Redesign of Chancellor Boulevard and Wesbrook Mall Intersection at UBC

CIVL 303, University of British Columbia

December 1, 2021

Prepared For:

[redacted]

Prepared by Team 11:

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November 20th, 2021

[redacted]
Vancouver, BC ,V6T 1Z4

Subject: Chancellor Boulevard and Wesbrook Mall Intersection- Preliminary Design Report

Dear [redacted],

Thank you for taking the time to review our company's preliminary design report regarding the redesign of Chancellor Boulevard and Wesbrook Mall intersection at UBC. The purpose of this project is to formulate an intersection design that accommodates safe travel and meets the anticipated traffic and pedestrian demands.

This report consists of a comprehensive breakdown of our proposed preliminary design, which takes into account all constraints and criteria and satisfies the stakeholder's needs. We have additionally conducted technical, safety and environmental analyses to determine the feasibility of the design and have developed a cost analysis to supplement this.

If your team has any questions, please contact us at Team11engineers@gmail.com. Thank you for your time, consideration and support. We look forward to working with you in implementing our design and beginning the construction process.

Sincerely,
__Signature__

[redacted]
Project Manager
Team 11 Engineers Ltd.

Encl: *Chancellor Boulevard and Wesbrook Mall Intersection- Preliminary Design Report*

Executive Summary

This report documents the preliminary design process and development of the Chancellor Boulevard and Wesbrook Mall intersection. The redesign aims to provide more efficient transportation of traffic through the intersection, whilst providing the necessary pathways for pedestrians and cyclists.

The current intersection is one of the major pathways leading to UBC, however, it is inefficient and does not support smooth transportation of pedestrians and buses. The updated design of the intersection introduces traffic lights in all directions and a pedestrian crosswalk across Chancellor Boulevard. Cyclist lanes will be also added to Wesbrook Mall in order to provide a clear pathway for cyclists toward UBC. Additionally, stormwater management and wastewater drainage systems will be updated.

Various considerations and constraints were taken into account, which govern the intersections' features, detailing all factors from a technical, economical, construction management and regulatory standpoint. Additionally, the intersection is designed in strict conformance to the Geometric Design Guidelines for UBC Roads and the BC Transportation and Infrastructure design guidelines. Construction of the intersection also has a significant impact from an environmental and safety standpoint. Identifying such impacts prior to design implementation reduces the risk of potential concerns in the detailed design and construction phases.

The total duration of the project is 285 working days, with construction commencing on May 1, 2022 and ending on December 8, 2022. The estimated total cost of the project is approximately $1.9 Million. A more detailed description of the redesign, features, project schedule and cost estimate can be found in the report below.

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1.0 Introduction

[redacted] had recruited Team11 Engineers to develop a preliminary design of the Chancellor Boulevard and Wesbrook Mall Intersection. It is important to acknowledge that the land on which this redesign will take place is the traditional, ancestral, and unceded territory of the Musqueam People. The overarching objective of this redesign is to enable safe and enjoyable travel by all modes of transportation and satisfy the anticipated traffic, bicycle and pedestrian demands. Additionally, this redesign must satisfy all stakeholders' needs and encourage sustainable travel modes, such as cycling and walking.

In order to formulate the preliminary design, all constraints and issues were thoroughly analyzed. Detailed technical analysis was conducted from an environmental and safety point of view and Synchro was used to model the intersection. A cost estimate was conducted to optimize the chosen design and the expected construction schedule is showcased in a Gantt chart.

1.1 Summary Table

The various contributions made by each member of team 11 are provided for the purpose of accountability. For questions regarding a specific section of the report, please contact the persons responsible listed below.

Table 1 - Team Member Contributions

Member Name	Contributions	Reviewed
[redacted]	Covering Letter Assumptions Issues and Criteria Class C Cost Estimate	Methodology Cost Estimate Analysis Results Preliminary Design

[redacted]	Class C Cost Estimate AutoCAD Drawing Analysis Results	Covering Letter Executive Summary Issues and Criteria Preliminary Design
[redacted]	Analysis Results Preliminary Design Introduction Executive Summary	Introduction AutoCAD Drawing Class C Cost Estimate
[redacted]	Introduction Cover Letter Preliminary Design Executive Summary	Issues and Criteria Analysis Results
[redacted]	Methodology Analysis Results Issues and Criteria Assumptions	Executive Summary Analysis Results Assumptions Class C Cost Estimate
Andrew Zhang	Introduction Gantt chart Analysis Results Class C Cost Estimate	Introduction Methodology Analysis Results

2.0 Methodology

In order to present a feasible preliminary design, the following methodology was used. In the conceptual design stage, a site visit was performed to develop the site constraints and analyze traffic flow. Open consultations were held with the local community and residents, including indigenous community consultations with the Musqueam Peoples. See Appendix 2 for a more detailed stakeholder consultation and communication plan. The design criteria were used to create a weighted decision matrix in order to evaluate the three design concepts in a quantitative way. The design option with the highest score was determined to be the most feasible design solution. Refer to Appendix 1 for the completed weighted design matrix and Appendix 6 for the designs considered. The preferred intersection design is chosen due to its relatively low cost,

efficient traffic flow, and consideration of multiple modes of travel. In the preliminary design stage, the project objectives, constraints, and criteria based on the client's objectives were brought in and refined from the conceptual design stage. The preferred design option was modelled using Synchro software to optimize efficiency. A full safety and environmental analysis was performed. Additionally, future land use and traffic volume was predicted in order to extend the design lifetime. After the design stage, construction applications were submitted to UBC Campus and Community planning in order to receive the relevant street and landscape and construction permits.

3.0 Site Visit

The project site is the intersection of Chancellor Boulevard and Wesbrook Mall, located at the North-East corner of the UBC Vancouver Campus. Chancellor Boulevard runs East-West and is primarily used by the 44 and 84 Translink bus routes. Wesbrook Mall runs North-South and is connected to major areas of the UBC campus, such as the bus loop, hospital and Student Union Boulevard.

A site visit was conducted to observe site conditions and measure the volume of traffic. Figure 1 demonstrates the current conditions of the intersection, while Figure 2 depicts an aerial view of the site. The volume of traffic was recorded in a 10-minute time period and resulted in similar values to the data provided from 2015. Refer to Table 4 in Appendix 4 for measured volumes. Additionally, it was observed that no dedicated pedestrian crossing, or bike lanes were present at the site. A concrete path that crosses the median on the east side of the intersection is present, however the crosswalk is not painted. The nearest marked crosswalk is the intersection of NW

Marine Dr & Chancellor Blvd, over 400m away. During the site visit, a large puddle had accumulated from the heavy rain on the north roadside of Chancellor Blvd, most likely due to the build up of leaves in an existing catch basin. Additionally, there was a near-collision due to a vehicle not obeying the stop sign.

