UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Stadium Neighborhood Underground Parkade and Water Storage

James Lee, Jason Angustia, Nan Suwanchotsiri, Xu Xin Liu, Zizheng Han, Alfred Lewis

University of British Columbia

CIVL 446

Themes: Water, Climate, Land

April 10, 2019

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Executive Summary

Siksin Consultants Ltd. has been tasked with developing a mixed solution of a car parkade and stormwater management system project to mitigate extreme flooding that may occur in a 1 in a 100-year storm event around the area of Marine Drive and West 16th Avenue, Vancouver. The goal of the design also includes creating a neighborhood welcoming atmosphere recreational area for the future neighborhood development.

On the surface, the parkade, bioswales, skate board park and amphitheater act as a part of the stormwater collecting system. In an extreme storm event, the skate park and amphitheater are intended to hold and temporary store stormwater to help slow down rainfall runoff and prevent erosion at the cliff. Under normal weather circumstances, precipitation is collected from the car parkade to the bioswales along the current slopes down to the field. The bioswales serve to control the runoff flow rate and act as a natural filtration system. The collected water then travels through underdrain beneath the bioswales and is stored in the underground retention pipe system. An UV filtration system is also installed for water purification purposes. Once the storage tanks have reached its capacity, additional water is left at the various collection points for natural infiltration and evapotranspiration or transported directly to the sea through existing pipes.

The existing car parkade is also revamped. A solar panel roof is added to provide renewable energy to the stormwater management system, in particular, supply energy to the pump. The current concrete ground is replaced by permeable porous asphalt to help infiltrate stormwater and additional storm drains will be placed for extra drainage. The car parkade capacity is reduced to 80 spots to encourage the use of alternative sustainable transportation methods.

The design also includes a reduction in number of lanes along West 16th Ave from two lanes to reducing one side of West 16th Ave road adjacent to the project site. The expansion of the green space median is also recommended. In addition, tennis courts and a playground are added to provide additional recreational area for the surrounding neighbourhood and future residences.

Ultimately, the proposed design has a total of $4100m^3$ of stormwater retention capacity. The total updated cost estimate is $4,645,000. The proposed construction date is May 1st, 2019 and has an expected duration of 131 days, completing on September 9th, 2019. Slight changes in schedule and project costs are anticipated given that unexpected events may occur during the construction phase.

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1.0 Introduction

The following Final Design Report has been developed by Siksin Consultants, Ltd. to provide a detailed design of the Stadium Neighbourhood Underground Parkade and Water Storage at the University of British Columbia (U.B.C.) and is intended to be used with the attached appendices for reference.

Since September 2018, both clients P. Eng Doug Doyle and David Gill from the UBC SEEDS indicate that current stormwater systems near the intersection of Marine Drive and West 16th Avenue at the University of British Columbia in Vancouver, would be incapable of handling increased demands from both the upcoming Stadium Road Neighbourhood and larger storm events. There is also a concern that the increased amount of stormwater would cause cliff erosion at the outfalls located nearby the project site.

The final detailed design by Siksin Consultants is designed to address said concerns while also providing the means for improving campus aesthetics. The design also meets other criteria that is deemed important as identified by Siksin Consultants, and recommendations moving forward have been provided. Table 1 outlines each member of Siksin Consultants Ltd. and their respective roles and responsibilities.

Table 1: Team Member Roles and Responsibilities

Team Member	Roles and Responsibilities
Jason Angustia	Design of skateboard park and West 16th Aveneue.
Zizheng Han	Design of hydrological components and cost estimation.
James Lee	Design of car parkade and scheduling.
Alfred Lewis	Design of tennis court and cost estimation.
Xu Xin Liu	Design of Playground and hydrological components.
Nan Suwanchotsiri	Design of bioswales, Amphitheatre and scheduling

2.0 Project Description

2.1 Project Scope

In this *Final Design Report*, the scope of work is intended to meet the deliverables as requested by the clients. Note that the design drawings and calculations in this report are a continuation of the Preliminary Design Report.

The final design includes detailed designs of structures and appropriate calculations, a revised construction plan, an updated Class D cost estimate and schedule, and some recommendations moving forward.

Guiding the overall project design are four essential objectives that must be fulfilled:

- Develop an efficient solution of a parkade and water storage/retention tanks, with a focus on creating a controlled stormwater management system capable of handling increased demands
- Design using best practices approach, with sustainability as a key foundation for enhancing the UBC environment and atmosphere
- Enrich the surrounding neighbourhood by creating community facilities
- Encourage other modes of transportation by minimizing parking space

2.2 Site Description

The project site is located next to the intersection of Marine Drive and West 16th Avenue, Vancouver, as shown in the Figure 1 below. University of British Columbia proposes plans to relocate the existing Stadium at the project site and the addition of an upcoming Stadium Road

Neighbourhood. In the development of the *Final Design Report*, information regarding the site have been provided by the clients, and is referenced to in developing the conceptual designs.

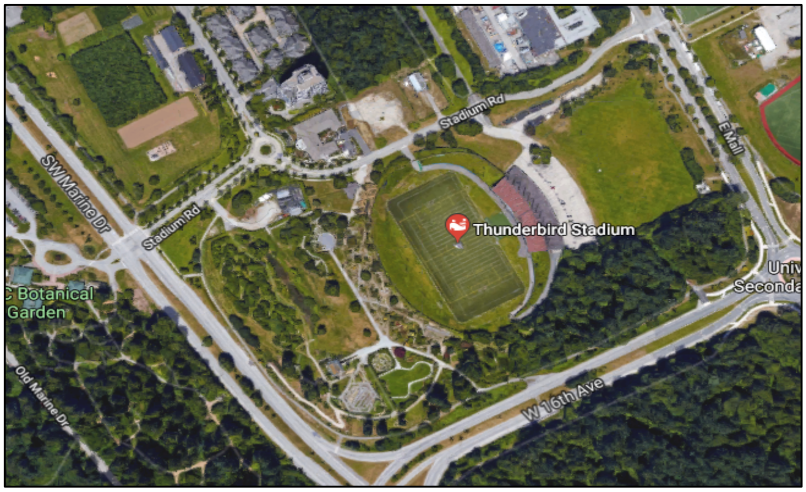

Figure 1: Location of project site (retrieved from Google Maps)

3.0 Key Design Components

In the development of the project, Siksin Consultants, Ltd. has noted that a fair approach to addressing the client's objectives is through the use of multiple structures. Figure 2 below shows the general location and dimension of each component. A description of the structures and their capabilities are provided in the following sub-sections.

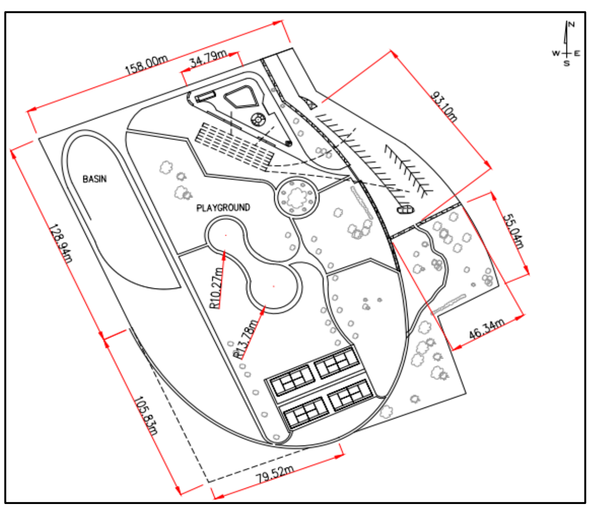

Figure 2: Location and general dimensions of design components

3.1 Underground Hydrological Components

The stormwater management system includes water retention, detention, filtration, outflow into the ocean, and supply to the new stadium. In the preliminary design stage, for 10-year storm event, it was found that the volume of storm water in the catchment area is 850 m^3 (Appendix B.2.1). On the other hand, for 100-yr storm event, the required capacity is 4000 m^3, shown in Section 5.1.1, Hydrotechnical considerations. To store these two volume, Siksin Consultants, Ltd. decided to design a hydro system with both retention and detention functionalities. The detention system including stake park and amphitheater can hold a volume of 3250 m^3 in the case of an extreme storm event. As a result, providing additional time for water to flow into the detention system with a slower rate. Meanwhile, the detention pipe operates to hold a volume of 850m^3 on a normal basis.

3.1.1 Water Detention System

Three on-surface water management facilities are designed to provide a dual functionality: retention and entertainment. The on-surface structures include a skateboard park and an amphitheater with a total water detention capacity of 3250 m^3. Below grade structure is a storage pipe system with a detention capacity of 850 m^3. Combined, the overall capacity of water detention is 4100 m^3 and can sufficiently store 4000 m^3 of water in the case of the most extreme storm event.

3.1.2 Water Retention System

The below grade storage pipe system mentioned in Section 3.1.1 is also capable of acting as a retention system. The system consists of 6 parallel HDPE pipes, each pipe measuring 2 meters in diameter and 45 meters in length. Having a total volumetric capacity of 850 m^3, the system is designed to handle the runoff volume of a 30-min, 100-year storm event with zero net flow. HDPE pipe were chosen due to the relatively higher strength to weight ratio, higher corrosion-resistant, and economic cost, compared to steel pipes. Four of the six large diameter pipes are designed for storing untreated water, and the other two are for treated water following a UV treatment. Figure 3 is a simple schematic diagram for storage pipes. During normal rain days, the treated water is used to supply the Thunderbird Stadium for non-potable activities. During an intense storm event, water is discharged through the drainage pipes. Additional information for the drainage pipes can be found in Section 3.1.6.

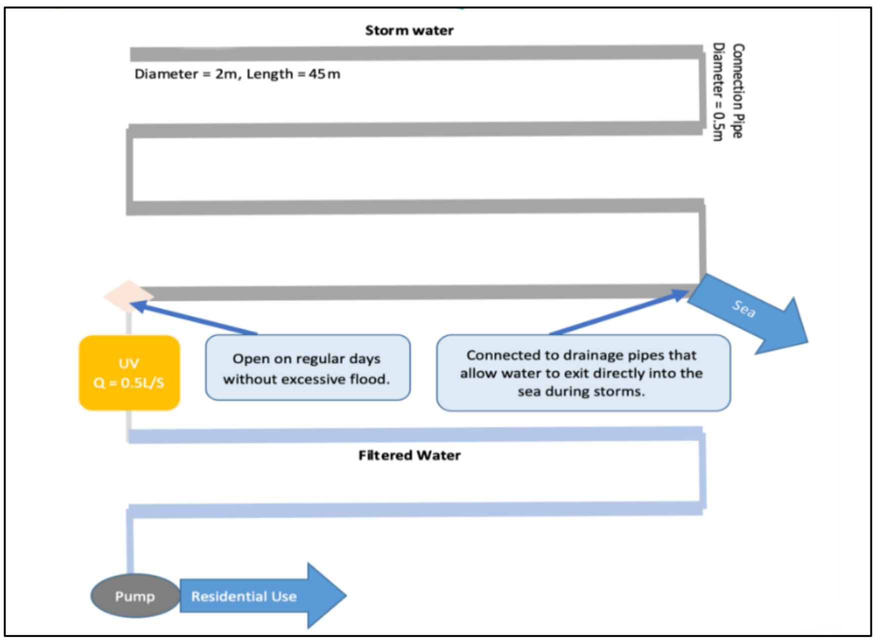

Figure 3: Schematic diagram of retention system network.

3.1.3 Ultraviolet (UV) light Filtration System

The UV light filtration system will be installed to treat the water that is supplied to the new stadium. The level of filtration is designed for irrigation and non-potable use only. The disinfection system uses a unit of 250 Watt, 0.5L/s VIQUA S8Q-PA ultraviolet disinfection light. Water disinfected is stored in treated water tanks.

3.1.4 Clean Water Distribution.

Clean non-potable water is provided to the new Thunderbird Stadium by controlling the water level in the corresponding detention/retention tanks. A 250mm HDPE pipe is used to transport the disinfected water from the retention tank to the new Thunderbird Stadium via a pump at a flow rate of 10 L/s. The new stadium is proposed to be 160 m away from the storage system and has a high elevation of 7m. Using a pipe loss calculator, we obtain a friction loss of 20.6m; as a result, the pipe head is 27.6m and is rounded up to 30m for potential minor losses. In this case, one CRE 32-1 pressure boosting pump is sufficient and is used.

3.1.5 Drainage Pipe

The HDPE drainage pipe is connected to existing storm sewer pipes located along the West 16th Ave. The pipes are located 210 meters away with a diameter of 600mm. This is consistent with the design's collection pipe and is used to expel excess stormwater at the associated outfall.

3.2 Car Parkade

The future outdoor car parkade remains at the existing location with a lower capacity. The number of parking spots is intentionally reduced to encourage the use of public and other means of transportation. A total of 80 standard car parking spots are provided, which is two thirds of the average daily user demand based on the credit card transaction data supplied by the client.

The construction of the parkade roof includes a solar energy storage panel system similar to the one displayed in Figure 4. The stored solar energy supplies electrical energy to the water supply pump used for delivering filtered water from the water detention system to the new stadium. An external contractor is hired to construct the solar panel roof system.

Figure 4. Image of proposed solar panel parked
(https://news.energysage.com/solar-canopy-installations-bring-shade-clean-energy-parking-lot/)

In terms of structural analysis, the anticipated applied loads mainly consist of gravity load and earthquake load. Following the National Building Code of the Canada (NBCC), the worst load combination of these two are calculated as 6.1 kPa (Appendix. B.2.2). Taking this into account, 44 columns and 11 square footings are needed for the new car parkade. The column section is HSS 152 X 9.5 with two of them required to construct a single set of columns. Each group of columns is installed on a single footing, resulting in a total of 22 columns in each row (2 rows of columns in total). The dimension of the footing is 1m x 1m x 0.5m and are installed at a depth of 2m from the surface of the car parkade (Appendix A).

0.5m to 0.8m of asphalt will be placed above the ground surface and the subsurface soil layers remain unchanged after ground consolidation. Low to medium degree of soil consolidation is required to withstand future loads from the car parkade roof and column. Furthermore, asphalt layer surface is 2 degrees negatively sloped towards bioswales to direct stormwater runoff to the bioswales.

3.3 Bioswales

The runoff water from the parkade and Stadium Road is guided towards the bioswales through the gentle slope design of the parkade. The bioswale layout has a 350mm thick growing medium on top, 100mm sand layer, 100mm pea gravel and the remaining 940mm drain rock. A perforated PVC pipe underdrain runs through the drain rock to guide water out of the bioswale into the retention tank during heavy rainfall events that floods the bioswale. A mesh filter is installed in between the pea gravel and the drain rock to prevent piping of fine material through the bioswale. The bioswale design for the steep slope between the parkade and the skatepark is illustrated in Appendix A.

The steep slope along the east side of the project site makes it ideal to utilize stepped bioretention cells with check dam and spillway to slow down the runoff and filter pollutants from the runoff water. The design of the check dam can be found in Appendix A. Under low runoff rate, the water will infiltrate directly beneath the bioswale and under high runoff rate, the water can overflow the check dam into the next spillway. Rock pits are placed upstream and at the toe of the check dam to reduce erosion caused by the water passing through the spillway. The check dam between bioretention cell prevents the erosion of growing medium in each cell. The sand and pea gravel under the growing medium help to remove pollutants from runoff water before the water flows into the filtration system. Perforated pipes are installed in the last bioretention cell to transport infiltrated water into the retention tank. A section view of the bioswale components is depicted in Figure 5 below. The plants and vegetation on the bioswales will be monitored monthly. Gardening should be done weekly on the bioswale to ensure best performance.

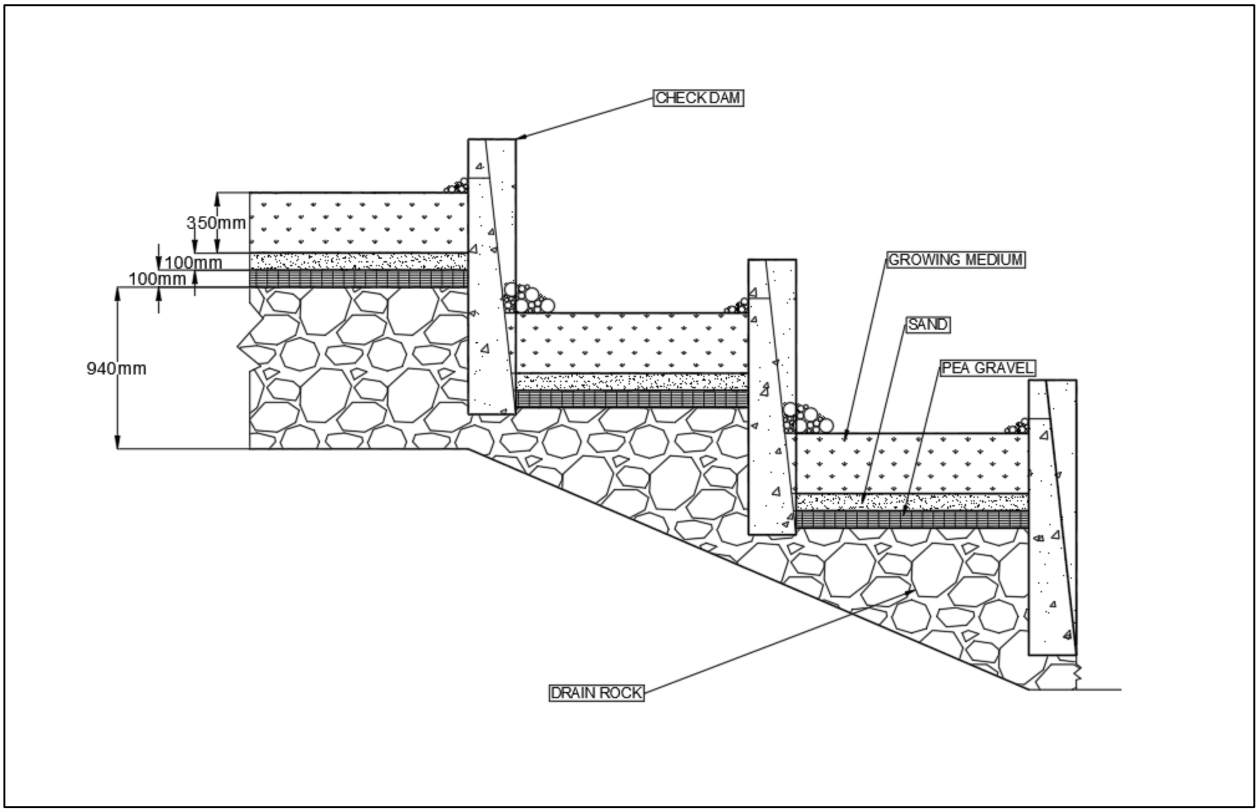

Figure 5: Bioswale Design Section View

The bioswales span 50m along the slope with four rows of 1.6m wide bioretention swales down the slope, making the total length 6.4m. The slope of the bioswale is 20°.

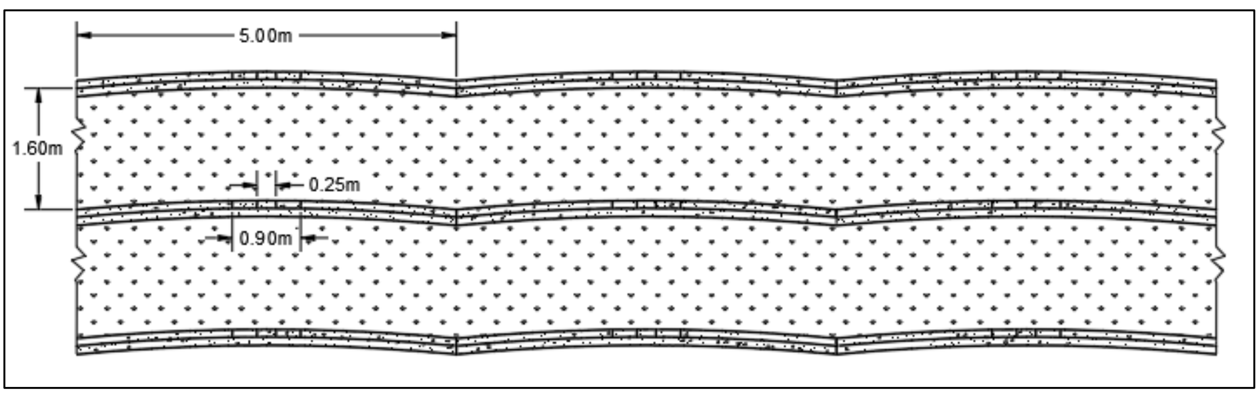

Figure 6: Bioswale Plan view

Figure 6 above illustrates how the check dams will be installed for the bioswale. The arch shape with thick base will help resist the load applied by soil and water. The check dam is 5m long and 1.6m high and is constructed with precast corrosive resistant concrete. The rebars used prevent steel corrosion and provide shrinkage protection. Ten check dams per row of the bioretention cell is required to span the 50m long bioswale. A total of 40 check dams will be used.

