East Mall – NW Marine Drive
Intersection Improvement Project

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CIVL 446

April 08, 2016

EAST MALL – NW MARINE DRIVE
INTERSECTION IMPROVEMENT PROJECT

FINAL DESIGN REPORT

PREPARED FOR

Infrastructure & Planning Services
UBC Campus & Community Planning

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April 8, 2016

Executive Summary

The intersection at East Mall and NW Marine Drive on the UBC campus has been characterized as an unconventional and inefficiently aligned uncontrolled intersection. UBC Campus and Community Planning approached Roundabout Solutions in September 2015 to develop an intersection layout that improves the interface between vehicles, pedestrians and cyclists while revitalizing the location's gateway aesthetic. The intersection improvement requires a low impact design that integrates into the existing BC Ministry of Transportation (BCMOT) roadway alignment.

In November 2015, Roundabout Solutions proposed a long term solution that would incorporate an immediate curb and lane improvement project that would demarcate cyclist travel with dedicated lanes, improve line markings to increase driver and pedestrian awareness of cross-traffic pathways, and improve turn storage and overall intersection geometry to improve driving experience. This low impact solution would deliver immediate improvements to the interaction experience by eliminating confusion and risk for all users. A roundabout design was ruled out due to significant issues with encroachment onto the Pacific Spirit Park and the existing unfavorable horizontal and vertical alignments.

Roundabout Solutions has anticipated future growth of the intersection and has proposed a long term vision of the intersection with future project add-ons for a signalized pedestrian crossing and a pre-timed signalized intersection arrangement. This design add-on meets the BC MOT guidelines for signalized intersection warrants.

A terraced lookout was proposed for the North greenspace of Allard Hall to revitalize the local aesthetic. This 2.5m retaining wall design would leverage the site's topography to produce a gathering area that would inspire movement to the North Campus area. The retaining wall is constructed from pre-fabricated blocks with granite façade and the 3000 square-foot patio area incorporates a functional and inviting seating area that will improve the gateway aesthetic.

Roundabout Solutions commenced on the detailed design phase of the project in January 2016. The estimated construction cost for the East Mall and NW Marine Drive intersection improvement project is forecasted at $1.0M. The project expected construction complete date is September 2016.

The following report outlines the specific design features of the project as well as the design inputs and estimated costs.

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Tables

1 Introduction

The East Mall + NW Marine Drive Intersection Improvement Project will revitalize the functionality and aesthetic of a key UBC campus gateway. This project achieves the objectives outlined in the *2014 UBC Transportation Plan* [1]:

- Prioritizing safe movements at the intersection with improvements to lanes, markings, and signage.
- Increasing driver awareness of pedestrians and cyclists with improved intersection features and geometry.
- Improving the gateway aesthetic for students, visitors, and the community at large with a newly inspired gathering place.

The East Mall + NW Marine Drive Intersection Improvement Project scope is divided into two primary areas:

1) The **roadway improvement scope** includes the pavement refurbishment, crossing and lane improvements, and the overall geometric improvements for the intersection and approaches.
2) The **lookout terrace scope** includes the new gathering space and accompanying landscaping improvements that highlight the importance of the gateway.

This detailed design was performed by Roundabout Solutions over the first quarter of 2016 and included a series of iterative design steps aimed at refining the vision outlined in the *2015 Preliminary Project Design*. Multiple field visits and design workshops have led to the development of a comprehensive scope of work. Analysis of terrace slope stability, traffic performance, and pavement resilience has guided the design of the project.

This report presents an outline of the specific design features of the project followed by an overview of the design inputs considered during the detailed design process.

The detailed project cost estimate has been updated and is also enclosed. The Summary Design Presentation slides are appended to the report along with a set of pertinent design calculations undertaken during the detailed design phase.

Figure 1: Birds-eye of East Mall + NW Marine Dr

2 Design Features

The East Mall + NW Marine Drive Intersection Improvement Project is divided between the transportation (Intersection Scope) and gateway lookout (Lookout Terrace Scope) objectives as illustrated in Figure 2 .

The transportation design improvement includes a revised curb layout to improve storage and turning performance. A new demarcated bike lane and improvements to the location and visibility of the intersection crosswalk will improve cyclist and pedestrian safety.

A long term solution to accommodate future growth of vehicle, cyclists, and pedestrians has been adopted into the short term design. If future demands warrant the implementation of a signalized cross walk or a pre-timed signalized intersection, the lighting, controls, and foundations will integrate within the proposed curb and lane layout.

The gateway lookout design integrates seamlessly with the existing greenspace north of the Allard Hall building. The retaining wall is designed to project north from the Allard Hall building giving a 2.5m lookout advantage for users. The lookout patio affords users unparalleled views into the Pacific Spirit Park.

The specific design features of each project area are outlined in this section detail.

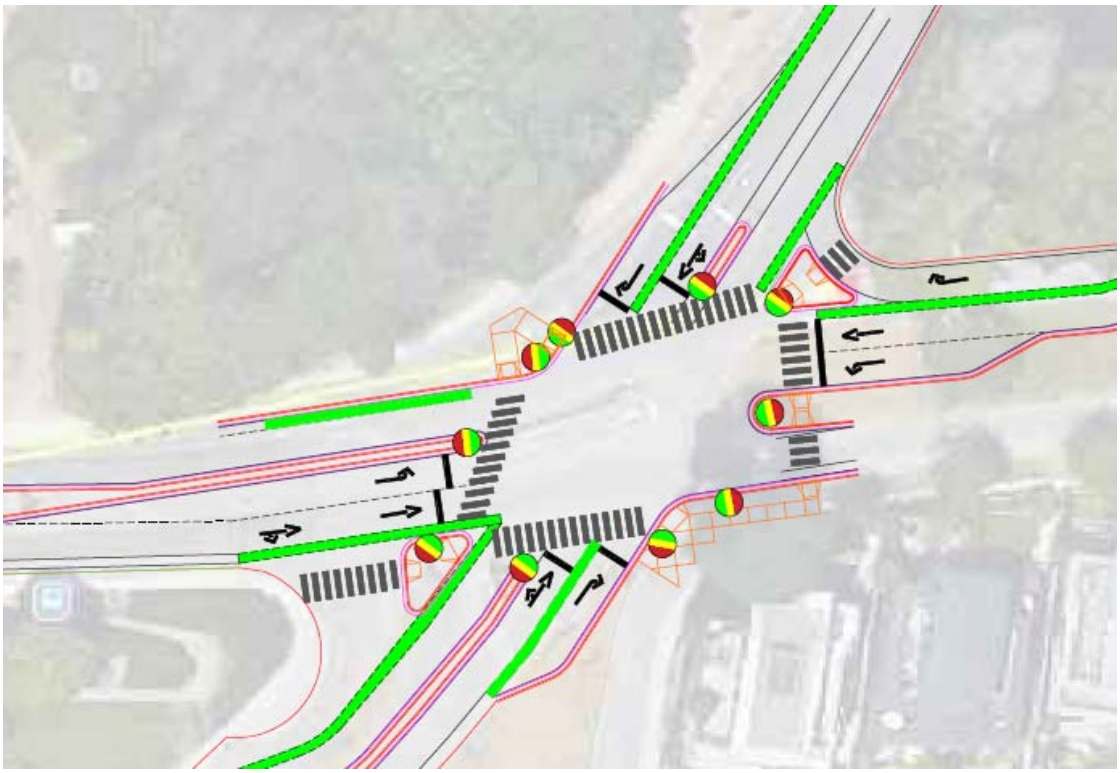
Figure 2: Scope of Work Breakdown

2.1 Intersection Scope

The objective of the intersection design improvements is to improve the horizontal alignment to improve efficiency and reduce confusion for users with limited interference to the adjacent properties and utilities.

The intersection scope of work is bounded by the private property lines that surround the intersection and include work on both provincial and private roads. Refer to Appendix C for all project drawings

Figure 3 - Scope for Phase 2 of Signalized Intersection



2.1.1 Curb, Lane, Stormwater Improvements

The curb layout was designed for minimal impact while improving stopping sight distance (SSD) and pedestrian and cyclist safety.

- Pedestrian cross-walks and bike lanes
- Proposed footprint to fit within existing
- Integrate with existing plans for Chancellor Blvd Bike Lane Alignment (Bunt & Associates).
- Proposed pavement to match existing elevations
- Lane widths of 3.6m and 1.5 were used for car and bicycle use respectively.

To ensure the local drainage patterns were preserved and guidelines for the UBC Integrated Stormwater Management Plan (ISMP) the following scope is proposed:

- 4 additional catch basins
- 5 catch basin rehabilitations

2.1.2 Pavement Rehabilitation

The pavement rehabilitation scope considered pavement rehabilitation and pavement construction.

- Pavement rehabilitation consists of milling off the top 50mm of existing pavement and applying a new wear-coarse of asphalt.
- New pavement area new consists of base courses of gravel, compacted fill, and asphalt.

2.1.3 Future Option – Specialized Crosswalk

Consideration has been made to incorporate a future allowance for a signalized crosswalk if future crossing opportunities are restructured by an increase in traffic volumes. The scope includes:

- Pedestrian crosswalk signals including foundations, electrical conduit, and poles
- Roadway improvements for pavement, curb and gutter
- Improved crosswalk signage.

2.1.4 Future Option - Traffic Signals

Design considerations have been made when volumes warrant the need to establish signalized control at the intersection:

- Installation of traffic control cubical box with a pre-timed signal phasing system
- Low voltage power and duct banks.
- Installation of traffic signals and accompanying supports.

2.2 Lookout Terrace Scope

The lookout terrace will be formed as a gravity wall using the proprietary "Recon" retaining wall system incorporating their standard drainage, fencing and wall cross sections. This was chosen because of the versatility of the design, ease of installation and ability to conform to UBC's visual aesthetic.

The Lookout addition provides a Gateway feature consistent with the UBC campus plan and addresses a larger scale community improvement with the creation of an enjoyable public space.

The lookout terrace project limits are bounded by the triangular green space adjacent to East Mall, Iona Drive, and the north face of the Allard Hall building and is shown on Figure 4.

The wall system, patio, and area improvement scope is discussed in further detail below.

2.2.1 Retaining Wall System

The retaining wall system serves as the structural support for the terrace patio and extends to the shallow footings supporting the stairway and the upper landing connected to the Allard Hall Gateway building.

The retaining wall will also serve as a Gateway entrance and feature a University of British Columbia sign.

2.2.2 Area Landscaping and Improvements

The Lookout landscaping and improvements scope is split into two sections, preservation and rehabilitation.

Most of the area encompassing the Lookout will be preserved, which includes mature trees and a monument (west of the Lookout), and a gas access (east of the Lookout). However, as the project commences the majority of the area will require rehabilitation. This includes the introduction of native and edible plants, shrubs, and other simple landscaping elements.

Recently planted ceremonial trees will need to be considered, as the trees are in the Lookout's footprint. This will require the relocation of the trees, which requires a Project Landscape Architect.

Figure 4: Allard Hall Lookout Terrace

3 Design Criteria

The design of the East Mall + NW Marine Drive Intersection Improvement Project has been developed to meet both the robust requirements of a provincial highway and the long term asset lifespan expected for a university facility. The BCMOT guidelines for highway design were used as the basis for lifespan requirements for the curb, pavement, and line markings.The British Columbia Building Code was used in conjunction with UBC specifications for asset reliability in determining the resilience and design loadings for the lookout structure.

3.1 Intersection Design Criteria

3.1.1 Design Life & Demand

A 20-year design life for the pavement and curb components was chosen based on BC MOT standards. The primary design loading consideration is the Equivalent Single Axle Loadings (ESALs) derived from available traffic count data.

Roundabout Solutions has specified a coloured bike lane treatment resilience in absence of a provincial or campus specific standard. Due to the high volume and variable stopping behavior at the intersection, a non-paint based marking system is specified which must exceed 6 times the expected lifespan of a traditional paint marking (1 year). The design ESAL loading, pavement lifespan and bike lane marking lifespans are illustrated in Table 1.

Table 1: Design Loading - Pavement

Criteria	Loading/ Lifespan
ESAL	3.32M
Spot Repairs (40mm thk patch)	10 years
Mill & Hot Mix Wearing Course	20 years
Green Bike Lane Markings	6 years

3.1.2 Transportation Design Manuals

The project's transportation design basis was established from the BCMOT manuals as outlined in Table 2.

Table 2: BCMOT Standards for Transportation Planning

BCMOT Document	Input Description
Electrical and Traffic Engineering Manual (2013)	Volumes required for signal warrants
Pedestrian Crossing Control Manual for British Columbia (1994)	Pedestrian crossing design options and volume warrants for signal controls
Planning and Designing Access to Developments (2009)	Project scope planning and governance identification

3.2 Lookout Terrace Design Criteria

3.2.1 Design Life & Loading

Roundabout Solutions criteria for the design of the Lookout Terrace retaining wall was developed with guidance from the 2012 BC Building Code. Following the above listed guidelines and others listed in Table 5, it was determined that the retaining wall for the lookout terrace would have a design life exceeding 20 years, and would comply with the designated factors of safety for stability listed in table 3. The Peak Ground Acceleration (PGA) used during the design phase was consistent with a 1-in-475-year seismic event.

Table 3: Design Criteria for Retaining Walls

Criteria	FoS/Lifespan
Global Stability	1.5
Sliding	1.5
Overturning	2.0
Bearing	2.5
Design Life	20 Years
Seismic Event	1 in 475 years

4 Project Design Standards

The following section outlines the various project standards that Roundabout Solutions incorporated into the transportation and lookout terrace design. The design standards were influential in both developing the design criteria and the detailed design attributes of the design drawings.

4.1 Roadway Design Standards

Roadway design inputs considered the various jurisdictions present in the project and can be summarized in Table 4.

Table 4: Roadway Design Inputs

BCMOT Document	Input Description
BC Supplement to TAC Geometric Design Guide (2007)	Vertical and horizontal alignment design constraints
BC MOT Highway Construction and Design Manual (2011)	Curb, gutter, pre-cast/ cast-in place concrete, crossing controls.
Manual of Standard Traffic Signs & Pavement Markings September (2000)	Line marking and lane width criteria
Pavement Structure Design Guidelines (2015)	Pavement structure design for calculated ESAL

4.2 Lookout Design Standards

The individual design inputs considered during the analysis of the Lookout Terrace design are consistent with the design references presented below in Table 5.

Table 5: Geotechnical Lookout Design References

Supporting Document	Input Description
British Columbia Building Code 2012 (BCBC)	Occupancy Loads
Soil Mechanics and Foundations 3rd Edition (BUDHU)	Retaining wall and footings design guide and reference
Acadia and Toronto Roads – Preliminary Geotechnical Report (2015)	Test hole results, soil classification and conditions, groundwater level
Concrete Design Handbook CAN/CSA-A23.3	Concrete retaining wall and shallow footing design

The *UBC Vancouver Campus Plan* [2] provided guidance on the landscaping requirements for the intersection area and can be summarized under Table 6.

Table 6: UBC Landscape Design Considerations

Landscape Consideration	Input Criteria (VCP Section 3)
Architectural Style	'International Style'
District design area	'Contemporary' district
Planting area edging width	3m
Street-side Trees	Maple (Chancellor Boulevard) and 'Reinforce Forest'

5 Technical Considerations

The detailed design of the East Mall + NW Marine Drive Intersection Improvement Project required engineering assessments for the transportation, stormwater, and geotechnical systems. Two major engineering challenges were reviewed.

Firstly, the intersection improvements needed to perform over a minimum 20 year lifespan. This required an extensive review of potential growth issues that might impact the intersection. Secondly, an assessment of the interaction between the retaining wall system and existing utilities and roadways was critical due to the close proximity between the intersection and the lookout terrace. This assessment also sought to evaluate the project's stormwater impact on the downstream system.The assessment tools used as well as the assessment findings are outlined in the following sections.

5.1 Project Assessment Tools

Engineering analysis software was used extensively throughout the detailed design of the project. Specific tools related to the transportation, stormwater, and geotechnical assessments are described further below.

5.1.1 Transportation Modelling & Assessment

Roundabout Solutions implemented *Synchro 6* as the traffic analysis platform to evaluate the intersection performance for both present day and future conditions. A baseline scenario using 2014 traffic count figures was established to develop a do-nothing scenario. Using growth factors (see

Table 7) developed in the Preliminary Design phase of this project, future conditions extending out to 2041 were modelled.

Roundabout Solutions evaluated the performance of the intersection using the stochastic features of *TrafficSIM* simulation. This software provided a visual representation of both live action performance of the intersection as well as visual representations of queue length.

5.1.2 Site Hydrology Analysis Software

Roundabout Solutions used QUALHYMO's *Water Balance Model (WBM)* to evaluate the post-development impact associated with the Lookout. This online tool rendered a model to evaluate runoff quantities and onsite source controls. *WBM* evaluated the impact associated with installing impervious paving of the terrace patio and reducing the site's overall cross slope grade.

5.1.3 Geotechnical Design Software

During the design of the Lookout Terrace, the geotechnical design calculations were completed using Microsoft's Excel program, and by hand. Please see Appendix E – Geotechnical Calculations for a typical example of calculations used for the Geotechnical Design.

5.1.4 CAD Design Software

The geometry of the road layout, alignment, and details were designed using AutoCAD Civil 3D 2016.

5.2 Traffic Forecasting Assessment

The transportation planning analysis was the starting point for the intersection design considerations. Traffic count data for 2013 and 2014 was supplied by the UBC Campus and Community Planning department.

The traffic count data contrasted the volumes between major (Chancellor Blvd and eastbound SW Marine Drive) and the minor (East Mall and southbound SW Marine Drive) routes. The anticipated growth of the vehicular and pedestrian/cyclist traffic was previously estimated by Roundabout Solutions in the 2015 Preliminary Design Report. The governing volume design scenario is presented in Table 7.

A major finding of the traffic assessment was the signal warrant volumes for both pre-timed intersection signals and pedestrian signals are not immediately large enough to warrant traffic flow interruption according to BC MOT specifications [3], [4]. This is illustrated using the Warrant 9 Peak Hour Volume graph in

Figure 5 [3]. Using the 1.7% vehicle growth rate, Roundabout Solutions estimates that the traffic volumes will warrant a signalized intersection in the year 2040. Furthermore, using a 2.7% pedestrian and cyclist growth, Roundabout Solutions estimates a specialized crosswalk will be warranted in 2036.

Evaluation of the proposed design layout using a 5-year growth estimate was performed in *Syncho 6*. The results of the analysis made the following conclusions:

- Short range capacity Utilization: 41%
- ICU Level of Service: A
- Average Delay: 4.9s
- East Mall V/C_{MAX}: 0.31

The Unsignalized Intersection Capacity Analysis is presented in Appendix A and informs Roundabout Solutions' conclusion that the intersection will exceed BCMOT performance requirements.