Figure 1. Chancellor Blvd & Wesbrook Mall Intersection

Figure 2: Aerial View of Site

4.0 Assumptions

Assumptions are formulated under safeguard that if they are proven false, the impact of the project outcome will be minimal. As such the following assumptions are made for the intersection:

- All resources will be accessible and available in order to complete construction as scheduled
- The equipment available is in good conditions
- The supplier will deliver resources on time
- All relevant stakeholders will come to meetings and provide significant input
- The cost of the project will remain consistent during the constructions and implementation
- The scope of the project will not change throughout the life cycle

- The design life of the intersection is expected to be 25 years

5.0 Issues and Criteria

The following section outlines the issues, criteria and constraints that the preliminary design has been developed to meet.

- Technical:

  The non-negotiable constraints are reflected in the intersection's makeup. The design must include bike lanes, travel lanes, sidewalks and curb-lines. The client has noted that the design must not include a roundabout and that on street parking is not permitted, or required. The design must also prominently feature the intersection as one of several "gateways" to UBC. Additionally, the operational efficiency of the intersection must be maximized to account for increased future demand and safety considerations must be met throughout construction and operation.

- Economical:

  The budget of the project, which refers to the overall expenditure incurred during construction and any unexpected expenses, or delays that might occur, must fit within the client's needs. The cost of the design must be optimized and is reflected in section 9.0, where a cost analysis is conducted.

- Construction Planning:

  A non-negotiable constraint in terms of construction planning is the land impact, as the client specified to work within property lines. Additionally, worker and public safety during construction should not be compromised and public health protocols must be adhered to at all times. Alternatively, a negotiable constraint includes the removal of trees and the subsequent landscaping of the impacted areas. Moreover, obtaining street closure

permits and the construction timeline schedule are flexible and are affected by external factors, such as the COVID-19 pandemic, which could cause additional delays in relation to health and safety.

- Regulatory:

  Regulatory constraints are composed of all non-negotiable factors, in accordance with the Geometric Design Guidelines for BC Roads and the BC Ministry of Transportation and Infrastructure design guidelines. The intersection will additionally be designed to accommodate WB-17 trucks and will tie in with adjacent roadways, including travel lanes, sidewalks and bike facilities.

- Environmental:

  The intersection design will include sustainability features, such as the addition of stormwater management and landscaping. An environmental analysis is conducted in section 7.2, to ensure that the redesign proves to be a sustainable project.

- Societal:

  The client has noted that the intersection redesign must aim to reduce single occupancy vehicle trips to and from the campus. In accordance with this technical criteria, pedestrian safety and traffic will be taken into consideration. Bike lanes will be added to provide alternative methods of transport and pedestrian crossing will be optimized.

6.0 Preliminary Design

6.1 Description

The preliminary design of the Chancellor Blvd & Wesbrook Mall intersection prioritizes pedestrian and bike traffic and adds traffic lights to both left-turning lanes as well as the lane

traveling northeast on Chancellor Blvd. Traffic traveling southwest on Chancellor Blvd is only limited by a pedestrian-activated amber flasher. A painted bike lane is added to Wesbrook Mall, continuing from where it terminates at Thunderbird Blvd, providing a safe lane for bicyclists to cross the street. According to the City of Vancouver, a painted bike lane exists along Chancellor Blvd, however it will be refreshed with paint to increase visibility (2021). The length of the left turning lane on Chancellor Blvd is increased to 50m to reduce delays for traffic travelling westbound. Additionally, the right turn lane for eastbound traffic travelling from Chancellor Blvd to Wesbrook Mall is eliminated in order to allow for the "Gateway to UBC" structure, further discussed in section 6.3. Figure 3 below displays a 3D model of the preliminary design.

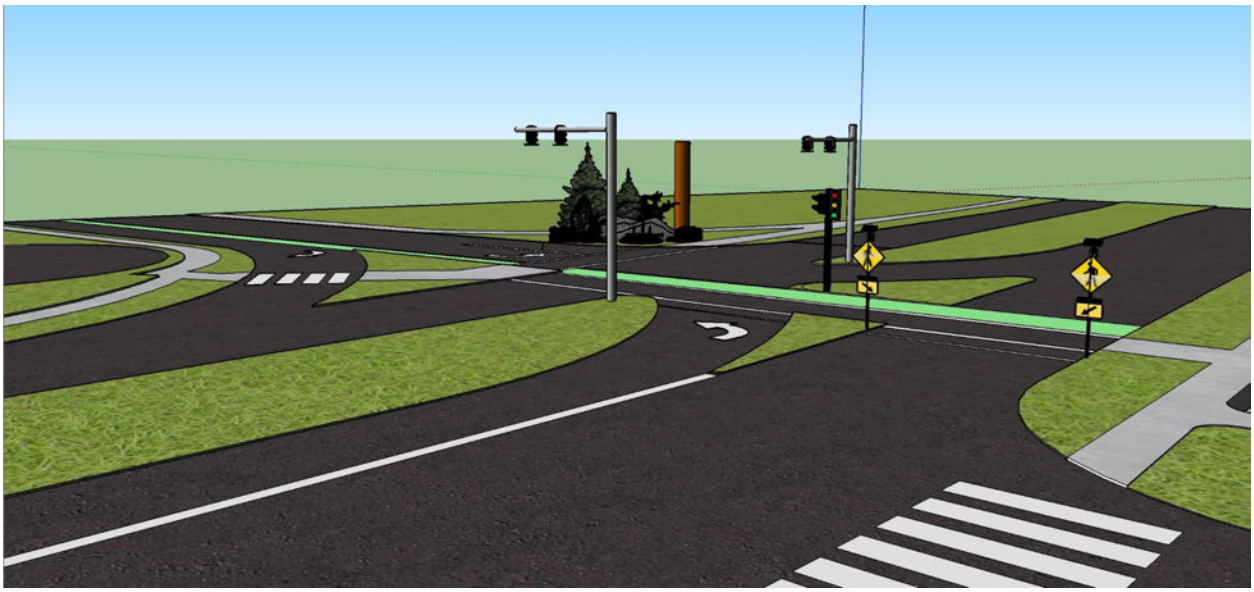

Figure 3: 3D Model of the Preliminary Design

Note that measurement standards were taken from the Geometric Design Guidelines for BC roads and Intersections created by the BC government. It is able to accommodate up to class WB-17 vehicles with a length of 19.5 metres. The minimum turning radius of 13.7m is achieved.

