.		
Photos	• Pre-construction digital photos of whole site and close-up photos of key features such as existing damaged infrastructure	☐	
Survey Plan	• Street address, street name(s) and location • Dimensions of site and site area, including north arrow • Location and building footprint dimensions of all existing buildings on the site. • Property line (if applicable) • Lane dedications, registered easements, encroachments and right-of-ways • Existing grades at each of the four corners of the site • Location of existing street crossings • Road painting • Existing grades at each corner of existing and/or proposed building envelope • Benches • Signage • Banners & Fixtures • Planters • Bollards • Waste Bins • Bike Racks • Statues or commemorative plaques	☐	
Context Plan	• Plan showing the relationship of the project area to surrounding streets and buildings in all directions	☐	
Site Plan	• Address • Street name(s) • Dimensions of site • Location of all building footprints • Size and location of all off-street parking and loading • Surface treatment of open areas, courtyards, pedestrian areas, etc. • Location of garbage facilities • Location of fire hydrants closest to the subject site • Fire access routes or lanes	☐	
Landscape Plan Drawings	• Identify and label common and botanical names, sizes and quantity of all proposed plant material/trees • Identify all landscape elements, plants and trees to be removed/relocated • All landscape elements, dimensions, and details, including new and existing surface materials, site furniture and structures	☐	
Material Samples	• Provide a sample of new surface material in proposed colour, unless specified in the UBC Technical Guidelines.	☐	
Furniture Specifications	• Provide full specification for proposed street furniture, unless specified in the UBC Technical Guidelines.	☐	
Proposed Site Grades and Drainage	• Provide all grading and drainage details on plan	☐	
Civil Drawings	• Key Plan including Drawing Index and Legend • Road works including UBC typical cross sections • Geodetic datum, monument number, location, and elevation • Underground utilities (i.e. watermain, sanitary sewer, electrical, gas, etc.) o 1 drawing per utility • Staging/phases of work	☐	

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Submission Requirements continued …			**Comments**
Geotechnical Report	• Prepared and signed by a Geotechnical Engineer identifying potentially hazardous or unstable areas	☐	
Stormwater Management and Erosion & Sediment Control Plans	• Sediment and Erosion Control Methodology • Truck access and egress routes • Identify all measures taken to protect the environment – gravel access pad, cover existing catch basins, sediment check dam, wheel wash facility, etc. • Weekly inspection of the system by record engineer and take samples during or after storm events with rainfall 10mm or greater • Refer to UBC Technical Guidelines - http://www.technicalguidelines.ubc.ca	☐	
Hoarding Plan	• Location of hoarding fences. (Note construction zone is to be minimized)	☐	
Construction Site Plan	• Location of site office, first aid station, site entrances, storage and lay down locations, and tree protection fencing. The Hoarding Plan and Construction Plan may be combined	☐	
Traffic Management Plan	• Truck routes to/from campus, street closures, traffic diversions, traffic control measures • Emergency vehicle access route(s) • Loading/Servicing locations • Location of all excavations on streets or fire access routes. http://planning.ubc.ca/sites/planning.ubc.ca/files/documents/planning-services/forms-documents/TMP-ToR-ProjectInfoForm-Nov2011.pdf	☐	
Parking	• List all construction vehicles including make, model, license plate number on site. Personal vehicles not permitted.	☐	
Site Profile	• See *UBC Procedures Related to Contaminated Sites Regulation*. A Stage 1 Preliminary Site Investigation and Site Profile may be required. http://riskmanagement.ubc.ca/environment/contaminated-site-procedures • Environmental Compliance Check List may be required http://planning.ubc.ca/sites/planning.ubc.ca/files/images/planning-services/forms-documents/DP-Envtl-ComplianceChecklist-Jun13.pdf	☐	
Tree Survey and/or Biophysical Assessment	• Show location, size and identification of all existing trees and other significant plant material on-site.	☐	
Tree Protection Plan	• A Tree Protection Plan shall be prepared and provided by the Landscape Architect and the Project Manager in accordance with the Vancouver Campus Plan Part 3 Section 2.4.6 - http://planning.ubc.ca/sites/planning.ubc.ca/files/documents/planning-services/policies-plans/VCP_Part3.pdf	☐	
Above and Below Ground Storage Tanks	• Provide a plan identifying the type, size and location of all new or existing above or below ground storage tanks (including fuel tanks, acid neutralization tanks, oil water separators, grease traps, septic tanks, liquefied gas tanks, waste water collection and containment tanks), chillers and generators for acceptance by the Chief Risk Officer.	☐	