Table 7: 2014 Traffic Count Volume Summary

2014 Volume Criteria	AM Peak Hr
E-W Cyclists	22 /hr
E-W Pedestrians	36 /hr
Combined Major Road	710 /hr
Highest Minor Road	136 /hr
Vehicle Growth Rate	1.7% / year
Ped/ Cycl. Growth Rate	2.7% / year

Figure 5 - MoT Traffic Signal Warrant Volumes

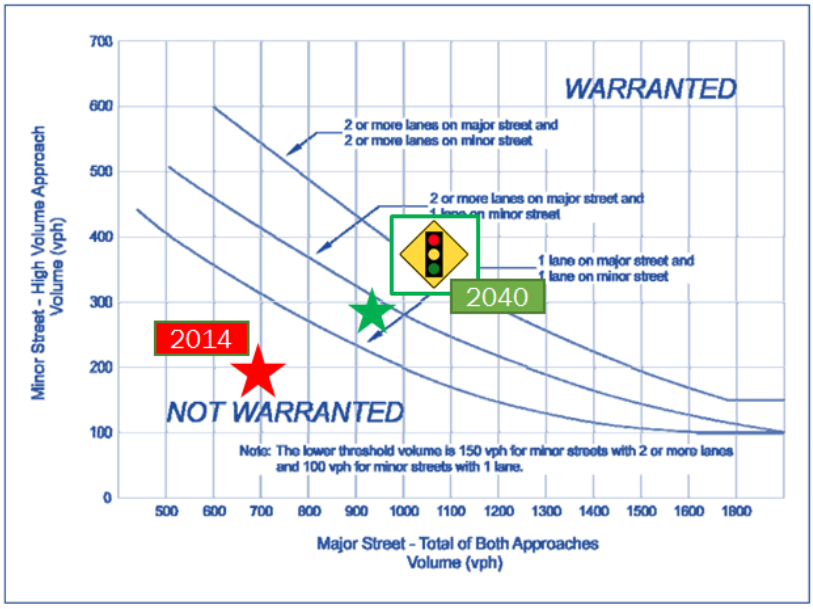
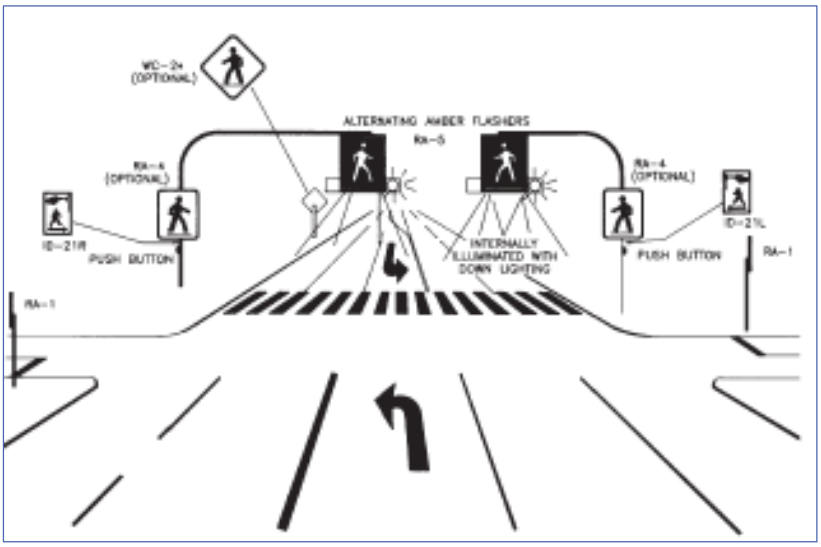


Figure 6: Special Crosswalk Arrangement [4]



5.3 Stormwater Assessment

According to the UBC Integrated Stormwater Management Plan, the East Mall + NW Marine Drive Intersection Improvement Project area is prone to chronic flooding of the roadway as confirmed during a site visit by Roundabout Solutions (see Figure 9).

A future stormwater management project, ISMP#11, has been identified by UBC and proposes a 1,700m^3 detention structure be installed within Chancellor Boulevard to retain a 1:200-year rainfall event [5]. Furthermore, it is understood that restrictions for stormwater infiltration exist due to concerns of slope erosion on the Pacific Spirit Regional Park [6].

Roundabout Solutions has assessed the post development impact of the curb improvement and lookout terrace designs to ensure a) no overland drainage impacts the system and b) adequate source controls are established to reduce stormwater volumes and velocities.

The Water Balance Model was used by Roundabout Solutions to assess the project impact. The results are available in Appendix B and can be summarized as the following:

- Point Source Control: Impervious Terrace Paving with 150mm thick sand base.
- Reduction to overland drainage: 18.6%

Roundabout Solutions has also incorporated improvements to the roadside catch basins as a site inspection revealed multiple stormwater catch basins are damaged and plugged. Details for the stormwater design can be found in the attached detailed design package.

Figure 7: ISMP Project #11 Prelminary Layout 2016

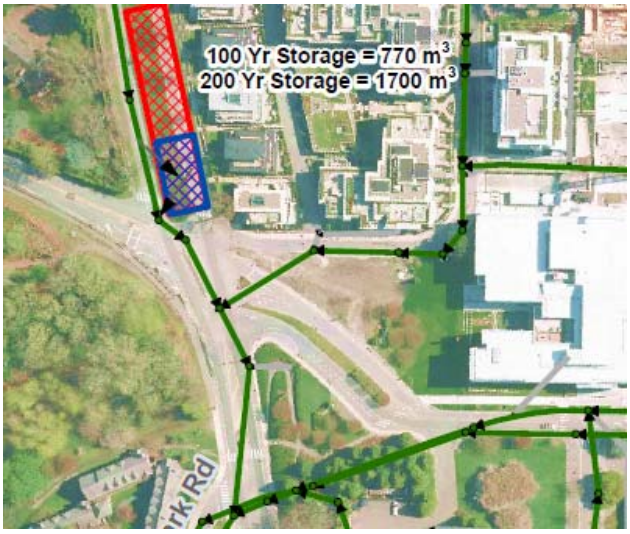


Figure 8: Water Ponding on SW Marine Drive - Photo Taken Jan 29 2016

5.4 Lookout Geotechnical Assessment

Geotechnical design and calculations were based on various design guides. Assumptions of soil characteristics were based on previous campus geotechnical reports. Further site investigation is strongly recommended to verify soil conditions. The design inputs, criteria, and presented assumptions are presented in Table 5 and Table 8.)

Table 8: Geotechnical Design Assumption Inputs

Soil Characteristic	Assumed Values
Primary Soil Layer Sand and Gravel (Trace silt)	0 – 0.9m, compact to stiff, Moisture Contents 18-33%
Primary Soil Layer properties	γ = 18 kN/m3, ϕ = 35°, tanδ = 0.5, c = 0
Secondary Soil Layer	Sand, some silt, 0.9m – 2.4 m, compact to dense, Moisture Content 10-33%
Ground Water Level (GWL)	2.4 m below surface

5.5 Recommended Pre-Construction Assessments

Roundabout Solutions recommends that UBC undertake a 2016 traffic survey and a geotechnical investigation. These additional assessments prior will reduce risk if done prior to construction and are outlined further below.

5.5.1 2016 Traffic Study Update

Roundabout Solutions recommends that a 2016 Traffic Count be performed on the intersection to establish a pre-development baseline performance.

A 2016 traffic count should include a qualitative study on pedestrian and cyclist experience through the intersection. This would be accomplished with the following data capture:

- *Street interview* to canvas pedestrians and cyclists using the intersection with emphasis on user experience.
- *Traffic study counts* of traffic violations made by pedestrians (jaywalking), cyclists (failure to stop), and cars (failing to yield).
- *Reports* of near-misses between traffic and pedestrians/ cyclists.

5.5.2 Geotechnical Investigation

The Geotechnical design process was completed using assumed values and soil conditions similar to *The Acadia and Toronto Roads – Preliminary Geotechnical Report (2015)* which was provided to Roundabout Solutions. Roundabout solutions is recommending that a further geotechnical investigation be completed in the area designated for the Lookout Terrace. The purpose of this Geotechnical Investigation would be to provide accurate site specific soil conditions, and more precise input values to be used during the design phase. The British Columbia Building Code: Schedule B, dictates that a Geotechnical Investigation be conducted during the design phase of a retaining wall. A prepared Geotechnical report will be invaluable in ensuring Roundabout Solutions can provide a cost-effective.

The Geotechnical Investigation would consist of two (boreholes) on site and would included a prepared report on the findings from the contracted Geotechnical Firm. The anticipated cost $5,000. The borehole drilling can be completed in one day, and the report would require a week to prepare.

6 Project Detailed Design Deliverables

6.1 Intersection Design Summary

All intersection design details are presented in the detailed design drawings available in Appendix F. The detail design features can be summarized as:

- New Pavement Structure: 100mm Hot Mix Asphalt c/w 600mm aggregate structure, Binder equivalent to 80/100A Pen (PG 64-22)
- Pavement Re-surface: 50mm Hot Mix Asphalt, Binder equivalent to 80/100A Pen (PG 64-22).
- Concrete Curb: 30MPa (28 day) mix, 0.45 W/C ratio, 6-8% Air as per BCMOT Section 582 [7].
- Line Marking: US Federal specification 595b (White 17886, Yellow 33538)
- Bike Lane Marking: PreMark ® 90 Mil Green Preformed Thermoplastic Marking [8].
- Catch Basin: Cast in Place concrete catch basins with bike safe grates as per BCMOT Section 582 and as detailed in drawing D3 provided in Appendix F.
- Stormwater Pipe: All pipe diameter to be consistent with existing sizes. All pipe specifications to conform with BCMOT Section 318 [7].
- Lamp Standard foundations: Armtec Pyramid service base drawing number refer to D3 for details

Drawing	Drawing ID
SITE PLAN	MC1
GEOMETRIC DESIGN	MC2
PAVEMENT PLAN	MC3
UTILITIES PLAN	MC4
DEMOLITION PLAN	MC5
SEDIMENT CONTROL PLAN	MC6
SIGNS AND LINEMARKING	MC7
CURB AND GUTTER DETAILS	D1
PAVEMENT DESIGN DETAILS	D2
STORMWATER AND LIGHTING	D3
SECTION 1	S1
SECTION 2	S2
SECTION 3	S3
TRAFFIC MANAGEMENT PLAN PHASE 1	TM1
TRAFFIC MANAGEMENT PLAN PHASE 2	TM2

6.2 Lookout Terrace Design Summary

All lookout design details are presented in the detailed design drawings available in Appendix F. The detail design features can be summarized as:

- Precast Retaining Wall System: ReCon gravity wall retaining system following block sizing standards provided by ReCon w/ ¾" crushed stone backfill and drainage.
- Shallow foundation: Shallow concrete foundation w/ no reinforcing (25MPa) levelling pad min. 6" thick stepped to match elevation
- Backfill: Coarse well-draining sand and native soils to be used as backfill behind retaining wall, topped with topsoil and sawd.
- Walkways: Match existing UBC standards
- Timber Shelters: Cantilevered glulam shelters w/ corrugated aluminum roofing (designed by others)

Drawing	Drawing ID
LOOKOUT LAYOUT	L1
ARCH. LOOKOUT LAYOUT	L2
ELEVATIONS	L3
LOOKOUT DETAILS	L4

7 Project Implementation

Roundabouts Solutions has developed a project implementation plan to help execute the project objectives. Thereby, two important elements need to be reviewed. First, the intersection will need sequencing during construction to help mitigate interruptions to traffic flow through the intersection. Second, a risk assessment is needed to provide a contingency for potential hazardous events that may occur during construction. The construction sequencing and risk assessment are outlined in the flowing sections.

7.1 Construction Sequencing

To help mitigate interruptions to traffic during construction, a sequencing plan was developed using MoT's *1999 Traffic Control Manual for Work on Roadways*.

Using this manual, a two-phase construction stage sequence was developed to mitigate traffic flow through the work area to provide safety for pedestrians, cyclists, workers, and other road users.

- Phase 1: A 21 day closer time will be implemented in the south section of the intersection, see Appendix F Drawing TM1 - Traffic Management Plan Phase 1 for work area and other details.

- Phase 2: A 7 day closer time will be implemented in the north section of the intersection, see Appendix F Drawing TM2 - Traffic Management Plan Phase 2 for work area and other details.

A traffic control company will be subcontracted to provide traffic management. This will consist of signage, fencing, delineators, message boards, stop guards, and other traffic management tools.

7.2 Risk Assessment

A project risk assessment was conducted to reduce the potential impact of a hazardous event.

Project activities that provide unknown risk characteristics were tabulated in a matrix.

The cost of the consequence and the probability of occurrence were determined.

The option to avoid, mitigate or accept the risk was made followed by a calculation of a reasonable project contingency value.

Please refer to Risk Matrix Analysis in the Appendix C for more detail of the risk assessment and contingency basis. The total risk contingency recommended for this project is approximately $82,000 or 7.4% of the total project construction cost.

The project cost estimates are prepared using a +/- 30% cost variance which equates to a $300,000 contingency in cost variance considerations.

8 Project Schedule

Roundabout Solutions has prepared a project schedule timeline. According to the BC MOT manual for development access, the detail plan will be the primary document for road authority approval. Estimates for permit processing time have been included in the overall timeline.

The detail project schedule forecasting the implementation date has been prepared in MS Project. The full project schedule is found in Appendix E: Project Schedule.

Highlights of the project timeline are as follows:

- A detailed design phase for the intersection and lookout has been estimated to occur over a 9-week window
- It is expected that a Traffic Impact Assessment (TIA) is required as a permitting deliverable and a 30 day TIA window has been developed into the project timeline
- Permitting for BC MOT and UBC Campus Planning is expected to take 30 days once the detailed design package is prepared
- A 38 day window for project procurement has been estimated for tendering once the permitting phase of the project is concluded.
- Construction is expected to kickoff at the beginning of July 2016 with a 56 day window estimated for the intersection and a 77 day window for the lookout. The intersection would be open for traffic in mid-September 2016 and the lookout would open for users mid-October 2016.
- Contingency for project unknowns has been built into the engineering and procurement phases. See the following section on
- Activity durations have been developed from past experiences with projects of similar scope and complexity.

9 Cost Estimate

The current cost estimate has been prepared using an 80% design complete assumption and available unit rates. This cost estimate will be refined once the design is accepted as "pre-tender". The estimating methods and cost breakdowns are identified in this section and detailed estimates are provided in the appendix.

9.1 Estimating Methodology

Roundabout Solutions has prepared the transportation project scope estimate using the 2013 MOTI Project Cost Estimating Guidelines. The current estimate is based on an 80% design-completeness assumption and implemented the prescribed "Elemental Parametric Estimating Method" as outlined in the guidelines. MOTI unit rates were used as a basis and a 20% (+/-) contingency range is proposed.

The Lookout Terrace cost estimate was prepared using estimated unit rate from precedent projects and past experience with work completed in the UBC area. Assumptions on ground conditions and available materials have been made for the project.

Maintenance cost estimates will be prepared for the final design report using the surface area of landscaped area and newly added fixtures such as lighting and hardware.

9.2 Intersection Cost Impact

A summary cost breakdown for the 2016 intersection curb improvement scope of work is presented in Table 8. A detailed cost estimate breakdown is appended to this report and outlines the unit rates, contingency allowance, and the forecasted cost of implementing a signalized intersection in year 2040.

Table 8: 2016 Intersection Cost Estimate
(80% Design Complete)

Intersection Scope	Cost (x 1000's)
Curbs, earthwork and Demo	301
Storm water	20
Pavement refurbishment	231
Line Marking and painting	6
Lighting	271
Total	**829**

9.3 Lookout Terrace Scope

A summary cost breakdown of the lookout terrace scope is prepared in Table 9. A detailed cost estimate breakdown has been prepared and is appended to this report.

Table 9: Lookout Terrace Cost Estimate (80% Design Complete)

Lookout Scope	Cost (x 1000's)
Stripping, Demolition	65
Earth-fill Import, Placement	33
Retaining Wall System	50
Surface Treatment, Seating	52
Landscaping	20
Total	**220**

10 Conclusion

Roundabout Solutions proudly stands behind our proposal to provide the University of British Columbia's Vancouver Campus with an un-signalized intersection layout which will improve the intersection's capability to safely interface with pedestrians, cyclists, and vehicles.

The refurbishment and redesign of intersection presented herein will exceed BC MOT performance requirements and prioritize the safe movement through the intersection with improvements to intersection geometry, signage, and lane control.

This design is a cost efficient solution to manage the present demands of the area. The implementation of protected crosswalks and a signalized intersection is included in the design to accommodate future growth and play a role in the long term solution to traffic management near the University.

The Gateway Lookout design will create an aesthetically attractive entrance to the UBC campus' East Mall. With stunning views facing the Pacific Spirit Regional Park, the lookout can serve as a gathering space for students, which is consistent with the requirements of the UBC campus plan. Overland drainage impacts across the intersection and lookout have been reduced to protect the Pacific Spirit Regional Park.