6.2 Justification and Synchro Analysis

The road geometry of the current intersection is utilized, with minimal changes, in order to reduce construction costs. The main goal of the intersection redesign is to increase accessibility for pedestrians and cyclists, while sustaining a steady traffic flow. The addition of light signalling will account for future growth, both in vehicle and pedestrian/bicycle traffic. Data from 2015 was used for Synchro analysis, however the UBC Vancouver student population has grown by 10% since the 2015-16 school year, based on the 2015 and 2021 enrolment reports (Redish & Mathieson, 2016; Mukherjee-Reed & Szeri, 2021). According to the UBC Transportation Plan, the student population was projected to grow to 47,294 by 2021 and 60, 294 by 2041 (2014). Team 11 Engineers estimated that the traffic will grow by about 25% in the next 25 years, based on student growth while also accounting for the completion of the Broadway Subway Project and other Rapid Transit, both of which will decrease the amount of cars travelling. The minimum vehicular volume to warrant a traffic light is 500 vph on the major street (British Columbia Ministry of Transportation and Infrastructure, 2019). As of 2015, the traffic travelling along Chancellor Blvd falls just short, at 400 vph at peak volume. However, the estimated 25% growth means the intersection will meet this standard some time in the next 25 years. The inclusion of pedestrian and bicycle traffic warrant some kind of stop mechanism at the intersection. A semi-actuated traffic light system will streamline the heavy amount of left-turning traffic while creating a welcoming environment for pedestrians and cyclists.

Since there is no reason to impede traffic flow for the southwest travelling lane on Chancellor Blvd, except for pedestrian travel, a pedestrian-controlled amber flasher is introduced instead of a full traffic light. The flasher will minimize stops in that direction, while still encouraging

pedestrian crossings. Delay time is also minimized by implementing sensors for the left turning lanes only, meaning the eastbound traffic on Chancellor Blvd will only be stopped if required.

Synchro analysis results for both the original intersection and the preliminary design can be found in Tables 5 & 6 in Appendix 5. Analysis of the design, using the projected traffic volumes, resulted in approximately 2x more delay time per vehicle than in the original intersection. However, the hourly exit rate increases, allowing more traffic to pass through the intersection than before. The new design also increases accessibility and safety for pedestrians and bicyclists, in accordance with the UBC Transportation Plan. It is integral to prioritize these modes of travel to promote alternate transportation methods and meet UBC's sustainable travel targets.

The left-turning lane on Chancellor Blvd was extended by approximately 20m to allow westbound traffic to remain clear during backups, reducing delay time significantly. The east right turn radius was converted into green space to allow for a design representing the entrance to the UBC campus. Due to the relatively small amount of traffic travelling in that direction, a typical short right turn lane will be added instead, as shown in Figure 5 (Appendix 6).

6.3 Aesthetics

The "Gateway to UBC" design is simple yet fitting. It is composed of multiple evergreen trees and various local plants and flowers surrounding a short stone wall containing the words "Welcome to UBC" and a school of fish made from metal. A small stone fountain sits in front, and a totem pole by a local Musqueam artist sits on the side. The design encapsulates the essence of UBC and Vancouver, incorporating elements from the ocean as well as the evergreen forests.

Art inspired by the Musqueam people is also included, as their culture is a large part of the history of the area. Additionally, an open call will be issued to Indigenous artists to submit designs to be painted on the two pedestrian crosswalks.

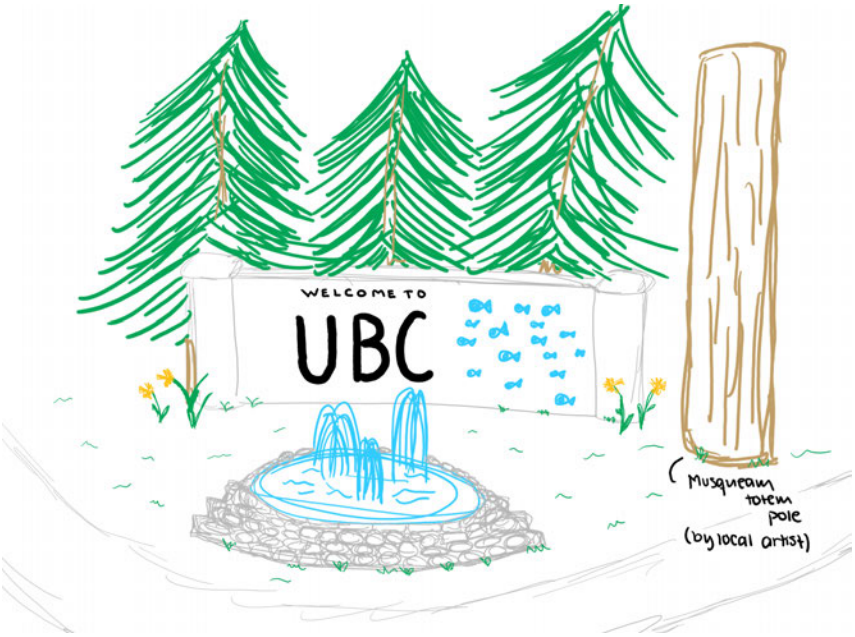

Figure 4: "Gateway to UBC" Design

7.0 Analysis Results

7.1 Safety Analysis

Dedicated stop lights for pedestrians and bicycles improves safety from the current situation. All traffic except for the SW travelling lane will have a full stop red light if pedestrians are crossing. As the travel speed along Chancellor Blvd is relatively high at 50 km/h, the SW travelling lane will have an amber flashing light, increasing visibility of any pedestrian traffic. The twin parallel line crosswalk design was selected as opposed to the zebra design, as is recommended for intersections with pedestrian-controlled signals (BC Ministry of Transportation and Highways,

1994). A painted bike lane also increases awareness of bicyclists and creates a safe route to turn left from Wesbrook Mall onto Chancellor Blvd.