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SLP Terms and Conditions

1. **Streets and Landscape Permit (SLP) Valid Duration**
The Streets and Landscape Permit (SLP) will expire after six (6) months from date of issue if project work has not commenced. It is the applicant's responsibility to re-apply to extend the expiry date of the SLP, at no additional charge, ten (10) working days prior to the expiration of the current permit.

2. **Construction Fence**
The construction site plan must clearly identify the location of the construction fence line.

3. **Letter of Undertaking**
For projects with a construction value of up to $250,000, a non-refundable fee of $200 and a Letter of Undertaking are required in lieu of a refundable damage deposit. The Project Manager (UBC Project Services or UBC Properties Trust) is required to submit a signed **"LETTER OF UNDERTAKING"** along with the full SLP application package. The Project Manager will be held responsible for deficiencies and damage in the landscape (hard and soft).

4. **Refundable Damage Deposit**
The applicant is to provide a Damage Deposit to be used to pay for any permanent or temporary repair and/or cleanup costs caused by construction activity. The Damage Deposit is to be submitted and payable to Campus and Community Planning(C&CP) in the form of a certified cheque or other acceptable form of credit. The applicant may apply for a refund of the Damage Deposit, with a formal written request (i.e. memo/letter), upon completion of all construction work and associated repair work. The refund request, to include a signed certification, must be received by C&CP from the coordinating Professional Engineer or Landscape Architect confirming that all capital improvement and restoration work has been completed in accordance with the SLP, that all required standards and codes have been adhered to, and that all damage to the surrounding areas has been restored. If the Damage Deposit is insufficient to cover all repair costs, the applicant will be billed for the balance. Repair work undertaken by the applicant must be approved by the University prior to commencement.

5. **Street and Landscape Restoration**
The applicant is responsible for restoring streets and landscape areas to the satisfaction of C&CP. Street restorations are to conform to the standards set in the City of Vancouver`s Street Restoration Manual (http://vancouver.ca/files/cov/vancouver_street_restoration_manual.pdf). The University, prior to commencement, must approve any restoration work. If the digital photographs submitted as part of the application submission do not clearly illustrate the pre-construction condition of existing elements, C&CP will determine the level of restoration required.

6. **Record Deposit Record Drawings**
The applicant is to provide a Record Deposit based on the numbers of drawings submitted. The record drawings (signed and sealed by the Engineer of Record) must be submitted upon completion of the project. Similar to the Damage Deposit, the applicant may apply for a refund of the Record Deposit, with a formal written request, upon completion of all construction work and associated repair work. The record drawings are to be in the format approved in the Technical Guidelines.

7. **Dissemination of Information and Adherence to the Building Permit Terms & Conditions**
The applicant is responsible for ensuring all trades, contractors and subcontractors that work on the job site are aware of and comply with these Terms and Conditions as well as the standard Terms & Conditions for Building Permits - http://planning.ubc.ca/sites/planning.ubc.ca/files/documents/planning-services/forms-documents/BP-TermsConditions_Jan14.pdf

APPENDIX I

Risk Assessment

RISK REGISTER

Revision Issue Date: 2016-04-08

Project: NW Marine Dr.-East Mall-Chancellor Blvd. Intersection Redesign
Client: UBC Campus + Community Planning
Owners: Musqueam First Nation & BC Ministry of Transportation
Consultant: Van Augustine Consultants