11 Works Cited

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12 Appendix A – Synchro 6 Capacity Analysis

HCM Unsignalized Intersection Capacity Analysis
4: East Mall & Chancellor Blvd 2016-04-02

Movement	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		4			4			4			4	
Sign Control		Stop			Stop			Free			Free	
Grade		-5%			4%			0%			0%	
Volume (veh/h)	38	5	47	8	5	31	34	192	50	41	201	8
Peak Hour Factor	0.73	0.63	0.84	0.44	0.38	0.84	0.71	0.74	0.75	0.77	0.81	0.63
Hourly flow rate (vph)	55	8	59	19	14	39	51	275	71	56	263	13
Pedestrians		12			12			73			3	
Lane Width (m)		3.6			3.4			3.4			3.6	
Walking Speed (m/s)		1.2			1.2			1.2			1.2	
Percent Blockage		1			1			6			0	
Right turn flare (veh)			5			4						
Median type		None			None							
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	899	812	325	808	783	355	275			287		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	899	812	325	808	783	355	275			287		
tC, single (s)	7.2	6.5	6.2	7.1	6.5	6.2	4.2			4.1		
tC, 2 stage (s)												
tF (s)	3.6	4.0	3.3	3.5	4.0	3.3	2.3			2.2		
p0 queue free %	72	97	92	92	95	94	96			96		
cM capacity (veh/h)	195	284	712	246	294	641	1216			1257		

Direction, Lane #	NB 1	SB 1	NE 1	NE 2	SW 1	SW 2
Volume Total	123	72	51	346	56	276
Volume Left	55	19	51	0	56	0
Volume Right	59	39	0	71	0	13
cSH	399	579	1216	1700	1257	1700
Volume to Capacity	0.31	0.12	0.04	0.20	0.04	0.16
Queue Length 95th (m)	10.3	3.4	1.0	0.0	1.1	0.0
Control Delay (s)	20.6	15.3	8.1	0.0	8.0	0.0
Lane LOS	C	C	A		A	
Approach Delay (s)	20.6	15.3	1.0		1.4	
Approach LOS	C	C				

Intersection Summary			
Average Delay	4.9		
Intersection Capacity Utilization	41.0%	ICU Level of Service	A
Analysis Period (min)	15		

East Mall - Chancellor MD 2041 11:30 am 2015-10-01 Forecast
University of British Columbia

Synchro 6 Report
Page 1

13 Appendix B – Water Balance Model

WATER Balance MODEL Powered By QUALHYMO

Report for

Lookout Terrace (Post Development)

NW Marine - East Mall

Report Details

Project

Site Name	NW Marine - East Mall
Site Description	CIVL 446 Capstone
Site Location	Vancouver, City of
Site Type	Site
Site Size	2645 sq. m
Stream Present	No
Climate Data File	Vancouver International Airport
Climate Start & End Dates	01/01/1965 to 12/31/1990

Scenario

Scenario Name	Lookout Terrace (Post Development)
Scenario Description	

Timestamps

Report Generated	Tue, 26 Jan 2016 19:35:33 -0600
Processed by QUALHYMO	Tue, 26 Jan 2016 19:32:10 -0600

Drainage Area Configuration

Drainage Areas

Drainage Areas	Native Soil Types	Land Uses	Surface Conditions	Source Controls
Modelled Area **Area** 2645 sq. m **Length** 86 m **High Elevation** 108 m **Low Elevation** 100 m **Slope** 0.093 m/m	Silty Clay **Area** 2645 sq. m **Depth** 300 mm **Field Capacity** 41.3% **Wilting Point** 29.5%	Park **Area** 2645 sq. m **Description** Park, Recreation, and Open Space Zones included in this category: RS-1, RS-1A, RS-1B, RS-2, RS-3, RS-3A, RS-4, RS-5, RS-6, RS-7S Maximum building coverage = 40% Maximum parking coverage = 30% Maximum total impervious coverage = 60% Note: Where the sum of maximum building and parking coverage exceeds total impervious coverage, building is given first priority	Impervious Paving **Area** 608.35 sq. m	Terrace Paving (c/w 150mm Sand) **Size** 456.2625 sq. m 152.0875 sq. m Treated By Terrace Underdrain
			Pervious Cover **Area** 1825.05 sq. m **Depth** 100 mm	1825.05 sq. m Treated By Bio-Swale with Drain

		in Surface Conditions, followed by parking.	Absorbent Landscape Soil **Area** 211.6 sq. m **Depth** 100 mm	Bio-Swale **Size** 194.672 sq. m 16.928 sq. m Treated By Bio-Swale with Drain

Surface Conditions

Name	Area	Type	Depression Storage	Rational Coefficient	Retardance Roughness	Field Capacity	Wilting Point
Impervious Paving	608.35 sq. m	Impervious	2 mm	-	.013	-	-
Pervious Cover	1825.05 sq. m	Pervious	6 mm	.3	.03	19%	10%
Absorbent Landscape Soil	211.6 sq. m	Pervious	6 mm	-	.03	See Underlying Native Soil Type	

Source Controls - Surface Enhancements

Terrace Paving (c/w 150mm Sand)

[Pervious Paving]

Size	Design Soil Rooting Depth
456.2625 sq. m	150 mm

Soil Definition

Name	Type	Depression Storage	Rational Coefficient	Retardance Roughness	Field Capacity	Wilting Point
Clean Sand	Pervious	7 mm	0.2	0.03	12.1%	11.7%

Bio-Swale

[Infiltration Swale - Without Underdrain]

Size	Crop Coefficient	Design Soil Rooting Depth	Ponding Depth (Optional)
194.672 sq. m	0.9	100 mm	450 mm

Soil Definition

Name	Type	Depression Storage	Rational Coefficient	Retardance Roughness	Field Capacity	Wilting Point
Clay Loam	Pervious	7 mm	0.2	0.03	35.9%	23.9%

Results

Exceedance Summary | Rainfall Mass Balance

14 Appendix B – Cost Estimate

Table 10: Intersection Detailed Estimate

Signalized Intersection Cost			
	Rate ($/m or $/m²)	Area/Length (m or m²)	Cost ($)
Roadwork			
Curb/Gutter Improvement	248	500	124000
Sidewalk	77	395.6	30461.2
Grading	54	430	23220
Landscaping	25	794	19850
Re-paving	80	2400	192000
New Asphalt	125	430	53750
Total Roadwork			**443281.2**
Lighting			
Traffic	-	-	65000
Pedestrian	-	-	157000
Illumination Lighting	1200	4	4800
Conduit	75	87.6	6570
Foundations (traffic and illumination)	10	223	2230
Total Lighting			**226800**
Painting			
Lines	4	500	2000
Bike Lanes	5952.4	0.4	2380.96
Total Painting			**4380.96**
Stormwater			
New Catch basins	2500	5	12500
Renovated catch basins	500	3	1500
RWL	275	8	2200
Total Stormwater			**16200**
Phase 1 Total - Curb improvements	$477,462.16		
Phase 2 Total - Pedestrian Lighting	$148,200.00		
Phase 3 Total - Traffic Lighting	$65,000.00		
Total Cost	$690,662.16		
Adjustment factor	1.2		
Total Cost	**$828,794.59**		

Table 11: Retaining Wall Detailed Estimate

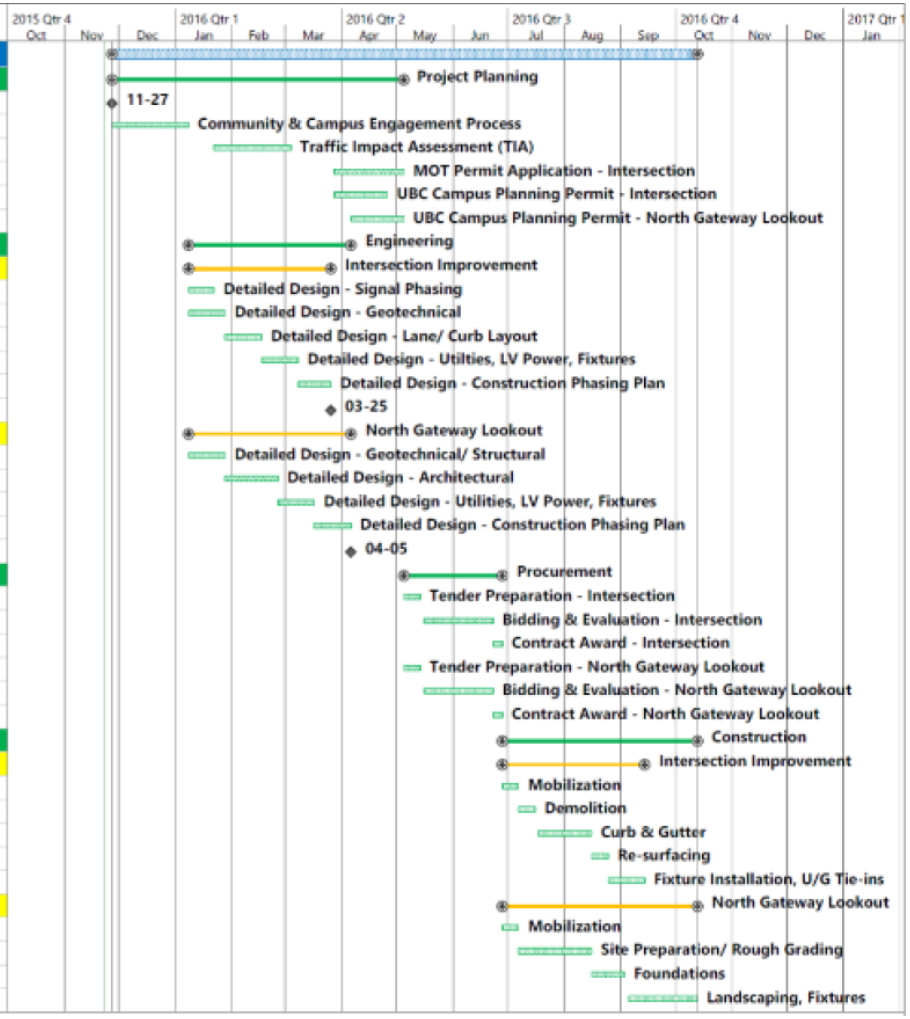
Retaining wall			
Component	Rate ($/qty.)	Quantity (m^2, hr, #)	Cost ($)
Block Retaining Wall	$30.00	1,696.00	$50,880.00
Block Retaining Wall Labor	$70.00	932.90	$65,303.00
Materials and Supplies	$3.25	1,696.00	$5,512.00
Stairs	$31.00	2.00	$62.00
Fill soil	$25.00	1,200.00	$30,000.00
Drainage soil	$36.00	90.00	$3,240.00
Exterior Wall Pot Lights	$50.00	10.00	$500.00
		Sub-Total	**$155,497.00**
Promenade Area			
Component	Rate ($/qty.)	Quantity (m^2, hr, #)	Cost ($)
Timber Cover Structure	$10,000.00	3.00	$30,000.00
Re-grassing / sod	$2.85	1,000.00	$2,850.00
Railing	$30.00	300.00	$9,000.00
Sitting areas	$400.00	12.00	$4,800.00
Trees	$200.00	8.00	$1,600.00
Stone walkway	$55.00	150.00	$8,250.00
Pathway lighting	$60.00	20.00	$1,200.00
Overall lighting	$450.00	6.00	$2,700.00
Study Tables	$550.00	6.00	$3,300.00
		Sub-Total	**$63,700.00**
Gateway Sign			
Component	Rate ($/qty.)	Quantity (m^2, hr, #)	Cost ($)
Signage	$144.69	3.00	$434.07
Lighting for sign	$82.93	4.00	$331.72
		Sub-Total	**$765.79**
		Lookout Gateway Total	**$219,962.79**

15 Appendix C – Project Risk Analysis

Risk Allocation - Retained, Shared, Transferred	Risk Id Number	Risk Category	Risk	Timing of Risk Event (Planning, Design, Construciton, Operations)	Description & Source of Risk	Consequence	Risk Treatment (Avoid, Transfer, Mitigate, Accept)	Cost Base	Probability of occurence	Cost of Consequence	Expected Value of Risk Event
Retained	1	Cost	Poor conceptual estimate under values the project cost when bids are received	Planning	In the panning stage, wrong estimation of the project budgets	Delay in project works commencement or completion and cost increases	Accepted: any over budget costs necessary for the project continuing processing must be undertaken.	$ 85,000	25%	$ 34,000	$ 8,500
Retained	2	Volume	Intersection is over capacity; doen't meet LOS	Operations	Under design intersection, cannot facilitate larger traffic volumes	non-functioning intersection and budget stress	Mitigate: Increase growth rate modelling by 50% and use outcome to determine solution. Or transfer project to UBC for further research and development.	$ 75,000	13%	$ 18,750	$ 2,344
Retained	3	Design	Storm water detention tank is inadequate	Operations	Major storm events of severity greater than that the tank is designed for	Flooding and surging during major storm events	Mitigate: Install more detention tanks to meet major storm event. Or upgrade sotrm water infrastructure in surrounding areas.	$ 60,000	2.00%	$ 60,000	$ 1,200
Retained	4	HSE	Removal of trees	Design	Due to widening of road right-of-way.	Fines, wildlife affected, Increased cost. Redesign of right-of-way	Avoid removal of tree. Relocate tree if necessary.	$ 100,000	1.30%	$ 100,000	$ 1,300
Transferred	5	HSE	Lost time Incident -	Construction	High risk areas around construction site	leads to OH&S Sight Shut down, 5 day		$ 400,000	13%	$ 275,000	$ 35,750
Retained	6	Design	Poor Engineering Details	Planning	Poor Engineering Details lead to construction error during major interface point in project	Trades are delayed	Employ 3D modelling	$ 200,000	8%	$ 24,000	$ 1,920
Transferred	7	Construction	Damage to Existing UG utilities	Construction	Damage to UG utilities requires repairs (steam, sewer, gas, water)	Damaged infrastructure	Spray paint infrastructure	$ 75,000	14%	$ 75,000	$ 10,500
Retained	8	Planning	Poor quality pre-tender estimate	Planning	Poor quality pre-tender estimate	forces additional consultant time redesigning the project scope	Require a Class A estimate prepared prior to tendering	$ 120,000	18%	$ 72,000	$ 12,960
Transferred	9	Design	Design Error in existing as-builts	Construction	Design Error in existing as-builts causes contractor delay and re-design charges	Re-engineering charges, late charges, delay charges	Employ 3D modelling	$ 80,000	14%	$ 16,000	$ 2,240
Retained	10	Planning	Late design request from client	Construction	Late design request from client requires contractor to perform rework and conflict with other trades,	14 day delay, 75k project cost additional	Gap analysis and collaborative session	$ 80,000	12%	$ 40,000	$ 4,800
Total										**$ 714,750**	**$ 81,514**

16 Appendix D – Project Schedule

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
0		East Mall - NW Marine Drive Intersection Improvement Proje	229 days	Fri 15-11-27	Wed 16-10-1	
1		Project Planning	114 days	Fri 15-11-27	Wed 16-05-0	
2		Preliminary Design Submittal	0 days	Fri 15-11-27	Fri 15-11-27	
3		Community & Campus Engagement Process	30 days	Fri 15-11-27	Thu 16-01-07	2
4		Traffic Impact Assessment (TIA)	30 days	Fri 16-01-22	Thu 16-03-03	2,10
5		MOT Permit Application - Intersection	28 days	Mon 16-03-28	Wed 16-05-04	15,4
6		UBC Campus Planning Permit - Intersection	21 days	Mon 16-03-28	Mon 16-04-25	15,4
7		UBC Campus Planning Permit - North Gateway Lookout	21 days	Wed 16-04-06	Wed 16-05-04	21
8		Engineering	63 days	Fri 16-01-08	Tue 16-04-05	
9		Intersection Improvement	56 days	Fri 16-01-08	Fri 16-03-25	
10		Detailed Design - Signal Phasing	10 days	Fri 16-01-08	Thu 16-01-21	3
11		Detailed Design - Geotechnical	14 days	Fri 16-01-08	Wed 16-01-27	3
12		Detailed Design - Lane/ Curb Layout	14 days	Thu 16-01-28	Tue 16-02-16	11
13		Detailed Design - Utilties, LV Power, Fixtures	14 days	Wed 16-02-17	Mon 16-03-07	12
14		Detailed Design - Construction Phasing Plan	14 days	Tue 16-03-08	Fri 16-03-25	13
15		Detailed Design Pkg Complete - Intersection	0 days	Fri 16-03-25	Fri 16-03-25	14
16		North Gateway Lookout	63 days	Fri 16-01-08	Tue 16-04-05	
17		Detailed Design - Geotechnical/ Structural	14 days	Fri 16-01-08	Wed 16-01-27	3
18		Detailed Design - Architectural	21 days	Thu 16-01-28	Thu 16-02-25	17
19		Detailed Design - Utilities, LV Power, Fixtures	14 days	Fri 16-02-26	Wed 16-03-16	18
20		Detailed Design - Construction Phasing Plan	14 days	Thu 16-03-17	Tue 16-04-05	19
21		Detailed Design Pkg Complete - North Campus Gateway	0 days	Tue 16-04-05	Tue 16-04-05	20
22		Procurement	38 days	Thu 16-05-05	Mon 16-06-2	
23		Tender Preparation - Intersection	7 days	Thu 16-05-05	Fri 16-05-13	6,7
24		Bidding & Evaluation - Intersection	28 days	Mon 16-05-16	Wed 16-06-22	23
25		Contract Award - Intersection	3 days	Thu 16-06-23	Mon 16-06-27	24
26		Tender Preparation - North Gateway Lookout	7 days	Thu 16-05-05	Fri 16-05-13	7
27		Bidding & Evaluation - North Gateway Lookout	28 days	Mon 16-05-16	Wed 16-06-22	26
28		Contract Award - North Gateway Lookout	3 days	Thu 16-06-23	Mon 16-06-27	27
29		Construction	77 days	Tue 16-06-28	Wed 16-10-1	
30		Intersection Improvement	56 days	Tue 16-06-28	Tue 16-09-13	
31		Mobilization	7 days	Tue 16-06-28	Wed 16-07-06	25
32		Demolition	7 days	Thu 16-07-07	Fri 16-07-15	31
33		Curb & Gutter	21 days	Mon 16-07-18	Mon 16-08-15	32
34		Re-surfacing	7 days	Tue 16-08-16	Wed 16-08-24	33
35		Fixture Installation, U/G Tie-ins	14 days	Thu 16-08-25	Tue 16-09-13	34
36		North Gateway Lookout	77 days	Tue 16-06-28	Wed 16-10-1	
37		Mobilization	7 days	Tue 16-06-28	Wed 16-07-06	28
38		Site Preparation/ Rough Grading	28 days	Thu 16-07-07	Mon 16-08-15	37
39		Foundations	14 days	Tue 16-08-16	Fri 16-09-02	38
40		Landscaping, Fixtures	28 days	Mon 16-09-05	Wed 16-10-12	39