7.2 Environmental Analysis

The preliminary design reflects the three pillars of sustainability: economy, environment and community. The general land use and the current outlier of private properties will not be affected. The UBC campus area is a high quality education community. Thus, a better entrance for the campus and a less congested outer ring can improve the community's cultural characteristics, positively affecting UBC's reputation and encouraging long-term economic growth. From the environmental perspective, very minimal green land will be lost in the construction area, landfills will be transferred inside the project area, and the overall elevation of the field will not be changed. Thus, the environmental effects are minimized, and will not affect the surface runoff, soil characteristics, and the ecosystem. Moreover, the new design displays less carbon monoxide (CO) and hydrocarbons (HC) emissions at the intersection (Appendix 5), which is more environmentally friendly in the long-term perspective. The stormwater management and wastewater drainage system will be slightly altered to resolve current water logging conditions. A catch basin will be added along the North side of Chancellor Blvd in order to reduce the water build up during periods of heavy rain. This catch basin connects to the existing storm water system. Sustainability was considered throughout the project, as recycled aggregates for concrete production were considered to use throughout the whole construction process.

8.0 Preliminary Schedule

The scheduled start date for construction is May 1, 2022 and will end on December 8, 2022. The total duration of the project is 285 work days, with construction taking 98 days. Main construction tasks include removing existing signage and unneeded lanes, excavation to utilities, installation of stormwater catch basins, the addition of a left turning lane, and the installation of traffic lights and pedestrian lights. A gantt chart with the preliminary schedule is available in Appendix 2.

9.0 Class C Cost Estimate

The Class C cost estimate that follows corresponds to a 33% completed design, with an approximate 2500 m² of construction area. The estimate was created using RSMeans Data[1].

Table 2: Class C Cost Estimate Breakdown

Description of Work	Quantity	Units	Unit Price	Cost	% Cost Breakdown
Traffic Light Installation	3	ea.	$ 244,000.00	$ 732,000.00	57.93%
Pedestrian Light Installation	3	ea.	$ 100,000.00	$ 300,000.00	23.74%
Curb Reinstallation	40	m	$ 30.00	$ 1,200.00	0.09%
Curbside Drain Grate	3	ea.	$ 20.00	$ 60.00	0.00%
Catchbasin Connection	20	m	$ 100.00	$ 2,000.00	0.16%
Ashphalt Removal	300	m^3	$ 150.00	$ 45,000.00	3.56%
Planting Grass	300	m^2	$ 200.00	$ 60,000.00	4.75%
Landscaping	72	/hr	$ 70.00	$ 5,040.00	0.40%
Bike Lane(s)	30	m^2	$ 80.00	$ 2,400.00	0.19%
Pedestrian Crosswalk	40	m^2	$ 60.00	$ 2,400.00	0.19%
Sculpture Commission	1	ea.	$ 100,000.00	$ 100,000.00	7.91%
Crosswalk Painting	40	m^2	$ 200.00	$ 8,000.00	0.63%
Sidewalk	90	m^2	$ 60.00	$ 5,400.00	0.43%

Subtotal Cost	$ 1,263,500.00
15% Contingency	$ 189,525.00
10% Profit Markup	$ 126,350.00
Consultation Fee	$ 300,000.00
TOTAL	$ 1,879,375.00

[1] RSMeans Data from Gordian, a North America's construction cost database. Detailed information and the service can be accessed from https://www.gordian.com/products/rsmeans-data-services/

The majority of cost arises from the actuated traffic lights, which require skilled labour to install and program. This estimate adds a 15% contingency cost which should account for the unforeseen during the project, as well as a 10% profit markup to account for the landscaping materials.

10.0 Recommendation

Team 11 Engineers Ltd. formulated the aforementioned redesign for the intersection at Wesbrook Mall and Chancellor Boulevard with signalized traffic lights and a service life of 25 years. The intersection includes accessible paths for cyclists and pedestrians. Stormwater management is updated with strategically placed catch basins. A totem pole commissioned from a local indigenous artist as well as painted crosswalks welcome those entering the UBC campus. This design complies with UBC's transportation planning objectives and meets the objectives set forth by the client. Team 11 Engineers Ltd. believes that this intersection will greatly benefit the UBC community and recommends its immediate implementation.

11.0 References

British Columbia Ministry of Transportation and Highways. (1994). *Pedestrian Crossing Control Manual for British Columbia - Second Edition*. https://www2.gov.bc.ca/assets/gov/driving-and-transportation/transportation-infrastructure/engineering-standards-and-guidelines/traffic-engineering-and-safety/traffic-engineering/traffic-management-and-traffic-control/pedestrian-crossing-manual.pdf

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Appendix 1: Weighted Decision Matrix

A weighted decision matrix was used to evaluate three conceptual design options. Each concept was scored out of ten for each of the design criteria. As can be seen in the figure below, the signalized intersection had the highest score. Thus the signalized intersection is the preferred design that is presented in this preliminary design report.

Table 3: Weighted Decision Matrix

Criteria	Weight (%)	Option 1: Signalized Intersection	Option 2: Straight Overpass	Option 3: Curved Overpass
Cost	25.00	7	4	3
Safety	12.50	8	8	8
Traffic Volume	15.00	6	9	8
Pedestrians	5.00	7	5	5
Cyclists	5.00	7	3	2
Buses	5.00	8	5	4
Trucks	2.50	7	5	5
Construction Time	7.50	8	5	4
Aesthetics	7.50	6	8	8
Sustainability	15.00	7	5	4
SUM	100.00	7.03	5.85	5.13