Risk ID	Risk Allocation *(Retained/Shared/Transferred)*	Risk Category	Risk	Timing of Risk Event (Planning, Design, Construction, Operations)	Description	Consequence	Risk Treatment (Avoid, Transfer, Mitigate, Accept)
1	Retained by Client	Site	Risk of protracted encroachment negotiations prior to roundabout construction	Design	Risk that Metro Vancouver might not accommodate encroachment upon the Pacific Spirit Park property line	Delay in select project works related to roundabout construction due to negotiations	Mitigate: Ministry of Transportation and Infrastructure is experienced in property negotiations with the regional body and can ensure timely grant of easement
2	Retained by Client	Planning	Risk of lengthy utility crossing permit approval periods prior to commencing utility/road works	Construction	Risk that utility owner approval process for the proposed works is longer than anticipated	Delay in roadworks construction commencement and completion, resulting in increased cost and traffic disruption during the start of school year due to the overlap between construction and academic schedules	Mitigate: UBC Campus + Community Planning can ensure that approval time is conservative in project planning timelines and ensure sound procedures are carried out
3	Transferred to Client	Design/Site	Risk of overestimation of catchment area for the stormwater system	Design	Risk that size of catchment area estimated to be draining into the site is overly conservative	Excessive expenditure associated with the oversized components of the stormwater management system	Mitigate: UBC Campus + Community Planning to supply reliable topographical information
4	Transferred to Contractor	Construction	Risk of existing invert elevations or manhole depths not being able to support the proposed system	Construction	Design of the new minor system assumes that the proposed upgrades can be accommodated around the existing infrastructure, and that the existing manhole barrel depths and mainline inverts will accommodate the bypass system that directs water to the underground detention facility	If invert elevations or manhole depths are not able to suppor the proposed system, an alternative configuration will need to be designed	Mitigate: Sequencing the roadworks after the completion of the Bike Garden helps mitigate this risk as the month of May is available for detailed utility survey and any necessary design revisions.

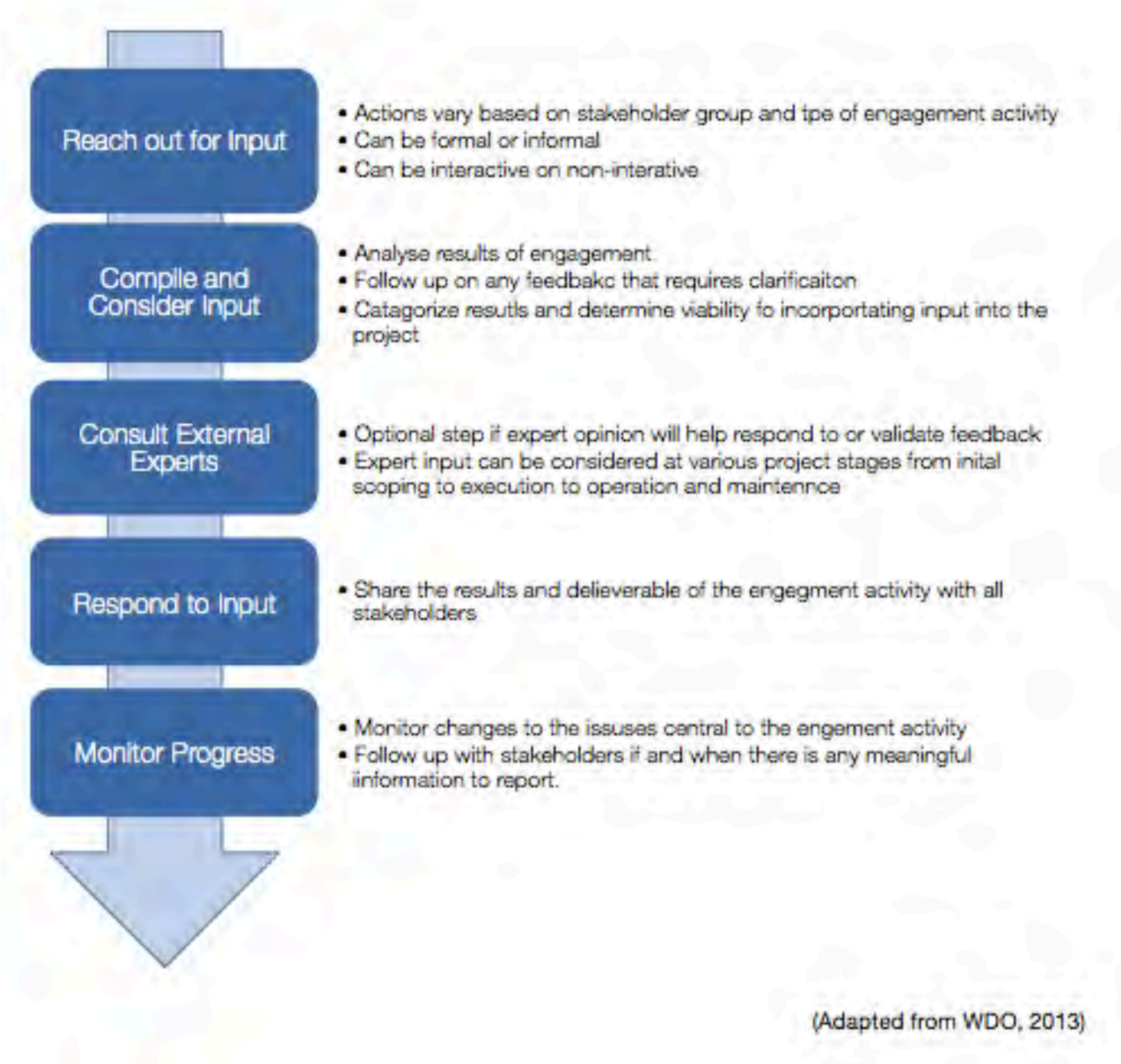
5	Shared with Client	Site	Risk of lengthy approval process associated with the construction plans for the Bike Park Gateway Building	Design	Risk that client review of gateway building plans is more drawn out than expected	Delay in building construction, completion and service commissioning. Trucks bringing in construction materials and taking out any excavated materials may cause traffic disruption during the high-traffic time the school year	Mitigate: UBC Campus + Community Planning has proposed an on-going review process to identify deficiencies in the building plans as early as possible
6	Transferred to Contractor	Construction	Risk that traffic volumes higher than those anticipated are experienced during the construction phase.	Construction	Traffic volumes higher than those anticipated are experienced during construction	May require the enforcement of additional traffic management measures. Also, increased traffic may slow down roadwork and construction activities, resulting in an off-schedule delivery	Mitigate: Inflation of traffic mangement budget.