17 Appendix E – Geotechnical Calculations

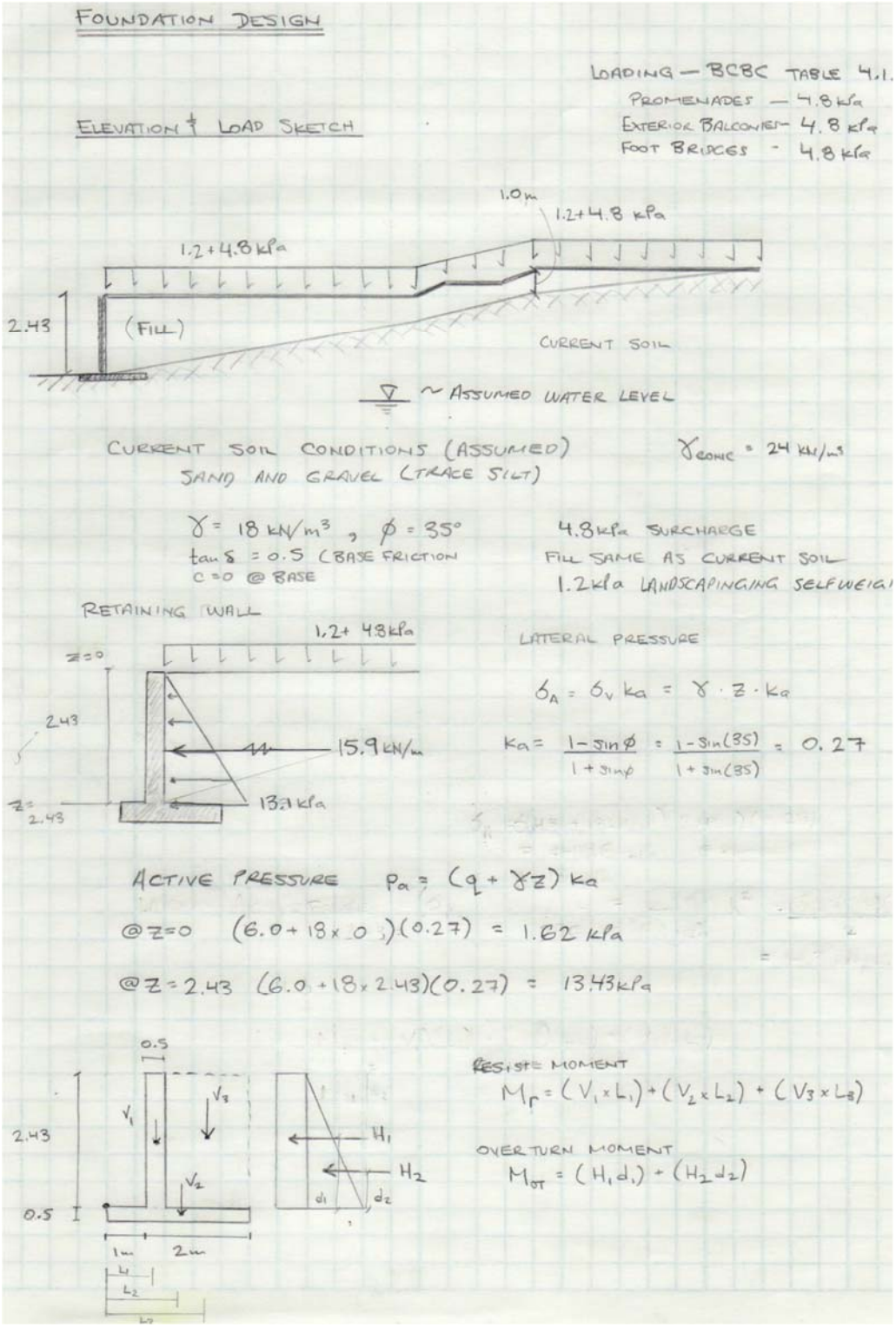


Figure 9: Geotechnical Calculations (Page 1 of 3)

$V_1 = (24\ kN/m^3)(0.5 \times 2.43) = 29.16\ kN/m$ $\quad L_1 = 1.25m$

$V_2 = (24\ kN/m^3)(0.5 \times 3m) = 36\ kN/m$ $\quad L_2 = 1.5m$

$V_3 = (18\ kN/m^3)(1.5 \times 2.43) = 65.61\ kN/m$ $\quad L_3 = 2.25m$

$H_1 = (1.3\ kPa)(2.43m) = 3.16\ kN/m$ $\quad d_1 = 1.22m$

$H_2 = (13.1 - 1.3)(2.43)(0.5) = 14.34\ kN/m$ $\quad d_2 = 0.81m$

$M_f = (29.16)(1.25) + (36)(1.5) + (65.61)(2.25) = 238\ kNm/m$

$M_{OT} = (3.16)(1.22) + (14.34)(0.81) = 16\ kNm/m$

FACTOR OF SAFETY (OVERTURNING)

OVERTURN $\rightarrow FS_{OT} = \Sigma M_r / \Sigma M_{OT} = 238/16 = 14.9 > 2$ OKAY

SLIDING $\rightarrow FS_{SLIDING} = \dfrac{\Sigma V \tan\delta + (2/3\, c B)}{\Sigma H}$

$= \dfrac{(29.16 + 36 + 65.61)(0.5) + (2/3\,(0)\,0.5)}{(3.16 + 14.34)} = 3.7 >$

Figure 10: Geotechnical Calculations (Page 2 of 3)

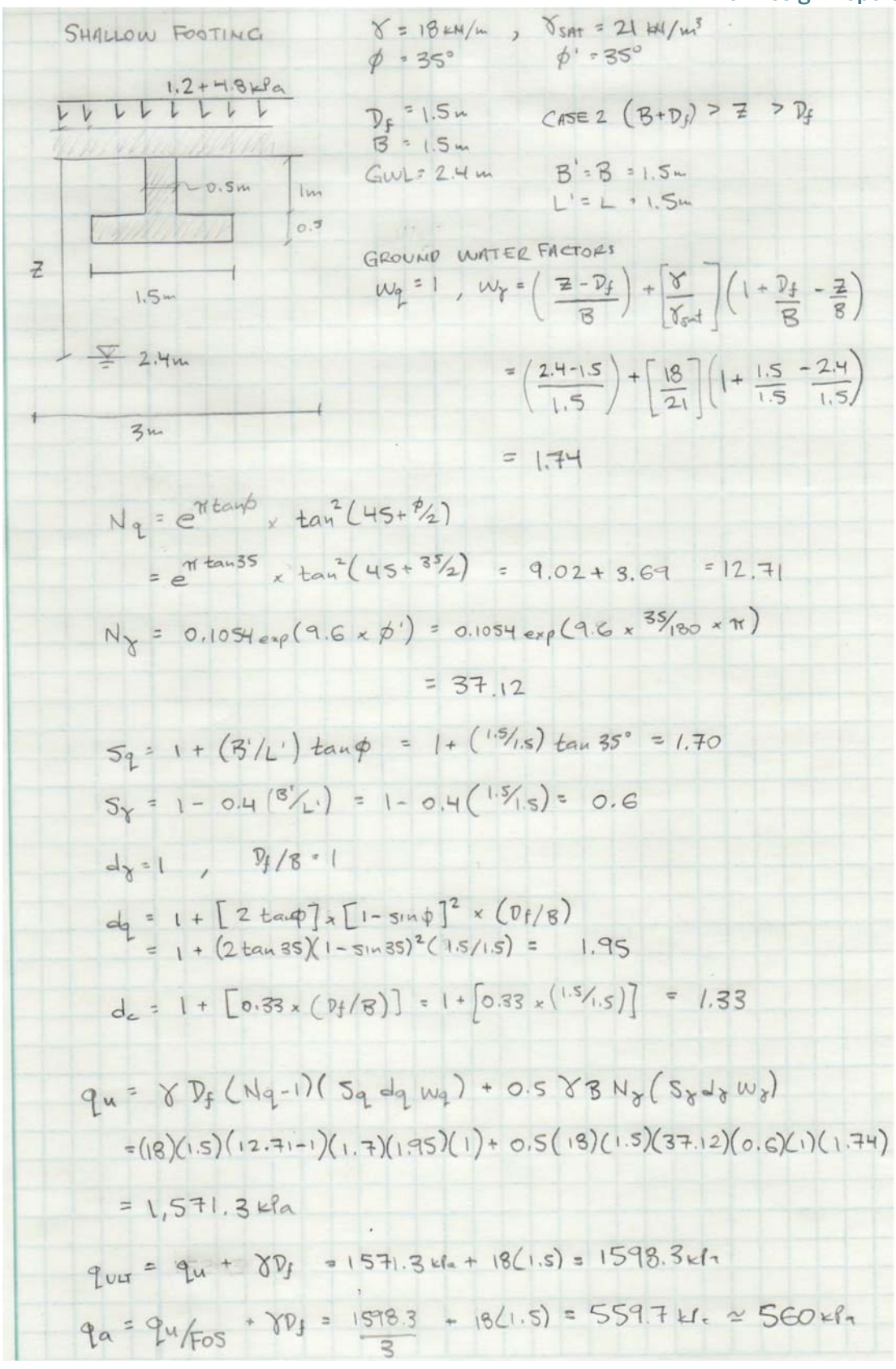
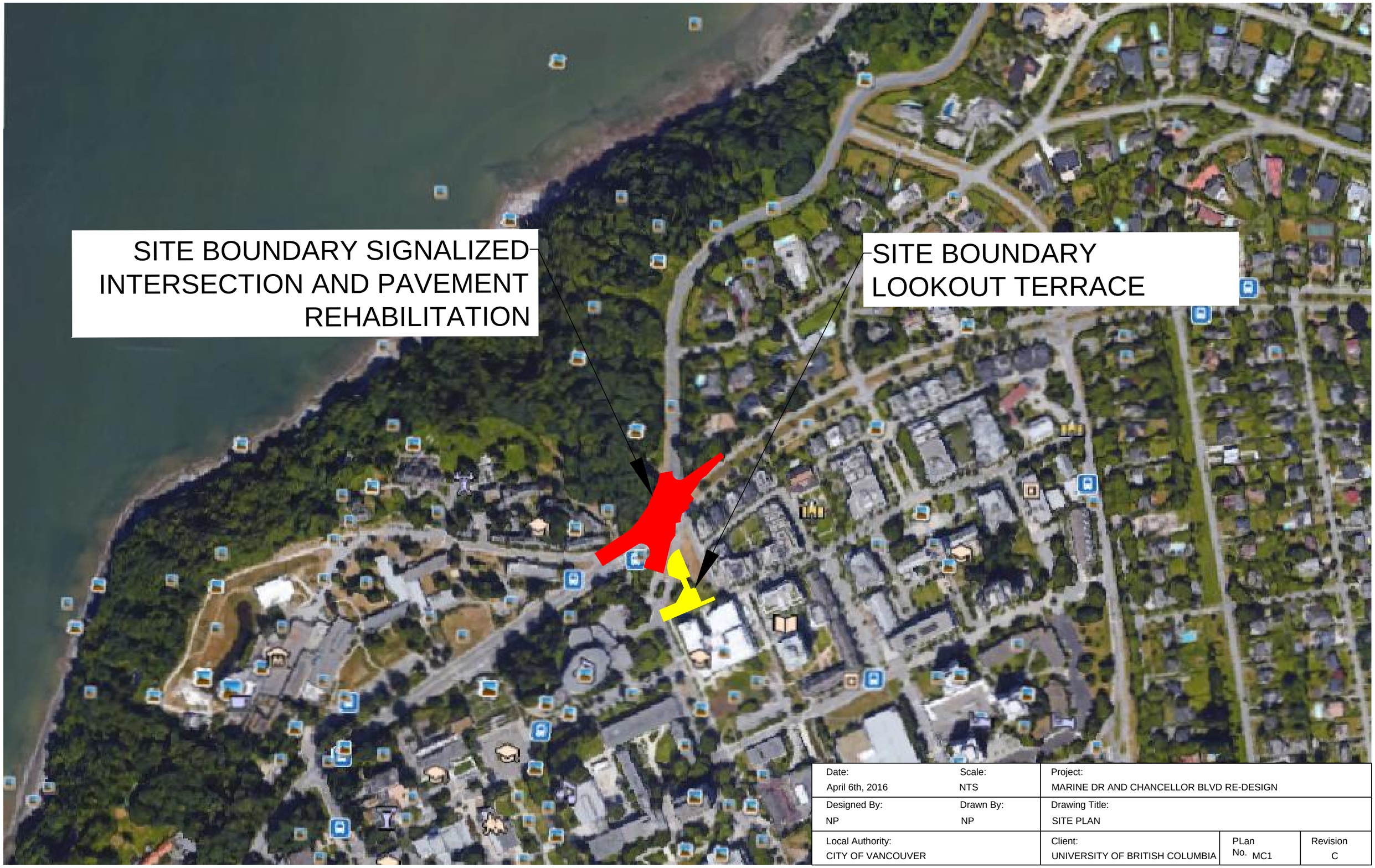


Figure 11: Geotechnical Calculations (Page 3 of 3)

18 Appendix F – Design Drawings



Date: April 6th, 2016	Scale: NTS	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: NP	Drawn By: NP	Drawing Title: SITE PLAN		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. MC1	Revision C

GEOMETRIC DESIGN LEGEND

B — CURB, GUTTER AND LINE-MARKING. LETTER DENOTES CURB TYPE, REFER TO DETAIL FOR SPECIFICATIONS

ALIGN NEW CURB AND GUTTER WITH EXISTING CURB AND GUTTER

ALL LANE ALIGNMENTS TO RUN STRAIGHT THROUGH INTERSECTION TYPICAL FOR BOTH INTERSECTING ROADWAYS

CONSTRUCT SIDEWALK RAMP AS PER DETAIL (TYP.)

ALIGN NEW CURB AND GUTTER WITH EXISTING CURB AND GUTTER

RETAIN EXISTING ISLAND AND CREATE SEAMLESS CONSTRUCTION WITH PROPOSED ISLAND GEOMETRY

ALIGN NEW CURB AND GUTTER WITH EXISTING CURB AND GUTTER

ALIGN NEW CURB AND GUTTER WITH EXISTING CURB AND GUTTER

ALIGN NEW CURB AND GUTTER WITH EXISTING CURB AND GUTTER

CONSTRUCT SIDEWALK RAMP AS PER DETAIL (TYP.)

CONSTRUCT CONCRETE WALKING PLATFORM AS OVERLAND FLOW PATH AT MIN 0.5% GRADE TO ENSURE THAT NO PONDING WILL OCCUR IF LOWEST STORMWATER CATCHBASIN IN IONA DR. IS PLUGGED.

ALIGN NEW CURB AND GUTTER WITH EXISTING CURB AND GUTTER

PROPOSED LOOKOUT TERRACE. REFER TO LOOKOUT TERRACE DRAWINGS FOR DETAILS

Date: April 6th, 2016	Scale: 1:250	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: NP	Drawn By: NP	Drawing Title: GEOMETRIC DESIGN		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. MC2	Revision C

PAVEMENT PLAN LEGEND

	PAVEMENT 'TYPE A'
	PAVEMENT 'TYPE B'
	PAVEMENT 'TYPE C'
	ALL REMAINING PAVEMENT WITHIN THIS BOUNDARY TO BE TREATED IN ACCORDANCE WITH PAVEMENT 'TYPE D'

Date: April 6th, 2016	Scale: 1:250	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: NP	Drawn By: NP	Drawing Title: PAVEMENT PLAN		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. MC3	Revision C

RETAIN AND RECONSTRUCT STORM WATER CATCHMENT BASIN GRATE TO NEW CONDITION.

TYPICAL OF ALL ELECTRICAL FOUNDATIONS AND ELECTRICAL CONDUIT. INSTALL LIGHT FOUNDATION AS DETAILED. CONNECT ELECTRICAL CONDUIT AS SHOWN ON PLAN OR TO NEAREST ELECTRICAL CORRIDOR AS PER INDUSTRY STANDARD. ENSURE DISTANCE TO ALL OTHER UTILITIES MEETS INDUSTRY STANDARDS.

INSTALL NEW CATCH BASIN TO DETAILED SPECIFICATIONS. CONNECT DIRECTLY TO ADJACENT STORMWATER CATCH BASING AS SHOWN ON PLAN AT 2% MIN GRADE. GROUT CONNECTIONS TO ENSURE NO LEAKAGE.

INSTALL NEW CATCH BASIN TO DETAILED SPECIFICATIONS. CONNECT DIRECTLY TO NEAREST STORMWATER MANHOLE AT 2% MIN GRADE. GROUT CONNECTION TO ENSURE NO LEAKAGE.

INSTALL NEW CATCH BASIN TO DETAILED SPECIFICATIONS. CONNECT DIRECTLY TO NEAREST STORMWATER MANHOLE AT 2% MIN GRADE. GROUT CONNECTION TO ENSURE NO LEAKAGE.

CONFIRM LOCATION AND CONDITION OF ALL EXISTING UTILITIES. CONDUCT COMPLETE SITE INVESTIGATION PRIOR TO CONSTRUCTION. PROTECT ALL EXISTING UTILITIES DURING CONSTRUCTION (TYP.)

DEMOLISH AND REUSE EXISTING STORMWATER CATCHMENT BASIN. ENSURE COMPACTION OF SUB-BASE TO MEET PAVEMENT REQUIREMENTS (REFER DETAIL)

CONFIRM LOCATION AND CONDITION OF UTILITY. PROTECT AND REROUTE DURING CONSTRUCTION

RETAIN AND PROTECT EXISTING STORMWATER CATCH BASIN

INSTALL NEW CATCHBASIN TO DETAILED SPECIFICATIONS. CONNECT DIRECTLY TO NEAREST STORMWATER MANHOLE AT 2% MIN GRADE. GROUT CONNECTION TO ENSURE NO LEAKAGE.

INVESTIGATE NATURAL GAS LINE PRIOR TO CONSTRUCTION. PROTECT DURING CONSTRUCTION AND ENSURE COVER REQUIREMENTS.

DEMOLISH AND REMOVE EXISTING STORMWATER CATCHMENT BASIN. ENSURE COMPACTION OF SUB-BASE TO MEET PAVEMENT REQUIREMENTS (REFER DETAIL)

DEMOLISH AND REMOVE OFF SITE EXISTING LIGHT POLE AND FOUNDATION. COMPACT SUB-BASE TO MEET PAVEMENT REQUIREMENTS AS DETAILED

RETAIN AND RECONSTRUCT STORM WATER CATCHMENT BASIN GRATE TO MATCH PROPOSED LEVELS.

DEMOLISH AND REMOVE EXISTING STORMWATER CATCHMENT BASIN. ENSURE COMPACTION OF SUB-BASE TO MEET PAVEMENT REQUIREMENTS (REFER DETAIL)

CONSTRUCT STORMWATER CATCHMENT BASIN AS PER DETAIL. CONNECT TO NEAREST STORMWATER MAIN AT 2% MIN GRADE.