Appendix 2: Stakeholder Engagement and Communication Plan

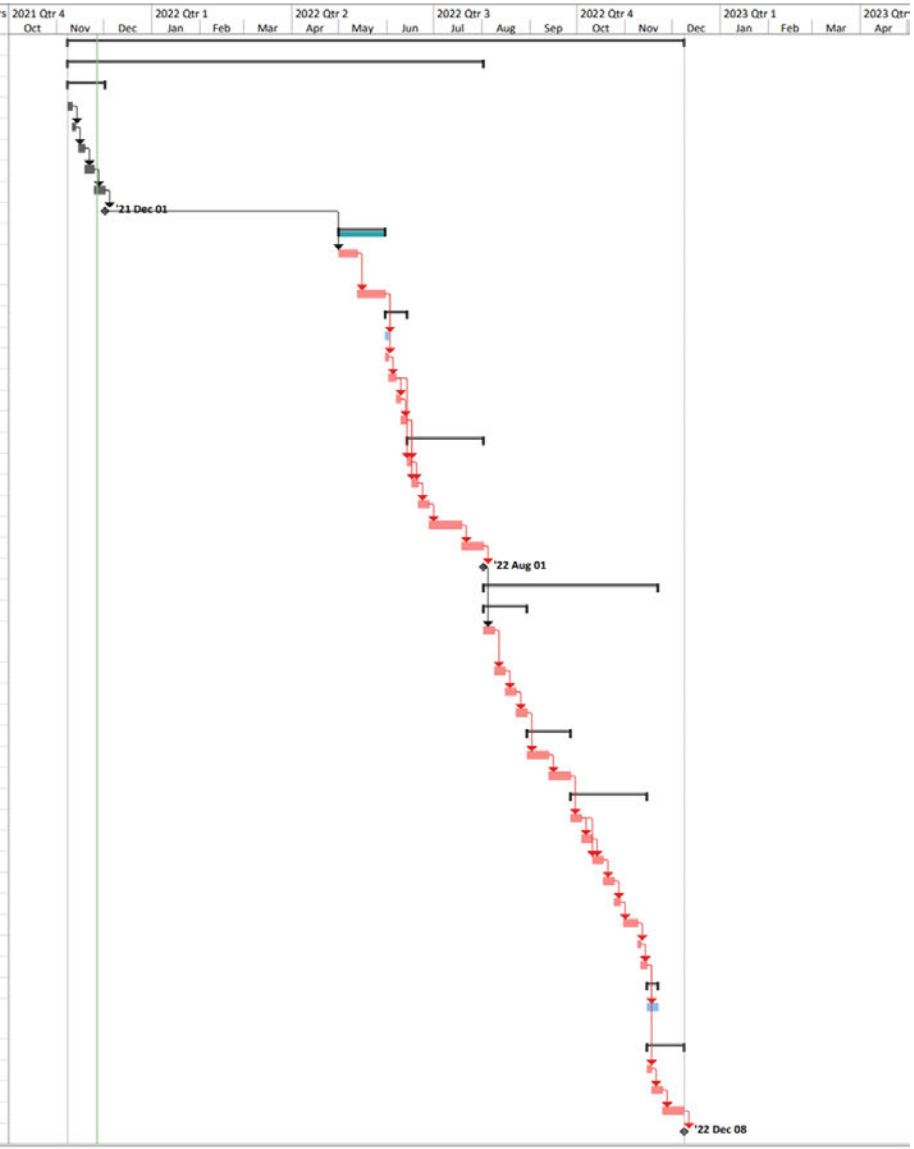
The stakeholders for this project include:

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

During the conceptual design stage, [redacted] held several public meetings. They were advertised through paper notices that were distributed to the local community and specifically the Chancellor Place neighbourhood. Three conceptual design options were presented in order to gain their feedback. Additionally, in the conceptual stage of the project Team 11 Engineers reached out to the Musqueam Peoples Administration Office through UBC channels. The consultations were initiated early on in the project to allow for an in-depth discussion. The Musqueam Band Office chose to hold a meeting with several of the project engineers. Communication lines with all stakeholder groups will remain open for the duration of the project.

Appendix 3: Gantt Chart of Preliminary Design Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Team 11 Project**	**285 days**	**Mon 21,11,08**	**Thu 22,12,08**	
2	**Pre-**	**192 days**	**Mon 21,11,08**	**Mon 22,08,01**	
3	**Office work**	**18 days**	**Mon 21,11,08**	**Wed 21,12,01**	
4	Receive notice to proceed and sign contract	3 days	Mon 21,11,08	Wed 21,11,10	
5	Submit reletive employees' documents	2 days	Thu 21,11,11	Fri 21,11,12	4
6	Prepare and submit project schedule	4 days	Mon 21,11,15	Thu 21,11,18	5
7	Obtain building permits	4 days	Fri 21,11,19	Wed 21,11,24	6
8	Submit preliminary reports and drawings	1 wk	Thu 21,11,25	Wed 21,12,01	7
9	Preliminary reports finished	0 days	Wed 21,12,01	Wed 21,12,01	8
10	**Submit drawings and order long lead iterms**	**22 days**	**Sun 22,05,01**	**Mon 22,05,30**	
11	Steel, electric, concrete, sod, painting, utilities (traffic lights, intersection signages, etc.)	2 wks	Sun 22,05,01	Thu 22,05,12	9
12	Detail, fabricate and deliver steel	12 days	Fri 22,05,13	Mon 22,05,30	11
13	**Mobilize on Site**	**10 days**	**Tue 22,05,31**	**Mon 22,06,13**	
14	Install temporary power	2 days	Tue 22,05,31	Wed 22,06,01	12
15	Install temporary water service	2 days	Tue 22,05,31	Wed 22,06,01	12
16	Setup site office	3 days	Thu 22,06,02	Mon 22,06,06	15
17	Set line and grade benchmarks	3 days	Tue 22,06,07	Thu 22,06,09	16
18	Prepare site - lay down yard and temporary fencing	2 days	Fri 22,06,10	Mon 22,06,13	17
19	**Site grading and utilities**	**35 days**	**Tue 22,06,14**	**Mon 22,08,01**	
20	Clear and grub site	3 days	Tue 22,06,14	Thu 22,06,16	16,18
21	Stone site access and temporary parking area	2 days	Fri 22,06,17	Mon 22,06,20	18,20
22	Rough grade site (cut and fill)	1 wk	Tue 22,06,21	Mon 22,06,27	21
23	Install storm drainage and exterior fire line	3 wks	Tue 22,06,28	Mon 22,07,18	22
24	Perform final site grading	2 wks	Tue 22,07,19	Mon 22,08,01	23
25	Pre-work finish	0 days	Mon 22,08,01	Mon 22,08,01	24
26	**During**	**80 days**	**Tue 22,08,02**	**Mon 22,11,21**	
27	**Removal**	**20 days**	**Tue 22,08,02**	**Mon 22,08,29**	
28	Current signage, and channelized North-East right turn off Chancellor Blvd.	1 wk	Tue 22,08,02	Mon 22,08,08	25
29	Utilities clean up	1 wk	Tue 22,08,09	Mon 22,08,15	28
30	Trees and sod	1 wk	Tue 22,08,16	Mon 22,08,22	29
31	Finialized clean up	1 wk	Tue 22,08,23	Mon 22,08,29	30
32	**Excavation**	**20 days**	**Tue 22,08,30**	**Mon 22,09,26**	
33	Stormwater system	2 wks	Tue 22,08,30	Mon 22,09,12	31
34	Re-landscape for gateway structure	2 wks	Tue 22,09,13	Mon 22,09,26	33
35	**Form and pour concrete**	**35 days**	**Tue 22,09,27**	**Mon 22,11,14**	
36	Install electrical underground	1 wk	Tue 22,09,27	Mon 22,10,03	34
37	Install drainage system underground	1 wk	Tue 22,10,04	Mon 22,10,10	36
38	Install traffic light and relative sensors underground	1 wk	Tue 22,10,11	Mon 22,10,17	36,37
39	Install rebar and other utilities	1 wk	Tue 22,10,18	Mon 22,10,24	38
40	Pour ground slab	4 days	Tue 22,10,25	Fri 22,10,28	39
41	Cure ground slab	7 days	Mon 22,10,31	Tue 22,11,08	40
42	Strip gorms from the ground slab	2 days	Wed 22,11,09	Thu 22,11,10	41
43	Off-ground utilities (wires and tubes) clean up	2 days	Fri 22,11,11	Mon 22,11,14	42
44	**Installation**	**5 days**	**Tue 22,11,15**	**Mon 22,11,21**	
45	Street light, traffic light, signage, Musqueam and UBC design, line paintings (pedestrain crosswalks, bike lanes, vehicle lane	1 wk	Tue 22,11,15	Mon 22,11,21	43
46	**Post-**	**18 days**	**Tue 22,11,15**	**Thu 22,12,08**	
47	System testing	3 days	Tue 22,11,15	Thu 22,11,17	43
48	Quality check	1 wk	Fri 22,11,18	Thu 22,11,24	47
49	On-site office and relative utilities removal	2 wks	Fri 22,11,25	Thu 22,12,08	48
50	End of the project	0 days	Thu 22,12,08	Thu 22,12,08	49