3.4 Amphitheatre

The Amphitheatre is an oval bowl structure to facilitate gravitational water flow into the basin. Four semi-circular concrete steps are installed on the North side of the basin to provide seating area. The South side will have a mellow 3° slope that gradually increases to 6° to provide picnic and recreational space. The Amphitheatre is 35m x 50m with a depth of 2m on the concrete step section. The concrete steps are prefabricated and are 1m wide and 0.5m deep. Underdrains are installed underneath the gravel in the Amphitheatre to filter and guide water into the retention tank.

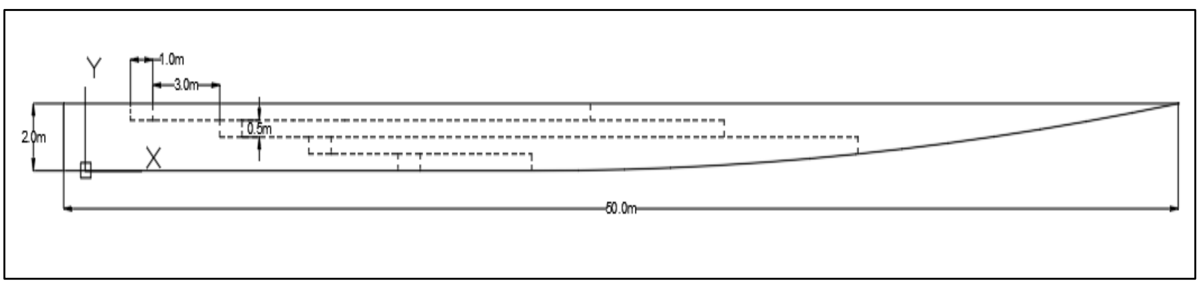

Figure 7: Side view of the Amphitheatre

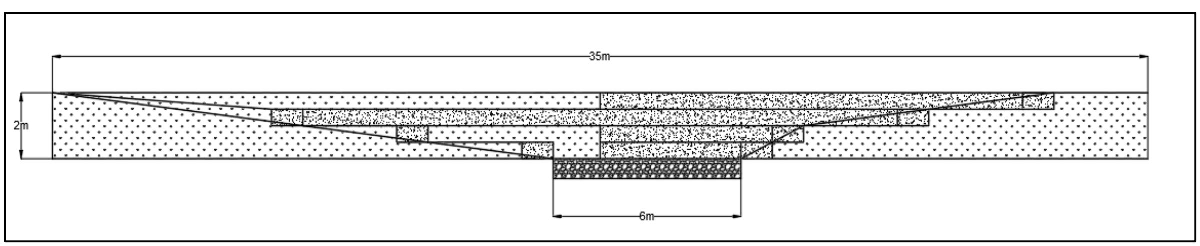

Figure 8: Front View of the Amphitheatre

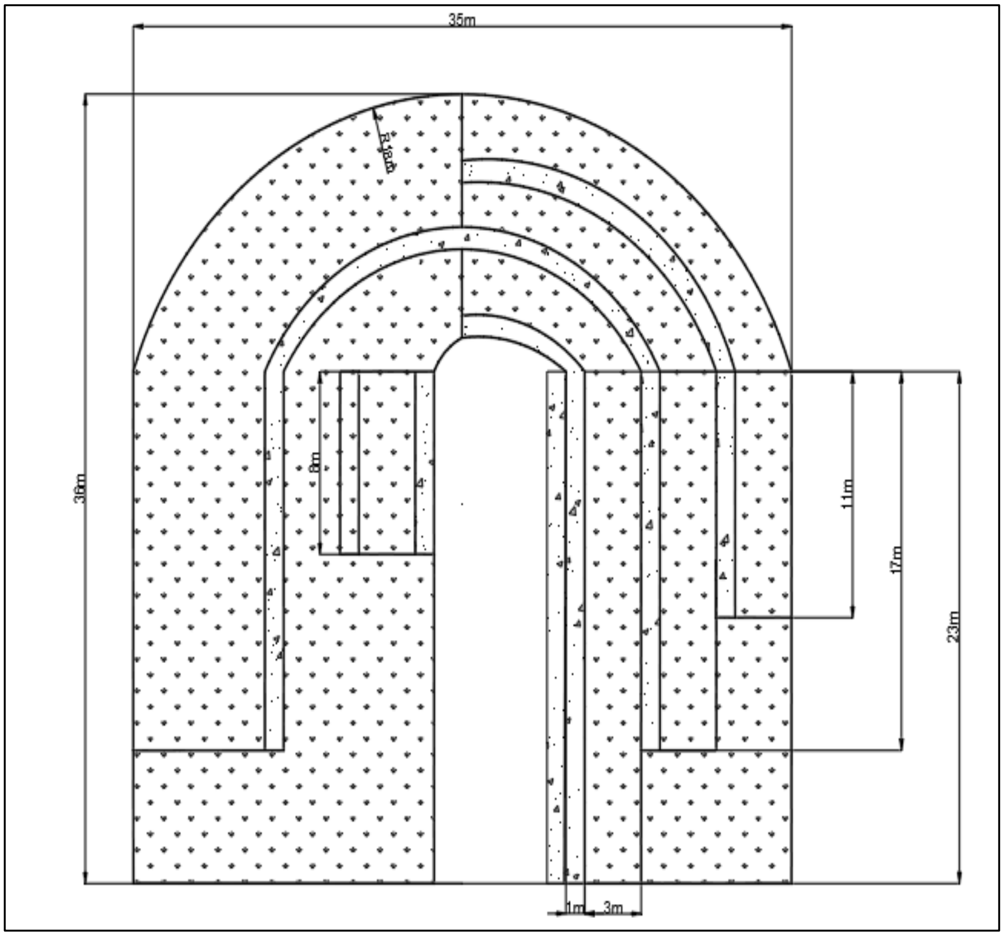

Figure 9: Top View of the Amphitheatre

3.5 Playground

The playground is located at the center of the design and is divided into two recreational areas. The entire play area will have fall absorbing ground cover and provide sufficient fall zone as required by CSA Z614-14. In addition, all playground equipment is pre-manufactured and comply with CSA standards as stated by the manufacturer. The expected live load is 4.79kN/m^2 assuming that playground conditions are similar to a gymnasium as identified in NBCC. The larger circular area on the South will contain the majority of the play equipment shown in Figure 10 below. The equipment is suitable for children from ages 5 to 12, have the capacity to carry a total of 97 people and weigh 8603.64kg. A plan view of the South play area with detailed design specifications is shown in Figure 11 below. The second circular area on the North West side of the play area will contain arch swings and are suitable for children ages 2-12 as depicted in Figure 12. Two sets of swing will be installed and weigh 363.94kg in total. The design life of the playground is 10 years with regular maintenance. The equipment must then be updated or installed again at the end of its design life.

Figure 10: Type of playground equipment on the South play area

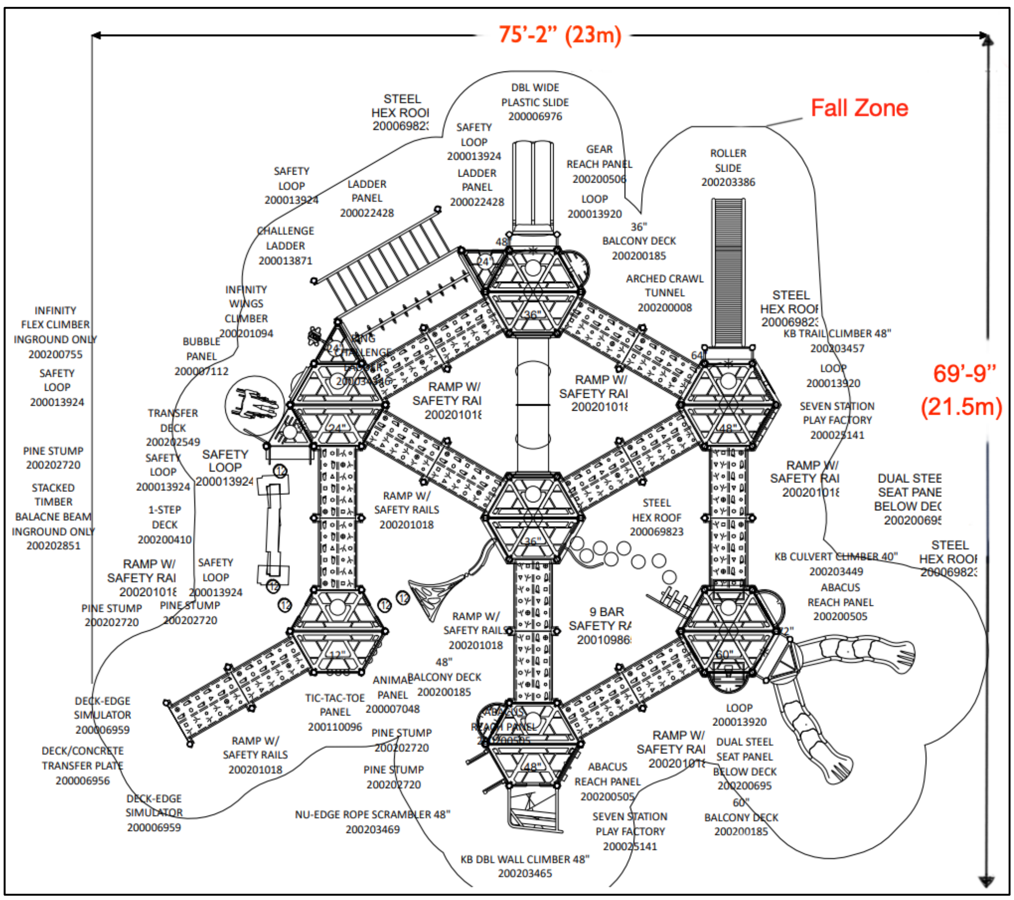

Figure 11: Plan view of the playground equipment on the South play area with design specifications

Figure 12: Arch swings to be placed on the North play area

3.6 Tennis court

Four tennis courts are located next to the playground for recreational purposes and occupy a total area of $3000m^2$ on the South of the site. The tennis court is layered with 6mm thick Poraflex porous acrylic sport surface to prevent water retention on the court, especially in Vancouver’s rainy climate. In addition, Poraflex’s durable, wear resistant and cushioning properties last throughout seasonal temperature changes. The measurements and spacing of the tennis courts are shown in Figure 13.

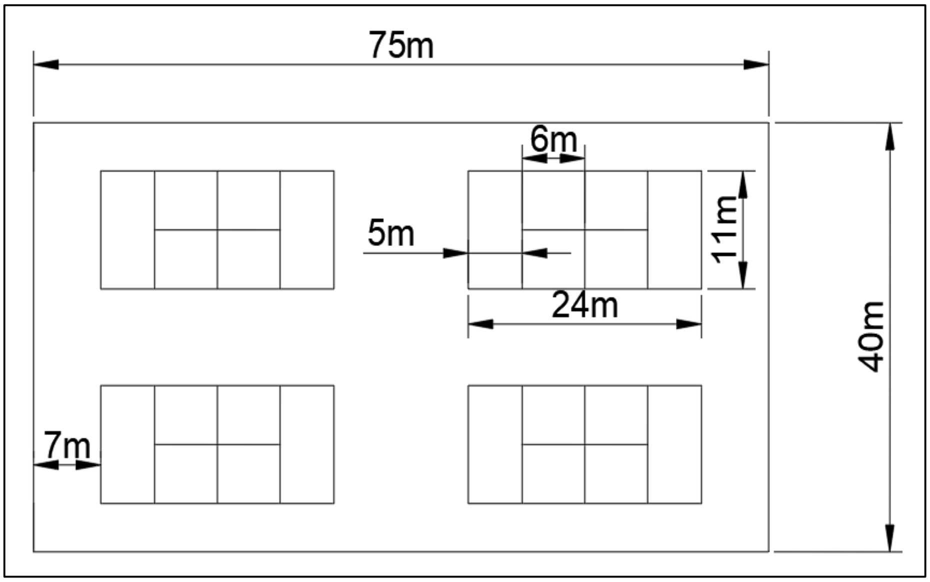

Figure 13: Layout of the Tennis Court

The subsurface layers of the tennis court have rapid drying and drainage properties illustrated in Figure 14 below. The water can quickly permeate through the porous acrylic sports surface and into the ground underneath the tennis court.

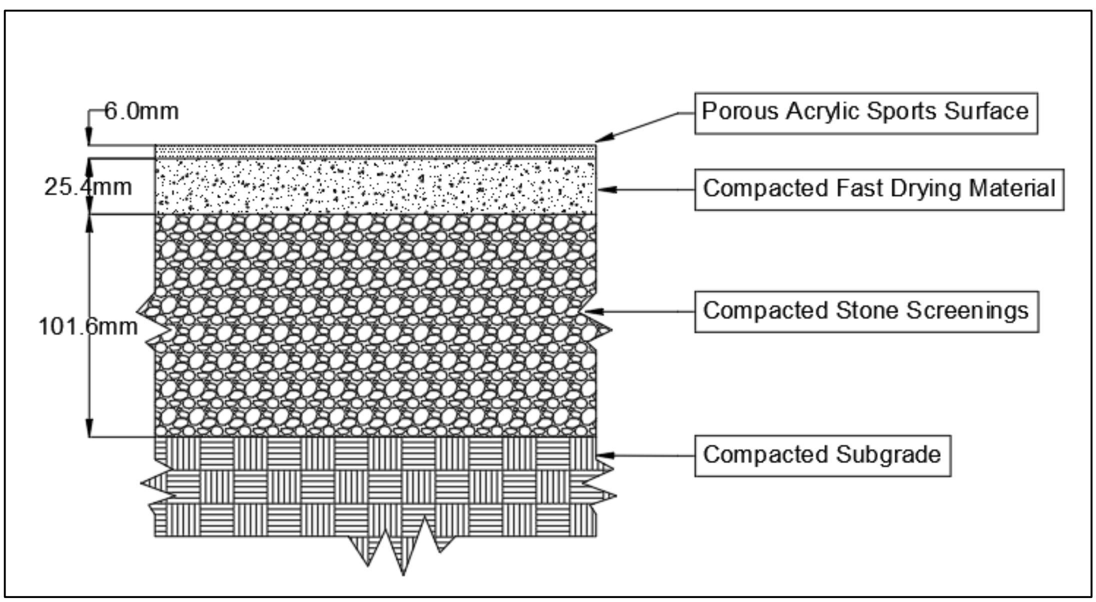

Figure 14: Groundwork of the Tennis Court

3.7 Skateboard park

Another component of the project design is the skateboard park as seen in Figure 15. The addition of the skateboard park has two functions, the primary being a structure capable of retaining 1250m^3 of rainwater, and the secondary being for recreational purposes. In terms of construction, the structure will be made using a concrete mix of 28MPa, which is air-entrained to improve resistance against freeze-thaw effects and improve overall longevity. A minimum 100mm thickness of concrete will be used to create the structure with certain parts of the park being reinforced with rebar. The life expectancy of the structure is expected to be 30+ years with minimal maintenance required.

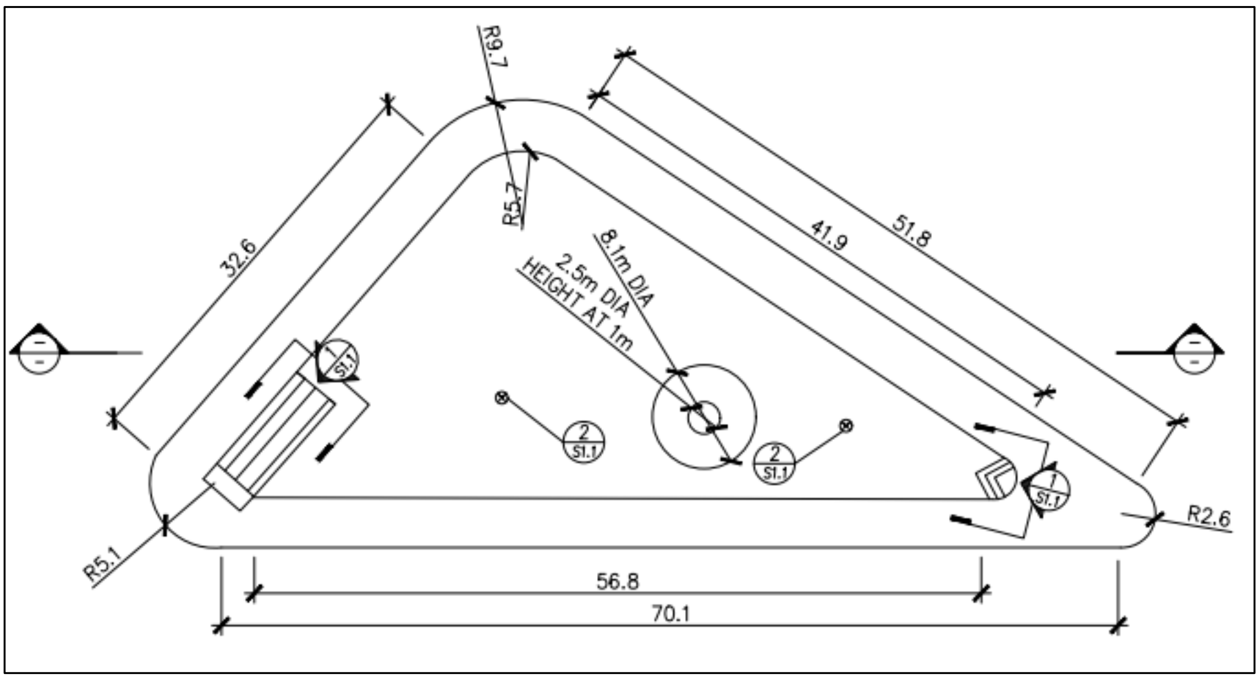

Figure 15: Plan View of Skateboard Park

In the case of the specified design and elevation of the skateboard park, below-grade drainage will be used. Two drain inlets located near the North and South ends of the structure will slope into drain boxes that have attached to them 11cm diameter PVC pipes. These sloped drain pipes are connected to a larger diameter pipes that empties into the detention tanks located underneath the Amphitheatre. As shown in Figure 16, the drain inlets have filters added to effectively remove larger sediments and materials before discharging into the pipes attached. Maintenance to these drain boxes should be done on a quarterly basis to ensure cleanliness and to prevent accumulation of debris.

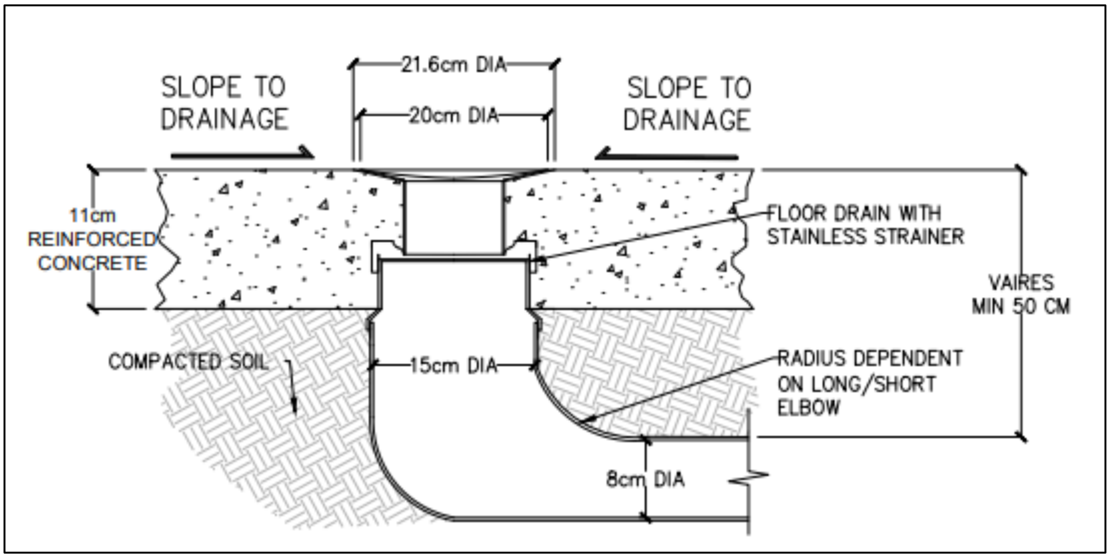

Figure 16: Typical Drainage Inlet design for the Skateboard Park

3.8 West 16th Ave Southbound

A final component to the Project Design is the change to the Southbound lane of West 16th Ave as seen in the Appendix A. Construction Drawings Page 8. Note however, that changes to a road requires jurisdiction and approval from city/provincial bodies. Therefore, the design is still in the infancy stage and requires further approval from transportation engineers associated with those city/provincial bodies.