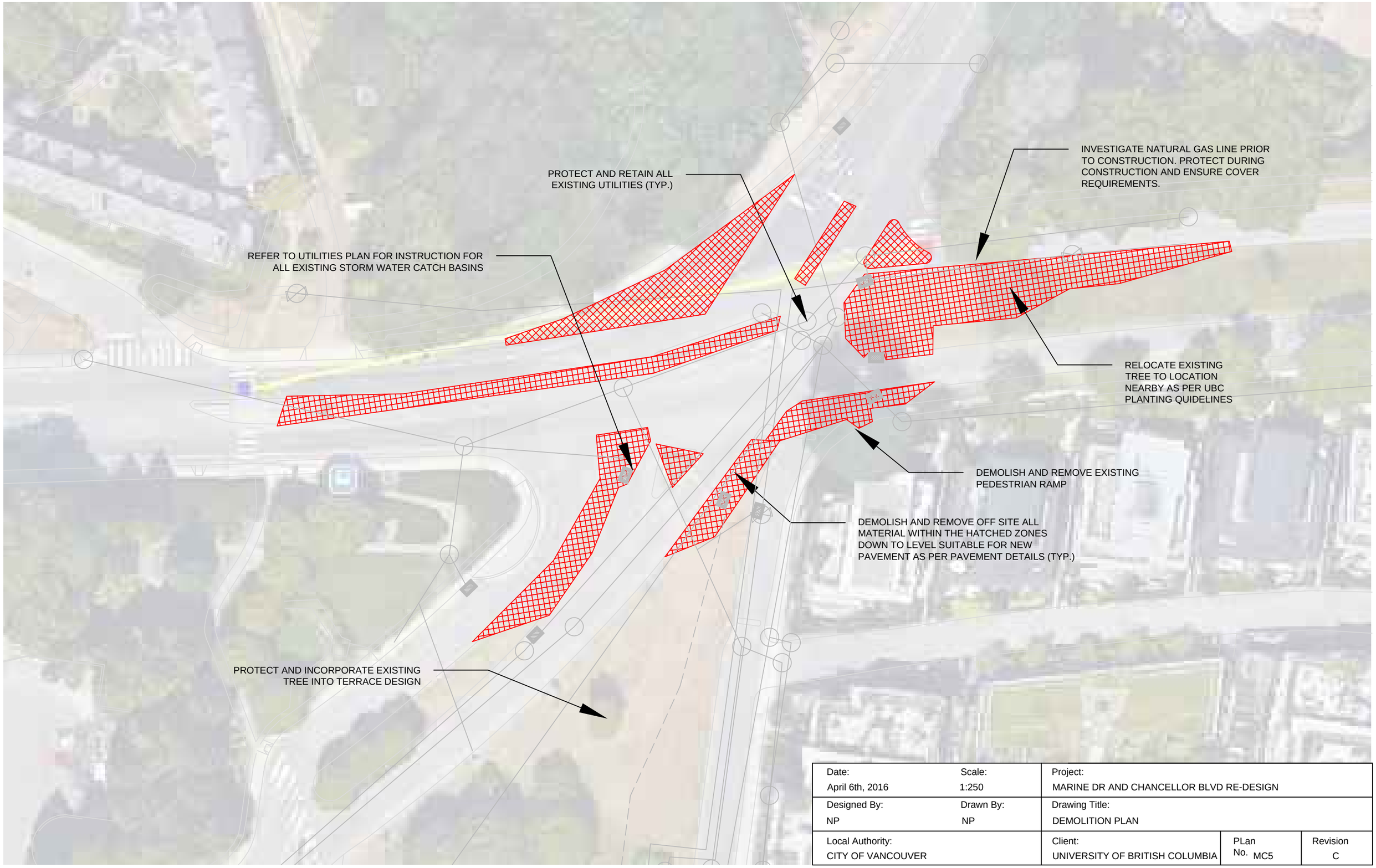
DEMOLISH AND REMOVE OFF SITE EXISTING LIGHT POLE AND FOUNDATION. COMPACT SUB-BASE TO MEET PAVEMENT REQUIREMENTS AS DETAILED

RETAIN AND PROTECT EXISTING STORMWATER CATCH BASIN

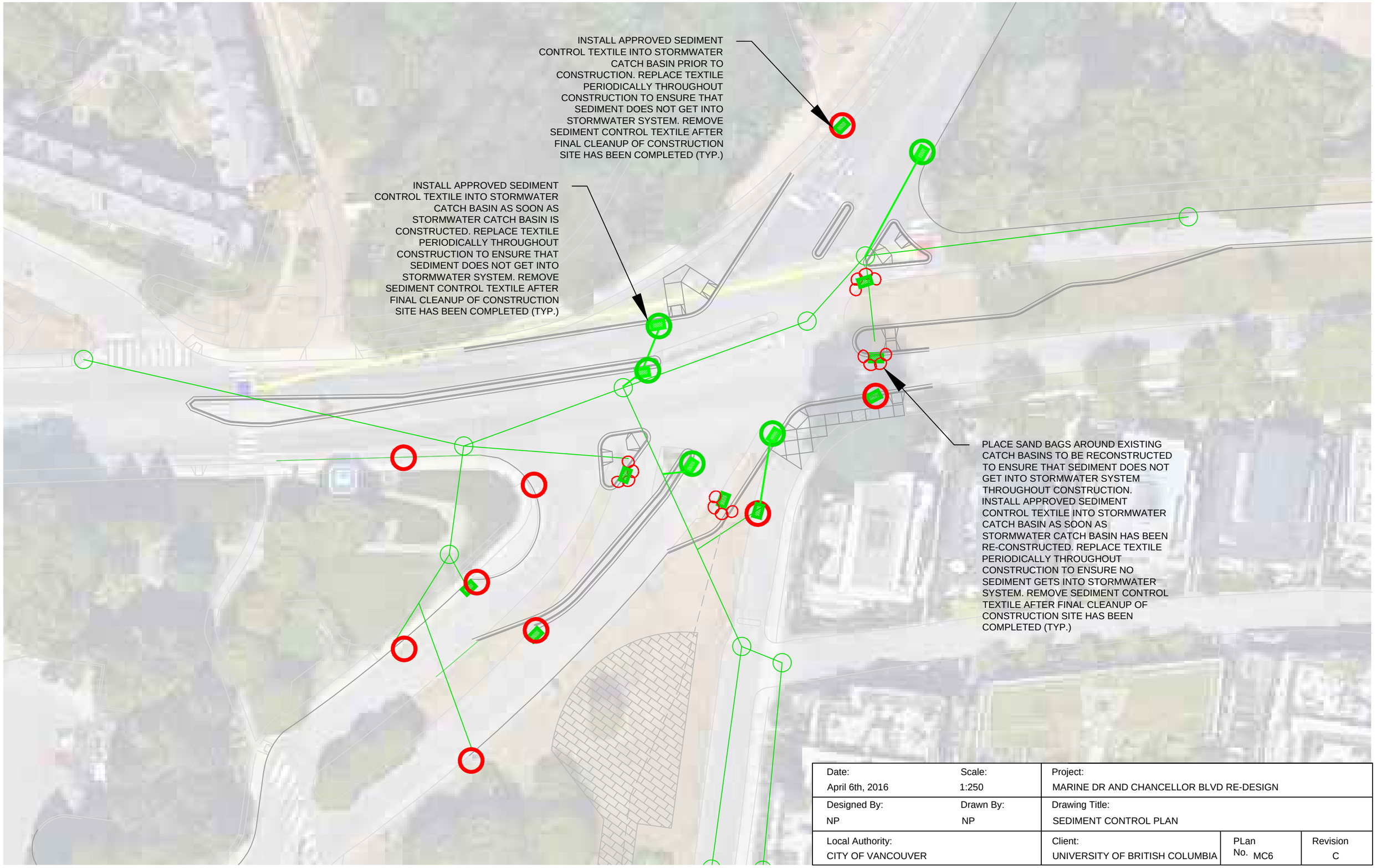
UTILITIES KEY

	GAS
	STORM WATER
	SEWER
	EXISTING ELECTRICAL CONDUIT
	STORM WATER CATCHMENT BASIN
	EXISTING LIGHT POLE
	PROPOSED TRAFFIC LIGHT FOUNDATION
	PROPOSED LOW VOLTAGE ELECTRICAL

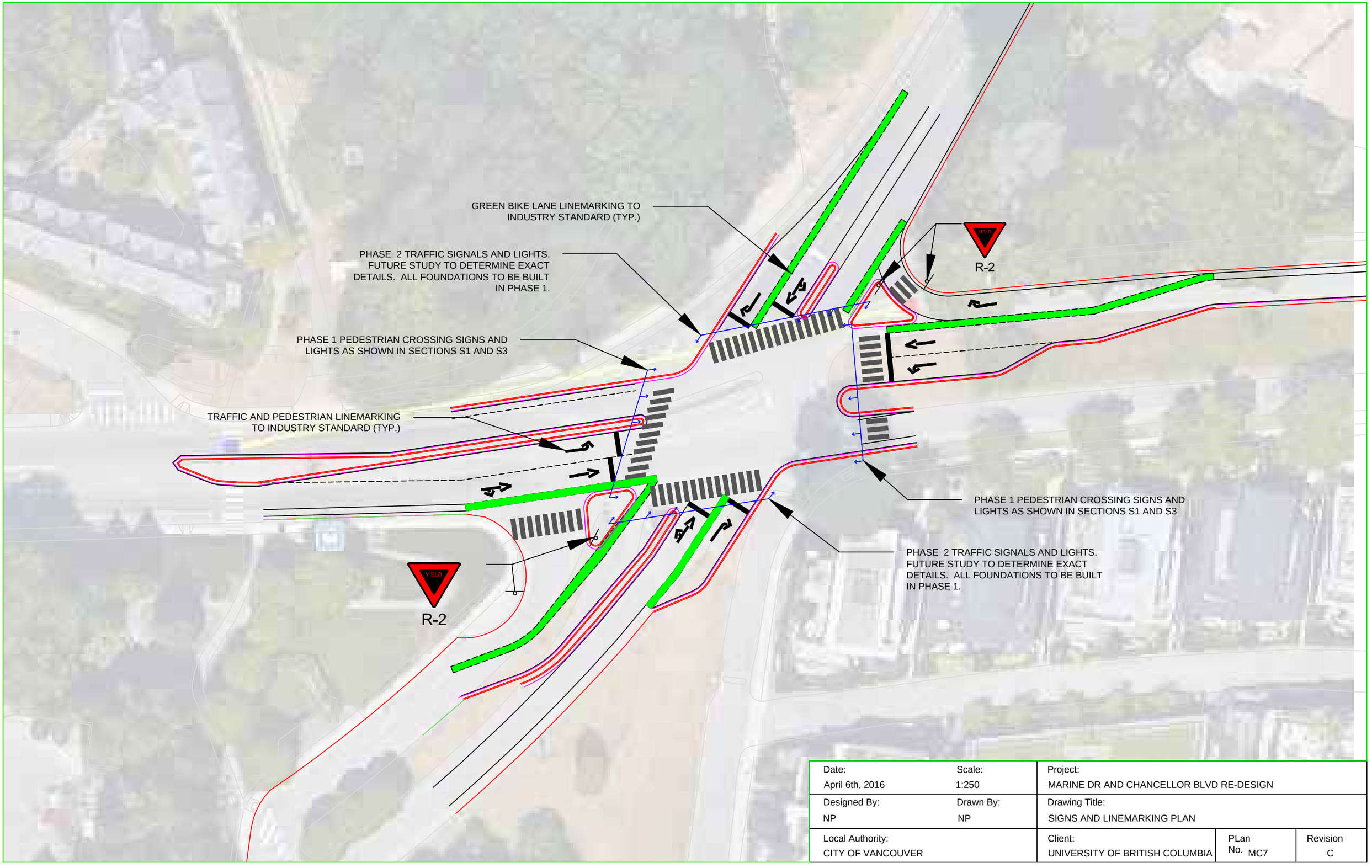
Date: April 6th, 2016	Scale: 1:250	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN	
Designed By: NP	Drawn By: NP	Drawing Title: UTILITIES PLAN	
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. MC4 / Revision C



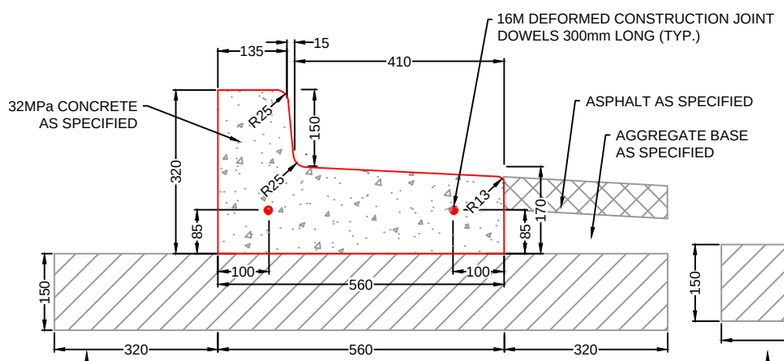
Date: April 6th, 2016	Scale: 1:250	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: NP	Drawn By: NP	Drawing Title: DEMOLITION PLAN		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. MC5	Revision C



Date: April 6th, 2016	Scale: 1:250	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: NP	Drawn By: NP	Drawing Title: SEDIMENT CONTROL PLAN		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. MC6	Revision C



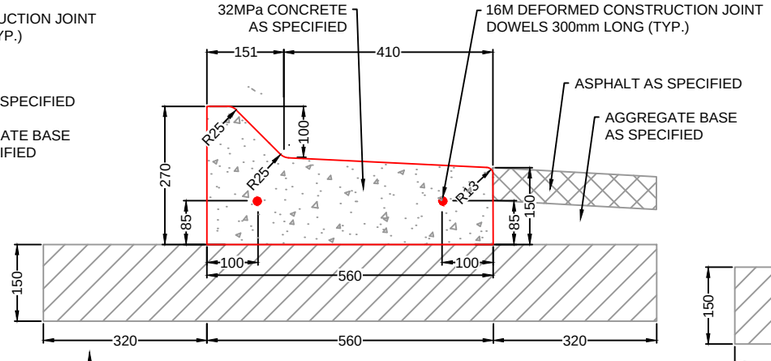
Date: April 6th, 2016	Scale: 1:250	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: NP	Drawn By: NP	Drawing Title: SIGNS AND LINEMARKING PLAN		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. MC7	Revision C