APPENDIX J

Stakeholder Engagement Strategy

Stakeholder Engagement Framework

Different stakeholder group require different levels of engagement at different stages in the project. To maintain consistency and transparency the following consultation model is followed once an engagement activity has been selected.



Stakeholder Registry

Project: NW Marine Dr./ Chancellor Blvd./ East Mall Intersection Redesign

Client: UBC Campus and Community Planning

Highest: 5 Lowest: 1		Power	Level of Concern	Location	Position	Expectations and Roles of stakeholders
		(Direct Control, Influence)	(Interest, Technical, Non-technical)	Internal/ External	Support/ Neutral/ Resist	
Stakeholder Name/ Group		Score: 1-5	Score: 1-5	Score: I / E	Score: S / N / R	
1	UBC Board of Governors	5	3	I	S or N	Funder/Decision Maker
2	UBC Senate	5	3	I	S or N	Funder/Decision Maker
3	UBC Campus and Community Planning	5	5	I	S	Coordinator
4	UBC Students	1	2	I	N	User
5	Alma Masters Society	3	2	I	S	User/ Indirect Financial Contributor
6	UBC Transportation Committee	3	4	I	S	Decision Maker
7	UBC Building Operations	2	1	I	N	Site Neighbor
8	UBC Facilities Management	2	1	I	N	Site Neighbor
9	Chan Centre	2	3	I	N or R	Site Neighbor / Destination for Users
10	Museum of Anthropology	2	3	I	N or R	Destination for Users
11	Musqueum First Nation	1	1	E	N	Owner
12	BC MOTI	5	5	E	S	Owner/Maintainer/ Regulator
13	Metro Vancouver	4	3	E	N or R	Decision Maker (to be confirmed)
14	Translink	3	4	E	N or R	User
15	Utility Owners	1	3	E	N or R	Service Provider
16	UBC Community Members	1	2	E	S and R	User
17	Nearby Residents	1	5	E	S and R	User / Site Neighbor
18	UBC Faculty Association	4	1	E	N	User
19	University Neighborhoods Association	3	3	E	S	User
20	UBC Community Liaison Committee	3	3	E	S	User
21	UEL Administration	3	3	E	S an R	User
22	UEL Citizens Advisory Committee	3	3	E	S and R	User
23	General Public	2	2	E	N	User