According to data produced by UBC Vancouver Transportation, there are more cars heading Northbound than Southbound throughout the day. Therefore, Siksin Consultants, has incorporated into the design, a reduction in the number of lanes from two to one, for the West 16th lane heading Southbound. A 75m merging lane along the avenue located, just at the roundabout off of East Mall and West 16th Ave, is implemented. The setup works perfectly as the existing right-hand side of the southbound lane is forked at the end such that vehicles and cyclists can travel north or south along Southwest Marine Dr. This leaves about 1400 m^2 of surface area to capture rainfall by extending the median along the Ave across one full road lane width of 4m, spanning all the way from the end of the merging lane to SouthWest Marine Drive. This configuration is aimed at decreasing the amount of surface runoff while increasing the area of water penetration into soil.

4.0 Design Life and Loads

The project has a design life of 100 years. Each element of the project is subjected to their own design life given the difference in material and structural properties and intended use. For example, the consequence of each material's exposure to different climate and chemicals. However, with proper maintenance, the overall design life can be achieved. Standard design life of each component is taken into consideration. In addition, given the difference in various design loads (i.e. expected live load), Table 2 below shows the design load for each component.

Table 2: Design loads of main components

	Elements	**Design Load (kN)**	**Area(m^2)**	**Pressure (kPa)**
Above ground	Parking Lot	18751	3024.748	6.2
	Bioswales	5023	320	15.6
	Amphitheatre	25751	1750	14.7
	Skate Park	41498.6	806	51.4
	Play ground	351.8	514.5	0.7
Below ground	Pipes (min)	1120	630	1.8
	Pipes (max)	11673.9	630	18.5

5.0 Technical Considerations

In the development of the components and their respective drawings, certain key considerations are taken into account and are listed below as follows.

5.1 Hydrotechnical considerations

5.1.1 Net Input Stormwater Volume of 100-year Storm

The net stormwater input volume is 4000m^3 obtained by multiplying total PPT of 100-year, 24hr duration depicted in Figure 17 by the total area of the catchment of 3.2Ha. This volume is used as the design volume for the detention system.

Station Info | IDF historical data | IDF under climate change

GEV | Gumbel

Tables | Plots | Interpolation Equations

Total precipitation amounts are presented in mm and precipitation intensity rates are presented in mm/h for different return periods (T) presented in years

◉ Total PPT (mm) ○ Intensity rates (mm/h)

T (years)	2	5	10	20	25	50	100
5 min	2.69	3.85	4.80	5.87	6.24	7.51	8.98
10 min	4.04	5.72	6.98	8.31	8.76	10.24	11.85
15 min	5.04	7.00	8.44	9.94	10.44	12.07	13.81
30 min	6.94	9.33	11.03	12.76	13.34	15.16	17.08
1 h	9.36	12.10	14.35	16.89	17.78	20.84	24.40
2 h	13.41	16.05	18.04	20.16	20.88	23.23	25.82
6 h	26.40	31.27	34.49	37.58	38.56	41.57	44.57
12 h	40.36	49.99	56.35	62.44	64.37	70.32	76.21
24 h	54.41	69.24	80.44	92.34	96.37	109.64	124.16

Figure 17: IDF For UBC VANCOUVER AREA, 2020

5.1.2 Zero net flow

The objective of zero net flow is to have no water outflow during short duration higher intensity periodic rainfall events. As a result, the 100-year, 30min duration rainfall is used with a resulting net input volume of 660m^3. In this case, a storage tank with a minimum volume of 660m^3 should be designed.

5.1.3 Minimum collection pipe diameter

Other than the above requirements indicated by the client, Siksin Consultants, Ltd. realize that having stale stormwater in surface detention facilities should be avoided. Therefore, one of the goals include dispelling stale water within 7 days without additional energy input. Taking advantage of nature slope and elevation differences from surface facilities to storage tank, stale water can be removed. The calculate the minimum collection pipe diameter is 600mm with the detail calculations in Appendix B2.2.

5.2 Skateboard Park

Constructing a future skateboard park in a field expected of large rainfalls means the ground should be consolidated to be capable of holding such load. As a result, the topsoil and any organic material should be completely removed to prevent further unwanted consolidation. A licensed geotechnical engineer should be contacted for determining proper soil stratigraphy and an experienced excavating contractor should be hired.

5.3 West 16th Ave.

In designing the West 16th Ave. changes, there were two main criteria that had to be met. The first being that the West 16th Ave. should have minimal design changes to minimize overall budget costs and traffic flow inefficiency. The second being that water surface run-off should be reduced. The suggested design incorporates a 75m merging lane that is adjacent to the median and then extending the median at the end of the merging lane, a full lane width, and spanning till the South West Marine Drive. Provided all this, making the changes still requires obtaining information from BC One Call for utilities underground, and applying BC Transportation codes to ensure that such changes are viable. In addition, extending the median a full road width on the Southbound section of West 16th Ave means having to adhere to Vancouver municipal design standards for designing the new median in order to make efficient rainfall infiltration.

6.0 Standards and software packages used in the design.

In the development of the designs, Siksin Consultants have used AutoCAD as their primary source for designing and specifying structure and structure dimensions. All designs in the report are classified as "FOR CONSTRUCTION" unless explicitly stated otherwise. In addition, all units in the drawings attached are in metres unless explicitly stated otherwise.

The design, construction and maintenance of recreational and park areas will follow the Parks Control bylaw and Park Development Standards.

7.0 Construction specifications

7.1 Draft Plan of Construction Work

The construction of the entire project is expected to be completed in the following order.

1. Obtain grade and building permits
2. Construction site fencing and place safety regulations and notices
3. Site cleanup to remove all unnecessary components (i.e. organic matter)
4. Material and construction equipment procurement
5. Marking of construction layout with accurate dimensions and orientation

6. Excavation for all design components
7. Retention tank and pump installation
    a. Install all storage pipes 1m from ground elevation
    b. Connect HDPE pipes using 50mm diameter screws (refer to Appendix A)
    c. Pump house and UV light cage
        i. Construct wood frame and steel reinforcement for concrete structure
        ii. Pour concrete into the wood frame and around steel reinforcement
        iii. Install CRE 32-1 pumps into pump house and connect to the storage and supply pipes
        iv. Install the reactor chamber, UV lamps, quartz sleeve and controller unit for UV filtration system
        v. Install ventilation and cooling system
        vi. Install lighting fixtures
    d. Assemble stairs to access pump house and UV facilities for maintenance purposes
8. Construction of design components (concurrent):
    a. Car parkade construction
        i. Ground consolidation for parkade area
        ii. Layout and dig footings
        iii. Assembling footing formwork
        iv. Use concrete shutters to properly shape concrete and prevent contact with soil
        v. Pour concrete into footings
        vi. Construct and connect concrete columns to footings for parkade roof
        vii. Construct general roof structure using and install solar panels
        viii. Place Concrete stopper for individual parking spaces
        ix. Paint the parking space dividers and place necessary wayfinding signs
        x. Install payment machine

b. Skatepark construction

    i. Place approximately 10 cm of wet crushed gravel and compact
    ii. Construct structural steel reinforcement
    iii. Pour 0.1m depth of 28 MPa concrete over compacted gravel and soil.
    iv. Install and connect below grade drainage pipes (min. diameter of 11cm, best PVC) at the lowest elevations of the skatepark with storm drain filters
    v. Screed the concrete for shaping and truing the surface meter by meter into the desired shape
    vi. Float finish concrete to smooth the surface of the concrete by evening the high and filling the low spots
    vii. Re-float entire surface and round the outside edges
    viii. Trowel to bring a glossy polished concrete surface
    ix. Strip formwork without disturbing the concrete
    x. Cure the concrete until the desired strength (recommended that the concrete is kept moist for at least four weeks)

c. Tennis court construction

    i. Establish subsurface and surface drainage
    ii. Conduct rough and fine grading
    iii. Construct the base and install and cure the pavement
    iv. Construct footings for net posts and lighting fixtures
    v. Level and patch surface pavements
    vi. Apply cushion and colour coating
    vii. Tape and paint the court lines
    viii. Construct access road to the courts
    ix. Install lighting fixtures, net posts and nets

d. Playground construction

i. Construct concrete foundation
ii. Level the site surface
iii. Stake use zones and fall zones
iv. Dig holes at the required locations for equipment installation
v. Assemble and install the playground equipment
vi. Install engineering certified wood fibre to the surface

e. Bioswale construction
   i. Remove additional soil to construct the steps at designed elevation
   ii. Scarify bottom and sides of native soils and construct concrete check dams for each step
   iii. Install underdrains beneath each bioswale step
   iv. Install pipes and connect underdrains to the stormwater retention system
   v. Place 350mm of growing medium, 100mm of sand, 100mm of pea gravel and drain rocks over the bioswale foundation
   vi. Plant and irrigate the vegetation
   vii. Apply mulch on the soil surface

f. Amphitheatre construction
   i. Excavate ground to a depth of 3m
   ii. Install underdrain beneath the trough of the amphitheatre and connect to stormwater retention system pipes
   iii. Construct casing for the underground pipes
   iv. Refill 1m of soil on top of the pipe casing
   v. Construct curved concrete steps on the North side of the amphitheatre
   vi. Fill the rest of the amphitheatre with the layers of subsurface material and shape the side slopes of the amphitheatre
   vii. Plant vegetation on the soil surface

9. Inspection and testing of electrical and plumbing works
10. Pump/retention tank inspection and test
11. Paint features and place necessary road, safety warning, and direction signs
12. Recreation zone commission

7.2 Anticipated Construction Issues

Issues that might occur during construction include shifts in subsurface conditions due to additional structural loads. This is in spite of the current design which aims to minimize the impact on nearby structures. In addition, project delays may occur due to unexpected weather conditions, difficulties in acquiring permits, funding issues, neighbourhood complaints, and equipment or material shortages. Various changes may also occur during the construction phase including policy change, building code change, change or additional requirements by the client, and change of key personnel in the construction team. However, majority of the issues listed above can be avoided or mitigated by thorough construction planning and early procurement.

8.0 Scheduling

The project's construction schedule is provided in Appendix C. The project construction is scheduled to last 4 months, commencing on May 1st, 2019 and completed in September 9th, 2019 which is 131 days or 4 months. The construction schedule is attached in Appendix C and provides a summary, the detailed schedule, and the critical path of the construction sequence. Site preparation takes 33 days, Excavation takes 7 days, retention system takes 26 days, construction of design components take 44 days and commissioning will take 10 days to complete. The construction time of the project is reduced via use of pre-fabrication. The

Construction time of the Amphitheatre will be reduced by using pre-fabricated concrete structure. The playground components are pre-manufactured.

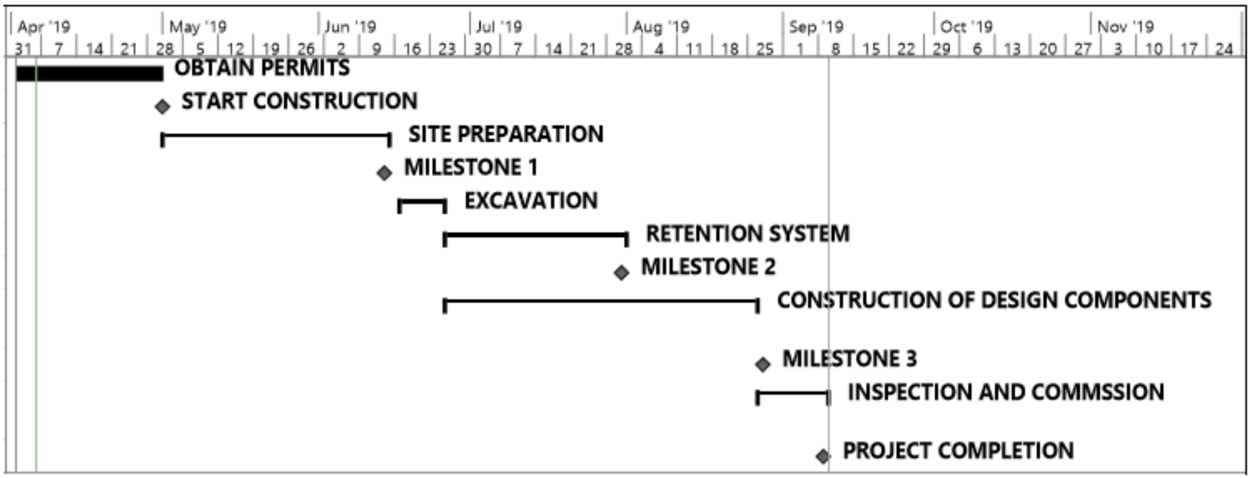

Figure 18: Summary of the Construction Schedule

The critical tasks of the construction schedule are site preparation, excavation, retention system, Amphitheatre and the commissioning of the project depicted in Figure 18.

Three milestones will be used to track the progress of the construction schedule.

- Milestone 1 marks the completion of Site Preparation and the start of Excavation
- Milestone 2 marks the completion of the Retention System
- Milestone 3 marks the completion of all the Design Components including skatepark, bioswale, parkade, Amphitheatre, tennis court and the playground.

9.0 Service-Life Maintenance Plan

The general maintenance procedure required for the design is listed below. The standard required duration between each scheduled maintenance is written in the bracket.

- Gardening (every week)
  - Plant, fertilize, trim and prune shrubs, trees, lawns and flowers
  - Regularly mow and trim grass areas to within a 38-51mm height range (CITE)

    - Apply pesticides
    - Clear weeds and brush
    - Mow and rake leave build up
    - Water plants using sprinklers or irrigation trucks
    - Evaluate plant health
- Clean park structures including restrooms, picnic areas, tennis courts, playground equipment, pools, and recreation areas (daily)
- Power-wash and scrub car parkade facilities including photovoltaic panels and payment machines (weekly)
- Check car parkade porous concrete for raveling, clogging and declivities and sweep when necessary (6 months or after every storm event)
- Power-wash skateboard park, playground and tennis courts to clean equipment and remove mold/debris or corrosive material (i.e. chloride) from various surfaces (weekly)
- Replace storm drain filters (every three years) unless there is a visible buildup of debris, sediment or standing water
- Check for hazardous material discharge in storm filters (monthly)
- Collect and haul trash and garbage cans (daily)
- Paints or stain structures (yearly)
    - Benches, tables, signs, trash cans, and playground and tennis court equipment
    - Wayfinding, traffic line, parking spot divider lines (if not visible, then immediate repair)
- Inspect underdrain pipe to ensure no blockage or clogging (monthly)
- Remove snow or ice (during winter months)

- Repair park, recreational and car parkade features, facilities or fixtures caused by vandalism to maintain aesthetic level when needed
- Litter and garbage pickup from above grade surfaces (daily)
- Inspect playground equipment for Improper depth of safety surfacing, loose fasteners, drive rivets missing from load-bearing clamps, worn bushings on swing hangers, etc. (daily)
- Inspect the tennis court surface for cracks, peels, bubbles, or other irregularities and repair when necessary (weekly)

10.0 Updated Cost Estimate and Schedule

The capital costs are a Class 'D' order of magnitude estimate which is typically used for cost comparison between alternative solutions. These capital unit costs are based on similar recently tendered projects in the Vancouver region, include a 30% contingency allowance, but do not include any GST. The final cost is $4,645,000 including $254,196 consulting fee. The calculation detail is attached in Appendix D.

11.0 CONCLUSION

Abiding by the rules, regulations, client requirements and design criteria, Siksin Consultants Ltd. is pleased to showcase the completed detailed design report for the Stadium Road Neighbourhood Parkade and Water Storage/Detention Facility. Focusing on maximizing the efficiency of stormwater management practices, several structures have been designed in addition to a revamped car parkade, all of which are tailored to meet the client, P.Eng. Doug Doyle's objectives. The proposed project is expected to begin construction on May 1st, 2019 with an anticipated completion date of September 9th, 2019. Siksin Consultants Ltd. looks forward to continue working alongside P.Eng. Doug Doyle to ensure successful tendering and construction of the project.

APPENDIX A. Construction Drawings

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THE UNDERSIGNED HEREBY GIVES ASSURANCE THAT THE DESIGN OF THE STRUCTURES HAS BEEN REVIEWED FOR RESISTANCE TO ALL TYPES OF LOADING AND HAS BEEN FOUND TO SUBSTANTIALLY COMPLY WITH APPLICABLE CODES AND REGULATIONS.

JASON A. CIVL 446
DATE : APRIL 2, 2019

PROJECT NO.: 2019.04.02

PROJECT:

UBC STORMWATER MGMT AND PARKING
2329 WEST MALL, V6T 1Z4
VANCOUVER, B.C.

LEGAL DESCRIPTION
VANCOUVER, B.C.
-

LIST OF DRAWINGS:

DWG. NO.	DRAWING DESCRIPTION
19.04.02.S.01.1	GENERAL NOTES
19.04.02.S.02.1	DETAILS AND SECTIONS
19.04.02.S.03.1	OVERALL PLAN VIEW
19.04.02.S.04.1	PIPE SYSTEM
19.04.02.S.05.1	SKATEPARK
19.04.02.S.06.1	BIOSWALE
19.04.02.S.07.1	PARKING LOT
19.04.02.S.08.1	WEST 16TH AVE

GENERAL NOTES

ALL ASSURANCES THAT THE REQUIREMENTS FOR STRUCTURAL DESIGN AND STRUCTURAL FIELD REVIEWS OF THIS PROJECT CONFORM WITH PART 4 OF THE B.C. BUILDING CODE (2012) EITHER IMPLIED OR SPECIFICALLY STATED IN ANY OF THE STRUCTURAL DOCUMENTS

IN EXECUTING THE WORKS DETAILED ON THESE DRAWINGS, THE CONTRACTOR SHALL EXERCISE A STANDARD OF CARE, SKILL AND DILIGENCE THAT WOULD NORMALLY BE PROVIDED BY AN EXPERIENCED AND PRUDENT CONTRACTOR EXECUTING WORKS SIMILAR TO THE WORKS DETAILED ON THESE DRAWINGS FOR SIMILAR PROJECTS. THE CONTRACTOR ACKNOWLEDGES AND AGREES THAT, THROUGHOUT THE CONSTRUCTION OF THE WORKS DETAILED ON THESE DRAWINGS, THE CONTRACTOR'S OBILIGATIONS, DUTIES AND RESPONSIBILITIES SHALL BE INTERPRETED IN ACCORDANCE WITH THIS STANDARD. THE CONTRACTOR SHALL EXERCISE THE SAME STANDARD OF DUE CARE AND DILIGENCE IN RESPECT OF ANY PRODUCTS, TRADES, CONSTRUCTION, OR CONTRUCTION PROCEDURES WHICH IT MAY RECOMMEND OR EMPLOY.

STRUCTURAL DRAWINGS SHALL BE READ IN CONJUNCTION WITH THE ARCHITECTURAL, LANDSCAPE, MECHANICAL, ELECTRICAL, AND PLUMBING DRAWINGS, ETC., FOR DETAILED DIMENSIONS OF TIE–INS AND DUCT OPENINGS, REBATES, CHASES, NAILERS, ETC.

THE CONTRACTOR SHALL COMPARE ALL STRUCTURAL DRAWINGS WITH THE ARCHITECTURAL DRAWINGS AND SHALL CHECK AND VERIFY ALL DIMENSIONS BEFORE COMMENCING THE WORK. ANY CONSTRUCTION ERRORS AND THE COSTS TO REMEDY THOSE CONSTRUCTION ERRORS RESULTING FROM ANY DISCREPANCIES NOT REPORTED TO THE ARCHITECT FOR CLARIFICATION SHALL BECOME THE RESPONSIBILITY OF THE CONTRACTOR.

THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN AND INSPECTION OF ANY AND ALL TEMPORARY STRUCTURAL ELEMENTS SUCH AS BUT NOT LIMITED TO SHORING, FALSEWORK, FORMWORK, ETC. AS REQUIRED DURING THE ERECTION/CONSTRUCTION OF THE PERMANENT STRUCTURAL ELEMENTS PER ALL W.C.B. REGULATIONS ; UNDERPIN WHERE NECESSARY ANY EXISTING STRUCTURE AND PROVIDE ANY AND ALL TEMPORARY STRUCTURAL ELEMENTS SUCH AS BUT NOT LIMITED TO BRACING, SHORING, FALSEWORK, ETC., NECESSARY TO SUPPORT ANY AND ALL ADJOINING SOIL, FLOORS, WALLS, ETC., AS REQUIRED TO RETAIN ALL WORK IN PLACE AND PREVENT THE TEMPORARY OVER–STRESSING OF THE PERMANENT STRUCTURE.

THE STRUCTURAL DRAWINGS HAVE BEEN PREPARED BY SIKSIN CONSULTS FOR THE ACCOUNT OF OWNER THE MATERIAL IN THEM REFLECTS SIKSIN ENG. INC.'S JUDGEMENT IN LIGHT OF THE INFORMATION AVAILABLE TO IT AT THE TIME OF PREPARATION. ANY USE WHICH A THIRD PARTY SHALL MAKE OF THE STRUCTURAL DRAWINGS, OR ANY RELIANCE ON DECISIONS TO BE MADE BASED ON THEM, SHALL BE THE RESPONSIBILITY OF SUCH THIRD PARTIES.