PLACE A MINIMUM OF 150mm GRANULAR BASE AT 95% MPD (20MINUS GRANULAR).
EXCAVATE 1200mm WIDE FOR CURB AND GUTTER

NOTES:
1. CONSTRUCT CONTROL JOINTS AT 4500mm INTERVALS (MIN. 50mm DEPTH).
2. COMPACT SUB-BASE AT 85% MPD

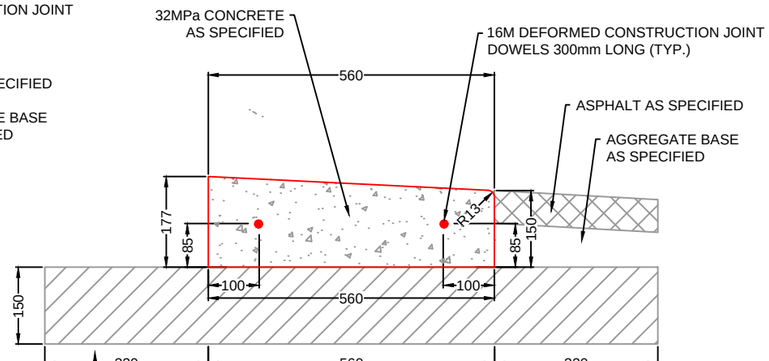
CURB AND GUTTER TYPE B



PLACE A MINIMUM OF 150mm GRANULAR BASE AT 95% MPD (20MINUS GRANULAR).
EXCAVATE 1200mm WIDE FOR CURB AND GUTTER

NOTES:
1. CONSTRUCT CONTROL JOINTS AT 4500mm INTERVALS (MIN. 50mm DEPTH).
2. COMPACT SUB-BASE AT 85% MPD

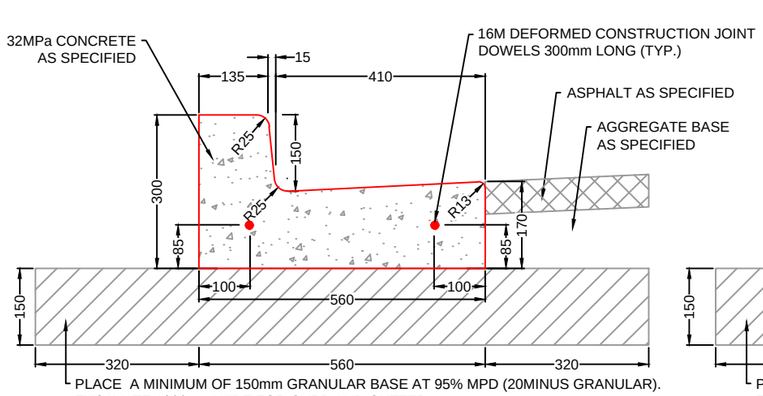
CURB AND GUTTER TYPE D



PLACE A MINIMUM OF 150mm GRANULAR BASE AT 95% MPD (20MINUS GRANULAR).
EXCAVATE 1200mm WIDE FOR CURB AND GUTTER

NOTES:
1. CONSTRUCT CONTROL JOINTS AT 4500mm INTERVALS (MIN. 50mm DEPTH).
2. COMPACT SUB-BASE AT 85% MPD

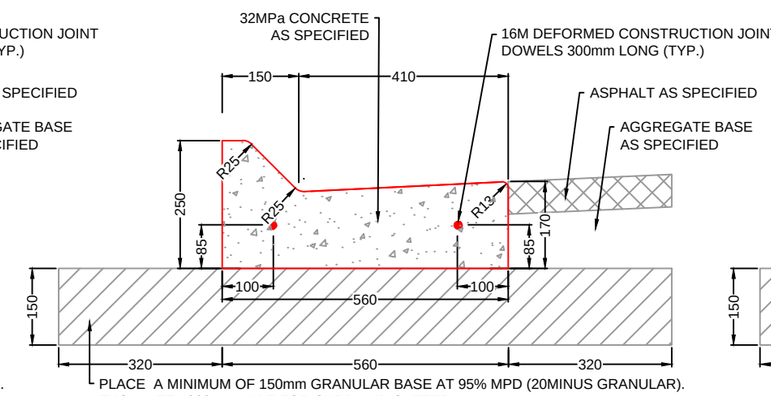
CURB AND GUTTER TYPE F



PLACE A MINIMUM OF 150mm GRANULAR BASE AT 95% MPD (20MINUS GRANULAR).
EXCAVATE 1200mm WIDE FOR CURB AND GUTTER

NOTES:
1. CONSTRUCT CONTROL JOINTS AT 4500mm INTERVALS (MIN. 50mm DEPTH).
2. COMPACT SUB-BASE AT 85% MPD

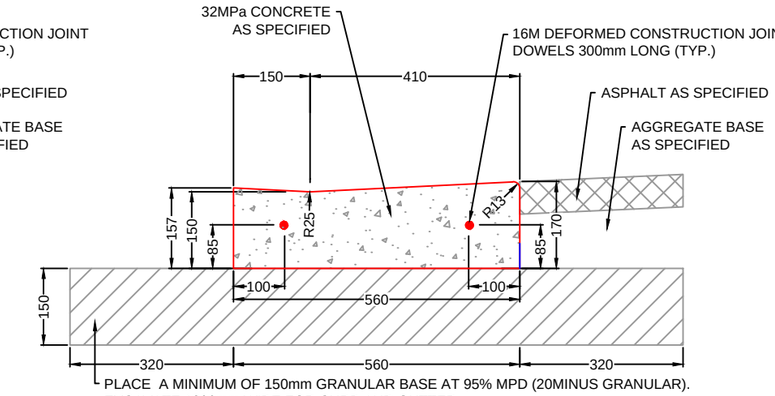
CURB AND GUTTER TYPE A



PLACE A MINIMUM OF 150mm GRANULAR BASE AT 95% MPD (20MINUS GRANULAR).
EXCAVATE 1200mm WIDE FOR CURB AND GUTTER

NOTES:
1. CONSTRUCT CONTROL JOINTS AT 4500mm INTERVALS (MIN. 50mm DEPTH).
2. COMPACT SUB-BASE AT 85% MPD

CURB AND GUTTER TYPE C

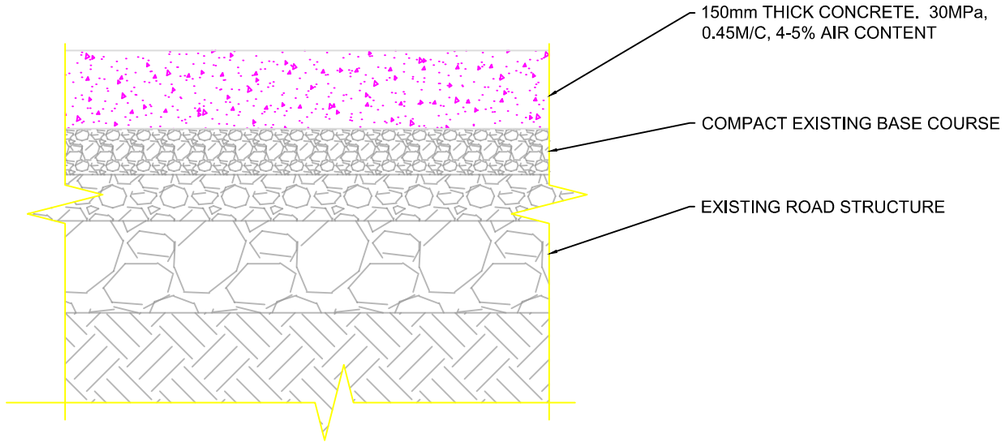


PLACE A MINIMUM OF 150mm GRANULAR BASE AT 95% MPD (20MINUS GRANULAR).
EXCAVATE 1200mm WIDE FOR CURB AND GUTTER

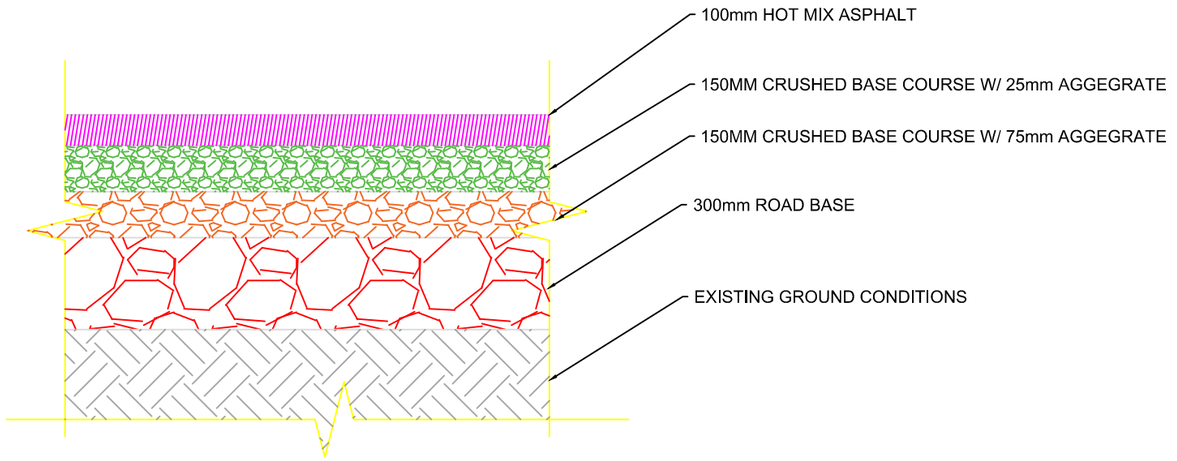
NOTES:
1. CONSTRUCT CONTROL JOINTS AT 4500mm INTERVALS (MIN. 50mm DEPTH).
2. COMPACT SUB-BASE AT 85% MPD

CURB AND GUTTER TYPE E

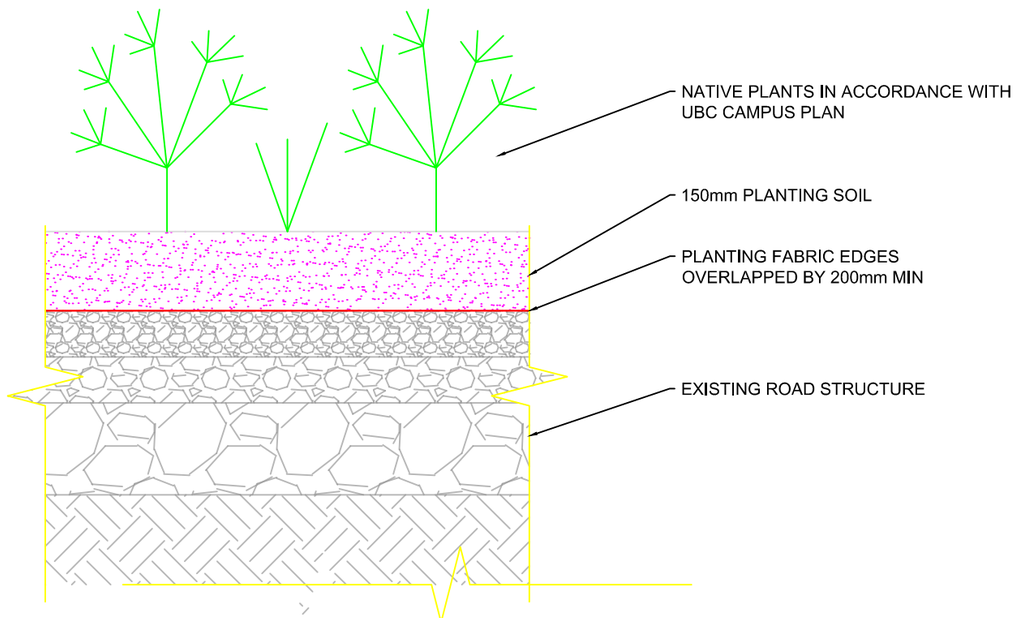
Date: April 6th, 2016	Scale: Dims as shown	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: NP	Drawn By: NP	Drawing Title: CURB AND GUTTER DETAILS		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. D1	Revision C



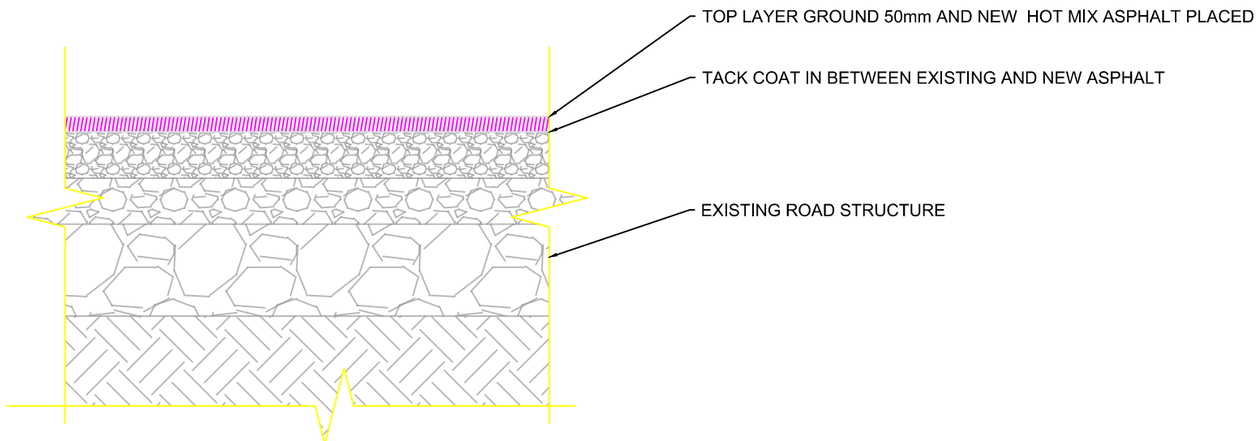
PAVEMENT TYPE A



PAVEMENT TYPE B

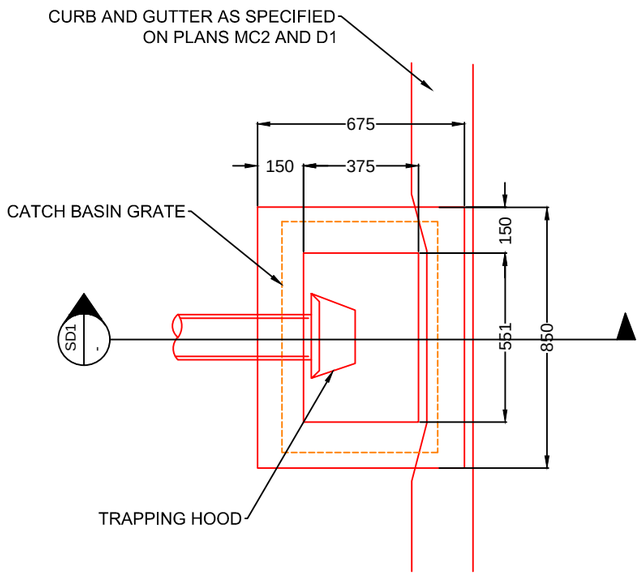


PAVEMENT TYPE C

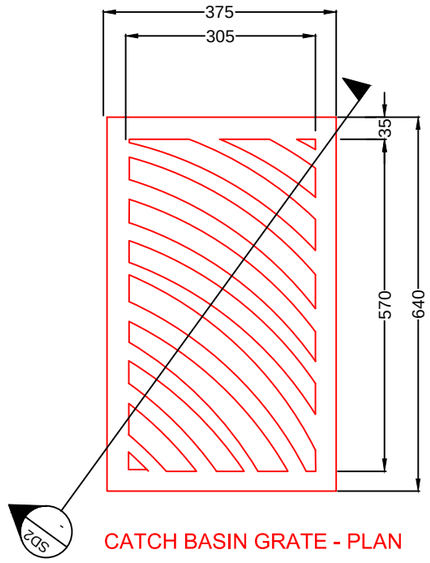


PAVEMENT TYPE D

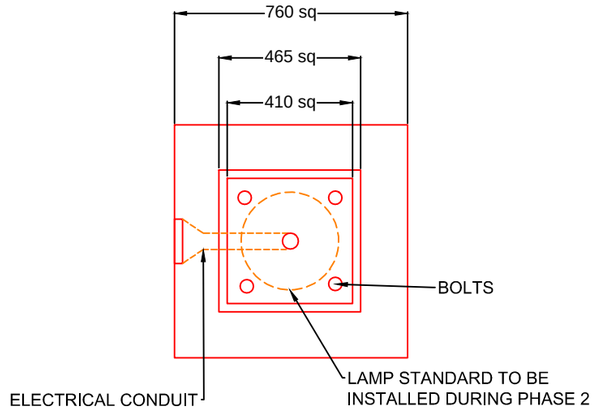
Date: April 6th, 2016	Scale: 1:250	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: SS	Drawn By: SS	Drawing Title: PAVEMENT DESIGN DETAILS		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. D2	Revision C



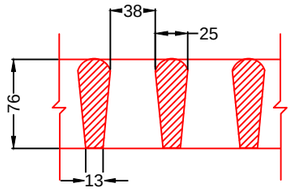
CAST IN PLAVE CONCRETE
CATCH BASIN - PLAN