Appendix 4: 2021 Traffic Data (9:00 - 9:10 AM)

Table 4: Measured Traffic Volumes

	South Approach (WB-CH)		**West Approach**		**East Approach**	
	Left	Right	Thru (CH)	Right (CH-WB)	Left (CH-WB)	Thru (CH)
Cars	6	8	15	11	34	61
Trucks	1	0	1	1	2	0
Buses	1	2	0	1	3	0
Total	**8**	**10**	**15**	**13**	**39**	**61**
Projected VPH	**48**	**60**	**90**	**78**	**234**	**366**

Appendix 5: Synchro Traffic Analysis Reports

Table 5: New Intersection Performance with Increased Traffic Flow

Total Network Performance

Total Delay (hr)	3.0
Delay / Veh (s)	39.3
Stop Delay (hr)	2.7
St Del/Veh (s)	36.1
Total Stops	126
Stop/Veh	0.46
Travel Dist (km)	46.4
Travel Time (hr)	4.2
Avg Speed (kph)	21
HC Emissions (g)	18
CO Emissions (g)	735
NOx Emissions (g)	65
Vehicles Entered	273
Vehicles Exited	271
Hourly Exit Rate	1626
Denied Entry Before	4
Denied Entry After	5

Table 6: Original Intersection Performance with Increased Traffic Flow

Total Network Performance

Total Delay (hr)	1.3
Delay / Veh (s)	18.9
Total Stops	215
Travel Dist (km)	82.7
Travel Time (hr)	3.4
Avg Speed (kph)	30
HC Emissions (g)	22
CO Emissions (g)	1003
NOx Emissions (g)	88
Vehicles Entered	258
Vehicles Exited	257
Hourly Exit Rate	1542
Denied Entry Before	3
Denied Entry After	1