CONCRETE

CONCRETE SHALL CONFORM TO THE REQUIREMENTS OF CSA STANDARDS A23.1–04/A23.3–04 AND SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 28MPa.

REINFORCING STEEL SHALL CONFORM TO THE REQUIREMENTS OF C.S.A. G.30.18M92 AND SHALL BE NEW BILLET STOCK HAVING A MINIMUM YIELD STRENGTH OF 400MPa.

ALL REINFORCING BARS SHALL BE SECURELY TIED TO PREVENT MOVEMENT.

SPECIALTY SYSTEMS

THE SPECIALTY STRUCTURAL SYSTEMS FOR THIS PROJECT COMPRISE HAND RAIL GUARDS AND HAND RAIL GLAZING.

A SPECIALTY SYSTEM SHALL COMPRISE ALL LOAD RESISTING ELEMENTS, ALL INCIDENTAL FRAMING AND ALL HARDWARE NECESSARY TO CONSTRUCT, CONNECT AND MAINTAIN THE SPECIATLY SYSTEM IN ITS CORRECT AND PERMANENT POSITION FOR THE LIFE OF THE BUILDING.

THE SPECIALTY SYSTEM STRUCTURAL DESIGN SHALL INCLUDE THE PROVISION OF ANY AND ALL TECHNICAL EXPERTISE NECESSARY TO EXECUTE THE STRUCTURAL DESIGN FOR AND PREPARATION OF DRAWINGS FOR THE RELATIVE POSITIONING OF THE SPECIALTY SYSTEM ELEMENTS ONE TO ANOTHER (THE LAYOUT DRAWING), THE INDIVIDUAL LOAD CARRYING ELEMENTS, ANY AND ALL INCIDENTAL FRAMING AND HARDWARE.

GENERAL MATERIALS

ALL ASSURANCES SHALL BE MADE THAT MATERIALS ARE DELIVERED ON TIME AND THAT SUCH MATERIALS SHALL ARRIVE ON SITE IN DRY AND CLEAN CONDITION.

MATERIALS TO BE DISPOSED OF SHALL BE BORN BY THE FULL RESPONSIBILITY OF THE CONTRACTOR. THE CONTRACTOR WILL AGREE THAT ANY EXCAVATED MATERIAL LEFT BEHIND SHALL NOT BE THE FINANCIAL RESPONSIBILITY OF THE OWNER.

SERVICES DURING CONSTRUCTION

SIKSIN CONSULTS HAS BEEN RETAINED BY OWNER TO CONDUCT STRUCTURAL FIELD REVIEWS OF THIS PROJECT DURING CONSTRUCTION. THIS SERVICE SHALL CONSIST OF PERIODIC SITE VISITS (THE NUMBER AT OUR DISCRETION, THE TIMING TO BE COORDINATED WITH THE CONSTRUCTION SCHEDULE) TO OBSERVE THAT THE CONSTRUCTED WORKS SUBSTANTIALLY CONFORM IN MATERIAL RESPECTS TO THE INFORMATION GIVEN ON THE STRUCTURAL DOCUMENTS AND/OR FIELD MEMOS, ADDENDA, CHANGE ORDERS ETC. PREPARED BY SIKSIN CONSULTS ENGINEERING FIELD REVIEWS SHALL NOT BE CARRIED OUT TO THE BENEFIT OF THE CONTRACTOR AND AS SUCH, THIS SERVICE SHALL NOT INCLUDE SUPERVISION OF THE CONSTRUCTION PROCESS OR, OF THE QUALITY OF THE CONTRACTORS WORKMANSHIP. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO ASCERTAIN THAT THE WORKS ARE CONSTRUCTED IN CONFORMANCE WITH THE DRAWINGS AND IN A GOOD WORKMANSHIP LIKE MANNER PRIOR TO CALLING THE PRINCIPAL ENGINEER FOR A FIELD REVIEW.

COMMENCEMENT OF FIELD REVIEW WILL NOT BE CARRIED OUT UNLESS THE CONTRACTOR SUBMIT THE FOLLOWING DOCUMENTS :

1. GEOTECHNICAL ENGINEER CONFIRM THE ALLOWABLE SOIL BEARING PRESSURE, SOIL PARAMETERS AND GROUND WATER TABLE FOR PROPORTIONAL THE FOUNDATION AND SUBSOIL STRUCTURES (e.g. RETAINING WALL, FOOTING AND PAD FOOTING).
2. ALL ENGINEERING CALCULATION SHALL BE PRESENTED IN METRIC UNIT AS PER CURRENT APPLICABLE CODE AND STANDARD.

THE FOLLOWING RULE SHALL BE APPLIED TO DETERMINE WHEN A STRUCTURAL FIELD REVIEW IS REQUIRED FROM THE STRUCTURAL ENGINEER OF RECORD : A STRUCTURAL FIELD REVIEW OF A STRUCTURAL ELEMENT (A STRUCTURAL ELEMENT IS ANY ELEMENT DETAILED ON THE STRUCTURAL DRAWINGS) SHALL BE REQUIRED IF AN ENSUING PHASE OF CONSTRUCTION (OF ANY NATURE) WILL CONCEAL FROM VIEW THE STRUCTURAL ELEMENT IN QUESTION TO THE EXTENT THAT IF CANNOT BE VIEWED (IN ITS ENTIRETY) IN THE FUTURE. ELEMENTS SUCH AS BUT NOT LIMITED TO REINFORCING STEEL (BAR OR WELDED–WIRE–MESH), BOLTS, WELDS, NAILS, CONSTRUCTION HARDWARE, ARE EXAMPLES OF STRUCTURAL ELEMENTS WHICH MUST BE VIEWED BY STRUCTURAL ENGINEER OF RECORD PRIOR TO BEING CONCEALED. IF THE CONTRACTOR IS IN DOUBT AS TO THE NEED FOR A STRUCTURAL FIELD REVIEW, HE SHALL CONTACT THE STRUCTURAL ENGINEER OF RECORD FOR CLARIFICATION.

THE CONTRACTOR SHALL INSPECT THE STRUCTURAL WORK HE IS REQUESTING AN INSPECTION FOR TO CONFIRM THAT IT IS COMPLETE AND ERECTED IN A GOOD WORKMANSHIP MANNER PRIOR TO ASKING THE STRUCTURAL ENGINEER OF RECORD FOR A SITE VISIT.

IN ORDER FOR THE PRINCIPAL ENGINEER TO RENDER A TIMELY SITE VISIT IN RESPONSE TO THE CONTRACTOR'S NOTIFICATION OF HIS INTENT TO COVER UP CERTAIN ELEMENTS OF THE STRUCTURAL WORK, THE CONTRACTOR, SHALL PROVIDE THE CONSULTANT 48 HOURS NOTICE.

NOTIFICATION PERIODS OF SHORTER DURATION MAY RESULT IN THE STRUCTURAL ENGINEER BEING UNABLE TO RENDER A SITE VISIT WHICH MATCHES THE CONTRACTOR'S PROPOSED SCHEDULE.

SHOULD THE CONTRACTOR ENCLOSE STRUCTURAL WORK WHICH HAS NOT BEEN OBSERVED BY THE STRUCTURAL CONSULTANT, THE CONTRACTOR SHALL, AT THE STRUCTURAL ENGINEER'S DISCRETION AND AT THE CONTRACTOR'S OWN EXPENSE, UNCOVER THE ENCLOSED WORKS FOR THE STRUCTURAL ENGINEER'S VIEWING. THE COST OF ENCLOSING THE WORKS AGAIN SHALL BE BORNE BY THE CONTRACTOR.

SHOULD THE CONSTRUCTION DEVIATE FROM THE STRUCTURAL DRAWINGS (FOR WHATEVER REASON), THE CONTRACTOR SHALL ADVISE THE ENGINEER OF THE DEVIATIONS. THE CONTRACTOR SHALL BE INVOICED (@ SIKSIN CONSULT'S PER DIEM RATES) FOR THE TIME SIKSIN CONSULTS SPENDS REVIEWING /ASSESSING THE DEVIANT WORKS.

THE CONTRACTOR SHALL PAY FOR ANY REVISIT IF INSPECTION WORK WAS POSTPONED OR FAILURE TO COMPLY WITH SPECIFICATIONS, DRAWINGS, BY–LAW, UNABLE TO ACCESS DUE TO HEALTH AND SAFETY HAZARDS OR UNCONCEALED STRUCTURAL ELEMENT FOR STRUCTURAL ENGINEER INSPECTION AT THE TIME OF VISIT. EACH PER DIEM REVISIT WILL BE NOTIFIED BY THE STRUCTURAL ENGINEER OF RECORD IN WRITING AND WILL BE INVOICED AT $300 PER VISIT BASED ON A MAXIMUM STAY OF 2 HOURS AT SITE.

OTHER SERVICES

ANY CALCULATIONS SUBMITTED INCLUDES SHOP FABRICATION ITEMS: PROPRIETARY STRUCTURAL ELEMENTS SUBMITTED TO REVIEW BY STRUCTURAL ENGINEER ON RECORD WILL BE CHARGED AT A RATE OF $100 PER HOUR, WITH A MINIMUM OF $500 PER DIEM, UNLESS A LUMP FARE FEE IS AGREED BETWEEN THE OWNER/CONTRACTOR AND THE E.O.R.

SITE REVIEW INCLUDES STRUCTURAL ELEMENT INSPECTION ON MECHANICAL OR ARCHITECTURAL ITEM(S) NOT INDICATED ON THE DRAWINGS SHALL BE CONSIDERED AS EXTRA WORK AND WILL BE CHARGED AT $300 PER VISIT.

THE UNDERSIGNED HEREBY GIVES ASSURANCE THAT THE DESIGN OF THE STRUCTURES HAS BEEN REVIEWED FOR RESISTANCE TO ALL TYPES OF LOADING AND HAS BEEN FOUND TO SUBSTANTIALLY COMPLY WITH APPLICABLE CODES AND REGULATIONS.

JASON A. CIVL 446
DATE : APRIL 2, 2019

REV.	BY:	CH:	DATE	REVISIONS
			MARCH 25, 19	ISSUED FOR SUBMISSION
1.0	CT	CT	MARCH 25, 19	ISSUED FOR COSTRUCTION

PROJECT NUMBER: 2019.04.02
SCALE: AS SHOWN

CLIENT: UBC SEEDS AND P.ENG DOUG DOYLE
PROJECT: UBC STORMWATER MGMT AND PARKING VANCOUVER B.C.

SC SIKSIN CONSULTANTS LTD.
ADDRESS
email : ...
Phone: ... Fax: ...

DRAWN : J. ANGUSTIA
DATE : SEPT 28, 19
DESIGNED : TEAM 24
DATE :
APPROVED\CHECKED :
DATE :

GENERAL NOTES

DRAWING NO. 19.04.02.S01.1
SHEET 1 OF 8
BP SUB________

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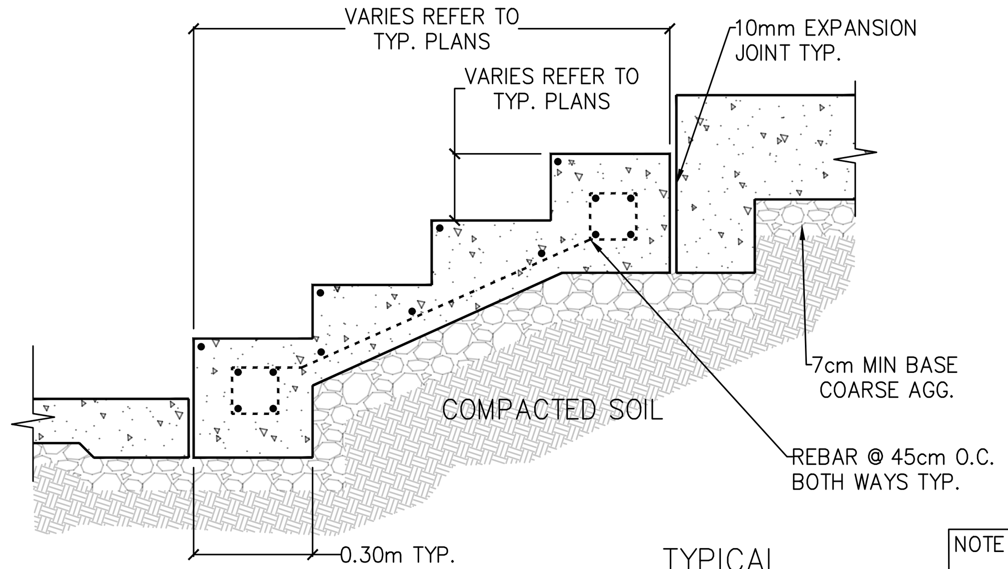
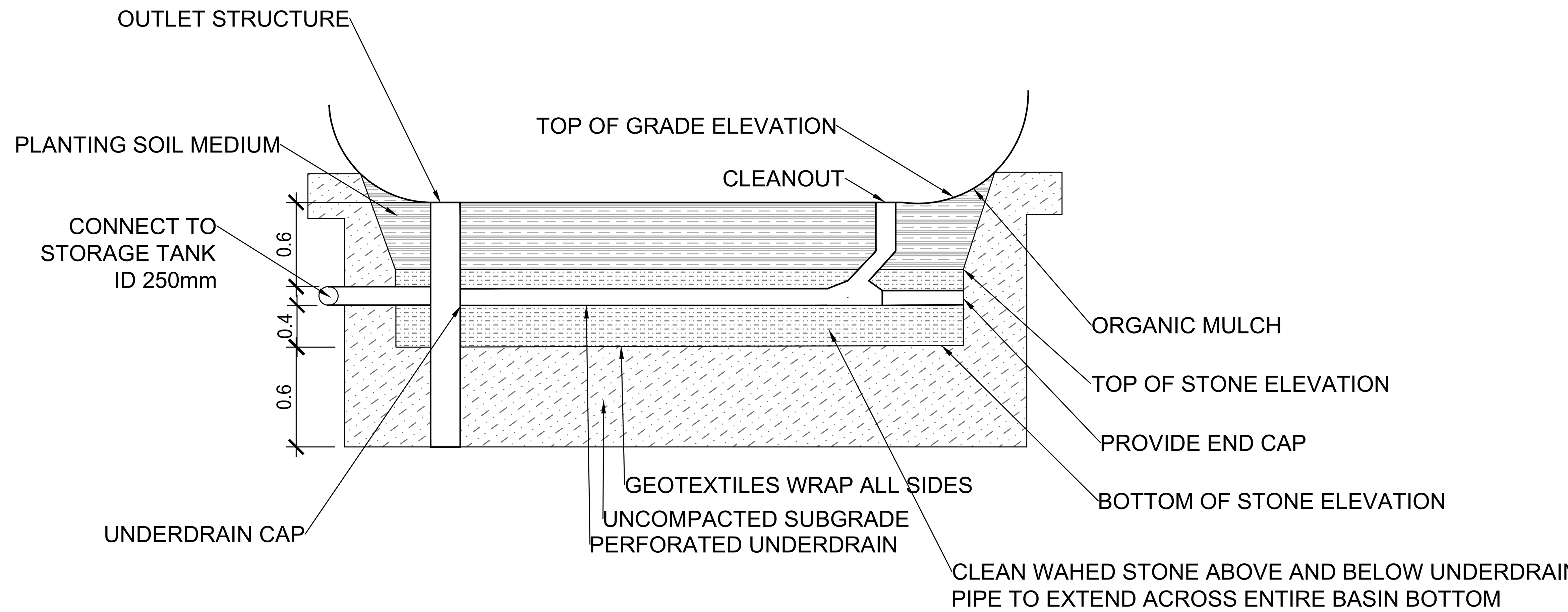
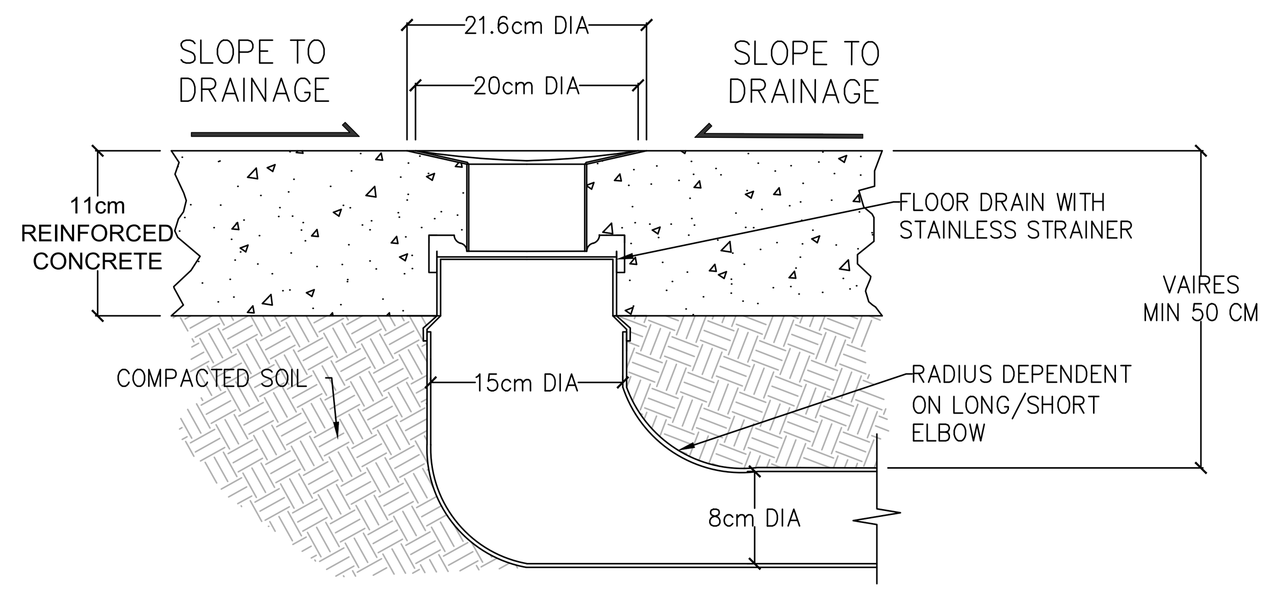


DETAIL 1 TYPICAL CONCRETE STAIRS
SCALE: 1"=1'-0" S5.1

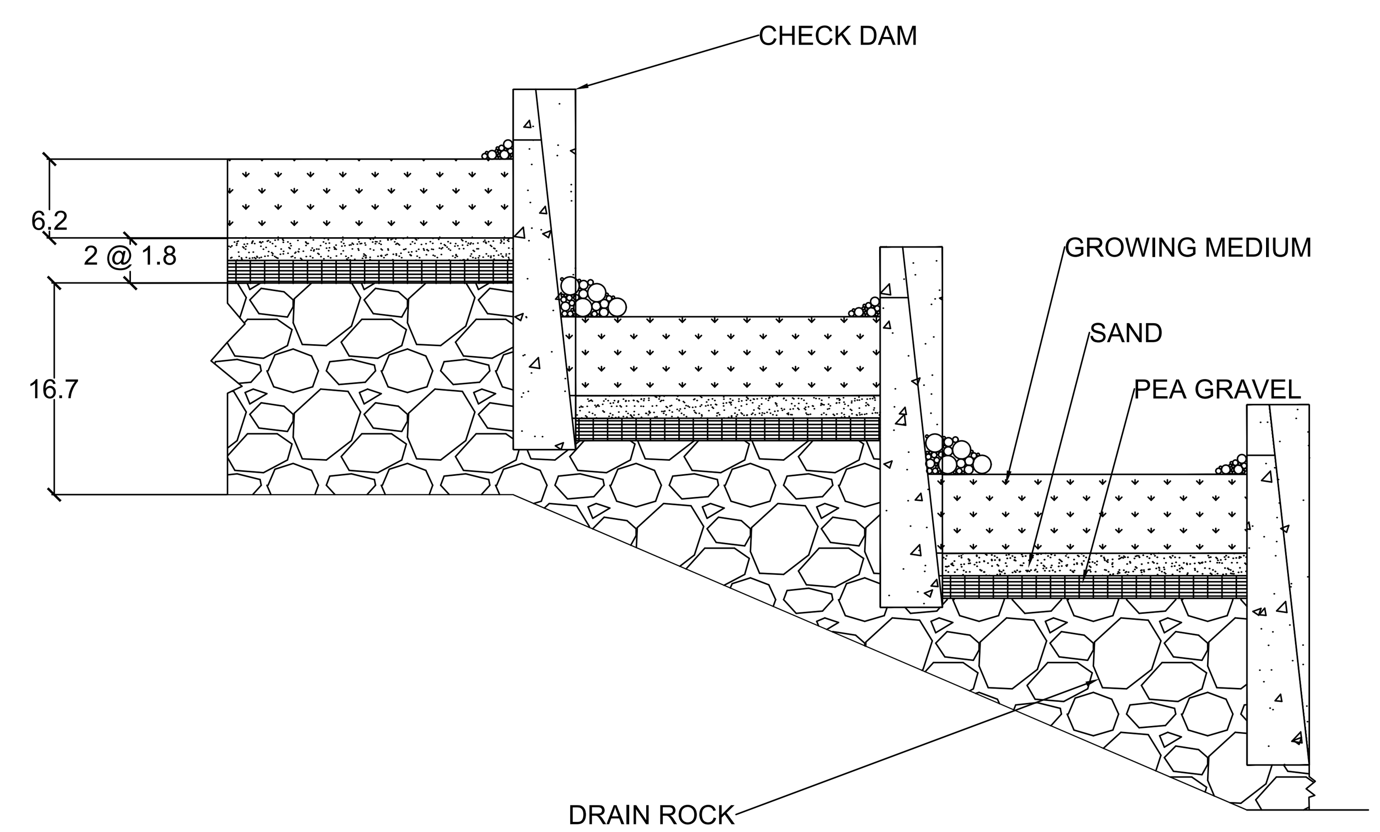
NOTE : REFER TO LAYOUT FOR OVERALL GOVERNING DIMENSION OF STAIR
CONTRACTOR TO ADJUST TO FIT AS DEEMED NECESSARY