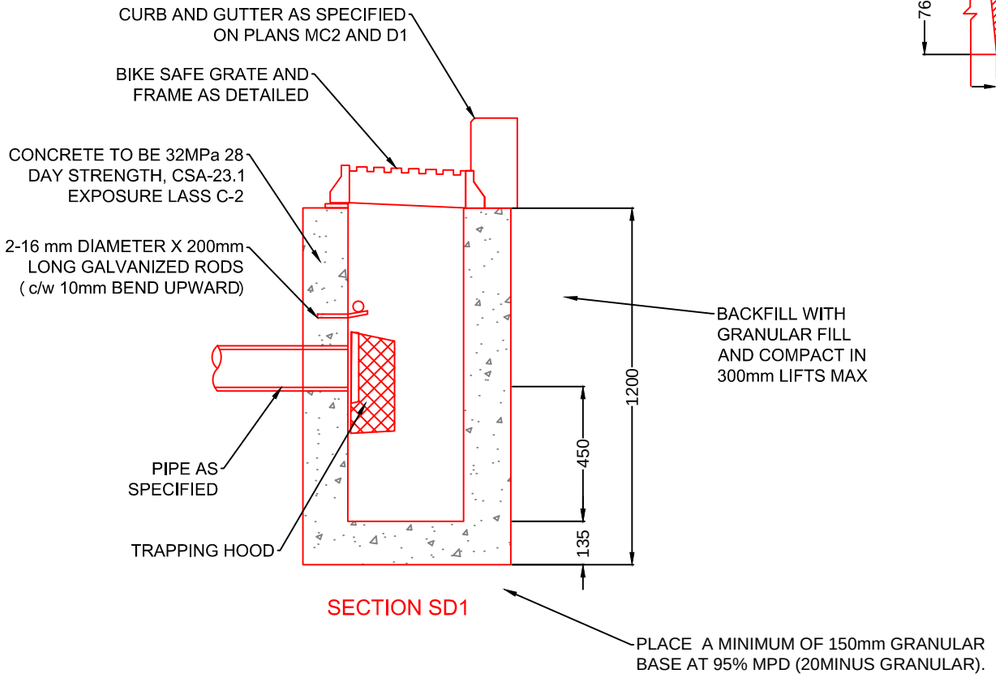
CATCH BASIN GRATE - PLAN



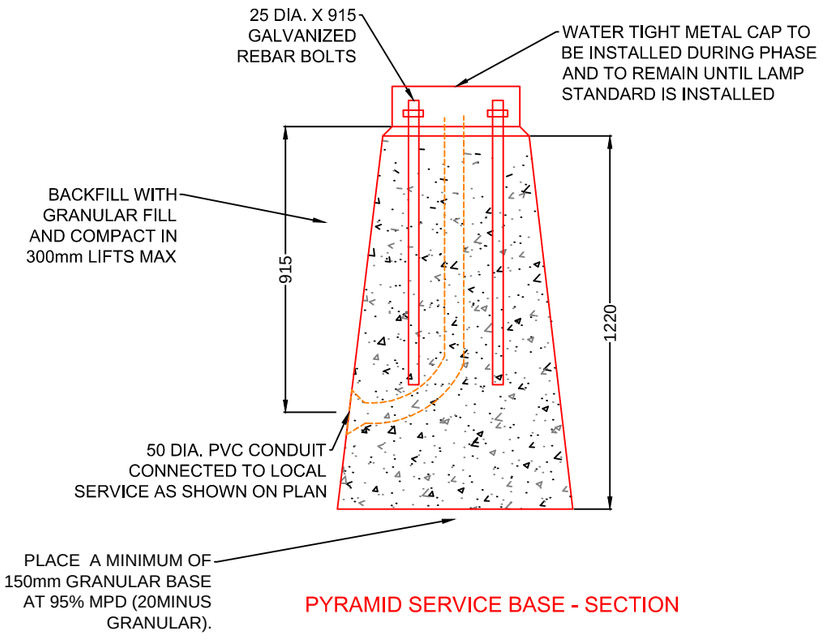
PYRAMID SERVICE BASE - PLAN



SECTION SD2

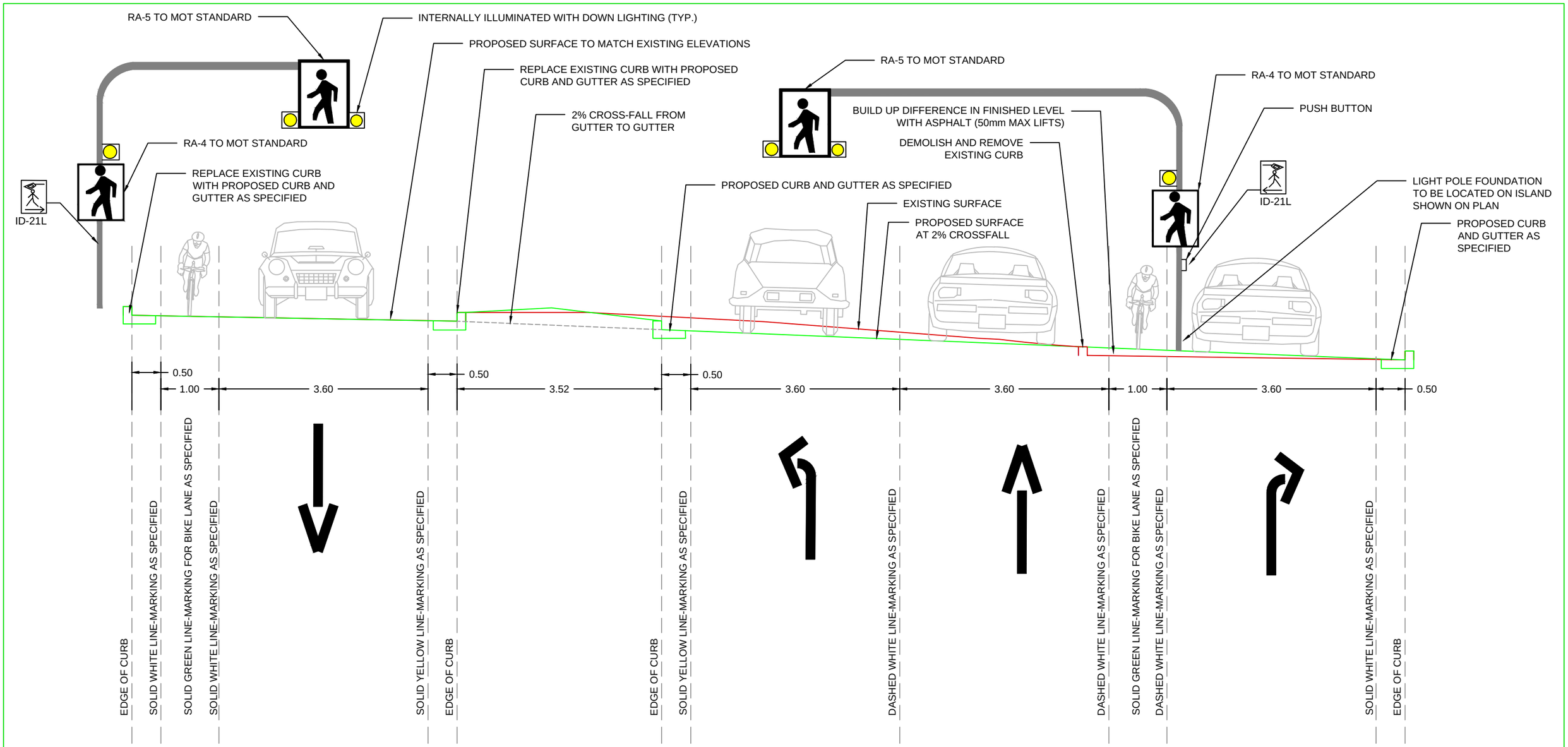


SECTION SD1



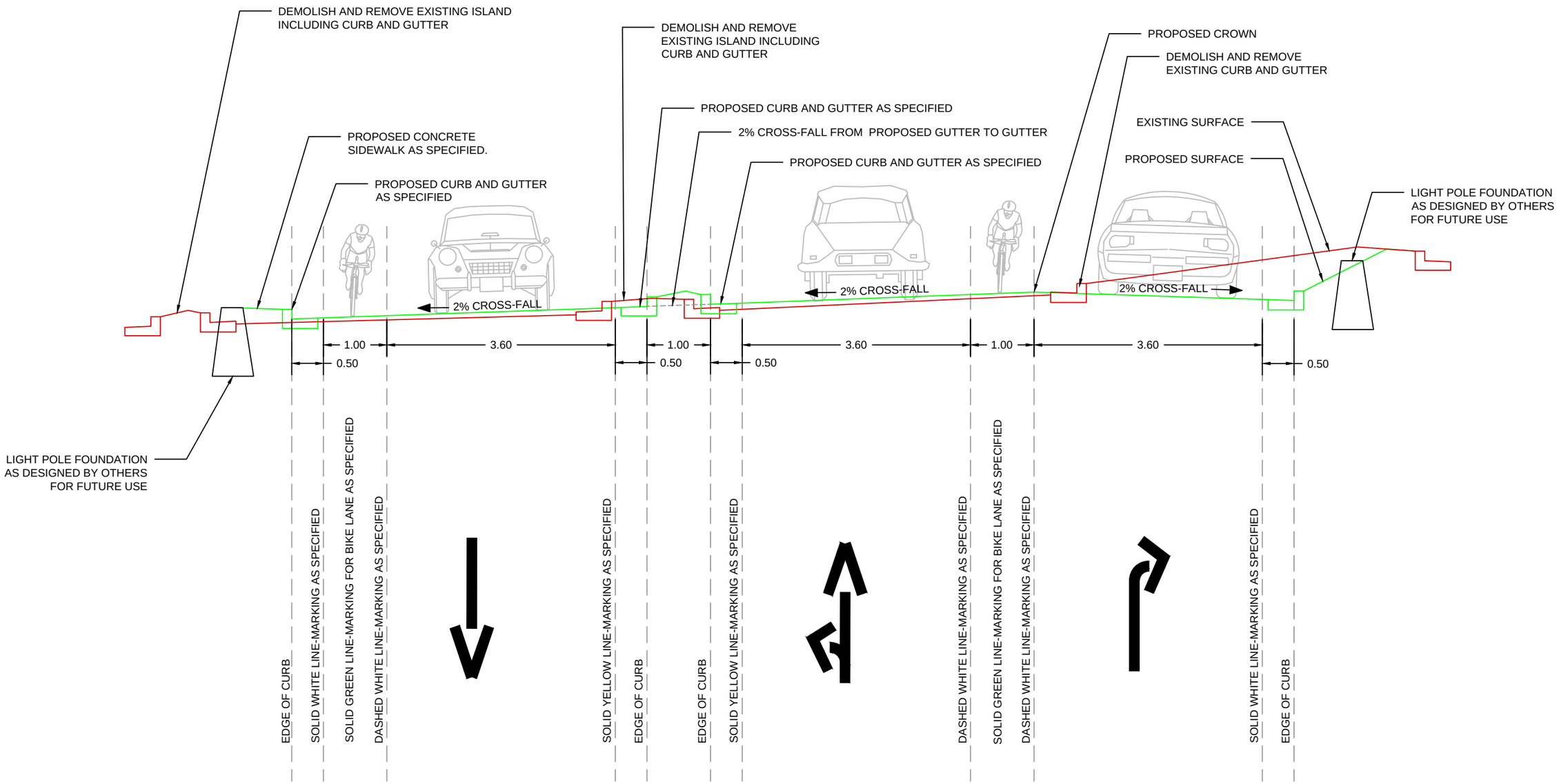
PYRAMID SERVICE BASE - SECTION

Date: April 6th, 2016	Scale: 1:250	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: NP	Drawn By: NP	Drawing Title: STORMWATER AND LIGHTING		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. D3	Revision C



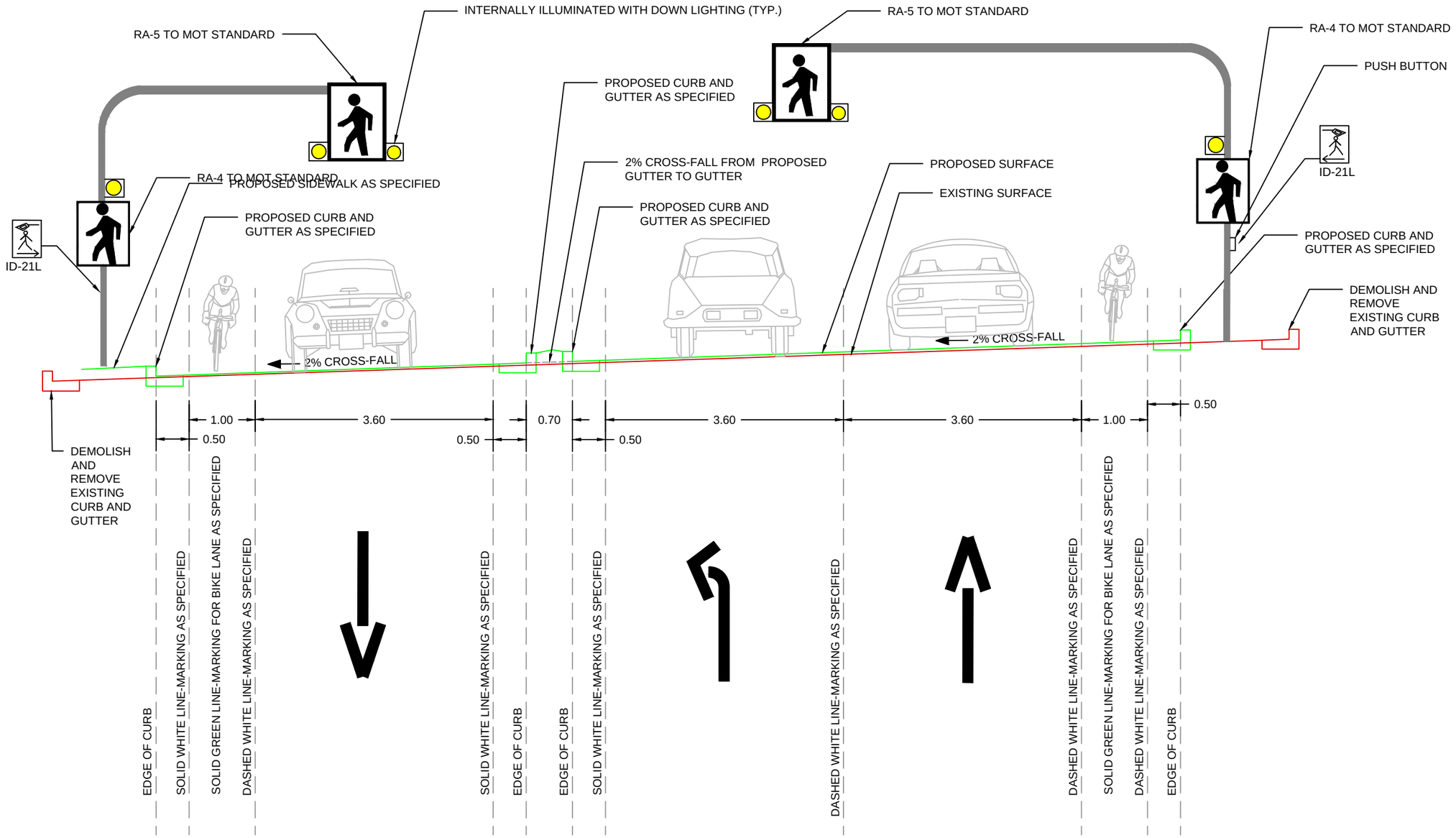
SECTION S1

Date: April 6th, 2016	Scale: 1:250	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: NP	Drawn By: NP	Drawing Title: SECTION S1		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. S1	Revision C



SECTION S2

Date: April 6th, 2016	Scale: 1:250	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: NP	Drawn By: NP	Drawing Title: SECTION S2		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. S2	Revision C



SECTION S3

Date: April 6th, 2016	Scale: 1:250	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: NP	Drawn By: NP	Drawing Title: SECTION S3		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. S3	Revision C

Figure 3.4.2 Lane Closure With Temporary Lane Control Signals – Two Lane Two-way Roadway

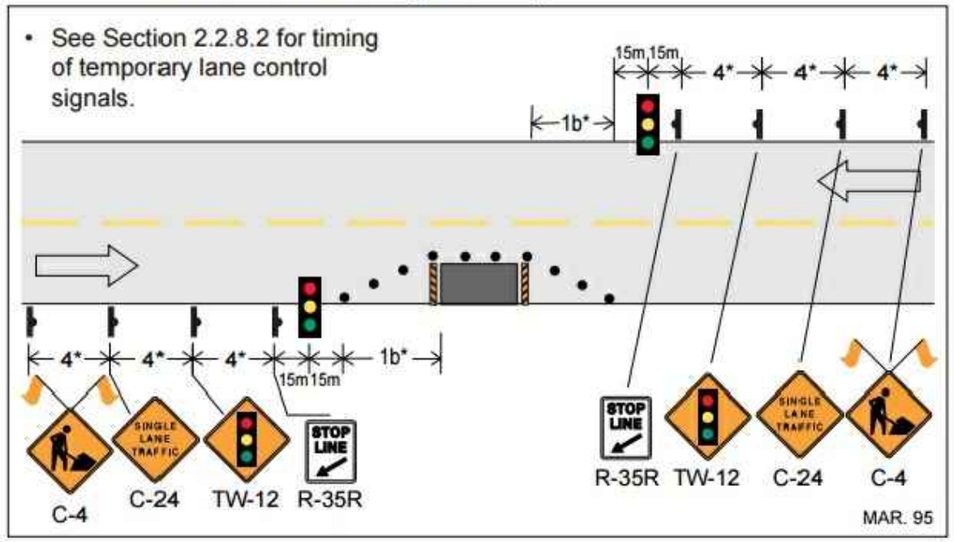
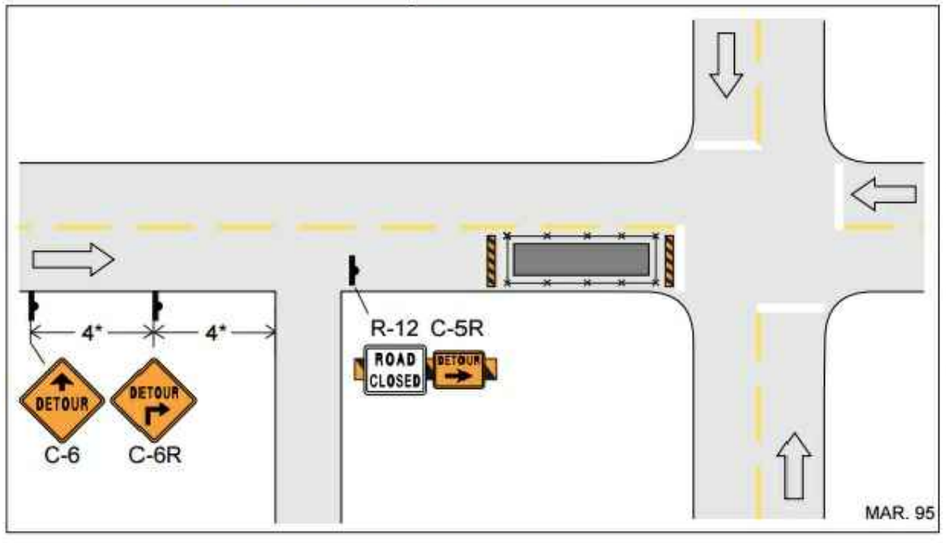
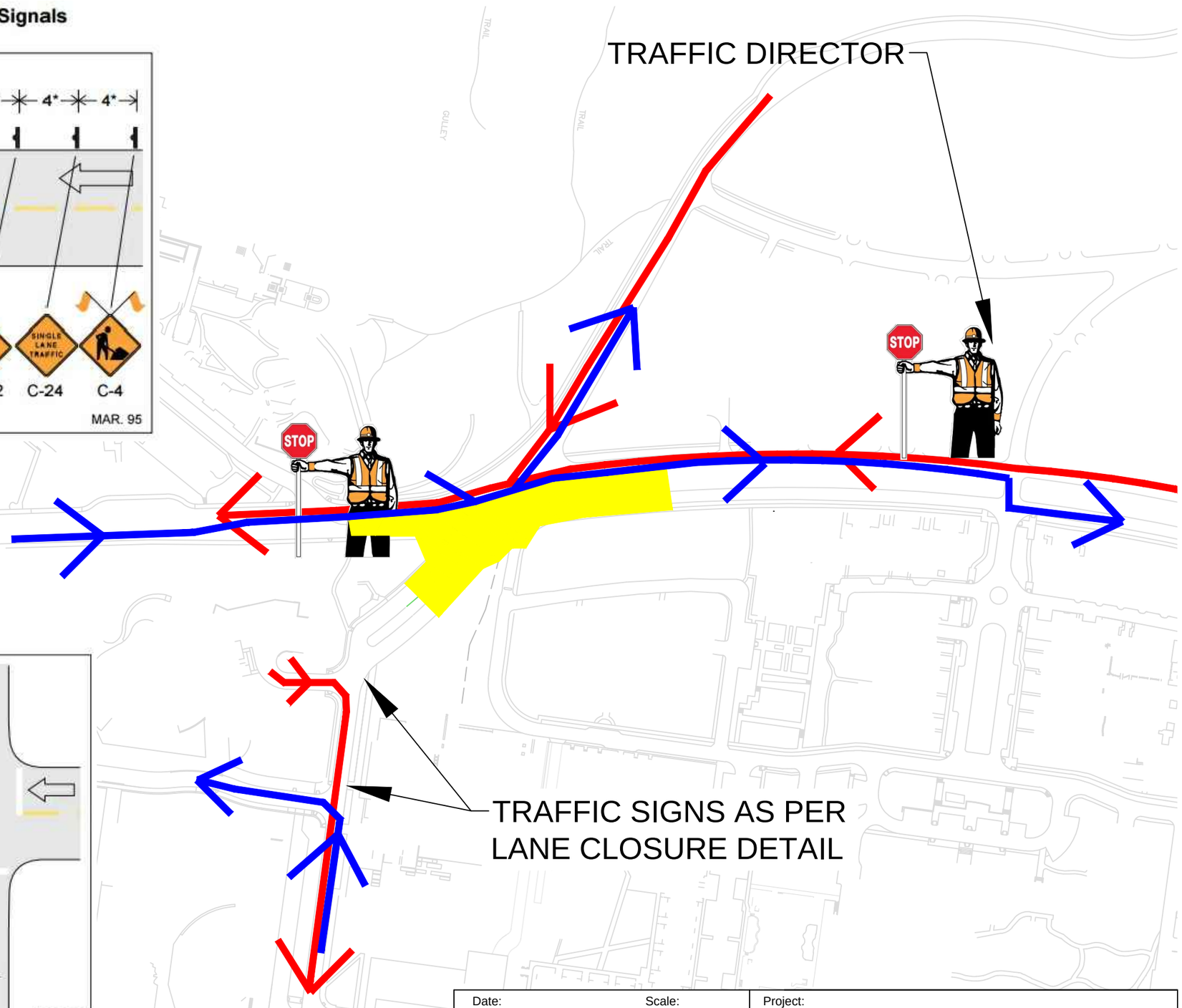


Figure 4.5.2 One Lane Closed (Near Side) – Two Lane Two-way Intersection



- This layout is to be used if an alternate route detour is available; if not, TCPs are required and the layout shown in Figure 4.3.1 should be used.