Appendix 6: Preliminary Design Drawings

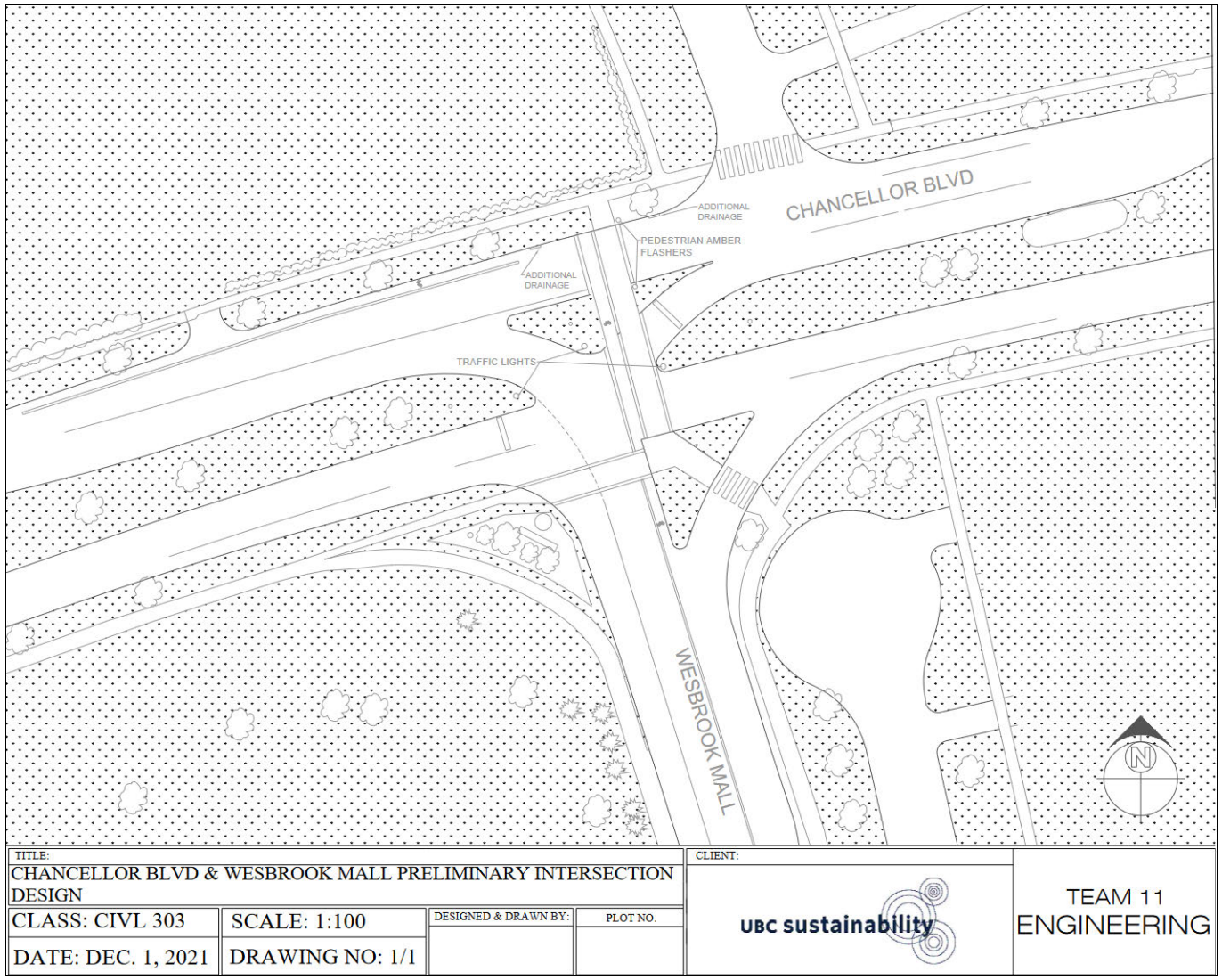


Figure 5: AutoCAD drawing of Design

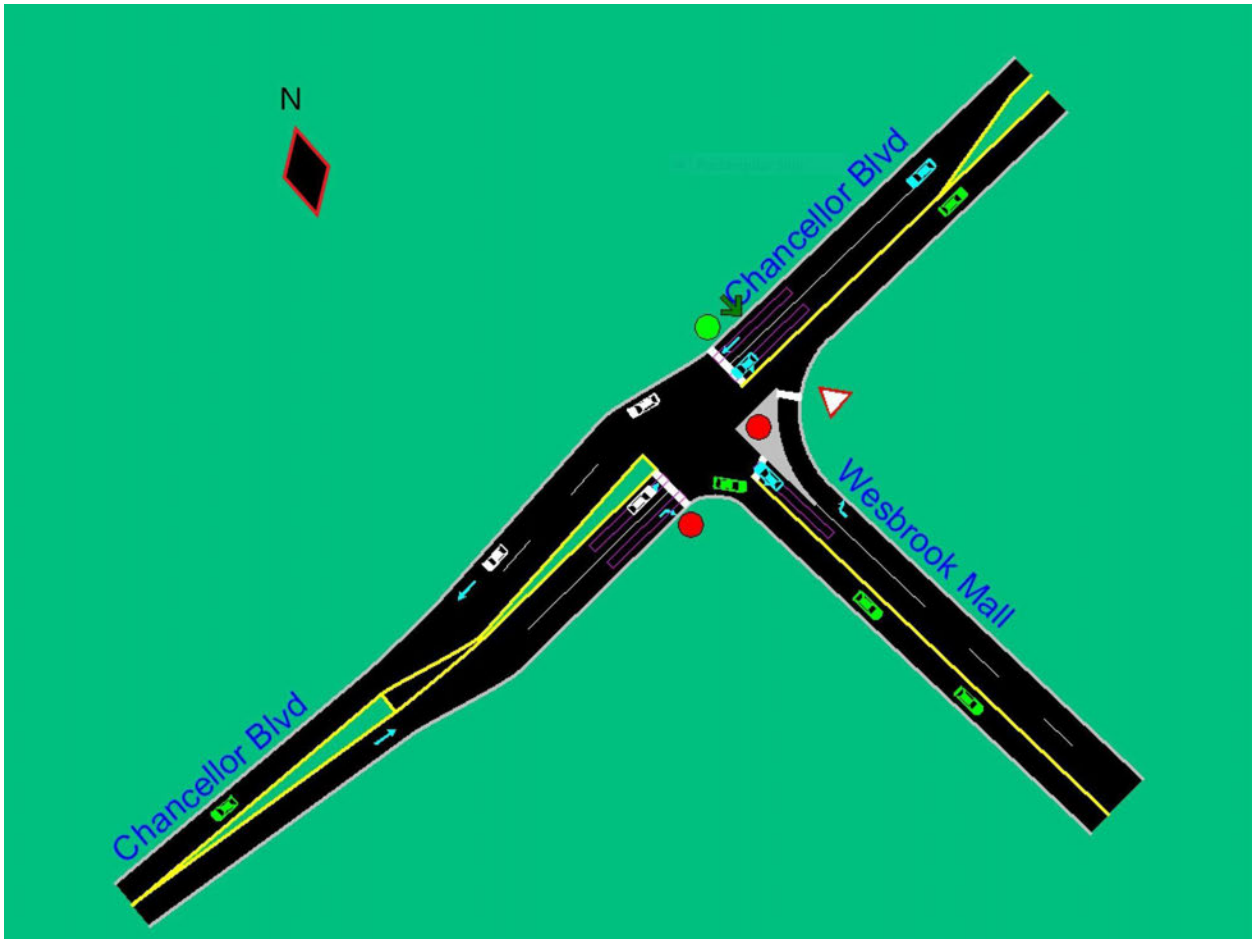


Figure 6: Preferred Design Synchro Model

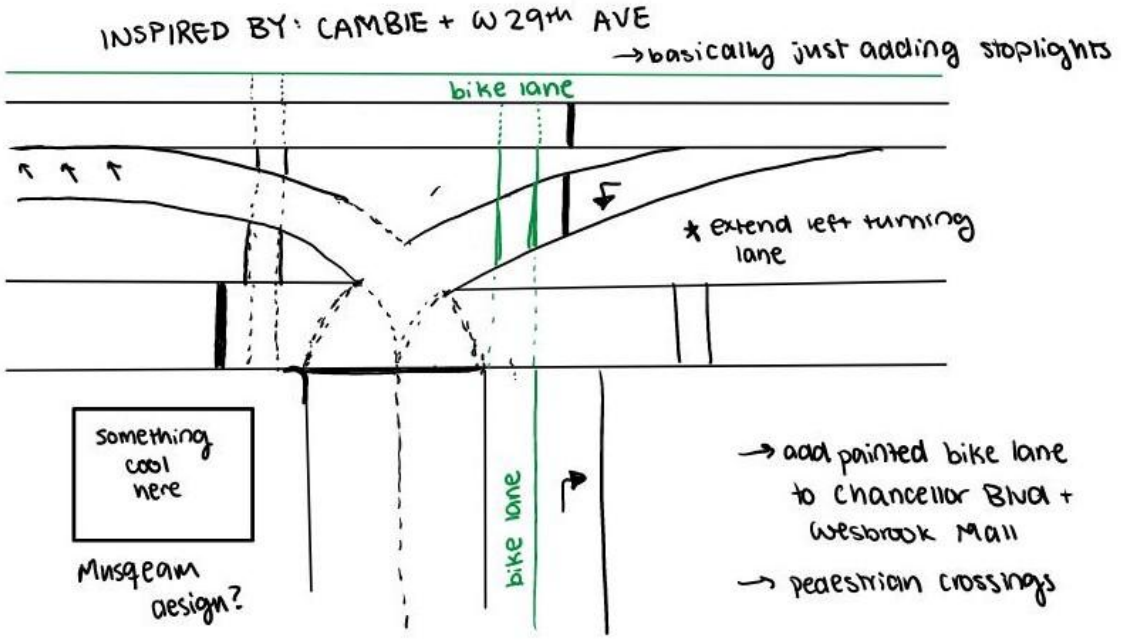