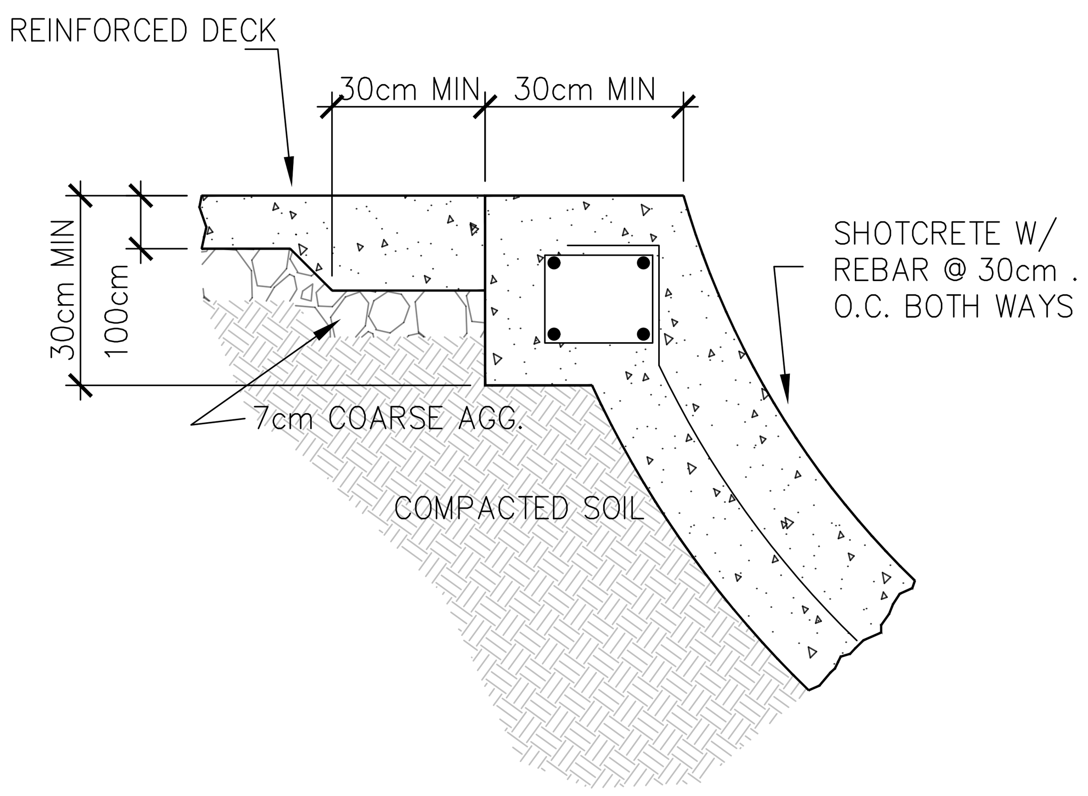
SECTION 4 TYPICAL BASIN UNDERDRAIN
SCALE: 1"=1'-0" S3.1



DETAIL 2 TYPICAL DRAINAGE INLET
SCALE: 1"=1'-0" S5.1



DETAIL 5 BIOSWALE
SCALE: 1"=1'-0" S6.1



SECTION 3
SCALE: 1"=1'-0" S5.1

NOTE: 1. REINFORCED REBARS TO USE TIES @ 45cm O.C.

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JASON A. CIVL 446
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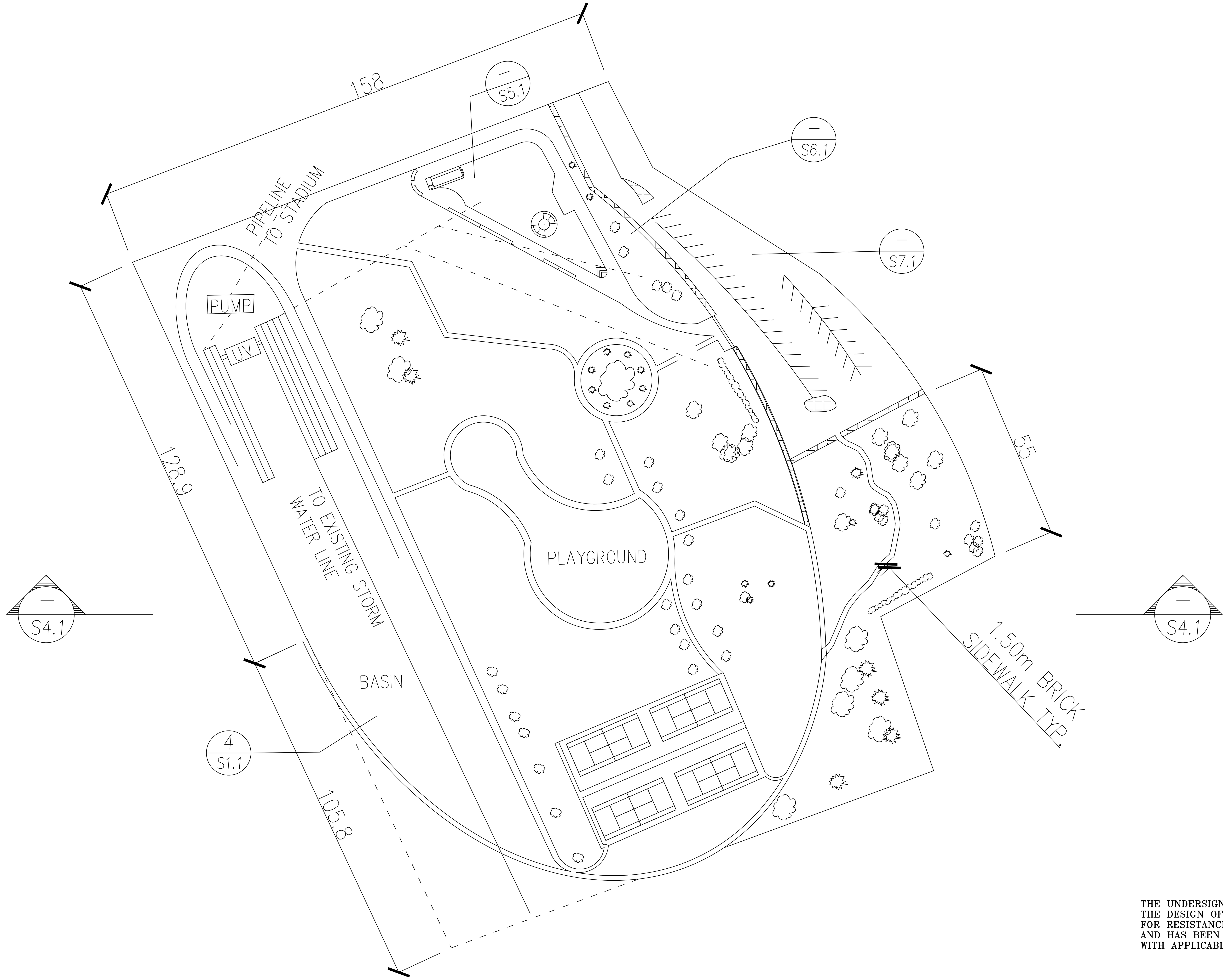
PROJECT NUMBER 2019.04.02
SCALE AS SHOWN
CLIENT UBC SEEDS AND P.ENG DOUG DOYLE
PROJECT UBC STORMWATER MGMT AND PARKING VANCOUVER B.C.

SC SIKSIN CONSULTANTS LTD.
ADDRESS
email : ...
Phone: ... Fax: ...

DRAWN : J. ANGUSTIA
DATE : SEPT 28, 19
DESIGNED : TEAM 24
DATE :
APPROVED\CHECKED :
DATE :

GENERAL NOTES

DRAWING NO. 19.04.02.S01.1
SHEET 2 OF 8
BP SUB________



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CLIENT: UBC SEEDS AND P.ENG DOUG DOYLE
PROJECT: UBC STORMWATER MGMT AND PARKING VANCOUVER B.C.

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DATE : SEPT 28, 19
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DATE :
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DATE :

OVERALL PLAN VIEW

DRAWING NO. 19.04.02.S03.1
SHEET 3 OF 8
BP SUB________

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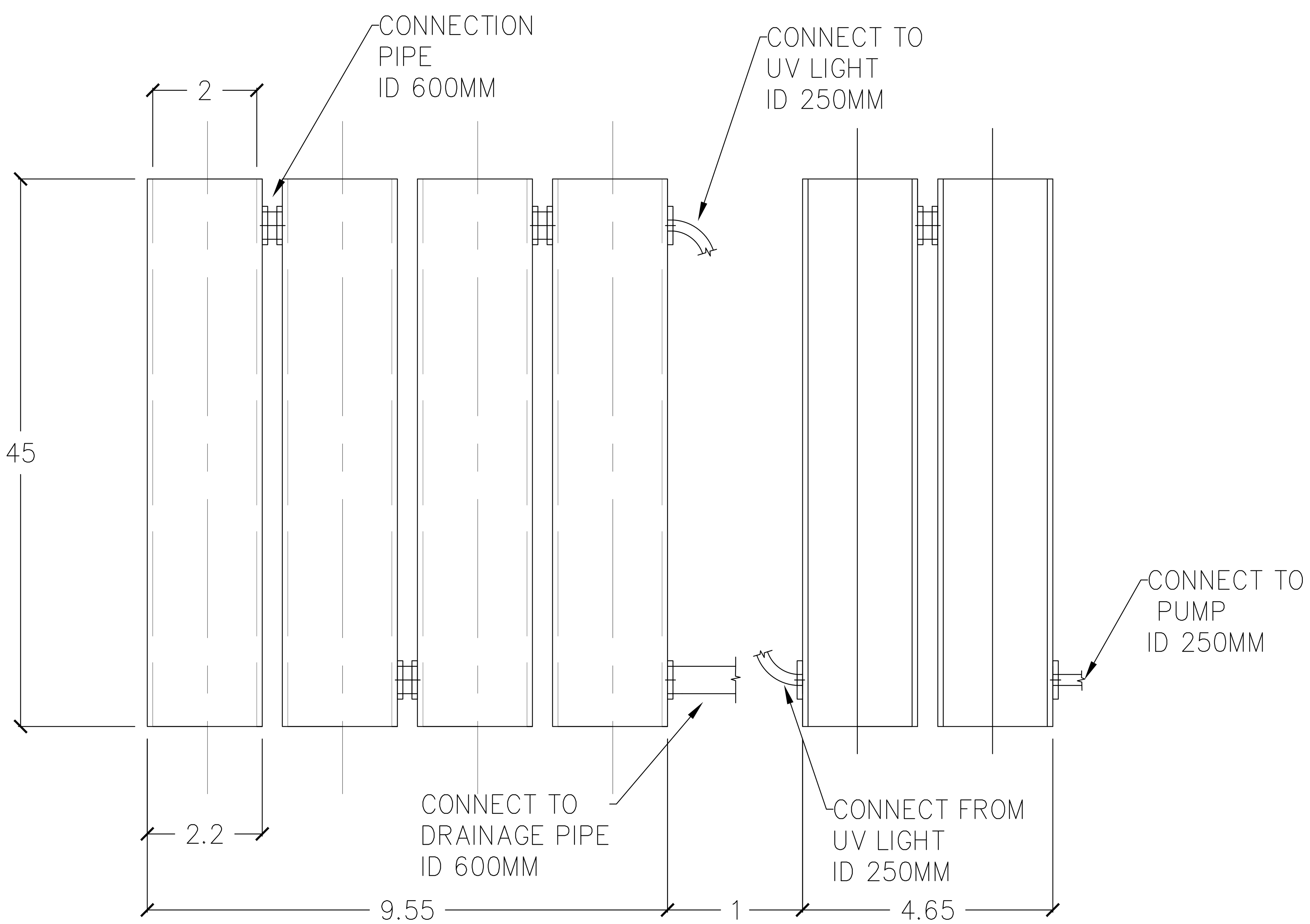
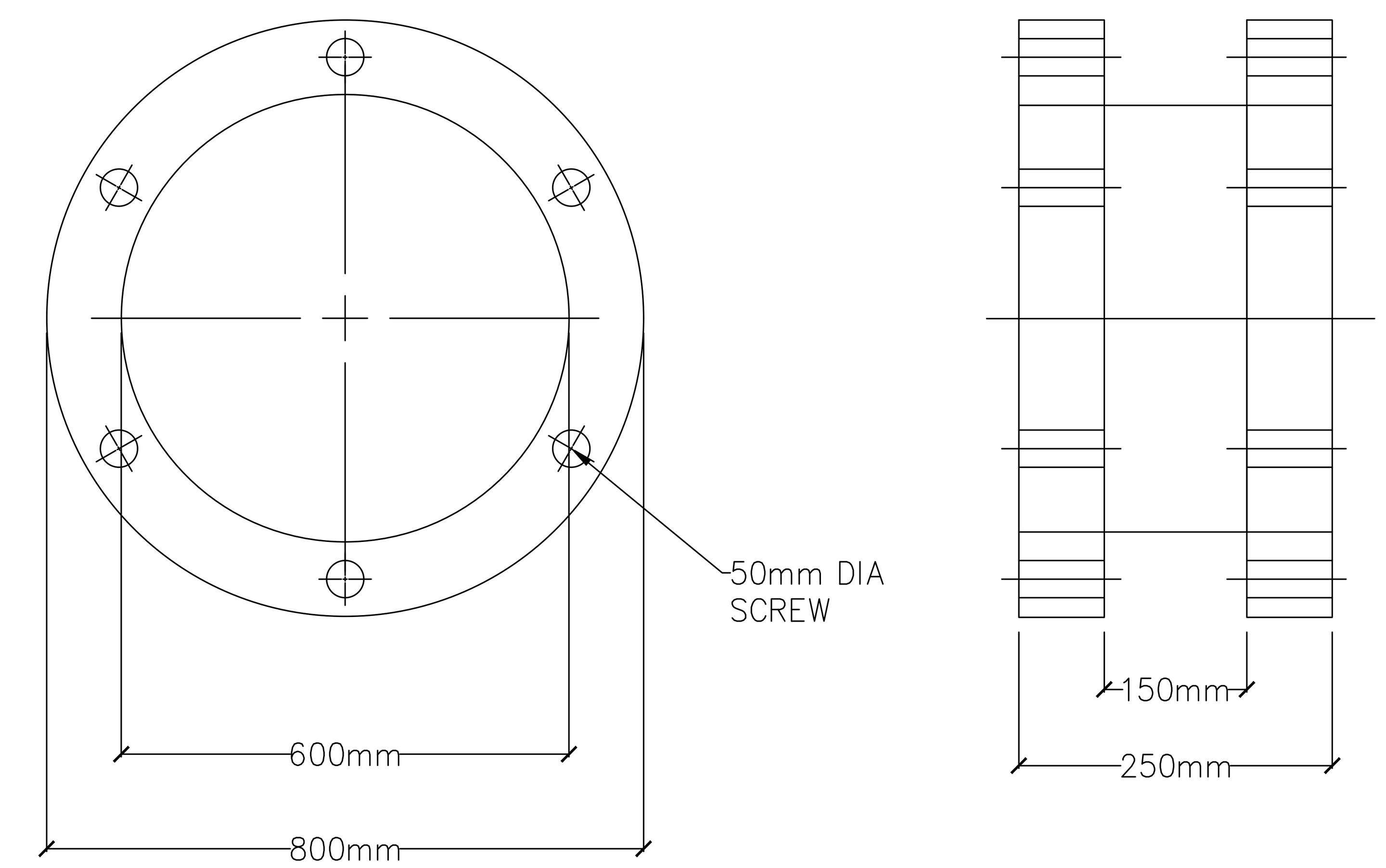
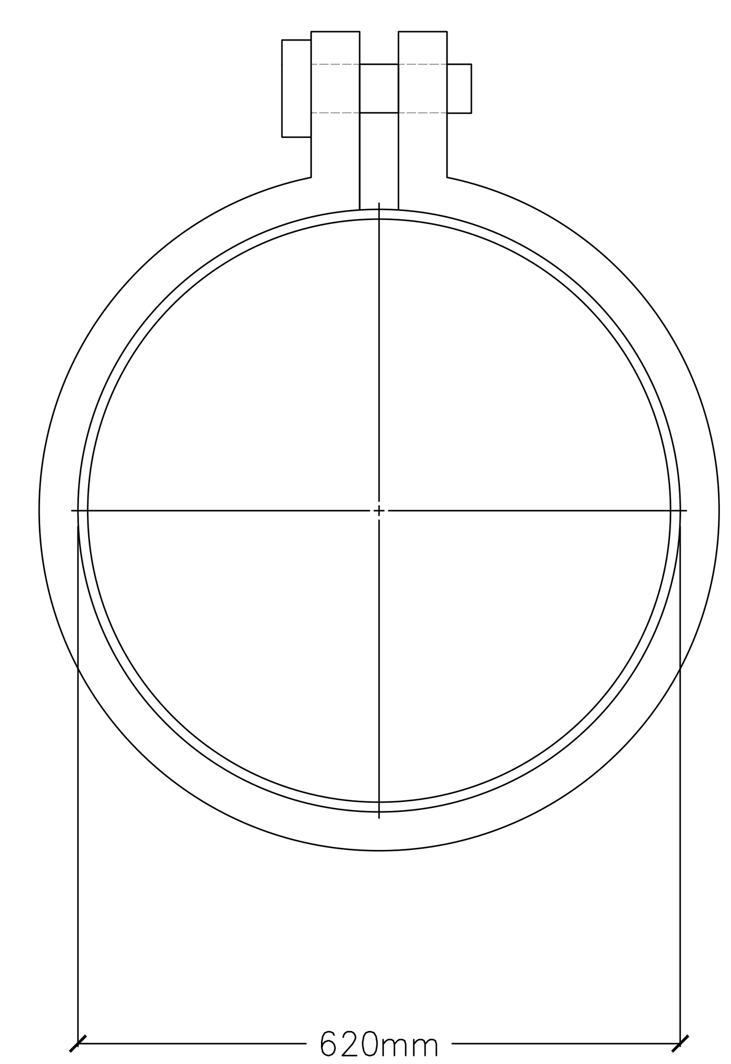


STORAGE TANK TOP VIEW



CONNECTION PIPE X-SECTION



DRAINAGE PIPE X-SECTION

NOTE : WALL THICKNESS 20mm
50mm DIA SCREW
CLAMP @ 15m O.C.