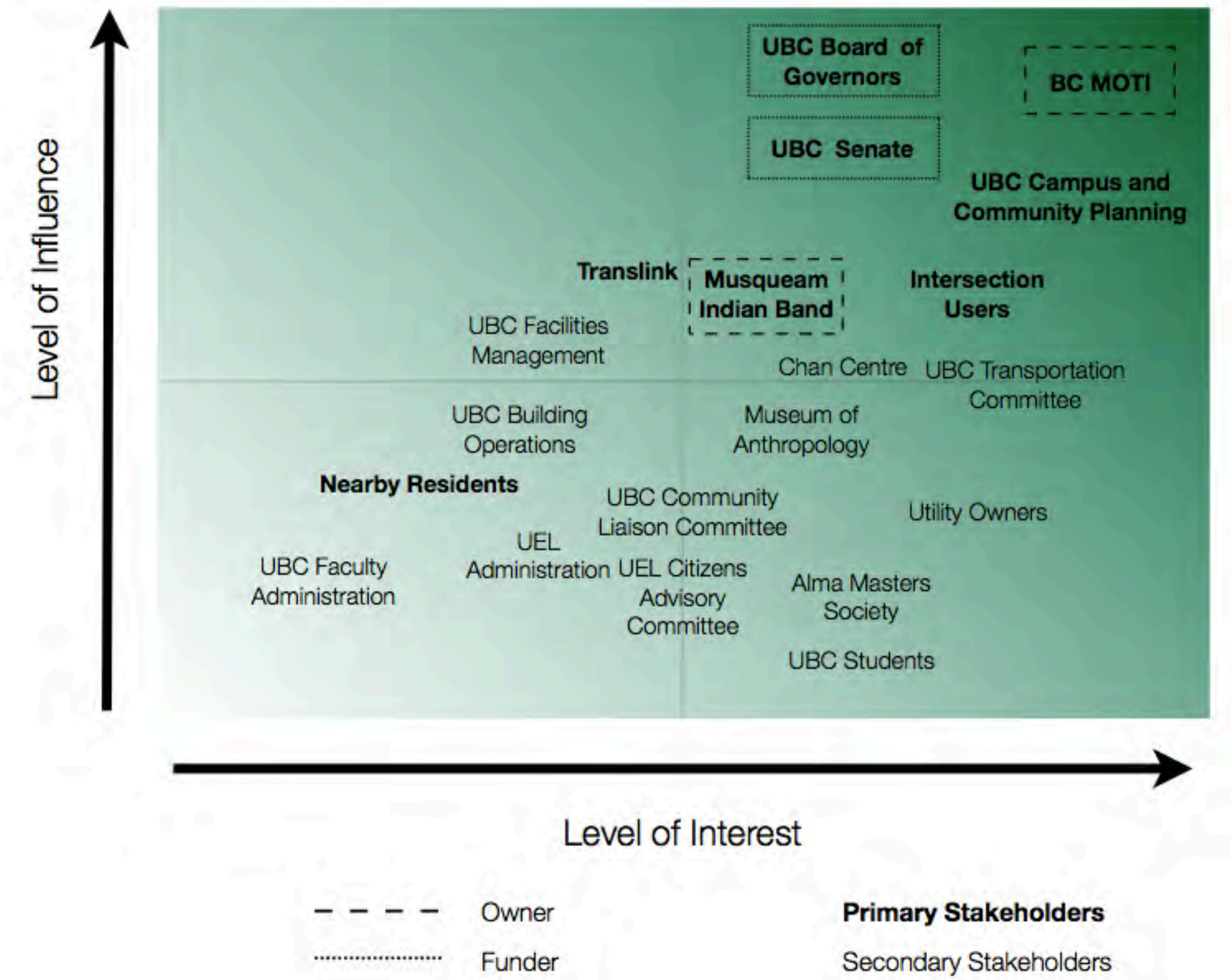


Figure 25: Stakeholder Classification