Figure 7: Chosen Conceptual Design Option

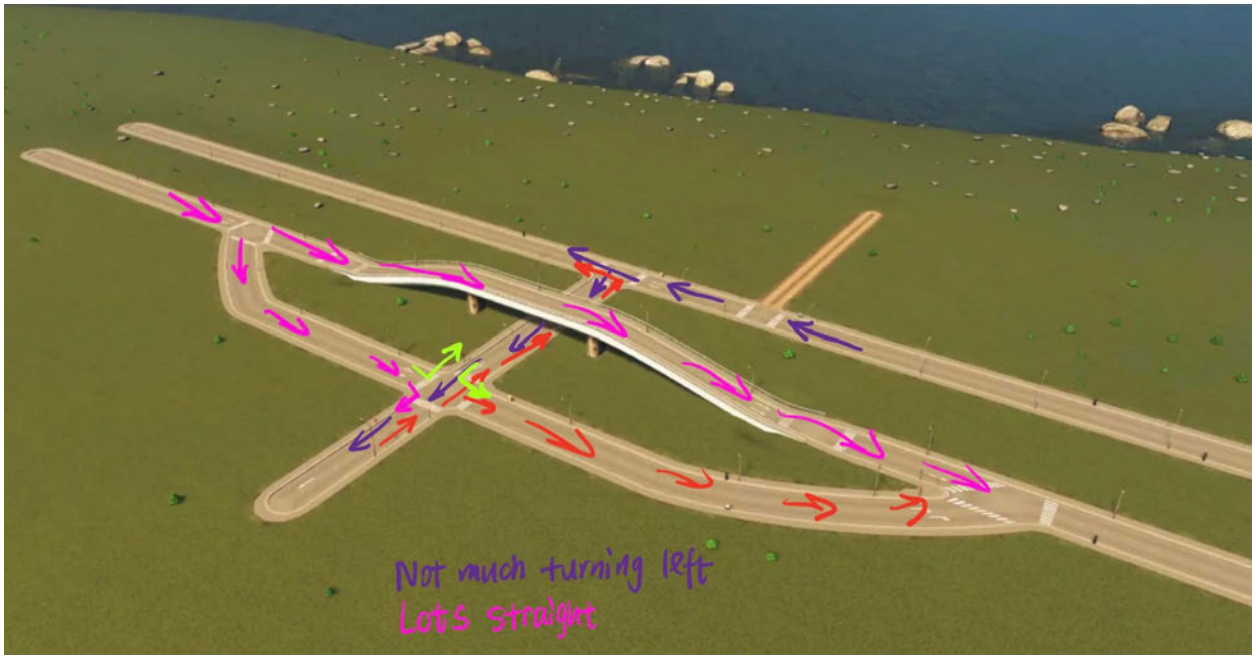


Figure 8: Conceptual Option 2, Straight Overpass

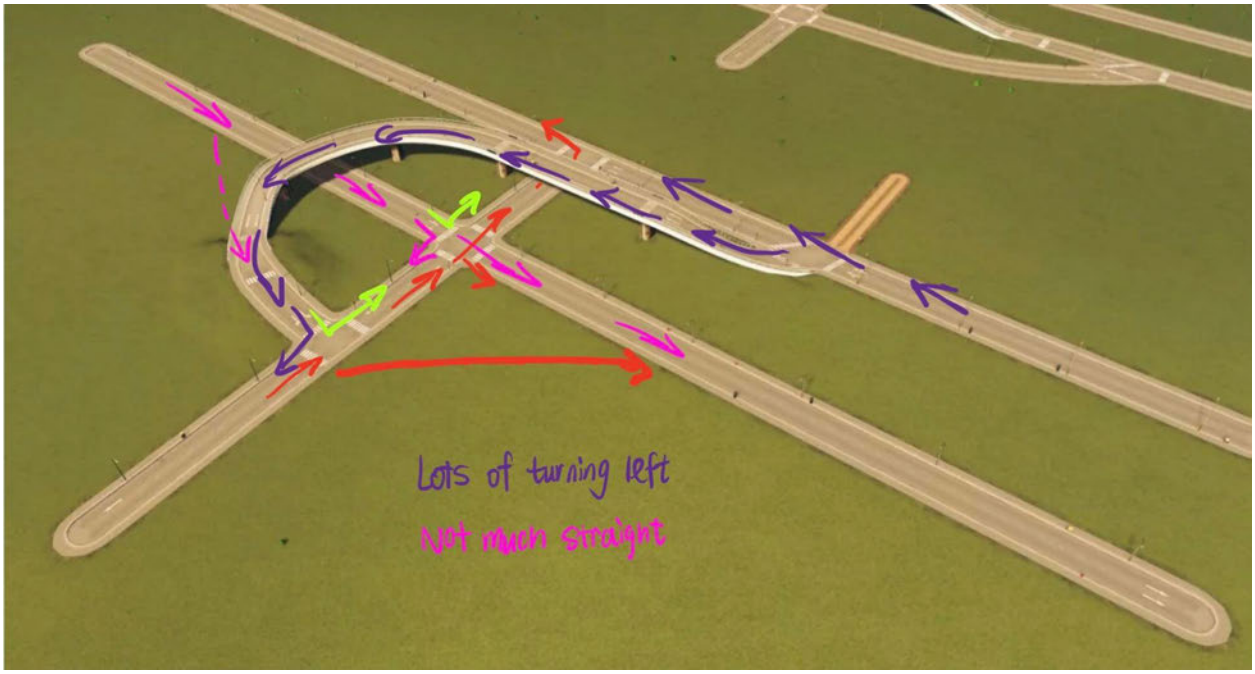


Figure 9: Conceptual Option 3, Curved Overpass