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DRAWN : J. ANGUSTIA
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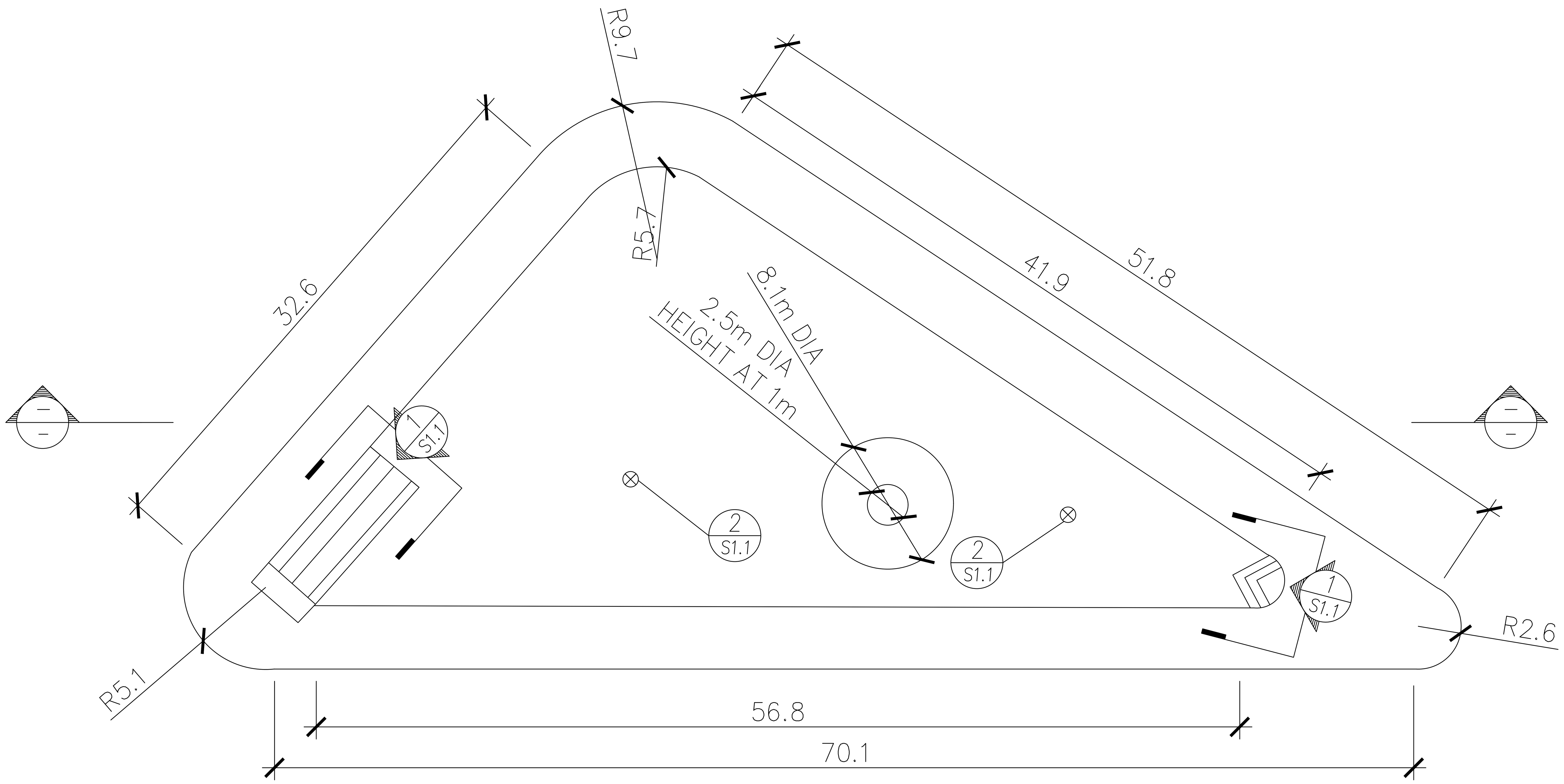
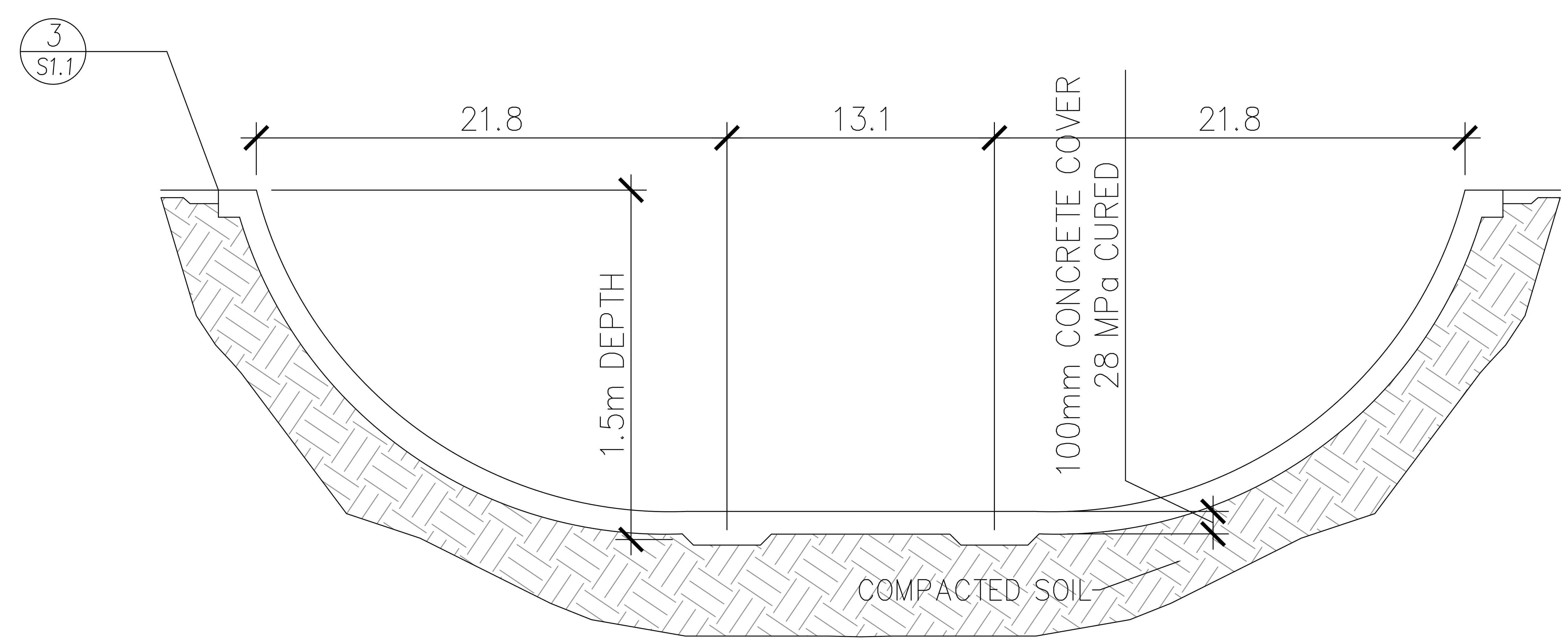
DATE :

PIPE SYSTEM

DRAWING NO. 19.04.02.S04.1
SHEET 4 OF 8
BP SUB________



PLAN VIEW



SECTION VIEW

NOTE : THE SECTION MARKS SHOWN

ON THIS DRAWING ARE TYPICAL SECTIONS AND APPLY TO ALL CONDITIONS OF A SIMILAR NATURE

THE UNDERSIGNED HEREBY GIVES ASSURANCE THAT THE DESIGN OF THE STRUCTURES HAS BEEN REVIEWED FOR RESISTANCE TO ALL TYPES OF LOADING AND HAS BEEN FOUND TO SUBSTANTIALLY COMPLY WITH APPLICABLE CODES AND REGULATIONS.

JASON A. CIVL 446
DATE : APRIL 2, 2019

REV.	BY:	CH:	DATE	REVISIONS
			MARCH 25, 19	ISSUED FOR SUBMISSION
1.0	CT	CT	MARCH 25, 19	ISSUED FOR COSTRUCTION

PROJECT NUMBER: 2019.04.02
SCALE: AS SHOWN

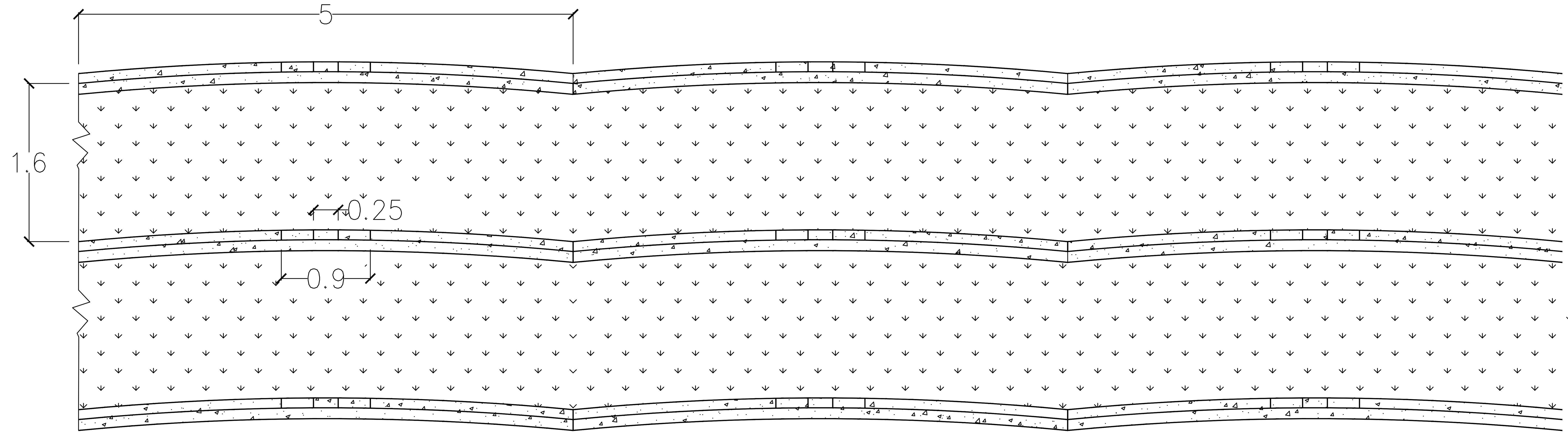
CLIENT: UBC SEEDS AND P.ENG DOUG DOYLE
PROJECT: UBC STORMWATER MGMT AND PARKING VANCOUVER B.C.

SC SIKSIN CONSULTANTS LTD.
ADDRESS
email : ...
Phone: ... Fax: ...

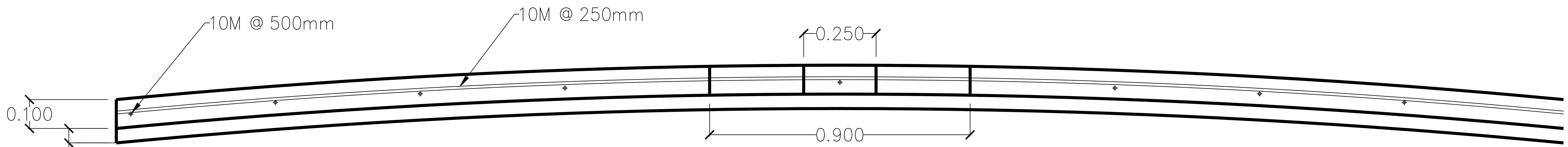
DRAWN : J. ANGUSTIA
DATE : SEPT 28, 19
DESIGNED : TEAM 24
DATE :
APPROVED\CHECKED :
DATE :

SKATEPARK

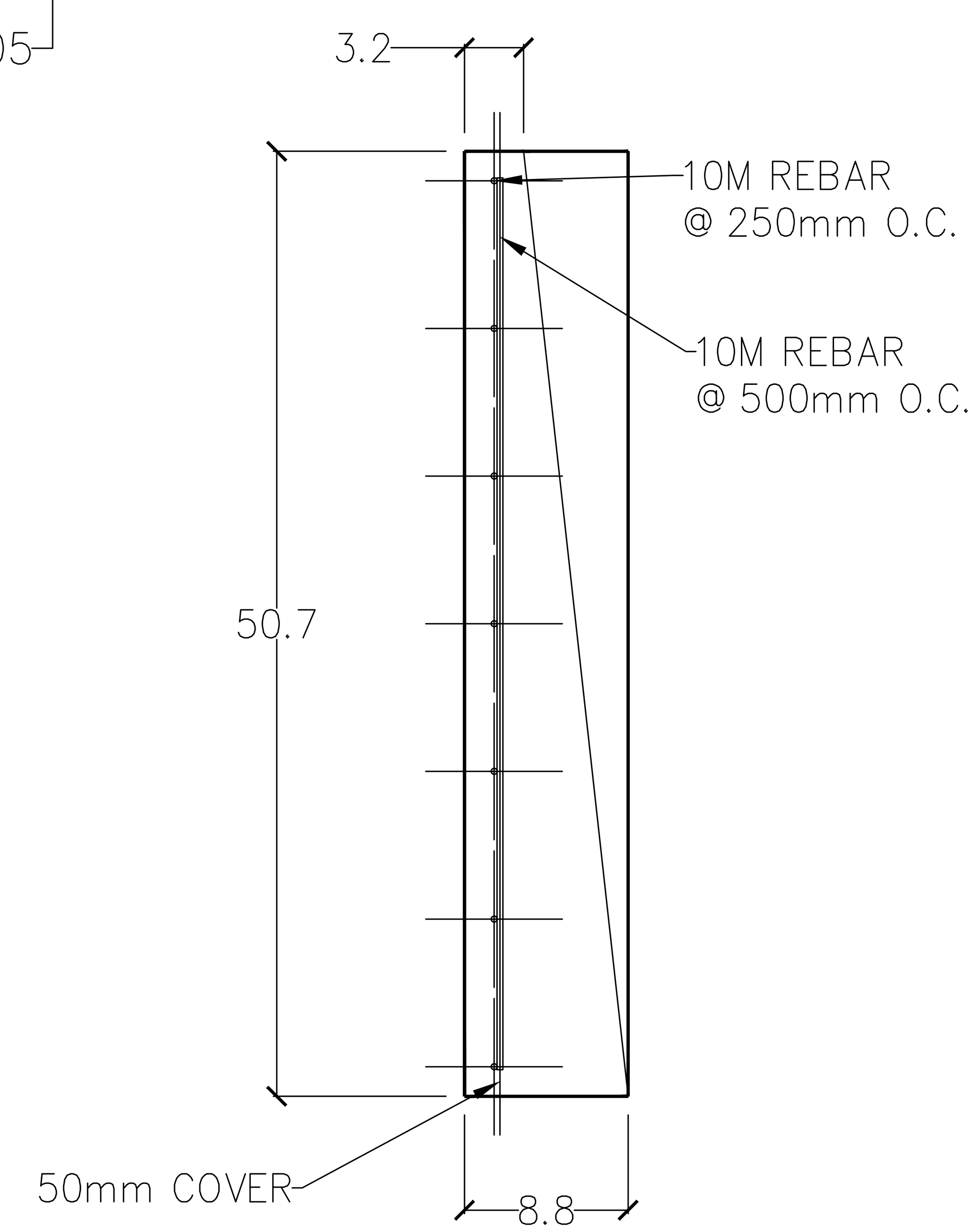
DRAWING NO. 19.04.02.S05.1
SHEET 5 OF 8
BP SUB________



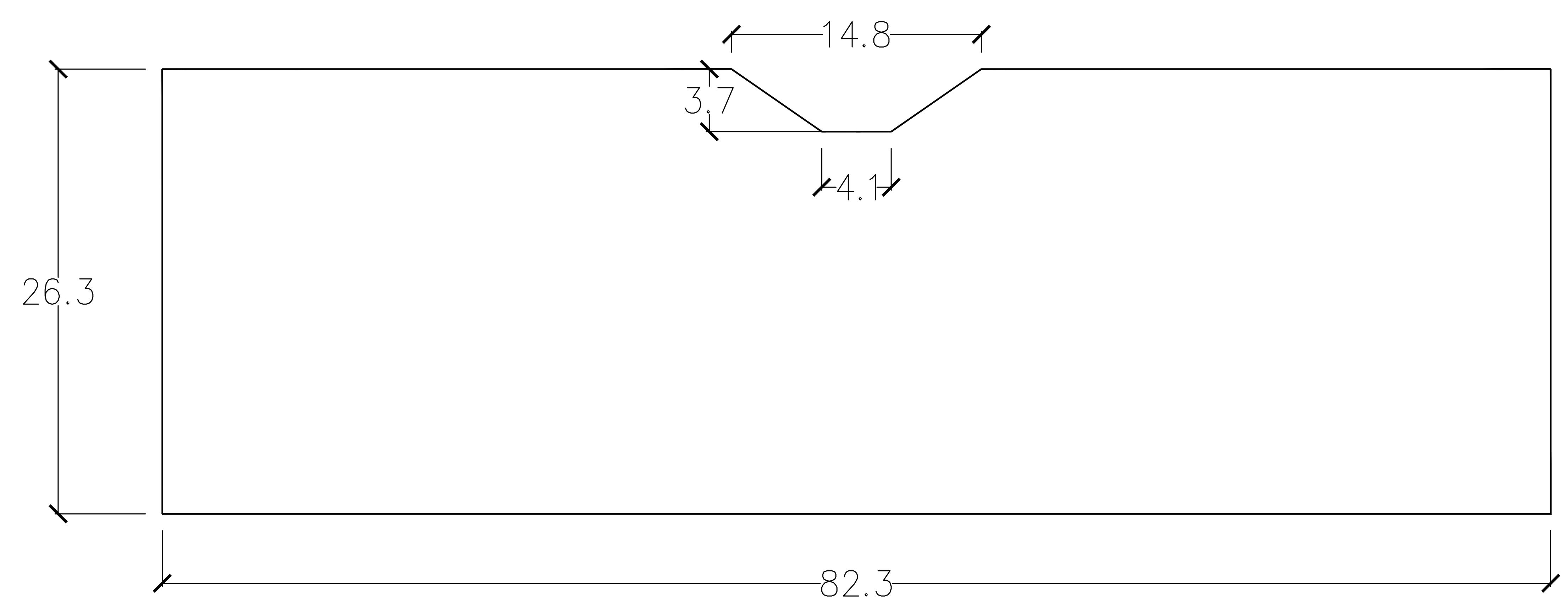
TOP VIEW OF BIOSWALE



CHECK DAM TOP



CHECK DAM SIDE VIEW



CHECK DAM SIDE FRONT VIEW

THE UNDERSIGNED HEREBY GIVES ASSURANCE THAT THE DESIGN OF THE STRUCTURES HAS BEEN REVIEWED FOR RESISTANCE TO ALL TYPES OF LOADING AND HAS BEEN FOUND TO SUBSTANTIALLY COMPLY WITH APPLICABLE CODES AND REGULATIONS.

JASON A. CIVL 446
DATE : APRIL 2, 2019

REV.	BY:	CH:	DATE	REVISIONS
			MARCH 25, 19	ISSUED FOR SUBMISSION
1.0	CT	CT	MARCH 25, 19	ISSUED FOR COSTRUCTION

PROJECT NUMBER: 2019.04.02
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CLIENT: UBC SEEDS AND P.ENG DOUG DOYLE
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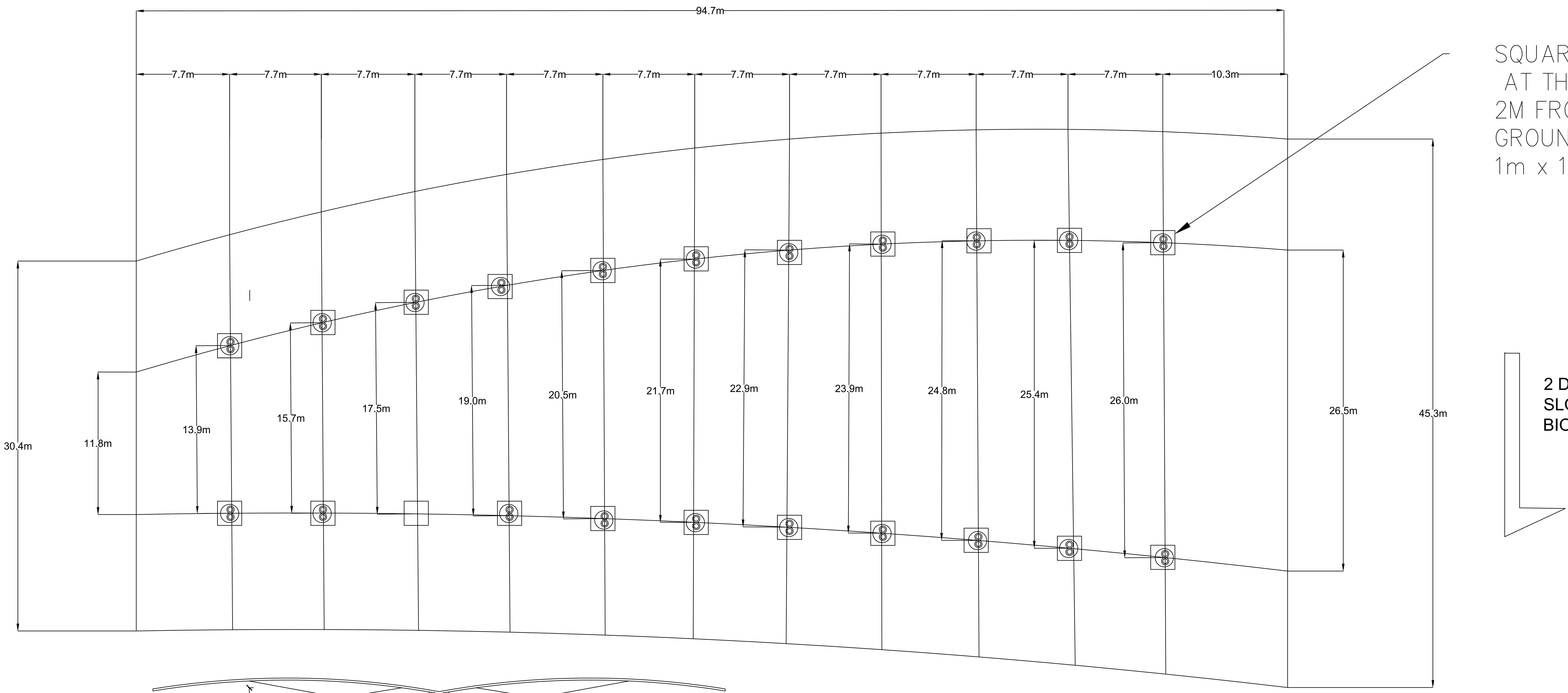
SC SIKSIN CONSULTANTS LTD.
ADDRESS
email : ...
Phone: ... Fax: ...