Date: April 6th, 2016	Scale: NTS	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: NP	Drawn By: NP	Drawing Title: TRAFFIC MANAGEMENT PLAN PHASE 1		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. TM1	Revision C

Figure 3.4.1 Lane Closure with TCPs – Two Lane Two-way Roadway

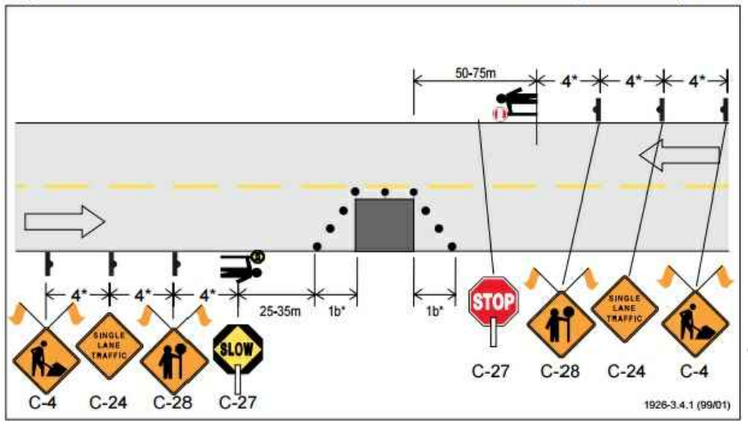
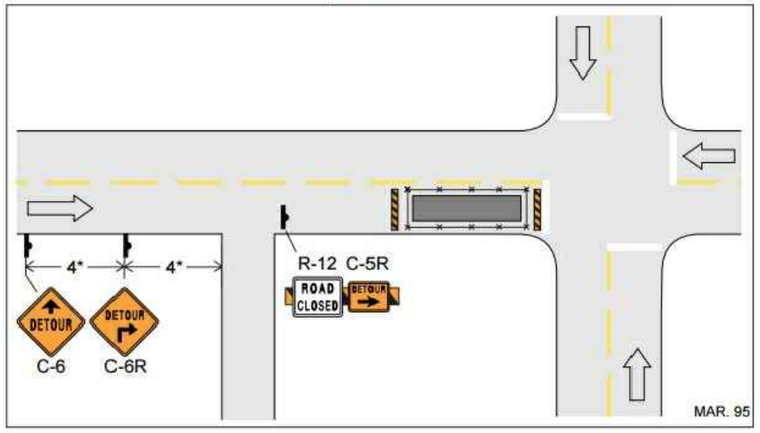


Figure 4.5.2 One Lane Closed (Near Side) – Two Lane Two-way Intersection



TRAFFIC SIGNS AS PER LANE CLOSURE DETAIL

TRAFFIC SIGNS AS PER LANE CLOSURE DETAIL

C-6R

DETOUR

DETOUR

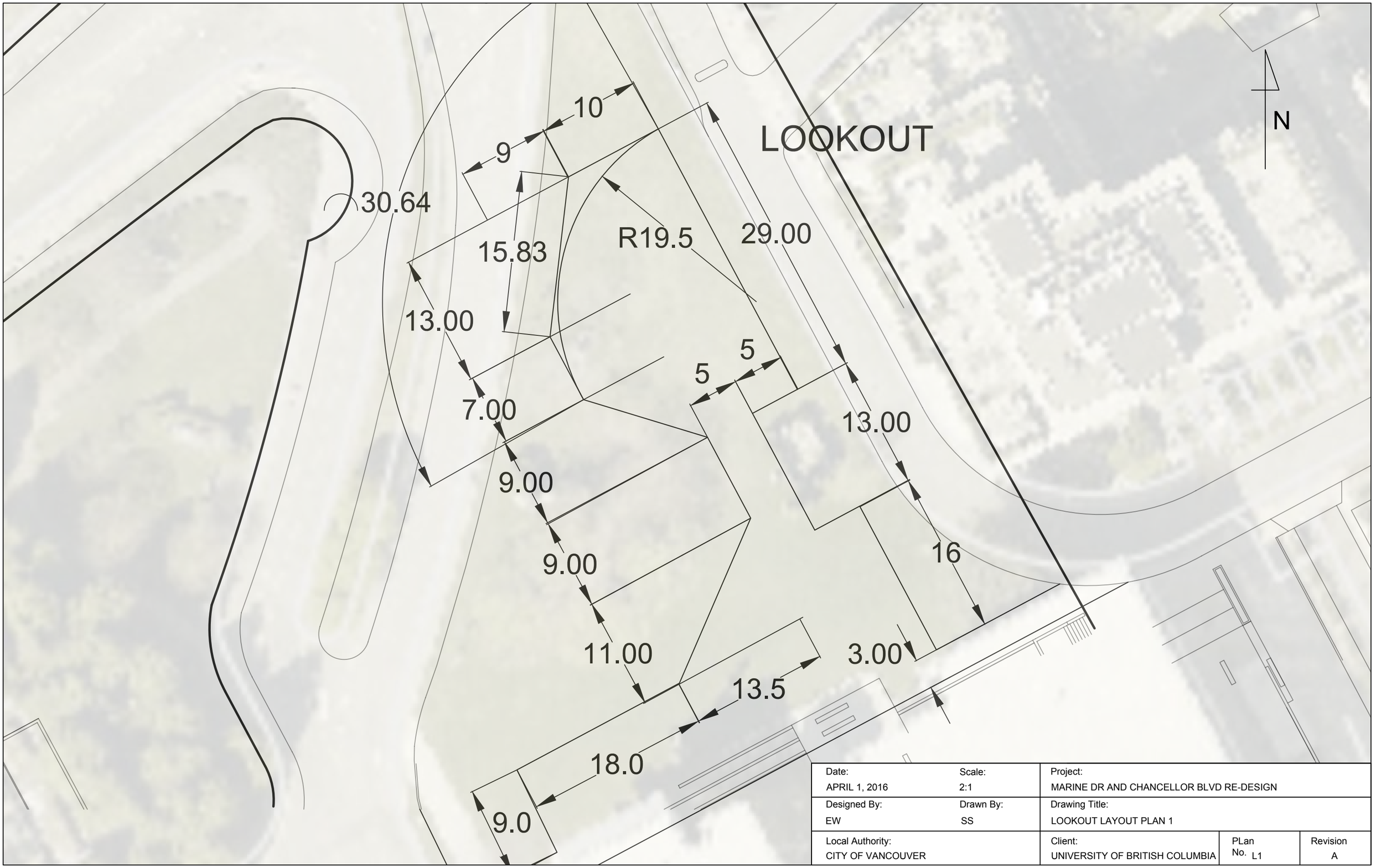
C-6R

STOP

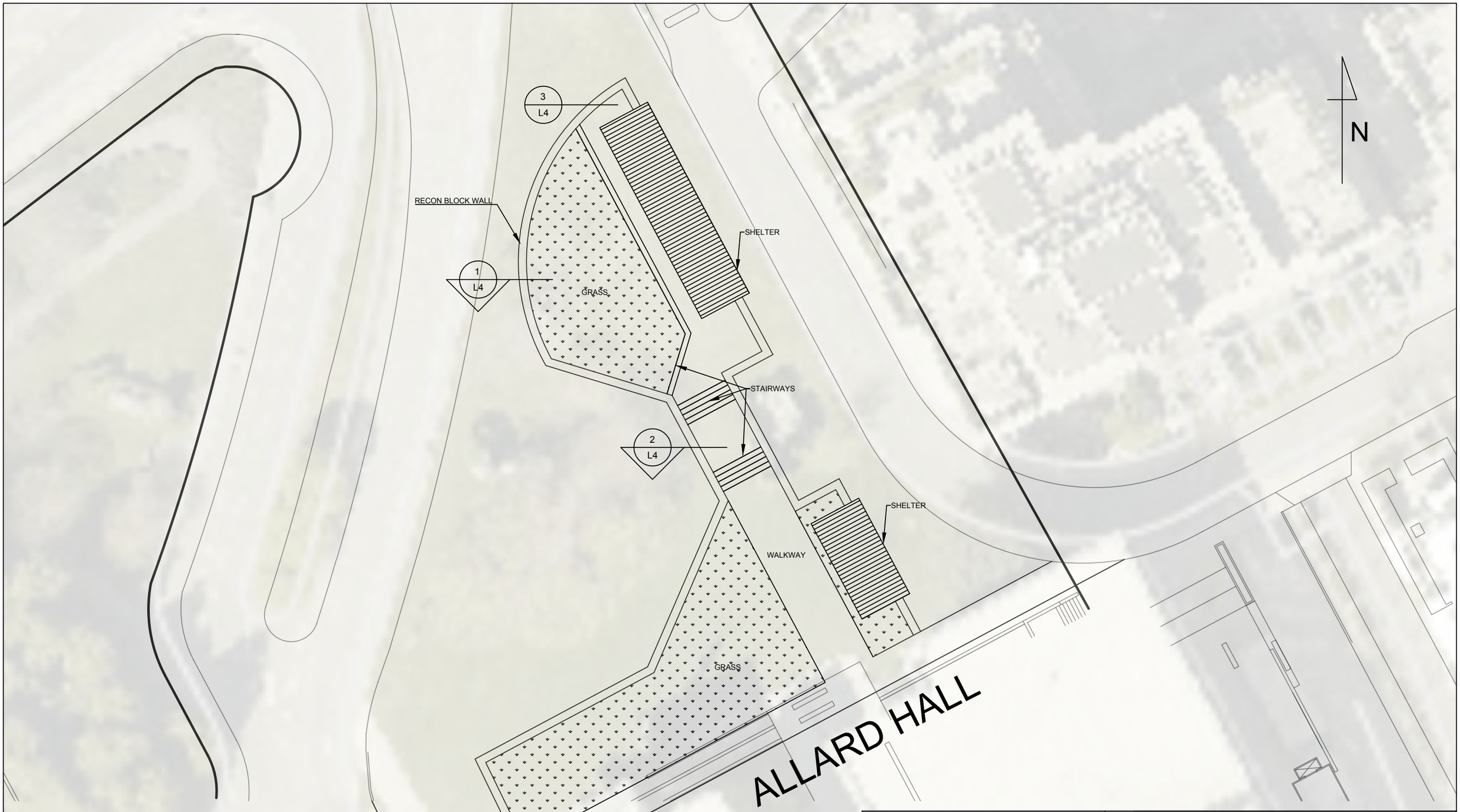
STOP

TRAFFIC DIRECTOR

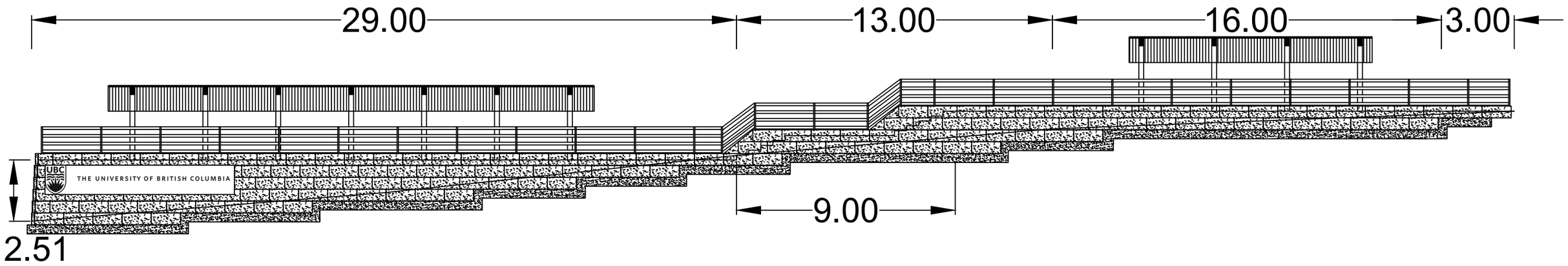
Date: April 6th, 2016	Scale: NTS	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: NP	Drawn By: NP	Drawing Title: TRAFFIC MANAGEMENT PLAN PHASE 2		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. TM2	Revision C



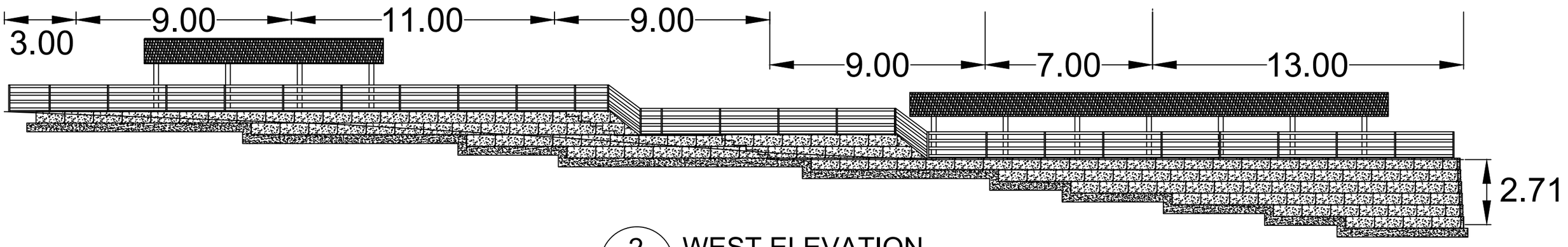
Date: APRIL 1, 2016	Scale: 2:1	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: EW	Drawn By: SS	Drawing Title: LOOKOUT LAYOUT PLAN 1		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. L1	Revision A



Date: APRIL 1, 2015	Scale: 3:1	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN			
Designed By: EW	Drawn By: SS	Drawing Title: LOOKOUT LAYOUT PLAN			
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. L2	Revision A	

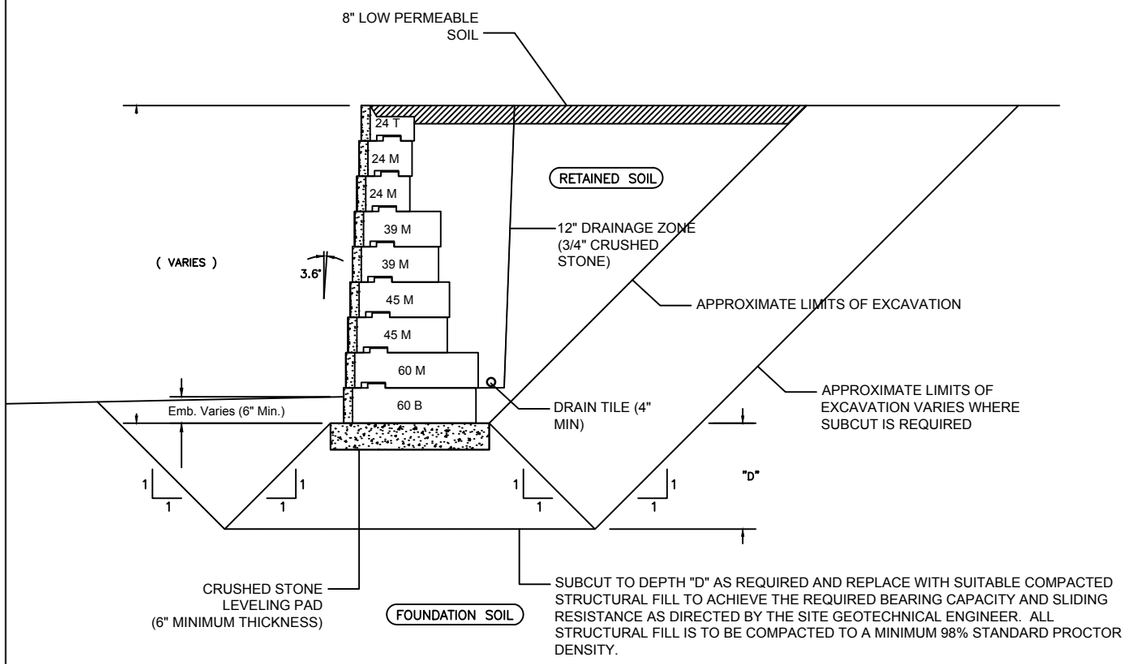


1 / L3 EAST ELEVATION



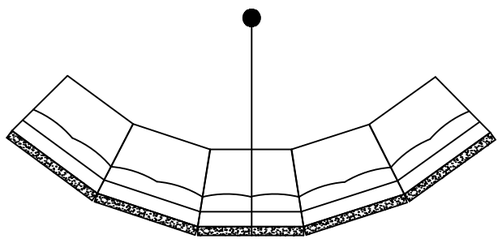
2 / L3 WEST ELEVATION

Date: APRIL 1, 2016	Scale: 6:1	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: SS	Drawn By: SS	Drawing Title: LOOKOUT ELEVATIONS		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. L3	Revision A



1 / L4 TYPICAL CROSS SECTION

Minimum turning radius for a one row high wall is 13'-1". However, see chart for recommended minimum base row radius for varying wall heights

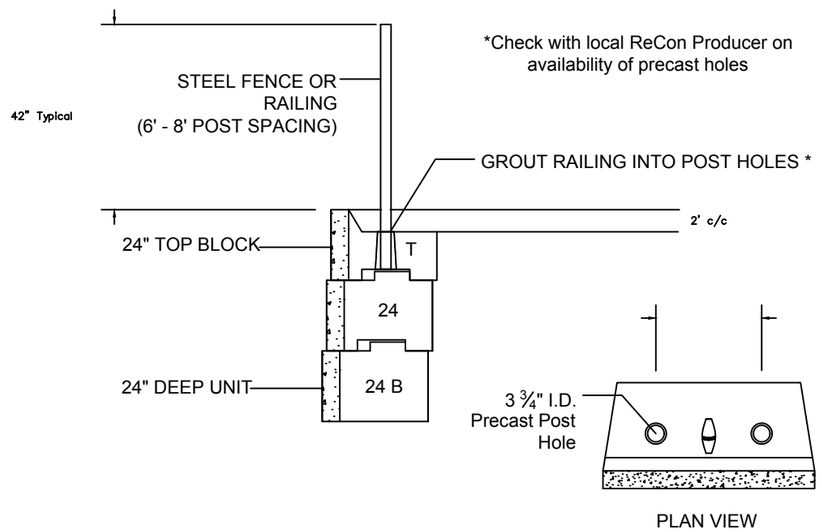


MINIMUM CONVEX / OUTSIDE RADIUS FOR FULL BLOCK

MINIMUM RADIUS TABLE CONVEX / OUTSIDE CURVE		
WALL HEIGHT (FT.)	NUMBER OF ROWS OF BLOCK	MIN. RADIUS OF BASE ROW
2'-8"	2	14'-0"
4'-0"	3	14'-6"
5'-4"	4	15'-0"
6'-8"	5	15'-6"
8'-0"	6	16'-0"
9'-4"	7	16'-6"
10'-8"	8	17'-0"
12'-0"	9	17'-6"

Note: The minimum radius for an Outside / Convex Curve using the Full Block is 13'-1" for a one row high wall. For curved walls with multiple rows of block, the radius of the base row of block must be increased to accommodate the set back (and resulting tightening of the radius) in each row of block added to the wall. The above Table sets forth the minimum radius of the base row, given varying wall heights. See Block $pecification and Installation Instructions for further details.

3 / L4 TYPICAL CURVED BLOCK PLACEMENT



FENCE SECTON DETAIL

PRECAST FENCE POST HOLES

NOTE:

1. MASS REQUIRED TO RESIST POST LOADING SHOULD BE DETERMINED ON A PROJECT-TO-PROJECT BASIS. THE MASS OF MORE THAN ONE BLOCK MAY BE REQUIRED
2. CONTACT RECON FOR MORE INFORMATION REGARDING FENCE POST LOADING AND BLOCK CONNECTION REQUIREMENTS
3. DETAIL DOES NOT APPLY TO PRIVACY FENCING OR OTHER APPLICATIONS WHERE WIND LOAD WOULD NEED TO BE TAKEN INTO ACCOUNT

2 / L4 TYPICAL FENCE INSTALLATION

Date: APRIL 1, 2015	Scale: 12:1	Project: MARINE DR AND CHANCELLOR BLVD RE-DESIGN		
Designed By: SS	Drawn By: SS	Drawing Title: LOOKOUT DETAILS		
Local Authority: CITY OF VANCOUVER		Client: UNIVERSITY OF BRITISH COLUMBIA	PLan No. L4	Revision A