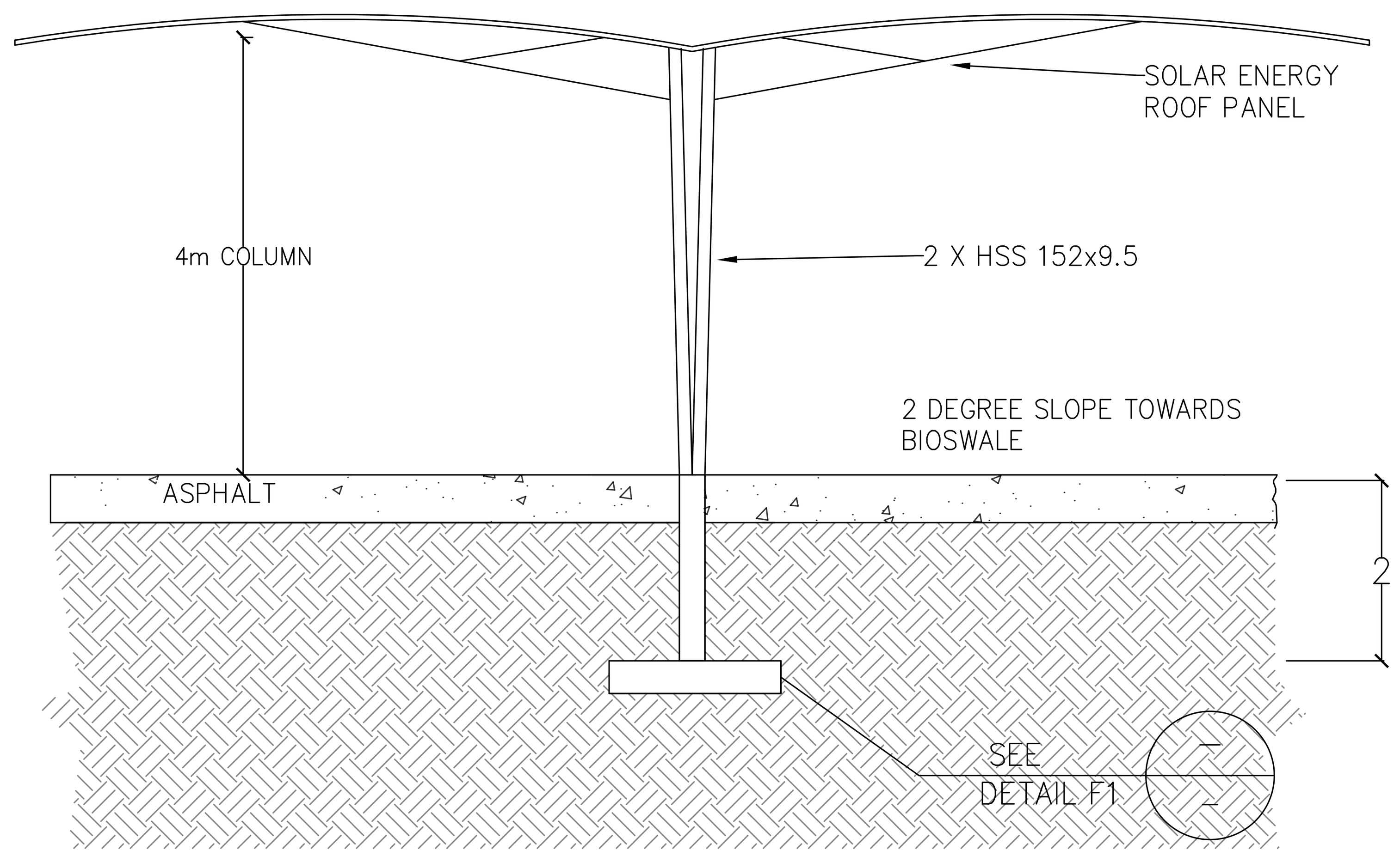
DRAWN : J. ANGUSTIA
DATE : SEPT 28, 19
DESIGNED : TEAM 24
DATE :
APPROVED\CHECKED :
DATE :

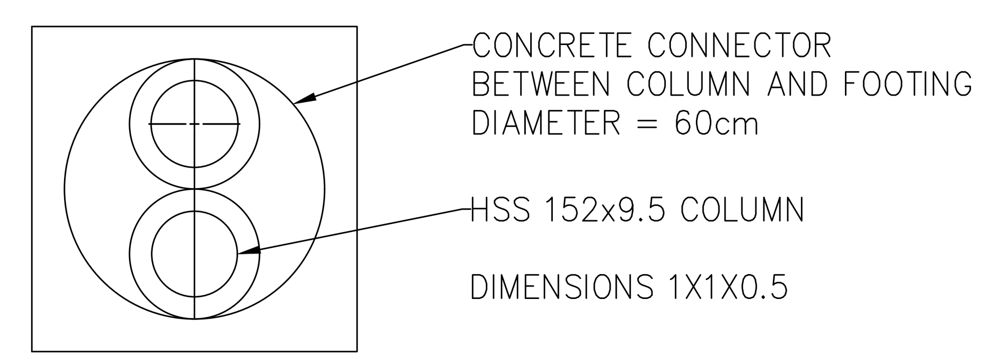
BIOSWALE

DRAWING NO. 19.04.02.S06.1
SHEET 6 OF 8
BP SUB_______

PRODUCED BY AN AUTODESK STUDENT VERSION







DETAIL — FOOTING F1

SCALE: 1"=1'-0"

SECTION

SCALE: 1"=1'-0"

NOTE:
1. CONCRETE CONNECTION BETWEEN COLUMN AND FOOTING.
2. SOLAR PANEL ROOF TO REQUIRE MATERIALS CONSULTANT

THE UNDERSIGNED HEREBY GIVES ASSURANCE THAT THE DESIGN OF THE STRUCTURES HAS BEEN REVIEWED FOR RESISTANCE TO ALL TYPES OF LOADING AND HAS BEEN FOUND TO SUBSTANTIALLY COMPLY WITH APPLICABLE CODES AND REGULATIONS.

JASON A. CIVL 446
DATE : APRIL 2, 2019

REV.	BY:	CH:	DATE	REVISIONS
			MARCH 25, 19	ISSUED FOR SUBMISSION
1.0	CT	CT	MARCH 25, 19	ISSUED FOR COSTRUCTION

PROJECT NUMBER: 2019.04.02

SCALE: AS SHOWN

CLIENT: UBC SEEDS AND P.ENG DOUG DOYLE

PROJECT: UBC STORMWATER MGMT AND PARKING VANCOUVER B.C.

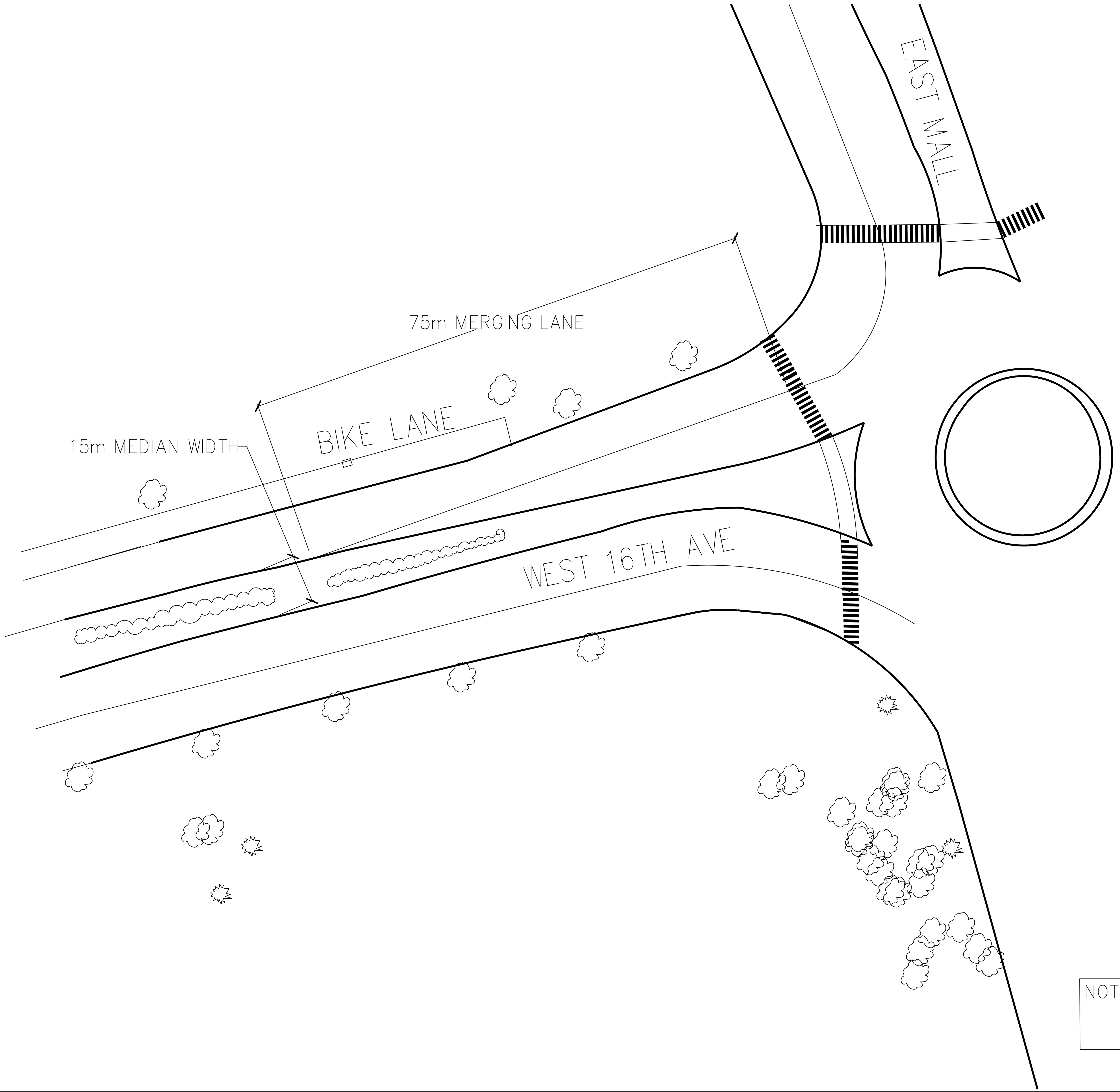
SC SIKSIN CONSULTANTS LTD.
ADDRESS
email : ...
Phone: ...
Fax: ...

DRAWN : J. ANGUSTIA
DATE : SEPT 28, 19
DESIGNED : TEAM 24
DATE :
APPROVED\CHECKED :
DATE :

PARKING LOT

DRAWING NO. 19.04.02.S07.1
SHEET 7 OF 8
BP SUB_______

PRODUCED BY AN AUTODESK STUDENT VERSION



NOTE : GOVERNMENT TO ADJUST TO FIT AS DEEMED NECESSARY

THE UNDERSIGNED HEREBY GIVES ASSURANCE THAT THE DESIGN OF THE STRUCTURES HAS BEEN REVIEWED FOR RESISTANCE TO ALL TYPES OF LOADING AND HAS BEEN FOUND TO SUBSTANTIALLY COMPLY WITH APPLICABLE CODES AND REGULATIONS.

JASON A. CIVL 446
DATE : APRIL 2, 2019

REV.	BY:	CH:	DATE	REVISIONS
			MARCH 25, 19	ISSUED FOR SUBMISSION
1.0	CT	CT	MARCH 25, 19	ISSUED FOR COSTRUCTION

PROJECT NUMBER: 2019.04.02

SCALE: AS SHOWN

CLIENT: UBC SEEDS AND P.ENG DOUG DOYLE

PROJECT: UBC STORMWATER MGMT AND PARKING VANCOUVER B.C.

SC SIKSIN CONSULTANTS LTD.
ADDRESS
email : ...
Phone: ... Fax: ...

DRAWN : J. ANGUSTIA
DATE : SEPT 28, 19
DESIGNED : TEAM 24
DATE :
APPROVED\CHECKED :
DATE :

WEST 16TH ADJUSTMENT

DRAWING NO. 19.04.02.S08.1
SHEET 8 OF 8
BP SUB________

PRODUCED BY AN AUTODESK STUDENT VERSION
PRODUCED BY AN AUTODESK STUDENT VERSION
PRODUCED BY AN AUTODESK STUDENT VERSION

APPENDIX B. Sample Calculations

B.1. Car Parkade

1. Load calculation

1.1 Dead load

a. Solar panel, including solar photovoltaics (PV) = 9 kg/m^2

9 kg/m^2 x3024.748 m^2 = 27222.7kg

27222.7kg X9.81 m/s^2 / 1000 = 267.1 kN

b. Factor of safety to account rest of the roofing system = 5.0

c. Total dead load = 267.1 X5 = **1335.5 kN**

Therefore, 1335.5 kN / 3024.748 m^2 = **4.42 kPa**

1.2 Lateral earthquake design force, V

a. Fundamental period, Ta = 0.085 * (height of column, 4m) ^(3/4) = 0.24

b. S(Ta) = 0. 885 where latitude: 49.253605 and longitude: -123. 247704

2015 National Building Code interpolated seismic hazard values

Spectral (Sa(T), where T is in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. NBCC2015 and S14 values are specified in bold font. Three additional periods are provided – their use is discussed in the NBCC2015 Commentary.

2%/50 years (0.000404 per annum) probability

Sa(0.05)	Sa(0.1)	Sa(0.2)	Sa(0.3)	Sa(0.5)	Sa(1.0)	Sa(2.0)	Sa(5.0)	Sa(10.0)	PGA	PGV
0.468	0.713	**0.881**	0.888	**0.787**	**0.442**	**0.266**	**0.083**	**0.030**	**0.382**	**0.576**

c. Importance factor, Ie: 1.0, Mv:1.0, Rd:1 and Ro:1

d. Therefore, V = S(Ta)*Mv* Ie* W /(Rd * Ro) = 0. 1593 kPa where W = 4.42 kPa

1.3. Load combination

According to NBCC load cases, the governing load case is as follows:

load case1: 1.4× D = 1.4×4.42 = 6.19 kPa

2. Design of column

a. Tributary area for each column = 3024.748m^2 / 36 columns = 84 m^2

b. Compression capacity (HSS 152 ×9.5)
Cr= ∅×A×Fy× 1+2n-1n

where r=I/A=11×106/4280=50.69

Fe=2×E(KLr)^2=319

λ= 350/319=1.04

∅:0.9 and Fy=350 MPa

Therefore, **Cr = 772 kN**

3. Foundation Design

The foundation is determined as 1m×1m square footing at depth of 2m from the local ground surface.

By according to Terzaghi's shallow footing equation, qult= 'D×Nq+0.4 'B Nr

where Nq=22.5 and Nr 22.1 for friction angle of sand, ∅'= 30 (fSilty sand)

Therefore, q.ult= 'D×Nq+0.4 'B Nr=32kPa × 22.5+0.4 × 6kNm3×1m ×22.1=773 kPa

Finally, q. allowable = q. ultF.O.S=1.5 = **515 kPa**

B.2. Hydrotechncial Design

1. 10-yearstrom event analysis

			10-yr (12hr)					10yr-(3hr)				
Name of Subcatchment	Area (hect)	Area(m2)	Ci	Ci*Ai (m^2)	C (10yr)	Intensity I (m/h)	Q(m^3/h)	Ci	Ci*A (m^2)	C	Intensity I (m/h)	Q(m^3/h)
C-L5D-NW177	1.378	13780	0.585	8061				0.649	8943			
C-L4D-NW176	0.276	2760	0.713	1968				0.759	2095			
C-N5D-SW0D10	2.056	20560	0.55	11308				0.62	12747			
C-N4D-SWOD7	1.18	11800	0.459	5416	0.59	0.006	284	0.543	6407	0.66	0.0085	445
C-JUNC-26	0.598	5980	0.503	3008				0.581	3474			
C-M4D-SW191F(Stadium)	2.475	24750	0.711	17597				0.757	18736			
	Summation	79630		47359					52403			

Therefore, retention size for daily operation (10-yr event) capacity = 445 m^3/h * 3 hr (duration) = 850 m^3

2. Pipe diameter calculation

2.1 Calculate the Flow required to discharge stale water in 7 days (Qr)

Maximum volume of 100-year storm = 4000 m^3

Qr=4000m^3 * 1000L/m^3 / 7d / 24hr/d / 3600s/hr = 6.61 L/s

2.2 Calculate Flow Rate (Qc) in the collection pipe for different pipe diameter (d)

Average elevation head difference = 3m

Equivalent length = 250m

Hazen-Williams Coefficient for HDPE pipe = 140

Set diameter d=400mm=0.4m

Flow of stale water and water in the storage tank =0

Pressure of stale water and water in the storage tank=0

Combining Bernoulli equation and Hazen-Williams equation:

$Z1+P2/(\gamma g)+V1^2/(2g)=Z2+P2/(\gamma g)+V2^2/(2g)+HL$

$Z1+0+0=0+0+0+HL$

$3m=10.67* (V2 * \pi * 0.4^2 / 4)^{1.852} * 250m / (140)^{1.852} / (0.4)^{4.8704}$

$V2=2.56$ m/s

$Qc=V2 * V2 * \pi * 0.4^2 / 4$

$Qc=3.22L/s < Qr$

The flow rate in 400mm pipe is 3.22 L/s, less than required flow rate of 6.61 L/s; as a result, try larger pipe diameter, set d=600mm.

$Z1+P2/(\gamma g)+V1^2/(2g)=Z2+P2/(\gamma g)+V2^2/(2g)+HL$

$Z1+0+0=0+0+0+HL$

$Z1=HL$

$3m=10.67* (V2 * \pi * 0.5^2 / 4)^{1.852} * 250m / (140)^{1.852} / (0.5)^{4.8704}$

$V2=3.30$ m/s

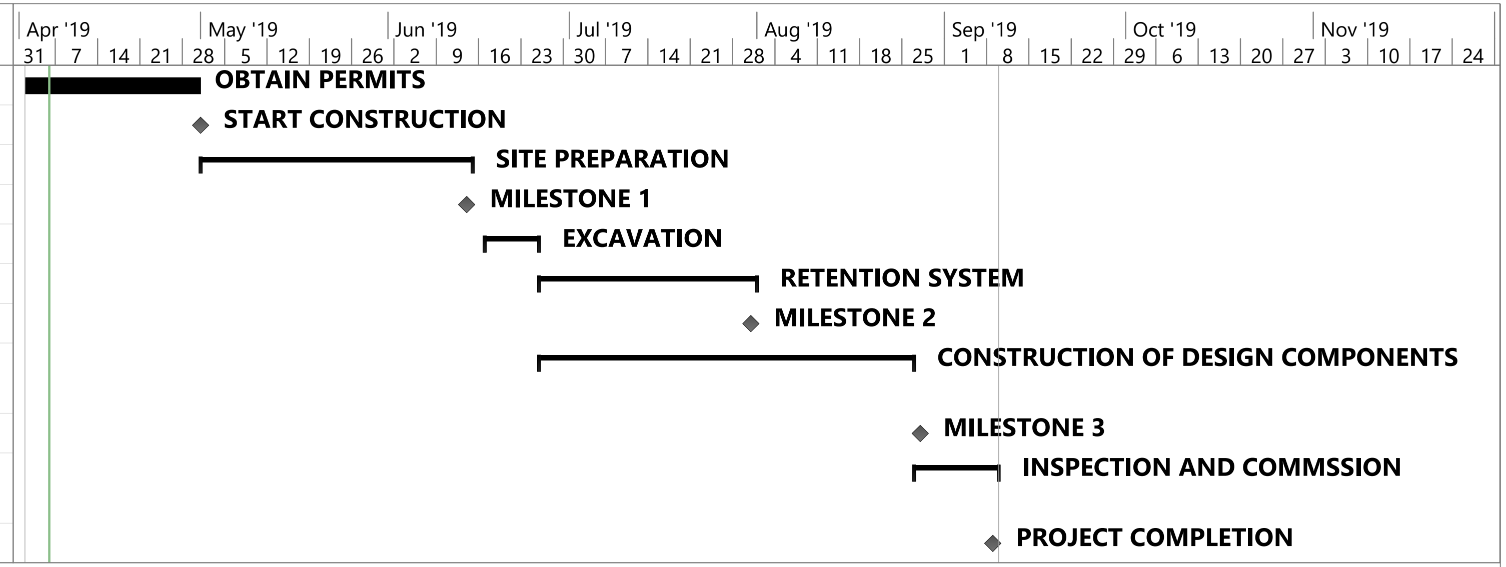
$Qc=V2 * V2 * \pi * 0.5^2 / 4$

$Qc=9.33L/s >Qr$

The flow rate in 600mm pipe is 9.33 L/s, greater than required flow rate of 6.61 L/s; also, 600mm is a reasonable pipe diameter for water collection, then the 600mm diameter pipe is used.

APPENDIX C. Scheduling

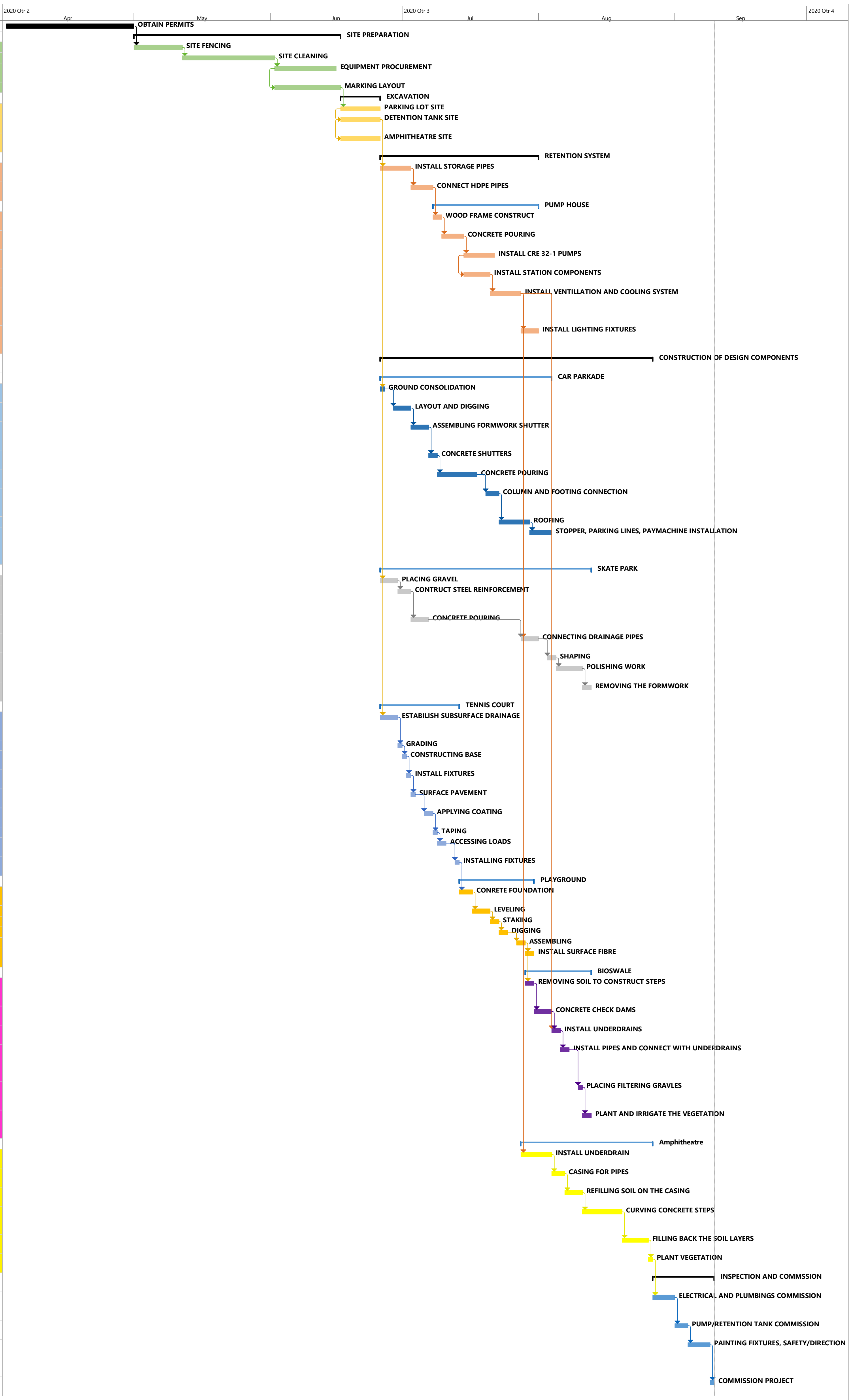
ID	Task Name	Duration	Start	Finish
1	OBTAIN PERMITS	21 days	Tue 4/2/19	Tue 4/30/19
2	START CONSTRUCTION	0 days	Wed 5/1/19	Wed 5/1/19
3	**SITE PREPARATION**	**33 days**	**Wed 5/1/19**	**Fri 6/14/19**
8	MILESTONE 1	0 days	Fri 6/14/19	Fri 6/14/19
9	**EXCAVATION**	**7 days**	**Mon 6/17/19**	**Tue 6/25/19**
13	**RETENTION SYSTEM**	**26 days**	**Wed 6/26/19**	**Wed 7/31/19**
23	MILESTONE 2	0 days	Wed 7/31/19	Wed 7/31/19
24	**CONSTRUCTION OF DESIGN COMPONENTS**	**44 days**	**Wed 6/26/19**	**Mon 8/26/19**
73	MILESTONE 3	0 days	Wed 8/28/19	Wed 8/28/19
74	**INSPECTION AND COMMSSION**	**10 days**	**Tue 8/27/19**	**Mon 9/9/19**
79	PROJECT COMPLETION	0 days	Mon 9/9/19	Mon 9/9/19



Project: 446 project
Date: Sat 4/6/19

- Task
- Split
- Milestone
- Summary
- Project Summary
- Inactive Task
- Inactive Milestone
- Inactive Summary
- Manual Task
- Duration-only
- Manual Summary Rollup
- Manual Summary
- Start-only
- Finish-only
- External Tasks
- External Milestone
- Deadline
- Path Predecessor Milestone Task
- Path Predecessor Summary Task
- Path Predecessor Normal Task
- Path Driving Predecessor Milestone Task
- Path Driving Predecessor Summary Task
- Path Driving Predecessor Normal Task
- Baseline
- Baseline Milestone
- Baseline Summary
- Progress
- Manual Progress

ID		Task Mode	Task Name	Duration	Start	Finish
1			OBTAIN PERMITS	21 days	Thu 20-04-02	Thu 20-04-30
2			**SITE PREPARATION**	**33 days**	**Fri 20-05-01**	**Tue 20-06-16**
3			SITE FENCING	7 days	Fri 20-05-01	Mon 20-05-11
4			SITE CLEANING	15 days	Tue 20-05-12	Mon 20-06-01
5			EQUIPMENT PROCUREMENT	10 days	Tue 20-06-02	Mon 20-06-15
6			MARKING LAYOUT	11 days	Tue 20-06-02	Tue 20-06-16
7			**EXCAVATION**	**7 days**	**Wed 20-06-17**	**Thu 20-06-25**
8			PARKING LOT SITE	7 days	Wed 20-06-17	Thu 20-06-25
9			DETENTION TANK SITE	7 days	Wed 20-06-17	Thu 20-06-25
10			AMPHITHEATRE SITE	7 days	Wed 20-06-17	Thu 20-06-25
11			**RETENTION SYSTEM**	**26 days**	**Fri 20-06-26**	**Fri 20-07-31**
12			INSTALL STORAGE PIPES	5 days	Fri 20-06-26	Thu 20-07-02
13			CONNECT HDPE PIPES	3 days	Fri 20-07-03	Tue 20-07-07
14			**PUMP HOUSE**	**18 days**	**Wed 20-07-08**	**Fri 20-07-31**
15			WOOD FRAME CONSTRUCT	2 days	Wed 20-07-08	Thu 20-07-09
16			CONCRETE POURING	3 days	Fri 20-07-10	Tue 20-07-14
17			INSTALL CRE 32-1 PUMPS	5 days	Wed 20-07-15	Tue 20-07-21
18			INSTALL STATION COMPONENTS	4 days	Wed 20-07-15	Mon 20-07-20
19			INSTALL VENTILLATION AND COOLING SYSTEM	5 days	Tue 20-07-21	Mon 20-07-27
20			INSTALL LIGHTING FIXTURES	4 days	Tue 20-07-28	Fri 20-07-31
21			**CONSTRUCTION OF DESIGN COMPONENTS**	**44 days**	**Fri 20-06-26**	**Wed 20-08-26**
22			**CAR PARKADE**	**27 days**	**Fri 20-06-26**	**Mon 20-08-03**
23			GROUND CONSOLIDATION	1 day	Fri 20-06-26	Fri 20-06-26
24			LAYOUT AND DIGGING	4 days	Mon 20-06-29	Thu 20-07-02
25			ASSEMBLING FORMWORK SHUTTER	2 days	Fri 20-07-03	Mon 20-07-06
26			CONCRETE SHUTTERS	2 days	Tue 20-07-07	Wed 20-07-08
27			CONCRETE POURING	7 days	Thu 20-07-09	Fri 20-07-17
28			COLUMN AND FOOTING CONNECTION	3 days	Mon 20-07-20	Wed 20-07-22
29			ROOFING	5 days	Thu 20-07-23	Wed 20-07-29
30			STOPPER, PARKING LINES, PAYMACHINE INSTALLATION	3 days	Thu 20-07-30	Mon 20-08-03
31			**SKATE PARK**	**34 days**	**Fri 20-06-26**	**Wed 20-08-12**
32			PLACING GRAVEL	2 days	Fri 20-06-26	Mon 20-06-29
33			CONTRUCT STEEL REINFORCEMENT	3 days	Tue 20-06-30	Thu 20-07-02
34			CONCRETE POURING	2 days	Fri 20-07-03	Mon 20-07-06
35			CONNECTING DRAINAGE PIPES	4 days	Tue 20-07-28	Fri 20-07-31
36			SHAPING	2 days	Mon 20-08-03	Tue 20-08-04
37			POLISHING WORK	4 days	Wed 20-08-05	Mon 20-08-10
38			REMOVING THE FORMWORK	2 days	Tue 20-08-11	Wed 20-08-12
39			**TENNIS COURT**	**12 days**	**Fri 20-06-26**	**Mon 20-07-13**
40			ESTABILISH SUBSURFACE DRAINAGE	2 days	Fri 20-06-26	Mon 20-06-29
41			GRADING	1 day	Tue 20-06-30	Tue 20-06-30
42			CONSTRUCTING BASE	1 day	Wed 20-07-01	Wed 20-07-01
43			INSTALL FIXTURES	1 day	Thu 20-07-02	Thu 20-07-02
44			SURFACE PAVEMENT	1 day	Fri 20-07-03	Fri 20-07-03
45			APPLYING COATING	2 days	Mon 20-07-06	Tue 20-07-07
46			TAPING	1 day	Wed 20-07-08	Wed 20-07-08
47			ACCESSING LOADS	2 days	Thu 20-07-09	Fri 20-07-10
48			INSTALLING FIXTURES	1 day	Mon 20-07-13	Mon 20-07-13
49			**PLAYGROUND**	**13 days**	**Tue 20-07-14**	**Thu 20-07-30**
50			CONRETE FOUNDATION	3 days	Tue 20-07-14	Thu 20-07-16
51			LEVELING	2 days	Fri 20-07-17	Mon 20-07-20
52			STAKING	2 days	Tue 20-07-21	Wed 20-07-22
53			DIGGING	2 days	Thu 20-07-23	Fri 20-07-24
54			ASSEMBLING	2 days	Mon 20-07-27	Tue 20-07-28
55			INSTALL SURFACE FIBRE	2 days	Wed 20-07-29	Thu 20-07-30
56			**BIOSWALE**	**11 days**	**Wed 20-07-29**	**Wed 20-08-12**
57			REMOVING SOIL TO CONSTRUCT STEPS	2 days	Wed 20-07-29	Thu 20-07-30
58			CONCRETE CHECK DAMS	2 days	Fri 20-07-31	Mon 20-08-03
59			INSTALL UNDERDRAINS	2 days	Tue 20-08-04	Wed 20-08-05
60			INSTALL PIPES AND CONNECT WITH UNDERDRAINS	2 days	Thu 20-08-06	Fri 20-08-07
61			PLACING FILTERING GRAVLES	1 day	Mon 20-08-10	Mon 20-08-10
62			PLANT AND IRRIGATE THE VEGETATION	2 days	Tue 20-08-11	Wed 20-08-12
63			**Amphitheatre**	**22 days**	**Tue 20-07-28**	**Wed 20-08-26**
64			INSTALL UNDERDRAIN	5 days	Tue 20-07-28	Mon 20-08-03
65			CASING FOR PIPES	3 days	Tue 20-08-04	Thu 20-08-06
66			REFILLING SOIL ON THE CASING	2 days	Fri 20-08-07	Mon 20-08-10
67			CURVING CONCRETE STEPS	7 days	Tue 20-08-11	Wed 20-08-19
68			FILLING BACK THE SOIL LAYERS	4 days	Thu 20-08-20	Tue 20-08-25
69			PLANT VEGETATION	1 day	Wed 20-08-26	Wed 20-08-26
70			**INSPECTION AND COMMSSION**	**10 days**	**Thu 20-08-27**	**Wed 20-09-09**
71			ELECTRICAL AND PLUMBINGS COMMISSION	3 days	Thu 20-08-27	Mon 20-08-31
72			PUMP/RETENTION TANK COMMISSION	3 days	Tue 20-09-01	Thu 20-09-03
73			PAINTING FIXTURES, SAFETY/DIRECTION SIGNS	3 days	Fri 20-09-04	Tue 20-09-08
74			COMMISSION PROJECT	1 day	Wed 20-09-09	Wed 20-09-09



Project: 446 project
Date: Fri 19-04-05

Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Path Predecessor Milestone Task
Path Predecessor Summary Task
Path Predecessor Normal Task
Path Driving Predecessor Milestone Task
Path Driving Predecessor Summary Task
Path Driving Predecessor Normal Task
Baseline
Baseline Milestone
Baseline Summary
Progress
Manual Progress

ID	Task Mode	Task Name	Duration	Start	Finish
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14		**PUMP HOUSE**	**18 days**	**Wed 20-07-08**	**Fri 20-07-31**
15		WOOD FRAME CONSTRUCT	2 days	Wed 20-07-08	Thu 20-07-09
16		CONCRETE POURING	3 days	Fri 20-07-10	Tue 20-07-14
17		INSTALL CRE 32-1 PUMPS	5 days	Wed 20-07-15	Tue 20-07-21
18		INSTALL STATION COMPONENTS	4 days	Wed 20-07-15	Mon 20-07-20
19		INSTALL VENTILLATION AND COOLING SYSTEM	5 days	Tue 20-07-21	Mon 20-07-27
21		**CONSTRUCTION OF DESIGN COMPONENTS**	**44 days**	**Fri 20-06-26**	**Wed 20-08-26**
63		**Amphitheatre**	**22 days**	**Tue 20-07-28**	**Wed 20-08-26**
64		INSTALL UNDERDRAIN	5 days	Tue 20-07-28	Mon 20-08-03
65		CASING FOR PIPES	3 days	Tue 20-08-04	Thu 20-08-06
66		REFILLING SOIL ON THE CASING	2 days	Fri 20-08-07	Mon 20-08-10
67		CURVING CONCRETE STEPS	7 days	Tue 20-08-11	Wed 20-08-19
68		FILLING BACK THE SOIL LAYERS	4 days	Thu 20-08-20	Tue 20-08-25
69		PLANT VEGETATION	1 day	Wed 20-08-26	Wed 20-08-26
70		**INSPECTION AND COMMSSION**	**10 days**	**Thu 20-08-27**	**Wed 20-09-09**
71		ELECTRICAL AND PLUMBINGS COMMISSION	3 days	Thu 20-08-27	Mon 20-08-31
72		PUMP/RETENTION TANK COMMISSION	3 days	Tue 20-09-01	Thu 20-09-03
73		PAINTING FIXTURES, SAFETY/DIRECTION SIGNS	3 days	Fri 20-09-04	Tue 20-09-08
74		COMMISSION PROJECT	1 day	Wed 20-09-09	Wed 20-09-09

Project: 446 project
Date: Fri 19-04-05

Task, Split, Milestone, Summary, Project Summary, Inactive Task, Inactive Milestone, Inactive Summary, Manual Task, Duration-only, Manual Summary Rollup, Manual Summary, Start-only, Finish-only, External Tasks, External Milestone, Deadline, Path Predecessor Milestone Task, Path Predecessor Summary Task, Path Predecessor Normal Task, Path Driving Predecessor Milestone Task, Path Driving Predecessor Summary Task, Path Driving Predecessor Normal Task, Baseline, Baseline Milestone, Baseline Summary, Progress, Manual Progress

APPENDIX D. Cost Estimation

Item	Description	Unit	Estimated Quantity	Unit Rate	TOTAL COST ($)	Comment
1	**Site Preparation**					
1.01	Excavation	cu.m	8,250	177	1,459,838	Excavation area 75mx55mx2m
1.02	Compaction	hr	16	60	960	$60.00 per hour compaction
1.03	Preparation	lm	800	23	18,400	Safety fences rent, etc.
	SUBTOTAL FOR TASK				**1,479,198**	
2	**Parkade**					
2.01	Poofing	sq.m	3,025	243	735,075	Solar photovoltaics panels
2.02	Column	lm	144	118	16,992	36 colums in 4m height, HSS 152*9.5
2.03	Floor	sq.m	3025	20	59,532	Permeable porous asphalt
2.04	Foundation	each	36	89	3,200	36 - 1m*1m square footing at 2m depth
2.05	Storm Drains	lm	93	222	20,646	collect stormwater to the detention tanks along the edge of the road (including filter)
	SUBTOTAL FOR TASK				**835,445**	
3	**Bioswale**					
3.01	Check dam	cu.m	48	218	10,464	4 of Concrete check dams: 0.15x50x1.6
3.02	Growing medium	cu.m	100	42	4,180	5x50x0.4
3.03	Sand	cu.m	25	15	380	5x50x0.1
3.04	Pea gravel	cu.m	25	26	650	5x50x0.1
3.05	Drain rock	cu.m	188	26	4,888	5x50x0.75
	SUBTOTAL FOR TASK				**20,562**	
4	**SkatePark**					
4.01	Flooring	cu.m	1,250	218	272,500	Skatepark flooring Volume
4.02	1 Skatepark Island Concrete	cu.m	0.56	218	122	.75mx.5mx1.5m
4.03	Rebar usage	kg	6418	0.661	4,244	
	SUBTOTAL FOR TASK				**276,866**	
5	**Basin**					
5.01	Concrete step	cu.m	64	218	13,843	Concrete side walls to create a stair-case like 'structure for aesthetic purposes.1m x 0.5m x127m
	SUBTOTAL FOR TASK				**13,843**	
6	**Detention and retenstionion system**					
6.01	Storage Pipes	lm	270	550	148,500	HDPE Length 45m dia 2M
6.02	Collection Pipes	lm	250	271	67,750	HDPE D600mm (including clumping)
6.03	Drainage Pipes	lm	210	271	56,910	HDPE D600mm (including clumping)
6.04	Connection	each	7	50	350	HDPE D600mm
6.05	Supply Pipes	lm	160	60	9,600	HDPE D250mm (including clumping)
6.06	Pump	each	1	800	800	CRE 32-1pressure boosting pump
6.07	UV disinfection system	each	1	440	440	VIQUA S8Q-PA
	SUBTOTAL FOR TASK				**284,350**	
7	**Playground**					
7.01	General Equipment Set	each	1	171,100	171,100	
7.02	Swings	each	6	931	5,586	
	SUBTOTAL FOR TASK				**176,686**	
8	**Tennis court**					
8.01	Flooring	cu.m	420	218	91,560	40m x 75m x0.14m, standard tennis court material
8.02	General Equipment Set	each	6	2,000	12,000	fencing, lights, net, etc
	SUBTOTAL FOR TASK				**103,560**	
9	**Engineering Service Fees**					
9.01	Hydrotechnical Engineering	hr	208	199	41,392	In charge of Hydrotechnical Engineering Service
9.02	Hydrotechnical Engineering	hr	208	162	33,696	Assistant design of detention facility
9.03	Geotechnical Engineering	hr	208	199	41,392	In charge of Geotechnical Engineering Service
9.04	Geotechnical Engineering	hr	208	162	33,696	Assistant design of underground structures
9.05	Structural Engineering	hr	208	227	47,216	Project Managing
9.06	Structural Engineering	hr	208	162	33,696	Assistant design of parkade
9.07	Minor disbursements	%	0.10	189,696	18,970	long distance charges, testing procedure, licensing and extra
	SUBTOTAL FOR TASK				**250,058**	
	CONSTRUCTION COST SUBTOTAL				**3,440,568**	
	Bonding and Insurance	5%			172,028	
	Contingencies	30%			1,032,170	
	TOTAL AMOUNT (excl. GST)				**4,645,000**	